MINERAL COMMODITY SUMMARIES OF THE CZECH REPUBLIC

(STATE TO 2008)

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Ministry of the Environment
Czech Geological Survey – Geofond

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EXPLANATORY NOTES

List of abbreviations, symbols and technical units

AOPK ČR	Agency for Nature Conservation and Landscape Protection (Nature Conservation Authority) of the Czech Republic (Agentura ochrany přírody a krajiny České republiky)
API	American Petroleum Institute
API degrees	Degrees of crude oil specific gravity defined by the API (°API) API gravity formulas: $°\text{API gravity} = \frac{141.5}{\text{SG at } 60°\text{ F}} - 131.5$ $\text{SG at } 60°\text{ F} = \frac{141.5}{°\text{API gravity} + 131.5}$ SG = specific gravity (t/m^3) 60° F = 15,6° C
APT	Ammonium Paratungstate, formula $(NH_4)_{10}[H_2W_{12}O_{42}]\cdot 4H_2O$
ARSM	(Czech) Association for recycling of building materials development (Asociace pro rozvoj recyklace stavebních materiálů)
a. s.	initials after a Czech company name indicate that it is a joint stock company (akciová společnost)
ATPC	Association of Tin Producing Countries
bbl	barrel of crude petroleum, 158.99 dm^3; 1 tonne of crude petroleum is approximately 7 bbl (6.76–7.75 bbl for crude petroleum extracted in the Czech Republic)
bill	billion, 10^9
BP	British Petroleum, British multinational petrochemical company
Btu	British thermal unit, 252 cal, 1,055.06 J
carat	abbreviated as ct – (metric carat), weight unit for gemstones, equal to 0.2 g – unit of gold content (purity) in its alloys equal to 4.167 %; 24 carats = 100 % for fine gold
CBM	Coal Bed Methane
ČBÚ	Czech Mining Office (Český báňský úřad)
ČEZ, a.s.	the biggest Czech producer of electricity
CFR	Cost and Freight (named port of destination)
CHKO	Protected landscape area (Chráněná krajinná oblast)
CHLÚ	Protected deposit area (Chráněné ložiskové území)
CI	Coal Information, mineral (coal) yearbook of the IEA
CIF	Cost, Insurance and Freight (named port of destination)
ČNB	Czech National Bank (Česká národní banka)
ČNR	Czech National Council (Česká národní rada)

COCHILCO	Comisión Chilena del Cobre, Chilean Copper Commission
COREX®	smelting reduction process that allows for the production of hot metal in blast furnace from non-coking coal and ore (concentrate) of various quality
ČR	Czech Republic (Česká republika)
CSK	Czechoslovak Koruna (československá koruna)
ČSÚ	Czech Statistical Office (Český statistický úřad)
CZK	Czech Koruna (česká koruna)
DRI	Direct Reduction of Iron, this method makes iron from high-grade ore without the use of a blast furnace, coke, or limestone
DU	depleted uranium (mostly within the range of 0.2–0.3 % ^{235}U)
e	estimate
ECFIN	Directorate General for Economic and Financial Affairs of the European Commission
ECU	European Currency Unit (European Union's currency before Euro was launched in 1999)
EFTA	European Free Trade Association (members since 1995 Iceland, Lichtenstein, Norway, Switzerland)
EIA	Environmental Impact Assessment
	Energy Information Administration, section of the Department of Energy of the USA providing energy statistics, data, analysis
EIU	Economist Intelligence Unit, world's provider of country, industry and management analysis, based in London
ESA	Euratom Supply Agency, European agency for common supply policy on the principle of regular and equitable supply of nuclear fuels for European Community users
EU	European Union
EU-15	EU members since 1995: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
EU-25	EU members since 2004: EU-15 + Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia
EU-27	EU members since 2007: EU-25 + Bulgaria, Romania
EUR	Euro, currency of Eurozone countries of the European Union
EUROSTAT	Statistical Office of the European Communities (European Union)
EXW	Ex Works (named place)
FAS	Free Alongside Ship (named port of shipment)
FISIM	an abbreviation for financial intermediation services indirectly measured, their income is given by the difference between the interest which they pay to lenders and interest they receive from borrowers for provided loans
FMPE	Federal Ministry of Fuels and Power (Federální ministerstvo paliv a energetiky)
FOB	Free on Board (named port of shipment)
FOL	Free on Lorry (named place) (United Kingdom)

FOT	Free on Truck (named place) (USA)
Ga	billion of years
GBP	British pound (Great Britain pound, pound sterling)
GBp	British pence
GCC	Ground Calcium Carbonate
GDP	Gross Domestic Product
HEU	highly-enriched uranium (above 20 % ^{235}U)
IAEA	International Atomic Energy Agency
ICSG	International Copper Study Group
IEA	International Energy Agency
IISI	International Iron and Steel Institute
ILZSG	International Lead and Zinc Study Group
IMF	International Monetary Fund
IOM	Interoceanmetal Joint Organization
IPE	International Petroleum Exchange (London, UK)
ISL	In Situ Leaching (leaching of U ores in their deposit)
ITRI	International Tin Research Institute
k. s.	initials after a Czech company name indicate that it is a limited partnership company (komanditní společnost)
kt	kilotonne, 1,000 t
lb	pound, 0.4536 kg
LEU	low-enriched uranium (up to 20 % ^{235}U, mostly 3–5 %)
LME	London Metal Exchange
Ma	million of years
MCS	Mineral Commodity Summaries, mineral yearbook of the US Geological Survey
mesh	to designate screen size as the number of openings per linear inch (including screen wire diameter)
Metals Economic Group	a leading worldwide minerals information and consulting company based in Canadian Halifax, founded in 1981
MF	Ministry of Finance (of the Czech Republic) (Ministerstvo financí)
MH ČR	Ministry of Economy of the Czech Republic (Ministerstvo hospodářství České republiky)
MHPR ČR	Ministry of Economic Policy and Development of the Czech Republic (Ministerstvo pro hospodářskou politiku a rozvoj České republiky)
MJ	megajoule, 10^6 J
mill	million, 10^6
MOX	mixed oxide fuel (mixture of plutonium and oxides of uranium from reprocessed burned nuclear fuel, where ^{235}U is replaced by ^{239}Pu as main energy source)
MPO ČR	Ministry of Industry and Trade of the Czech Republic (Ministerstvo průmyslu a obchodu České republiky)

mtu	metric tonne unit, 10 kg, in concentrates (1 % by weight of useful component content in 1 tonne of concentrate or ore purchased by smelter)
MŽP ČR	Ministry of the Environment of the Czech Republic (Ministerstvo životního prostředí České republiky)
N	not available or not reliable data
NP	Natural park (Národní park)
NPP	nuclear power plant
NYMEX	New York Mercantile Exchange
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
PCC	Precipitated Calcium Carbonate
PCE	Pyrometric cone equivalent
PET	Polyethylene Terephthalate, used mainly for manufacture of beverage bottles and (mainly) synthetic fibers ("polyester" in textile)
ppm	parts per million, 0.0001 %
PÚ	exploration area (průzkumné území)
Sb.	Collection of Laws (abbreviated as Coll.) of the Czech Republic
s. p.	initials after a Czech company name indicate that it is a state public enterprise (státní podnik)
spol. s r. o.	initials after a Czech company name indicate that it is a limited liability company (společnost s ručením omezeným), ditto initials s. r. o.
s. r. o.	initials after a Czech company name indicate that it is a limited liability company (společnost s ručením omezeným), ditto initials spol. s r.o.
SEU	slightly enriched uranium (0,9–2 % ^{235}U)
st	short ton, 907.2 kg
t	metric tonne, 1,000 kg, 1,000,000 g
ths	thousand, 10^3
troy oz	Troy ounce (t oz), 31.103 g
T/C	Treatment Charge, the amount per tonne of ore or concentrate (Sn, Pb, Zn, Cu, etc.), charged by the smelter for converting ore or concentrate to metal; it is incorporated into price at which the smelter buys 1 % by weight of useful component content in concentrate or ore (mtu)
UEPG	Union Européenne des Producteurs de Granulats, European Aggregate Association
UI	Uranium Institute
UNCTAD	United Nations Conference on Trade and Development
USBM	United States Bureau of Mines (disbanded in 1995–1996)
USD	United States Dollar
USc	United States cent
USGS	United States Geological Survey
VAT	value added tax

v. o. s.	initials after a Czech company name indicate that it is an unlimited company (general partnership) (veřejná obchodní společnost)
WBD	Welt Bergbau Daten (World Mining Data), mineral yearbook of Austrian Federal Ministry for Economy, Family and Youth
WMMR	World Metals & Mineral Review 2007, mineral yearbook of the Metal Bulletin Plc
WMP	World Mineral Production, mineral yearbook of the British Geological Survey since 2005
WMS	World Mineral Statistics, mineral yearbook of the British Geological Survey till 2004
WNA	World Nuclear Association
WOGR	World Oil and Gas Review, mineral (petroleum, natural gas) yearbook of the Italian multinational petrochemical company ENI (Ente Nazionale Idrocarburi) S.p.A.
ZCHÚ	Specially protected area (Zvláště chráněné území)

Exchange and inflation rates of currencies in which minerals are priced

Annual inflation rates in the USA (US), United Kingdom (UK), Euro Area (EUR) and Czech Republic (CZ)

	US	UK	EUR	CZ
1991	4.2	7.4	–	56.6
1992	3.0	4.3	–	11.1
1993	3.0	2.5	–	20.8
1994	2.6	2.1	–	10.0
1995	2.8	2.6	–	9.2
1996	2.9	2.4	–	8.8
1997	2.3	1.8	–	8.4
1998	1.5	1.6	–	10.6
1999	2.2	1.3	1.1	2.3
2000	3.4	0.9	2.1	3.8
2001	2.8	1.2	2.4	4.7
2002	1.6	1.3	2.3	1.8
2003	2.3	1.4	2.1	0.1
2004	2.7	1.3	2.1	2.8
2005	3.4	2.0	2.2	1.8
2006	3.2	2.3	2.2	2.5
2007	2.9	2.3	2.1	2.8
2008	3.8	3.6	3.3	6.3

Notes:

- source – IMF. World Economic Outlook Database. October 2009
- inflation rates based on average annual changes of consumer price indices (index, 2000 = 100)

Average yearly exchange rates of CZK against EUR, USD and GBP

	EUR	USD	GBP
1991	–	29.5	52.0
1992	–	28.3	49.9
1993	–	29.2	43.8
1994	–	28.8	44.0
1995	–	26.5	41.9
1996	–	27.1	42.3
1997	–	31.7	51.9
1998	–	32.3	53.4
1999	36.9	34.6	56.0
2000	35.6	38.6	58.4
2001	34.1	38.0	54.8
2002	30.8	32.7	49.0
2003	31.8	28.2	46.0
2004	31.9	25.7	47.1
2005	29.8	23.9	43.6
2006	28.3	22.6	41.6
2007	27.8	20.3	40.6
2008	24.9	17.0	31.4

Source: Czech National Bank

Mineral reserve and resource classification in the Czech Republic

The Czech classification

After 1948 the reserve classification of the USSR was progressively adopted in Czechoslovakia, of which the Czech Republic formed part. A Commission for Classification of Mineral Reserves *(Komise pro klasifikaci zásob – KKZ)* was established in 1952, as a state agency to review the categorisation and estimation of reserves of all types of minerals, except radioactive ores.

Initially geological reserves (all reserves in their original state in the deposit without subtracting losses from mining, beneficiation and processing) were classified into subdivisions of groups and categories (slightly simplified).

Groups of geologic reserves according to industrial utilisation:

nebilanční potentially economic – currently unminable due to a low grade, small deposit thickness, particularly complicated mining conditions, or due to the unfamiliarity with economic processing methods for the given mineral type, yet which may be considered as exploitable in the future

bilanční economic – minable, suitable for industrial utilisation and for the technical mining conditions for extraction

Categories of geological reserves according to the degree of deposit exploration:

A – explored in detail and delimited by mining works or boreholes, or by a combination of these. Geological setting, distribution of quality mineral types in the deposit and the technological properties of the mineral are known to such a degree that allow for the development of a method for beneficiation and processing of the mineral. Natural and industrial types of minerals are given. Reserves A include those parts of the deposit, where the geological setting, hydrogeological conditions and mining conditions are known to such a degree that a deposit development method can be developed.

B – explored and delimited by mining works or boreholes, or by a combination of these in a sparser network than in category A. It further includes reserves of deposits adjoining blocks of category A, verified by exploration works. The manner of geological setting, natural and industrial types of minerals are determined without knowing their detailed distribution in the deposit. The quality and technological characteristics of the minerals are given within a range allowing for a basic choice of a processing method. Hydrogeological conditions and general principles of deposit development are sufficiently clarified.

C_1 – determined by a sparse network of boreholes or mining works, or by a combination of these, as well as reserves which adjoin the reserves of categories A and B, if they are justified from a geological perspective. They also include the reserves of relatively complex deposits with a very irregular distribution of the mineral, even though these deposits were explored in detail. Included here are the deposit reserves partially mined-out with low recovery methods. The setting conditions, quality, industrial types and processing technology of the mineral are defined based on analyses or laboratory tests of samples, or based on analogy with explored deposits of a similar type. The hydrogeological conditions and the principles of deposit development are defined quite in general.

C_2 – are assumed based on geological and geophysical data, confirmed by sampling of the mineral deposit from outcrops, isolated boreholes or mining works. Also, reserves adjoining the reserves of categories A, B, C_1, where geological conditions for this exist.

It is further defined that project development and investment amounts for the construction of mining facilities are permitted on the basis of the economic mineral reserves in categories A+B+C_1, which are therefore reserves eligible for industrial utilisation. That is why, in practice, the economic reserves of categories A, B, C_1, or their total A+B+C_1 was designated by the term industrial reserves.

In 1963, KKZ established the prognostic reserves *(prognózní zásoby)* category in an amendment of its Principles for the reserves classification of solid minerals (hereinafter Principles) *(Zásad pro klasifikaci zásob pevných nerostných surovin)*. They were defined as unexplored mineral reserves, assumed on the basis of the formation patterns and the distribution of mineral deposits, and investigations, dealing with the geological structure and the history of geological evolution of the evaluated locality. The parameters for the evaluation of prognostic reserves (strike length, thickness, average grade and the like) are determined according to geological assumptions or they are derived. According to the Principles, prognostic reserves are not listed in the national Register of Reserves *(bilance zásob)*. They serve only as a basis for future planning of geological exploration.

In 1968, KKZ innovated the definition of prognostic reserves. In the amended Principles, it established the division of reserves into proved (by exploration or mining) and assumed, or prognostic. Prognostic geological reserves are unverified reserves, however they are assumed based on geological, geophysical and other scientific knowledge and material. They are predominantly the reserves of larger localities and formations, and, in isolated cases, the reserves of unexplored parts of large structures or deposits.

Due to the establishment of the prognostic reserve category, geological reserves *(geologické zásoby)* can, with regard to contents, be translated into English as total resources. However up to 1989, the term resources did not appear in Czech or Czechoslovak classifications. But up to now, reserves also represent mineral accumulations, which meet the reserves criteria due to being explored, but which do not meet them due to technical and economic reasons (potentially economic reserves *nebilanční zásoby*). They are therefore mineral resources.

In 1981, the Czech Geological Office issued Directive no. 3 [3], where the present prognostic reserves *(prognózní zásoby)* were divided into categories D_1, D_2, D_3. They are defined as follows:

D_1 – relate to verified mineral deposit reserves, with which they form one whole deposit. Determined in delimited areas and quantifiable based on positive detection of an existing mineral and its basic quality characteristics.

D_2 – territorially independent. They are determined in a delimited area based on positive detection of an existing mineral and its basic quality characteristic. Analogies are also used for their determination.

D_3 – determined on the basis of regional investigation. So far, mineral existence has not been proven in such a way, in order to be able to delimit the area of their occurrence and to quantify the prognosis.

In October 1989, the Czech Geological Office issued Decree no. 121/1989 Coll., which redefined the prognostic reserve categories, changed their designation, and for the first time in the Czech Republic established the term resources. The term prognostic resources has been used instead of the term prognostic reserves ever since. The categories P_1, P_2, P_3 were as follows:

P_1 – assumed due to the continuation of an already investigated deposit beyond the reserve outline of category C_2 or due to the discovery of new deposit parts (bodies). The basis for this category are the results of geological mapping, geophysical, geochemical and other work in the area of possibly occurring prognostic resources: geological extrapolation of data results from the investigation, or the verification of part of the deposit. In justified cases this category also includes areas with isolated technical works which do not fulfill the requirements in order to be included in the reserves category C_2. The quantity and quality of the prognostic resources of this category is estimated according to the given deposit type and its part with detected reserves.

P_2 – assumed in basins districts and geological regions, where deposits of the same formation and generation type were detected. It is based on a positive evaluation of deposit indications and anomalies observed during geological mapping and geophysical, geochemical and other work, whose prospect is, if necessary, confirmed by a borehole or surface excavation work. The prognostic resource estimate of assumed deposits and the concept of the shape and dimensions of the bodies, their composition and quality, are derived by analogy with known deposits of the same type.

P_3 – assumed solely on the basis of conclusions concerning the formation possibilities of the deposit types under consideration with regard to favourable stratigraphic, lithological, tectonic and paleogeographic conditions detected while evaluating the locality during geological mapping, and during analysis of geophysical and geochemical data. The quantity and quality of prognostic resources is estimated according to assumed parameters of the deposit development by analogy with more closely explored localities, where deposits of the same genetical type were detected or verified. The prognostic resources of minerals in category P_3 can only be displayed by a surface projection.

The amendment of Mining Act no. 541/1991 Coll. divided the classification of reserves (reserved deposits) according to exploration into the categories of prospected reserves (*vyhledané zásoby)* and explored reserves *(prozkoumané zásoby)*, and, according to exploitability conditions, into economic reserves *(zásoby bilanční)* and potentially economic reserves *(zásoby nebilanční)* .

Economic – reserves suitable for existing technical and economic conditions in exploiting a reserved deposit.

Potentially economic reserves – currently unexploitable due to being unsuitable for existing technical and economic conditions of exploitation, yet assumed to be exploitable in the future in consideration of expected technical and economic development.

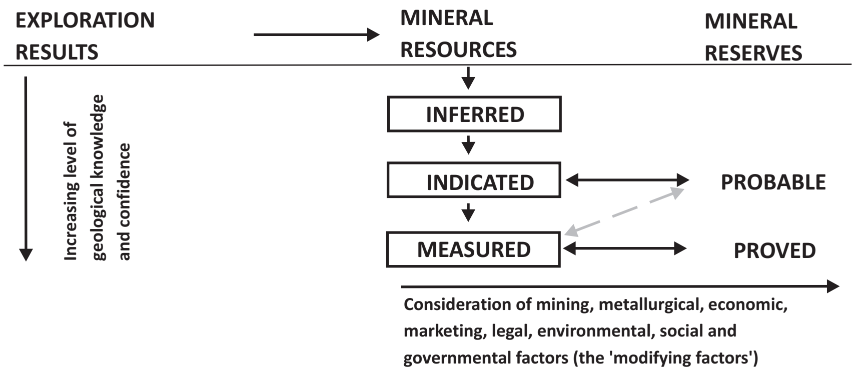
Neither this amendment nor any other regulation defined the content of the terms **prospected** and **explored** reserves. In practice, these categories are identified with the categories of reserve exploration, as they were in effect before the amendement of Mining Act no. 541/1991 Coll., in the following manner: explored reserves = sum of reserve categories A + B + C_1 (also called industrial), prospected reserves = reserves of category C_2.

International classifications

International systems of classifying reserves and resources developed most rapidly in the last quarter of the twentieth century. In 2001, the European Code for Reporting of Mineral Exploration Results, Mineral Resources and Mineral Reserves was published [1]). This corresponds to the reporting standards of the Australian, Canadian, South African and other organisations grouped in the Combined Reserves International Reporting Standards Committee (now called Committee for Mineral Reserves International Reporting Standards) – CRIRSCO which is a subcommittee of CMMI (Council of Mining and Metallurgical Industries). It is summarized as follows:

Relations between mineral reserves and resources, their definitions

Chart of the relations [1]



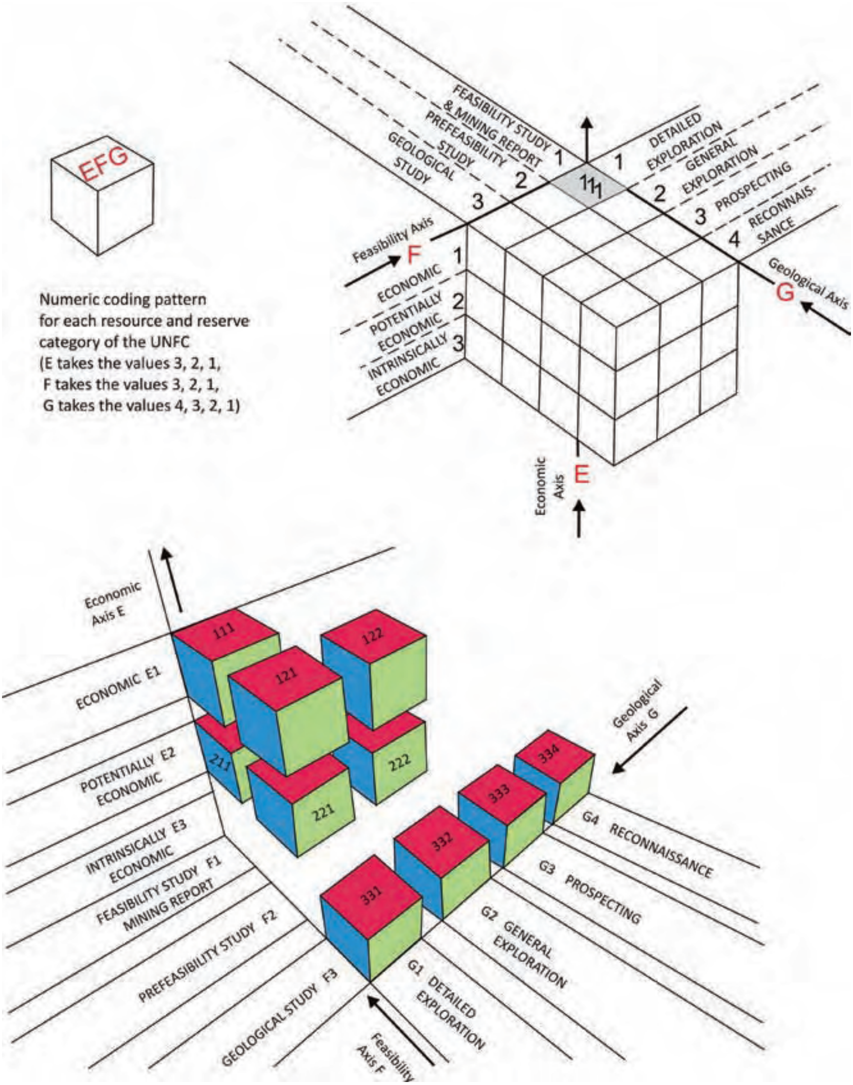
The given definitions are in accordance with the definitions of the UNFC (United Nations Framework Classification) classification of the UN, published by UN-ECE in 1997 [4]. This classification divides (just as, for example, the classification of the USA [5]) its categories according to economic feasibility (quantity and quality of the mineral in situ) in one direction into 3 groups. For the division according to the level of geological knowledge it does not use one direction, one criterion (verification according to technical work carried out), as is common, but two directions, two criteria: 1) According to which of the 4 phases of exploration (from geological to mining) and 2) according to which study (from geological to mining) the given mineral accumulation was prospected or verified. Thus in the area between the axes E (economic), F (feasibility) and G (geological), a total of 36 categories can be established mechanically, out of which about 10 actually exist. The categories are marked with a three-digit code and a priori do not have designations (although recommended designations exist).

(Notice: In the course of discovery and verification of mineral deposits and their estimations of mineral resources and reserves two fundamental stages connect at each other: prospecting and exploration.

Prospecting is a set of geological activities aiming at discovery a mineral accumulation (mineral accumulations) which could be a mineral deposit (mineral deposits) and to express in numbers its (their) mineral resources.

Exploration is to decide if a mineral accumulation (prospective mineral deposit) is a mineral deposit or not and if it is, to estimate its mineral reserves.)

Two ways of presenting UNO spatial mineral resource – reserve classification system (United Nations Framework Classification)[4]



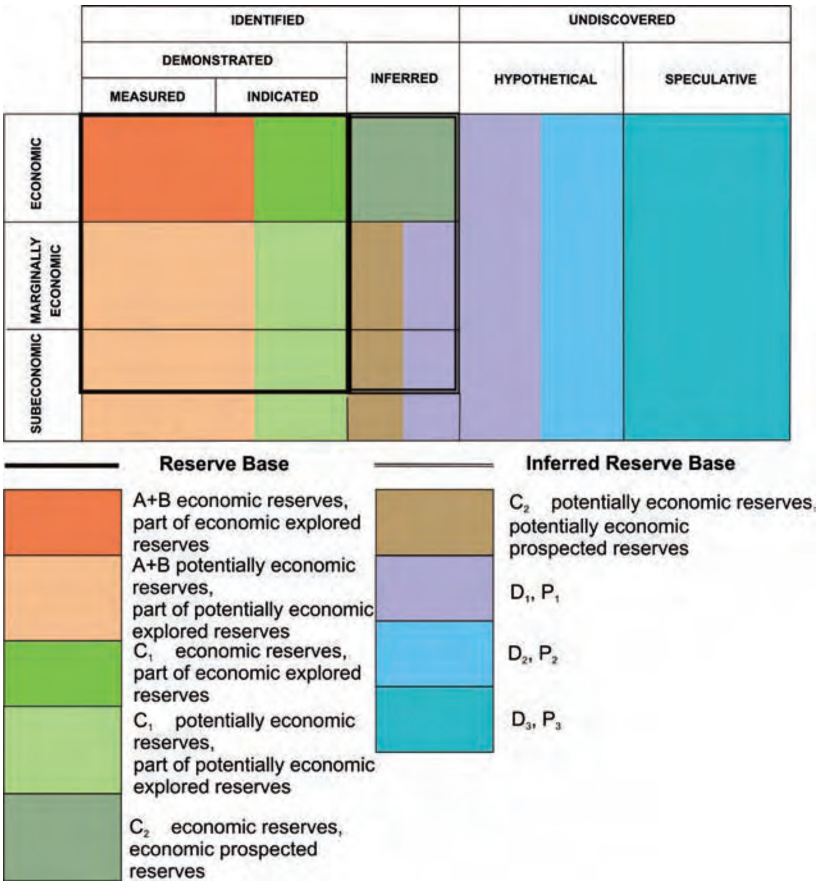
An important aspect of the European and similar reporting codes is the concept of the "competent person". He/she is responsible for the calculation of reserves and its categories, is a member of an acknowledged professional society (which sees to the expertise and ethics of its members via sanctions), and has expert and moral qualities. His estimates are accepted as reliable by banks and securities exchanges. Competent persons are members of Recognized Overseas Professional Organizations (ROPO). A list of organisations is compiled by the Australasian Joint Ore Reserves Committee (JORC).

Although some national and international classifications are relatively complicated, the mining industry frequently still makes do with only the categories of proved and probable reserves. If it is seeking funds from banks or share flotations on securities exchanges, it must respect the regulations for reporting its mineral reserves. The securities exchanges have reporting requirements which are particularly strict or even provided by law. In general they require adherence to the reporting codes of the international organizations such as those that cooperate in framing the European Code [1].

Comparison of Czech and international systems of classification

The following scheme and table compare the reserve and resource classifications of the Czech Republic with the international classifications discussed above.

Comparison of the mineral resource classification valid in the USA from 1980 [5] with the reserve and resource classifications valid in the territory of the Czech Republic from 1956



Is to be noted that reserves in the Czech classification still include potentially economic reserves, i.e. reserves which are currently not recoverable and which are, therefore, potentially economic resources. The term reserves as used, by contrast, in standard international classifications represents only the parts of explored resources which are available for immediate extraction. All other registered parts are resources, not reserves, of a given mineral.

Comparison of UNFC with the reserve and resource classifications of the Council of Mining and Metallurgical Industries (CMMI) [4] and of the Czech Republic

Code of the UNFC category	Proposed designation of the UNFC category	CMMI category	Czech categories up to 1981	Czech categories in 1981–1989	Czech categories in 1989–1991	Czech categories after 1991
111	Proved Mineral Reserve	Proved Mineral Reserve	economic reserves – part of exploitable part* A+B	economic reserves – part of exploitable part* A+B	economic reserves – part of exploitable part* A+B	part of exploitable part* of explored economic reserves
121 + 122	Probable Mineral Reserve	Probable Mineral Reserve	economic reserves – part of exploitable part* of A + B + C_1	economic reserves – part of exploitable part* of A + B + C_1	economic reserves – part of exploitable part* of A + B + C_1	part of exploitable part* of explored economic reserves
123		Inferred Mineral Resource	economic reserves – C_2	economic reserves – C_2	economic reserves – C_2	prospected economic reserves
211	Feasibility Mineral Resource	Measured Mineral Resource	potentially economic reserves – A+B	potentially economic reserves – A+B	potentially economic reserves – A+B	part of explored potentially economic reserves
221 + 222	Prefeasibility Mineral Resource	Indicated Mineral Resource	potentially economic reserves – C_1	potentially economic reserves – C_1	potentially economic reserves – C_1	part of explored potentially economic reserves
223		Inferred Mineral Resource	potentially economic reserves – C_2	potentially economic reserves – C_2	potentially economic reserves – C_2	prospected potentially economic reserves
331	Measured Mineral Resource	Measured Mineral Resource	potentially economic reserves – A+B	potentially economic reserves – A+B	potentially economic reserves – A+B	part of explored potentially economic reserves
332	Indicated Mineral Resource	Indicated Mineral Resource	potentially economic reserves – C_1	potentially economic reserves – C_1	potentially economic reserves – C_1	part of explored potentially economic reserves

Code of the UNFC category	Proposed designation of the UNFC category	CMMI category	Czech categories up to 1981	Czech categories in 1981–1989	Czech categories in 1989–1991	Czech categories after 1991
333	Inferred Mineral Resource	Inferred Mineral Resource	potentially economic reserves – C_2 + part of prognostic reserves	potentially economic reserves + part of D_1	potentially economic reserves + of P_1	prospected potentially economic reserves + part of P_1
334	Reconnaissance Mineral Resource	not available	part of prognostic reserves	D_2 + D_3 + part of D_1	P_2 + P_3 + part of P_1	P_2 + P_3 + part of P_1

* geological reserves reduced by amount of prospective mining losses

Conclusions

If they are to be of practical use national and international classifications have to respect the information base given by the reserve estimations of mining enterprises. It may be unsuitable to overly expand the classification requirements or expectations beyond the realistic means of this base. Combining a classification with a study (project), which classifies given resources or reserves, or with a prospecting and exploration phase, in which mineral resources and reserves were estimated, causes problems. For economic (acquiring financial means, taxes, market position) or political reasons, a prospector or a mining company developer may be led, for example, to move their exploration phase higher or lower in comparison with its actual position. In socialist (communist) Czechoslovakia with its completely nationalised industry, commerce and services, results of geological prospecting and exploration were judged**,** not according to the mineral reserves prospected or verified by exploration, but according to the fulfillment of exploration work plans, whether planned investments in exploration were completely spent on "drilling and digging", or not. The wage of the employees of exploration and mining organisations depended on the fullfilment of plans. That is why at all levels**,** there was also an interest, that prospecting and exploration constantly continue. Consequently, prospecting strictly speaking and general exploration were the most frequent type of prospecting, and verified reserves were possibly never categorised under A. They were commonly only inserted into categories C_1 and C_2. That enabled their permanent verification. On the other hand, many mining organisations mined the reserves of category C_2 which however could have been ranked factually higher; they were over-explored.

Literature

[1] Code for reporting of mineral exploration results, mineral resources and mineral reserves (The Reporting Code). – http://geolsoc.org.uk/webdav/site/GSL/shared/pdfs/Fellowship/UK_Euro%20Reporting%20Code.pdf

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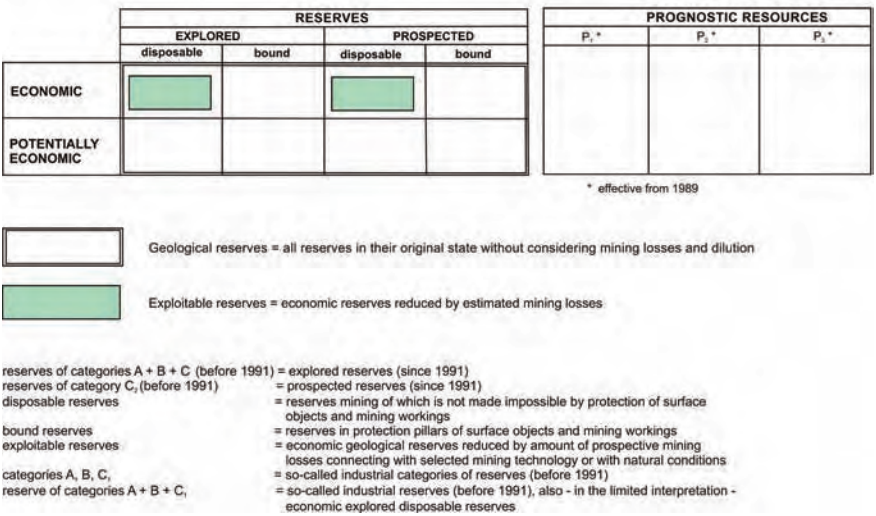
Translations of Czech article titles:

* Problems of evaluation and classification of reserves/resources of solid mineral raw materials
** Directive no. 3/1981 of the Czech Geological Office for evaluation and registration of geological prognoses and prognostic reserves of minerals
*** Mineral exploration and management of reserved deposit mineral reserves (proposal for analysis of the third part of the Mining Act)

HISTORY OF RESERVE AND RESOURCE CLASSIFICATION ON THE TERRITORY OF THE CZECH REPUBLIC



INTRODUCTION

The *Mineral Commodity Summaries of the Czech Republic*, published for the seventeenth time, is intended to inform professional and particularly business communities, and to assist in the expansion of the minerals industry in line with valid legislation and the interests of mining organisations.

The work of the author team, which was expanded again this year, is revised by a team of domestic and foreign reviewers. The reviewer team, which was made up of prominent experts in their particular fields, changed this year. The most significant changes were the departure of Dr. Miloš Kužvart, a world renown expert in geology of industrial minerals, and the arrival of Dr. Anatoly Stavskiy (Анатолий Ставский) who, among other things, is responsible for the publication of the minerals yearbook of the Russian Federation.

Suggestions of the reviewers and readers are being incorporated into the yearbook gradually depending on the author team‘s availability and time constraints resulting from the preparation schedule of the yearbook.

This newly edited publication not only covers the most important minerals of the Czech Republic that are or have recently been of industrial importance, but also those minerals, whose reserves or (approved and unapproved) resources have not been mined in the Czech Republic in the past. The listed minerals also include minerals unmined in the present and past, without existing resources and reserves, which are items of Czech foreign trade that can be monitored via tariff items. The publication includes basic data on the status and changes in the mineral reserves of the Czech Republic taken from the Register of Mineral Deposit Reserves (hereinafter the Register), which is published for a limited number of state administration agencies.

Additional information on prices of minerals, their technological parameters and use, imports and exports, major mining companies, and the location of mineral deposits is intended to assist in understanding the mineral potential of the Czech Republic and to stimulate investment in the minerals industry. This is also aided by the newly listed prognostic resources, both officially approved by the Commission for Projects and Final Reports of the Ministry of the Environment (Komise pro projekty a závěrečné zprávy – KPZ) in categories P_1, P_2, P_3 and unapproved by KPZ (mentioned only in expert reports).

The publication is being updated by relevant statistical data in relation to the development of the national information system, international cooperation, and readers’ comments.

The mineral reserves presented are geological reserves, also called *total reserves,* i.e. original reserves (in situ) within individual deposits, estimated according to the given classification and technical-economic conditions of their exploitability. The initial data come from mineral reserve estimates, which were approved or verified in the past by the Commission for Classification of Mineral Reserves and/or by the Commission for Exploration and Mining of Reserved Minerals of the former MHPR ČR and MH ČR, or by former commissions for management of mineral reserves of individual mining and processing industries. Uranium reserves and reserve estimates were approved by the Commission for Classification of Radioactive Mineral Reserves of the former Federal Ministry of Fuels and Energy. Currently, mineral reserves are approved by the Commission for Projects and Final

Reports of the Ministry of the Environment of the Czech Republic (KPZ) or by agencies authorising geological work.

There are reserved and non-reserved minerals and deposits as defined by the Mining Act no. 44/1988 Coll., as amended. Reserved minerals always form reserved deposits which are owned by the Czech Republic. Non-reserved deposits are owned by landowners. Non-reserved minerals (construction minerals) can form both reserved and non-reserved deposits. Until 1991, reserved deposits of sufficient mineral quantity and quality were proclaimed „suitable for the needs and development of the national economy" as defined by the Mining Act at that time. Since 1991, the newly recognised and explored deposits of non-reserved minerals form non-reserved deposits.

As of 31 December 2008, total geological reserves of reserved deposits of reserved and non-reserved minerals have reached 55.4 billion tonnes of predominantly energy minerals (48 % of total geological reserves) and construction minerals (35 % of total geological reserves). In 1993–2001, the Ministry of the Environment along with the Ministry of Industry and Trade undertook a fundamental economic revaluation of the mineral wealth of the Czech Republic**.** In 2003 - 2006, the task has continued to a smaller extent. Therefore compared to past years, many considerable changes have occurred in the number of deposits and registered reserves of many minerals (especially metallic ores).

The *Mineral Commodity Summaries of the Czech Republic* includes selected minerals according to whether they are or were mined in the territory of the Czech Republic. Currently mined minerals also include approved prognostic resources, if existing. Currently unmined minerals are divided into those that were mined in the past and those that have never been mined. In both cases, it is distinguished whether their resources and reserves are known or not and, generally, also whether they are metallic ores or industrial minerals. Separate chapters are dedicated to each mineral, or mineral grouping common in its deposit. Each chapter is structured identically. The separate chapters of currently mined minerals listed - mineral fuels, industrial and construction minerals, and metallic ores, which are of economic importance and of substantial reserves in the territory of the Czech Republic - consist of eleven parts.

Part 1. Characteristics and use – provides a basic description of the mineral raw material, its natural occurrence, major minerals and general economic use.

Part 2. Mineral resources of the Czech Republic – describes major regions of occurrence, deposit characteristics, ore types, mining and potential use of the given mineral.

Part 3. Registered deposits and other resources of the Czech Republic – is based on the Register of Mineral Deposits of the Czech Republic and, for the majority of minerals, includes a list of deposits and their location. The names of exploited deposits are given in bold. As for energy minerals and some industrial minerals, only regions and basins rather than single deposits are given. As for dimension stone and construction minerals, which are scattered in hundreds of deposits over the whole territory of the Czech Republic, their groupings are located in the subdivisions of reserved, non-reserved, exploited and unexploited deposits.

Part 4. Basic statistical data of the Czech Republic as of December 31 – are extracted especially from the Register. There are 3 groups of minerals (ores, energy minerals, and reserved industrial and construction minerals) registered in the Czech Republic. Mine production of non-reserved deposits has been monitored since 1999. Approved prognostic resources are stated, too, proved they exist.

NOTE: **The *Register* presents the *reserves* data in the catagories on exploration (prospected, explored) and economic use (economic, potentially economic), as stipulated by relevant statutes starting with the Mining Act. *Reserves* include *potentially economic reserves*, i.e. reserves which are currently not recoverable and which are, therefore, *potentially economic resources.* Consequently, *total mineral reserves* are in reality *total mineral resources*. The term *reserves* as used, by contrast, in standard international classifications represents only the parts of explored resources which are available for immediate extraction. All other registered parts are resources, not reserves, of a given mineral.** The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter of this yearbook ***"Mineral reserve and resource classification in the Czech Republic"***.

Part 5. Foreign trade – provides import and export information on important tariff items of the given raw material. The foreign trade data are the latest (continuously reviewed) data of the ČSÚ.

Part 6. Domestic market and foreign trade prices – provides indicative prices on domestic production, import and export prices. Domestic prices do not include VAT.

Part 7. Mining companies in the Czech Republic as of December 2006. - provides a list of companies mining the given mineral in the territory of the Czech Republic. The companies are listed according to production level. Their addresses are available from the Czech Geological Survey – Geofond.

Part 8. World production – provides data on mining and production of commercial products for the last 5 years, and lists significant world producers, i.e. the top 5–10 countries in world production.

Part 9. World market prices – provides a summary of world prices and their evolution in the last five years as well as current qouted or negotiated prices.

Part 10. Recycling – provides a brief description of possible recycling methods in worldwide use.

Part 11. Substitutes – provides an appraisal and a list of possible material substitutes in worldwide use.

Numerous domestic and foreign data, used in compiling the present yearbook, came from journals, expert literature and the latest editions of various international statistical yearbooks (e.g. Welt Bergbau Daten 2008 (WBD), Mineral Commodity Summaries 2009 (MCS), World Mineral Statistics (WMS), World Mineral Production 2003–2007 (WMP), World Oil and Gas Review 2009 (WOGR), Coal Information (CI), World Metals & Mineral Review 2006 (WMMR), BP Statistical Review of World Energy 2009, Estadísticas del Cobre y Otros Minerales de Comisión Chilena del Cobre).

MINERAL BASE OF THE CZECH REPUBLIC AND ITS DEVELOPMENT IN 2008

Tomáš Sobota and Josef Janda,
Ministry of the Environment

The minerals defined in Act No. 44/1988 Coll., on the Protection and Use of Mineral Resources (the Mining Act) as amended, are classified as being reserved and non-reserved. Natural accumulations of reserved minerals form reserved mineral deposits which constitute the mineral wealth of the country and are owned by the Czech Republic. Deposits of non-reserved minerals (especially sand and gravel, crushed stone and brick clay) are a constituent part of the land as stipulated in § 7 of the Mining Act. The former option, declaring significant non-reserved mineral deposits as reserved deposits, was cancelled by the amendment of the Mining Act in 1991. Decisions of administrative agencies in this matter, which had been issued before the amendment went into effect, remain valid based on transitional provisions (§ 43 and 43a par. 1 of the Mining Act). The deposits specified by these decisions are still reserved deposits, i.e. owned by the state, separated from the land itself.

Prospecting and exploration for reserved mineral deposits, by virtue of the ČNR Act No. 62/1988 Coll., on Geological Work (the Geological Act) as amended, may be conducted by an individual or organisation, providing that the work is managed and guaranteed by a qualified and certified person (certified responsible manager for the geological work). An organisation seeking to prospect for and explore these mineral deposits, to verify their reserves, and to process geological documents for their exploitation and protection, must make a request to the Ministry of the Environment to establish an exploration area. The proceedings, subject to administrative rules, are concluded by the establishment or non-establishment of an ‘exploration area’ (exploration permit). In the former case, the following must be determined: the survey area, the mineral to be prospected and explored for which the exploration area is being established, the conditions for the execution of the work, and the period of validity of the exploration area. The exploration area is not a territorial decision, but provides the entrepreneur or organisation (hereinafter entrepreneur) with the exclusive privilege to prospect for the mineral in a given exploration area. In the first year, the entrepreneur is obliged by law to pay a tax of CZK 2,000 per km² or km² piece of exploration area, which increases annually by CZK 1,000 per km² and its piece (to CZK 3,000 in the second year, to CZK 4,000 in the third year, etc.). These taxes represent an income for the municipalities, in whose cadastral areas the exploration area is established.

Within the scope of planning and conducting the prospecting for and exploration of reserved mineral deposits, the organisation must consider the conditions and interests protected by special regulations (§ 22 of the Act on Geological Work). These primarily refer to laws for the protection of landscape and nature, agricultural and forest land; to the Water and Mining Acts etc. The Ministry of the Environment can cancel the established exploration area, if the organisation repeatedly or severely violates the obligations set by the Geological Act.

The above-mentioned enactments apply to prospecting and exploration for non-reserved mineral deposits, only, if they were previously declared as reserved deposits according to the transitional provisions of the Mining Act. In other cases, an organisation can prospect and explore for non-reserved minerals only upon agreement with the landowner. The provision under § 22 of the Act on Geological Work is also valid in these cases. The mining of reserved deposits is considered to be a mining operation and the mining of non-reserved deposits, which constitute a part of the land, an operation conducted according to the mining methods set by Act No. 61/1988 Coll., on Mining Operations, Explosives and the State Mining Administration, as amended.

If, during prospecting and exploration, a reserved mineral is found to be of quality and quantity indicative of its accumulation (supported by a partial deposit reserve estimate given in the category of prospected reserves), the organisation must report it to the Ministry of the Environment, which issues a certificate for the reserved deposit owned by the state. At the same time, this certificate ensures the deposit against actions rendering its mining difficult or impossible by the establishment of a protected deposit area (CHLÚ) according to § 17 of the Mining Act.

The entrepreneur's right to mine the reserved deposit is provided by the grant of a mining lease. The submittal of a proposal for the grant of a mining lease must be preceded by an approval from the Ministry of the Environment, which may depend on the fulfilment of limiting conditions accounting for the interests of the state mineral policy, and on covering expenses of geological work already funded by the state. The organisation, on whose behalf the exploration was carried out, has priority in receiving the approval for the grant of the mining lease. If it fails to assert its mining lease, precedence is then given to the organisation which participated financially in the exploration. Somewhat different rules apply to cases concerning crude oil and natural gas based on a transposed EU directive.

The mining lease is only granted to an entrepreneur possessing a *Certificate of Mining Operations* issued by an authorised Regional Mining Office. This grant procedure takes place in cooperation with relevant administrative agencies, mainly in agreement with environmental, land use planning and building authorities. The entrepreneur‘s proposal for the grant of a mining lease must be furnished with documentation as stipulated by law. The procedure deals with landowner relations and settlement of conflicts of interests, which are protected by special regulations. The environmental impact assessment (EIA) represents a part of the documentation, too. The grant of a mining lease represents a mining as well as land use authorisation.

The entrepreneur, who has been granted a mining lease, may start mining operations only after obtaining a mining permit from the authorised Regional Mining Office. Issue of this permit is subject to an administrative procedure assessing the plans of opening, the preparation and the mining of the deposit, and the plans for rehabilitation and reclamation after termination of mining. In justified cases, the Regional Mining Office may combine the grant of a mining lease and of a mining permit into one administrative procedure.

The entrepreneur is obliged to pay royalties on the mining lease and the extracted reserved minerals. An annual lease payment of CZK 100–1,000 is assessed on every hectare opened within the mining lease area, which is marked off on the surface. The payment is graded with respect to the degree of environmental protection of the affected area, the type of activity conducted in the mining lease, and its environmental impact. The Regional Mining Office fully transfers this payment to the municipalities, in whose territories the mining lease is located, according to the lease proportions in each municipal territory.

An annual royalty on minerals extracted in mining leases is given by the MPO Decrees No. 426/2001 Coll., and 63/2005 Coll., which amend the Decree No. 617/1992 Coll., detailing the payment of royalties on mining leases and extracted minerals.

The royalty on extracted minerals is calculated as

$$U = \frac{Nd}{Nc} \cdot T \cdot \frac{S}{100},$$

whereby

Nd = costs of mineral extraction (ths CZK)
Nc = total costs of the enterprise for manufacture of products (ths CZK)
T = sales (ths CZK)
S = royalty rate (%)
U = royalty total (ths CZK)

The Regional Mining Office transfers 25 % of the yielded royalty to the state budget of the Czech Republic to be purposefully used in remediation of environmental damage caused by the mining of reserved and non-reserved deposits, and the remaining 75 % to the budget of the relevant municipalities.

During the course of mining, the entrepreneur is required to generate sufficient financial reserves for mine damages and for reclamation of areas affected by the deposit exploitation. Generating of the financial reserves is approved by the Regional Mining Office during the mining permit procedure regarding the opening and extraction of the deposit. Drawing on the reserves is permitted by the Regional Mining Office upon agreement with the Ministry of the Environment and upon notification by the relevant municipality. In the case of (partially) state-owned enterprises, the Regional Mining Office decides in agreement with the Ministry of Industry and Trade.

Selected statistical data on exploration and mining on the territory of the Czech Republic

Statistical data/Year	2004	2005	2006	2007	2008
registered geological works	2 850	2 631	2 563	2 940	3 450
protected deposit areas	1 052	1 048	1 060	1 048	1 057
mining leases – total number	1 004	998	986	988	979
number of exploited reserved deposits	513	517	508	512	508
number of exploited non-reserved deposits	220	224	219	220	222
mine production of reserved deposits, mill t [a)]	134	135	138	151	138
mine production of non-reserved deposits, mill t [a)]	13	14	15	16	17
organizations managing reserved deposits	314	335	328	338	315
organizations mining reserved deposits	227	215	204	205	200
organizations mining non-reserved deposits	167	190	165	188	160

Note:
[a)] conversions: natural gas 1 mill m^3 = 1 kt, dimension and crushed stones 1,000 m^3 = 2.7 kt, sand and gravel and brick clays and related minerals 1,000 m^3 = 1.8 kt

Significance of mining in the Czech economy

Ratio/Year	2004	2005	2006	2007	2008
Real annual GDP growth, %	4.5	6.3	6.8	6.1	3.2
Share of mining and quarrying in GDP, %	1.1	1.0	1.2	1.0	1.0*
Share of mining and quarrying in industrial production, %	2.6	2.6	2.5	1.9	1.8*

Note:
* preliminary data

Trends of reserves of minerals
(economic explored disposable reserves)

Totals in mill t (if not otherwise stated)

Group/Year		2004	2005	2006	2007	2008
Metallic ores	a)	26	26	26	26	26
Energy minerals	b)	3 015	2 972	2 830	2 778	2 813
of which: uranium (U)(kt)		2	2	2	2	2
crude oil		13	13	12	15	16
natural gas	b)	2	2	2	2	2
Industrial minerals		2 726	2 705	2 669	2 779	2 726
Construction minerals	c)	5 316	5 350	5 220	5 200	5 170

Note:
a) metals in ores total, since 2004 only Au ores (25 642 kt)
b) natural gas – conversion into kt: 1 mill m^3 = 1 kt
c) at reserved mineral deposits including dimension stone, conversion into kt – dimension and crushed stones 1,000 m^3 = 2.7 kt, sand and gravel and brick clays and related minerals 1,000 m^3 = 1.8 kt

Summary of exploration licences valid in 2008 and newly issued in 2008 (listed according to minerals)

Exploration areas (EA) in 2008

Prospecting and exploration works financed by companies

Minerals	Number of valid EA (min. 1)	Number of valid EA (min. 2)	Number of new issues in 2008	Start of validity in 2008
Bituminous coal	1	0	0	0
Crude oil and natural gas	35	0	1	1
Gemstones	1	1	0	0
Kaolin	6	1	4	4
Clays	9	0	1	1
Bentonite	6	1	4	4
Feldspar and feldspar substitutes	8	1	0	0

Table from page 30 continued

Minerals	Number of valid EA (min. 1)	Number of valid EA (min. 2)	Number of new issues in 2008	Start of validity in 2008
Silica raw materials	1	0	0	0
Dimension stone	1	0	0	0
Crushed stone	0	0	0	0
Sand and gravel	4	2	0	0
Total	**72**	**6**	**9**	**9**

Mineral 1 (min. 1) – in case that the raw material is the major one
Mineral 2 (min. 2) – in case that the raw materials is a by-product

Prospecting and exploration works financed from the state budget

In 2008, the Ministry of Environment conducted state-funded geological work related to the reevaluation, prospecting, exploration and protection of reserved deposits in the amount of CZK 9.877 mill. For instance, exploration of new deposits of reserved minerals was carried out in order to safeguard them for future use. This concerns the exploration of bentonite, glass and foundry sands, kaoline, clays and feldspar deposits.

The Central Geological Authority of the state administration fulfils the duty involving the state register of reserved deposits – state property (§ 29 of the Mining Act). Accordingly, it issues the register as one of the main sources for

- land use planning
- the raw material policy
- the energy policy
- the environmental policy
- the structural policy
- the employment policy

The register lists the **latest status of the deposits as documented in the reserves estimate.** The reserves estimate is prepared **with respect to the conditions of exploitability** expressing

- the state of the market, prices, business economy,
- the mining and technical conditions of exploitation,
- the conflicts of interests arising from the deposit exploitation (primarily environmental protection and other conflicts)

It is altogether entirely unstable factors reflecting political, economic and social change (in the largest sense).

Reevaluation of deposits not allocated for entrepreneurial exploitation continued.

A portion of funds from the state budget was allocated to rectify the consequences of mineral exploration and mining.

Some technical workings which were carried out during geological explorations in the past and which started to endanger the environment, had to be liquidated. In 2008, CZK 2.200 mill were spent on the liquidation of these workings.

A partial programme continued aimed at reevaluating heaps, dumps and tailings after termination of mineral mining from two fundamental standpoints:

a) which of the existing heaps, dumps and tailings represent a mineral accumulation potentially exploitable in the future, and should therefore be considered as such;

b) what is the biotope status in the heaps, dumps and tailings, and which of them pose a hazard from a perspective of environmental management.

The results of work in this area are also used to evaluate the impact of former mining operations in individual localities. CZK 6.972 mill were spent on this work in 2008.

Expenditures for state-funded exploration work related to economic geology

(rounded values)

1993	CZK 248.7 mill
1994	CZK 249.8 mill
1995	CZK 242.3 mill
1996	CZK 163.0 mill
1997	CZK 113.2 mill
1998	CZK 114.2 mill
1999	CZK 110.8 mill
2000	CZK 26.3 mill
2001	CZK 21.5 mill
2002	CZK 17.0 mill
2003	CZK 7.0 mill
2004	CZK 26.2 mill
2005	CZK 12.0 mill
2006	CZK 1.7 mill
2007	CZK 3.0 mill
2008	CZK 9.9 mill

Mainly geological work of a *non-deposit* character was funded by the state. Individual projects were publicly commissioned in order to implement the following partial programmes:

- rectify the consequences of past geological (non-deposit) work financed by the state (mine workings not yet liquidated, boreholes)
- geological informatics
- geological mapping
- geohazards of the environment
- hydrogeology
- engineering geology
- comprehensive geological studies

Following expenditures were spent on these geological works since 2001:

2001	CZK 72.8 mill

2002	CZK 61.0 mill
2003	CZK 67.0 mill
2004	CZK 52.1 mill
2005	CZK 60.3 mill
2006	CZK 55.4 mill
2007	CZK 58.1 mill
2008	CZK 41.0 mill

Summary of selected legal regulations on mineral prospecting and exploration in force as of June 30, 2009

Acts

Act No. 44/1988 Coll., on Mineral Protection and Use (the Mining Act) – as amended by the Acts No. 541/1991 Coll., No. 10/1993 Coll., No. 168/1993 Coll., No. 132/2000 Coll., No. 258/2000 Coll., No. 366/2000 Coll., No. 315/2001 Coll., No. 61/2002 Coll., No. 320/2002 Coll., No. 150/2003 Coll., 3/2005 Coll., No. 386/2005 Coll., No. 186/2006 Coll., No. 313/2006 Coll., No. 296/2007 Coll. and No. 157/2009 Coll.

Act No. 61/1988 Coll., on Mining Operations, Explosives and the State Mining Administration as amended by the Acts No. 425/1990 Coll., No. 542/1991 Coll., No. 169/1993 Coll., No. 128/1999 Coll., No. 71/2000 Coll., No. 124/2000 Coll., No. 315/2001 Coll., No. 206/2002 Coll., No. 320/2002 Coll., No. 226/2004 Coll., No. 3/2005 Coll., No. 386/2005 Coll., No.186/2006 Coll., No. 313/2006 Coll., No. 342/2006 Coll., No. 296/2007 Coll., No.376/2007 Coll., No.124/2008 Coll. and No.274/2008 Coll.

Act No. 62/1988 Coll., on Geological Work, as amended by the Acts No. 543/1991 Coll., No. 366/2000 Coll., No. 320/2002 Coll., No. 18/2004 Coll., No. 3/2005 Coll., No. 444/2005 Coll., No. 186/2006 Coll. and No.124/2008 Coll.

Other legal regulations

Mineral deposits exploitation

Decree of the ČBÚ No. 306/2002 Coll., that determines the **operation districts of the Regional Mining Offices.**

Decree of the ČBÚ No. 104/1988 Coll., **on efficient use of reserved deposits, on permits and notification of mining operations and other activities employing mining methods,** as amended by the Decree No. 242/1993 Coll., No. 434/2000 Coll., and No. 299/2005 Coll.

Decree of the ČBÚ No. 415/1991 Coll., **on construction, the elaboration of documentation and the determination of safety pillars, rods and zones for the protection of underground and surface sites** in the wording of the Decree of the ČBÚ No. 340/1992 Coll., and No. 331/2002 Coll.

Decree of the ČBÚ No. 172/1992 Coll., **on mining leases** in the wording of the Decree No. 351/2000 Coll.

Decree of the ČBÚ No. 175/1992 Coll., **on the conditions of non-reserved mineral deposit exploitation** in the wording of the Decree No. 298/2005 Coll.

Decree of the MŽP ČR No. 363/1992 Coll., **on the survey and registry of old mine workings** in the wording of the Decree of the MŽP No. 368/2004 Coll.

Decree of the MŽP ČR No. 364/1992 Coll., **on protected deposit areas**

Decree of the ČBÚ No. 435/1992 Coll., **on mine surveying documentation during mining and during some operations employing mining methods** in the wording of the Decree of the ČBÚ No. 158/1997 Coll. and the Decree No. 298/2005 Coll.

Decree of the MH ČR No. 617/1992 Coll., **detailing the payment of royalties on mining leases and extracted minerals**, in the wording of the Decree of the MPO No. 426/2001 Coll. and No. 63/2005 Coll.

Decree of the MHPR ČR No. 497/1992 Coll., **on the registration of reserves of reserved mineral deposits**

Geological work

Decree of the MŽP No. 282/2001 Coll., **on the registration of geological work**, in the wording of the Decree of the MŽP No. 368/2004 Coll.

Decree of the MŽP No. 368/2004 Coll., **on geological documentation**

Decree of the MŽP No. 369/2004 Coll., **on the planning, execution and evaluation of geological work, on announcing geohazards, and on the procedure for estimating reserves of reserved deposits** as amended by the Decree of the MŽP No.18/2009 Coll.

Regulations on licensing of mining operations and verification of qualification

Decree of the ČBÚ No. 298/2005 Coll., **on the requirements for professional qualification and competence in mining or operations employing mining methods, and on some legal regulation changes,** in the wording of the Decree No. 240/2006 Coll.

Decree of the ČBÚ No. 15/1995 Coll., **on the licensing of mining operations and operations employing mining methods as well as on the development of sites and installations, which constitute these operations,** in the wording of the Decree No. 298/2005 Coll.

Decree of the MŽP ČR No. 206/2001 Coll., **on the certificate of qualification for planning, executing and evaluating geological work**

Development of the Czech and world economy and importance of raw materials

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1. Growth performance of the Czech economy

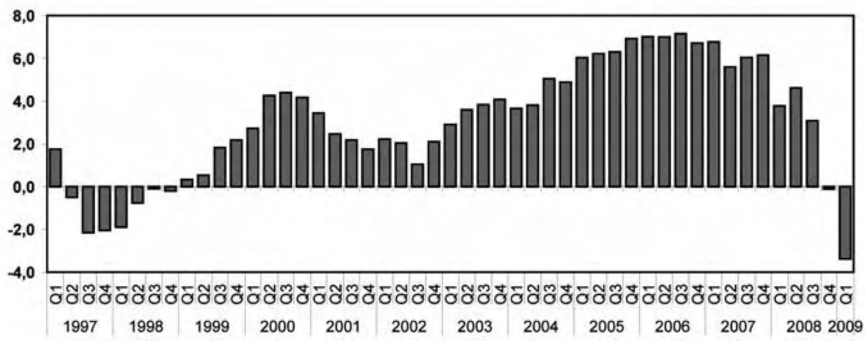
2005–2007 was one of the most prosperous periods for the Czech economy in the history of the Czech Republic. The real growth of the gross domestic product (GDP) **[1]** reached an annual rate of 6.5 %. Compared to preceding years, it not only increased considerably but also became healthier in terms of growth factors on both the supply and demand sides. By contrast with the majority of new Member States of the EU from Central and Eastern Europe, tt is remarkable that the growth rate increase was not accompanied by a deteriorating macroeconomical balance. On the contrary, compared to the preceding three years, the balance of trade became positive, the current account deficit and public finance deficit decreased, and the situation on the labour market improved significantly.

Restructuring and modernisation on the supply side **[2]** was spurred on by a strong inflow of foreign direct investment and by the increasing importance of foreign-controlled enterprises with their considerably higher productivity. More accessible financial resources from banks, low interest rates and an expansive fiscal policy also contributed to the growth. A positive impulse was undoubtedly the entry of the Czech Republic into the EU in 2004, which cultivated the institutional environment and increased the possibilities of free movement of goods, services, capital and labour. Other positive effects include the economic recovery in Western Europe (particularly in Germany, the major trade partner of the Czech Republic), the increase in the profitability of non-financial enterprises or the increase in credits provided to enterprises and households.

The development **in 2008** gradually brought about continuously deteriorating trade conditions, and economic growth began to slow down significantly in the second half of the year. Developed countries were affected by the financial crisis and slid into recession in the second half of the year. From the perspective of the Czech Republic, the impact of the strong decline in economic activity in Germany and other eurozone countries was serious for Czech export, which depends on their demand. Domestic conditions also deteriorated (even though the financial system did not slide into a crisis, mistrust grew and credits provided to households and enterprises slowed down, lower expectations of consumers, producers and investors materialised, and the economy was hit by a strong external demand shock). The sharp increase in world prices of crude oil and food in the first half of the year, which crossed over to the opposite extreme and gradually lowered the rate of inflation, represented a positive effect.

During the course of the year, the economic growth rate and dynamics of foreign trade declined, and primarily the development trends in the fourth quarter of the year exhibited a considerable change (a sharp fall in industrial production and export, a rise in unemployment). The preliminary data on GDP growth for the entire year of 2008 (2.8 %), which is less than half of the growth rate in 2007, do not show the gravity of the situation and cannot serve as a basis for forecasting future development. The speed of change requires greater focus on quarterly and monthly data.

On a quarterly basis, the economic growth rate in the Czech Republic has been increasing considerably since 2003. Strong quarterly year-on-year dynamics exceeding 6 % were maintained in all 11 quarters starting with 2005. In 2008, year-on-year growth dynamics slowed down considerably (from 4.6 % in the second quarter to -0.1 % in the fourth quarter) and, according to preliminary ČSÚ data, the GDP already fell by 3.4 % in the first quarter of 2009 (see Figure 1). However, quarter-on-quarter data registered a stronger GDP decline of 1.7 % in the last quarter of 2008, which, along with the unfavourable economic development at the start of 2009, shows that the Czech economy slid into recession.[1]



Source: ČSÚ – quarterly national accounts (June 2009).

Figure 1: Growth of quarterly real GDP annualized, in per cent

When compared internationally, the Czech Republic registered a considerably faster growth in GDP per capita compared to the growth in EU countries, which manifested itself in the acceleration of real convergence (catch-up of the level of the average per capita income of EU citizens). The GDP per capita in purchasing power parity **[3]** increased in relation to the entire EU from 68.6 % in 2000 to 81.3 % in 2008, i.e. by 12.7 percentage points. The convergence process of the Czech economy in 2001–2008 was the quickest of the Central European new Member States of the EU behind Slovakia, as well as being one of the most developed behind Slovenia.

The growth on the **supply side** in 2008 was driven by the growth in gross value added (GVA) **[4]** in industry and services (see Table 1). However the robust, more than two-digit growth, in GVA in **industry** in previous years has slowed down considerably. The manufacturing industry was key for the growth in industrial production, particularly the manufacture of vehicles and transport equipment, the electrical and optical equipment industries,

1 A recession is considered to be a quarter-on-quarter decline in GDP in at least two quarters in a row. From this perspective, the quarter-on-quarter decline in the fourth quarter is important, because GDP growth indexes in comparison with the same period of the previous year register important changes in economic development with a certain delay, while quarter-on-quarter data register changes in trends sooner. This plays an important part in the case of a changes in the development of the economy.

the manufacture and repair of machinery and equipment, and the manufacture of rubber and plastic products. However, the strongly export-oriented manufacturing industry is vulnerable as a result of lower foreign demand. A strong decrease in GVA occurred in agriculture, mining and quarrying, and construction. **Services** registered a GVA growth of nearly 4 % and, due to their large share of total GVA (60 % in 2008), contributed substantially to the growth in the economy. The development in individual service sectors varied. The fastest dynamics were registered in trade, banking and insurance. By contrast, GVA in 2008 declined in the hospitality industry, transportation and real estate.

Table 1: Growth of gross value added in industries (annual percentage change)

	2001–2008	2004	2005	2006	2007	2008
Agriculture, fishing and forestry	-2.0	7.8	11.0	-15.6	-11.7	-8.4
Industry (total)	6.2	12.8	9.8	13.4	7.3	6.0
Mining and quarrying	-2.9	14.4	-12.4	0.8	-5.0	-3.7
Manufacturing	7.3	13.2	11.9	14.6	9.2	6.6
Electricity, gas and water supply	1.9	9.1	2.9	9.7	-0.4	5.3
Construction	0.5	5.7	-1.2	7.0	4.7	-6.7
Services	4.2	0.2	5.4	5.7	6.0	3.7
GVA total	4.4	4.5	6.6	7.6	5.9	3.5

Note: GVA at basic prices differs from GDP by taxes and subsidies on products. Source: ČSÚ – quarterly national accounts (June 2009), own calculations.

Industrial production, which is measured by the industrial production index, stagnated in 2008 after strong growth in 2004–2007 and registered a steep fall in the fourth quarter of 2008 (-13.2 %) that also continued in the first quarter of 2009 (-21 %). Practically all industries were hit by the decline in production. This was due to the export orientation of the majority of industries and their dependence on the cyclical nature of foreign demand. While these industries grew rapidly during the expansion of the world economy (mostly due to strong penetration of foreign-controlled enterprises), their exports and production are falling during the world recession.

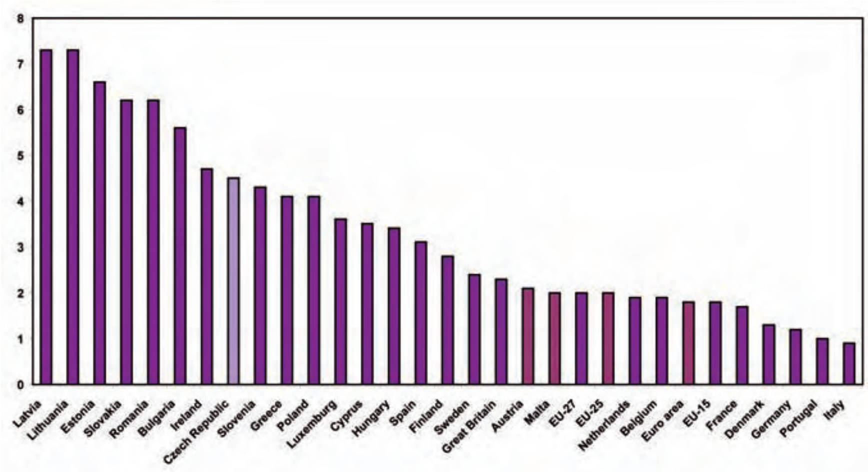
On the **demand side** [**5**], the growth in household demand (consumption and investment) was a fundamental factor for GDP growth in 2001–2008. The only exception was 2005, when foreign trade (net exports) contributed the most to GDP growth. Compared to previous years, the foreign trade balance in goods and services **[6]** registered positive and increasing values due to a strong increase in Czech exports in 2004-2008, and foreign trade became an important growth factor. In 2008 however, primarily in the last quarter of the year, the development in foreign trade reflected the recession in the world economy. The export of goods (excluding services) even registered a real decline of 9.4 % in the fourth quarter (and 21.7 % in the first quarter of 2009). On the domestic demand side, the growth in final household consumption accelerated in 2006 and 2007, which reflected a relatively rapid growth in real disposable household income, whose development was influenced above all by a rise in employment and real wages. The decline in economic activity in 2008 was also reflected in a slowdown in the growth of private consumption. Gross capital formation exhibited considerable fluctuations reflecting the development of reserves, the course of the trade cycle, and the expectations of investors. The development of fundamental demand components is shown in Table 2.

Table 2: Growth of real GDP and final demand components (annual percentage change)

	GDP [1]	Final consumption [7]	Private consumption [8]	Public consumption [9]	Gross capital formation [10]	Gross fixed capital formation [11]	Domestic demand [12]	Export	Import
2001	2.5	2.6	2.3	3.6	6.6	6.6	3.7	11.2	12.8
2002	1.9	3.5	2.2	6.7	4.6	5.1	3.8	2.1	5.0
2003	3.6	6.3	6.0	7.1	-1.4	0.4	4.2	7.2	8.0
2004	4.5	0.9	2.9	-3.5	9.1	3.9	3.1	20.7	17.9
2005	6.3	2.6	2.5	2.9	-0.8	1.8	1.7	11.6	5.0
2006	6.8	3.9	5.0	1.2	9.6	6.0	5.4	15.8	14.3
2007	6.1	3.7	4.8	0.7	9.4	10.8	5.2	15.0	14.3
2008	3.0	2.4	2.7	1.7	-2.3	-0.1	1.1	6.7	4.6

Source: ČSÚ – quarterly national accounts (June 2009), own calculations..

When **compared internationally**, the Czech Republic´s annual growth dynamics of 4.5 % in 2001–2008 ranked eighth among EU-27 countries, which are led by the Baltic states followed by Slovakia, Romania and Bulgaria. Ireland was the only developed western country that reached a higher GDP growth than the Czech Republic (see Figure 2). The slowest growing countries were Portugal, Italy and Germany, where the average annual GDP growth ranged around 1 % in 2001–2008. Czech economic growth outgained that of EU-27, where the average annual GDP growth was only 2.0 % in 2001–2008, and sped up the real convergence process.



Source: EUROSTAT, Structural Indicators (June 2008), own calculations

Figure 2: Real GDP (percentage average annual change in 2001–2008)

During the world crisis, **development forecasts** for the Czech economy for 2009 and 2010 are becoming very difficult. All of the forecasts from 2008 proved to be inaccurate and considerably optimistic. The forecasts of international organisations and the Ministry of Finance from spring and fall 2008 even anticipated an acceleration in economic growth in 2009 compared to 2008. The forecasts from spring 2009 are substantially more pessimistic and the Czech economic outlook is deteriorating rapidly. The main reason is the deepening recession in EU countries, which has a negative influence on Czech exports, the inflow of direct foreign investment, and on the continuing problems in the financial sector that are reflected in the decrease in credits granted to households and businesses. The quantification of the quickly changing conditions is difficult and the latest forecasts indicate a 2–4 % GDP decline in 2009. A projection of the International Monetary Fund from spring 2009[2] anticipates a 3.4 % decline in GDP. This forecast appears to be pessimistic compared to the prediction of the Ministry of Finance from April 2009, which expects a 2.4 % decline in GDP. According to the European Commission[3], the GDP decline in 2009 should amount to 2.7 %. Risks for future development lie primarily in the external environment, which will influence exports, the inflow of foreign direct investment and the prosperity of foreign-controlled businesses. The problems of the financial sector may be intensified by the recession of the real economy. Lower expectations will dampen investment activity and consumer demand. Tougher competition on the world market will require a faster transition from competitive strength based on expenditures and prices to competitiveness based on qualitative factors, primarily on the use of new technologies and high qualifications, and on improvement of innovation effectiveness and of the institutional environment.

2. Structural changes of the Czech economy

Since 1989, the structure of the Czech national economy underwent significant changes, which were related to changing domestic and foreign demand, to price and foreign trade liberalisation, and to extensive privatisation. The biggest structural changes took place in 1990–1995, when it was necessary to overcome the so-called industrialisation structure focused on industry and mainly heavy industry. This was also reflected by the decline in the importance and share of industries that mine and process minerals. In 1995–2008, the structure of the Czech economy changed slowly (Table 3). The share of agriculture in GVA continued to decrease (from 5 % to 2.2 %). Industry retained its share of more than 30 %, and construction maintains its share that ranges around 6.5 %. The share of services increased gradually to 60 %, however it still remains low by international standards (of the entire EU, it reached 71.5 % in 2007). The decline in the share of the mineral extraction industry was more noticeable in total employment than in GVA, which reflects a growth in labour productivity that is above-average in this industry.

The Czech Republic has a relatively low share of services and a high share of industry within the EU. This is due, among other factors, to the country's long industrial tradition. A very steep drop in industrial production occurred at the beginning of the transformation due to the losses of eastern markets, altered domestic and foreign demand, and strong foreign competition after the liberalisation of foreign trade.

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2 IMF: World Economic Outlook, April 2009.

3 ECFIN: Economic Forecast, Spring 2009.

Table 3: Structure of the gross value added (current prices) and employment (in per cent)

	Gross value added			Employment		
	1995	2000	2008	1995	2000	2008
Agriculture and forestry	5.0	3.9	2.2	6.0	4.7	3.4
Industry	31.7	31.6	31.2	29.9	29.8	29.3
Mining and quarrying	2.2	1.5	1.5	1.8	1.3	0.8
Construction	6.6	6.5	6.4	10.1	8.7	8.6
Services	56.7	58.0	60.2	54.0	56.8	58.7

Source: ČSÚ – quarterly national accounts (June 2009), own calculations

A strong revival of industrial production occurred in 2004-2007, as the inflow of foreign direct investments and foreign-controlled businesses began to manifest itself more clearly. The real growth of gross value added **[13]** in industry was enormous in 2004–2007 (an annual average of nearly 11 %), while GVA in industry practically stagnated in the preceding three years. Employment in agriculture, mining and quarrying, and in electricity, gas and water production fell over the long term. In the past five years, employment in the manufacturing industry has risen by an annual average of 1.4 %.

Individual branches of industry developed very differently in 2008. The highest growth was registered in the coke production industry and petroleum refining (10.8 % growth), followed by the manufacture of electrical and optical equipment (9.8 % growth), production of chemical substances, agents, medicine and synthetic fibre (6.1 % growth), and the manufacture and repair of machinery and equipment (2.7 % growth). A decrease was registered in the production of textiles, textile and clothing products (-12.2 %), in the production of food products, beverages and tabacco products (-6.9 %), and in the production of basic metals and fabricated metal products (-2.5 %).

The importance of minerals, measured by this industry´s share of gross value added and employment, is rather small and diminishing in terms of the entire national economy of the Czech Republic. The share of total GVA in mining and quarrying fell from 2.2 % in 1995 to 1.5 % in 2008. The decrease in its share is considerable, even though its share of industrial GVA is higher. In 1995, mining and quarrying had a 6.9 % share of industrial GVA (according to national accounts), and only 4.6 % in 2008. Employment in the mineral extraction industry fell by more than half between 1995–2008 (from 98.1 thousand workers in 1995 to 42.9 thousand in 2008), and the industry´s share of total employment in the national economy fell from 1.8 % in 1995 to 0.8 % in 2008. The lower share of employment than that of GVA shows that labour productivity in this industry is relatively higher compared to the average productivity in the entire national economy.

According to the index of industrial production **[14]** based on the production statistics of selected products (the index of industrial production 2008/2000 equalled 100.1), the mineral extraction industry stagnated in 2001–2008. Production of energy minerals fell over the long term (index 2007/2000 = 89.8) and only production of other minerals registered an average annual growth of more than 4 % in 2001–2007. A decrease of 1.2 % occurred only in 2008. As for energy minerals, mine production of coal, lignite and peat fell, and production of crude oil and natural gas increased (except in 2007 and 2008). However, production of crude oil and natural gas carries very little weight in the entire mineral extraction industry, and the future development of coal mining, which has the largest share of production in the industry, will depend on the development of demand and on solving the issues of ecological-territorial limits in North Bohemia. The position of the mineral extraction industry in the entire national economy is shown in Table 4.

Table 4: Gross value added in current prices (CZK billion)

	2003	2004	2005	2006	2007	2008
Agriculture	72.7	82.8	80.4	74.9	77.8	73.5
Mining and quarrying	26.5	34.2	36.4	36.4	38.5	50.3
Manufacturing	577.7	678.0	704.9	765.5	843.7	838.0
Electricity, gas and water supply	86.8	99.4	103.8	126.0	135.4	150.9
Construction	149.2	164.5	168.0	183.0	204.2	213.0
Services	1429.5	1470.3	1581.2	1721.3	1877.9	2003.4
GVA total in basic prices	2343.1	2529.7	2675.3	2907.7	3178.0	3329.5

Source: ČSÚ – quarterly national accounts (June 2009).

From a macroeconomic perspective **[15]**, the low and diminishing importance of mining and quarrying is due to the Czech Republic's relative mineral scarcity (except for coal and construction minerals) and dependence on import of important energy and other minerals (especially crude oil and natural gas), and also due to ongoing structural changes resulting in the declining importance of a mineral-dependent industry. According to tables of inter-industry relations **[16]** for 2005, a decisive part of resources (domestic production and import) of the mineral extraction industry is used for intermediate consumption. According to the OKEČ **[17]**, two industries – production of coke and nuclear fuel, and petroleum refining (DF), and electricity, gas and water supply (E) – are the largest consumers of the CA subindustry (coal, lignite and peat; crude oil and natural gas; uranium and thorium ores – only uranium ores in the Czech Republic). The CB subindustry (other minerals) has three major consumers – production of other non-metallic mineral products (DI), production of basic metals and fabricated metal products (DJ), and construction (F). The weight of the DI and DJ subindustries in total industry is relatively large (20 % of industrial production), and the importance of domestic minerals also have to be assessed based on the weight of manufacturing industries, which exploit them, in the national economy. Environmental aspects are also an indispensable factor because, for the most part, the mining industry has a negative effect on the environment.

Calculated at current prices, the GVA of the mineral extraction industry grew annually in 2004–2008 except in 2006. The industry registered strong growth in 2008, due to a sharp rise in prices (GVA registered a real decline of 3.7 % in 2008). The price deflator of GVA **[18]**, reflecting the growth in prices in the mineral extraction industry, increased by 35.6 % in 2008.

3. World economy trends

The development of the world economy deteriorated rapidly during the course of 2008 and in the first half of 2009. After years of strong expansion, the world entered an uncertain and very difficult period affected by the global financial crisis and by recession in the majority of countries. A comparison with the past shows that this will be the deepest recession in the post-war era, which is moreover global and which will last for a relatively long time. The anticipated revival in 2010 will probably be weak. The effects of the financial crisis were clearly reflected in the real economy in the second half of 2008 and then primarily in the fouth quarter, and the majority of developed countries slid into recession.

The initial cause of the global crisis was the **financial crisis**, which began with a mortgage market crisis in the USA in mid-2007 and which gradually spilled into the entire financial system, not only in the USA but also in other countries. In September 2008, the financial crisis spread dramatically in connection with the collapse of the large Lehman Brothers bank, followed by a second wave that spilled into developing economies. IMF labeled this crisis as the worst since the Great Depression in 1929. A number of factors led to the crisis, e.g. prior sufficiency of liquidity, strong growth in credit and asset prices (primarily real estate) as well as grants of loans to clients incapable of paying them off. Complex capital and high-risk transactions using sophisticated financial instruments, and insufficient transparency in and regulation of the financial market also had an negative effect. The financial system crisis is characterised by a strong increase in losses at finacial institutions from bad assets, by bankruptcies of some large financial institutions, by growing mistrust in the financial system, by the reluctance to lend to one another, and by credit restrictions. In a global and considerably liberalised financial system, the crisis spread from the USA to Europe and other countries. According to IMF, total losses in the USA, Europe and Japan may possibly reach USD 4.1 trillion of a total asset value of 58 trillion (USD 1 trillion has already been written off). Two thirds of the losses will be at the expense of banks. Thus the dramatic development of the financial market increased the risks for future development. The serious financial sector problems are aggravated by the ongoing recession, the decline in real estate and asset prices, and by the continuing global macroeconomic imbalance.

The spill-over into the real economy is occurring through various channels. A direct impact is is reflected in a credit crunch, which is lowering consumer and investment demand. The decline in asset and real estate prices is leading to considerable losses of wealth with the effect of lowering demand. The losses of banks and other financial institutions are increasing mistrust on financial markets. The global nature of the crisis is worsening the external environment, and the slump in demand and foreign trade has a chain reaction in a globalised and highly interconnected world economy. Emerging and developing economies, which greatly depend on imports, have been hit hard by this channel. World trade fell by 24 % (annualised) in the fourth quarter of 2008 and a similar decline also occurred in the first quarter of 2009. This was the biggest drop after World War II. In addition, the financial crisis and loss of confidence are leading to a decrease in capital flow between countries, and countries with considerable current account deficits are having big problems with financing them.

The world crisis has a negative impact on employment and the **rise in umemployment** is becoming a serious social problem. According to ILO (International Labour Organisation) estimates, the number of unemployed in 2009 could rise by 40 million. Experience of past recessions show that the labour market recovers slowly and that the rise in unemployment will also continue in 2010. According to IMF, the rate of unemployment in developed countries will probably rise from 5.8 % in 2008 to 9.2 % in 2010. The majority of large countries will register an unemployment rate exceeding 10 % (USA, Germany, France, Italy, Spain) in 2010. Spain (19.3 %), followed by Ireland (13 %), will probably have the highest unemployment rate.

The danger of **inflation** as a result of the rapid rise in commodity prices (primarily crude oil, food and agricultural raw materials) in 2007 and in the first half of 2008 was staved off by a strong decline in world commodity prices in the second half of 2008 and at the beginning of 2009. The main reason for the fall in prices was lower demand due to the recession in developed countries and to the decline in economic activity in rapidly developing countries such as China and India. Supply reacted slowly resulting in an increase in commodity stocks. The fall in crude oil prices from its peak in July 2008 along with a moderate increase in wages led to a considerable decline in prices. The inflation rate in developed countries dropped below 1 % in February 2009 and a stagnation in consumer prices is expected throughout the year. In connection with this, there are growing worries about deflation, which could further decrease economic activity as in the case of Japan in the 1990s or during the Great Depression in the 1930s.[4]

The unbalanced development of the world economy led to high current account deficits in one group of countries (USA and a number of developing and emerging countries) and to large surpluses in other countries, e.g. Japan and China. In the past, current account balances adapted rather rapidly to external shocks via changes in interest rates, and by slowing down demand and economic growth. In addition, the exchange rate channel **/19/** also had an effect. Sufficient financial resources also existed and the financial system allowed for a generally smooth transfer of resources from countries with a savings surplus to countries with a savings deficit. However, the financial crisis weakened capital flows between countries as well as the willingness of foreign banks and investors to finance current account deficits of countries, which are in a very serious economic situation and which include not only a number of developing countries, but also Central and Eastern European countries such as Ukraine, the Baltic states, and Hungary.

The **complexity of the situation** and the uncertain global economic outlook are also complicating **economic policies.** An immediate challenge lies in the stabilisation of the financial system, and preventing a sharp drop in economic activity, high unemployment and protectionism in foreign trade. The main priority and requirement for a sustainable revival lies in healing the financial system. In order to **stabilise the financial system** and to save a number of large banks, central banks and governments provided enormous public funds. The majority of governments in developed countries adopted **stimulation packages**, which were allocated enormous budgetary resources. As a result, however, the situation of public budgets, which plunged into large deficits, worsened considerably. To support demand, central banks lowered interest rates substantially and, in a number of countries, this instrument has basically been exhausted.

Structure of the world economic growth

In 2008, the developed countries of the world greatly slowed down economic growth, and the effects of the financial crisis manifested themselves dramatically in the real economy in the second half of the year and then primarily in the fourth quarter, and most of the developed countries slid into recession. However, the actual GDP growth for the entire year of 2008 (global GDP of 3.2 % and GDP of developed countries of nearly 1 %) conceals large disparities in the individual quarters of the year, and only the results for the last quarter of 2008 show the depth of the slump. The GDP of developed countries fell by nearly 8 %

4 Deflation is dangerous for companies whose earnings and profits decrease due to low prices, and for debtors whose real debt increases. Weakened economic activity then deteriorates and increases the number of companies going bankrupt.

and a roughly similar decline was also registered in the first quarter of 2009. Emerging countries were hit by the crisis later on and their GDP fell by 4 % in the fourth quarter. This was caused by the financial crisis and trade slump in Asian, Central and Eastern European countries, which depend highly on export. The depth and length of the recession are influenced by the fact that this is a global crisis, in which the financial crisis was the fundamental cause of the recession, which is again manifesting itself negatively in the financial sector.

The dramatic changes in the development of the world economy demonstrated that the forecasts in fall 2008 and at the start of 2009 were overly optimistic. The last IMF prognosis from April 2009 is far more pessimistic and the global GDP will probably fall by 1.3 % (measured in PPP – see Table 5) in 2009. IMF expects the GDP to fall by 3.8 % in developed countries, even in spite of the enormous resources allocated to stabilise the financial sector and strengthen demand. This will be the deepest recession of the post-war era. The production decline will be accompanied and deepened by a sharp drop in world trade (by an unprecedented 11 % in the post-war era). Emerging countries will probably sustain a positive growth (1.6 %). Only a slight revival of the world economy is expected in 2010 (1.9 % growth) and the economies of developed countries will probably stagnate. Even if the world economy recovers, a relatively long period must be reckoned with, during which growth rates will be considerably lower than in the recent past.

Table 5: IMF projection of real GDP (annual percent change)

	2007	2008	2009 Projection
GDP – world	5.2	3.2	-1.3
USA	2.0	1.1	-2.8
EU	3.1	1.1	-4.0
Japan	2.4	-0.6	-6.2
China	13.0	9.0	6.5
India	9.3	7.3	4.5
Russia	8.1	5.6	-6.0
Emerging countries	8.3	6.1	1.6
World trade	7.2	3.3	-11.0

Note: A country´s weight in global GDP is based on purchasing power parities (PPP), which increase the importance of less developed economies in total world growth. By using real GDP growth calculated at current exchange rates, the real GDP growth of the world economy would decrease by about 1 percentage point. The growth of the world real GDP would be 2.1 % in 2008 and -2.5 % in 2009 on the basis of exchange rates. Source: MMF – World Economic Outlook, April 2009.

The development in **European Union** countries is important for the **Czech Republic**, because it directs 85 % of its exports at and obtains the majority of foreign investment from them. In 2006 and 2007, the EU accelerated its growth dynamics by an average of 3 % annually. In fall 2008, the financial crisis grew to dangerous levels, economic activity declined, and the majority of countries slid into recession. Nevertheless, there are considerable differences between individual countries, and the impacts of the financial and real estate market crisis, the decrease in demand, and the deteriorated external environment hit individual countries to various degrees. Economic and financial stability became a priority of monetary and fiscal policies. The growing losses and bank collapses, a badly functioning interbank market, and credit restrictions required the intervention of the European Central Bank (ECB) and banks of member states. The measures to stabilise financial markets include the provision of necessary liquidity, the increase of capital at important financial institutions, the safeguarding of client deposit, transparency, international coordination and heightened accountability of shareholders and management. By February 2009, the majority of member states adopted measures to save the banking system, which amount to EUR 300 billion for bank recapitalisation and EUR 2 400 billion for various guarantee schemes. The intervention aims to stabilise the financial system, to stimulate the interbank market, and to revive continuous credit flow to the real economy. In November 2008, the European Commission adopted the European Economic Recovery Plan, which was approved by the European Council in December 2008. The goal is to reduce the impact of the financial crisis on the real economy and to renew confidence in the functioning of the market economy. The plan contains measures allowing for an increase in domestic demand and supports projects based on the Lisbon Strategy.

The projection of the European Commission from April 2009[5] anticipates the growth dynamics of EU-27 to fall from 0.9 % in 2008 to -4 % in 2009 and to -0,1 % in 2010. The recession deepened in the first quarter of 2009, primarily due to a decline in foreign trade coupled with a decrease in industrial production. That increased uncertainties as well as risks for future development. Amid this situation, it is difficult to estimate when the revival of the economy will occur. It cannot be ruled out that the recession may linger longer than expected, or that it may come earlier and be stronger. The decline will probably be particularly strong in large European economies such as Germany, Great Britain and Italy. A decline of nearly 6 % in 2009 awaits the German economy, which is the recipient of more than 30 % of Czech exports. The reason is a sharp drop in export, which was one of the fundamental growth factors in the past.

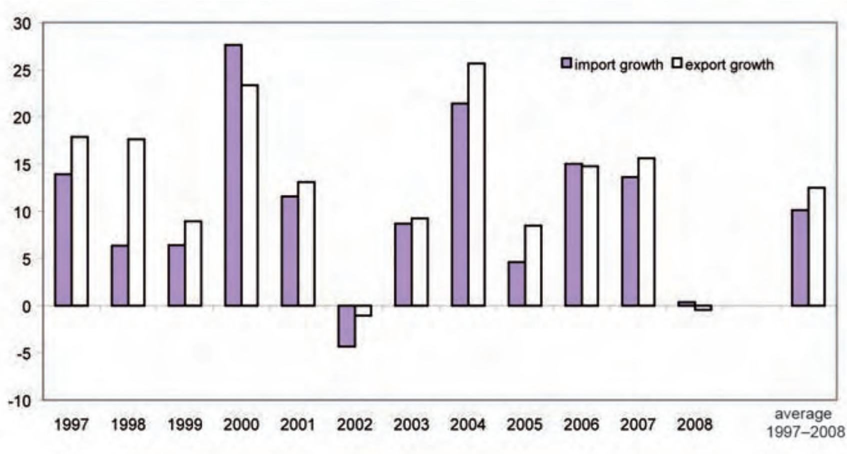
4. Foreign trade and external economic balance [20]

The development of foreign trade plays a dominant role in the development of the Czech economy, because it is quite open**,** and because of the strong inflow of foreign capital and entry into the EU, important changes are taking place in foreign trade – exports are increasing rapidly, their structure, technical level and prices are changing, and considerable changes in terms of trade **[21]** are occurring. On the other hand, this strong pro-export orientation represents a problem, which manifested itself in a strong external demand shock in connection with the existing financial crisis and with the onset of recession in the main trading partners of the Czech Republic.

The considerable importance of foreign trade for the Czech Republic results from the high share of the export value of goods and services in GDP, which reached 77.0 % for exports and 72.1 % for imports at current prices in 2008. In recent years, the very good results of Czech foreign trade point to the growing competitive strength of production, which is gaining ground in challenging markets. This is also supported by the fact that the foreign trade balance has improved considerably, even in spite of the decline in economic activity in old EU countries in 2001–2005, and then primarily in the Czech Republic´s main trading partner, Germany. From a macroeconomic perspective, it is also important that foreign trade in goods and services has become an important factor in GDP growth on the demand side in recent years. While double-digit growth rates of exports and imports were registered in 2006 and 2007, a strong slowdown in year-on-year growth rates of exports and imports

[5] European Commission, Directorate-General for Economic and Financial Affairs: Economic Forecast, Spring 2009, Brussels.

occurred in 2008 – see Figure 3. The comparison of the long-term (twelve-year) growth rates of both magnitudes (in 1997–2008) shows that, in the case of Czech export of goods, the average rate was 12.5 % and that it exceeded the average growth rate of imports (10.1 %) by more than two percentage points.

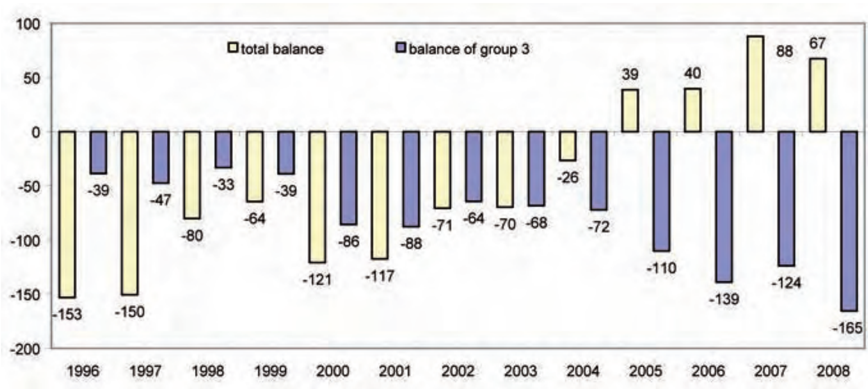


Source: ČSÚ (June 2009), own calculations

Figure 3: Imports and export of goods, 1997–2008 (annual percentage change, current prices)

In 2007, the trade balance surplus reached its highest level in the history of the Czech Republic (CZK 87.9 billion). In 2008, it fell by CZK 20.5 billion to CZK 67.5 billion. Although a year-on-year decline was registered, the result for 2008 was very favourable (the development of the balance in the first three quarters even surpassed the record year of 2007) and may be regarded as an emphasis of the competitive strength of Czech export in a turbulent and relatively unfavourable economic environment. This result was also partially aided by the exchange rate of the Czech crown, which returned to the values of 2002 and 2003 after considerable appreciation (overshooting long-run equilibrium paths) in previous years. This undoubtedly helped exporters vying for customers, because it created room to react to the declining demand via price and non-price schemes. Generally, it is possible to consider not only the entry of the Czech Republic into the EU as one of the factors leading to favourable foreign trade results, but also mainly the strong inflow of foreign direct investment directed at industries with a high share of exports (e.g. manufacture of transport equipment, telecommunication equipment, consumer electronics and computer technology) and the gradual diversification of trading partners (and export markets), which allows for the slowdown in the boom of the main Czech trading partner (Germany) to be compensated by exporting to other markets in the EU and the world.

In terms of commodities, the highest deficit is still generated by group 3 (mineral fuels, lubricants and related materials – see Figure 4). In terms of destination, export increased the most to the Commonwealth of Independent States (CIS) (by more than 15 %) with a share of 4.3 %. The EU-27 countries, which account for more than 85 % of Czech exports and for nearly 67 % of Czech imports, retain the dominant position. Germany is the main

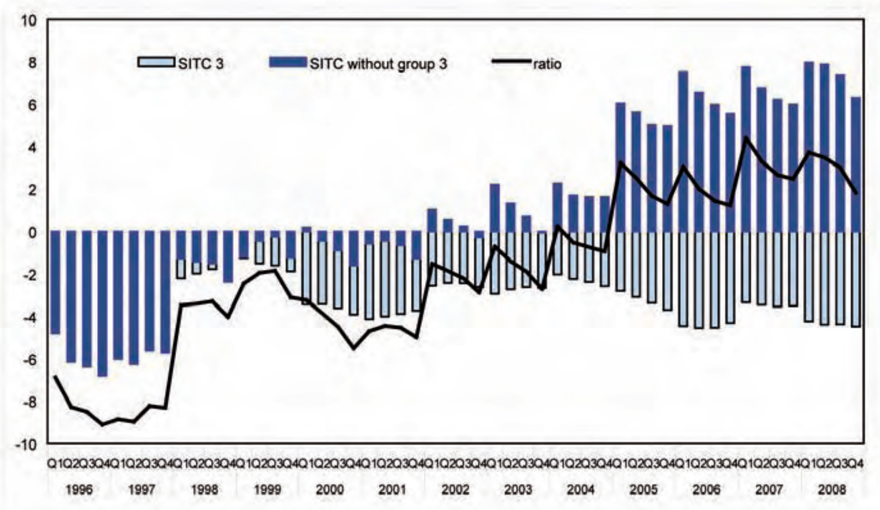


Note: according to SITC Rev. 4, group 3 includes mineral fuels, lubricants and related materials. Numbers for 2008 are preliminary. Source: ČSÚ (2009), Foreign Trade Statistics (June 2009).

Figure 4: Balance of foreign trade, 1996–2008 (in CZK billion)

trading partner and, over several years, its share has already stabilised at nearly 31 % of Czech exports and at around 28 % of Czech imports (its share has slowly been falling in recent years). Slovakia´s share has remained more or less constant for several years (9 % of export) and its share of imports has been increasing gradually (more than 5 % in the past five years). The Slovak Republic, therefore, still maintains a important position. In the past few years, the share of imports from China (in 2008 nearly 9 % of total imports, with an insignificant export volume of around 0.7 %) or Russia rose sharply. In terms of exports, the shares of Poland, Austria, Russia or France are increasing (values for Italy or the United Kingdom are stagnating between 4-5 % of total Czech exports). This represents the desired diversification of Czech exports and a limitation of a relatively high dependence on a single (German) market. The Czech Republic has considerable trade surpluses with EU countries (Germany, Slovakia, the United Kingdom or France) and, on the other hand, foreign trade deficits with CIS countries (Russia), Asian economies (primarily China – nearly CZK 200 billion), other developed markets (Japan, South Korea, Taiwan), and with some developing economies (e.g. Thailand).

The development of the foreign trade balance (cumulative quarterly balances) is shown very clearly in Figure 5. While SITC 3 group registered a relatively stable deficit value for the entire monitored period, which changed mainly due to the influence of imported raw material prices and exchange rate fluctuations, a gradual improvement in the export performance of the Czech economy is evident in other groups. The influence of the changes in raw material prices, which began to show itself in the growth of the balance deficit of group 3 (since 2004) and which influenced the total foreign trade balance significantly, is striking. The temporary stabilisation in 2007 was followed again by a rise in 2008 to the values of 2006, caused by two conflicting factors (an increase in raw material prices and the strengthening of the Czech crown in the first half of the year were followed by falling raw material prices and the weakening of the crown during the second half of 2008). To a large extent, both factors compensated one another and the resulting balance in relation to GDP, therefore, remained nearly unchanged.



Note: according to SITC Rev. 4, group 3 (SITC – Standard International Trade Classification) includes mineral fuels, lubricants and related materials. The Ratio is the difference between total balance (excluding group 3) and the balance of group 3. Numbers for 2008 are preliminary. Source: ČSÚ (2009), Foreign Trade Statistics, quarterly national accounts (June 2009), own calculation.

Figure 5: Trade balance, 1996–2008 (in per cent of GDP, annual moving average)

Although the total foreign trade balance fell year-on-year by CZK 20.5 billion in 2008, the development of individual groups varied. The trade deficit in the case of mineral fuel and lubricant imports grew year-on-year due to the weakening Czech crown (from CZK 123.8 billion in 2007 to CZK 164.5 billion for 2008, i.e. by more than CZK 40 billion). The trade deficit in chemical products fell slightly (from CZK 104.3 billion to CZK 99.8 billion), and also the deficit in food and live animals decreased year-on-year (from CZK 31.1 billion to CZK 27.2 billion). Group 1 (beverages and tobacco) reached a surplus in 2008 (CZK 3.7 billion from a deficit of CZK 1.3 billion). The increased deficit in mineral fuel imports was compensated by surplus growth in manufactured goods classified chiefly by material (group 6, by CZK 8.1 billion year-on-year) and primarily in group 7 (machinery and transport equipment), which is the most dominant group in terms of Czech foreign trade and which continued its sharp rise (a year-on-year improvement of CZK 19.1 billion), specifically from CZK 315.4 billion in 2007 to CZK 334.4 billion in 2008.

In recent years, two groups have dominated Czech export – manufactured goods classified chiefly by material (group 6) and then mainly machinery and transport equipment (group 7). The latter increased its share of total exports from 32.8 % in 1996 to 53.6 % in 2008 (see Table 6). By contrast, the shares of all other groups declined. The shares of group 2 and 3, which are closely linked to the mineral extraction industry, fell from 9.3 % in 1996 to 6.1 % in 2008, despite their gradual growth in the past three years (2005–2008). In terms of imports, a gradual increase in the share of mineral fuels, lubricants and related materials, specifically to 10.4 % of total imports in 2008, can be observed in the past two years. Therefore, last year surpassed the highest value of 9.6 % thus far, which was recorded in 2000, and halted the falling trend observed in recent years. This strong fluctuation of the share was caused primarily by considerable changes in the prices of crude oil and natural gas, and also by the strengthening of the Czech crown in 2004–2007. This group has a substantially higher share of imports than exports, which also results in a very high and growing negative balance (see Figure 4 above).

Table 6: Commodity structure of foreign trade, Czech Republic, selected years (in per cent)

SITC (Rev. 4 Section/Code)	Export				Import			
	1996	2000	2005	2008	1996	2000	2005	2008
0, 1 – Food and live animals, beverages and tobacco	5.0	3.7	3.8	3.9	6.6	4.6	5.1	4.9
2 – Crude materials, inedible, except fuels	4.8	3.5	2.5	2.6	3.7	3.2	2.8	2.6
3 – Mineral fuels, lubricants and related materials	4.5	3.1	3.1	3.5	8.7	9.6	9.2	10.4
4 – Animal and vegetable oils, fats and waxes	0.2	0.1	0.1	0.1	0.3	0.2	0.2	0.2
5 – Chemical and related products	9.0	7.1	6.4	5.9	11.9	11.2	11.0	10.3
6 – Manufactured goods classified chiefly by material	28.6	25.4	21.7	19.6	19.3	20.8	20.5	19.8
7 – Machinery and transport equipment	32.8	44.5	50.8	53.6	38.0	40.0	40.3	41.3
8, 9 – Miscellaneous manufactured articles	15.1	12.6	11.6	10.9	11.5	10.4	11.0	10.6

Note: Numbers for 1996 and 2000 respect the methodology used since 1. 7. 2000. Numbers for 2008 are preliminary, but revised at the end of February 2009. Source: ČSÚ – Foreign Trade (June 2009).

The development of selected import and export commodities is given in Table 7.

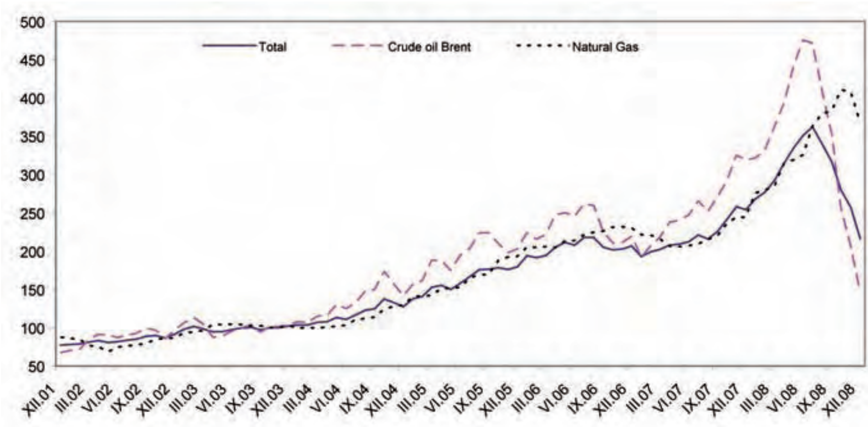
Table 7: Foreign trade – selected commodities (thousands tonnes)

	Export			Import	
	Cement	Kaolin	Limestone	Crude oil	Iron ore
1999	1 559	428	239	5 997	5 357
2000	1 494	443	305	5 819	6 933
2001	866	455	270	6 005	6 891
2002	466	445	212	6 082	6 812
2003	562	442	103	6 344	8 222
2004	747	484	140	6 406	7 639
2005	559	271	124	7 730	6 807
2006	496	261	162	7 752	7 987
2007	646	249	98	7 147	5 256
2008	664	239	109	8 142	6 803

Note: Numbers for 2007 are final, numbers for 2008 are preliminary. Source: ČSÚ (2009), Social and Economic Indicators of the Czech Republic 1990 – 4 Q 2008.

While the export of some traditional raw materials is gradually declining (except for cement, which registered a sharp increase in 2007 and only a slight year-on-year increase of 2.8 % in 2008), the import of energy minerals in 2008 registered a sharp surge in crude oil (to more than 8 million tonnes)[6] and also iron ore, which halted its fall from 2007.

The development of the trade balance is to a considerable extent influenced by the development of the **prices of raw materials**, which are imported into the Czech Republic (as shown above). Global prices of industrial commodities and food have risen in the past few years (see Figure 6). This already resembles the situation at the beginning of the 1970s and during the period of the second oil shock.[7] The negative impact on foreign trade results was suppressed by the movement of the exchange rate (appreciation **[22]** of the Czech crown against the dollar).[8] The continuously rising prices fell only in the second half of 2006, however the rising trend resumed at the start of 2007 and, thus far, crude oil prices reached their highset levels.



Note: ČSÚ ceased to publish the values of this index in January 2009. Source: ČSÚ (2009), own calculations

Figure 6: ČSU index of world prices of industrial commodities and food, December 2001–December 2008 (average of 2000 = 100)

6 One can only speculate about the possible effect of the conflict regarding the transit of energy minerals (natural gas) between Ukraine and Russia, which escalated at the end of 2008 and at the beginning of 2009, on the actual crude oil volume imported into the Czech Republic (effort to stock up).

7 If the highest price per barrel of Brent Crude (quoted on the New York Mercantile Exchange) during the second oil crisis in the amount of USD 39.50 from April 1980 is taken into account, then a barrel of crude oil would cost approximately USD 103.76 recalculated to reflect the present value of money (today, 1 USD from 1980 has a value of USD 2.61 – based on the consumer price index). During the first oil crisis, the price did increase from about USD 3 to USD 12 per barrel (1974), however at today´s prices that amounts to only USD 52.29. The record from 1990, due to the Persian Gulf War (USD 40.42 per barrel), amounts to only USD 66.44 per barrel after being recalculated at today´s prices. The present record value was reached in June – USD 139.89 per barrel. Since then, the price of crude oil has fallen sharply to values ranging between USD 40–50 per barrel (December 2008). The price remained in this range until mid-April, when it began to rise again. At the time of writing (June 2009), the price fluctuated in a relatively narrow range at around USD 70 per barrel.

8 However, the persisting high energy demand of the Czech economy, which is also reflected in increased raw material imports, is problematic.

The development of raw material prices is also reflected in the development of the terms of trade, which deteriorated by 1.3 % year-on-year in 2008, when favourable values from the first four months of the year were followed by a decline and neither renewed growth nor considerable improvement at the end of the year (November and mainly December) could compensate for the unfavourable development for the entire year. After improvement in 2007 (by 2.3 %), 2008 thus represented the third year in the past four, when the terms of trade declined (in 2005 and 2006, terms of trade fell by 1.0 % and 1.5 %, respectively). In the first months of 2009, an exceptionally favourable situation lingered from the end of 2008, and the terms of trade amounted to 103.5 % on average in the first quarter compared to the same period in 2008 (103.3 % in the last quarter of 2008). The workhorse responsible for this improvement were the improved terms of trade in mineral fuels, intermediate products and transport equipment.

Table 8 summarises crude oil prices and the cumulative index, which reflect the development of mineral prices except for mineral fuels. That way, the price fluctuations in 1998–1999, 2000–2001 and the gradual rise in 2002–2008 are very visible. The impact on the trade balance and, consequently, on businesses can be estimated based on the development of the index in CZK, which, apart from crude oil prices, also reflects the development of the exchange rate of the Czech crown against the USD. The impact was more pronounced in some years (in 2000 the USD reached historical values against the CZK) or, more precisely, the unfavourable development of prices was suppressed by the strengthening crown (e.g. this trend is really noticeable in 2004–2005) and a renewed slight decline was suppressed by the depreciation of the CZK in 2006–2007 and partially in 2008. The index of non-energy commodity prices was influenced by a sharp rise in food and raw material prices, which however became an investment instrument for international investors in addition to the rising consumption in a number economies worldwide (e.g. China, India, some Latin American countries). As a result, price fluctuations are becoming more pronounced in both directions.

Table 8: Changes in average prices of commodities in 1996–2008

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Crude oil	USD/barrel	20.5	19.1	12.7	17.8	28.3	24.4	25.0	28.8	38.3	54.4	65.4	72.7	97.7
Brent	*SOPR = 100*	*119.9*	*93.5*	*66.5*	*140.0*	*159.0*	*86.2*	*102.5*	*115.3*	*133.0*	*142.0*	*120.2*	*111.2*	*134.4*
Index in CZK	2000 = 100	50.8	55.5	37.6	56.1	100.0	85.0	74.9	74.5	90.2	119.3	135.3	135.1	150.3
	SOPR = 100	*122.5*	*109.3*	*67.7*	*149.2*	*178.3*	*85.0*	*88.1*	*99.5*	*121.1*	*132.3*	*113.4*	*99.9*	*112.7*
Index NFC [1)]	2000 = 100	124.9	120.4	104.6	95.9	100.0	95.2	97.0	102.8	122.2	121.7	154.7	176.6	273.2
	SOPR = 100	*98.8*	*96.4*	*86.9*	*91.7*	*104.2*	*95.2*	*101.9*	*105.9*	*118.9*	*102.8*	*123.2*	*114.1*	*154.8*
Index NFC [2)]	2000 = 100	86.9	98.4	85.8	85.8	100.0	93.9	83.0	74.7	81.9	78.1	97.5	104.0	103.1
	SOPR = 100	*100.4*	*113.2*	*87.2*	*100.0*	*116.3*	*93.9*	*87.7*	*91.3*	*108.3*	*95.8*	*116.4*	*102.4*	*95.5*

Note: the average is based on spot prices. SOPR – previous year = 100. NFC – Nonfuel commodities. Values are annual averages. [1)] on USD basis, [2)] on CZK basis. Source: MF ČR (Macroeconomic Predictions, various years), own calculations.

The external economic balance, which is evaluated based on the current account balance, registered a pronounced change in its structure in 2005–2008. The income balance replaced the trade balance as the main source of the current account deficit in 2004. The income balance deficit was not even compensated for by a growing trade balance surplus in goods and services, which went from a deficit exceeding 2 % of GDP annually in 2001–2003 to a growing surplus that reached 2.8 % of GDP (a year-on-year decline). In previous years, the inflow of foreign direct investment, the entry of the Czech Republic into the EU, and a change in the demand of major trading partners influenced the strong growth of Czech export favourably.

The current account balance in 2008 was influenced by both a year-on-year fall in the trade balance surplus and a renewed year-on-year deepening of the income balance deficit. A slightly improved year-on-year services balance (2.2 % of GDP) contributed to stabilise the current account deficit of the Czech Republic at 3.1 % of GDP. The pure outflow of primary income abroad in 2008 in the form of wages, reinvested or repatriated profits and interest represented 7.8 % of GDP, and lowered the national income of the Czech Republic considerably. This amount corresponds the difference between the gross national income **[23]** of the Czech Republic and the GDP. Along with some other countries such as Ireland and Hungary, the Czech Republic is becoming a country that is losing a significant part of the created value, which cannot be used for consumption or investment. Reinvestment and repatriation of profit will also be the main source of the current account deficit in the future, specifically due to expected restrictions on (re)investment of profit in existing companies and due to the continuing income flow to parent companies abroad.

Table 9: Current account balance (as per cent of GDP)

	Current account	Balance of trade	Balance of services	Balance of incomes	Current transfers
2001	-5.3	-5.0	2.5	-3.6	0.8
2002	-5.5	-2.9	0.9	-4.7	1.2
2003	-6.2	-2.7	0.5	-4.7	0.6
2004	-5.2	-0.5	0.6	-5.6	0.2
2005	-1.3	2.0	1.2	-4.8	0.2
2006	-2.6	2.0	1.4	-5.6	-0.4
2007	-3.1	3.4	1.6	-7.6	-0.5
2008	-3.1	2.8	2.2	-7.8	-0.3

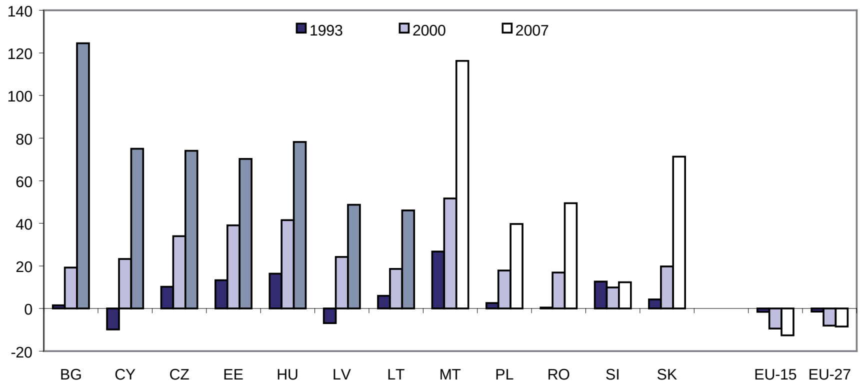
Source: ČNB (2009), Balace of Payments Statistics, own calculations.

In the past four years, the current account deficit of the Czech Republic stabilised at an annual average of 2.5 % of GDP (see Table 9). That is significantly more than the average deficit of the developed countries of EU-15, however it is an acceptable imbalance for an economy at a lower economic level, which is gaining on the level of income in developed countries. The Czech Republic had the lowest current account deficit of the twelve new Member States of the EU in 2007 and 2008.[9] In terms of national economy, the current account deficit is the result of insufficient national savings in relation to investments. This

[9] Other new member states registered much higher current account deficits, in a number of cases even above the threshold recommended by international organisations (5 % of GDP). In 2008, Bulgaria had a deficit of 25.3 % of GDP, Romania 12.2 % , Estonia 9.2 %, Lithuania 11.6 % and Latvia 12.7 %.

gap has to be financed with foreign sources. While the entrepreneurial sector increased its ability to generate savings and improved its profitability considerably, households lowered their ability to generate savings significantly and their measure of savings is on a very low level compared to developed EU countries. The negative gap between savings and investments is generated mainly by government and household sectors.

Foreign direct investments (FDI) became an important factor in growth in new Member States of the EU including the Czech economy. In the case of the Czech Republic, their inflow intensified after 1998 in connection with the acceptance of investment incentives and the continuing privatisation and restructuring of businesses. In 2007, the Czech Republic ranked third among the ten new Member States of the EU (behind Bulgaria and Hungary) in cumulative net FDI in % of GDP (74.0 %).[10] Approximately 37 % of the total volume of FDI was directed at the Czech manufacturing industry (this share has been declining in recent years, which benefits some services sectors). The influence of foreign-controlled businesses also increased significantly with the inflow of FDI. In the sector of non-financial enterprises, these businesses accounted for nearly 51 % of book value added in 2008, their share of employment reached 41 %, and their share of total output amounted to more than 54 %. A clear difference between the productivity of foreign-controlled businesses and private or non-financial businesses continues to exist, although it has diminished considerably in recent years (in 2008, the productivity of public and private enterprises reached nearly 83 % and 63 % of the productivity of foreign-controlled enterprises, respectively). In the case of private industrial enterprises with more than 20 employees, foreign-controlled enterprises accounted for 59 % of total income and their share of employment exceeded 46 % in 2008 (mostly due to the start-up of some operations in the electrical and automotive industries).



Note: EU-15 = old EU Member States. Net stock = the difference between stock of FDI in a country and stock of that country abroad. Numbers for 2007 are preliminary. Source: UNCTAD (2009), FDI database; ECFIN (2009), own calculation.

Figure 7: Stock of FDI in new EU Member States (inward, share of GDP in per cent)

10 According to data of the United Nations Conference on Trade and Development (UNCTAD), in 2007 the Czech Republic was first (ahead of Estonia and Hungary) among new Member States of the EU, excluding Cyprus and Malta, in terms of the cumulative amount of FDI (inward) per capita (nearly USD 9.2 thousand).

In the past three years, a striking qualitative change in the structure of FDI directed at the Czech economy has also occurred. The majority of investments are not financed with the capital of parent companies, but generated by companies (affiliates) in the Czech Republic, i.e. reinvested earnings. The onset of reinvestment in the Czech Republic started in 1998 and its extent and importance in relation to the total investment activity of foreign companies varied substantially in individual years. Initially, its importance was entirely marginal. However, it increased gradually with the generation of profits by foreign-controlled enterprises (in accordance with the so-called investment life cycle). In 2003, reinvestments practically represented the only source of FDI inflow and, in 2004 and 2005, they reached nearly CZK 80 billion annually and generated a substantial source of financing the investments of foreign-controlled enterprises. In 2006–2007, reinvestments greatly exceeded the actual FDI inflow in the form of equity capital. According to preliminary ČNB data, they reached nearly CZK 125 billion in 2008 and accounted for more than 68 % of FDI volume.

The importance of foreign capital measured by the cumulative inflow of foreign direct investment into the mineral extraction industry corresponded roughly to the industry´s share of GDP (see Table 10). Investments in industries declined in 2008, specifically in connection with the end of the commodity market boom that lasted several years and with the spread of the financial crisis to other countries and economic sectors worldwide. Thus, a number of originally planned investments were held back or suspended due to sufficient and exisiting capacities. This is reflected in the fall in both direct (new) investment capital, corresponding to only 0.7 % of the total volume of new capital invested in the Czech Republic in 2008, and reinvested earnings (0.3 % of the total volume of reinvested earnings in 2008). Businesses from Germany, Austria, the Netherlands, Luxembourg and Russia are major investors in the Czech Republic.

Table 10: Stock of foreign direct investment in the Czech economy, as of December 31, 2008 (cumulation by the end of time-period, in CZK million)

	Equity capital	Reinvested earnings	Other capital	Total
Total amount	1 145 771.4	872 310.8	196 825.5	2 214 907.7
Mining and quarrying	35 437.8	23 506.0	-1 691.9	57 251.9
Share of mining and quarrying (in per cent)	3.1	2.7	*x*	2.6

Note: values for 2008 are preliminary. Source: ČNB (2009), Balance of Payments Statistics, own calculation.

The flow of Czech foreign direct investment abroad is, also with regard to the structure of the economy (see Table 11), substantially lower. Yet in recent years, Czech capital has with increasing success continued to penetrate foreign markets and thus also into foreign companies, which supply domestic markets or provide supplies of raw materials and intermediate products (for example coal mining in Poland, and exploration and production of crude oil and natural gas in African countries and CIS countries by the Moravské naftové doly company). There however, they face strong competition from large enterprises (state-owned and with a strong capital position), e.g. from Russia, China or India.

In terms of FDI volume, 2008 equalled 2007, when the total FDI volume reached CZK 32.4 billion (compared to CZK 32.9 billion in 2007), and thus represents the third year in a row that the volume exceeded CZK 30 billion (for now, 2006 holds the record with CZK 33.2 billion). Last year, the flow of Czech FDI abroad in mining and quarrying declined from the total registered in 2007, because the total volume only exceeded CZK 0.5 billion and accounted for only less than 1.6 % of the total volume of Czech FDI (in 2007, it was CZK 1.2 billion and 3.6 % of total investments). Although investment in the form of equity capital accounted for about one fourth of the flow, the volume of reinvested earnings continued to dominate and other capital was not recorded. (The existing maximum of nearly CZK 1 billion and about 17 % of total FDI outflow was reached in 2003). 2008 represented another year in which the growth, which was recorded in 2006, continued. The recent trend associated with a wave of Czech companies interested in foreign acquisitions continued. In terms of volume, mining and quarrying is comparable to the manufacturing industry dealing with chemical products. The mineral extraction industry´s shares of total and partial FDI categories are shown in Table 11.

Table 11: Stock of Czech foreign direct investment abroad, as of December 31, 2008 (cumulation by the end of time-period, in CZK million)

	Equity capital	Reinvested earnings	Other capital	Total
Total amount	75 861.6	94 854.3	16 343.3	187 059.2
Mining and quarrying	1 076.9	901.0	472.4	2 450.4
Share of mining and quarrying (in per cent)	1.4	1.0	2.9	1.3

Note: values for 2008 are preliminary. Source: ČNB (2009), Balance of Payments Statistics, own calculation.

Glossary to selected economic terms

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[1] **Gross domestic product** (GDP) is the most often used indicator of the total economic performance of the economy. It can be defined either as a sum of the gross value added **[4]** of various sectors and branches of the national economy or as a value of the domestic final demand (final consumption **[6]** and gross capital formation **[9]**) increased by exports and reduced by imports.

[2] **Supply side** of the economy relates to the basic factors of economic activity (labour, capital and total factor productivity) and to the main branches of activity (agriculture, industry, construction, services).

[3] **Purchasing power parity** is a notional, artificially calculated currency exchange rate, which corresponds to its purchasing power. It is a rate at which we would obtain the same amount of goods and services at home as well as in the country with which we compare ourselves. It is used in the international comparisons of the real magnitudes as for instance the GDP per capita, for which the market exchange rates are not useful.

[4] **Gross value added** (GVA) is a widely used indicator of the total economic performance of each branch. It is an indicator corresponding to the GDP in the whole national economy. It is calculated by subtraction of the intermediate consumption (consumption of the raw materials, energy, materials) from the total value of the production.

[5] **Demand side** explores the basic components of the demand which determine economic activity (personal consumption, public consumption, investment and foreign trade).

[6] **Balance of foreign trade** is the difference between the value of exports and imports. When exports exceed imports, a surplus is formed, and in the opposite case there is a deficit.

[7] **Final consumption** includes personal and public consumption, it determines the growth of standard of living and it represents the largest component of the final utilization of the production.

[8] **Private consumption** contains consumption of products and services for final use, which is covered from the disposable income of households.

[9] **Public consumption** is the part of final consumption which is covered from the disposable income of government institutions.

[10] **Gross capital formation** (total investments) includes gross fixed capital formation, changes in inventories and net acquisitions of assets.

[11] **Gross fixed capital formation** is a basic component of investment and it includes acquisitions of fixed assets (esp. machinery, equipment, buildings and constructions) during a certain period.

[12] **Domestic demand** is a sum of final consumption and gross capital formation.

[13] **Real growth of gross value added** is growth calculated in constant prices, which excludes the influence of price changes

[14] **Index of industrial production** is calculated in agreement with the international standards and it is based on statistics of selected products and a two-stage weighting system. It is a selective index representing the weighted arithmetic average of the indexes of selected indicators, which is used to characterize the industrial production growth.

[15] **Macroeconomic point of view** is a viewpoint which is based on the view of whole national economy and takes into account mutual linkages and connections.

[16] **Tables of inter-industry relations** (input-output tables) are chessboard tables (in form of matrices), which show flows of the production of individual industries. Use of the production of the industry in the intermediate consumption (according to individual industries) and in final use is given in the lines. Costs of the industry according to the supplier industries are given in the columns.

[17] **OKEČ** (Odvětvová klasifikace ekonomických činností – Classification of industries by economic activity) is the internationally standardized classification of the economic activities according to the viewpoint of a similar economic utilization of the production. OKEČ divides the national economy into 16 basic groups (sections). Industry is divided into three sections (mining and quarrying, manufacturing and electricity, gas and water supply). More detailed division of industry then includes 17 branches.

[18] **Price deflator** is a price index mostly indirectly measured. Deflator of the gross value added has to be calculated from the changes of the total production and intermediate consumption prices. It equals a ratio of the GVA in current prices to the GVA in constant prices.

[19] **Exchange rate channel** expresses influence of the exchange rate changes on other economic magnitudes. In case of the foreign trade and current account deficit, the exchange rate change (weakening of strengthening of the currency) influences exports and imports of the country and by that also the external economic balance.

[20] **External economic balance** is given by the relationship of the total income of the country from abroad (incomes from the export of goods and services and inflow of primary incomes and transfers) and expenses to foreign countries (import of goods

and services, outflow of primary incomes and transfers). It can be assessed from the current account balance.

[21] Terms of trade express the movement of prices in foreign trade (the ratio of changes of the prices of exports to prices of imports). They are calculated by division of an index of the prices of exports by an index of the prices of imports. Where prices of exports grow more quickly than those of imports, the country can import a higher physical volume of imports for the same physical volume of exports.

[22] Appreciation means valuation (strengthening) of the currency exchange rate of one country against the other depending on the demand and supply on the foreign exchange market.

[23] Gross national income is an indicator based on the gross domestic product which takes into account inflow and outflow of primary incomes (incomes from labour, capital and ownership). Primary income balance towards the foreign countries influences the so-called disposable incomes of the country, on which depend final consumption and savings. In case that the outflow of incomes is higher than inflow, possibilities to increase standard of living are reduced. This indicator is therefore more appropriate for characterising the growth of the country's welfare than GDP.

Mineral Facts: Aggregates – Focus Europe

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1. Introduction

Raw materials mark the beginning of a value-added chain in industrial economies. They provide the basis for economic efficiency, development and growth. The importance of a secured supply of raw materials for the European industry is evident; a fact to which too little attention has been paid in Europe to so far. Aggregates, which are the basis of construction development, are of particular importance. Construction sector is predicted to grow in the Member States, especially in new EU-members. Fulfilling demands requires an eco-efficient and sustainable supply chain (planning, extraction, transport, use and recycling), and socio-eco friendly quarrying, to preclude opposition to extraction and restricted growth.

2. Importance of aggregates

More than 3,5 billion tonnes of sand, gravel and crushed stone with a value more than 35 billion € are produced annually in Europe to meet the demands of the building and construction industry.

Use of aggregates

Aggregates are of manifold use, for example in road, rail and channel construction as well as in the construction of residential buildings, offices and industrial buildings. The different use of aggregates either as sand and gravel, crushed rock, natural stone is to some extent dependent of the required chemical and physical characteristics of a product. For instance, the tracks of the ICE railroad line of German Railways from Cologne to Frankfurt are bedded on a substructure of concrete that consists of 80% aggregate (sand and gravel). However, even the underground of such a “concrete roadway” must be capable of bearing and must not yield to the load of these trains, travelling with more than 300 kilometres per hour, which cause vibrations and oscillations because of their high speed. According to analyses of German Railways, for this particular application an aggregate of sand and gravel lying deep under the tracks is the best solution (Steine- und Erden-Industrie, 2001).

The following data also indicate the economical importance of aggregates: A single family home with basement contains about 450 tons of raw materials. In an 80m² flat approximately 100 tons of raw materials have been processed. For the construction of one kilometre of highway about 160,000 tons of minerals are needed, for one kilometre of main road about 64,000 tons, for one kilometre country road 32,000 tons. Cosmetics and pharmaceuticals cannot be produced without a great part of mineral raw materials either[1].

The need of aggregates also is addressed by table 1: Table 1 describes the average consumption of mineral raw materials of an EC citizen over the duration of a life of 70 years.

[1] www.rohstofforum.at

Table 1: Raw materials demand of an EU citizen

Sand and Gravel	307 t	Silica Sand	4.7 t
Brown Coal	158 t	Kaolin	4.0 t
Crushed Rock	130 t	Potash (K_2O)	3.4 t
Petroleum	116 t	Aluminium	1.7 t
Natural Gas (1000 m^3)	89.6	Copper	1.1 t
Limestone, Dolomite	72 t	Steel Alloying Metals	0.9 t
Hard Coal	67 t	Sulphur	0.2 t
Crude Steel	39.5 t	Asbestos	0.16 t
Cement	29 t	Phosphate Rock	0.15 t
Rock Salt	12 t	Electricity (MWh)	293.2
Gypsum	8.5 t		

Source: (German) Federal Institute for Geosciences and Natural Resources [Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)], 2009

Macro economic importance

Aggregates are essential due to their embedding into construction and housing activities throughout Europe.

3. Demand for aggregates

3.1. Aggregates

Global demand for aggregates is expected to grow 4.7% per year through 2011 to 26.8 billion tons.[2] Growing environmental and land use concerns will spur above-average sales gains for aggregates composed of recycled materials like crushed hydraulic and asphaltic concrete and by-products like fly and blast furnace slag. Some of the strongest sales will be in India, which is already one of the largest national markets, as well as the huge Chinese market. Smaller markets such as Indonesia, Thailand and a number of developing countries in Asia, and Iran will also record strong gains, spurred by industrialization activities and growth in infrastructure construction. Global advancement will not be as strong in the developed areas of the world, including U.S., Japan and Western Europe. Infrastructure repair and maintenance construction will drive demand in these areas through 2011. An increase in non-building construction projects in the U.S. will also contribute to overall aggregates market growth, despite a slowdown in residential building activity.[3]

Demand at European level

Aggregate volumes in Europe, Middle East and Africa account about 6.5billion tonnes in 2007 (rising from 6 billion tonnes in 2006 to around 6.5billion tonnes in 2007).[4] According

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2 http://www.dustboss.com/_data/files/showcase/articles/C_DR_JulAug08.pdf
3 http://www.dustboss.com/_data/files/showcase/articles/C_DR_JulAug08.pdf
4 http://www.aggbusiness.com/articles/market-report/eastern-price-promise-310/

Aggregates	Construction & Housing	EU economy
Gross Value Added 11.4 bill. EUR	Gross Value Added 386.4 bill. EUR	Gross Value Added 7 229 bill. EUR
Employment 200 000	Employment 1 591 000	Employment 180 760 000
CO_2 emissions 5.9 mill t (GER)	CO_2 emissions 576.42 mill t (incl. processing)	CO_2 emissions 3 447 mill t
cement production – approx. 5 % of global CO_2 emissions	building processes – approx. 4 % for built environment altogether – approx. 30 – 40 % of global CO_2 emissions	
Domestic Extraction 2 910 mill t	Domestic Material Input 2 950 mill t	Domestic Material Consumption 5 620 mill t
Domestic Extraction + Hidden Flows 3 540 mill t	Domestic Material Input + Hidden Flows of Imports 3 620 mill t	Total Material Requirement 19 000 mill t

(Sources: Bleischwitz/Bahn-Walkowiak, 2006. Data based on: Eurostat internet data base 2006, UNEP 2006, OECD 2005, German Federal Statistical Office 2006, own calculations (i.e. Bleischwitz/Bahn-Walkowiak). All data for 2003, Gross value added at constant prices (1995), material data for 2000)

Figure 1: Comparisons of various variables indicating the proportions of the EU economy, the construction housing sector and the aggregates sub-sector in EU-15.

to the Data of British Geological Survey, the production of aggregates in Europe appeared widely constant in the years from 1999 to 2004 and ranged between 2,500 to 2,700 million tonnes per year. Countries like UK, Germany, France, Italy and Spain remain in these years in principle in a stable position of being important markets. Demand is slightly increasing at the beginning of 2004 influenced by new EU Member States, particularly Czech Republic, Hungary, Poland, Slovenia and Slovakia. 2006 production of aggregates come up nearly to 2,900 million tonnes per year (Koziol et. al, 2008). Figure 2 is illustrating the production of aggregates of the EU-27 between 2003 and 2007.

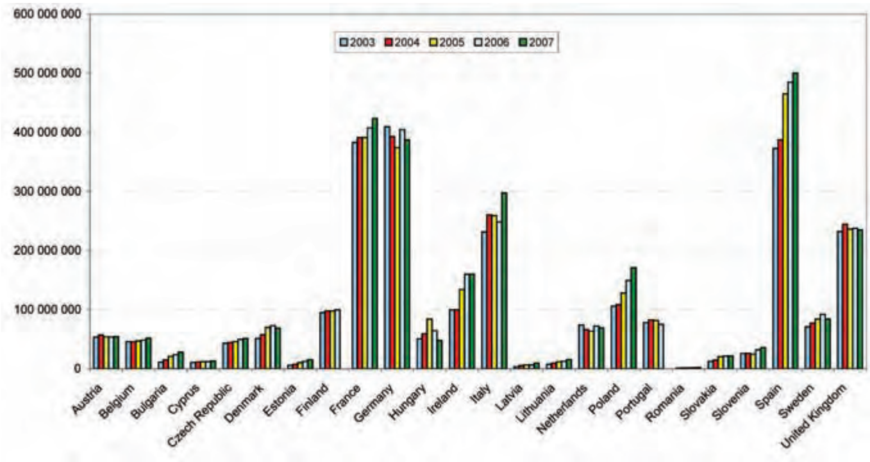


Figure 2: Production of aggregates 2003-2007 of EU-27 (source: British Geological Survey, 2009)

3.2. Construction

Aggregates and construction can be considered a moderate growth market in Europe in the last years. Housing and civil engineering are one of the driving forces in the construction industry.

As an example the UK is named.[5] UK aggregates production had been increasing during the 1980s, and reached a peak in 1989 before falling in line with a drop in construction activity. Demand showed some recovery in 1994 when several major road schemes were completed, but then fell again in 1995 and 1996, due, in part, to the introduction of the landfill tax in 1996. The introduction of the landfill tax in 1996 has encouraged greater reuse of construction and demolition waste. The figures indicate an increase in construction output in the last years despite a drop in primary aggregate sales on the one side, an increase in using recycled aggregates on the other side.

Data are pointing out three construction market cycles, the 1st cycle in 1993–1999 and the 2nd cycle in 1999–2006. The European construction market is at a peak in the 2nd cycle in 2006. With other words: 2006 is the culmination of 6 years of development in the construction industry. The highest growth rates are recorded in all countries observed (EU-19 = EU-15 + Czech Republic, Hungary, Poland and Slovakia) during the period of years 2004–2006. Construction showed the highest growth rates in 2006 and total European growth reached a peak in the second cycle of 2007 (3.7%). It was expected to see the next peak of the European construction in 2012 (3rd cycle), 2007 as the starting year of the third cycle. However, the growth of European aggregates market in 2008–2009 was affected by the finance crises. Many European banks were involved and it was clear that a long term slump could affect investment levels in Europe in the next years.

5 All information from http://www.europeanmineralsfoundation.org/minerals_2008_documents.htm

The investment outlook for European housing markets and civil engineering construction in 2009 (calculated in 2007 from EUROCONSTRUCT) is positive. Regardless the financial crises a positive development of housing markets was proposed in a majority of European countries, above all in Spain, Ireland, Finland and Portugal. Also a positive development of civil engineering was proposed: New pressures in various countries were stimulating in 2007 demand for civil engineering works like road construction in the forecast period. Thus, the investment outlook of European countries in the years ahead was optimistic, with growth rates between 3 and 4% annually. The major relative contribution was noticed from the Central and Eastern European countries, with yearly growth rates above 10%.

4. Aggregate production

From a global geological perspective, there is no indication of imminent physical shortage of the majority of aggregates in Europe. However, geological availability does not necessarily mean access to these raw materials for the mining companies. Access to land (i.e. deposits) is increasingly influenced by policy issues, for instance, lack of mineral planning policies or polices like taxes and charges (see section 6.2). Reduced availability of deposits is a phenomenon existing in whole Europe (and is impacting the competitiveness of the aggregates industry). However, the availability of aggregates from regional and local sources is essential for economic development, in view of logistical constraints and transport costs. Kündig et. al. (1997) stated for Switzerland that from initial 100 % of sand and gravel reserves about 10 % is deducted in favour of outdated or present gravel pits, 18 % in favour of residential areas, 5 % for protection of nature and environment, 16 % for forests, 30 % for groundwater, 1 % for traffic and only about 20 % remain available for exploitation.

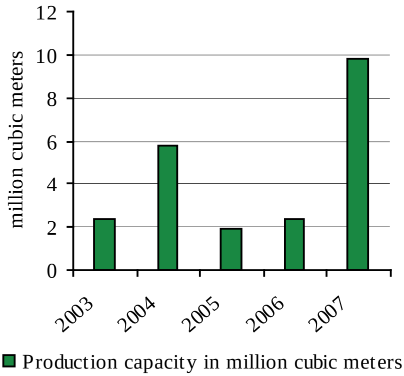
Regarding Europe, there are countries having a bigger potential of sand and gravel, countries having a bigger potential of crushed rocks, besides that some countries have both mineral categories available. This for sure also can determine the production possibilities and the development of aggregates market in a country or even between countries. Table 2 gives an overview of the relation of sand and gravel – crushed rock production in selected countries of Europe.

Mounting statistical data of aggregates in Europe difficulties occur due to yet overlapping definitions and data (for instance data sources from British Geological Survey and UEPG). Present data are fragmentary, often inconsistent, partly not EU wide. Data refer to different definitions and terminology of material groups like construction minerals, building materials or simply minerals which all include aggregates to a large extent. Although some studies indicate that the separation of a category like aggregates may be negligible in some cases because the output figures are very close to the total construction minerals extraction, the problem of inconsistent definitions and data remains at present (Bleischwitz/Bahn-Walkowiak, 2006). The narrowness of available raw materials data is explicitly mentioned in the Commission Staff Working Document “Analysis of the competitiveness of the non-energy extractive industry” (2007). Especially, official statistics for aggregates are rather incomplete. This problem can be traced back, among other causes, to the structure of the building raw materials sector which is particularly concerned, which exhibits a large number of middle, small and very small enterprises in most member states. These are not covered by national statistics and thus neither by EUROSTAT. At the same time, the importance of this sector is displayed insufficiently.

Table 2 is providing data from selected European countries, i.e. companies, sites, employees, production (UEPG, 2008). Note: the difference of data provided from UEPG (2008) compared to data provided by BGS (e.g. Figure 2).

The aggregates industry is present in each European country, although the amount produced varies greatly between countries depending on amongst other causes country area, population density, GDP.

Referring to table 2, the main producers in the European Union are Germany, Spain, France, Italy and the United Kingdom, accounting for approximately two thirds of production in the EU-25: Germany (17 % of total production), Spain (13 %), France (12 %), Italy (10 %) and UK (7 %). These countries (total area > 50 % of EU area, population > 60%) are producing around 2,2 billion tons of aggregates, i.e. 59% of total EU aggregates production.



Source: (http://www.aggbusiness.com)

Figure 3: Aggregate production capacity in Russia

5. Aggregate markets

5.1. Influencing parameters

Aggregate markets are characterised through the encounter of suppliers and consumers for the trading of aggregates. Development of aggregates market is depending on different issues, i.e. geological, geographical, policy issues, export possibilities. States with low density of population for instance usually use a higher share of aggregates for roads construction, whereas new Member States are concentrating on improving their basic infrastructure. Particularly a key issue is the GDP of a country: Aggregates demand is significantly influenced by the decisions of the public sector, for instance infrastructure development. Construction raw materials consumption is in proportion with population after the linear regression equation $y = 0.1711\ x + 1\ 474.5$ with correlation of 87 %, where x = consumption in thousands tonnes and y = population in thousands (Source: Commission Working Staff Paper, 2007. Consumption data based on BGS data of production, import and export of construction raw materials in 2003).

Table 2: Aggregates production in Europe. The European Aggregates Industry – Annual Statistics 2006 (UEPG, 2008)

Country	Companies	Sites	Employees (1)	Production (Million t)					
				Sand & Gravel (2)	*Crushed rock (3)*	*Marine Aggregates*	*Recycled Aggregates (4)*	*Manufactured Aggregates (5)*	*Total*
Austria	950	1,260	21,400	66	32	0	3.5	3.0	104.5
Belgium	184	253	15,919	10.1	55.5	3.5	13	1.3	83.4
Croatia	500	330	7,000	6.2	21.8	0	0	0	28.0
Czech Republic	208	490	3,368	27.1	41.5	0	3.8	0.3	72.7
Denmark*	350	400	3,000	58	0.3	13.6			72.0
Finland	400	3,550	3,000	54	46	0	0.5	0	100.5
France	1,680	2,700	17,300	167	233	7	14	9	430.0
Germany	1,800	5,396	92,625	277	270	0.4	48	30	625.4
Ireland*	250	450	5,100	54	79		1	0	134.0
Italy	1,700	2,360	24,000	210	135	0	5.5	3.5	354.0
Netherlands	60–70	40–45	400	44.5		50	25		119.5
Norway	1,500	2,000	1,839	13.4	45	0			58.4
Poland	2,200	2,550	53,600	115	43		8	3	169.0
Portugal	331	379	4,560	97.5		0			97.5
Romania		440	11,600	15.5	6.5	0	0.5	0.5	23.0
Slovakia	175	213	3,700	10	16.5	0	0.2	0.3	27.0
Spain	1,600	1,950	86,000	170	314	0	1.5	0	485.5
Sweden	120	2,410	3,500	23	62	0	1.8	0.2	87.0
Switzerland	350	480	3,200	50	5.7	0	5.7		61.4
Turkey	770	770	20,240	24	260	0	0	0	284.0
United Kingdom	350	1,300	46,000	68	123	13	58	12	274.0
Total	**15,418**	**29,681**	**427,351******	**1560.3**	**1789.8**	**87.5**	**190**	**63.1**	**3,690.7**

* Data 2005	*** Data 2003
** Data 2004	N

****note: this value differs from the value mentioned in fig.2 (200.000)

Besides that aggregate prices are an important issue. In relation to overall construction costs, the cost of aggregate materials is low, and so demand for aggregates is generally inelastic. Aggregate prices can vary dramatically from country to country depending on the availability of hard rock, limestone and sand and gravel resources, as well as their quality. The rate of price growth in the aggregates sector is linked to the overall rate of growth of the economy but only when growth is above 3%.[6] When economic growth rates are below 3%, there will be very little influence on the aggregates market. But if the economy grows faster than 3%, then generally the aggregates market will see gains in the region of 5%. The same is true in recession but the downturn will often be felt more sharply. The level of competition that exists in some national aggregates markets has kept price rises down as quarry operators try to keep concrete and asphalt prices at a reasonable level. Aggregates are not the end of the chain, so cannot command the same price as downstream products. However, aggregate prices in each nation are closely allied with the market price for cement. Markets where the cement price is high will also command a higher price for its aggregates.[7]

5.2. Supply regions

As mentioned above, for aggregates Europe is self-sufficient. The question is: who produces what, who consumes what. The old picture is that in many countries (or regions within a country) the production of aggregates mostly was almost equal to consumption. However, in the last years the picture gradually changed – increasing imports not only from region to region in a country but also outside and further, imports from country to country can be observed. The reason here is different. A general issue is that access to land becomes more and more limited due to lack of mineral planning policies, restrictive environmental regulations (NATURA 2000 areas etc.), particularly in the more populated countries of Western Europe. Additionally, sterilisation of deposits is an issue: Information about deposits of a country provided by the geological survey commonly exists, however information mostly is not considered in land use plans.[8]

It seems that in Europe the ratio between supply regions (i.e. regions which supply also other region of a country or outside a country) and regions with reduced aggregates production is increasing. For instance Austria: In the region Marchfeld, near Vienna, about 7 mill

6 http://www.aggbusiness.com/articles/market-report/eastern-price-promise-310/
7 http://www.aggbusiness.com/articles/market-report/eastern-price-promise-310/
8 Department of Mining and Tunnelling University of Leoben (2004), Minerals Policies and Supply Practices in Europe, Final Report.

⇦

Notes to the Table 2
(1) Number of people directly employed (i.e. under the payroll of the companies), comprising full-time employees and part-time employees as well as people indirectly employed including all on-site contractors (e.g. truck operators, cleaners etc).
(2) Sand and Gravel: sold production including crushed gravel.
(3) Crushed rock: sold production (excluding crushed gravel).
(4) Recycled Aggregates: materials coming from construction and demolition waste used in aggregates market.
(5) Manufactured aggregates include blast-furnace-slag, electric-arc-furnace-slag, incinerator bottom ash (IBA), pulverised fuel ash (PFA) and other industrial and extraction by-products for construction and civil engineering.

t sand and gravel annually are produced; this is 10 per cent of the whole sand and gravel production in Austria. The main consumer is Vienna but also other regions are supplied.

Transport issue

In principle: Markets for aggregates are supplied within a limited radius. Transporting aggregates from the quarry to the customer is a costly business (bulk weight of the material) and many aggregate prices are quoted as ex-works to make the cost per tonne comparable. The portion of transport costs in the aggregates sector is about 13 %. Road transport is often the easy solution for delivering quarried materials (either inside a region or between regions) direct to the customer. For example, the tonnage of aggregates transported in Germany via freight vehicle amounts to 45 % of total goods transported.[9] The same is true for Austria.

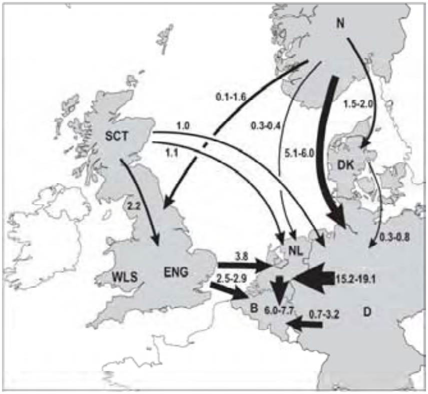
Thus, the nature of aggregate products, being of low value and homogeneous, makes them unprofitable to transport over long distances (>50km). However, in the last years due to different reasons – not necessarily geological but as mentioned particularly policy reasons – also road transport over longer distances in a country or between countries can be observed, for instance: the significant trade in sand and gravel occurring between Germany (North Rhine-Westphalia) and the Netherlands, and between the Netherlands and Belgium (see figure 4).[10]

For many quarry operators road transport is the only way to get aggregates to their market but for some sites alternative solutions are helping to open new doors – and keep existing ones open – for the industry. Water borne transport, country having possibilities like it can be found in France (Seine), Poland, Germany, Austria (Donau) plays an increasing role. In Paris for instance, Lafarge is using water-borne transport to reduce road congestion. The company estimates that deliveries from its Bernières-sur-Seine wharf eliminate 120,000 truck journeys into Paris each year. The gravel pit is located on a plateau that overlooks the Seine valley but is not connected by roads suitable for frequent passing of quarry trucks. The unprocessed aggregates from the quarry are carried via a 7 km long series of conveyor belts.[11]

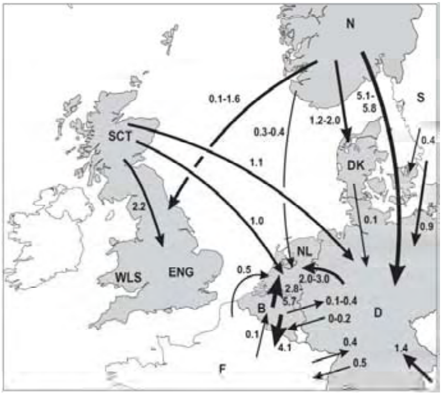
Additionally external water transport between countries can be observed: For instance exports of sand and gravel fractions in marine-dredged sand-gravel mixtures from the UK to Belgium and Netherlands (see figure 4). Crushed rock is transported over larger distances than sand and gravel, there are three major exporting states: Scotland, Norway and Belgium. The larger part of their export volumes are imported by the Netherlands and Germany ((Dutch) Ministry of Transport, Public Works and Water Management, 2003).

Obviously within the countries of Europe, there is a growing trade of aggregates. In 2000, about 65 mill tonnes of aggregates were traded between the countries in NW-EU, which is about 13% of the total production of 508 Mill tonnes (disregarding fill material; Ministry of Transport, Public Works and Water Management, 2003). Scotland, Norway and Germany are the main exporting states; the Netherlands and Belgium are net importing states. Comparisons with figures of 2001 show a tendency of increasing trade, particularly within Central and Northern Europe (Bleischwitz/ Bahn-Walkowiak, 2006). In 2007, main

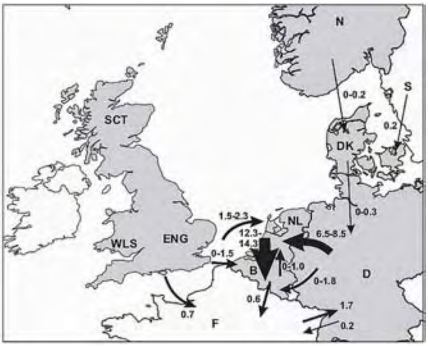
9 http://www.aggbusiness.com/articles/environment/highway-alternatives-707
10 The sand imported by the Netherlands from Germany is generally coarser than the sand exported from the Netherlands to Belgium.
11 http://www.aggbusiness.com/articles/environment/highway-alternatives-707/



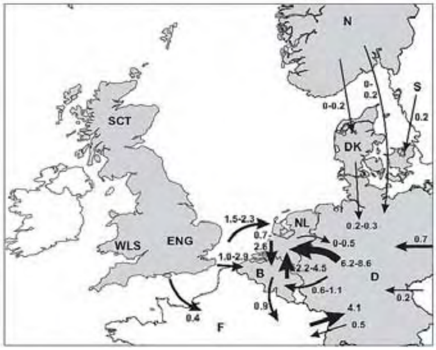
Trade in gravel



Trade in crushed rock



Trade in sand (filling sand excluded)



Net trade in aggregates.
The arrows indicate the direction of net supply, the absolute difference between exports and imports

Source: (Dutch) Ministry of Transport, Public Works and Water Management, 2003

Figure 4: Aggregates trade in 2000 (mill tonnes.) in North-Western Europe

net importers are the Netherlands, Belgium, Luxembourg, Switzerland but also Italy and Poland. But also France is importing many aggregates from other countries (especially: Scotland). The main net exporters (again) are Norway, Germany and United Kingdom.

Only fragmentary data are available concerning the proportion of aggregates in long distance goods transport, i.e. transport between Europe and other continents. However, due to its relatively high value, natural stone has become an important export product, with North America in particular providing a significant market outlet for European producers; here competition is increasingly being experienced from low-cost producers in countries such as India, Brazil and China.[12]

12 http://www.freedoniagroup.com/World-Construction-Aggregates.html

Level of self-supply (national level)

The production/demand ratio for aggregates is a proxy for the extent to which a country is self-supporting. Here different factors play an important rule. The production/demand ratio is only partly related to the available geological resrves; much more important factor affecting the ratio is the policy governing the exploitation of resources. In 2003 a study in North-West-Europe countries (Norway, Denmark, Belgium, the Netherlands, Germany (Lower-Saxony) and UK) was conducted which is underlining this issue.[13] The study shows that North-West-Europe as a whole is self-supporting. However, there are some notable differences with regard to the production/demand ratio but also export/import ratio. While Lower-Saxony and Denmark in 2000 are self-supporting countries, Belgium and the Netherlands are net importing countries, net exporting states with ratios >1 are Norway, North Rhine-Westphalia, Scotland and England/Wales. Belgium has limited sand reserves, the Netherlands has limited reserves of coarse aggregates; in both cases, certain levels of import are inevitable. Belgium, though overall dependent on imports, is a net exporter of crushed rock. The Netherlands, on the other hand, is a net importer of concreting and masonry sand, of which large resources are available in the south eastern and eastern parts of the country. That means: The Netherlands is a country which maintains an underproduction of an amply available aggregate. This illustrates the fact that the mineral policy of a country is an important issue. Both the Belgian and Netherlands policy does not contribute (significantly) to the low overall level of self-supply (Ministry of Transport, Public Works and Water Management, 2003).

6. Environmental issue

6.1. General

The aggregates industry can be considered the most resource-intensive sector throughout Europe. According to Eurostat, in 2002 they represent 40% of the Direct Material Inputs (DMI) into the European economy.[14] Obviously, production of aggregates has different impacts on the environment. In general, aggregates are associated with three types of environmental pressure, i.e. depletion of non-renewable resources, the threats they pose to the environment of the particular extraction site (e.g. land use issues), environmental pressure they generate through extraction, transport, use and further processing (i.e. energy, water and emission issues).

At the extraction processes, direct and non-reversible landscape alterations (concerning the cultural assets of a region or more particular e.g. the groundwater) are generated and also the competition of land uses (with agriculture and nature conservancy) is significant. After extraction, further environmental impacts occur during the (albeit rather long) life cycle of aggregates. Extractive operations often generate large volumes of waste due to the normally high waste-to-product ratios and these wastes may be major sources of pollution, including topsoil, overburden, waste rock and tailings. Energy- and emission intensive manufacturing processes of the concrete, cement, glass and ceramic production, which use

[13] (Some results of the study already was mentioned above.) Ministry of Transport, Public Works and Water Management (2003): Construction Raw Materials Policy and Supply Practices in Northwestern Europe, Delft. Information available on http://internationaal.bouwgrondstoffen.info/.

[14] Presentation of Steering Committee of the European Technology Platform on sustainable minerals, Brussels, January 2006

aggregates as basic material, account for the indirect environmental impacts of aggregates. Most of the energy use and emissions result from transport within quarries, from quarries to local customers and to the location sites for further processing. This will be increasingly important in case of more remote quarries and growing trade and imports. The average water consumption during 2003 was 0.4 m3 per ton of saleable product (Bleischwitz, Bahn-Walkowiak, 2006). In particular, the production of gravel is water intensive. Energy and emission intensity rises with any further production step, particularly the production of concrete and cement. Concrete is the most important building material in the world, the average production is between 1.5 and 3 tonnes per capita/year. About 70-80% of concrete consists of aggregates. Last but not least, aggregates mainly contribute to the transformation of land into built-up area (streets, highways, buildings) implicating impacts like soil sealing and land filling when buildings are demolished (Bleischwitz, Bahn-Walkowiak, 2006).

Summarized it has to be said that environmental impacts of aggregates can be considered far from being negligible. To improve it research and different political measures are necessary. A political approach to find a balance between economical and environmental issues of aggregates is using taxes and charges. This will be discussed in the next section.

6.2. Environmental taxes

Environmental taxes and charges are market-based instruments to balance environmental and economic policy objectives in a cost-effective way. Two forms of aggregates taxes have to be distinguished in general: ad valorem taxes (monetary tax base) and ad quantum taxes (physical tax base).

As mentioned above, the nature of aggregate, products being of low value and homogeneous, makes them in principle unprofitable to transport over long distances. In relation to overall construction costs, the cost of aggregate materials is low, and so demand for aggregates is generally inelastic. Before introducing a tax therefore the elasticity of demand needs to be considered, since it determines how sensitive producers and consumers will be to a change in price and thus, how effective it will be. Whether demand from the construction industry is met by recycled aggregates or primary aggregate materials is influencing the relative price between them. The cross-price elasticity between recycled and primary aggregates is an important consideration when deciding the level and assessing the effect of the aggregate tax. The aggregate tax can provide an important signal that the government is committed to changing the behaviour of producers and consumers of aggregate materials.

In the following some examples are given. Denmark and Sweden for instance are examples for ad quantum taxes. Countries, which rate the extraction of mineral raw materials ad valorem, are the Czech Republic and Poland. Pure aggregates taxes (including sand, gravel and/ or crushed rock) are implemented in Denmark, Sweden (‘natural gravel tax’), the United Kingdom (‘aggregates tax’), and in Belgium (Flanders) and Italy – on a regional level. Other countries raise mining or extraction charges. Table 3 below shows taxes and charges related to aggregates extraction that are presently in force in Europe.

For the extraction of gravel in the Province of Limburg (Flemish Region, Belgium), the Regional Government has taken a significant initiative. On 14 July 1993, they approved a Gravel Decree, aiming at a systematic reduction of river gravel production in the Belgian Province of Limburg. This Decree was further amended by the Decree of 6 July 2001. From 2006 onwards, there should be no more extraction of river gravel, except as a side prod-

Table 3: Taxes and charges on aggregates on national level (Source: European Environment Agency, 2008).

Member State	Name of tax, charge or fee	Purpose of Instrument	Year of introduction
Belgium	Gravel levy (regional, Flanders)	Termination of extraction by 2010	1993
Bulgaria	Mining charge	No purpose stated	1997
Cyprus	Quarrying charge	No purpose stated	N
Czech Republic	Payments for mineral extraction	No purpose stated	1993
Denmark	Duty on raw materials	Efficient use of natural resources	1978
Estonia	Mineral extraction tax	Efficient use of natural resources/cost coverage	1991
France	General tax on activities causing pollution; extracted materials (granulates)	Cost coverage	1999
Germany	Mining charge (Laender level)	No purpose stated	1980
Hungary	Mining charge	Fundraising for mine redemption	N
Italy	Quarrying activities (regional)	Compensation for environmental costs	N
Latvia	Natural resources charge; materials extraction charge	Efficient use of natural resources/cost coverage No purpose stated	1996 N
Lithuania	Mineral extraction charges	Efficient use of natural resources/cost coverage	1991
Poland	Mineral extraction charge	Cost coverage	N
Slovakia	Mining charge	Revenue raising	N
Sweden	Mineral act charge; natural gravel tax; excavation charge	Cost coverage Efficient use of natural resources/cost coverage	1992 1996 1999
United Kingdom	Aggregates levy	Reduce demand of primary materials	2002

uct of other extraction activities (e.g. sand extraction or large civil engineering projects). A fee is charged per tonne of gravel extracted and an organisation (foundation) has been established to manage this money. The aim of the foundation is amongst others to examine alternatives for gravel, to help in the re-structuring of this branch of the industry and to assist with the social aspects for the people working in the quarries (Department of Mining and Tunnelling, 2004).

With regard to aggregates, the Swedish government has imposed a tax on the production of sand and gravel in order to preserve limited reserves in the southern part of the country where the majority of construction activities are taking place. The goal is to reduce the use of sand and gravel from the present (2002) 23 mill tonnes per year to about 12 Mill tonnes in 2010. By the same time recycled materials should constitute 15 per cent of the total aggregate consumption. The policy decision also has been taken to increase the use of recycled aggregates and alternative materials. In a similar way, the Netherlands have taken the decision to encourage increased use of secondary raw material in the building and construction industry. The following advantages are seen: it reduces the amount of waste that needs to be landfilled and it reduces the amount of raw materials that need to be extracted. This double-edged reduction of land use is welcome in densely populated countries, like the Netherlands. Research, and the development of policies, has enabled the Netherlands to extend the uses of secondary raw materials (Department of Mining and Tunnelling, MU Leoben, 2004).

In Italy and the United Kingdom the objective of the tax is to target the environmental externalities associated with quarry activity.[15] This differs to the objectives in Sweden and the Czech Republic where the tax is aimed at preserving the landscape and maintaining resources, see Table 4. The application of the aggregates tax or charge differs across the countries. In the Czech Republic the charge is based on a combination of the area of land above the surface that was being exploited and also the volume of material that was produced. Italy taxes the volume of material extracted whilst Sweden taxes the tonnage of material. The United Kingdom has introduced a sales tax on the weight of material sold from the quarry site. Exclusions also applied in some of the countries, for example Sweden only applied the tax on natural gravel.

Table 4: Context of tax or charge (source: European Environment Agency, 2008)

	Czech Republic	Italy	Sweden	United Kingdom
Objective of tax or charge	1) To raise revenue 2) To encourage deep mining and preserve the landscape.	1) To compensate for the environmental costs caused by quarry activity e.g. preserve natural capital 2) To preserve landscape	1) To safeguard gravel resources and water quality 2) To preserve the landscape	1) To compensate for environmental externalities caused by quarry activity 2) To reduce demand for aggregates and encourage recycling

15 All information provided by: European Environment Agency (2008).

Table 4 from page 73 continued

	Czech Republic	Italy	Sweden	United Kingdom
Coverage of tax or charge	Applied across all mining activity. Only reserved deposits subject to the tax	Applied to sand, gravel, ornamental stones, crushed rock	Applied to natural gravel = sand, gravel and cobbles	Applied to rock, gravel and sand
How the tax or charge is applied	Area based and charged per cubic meter	Charged per cubic meter	Charged per tonne extracted	Charged per tonne sold
Tax or charge rate on aggregates	EUR 0.1 per tonne	Varies by region EUR 0.2–0.3 per tonne	EUR 1.43 EUR per tonne	EUR 2.4 per tonne
Tax as % of aggregate price	2–3 %	4 %	12%	20%
Total revenue raised from tax	EUR 1.4 million	EUR 117 million	EUR 22 million	EUR 454 million
Aggregate tax revenue as % of total tax revenue	0.6 %	Not available	0.02 %	0.1 %
Administrative cost of tax	Not available	Not available	EUR 0.38 million per year	EUR 1.5 million per year

The tax rate also varies considerably across the countries. The Czech Republic and Italy has very low rates of tax or charges which are below 4 % of the average price of aggregate material. In contrast the United Kingdom has introduces an exceptionally high tax rate of 20 %, which equates to a fifth of the price of the materials. Sweden gradually has raised the tax on natural gravel over a period of time to reinforce the signal to producers and facilitate a gradual restructuring within the sector, however, the tax in Sweden remains considerably lower than the tax rate applied in the United Kingdom. The revenues raised by the tax are influenced by both the tax rates and the quantity of material being produced.

United Kingdom-tax

Once again, the UK tax is mentioned, as it has had significant influences on the quarry operators. The UK aggregates tax was introduced in April 2002 and justified by the presence of external costs of aggregates extraction.[16] The tax is charged on quarry operators and other organisations that commercially exploit aggregates. It was introduced at a rate of EUR 2.35 (or GBP 1.60) per tonne, which equates to approximately 20 % of the average price per tonne of material. If the aggregate is to be supplied to people outside the United Kingdom, then the tax is refundable, and any aggregates imported from outside the United Kingdom become subject to the tax once they are commercially exploited. The objective of the UK aggregate tax has been principally two-fold. The primary aim has been to reduce the environmental costs associated with quarrying operations, e.g. noise, dust, visual intrusion,

[16] All provided information from: European Environment Agency (2008).

loss of amenity and damage to biodiversity. Secondly, the tax aims to reduce the demand for aggregates and encourage the use of alternative materials (e.g. recycled aggregate materials). Analysis undertaken by the Quarry Products Association (QPA) shows that the impact of introducing the aggregate tax has been most marked in reducing sales of low quality crushed rock, which they estimate to have fallen by 6 million tonnes. This has resulted in the substitution of lower quality taxed aggregates by waste streams from other non-taxed extracted minerals such as shale, slate and china clay.

It is the combination of policies that have given a signal to producers of the need to change production methods and practices. The aggregate tax forms an important component of the policy package; and it is the multi-level approach that creates strong incentives to which the aggregate industry has responded. The overall effect has been to encourage the substitution of primary aggregates for recycled construction and demolition waste, which creates a much lower environmental impact from energy use and carbon dioxide emissions. It is important to understand how a wider set of policies, in addition to the tax, interact with the aggregate system. The combination of a tax with other policy levers (e.g. permits, quality standards) introduced as a package of interventions is often more effective in delivering environmental improvements. The tax on its own may not be enough to correct the market failures, such as the environmental harm, caused by aggregate extraction.

6.3. Recycling

Recycling of aggregates is important in different ways. Recycling reduces the need of primary minerals, reduces the construction waste leading it to a significant renewable source and decreases also the amount of waste.

Main products are for example secondary asphalt, secondary aggregates for new concrete and new road base, and cement bound (asphalts) granulate road base. Thanks to the continuous improvement of the legal framework, incentives from competent authorities and technical innovation, some European countries have achieved a high recovery rate of construction waste.

Demolition generates high volumes of waste that might use valuable space when they are landfilled. Recycling of construction and demolition waste is therefore constantly increasing. The use of recycled materials from Construction and Demolition (C&D) waste represents one alternative which UEPG encourages in order to meet the demand of aggregates in areas where there is a shortage of natural materials deposits. Depending on the nature of C&D waste, collected materials can be used either directly or processed in special installations. C&D waste processing represents today a genuine industry which profitability depends on the technical, economic, geological and political environment of the markets in which it operates. Recycled aggregates have an environmental-friendly image as they contribute to: save natural resources, reduce landfill sites, reduce negative effects of transport. But still suffer from a low acceptability due to: a reluctance of certain building designers and managers, a lack of support from public procurement.

The quality of aggregate produced depends on the quality of the original material and the degree of processing and sorting. When well cleaned, the quality of recycled coarse aggregate is generally comparable to virgin aggregate and the possibilities for use are equally comparable.

Recycling rate

Recycling rates have to be interpreted with caution as they presently tend to over- or underestimation due to different ways of accounting of recycling, secondary use, etc. The order of magnitude however correlates to the different national availability throughout Europe and transportation costs. A study by the National Ready Mixed Concrete Association (NRMCA) in the US has concluded that up to 10% recycled concrete aggregate is suitable as a substitute for virgin aggregate for most concrete applications, including structural concrete. UK research indicates that up to 20% of recycled concrete aggregate can be used for most applications (including structural). Australian guidelines state that structural concrete up to 30% recycled aggregate content is without any noticeable difference in workability and strength compared with natural aggregate. German guidelines state that under certain circumstances recycled aggregate can be used for up to 45% of the total aggregate, depending on the exposure class of the concrete (World Business Council for Sustainable Development, 2009).

The recycling rates of construction and demolition waste are assessed to be increasing in future. Estimations of recycling potentials show that the 180 million tonnes of C&D waste that are annually being produced in the EU may be recycled up to 50%. This would correspond to about 45 million m3 concrete. The total production of ready-mixed concrete in 2005 (data collected for 20 ERMCO[17] member countries) amounted to about 430 million m3; compared to the volume needed to meet the current demand, this is roughly 10% (Bleischwitz/ Bahn-Walkowiak, 2006).

Recycled aggregate accounts presently for 6% to 8% of aggregate use in Europe, with significant differences between countries. The greatest users are the United Kingdom, the Netherlands, Belgium, Switzerland and Germany whilst Spain, Finland, Sweden, Slovakia, Ireland and Italy have very low rates. This is largely due to a strong consumer preference for virgin aggregate materials and a lack of awareness or confidence in the performance of recycled materials within these countries.

The UK now has a recycling rate of over four times the European average (according UEPG 2004 report):

Recycled aggregates in Europe

Country	Proportion of recycled aggregates to total primary and recycled aggregates production
United Kingdom	23 %
Germany	16 %
Belgium	5 %
France	4 %
Italy	1 %
Spain	0.5 %
Total Europe inc UK	7 %
Total Europe exc UK	5 %

Compared to USA: it was estimated in 2000 that ~5% of aggregate in the US was recycled aggregate (World Business Council for Sustainable Development, 2009)

[17] ERMCO – the European Ready Mixed Concrete Organization

Recycling standards

It is important to set standards that do not arbitrarily exclude recycled aggregate. Standards should highlight and encourage the use of recycled aggregate. Some useful standards include new ISO standards, which are being developed on "Environmental Management for Concrete and Concrete Structures". To mention is also the EHE Spanish standard (Instrucción Española de Hormigón Estructural), which recommends a 20% replacement of coarse aggregate by recycled concrete. Various European standards exist, and Japanese and Australian standards are also well developed. The International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM from the French name **R**éunion **I**nternationale des **L**aboratoires et **E**xperts des **M**atériaux, systèmes de construction et ouvrages) has also been involved in standards development (World Business Council for Sustainable Development, 2009).

7. Conclusion

Raw materials, especially aggregates are the fundament of the development and growth possibilities (opportunities) of a national economy. It is a fact that the per capita demand for aggregate in Europe will remain on a high level. However, there are many problems/challenges related to aggregates production and supply in South East Europe.

First there is a need to homogenise the different statistical data in Europe, compiling data coming from different sources to useful EU minerals statistics.

Second, future research on aggregates is important. Future research should establish causal links between supply and demand of aggregates on the one hand, and their utility on the other hand. Evaluating utility means analysing areas such as housing and construction infrastructures. Such analysis would also contribute to analysing value chains and purposes of production; it would also contribute to horizontal policy integration (Bleischwitz, Bahn-Walkowiak, 2006). There is no reason to determine that aggregate industry itself should be sole subject to economic instruments in order to increase resource productivity while reducing environmental impacts. Because of the interdependencies among industrial sectors and final demand, any instrument will achieve greatest sustainability benefits if it tackles questions of supplying aggregates, sustainable housing and infrastructure simultaneously (Bleischwitz, Bahn-Walkowiak, 2006).

This also underlines the importance of projects related to aggregates at EU-level, as it presently done by the SARMa-project. The expected results of the SARMa-project shall be applicable across South East Europe area, enabling countries to implement harmonized approaches, thus increasing sustainable quality of life, resource efficiency, and long term cooperation. Results will be applicable beyond SEE area, and will continue to be transferable via the manuals that describe best practices, tools and methods, as well as through results of pilot studies and content of the information system for aggregates. Project progress can be observed on www.sarmaproject.eu.

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The economic situation of domestic mining enterprises

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Tab. 1: Mining total

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		225	223	208	153	232
Number of employees		103 682	101 712	98 340	85 309	81 165
Sales	mill. CZK	196 583	208 614	218 522	218 203	225 280
Value added	mill. CZK	72 082	74 677	79 108	76 348	84 652
Acquisition of grounds and deposits	ths. CZK	564 534	608 115	1 181 289	358 967	1 334 684
Sales per employee	ths. CZK/ employee	1 896	2 051	2 222	2 558	2 776
Labour productivity based value added	CZK/ employee	695 224	734 193	804 436	894 966	1 042 972
Hourly labour productivity	CZK/ working hour	410	436	476	530	609
Average salary	CZK/ employee	20 639	21 777	23 413	25 034	27 594
(Value added - salaries) per employee	CZK/ employee	674 585	712 416	781 023	869 932	1 015 377

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	3%	-1%	-7%	-26%	52%
Number of employees	-22%	-2%	-3%	-13%	-5%
Sales	15%	6%	5%	0%	3%
Value added	17%	4%	6%	-3%	11%
Acquisition of grounds and deposits	136%	8%	94%	-70%	272%
Sales per employee	46%	8%	8%	15%	9%
Labour productivity based value added	50%	6%	10%	11%	17%
Hourly labour productivity	48%	6%	9%	11%	15%
Average salary	34%	6%	8%	7%	10%
(Value added - salaries) per employee	51%	6%	10%	11%	17%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

There are five specific characteristics of the data for mining enterprises (Tab. 1: Mining total) discussed in this yearbook:

1. It is impossible to distinguish pure mining from other activities. All data are for the enterprise as a whole, such as, for example, the production of bricks and the trade activity together.
2. The enterprises belong not only to the group OKEČ (CZ-NACE)* C mining and quarrying, but also to CZ-NACE D manufacture of other non-metallic mineral products (glass and construction minerals) and a few enterprises belong to other groups (mining is one of the activities).
3. Sampling is influenced by the accessibility of data. In the case of sales and book value added, the sample corresponds to 95 % of the whole, but it covers a much lower proportion of the number of enterprises. Data for very small enterprises are not available.
4. It is possible to collect a lot of data (for example from annual reports) for the large enterprises, but in the case of small ones data are not available. This affects the selection of indexes.

* *Translator's note:* OKEČ (Odvětvová klasifikace ekonomických činností) is the same as CZ-NACE – Czech adoption of the General Industrial Classification of Economic Activities within the European Communities (Nomenclature générale des Activités économiques dans les Communautés Européennes)

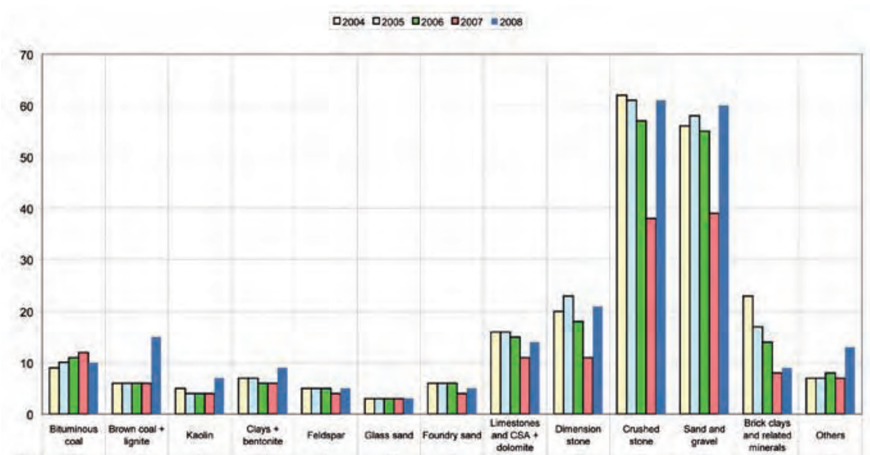
5. In view of secret individual data, it was necessary to group the mining enterprises into bigger aggregates (aggregate of „Others“ includes uranium, crude oil, natural gas, graphite, gemstones, diatomite + silica minerals and gypsum).

The selection of indicators is as follows:

- number of enterprises
- registered average number of employees
- sales (sales of goods and sales of own goods and services)
- book value added (VA) {[sales + change of stocks of own production + capitalization (production of an enterprise for own consumption)] – purchased goods – intermediate consumption (consumption of supplies and raw materials, energy and services)}
- acquisition of land and mineral deposits (investment in new land and mineral deposits)
- sales per employee (labour productivity based on sales, i.e. sales per registered employee)
- book value added per employee (labour productivity based on book value added, i.e. book value added per registered employee)
- hourly labour productivity (book value added per working hour)
- average salary
- (the book value added – salaries) per employee, i.e. book value added after deduction of salaries.

The situation of mining enterprises is for the period of 2004–2008. Indicators for time series are supplied by chain indices.

Comparable indices are compared with data for Mining total (Mining total = 100 %).

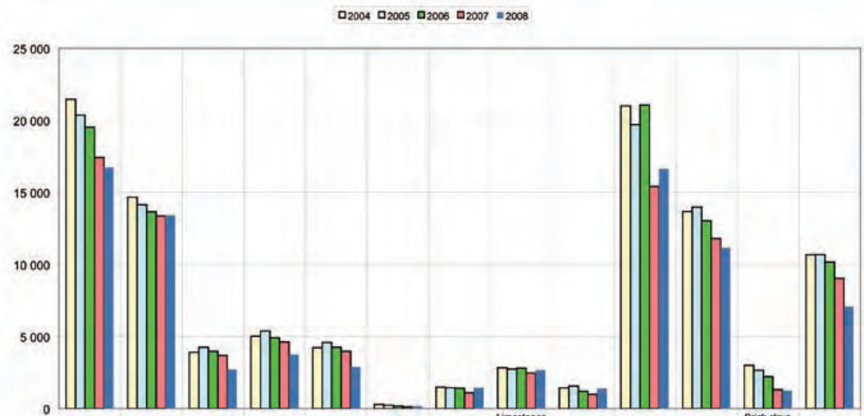


	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	9	6	5	7	5	3	6	16	20	62	56	23	7
2005	10	6	4	7	5	3	6	16	23	61	58	17	7
2006	11	6	4	6	5	3	6	15	18	57	55	14	8
2007	12	6	4	6	4	3	4	11	11	38	39	8	7
2008	10	15	7	9	5	3	5	14	21	61	60	9	13

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data (CSA in this and following figures means “Corrective additives for cement production”)

Fig. 1. Number of enterprises

The number of enterprises (Fig. 1) has been generally stable in 2004–2008, except for 2007. Changes are connected with mergers of enterprises (reductions) and with acquisition of data for new enterprises. The number of enterprises in 2007 is lower due to a different data collection. In 2004–2006, data were collected for enterprises with 20 or more employees and, in 2007, for enterprises with 50 or more employees. In 2008, data were once again collected on enterprises with 20 or more employees. Foundry sand, dimension stone, crushed stone, sand and gravel, and brick clays were affected by this difference in the data collection. We will treat this topic in more detail in the following figures.



	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	21 464	14 667	3 901	5 020	4 223	296	1 485	2 835	1 432	21 008	13 677	3 003	10 672
2005	20 360	14 138	4 259	5 375	4 584	227	1 450	2 752	1 551	19 700	13 978	2 656	10 682
2006	19 523	13 657	3 977	4 910	4 251	163	1 402	2 797	1 197	21 061	13 030	2 209	10 165
2007	17 423	13 366	3 685	4 626	3 978	124	1 099	2 467	989	15 404	11 801	1 319	9 028
2008	16 729	13 405	2 706	3 733	2 855	156	1 418	2 647	1 395	16 631	11 158	1 249	7 080

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

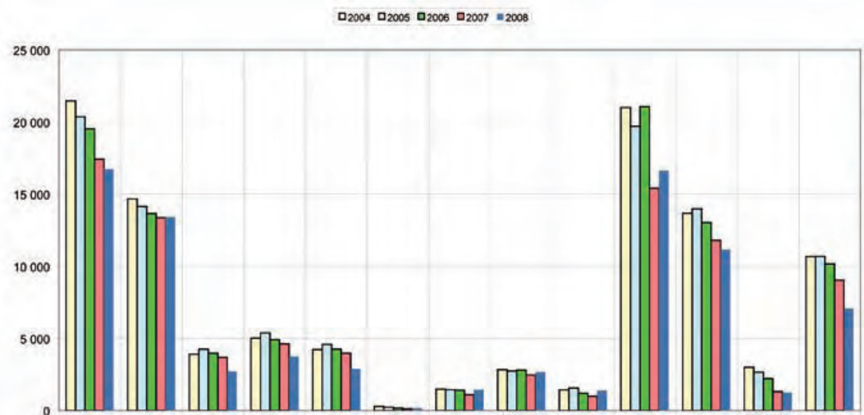
Fig. 2. Number of employees

The recalculated number of employees (Fig. 2) in 2004–2008 has, as expected, a declining trend. There are, of course, several causes for this development and they have to be considered separately in terms of individual minerals.

There is a steady decrease in the number of employees in “classical” mining branches such as, for example, coal mining. In the case of kaolin, clays, and feldspar, the reason for the development in the number of employees is not so much an increase of employees working in mining, as an increase of employees working in consecutive manufacture and trade. The biggest problem in evaluating economic results stems from the influence of mergers of mining and manufacturing activities.

In the case of foundry sand, dimension stone and crushed stone, the decrease in the number of employees in 2007 poses a problem, and there is an obvious effect caused by a different list of enterprises in 2007 compared to 2006. The situation changed in 2008 due to data collection on enterprises with 20 or more employees.

It can be expected that the number of employees working directly in mining will decrease in the future.



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Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

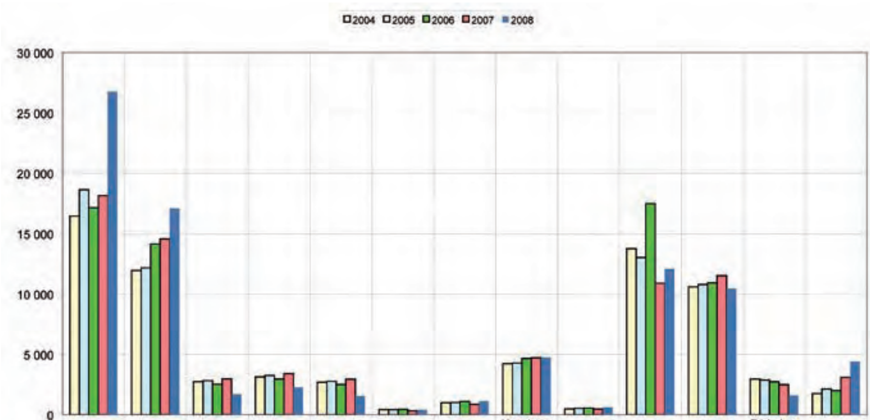
Fig. 3. Sales (CZK million)

Sales (Fig. 3) are growing over time not only because of the connection with subsequent manufacture (as in the case of kaolin, clays and feldspar). Sales are also increasing in coal mining enterprises where the influence of subsequent manufacture is minimal.

Sales growth in 2004–2006 was high. Although somewhat of a stagnation occurred in 2007, sales grew again in 2008. Sales grew by 15 % over the entire period of 2004–2008.

The advantage of value added (Fig. 4) compared to sales is that it does not change as a result of enterprise disintegrations and mergers. From this perspective, indices of value added are more informative than those of sales. In 2004–2008, value added grew by 17 %, i.e. by 2 percentage points more than sales.

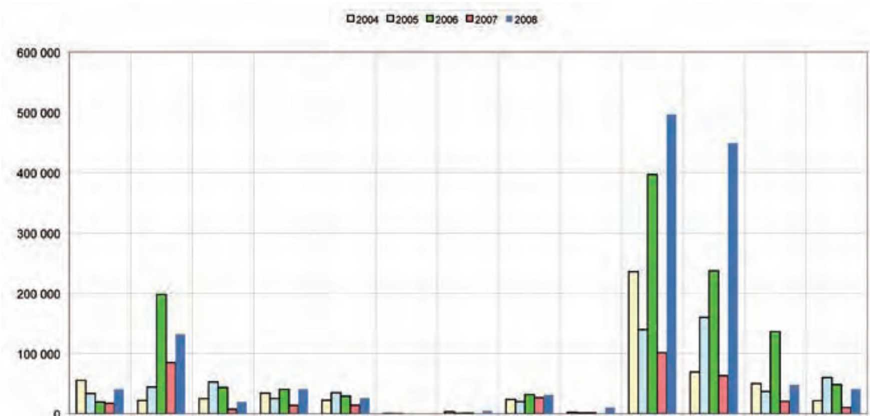
Due to the fact that mineral extraction is coupled with subsequent mineral processing, lower growth should occur in value added in comparison with sales. Because the share of value added in sales of “pure“ extraction hovers above 40 % and of the manufacturing industry below 20 %. However, growth of value added is calculated from a considerably smaller base and, therefore, a higher growth of the value added index should occur compared to sales.



	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	16 446	11 949	2 735	3 127	2 689	425	983	4 224	469	13 759	10 582	2 948	1 744
2005	18 637	12 166	2 812	3 247	2 772	425	1 007	4 275	532	13 022	10 773	2 880	2 129
2006	17 153	14 135	2 522	2 953	2 498	430	1 099	4 660	547	17 479	10 924	2 722	1 988
2007	18 145	14 561	2 965	3 408	2 941	321	865	4 704	453	10 892	11 513	2 486	3 096
2008	26 742	17 082	1 675	2 236	1 534	382	1 108	4 725	619	12 084	10 458	1 605	4 402

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 4. Book value added (CZK million)

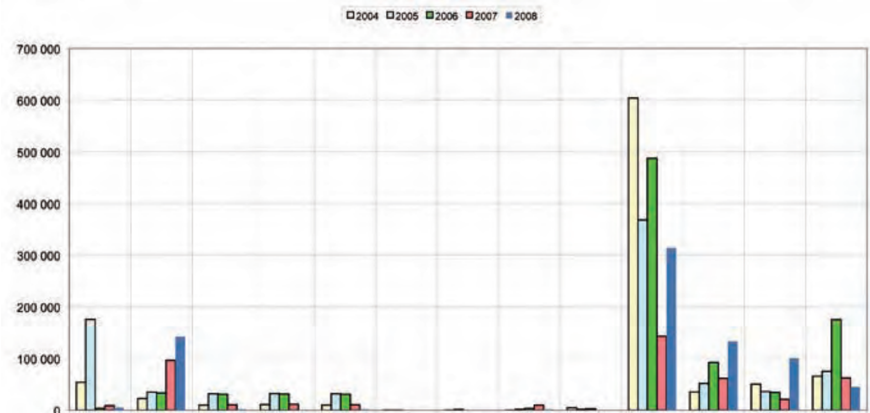


	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	55 473	21 978	25 153	34 042	22 361	548	3 051	23 513	2 505	235 638	69 010	49 752	21 510
2005	33 496	44 106	52 848	25 240	34 611	123	647	19 971	1 375	139 468	159 652	36 740	59 839
2006	19 214	197 748	43 331	40 242	28 918	0	946	31 613	1 422	396 754	236 847	136 091	48 163
2007	17 417	84 730	7 374	13 690	13 967	0	110	26 622	41	101 245	63 039	20 370	10 362
2008	39 794	131 372	19 110	40 271	25 563	0	4 298	30 847	9 869	496 510	448 653	47 995	40 402

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 5. Acquisition of land and mineral deposits (CZK thousand)

The data on acquisition of land and deposits (Fig. 5) include investment into new land for both manufacturing and mining purposes (it is impossible to distinguish). Investments into land in 2004–2005 were half the amount in 2006. A decrease in 2007 occured due to the fact that, in 2008, investment into land and mineral deposits grew to record levels.



	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	53 930	22 408	9 910	10 790	9 910	256	259	416	4 637	604 238	35 140	50 257	65 774
2005	175 597	34 886	32 152	32 452	32 152	300	1 447	1 712	1 738	368 172	51 837	35 895	75 050
2006	3 267	33 028	30 980	31 352	30 980	0	73	3 293	2 816	487 383	92 118	34 176	175 157
2007	8 658	96 779	10 508	11 455	10 508	0	0	9 792	112	142 934	61 958	21 169	62 391
2008	4 594	142 190	1 319	182	1 319	0	239	1 383	0	314 113	133 068	100 910	45 063

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 6. Sales of land and mineral deposits (CZK thousands)

It is necessary to supplement the data on the acquisition of land and deposits with information regarding their sale.

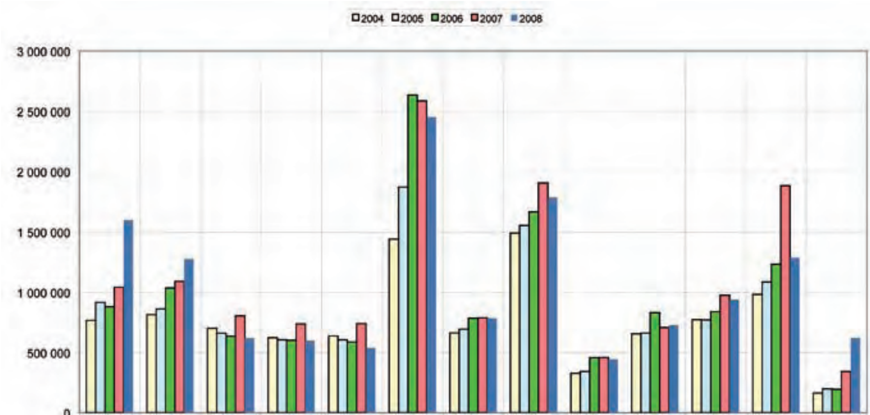
The balance of acquisitions to sales of land and deposits (Fig. 7) provides an informative summary to Figure 5 and 6. In 2004–2005, the sale of land exceeded acquisition. In 2006, mining companies purchased more land than they sold. The situation reversed itself again in 2007, and sales exceeded acquisition. Another reversal ensued in 2008, and acquisition exceeded sales by a considerable margin.

The positive balance probably reflects acquisition of land for potential mining. Negative balance is given first of all by sale of unnecessary land and also by sale of mined-out deposits. However, interpretation of balance is equivocal, as we do not have any information on the deposits themselves.

	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	1 543	-430	15 243	23 252	12 451	292	2 792	23 097	-2 132	-368 600	33 870	-505	-44 264
2005	-142 101	9 220	20 696	-7 212	2 459	-177	-800	18 259	-363	-228 704	107 815	845	-15 211
2006	15 947	164 720	12 351	8 890	-2 062	0	873	28 320	-1 394	-90 629	144 729	101 915	-126 995
2007	8 759	-12 049	-3 134	2 235	3 459	0	110	16 830	-71	-41 689	1 081	-799	-52 029
2008	35 200	-10 818	17 791	40 089	24 244	0	4 059	29 464	9 869	182 397	315 585	-52 915	-4 681

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 7. Balance acquisition – sale of grounds and mineral deposits (CZK thousand)



	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	766 212	814 684	701 211	622 834	636 862	1 439 824	662 379	1 490 063	327 448	654 960	773 718	981 717	163 424
2005	915 357	860 557	660 293	604 200	604 713	1 871 185	694 188	1 553 192	342 669	660 984	770 719	1 084 344	199 317
2006	878 606	1 034 945	634 189	601 502	587 632	2 635 394	784 288	1 666 071	456 865	829 901	838 354	1 232 195	195 582
2007	1 041 427	1 089 399	804 661	736 680	739 276	2 586 412	787 376	1 906 767	458 621	707 076	975 543	1 884 091	342 952
2008	1 598 525	1 274 288	618 805	598 970	537 301	2 450 526	781 319	1 784 975	443 897	726 586	937 219	1 284 502	621 748

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

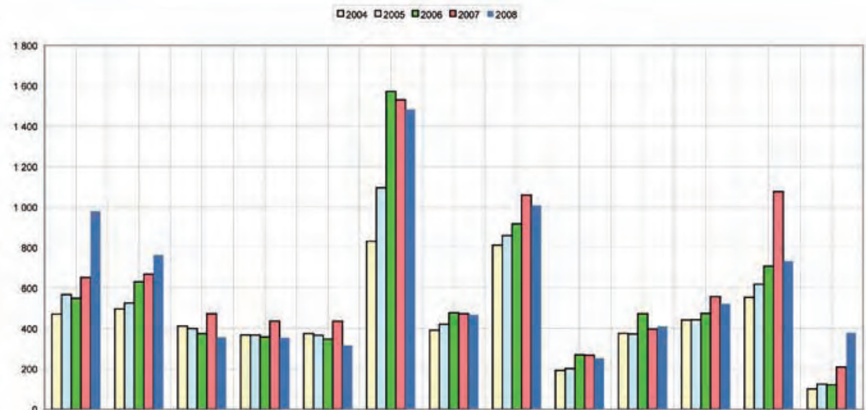
Fig. 8. Labour productivity based on value added (CZK/employee)

The value added labour productivity is one of the main indicators for evaluating the enterprises in our sample of indicators. It can be seen from the Fig. 8 that big differences exist between different minerals. Minerals for glass manufacture, limestone, cement raw materials, dolomites and brick clays seem to be excellent. On the other hand, the indices of other minerals are probably kept low by uranium mining, where practically nothing is produced, yet mining costs are high.

The rapid improvement of bituminous coal, brown coal and lignite, and other minerals in 2008 is interesting, because labour productivity in terms of energy minerals (other minerals include crude oil, natural gas and uranium) improved significantly. On the other hand, after the extreme in 2007, brick clays and related minerals nearly returned to the 2006 level.

Since it is a comparative indicator, a comparison of each mineral with Mining total is possible as well as a comparison of the mining total with bigger units which are CZ-NACE aggregates. In comparison with total industry in 2008, labour productivity in the mining total is about 10 % higher. Industry is composed of mining (included in our sample), of manufacture (partly included in our selection) and of energy. The mining total has book value added labour productivity lower than mineral extraction (by about 25 %), higher than manufacturing industry (by about 11 %) and higher than the manufacturing industry (by about 37 %). Our sample is partly connected with manufacture (for example kaolin and ceramics), which is the reason for the labour productivity decrease.

In the non-financial sector of enterprises the value added labour productivity of mining is second place behind energy. It is specific for mining because the consumption of materials is very low – there are not manufactured products from purchased supplies.

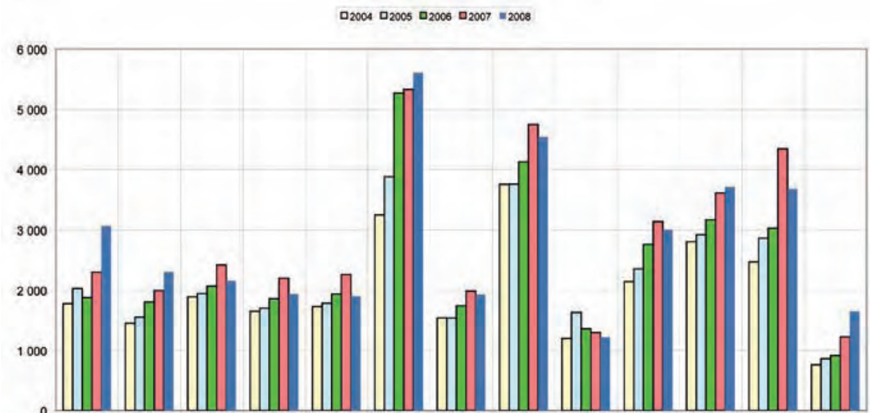


	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	470	495	411	368	374	831	391	811	191	375	441	553	100
2005	567	525	399	366	365	1 095	420	859	201	372	443	619	123
2006	549	630	373	357	347	1 571	477	916	269	473	474	707	120
2007	651	668	473	436	435	1 530	472	1 060	267	397	557	1 077	209
2008	978	762	354	352	314	1 483	465	1 007	252	410	520	732	377

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 9. Hourly labour productivity (CZK/working hour)

Hourly value added labour productivity (Fig. 9) has similar characteristics to book value added per employee (Fig. 8). It is a more precise expression of productivity, because it shows the book value added per working hour.



	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	1 773	1 449	1 888	1 647	1 724	3 248	1 539	3 756	1 197	2 138	2 803	2 468	759
2005	2 027	1 550	1 941	1 698	1 781	3 881	1 537	3 757	1 628	2 350	2 920	2 861	861
2006	1 875	1 802	2 067	1 858	1 934	5 269	1 740	4 128	1 358	2 757	3 164	3 026	914
2007	2 297	1 991	2 419	2 197	2 257	5 327	1 981	4 748	1 296	3 136	3 610	4 345	1 223
2008	3 058	2 301	2 154	1 929	1 892	5 608	1 923	4 544	1 216	2 998	3 709	3 678	1 649

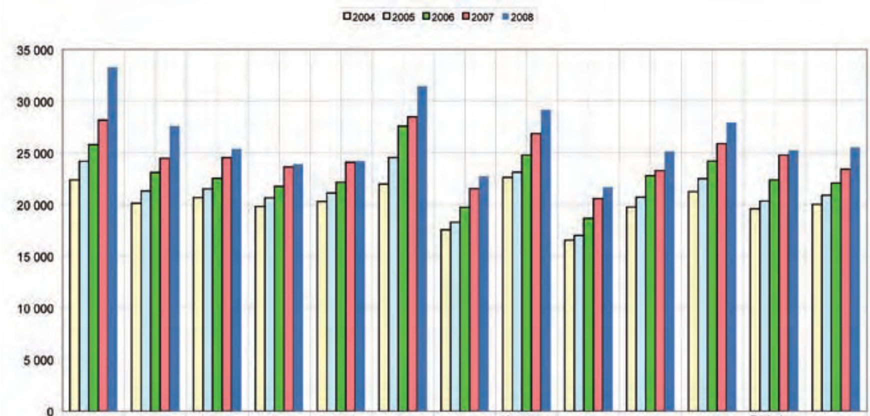
Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 10. Sales per employee (CZK thousand/employee)

When compared with other aggregates in our sample, sales per employee (Fig. 10) exhibits opposite results compared to value added labour productivity. In our sample there are higher sales per employee than in statewide aggregated mining (by about 4 %), but lower than in the manufacturing industry (probably by about 39 %) and in total industry (probably by about 28 %). Higher sales per employee than in statewide aggregated mining are once more connected with including of a part of manufacture into our sample.

Mining takes the last position in sales per employee in comparison with industry and non-financial sphere total aggregates. This can be expected, as e.g. in manufacturing industry, the enterprises supply each other with intermediate products which are then added to sales. This addition does not operate in value added, as stated above.

The average salary (Fig. 11) is more or less equal despite relatively big differences in labour productivity between individual minerals. Compared to industrial aggregates in 2008, our average salary is 8 % lower than in the statewide aggregate of mining, 11 % higher than in the statewide aggregate of industry, 15 % higher than in manufacturing industry.



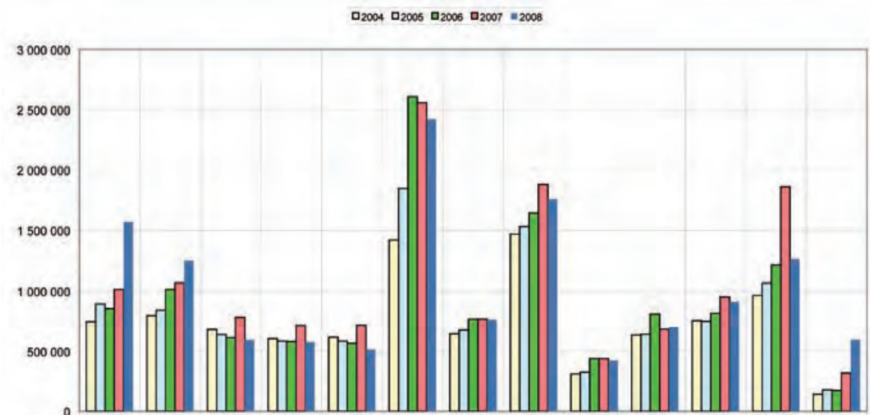
	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	22 378	20 120	20 669	19 814	20 285	21 972	17 554	22 617	16 546	19 760	21 247	19 588	20 029
2005	24 181	21 315	21 517	20 638	21 105	24 553	18 275	23 126	16 996	20 712	22 512	20 335	20 894
2006	25 787	23 099	22 533	21 755	22 145	27 575	19 726	24 789	18 659	22 788	24 201	22 385	22 076
2007	28 157	24 478	24 542	23 632	24 081	28 478	21 544	26 869	20 574	23 284	25 899	24 784	23 423
2008	33 276	27 581	25 369	23 902	24 205	31 434	22 729	29 136	21 664	25 134	27 923	25 235	25 517

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 11. Average salary (CZK/employee)

The comparison corresponds to the fact that mining occupies the second position after the energy production as salaries concerns. This represents again a specificity of mining given by the employees' structure.

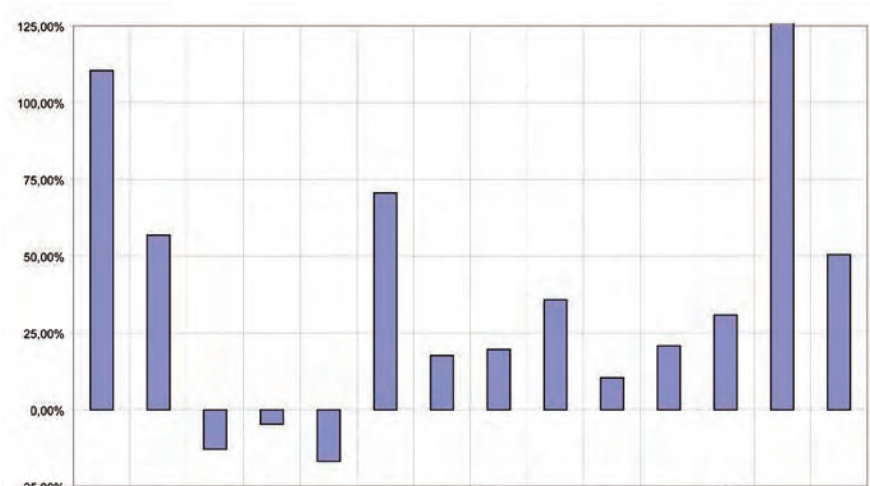
The difference between value added labour productivity and average salary (Fig. 12) is a deciding indicator for the evaluation of an enterprise's productivity (in our selection of indices). The higher the value, the better, i.e. it leaves more money for covering other costs (depreciation, social taxes, financial costs etc.) and for profit creation. In view of the fact that average salaries are not too variable, the result is due to differences in the book value added labour productivity.



	Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others
2004	743 834	794 564	680 541	603 020	616 577	1 417 852	644 824	1 467 446	310 902	635 200	752 471	962 129	143 395
2005	891 175	839 242	638 776	583 562	583 608	1 846 632	675 912	1 530 066	325 674	640 272	748 207	1 064 009	178 423
2006	852 819	1 011 846	611 655	579 746	565 487	2 607 819	764 562	1 641 282	438 206	807 113	814 153	1 209 810	173 506
2007	1 013 270	1 064 921	780 119	713 048	715 195	2 557 934	765 832	1 879 898	438 047	683 792	949 644	1 859 307	319 530
2008	1 565 249	1 246 707	593 436	575 068	513 096	2 419 092	758 591	1 755 839	422 233	701 452	909 295	1 259 267	596 231

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 12. (Value added – salaries) per employee (CZK/employee)



Bituminous coal	Brown coal + lignite	Kaolin	Clays + bentonite	Feldspar	Glass sand	Foundry sand	Limestones and CSA + dolomite	Dimension stone	Crushed stone	Sand and gravel	Brick clays and related minerals	Others	Mining total
110,43%	56,90%	-12,80%	-4,64%	-16,78%	70,62%	17,64%	19,65%	35,81%	10,43%	20,84%	30,88%	315,80%	50,52%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Fig. 13. Index 2008/2004 (book value added – salaries) per employee

The 2008/2004 index (Fig. 13) was calculated to orientate better in the index (value added – salaries) per employee. A positive aspect is that total mining registered a growth of 51 %. In other words, mining business paid more in 2008 than in 2004. The mining of other minerals, bituminous coal and glass sand is excellent.

A review of individual minerals follows.

Tab. 2: Bituminous coal

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		9	10	11	12	10
Number of employees		21 464	20 360	19 523	17 423	16 729
Sales	mill. CZK	38 048	41 260	36 599	40 021	51 166
Value added	mill. CZK	16 446	18 637	17 153	18 145	26 742
Acquisition of grounds and deposits	ths. CZK	55 473	33 496	19 214	17 417	39 794
Sales per employee	ths. CZK/ employee	1 773	2 027	1 875	2 297	3 058
Mining total = 100%	*%*	*93%*	*99%*	*84%*	*90%*	*110%*
Labour productivity based value added	CZK/ employee	766 212	915 357	878 606	1 041 427	1 598 525
Mining total = 100%	*%*	*110%*	*125%*	*109%*	*116%*	*153%*
Hourly labour productivity	CZK/ working hour	470	567	549	651	978
Mining total = 100%	*%*	*115%*	*130%*	*115%*	*123%*	*160%*
Average salary	CZK/ employee	22 378	24 181	25 787	28 157	33 276
Mining total = 100%	*%*	*108%*	*111%*	*110%*	*112%*	*121%*
(Value added - salaries) per employee	CZK/ employee	743 834	891 175	852 819	1 013 270	1 565 249
Mining total = 100%	*%*	*110%*	*125%*	*109%*	*116%*	*154%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	11%	12%	9%	9%	-17%
Number of employees	-22%	-5%	-4%	-11%	-4%
Sales	34%	8%	-11%	9%	28%
Value added	63%	13%	-8%	6%	47%
Acquisition of grounds and deposits	-28%	-40%	-43%	-9%	128%
Sales per employee	73%	14%	-7%	23%	33%
Labour productivity based value added	109%	19%	-4%	19%	53%
Hourly labour productivity	108%	21%	-3%	19%	50%
Average salary	49%	8%	7%	9%	18%
(Value added - salaries) per employee	110%	20%	-4%	19%	54%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

There are not many bituminous coal (Tab. 2) extracting enterprises (around 4 % of enterprises in our selection of enterprises in 2008), but it is one of the most significant parts of mining for sales (probably 23 %), employee numbers (21 %) and value added (32 %). In the relative indices bituminous coal has excellent growth and in comparison with the mining total it is an outstanding mineral from the economic point of view.

There are also few brown coal and lignite (Tab. 3) extracting enterprises (6.5 % of enterprises), but they have a higher share in terms of sales (14 %), employee numbers (16.5 %) and value added (20 %). It is one of the most important mineral industries. Compared to the mining total, the mineral industry is above-average regarding labour productivity based on value added, hourly labour productivity and the difference (value added – salaries) per employee.

Tab. 3: Brown coal and lignite

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		6	6	6	6	15
Number of employees		14 667	14 138	13 657	13 366	13 405
Sales	mill. CZK	21 259	21 920	24 613	26 609	30 849
Value added	mill. CZK	11 949	12 166	14 135	14 561	17 082
Acquisition of grounds and deposits	ths. CZK	21 978	44 106	197 748	84 730	131 372
Sales per employee	ths. CZK/ employee	1 449	1 550	1 802	1 991	2 301
Mining total = 100%	*%*	*76%*	*76%*	*81%*	*78%*	*83%*
Labour productivity based value added	CZK/ employee	814 684	860 557	1 034 945	1 089 399	1 274 288
Mining total = 100%	*%*	*117%*	*117%*	*129%*	*122%*	*122%*
Hourly labour productivity	CZK/ working hour	495	525	630	668	762
Mining total = 100%	*%*	*121%*	*120%*	*132%*	*126%*	*125%*
Average salary	CZK/ employee	20 120	21 315	23 099	24 478	27 581
Mining total = 100%	*%*	*97%*	*98%*	*99%*	*98%*	*100%*
(Value added - salaries) per employee	CZK/ employee	794 564	839 242	1 011 846	1 064 921	1 246 707
Mining total = 100%	*%*	*118%*	*118%*	*130%*	*122%*	*123%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	150%	0%	0%	0%	150%
Number of employees	-9%	-4%	-3%	-2%	0%
Sales	45%	3%	12%	8%	16%
Value added	43%	2%	16%	3%	17%
Acquisition of grounds and deposits	498%	101%	348%	-57%	55%
Sales per employee	59%	7%	16%	10%	16%
Labour productivity based value added	56%	6%	20%	5%	17%
Hourly labour productivity	54%	6%	20%	6%	14%
Average salary	37%	6%	8%	6%	13%
(Value added - salaries) per employee	57%	6%	21%	5%	17%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Tab. 4: Kaolin

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		5	4	4	4	7
Number of employees		3 901	4 259	3 977	3 685	2 706
Sales	mill. CZK	7 365	8 266	8 222	8 913	5 829
Value added	mill. CZK	2 735	2 812	2 522	2 965	1 675
Acquisition of grounds and deposits	ths. CZK	25 153	52 848	43 331	7 374	19 110
Sales per employee	ths. CZK/ employee	1 888	1 941	2 067	2 419	2 154
Mining total = 100%	*%*	*100%*	*95%*	*93%*	*95%*	*78%*
Labour productivity based value added	CZK/ employee	701 211	660 293	634 189	804 661	618 805
Mining total = 100%	*%*	*101%*	*90%*	*79%*	*90%*	*59%*
Hourly labour productivity	CZK/ working hour	411	399	373	473	354
Mining total = 100%	*%*	*100%*	*92%*	*78%*	*89%*	*58%*
Average salary	CZK/ employee	20 669	21 517	22 533	24 542	25 369
Mining total = 100%	*%*	*100%*	*99%*	*96%*	*98%*	*92%*
(Value added - salaries) per employee	CZK/ employee	680 541	638 776	611 655	780 119	593 436
Mining total = 100%	*%*	*101%*	*90%*	*78%*	*90%*	*58%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	40%	-20%	0%	0%	75%
Number of employees	-31%	9%	-7%	-7%	-27%
Sales	-21%	12%	-1%	8%	-35%
Value added	-39%	3%	-10%	18%	-44%
Acquisition of grounds and deposits	-24%	110%	-18%	-83%	159%
Sales per employee	14%	3%	7%	17%	-11%
Labour productivity based value added	-12%	-6%	-4%	27%	-23%
Hourly labour productivity	-14%	-3%	-7%	27%	-25%
Average salary	23%	4%	5%	9%	3%
(Value added - salaries) per employee	-13%	-6%	-4%	28%	-24%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

In 2008, kaolin accounted for a 3 % share of number of enterprises, a 2.6 % share of sales, 3.3 % share of number of employees, and a 2 % share of value added of the mining total. From this perspective, it is of low importance. In terms of relative indices such as sales per employee, labour productivity etc., kaolin generally reaches lower values than Mining total.

Tab. 5: Clays and bentonite

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		7	7	6	6	9
Number of employees		5 020	5 375	4 910	4 626	3 733
Sales	mill. CZK	8 267	9 124	9 122	10 163	7 203
Value added	mill. CZK	3 127	3 247	2 953	3 408	2 236
Acquisition of grounds and deposits	ths. CZK	34 042	25 240	40 242	13 690	40 271
Sales per employee	ths. CZK/ employee	1 647	1 698	1 858	2 197	1 929
Mining total = 100%	*%*	*87%*	*83%*	*84%*	*86%*	*70%*
Labour productivity based value added	CZK/ employee	622 834	604 200	601 502	736 680	598 970
Mining total = 100%	*%*	*90%*	*82%*	*75%*	*82%*	*57%*
Hourly labour productivity	CZK/ working hour	368	366	357	436	352
Mining total = 100%	*%*	*90%*	*84%*	*75%*	*82%*	*58%*
Average salary	CZK/ employee	19 814	20 638	21 755	23 632	23 902
Mining total = 100%	*%*	*96%*	*95%*	*93%*	*94%*	*87%*
(Value added - salaries) per employee	CZK/ employee	603 020	583 562	579 746	713 048	575 068
Mining total = 100%	*%*	*89%*	*82%*	*74%*	*82%*	*57%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	29%	0%	-14%	0%	50%
Number of employees	-26%	7%	-9%	-6%	-19%
Sales	-13%	10%	0%	11%	-29%
Value added	-28%	4%	-9%	15%	-34%
Acquisition of grounds and deposits	18%	-26%	59%	-66%	194%
Sales per employee	17%	3%	9%	18%	-12%
Labour productivity based value added	-4%	-3%	0%	22%	-19%
Hourly labour productivity	-4%	0%	-3%	22%	-19%
Average salary	21%	4%	5%	9%	1%
(Value added - salaries) per employee	-5%	-3%	-1%	23%	-19%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

In the case of clays and bentonite (Tab. 5), the situation is similar to that of kaolin. It is an insignificant mineral industry in terms of share of number of enterprises (3.9 %), sales (3.2 %), number of employees (4.6 %) and value added (2.6 %) in 2008. The values of relative indices are below the level of the mining total.

Feldspar (Tab. 6) – again an insignificant mineral industry in 2008, with a 2.2 % share of number of enterprises, a 2.4 % share of sales, a 3.5 % share of number of employees, and a 1.8 % share of value added. Its effectiveness is clearly below the average of the mining total.

Tab. 6: Feldspar

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		5	5	5	4	5
Number of employees		4 223	4 584	4 251	3 978	2 855
Sales	mill. CZK	7 279	8 164	8 221	8 977	5 403
Value added	mill. CZK	2 689	2 772	2 498	2 941	1 534
Acquisition of grounds and deposits	ths. CZK	22 361	34 611	28 918	13 967	25 563
Sales per employee	ths. CZK/ employee	1 724	1 781	1 934	2 257	1 892
Mining total = 100%	*%*	*91%*	*87%*	*87%*	*88%*	*68%*
Labour productivity based value added	CZK/ employee	636 862	604 713	587 632	739 276	537 301
Mining total = 100%	*%*	*92%*	*82%*	*73%*	*83%*	*52%*
Hourly labour productivity	CZK/ working hour	374	365	347	435	314
Mining total = 100%	*%*	*91%*	*84%*	*73%*	*82%*	*52%*
Average salary	CZK/ employee	20 285	21 105	22 145	24 081	24 205
Mining total = 100%	*%*	*98%*	*97%*	*95%*	*96%*	*88%*
(Value added - salaries) per employee	CZK/ employee	616 577	583 608	565 487	715 195	513 096
Mining total = 100%	*%*	*91%*	*82%*	*72%*	*82%*	*51%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	0%	0%	0%	-20%	25%
Number of employees	-32%	9%	-7%	-6%	-28%
Sales	-26%	12%	1%	9%	-40%
Value added	-43%	3%	-10%	18%	-48%
Acquisition of grounds and deposits	14%	55%	-16%	-52%	83%
Sales per employee	10%	3%	9%	17%	-16%
Labour productivity based value added	-16%	-5%	-3%	26%	-27%
Hourly labour productivity	-16%	-2%	-5%	25%	-28%
Average salary	19%	4%	5%	9%	1%
(Value added - salaries) per employee	-17%	-5%	-3%	26%	-28%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Tab. 7: Glass sand

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		3	3	3	3	3
Number of employees		296	227	163	124	156
Sales	mill. CZK	960	881	860	661	875
Value added	mill. CZK	425	425	430	321	382
Acquisition of grounds and deposits	ths. CZK	548	123	0	0	0
Sales per employee	ths. CZK/ employee	3 248	3 881	5 269	5 327	5 608
Mining total = 100%	*%*	*171%*	*189%*	*237%*	*208%*	*202%*
Labour productivity based value added	CZK/ employee	1 439 824	1 871 185	2 635 394	2 586 412	2 450 526
Mining total = 100%	*%*	*207%*	*255%*	*328%*	*289%*	*235%*
Hourly labour productivity	CZK/ working hour	831	1 095	1 571	1 530	1 483
Mining total = 100%	*%*	*202%*	*251%*	*330%*	*289%*	*243%*
Average salary	CZK/ employee	21 972	24 553	27 575	28 478	31 434
Mining total = 100%	*%*	*106%*	*113%*	*118%*	*114%*	*114%*
(Value added - salaries) per employee	CZK/ employee	1 417 852	1 846 632	2 607 819	2 557 934	2 419 092
Mining total = 100%	*%*	*210%*	*259%*	*334%*	*294%*	*238%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	0%	0%	0%	0%	0%
Number of employees	-47%	-23%	-28%	-24%	26%
Sales	-9%	-8%	-2%	-23%	32%
Value added	-10%	0%	1%	-25%	19%
Acquisition of grounds and deposits	-100%	-78%	-100%		
Sales per employee	73%	20%	36%	1%	5%
Labour productivity based value added	70%	30%	41%	-2%	-5%
Hourly labour productivity	79%	32%	44%	-3%	-3%
Average salary	43%	12%	12%	3%	10%
(Value added - salaries) per employee	71%	30%	41%	-2%	-5%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

The least important mineral industry, accounting for a 1.3 % share of number of enterprises, and for around 1 % in terms of sales, number of employees and value added. However clearly the best mineral industry in terms of labour productivity and other relative indices. The least important, but the most effective mineral industry.

Tab. 8: Foundry sand

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		6	6	6	4	5
Number of employees		1 485	1 450	1 402	1 099	1 418
Sales	mill. CZK	2 285	2 229	2 439	2 177	2 726
Value added	mill. CZK	983	1 007	1 099	865	1 108
Acquisition of grounds and deposits	ths. CZK	3 051	647	946	110	4 298
Sales per employee	ths. CZK/ employee	1 539	1 537	1 740	1 981	1 923
Mining total = 100%	*%*	*81%*	*75%*	*78%*	*77%*	*69%*
Labour productivity based value added	CZK/ employee	662 379	694 188	784 288	787 376	781 319
Mining total = 100%	*%*	*95%*	*95%*	*97%*	*88%*	*75%*
Hourly labour productivity	CZK/ working hour	391	420	477	472	465
Mining total = 100%	*%*	*95%*	*96%*	*100%*	*89%*	*76%*
Average salary	CZK/ employee	17 554	18 275	19 726	21 544	22 729
Mining total = 100%	*%*	*85%*	*84%*	*84%*	*86%*	*82%*
(Value added - salaries) per employee	CZK/ employee	644 824	675 912	764 562	765 832	758 591
Mining total = 100%	*%*	*96%*	*95%*	*98%*	*88%*	*75%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	-17%	0%	0%	-33%	25%
Number of employees	-4%	-2%	-3%	-22%	29%
Sales	19%	-2%	9%	-11%	25%
Value added	13%	2%	9%	-21%	28%
Acquisition of grounds and deposits	41%	-79%	46%	-88%	3807%
Sales per employee	25%	0%	13%	14%	-3%
Labour productivity based value added	18%	5%	13%	0%	-1%
Hourly labour productivity	19%	7%	14%	-1%	-2%
Average salary	29%	4%	8%	9%	5%
(Value added - salaries) per employee	18%	5%	13%	0%	-1%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Foundry sand (Tab. 8) is an insignificant mineral industry accounting for a 1–2 % share of the mining total. Its effectiveness is, as it tends to be (with the exception of glass sand) below the average of the mining total.

A more important mineral group in terms of size, i.e. limestone, corrective additives for cement production and dolomites (Tab. 9) are mineral industries which account for about 6 % of enterprises, 3.3 % of employees, 5.3 % of sales and 5.6 % of value added of the mining total. They are also stars in terms of labour productivity, which is almost twice as high as the total.

Dimension stone (Tab. 10) is an insignificant mineral industry with very low labour productivity and average salaries, yet with the third highest number of enterprises.

Tab. 9: Limestones and corrective additives for cement production and dolomite

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		16	16	15	11	14
Number of employees		2 835	2 752	2 797	2 467	2 647
Sales	mill. CZK	10 648	10 341	11 545	11 711	12 028
Value added	mill. CZK	4 224	4 275	4 660	4 704	4 725
Acquisition of grounds and deposits	ths. CZK	23 513	19 971	31 613	26 622	30 847
Sales per employee	ths. CZK/ employee	3 756	3 757	4 128	4 748	4 544
Mining total = 100%	*%*	*198%*	*183%*	*186%*	*186%*	*164%*
Labour productivity based value added	CZK/ employee	1 490 063	1 553 192	1 666 071	1 906 767	1 784 975
Mining total = 100%	*%*	*214%*	*212%*	*207%*	*213%*	*171%*
Hourly labour productivity	CZK/ working hour	811	859	916	1 060	1 007
Mining total = 100%	*%*	*198%*	*197%*	*192%*	*200%*	*165%*
Average salary	CZK/ employee	22 617	23 126	24 789	26 869	29 136
Mining total = 100%	*%*	*110%*	*106%*	*106%*	*107%*	*106%*
(Value added - salaries) per employee	CZK/ employee	1 467 446	1 530 066	1 641 282	1 879 898	1 755 839
Mining total = 100%	*%*	*218%*	*215%*	*210%*	*216%*	*173%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	-13%	0%	-6%	-27%	27%
Number of employees	-7%	-3%	2%	-12%	7%
Sales	13%	-3%	12%	1%	3%
Value added	12%	1%	9%	1%	0%
Acquisition of grounds and deposits	31%	-15%	58%	-16%	16%
Sales per employee	21%	0%	10%	15%	-4%
Labour productivity based value added	20%	4%	7%	14%	-6%
Hourly labour productivity	24%	6%	7%	16%	-5%
Average salary	29%	2%	7%	8%	8%
(Value added - salaries) per employee	20%	4%	7%	15%	-7%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Tab. 10: Dimension stone

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		20	23	18	11	21
Number of employees		1 432	1 551	1 197	989	1 395
Sales	mill. CZK	1 713	2 525	1 625	1 282	1 696
Value added	mill. CZK	469	532	547	453	619
Acquisition of grounds and deposits	ths. CZK	2 505	1 375	1 422	41	9 869
Sales per employee	ths. CZK/ employee	1 197	1 628	1 358	1 296	1 216
Mining total = 100%	*%*	*63%*	*79%*	*61%*	*51%*	*44%*
Labour productivity based value added	CZK/ employee	327 448	342 669	456 865	458 621	443 897
Mining total = 100%	*%*	*47%*	*47%*	*57%*	*51%*	*43%*
Hourly labour productivity	CZK/ working hour	191	201	269	267	252
Mining total = 100%	*%*	*47%*	*46%*	*56%*	*50%*	*41%*
Average salary	CZK/ employee	16 546	16 996	18 659	20 574	21 664
Mining total = 100%	*%*	*80%*	*78%*	*80%*	*82%*	*79%*
(Value added - salaries) per employee	CZK/ employee	310 902	325 674	438 206	438 047	422 233
Mining total = 100%	*%*	*46%*	*46%*	*56%*	*50%*	*42%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	5%	15%	-22%	-39%	91%
Number of employees	-3%	8%	-23%	-17%	41%
Sales	-1%	47%	-36%	-21%	32%
Value added	32%	13%	3%	-17%	37%
Acquisition of grounds and deposits	294%	-45%	3%	-97%	23971%
Sales per employee	2%	36%	-17%	-5%	-6%
Labour productivity based value added	36%	5%	33%	0%	-3%
Hourly labour productivity	32%	5%	33%	-1%	-6%
Average salary	31%	3%	10%	10%	5%
(Value added - salaries) per employee	36%	5%	35%	0%	-4%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Tab. 11: Crushed stone

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		62	61	57	38	61
Number of employees		21 008	19 700	21 061	15 404	16 631
Sales	mill. CZK	44 914	46 290	58 074	48 311	49 852
Value added	mill. CZK	13 759	13 022	17 479	10 892	12 084
Acquisition of grounds and deposits	ths. CZK	235 638	139 468	396 754	101 245	496 510
Sales per employee	ths. CZK/ employee	2 138	2 350	2 757	3 136	2 998
Mining total = 100%	*%*	*113%*	*115%*	*124%*	*123%*	*108%*
Labour productivity based value added	CZK/ employee	654 960	660 984	829 901	707 076	726 586
Mining total = 100%	*%*	*94%*	*90%*	*103%*	*79%*	*70%*
Hourly labour productivity	CZK/ working hour	375	372	473	397	410
Mining total = 100%	*%*	*91%*	*85%*	*99%*	*75%*	*67%*
Average salary	CZK/ employee	19 760	20 712	22 788	23 284	25 134
Mining total = 100%	*%*	*96%*	*95%*	*97%*	*93%*	*91%*
(Value added - salaries) per employee	CZK/ employee	635 200	640 272	807 113	683 792	701 452
Mining total = 100%	*%*	*94%*	*90%*	*103%*	*79%*	*69%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	-2%	-2%	-7%	-33%	61%
Number of employees	-21%	-6%	7%	-27%	8%
Sales	11%	3%	25%	-17%	3%
Value added	-12%	-5%	34%	-38%	11%
Acquisition of grounds and deposits	111%	-41%	184%	-74%	390%
Sales per employee	40%	10%	17%	14%	-4%
Labour productivity based value added	11%	1%	26%	-15%	3%
Hourly labour productivity	9%	-1%	27%	-16%	3%
Average salary	27%	5%	10%	2%	8%
(Value added - salaries) per employee	10%	1%	26%	-15%	3%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Crushed stone (Tab. 11) is a mineral industry with the highest number of enterprises (26.3 % share), and with the second highest share of sales (22.1 %) and number of employees (20.5 %). It has the third highest share of value added (14.3 %). Along with bituminous coal, it is the most important mineral industry. However when compared to bituminous coal, it is below average in terms of performance except for the sales per employee index.

Table 12 lists the second most numerous mineral industry (25.9 % share), sand and gravel. It also has a considerable share of sales (18.4 %), number of employees (13.7 %) and of value added (12.4 %). In terms of effectiveness, the mineral industry was above average in 2008 in sales per employee. It is equal to the mining total in terms of average salary, and below average in terms of the other indices. However in 2004–2007, it was above average in all indices. The decrease in effectiveness occurred because enterprises from the OKEČ category of glass, ceramics and building materials manufacture were due to be processed in 2008. Mining and manufacture cannot be distinguished because mining and manufacturing companies merged and, therefore, mining was not separated from manufacture.

Brick clays and related minerals (Tab. 13) most likely belong among least important mineral industries (2 % of sales, etc.) with high above-average labour productivity, but below average salary.

Tab. 12: Sand and gravel

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		56	58	55	39	60
Number of employees		13 677	13 978	13 030	11 801	11 158
Sales	mill. CZK	38 336	40 818	41 228	42 607	41 385
Value added	mill. CZK	10 582	10 773	10 924	11 513	10 458
Acquisition of grounds and deposits	ths. CZK	69 010	159 652	236 847	63 039	448 653
Sales per employee	ths. CZK/ employee	2 803	2 920	3 164	3 610	3 709
Mining total = 100%	*%*	*148%*	*142%*	*142%*	*141%*	*134%*
Labour productivity based value added	CZK/ employee	773 718	770 719	838 354	975 543	937 219
Mining total = 100%	*%*	*111%*	*105%*	*104%*	*109%*	*90%*
Hourly labour productivity	CZK/ working hour	441	443	474	557	520
Mining total = 100%	*%*	*108%*	*102%*	*100%*	*105%*	*85%*
Average salary	CZK/ employee	21 247	22 512	24 201	25 899	27 923
Mining total = 100%	*%*	*103%*	*103%*	*103%*	*103%*	*101%*
(Value added - salaries) per employee	CZK/ employee	752 471	748 207	814 153	949 644	909 295
Mining total = 100%	*%*	*112%*	*105%*	*104%*	*109%*	*90%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	7%	4%	-5%	-29%	54%
Number of employees	-18%	2%	-7%	-9%	-5%
Sales	8%	6%	1%	3%	-3%
Value added	-1%	2%	1%	5%	-9%
Acquisition of grounds and deposits	550%	131%	48%	-73%	612%
Sales per employee	32%	4%	8%	14%	3%
Labour productivity based value added	21%	0%	9%	16%	-4%
Hourly labour productivity	18%	0%	7%	18%	-7%
Average salary	31%	6%	8%	7%	8%
(Value added - salaries) per employee	21%	-1%	9%	17%	-4%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Tab. 13: Brick clays and related minerals

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		23	17	14	8	9
Number of employees		3 003	2 656	2 209	1 319	1 249
Sales	mill. CZK	7 412	7 600	6 684	5 732	4 596
Value added	mill. CZK	2 948	2 880	2 722	2 486	1 605
Acquisition of grounds and deposits	ths. CZK	49 752	36 740	136 091	20 370	47 995
Sales per employee	ths. CZK/ employee	2 468	2 861	3 026	4 345	3 678
Mining total = 100%	*%*	*130%*	*140%*	*136%*	*170%*	*133%*
Labour productivity based value added	CZK/ employee	981 717	1 084 344	1 232 195	1 884 091	1 284 502
Mining total = 100%	*%*	*141%*	*148%*	*153%*	*211%*	*123%*
Hourly labour productivity	CZK/ working hour	553	619	707	1 077	732
Mining total = 100%	*%*	*135%*	*142%*	*148%*	*203%*	*120%*
Average salary	CZK/ employee	19 588	20 335	22 385	24 784	25 235
Mining total = 100%	*%*	*95%*	*93%*	*96%*	*99%*	*91%*
(Value added - salaries) per employee	CZK/ employee	962 129	1 064 009	1 209 810	1 859 307	1 259 267
Mining total = 100%	*%*	*143%*	*149%*	*155%*	*214%*	*124%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	-61%	-26%	-18%	-43%	13%
Number of employees	-58%	-12%	-17%	-40%	-5%
Sales	-38%	3%	-12%	-14%	-20%
Value added	-46%	-2%	-5%	-9%	-35%
Acquisition of grounds and deposits	-4%	-26%	270%	-85%	136%
Sales per employee	49%	16%	6%	44%	-15%
Labour productivity based value added	31%	10%	14%	53%	-32%
Hourly labour productivity	33%	12%	14%	52%	-32%
Average salary	29%	4%	10%	11%	2%
(Value added - salaries) per employee	31%	11%	14%	54%	-32%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Tab. 14: Other minerals (uranium + crude oil + graphite + gemstones + silica minerals + gypsum)

Indicator	Unit	2004	2005	2006	2007	2008
Number of enterprises		7	7	8	7	13
Number of employees		10 672	10 682	10 165	9 028	7 080
Sales	mill. CZK	8 096	9 197	9 292	11 039	11 673
Value added	mill. CZK	1 744	2 129	1 988	3 096	4 402
Acquisition of grounds and deposits	ths. CZK	21 510	59 839	48 163	10 362	40 402
Sales per employee	ths. CZK/ employee	759	861	914	1 223	1 649
Mining total = 100%	*%*	*40%*	*42%*	*41%*	*48%*	*59%*
Labour productivity based value added	CZK/ employee	163 424	199 317	195 582	342 952	621 748
Mining total = 100%	*%*	*24%*	*27%*	*24%*	*38%*	*60%*
Hourly labour productivity	CZK/ working hour	100	123	120	209	377
Mining total = 100%	*%*	*24%*	*28%*	*25%*	*39%*	*62%*
Average salary	CZK/ employee	20 029	20 894	22 076	23 423	25 517
Mining total = 100%	*%*	*97%*	*96%*	*94%*	*94%*	*92%*
(Value added - salaries) per employee	CZK/ employee	143 395	178 423	173 506	319 530	596 231
Mining total = 100%	*%*	*21%*	*25%*	*22%*	*37%*	*59%*

Index	08/04	05/04	06/05	07/06	08/07
Number of enterprises	86%	0%	14%	-13%	86%
Number of employees	-34%	0%	-5%	-11%	-22%
Sales	44%	14%	1%	19%	6%
Value added	152%	22%	-7%	56%	42%
Acquisition of grounds and deposits	88%	178%	-20%	-78%	290%
Sales per employee	117%	13%	6%	34%	35%
Labour productivity based value added	280%	22%	-2%	75%	81%
Hourly labour productivity	278%	24%	-3%	74%	81%
Average salary	27%	4%	6%	6%	9%

Source: own calculations according to Ministry of Industry and Trade and Czech Statistical Office data

Because there were only few enterprises in the other mineral sectors, it is impossible to publish data on them. Therefore they were aggregated into one group called Other minerals (Tab. 14). It includes extraction of uranium, crude oil, natural gas, graphite, gemstones, diatomite, silica minerals and gypsum. To write any commentary on such mixture is too problematic. They embrace both very effective mineral (crude oil, natural gas) industries, but also, in connection with a very low production, the very problematic ones.

We have tried to compile selected accessible economic data concerning the mining enterprises in this sector. There are too little data, but in view of their accessibility for small enterprises, this is the maximum available.

Outline of domestic mine production

		2004	2005	2006	2007	2008
Energy minerals						
Uranium	t U	435	420	383	322	290
	Concentrate production, t U(1)	412	409	358	291	261
Bituminous coal	kt	14 648	12 778	13 017	12 462	12 197
Brown coal	kt(2)	47 840	48 658	48 915	49 134	47 456
Lignite	kt	450	467	459	437	416
Crude oil	kt	299	306	259	240	236
Natural gas	mil m^3	175	356	148	148	168
Industrial minerals						
Graphite	kt	5	3	5	3	3
Pyrope bearing rock	kt	42	43	39	34	24
Moldavite (tectite) bearing rock	ths m^3	114	74	95	114	99
	kt (1 m^3 = 1.8 kt)	205	133	171	205	178
Kaolin	Raw, kt (3)	3 862	3 882	3 768	3 604	3 833
	Beneficiated, kt	596	649	673	682	672
Clays	kt	649	671	561	679	574
Bentonite(4)	kt	224	216	267	335	235
Diatomite	kt	33	38	53	19	31
Feldspar	kt	466	472	487	487	488
Feldspar substitutes	kt	26	23	31	25	36
Silica minerals	kt	10	15	17	19	18
Glass sand	kt	828	920	963	942	1 151
Foundry sand	kt	831	807	773	850	702
Limestones and corrective additives for cement production	kt	10 800	10 190	10 441	11 670	11 465
Dolomite	kt	345	419	409	385	449
Gypsum	kt	68	24	16	66	35
Construction minerals						
Dimension stone	Mine production in reserved deposits, ths m^3 (5)	273	288	242	242	229
	Mine production in reserved deposits, kt (1 m^3 = 2.7 kt) (5)	737	778	653	653	618
	Mine production in non-reserved deposits, ths m^3 (6)	65	55	55	50	45
	Mine production in non-reserved deposits, kt (1 m^3 = 2.7 kt)(6)	176	149	149	135	122

		2004	2005	2006	2007	2008
Crushed stone	Mine production in reserved deposits, ths m^3 (5)	11 966	12 822	14 093	14 655	14 799
	Mine production in reserved deposits, kt (1 m^3 = 2.7 kt) (5)	32 308	34 619	38 051	39 569	39 957
	Mine production in non-reserved deposits, ths m^3 (6)	960	1 270	1 300	1 350	1 600
	Mine production in non-reserved deposits, kt (1 m^3 = 2.7 kt)(6)	2 592	3 429	3 510	3 645	4 320
Sand and gravel	Mine production in reserved deposits, ths m^3 (5)	8 859	9 075	9 110	9 185	8 770
	Mine production in reserved deposits, kt (1 m^3 = 1.8 kt) (5)	15 946	16 335	16 398	16 533	15 786
	Mine production in non-reserved deposits, ths m^3 (6)	4 900	5 100	6 000	6 450	6 350
	Mine production in non-reserved deposits, kt (1 m^3 = 1.8 kt)(6)	8 640	9 000	10 800	11 700	11 520
Brick clays and related minerals	Mine production in reserved deposits, ths m^3 (5)	1 554	1 543	1 286	1 433	1 242
	Mine production in reserved deposits, kt (1 m^3 = 1.8 kt) (5)	2 797	2 777	2 282	2 579	2 236
	Mine production in non-reserved deposits, ths m^3 (6)	330	220	290	300	270
	Mine production in non-reserved deposits, kt (1 m^3 = 1.8 kt)(6)	594	396	540	540	520
Metallic ores (not mined)						

(1) corresponds to sales production (without beneficiation losses)
(2) ČSÚ (Czech Statistical Office) presents so-called sales mining production which is production of marketable brown coal and reaches on average about 95 % of given mine production
(3) raw kaolin, total production of all technological grades
(4) including mining of montmorillonite clays overburden of kaolins since 2004
(5) decrease of mineral reserves by mining production
(6) estimate

Domestic share in the world mine production

		2004	2005	2006	2007	2008
Energy minerals						
Uranium (U)	world (source): UI/WNA	1.081%	1.007%	0.971%	0.780%	0.660%
Bituminous coal	world (source): WBD	0.317%	0.259%	0.251%	0.226%	N
Brown coal + Lignite	world (source): WBD	5.215%	5.311%	5.529%	5.570%	N
Crude oil	world (source): WBD	0.008%	0.008%	0.007%	0.006%	N
Natural gas	world (source): BP	0.006%	0.013%	0.005%	0.005%	0.005%
Industrial minerals						
Graphite	world (source): MCS	0.509%	0.283%	0.485%	0.270%	0.270%
Pyrope bearing rock		N	N	N	N	N
Moldavite (tectite) bearing rock		N	N	N	N	N
Kaolin	world (source): MCS	8.679%	8.685%	10.048%	9.241%	9.904%
Clays		N	N	N	N	N
Bentonite****	world (source): MCS	2.133%	1.846%	2.282%	2.815%	1.450%
Diatomite	world (source): MCS	1.710%	1.881%	2.454%	0.905%	1.550%
Feldspar	world (source): MCS	4.396%	3.659%	3.162%	2.840%	2.667%
Feldspar substitutes		N	N	N	N	N
Glass + Foundry sand	world (source): MCS	1.443%	1.464%	1.471%	1.422%	1.459%
Limestones and corrective additives for cement production		N	N	N	N	N
Dolomite		N	N	N	N	N
Gypsum	world (source): MCS	0.062%	0.020%	0.015%	0.043%	0.023%
Construction minerals						
		N	N	N	N	N
Metallic ores (not mined)						

MINERALS IN THE CZECH FOREIGN TRADE

Minerals and mineral products represent an important group in the Czech foreign trade. However, the foreign trade balance of minerals and mineral products has been permanently negative owing to the large import volume of mineral (fossil) fuels (crude oil and natural gas), iron ores and materials for mineral fertilizers production. The following 38 items of the Customs tariff nomenclature HS-4 and HS-6 are the most important minerals and products of Czech foreign trade at the present time:

Definition of selected customs tariff items

Raw material	Code[1)]	Specification of item according to the customs tariff
Fe-ores and concentrates	2601	Iron ores and concentrates incl. roasted iron pyrites
Mn-ores and concentrates	2602	Manganese ores and concentrates including Mn-Fe ores and concentrates with 20 wt % Mn or more (calculated on dry substance)
Ni-ores and concentrates	2604	Nickel ores and concentrates
Cu-ores and concentrates	2603	Copper ores and concentrates
Pb-ores and concentrates	2607	Lead ores and concentrates
Zn-ores and concentrates	2608	Zinc ores and concentrates
Sn-ores and concentrates	2609	Tin ores and concentrates
W-ores and concentrates	2611	Tungsten ores and concentrates
Ag-ores and concentrates	261610	Silver ores and concentrates
Au-ores and concentrates	7108 261690	Gold in unwrought or semimanufactured form, gold powder Other precious metal ores and concentrates
U-ores and concentrates	261210	Uranium ores and concentrates
Crude oil	2709	Petroleum oils and oils obtained from bituminous minerals, crude
Natural gas	271121	Natural gas
Hard coal	2701	Hard coal, briquets and similar solid fuels made of bituminous coal
Brown coal	2702	Lignite, also agglomerated, except jet[2)]
Fluorspar	252921 252922	Fluorspar, containing 97 wt % or less of calcium fluoride Fluorspar, containing more than 97 wt % of calcium fluoride
Barite	251010	Natural barium sulphate (barite)
Graphite	2504	Natural graphite
Kaolin	2507	Kaolin and other kaolinitic clays, also calcined
Clays	2508	Other clays (except expanded clays No. 6806), andalusite, kyanite, sillimanite, also baked, mullite, chamotte or dinas earths
Bentonite	250810	Bentonite

Feldspar Feldspar substitute	252910 252930	Feldspar Leucite, nepheline and nepheline syenite
Silica minerals	2506	Quartz (except natural sand), crude quartzite, also dressed
Glass and foundry sand	250510	Silica sand and quartz sand
Limestones	2521	Limestone flux, limestone and other calcareous stone for lime or cement manufacturing
Dolomite	2518	Dolomite, dolomite calcined, roughly worked or cut, agglomerated
Gypsum	252010	Gypsum, anhydrite
Dimension stone	2514 2515 2516 6801 6802 6803	Slate, also roughly worked or cut by saw or other way only into blocks or rectangular slabs Marble, travertine, ecaussine and other calcareous monumental or crushed stone, density 2.5 or higher, and alabaster, also roughly worked or cut by saw or other way cut only into blocks or rectangular slabs Granite, porphyry, basalt, sandstone and other monumental or crushed stone, also roughly trimmed or cut into blocks or rectangular slabs Setts, curbstones and flagstones of natural stone (except slate) Worked monumental and crushed stone (except slate and slate products, except products No. 6801; little stones for mosaics or tasselated pavements or similar objects, also on beds; artificially coloured granules, chippings and dust of natural stone (including slate) Worked slate and articles of slate or of agglomerated slate
Crushed stone	251710*	Pebbles, gravel, broken or crushed stone in general used for concreting and gravelling of roads, railroads etc., flint and hard head also heat-treated
Sand and gravel	250590 251710*	Other sand (natural sand of all kinds, also coloured, except sand containing metals and except silica sand and quartz sand) Pebbles, gravel, broken or crushed stone in general used for concreting and gravelling of roads, railroads etc., flint and hard head also heat-treated

1) *Code of the customs tariff*
2) *Jet is compact black variety of brown coal used in (mourning) jewelry*
* *item included in one commodity only*

Definition of other important customs tariff items

Raw material	Code[1)]	Specification of item according to the customs tariff
Al-ores and concentrates	2606	Aluminium ores and concentrates
Ti-ores and concentrates	2614	Titanium ores and concentrates
Nb, Ta, V and Zr-ores and concentrates	2515	Niobium, tantalum, vanadium or zirconium ores and concentrates
Coke	2704	Coke and semi-coke of coal, lignite or peat; agglomerated; retort carbon
Salt	2501	Salt (inclusive table and denatured salt), pure sodium chloride; also in water solution
Sulphur	2503 2802	Sulphur of all kinds, other than sublimed, precipitated and colloidal Sulphur, sublimed or precipitated colloidal sulphur
Sulphuric acid oleum	2807	Sulphuric acid
Natural phosphates	2510	Natural calcium phosphates, aluminium calcium phosphates, etc., unground
Phosphoric substances	2809	Diphosphorus pentaoxide, phosphoric acid and polyphosphoric acids
Nitrogenous fertilizers	3102	Mineral or chemical fertilizers, nitrogenous
Phosphatic fertilizers	3103	Mineral or chemical fertilizers, phosphatic
Potassic fertilizers	3104	Mineral or chemical fertilizers, potassic
Fertilizers of more elements	3105	Mineral or chemical fertilizers of 2–3 of elements
Magnesite	251910	Natural magnesium carbonate (magnesite)
	251990	Magnesia, fused, dead-burned, magnesium oxides
Talc	2526	Natural steatite, also roughly worked or cut etc., talc
Quicklime	2522	Quicklime, slaked and hydraulic, other than calcium oxide and calcium hydroxide of 2825
Cement	2523	Portland, aluminous cement, slag, supersulfate and other hydraulic cement

[1] *Code of the customs tariff*

Main export and import countries of minerals and intermediate products made from them (in % share of FOB current prices):

	Country / year	2004	2005	2006	2007	2008
Export	Germany	28.5	24.6	22.3	24.1	34.5
	Slovakia	24.3	24.4	24.3	23.0	21.1
	Austria	26.5	29.6	23.9	21.9	18.8
	Poland	7.7	5.8	5.9	17.5	15.3
	Hungary	4.7	8.9	14.7	5.2	4.0
	Italy	1.1	1.2	1.3	1.1	1.1
	Finland	0.4	0.0	0.8	1.1	0.9
	Others	6.8	5.5	6.8	6.1	4.3
Import	Russia	54.2	61.7	62.7	62.4	61.3
	Azerbaijan	6.7	9.7	12.6	13.5	12.0
	Ukraine	7.6	5.1	4.4	4.5	5.3
	Poland	9.2	4.1	4.4	6.0	4.9
	Norway	8.0	7.8	6.2	3.2	4.9
	Kazakhstan	1.6	1.8	2.7	1.7	3.3
	Germany	2.3	1.8	1.8	1.9	2.3
	Slovakia	2.6	2.0	1.7	2.0	1.8
	Libya	1.6	1.9	1.2	0.3	0.3
	Algeria	1.3	1.0	0.1	2.0	0.2
	Syria	1.8	0.2	0.0	0.0	0.1
	Others	3.1	3.9	2.2	2.5	3.6

A significant change in the structure of import by country of origin in current prices occurred in the period of 1999–2000. The reasons were the radical price increase of crude oil and the simultaneous weakening of CZK against USD (the most important items of mineral raw materials – crude oil, natural gas – have a worldwide USD market). A big share of countries, from which Czech Republic imports crude oil and natural gas, was manifested also in the continuing years 2001 to 2007 with regard to high world prices of both commodities, and regardless of a repeated strengthening of CZK against USD. The importance of import from Norway has been decreasing during the recent years – this is caused by decrease of the imported Norwegian natural gas volume (9 % share in 2007 compared to 18 % in 2006). Norway has therefore fallen down from the third to the fifth position.

Czech foreign trade with raw materials is thus characterized by a high dependence on the import of strategic natural fuels, especially oil and gas. A fact that predominant part of raw material import comes from countries outside the EU represents another characteristic feature. The import of raw materials from the EU-15 oscillates between only 2 and 4 % in current prices of the import on a long term. When new member countries are included, this proportion has been slightly increasing (thanks to Poland and Slovakia), amounting to 15.7 % in 2004, 9.1 % in 2005 and 2006, and 11.4 % in 2007. About 85–90 % of commodities is nevertheless imported from the territories outside the EU. Foreign trade in raw materials between the Czech Republic and the brand new EU members Bulgaria and Romania is surprisingly almost zero.

About 15 % of total Czech import of minerals in value was imported from EU-15 and almost 54 % from EU-25 in 2007 when crude oil and natural gas are not included. The territorial structure of import would in such a case be: Poland 28.2 %, Ukraine 21.6 %, Russia 18.9 %, Slovakia 9.4 %, Germany 9.1 %.

The situation on the side of the Czech raw material export is completely different. Predominant part of the Czech export is directed traditionally to western and central European markets. Export to three most important customer countries (Germany, Austria and Slovakia) exceeds 70 % of the value of total Czech export of raw materials and intermediate products made of these on a long term. In addition, the proportion of export to Poland has been dynamically increasing since 2005 when Poland and the Czech Republic entered into European Union in 2004; it increased from less than 5 % in 2004 to 17.5 % in 2007.

Share of EU-15 resp. EU-25 (27) countries on the Czech foreign trade with raw materials (% of FOB current prices)

Group of countries/year	2004	2005	2006	2007	2008
Import from EU-15 (%)	3.7	2.7	2.7	3.0	3.3
Import from EU-25 (%)	15.7	9.1	9.1	11.4	10.5
Import from EU-27 (%)	–	–	–	11.4	10.5
Export to EU-15 (%)	58.4	56.7	49.6	49.4	56.6
Export to EU-25 (%)	96.1	96.8	95.2	96.0	97.8
Export to EU-27 (%)	–	–	–	96.4	98.1

Share of EU-15 resp. EU-25 (27) countries on the Czech foreign trade with raw materials* (% of FOB volumes)

Group of countries/year	2004	2005	2006	2007	2008
Import from EU-15 (%)	NA	NA	5.9	5.1	6.3
Import from EU-25 (%)	NA	NA	25.7	26.3	29.5
Import from EU-27 (%)	–	–	–	26.3	29.5
Export to EU-15 (%)	NA	NA	42.7	41.2	39.1
Export to EU-25 (%)	NA	NA	95.4	96.9	98.1
Export to EU-27 (%)	–	–	–	97.2	98.1

* *Including metallic ores, energy minerals, industrial minerals, construction minerals and selected mineral intermediate products. Ferrous, nonferrous and precious metals are excluded.*

Note:
EU-15: *Belgium, Denmark, Finland, France, Italy, Ireland, Luxembourg, Germany, the Netherlands, Portugal, Austria, Greece, Spain, Sweden, Great Britain*
EU-25: *EU-15 + CR, Estonia, Cyprus, Lithuania, Latvia, Hungary, Malta, Poland, Slovakia, Slovenia*
EU-27: *EU-25 + Bulgary, Romania*

The most important commodities of the Czech export of mineral substances in 2007 were as follows: bituminous coal – 49.3 %, coke – 14.4 %, natural gas – 7.1 %, brown coal – 4.3 %, and cement – 2.1 %. Main import commodities were in the same year: crude oil – 46.8 %, natural gas – 32.4 %, and iron ore – 7.9 % (% of raw material import, resp. export in current prices). Detailed data are given in the following table.

Export and import of selected raw materials registered in Raw Material Policy *
(in mill CZK)

Raw material		Customs tariff code	2004	2005	2006	2007	2008*
Ores and concentrates – total	import		13 419	12 787	13 805	12 356	18 363
	export		5	2	1	2	2
Fe-ores and concentrates	import	2601	13 352	12 704	13 707	12 272	18 198
	export		0	0	0	0	0
Mn-ores and concentrates	import	2602	64	79	71	74	159
	export		3	1	0	1	2
Ni-ores and concentrates	import	2604	3	3	5	8	5
	export		2	1	1	1	0
Cu-ores and concentrates	import	2603	0	0	0	0	0
	export		0	0	0	0	0
Pb-ores and concentrates	import	2607	0	0	20	0	0
	export		0	0	0	0	0
Zn-ores and concentrates	import	2608	0	0	1	1	1
	export		0	0	0	0	0
Sn-ores and concentrates	import	2609	0	0	1	1	0
	export		0	0	0	0	0
W-ores and concentrates	import	2611	0	1	0	0	0
	export		0	0	0	0	0
Ag-ores and concentrates	import	261610	0	0	0	0	0
	export		0	0	0	0	0
Au-ores and concentrates	import	261690	0	0	0	0	0
	export		0	0	0	0	0
Fuels – total	import		76 887	116 608	145 854	127 052	182 260
	export		13 667	15 457	16 913	19 157	28 884
Uranium-ores and concentrates	import	261210	N	N	N	N	N
	export		N	N	N	N	N
Crude oil	import	2709	41 865	68 287	82 534	72 034	102 922
	export		437	516	422	165	230
Natural gas	import	271121	31 838	45 560	59 429	49 808	72 366
	export		389	428	815	2 224	7 893

Raw material		Customs tariff code	2004	2005	2006	2007	2008*
Bituminous coal	import	2701	3 175	2 757	3 821	5 163	6 915
	export		11 628	13 109	13997	15 424	18 752
Brown coal	import	2702	9	4	70	47	57
	export		1 213	1 404	1 679	1 344	2 009
Industrial minerals and construction minerals – total	import		1 514	1 507	1 848	2 110	2 069
	export		2 941	2 442	2 483	2 670	2 505
Fluorspar	import	252921 252922	127	111	116	107	16
	export		64	61	73	78	37
Baryte	import	251110	47	55	43	39	40
	export		4	8	5	5	3
Graphite	import	2504	73	116	130	126	129
	export		87	85	101	107	110
Kaolin	import	2507	58	69	87	106	95
	export		1 140	654	626	655	574
Clays	import	2508	195	193	217	284	238
	export		557	525	458	501	512
Bentonite	import	250810	64	71	70	124	93
	export		199	211	204	225	225
Feldspars	import	252910	24	33	39	34	29
	export		142	161	129	184	162
Glass and foundry sand	import	250510	127	136	180	202	184
	export		262	271	298	304	262
Limestones	import	2521	97	40	39	93	84
	export		67	62	70	42	45
Gypsum	import	252010	42	36	84	128	144
	export		27	12	19	19	21
Dimension stone	import	2514-6 6801-3	571	558	731	856	956
	export		531	520	559	653	703
Crushed stone	import	251710	133	136	150	93	110
	export		56	80	133	103	72
Sand and gravel	import	250590 251710	153	160	182	135	154
	export		60	83	145	122	76
Raw materials – total	import		91 820	130 902	161 507	141 518	202 692
	export		16 613	17 901	19 397	21 829	31 391

Note:
* *data for 2008 are preliminary according to the Czech Statistical Office information*

Export and import of other selected customs tariff items from the class V. – mineral products (in mill CZK)

Raw material		Customs tariff code	2004	2005	2006	2007	2008*
Al-ores and concentrates	import	2606	62	68	79	93	96
	export		14	0	0	4	4
Alumina oxide	import	281820	303	300	316	380	326
	export		4	5	3	5	5
Alumina hydroxide	import	281830	98	98	70	62	60
	export		4	2	1	1	1
Ti-ores and concentrates	import	2614	189	421	458	513	640
	export		13	6	9	12	10
Nb, Ta, V a Zr-ores and concentrates	import	2615	30	18	44	40	18
	export		1	0	0	0	0
Pig iron and spiegeleisen in pigs, blocks or other primary forms	import	7201	842	707	1 069	900	1 174
	export		419	153	147	269	324
Ferro-manganese, ferro-silico-manganese, ferro-tungsten and ferrosilico-tungsten	import	720211, 720219	2 322	1 766	1 595	2 114	3 155
	export	720230, 720280	111	315	213	149	336
Refined copper and copper alloys, unwrought	import	7403	350	370	815	2 131	1 847
	export		544	330	1520	1 189	1 012
Unwrought lead	import	7801	1 569	1 662	2 101	3 327	2 364
	export		186	194	359	853	833
Unwrought zinc	import	7901	1 034	1 281	2 630	3 620	1 965
	export		157	258	454	1 385	676
Unwrought tin	import	8001	107	118	130	235	176
	export		37	43	9	65	22
Tungsten and articles thereof, including waste and scrap	import	8101	222	295	319	284	257
	export		216	142	137	127	101
Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form	import	7106	1 028	265	1 070	1 234	1 224
	export		1 123	265	1 058	1 073	1 100
Gold (including gold plated with platinum), unwrought or in semi-manufactured forms, or in powder form	import	7108	152	199	425	478	858
	export		685	291	252	372	527
Coke	import	2704	4 358	2 295	2 788	2 997	2 836
	export		5 324	6 005	4 557	4 492	6 324

Raw material		Customs tariff code	2004	2005	2006	2007	2008*
Rock salt	import	2501	1 070	995	1 469	800	816
	export		41	43	84	65	61
Azbestos	import	2524	13	0	0	0	0
	export		0	8	0	0	0
Magnesite	import	251910	26	24	14	49	22
	export		8	10	1	2	2
Talc	import	2526	73	71	78	88	76
	export		2	2	2	3	3
Perlite	import	25301010	13	12	13	26	24
	export		1	2	0	1	4
Sulphur	import	2503, 2802	232	217	237	244	376
	export		24	22	19	13	54
Sulphuric acid	import	2807	39	48	53	64	96
	export		60	54	70	71	152
Natural phosphates	import	2510	51	63	85	83	126
	export		1	19	23	24	35
Phosphorous substances	import	2809	105	170	148	111	103
	export		421	657	647	545	1 053
Nitrogenous fertilizers	import	3102	1 815	2 040	2 195	2 291	4 193
	export		1 717	1 870	2 110	2 466	3 409
Phosphatic fertilizers	import	3103	50	51	50	135	281
	export		6	15	9	10	13
Potassic fertilizers	import	3104	476	459	506	575	1 192
	export		31	44	48	44	64
Fertilizers of more elements	import	3105	772	709	713	1 112	1 848
	export		182	197	163	266	220
Quicklime	import	2522	144	135	173	190	183
	export		272	244	238	262	275
Cement	import	2523	1 953	1 921	1 873	1 841	1 899
	export		782	677	590	913	976
Total	import		**18 470**	**16 513**	**20 446**	**24 783**	**27 007**
	export		**12 386**	**11 873**	**12 723**	**14 681**	**17 596**

*Note: * data for 2008 are preliminary according to the Czech Statistical Office information*

ENVIRONMENT AND MINERALS

Mining and nature protection

1,492 reserved and 732 non-reserved mineral deposits were registered in the Czech Republic as of December 31, 2008. The number of exploited deposits was markedly lower – 508 reserved and 222 non-reserved. Only 48 reserved and 16 non-reserved deposits were mined in the specially nature protected areas, which represents 9.5 % and 7.6 % of the total number, respectively.

Act No 114/1992 Sb. on nature and landscape protection in its present wording regulates activities in specially protected areas (ZCHÚ) of the Czech Republic (national parks – NP (Národní park), protected landscape areas – CHKO (Chráněná krajinná oblast), national nature reserves, nature reserves, national nature monuments and nature monuments). According to this Act, all mineral mining (section 16) in national parks (with exception of crushed stone and sand mining for construction in the territory of the national park), in the first zone of protected landscape areas (section 26) and in national nature reserves (section 29) is prohibited. Although the mining of mineral resources is not prohibited by law in other areas (2nd to 4th zones of the CHKO, nature reserves, national nature monuments and nature monuments), it is very difficult to obtain authorization. Legal regulations which mention prohibition of the “permanent damage of the soil surface” are the main reason – and they practically exclude mineral mining. A further reason is the civil activity in the field of environmental protection.

Mineral deposits are mined, and were in the past mined, in the CHKO in majority of cases where the mining claims were already determined before these CHKO were established. Mining in the CHKO declined after 1989 till 2002, after it rather grows namely of registered deposits, which follows from the data in the table “Mining of reserved and non-reserved mineral deposits in CHKO” below and also from the fact that reserved deposits were mined in 19 from 25 CHKO in 2007 and 2008 (see the table “Mining of reserved and non-reserved mineral deposits in individual CHKO”) compared to 17 from 25 CHKO in 2006.

Specially protected areas (ZCHÚ) in the Czech Republic

Number/Year	2004	2005	2006	2007	2008
Total number	2 202	2 210	2 217	2221	2234
national parks (NP)	4	4	4	4	4
protected landscape areas (CHKO)	24	25	25	25	25
others	2 174	2 181	2 188	2192	2205

Source: AOPK ČR (2008)

Structure of ZCHÚ in 2008

Category of specially protected areas	Number	Area (km^2)	Proportion on the territory of the Czech Republic 78 864 km^2 (%)
LARGE-EXTENT ZCHÚ:			
national parks (NP) – mining explicitly prohibited	4	1 195	1.52
protected landscape areas (CHKO)	25	10 867	13.78
– (in them the 1st zones of CHKO where mining is explicitly prohibited)	25	881	1.12
ZCHÚ with mining explicitly prohibited by the Act No. 114/1992 Sb.	29	2 076	2.64
SMALL-EXTENT ZCHÚ:			
national nature monuments (NPP)	106	30	0.04
national nature reserve (NPR)	112	285	0.36
nature monuments (PP)	1 199	200	0.25
nature reserves (PR)	788	379	0.48
NPP, NPR, PP, PR	2 205	894	1.13
– (from them NPP, NPR, PP, PR on the area of NP, CHKO)	704	468	0.59
LARGE-EXTENT AND SMALL-EXTENT ZCHÚ – total	2 234	12 488	15.84

Source: AOPK ČR (2008)

Mining of reserved and non-reserved mineral deposits in CHKO, kt

	Reserved deposits					Non-reserved deposits				
mineral	2004	2005	2006	2007	2008	2004	2005	2006	2007	2008
Gemstones*	31	32	31	21	24	–	–	–	–	–
Crude oil	1.5	1.1	0.9	0	0	–	–	–	–	–
Natural gas**	3.0	4.9	14.1	13.8	8.8	–	–	–	–	–
Quartz sand	0.4	0	1.5	0.8	0.6	–	–	–	–	–
Feldspar	296	296	290	306	280	–	–	–	–	–
Limestone	3 427	3 096	3 111	3 171	3 301	–	–	–	–	–
Dimension stone**	37	37	39	31	37	3.8	2.8	3.6	3.2	5.2
Crushed stone**	2 797	3 171	3 739	3 604	3 950	45	82	51	32	38
Sand and gravel**	1 755	1 649	1 737	1 735	1 463	91	81	116	51	50
Brick clay**	31	99	0	23	29	4	4	3.6	3.6	3.6
Total	8 377	8 386	8 963	8 906	9 093	143	169	174	90	97
Index, 1990=100	52	52	56	55	56	–	–	–	–	–
Index, 2000=100	–	–	–	–	–	47	55	57	29	31

* *pyrope bearing rocks*

** *conversion to kt: natural gas (1,000,000 m^3 = 1 kt), dimension and crushed stone (1,000m^3 = 2.7 kt), sand and gravel and brick clays (1,000 m^3 = 1.8 kt)*

Mining of reserved and non-reserved mineral deposits in individual CHKO, kt*

Name of CHKO	2004	2005	2006	2007	2008
Beskydy Mts.	38	74	68	46	51
Bílé Karpaty Mts.	21	28	28	31	136
Blaník	0	0	0	0	0
Blanský les	583	483	761	632	729
Broumov region	123	110	137	133	123
České středohoří Mts.	1 400	1 736	1 876	1 736	1 818
Český kras (Bohemian Karst)	3 346	3 239	3 353	3 338	3 421
Český les Mts.	0	0.2	0.2	0.2	0.2
Český ráj	0	0	0	0	0
Jeseníky Mts.	135	105	173	162	138
Jizerské hory Mts.	0	0	0	0	0
Kokořín region	4	4	4	4	4
Křivoklát region	269	274	324	402	387
Labské pískovce (Elbe sandstones)	0	0	0	0	0
Litovelské Pomoraví region	83	58	49	92	67
Lužické hory Mts.	0	5	9	10	12
Moravský kras (Moravian Karst)	222	175	143	154	194
Orlické hory Mts.	0	0	0	0	0
Pálava region	71	0	0	0	0
Poodří region	27	99	0	23	29
Slavkovský les region	165	188	181	204	171
Šumava Mts.	30	57	70	51	70
Třeboň region	1 737	1 713	1 813	1 760	1 521
Žďárské vrchy Mts.	49	38	68	91	98
Železné hory Mts.	76	167	81	127	223
Total mine production (rounded)	8 377	8 545	9 138	8 996	9 192

* till 2004 only mine production of reserved deposits was given, starting from 2005 mine production both reserved and non-reserved deposits is stated

As far as the impact of mining on the area is concerned, the CHKO Český kras (Bohemian Karst – limestone mining) is especially unfavourably affected. The impact on some other CHKO, especially CHKO Třeboň region, Poodří, České středohoří Mts., Blanský les and Moravský kras (Moravian Karst) is still rather high (see Tab. “Impact of mining of reserved deposits in CHKO”).

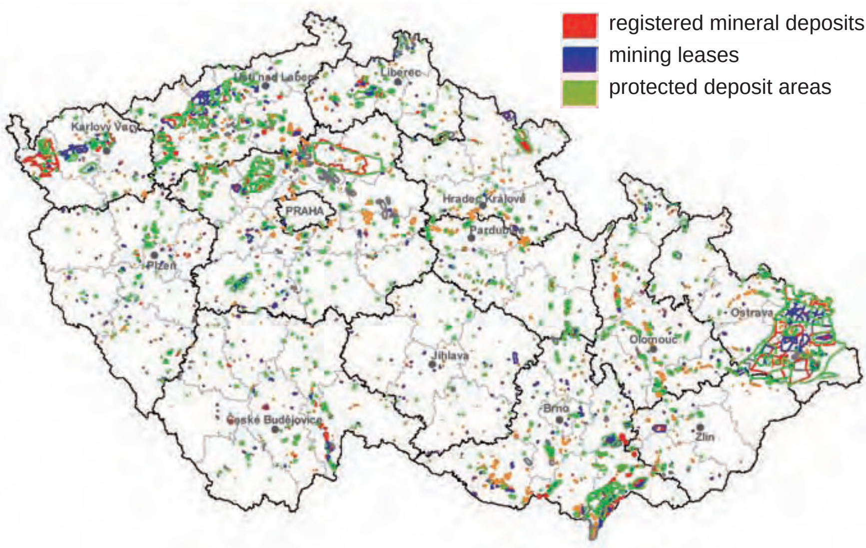
Impact of mining of reserved deposits in CHKO, t/km^2 in a year
(areas of CHKO as of December 31)

Name of CHKO	area km^2 in 2008	2004	2005	2006	2007	2008
Beskydy Mts.	1 160	32	62	59	40	44
Bílé Karpaty Mts.	715	28	38	39	43	190
Blaník	40	0	0	0	0	0
Blanský les	212	2 653	2 199	3 592	2 981	3 439
Broumov region	410	286	233	334	324	300
České středohoří Mts.	1 070	1 311	1 626	1 753	1 622	1 699
Český kras (Bohemian Karst)	**132**	**25 301**	**24 495**	**25 402**	**25 288**	**25 917**
Český les Mts.	473	0	0	0	0	0
Český ráj	182	0	0	0	0	0
Jeseníky Mts.	740	182	142	234	219	186
Jizerské hory Mts.	350	0	0	0	0	0
Kokořín region	270	13	13	13	15	15
Křivoklát region	630	430	439	514	638	614
Labské pískovce (Elbe sandstones)	245	0	0	0	0	0
Litovelské Pomoraví	96	887	617	506	958	698
Lužické hory Mts.	270	0	19	34	37	44
Moravský kras (Moravian Karst)	92	2 437	1 918	1 559	1 674	2 109
Orlické hory Mts.	200	0	0	0	0	0
Pálava region	70	832	0	0	0	0
Poodří region	82	335	1 228	0	280	354
Slavkovský les	640	269	307	283	319	267
Šumava Mts. (CHKO + NP)	1 684	18	34	42	30	42
Třeboň region	700	2 526	2 492	2 589	2 514	2 173
Žďárské vrchy Mts.	715	69	53	95	127	137
Železné hory Mts.	380	264	585	213	334	587
TOTAL(total mining/total area)	10 867	723	738	841	828	846

Note: an impact exceeding 10,000 t/km^2 in a year is concerned critical

It is possible to get a clearer picture of mining activities in the Czech Republic from following map.

Mining activities charge of the Czech Republic territory



As well as the Act No. 114/1992 Sb. on nature and landscape protection, Act No. 100/2001 Sb. on environmental impact assessment and the Decree of the MŽP No. 175/2006 Sb. (formerly No. 395/1992 Sb.), by which some provisions of the Act No. 114/1992 Sb. are applied, have a fundamental influence on permission for exploration and mining.

The Mining Act No. 44/1988 Sb. obliges the mining companies by its section 31 to reclaim the areas with mining impacts and to create financial means for this reclamation. These are considered as mining costs from the viewpoint of the profit tax. Table “Development of reclamations after mining” shows that the areas with mining impact decreased and those reclaimed increased in 2004–2008.

Methods of reclamation used in 2008 are shown in the table “Reclamation after mining of reserved minerals in 2008”.

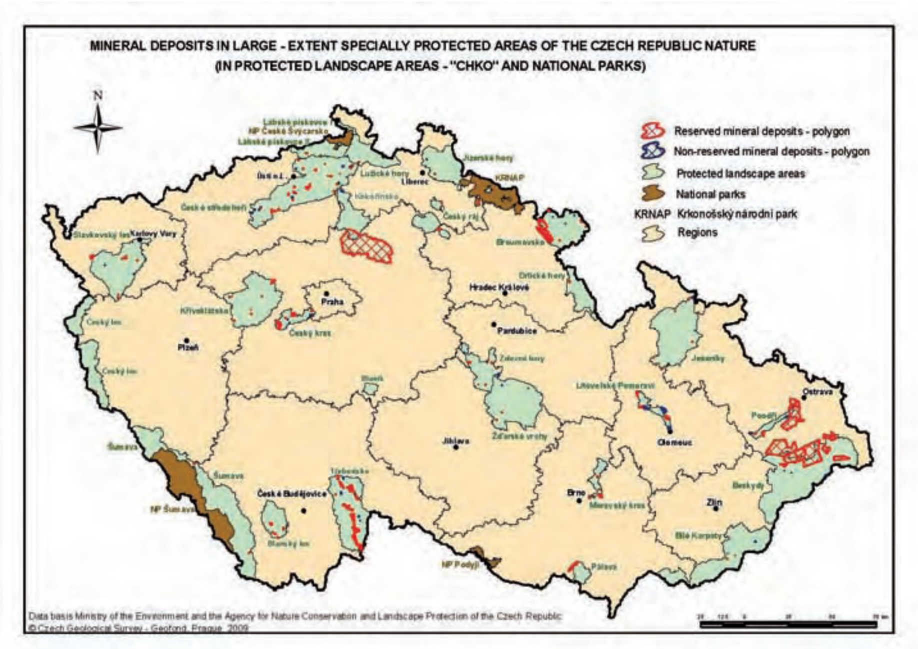
Development of reclamations after mining

km^2		2004	2005	2006	2007	2007
Reserved deposits	Area with manifestation of mining, not yet reclaimed	822	760	697	663	637
	Reclamations in process	111	96	110	113	115
	Reclamations finished since the start of mining	169	170	178	181	195
	Reclamations finished in the given year	4	9	11	8	11
Non-reserved deposits	Area with manifestation of mining, not yet reclaimed	16	16	17	16	16
	Reclamations in process	3	3	3	3	3
	Reclamations finished since the start of mining	2	2	2	2	2
	Reclamations finished in the given year	0.6	0.5	0.5	0.5	0.2

Reclamation after mining of reserved minerals in 2008

[ranked according to regions and way of reclamation; DP = mining lease (in = within, out = outside), areas in hectares (1 km^2 = 100 ha)]

Region	Reclamations in process								Reclamations finished							
	agricultural		forest		water		other		agricultural		forest		water		other	
	in DP	out DP	in DP	out DP	in DP	out DP	in DP	out DP	in DP	out DP	in DP	out DP	in DP	out DP	in DP	out DP
Prague	1	0	0	0	0	0	1	3	2	1	0	0	0	0	0	4
Central Bohemia	195	0	163	10	51	0	103	2	430	38	64	8	87	31	29	16
South Bohemia	13	2	45	3	6	0	13	0	70	55	147	2	245	0	29	1
Plzeň	13	0	40	1	0	0	37	0	35	37	52	60	3	0	2	0
Karlovy Vary	110	120	812	1 281	509	6	54	37	282	1 035	673	1 253	58	26	144	18
Ústí nad Labem	616	324	1 728	1 187	346	29	949	745	996	2 032	1 535	3 207	363	205	535	1 436
Liberec	35	0	88	22	0	0	0	0	65	45	184	13	5	0	0	0
Hradec Králové	36	0	52	7	3	0	12	0	68	7	94	4	59	39	6	14
Pardubice	9	0	22	7	95	0	2	2	36	0	1	7	0	0	7	2
Vysočina	1	1	1	0	0	0	5	0	0	0	29	5	0	0	2	2
South Moravia	167	10	62	0	2	0	32	9	509	32	145	9	9	0	14	8
Olomouc	16	2	75	58	86	0	4	2	27	47	7	3	48	0	8	5
Zlín	27	0	1	0	3	0	3	0	78	54	31	0	130	6	98	4
Moravia and Silesia	45	2	610	35	135	2	162	17	996	79	548	36	325	5	279	15
Czech Republic in total	1 284	461	3 699	2 611	1 236	37	1 377	817	3 594	3 462	3 510	4 607	1 332	312	1 153	1 525



Mining influences the environment, changes the character of the landscape, and alters ecological conditions for flora and fauna. In some areas mining activities can last several human generations. This way the impact of mining persists and a more permanent new arrangement of natural conditions and relationships in its area is not quickly evident. The new arrangement can be equal to or even better than the original one, of course on a different level. Examples include artificial lakes formed e.g. in south Bohemia by sand and gravel mining, constructions and sport grounds in former quarries or specially protected nature areas proclaimed paradoxically in the territory of former quarries, and also 35 hectares of new vineyards planted as agricultural reclamation of a closed brown coal mine in the north of Bohemia in the Most wine region. They represent by their area almost 6.5 % of the total 550 hectares of productive vineyards of the Czech wine region.

Share of specially Protected Areas of the Czech Republic nature [zvláště chráněná území přírody České republiky (ZCHÚs)] established in localities with former mining (“after mining”) in all the ZCHÚs (compiled after data of the Agency for Nature Conservation and Landscape Protection of the Czech Republic – AOPK ČR)

Region	Number of ZCHÚs (without CHKOs)	Area of ZCHÚs (without CHKOs) (ha)	Number of ZCHÚs "after mining"	Area of ZCHÚs (without CHKOs) "after mining" (ha)	Share of ZCHÚ areas "after mining" in the all ZCHÚs area	Share of ZCHÚ number "after mining" in the all ZCHÚs number
Central Bohemia	225	13 044	44	2 334	17.89%	19.56%
Prague	89	2 266	21	367	16.20%	23.60%
Karlovy Vary	70	3 381	7	237	7.01%	10.00%
Olomouc	139	5 441	9	228	4.19%	6.47%
South Moravia	283	10 469	10	253	2.42%	3.53%
Pardubice	97	5 715	3	92	1.61%	3.09%
Plzeň	181	8 900	14	100	1.12%	7.73%
Zlín	169	2 232	7	25	1.12%	4.14%
Moravia and Silesia	147	5 851	11	32	0.55%	7.48%
Liberec	112	43 487	6	215	0.49%	5.36%
Vysočina	170	5 677	3	28	0.49%	1.76%
Ústí nad Labem	141	11 363	8	27	0.24%	5.67%
Hradec Králové	110	7 434	6	12	0.16%	5.45%
South Bohemia	304	83 420	8	42	0.05%	2.63%
Czech Republic total	2 237	208 680	157	3 992	1.91%	7.02%

Eliminating negative consequences of mining in the Czech Republic – main methods and financial resources

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Introduction

The process of restructuring coal, uranium and ore mining, and of eliminating negative environmental consequences of mining in the landscape and erasing these consequences in affected areas of the Czech Republic, is executed in several ways and with various financial resources. It specifically involves:

1. Use of funds from a financial reserve generated by mining companies for remediation, reclamation and mining damages
2. Use of funds from annual royalties paid by mining companies on mining leases and on extracted reserved minerals pursuant to the Mining Act
3. Phase-out of mining activities and erasing consequences of coal, ore and uranium mining funded by the state
4. Use of proceeds from privatisation of state assets in eliminating old ecological burdens caused by mining, existing prior to privatisation of mining companies
5. A programme which deals with ecological damage caused prior to privatisation of brown coal mining companies in the Ústí nad Labem Region and Karlovy Vary Region, with ecological revitalisation upon termination of mining operations in the Moravian-Silesian Region, and with reducing the impacts caused by the termination of coal mining in the Kladno Region based on Government resolutions in 2002. Funds are provided by proceeds from privatisation of state assets.

1. Use of funds from a financial reserve generated by mining companies for remediation, reclamation and mining damages

Financial reserve for remediation and reclamation

The most important source for funding the elimination of the consequences of mining operations in the Czech Republic is the financial reserve for remediation and reclamation, generated by mining companies during the exploitation of reserved mineral deposits.

An amendment of Mining Act No. 541/1991 Coll., under article 31 section 6, imposes an obligation on the mining company to generate a financial reserve in order to meet the obligation established under article 31 section 5 of the Mining Act, thus guaranteeing the remediation and reclamation of all plots of land affected by mining (hereinafter “reserves”). The reserves are part of the company´s expenses. Pursuant to article 32 section 2 of the Mining Act, the determination of anticipated expenses for remediation and reclamation is part of the plan for opening, preparation and exploitation of reserved deposits (hereinafter “POPD”), and the POPD must also contain a proposal regarding the amount of, and the method for, generating the required financial reserve. However, the anticipated amount of financial costs for remediation and reclamation must for the first time already be included, pursuant to the provision under article 2 section 3 letter k) item 4 of Decree No. 172/1992 Coll., as amended, in the application for the grant of a mining lease. An interim provision of Act No. 541/1991 Coll. established that the required reserve amount should be provided in 10 years (i.e. by 20 December 2001) in the case of existing mines. In a subsequent amendment of the Mining Act by Act No. 168/1993 Coll., the time period for generating the reserve was changed to last for the duration of the economic life of the mine, quarry or their sections. However, that did not apply to companies with an announced or approved phase-out programme (ores, coal).

According to the provision under article 37a section 2 of the Mining Act, the generating of reserves is subject to approval by Regional Mining Authorities (OBÚ). Upon the request of a company, these also permit the drawing on funds from the generated reserve upon agreement with the Ministry of the Environment and upon notification by the relevant municipality. In the case of public enterprises, the OBÚ makes a decision regarding the drawing on the reserve upon agreement with the Ministry of Industry and Trade.

The issues mentioned are further regulated by FMF (Federal Ministry of Finance) Measure No. ref. V/20 100/1992 Coll., on the chart of accounts and on accounting procedures, which lays down the rules regarding the generating and use of financial reserves by companies with permitted mining operations. At the end of each accounting period, companies execute closings of books and carry out document inventories, which verify the balancing of books (Act No. 593/1992 Coll. and No. 563/1991 Coll.).

The last update of the legal regulation of reserves for remediation, reclamation as well as mining damage occurred after Act No. 223/2006 Coll. (amendement of the Reserves Act) and No. 313/2006 Coll. (amendment of the Mining Act) went into effect.

Generated and drawn reserves for remediation and reclamation (in CZK thousand)

Year	Bituminous coal		Brown coal		Crude oil and natural gas		Ores		Industrial minerals		Radioactive minerals		Total	
	generated	drawn	generated	drawn	generated	drawn	generated	drawn	generated	drawn	generated	drawn	generated	drawn
1993	118 500	0	1 341 769	65 615	12 722	0	0	0	97 438	8 236	0	0	1 570 429	73 851
1994	123 750	18 600	573 242	259 929	6 836	0	0	0	255 155	30 335	0	0	958 983	308 864
1995	85 895	136 064	3 845 935	265 856	22 414	370	0	0	276 724	24 230	0	0	4 230 968	426 520
1996	143 500	97 993	1 436 957	831 817	25 811	113	0	0	270 432	31 829	0	0	1 876 700	961 752
1997	108 000	42 108	1 302 735	1 087 993	62 618	5 569	0	0	484 420	53 262	0	0	1 957 773	1 188 932
1998	51 594	48 033	1 226 036	994 133	22 112	9 541	0	0	466 649	59 913	0	0	1 766 391	1 111 620
1999	132 143	56 236	1 199 633	704 199	26 181	7 473	0	0	318 852	141 530	0	0	1 676 809	909 438
2000	42 747	52 029	1 119 474	683 179	23 487	600	0	0	307 433	140 225	0	0	1 493 141	876 033
2001	876 194	77 458	1 267 431	678 515	23 184	2 750	390	0	215 379	53 893	0	0	2 382 578	812 616
2002	887 250	129 600	1 007 561	653 557	100	250	0	0	157 721	50 604	0	0	2 001 946	822 491
2003	1 800	498	5 199 919	4 844 371	11 782	1 050	0	0	179 763	57 848	0	0	5 393 264	4 903 767
2004	65 002	54 162	1 031 828	720 168	4 770	0	0	0	160 102	73 177	0	0	1 261 702	847 507
2005	66 504	54 204	964 222	547 883	17 524	9 409	0	0	228 713	113 743	0	0	1 254 884	766 460
2006	74 178	113 691	845 008	663 055	17 893	3 300	0	0	144 665	92 489	0	0	1 081 744	872 535

Financial reserve for mining damages

Pursuant to article 37a section 1 of the Mining Act, a mining company is obliged to generate a financial reserve to ensure settlement of mining damages. The reserve amount generated and charged to expenses must correspond to the needs for settling mining damages in the course of time depending on their creation, or prior to their creation (article 37 section 4).

Generating of reserves is subject to approval by the relevant Regional Mining Authority, which also approves the drawing on these reserves upon agreement with the Ministry of the Environment. Prior to making a decision on the drawing on theses reserves, the Regional Mining Authority requests a statement from the relevant municipality. In the case of public enterprises, the OBÚ decides in agreement with the Ministry of Industry and Trade.

A company´s request to draw on the financial reserve for mining damages must be furnished with a list of mining damages, an expense estimate for their elimination and a time table of resource expenses for the elimination of mining damages.

Generated and drawn reserves for mining damages (in CZK thousand)

Year	Bituminous coal		Brown coal		Crude oil and natural gas		Ores		Industrial minerals		Radioactive minerals		Total	
	generated	drawn	generated	drawn	generated	drawn	generated	drawn	generated	drawn	generated	drawn	generated	drawn
1993	400 721	4 093	150 548	42 957	0	0	0	0	28 462	0	0	0	579 731	47 050
1994	105 650	38 813	50 000	32 223	0	0	0	0	9 328	28 852	0	0	164 978	99 888
1995	204 785	86 001	209 207	37 748	0	0	0	0	10 673	9 394	0	0	424 665	133 143
1996	151 643	74 952	259 779	84 258	0	0	0	0	13 100	3 407	0	0	424 522	162 617
1997	77 900	142 512	318 981	127 715	0	0	0	0	5 733	683	0	0	402 614	270 910
1998	185 723	174 640	252 920	112 852	0	0	0	0	16 043	3 638	0	0	457 686	291 130
1999	111 588	174 640	212 722	40 448	0	0	0	0	10 803	6 844	0	0	335 113	221 932
2000	110 088	107 852	240 655	188 685	0	0	0	0	11 414	1 020	0	0	362 157	297 557
2001	145 750	188 073	105 513	217 306	192	0	100	0	35 877	6 628	0	0	286 872	412 007
2002	102 750	168 531	102 700	510 200	0	0	0	0	2 327	2 338	0	0	207 777	681 069
2003	0	0	816 197	999 271	90	0	0	0	12 576	2 263	0	0	828 863	1 001 534
2004	187 700	139 714	164 700	315 321	0	0	0	0	3 007	4 560	0	0	355 407	459 595
2005	191 700	143 974	97 433	279 955	0	0	0	0	6 597	4 273	0	0	295 730	428 202
2006	N	N	N	N	N	N	N	N	N	N	N	N	N	N

2. Use of funds from annual royalties paid by mining companies on mining leases and on extracted reserved minerals pursuant to the Mining Act

Royalties on mining leases

Act No. 44/1988 Coll., on the protection and use of the mineral resources (the Mining Act), imposes an obligation on mining companies, under sect. 32a) par. 1, to pay to the account of the relevant Regional Mining Authority an annual royalty, on the mining lease. The amount of royalty on the mining lease is set at CZK 100 to CZK 1 000 per hectare, and graded with respect to the environmental protection level of the relevant area, the type of activity conducted in the mining lease and its environmental impact.

The ultimate recipient of the mining lease royalties are the municipalities, in whose territory the mining lease is located. These resources are used, in large measure, as compensation for negative impacts of mining on the municipalities in question. As shown in the following table, a total of CZK 348.3 million was paid out to municipalities in 1993–2008 since the inception of royalty payments on mining leases.

Royalties from mining lease areas paid out to municipalities pursuant to article 32a) sect. 1 of the Mining Act (in CZK thousand)

Year	Number of municipalities	Total
1993	1 327	25 929
1994	1 194	22 752
1995	1 168	24 114
1996	1 225	24 032
1997	1 191	23 446
1998	1 269	22 885
1999	1 208	23 629
2000	1 178	23 780
2001	1 171	23 728
2002	1 168	22 899
2003	1 158	21 740
2004	1 161	21 511
2005	1 138	21 077
2006	1 127	16 178
2007	1 118	15 512
2008	1 305	15 127
Total		**348 339**

Royalties on extracted reserved minerals

The royalty on extracted minerals established under article 32a) section 2 of Act No. 541/1991 Coll., amounts to 10 % of the market price of extracted minerals at the most and, pursuant to section 4, from the royalty yield, pursuant to section 2, the Regional Mining Authority transfers 50 % to the state budget of the Czech Republic and 50 % to the budget of the municipality in whose territory the mining lease is situated. If the mining lease is located in the territory of several municipalities, the Regional Mining Authority distributes the revenue according to the share in mining, similarly to the royalty on a mining lease.

Amendment No. 10/1993 Coll. of the Mining Act established that 50 % of the royalties transferred to the state budget will be used for the purpose of remediation of environmental damage caused by the mining of reserved deposits.

Distribution of royalties on extracted reserved minerals pursuant to sect. 32a) par. 4 of the Mining Act (in CZK thousand)

Year	50 % SR (State budget)		50 % Municipalities	Total
1993	230 400		230 526	460 926
1994	245 762		245 276	496 961
1995	221 909		221 566	458 005
1996	229 703		229 703	460 588
1997	228 874		228 874	473 400
1998	220 885		220 886	442 577
1999	219 938		219 938	429 603
2000	227 778		227 859	463 648
Total	**1 825 249**		**1 824 628**	**3 649 877**
	12.5 % MPO (Ministry of Industry and Trade)	**12.5 % MŽP (Ministry of the Environment)**	**75 % Municipalities**	**Total**
2001	153 166	12 500	302 221	472 492
2002	55 000	59 500	356 724	475 632
2003	61 713	61 800	371 827	495 582
2004	70 000	69 500	393 695	532 750
2005	76 398	76 700	449 135	602 509
2006	76 305	76 400	455 947	608 614
2007	82 716	82 300	494 737	659 288
2008	84 367	84 250	505 782	674 399
Total 2001–2008	**659 665**	**522 950**	**3 330 068**	**4 521 266**
Total 1993–2008	**2 484 914**	**522 950**	**5 154 696**	**8 162 560**

In 2000 a change occurred and article 32a) section 4 of Act No. 366/2000 Coll. established that, of the royalty pursuant to section 2, the Regional Mining Authority shall transfer only 25 % to the state budget of the Czech Republic, from which these funds will be used for the purpose of remediating environmental damage caused by the mining of reserved as well as non-reserved deposits, and that the Regional Mining Authority shall transfer the remaining 75 % to the municipality´s budget. Simultaneously, Government Resolution No. 906/2001 and, again, Government Resolution No. 69/2008 approved to divide the 25% of royalty transferred to the state budget into 12.5 % for use by the Ministry of Industry and Trade in remediation of environmental damage caused by the mining of reserved as well as non-reserved deposits, and into 12.5 % for use by the Ministry of the Environment in liquidation of old mine workings.

At the same time, Government Resolution No. 69/2008 approved the transfer of the yield from royalties on extracted minerals pursuant to sect. 32a par. 4 of Act No. 44/1988 Coll., on the protection and use of mineral resources (Mining Act), as amended, via Regional

Mining Authorities directly to the income accounts of the budget of the Ministry of Industry and Trade and the Ministry of the Environment starting in 2008.

The table above clearly shows the payment and use of funds for the 1993–2008 period. In 16 years mining companies paid a total of CZK 8.16 billion., of which municipalities received CZK 5.15 billion, and Regional Mining Authorities transferred to the state budget a total of CZK 3.0 billion for remediation of environmental damage caused by the mining of reserved as well as non-reserved minerals, which was subsequently released from the state budget and of which CZK 2.48 billion went to the Ministry of Industry and Trade and CZK 0.52 billion to the Ministry of the Environment.

3. Phase-out of mining activities and erasing consequences of coal, ore and uranium mining funded by the state

The restructuring of industry in the Czech Republic, specifically of metallurgy and engineering, initiated after 1989, had an immediate impact on the mining sector. Uneconomic ore, coal and uranium mining, and a lower raw material demand were the decisive reasons for the restructuring and subsequent privatisation of mining companies. Part of the restructuring of the mining industry was the announcement of a phase-out of mining activities in uneconomic underground mines and quarries.

The essential method of funding the restructuring of the mining sector is provided by subsidies from the state budget, in accordance with relevant Government resolutions, for the phase-out and to erase the consequences of mining operations.

In the initial phase, the phase-out in individual branches of mining occurred independently, mainly because mining companies reported to various departments.

The phase-out of uranium mining was already decided upon in 1989, as based on documents processed by the Federal Ministry of Fuel and Energy, which was approved by ČSSR (Czechoslovak Socialist Republic) Cabinet Resolution No. 94/1989 on the concept of lowering the unprofitability of uranium mining in the ČSSR in 1990, in the 9th and 10th five-year plans by phasing it out. This Cabinet resolution from 1990 was subsequently amended by the Government of the ČSFR (Czechoslovak Federal Republic) with new Government Resolution No. 894/1990 regarding the modification of the phase-out concept for uranium mining in the ČSFR.

In 1990, ore mining fell under the Federal Ministry of Metallurgy, Engineering and Electric Engineering which, for the purpose of dealing with ore mining and the announcement of a phase-out programme for the ore mining industry as of 1 July 1990, processed documents for Government proceedings and Government Resolution No. 440/1990 was adopted.

The phase-out of coal mining was announced at the end of 1992 based on Government Resolution No. 691/1992 concerning the programme for restructuring the coal industry, and documents for Government proceedings were processed by the Ministry of Industry and Trade.

Even though the phase-out of ore mining was not completed, a merger of Rudné doly Příbram state enterprise with DIAMO state enterprise occurred as of 1 January 2001, thereby ending the industry-by-industry monitoring of the phase-out, i.e. ore and uranium mining.

Another modification of the reporting method concerning the drawing on state budget funds occurred in 2003, when, in addition to the proposed state participation in the completion of the restructuring of coal mining, Government Resolution No. 395/2003 authorised the transfer of the Barbora locality from OKD, a. s. company to DIAMO state enterprise, and the localities of Ležáky, Kohinoor and of Kladenské doly to Palivový kombinát Ústí state enterprise.

Use of state budget subsidies for the phase-out of mining and to erase consequences of mining and mandatory social health expenses (in CZK million)

Year	Mining in total			Coal mining			Ore mining			Uranium mining		
	TÚ	MSZN	Total	TÚ	MSZN	Total	TÚ	MSZN	Total	TÚ	MSZN	Total
1992	1 100.3	0	1 100.3	555.7	0	555.7	248.0	0	248.0	296.6	0	296.6
1993	2 555.1	1 436.3	3 991.4	1 816.1	949.7	2 765.8	43.2	189.0	232.2	695.8	297.6	993.4
1994	3 940.1	1 528.0	5 468.1	2 333.4	1 011.7	3 345.1	35.1	179.6	214.7	1 571.5	336.7	1 908.2
1995	3 861.1	1 678.1	5 539.2	1 956.8	1 329.9	3 286.7	198.8	36.4	235.2	1 759.3	346.4	2 105.7
1996	3 755.5	1 823.2	5 578.7	2 168.3	1 422.7	3,591,0	126.7	33	159.7	1 486.9	367.0	1 853.9
1997	2 305.9	1 811.1	4 117.0	1 364.6	1 362.8	2 727.4	100.1	34.9	135.0	836.6	413.4	1 250.0
1998	2 571.7	1 862.9	4 434.6	1 690.2	1 403.7	3 093.9	94.8	30.2	125.0	979.7	422.9	1 402.6
1999	2 073.5	1 955.8	4 029.3	1 206.1	1 475.9	2 682.0	79.2	37.6	116.8	787.9	442.2	1 230.1
2000	2 064.2	1 986.1	4 050.3	1 193.8	1 475.2	2 669.0	158.0	30.2	188.2	712.3	474.9	1 187.2
2001	2 296.2	1 955.6	4 251.8	1 118.4	1 451.0	2 569.4	part of uranium mining			1 174.6	500.4	1 675.0
2002	1 729.9	1 913.8	3 643.7	574.9	1 359.2	1 934.1				1 154.8	553.3	1 708.1
2003	2 148.5	1 751.1	3 899.6	654.4	1 294.2	1 948.6				1 494.1	455.5	1 949.6
2004	2 576.1	1 713.2	4 289.3	With the merger of s. p. Rudné doly Příbram with s. p. DIAMO and the takeover of phased out areas of OKD, a. s., monitoring on an industry-by-industry basis was terminated								
2005	2 110.3	1 669.1	3 779.4									
2006	2 069.8	1609.3	3 679.1									
2007	1 917.9	1 574.1	3 492.0									
2008	1 971.9	1 465.7	3 437.6									
Total	41 048.0	27 733.4	68 781.4	16 632.7	14 536.0	31 168.7	1 083.9	570.9	1 654.8	12 950.1	4 610.3	17 560.4

TÚ – technical work related to phase-out and erasing consequences of mining operations
MSZN – mandatory social health expenses

Since the initiation of the phase-out of mining in 1992, a total of CZK 68.48 billion, i.e. an annual average of CZK 4.03 billion, was released from the state budget for the phase-out of mining and to erase the consequences of mining. As shown in the table above, CZK 41.05 billion were spent on technical work related to the phase-out of mining and on erasing the consequences of mining operations, and CZK 27.73 billion on social health benefits for miners.

In light of the steady decrease in state budget funds used to erase the consequences of mining in recent years, the deficit in 2008 was dealt with by Government Resolution No. 688 on 9. 6. 2008 by releasing CZK 300 million from the sale of privatised assets and the profit from state participation in enterprises in order to fund activities linked with rectifying environmental damage caused by mineral extraction.

4. Use of proceeds from privatisation of state assets in eliminating old ecological burdens caused by mining prior to privatisation of mining companies

Based on a decision by the Czech Republic Government, the former National Property Fund of the Czech Republic (as of 1 January 2006 the Ministry of Finance, based on Act No. 179/2005 Coll.) pledged, by virtue of "ecological contracts" entered into with individual assignees of assets from privatisation, to eliminate, with its privatisation proceeds, old ecological burdens created prior to privatisation.

The procedures and process principles for implementing measures leading to remediation of old ecological burdens created prior to privatisation are established in accordance with Government Resolution No. 51 from 10 January 2001.

The process adheres primarily to the following Acts and Resolutions of the Czech Republic Government:

a) Act No. 92/1991 Coll., on the terms and conditions regarding the transfer of state assets to other persons, as amended;
b) Act No. 171/1991 Coll., on the responsibility of Czech Republic authorities in cases of transfer of state assets to other persons, and on the National Property Fund of the Czech Republic, as amended;
c) Government Resolution No. 51 from 10 January 2001, which contains the appendix entitled *Principles for Settlement of Ecological Obligations Arising during Privatisation* (hereinafter Principles), as amended;
d) Government Resolution No. 212/1997 on the procedure principles during privatisation pursuant to Act No. 92/1991 Coll. and Act No. 171/1991 Coll., which substituted prior Government Resolutions No. 568/1993, No. 393/1994, No. 178/1995, No. 773/1995 and No. 20/1997;
e) Act No. 137/2006 Coll., on public contracts.

The processing of the programme is always provided by the Ministry of Finance. The Ministry of the Environment provides guaranteed expertise in the process and issues binding opinions on individual process steps. Mutual collaboration of both authorities in this process is regulated by the "Rules for Mutual Collaboration of the Ministry of the Environment and the Ministry of Finance in the Awarding of 'Ecological Contracts' to Eliminate Old Ecological Damage".

The elimination of old ecological damage created prior to privatisation proceeds for the most part according to priorities established by the MŽP ČR (Ministry of the Environment).

Overview of entities with which "ecological contracts" were entered into, including guaranteed financial sums and their actual amount drawn (in CZK) – as of 31. 8. 2009

Name of mining company	Amount of guarantee	Drawn from guarantee	Amount available for drawing
DIAMO, státní podnik	4 000 000 000	991 816 153	3 008 183 847
DIAMO, státní podnik	3 432 000 000	1 467 093 262	1 964 906 738
OKD, a.s.	27 800 000 000	2 570 416 802	25 229 583 198
Sokolovská uhelná, a.s.	214 000 000	100 790 043	113 209 957
Severočeské doly, a.s.	172 265 000	2 094 077	170 170 923
GRANITOL akciová společnost	282 473 000	11 451 511	271 021 489

5. A programme dealing with ecological damage caused prior to privatisation of brown coal mining companies in the Ústí nad Labem Region and the Karlovy Vary Region, with ecological revitalisation upon termination of mining in the Moravian-Silesian Region, and with reducing impacts caused by the termination of coal mining in the Kladno Region based on Government resolutions in 2002. Funds are provided by proceeds from privatisation of state assets.

After the privatisation of mining companies, the financial settlement of related ecological damage was not resolved in an appropriate manner, within the scope of privatisation projects. However within the scope of privatisation, companies took over not only mining localities but also extensive areas from the state, which were designated for revitalisation and for which a required financial reserve was not generated in the past.

Mining companies are only obliged to generate a financial reserve for remediation and reclamation of areas affected by mining since 1994, and that on the basis of Amendment (No. 168/1993 Coll.) of the Mining Act.

In 2002, the Czech Republic Government being aware of this fact began to intervene financially in the ecological and partially economic revitalisation of regions with active or terminated mining operations. The goal was to eliminate environmental damage caused by mining operations prior to implemented legal regulation.

For this purpose it earmarked, from the proceeds from sale of assets designated for privatisation and from the profits of public enterprises, CZK 15 billion to deal with ecological damage created prior to privatisation of brown coal mining companies in the Ústí nad Labem Region and Karlovy Vary Region, CZK 20 billion to deal with ecological damage caused by mineral mining, primarly underground mining of bituminous coal in the Moravia and Silesia Region, and CZK 1.177 billion to deal with reducing the impacts caused by the termination of coal mining in the Kladno Region.

The funds from the proceeds from privatisation are released in accordance with Government decisions to cover the expenses of eliminating environmental damage caused by present operations of mining companies, to cover the expenses of and support investment and non-investment activities connected with the remediation of environmental damage caused by mineral mining and to revitalise affected areas, and for financial support of development projects in areas designated for industrial use approved by the Government.

Dealing with ecological damage created prior to privatisation of brown coal mining companies in the Ústí nad Labem Region and the Karlovy Vary Region

For more than 150 years, the character of the landscape was affected significantly by intensive opencast and underground mining of brown coal in the Krušné Hory Mts. piedmont area of Northwest Bohemia. Undergroung mining primarily affected the territory with the deepest seams (up to 450m below the surface) in the central, Most-Bílina area of the basin as well as the Teplice area of the North Bohemian Basin. Opencast mining occurred primarily in areas of coal seam outcrops southwest of Chomutov, west and east of the City of Most, north of the City of Bílina, northwest of the City of Teplice, southwest and north of the City of Ústí nad Labem.

In 2002, the then National Property Fund of the Czech Republic was bound by resolutions of the Czech Republic Government to eliminate ecological damage caused by the activities of coal mining companies in the Ústí nad Labem Region and the Karlovy Vary Region, and to revitalise affected areas. The process was initiated that same year.

In accordance with a relevant resolution of the Czech Republic Government, the process dealing with ecological damage created prior to privatisation of brown coal mining companies in the Ústí nad Labem Region and the Karlovy Vary Region includes both of the Krušné hory Mts Basin situated in the territory of the Districts of Sokolov, Chomutov, Most, Teplice and of Ústí nad Labem, i.e. the Sokolov Basin and the North Bohemian Basin, or the mining leases of Sokolovská uhelná, a.s., Severočeské doly, a.s., Mostecká uhelná společnost, a.s., Kohinoor, a.s., and Palivový kombinát Ústí, s. p.

The programme mentioned specifies a group of projects aimed primarily at creating and renewing:
- forest stands,
- agricultural land,
- bodies of water,
- landscape vegetation,
- biocorridors and biocentres,
- areas for recreation,
- areas designated for ecology and natural science,
- building sites.

The funds actually spent on **86** concluded projects amount to **CZK 3.152 billion**, and on **68** projects in progress they amount to **CZK 1.707 billion** as of the specified date. The remaining financial amount required to secure additional money for the projects in progress amounts to ca. **CZK 3.078 billion** according to contracts.

List of companies included in the programme plan:

Sokolovská uhelná, legal successor, a.s. (SU)

Severočeské doly, a.s. (SD)

Mostecká uhelná společnost, a.s. (MUS)

Palivový kombinát Ústí based in Ústí nad Labem (PKÚ)

List of regions (projects of cities and municipalities) included in the programme plan:

Karlovy Vary Region – KK

Ústí nad Labem Region – ÚK

Projects concluded and projects in progress (in CZK thousand)

Coal Companies	Projects concluded		Projects in progress		
	Number of projects	Project costs	Number of projects	Project prices	Amount drawn as of 31 Dec 2008
SU	3	293 803	19	2 103 741	875 686
SD	8	450 538	6	813 454	125 313
MUS	29	325 529	15	634 443	275 446
PKÚ	26	1 757 014	13	890 704	316 5397
Total 1	**66**	**2 826 884**	**53**	**4 442 344**	**1 592 985**

Municipalities Total	Projects concluded		Projects in progress		
	Number of projects	Project costs	Number of projects	Project prices	Amount drawn as of 31 Dec 2008
KK	16	259 128	7	155 369	51 804
ÚK	4	65 999	8	160 966	62 441
Total 2	**20**	**325 127**	**15**	**316 336**	**114 246**

Total 1 + 2	**86**	**3 152 012**	**68**		**1 707 231**

Revitalisation of the Moravian-Silesian and South Moravian Region

Currently, the revitalisation of the Moravian-Silesian Region is aimed primarily at eliminating the consequences of ecological burden caused by bituminous coal mining.

As of 31 March 2009, the funds actually spent on **19** concluded projects amount to ca **CZK 0.24 billion**, and on **31** projects in progress they amount to ca **CZK 0.91 billion** as of the specified date**.** The remaining financial amount required to secure additional money for the projects in progress amounts to ca **CZK 0.835 billion** according to contracts**.**

Categories of priority projects, approved by the Government, which deal with eliminating environmental damage caused by mineral mining in the Moravian-Silesian and South Moravian Region

1. Reclamation work
2. Reducing thermal activity
3. Comprehensive site development
4. Comprehensive reduction of uncontrolled methane emissions
5. Eliminating old ecological burdens in OKD, a. s.
6. Land development upon termination of mining
7. Eliminating the ecological burden caused by the exploration and extraction of crude oil and natural gas in designated areas of the South Moravian Region

Projects concluded (in CZK)

Project name	Project costs
Reclamation work	
Reclamation of the Zofie waste dump	1 950 601
Total 1	**1 950 601**
Reducing thermal activity	
Survey and monitoring of thermal activity in the Heřmanice waste dump	4 962 696
Survey and monitoring of thermal activity in the Hedvika waste dump	6 506 627
Total 2	**11 469 323**
Comprehensive site development	
Height measurement in areas with phased out mining operations	1 094 800
Examiner´s report – Height measurement in areas with phased out mining operations	44 140
Total 3	**1 138 940**
Comprehensive development of sites with uncontrolled methane emissions	
Comprehensive analysis of the methane problem in connection with old mine workings – study	7 602 000
Examiner´s report on the conceptual solution of the methane problem	35 000
Measures for removing emergency measures regarding methane emissions in the City of Orlová	62 873 211
Preparing individual methodical procedures of basic activities	1 856 400
Survey of mine gas emissions in areas with phased out coal mining and related health and environmental risks	2 344 300
Total 4	**74 710 911**
Eliminating old ecological burdens in OKD, a.s.	
Remediation and reclamation of the Křemenec area	113 929 281
Processing the “Remediation and reclamation of the Kašpárkovice lands“ project	809 200
Processing the “Remediation of the Solca tailing ponds“ project	1 224 510
Processing the “Development of lands including Karvinský Creek in the area of Špluchov – phase 3“ project	1 860 565
Expert assessment of the legitimacy of OKD, a.s. request for approval of Method Changes No. 3 – Křemenec	39 668
Total 5	**117 863 224**
Land development upon termination of mining	
Demolition KOBLOV	6 914 609
Demolition HRUŠOV	6 845 432
Project documentation regarding land development within the scope of eliminating environmental damage upon termination of mining – executed in areas no. 1 and 3 of project no. 45	1 543 500

František premises, phase 1	13 917 808
Total 6	**29 221 349**
Total 1–6	**236 354 348**

Projects in progress (in CZK)

Project name	Project price	Project costs thus far
Reclamation work		
Rudná land reclamation, structure 5 (along Polanecká street)	5 711 866	3 420 929
Remediation and reclamation of reservoirs and lands below the Stachanov reservoirs	53 926 603	29 958 940
Drainage of lands south of Kuboň Pond – site A and B	2 379 151	2 053 633
Reclamation of NP 1 lands	116 095 818	33 977 844
Remediation SALMA	7 110 595	3 280 403
Reclamation of the Oskar waste dump	6 074 753	2 748 987
Development along the Orlovská Stream	6 519 187	5 265 932
Development along the Sušanky Stream	2 340 718	0
Remediation of the Urx lanslide area	6 948 449	0
Total 1	226 680 268	**80 772 647**
Reducing thermal activity		
Survey and monitoring of thermal activity in the Heřmanice waste dump – site II	4 224 595	3 802 054
Survey and monitoring of thermal activity in the Ema waste dump	1 495 848	961 956
Comprehensive remediation of the contaminated area of the Trojice locality – phase I: updating analyses of the contaminated area	2 337 636	0
Total 2	8 058 079	**4 764 010**
Comprehensive land development		
Height measurement in areas with phased out mining operations managed by DIAMO (ODRA) – execution phase	5 604 305	1 882 840
Total 3	5 604 305	**1 882 840**
Comprehensive development of sites with uncontrolled methane emissions		
Reducing verified methane emissions in the City of Orlová – Project Orlová 2	34 575 450	20 111 531

Monitoring and maintaining the old mine working during the project execution, methane-screening	21 748 615	475 224
Land categorisation map OKR	2 249 100	610 470
Economics of filling underground spaces	2 261 000	2 034 900
Geophysical and borehole survey	1 707 650	1 536 885
Scientific-research support for significant safety improvements regarding uncontrolled mine gas emissions from old workings, as a result of dealing with residual coal gas capacity and gas bearing capacity of phased out and abandoned mine sections	2 261 000	2 034 900
Total 4	64 802 815	**26 803 910**
Eliminating old ecological burdens in OKD, a.s.		
Decontamination and reclamation of sludge tanks – phase III., IV. and V.	260 993 363	174 113 407
Darkov land reclamation, phase I, locality C2	394 939 113	378 100 043
Louky land reclamation – structure 8	62 491 957	52 214 909
Reclamation of waste dump D – reclamation of waste dump D1 and D2	57 386 059	50 605 783
Expert witness verification of the accuracy in establishing the share of state and OKD funding of submitted partial projects	30 000	0
Decontamination and reclamation of the Lazy mine sludge tanks, phase I. and II.	33 665 792	3 297 757
Reclamation of the Lazy waste dump	85 009 115	0
Huminisation of the town centre of Orlová-Lutyně – study	1 897 000	0
Total 5	896 412 399	**658 331 898**
Land development upon termination of mining		
Ostravice Dam – Hrabová km 12.05, no. st. 237	63 580 471	38 673 351
Land development within the scope of revitalising the František locality	380 644 254	69 497 046
Reclamation of lands of the former František – Horní Suchá mine	95 178 855	25 031 518
Total 6	539 403 580	**133 201 915**
Total 1–6		**905 757 220**

Reducing impacts caused by the termination of coal mining in the Kladno Region

In the middle of 2002, the Czech Republic Government decided to phase out underground mining of bituminous coal in the Kladno Region due to the economic ineffectiveness of mining. This hasty closure of mines in this region brought about, similarly as in the preceding coal districts, the need to deal with eliminating environmental damage caused by past mining operations in a special way.

In consideration of the situation which developed in the Kladno Region, the Czech Republic Government noted the need to reduce the impacts caused by the termination of coal mining in the Kladno Region, by issuing Resolution No**.** **552** on 4 June 2003, dealing with the reduction of impacts caused by the termination of coal mining in the Kladno Region. It agreed with the idea of gradually releasing, according to the means of the National Property Fund of the Czech Republic, an amount of up to **CZK 1.177 billion** from FNM resources starting in 2004 in order to deal with ecological impacts caused by coal mining in the past and with land reclamation. Considering the shortage of funds in order to carry out the "Reclamation of the Tuchlovice Mine Waste Dump" contract, the Czech Republic Government modified the above-mentioned resolution with Resolution No. **1467** on 20 December 2006, and **agreed** with the idea of gradually releasing, according to the means of the MF, funds in the amount of up to **CZK 1.427 billion** starting in 2004 from a special account managed by the MF pursuant to article 4 of Act No. 178/2005 Coll., on the termination of the National Property Fund, in order to deal with ecological burdens caused in the past and with land reclamation.

The following projects are considered essential:

- eliminating the dangerous conditions at the V Němcích Schöeller mine waste dump
- reclamation of the Tuchlovice mine waste dump

The funds actually spent on **3** concluded projects amount to **CZK 0.387 billion** and on **1** project in progress they amount to **CZK 0.516 billion** as of the date specified**.** The remaining financial amount required to secure additional money for projects in progress amount to ca **CZK 0.507 billion** according to contracts**.**

Projects concluded (in CZK thousand)

Project name	Project costs
V Němcích Schoeller mine waste dump – eliminating dangerous conditions	234 429
Eliminating the dangerous conditions at the V Němcích Schoeller mine waste dump – stage 2, western section	106 862
Eliminating the dangerous conditions at the V Němcích Schoeller mine waste dump – additional construction work	46 609
Total	**387 900**

Projects in progress (in CZK thousand)

Project name	Project price	Project costs thus far
Reclamation of the Tuchlovice mine waste dump	1 023 419	516 019
Total	**1 023 419**	**516 019**

GEOLOGY AND MINERALS

Geological evolution of the area of the Czech Republic

Arnošt Dudek

The Czech Republic is located in the very centre of Europe at the limit between the Hercynian Meso-Europe and the Neo-Europe (Fig. 1). There is hardly any country with such a variegated geological structure in such a small area and with such a complex geological evolution. Practically all known rocks and the majority of geological formations and known types of ores and industrial minerals occur on the state territory. Even though most ore deposits are interesting mainly from a scientific and mineral collectors' point of view, a number were of European importance during the Middle Ages and the beginning of modern time. The interesting and complex history of this area attracted attention of researchers already in early times and it strongly influenced the evolution of the mining and geological sciences. It was on this territory where one of the oldest mining laws, the Jihlava Mining Law (1260), and slightly later the mining law of the King Wenceslas II "Ius regale montanorum" (1300), which became basis of many mining laws in other states of the world especially in South America, came into being. The origin of the world-known works of Georgius Agricola, especially his book "Bermannus sive de re metallica dialogus" (1530), is also linked to the territory of the Bohemian Massif.

Three main structural complexes form the geological structure of Czech territory. The oldest one, consolidated already during the Precambrian orogenies, is **Brunovistulicum**, taking basically the area of Moravia. This segment of the Earth's crust probably represents an extremity of the East European platform, even though some researchers consider it as a part of the African plate. The influence of the younger – Paleozoic and Alpine – orogenies was only minor and it served as a foreland of the nappe structures which were thrust over it. The **Hercynian-consolidated Bohemian Massif**, overlapping to the area of the neighbouring Austria, Germany and Poland in the south, west and north, forms the major part of the state territory. Bohemian Massif belongs to the Paleo-Europe. The Hercynian orogeny in the end of the Carboniferous put the finishing touches on it, even though it also contains older building elements. It already behaved as a consolidated block after the Hercynian orogeny, only sometimes flooded by epi-continental sea and affected only by fault tectonics. As a crustal block rising from young sedimentary formations, it broke up only during the younger mountain-building processes, morphologically only in the end of the Neogene and in the Quaternary. Geological continuation of the Hercynides towards the west is indicated by other crustal blocks which were created later – Schwarzwald, Vosges Mountains, the French Massif Central and Iberian Meseta, in the northern branch then the Armorican Massif and massifs in southern England and Ireland. The eastern margin of the Bohemian Massif was thrust over the Cadomian unit of the Brunovistulicum during the Hercynian orogeny. The boundary between the hercynian Mesoeurope and alpine Neoeurope crosses the eastern part of the Czech Republic. The Alpides are represented there by the **West Carpathians**. They are built by an inner unit – Central West Carpathians, Outer Flysh Carpathians and the Carpathian Foredeep. The ***Central West Carpathians*** are formed by pre-Mesozoic volcanosedimentary complexes, mostly metamorphosed and penetrated by late-Hercynian granitoid plutons, and their sedimentary cover (Trias to Lower Cretaceous). At the beginning of Upper Cretaceous the Central Carpathians were intensively folded and

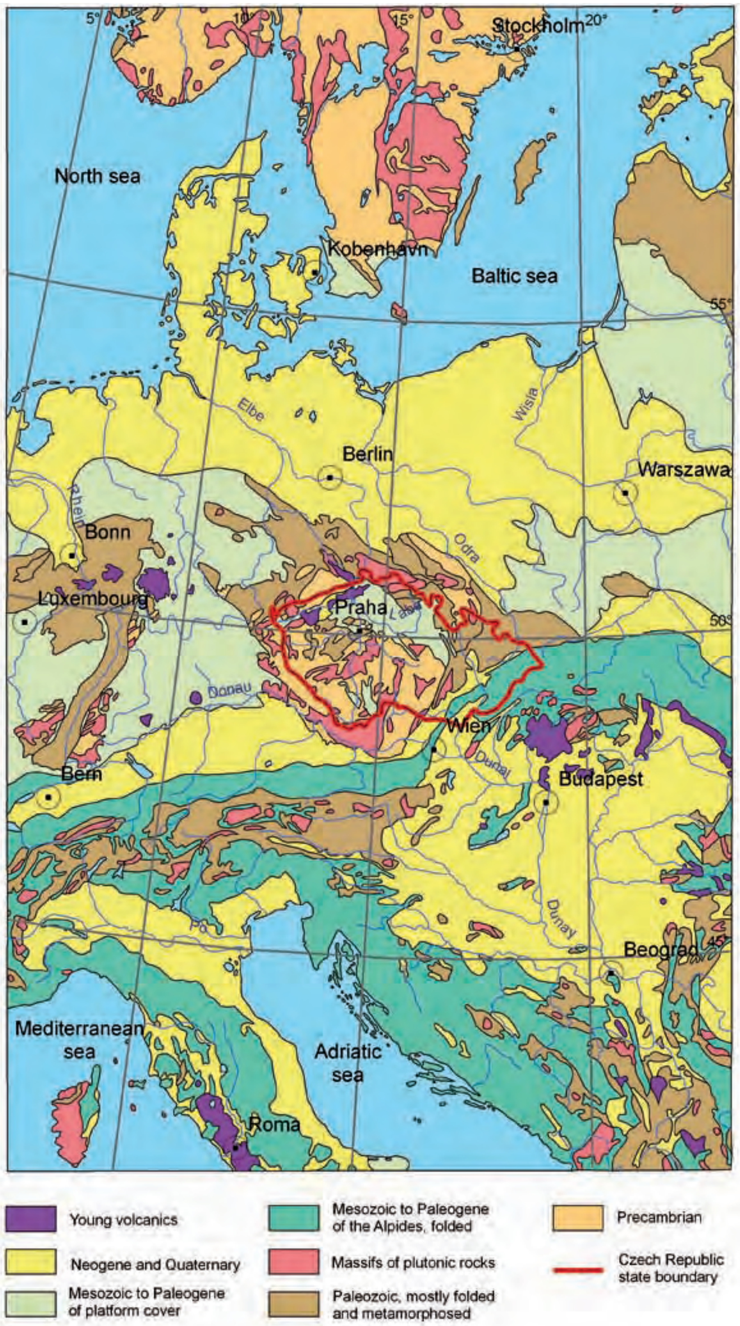

Fig. 1. Geological position of the Czech Republic in Europe

in places also metamorphosed. A tectonic zone of first order – the ***Klippen Belt,*** built mostly by Mesozoic sedimentary rocks separates the Central Carpathians from the external Flysh Carpathians. The ***Outer Flysh Carpathians*** are formed (besides rare uppermost Jurassic sediments and local Cretaceous volcanics) predominantly by sedimentary complexes of Cretaceous and Paleogene age. These complexes were as horizontal nappes thrust over the Brunovistulian basement and its sedimentary cover over a distance of tens of kilometres partly even over the Neogene Carpathian Foredeep.

As in the study of the history of mankind, there is little information on the oldest periods of the evolution of the Earth we live on, and our findings are accompanied by a large number of uncertainties. This of course applies also for the Czech territory, even though it belongs to the areas where systematic geological research was in progress since the beginning of the 19th century.

Complexes of the **Brunovistulicum** crop out on the surface only in the western Moravia, but they reach far to the east below the overthrust nappes of the Outer Flysh Carpathians. They are formed by metamorphic rocks – mainly monotonous biotite paragneisses – which were altered during the Proterozoic orogenies, and intruded by huge massifs of abyssal magmatic rocks of about 550 Ma age at the boundary between the Proterozoic and Paleozoic. The Brno and Dyje Massifs represent the exposures of these rocks. Granitoid plutons covering large areas as well as smaller basic massifs of gabbros and norites compacted this unit and prevented its later reworking by younger mountain-building processes, which formed the Bohemian Massif. Western parts of the Brunovistulicum are built by variegated volcano-sedimentary complexes (involving limestones, graphitic rocks, quartzites, amphibolites and orthogneisses). These parts were strongly affected by the Hercynian tectonometamorphic processes. They crop out from beneath of the overthrust Hercynian complexes of the Moldanubicum and Lugicum in tectonic windows of the Dyje and Svratka Domes of the **Moravicum** and Desná Dome of the **Silesicum**. Their appurtenance to the Brunovistulicum has not been commonly accepted yet and these units are by some authors ranked to the Lower Paleozoic and to the Hercynian Bohemian Massif. Platform sediments – the Cambrian conglomerates and sandstones in limited areas, marine Silurian shales sporadically and extensive and important sediments of the Devonian, Mississippian (Lower Carboniferous) and continental sediments of the coal-bearing Pennsylvanian (Upper Carboniferous) – are deposited on the Cadomian basement. The younger platform cover is represented by sediments of the Jurassic, Cretaceous, Paleogene and the Neogene of the Carpathian Foredeep. This consolidated basement was overthrust by nappes of the Outer Flysh Carpathians from the east (Fig. 2).

The lower level (basement) of the **Bohemian Massif** – the epi-Variscan platform – is built by metamorphic rocks intruded by numerous and very large granitoids massifs, and by only weakly metamorphosed or unmetamorphosed but Hercynian-folded Lower Paleozoic. Regionally it is divided (Fig. 3) into the core, formed by the highly metamorphosed **Moldanubicum** and mostly only weakly metamorphosed **Bohemicum**. This core is rimmed by the **Saxothuringicum** (Krušné hory Mts.) on the NW, **Lugicum** (Krkonoše Mts., Orlické hory Mts., Králický Sněžník) on the north and **Moravo-Silesicum** (Jeseníky Mts., eastern part of the Českomoravská vrchovina Highlands) on the east (see Fig. 3). These marginal complexes are metamorphosed mostly less intensively than the central Moldanubicum.

The ***Moldanubicum*** is formed by rocks metamorphosed mainly in the amphibolite facies – sillimanite and cordierite gneisses and migmatites with intercalations of orthogneisses,

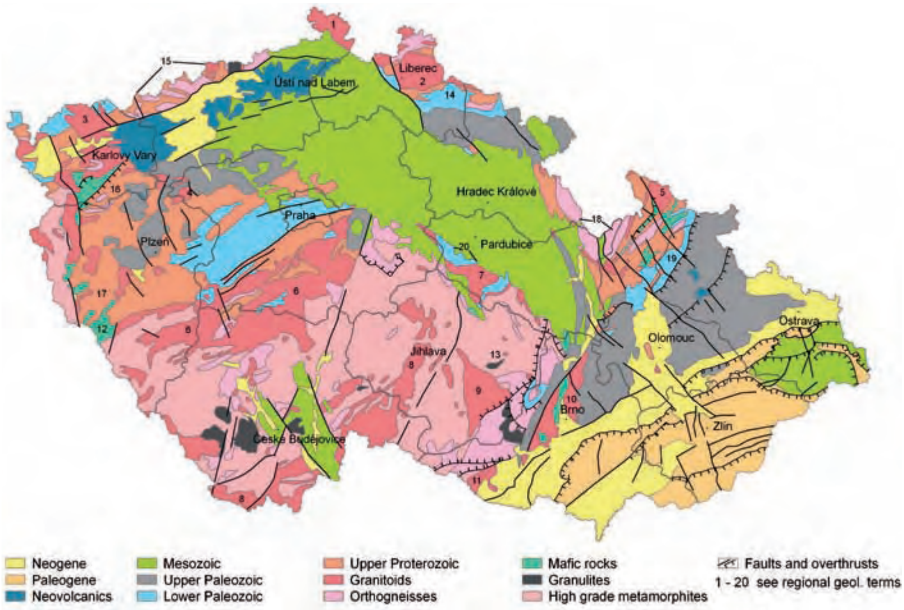

Fig. 2. Geology of the Czech Republic

marbles, quartzites, graphitic rocks and amphibolites. Bodies of high-temperature and high-pressure metamorphic rocks – granulites and garnet peridotites with eclogites – are numerous, too. Their occurrences mark the course of old tectonic zones, along which these rocks were exhumed from depth. They are exposed mainly in southern Bohemia (Blanský les, Prachatice, Křišťanov and Lišov granulite massifs) and western Moravia (Bory and Náměšť granulite massifs). The age of the protolith of Moldanubian complexes is probably Upper Proterozoic; their metamorphism under the amphibolite, granulite and eclogite facies conditions is linked to the Hercynian orogeny. Pre-Paleozoic, Cadomian metamorphism of regional extent, mostly overprinted by the Hercynian processes, is nevertheless documented. Minor bodies of old orthogneisses exhumed along deep-reaching faults in the southern Bohemia, the radiometric age of which is even 2.1 Ga, represent a single exception. They document the existence of the Lower Proterozoic in the deeper crustal structure of the Bohemian Massif. Some Moldanubian rocks, especially gneisses, granulites and amphibolites, represent common resources of building stone.

The metamorphic rock complexes of the central Bohemian ***Bohemicum*** as well as the marginal complexes of the Saxothuringicum, Lugicum and Moravo-Silesicum developed by regional metamorphism of mainly Upper Proterozoic protoliths (1,000–545 Ma). During this period, the area of today's Bohemian Massif was covered by a deep sea, in which sandy and clayey rocks were deposited. Surrounding continents, probably rather distant in the mainland formed by very old rocks, represented the source area of the deposited material. Some clastic minerals from metamorphic rocks of the southern Bohemia (up to 2.7 Ga old, in the neighbouring Bavaria even 3.8 Ga) were at least in part derived from the Archaic of the African shield. They were of course deposited much later. The sedimentation was accompanied by submarine volcanism of tholeiitic basalts, which formed linear structures tens of kilometres long, maybe in some cases standing out above the sea level (*island arcs*) as well as much less extensive acid volcanism. The volcanic activity was accompanied by deposition of black shales with abundant pyrite and of siliceous sediments – lydites. Finely banded structures resembling organogenic stromatolites, which would belong to the oldest organic remnants on the Czech territory, were found rarely in the latter. A set of these sediments and volcanic rocks was intensively folded and mostly also metamorphosed in the end of the Proterozoic. Very weakly metamorphosed Proterozoic rocks are nowadays exposed only in central Bohemia between Prague and Plzeň (in the so-called *Barrandian*). The intensity of their alteration increases towards the marginal mountains. A continuous succession of thin metamorphic zones of Barrovian type up to gneisses with kyanite and sillimanite developed especially towards the W and SW. Proterozoic rocks are altered into gneisses and amphibolites also in the Krušné hory Mts., Krkonoše Mts., Orlické hory Mts. and Hrubý Jeseník Mts. These complexes were intruded by numerous massifs of granites (especially Stod, Čistá-

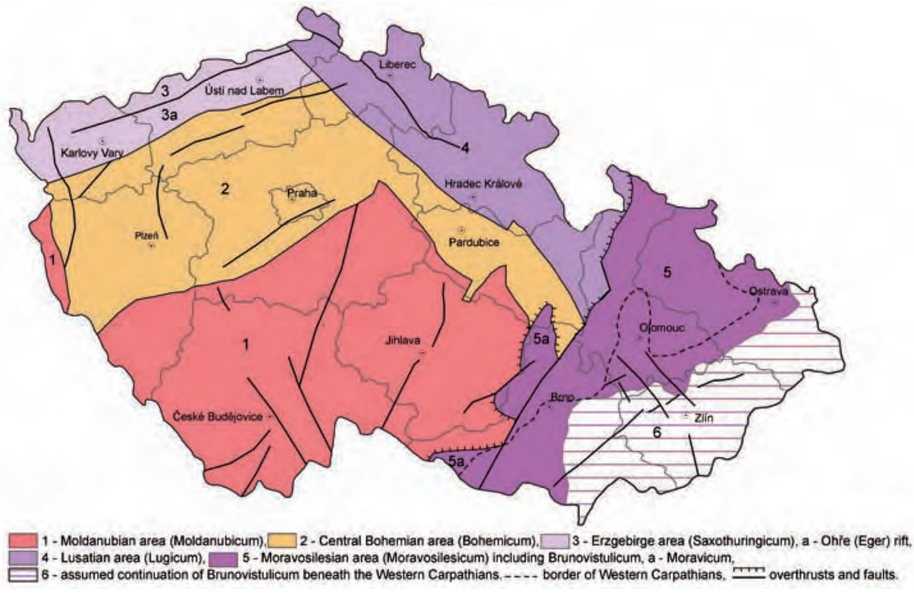

Fig. 3. Regional basement division of the Bohemian Massif on the territory of the Czech Republic

Jesenice and Lužice massifs) and gabbros (Kdyně and Poběžovice massifs) in the end of the tectonometamorphic processes especially in the western and northern Bohemia. The Pre-Paleozoic ***Cadomian orogeny*** represents one of the most important magmatogennic and tectonometamorphic processes in the evolution of the Bohemian Massif.

The Earth's crust in Czech territory was not completely solid after the Cadomian orogeny and it gradually broke into a number of smaller blocks, which moved away from each other and were partly flooded by sea again during the ***Lower Paleozoic*** [Cambrian, Ordovician, Silurian, Devonian to Mississippian (Lower Carboniferous)]. Unaltered sediments were preserved especially in central Bohemia, in the area between Prague and Plzeň (Pilsen), named Barrandian, to a lesser extent also in other parts of the Bohemian Massif. In its marginal parts (excluding Brunovistulicum), Paleozoic complexes experienced strong metamorphism and therefore their identification and dating is commonly very difficult. In the Barrandian, sedimentation started already in the ***Lower Cambrian***, represented by a formation of conglomerates and sandstones up to several hundred to thousand meters thick. Sporadic occurrences of shales of fresh-water or brackish origin, in which the oldest fossils of arthropods in Bohemia were found, are known here. Sea penetrated to central Bohemia in the Middle Cambrian and deposited sandstones and especially shales, which are world-known for their occurrences of trilobite fauna. The evolution of the Cambrian was terminated by extensive rhyolites and andesite terrestrial volcanism.

The ***Ordovician*** started by the sea again transgressing in central Bohemia and by the formation of the so-called ***Prague Basin***, the evolution of which continued until the Middle Devonian. The Ordovician rocks are represented mainly by clastic sediments, mostly various types of shales with thick quartzite intercalations), the deposition of which was accompanied by intensive basaltic volcanism. Deposits of sedimentary iron ores (e.g. Nučice, Ejpovice etc.) which were of a high importance in the 19th and beginning of the 20th century originated in relation to the volcanic activity. The Bohemian Massif was located close to the southern polar circle in the Ordovician and sedimentation of rocks as well as volcanic activity proceeded in the sub-polar climate. This crustal segment moved rather rapidly to the north, into warmer waters of the tropic of Capricorn in the end of the Ordovician.

The change of the climate and by this also conditions of development of organisms and sedimentation during the ***Silurian*** resulted in formation of fine-grained black shales with abundant graptolite fauna, accompanied also by intensive volcanic activity and intrusions of numerous diabase sills. Mass development of organisms with carbonate shells occurred in its upper parts with regard to the increasing temperature and massive limestone formations were formed.

Continuous carbonate sedimentation in the Prague Basin lasted until the ***Devonian***, whereas in the surrounding parts of Europe as well as more distant areas the rock deposition was interrupted by the ***Caledonian orogeny***. Gradual unaffected evolution of both the sediments and organisms and their long-lasting detailed study by several generations of Czech paleontologists was a prerequisite for the determination of the first, globally valid ***stratotype*** between two systems (Silurian and Devonian) in Klonk u Suchomast SW of Prague. The limestone sedimentation in the Prague Basin terminated in the Middle Devonian and sandstones with terrestrial flora ended the Devonian sedimentation in this area.

Sedimentation of the Devonian rocks continued in the Upper Devonian only in the area of the Krkonoše Mts. (on Ještěd Mt.) and especially in Moravia in the Jeseníky Mts. and in the Moravian Karst. Evolution of the Devonian in Moravia differed from that on the Bohemian territory. Transgressive complex of the siliciclastic and volcanic rocks with stratiform deposits of Fe, Cu, Au, Zn and Pb overlie the old Brunovistulian basement in its western, more mobile part. This clastic sedimentation continues also in the Mississippian (Lower Carboniferous). The Devonian rocks on the more stable Brunovistulian basement in the south and east begin by clastic rocks, which in places reach over 1,000 m in thickness. Limestones appear only in the Upper Devonian and their evolution continues until the Mississippian (Lower Carboniferous). There is therefore no manifestation that the sedimentation was interrupted by the Hercynian orogeny in Moravia. Sedimentation spaces just moved to the east to Ostrava region and to today's Carpathian basement. Limestones of the

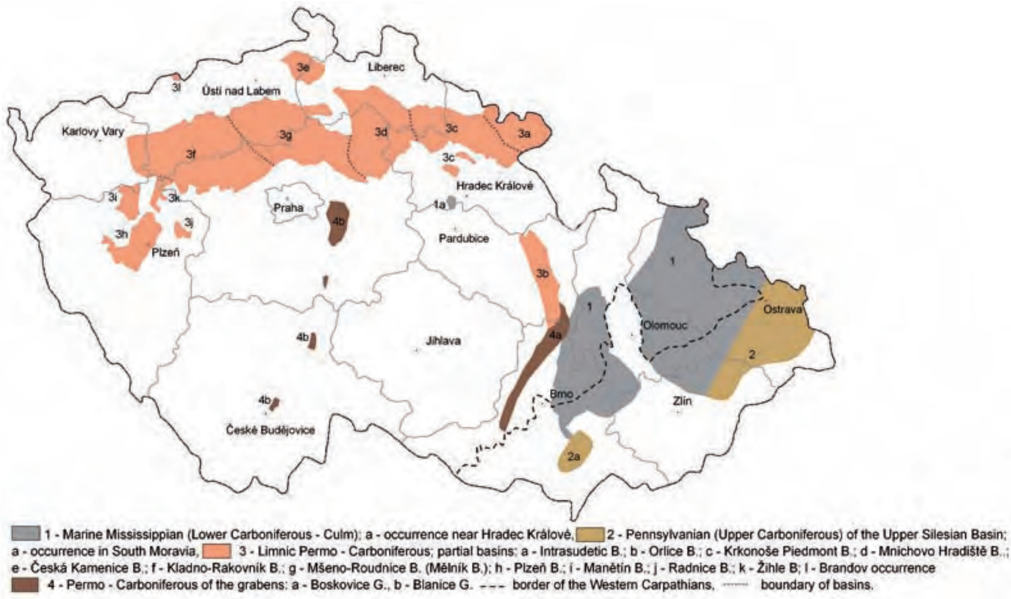

Fig. 4. Carboniferous and Permian in the Bohemian Massif and in the basement of the Western Carpathians on the territory of the Czech Republic

Upper Devonian form important deposits especially in central Moravia (e.g. Mokrá, Líšeň, Hranice etc.).

A change in the character of the sedimentation in the end of the Devonian is an expression of the ***Hercynian orogeny***, which affected (about 340–310 Ma ago) the majority of the Czech lands with a high intensity and expressed itself by the development of the nappe structure and a very strong metamorphism of large areas. Even the crystalline complexes formed during the Cadomian orogeny were metamorphosed again. Vast massifs of granitoid magmatic rocks of several thousand km^2 extent, not yet completely uncovered by denudation, formed practically simultaneously. Their intrusions were accompanied also by extensive surface volcanic activity and the development of very numerous deposits of variable genetic types (e.g. Krušné Hory Mts. massifs and Sn, W, Li, Ag, U, Co, Ni mineralization in the Saxothuringicum or Central Bohemian and Moldanubian Plutons in the Moldanubicum and Au, Sb, Ag, Pb, Zn, U mineralization). Granitoid massifs represent an important resource of building and dimension stone as well as feldspar raw materials. Weathered crusts of granitoids (e.g. Krušné hory Mts. massifs, Dyje Massif) are an important source of kaolin, too.

There are two different types of the ***Carboniferous*** and its rocks in the Bohemian Massif as a result of the Hercynian orogeny. The Mississippian (Lower Carboniferous) is missing in Bohemia and sedimentation of the continental type begins in the intra-mountain basins only in the Pennsylvanian (Upper Carboniferous, Westphalian) and continues in the Permian. Basins with partly individual evolution extend in the Plzeň (Pilsen) surroundings towards the North and Northeast as far as the Broumov area in the NE tip of the Czech Republic (Fig. 4), where their stratigraphic extent is the largest and the sedimentation finishes as late as the Lower Triasic. They are to a large extent overlain by sediments of the Bohemian Cretaceous Basin. River and lake deposits – conglomerates, arkoses and shales with layers of tuffs and tuffites – are in many places accompanied also by formation of coal seams, which were and still are of a high economic importance. Some seams show an elevated U content making them even potential deposits. The Carboniferous arkoses in the Plzeň (Pilsen) and Podbořany regions gave rise to important deposits of kaolin. Carboniferous mainly refractory clay and claystone are important, too. The Bohemian Massif reached the equator on its way to the north and coal formation reflects the dominating tropical climate.

In Moravosilesian area, which was just weakly influenced by the Hercynian orogeny thanks to the solid Brunovistulian basement, the Devonian sedimentation was continuous until the Mississippian (Lower Carboniferous), when the formation of limestones terminated. It was followed by flyshoid sedimentation of conglomerates, greywackes and shales in multiple alternation of individual layers (Culm development). The greywackes represent a resource of a high-quality building stone. The depositional environment gradually changed from marine to fresh-water during the Pennsylvanian (Upper Carboniferous) and important deposits of bituminous coal (paralic basins of the Ostrava region) formed in the coastal marshes. The Czech part of the Upper Silesian Basin represents the most important bituminous coal mining district in the Czech Republic. The Carboniferous system in the Czech Republic was, and remains, not only an important energy base of the state but also a world-known classical area of Carboniferous flora and fauna.

The Hercynian mountains were rapidly lowered by erosion and denudation in the ***Permian***, and thick formations of red-brown conglomerates, sandstones, arkoses and shales formed. Sedimentation was accompanied also by basaltoid volcanism of the intra-plate type and sedimentation of clastic rocks with elevated Cu content. A substantial change of climate, caused by the shift of the lithospheric plate with the Bohemian Massif further north, into the belt between the equator and tropic of Cancer, resulted in the formation of deserts, which covered most of Europe. These sediments are today preserved in the Bohemian Massif only in relics. They reach the highest thickness – up to 3 km – in tectonic troughs of roughly N-S direction, so-called grabens (Boskovice and Blanice grabens). Coal seams (today already mined out) occur locally on the basis of the Permian in these grabens and higher horizons contain restricted lake and river calcareous sediments. These are commonly overfilled by relics of Stegocephalians and especially of the Permian insects, which made the Boskovice Graben famous.

The Bohemian Massif was slowly uplifted as a compact block after the Hercynian consolidation and it remained mainly land almost until the end of Mesozoic. White lake sandstones of the ***Triassic*** are represented only to minor extent in NE Bohemia in the Krkonoše Mts. Piedmont and Intra-Sudetic Basins. Sea penetrated from the Carpathian area to northern Germany by a narrow channel across northern Bohemia (roughly between Brno and Dresden) in the ***uppermost Jurassic***. This channel linked the deep Tethys on the SE with the shallow shelf sea to the north from the Bohemian Massif. Limestones (Oxfordian–Kimmeridgian) are exposed only in small islands along the Lužice Fault. Transgression of the ***Upper Cretaceous*** sea, which flooded all the northern and partly also the central part of the Bohemian Massif, was of much higher importance. Several hundreds meters thick strata of the Upper Cretaceous claystones, marlites, sandy marlites and sandstones (the Bohemian Cretaceous Basin – Fig. 5) developed there. The Bohemian Cretaceous Basin is divided into facies areas (developments) shown in Fig. 5 based on character of sedimentation in particular parts of the Basin. Rock complexes of the Basin represent the most

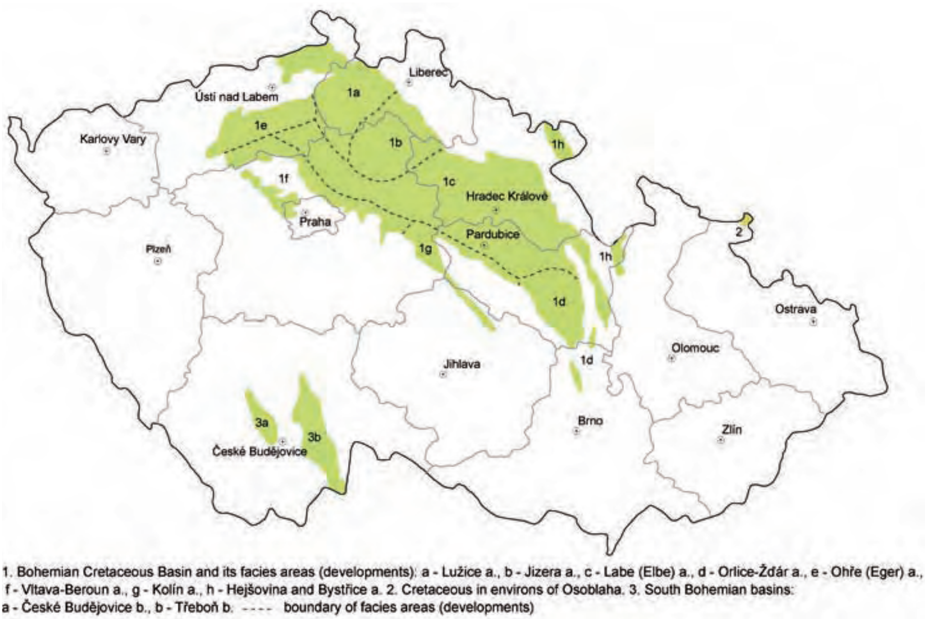

Fig. 5. Upper Cretaceous in the Bohemian Massif on the territory of the Czech Republic

important underground water reservoir in the Czech Republic and also an important raw material resource (ceramic and refractory clay, glass, foundry and mortar sand, cement raw materials, building and sculpture stone but also uranium). A small occurrence of Upper Cretaceous sediments near Osoblaha is an extremity of the Polish Opole Cretaceous Basin. Smaller, but fresh-water Upper Cretaceous basins formed also in southern Bohemia. It is the České Budějovice Basin localized more westward and the Třeboň Basin localized more eastward.

The evolution in Moravia was different. The Triassic is not represented at all, whereas in the ***Jurassic*** the sea penetrated from the Mediterranean area far to the NW and flooded the eastern margin of the Bohemian Massif. Jurassic sediments are nowadays to a large extent covered by rocks of the Neogene or the Outer Flysh Carpathian nappes. Tectonic blocks of the Jurassic limestones, exhumed from depth in front of the Carpathian nappes and forming isolated klippen by Štramberk and in the Pavlovské vrchy Hills, represent an important land-forming element and also an important resource of very pure carbonate raw material.

The character of the sedimentation in the Outer Carpathians markedly changed in the ***Cretaceous***. Sediments formed in deeper sea from submarine slides and turbidite currents, transporting clastic material far from the land. They are characterized by multiple alternations of sandy and clayey layers of a low thickness (dm to m) and infrequently also sandstone benches, which are collectively called **flysh**. The sediments reach even many thousand meters in thickness. The flysh sedimentation continued in this area also in the Paleogene (Fig. 6).

The Bohemian Massif remained land which was only occasionally flooded in the east by shallow epicontinental sea from the Carpathian area. Nevertheless, several depressions with intensive freshwater sedimentation were formed as a result of strong tectonic movements in

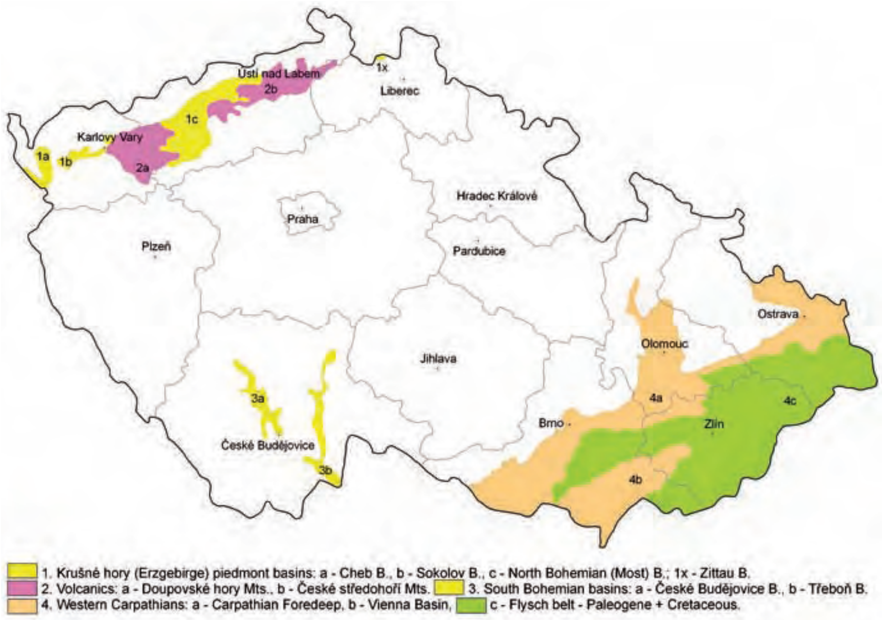

Fig. 6. Tertiary in the Bohemian Massif and Western Carpathians on the territory of the Czech Republic

the Alpine and Carpathian space in the end of the ***Paleogene and in the Neogene***. This is the area of the South Bohemian basins (the České Budějovice Basin and the Třeboň Basin) with lignite, clay and diatomite deposits and also a marked tectonic trough of the SSW-NNE direction (Ohře Rift) in north-western Bohemia, where the Krušné Hory Piedmont basins (Cheb, Sokolov, North Bohemian and Zittau) formed – see Fig. 6. Sandstones and especially clays and claystones with thick (exceptionally and locally up to 60 m) brown coal seams sedimented in these basins. Brown coal deposits in the North Bohemian and Sokolov basins represent the most important brown coal deposits in the Czech Republic. Important deposits of Neogene clays then occur in the Cheb Basin. Formation of basins was accompanied by very intensive **volcanic activity** and a large accumulation of lavas and pyroclastics (the Doupovské hory Mts. Volcanic Complex, České středohoří). The rocks are mainly various types of olivine basalts and alkaline basaltic rocks, to lesser extent also more acid phonolites. Volcanic conduits and necks give today's landscape a beautiful character. The main volcanic activity took place 35–17 Ma ago, a younger phase 8 Ma ago and the last minor volcanoes are just several thousand years old (Komorní and Železná hůrka). The area represents a classical example of alkaline volcanism and it played an important role in the evolution of geosciences. The rocks are important not only as a building stone but also as a raw material for manufacture of molten basalt products. Deposits of the Bohemian garnets at the southern margin of České středohoří are related to the volcanic activity, too (pyropes were carried up by volcanic necks from the ultrabasic rocks in the crystalline basement). Weathering and decomposition of tuffs of the Doupovské hory and České středohoří Mts. resulted in the formation of important bentonite deposits.

The flysh complexes of the Carpathian area were folded and thrust in the form of nappes (verified by exploration) over a distance of several tens of kilometres towards the west and southwest over the Bohemian Massif in the end of the ***Paleogene***. The Carpathian Foredeep, partly still covered by the arriving nappes, formed in front of the thrust nappes in the ***Neogene*** (Miocene). The sediments of the Vienna Basin (of up to 5 km in thickness) were subsequently hardly folded. These are represented mainly by marine clay, marl and sand, just partially diagenetically consolidated, which contain smaller deposits of oil and gas. The depositional setting of the younger formations became progressively fresh-water. The youngest ones contain deposits of lignite.

Important tectonic processes expressing themselves by marked vertical movements of individual crustal segments operated in the Bohemian Massif in the end of the Tertiary and beginning of the Quaternary. In this way, the marginal mountains – Šumava Mts., Český les Mts., Krušné hory Mts., Krkonoše Mts., Orlické hory Mts. as well as Hrubý Jeseník Mts. – were uplifted by up to 1,000 m and the Bohemian basin was formed. This is sometimes considered as being formed by the impact of a large meteorite, but this is a nonsense resulting from the

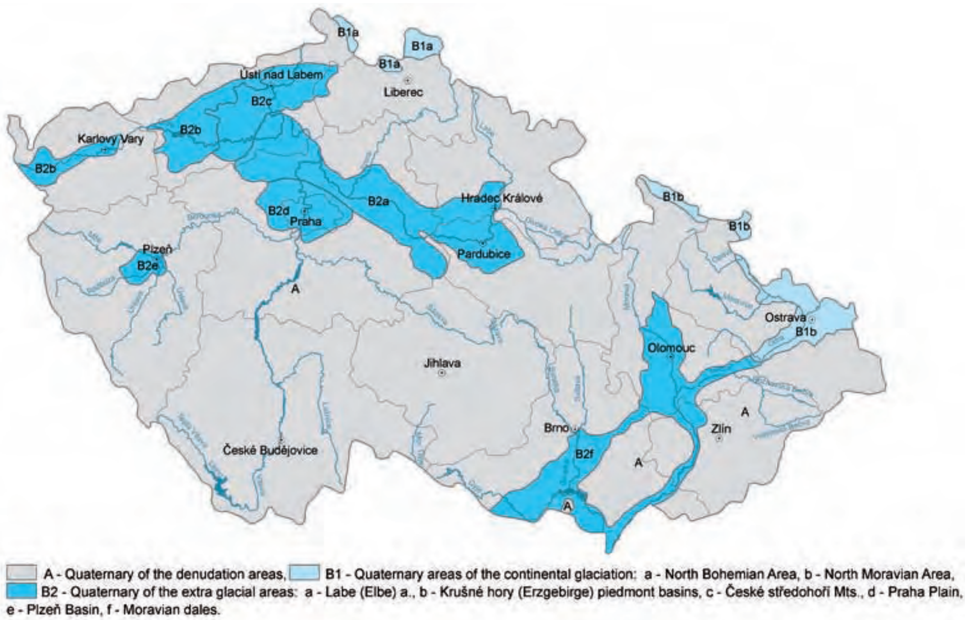

Fig. 7. Quaternary division on the territory of the Czech Republic

interpretation of satellite images without knowledge of the real structure of the massif. The Bohemian Massif was influenced by several phases of continental and mountain **glaciations** during the ***Quaternary***. A periglacial climate dominated here, which resulted in the formation of massive stony debris and block-seas, terrace system of the rivers (Fig. 7) as well as really extensive loesses. Terrace sediments of rivers especially form important deposits of sand and gravel and feldspar raw materials, and loesses of brick clays. The continental ice sheet reached as far as the northern margin of the massif and left sediments of frontal moraines in the Ostrava region, on the northern piedmont of the Hrubý Jeseník Mts. and in the Šluknov and Frýdlant extremities. Mountain glaciers modified morphology of the marginal mountains, especially the Krkonoše Mts., to a lesser extent also the Jeseníky Mts. and Šumava Mts., where even minor glacier lakes formed.

Figures in this chapter were adapted by the author from:

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Regional geological terms

(used in sub-chapter 2. Mineral resources of the Czech Republic)

Arnošt Dudek

Bíteš orthogneiss – mostly muscovitic orthogneiss of the Cadomian age, characteristic of the Moravicum of the Dyje and Svratka domes between Krems in Austria and Svojanov in the Czech Republic (opal, kaolin, crushed stone) – Fig. 3 – unit 5a

Blanice Graben – fault system of the NNE-SSW direction in central and southern Bohemia, marked also by downthrown islands of the uppermost Carboniferous and Permian with hard coal an anthracite seams. It continues as Rodel line in Austria (Au-Ag-ores) – Fig. 4 – unit 4b

Bohemian Cretaceous Basin **–** sediments of the Upper Cretaceous (Cenomanian to Santonian), overlying crystalline rocks in the northern part of the Bohemian Massif. Based on the lithological character, it has been regionally classified into facial developments as follows:

- *Lužice* (U-Zr-ores, glass and foundry sand) – Fig. 5 – unit 1a
- *Jizera* (glass and foundry sand, dimension stone) – Fig. 5 – unit 1b
- *Orlice-Žďár* (foundry sand) and its *east Bohemian* (clays) and *Moravian parts* (clay) Fig. 5 – unit 1d
- *Ohře (Eger)* – the Most, Teplice (quartzite, corrective additives for cement production) and Louny part (clay) Fig. 5 – unit 1e
- *Vltava-Beroun* including Prague surroundings (clay, dimension stone) Fig. 5 – unit 1f

Boskovice Graben – tectonic trench of the NNE-SSW direction in western Moravia filled with sediments of the uppermost Carboniferous and Permian (hard coal) Fig. 4 – unit 4a

Bory granulite massif – a small granulite body in the Moldanubicum N of Velké Meziříčí in western Moravia (feldspar, crushed stone) – Fig. 4 – unit 4a

Brno Massif **–** a large massif in western Moravia built by a variable series of both acid and basic plutonic rocks of the Cadomian age (feldspar, crushed stone) – Fig. 2 – unit 10

Carpathian Flysh – a part of the Outer Carpathians in eastern Moravia built by clayey and sandy Cretaceous and Paleogene sediments, with a marked nappe structure of the pre-Miocene age. It composes the Chřiby Mts. and the Ždánice Forest and mountain ranges on the border with Slovakia – the Beskydy, Javorníky and Bílé Karpaty Mts. (natural gas) – Fig. 6 – unit 4c

Carpathian Foredeep – the external part of the Carpathian mountain chain in eastern Moravia, which was formed in front of the Outer Carpathian nappes and overlies the south-eastern slope of the Bohemian Massif. It is filled with the Miocene sediments of the Egerian to Badenian (oil, natural gas, clay, bentonite, gypsum in the Opava Basin) – Fig. 6 – unit 4a

Central Bohemian Pluton – an extensive Hercynian granitoids pluton on the border between Bohemicum and Moldanubicum, more basic than the massifs of the Krušné hory Mts. and in Českomoravská vrchovina Highlands (granodiorites, tonalite, diorite). Important deposits in the exocontact (U, Au, Ag-Pb-Zn-ores, feldspar, quartz, dimension and building stone) – Fig. 2 – unit 6

Cheb Basin – the westernmost of the Tertiary basins, at the crossing of the Ohře rift and the Tachov Graben. Sedimentation continued from Eocene until Pliocene (brown coal, kaolin, clay, diatomite, glass and foundry sand – numerous conflicts of interest) – Fig. 6 – unit 1a

České Budějovice Basin **–** a smaller, western subbasin of South Bohemian basin, filled with fresh-water sediments of the Upper Cretaceous and to a minor extent Neogene and Quaternary. Episodic ingressions of the sea from the Alpine foredeep (lignite, tectites, diatomite, sand and gravel) – Fig. 6 – unit 3a

České středohoří Mts. **–** a classical area of the Tertiary alkaline volcanic rocks (olivine basalts to phonolites) exposed in the Ohře (Eger) rift between Chomutov and Nový Bor, with the main volcanic centre in Roztoky nad Labem (pyrope, diatomite, feldspar substitutes, crushed stone) – Fig. 6 – unit 2b

Čistá-Jesenice Massif – a minor granitoid massif in western Bohemia composed of both Cadomian and Hercynian bodies. It is covered from a large part by Carboniferous and Permian sediments (feldspar, dimension and building stone) – Fig. 2 – unit 4

Domažlice Crystalline Complex – south-western part of the upper Proterozoic of the Bohemicum in the Šumava piedmont, metamorphosed during both Cadomian and Hercynian orogeny, with minor massifs of granitoids and gabbroic rocks and abundant pegmatites (feldspar) – Fig. 2 - unit 17

Doupovské Hory Mts. – a volcanic complex of the Tertiary age at the crossing of the Ohře rift with the Jáchymov fault, between Karlovy Vary and Kadaň. Alkaline volcanic rocks are represented mainly by olivine basalt, “leucitic” tephrite and abundant tuffs. Phonolites are missing (bentonite, crushed stone) – Fig. 6 – unit 2a

Dyje Massif – a massif of the Cadomian granitoids in the Dyje Dome of the Moravicum in SW Moravia, extending from the northern vicinity of Znojmo almost to Danube. It was affected by a strong tropical weathering in the Jurassic and Neogene and from a large part covered by sediments of the Carpathian foredeep (kaolin, feldspar, building stone) – Fig. 2 – unit 11

Hroznětín Basin – the northern extremity of the Sokolov Basin N of Karlovy Vary (bentonite) – Fig. 6 – unit 1b

Intra-Sudetic Basin – Permocarboniferous basin in the NE tip of Bohemia with sedimentary fill from the Mississippian (Lower Carboniferous) to Upper Cretaceous about 3,000 meters in thickness and Permian volcanites. Southern extremity of the Lower Silesian Basin (hard coal) – Fig. 4 – unit 3a

Islet zone of the Central Bohemian Pluton – a number of both large and minor blocks of the contact metamorphosed Proterozoic and Lower Paleozoic rocks from the mantle of the pluton, downthrown into granitoids (Au, building stone, barite, limestone) – Fig. 2 – unit 6

Jílové Belt – a belt of the Upper Proterozoic volcanic (basalt, andesite, boninite and rhyolites), subvolcanic and acid plutonic rocks extending over 120 km in NNE-SSW direction south of Prague, from a major part enclosed in granitoids of the Central Bohemian Pluton (Au-ores, building stone) – Fig. 2 – unit 6

Kdyně Massif – a complex of metabasic, gabbroic and dioritic rocks in the Domažlice Crystalline Complex on the border of Šumava and Bohemian Forest (dimension and building stone) – Fig. 2 – unit 12

Kladno-Rakovník Basin – one of the basins of the Central Bohemian limnic Permocarboniferous, partly covered by Cretaceous sediments (hard coal, kaolin, claystone) – Fig. 2 – unit 12

Krkonoše-Jizera Crystalline Complex – western part of the Lužice area built by metamorphic rocks of the Proterozoic and Lower Paleozoic age (limestone, dolomite) and intruded by plutons of the Cadomian (Lužice) and Hercynian (Krkonoše-Jizera) age (feldspar, dimension and building stone). Fe-bearing skarns, Sn and W-ores, fluorite and barite occur in the exocontact of the plutons – Fig. 2 – unit 14

Krkonoše-Jizera Massif – Hercynian granitoid massif building the border range with Poland (excellent dimension stone, feldspar) – Fig. 2 – unit 2

Krkonoše Mts. piedmont basin – one of the Central Bohemian Permocarboniferous basins partially covered with Cretaceous sediments. Formations encompass whole Permian and extend up to the lowermost Trias (Cu-ores, Au paleoplacers, bituminous coal, pyrope) – Fig. 4 – unit 3c

Krušné hory Mts. Piedmont basins – a group of limnic Tertiary basins associated with the Ohře Rift SE of the Krušné hory Mts. From WSW to ESE, these are: Cheb, Sokolov and North Bohemian basins. – Fig. 6 – unit 1

Krušné hory Mts. Pluton – a large Hercynian granitoid pluton underlying metamorphic rocks of the Krušné Hory and Smrčiny Mts., exposed by erosion only in numerous partial massifs (Sn-W-ores, kaolin, feldspar, quartz, building stone) – Fig. 2 – unit 3

Krušné hory Mts. Crystalline Complex – a part of the Saxothuringicum built by metamorphic complexes mostly of the Proterozoic, subordinately also of the Lower Paleozoic age (U, Ag, Bi, Co, As-ores, Cu-ores, Sn-skarns, fluorite, barite, kaolin) and intruded by Hercynian granitoids. – Fig. 3 – unit 3 (Fig. 2 – unit 15)

Lužice Massif – an extensive Cadomian granitoids massif predominantly on the German territory, extending into the Jizera Mts. (quartz, dimension and building stone) – Fig. 2 – unit 1

Moldanubian Pluton – the largest Hercynian granitoids complex in the Bohemian Massif in Českomoravská vrchovina Highlands, Šumava and Waldviertel (dimension and building stone; Au-W and U-ores and Ag-Pb-Zn-ores in the exocontact) – Fig. 2 – unit 8

Moldanubicum **–** basement of the southern part of the Bohemian Massif built by high-grade metamorphic complexes of Proterozoic and probably also Lower Paleozoic age. The cadomian tectonometamorphic processes were followed by hercynian high temperature and low pressure metamorphism and whole complex was penetrated by numerous late-Hercynian granitoid plutons. – Fig. 3 – unit 1

Moravian-Silesian Devonian – weakly metamorphosed volcano-sedimentary unites in the Jeseníky Mts. – *Vrbno Strata, Šternberk-Benešov Belt* (Fe-ores, Cu-ores, Pb-Zn-ores, barite, quartzite, dolomite) – Fig. 2 – unit 19

Moravian-Silesian Carboniferous – marine flyshoid Mississippian (Lower Carboniferous) of the Nízký Jeseník Mts. and Drahany Highlands (slate, quartz) and paralic to limnic Pennsyvian (Upper Carboniferous) of the Ostrava region (Upper Silesian Basin – hard coal, natural gas) – Fig. 4 – unit 1, 2

Mšeno-Roudnice Basin – one of the Central Bohemian Permocarboniferous basins, completely overlain by the Bohemian Cretaceous Basin (hard coal) – Fig. 4 – unit 3g

Nasavrky Massif – a minor however very complex Hercynian granitoid body exposed in the Železné hory Mts. (pyrite, dimension and building stone; fluorite and barite in the exocontact) – Fig. 2 – unit 7

North Bohemian Basin **–** the largest Tertiary basin of the Ohře Rift between the Doupov Mts. and České středohoří Mts. (brown coal, clay, bentonite, diatomite, quartzite) – Fig. 6 – unit 1c

Ohře rift **–** a prominent fault structure in the south-eastern piedmont of the Krušné hory Mts. delimited by the Krušné hory and Litoměřice faults and their directional continuations. Tertiary alkaline volcanites, coal-bearing basins and mineral as well as thermal waters are associated with the rift – Fig. 3 – unit 3a

Orlické hory Mts.-Kłodzko Crystalline Complex – metamorphic complexes of probably Proterozoic age in the eastern part of the Lužice area in the Orlické hory and Rychleby Mts. and in Kłodzko – Fig. 2 – unit 18

Outer klippen zone of the Western Carpathians – extensive fragments of Jurassic and Cretaceous sediments brought up from depth in front of the flysh nappes – Štramberk, Pavlovské vrchy (limestone) – Fig. 2 and 6 – unit 4c

Plzeň Basin – an independent basin at the SW margin of the Central Bohemian Permocarboniferous (hard coal, kaolin, clay) – Fig. 4 – unit 3a

Quaternary alluvia – alluvia and terraces of majority of larger water courses (feldspar, sand and gravel, in south Bohemia and SW Moravia also tectites) – Fig. 7 – units B2a, B2b, B2f

Quaternary placers – in piedmont of the Šumava and Jeseníky Mts. (Au), Krušné Hory Mts. (Sn), southern piedmont of the České středohoří Mts. (pyrope)

Sokolov Basin – the smallest Tertiary basin of the Ohře Rift WSW of the Doupovské hory Mts. with important deposits of energy minerals (brown coal, U, clay, bentonite) – Fig. 6 – unit 1b

South Bohemian Basins – freshwater sedimentation space of the Upper Cretaceous and Tertiary age, where the Rudolfov horst separates the smaller České Budějovice Basin in the west from the larger Třeboň Basin in the east – Fig. 6 – unit 3

Svratka Dome of the Moravicum – the northern of the domes built by metamorphic rocks of the Moravicum W of Brno (graphite, feldspar, limestone, building stone) – Fig. 3 – unit 5a

Syrovice-Ivaň terrace – a higher located Quaternary terrace between the Jihlava and Svratka rivers S of Brno (feldspar) – Fig. 7 – unit B2f

Teplá Crystalline Complex – the NW part of the Proterozoic of the Central Bohemian area (Bohemicum) with a rapid succession of metamorphic zones from SE to NW into the Slavkov les Forest (feldspar) – Fig. 2 – unit 16

Tertiary relics of the Plzeň region – relics of the formerly more extensive Tertiary sediments on the site of a river paleostream discharging into the North Bohemian Basin (clay, bentonite) – not shown on scale of the maps

Třebíč Massif – an extensive massif of the Hercynian melanocratic granitoids and syenitoids (durbachites) in the Českomoravská vrchovina Highlands (amethyst, morion, feldspar, dimension stone) – Fig. 2 – unit 9

Třeboň Basin – a larger, eastern subbasin of South Bohemian basin with continental Cretaceous and Teriary sediments (kaolin, clay, bentonite, diatomite) – Fig. 6 – unit 3b

Upper Silesian Basin – a Pennsylvanian (Upper Carboniferous) basin situated predominantly in Poland and extending to the Czech Republic only by its SW part. It is formed by volcanoclastic sediments with numerous hard coal seams. On the Czech territory, it is further subdivided into i) western, more mobile paralic Ostrava part, ii) eastern, platform limnic Karviná part and iii) southern Beskydy part (hard coal, natural gas) – Fig. 4 – unit 2

Variegated Group of the Moldanubicum – metamorphic complexes of paragneisses and migmatites with numerous intercalations of amphibolites, marbles, quartzites, graphitic rocks and skarns (Fe-skarns, graphite, feldspar, limestone, dolomite, fluorite, building stone) – part of the Modanubian unit 1, in Fig. 3

Vienna Basin – an extensive Tertiary Neogene basin with marine sedimentary fill gradually becoming freshwater of more than 5,000 m in thickness (lignite, oil, natural gas) – Fig. 6 – unit 4b

Železné hory Mts. area – part of Bohemicum built by weakly metamorphosed volcanosedimentary series of the Upper Proterozoic and sediments of the Lower Paleozoic (Mn-Fe-carbonates, pyrite, fluorite, barite, limestone) and the Hercynian granitoid Nasavrky Massif – Fig. 2 – unit 20

Zittau Basin – a Tertiary basin in the continuation of the Ohře Rift, extending only by a negligible south-eastern extremity into the Czech territory (brown coal, lignite, clay) – Fig. 6 – unit 1d

Žulová Massif – a minor Hercynian granitoid massif in the northern tip of the Moravian-Silesian area (kaolin, quartz, dimension and building stone) – Fig. 2 – unit 5

MINERALS CURRENTLY MINED IN THE CZECH REPUBLIC

ENERGY MINERALS
– geological reserves and mine production

Significant geological reserves and resources of energy minerals on the territory of the Czech Republic can be found only for uranium ores, bituminous (hard) coal and subbituminous coal (brown coal and lignite). Geological reserves of these raw materials take a share in the order of some percent in the world resources. Brown coal deposits are concentrated in the Krušné Hory Mts. Piedmont Basins. About 60 % of domestic electric energy and heat (heating plant) production is covered by coal from these basins. All the bituminous coal mining is at present concentrated in the Czech part of the Upper Silesian Basin. At present level of the uranium world prices, the Czech territory is perspective also as resources of these energy mineral concerns. Prospective use of these resources can be however complicated and limited, first of all due to conflicts of interest with the environment protection.

Coal production started to thrive on the Czech territory in the 19th century in the course of the Industrial Revolution. After the World War II, uranium ore mining developed. Production of energy minerals as a whole reached its peak in the second half of the 1980' and after that a recession came connected with the decline of U-ore and all kinds of coal mining. Out of mineral fuels, the quickest decline affected the uranium ore mining; however, this process has been re-valuated with regard to the marked increase of uranium world prices in 2004–2008. State subventions for closure programs directed towards social costs, technical liquidations, health and safety activities (maintenance) and reclamation in 1990–2008 are the object of the chapter *Eliminating negative cosequences of mining in the Czech Republic – main methods and financial resources* in this yearbook.

In the past, all uranium needs of the Czech Republic were covered from domestic production. This coverage from domestic sources has been continuously decreasing so that it reached about one third of the total needs in 2008. The Czech Republic's needs for coal are totally met from domestic production, and bituminous coal is also exported, but nearly all the oil and gas needed is imported. The world prices of crude oil and natural gas started to increase significantly in 2000. The Czech Republic then purchased the both strategic raw materials for CZK 82.3 billion (in 1999 it was only 41 billion). This amount represented 90 % of all finances used for purchase of primary mineral raw materials. High sums were paid for purchase of crude oil and natural gas in 2001 (more than CZK 86 billion), 2002 (67 billion), 2003 (72 billion), 2004 (74 billion) and 2005 (116 billion). CZK 142 billion in 2006 represented twice as much than in 2003 at comparable volume. This enormous charge of Czech foreign trade balance was slightly annually lowered to CZK 122 billion in 2007. In 2008, it represented again an astronomic value of CZK 175 billion despite the oil and gas price drop in the last quarter of the year.

Also other energy minerals i.e. all coal types showed an important increase of the world prices in 2004–2008. Increase of uranium prices was, however, enormous. Its price has been rapidly increasing since a long period of stability until the year 2003 and it reached already multiple of the starting value from the end of 2003 till July 2007. These high prices were partially corrected in several phases since the second half of 2007. In the middle of 2009, uranium prices searched a new balance on levels around 50 USD/lb, which still represents about five-fold of multiyear price levels.

Mining of energy minerals

Raw material	Unit	2004	2005	2006	2007	2008
Uranium	t U	435	420	383	322	290
Bituminous coal	kt	14 648	12 778	13 017	12 462	12 197
Brown coal	kt	47 840	48 658	48 915	49 134	47 456
Lignite	kt	450	467	459	437	416
Crude oil	kt	299	306	259	240	236
Natural gas	mill m^3	175	356	148	148	168

Lifetime of industrial reserves

(economic explored disposable reserves) and so-called exploitable (recoverable) reserves, after the decrease of reserves by production incl. losses of registered deposits per year 2008 (A) and as the average annual decrement of reserves in period 2004–2008 (B) was as follows:

Raw material	Lifetime – A (years)		Lifetime – B (years)	
Reserves	industrial	exploitable	industrial	exploitable
Uranium ore	12	2	13	3
Bituminous coal	62	9	66	10
Brown coal [a)]	29	19	28	18
Brown coal [b)]	45	–	45	–
Lignite [c)]	> 100	3	> 100	2
Crude oil	62	7	55	6
Natural gas	14	> 100	12	> 100

a) except reserves blocked by territorial limits
b) including reserves blocked by territorial limits (partly even potentially economic)
c) (Czech) variety of brown coal with the lowest degree of coalification

Bituminous coal

1. Characteristics and use

Bituminous (hard or black) coal and anthracite are phytogenic caustobiolites exhibiting a higher degree of coalification than brown coal. Boundary between brown and bituminous coal is not internationally exactly defined but generally accepted at calorific value on an ash-free and moist-free basis ($Q_s^{m,af}$) higher than 24 MJ/kg and the value of vitrinite reflectance R_r > 0,6 %. Among anthracites all the coal ranks which has the value of vitrinite reflectance R_r > 2 %. Boundary value between metaanthracite (anthracite with the highest degree of coalification) and semi-graphite is hydrogen content in combustible matter (H^h) 0,8 %.

According to the IEA 2006, the world proved recoverable reserves of bituminous coal reach about 479 bill t. Predominant part of these reserves is located on the territory of the USA (23 %), India (19 %), China (13 %), Russia and South Africa (each 10 %), further Australia (8 %), Kazakhstan (6 %), Ukraine and Poland (roughly 3 % each).

Coking coal by definition is a bituminous coal, which allows producing coke for blast-furnace production of pig iron and/or for heating. Other coal is classified as steam coal and it is used predominantly for electric energy production (40 % of electric energy in the world is generated by coal burning).

2. Mineral resources of the Czech Republic

Both the coking coal and the steam coal deposits occur on the territory of the Czech Republic. Czech part of the Upper Silesian Basin with an area of about 1,550 km^2 (about 30 % of coal reserves is in the Czech Republic and 70 % in Poland), is of a decisive importance. This part called the Ostrava-Karviná Coalfield containing an important portion of coking coal, represents essentially the only area with bituminous coal mining in the Czech Republic at present, mined by OKD, a.s. company.

- The Bludovice fault divides the Czech part of the Upper Silesian Basin into two sections: the northern Ostrava-Karviná and the southern Beskydy Mts. Piedmont sub-basins. A major fault (the so-called Orlová structure) separates the western (Ostrava) and eastern (Karviná) part of the Ostrava-Karviná Coalfield. The former is filled with older sediments heavily affected by tectonics, of paralic character of sediments. The latter, less complex, exhibits both paralic and limnic character of the sediments as well as of coal. The western part consists of several tens of high-grade coking coal seams of relatively low thickness (about 0.7 m on average), whereas the eastern part is characterised by abundant seams of medium thickness (about 1.8 m on average) in mineable depths containing mixed coking coal and high volatile steam coal. 4 mines with 7 deposits (mining leases Darkov, Doubrava, Karviná-Doly I and II, Lazy, Louky, Stonava) in the Karviná part of the basin supply roughly 92 % of the basin production at present (mining of Dolní Suchá deposit was terminated in mid-2006). The calorific value of mined coal Q_i^r is mostly 23–30 MJ/kg and ash content A^d between 10 and 30 %. A long-term intensive mining activity resulted in that the mining in the Ostrava part of the basin reached deeper and deeper levels (even above 1,000 m), which together with complex and unfavourable mining and geological conditions increased the mining costs. Consequently, the Ostrava mines became unprofitable and they were gradually closed and liquidated. The majority of mines in the eastern part have enough reserves with a less complex geological structure, which makes their extraction less expensive. This coal is, however, of a lower grade because of its poor coking properties.

- One deposit of predominantly coking coal in the Ostrava Formation are still extracted by a single mine in the northern part of the Beskydy piedmont part of the basin (mining lease Staříč). The calorific value of mined coal Q_i^r is mostly 28–29 MJ/kg and ash content A^d between 11 and 19 %. Relatively large reserves of coal were verified south of the original Upper Silesian Basin, particularly near Frenštát pod Radhoštěm, where Carboniferous sediments are buried under Miocene sediments and the Beskydy nappes. Here, the coal would be extracted from the depths of 800 to 1,300 m under difficult geological and mining conditions. Besides, a part of the deposit extends into the Protected Landscape Area (CHKO) Beskydy Mts. and this is why its exploitation is not considered in the meantime.
- Kladno-Rakovník Basin in central Bohemia, west of Prague, part of the Central Bohemian Basins, represented the second most important area with bituminous coal reserves until the mining in the three last mining leases (Kačice, Srby, Tuchlovice) was definitely terminated. The major part of the coal reserves (steam coal) were already mined out and the remaining ones lost their economic importance. The calorific value of mined coal Q_i^r was 18–20 MJ/kg in average and ash content A^d between 20 and 35 %. Another deposit with a small share of coking coal of a rather high quality was discovered and explored in the 1950s and 1960s near Slaný. It is the north-eastern extension of the Kladno part of the basin and has about 364 mill tonnes potentially economic reserves of coal. In addition to a high depth of 700 to 1,300 m, the hydrogeological and gas situation is complicated, too. The average calorific value of the coal Q_i^r is mostly 18–22 MJ/kg and ash content A^d between 20 and 40 %. The development of the deposit was terminated in the beginning of the 1990s after two shafts were put down.
- The so-called Mšeno part of the Mšeno-Roudnice Basin, having more than 1.1 bill tonnes of reserves of steam coal, has been explored northeast of Prague. The calorific value Q_i^r is between 16–20 MJ/kg in average and ash content A^d between 24 and 40 %. However, economic aspects and conflicts of interest – the overlying Cretaceous sandstones represent a source of potable water for central Bohemia – obstruct exploitation of this deposit. The neighbouring Roudnice part of the Basin and the eastward neighbouring Mnichovo Hradiště Basin appear to be completely unprospective at present.
- A deposit of low-quality steam bituminous coal of a low prospectivity has been evaluated in the Krkonoše Mts. Piedmont Basin.
- The underground mining of mainly steam coal in the Czech part of the Intra-Sudetic (Lower Silesian) Basin was definitely terminated in the beginning of the 1990s. A surface mining of a very restricted extent has been taking place since 1998 on the Žacléř deposit.
- The bituminous coal mining in the Plzeň (Pilsen) region (Plzeň and Radnice Basins) was definitely terminated in the first half of the 1990s, too. The remaining reserves were eliminated from The Register in 2002. Negligible short-time mining in adjacent Manětín and Žihle Basins and isolated relics in the Carboniferous by Mirošov, Merklín, Tlustice, Malé Přílepy etc. were of a limited local importance.
- Steam coal mining in the Boskovice Graben (Rosice-Oslavany District) west of Brno was definitely terminated early in 1992.
- Minor isolated relics of bituminous coal to anthracite in the Blanice Graben were locally mined, e.g., by Lhotice NE of České Budějovice, W of Vlašim and in Český Brod area in the past.

- Neither the negligible anthracite mining in a small basin by Brandov in the Krušné Hory Mts. was of a higher importance.

3. Registered deposits and other resources in the Czech Republic

(see map)

Coal basins:

(Names of basins with mined deposits are indicated in **bold type**)

1 **Czech part of the Upper-Silesian Basin**
2 Czech part of the Intra-Sudetic Basin
3 Krkonoše Mts. Piedmont Basin
4 Central Bohemian Basins (namely Kladno-Rakovník Basin)
5 Mšeno Part of Mšeno-Roudnice Basin
6 Plzeň Basin and Radnice Basin
7 Boskovice Graben
8 Roudnice Part of Mšeno-Roudnice Basin
9 Mnichovo Hradiště Basin

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

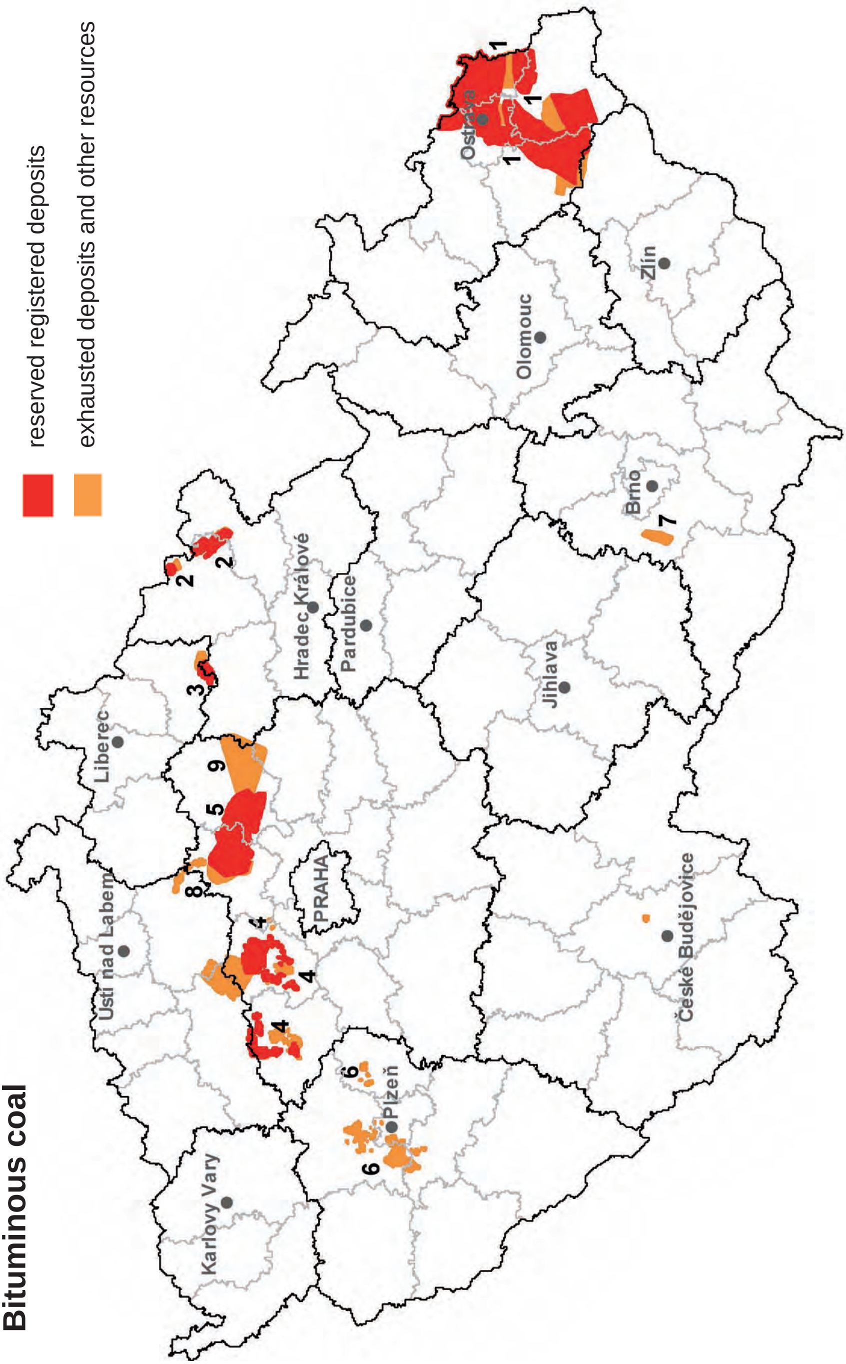
Year	2004	2005	2006	2007	2008
Deposits – total number	62	63	63	63	62
Exploited	11	11	10	9	8
Total *reserves, kt	16 093 442	16 094 030	16 063 718	16 159 327	16 193 970
economic explored reserves	1 670 133	1 672 651	1 587 320	1 566 771	1 523 979
economic prospected reserves	5 891 506	5 880 437	5 869 966	5 876 191	5 928 406
potentially economic reserves	8 531 803	8 540 942	8 606 432	8 716 365	8 741 585
exploitable (recoverable) reserves	271 120	269 198	134 060	182 165	192 182
Mine production, kt	14 648	12 778	13 017	12 462	12 197

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	590 300	590 300	590 300	590 300	590 300
P_2		–	–	–	–	–
P_3		–	–	–	–	–

Bituminous coal



Domestic production of selected intermediate products

Year/ kt	2004	2005	2006	2007	2008
coke	3 548	3 412	3 428	3 258	3 399

Coke production

Mittal Steel Ostrava a.s. – Coke Oven Plant

OKD, OKK a.s.

Třinecké železárny, a.s.

The coking plant of Mittal Steel Ostrava a.s. is the biggest coke producer in the Czech Republic. It has three coke oven batteries, two of which are stamp-charged with coal prisms and the third is a so-called large-capacity coke oven battery with top charging. The coking plant produces a total of up to 1.5 million tonnes of coke, 90 % of which is a high-quality blast-furnace coke with a grain size above 30 mm. Coke-oven gas, which is subsequently used at the metallurgical facility, is purified in the chemical facility of the coking plant. This process produces chemical products such as crude coal tar, crude coking benzol and liquid sulphur, which are successful on the domestic as well as foreign market.

OKD, OKK, a.s. mainly produces coke from practically all types of coal suitable for coking, which is mined by OKD, a.s. The company produces metallurgical coke (foundry coke, blast-furnace coke), heating coke, coke for technological purposes, and by-products that are coke-chemical products (coke-oven gas, tar, benzol, ammonium sulphate, and liquid and solid sulphur), which form during high-temperature coal carbonisation.

Třinecké železárny, a.s. uses two coke oven batteries to produce 700 thousand tonnes of coke annually. Coal for blast-furnace production of coke is transported by rail from the nearby Ostrava-Karviná Coalfield of bituminous coal. The coke oven batteries are equipped with a mechanism for wet coke quenching.

Domestic coke production dropped significantly in the first half of 2009 in relation to the global financial and economic crisis and to the difficulties of the Central European metallurgical sector. The OKD, a.s. therefore decided to close down the Jan Šverma coking plant in Ostrava and to transfer whole production to the Svoboda coking plant.

5. Foreign trade

2701 – Bituminous coal, briquettes and similar solid fuels made from bituminous coal

	2004	2005	2006	2007	2008
Import, kt	1 696	1 264	1 981	2 532	2 223
Export, kt	5 705	5 261	6 515	6 687	6 002

Detailed data on bituminous coal imports (kt)

Country	2004	2005	2006	2007	2007
Poland	1 630	1 225	1 923	2 371	1 885
Russia	53	32	51	90	172
others	13	7	7	70	166

Detailed data on bituminous coal exports (kt)

Country	2004	2005	2006	2007	2008
Austria	2 170	1 974	1 748	1 820	1 970
Slovakia	2 013	1 757	1 822	1 867	1 842
Poland	621	637	1 570	2 008	1 681
Hungary	304	251	516	559	318
Germany	587	525	551	281	187
Bosnia and Herzegovina	1	108	307	150	0
others	9	9	3	2	4

2704 – Coke and semi-coke from bituminous coal, brown coal or peat, agglomerated retort coal

	2004	2005	2006	2007	2008
Import, kt	756	510	768	725	503
Export, kt	958	980	971	798	831

Detailed data on coke imports (kt)

Country	2004	2005	2006	2007	2008
Poland	686	423	704	672	392
Slovakia	38	75	56	45	87
others	32	12	8	57	24

Detailed data on coke exports (kt)

Country	2004	2005	2006	2007	2008
Germany	437	409	372	319	364
Austria	323	344	280	233	243
Finland	31	0	50	73	80
Poland	46	99	73	68	45
Slovakia	42	34	103	28	33
others	79	94	93	77	66

Bituminous coal represents one of the most important Czech mineral export items in terms of volume and finances. The export volume traditionally hovered around 5.5 million tonnes. In 2006, it increased to 6.7 million tonnes, which represents more than a half of domestic mine production. The Czech export volume in 2007 and 2008 was again high, approx. 6 million tonnes. The bituminous coal import is roughly three times lower and comes almost exclusively from Poland. Czech foreign trade in coke is more balanced. While import traditionally ranges around 500–800 kt and comes almost exclusively from Poland, Czech export remained slightly below 1 million tonnes on a long term and it was directed to neighbouring countries, mainly Germany and Austria and also Finland.

6. Prices of domestic market and foreign trade

2701 – Bituminous coal, briquettes and similar solid fuels made of bituminous coal

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	1 872	2 181	1 950	2 040	3 088
Average export prices (CZK/t)	2 038	2 492	2 187	2 307	3 124

2704 – Coke and semi-coke from bituminous coal, brown coal or peat, agglomerated retort coal

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	5 765	4 498	3 557	4 132	5 639
Average export prices (CZK/t)	5 558	6 131	4 700	5 630	8 254

The prices of bituminous coal on the domestic market are contractual and OKD, a.s. considers them to be confidential. Nevertheless, it may be assumed that prices increased considerably in 2004–2008, which roughly reflected the increase in import and export prices. The trend changed and the prices decreased in the end of 2008 and beginning of 2009.

7. Mining companies in the Czech Republic as of December 31, 2008

OKD, a. s., Ostrava

8. World production

World production of bituminous coal exceeded 3 000 million tonnes in 1985. Despite the prognoses of the UN Economic Commission for Europe from 1995, world mine production already exceeded the limit of 4 000 million tonnes in 2003 (not after 2010 as forecasted by the commission). In recent years, the increase in mine production has been accelerating: the limit of 5 000 million tonnes was reached in 2005, which represented an increase of more than 20 % in two years. The year-on-year increase in mine production in 2006/2005 represented an additional 8 %. According to the preliminary data, the limit of 5.5 billion tonnes was surpassed in 2007. Mine production of steam coal greatly exceeds that of coking coal. The long-term decrease in mine production in Europe is being replaced by mine production in Asia and South America. The Asian continent has a share of about 60 % in world mine production of steam coal, and of about 50 % in that of coking coal. In recent years, the increase in mine production in China, India, as well as in Indonesia, Colombia and Kazakhstan has been particularly dynamic. In the past five years, world mine production has been developing as follows:

World bituminous coal mine production

Year	2004	2005	2006	2007	2008 e
Mine production, mill t (IEA/OECD)	4 610	4 925	5 209	5 442	5 845
Mine production, mill t (WBD)	4 620	4 934	5 196	5 520	N

In addition, the *Welt-Bergbau-Daten* (World-Mining-Data) statistical summary provides a classification of mine production according to the main technological types (grades) of bituminous coal:

World bituminous coal mine production by grade

Mine production, mill t	2004	2005	2006	2007	2008 e
Steam coal	4 037	4 292	4 503	4 782	N
Coking coal	583	642	693	738	N

Main producers' share in the world mine output (2007; according to WBD):

Steam coal		**Coking coal**	
China	45.9 %	China	48.3 %
USA	19.5 %	Australia	19.2 %
India	8.9 %	Russia	8.4 %
South Africa	5.1 %	USA	6.4 %
Indonesia	4.2 %	Canada	3.9 %
Australia	3.8 %	India	3.4 %
Russia	3.8 %	Ukraine	3.0 %
Poland	1.5 %	Germany	1.9 %
Kazakhstan	1.5 %	Poland	1.9 %
Colombia	1.5 %	Kazakhstan	1.5 %
Vietnam	0.9 %	Czech Republic	1.0 %
Ukraine	0.8 %	Mexico	0.3 %

According to the World Coal Institute, about 16 % of bituminous coal production (approximately 900 million tonnes) is traded on the international market. The world´s largest exporters in 2007 were Australia (244 million tonnes), Indonesia (202 million tonnes), Russia (100 million tonnes), Columbia (67 million tonnes) and South Africa (67 million tonnes). The largest importers were Japan (182 million tonnes), followed by South Korea

(88 million tonnes), Taiwan (69 million tonnes), India (54 million tonnes), Great Britain (50 million tonnes), China (48 million tonnes) and Germany (46 million tonnes).

9. World market prices

Prices for spot sales and futures contracts are quoted on the world coal market. Both basic grades of bituminous coal (coking and steam coal) are further divided in international trade according to the calorific value and the contents of volatile constituents, sulphur and ash. According to IEA, roughly 840 million tonnes of bituminous coal was transported by sea transport in 2007, of which 610 million tonnes was steam coal and roughly 230 million tonnes coking coal. The volume of bituminous coal transported by sea has been increasing annually by 5.7 % on average since 1984.

Prices of Australian and US coal have traditionally been a determining factor due to its share in world trade. Prices are quoted in USD/t FOB, FAS or CIF. During the last decade, CIF prices of overseas coal on the European market fluctuated in majority of cases between USD 34–110 per tonne of steam coal and between USD 48–140 per tonne of coking coal. Prices fluctuated due to fluctuations in supplies and demands as well as sea transport costs. In the last third of the 20th century, lower prices of overseas coal lead to a phase-out of coal mining in European countries, where mining costs were considerably higher. Since 2004, there has been considerable growth in world bituminous coal prices (of both coking and steam coal).

Average annual prices of bituminous coal in USD per tonne CIF EU (according to the International IEA Statistics):

Commodity/Year		2004	2005	2006	2007	2008
Bituminous coking coal, American, CIF EU	USD/t	84.75	110.91	123.44	126.95	175.35
Bituminous coking coal, Australian, CIF EU	USD/t	73.63	114.89	135.52	127.74	220.54
Bituminous coking coal, South African, CIF EU	USD/t	61.31	71.77	66.18	96.82	141.18
Bituminous coking coal, Polish, CIF EU	USD/t	108.71	138.92	118.82	139.47	245.85
Bituminous steam coal, American, CIF EU	USD/t	61.50	86.75	82.08	97.50	138.40
Bituminous steam coal, Australian, CIF EU	USD/t	69.05	106.40	109.71	103.73	184.75
Bituminous steam coal, South African, CIF EU	USD/t	58.00	67.64	66.24	80.25	142.07
Bituminous steam coal, Chinese, CIF EU	USD/t	60.61	93.41	150.20	73.02	161.12
Bituminous steam coal, Russian, CIF EU	USD/t	65.14	68.46	67.93	79.03	131.62
Bituminous steam coal, Polish, CIF EU	USD/t	68.95	78.34	75.65	94.13	156.01
Bituminous steam coal, Columbian, CIF EU	USD/t	61.54	67.98	66.07	78.16	138.32

Note:
The calorific value of coal and its other qualities differ tremendously between mines, let alone between countries, which is partly reflected by price differences.

A significant increase in prices of all grades of bituminous coal occurred in 2004. The year-on-year increase was 20–75 %. This was clearly caused by a change in the raw material consumption of Third World countries. Until recently, a number of these countries supplied developed countries with large volumes of bituminous coal and their own domestic consumption was negligible. However, in recent years the domestic consumption of these countries has been often growing dramatically and, therefore, ever-increasing raw material volumes are already consumed in the mother country. However, this concerns nominal prices whose rise was also influenced by the long-term weakening of the US dollar. This rise continued and even accelerated in some cases in 2005, when prices of primarily American and Australian coking coal and South African and American steam coal rose. In 2006, the trend in prices differed by country: the prices of American and Australian coking coal and, due to excess demand, especially the prices of Chinese coal (by 60 % year-on-year) continued to grow. Others price quotations more or less stagnated. Growth of those quotations which grew little in 2006 (the South African, Polish and Russian coal) was characteristic for 2007. On the contrary, the prices that escalated in 2006 (Chinese steam coal, Australian coking coal) were corrected. This trend was influenced by different timing of contracts in individual countries.

10. Recycling

Coal cannot be recycled once its energy is consumed.

11. Possible substitutes

Coking coal can be substituted by steam coal or natural gas due to the introduction of new technologies in the production of pig iron (e.g. COREX®). Other energy minerals can replace coal in energy generation.

Brown coal

1. Characteristics and use

Brown coal (sub-bituminous coal, lignite) is a phytogenic caustobiolite showing lower degree of coalification than bituminous coal. Boundary between brown and bituminous coal is not internationally exactly defined but generally accepted at calorific value on an ash-free and moist-free basis ($Q_s^{m,af}$) lower than 24 MJ/kg and the value of vitrinite reflectance R_r < 0,6 %. The brown coal showing the highest degree of coalification (brown coal metatype in Czech terminology) is designated as subbituminous coal in foreign literature. Limit between sub-bituminous coal and lignite has not been internationally determined. Usually a raw material with carbon content in combustible matter below 65 % and calorific value below 17 MJ/kg is considered as lignite. The coal terminology is not uniform in the international practice. The English term lignite sometimes designates both coal of Czech (Central European) brown coal grade and Czech lignite grade whereas the latter is registered separately in the Czech Republic.

World proved recoverable reserves of sub-bituminous coal and lignite are estimated between 420 and 430 bill t, resp. (EIA 2006). About 250 bill t of this amount represent sub-bituminous coal and about 170 bill t lignite. Major part of these reserves is located on the territory of the USA (31 %), Russia (25 %), further China (12 %) and Australia (9 %). Rather large reserves are also on the territory of Ukraine (4 %), Brazil and Germany (roughly 2 % each).

Brown coal is used mainly in the production of energy and to a smaller extent in chemical industry.

2. Mineral resources of the Czech Republic

The majority of brown coal in the Czech Republic has been used for energy generation. The major Bohemian brown coal basins originated and are located in the graben along the Krušné hory Mts, which follows the Hercynian direction and the NW boundary of the Czech Republic. The total area of the coal-bearing sediments is 1,900 km^2 large. The underlying sediments are of the Eocene age. The brown coal seams and overlying sediments, of 400 m thickness or even more, are of the Early Miocene age. The sedimentation in the Cheb Basin was terminated as late as in the Pliocene. The following independent basins are recognized in the whole area of the Krušné hory Mts. Basin (from NE to SW): North Bohemian, Sokolov and Cheb Basins. The largest North Bohemian Basin is then divided into three parts. The share of the North Bohemian Basin on the total mine production of the brown coal in the Czech Republic is about 79 %, the remaining 21 % comes from the Sokolov Basin. The coal is exploited with one exception only by open-pit mining operations.

- In the Chomutov part of the North Bohemian Basin, the coal seam is divided into 3 benches. These become connected or are close to each other towards the north-western part of the basin, which allows their common open-pit mining. The raw material represents less calorific steam coal with a low degree of coalification. Its major use is burning in power plants. The problem with the elevated sulphur content in this coal (S^d of about 2.6 %) was solved by desulphurization of power plants exhaust gases. The ash content in general increases from NW to SE, where it can reach up to 50% (being about 35 % on average). The average thickness of the mined seam is about 23 meters and the calorific value of the coal

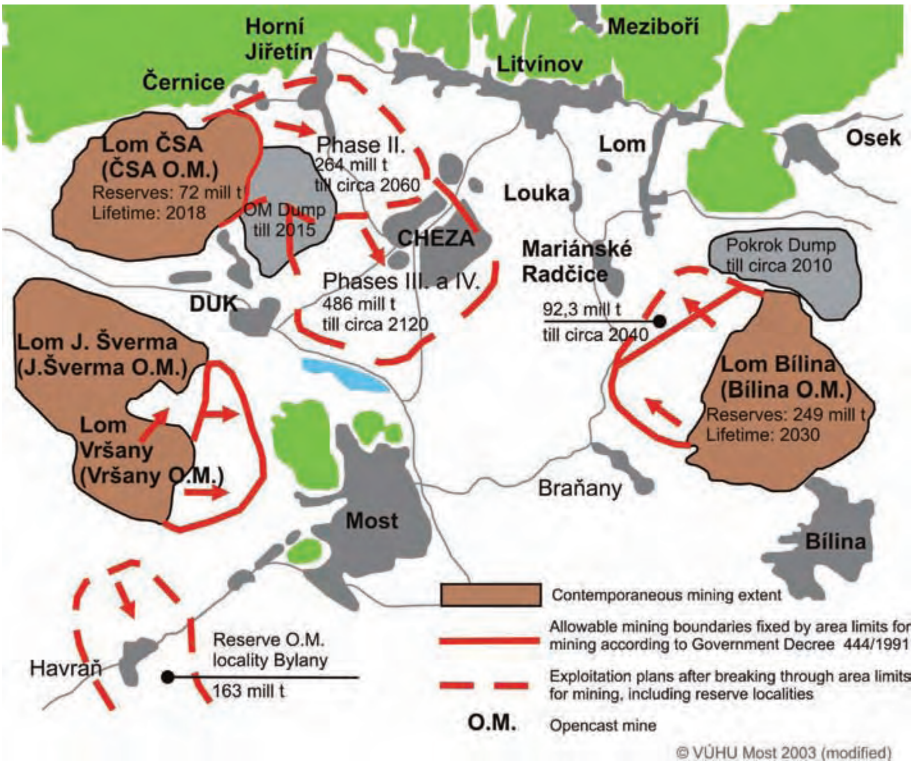
Q_i^r is 10–11 MJ/kg. The coal in this part of the basin is extracted by one large open-pit mine Tušimice-Libouš (mining lease Tušimice).

- Brown coal in the Most part of the North Bohemian Basin shows higher degree of coalification and a lower content of ash (10–34 %). The coal is used in energy generation; sorted types for small customers are produced, too. Locally, however, it is very rich in sulphur (S^d between 1 and 1.5 % generally) and arsenic. The average thickness of the mined seam is between 20–30 meters, the calorific value of the coal Q_i^r is 10–17 MJ/kg. The depth of open-pit mines continues to increase, being currently at about 150 m in some parts. The extraction takes place in four large open-pit mines: Bílina-Velkolom Maxim Gorkij, Ervěnice-Velkolom ČSA, Holešice a Vršany (mining leases Bílina, Ervěnice, Holešice, Vršany) and one underground mine Důl Dolní Jiřetín-Centum (mining lease Dolní Jiřetín u Mostu) at present.
- Mine production of the Teplice part of the North Bohemian Basin was terminated in 1997 by closure of the Chabařovice open-pit mine. The remaining reserves of high-quality almost sulphur- and ash-free brown coal located under the Chabařovice municipality cannot be mined out because of the conflicts of interests and complex hydrogeological conditions. Similar conflicts will probably block extraction of the other reserves of the high-quality coal also in other parts of the basin. Minor isolated occurrences of small sub-bituminous coal seams in the České středohoří area were from a large part mined out in the past.
- The Sokolov Basin west of Karlovy Vary has two main groups of strata – Antonín and Josef. The major reserves are confined to the thickest and the uppermost seam called Antonín, which is separated into 2 to 3 thin benches in its western part. The steam coal is of a lower to medium coalification, relatively poor in sulphur (S^d of about 1 %) and rich in water compared to the coal of the North Bohemian Basin. Only the east of the central part of the basin has been mined since 2001. The seam is extracted by two large open-pit mines Alberov-Velkolom Jiří (mining lease Alberov) and Nové Sedlo-Družba (mining lease Nové Sedlo) and one smaller open-pit mine Královské Poříčí-Marie (mining lease Královské Poříčí). The calorific value Q_i^r is 12–13 MJ/kg and ash content A^d between 20 and 23 %. The coal is used mainly in energy generation (sorted brown coal, burning in power plants, gas and briquette production) but also in some carbochemical products. Coal of the lower Josef seam with higher degree of coalification but at the same time higher ash, Ge, sulphur and other impurities (As, Be) contents, is not used anymore. It was mined at isolated relics south from Karlovy Vary in a smaller extent in the past.
- The Cheb Basin has more than 1.7 billion tonnes of geological reserves of brown coal of a low coalification (the calorific value Q_i^r is about 10 MJ/kg). The coal is characterised by a high content of water, ash (20–40 %), sulphur (2-4 %) and other impurities. It might be suitable for chemical processing due to its locally high content of liptodetrite (an organic coal component) and therefore also mineral tar. It was shortly mined in a small extent mainly in the Pochlovice part of the basin on the east in the past. Renewal of the mining operations in this basin is though excluded for the time being as major part of the reserves is blocked by protection of the mineral water sources of the Františkovy Lázně Spa.
- The Zittau (Žitava) Basin extends into the Czech Republic by a minor part from Poland and Germany. The upper seam was already mined out by surface mining. Remaining two lower seams are difficult to be mined underground because of both technical and economical problems associated with overlying quicksand.
- Minor occurrences of low-quality brown coal in the Bohemian Cretaceous Basin were in a negligible amount occassionally mined as a byproduct at the refractory clay extraction, e.g., near Moravská Třebová, Svitavy in the past.

Ecological territorial limits

Rather large brown coal reserves in northern Bohemia (in North-Bohemian Basin) are blocked based on the announcement of the so-called ecological territorial limits of brown coal mining in northern Bohemia. These were established by the Czech Republic Government Resolution No. 444 from 1991, which was accepted upon suggestion of the former Minister of the Environment Ivan Dejmal. The resolution of the government defines mining leases and areas which should remain unexploited. Environmental and landscape protection in the area of northern Bohemia was the main reason for their establishment. Lifetime of reserves beyond the ecological territorial limits represents about 18-year mining and concerns namely the ČSA, Bílina and Vršany open-pit mines. Reserves of about 0.9 billion tonnes are bound by these so-called ecological territorial limits. There is an increasing pressure on revaluation or correction of the original decision from 1991 in relation to decreasing brown coal reserves in the mined localities. It remains a fact that brown coal is, along with nuclear power stations, a single relevant raw material for the Czech energy production. Brown coal represents also an essential raw material for the Czech heating industry. In terms of energy security, domestic raw material resources are also gaining in importance.

Distribution of ecological territorial limits in the North Bohemian Basin



3. Registered deposits and other resources in the Czech Republic

(see map)

Coal basins:

(Names of basins with mined deposits are indicated in **bold type**)

1 Cheb Basin

2 **Sokolov Basin**

3 **North-Bohemian Basin**

4 Czech part of the Zittau (Žitava) Basin

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	57	55	54	54	54
exploited	9	9	9	9	9
Total *reserves, kt	9 873 178	9 423 625	9 192 305	9 140 769	9 090 892
economic explored reserves	3 088 277	2 616 759	2 562 306	2 516 982	2 608 212
economic prospected reserves	2 334 200	2 305 437	2 305 437	2 305 437	2 168 466
potentially economic reserves	4 450 701	4 501 429	4 324 562	4 318 350	4 314 214
exploitable (recoverable) reserves	1 091 284	1 045 968	978 839	931 488	886 223
Mine production, kt	47 840	48 658	48 915	49 134	47 456

Notes:

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

- After MPO ČR report "A. Bufka: Uhlí, koks a brikety v České republice v roce 2006" (A. Bufka: Coal, coke and briquettes in the Czech Republic in 2006) mine production after treatment of coal was 48,600 kt inclusive 3,692 kt sorted and 44,908 kt industrial brown coal in 2006.

Domestic production of selected intermediate products

Year / kt	2004	2005	2006	2007	2008
Briquettes	301	301	345	247	156

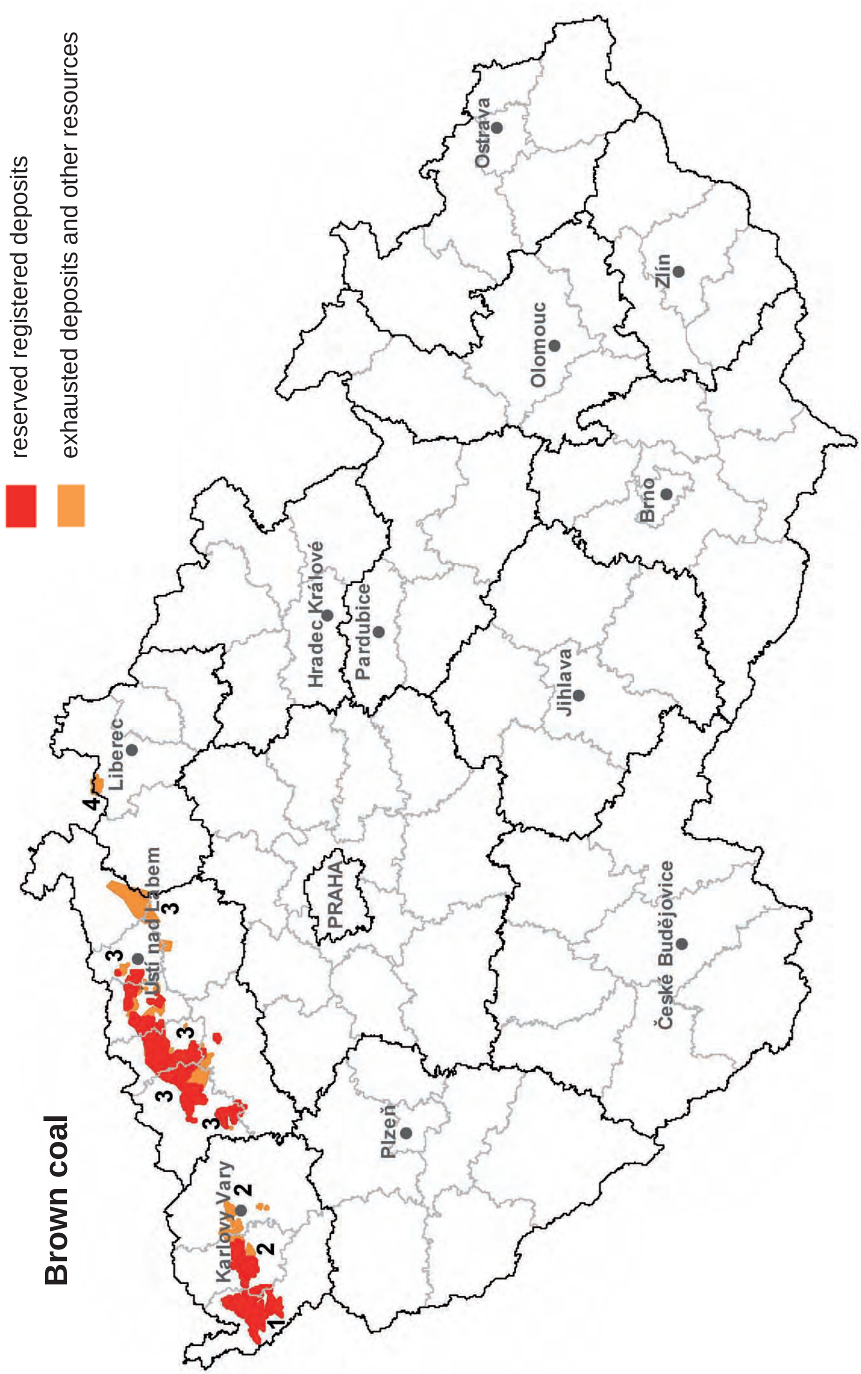
5. Foreign trade

2702 – Brown coal, also agglomerated, except jet

	2004	2005	2006	2007	2008
Import, kt	4	2	25	34	50
Export, kt	1 233	1 475	1 563	1 164	1 635

Note: jet is a compact black variety of brown coal used in (mourning) jewelry

Brown coal


reserved registered deposits
exhausted deposits and other resources
Liberec
Ústí nad Labem
Karlovy Vary
Plzeň
PRAHA
Hradec Králové
Pardubice
Jihlava
České Budějovice
Brno
Olomouc
Zlín
Ostrava
1
2
2
3
3
3
3
3
3
4

Detailed data on brown coal exports (kt)

Country	2004	2005	2006	2007	2008
Slovakia	743	862	938	777	895
Germany	158	174	223	130	110
Hungary	272	347	366	157	425
others	60	92	36	99	205

Brown coal belongs to raw materials, whose domestic production fully covers domestic consumption. The raw material, therefore, is not an import item and also its export volume is relatively small compared to the volume of mine production. In recent years, exports have been fluctuating between 1 and 2 million tonnes per year and directed mainly at neighbouring Slovakia. In the past five years, export to Germany declined considerably – in 1999–2001, it still amounted to approximately 2 million tonnes.

6. Prices of domestic market and foreign trade

2702 – Brown coal, also agglomerated, except jet

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	N	N	N	N	N
Average export prices (CZK/t)	983	952	1 111	1 155	1 228

Brown coal prices depend on the calorific value and granularity. Severočeské doly a.s. offers graded coal from the Důl Bílina mine, with an average calorific value of 17.6 MJ/kg, categorised as nut coal II at CZK 1 700–2 050 per tonne, as cube coal I at CZK 1 620–1 940 per tonne, and as cube coal II at CZK 1 320–1 590 per tonne. Prices of coarse brown coal dust fluctuated between CZK 700 and 1 020 per tonne, and prices of brown coal industrial mixtures (with a calorific value of 11.4–15.6 MJ/kg) between CZK 620 and 850 per tonne. The industrial mixture from the Doly Nástup Tušimice mine (calorific value of 10.5–11.5 MJ/kg) was offered at CZK 478 per tonne. Mostecká uhelná společnost a.s. offered graded coal categorised as nut coal at about CZK 1 870 per tonne, as cube coal I at about CZK 1 780 per tonne, and as cube coal II at about CZK 1 180 per tonne until 2007. After the structure of the Mostecká uhelná a.s. was changed, the Czech Coal a.s. does not make public prices of produced coal; all contracts are formed based on negotiated prices. Sokolovská uhelná offers nut coal at CZK 950–1 120 per tonne and cube coal at CZK 880–1 020 per tonne. Dried brown coal dust was sold at prices fluctuating between CZK 1 270 and 1 625 per tonne. Prices of brown coal briquettes fluctuate from CZK 1 540/t (fragments) to CZK 4 200/t (packaged prisms). The price list has not been published in recent years.

Domestic brown coal prices

Product specification	2006	2007	2008*
graded; cube coal II; 17.6 MJ/kg; Severočeské doly	1 460–1 600	1 707–2 045	1 707–2 045
graded; nut coal I; 17.6 MJ/kg; Severočeské doly	1 380–1 660	1 619–1 942	1 619–1 942
graded; nut coal II; 17,6 MJ/kg; Severočeské doly	1 120–1 340	1 325–1 586	1 325–1 697
coarse coal dust I, II; Severočeské doly	660–960	708 –1 023	N
industrial mixture; 10,5-11,5 MJ/kg; Severočeské doly	600–815	627–855	N
graded; cube coal; Mostecká uhelná	1 450–1 750	1 869	N
graded; cube coal I; Mostecká uhelná	1 380–1 660	1 780	N
graded; cube coal II; Mostecká uhelná	850–1 030	1 181	N
graded; cobble; Sokolovská uhelná	860–1 010	N	950–1 120
graded; cube coal; Sokolovská uhelná	800–920	N	880–1 020
dried brown coal dust; Sokolovská uhelná	1 150–1 480	N	1 270–1 625

* Prices given without taxes on solid fuels.

Average export prices increased in 2003, when they exceeded 900 CZK/t. They increased to more than 1 100 CZK/t in 2006 and oscillated between 1,150 and 1,250 CZK/t in 2007–2008. Import prices are not representative due to their negligible volume of trade.

7. Mining companies in the Czech Republic as of December 31, 2008

Severočeské doly a.s., Chomutov

Sokolovská uhelná, legal successor, a.s., Sokolov

Vršanská uhelná a.s., Most

Litvínovská uhelná a.s., Most

Důl Kohinoor a.s., Dolní Jiřetín

8. World production

World production of brown coal (including lignite) exceeded 1 000 million tonnes in 1980. It probably reached its peak in 1989 with 1 273 million tonnes, followed by a gradual decline. In the second half of the 1990s, world production stagnated at around 850 million tonnes per year. Mine production in Germany (the most important world producer) has been stable at around 180 million tonnes in recent years, and mine production in Greece ranges between 60–70 mill tonnes annually. Poland, which is another important European brown coal producer, produces about 60 million tonnes per year. Mine production in Russia increased significantly in 2006 (90 million tonnes). Mine production of Turkey has been increasing in recent years, too (44 mill t in 2003–2004; 56 mill t in 2005; 62 mill t in 2006; 70 mill t in 2007).

Years	2004	2005	2006	2007	2008
Mine production, mill t (WBD)	926	925	893	890	N
Mine production, mill t (IEA/OECD)	924	929	937	945	N

Major producers (2007; according to WBD):

Germany	20.3 %	Greece	7.0 %
Russia	8.1 %	Poland	6.5 %
USA	8.0 %	Czech Republic	5.6 %
Turkey	7.9 %	Canada	4.1 %
Australia	7.3 %	Serbia	4.0 %

9. World market prices

Brown coal is not an important world trade item, and its sales are usually conducted only between neighbouring countries based on individual contracts and negotiated prices regarding quality and transport costs. Data on international trade prices are not available.

10. Recycling

Brown coal cannot be recycled once its energy is consumed.

11. Possible substitutes

Possible substitutes differ according to the type of brown coal and its use. In terms of energy generation, it can be substituted by other primary energy sources, particularly nuclear fuel. This substitution, however, represents a big investment and poses environmental as well as other problems in some countries. Use of brown coal in energy production is hampered by the fact that it represents a source of emissions, similarly to bituminous coal, natural gas, fuel oils and biomass. Brown coal (lignite) has the highest CO_2 output per unit energy generated of all fossil fuels doe to its low degree of coalification.

Crude oil

1. Characteristics and use

Oil (crude oil, petroleum) is a natural mixture of gaseous, liquid and solid chemical compounds, predominantly hydrocarbons. Its specific gravity fluctuates between 0.75 and 1 t/m^3, the average content of carbon is between 80 and 87.5 %, hydrogen between 10–15 % and its calorific value ranges between 38 and 42 MJ/kg. Hydrocarbons are derived from an organic matter originating from subaqueous biochemical decomposition of biomass under specific conditions. The crude oil originates at temperatures between 60 and 140°C in pelitic oil-bearing sediments at depths between 1,300 and 5,000 m. From these sediments it subsequently migrates and accumulates in permeable, porous reservoirs or fractured collector rocks. The extracted oil is called crude oil and it has highly variable properties such as colour, viscosity, molecular mass and specific gravity.

Crude oil is classified as light, medium or heavy according to its measured API degrees of gravity. At 60° F (15.6° C) light has a gravity higher than 31.1° API, medium has gravity between 22.3–31.1° API, heavy has gravity below 22.3° API.

Principally 4 types of crude oil can be distinguished, based upon its chemical composition – paraffin-base petroleum, asphalt-base petroleum, naphtene petroleum, and mixed bases (aromatic) petroleum.

Sweet and sour crude oil is also distinguished after its sulphur content (sweet below 0.5 wt. % S, sour above this limit).

Total world proved reserves are estimated at 165,000 mill tonnes (more than 1.2 trillion barrels), about 75 % of which are located in the OPEC member countries. The highest amount of the proved reserves is found on the territory of Saudi Arabia (22 %), Iran (11 %), Iraq (almost 10 %), Kuwait and United Arab Emirates (8 % each), Russia and Venezuela (almost 7 % each).

Tar sands, also called to as oil or bituminous sands, resources of which are estimated at 3.5 trillion barrels (472.5 billion tonnes) represent a prospective petroleum source. The largest world deposits and resources are in Venezuela and Canada (Alberta). They are mined in a large amount only by open-pits in Canada as their extraction is economically and technically demanding. The content of bitumen (8–14° API) in sands ranges usually between 10 and 12 %. Tar sands are mined to extract the oil-like bitumen which is upgraded into synthetic crude oil or refined directly into petroleum products by specialized refineries.

Crude oil is processed mainly by distillation (refining) so that its individual fractions are separated: gasoline, petrol, kerosene, oil, and lubricating oil, asphalt. Higher carbohydrates (long carbohydrate chains) are processed (shortened) by cracking. Oil is widely used in industry and new applications are still under way. Nevertheless, use as energy in automotive systems, energy generation in general, petrochemical (feeding the transport sector) and chemical industries are the principal oil consumers.

2. Oil resources of the Czech Republic

In contrast to coal, the Czech Republic does not possess sufficient resources of oil or gas. Industrial important accumulations of crude oil are concentrated mainly in southern

Moravia and they are associated with geological units of the Western Carpathians and the south-eastern slopes of the Bohemian Massif. Even though the domestic mine production of crude oil had increased till 2003 and has stabilized in recent years, it covers only roughly 4 % of domestic consumption.

- The deposits of the Vienna Basin (Moravian part) are distributed over a great number of individual oil-bearing structures and producing horizons situated at the depth going down mainly from 450 to 2,000 m. Sandstones of the Middle and the Upper Badenian represent the most productive oil-bearing rocks. The Hrušky deposit, major part of which has been already extracted, represents the largest deposit of this area. Prospecting in this area however still continues. A new oil deposit with a gas cap has been discovered and exploited (approximately 6 % of the total) in the area of Poštorná.
- Another region with oil deposits lies in the Moravian part of the Carpathian Foredeep and on the south-eastern slope of the Bohemian Massif. The most important accumulations occur particularly in the collectors in the Miocene, Jurassic and jointed and weathered portions of the crystalline rocks. The Dambořice deposit represents the largest and most important deposit at present. Other important deposits – Žarošice, Uhřice-jih and Uhřice-JV – have been discovered by a systematic exploration based on the 3D interpretation of the seismics. Oil is accumulated in the Jurassic sediments – the so-called Vranovice carbonates in the Žarošice deposit and sandstones of Gresten Formation In the Uhřice-jih deposit. These deposits are intensively exploited at present – they take a share of roughly 80 % in the total crude oil mine production in the Czech Republic. Technology of horizontal drilling has been used at the exploitation in order to reach the highest possible yield. Gas is moreover injected into the apical parts of the deposits to maintain the deposit pressure in case of the Uhřice-jih and Dambořice deposits. This method does not have to be applied in Žarošice deposit yet as the gas cap along with the active bedding water represent here an important source of pressure.

Oil and gas deposits are mutually genetically related. Oil deposits of the Vienna Basin are concentrated in the Badenian and Lower Miocene sediments, whereas in the Sarmatian gas deposits prevail. The light, sulphur-free paraffin to paraffin-naphtene oil prevails in the Czech Republic. Three grades of oil – light, medium even heavy – with specific gravity from 812 to 930 kg/m^3 at 20°C, which corresponds to 20–43° API, with sulphur content of 0.08–0.32 wt %, were extracted in 2008.

3. Registered deposits and other resources in the Czech Republic

(see map)

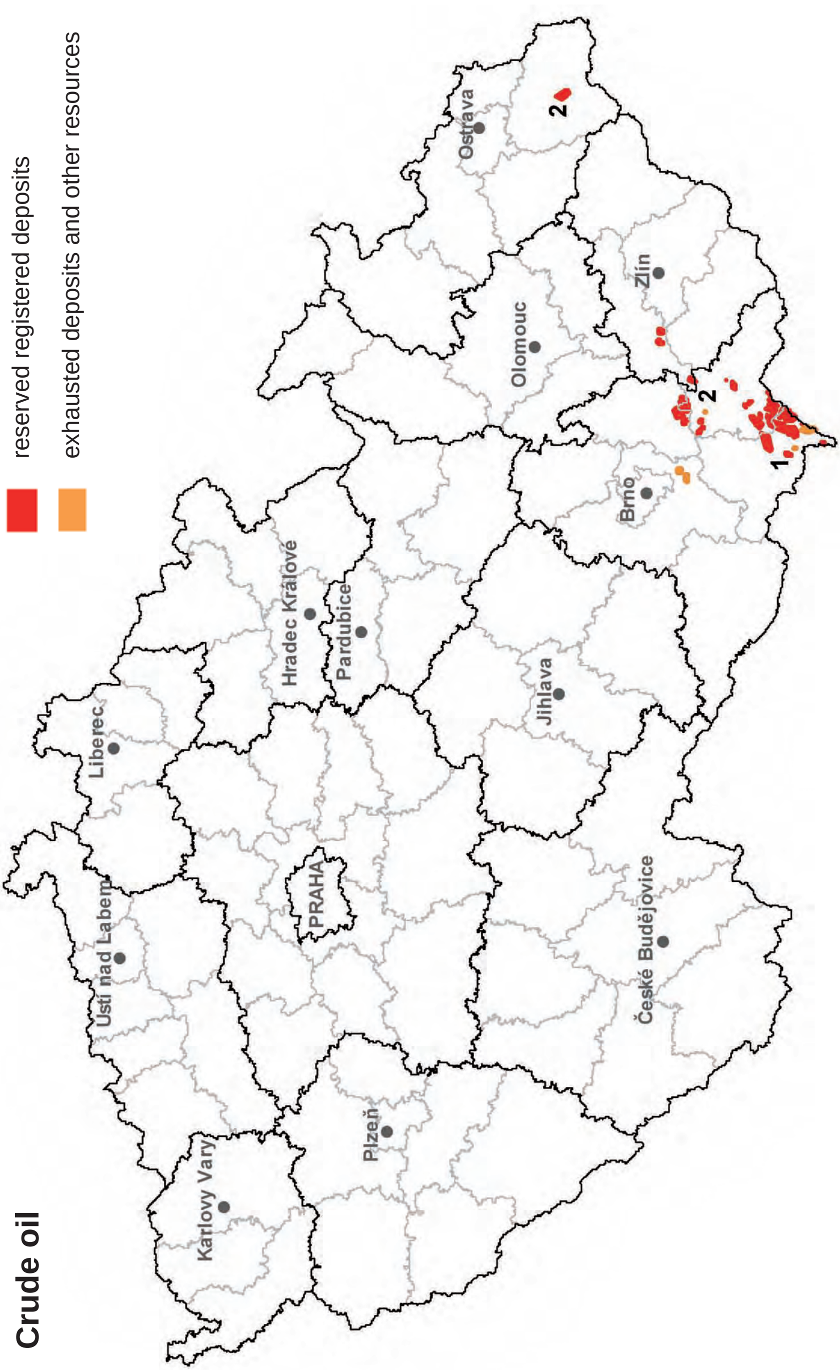
Principal areas of deposits presence:

(names of areas with exploited deposits are indicated in **bold** type)

1 **Vienna Basin**

2 **West-Carpathian Foredeep**

Crude oil


reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Liberec
Jihlava
Ústí nad Labem
PRAHA
České Budějovice
Plzeň
Karlovy Vary
1
2
2

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	28	28	28	28	30
exploited	19	19	21	22	24
Total *reserves, kt	32 790	32 536	32 277	31 118	31 144
economic explored reserves	12 824	12 526	12 315	14 602	15 553
economic prospected reserves	8 567	8 613	8 609	5 163	5 113
potentially economic reserves	11 399	11 397	11 353	11 353	10 478
exploitable (recoverable) reserves	3 065	2 325	2 135	1 793	1 718
Mine production, kt	299	306	259	240	236

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Crude oil refineries:

Česká Rafinérská, a.s. – Kralupy nad Vltavou and Litvínov refineries

PARAMO, a.s. – Pardubice and Kolín refineries

Česká Rafinérská, a.s. is the largest crude oil processing company and producer of oil products in the Czech Republic, and operates refineries in Litvínov and Kralupy nad Vltavou. Both refineries produce fuel. The refinery in Litvínov processes the Russian Export Blend (REB) crude oil (crude oils with medium sulphur content imported from the Russian Federation primarily via the Družba pipeline). The refinery in Kralupy processes the so-called sweet crude oil, i.e. crude oil with a low sulphur content imported to the Czech Republic via the IKL (Ingolstadt – Kralupy – Litvínov) pipeline, and crude oil produced domestically by Moravské naftové doly a.s. Česká Rafinérská, a.s. is owned by three shareholders: the refinery-petrochemical holding Unipetrol (51.23 %), and the foreign companies ENI (32.44 %) and Shell (16.33 %). Since August 2003, Česká Rafinérská, a.s. has been working in a so-called processing mode, which means that it is no longer involved in trading but that it only processes crude oil into a variety of oil products and intermediate products that are determined in advance by the commercial representatives of the shareholders, which purchase the necessary crude oil themselves.

PARAMO, a.s. is an important Czech producer of oil products such as fuels (diesel fuel, light heating oil, heating oil), mineral lubricating fuels, plastic lubricants and asphalts. PARAMO, a.s. operates a refinery in Pardubice for converting Russian crude oil primarily into fuels, lubricating oils and asphalts, and a smaller plant in Kolín, which is an oil refinery equipped with a modern unit for redistillation of oil hydrogenates (raw materials from the Litvínov refinery) producing lubricating oil. The Unipetrol company is the main shareholder (88.03 %) of PARAMO, a.s.

5. Foreign trade

2709 – Petroleum oils and oils obtained from bituminous minerals, crude

	2004	2005	2006	2007	2008
Import, kt	6 406	7 730	7 752	7 147	8 142
Export, kt	64	58	42	17	20

Detailed data on crude oil imports (t)

Country	2004	2005	2006	2007	2008
Russia	4 440	5 458	5 187	4 611	5 404
Azerbaijan	983	1 455	1 951	1 963	1 893
Kazakhstan	218	249	413	232	533
Norway	0	0	0	0	210
Libya	236	270	175	51	40
Algeria	188	178	20	279	20
Syria	316	49	6	0	15
others	25	71	0	11	27

271011 – Petrol (Gasoline)

Commodity	2004	2005	2006	2007	2008
Import, kt	1 235	1 055	732	N	768
Export, kt	200	172	311	221	253

Detailed data on petrol imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	554	457	377	N	398
Austria	145	113	85	N	214
Germany	275	294	190	N	120
Poland	240	175	65	N	18
others	21	16	15	N	18

With regard to the fact that domestic production only covers a negligible amount of domestic crude oil consumption (about 3–5 %), most of the raw material has to be imported. In recent years, the total import volume has been increasing systematically – in 2002–2006, it increased by 27.5 %, i.e. 5.5 % annually. The import volume in 2007 was slightly lower, which was, however, not due to a decrease in consumption, but due to an unplanned partial outage of the Litvínov-Záluží refinery. The historically largest volume (8.1 million tonnes) of crude oil was then imported into the Czech Republic in 2008. Traditionally, the largest amount of imported crude oil comes from Russia – roughly two thirds of the total import. The second most important country from which crude oil is imported is Azerbaijan, whose share increased from about 15 % in 2002 to about 25 % in 2006, and to about 27 % in 2007. Kazakhstan, Algeria and Libya also rank among the more significant constant suppliers of crude oil to the Czech Republic. Imports from other countries vary.

In addition to crude oil, the Czech Republic also imports oil derivates, especially petrol. The volume of imported petrol ranges between 0.7–1.2 million tonnes, most of which is imported from Slovakia and Germany. Data on the volume of imported petrol for 2007 are not reliable. The only data available shows that the Czech Republic imported CZK 11.7 billion (EUR 423 million) worth of petrol and exported CZK 3.1 billion (EUR 112 million) worth of petrol in 2007. Foreign trade with petrol in 2008 was as follows: import for CZK 9.8 billion (EUR 399 million) and export for CZK 3.5 billion (EUR 140 million).

6. Prices of domestic market and foreign trade

2709 – Petroleum oils and oils obtained from bituminous minerals, crude

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	6 536	8 834	10 646	10 079	12 641
Average export prices (CZK/t)	6 776	8 952	10 103	9 975	11 695

271011 – Petrol (Gasoline)

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	10 705	13 015	14 636	N	12 711
Average export prices (CZK/t)	9 915	12 938	14 519	14 104	13 751

In past years, average import prices of crude oil in the Czech Republic increased sharply in relation to a sharp increase in world crude oil prices. In comparison with 1999, when crude oil was imported at an average price of CZK 3 680 per tonne, import prices doubled in 2000 (CZK 7 486 per tonne). This was caused by a sharp increase in crude oil prices on world markets and also by a considerable weakening of the CZK against the USD. In 2001, the import price of crude oil was also still relatively high (CZK 6 808 per tonne) due to the situation on world markets, irrespective of a repeated strengthening of the CZK against the USD. This unfavourable trend did not improve until 2002, when the average import price of CZK 5 501 per tonne was reached (due to lower crude oil prices on the world market and the long-term strengthening of the CZK against the USD). In 2003, the average import price increased again to CZK 5 732 per tonne due to the development on the world market, and this trend also continued in 2004, when the average import price reached CZK 6 536/t (34.7 USD/bbl). The steep rise in crude oil prices also continued in 2005, when the import price already reached 8 834 CZK/t (51.3 USD/bbl). In 2006, even the limit of CZK 10 thousand per tonne was surpassed, when import prices still continued to rise and the average price of crude oil imports to the Czech Republic hovered around USD 66/bbl. In 2007, the annual average reached CZK 10 000 (68.5 USD/bbl) due to a temporary price decrease in crude oil imports in the first quarter of the year. However, import prices again continued to rise the rest of the year. The strengthening of the CZK against the USD protected the domestic economy from even more serious impacts. Import prices culminated in 2008 thanks to the record crude oil prices – they increased from approx. 12,000 CZK/t in January 2008 to almost 15,000 CZK/t in September 2008. The last quarter of the year has seen a marked drop of import prices below the limit of 10,000 CZK/t.

7. Mining companies in the Czech Republic as of December 31, 2008

Moravské naftové doly a.s., Hodonín
MND Production a.s., Hodonín
Česká naftařská spol. s.r.o., Hodonín
UNIGEO a.s., Ostrava-Hrabová

8. World production

World crude oil production fluctuated between 3.5 and 3.9 billion tonnes in recent years. In the 1990s, Russia's production decreased significantly. The production volume was greatly influenced by the OPEC cartel, whose members agreed on a production reduction of 1.7 million barrels per day in spring 1999 to confront the record low prices at that time (1 barrel = 158.987 litres, 1 tonne of crude oil corresponds to approximately 7 barrels). The decrease in crude oil production by OPEC and four non-OPEC countries amounted to 2.1 million barrels per day. The cartel significantly influenced the world crude oil market also in the following years, when a raw material supply shortage on the market resulted in a steep rise in prices. In 2007, OPEC´s influence did not diminish by any means, as its member countries had a 43.0 % share of world crude oil production. On the contrary, Angola joined OPEC and Ecuador renewed its membership in 2007. Sudan is considering joining OPEC and similar considerations are also appearing in the case of Brazil, near whose shore potentially large raw material deposits have recently been found. By contrast, Indonesia left the cartel to December 31st, 2008 because it transformed from a pure exporter to a pure importer due to a high increase in domestic consumption.

In recent years, the crude oil production of Saudi Arabia, Russia, Algeria, Brazil, Angola and Canada has been increasing, while that of the USA, Mexico, Great Britain, Norway and Indonesia has been decreasing. A high disproportion between producing and consuming regions is typical for crude oil: for instance, the USA has a 7.8 % share of world production whereas its share of world consumption is 22.5 %. The EU 25 countries have only a 2.7 % share of production compared to a 17.9 % share of consumption. China had a 4.8 % share of production whereas a 9.6 % share of consumption in 2008. Japan is one of a few countries that have been decreasing crude oil consumption over the long term. The data of individual international statistical summaries differ from each other. For instance, according to the International Energy Outlook 2004, world production reached about 83 million barrels per day already in 2002. By contrast, data given by the OPEC cartel in the Annual Statistical Bulletin 2008 are substantially lower. In 2007, the ten most important producing countries had nearly a 62 % share of world production. Angola and Azerbaijan recorded a considerable year-on-year production increase in 2007/2006, in 2007/2008 it was e.g. Iraq, Quatar, Columbia or Congo (Zair).

World crude oil production

Year	2004	2005	2006	2007	2008 e
Production, ths bbl/day (BP)	80 256	81 089	81 497	81 443	81 820
Production ths bbl/day (OPEC)	70 512	71 641	71 729	71 387	72 028
Production, mill t (WBD)	3 750	3 837	3 866	3 856	N

Major producers (2007; according to WBD):

Saudi Arabia	12.8 %	Mexico	4.6 %
Russia	12.7 %	Venezuela	4.0 %
USA	8.2 %	Kuwait	3.5 %
Iran	5.5 %	Norway	3.4 %
China	4.9 %	United Arab Emirates	3.3 %

9. World market prices

The major world commodity exchanges (IPE, NYMEX etc.) quote spot prices and prices of futures contracts in USD per barrel, FOB. Daily quotes primarily include prices of the North Sea Brent Crude, the American West Texas Intermediate (WTI) and the OPEC Basket (12 types of crude oil – Saharan Blend from Algeria, Girassol from Angola, Oriente from Ecuador, Iran Heavy from Iran, Basra Light from Iraq, Kuwait Export from Kuwait, Es Sider from Libya, Bonny Light from Nigeria, Qatar Marine from Quatar, Arab Light from Saudi Arabia, Murban from the United Arab Emirates and Merey from Venezuela). Different crude oil prices reflect its grade to a certain extent, which is expressed in degrees API (Brent 38°, WTI 34.5°, Arab Light 34°, Dubai Fateh 32°, Russian Export Blend 32°).

Crude oil is a commodity that is extremely sensitive to global political and economic development in the world. Until recently, the highest prices were reached in 1990 at over USD 40/barrel as a result of the Gulf War. In 1991–1995, the crude oil price decreased sharply to USD 15–20/barrel. During 1996, the price rose again to USD 24/barrel. However since the end of 1996, prices had been decreasing continuously primarily due to an uncontrollable growth in production. The crude oil price hit a twelve-year minimum (USD 10/bbl) in December 1998. The OPEC members reacted by signing an agreement to sharply cut production in spring 1999, which was joined by some important non-OPEC producers (Mexico, Oman, Russia, Norway). The surprising observance of the production limits by the member states led to a sharp rise in prices. During 1999, prices nearly trippled and hovered between USD 24 (Dubai) and USD 27 (Brent) per barrel by the end of the year. OPEC also dictated world crude oil prices in 2000, when prices rose even though OPEC production increased several times and even though its year-end production was higher than during the price crisis at the beginning of 1999. OPEC succeeded in draining a considerable amount of crude oil reserves in individual countries, thereby causing the impression of a raw material shortage. At the beginning of September 2000, Brent Crude was traded at around USD 37/barrel and Dubai Crude at around USD 31–32/barrel. In 2001, OPEC once again succeeded in dictating world prices – Dubai Crude was traded at around USD 16–27/barrel, and Brent Crude at roughly USD 17–29/barrel. During 2002, crude oil prices on the world market hovered around 18–30 USD/barrel (Brent) and 17–28 USD/barrel (Dubai), respectively. In 2003, another increase in world crude oil prices occurred on world markets. Its major cause was a conflict in the Middle East, which lead to uncertainty concerning the supply of the world market with this strategic raw material. As a result of the international situation, crude oil prices fluctuated between 23–34 USD/barrel (Brent) and 22–31 USD/barrel (Dubai), respectively.

The world price of crude oil developed dramatically in 2004. The uncertainty regarding deliveries from the Persian Gulf, which was continuously shaken by violence, was combined with an even more important factor involving a rocketing growth in crude oil consumption in rapidly developing economies of the newly industrialised countries (China, India, Indonesia, Brazil etc.). A prime example is Indonesia, until recently an important world exporter of crude oil, which left OPEC as it became a pure importer of crude oil during several last years. As a result of these factors, the price of Brent Crude increased systematically throughout ten months from around USD 29/barrel (January 2004) to USD 52/barrel (October 2004). The price development of Dubai Crude followed a similar scenario in 2004 with only a narrower price range (USD 27–41/bbl). Crude oil prices followed similar trends in 2005. During the first three quarters of 2005, the price of Brent Crude more or less gradually increased from 40 USD/barrel to 68 USD/barrel, and fluctuated between 54–66 USD/barrel in the last quarter of 2005 after a subsequent slight correction. The price range of Dubai Crude fluctuated between 34–60 USD/barrel with a similar sharp increase in January–September and a slight correction and stagnation towards the end of the year. During 2006, world prices of crude oil remained very high, and in the case of Brent Crude fluctuated in a wide range of 58–78 USD/barrel. The period of January–August 2006 was characterised an almost continuous price rise up to then nominal historical maximum of above 78 USD/barrel in the first ten days of August. The prices decreased to around 60 USD/barrel in August–October 2006. World crude oil prices continued to rise sharply also in 2007. In the first half of 2007, they increased practically continuously to 80 USD/barrel and, after a short correction, rose to 95 USD/barrel by the end of the year. In addition to the existing causes (consumption increase in rapidly modernising economies, stable consumption in developed countries, political instability in some producing regions), the crude oil price was increasingly influenced by the depreciation of the US dollar. The magical limit of 100 USD/t was surpassed at the beginning of March 2008. Subsequently, world crude oil prices increased to 140 USD/barrel in the second quarter of 2008. A fundamental and, by some experts, unexpected change occurred in the second half of 2008, when the growth trend of the past several years, supported by fundamental reasons, changed and crude oil prices started to decrease significantly. Consequently, prices of natural gas, non-ferrous metals and other industrial commodities also dropped. This has been commonly interpreted as a result of the global financial, economic and stock market crisis. However, it is more probable that it was just the extremely high prices of crude oil and other energy and metal commodities that caused the overheating of the global economy. This is shown by the fact that crude oil prices started to decrease many weeks before the financial crisis started is one of the evidence for this. Crude oil prices dropped in two waves to 90 and then to hardly believable 140 USD/barrel during the second half of 2008. The prices stagnated between 40 and 50 USD/barrel looking for a new equilibrium level in the first quarter of 2009. In the second quarter of 2009, the prices started to increase and reached 70 USD/barrel. In view of the fact that the fundamental causes of the growth trend will not cease to exist in future, it can be expected that prices of industrial commodities will increase again after the problems related to the global economic problems are solved.

Average spot price quotations (according to IEA and BP)

Commodity/Year		2004	2005	2006	2007	2008
Brent crude oil, CIF Rotterdam	USD/barrel	38.26	54.57	65.14	72.39	97.26
OPEC Basket, CIF Rotterdam	USD/barrel	33.43	49.40	61.50	68.19	94.34
West Texas Intermediate (WTI) oil, CIF Rotterdam	USD/barrel	41.51	56.64	66.02	72.20	100.06
Nigerian Forcados, CIF Rotterdam	USD/barrel	38.13	55.69	67.07	74.48	101.43

10. Recycling

Crude oil cannot be recycled once its energy has been consumed. However, some products made from oil can be recycled, especially plastics. The Czech Republic belongs among important producers of plastic products. Domestic production of plastics increased by 93 % in 2000–2004, which was the most in the entire EU. The development of the sector is mainly related to an increase in automobile production in the Czech Republic, because each vehicle has 100–200 kg of plastic products. At the same time, demand is also on the rise in the packaging industry, which is a dominant plastics consumer in the Czech Republic (47 %). The average per capita consumption of plastics in the Czech Republic is about 60–70 kg, which is the most of any Central and Eastern European country. The per capita average of EU countries ranges between 90–100 kg.

In terms of plastic recycling, the Czech Republic is second behind Germany among EU countries. In the Czech Republic, 38 % of sorted plastics were recycled in 2004, 42 % already in 2005, and even 52 % in 2007. Fibres, which can be used as sleeping bag or winter jacket filling and also added to commercial carpets, can be made from recycled PETE bottles. Waste bags, waste baskets or garden furniture can be made by recycling other plastics.

11. Possible substitutes

To a certain extent, crude oil may be substituted by other types of fuels in energy generation. It is disputable if the use of crude oil only for energy generation is economic, when there is number of other technologies for energy production. As for fuels, crude oil derivatives can be substituted to a certain degree by plant-based fuels.

Lignite

1. Characteristics and use

Lignite in the Czech terminology is a variety of brown coal, which exhibits the lowest degree of coalification, is mostly of xylitic character with large or small fragments of wood and tree trunks with preserved growth rings. Lignite is usually comprised in the term brown coal in the world use, whereas it has been traded separately in the Czech Republic. From the petrological viewpoints, it is a brown coal hemitype. Its calorific value on an ash-free but moist basis is lower than 17 MJ/kg (in the US use below about 19 MJ/kg).

However, no strong boundary between brown coal grade and lignite grade of coal has been internationally established and term lignite can designate both Czech brown coal grade and lignite grade of coal which are marketed separately in the Czech Republic.

World proved recoverable reserves of lignite are estimated at about 170 bill. tonnes. Their predominant part is located on the territory of Australia (22 %), the USA (19 %), China (11%), Serbia (9 %) and Russia (6 %).

Lignite is used in energy generation and for heating. It represents the lowest quality mineral fuel, consumption of which gradually decreases.

2. Mineral resources of the Czech Republic

- Largest deposits of lignite occur along the northern margin of the Vienna Basin, which extends from Austria into southern Moravia. There are two lignite seams in the youngest sediments of the Pannonian age. Reserves of the northern Kyjov seam are already exhausted (the last mine Šardice was closed in the end of 1992). Those of the southern Dubňany seam have been mined by only one underground mine Hodonín-Mikulčice since 1994, when the mining at Dubňany deposit was terminated. The last mine was supposed to closed in 2004, nevertheless negotiations on prolongation of the contract with ČEZ, a.s. and by that also continuation of the mining are in progress. Practically all production is burned in the Hodonín power station owned by ČEZ, a.s. Economic reserves are registered at six other deposits, but their exploitation is not anticipated at the present time. South Moravian lignite is of a xylodetrital character with numerous tree trunks. It is rich in water (45–49 %), ash content A^d is between 23 and 26 %, average content of sulphur S^d is 1.5–2.2 % and its calorific value Q_i^r is 8–10 MJ/kg. Recently, local lignite has also been used in other ways than as a fuel. So-called teraclean for soil fertilization is produced after lignite processing by crushing and grinding.
- Other deposits of low-quality lignite occur in narrow lobe-shaped extremities of the České Budějovice Basin. Major part of the reserves has been mined out and the remaining ones are not of any economic importance.
- Smaller isolated occurrences of lignite (Miocene) in the Zittau (Žitava) Basin were to a large extent mined out, too, and the remaining reserves are not of any economic importance.
- Small occurrence near Uhelná in Silesia east of Javornik and another near Dolní Životice, south-western from Opava, were also mined out for the most part in the past.

3. Registered deposits and other resources in the Czech Republic

(see map)

Principal areas of deposits presence:
(Names of regions with mined deposits are indicated in **bold type**)

1 **Vienna Basin** 2 České Budějovice Basin 3 Czech part of the Zittau (Žitava) Basin

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	11	11	9	9	9
exploited	1	1	1	1	1
Total reserves*, kt	1 010 123	1 007 933	976 985	976 367	975 702
economic explored reserves	212 982	210 792	205 030	204 412	204 221
economic prospected reserves	622 534	622 534	615 273	615 273	615 273
potentially economic reserves	174 607	174 607	156 682	156 682	156 208
exploitable (recoverable)	3 065	3 003	2 544	2 107	2 165
Mine production, kt	450	467	459	437	416

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year	2004	2005	2006	2007	2008
P_1, kt	232 867	232 867	232 867	232 867	232 867
P_2	–	–	–	–	–
P_3	–	–	–	–	–

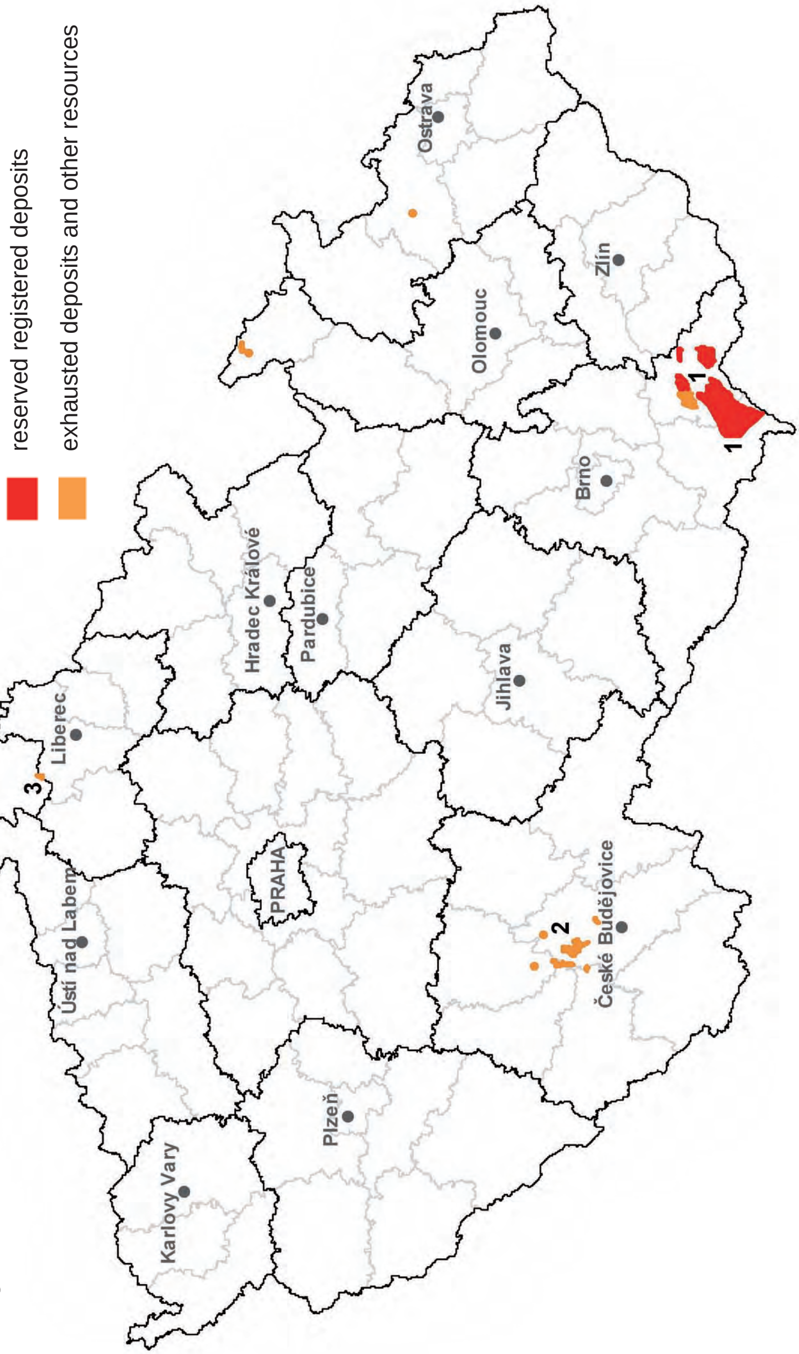
5. Foreign trade

No separate tariff item exists for lignite.

6. Prices of domestic market and foreign trade

In recent years, prices of South Moravian lignite for energy production (predominant part of the mine production) have ranged between CZK 500 and 750 per tonne. Graded lignite categorised as nut coal was offerred at CZK 730 per tonne, and as cube coal at CZK

Lignite



reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Jihlava
Liberec
Ústí nad Labem
PRAHA
České Budějovice
Plzeň
Karlovy Vary
1
1
2
3

740 per tonne in 2008. The calorific value of the lignite offered fluctuates between 8.0 and 10.0 MJ/kg.

7. Mining companies in the Czech Republic as of December 31, 2008

Lignit Hodonín s.r.o., Mikulčice

8. World production

Worldwide, lignite production is included in brown coal (lignite) production. Mine production of lignite (according to Czech terminology) has traditionally been reported primarily in Central and Southeast Europe (e.g. in Austria, Hungary, Bulgaria, Serbia, Slovenia, Bosnia and Herzegovina, Macedonia).

9. World market prices

Lignite is generally not traded outside a producing country.

10. Recycling

Lignite is not recycled.

11. Possible substitutes

Lignite, which is exclusively used as fuel, can be substituted by other energy minerals.

Natural gas

1. Characteristics and use

There are two types of natural gas: natural gas more or less associated with crude oil and natural gas from coal. Natural gas is a mixture of gaseous hydrocarbons, principally methane (CH_4), with other gases (nitrogen, carbon dioxide, hydrogen sulphide, hydrogen, inert gases). Methane dominates in the mixture from more than 50 %. There is also some natural blending with crude oil, water and sand when exploiting natural gas. Three principal grades of natural gas are recognized in the Czech Republic: dry gas (containing 96–99 % of methane), wet gas (85–95 % of methane plus admixture of other hydrocarbons) and gas containing higher portion of inert components (50–65 % of methane, more than 10 % of nitrogen – N_2 and more than 20 % of carbon dioxide – CO_2).

The world´s economic reserves of natural gas were estimated at about 178 trillion cubic meters. The greatest part of economic reserves is situated in the territories of Russia (above 25 %), Iran (almost 16 %) and Qatar (above 14 %). Rather large reserves are also on the territory of Saudi Arabia (4 %), United Arabian Emirates and the USA (above 3 % each), Niger and Venezuela (3 % each), Algeria (roughly 2.5 %).

Solid methane in form of the so-called gas hydrate could represent a potential resource. Usually it occurs in sediments of the ocean floor or in permafrost. However, its extraction has not been completely technologically and economically solved.

Gas of usually Carboniferous age emitted out of coal seams (Coal Bed Methane – CBM) may be classified as natural gas, too. The Carboniferous gas contains 90–95 % of methane. Its volume varies from 0 to 25 m^3 per tonne of coal. It depends on a degree of carbonification and on the depth of occurrence.

Natural gas is along with crude oil and coal one of the main world natural fuels. It is a universal energy source – the most often it is used for heating and electric energy production.

2. Natural gas resources of the Czech Republic

As with crude oil, the Czech Republic is not endowed with sufficient reserves of natural gas either. Deposits and reserves are accumulated in southern and northern Moravia. They are associated with geological units of the Western Carpathians and the south-eastern slopes of the Bohemian Massif, where they usually occur together with crude oil. In northern Moravia they are also associated with coal seams of the Upper Silesian Basin. Extraction of natural gas in the Czech Republic has been rather stable on a long term and it covers roughly 1–2 % of domestic consumption. The exploitation has violently increased in 2005 due to a single-phase exhaust of recoverable reserves of gas cushion of the underground gas storage Dolní Bojanovice (Poddvorov deposit).

- Natural gas deposits, genetically associated with formation of oil, occur in the Moravian part of the Vienna Basin. Crude oil deposits are concentrated mainly in the central part of the Basin, natural gas deposits prevail in peripheral areas. They occur in the Badenian sediments along with oil deposits either as independent natural gas deposits or in form of gas caps of the oil deposits or gas dissolved in the oil. The overlying Sarmatian sediments contain almost exclusively only natural gas deposits. Exploited natural gas contains 87.2–98.8 % volume of CH_4, its calorific value is 35.6–37.7 MJ/m^3 (dry natural gas at 0°C), specific gravity is 0.72–0.85 kg/m^3 (at 0°C) and H_2S content is under l mg/m^3. New natural gas resources have been discovered especially in the Prušánky and Poštorná area during exploration mostly using the 3D seismics. Based on these positive results, further exploration will focus on analogical types of deposit structures. The largest depleted natural gas deposits from the Hrušky and Poddvorov fields have been used as underground gas storages Tvrdonice and Dolní Bojanovice.

- The Carpathian Foredeep and south-eastern slopes of the Bohemian Massif represent another area with common oil and gas occurrences. Dolní Dunajovice, Uhřice and Horní Žukov (gas deposits converted into underground storages) and Lubná-Kostelany (today almost mined out) belong to the largest deposits. The most important accumulations are confined mainly to collectors in the Miocene, Jurassic and jointed and weathered portions of the crystalline rocks. The deepest exploited deposit is Karlín, where natural gas (and gas condensate) was mined from depth of more than 3,900 m. The composition of local gas deposits varies considerably. The Dolní Dunajovice deposit is characterized by high content of methane (98 %), whereas the deposit Kostelany–západ contains only 70 % methane and is rich in helium and argon, which can be extracted on industrial scale. Considerable reserves are bound in gas caps of the heavy crude oil deposits Ždánice-Miocene and Kloboučky. Mining technology which would enable to extract economically not only the natural gas bound in gas caps but also a part of heavy oil reserves has been intensively searched for. New natural gas resources have been discovered especially in the Poštorná area during exploration mostly using the 3D seismics. Based on these positive results, further exploration will focus on analogical types of deposit structures. Gas deposits Dolní Dunajovice and Uhřice are secondarily used as underground gas storages. In northern Moravia, specifically between Příbor and Český Těšín, the gas deposits are mostly associated with the weathered and tectonically affected Carboniferous paleorelief, or with the directly overlying clastic rocks of the Miocene. Several natural gas deposits have been opened in this area during the last years, with the most important deposit Janovice. The origin of gas in these deposits developed in the apical parts of the Carboniferous morphological elevations has not been explained yet – either the gas is formed during the coalification of coal deposits, or it is related to crude oil formation. This concerns especially Bruzovice and Příbor deposits. Part of the Příbor gas deposit or already mined-out Žukov deposit is used as underground gas reservoir.
- Natural gas of obviously Carboniferous origin and age is extracted during so-called degassing (extraction from already closed underground mines) of coal seams of the Czech part of the Upper Silesian coal basin. Mine gases are diluted by air and the resulting concentration of such gases reaches about 50–55 % CH_4. O_2, N_2, CO and CO_2 are present, too. The natural gas quality varies considerably depending on the method of extraction and technical limitations related to degassing. CH_4 content in non-diluted Carboniferous gas is 94–95 %. Gas from individual localities is delivered by more than 100 km long network of gas pipelines to local consumers (e.g. Mittal Steel). Natural gas adsorbed on coal seams makes at about 20 % of the total present production in the Czech Republic. However, its proportion represents almost 88 % of the approximate total of 28 billion m^3 of recoverable reserves. Natural gas from the mines Dukla, Lazy and Doubrava goes by 22 km long pipeline to the steel works Nová Huť in Ostrava.

- Numerous occurrences of natural carbohydrates both on the terrain surface and in boreholes were found in the area of the Carpathian flysh nappes. Extraction of several deposits (e.g. Hluk) of restricted extent took place in the past.

3. Registered deposits and other resources in the Czech Republic

(see map)

Principal areas of deposits and underground gas reservoir Háje:

(Names of regions with mined deposits are indicated in **bold type**)

1 **South-Moravian region** 2 **North-Moravian region** 3 underground gas reservoir Háje

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	83	84	84	85	88
exploited	35	38	40	39	41
Total *reserves, mill m^3	41 731	46 542	46 811	45 989	46 044
economic explored reserves	4 097	3 848	4 109	4 139	4 265
economic prospected reserves	35 606	40 643	40 593	39 765	39 807
potentially economic reserves	2 028	2 051	2 109	2 085	1 973
exploitable (recoverable) reserves	24 933	27 982	28 160	27 819	27 812
Mine production, mill m^3	175	356	148	148	168

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

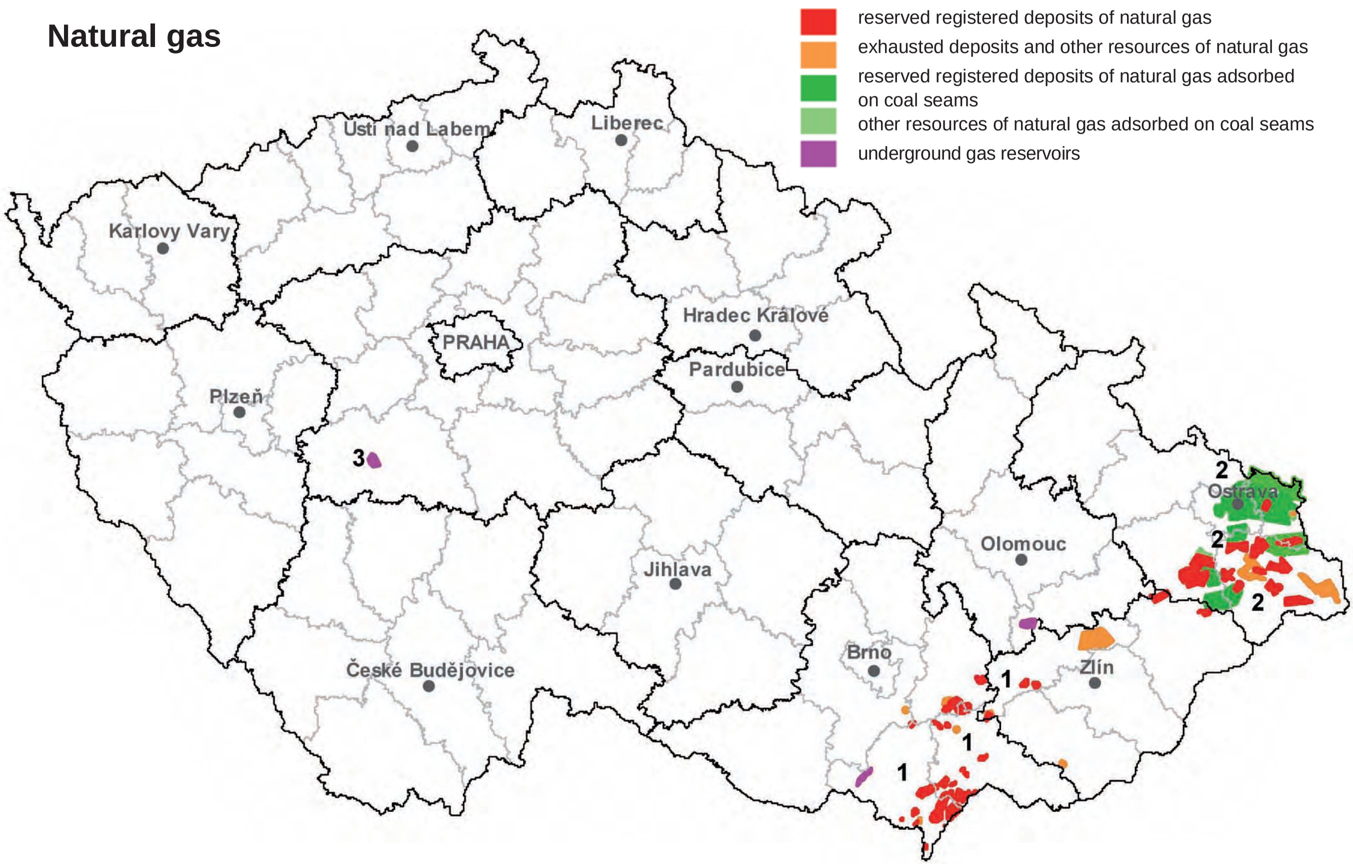
Year	2004	2005	2006	2007	2008
P_1, mill m^3	16 767	16 767	16 767	16 767	16 767
P_2	–	–	–	–	–
P_3	–	–	–	–	–

5. Foreign trade

271121 – Natural gas

	2004	2005	2006	2007	2008
Import, mill m^3	9 169	9 759	9 761	8 378	8 692
Export, mill m^3	63	N	86	N	N

Natural gas


reserved registered deposits of natural gas
exhausted deposits and other resources of natural gas
reserved registered deposits of natural gas adsorbed on coal seams
other resources of natural gas adsorbed on coal seams
underground gas reservoirs
Ústí nad Labem
Liberec
Karlovy Vary
Hradec Králové
PRAHA
Pardubice
Plzeň
3
Ostrava
2
2
2
Olomouc
Jihlava
Brno
Zlín
České Budějovice
1
1
1

The territorial breakdown of imports is paradoxically considered as confidential. However, in principle roughly 75 % of natural gas is imported from Russia and the approximately remaining fourth from Norway. Czech natural gas is exported on the order of a lower volume to Austria, Poland and Germany. Import was provided by RWE Transgas (97 %) and Vemex (3 %).

6. Prices of domestic market and foreign trade

271121 – Natural gas

	2004	2005	2006	2007	2008 e
Average import prices (CZK/ths m^3)	3 472	4 668	6 088	5 929	8 326

As in the case of crude oil (as natural gas prices are tied to crude oil prices), import prices doubled in 2000 (CZK 2 063 per thousand m^3 in 1999, CZK 4 059 per thousand m^3 in 2000) in connection with a rise in world natural gas prices and the weakening of the CZK against the USD. Import prices of natural gas also remained high in the following years. A slight decrease in the average import price in 2004 was due to the strengthening of the CZK against the USD. In 2006, another rise in average import prices of natural gas occurred by 30 % year-on-year. Import prices remained high in 2007, and reached nearly 6 000 CZK/ths m^3. Total consumption of natural gas reached about 8.685 billion cubic metres in 2008, which is 7 % less than in 2006. The decrease was caused primarily by high commodity prices, which led some consumers to change energy sources. The average import prices of natural gas to the Czech Republic increased as well subsequent to the historical maxima reached by the world crude oil prices in the first half of 2008. The average import prices reached 8,326 CZK/ths m^3 in this period, which represents approx. 488 USD/ths m^3.

7. Mining companies in the Czech Republic as of December 31, 2008

Moravské naftové doly a.s., Hodonín
Green Gas DPG, a.s., Paskov
UNIGEO a.s., Ostrava-Hrabová
MND Gas Storage a.s., Hodonín
MND Production a.s., Hodonín
Česká naftařská spol. s.r.o., Hodonín

There are eight underground reservoirs of natural gas in total operated by three companies in the Czech Republic. Their total capacity represents roughly one third of the natural gas consumption in the Czech Republic. RWE Transgas, a.s. (a subsidiary of the German company RWE AG), via its daughter company RWE Gas Storage s.r.o., owns six underground reservoirs in the territory of the Czech Republic (Dolní Dunajovice, Tvrdonice, Štramberk, Lobodice, Háje u Příbrami and Třanovice) with a total capacity of about 2.321 billion cubic metres. The company plans to increase the capacity of the reservoirs by an additional 0.77 billion cubic metres.

MND Gas Storage company operates the Uhřice underground gas reservoir with a capactiy of 180 million cubic metres, which was opened in 2001. The company, together with

VEMEX Company, is considering the construction of another reservoir with a capacity of 570 million cubic metres.

SPP Bohemia a.s. owns and operates the Dolní Bojanovice underground reservoir with a capacity of 570 million cubic metres. However, this underground gas reservoir is used only for the needs of the Slovak Republic.

8. World production

During the last five years, world natural gas production persisted in the range of about 2,700–3,000 billion m^3 per year. In the past years, moderate increase in mine production occurred in Russia, Iran and Norway. Mine production of Quatar (trippled during 2003-2008), Egypt and Niger grew very dynamically; however, these states have a share of world mine production of only a few percent. In Canada, Algeria and Indonesia the mine production stagnated, whereas in the Great Britain it has been decreasing since 2001. Mine production of natural gas increases rather dynamically also in China, however, its share in the world production is only 2.5 %. The regional disproportion between natural gas producers and consumers is lower than in the case of crude oil. The USA has a 19.3 % share of the world production and a 22.0 % share of consumption. China has a 2.5 % share of world production and an almost equal 2.7 % share of consumption. China climbed from the 15th to the 10th position of the world ladder of mine production. The EU members have a 6.2 % share of world production and a 16.2 % share of consumption. World natural gas production was as follows (according to British Petroleum and Welt–Bergbau–Daten):

World natural gas extraction

Year	2004	2005	2006	2007	2008 e
Mine production, bill. m^3 (BP)	2 694	2 778	2 876	2 945	3 066
Mine production, bill. m^3 (WBD)	2 709	2 820	2 930	3 010	N

Major producers (2007; according to WBD):

Russia	21.6 %	Algeria	2.8 %
USA	17.9 %	Indonesia	2.6 %
Canada	6.1 %	Great Britain	2.6 %
Iran	3.7 %	Saudi Arabia	2.5 %
Norway	3.0 %	China	2.3 %

Note:
Russian natural gas production has been reported under the standard pressure of 0.1 MPa and temperature of 20 ^{o}C. To compare it with western standards it is necessary to multiply the values by a factor of 0.9315.

Carboniferous gas emitted during the extraction of coal seams reached about 25 billion m^3 annually, which represented 4–6 % of all methane emissions from natural and artificial sources of methane in the world. About 1.6 billion m^3 of gas, i.e. approximately 6 % of the given 25 billion m^3, were used for industrial purposes and the remainder entered the atmosphere. According to 1996 data, 10 countries used Carboniferous gas – China, Russia, the Czech Republic, Germany, Poland, Great Britain, the USA, Australia, France and Ukraine.

9. World market prices

Most of the contract prices of natural gas are linked to crude oil market prices because internationally quoted world prices of natural gas do not exist, but bilateral long-term contracts for the supply of natural gas do exist.

In recent years, a rise in natural gas consumption was accompanied by a decrease in costs of consumer countries for imported natural gas (approximately 75 % is transported via pipelines and 25 % in liquefied state via tankers). Natural gas prices are negotiated and quoted in USD/mill Btu. The natural gas price for a customer in Europe that still fluctuated between 3.6–4 USD/mill Btu in 1985, hovered around 2.25 USD/mill Btu in 1996. In 1998, prices fell to 1.7–2.0 USD/mill Btu and, in 1999, they fluctuated between 1.8–2.9 USD/mill Btu. During the course of 2000, primarily in connection with another rise in crude oil prices, natural gas prices increased considerably and, in autumn surpassed 5 USD/mill Btu for the first time in history. In 2001, prices hovered in the range of 1.9–3.4 USD/mill Btu and, in 2002, in the range of 2.0–5.3 USD/mill Btu. The local maxima were reached in 2003, when natural gas was traded for a short time at 9.5 USD/mill Btu at the end of February. For the rest of the year, prices fluctuated primarily between 4.5 and 7.2 USD/mill Btu, with an annual average of 5.5 USD/mill Btu. The high prices of natural gas in 2003 copied the record-breaking prices of crude oil. In 2004, the price of natural gas remained relatively high due to the continuing record prices of crude oil, and fluctuated in the range of 4.5–9.0 USD/mill Btu. The annual average was 6.17 USD/mill Btu. In 2005, world prices of natural gas fluctuated widely between 5.5 USD/mill Btu and USD 15.5/mill Btu. A considerable increase occurred primarily during the second half of the year, when prices reached very high values. During 2006, natural gas prices ranged between 5.5–11.0 USD/mill Btu, with a decrease in the first half and a repeated rise in the second half of the year. In 2007, prices hovered between 6–9 USD/mill Btu. In the first half of 2008, natural gas prices rose considerably from 8 to 13 USD/mill Btu in response to record prices of crude oil. The cause of this increase in world natural gas prices is due to the fact that this energy mineral is considered as an alternative to the other mineral fuels. As in the case of crude oil and other minerals, the stated prices were nominal and, apart from fundamental factors, their rise was also partially influenced by the long-term decrease of the US dollar. The drop of the natural gas prices back to the level around 4 USD/mill Btu reflected the drop in the world prices of crude oil due to the start of the global financial, commodity and economic crisis.

10. Recycling

Natural gas cannot be recycled once its energy is consumed.

11. Possible substitutes

In terms of energy generation, natural gas can be successfully substituted to a certain extent by other types of fuel. However, natural gas itself represents an economically and ecologically effective substitute for other mineral fuels (and emits the least amount of CO_2 per unit of energy produced).

1. Characteristics and use

Uranium, with its average abundance in the Earth's crust of about 2.7 ppm, is a rather common element such as tin or zinc. Some rocks, such as granites, shales or phosphates, may contain substantially higher concentrations – from 5 to 25 ppm. Natural uranium has a lithophile character and occurs in the form of oxides and other compounds. It is a mixture of three isotopes: 99.2836 % of ^{238}U, 0.711 % of ^{235}U and 0.0054% of ^{234}U. For the majority of industrial uses, natural uranium has to be enriched, i.e. the content of ^{235}U, which is fissionable in contrast to ^{238}U, has to be increased. For use as fuel in the majority of commercial nuclear reactors, it is enriched to 3–5 % of ^{235}U (LEU), for nuclear weapons to over 90 % (HEU). On the contrary, depleted uranium (DU), with a reduced concentration of ^{235}U of mostly below 0.3 %, is suitable for other uses (e.g. conventional weapons (anti-tank ammunition), shielding).

The uranium ores of various genetic types represent a raw material resource for fuel production in nuclear power plants. Uranium is present in several tens of minerals (oxygen-bearing compounds only), of which the economically most important ones are oxides (uraninite – pitchblende), phosphates (torbernite, autunite), silicates (coffinite, uranophane), titanates (brannerite, davidite), vanadates (carnotite) and organic compounds (anthraxolite).

IAEA subdivides uranium deposits into 15 main categories according to geological setting. Economically, the most important ones are unconformity-related deposits (the most important of which are Canadian deposits, e.g. McArthur River), sandstone deposits (Niger and the majority of deposits in Kazakhstan and the USA), volcanogenic (Krasnokamensk, Russian Federation), intrusive deposits (Rössing, Namibia) and breccia complex deposits (Olympic Dam, Australia). The metall content of mined ores varies greatly depending on the deposit type, amount of reserves and mining method. Apart from the extremely rich "unconformity" type deposits, in which the metal content even reaches several percent (up to 20 %, e.g. McArthur River), the average uranium content usually ranges between 0.05–0.4 %.

Products of uranium ore processing are chemical concentrates containing 70–90 weight percent of uranium. Identified world resources of uranium in ores (primary resources) consist of Reasonably Assured Resources (RAR) and Inferred Resources (IR). Their reported amount is 3.8–5.1 milion tonnes (according to WNA and IAEA, 5.47 mill t according to the "Red Book 2007" - a joint report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency) recoverable at a cost of 80 USD/kg U–130 USD/kg U. The largest reserves and resources are concentrated in Australia (above 23 %), Kazakhstan (15 %), Russia (10 %), Canada and South Africa (8 % each), the USA (6 %), as well as Namibia, Brazil, Niger (5 % each), Ukraine (4 %), and Uzbekistan and Jordan (2 % each).

The history of uranium use began only about 150 years ago, when small quantities of uranium compounds were used in dyes for ceramics and glass production. In the first half of 20th century uranium ores were mined as source of radium (USA, Czechoslovakia, Canada, Congo, Portugal). A major demand began at the end of World War II for military purposes, which was replaced by use for energy purposes (1 tonne of uranium can produce 40 gigawatt-hours of electric energy, which is comparable to burning 16 thousand tonnes of coal or 80 thousand barrels of crude oil) in the late 1960s. Today, this whole development can be tracked via reserves of depleted uranium from the enrichment process (uranium missing a substantial part of isotope ^{235}U). Approximately 2.4 million tonnes of uranium have been mined worldwide since 1945 for all uses. Uranium is primarily used in nuclear power reactors, much less in research reactors (and, e.g., in the preparation of radioisotopes for medicine and in defectoscopy), and as fuel in nuclear propulsion in the navy, icebreakers and submarines. Depleted uranium is used in shielding, counterweights (boats, planes) and in the manufacture of special munitions (in artillery shells doe to high density to increase penetrating power). Negligible quantities of uranium salts are used for colouring stained glass. A considerable amount of extracted and enriched uranium is still stored as nuclear warheads.

2. Mineral resources of the Czech Republic

The Czech Republic ranked among the world´s most important uranium producers. Historically it occupies the 9th position in the world with a total production of over 110 thousand tonnes of uranium in 1946–2008 in the form of sorted ores and chemical concentrate. The main period of uranium mining in the Czech Republic lasted from the late 1940s to the beginning of the 1990s, when the mining of all vein deposits mined thus far (except for the Rožná deposit) was terminated doe to unprofitability. In 1995, mining was terminated at the Hamr deposit and largely from ecological reasons at the Stráž deposit a year later, whereby also the mining of sandstone-type deposits was terminated. The annual mine production of uranium amounted to 2,000–2,900 tonnes (max. slightly above 3, 000 tonnes in 1960) during the highest mining boom (1955–1990). With a current production of about 275 tonnes U in 2008 representing about 0.6 % share of world production, the Czech Republic ranks 13th in the world. Next decline to less than 250 tonnes U is expected in following years.

Exploitable uranium deposits were found both in the crystalline basement and in the cover formations of the Bohemian Massif. Two major periods of uranium ore formation can be distinguished: Late Variscan and Alpine.

According to an IAEA classification, practically only two types of deposits occurred in Czech territory – the vein (including "zone" deposits) and sandstone types. Hydrothermal vein deposits (veins in metamorphic rocks, zone deposits in metamorphic rocks and along large dislocations in granitoids) were of the highest importance in terms of metal production. The total mine production of uranium metal from these deposit types reached almost 80 kt. In terms of production, the deposits of uranium-bearing sandstones of the Bohemian Cretaceous Basin rank second with 29.5 kt of uranium. The remaining scant 0.9 kt of uranium come from deposits in Carboniferous to Permian and Tertiary sediments (mainly of coal or lignite type according to IEAE classification). The absolute majority of exploited uranium – about 85 % – was mined by conventional underground mining methods. Open-pit mining produced only about 400 tonnes of uranium, which represents about 0.3 % of the total amount. The remaining amount of uranium (nearly 15 %) was produced primarily by in-situ leaching.

Vein deposits in the Czech Republic were divided into 3 subtypes:

- Veins and vein systems of hydrothermal origin in metamorphic rocks. The predominant uraninite– pitchblende mineralisation is very irregular and is spatially and genetically associated with Variscan granitoid massifs. The mostly steeply dipping ore bodies (veins) have a thicknes of several cm to 1 m, rarely more. The uranium content in these deposits ranged mostly from 0.1 % to several tenths of per cent, and rarely around 1 %. This type included the largest Czech and one of the world´s largest hydrothermal vein deposits located at Příbram, and the once important deposits of Jáchymov, Horní Slavkov and other smaller deposits, e.g. Licoměřice-Březinka, Zálesí u Javorníka, Přebořice, Chotěboř, Slavkovice, Lázně Kynžvart-Kladská, Planá u Mariánských Lázní-Svatá Anna et al.

- Graphitised and chloritised or solely chloritised ore-bearing crushed zones in metamorphic rocks with uneven boundaries of a predominantly steep dip. The mineralisation is distributed irregularly, mainly disseminated, with the main minerals being uraninite, coffinite and brannerite. The tabular ore bodies are X m to 10 m thick and the uranium content ranged between 0.09–0.3 %. The Rožná deposit, which is the only deposit still being mined, as well as the Zadní Chodov, Olší, Dyleň, Okrouhlá Radouň, Jasenice-Pucov deposits, et al., belong to this deposit type.
- Metasomatic mineralisation associated with chloritised tectonic zones in Variscan granitoids predominantly with uraninite-coffinite-brannerite mineralisation. The mineralisation is relatively uniform and forms mostly steeply dipping columnar or lenticular ore bodies. The uranium content in the deposits ranged primarily between 0.07–0.13 %. The most significant deposit of this type is Vítkov 2, and other examples are Lhota u Tachova, Nahošín.

Deposits of uranium-bearing sandstones:

- Predominantly stratabound mineralisation in Cretaceous sediments – ore bodies formed mainly by uraninite and uranium blacks, locally with zircon, confined to water-bearing Cenomanian sediments of the Laussicum development of the Bohemian Cretaceous Basin. The ore bodies are deposited horizontally or subhorizontally and have a stratiform, tabular and, less often, a lenticular shape with a thickness of several decimetres to several metres. The mineralisation makes up part of the matrix and is relatively uniformly disseminated. The uranium content in the deposits ranges on average from 0.03 % to 0.14 %. The deposits in the surroundings of Stráž pod Ralskem, where both conventional underground mining (Hamr, Křižany, Břevniště) and ore leaching from boreholes (Stráž) took place, were of crucial importance. Other explored deposits (Osečná-Kotel) and prognosticated resources (Hvězdov, Mimoň, Heřmánky and others) have not yet been mined. More than 98 % of registered reserves in the Czech Republic (mostly potentially economic, i.e. currently irrecoverable resources) are associated with this deposit type. Uranium reserves (better said, resources) would be economically recoverable primarily by in situ leaching (ISL), which is, however, currently impossible due to ecological reasons.

Other deposits:

- Stratabound mineralisation confined to Late Paleozoic sediments, formed by uranium-bearing coal seams and surrounding rocks of the Upper Carboniferous and Lower Permian in the Intra-Sudetic Basin (e.g. Radvanice, Rybníček, Svatoňovice) and Kladno-Rakovník Basin (Jedomělice, Rynholec). The mineralisation of mainly uraninite was in the form of small moderately dipping irregular lenses, or slabs with a maximum thickness in decimetres. The average uranium content in the deposits ranged between 0.1–0.3 %.
- Stratabound mineralisation in the eastern part of the Sokolov Basin (e.g. Mezirolí, Podlesí) and its Hroznětín part (e.g. Hájek, Ruprechtov, Hroznětín). The irregular mineralisation in sediments enriched with organic material (including coal), formed mainly by

uranium blacks, was usually shaped as smaller slabs and lenses with a thickness from tens of centimetres to several metres. The uranium content ranged on average between 0.1–0.2 %.

Economically important and intensively exploited deposits, particularly in the past, were concentrated into five regions. The following summary lists the regions with the type of mineralisation, and the most important deposits are listed according to the amount of uranium produced. The percentage share of the total mine production of each individual region is given in parentheses.

- Central Bohemian region – vein mineralisation: e.g. Příbram, Předbořice (nearly 40 % of the total uranium mine production)
- North Bohemian region – mineralisation in Cretaceous sediments: e. g. Stráž pod Ralskem, Hamr, Břevniště (more than 23 %)
- Moravian region – mineralised fracture zones and hydrothermal veins – Rožná, Olší (nearly 17 %)
- West Bohemian region – zone and vein mineralisation: e.g. Zadní Chodov, Vítkov 2, Horní Slavkov, Dyleň (10 %)
- Krušné hory Mts. region – vein deposits and mineralisation in Tertiary sediments: e.g. Jáchymov, Hájek (less than 7 %).

Other small deposits and occurrences scattered in the remaining parts of the Bohemian Massif such as in the Železné hory Mts., Rychlebské hory Mts., Krkonoše Mts., and the Okrouhlá Radouň deposit make up the remaining 3 % of the total post-World War II production of 110 442 t U.

Only two registered uranium ore deposits produced uranium concentrate in 2007.

Only one of them was mined – the zone-type Rožná deposit. The other – the Stráž pod Ralskem deposit in the Bohemian Cretaceous Basin – produced uranium during remediation work. Conventional underground mining took place at the Rožná deposit (average uranium grade of 0.2–0.3 % in economic reserves). The Stráž deposit (average uranium grade of 0.03 % or minimum given productivity 1 kg/m^2 in economic reserves) was exploited by in-situ leaching until 1 April 1996. Since this date, uranium has been recovered as a byproduct while treating groundwater and technological solutions within the scope of mine liquidation and reclamation work, with a decreasing trend from 150 tonnes of uranium to the current amount of about 30 tonnes per year.

All extracted ore was chemically processed to produce a chemical concentrate (yellowcake). It was exported for further processing (conversion and enrichment) abroad. In the past 15 years, the Czech power company ČEZ, a.s. was nearly the sole exclusive consumer of the uranium concentrate. The present consumption of uranium in the Dukovany and Temelín nuclear power plants (NPP) reaches 670–700 tonnes annually. The production surplus from the beginning of the 1990s was stored by the Administration of State Material Reserves and, after 2000, most of the uranium (more than 2,300 tonnes) was sold on the world market.

The tailing pond in Stráž pod Ralskem, where waste from the leaching of the deposit containing 0.030–0.063 % of rare earths (lanthanum–gadolinium) accumulated for 30 years, is also a potential source of scandium, yttrium, niobium, zirconium and hafnium. Except for Zr, the reserves of these metals have not yet been evaluated.

3. Registered deposits and other resources in the Czech Republic

(see map)

Reserved registered deposits

(Names of mined deposits are indicated in **bold type**)

1 **Rožná**
2 Brzkov
3 Břevniště pod Ralskem
4 Hamr pod Ralskem
5 Jasenice-Pucov
6 Osečná-Kotel
7 Stráž pod Ralskem*

* uranium is recovered only as a byproduct from the treatment of groundwater and technological solutions during mine liquidation and reclamation work upon termination of in-situ leaching (ISL) of uranium ores

Exhausted deposits and other resources

8 Příbram
9 Jáchymov
10 Zadní Chodov + Vítkov 2
11 Olší
12 Horní Slavkov
13 Okrouhlá Radouň
14 Dyleň
15 Javorník
16 Licoměřice-Březinka
17 Radvanice + Rybníček + Svatoňovice
18 Předbořice
19 Hájek + Ruprechtov
20 Chotěboř
21 Slavkovice
22 Mečichov-Nahošín

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	7	7	7	7	7
exploited	1	1	1	1	1
Total * reserves, t U	136 044	135 990	135 812	135 729	135 553
economic explored reserves	1 622	1 655	1 671	1 677	1 545
economic prospected reserves	19 418	19 411	19 476	19 435	19 428
potentially economic reserves	115 004	114 924	114 665	114 617	114 581
exploitable (recoverable) reserves	570	596	677	643	503
Mine production, t U	435	420	383	322	290
Production of concentrate, t U **	412	409	358	291	261

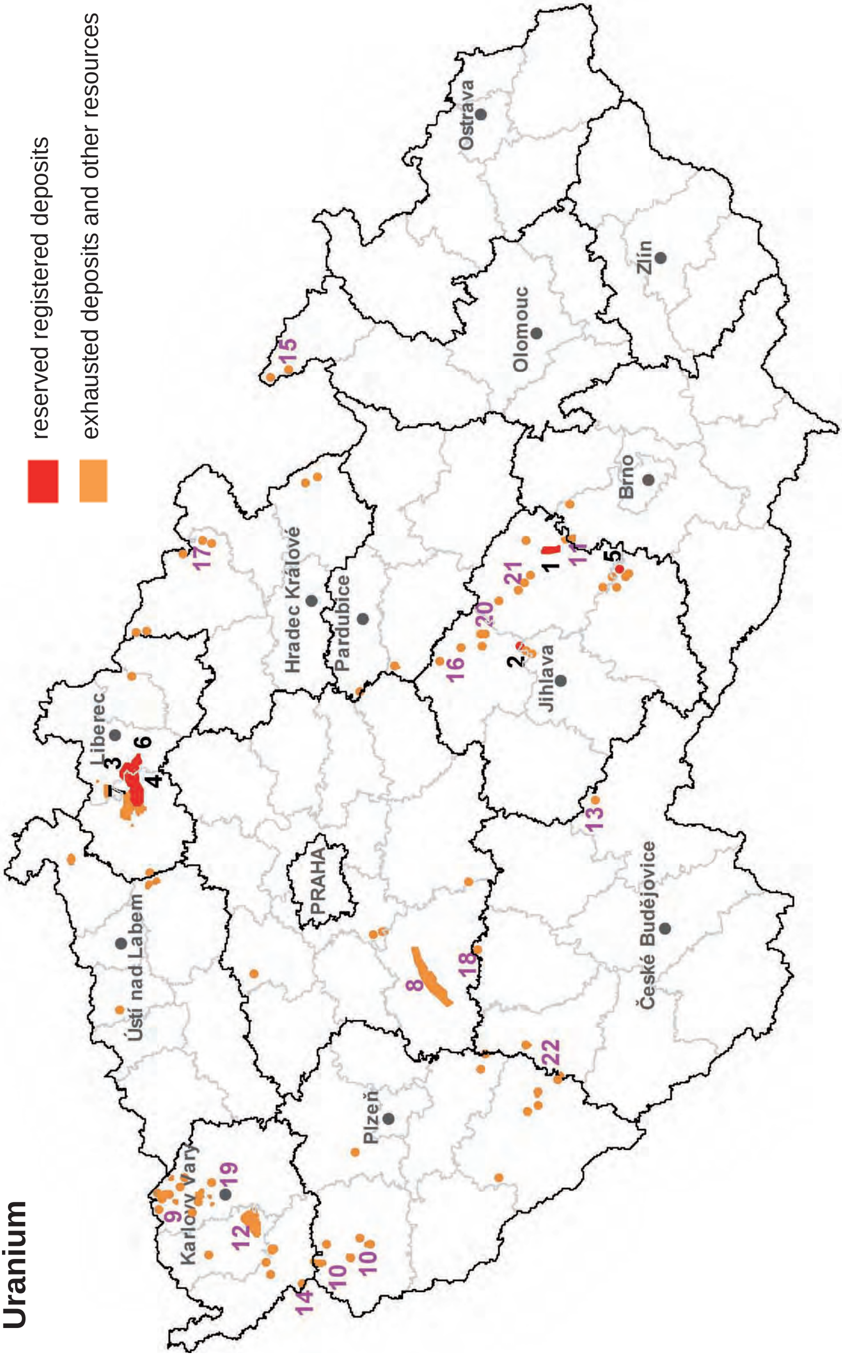
* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

** sales production (without ore milling losses)

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1		–	–	–	–	–
P_2,	t U	8 480	8 480	8 480	8 480	8 480
P_3		–	–	–	–	–

Uranium


reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Jihlava
Liberec
PRAHA
Ústí nad Labem
České Budějovice
Plzeň
Karlovy Vary
1
2
3
4
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22

5. Foreign trade

28441030 – Natural uranium – wrought

	2003	2004	2005	2006	2007	2008
Import, t U	N	N	N	N	N	N
Export, t U	1 016	665	867	529	420	131

Uranium imports are not published due to the protection of confidential data of private companies. Approximately 80 tonnes of enriched and processed uranium has been imported annually by ČEZ, a.s., in the form of nuclear fuel.

In 2000–2005, all domestically produced uranium was purchased by the Czech power company ČEZ, a. s. (utility), and exported for processing and fabrication of fuel for the Dukovany and Temelín nuclear power plants (NPP) (with the exception of sales from the State Material Reserves). This covered approximately 93 % of their consumption in 2000–2002, however, in consequence of gradual decrease of domestic mine production only about one third of their needs in 2008. The remaining amount of uranium is purchased on world markets or imported as already enriched uranium fuel in the case of the Russian supplier – TVEL Company, which delivers fuel elements for the Dukovany nuclear power plant. Fuel elements for the Temelín nuclear power plant are currently being supplied by Westinghouse Company and will begin to be supplied by TVEL Company in 2010.

According to a governement decision on October 2005, the last Czech uranium mine Rožná was scheduled to close in 2008. In May 2007, on the basis of favourable price position on the uranium market, the government approved the continuation of mining at the Rožná mine, provided that it is economically viable. Remaining reserves enable stretch out the life span of the mine till 2012–2013.

6. Prices of domestic market and foreign trade

28441030 – Natural uranium – wrought

	2004	2005	2006	2007	2008
Average import prices (CZK/kg U)	N	N	N	N	N
Average export prices (CZK/kg U)	844	1 445	1 345	1 764	2 491

7. Mining companies in the Czech Republic as of December 31, 2008

DIAMO, s.p., Stráž pod Ralskem

8. World production

According to IAEA, the world consumption of uranium as nuclear plant fuel was about 67–68 kt per year (65 kt according to WNA). About 67 % of this amount was covered by primary resources which indicates their growing proportion in comparison with preceding years. The remaining 33 % of uranium consumption was covered by secondary resources (strategic reserves of natural and enriched uranium, mainly the USA and Russia, uranium from dismantled Russian nuclear warheads – “diluted” HEU, reprocessed spent fuel including MOX, and uranium obtained by re-enrichment of depleted uranium from earlier processing).

After temporary year-on-year production decline in 2006 by 5 % a slight growth continued in 2008 as well especially on account of steeply growing production of Kazachstan and its increase in Namibia. Certain manufacturing difficulties persisted at major producers at Canadian and Australian deposits.

Since 1945, approximately 2.4 million tonnes of uranium have been exploited in the world for all types of uses. A large increase in world production of uranium ores began in the 1950s as a result of the nuclear arms race and, subsequently, also due to nuclear energy development, especially after the first “oil shock” in 1973. A record production of 45.6 kt of uranium was reached in 1990. Subsequently, mine production fell due to a supply surplus on the world market coming from U stockpiles of former USSR (CIS states) and other secondary sources and has slowly been rising again in the past two years, especially in Kazakhstan, Namibia, Uzbekistan and Russia. As far as European countries are concerned, uranium is produced steady on the long term basis about 800 tonnes U per year in the Ukraine, gradual production decrease happens in the Czech Republic, in a small amount in Romania, and during liquidation work in Germany from purification of mine waters. In 2008, the share of world production of the Czech Republic was roughly 0,6 %. The following countries had a share of uranium mine production (according to The Uranium Institute/World Nuclear Association, World Mineral Statistics and Welt–Bergbau–Daten):

World mine production of uranium

Year	2004	2005	2006	2007	2008
Mine production, t U (UI/WNA)	40 251	41 702	39 429	41 279	43 930
Mine production, t U_3O_8 (dle WBD)	47 407	48 783	45 596	49 109	N

Conversion: 1 t U = 0.848 t U_3O_8
1 t U_3O_8 = 1.179 t U

Main producers’ share in the world mine output (2008; on the basis of WNA data):

Canada	20.5 %	Uzbekistan	5.3 %
Kazakhstan	19.4 %	USA	3.3 %
Australia	19.2 %	Ukraine	e1.8 %
Namibie	9.9 %	China	e1.8 %
Russia	e8.0 %	South Africa	1.5 %
Niger	6 9 %	Brazil	0.8 %

In 2008 about 25 % of the primary production of uranium came from open-pit mining, 37 % from underground mining, over 28 % was recovered by in-situ leaching (ISL or newly used term “in-situ recovery” – ISR) or leaching from dumps, and around 10 % represented by-products of processing of other ores (predominantly Cu). In the 1990s, significant uranium mining companies merged. In 2008, the following eight of the world´s largest mining companies (with an annual production volume of more than 1 000 tonnes) covered solely 87 % of world production: Rio-Tinto (United Kingdom), Cameco (Canada), Areva (formerly Cogema, France), KazAtomProm (Kazakhstan), ARMZ (Russia), BHP Billiton (Australia), Navoi (Uzbekhistan), Uranium One (Canada) (according to the WNA). The following The most important deposits mined in the world were in 2007: McArthur River (Canada) – 6,383 t U, Ranger (Australia) – 4,527 t U, Rossing (Namibia) – 3,449 t U, Olympic Dam (Australia) –3,344 t U as a by-product of Cu mining, Krasnokamensk (Russia) – 3 050 t U, and Arlit (Niger) – 1 743 t U.

9. World market prices

Unlike other minerals, uranium was not traded on any commodity exchange until recently. At the beginning of May, the New York Mercantile Exchange (NYMEX) launched the trading in uranium, however, only in the form of futures contracts, not physical supplies. However, this has not been used by primary consumers – electric power companies ("utilities") due to small realized volumes, and mainly for their long-term uranium procurement strategies closely linked to logistic of subsequent uranium processing (conversion, enrichment and fuel fabrication). The difference between uranium and other commodities can be demonstrated on the fact that uranium consumption hasn't fallen in the wake of the current financial crises, as utilities continue to operate their reactors. World market prices are quoted mostly in USD/lb U_3O_8 (the Ux Weekly quotes them also in EUR). World market prices are quoted in USD/lb U_3O_8. For the purpose of this report, they have been recalculated to USD/kg U (multiplied by an index of 2.6).

The uranium price history was influenced by three main periods of uranium usage: (1) the era of weapons procurement (1940–1969), (2) inventory accumulation – commercial era (1970–1989), and (3) the era of inventory liquidation (1990–2005). While the first period was characterised by subsidised production, or prices set by governments acting as customers, prices in the second period were derived from costs of already existing deposits. Prices were also driven up by expectations of rapid development of nuclear energy in the late 1970s, and reached their historic maximum of 112.8 USD/kg (43.4 USD/lb U_3O_8) in 1978, which would be more than 300 USD/kg in constant 2008 USD. A boom in uranium exploration occurred worldwide. However, expectations of rapid development of nuclear energy were constrained after the Three Mile Island and Chernobyl accidents. A flood of cheap uranium from former Soviet Union countries led to a drop in world prices at the beginning of 1990s. A continuing surplus of uranium from secondary sources further decreased uranium prices on the market for many years, which led to radical mining phase-outs and closures of uranium mines in many countries (e.g., France, the USA, Spain, Gabon, Czechoslovakia, East Germany, South Africa), and delayed the next exploration cycle as there was little economic incentive to invest in the acquisition of new uranium deposits.

Despite the common long-term perception that prices should rise, this happened only after several severe warnings of market disruptions to production in 2003–2004, like:

- Flooding at McArthur River mine (Canada)
- Fire at Olympic Dam mill (Australia)
- Strike at Cameco's in conversion facility at Port Hope (Canada)

- Cutting off US trader GNSS (Globe Nuclear Services and Supply Ltd) operating mainly at US market from sources of Russian uranium by parent Russian state-owned company TENEX (Техснабэкспорт – Techsnabexport)

These negative signals in conditions of heavily consolidated uranium mining sector proved its high vulnerability and caused gradual increase in uranium prices. Such price development in the uranium market attracted investment and hedge funds and their strong buying activities for speculative purposes accelerated price growth. It was completely new, previously not known situation in the uranium market. However, ongoing steep price growth was heavily influenced by additional problems in 2006:

- Partial production cuts in consequence of temporary flooding at Ranger Mine (Australia)
- Flooding at developed Cigar Lake mine (Canada) with probability of 5 years' delay in mining initiation
- Very low liquidity in the uranium market caused problems to number of producers which were forced to buy uranium to perform their supplier obligations because of their technical mining problems. In comparison with a situation 5–10 years ago, availability of uranium from strategic reserves markedly declined and uncertainty about additional supplies of blended uranium from dismantled warheads after 2013 was increasing; on the contrary, consumers´ policy prevailed to enlarge and to hold the reserves in the long term.

As a result of the previous facts, the market was facing shortage of uranium and uranium spot price became exceptionally volatile. The spot price culminated in the beginning of June 2007 hitting a peak of 353,6 USD/kg U (136 USD/lb U_3O_8). The long term price indicators climbed to the level of 247 USD/kg U (95 USD/lb U_3O_8) and stabilised on it for 11 months until March 2008. After hitting its historical maximum the spot price started its steep decline fluctuating then between 195–242 USD/kg (75–93 USD/lb) in the second half of 2007. The spot price continued its fall during all 2008, however with lower volatility then in 2007. This fall was accelerated by the world financial collapse and the spot price bottomed at a low of 114,4 USD/kg in October 2008, as a number of sellers, led by financial and hedge funds destocking (in order to escape bankruptcy), pushed a sizeable amount of material to the market. On the other hand, demand remained limited and allowed just modest rebound of the price to 138 USD/kg in the end of the year. In principle, utilities, reasonably covered by their U stocks, were not willing to take part in purchasing competition when prices climbed to 260 USD and higher. During the downtrend period a majority of them were then waiting for the best purchasing opportunities.

A substantial difference between the lower spot price and the long-term price ("term price") in 2008 attracted other entities ("financial players") to the market which was primary a venue dominated by producers. The price difference meant arbitrage opportunities when buying on the low spot market and offering fixed-price forward sales for the midterm. It resulted in drop of the term price gradually to the 80 USD/lb U_3O_8 (208 USD/kg) level in July 2008. As the financial market collapsed in fall, the term price fell again and ended the year at the 182 USD level (72 USD/lb U_3O_8).

In 2005 the World Nuclear Association declared nuclear renaissance in relation to energy scarcity in countries like China and India and of a general growth of prices of all energy sources. For instance, China only plans to build 40 new nuclear power stations in future

15 years. Russia has similarly ambitious plans. In recent years, other countries such as the USA have announced a shift towards or a return to nuclear energy. In Europe these were e.g. Great Britain, Italy and Poland. One new reactor is already in a progressed phase of construction in Finland and construction of one started in France. Interest of many of former developing countries (Indonesia, Vietnam, Egypt, Yemen,, Turkey e.o.) to join the nuclear club represents a new trend, too. The new demand for uranium can help to stabilise uranium prices on a reasonable level which would support needed investment into exploration activities and opening of new mines.

The average prices of uranium concentrate in USD per kg of uranium (U) fluctuated as follows:

Price/Year	2003	2004	2005	2006	2007	2008
Annual average spot (TradeTech)	30.05	48.49	74.92	129.84	258.05	159.68
End of the year spot (Ux Weekly)	37.70	53.82	94.25	187.20	234.00	137.80
End of the year long-term Indicator (TradeTech) 1)	40.30	65.00	93.60	179.40	247.00	182.00
Long-term average in EU15 2)	34.50	36.32	41.76	48.23	56.16	69.47

Notes:
1) the price indicator shows the base price level for which it was possible to conclude long-term (multi-annual) supply contracts at the given time
2) ESA average prices for deliveries under long-term (multi-annual) contracts in the given year

10. Recycling

The majority of present-day reactors operate in the so-called open fuel cycle, i.e. that only approximately 5 % of the energy contained in the uranium fuel is consumed. In this case, spent fuel is stored (for 40–50 years) in intermediate storage facilities with the prospect of final disposal at permanent repositories constructed in a suitable geological environment. Meanwhile, only a small amount (due to economic as well as health and safety reasons) of spent fuel is reprocessed in the so-called closed fuel cycle, in order to lower amounts of highly radioactive waste and, furthermore, to use the unburned fissile material (^{235}U and ^{239}Pu) again as a fuel, which increases the efficiency of uranium utilisation by up to 30 %, compared to the open cycle. Fast neutron reactors or advanced fast reactors using other types of fuel and cooling fluids (He, Na, etc.) than current water- and gas-moderated reactors, offer the prospect of vastly more efficient use of uranium for energy needs.

11. Possible substitutes

Thermal and atomic power and propulsion reactors are designed for usage of a specific fuel and form of processed uranium (low enriched or natural uranium in thermal reactors, or highly enriched uranium in reactors of nuclear ships and submarines). From this point of view, there is no substitute for uranium in these types of reactors. Thorium (Th) is another primary element, which can be used as fuel in specially designed nuclear reactors. Currently, only India has been seriously considering future exploitation of Thorium for its ambitious nuclear energy programme due to a shortage of domestic uranium resources, and also due to early introduced restrictions by other countries on uranium import to India, because India has not yet signed the Nuclear Non-Proliferation Treaty. The restrictions were lifted over the last year. India is going to exploit Th in its future breeder reactors in conjunction with usage of plutonium, i.e., when a sufficient amount of Pu is accumulated from reprocessed spent fuel from current reactors. Norway is other country which has been recently considering pursuing the thorium fuel cycle on the basis of its vast Th resources. Norway is another country considering Th fuel cycle based on its vaste thorium reserves. Brazil studied thorium power plant too, at pilot scale during the 70s.

Within the framework of the total energy balance, the substitution of nuclear power as base load source is currently possible only by another energy sources, e.g. fossil fuels, however, these produce greenhouse gases. Positive and negative sides of nuclear power supply have been broadly discussed in the world, in particular in relation to electricity production from classical fuels – coal, oil and gas and their substitutes.

Nevertheless, urgent electricity needs in some fast-growing economies (China, India) and a broadly accepted idea of the necessity to prevent additional growth in emissions of greenhouse gases in developed countries seem to give birth to the nuclear renaissance.

INDUSTRIAL MINERALS
– geological reserves and mine production

In addition to energy minerals, industrial minerals represent the most important group of minerals on the territory of the Czech Republic. Raw materials for ceramic and glass industry are traditionally important as their geological reserves as well as mining concerns. Kaolin of the Plzeň (Pilsen) and Karlovy Vary regions as well as Kadaň and Podbořany regions is the most significant one. Other important raw materials are glass sand from Střeleč and Provodín surroundings, feldspar from Halámky, Krásno and Luženičky and clay from the Cheb Basin and central Bohemia. Reserves of limestone and raw materials for cement production are large and their mine production reaches high volume.

Kaolin, quartz sand, feldspar, clays and limestone represent also important export commodities in the mineral sector.

On the other hand, the former important period of graphite, pyrite, fluorite, barite and some other industrial mineral mining probably definitively terminated.

Mining of industrial minerals – reserved deposits

Raw material	Unit	2004	2005	2006	2007	2008
Graphite	kt	5	3	5	3	3
Pyrope-bearing rock	kt	42	43	39	34	24
Moldavite-bearing rock	kt	205	133	171	205	177
Kaolin	kt	3 862	3 882	3 768	3 604	3 833
Clays	kt	649	671	561	679	574
Bentonite	kt	201	186	220	284	174
Feldspar	kt	488	472	487	514	488
Feldspar substitute (phonolite)	kt	26	23	31	25	36
Silica minerals	kt	10	15	17	19	18
Glass and foundry sand	kt	1 659	1 727	1 736	1792	1 853
Fusible basalt	kt	12	14	19	16	16
Diatomite	kt	33	38	53	19	31
Limestones (total)	kt	10 568	9 912	10 193	11 279	10 957
high percentage limestones	kt	4 629	4 199	4 386	4 885	4 602
other limestones	kt	4 666	4 500	4 643	5 138	5 198
Dolomites	kt	345	419	409	385	449
Corrective additives for cement production	kt	232	278	248	391	507
Gypsum	kt	68	24	16	66	35

Lifetime of industrial reserves

(economic explored disposable reserves) based on the decrease of reserves by mine production incl. losses in registered deposits per year 2008 (A) and on the average annual decrement of reserves in period 2004–2008 (B) is as follows:

Raw material	Lifetime – A (years)	Lifetime – B (years)
Graphite	> 100	> 100
Pyrope-bearing rock	88	55
Moldavite-bearing rock *	4	4
Kaolin	42	42
Clays	> 100	> 100
Bentonite	> 100	> 100
Feldspar	46	46
Feldspar substitute (phonolite)	> 100	> 100
Glass and foundry sand	94	46
Silica minerals **	42	48
Fusible basalt	> 100	> 100
Diatomite	> 100	93
Limestones (total)	> 100	> 100
high percentage limestones	> 100	> 100
other limestones	> 100	> 100
Dolomites	> 100	> 100
Corrective additives for cement production	> 100	> 100
Gypsum	> 100	> 100

Notes:
* economic prospected disposable reserves
** reserves of mined deposits

1. Characteristics and use

Bentonite is a soft, very fine-grained heterogeneous rock of various colours, composed mostly of clay mineral montmorillonite, which originated mostly by submarine or atmospheric weathering of basic (to a smaller extent also of acid) volcanic rocks (mainly tuffs). Montmorillonite gives to bentonite its typical properties – high sorption capacity, characterized by a high value of cation exchange (the ability to receive certain cations from solutions, and replace them with its own molecules – Mg, and in some cases also Ca and alkalies); internal swelling after contact with water (some bentonites do not swell, but have a high absorptive capacity as bleaching clays, especially when they are activated); high plasticity and binding ability. Bentonite also contains other clay minerals (kaolinite, illite, beidellite), Fe compounds, quartz, feldspars, volcanic glass, etc., which represent impurities and if possible they are removed during the mineral processing.

World economic reserves of bentonite are estimated at more than 1,400 mill t.

Bentonite has many uses, which depend upon its mineralogical composition and technological properties. It is mostly used in the foundry industry, for pelletizing of iron ores (4–10 kg per tonne of pellets), as an adsorbent (decolourization, catalysis, refining, filtration, drying, waste water treatment, pesticide carrier), in drilling mud, as a filler (dyes, varnishes, pharmaceutical and cosmetic products), a suspension (lubricating oils), in the building industry (sealing material), in agriculture, etc. Bentonite use as a cat litter and a granulated food binder has been increasing recently.

2. Mineral resources of the Czech Republic

All bentonite deposits in the Czech Republic were formed by clay weathering of volcanic rocks. Bentonite deposits and reserves in the Czech Republic are almost exclusively concentrated in the area of the Doupovské hory Mts. and the České středohoří Mountains. A large portion of bentonite from these deposits is of the highest grade, suitable especially for the foundry industry (bonding agent for moulding sand) – both activated (Ca^{2+} and Mg^{2+} ions replaced by Na^{+} ions) and non-activated bentonites are used for this purpose.

Mining, mineral processing and use of bentonite in the Czech Republic started only in the late 1950s, particularly due to its use in the foundry industry. The mining culminated first both at the beginning and at the end of the 1980s (207 kt in 1987). Decreased demand from the foundry industry in the first half of the 1990s resulted in reduced mine production (54 kt in 1995). Mine production increased substantially in 1996–2000 especially due to the higher demand for non-traditional bentonite use (bedding, use in animal food, insulation materials etc.). This trend still continues.

- The eastern margin of the Doupovské hory Mts. at the contact with the North Bohemian Basin represents the most important area with bentonite deposits. A major part of the reserves and the largest bentonite deposits are concentrated in Kadaň and Podbořany surroundings. Rokle is the most important deposit mined at present.
- Bentonite deposits of the western margin of the Doupovské hory Mts. at the contact with the Hroznětín Basin are concentrated mainly in Hroznětín surroundings. Mining and

processing activity at Hroznětín-Velký Rybník deposit was terminated in 1993 for economic reasons. Large reserves were evaluated at several deposits at the end of the 1990s. A majority of these deposits (except Všeborovice deposit) have however unfavourable stripping conditions, they are less explored and in some cases also the raw material is of a lower quality than that of the Podbořany, Kadaň and Most regions deposits.

- Deposits of the Most region at the contact of the south – eastern margin of the North Bohemian Basin and the České středohoří Mts. represent the second most significant bentonite area of the Czech Republic at present. Braňany-Černý vrch, Stránce and Střimice deposits belong to the most important ones.
- Tertiary basins of the Plzeň region (Dnešice) and south Bohemian basins (Maršov, Rybova Lhota) represent the less important bentonite areas. Local raw material – mostly montmorillonite clay – is mostly of a lower quality. It is suitable mainly for agriculture or as a sealing material, to a lesser extent also for bedding production. Bentonites occur also in the Sokolov Basin, where the raw material suitable for bedding production (montmorillonite clay) mostly from the Božičany-Osmóza-jih deposit has been processed since 2004.
- Montmorillonite clays predominate in the Miocene sediments of the Carpathian Neogene in southern Moravia. The material is, with some exceptions (Ivančice-Réna), of a lower quality, suitable mainly for agriculture or as a sealing material. Two small deposits have been evaluated here (Ivančice-Réna, Poštorná).

Bentonite has been defined as a single raw material in The Register since 2006 – the foundry and other bentonite were therefore merged.

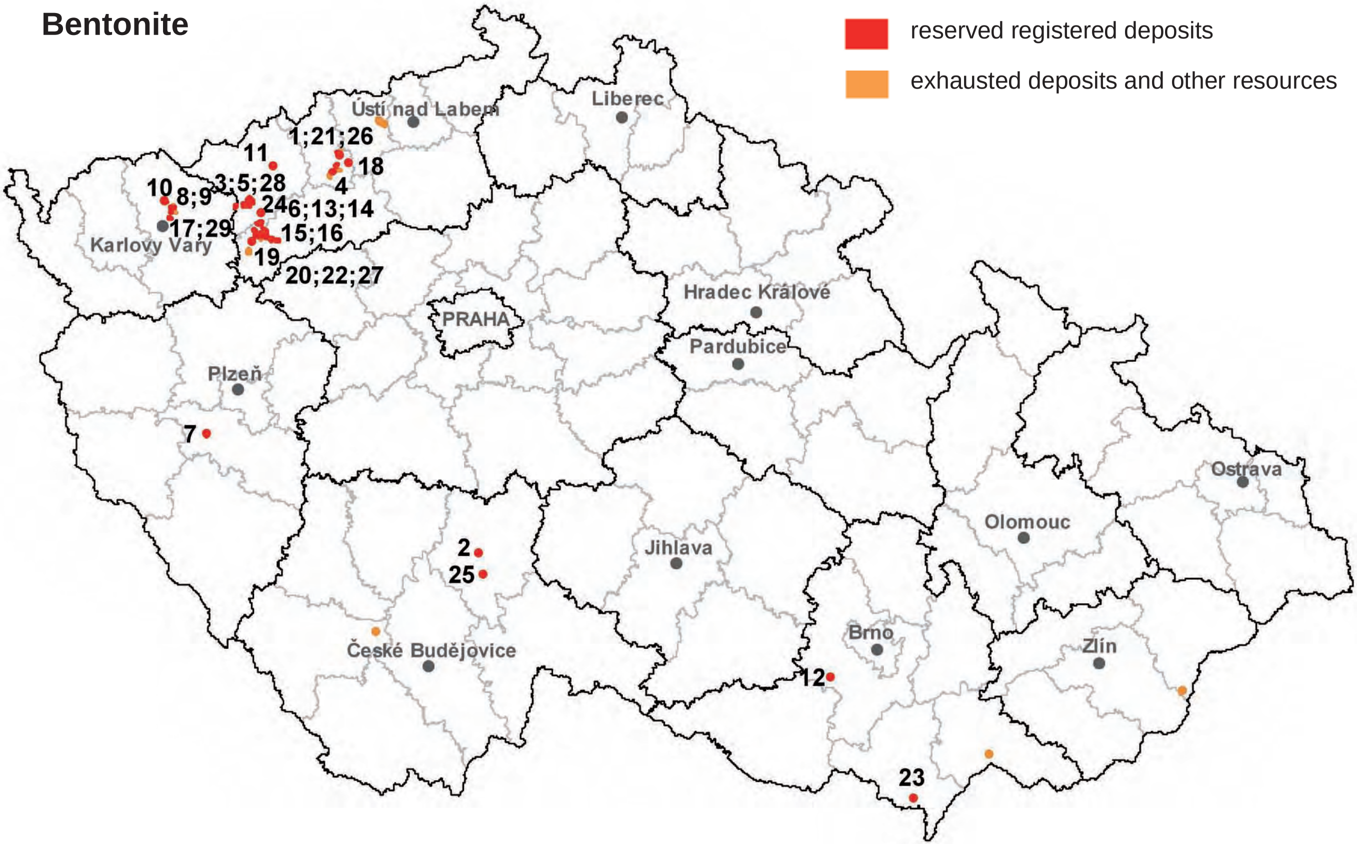
3. Registered deposits and other resources in the Czech Republic

(see map)

Names of mined deposits are indicated in **bold type**

1 **Braňany-Černý vrch**
2 **Maršov u Tábora**
3 **Rokle**
4 **Stránce**
5 Blov-Krásný Dvoreček
6 Blšany 2
7 Dnešice-Plzeňsko-jih
8 Hájek 1
9 Hájek 2
10 Hroznětín-Velký Rybník
11 Chomutov-Horní Ves
12 Ivančice-Réna
13 Krásný Dvůr-Brody
14 Krásný Dvůr-Podbořany
15 Krásný Dvůr-VysokéTřebušice 1
16 Krásný Dvůr-VysokéTřebušice
17 Lesov
18 Liběšice
19 Nepomyšl
20 Nepomyšl-Velká
21 Obrnice-Vtelno
22 Podbořany-Letov
23 Poštorná
24 Račetice
25 Rybova Lhota
26 Střimice 1
27 Veliká Ves-Nové Třebčice
28 Vlkaň
29 Všeborovice

Bentonite



reserved registered deposits
exhausted deposits and other resources
Ústí nad Labem
Liberec
Karlovy Vary
PRAHA
Hradec Králové
Pardubice
Plzeň
Ostrava
Olomouc
Jihlava
Brno
Zlín
České Budějovice
1;21;26
18
4
11
10
8;9
3;5;28
24
6;13;14
17;29
15;16
19
20;22;27
7
2
25
12
23

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	28	28	29	29	29
exploited	4	4	4	4	2
Total *reserves, kt	315 256	315 413	327 155	317 813	319 613
economic explored reserves	54 035	53 997	53 893	50 895	51 228
economic prospected reserves	168 104	168 104	177 893	162 625	163 176
potentially economic reserves	93 117	93 312	95 369	104 293	105 209
Mine production, kt**	224	216	267	335	235

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

** Including montmorillonite clays from kaolin deposits overburden

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	23 792	23 792	23 792	23 792	23 792
P_2,	kt	36 874	36 874	36 874	36 874	36 874
P_3		–	–	–	–	–

5. Foreign trade

250810 – Bentonite

	2004	2005	2006	2007	2008
Import, t	19 944	15 084	18 521	24 756	24 320
Export, t	62 012	85 146	86 298	97 474	105 408

250820 – Decolourizing earths and fuller's earth

	2004	2005	2006	2007	2008
Import, t	564	1 333	1 104	0	0
Export, t	27	0	1	0	0

Detailed data on bentonite imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	13 721	8 409	12 046	14 415	13 045
Germany	4 115	4 267	4 016	6 171	6 539
Italy	623	995	1 329	1 839	2 278
others	1 485	1 413	1 130	2 331	2 458

Detailed data on bentonite exports (t)

Country	2004	2005	2006	2007	2008
Germany	44 032	60 129	60 754	53 204	53 650
Austria	8 247	13 447	12 700	15 207	18 470
France	0	0	0	10 761	14 302
Poland	3 703	4 967	5 838	7 709	8 555
Slovakia	3 317	4 052	4 048	3 054	3 109
others	2 713	2 551	2 958	7 539	7 322

Bentonite belongs to minerals the export of which is several times higher than import (about four to five times in the last years). It has been traditionally imported mainly from Slovakia, from where also the high-quality raw material from the Jelšový potok 1 deposit and also Lastovce-Michaľany and Brezina-Kuzmice deposits is imported, and from Germany. The volume of import from Italy has been increasing recently. Czech bentonite is exported mainly to Germany (three-fold increase between 2002 and 2005) and to Austria, since 2007 newly also to France.

6. Prices of domestic market and foreign trade

250810 – Bentonite

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	3 192	4 688	3 782	5 001	3 817
Average export prices (CZK/t)	3 216	2 481	2 365	2 307	2 134

Technical bentonite, which can be used as sealing and backfilling material or as an additive in fertilizers, has been sold on domestic market for prices from CZK 3,000 per tonne. Import prices have been fluctuating between 2,000 and 6,500 CZK/t (100–350 USD/t) during the last five years. Export prices show much larger variations. However, they have decreased recently significantly in consequence of the marked increase of the volume of export to Germany. The average export prices oscillated between 105 and 115 USD/t between 2005 and 2007 and between 95 and 140 USD/t in 2008, depending on quality and grade.

7. Mining companies in the Czech Republic as of December 31, 2008

KERAMOST a.s., Most

LITH s.r.o., Malé Chvojno

8. World production

Annual world production of bentonite is about 15 mill tonnes. World production oscillated between 10 and 15 mill tonnes in the last 5 years. Data of the individual statistical reviews differ considerably. The mine production of China has increased by about 1 mill tonnes, i.e. by full 50 %, during the last 5 years. The mine production of the Europe´s largest producer Greece as well as the largest world producer the USA has been decreasing too, although with small fluctuations. Mine production in Great Britain, Russia and Turkey markedly decreased whereas that of Mexico, Argentine, Brazil and namely India (three-fold production) increased during the last five years. World production of the so-called fuller´s earth (Ca-bentonite in fact) has been oscillating between 3.9 and 5.6 mill t during the recent years (according to the Mineral Commodity Summaries).

World bentonite mine production

Year	2004	2005	2006	2007	2008
Mine production, kt (MCS)	10 500	11 700	11 700	11 900	12 000
Mine production, kt (WBD)	13 688	13 731	14 630	15 001	N

Main producers' share in the world mine output (2007; according to WBD):

USA	32,1 %	Italy	4,0 %
China	21,3 %	Russia	3,3 %
Greece	9,2 %	Japan	2,8 %
India	4,2 %	Turkey	2,7 %
Mexico	4,1 %	Germany	2,6 %

The share of the Czech Republic for 2006 is about 2.0 % (11th place) as given by WBD.

Important European bentonite producers are united in the European Bentonite Producers Association (EUBA), which is a member of the European Industrial Minerals Association (IMA). In 2007, the EUBA members were as follows: Bentonite Performance Minerals, Cebo Holland, Cetco Europe Ltd., Damolin A/S, Laviosa Chimica Mineraria Spa, Oil Dri, Peletico Ltd., Rockwood Additives Ltd., S&B Industrial Minerals S.A., Steetley Bentonite & Absorbents Ltd., Süd-Chemie AG and Tolsa S.A.

9. World market prices

Bentonite prices showed short-term fluctuations in the last few years. The higher increase in price of some types of bentonite came in 2000. The prices of a majority of the mentioned categories continued to increase in 2001 and stagnated in 2002–2004. The price of the foundry bentonite of Indian provenance rose markedly in 2005. Subsequently prices of American bentonite from Wyoming increased by 7–40 % in 2006. There was no further price increase in 2007. According to quotations in the Industrial Minerals magazine, the average prices at year-end were as follows:

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Wyoming, crude, bulk, rail hopper cars, FOB ex-works	USD/st	44.50	46.50	59.00	59.00	72.00
Wyoming, foundry grade, bagged, rail cars, FOB ex-works	USD/st	63.00	63.00	67.50	67.50	80.00
Wyoming, API, bagged, rail cars, FOB ex-works	USD/st	48.00	48.00	67.50	67.50	85.00
Indian bentonite, cat litter grade, crushed, dried, bulk, FOB Kandla	USD/t	36.00	36.00	36.00	36.00	37.00
Indian bentonite, foundry grade, crushed, dried, bulk, FOB Kandla	USD/t	42.50	67.50	67.50	67.50	67.50
Cat litter grade, 1–5 mm, bulk, FOB main European port	EUR/t	40.00	43.50	43.50	43.50	60.00

10. Recycling

Bentonite can be recycled on a very limited scale only.

11. Possible substitutes

In moulding sand, bentonite can be replaced by bonding agents containing graphite, synthetic polymers, or other clay minerals. Drilling mud can use similar substitutes; fillers can use chalk, dolomite, limestone, etc., in ecological applications bentonite can be replaced by zeolites. Bentonite begins to be replaced by cheap chalk or silica-based litter for cats (or some form of cellulose (cardboard-base) product). In production of iron ore pellets, burnt lime, polymers and other binders can replace bentonite.

Clays

1. Characteristics and use

Clays are sedimentary or residual unconsolidated rocks consisting of more than 50 % of clay fraction (particle size less than 0.002 mm), containing as the major constituent clay minerals, particularly those of the kaolinite group, but also hydromicas (illite) and montmorillonite (see bentonite). Depending on the composition of clay minerals, clays are divided into monomineral (e.g. kaolinite, illite, etc.) and polymineral clays (composed of more clay minerals). Clays can contain various admixtures, e.g. quartz, micas, carbonates, organic matter, oxides and hydroxides of Fe, etc. Their colour depends on admixtures and can be white, grey, yellow, brown, violet and commonly green, etc. They can be also secondarily consolidated (claystones) or recrystallized unmetamorphosed (shales or clay shales).

From the point of view of deposits and further technological processing, this category includes a wide selection of rocks rich in clay minerals. Abroad, bentonite, brick-clays and even kaolins are often included in this category. Clays can be found in virtually all sedimentary formations all over the world. They are mostly used in production of ceramics, as refractory and sealing materials, fillers, in paper industry and for filtration of oils, etc.

2. Mineral resources of the Czech Republic

According to the technological properties and use, the clays in the Czech Republic are classified as follows:

- Whiteware clays – they are used as a raw material for the production of ceramics with white- or light-burning colour, sintering at temperatures over 1 200 °C. The clay minerals are represented mostly by kaolinite; the content of clastic particles is low.
- Refractory clays for grog (fireclays) – after firing these clays are suitable as grog for production of fireclay products. The material is required to contain maximum Al_2O_3 and a minimum Fe_2O_3; other required parameters are very high refractoriness and the lowest possible absorption capacity after firing. The major clay mineral is again kaolinite (and/or dickite).
- The other refractory (ball) clays – used as binding (plastic) clays in the production of mainly refractory products. Besides high binding properties they should contain as low amount of Fe_2O_3 and clasts as possible.
- Non-refractory ceramic clays – clay minerals of wide technological properties and uses (production of floor and wall tiles, additives, etc.) range.
- Aluminous underlying clays – kaolinite clays underlying the coal seams near Most in the North Bohemian Basin, containing about 40 % Al_2O_3, locally 3–7 % TiO_2 and usually a large amount of siderite. These clays were considered as a possible source of Al in the past. They are of no importance today due to the energy-intensive processing. They are moreover overlain by waste dumps of coal mines.

Clay deposits in the Czech Republic are concentrated in the following major areas:

- The Kladno-Rakovník Permocarboniferous – the deposits contain mostly high-grade refractory claystones (shales or schistose clays), fireclays, which are used in the production of refractory grogs. Less common are deposits of red-burning tile clays and grey non-refractory claystones (non-refractory ceramic clays). A large Rynholec-Hořkovec 2 deposit and a smaller Lubná-Marta deposit represent the most important deposits.

- Moravian and east Bohemian Cretaceous sediments – this is the area of the largest clay reserves (fireclays), with the same use as the ones from the previous area (but of a slightly lower quality). A single deposit Březinka is mined at present.
- Cretaceous sediments in the Prague surroundings – these clays are suitable as a highly refractory (non-plastics) grog (fireclays) and refractory binding clays (ball clays), as well as whiteware clays. The most important are deposits of fireclays Vyšehořovice and Brník.
- The Louny Cretaceous – these clays are suitable as whiteware clays and other refractory (ball) clays, but particularly as (non-refractory) ceramic clays. A medium-sized Líšťany deposit (non-refractory ceramic clays) is the only deposit mined at present.
- South Bohemian Basins – medium or high-grade refractory clays, suitable for use namely as binding clays (ball clays), whiteware clays and non-refractory ceramic clays. Borovany-Ledenice (ball clays, diatomite is mined here, too) and Zahájí-Blana represent the main deposits.
- The Plzeň Basin and Tertiary relics of Central and Western Bohemia – mostly medium grade refractory clays, classified as binding (ball) clays and ceramic non-refractory clays for production of floor and wall tiles, as well as for stoneware. The large Kyšice-Ejpovice deposit of ball clays is the most important deposit here.
- The Cheb and Sokolov Basins – more significant is the Cheb Basin containing important binding (ball) clays, whiteware clays, refractory and sintering (non-refractory) clays (JO, JN), etc. Nová Ves u Křižovatky 2 represents the significant exploited deposit of ball clays.
- North Bohemian and the Žitava (Zittau) Basins – apart from high aluminous underlying clays, there are also overlaying ceramic (mostly sintering and tile) non-refractory clays. Only a medium-sized deposit of non-refractory clays Tvršice in the North Bohemian Basin is mined.
- Tertiary and Quaternary sediments in Moravia – mostly ceramic non-refractory (sintering and tile) clays. The mining in this region was restarted in 2008 (Poštorná).

The most important areas with clay deposits in the Czech Republic are nowadays Cheb Basin, south Bohemian Basins, Cretaceous in the Prague surroundings, Permo-Carboniferous of Rakovník region and less Cretaceous of Moravia and eastern Bohemia. Clays and claystones in the Czech Republic are extracted by open-pit mining and only locally by underground operations (Lubná, Březinka).

3. Registered deposits and other resources in the Czech Republic

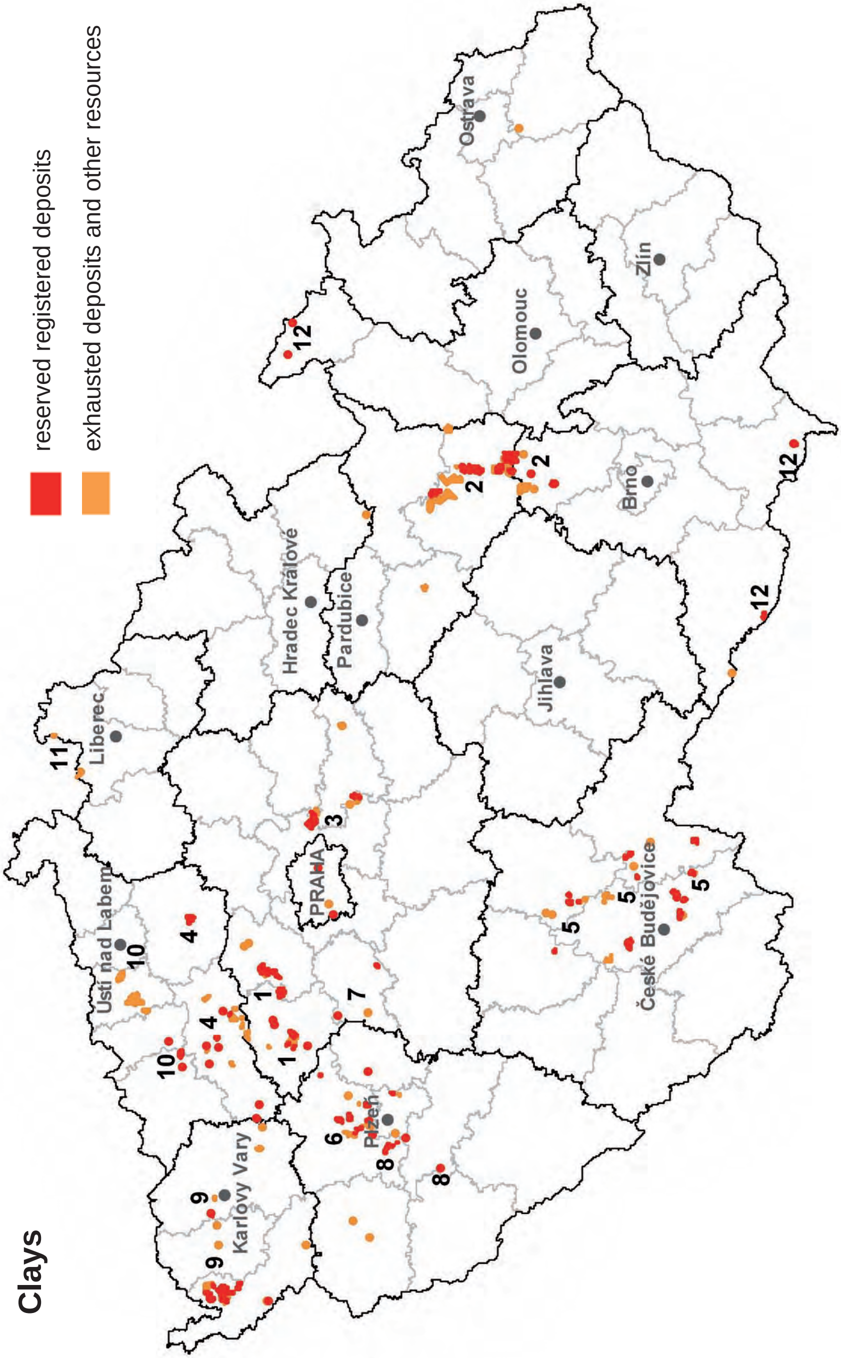
(see map)

Principal areas of deposits presence:

(Names of areas with mined deposits are indicated **in bold**)

1	**Kladno-Rakovník Permo-Carboniferous**	7	**Tertiary relics of Central Bohemia**
2	**Moravian and East-Bohemian Cretaceous**	8	**Tertiary relics of Western Bohemia**
3	**Cretaceous in the Prague surroundings**	9	**Cheb Basin and Sokolov Basin**
4	**Louny Cretaceous**	10	**North-Bohemian Basin**
5	**South-Bohemian Basins**	11	Zittau Basin
6	**Plzeň Basin**	12	Tertiary and Quaternary in Moravia

Clays



reserved registered deposits
exhausted deposits and other resources
Liberec
Ústí nad Labem
Hradec Králové
Pardubice
PRAHA
Ostrava
Olomouc
Zlín
Brno
Jihlava
České Budějovice
Plzeň
Karlovy Vary

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	111	111	110	106	124
exploited	25	25	22	21	19
Total *reserves, kt	959 285	956 937	944 607	927 520	927 639
economic explored reserves	193 861	193 230	188 102	185 168	179 551
economic prospected reserves	416 348	414 014	411 630	396 645	397 614
potentially economic reserves	349 076	349 693	344 875	345 707	350 474
Mine production, kt	649	661	561	679	574

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	83 544.19	83 544.19	83 544.19	83 544.19	83 544.19
P_2,	kt	38 196.00	38 196.00	38 196.00	38 196.00	38 196.00
P_3		–	–	–	–	–

Domestic production of selected intermediate products

Year / kt	2004	2005	2006	2007	2008
Fire-clay	26.1	24.9	23.8	27.2	23.7
Non-shaped refractories	82.0	96.1	85.6	96.1	81.3
Other refractories	67.0	66.2	68.4	101.0	82.9

5. Foreign trade

2508 – Other clays (except expanded clays), andalusite, kyanite, sillimanite, also baked, mullite, fire-clay or ganister earths

	2004	2005	2006	2007	2008
Import, t	59 004	57 634	64 285	70 556	64 625
Export, t	230 108	209 718	189 026	201 953	216 133

As the item 2508 includes various raw materials (often with a different way of application), also numbers on foreign trade on chosen sub-items are given below:

250830 – Refractory (fire) clay

	2004	2005	2006	2007	2008
Import, t	11 937	11 294	18 087	23 275	14 114
Export, t	41 722	35 140	36 623	31 830	30 663

Detailed data on refractory clay imports (t)

Country	2004	2005	2006	2007	2008
Poland	9 869	8 421	14 655	14 022	9 268
Germany	767	1 891	1 531	5 905	3 348
Ukraine	1 236	893	1 720	3 109	1 240
others	65	89	181	239	258

Detailed data on refractory clay exports (t)

Country	2004	2005	2006	2007	2008
Germany	13 787	21 509	23 729	20 053	18 579
Slovakia	8 074	5 800	5 507	3 901	4 942
Italy	2 452	1 413	1 148	970	1 116
Austria	11 558	201	234	910	848
others	5 851	6 237	6 005	5 996	5 178

Refractory clays belong to the most important items of clay foreign trade. The volume of imports roughly doubled between 2003 and 2006 as a result of increased imports from Poland. In contrast, traditionally high export has been gradually decreasing during the last years. Czech refractory clays are exported mainly to Germany and Slovakia. Whereas the volume of exports to Germany has been increasing, exports to Slovakia decreased to one half during the period 2002–2006 and decreased also in 2007. Export to Austria has become less important in recent years.

250840 – Other clays

	2004	2005	2006	2007	2008
Import, t	16 892	23 955	17 655	14 055	16 478
Export, t	44 383	6 979	8 940	11 405	11 128

250870 – Fireclay or ganister earths

	2004	2005	2006	2007	2008
Import, t	5 889	2 235	2 168	2 862	3 026
Export, t	81 891	82 246	56 556	61 124	68 933

6. Prices of domestic market and foreign trade

250830 – Refractory (fire) clay

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	1 264	1 625	1 896	1 932	2 306
Average export prices (CZK/t)	1 766	1 402	1 249	1 331	1 184

250840 – Other clays

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	2 906	1 920	1 985	3 038	1 995
Average export prices (CZK/t)	834	1 863	1 815	2 237	2 090

250870 – Fireclay or ganister earths

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	3 214	5 847	5 309	4 617	4 147
Average export prices (CZK/t)	3 009	3 035	3 300	3 405	3 301

Different qualities of clay and schistose clay have different market prices. For example, crude refractory clay is delivered at CZK 450–850 per tonne, average price is roughly CZK 650 per tonne, dried refractory clay reaches CZK 860–2,000 per tonne, and average prices are about CZK 1,400 per tonne. Kaolinic clay with high plasticity and refractoriness of about 1,700 ^{o}C were sold for CZK 450–1,110 in crude state and for CZK 2,500–5,000 dried.

Prices of crude sintering clay oscillate between CZK 200–800 per tonne, average price is CZK 450 per tonne. Dried sintering clay is sold at CZK 1,200 per tonne. Prices of crude bleaching clay oscillate between CZK 400 and CZK 1,700 per tonne, average price is about CZK 1,300 per tonne, prices of dried bleaching clay reach CZK 1,400–3,000 per tonne, and average price is about CZK 2,200 per tonne. The average prices of other crude clays are about CZK 300 per tonne; prices of dried ones are about CZK 1,450 per tonne.

Prices of crude schistose clay on the domestic market oscillate between CZK 400–600 per tonne. Calcined schistose clay is sold at CZK 2,600–4,000 per tonne.

Prices of clays differ according to locality except product finishing. E. g. prices of Nová Ves clays vary within CZK 320–950 per tonne, of Vackov 200–630, of Suchá CZK 650–1,200 per tonne.

7. Mining organizations in the Czech Republic as of December 31, 2008

LB Minerals a.s., Horní Bříza

KERAMOST a.s., Most

České lupkové závody a.s., Nové Strašecí

P-D Refractories CZ a.s., Velké Opatovice

Sedlecký kaolín a.s., Božíčany

RAKO – Lupky s.r.o., Lubná u Rakovníka

Kaolin Hlubany a.s., Podbořany

8. World production

Overall data on the world production of clays are not available. There are some partial statistics on certain grades of clays; according to these, the production of clays has been slowly but steadily growing. Total yearly production of clays in the USA has been approximately 26 mill tonnes in the last years with a decreasing trend. Germany, Canada, Ukraine, Thailand and Austria belong to important refractory clay producers.

9. World market prices

The average prices of most of the clays were steadily growing. Prices of some of the clays were quoted each month in the Industrial Minerals magazine.

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Refractory clay, 45 % Al_2O_3, FOB China	USD/t	67.50	84.00	84.00	84.00	84.00
Calcined kaolinic clay, 47 % Al_2O_3, FOB EU	USD/t	140.00	140.00	140.00	140.00	140.00

10. Recycling

The material is not recycled.

11. Possible substitutes

A majority of the clays are used in various fields of ceramics production. Depending on the use, the following substitutes are possible:

- Whiteware clays used in ceramic recipes – here the clays are irreplaceable. On the contrary, the selection of clays used is still wider, depending on local resources and new recipes.
- Clays for grogs – especially in production of fireclay and similar materials, the clays can be successfully substituted by a number of refractory materials – andalusite, mullite (recently even synthetic mullite), etc. – depending on the use and local availability.
- The same applies to clays used in production of other refractory products; there are a number of possible substitutes, which depend on the purpose and use of these products, economic limits, and local resources.
- Clays for non-refractory ceramic products (earthenware pipes, tanks for acids, floor and wall tiles, jars, etc.) – besides natural mineral substitutes (such as halloysite for floor tiles, mineral pigments instead of colour-burning clays, cast basalt), other possible substitutes can be glass (tiles), artificial stoneware (floor tiles, paving bricks, slabs), metals, plastics, etc. However, in the ceramic production itself, the clays are irreplaceable.
- Titanium-bearing and aluminous clays are a potential source of titanium and aluminium and as such represent a substitute for traditional metallic ores of these elements.

1. Characteristics and use

Diatomite is a sedimentary rock, consisting mainly of the microscopic cells of freshwater or marine diatoms. This rock shows various degrees of consolidation – it is either loose (diatomaceous earth) or consolidated (diatomaceous shale or chert). Loose rock has a character of very fine-grained sediment. Shells are partly dissolved during diagenesis and the sediment is impregnated by released opal, which leads to consolidation and schistosity development. Polishable and absorbing shales, sometimes even opal cherts are distinguished depending on the degree of porosity. Chemically, diatomite is dominated by $SiO_{2,}$ the content of which should be the highest possible. From the technological point of view, important parameters are porosity, resistance against acids, refractoriness, thermal and electric conductivity, density, moisture, chemical composition et al. Clastic, clayey and organic particles (sponges) and higher Al_2O_3, Fe_2O_3 and CaO contents are contaminants. Deposits originate in water basins with low content of $CaCO_3$ and suspended aluminosilicate material. The most favourable conditions are in cool water near volcanic areas. The world economic reserves are estimated at 800 mill t, about 250 mill t of which occurs in the USA.

The material is used for filtration purposes (the highest grades), in production of fillers (rubber, paper, cosmetics), as abrasives, as carrier for catalysts, and in building industry for manufacturing of thermal and sound insulating materials.

2. Mineral resources of the Czech Republic

Diatomite accumulations in the Czech Republic are confined to areas with Tertiary and Quaternary lake sediments, first of all to the Tertiary sediments of the South Bohemian basins and volcanic rocks of the České středohoří Mts. Smaller occurrences are known from other areas of the Bohemian Massif and in the Neogene of the Carpathian Foredeep and flysh.

- The biggest accumulations of diatomite in Bohemia are situated in the south Bohemian basins. Spongy diatomites and diatomaceous clays (low-grade building diatomites) occur together with lignite. The only registered and also mined deposit in the Czech Republic – Borovany-Ledenice – is located in the Třeboň Basin. Tertiary sediments were deposited in tectonically confined space on the Moldanubian basement. Deposit layer of diatomites, diatomite clays and spongy diatomites occur in the upper part of the Mydlovary Formation. Diatomites are in subhorizontal position, of whitish grey to ochre colour, unconsolidated with average thickness about 8.5 m (15 m at maximum). High-grade diatomite is used after processing for filtration purposes or as filler in food, chemical, pharmaceutical industries, etc. The highest-grade (extra pure) diatomite is used in wine, spirits, beer, edible oil or fat filtration. Diatomite of lower grade is suitable mostly for building and insulation materials production. It is partly used for cat litter production at present.
- Many diatomite outcrops, which were occasionally mined already in the first half of the 19th century as a raw material for abrasives and polishing materials production, are known in the České středohoří Mts. The most significant deposit Kučlín was mined out in 1966. These occurrences are of no importance at present.

- Lens-shaped occurrences of diatomites in the Carpathian flysh south of Brno (Pouzdřany) were prospected, with a negative result.
- Quaternary diatomites are known from the Most (together with lake mud rich in organic matter) and Františkovy Lázně surroundings (deposit Hájek – earlier mined together with peat, nowadays a natural preserved area Soos).

3. Registered deposits and other resources in the Czech Republic

(see map)

Mined deposit:

1 **Borovany-Ledenice**

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	1	1	1	1	1
exploited	1	1	1	1	1
Total *reserves, kt	4 562	4 519	4 451	4 432	4401
economic explored reserves	4 234	4 191	4 123	4 104	4073
economic prospected reserves	328	328	328	328	328
potentially economic reserves	0	0	0	0	0
Mine production, kt	33	38	53	19	31

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

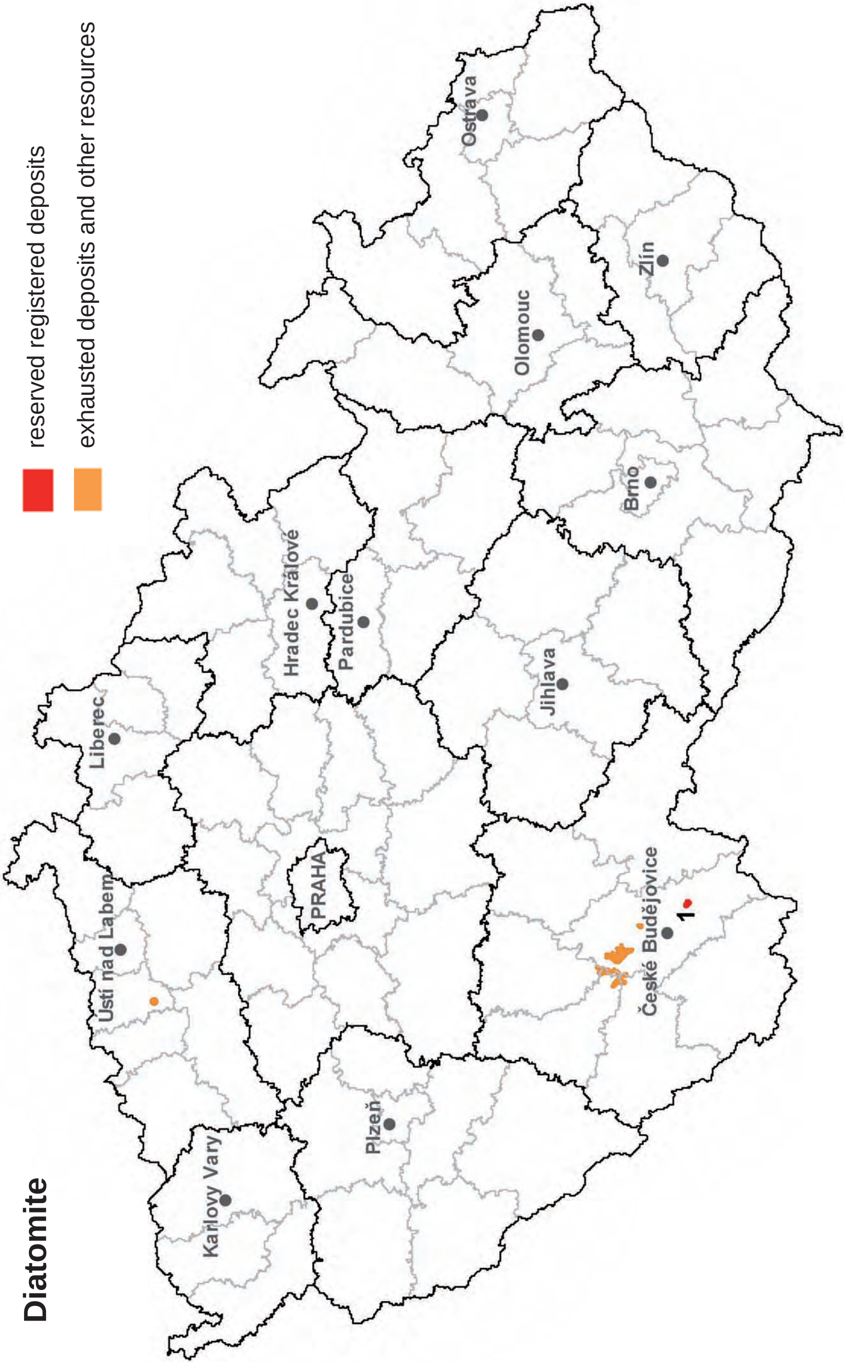
5. Foreign trade

2512 – Siliceous fossil meal*, siliceous earth

	2004	2005	2006	2007	2008
Import, t	1 969	2 267	2 262	3 273	4 776
Export, t	4 734	4 274	4 566	3 616	4 147

Note: * diatomite

Diatomite


reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Jihlava
Liberec
PRAHA
Ústí nad Labem
České Budějovice
1
Plzeň
Karlovy Vary

Detailed data on diatomite imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	0	0	0	434	1 181
Italy	12	26	3	223	990
Denmark	310	479	567	585	986
France	674	675	438	749	704
Mexico	2	2	2	606	323
USA	767	843	996	481	90
others	204	242	256	195	502

Detailed data on diatomite exports (t)

Country	2004	2005	2006	2007	2008
Germany	1 389	1 337	1 817	1 646	1 765
Austria	1 811	1 461	1 180	956	921
Switzerland	261	400	554	522	612
others	1 273	1 076	1 015	492	849

6901 – Bricks, blocks etc. and other ceramic goods of siliceous fossil meals

	2004	2005	2006	2007	2008
Import, t	1 612	1 839	3 938	3 697	3 197
Export, t	215	978	3 303	4 684	191

The import volume has been oscillating between 2 and 5 kt of high-quality raw material per year with gradually increasing trend in the last years. The volume of the Czech export has traditionally been two to three times higher. However, the import to export balance has gradually been equilibrating in recent years. Diatomite is imported to the Czech Republic traditionally from France, the USA and Denmark, in recent years also newly from Slovakia and Italy. Czech diatomite of lower grade is exported mainly to neighbouring countries.

6. Prices of domestic market and foreign trade

2512 – Siliceous fossil meal*, siliceous earth

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	12 391	10 864	12 945	10 803	6 985
Average export prices (CZK/t)	8 661	8 427	8 520	8 825	9 069

Note: * diatomite

Diatomite for filtration purposes of variable parameters (filtration velocity, pouring mass, pH) is sold for CZK 14–15 thousand per tonne on domestic market. Crushed diatomite was hawked for CZK 8,400 per tonne. Diatomite absorbent, used as pet litter, or to remove bad smells were accessible for prices of about CZK 40 per kg. Markedly higher import prices, reflecting difference in quality, are typical for the foreign trade prices. Marked decrease in import prices to one half in 2008 was caused by import of a higher amount of lower-grade diatomite from Slovakia.

7. Mining companies in the Czech Republic as of December 31, 2008

LB Minerals a.s., Horní Bříza

8. World production

World production of diatomite oscillated between about 1 and 2 mill t per year. Data of the individual statistical reviews differ considerably; the yearbook Welt Bergbau Daten (WBD) gives traditionally lower values, mine production in China is however not included in the totals.

World diatomite mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt (MCS)	1 930	2 020	2 160	2 100	2 000
Mine production, kt (WBD)	1 357	1 377	1 592	1 473	N

Main producers' share in the world mine output (2007; according to MCS):

USA	32.7 %	France	3.6 %
China	20.0 %	Mexico	3.0 %
Denmark	11.0 %	Czech Republic	2.6 %
Japan	5.7 %	Germany	2.6 %
Countries of the former USSR	3.8 %	Peru	1.7 %

9. World market prices

Only prices of the American diatomite are published on the world market. Average prices on the American market ex-works oscillated between USD 220 and 270 per tonne. Diatomite is quoted in the renowned magazine Industrial Minerals monthly as CIF, UK. World prices of both diatomite sorts have been very stable.

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Diatomite calcined, filtration, CIF UK	GBP/t	390.00	390.00	390.00	390.00	390.00
Diatomite calcined, burned, filtration, CIF UK	GBP/t	400.00	400.00	400.00	400.00	400.00

10. Recycling

Diatomite can be recycled only on a very restricted scale.

11. Possible substitutes

Diatomite, which has a number of applications due to its unique properties, can be replaced by a number of materials. In filtration – the dominant area of use – it can be replaced by expanded perlite or quartz sand, respectively by various types of membranes. Substitutes are, however, seldom as effective as diatomite. As filler, diatomite can be replaced by talc, ground quartz sand, crushed mica, some clay types, perlite, vermiculite or ground limestone. As a heat insulating material, it can be replaced also by various types of clay and bricks, mineral wool, expanded perlite or vermiculite. As friction material, it can be replaced by asbestos, barite, bauxite, alumina, clays, graphite, gypsum, mica, pumice, pyrophyllite, silica, slate, vermiculite and zircon.

Dolomite

1. Characteristics and use

In the Czech Republic, carbonates containing at least 27.5% of $MgCO_3$ and more than 80 % of $MgCO_3$ + $CaCO_3$ are classified as dolomites.

Pure dolomite is important material for glass, ceramic and chemical industries. Dolomitic rocks are used in production of dolomitic lime, hydrated lime, magnesium cements, and magnesia refractories for metallurgy, in desulphurization of power station waste gases. They are also used as dimension stone, in production of fertilizers and fillers and often also for crushed stone production and other building purposes. And as acid soil correctives.

2. Mineral resources of the Czech Republic

Dolomite and calcitic dolomite deposits and occurrences are located in the following main regions of the Czech Republic:

- Crystalline Complex of the Krkonoše–Jizerské hory Mts. – crystalline calcitic dolomite and dolomite deposits in the form of lenses in host rocks. This region is the most important in the Czech Republic, because it has the highest number of deposits and the largest volume of reserves. The largest and the most important deposit of dolomites in the Czech Republic Horní Lánov contains raw material with 32 % of CaO and nearly 19 % of MgO on average.
- Šumava Mts. and Bohemian Moldanubicum – it contains several smaller pure dolomite deposits (mined deposit Bohdaneč, abandoned deposit Jaroškov) and calcitic dolomite deposits (Podmokly, Krty).
- Crystalline Complex of the Krušné hory Mts. – several small deposits near Kovářská and Přísečnice (for instance mined-out deposit of pure dolomite Vykmanov).
- Moravian branch of the Moldanubicum with small but often high-quality dolomite occurrences (mined-out deposit Dolní Rožínka) and little explored prognostic resources (Lukov at Moravské Budějovice, Číchov et al.).
- Devonian of the Barrandian – a typical dolomite deposit (Velká Chuchle) already mined out.
- The Orlické hory Mts.–Kłodzko crystalline complex and Silesicum (Velké Vrbno group) – several smaller deposits (Bílá Voda).
- Moravian (Čelechovice–Přerov) Devonian near Olomouc – with two larger deposits of Lažánky calcitic dolomites (Hněvotín, Bystročice), associated here with Vilémovice limestones (VO). The average content of Mg in both deposits is 17 %. Another medium-sized deposit of Lažánky calcitic dolomites occurs near Čelechovice. The reserves are blocked by the spa protection zone.

Krkonoše–Jizerské hory Mts. Crystalline Complex and Moravian Devonian are the most important regions where dolomites partly occur in some deposits (Lánov, Hněvotín), but these are mainly calcitic dolomites. Deposits of the Šumava branch of the Moldanubicum are usually smaller or formed by impure calcitic dolomites. In the other regions, dolomites form only smaller lenses and they are often not enough explored (especially in the western Moravia).

3. Registered deposits and other resources in the Czech Republic

(see map)

Names of mined deposits are indicated in **bold type**

1	**Bohdaneč**	5	Hněvotín	9	Kryštofovo Údolí
2	**Lánov**	6	Horní Rokytnice	10	Křížlice
3	Bystročice	7	Jesenný-Skalka	11	Machnín-Karlov pod Ještědem
4	Čelechovice na Hané	8	Koberovy	12	Podmokly

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	12	12	12	12	12
exploited	2	2	2	2	2
Total *reserves, kt	515 382	514 963	514 554	514 168	513 719
economic explored reserves	80 255	79 836	79 427	79 041	78 600
economic prospected reserves	340 843	340 843	340 843	340 843	340 843
potentially economic reserves	94 284	94 284	94 284	94 284	94 276
Mine production, kt	345	419	409	385	449

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	23 946	23 946	23 946	23 946	23 946
P_2		–	–	–	–	–
P_3		–	–	–	–	–

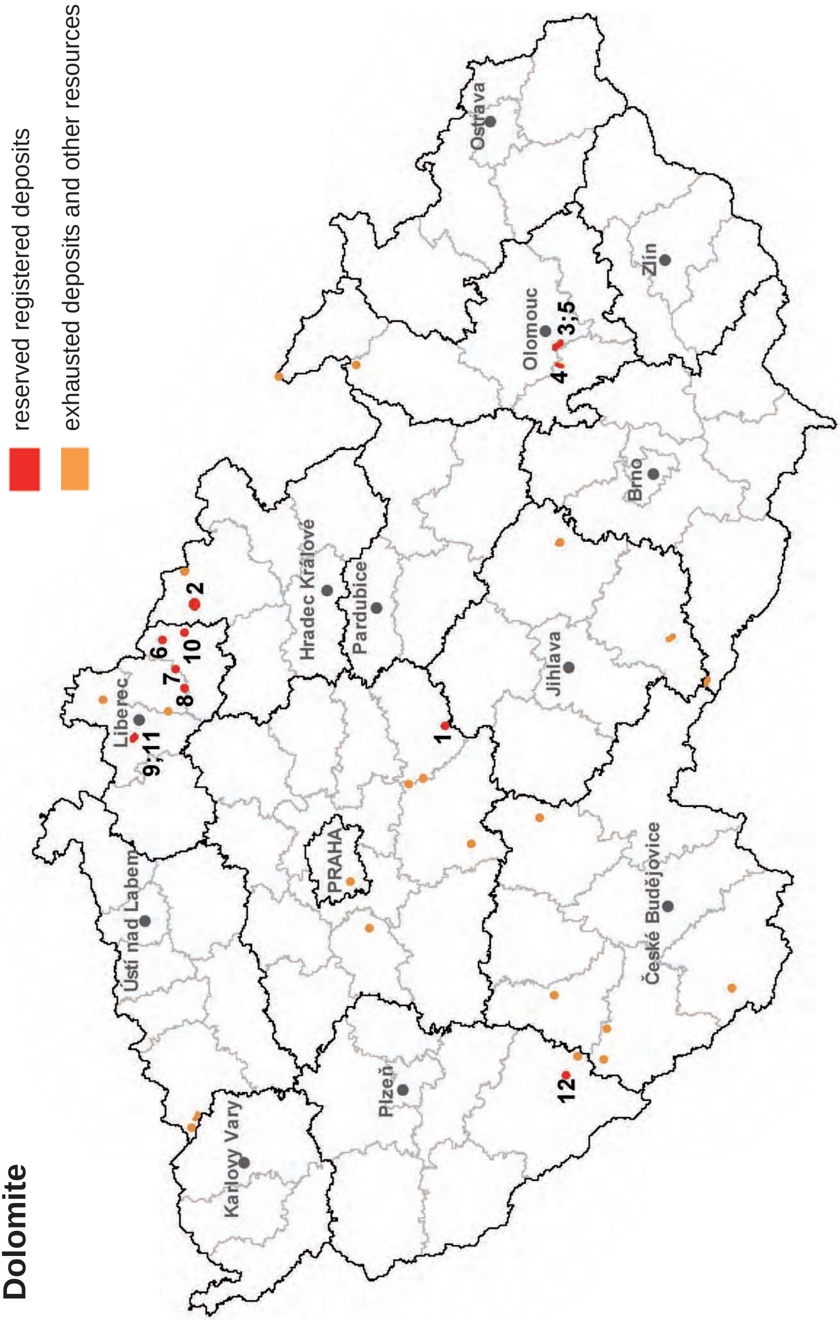
5. Foreign trade

2518 – Dolomite calcined, roughly worked or cut; agglomerated

	2004	2005	2006	2007	2008
Import, t	463 601	364 125	447 424	493 559	587 459
Export, t	14 403	13 164	19 047	19 908	22 613

Predominant part of dolomite (and dolomitic limestones in form of crushed stone) comes from the neighbouring Slovakia. In contrast, predominant part of the Czech export is directed to Poland. High-quality white dolomite is exported for markedly higher export prices.

Dolomite


reserved registered deposits
exhausted deposits and other resources
Ostrava
Olomouc
Zlín
Brno
Hradec Králové
Pardubice
Liberec
Ústí nad Labem
PRAHA
Jihlava
České Budějovice
Plzeň
Karlovy Vary
1
2
3;5
4
6
7
8
9;11
10
12

6. Prices of domestic market and foreign trade

2518 – Dolomite calcined, roughly worked or cut; agglomerated

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	288	261	214	224	238
Average export prices (CZK/t)	2 205	2 863	2 587	2 389	2 379

Prices of lump dolomite are from CZK 75 per tonne; prices of dolomite aggregates reach CZK 210–350 per tonne depending on granularity. Ground calcitic dolomite is sold in bulk at CZK 600-690 per tonne, on pallets at CZK 1,615 per tonne. Crushed white dolomite is offered from 950 CZK/t (0–2 mm) to 1,330 CZK/t (2–5, 5–8, 8–16 mm).

The average prices of traded commodities on the domestic market

Product specification	2006	2007	2008
Dolomite aggregates, CZK/t	190–330	210–350	210–350
Ground calcitic dolomite bulk, CZK/t	510–610	540–640	600–690
Ground calcitic dolomite on pallets, CZK/t	1 580	1 580	1 615

7. Mining companies in the Czech Republic as of December 31, 2008

Krkonošské vápenky Kunčice a.s.

UNIKOM a.s., Kutná Hora

8. World production

The dolomite production and consumption are not statistically followed in the world market. Annual market production in Slovakia has been oscillating roughly between 1.7 and 2.0 mill t during the last five years. The Polish annual mine production of dolomite has been between 5 and 6 mill tonnes. The USA production of dolomite crushed stone was 91 mil t in 2004 and 95 mill t in 2005, it decreased to 87.7 mill tonnes in 2006,and about 85 mill tonnes in 2007.

9. World market prices

World market prices are not given in the international statistical surveys. In 2006, average price of dolomite used as crushed stone in the US market was 7.75 USD/t.

10. Recycling

Dolomite is not recycled.

11. Possible substitutes

Dolomite as source of Mg is substituted by magnesite, by Mg obtained from seawater and salt brines and by brucite.

1. Characteristics and use

Feldspar is economic geological term for rocks with the predominance of some mineral of the feldspar group or feldspar mixture in such a form, quantity and quality, which allow their industrial extracting. Feldspars are a group of monoclinic (orthoclase, sanidine) and triclinic (microcline, plagioclases) potassium and sodium-calcium alumosilicates, and together with quartz they represent the most common rock-forming minerals, which create 60 % of the Earth's crust. Potassium feldspars (orthoclase, microcline) and acid plagioclases (Na > Ca; albite, oligoclase, andesine) are suitable for industrial use. Basic plagioclases (Ca > Na; labradorite, bytownite, anorthite) are of a marginal importance. Suitable feldspar resources are dike rocks (pegmatites, aplites), igneous rocks (granites) and sediments (feldspar-bearing sand and sand and gravel), eventually also residues of incompletely kaolinized rocks and metamorphic rocks. The major impurity represents higher content of iron in the feldspar structure (unremoveable) or in the form of admixtures (removeable).

Because of their low melting point, feldspars are used as a melting agent in ceramic mixtures, glass batches, glazes, enamels and recently also as casting powders. Almost 90 % of feldspars are consumed by the glass and ceramic industry. A small amount is used as filler, especially in colours and plastic materials.

Rocks containing alkalies in other mineral than feldspar (mostly nepheline – anhydrous sodium-potassium alumosilicate) can be used as substitutes for feldspar raw materials. Particularly nepheline syenites, to a lesser extent nepheline phonolites, are used for this purpose in the world.

2. Mineral resources of the Czech Republic

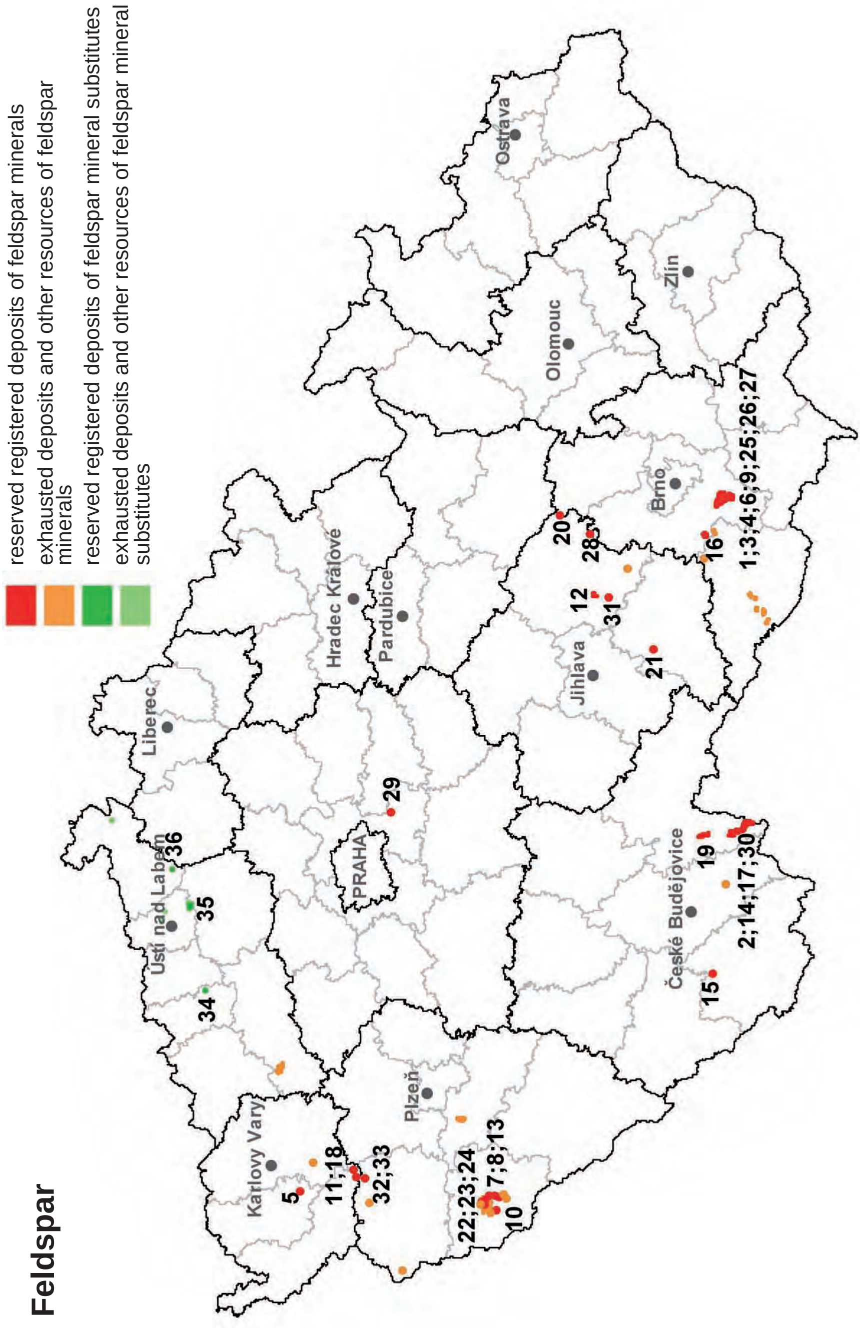
Deposits of feldspar raw materials in the Czech Republic are first of all associated with primary sources, formed mainly by leucocratic granitoids and pegmatite bodies. Nevertheless, the importance of secondary sources, represented by feldspar sand and gravel, has been increasing.

- Fluvial Quaternary feldspar placer deposits represent at present the most important feldspar resource. They were formed by deposition of disintegrated granitic rocks with a high content of mainly potassium feldspar phenocrysts. The major deposits are concentrated into two regions.
  1. the upper course of the Lužnice River with the crucial exploited deposit Halámky, mined from water. Other deposits of the region – Tušť, Dvory nad Lužnicí and Majdalena – are not mined yet. A large part of reserves of these deposits is blocked by conflicts of interests with nature protection, especially with the Protected Landscape Area (CHKO) Třeboňsko.
  2. the area south of Brno with sediments of the Jihlava River – the so-called Syrovice-Ivaň terrace with deposits Bratčice, Žabčice-Smolín, Hrušovany, Ledce, etc. Quality of feldspar is slightly lower, as it has higher Fe contents. A major part of the local raw material is used only as a construction sand and gravel at present. Only a portion – size fraction 4–8 mm – has been stored in depots for later use as feldspar raw material since 2000. Similar deposits of feldspar accumulations of the Jihlava River are located in the Ivančice area southwest of Brno.

Feldspar sand and gravel with a predominance of potassium feldspar over plagioclase represents the raw material of fluvial deposits. It is suitable for production of utility china, sanitary ceramics, glass and to a limited extent also glazes.

- Fine to medium-grained leucocratic granitoids (granites and granite aplites, quartz diorites) represent another important feldspar raw material. Feldspar deposits are developed for instance in the Krušné hory Mts. Pluton (with the fundamental deposit Krásno mined by open pit: albite-bearing aplitic granite), Mračnice Granitoid Massif (Mračnice: quartz diorite-trondhjemite), Třebíč Massif (Velké Meziříčí-Lavičky: aplitic granite). Prospecting was carried out also in other massifs such as the Brno Massif (Moravský Krumlov), Dyje Massif (Přímětice), Chvaletice Massif, Babylon, Blatná and other individual massifs of the Central Bohemian Pluton (all granites and granodiorites). Mineral consists mainly of sodium-potassium feldspars and it is used for sanitary ceramics, coloured glass, china and abrasive disc production.
- Coarse-grained to porphyric leucocratic granitoids could represent an important resource of the feldspar raw material in future. Such rocks occur in the Říčany Massif (Štíhlice), in the Čistá-Jesenice and Bory massifs, the Krkonoše-Jizera (Izera-Karkonosze) Pluton (Liberec granite) etc. Raw material consists mainly of sodium-potassium feldspars, which mostly require high-intensity magnetic separation to decrease the Fe content.
- Deposits of feldspar materials forming lenses in metamorphosed rocks have recently been the subjects of new prospecting. Deposit of orthoclasite to microclinite Markvartice by Třebíč is located in the western branch of the Varied Group of the Moldanubicum in Moravia. The albitite deposit Malé Tresné is situated at the north-western margin of the Svratka dome at the contact of the Micaschist Zone and Olešnice Unit. A small deposit of anorthosite to gabbro Chvalšiny occurs within amphibolites of the Český Krumlov Varied Group of the Moldanubicum in Šumava.
- Pegmatite deposits known from several regions represented the only source of the raw material used mainly for ceramic production in the past. Pegmatites of medium to lower quality occur in south-west Bohemia in the Poběžovice-Domažlice region (e.g. Luženičky, Meclov, Otov). These pegmatites contain equal proportions of sodium and potassium feldspars and an admixture of dark minerals. In this region there are also deposits of high-quality sodium and sodium-calcium feldspars, used for glazes and pellucid glass (Ždánov). K-feldspars are dominant in pegmatites in the other regions. Abundant occurrences of relatively high-quality feldspar with low contents of impurities (Beroun, Křepkovice, Zhořec) occurs in the Teplá region in western Bohemia. The Písek region with its pegmatites appears to be promising but has not been well explored yet. Some smaller deposits of feldspar are known from the Humpolec, Tábor and Rozvadov (Česká Ves) areas, from western Moravia (Smrček) etc. Feldpars from pegmatites do not represent too perspective feldspar resource anymore at present due to irregular shape of deposit bodies, small and to a large extent mined-out reserves and also conflicts of interests. Large amount of the highest-quality raw material of the pegmatite deposits (mainly from the Poběžovice-Domažlice and Písek regions) has been to a large extent exhausted by mining in the past – this involves especially the more easily accessible subsurface parts. This holds true also for the area of the Bory Granulite Massif with a small deposit Bory-Olší, linked to a classical but mined-out deposit Dolní Bory.
- Kaolinized feldspar materials with unaltered or imperfectly altered feldspars can represent another promising resource of the feldspar. This concerns most of all arkoses of the Plzeň and Podbořany regions and gneisses and granitoids of the Znojmo region (see Kaolin – KZ).

Feldspar


reserved registered deposits of feldspar minerals
exhausted deposits and other resources of feldspar minerals
reserved registered deposits of feldspar mineral substitutes
exhausted deposits and other resources of feldspar mineral substitutes
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Jihlava
Liberec
Ústí nad Labem
PRAHA
České Budějovice
Plzeň
Karlovy Vary
1;3;4;6;9;25;26;27
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2;14;17;30
15
5
11;18
32;33
22;23;24
7;8;13
10

- Tertiary volcanic rocks – nepheline phonolites from České středohoří (Želenice deposit) – are used as feldspar substitutes in the Czech Republic. They can be used in the glass and ceramic industry only as a melting agent in coloured materials, due to high contents of colouring oxides. A high content of alkalis (10–10.5 % Na_2O and 3.5–5 % K_2O) results in a lower melting temperature and a shorter burning time.

3. Registered deposits and other resources in the Czech Republic

(see map)

Feldspar minerals:
(Names of mined deposits are indicated in **bold type)**

1 **Bratčice**
2 **Halámky**
3 **Hrušovany u Brna**
4 **Hrušovany u Brna-Protlas**
5 **Krásno-žula**
6 **Ledce-Hrušovany u Brna**
7 **Luženičky**
8 **Mračnice**
9 **Žabčice-Smolín**
10 **Ždánov**
11 Beroun-Tepelsko
12 Bory-Olší
13 Bozdíš
14 Dvory nad Lužnicí-Tušť
15 Chvalšiny
16 Ivančice-Němčice
17 Krabonoš
18 Křepkovice
19 Majdalena
20 Malé Tresné
21 Markvartice u Třebíče
22 Meclov 2
23 Meclov-Letiště
24 Meclov-západ
25 Medlov
26 Medlov-Smolín
27 Smolín-Žabčice
28 Smrček
29 Štíhlice
30 Tušť-Halámky
31 Velké Meziříčí-Lavičky
32 Zhořec 1
33 Zhořec 2-Hanovské pásmo

Feldspar mineral substitutes:
(Names of mined deposits are indicated in **bold type)**

34 **Želenice**
35 Tašov-Rovný
36 Valkeřice-Zaječí vrch

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Feldspar

Year	2004	2005	2006	2007	2008
Deposits – total number	33	34	33	33	34
exploited	8	10	10	10	8
Total *reserves, kt	68 093	67 610	65 497	71 092	69 234
economic explored reserves	25 432	24 979	24 518	30 126	28 594
economic prospected reserves	35 516	35 590	27 566	27 220	26 829
potentially economic reserves	7 145	7 041	13 413	13 746	13 811
Mine production, kt	466	472	487	514	488

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Feldspar

Year	2004	2005	2006	2007	2008
P_1, kt	15 868.80	15 868.80	15 868.80	15 868.80	15 868.80
P_2	–	–	–	–	–
P_3	–	–	–	–	–

Number of deposits; reserves; mine production

Feldspar substitutes (nepheline phonolites)

Year	2004	2005	2006	2007	2008
Deposits – total number	3	3	3	3	3
exploited	1	1	1	1	1
Total *reserves, kt	200 084	200 061	200 030	200 005	199 969
economic explored reserves	0	0	0	0	0
economic prospected reserves	200 084	200 061	200 030	200 005	199 969
potentially economic reserves	0	0	0	0	0
Mine production, kt	26	23	31	25	36

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Feldspar substitutes (nepheline phonolites)

Year	2004	2005	2006	2007	2008
P_1	–	–	–	–	–
P_2, kt	52 900	52 900	52 900	52 900	52 900
P_3	–	–	–	–	–

5. Foreign trade

252910 – Feldspar

	2004	2005	2006	2007	2008
Import, t	8 785	13 315	16 035	12 631	11 413
Export, t	143 941	160 490	154 671	185 859	171 596

Detailed data on feldspar imports (kt)

Country	2004	2005	2006	2007	2008
Germany	6 284	9 800	12 414	10 205	10 587
Austria	1 169	2 211	2 563	314	262
Turkey	597	870	625	812	106
Finland	313	431	384	383	0
others	422	3	49	917	458

Detailed data on feldspar exports (kt)

Country	2004	2005	2006	2007	2008
Poland	109 724	121 856	111 854	140 521	127 553
Germany	4 252	8 955	11 677	16 067	15 275
Hungary	15 732	19 250	17 295	15 571	14 743
Slovakia	8 956	6 990	10 594	8 303	9 092
Russia	354	1 142	1 290	2 496	2 710
Croatia	832	730	614	883	703
Austria	3 495	658	18	0	0
others	596	609	1 329	2 018	1 520

252930 – Leucite, nepheline and nepheline syenite

	2004	2005	2006	2007	2008
Import, t	916	1 089	1 321	1 846	2 105
Export, t	0	0	1	4	0

Feldspars rank among the Czech minerals which are successfully traded on foreign markets. As the west European markets are dominated by Italian and Turkish feldspar, the Czech feldspar traditionally found its place almost exclusively in the central European region. Poland, followed after a big gap by Hungary, Germany and Slovakia, are the biggest importers of the Czech feldspar. Total volume of feldspar export has doubled between 1999 and 2001 and since 2005 it exceeds 150 kt per year. Import has been oscillating around 10-15 kt per year, representing 5 to 10 % of the Czech export volume in the last years. Cheap Turkish feldspar started to appear more systematically on domestic market since 2002, the traded amounts are though still negligible. Nepheline syenite is imported to the Czech Republic traditionally from Norway, since 2004 also from Spain.

6. Prices of domestic market and foreign trade

Potassium feldspar, which can be used for flat and utility glass and package glassware production, is sold on domestic market for CZK 950–1,150; feldspar for special utility glass, lights and TV-screens production for CZK 1,100–1,250 per tonne. Potassium feldspar, which can be used for ceramics, china, glazes and electroporcelain production, was offered for 1,350–1,700 CZK in 2003. Sodium-potassium feldspar used as fluxing agent and grog in ceramic materials is offered on domestic market for CZK 500 per tonne. The material is delivered crushed down to a size 0–5 mm. Feldspars from Krásno were offered at CZK 560–580 per tonne, ground and bagged feldspar for CZK 2,350/t on domestic market.

The average prices of traded feldspar on the domestic market

Product specification	2006	2007	2008
feldspar Krásno, ŽK 05 Ž 55 NaK 60, CZK/t	560	560	560
feldspar Krásno, Ž 55 NaK 60, CZK/t	582	582	582
feldspar Krásno, Ž 55 NaK 60 – ground, CZK/t	2 350	2 350	2 350

252910 – Feldspar

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	2 733	2 514	2 442	2 681	2 557
Average export prices (CZK/t)	989	1 005	834	991	942

252930 – Leucite, nepheline and nepheline syenite

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	8 913	8 884	7 346	7 045	6 478
Average export prices (CZK/t)	32 823	–	3 529	29 858	–

Decrease of the average import prices of feldspar in 2005-2006 was caused by strengthening of the Czech crown against foreign currencies. Special feldspar types imported from Finland are the most expensive, Austrian mineral is the cheapest. German and Turkish feldspar are as a rule slightly less expensive than the annual averages. Export prices of Czech feldspar oscillate on average around CZK 1 000 per tonne. Export prices to Poland, the biggest importer of Czech feldspar, are usually by 10–15 % lower than the annual price averages.

7. Mining companies in the Czech Republic as of December 31, 2007

LB MINERALS a.s., Horní Bříza
KMK Granit s.r.o., Sokolov
Žula Rácov, s.r.o., Batelov
Družstvo DRUMAPO, Němčičky
AGRO Brno-Tuřany, a.s.
KERAMOST a.s., Most (feldspar substitutes)

8. World production

Annual world production (including nepheline syenite and aplite) is about 15-20 mill tonnes. The production continues to rise owing to an increase of use in metallurgy and other industrial branches. Mine production increased rather rapidly in Turkey, Iran, Argentine, Korea, Mexico, Germany, Spain and the Czech Republic. Feldspar production stagnated in the USA and France. Mine production in Italy decreased until 2002, though it has increased during recent years. Surprisingly, Japanese mine production has been decreasing in recent years. Data from various sources often differ considerably, however, there is an agreement concerning the high dynamics of world production growth in recent years. Data on the mine production come from Mineral Commodity Summaries (MCS) and Welt Bergbau Daten (WBD). The Welt Bergbau Daten yearbook presents a fundamentally higher estimate of the total world production in its last issue from 2009. Overall lower values given formerly by MCS are probably because Chinese production (about 2 mill tonnes) is not included. Real China's production remains unknown.

World feldspar mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt (MCS)	11 100	12 900	15 400	18 100	18 300
Mine production, kt (WBD)	17 167	19 589	20 805	22 878	N

Main producers' share in the world mine output (2007; according to MCS):

Italy	23.2 %	the USA	4.0 %
Turkey	21.0 %	France	3.6 %
China	11.0 %	Spain	3.3 %
Thailand	5.5 %	Czech Republic	2.7 %
Japan	4.1 %	Mexico	2.5 %

According to the USGS yearbook Mineral Commodity Summaries, the Czech Republic occupies the 9th position in the world with a share of 2.7 %. Statistical summary Welt Bergbau Daten presents the Czech Republic on the 10th place with a share of 2.25 %. On the European scale, it occupies the 4th–5th place.

The largest producers of nepheline syenite were Canada, Norway and Russia. Nepheline phonolite was mined in France, Germany and in the Czech Republic.

9. World market prices

The average indicative prices of sales quoted in the Industrial Minerals magazine were constant during the period 1990–1992. Feldspar prices were increasing in 1993 and in 1995 in consequence of the recovery of demand. Feldspar prices stagnated until 2006. The prices of a part of the Turkish feldspar increase in 2007 (40–70 %).

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Feldspar, ceramic grade, bagged, FOB Durban, South Africa	USD/t	138.50	138.50	138.50	138.50	138.50
Feldspar, micronised, bagged, FOB Durban, South Africa	USD/t	205.00	205.00	205.00	205.00	205.00
Sodium feldspar, crude, max. 10 mm, bulk, FOB Gulluk, Turkey	USD/t	13.50	13.50	13.50	22.50	22.50
Sodium feldspar, ground, max. 63 microns, bagged, FOB Gulluk, Turkey	USD/t	77.50	77.50	77.50	77.50	77.50
Sodium feldspar, glass grade, max. 500 microns, bagged, FOB Gulluk, Turkey	USD/t	55.00	55.00	55.00	70.00	70.00
Potassium feldspar, ceramic grade, bulk, FOB India	USD/t	26.00	26.00	26.00	26.00	26.00
Nepheline syenite, Norwegian; glass grade, 0.5 mm, bulk, FOL UK port	GBP/t	97.00	97.00	97.00	97.00	97.00
Nepheline syenite, Norwegian; ceramic grade, 45 microns, bulk, FOL UK port	GBP/t	146.00	146.00	146.00	146.00	146.00

10. Recycling

The recycling of glass reduces the consumption of virgin materials, including feldspar in glass production. The recycling rate is about 33 % in the USA and as high as 90 % in some European countries like Switzerland.

11. Possible substitutes

Feldspar substitutes are materials having alkali metals bound in other minerals than feldspars, like nepheline syenites or – in the case of the Czech Republic – nepheline phonolites. These materials replace feldspars used as a melting agent. In other applications (fine abrasives, filler in rubber, plastics and paints), feldspars can be replaced by bauxite, corundum, diatomite, garnet, magnetite, nepheline syenite, olivine, perlite, pumice, silica sand, staurolite, ilmenite, barite, kaolin, mica, wollastonite, calcined alumina, clays, talc, spodumene, pyrophyllite or their mixtures.

Foundry sand

1. Characteristics and use

Foundry sand is granular, light-coloured rock, being used directly or after mineral dressing for production of foundry moulds and cores. The main required properties include sufficient resistance to high temperatures and strength (depends on quality and quantity of the binding component), and suitable grain size (the average grain size and its regularity). Because of its variability, natural foundry sand is more and more often being replaced by artificial sand, i.e. quartz sand mixed with appropriate amount of binding agents (mostly bentonite).

Natural quartz sand is after washing, separation and drying often coloured by inorganic pigments and used for plasters, as gunite sand and for other decorative purposes.

2. Mineral resources of the Czech Republic

Foundry sand (material of lower grade) deposits always accompany glass sand, but they can occur also separately. Deposits in the Provodín and Střeleč surroundings are of a highest importance, the same way as in case of glass sand.

- Orlice-Žďár facies area of the Bohemian Cretaceous Basin represents the third most important area. The material consists of weakly consolidated Cenomanian quartz or glauconitic (so-called natural sand) sandstones. The mining operations are concentrated in Blansko, Voděrady and Svitavy surroundings.
- There is no interest in glacial sand of the northern Moravia (Palhanec-Vávrovice, Polanka nad Odrou), aeolian sand in the Labe River area (Zvěřínek, Kluk) and southern Moravia (Bzenec, Strážnice, Břeclav), fluvial terrace sand of the central (Tetín, Srbsko, mined-out Kobylisy-Dolní Chabry), southern (Lžín) and western Bohemia (Kyšice) and other at present. The reasons are a low quality which demands processing of the raw material and sufficient amount of a higher-quality raw material from other sources. The same holds for sand of the Carpathian Neogene basins (Nový Šaldorf) etc.
- Pliocene sand of the Cheb Basin (Velký Luh) is of a local importance.
- In addition, sand representing a waste product of kaolin processing (e.g., Krásný Dvůr) is used in foundry industry, too.

Glass and foundry sand deposits in the Czech Republic are extracted by open pits. Lower-quality sand is used in the building industry.

3. Registered deposits and other resources in the Czech Republic

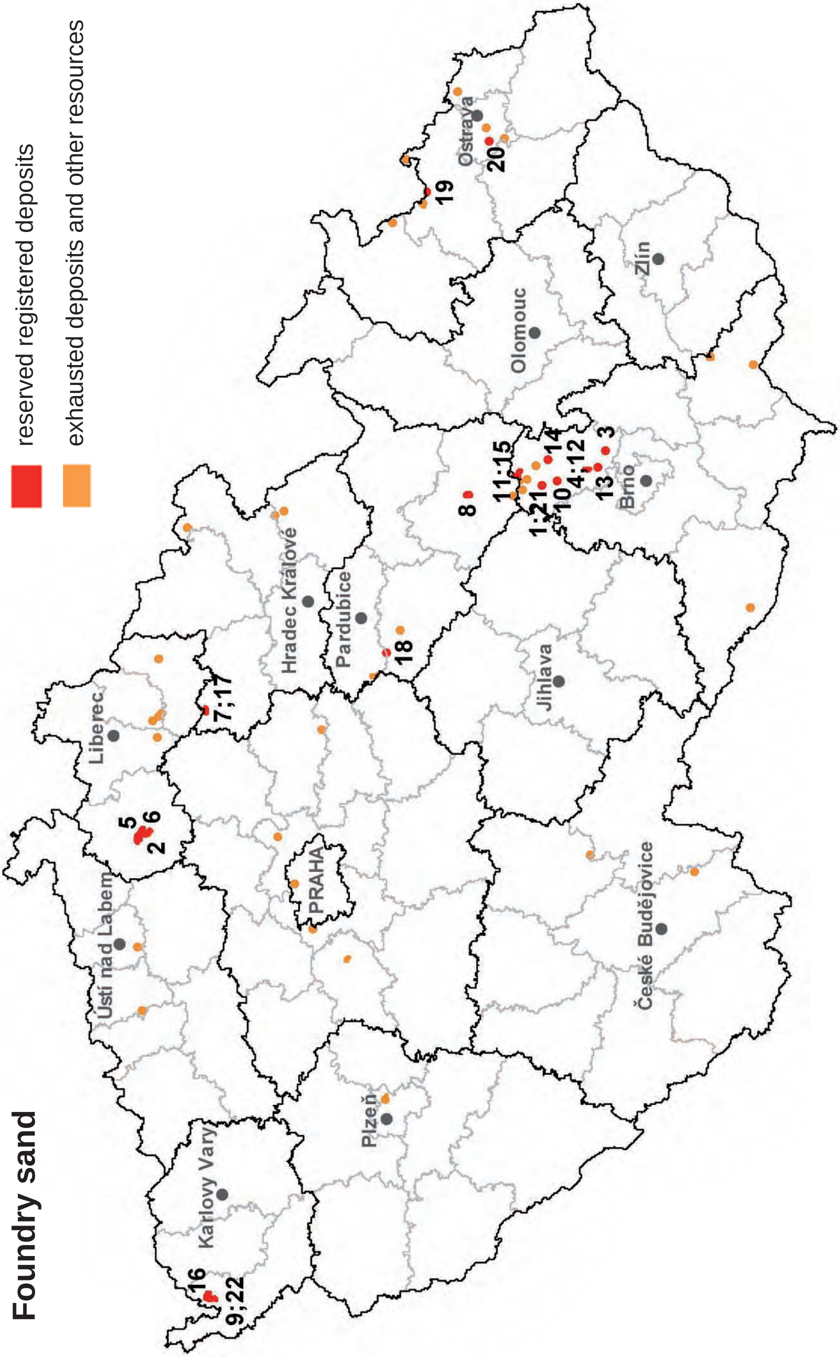
(see map)

Names of mined deposits are indicated in **bold type**

1	**Nýrov**	8	**Svitavy-Vendolí**	15	Deštná-Dolní Smržov
2	**Provodín***	9	**Velký Luh***	16	Lomnička u Plesné
3	**Rudice-Seč**	10	**Voděrady**	17	Mladějov v Čechách*
4	**Spešov-Dolní Lhota**	11	Babolky	18	Načešice
5	**Srní-Okřešice***	12	Blansko 1-Jezírka	19	Palhanec-Vávrovice
6	**Srní 2-Veselí***	13	Blansko 2-Mošna	20	Polanka nad Odrou
7	**Střeleč ***	14	Boskovice-Chrudichromy	21	Rudka-Kunštát
				22	Velký Luh 1

* deposits of glass and foundry sands

Foundry sand



4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	29	29	26	22	24
exploited	12	12	10	10	10
Total *reserves, kt	442 305	418 304	387 667	378 201	378 977
economic explored reserves	142 134	138 820	137 955	134 964	134 202
economic prospected reserves	85 786	81 956	81 907	80 465	80 455
potentially economic reserves	214 385	197 528	167 805	162 772	164 320
Mine production, kt	831	807	773	850	702

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	23 157.00	23 157.00	23 157.00	23 157.00	23 157.00
P_2,	kt	14 723.27	14 723.27	14 723.27	14 723.27	14 723.27
P_3		–	–	–	–	–

5. Foreign trade

Item 250510 (Silica sand and quartz sand) of the customs tariff unfortunately clearly includes both glass and foundry sand, and also a part of sand and gravel. The data below therefore correspond to those presented in chapter on glass sand, in which also a more detailed classification of export and import according to countries.

250510 – Silica sand and quartz sand

	2004	2005	2006	2007	2008
Import, t	245 139	263 151	360 174	322 259	333 862
Export, t	555 118	516 770	564 608	516 050	515 810

6. Prices of domestic market and foreign trade

250510 – Silica sand and quartz sand

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	518	517	501	626	552
Average export prices (CZK/t)	472	524	528	590	508

Average import prices of quartz sand (customs tariff item 250510) were around 500 CZK/t on a long term and they were in principal comparable with average export prices. The average import and export prices increased markedly in 2007. This was caused in general by an increase in world prices of quartz sand due to an energy price rise as well as by a higher demand in Central Europe, where the smelting industry was strongly revitalized.

Prices of foundry sand are lower than prices of glass sand. In 2008, bulk sand was sold at CZK 220–300 per tonne, bulk dry sand at CZK 750–850 per tonne and bagged sand for CZK 1,250 to 1,500 per tonne.

7. Mining companies in the Czech Republic as of December 31, 2007

Provodínské písky a.s., Provodín

Sklopísek Střeleč a.s., Mladějov

Moravské keramické závody a.s., Rájec-Jestřebí

LB Minerals a.s., Horní Bříza

Jaroslav Sedláček – SEDOS, Drnovice

PEDOP s.r.o., Lipovec

P-D Refractories CZ a.s., Velké Opatovice

SETRA s.r.o., Brno

8. World production

World statistics provide only data on total production of sand for industrial use (glass production, foundry industry, abrasives etc.). Therefore the data given below are identical to those presented in the chapter on glass sand. These numbers are moreover distorted by that they are not available for all countries.

The production had been rising until 1988 (119 mill t). Since then the production was decreasing due to general economic recession. The volume of production returned back to the level of about 120 mill t in 1995. World mine production slowly increased between 1996 and 2002. The change did not arrive until 2003, when the production increased again to about 110 mill tonnes. In 2004–2007, mine production has been increasing in relation to the global economic growth, reaching the present limit of about 130 mill tonnes. Numbers of world production volume according to Mineral Commodity Summaries (MCS):

World silica sand for industrial use mine production

Year	2004	2005	2006	2007	2008 e
Mine production, mill t (MCS)	115	118	118	126	127

Main producers' share in the world mine output (2007; according to MCS):

USA	23.8 %	Australia	4.2 %
Italy	11.1 %	Spain	4.0 %
Germany	6.1 %	France	4.0%
Austria	5.4 %	Japan	3.4 %
United Kingdom	4.4 %	South Africa	3.0 %

9. World market prices

The average price of foundry sand for industrial use on the European market was steady (around 10 GBP/t) in the first half of the 1990s. It slowly increased in the period 1995–2001. Between 2002 and 2005, foundry sand world prices stagnated. In 2006, the US foundry sand price increase approximately by 38 % due to energy price rise as well as the continuous weakening of the US currency. World prices remain stable since 2002. Prices of foundry sand quoted by the Industrial Minerals magazine at year-end were as follows:

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Foundry sand, dry, bulk, EXW UK	GBP/t	16.00	16.00	16.00	16.00	16.00
Foundry sand, dry, bulk, EXW USA	USD/t	19.50	19.50	27.00	27.00	27.00

10. Recycling

Foundry sand used in moulding is mixed with bentonites, water glass, etc; having been exposed to high temperatures, their properties change to such extent, which makes their full recycling impossible. A research with an objective to increase a share of recycled sand in new mixtures is carried out in many countries, also in the Czech Republic.

11. Possible substitutes

Foundry sand for moulding mixtures, especially in precision casting and few other uses, can be replaced by crushed olivine, staurolite or chromite with graphite binder.

Gemstones

Jaroslav Hyršl

(subchapters 1., 2., 6. – except tables, 8. – except data on world mine production of diamonds and garnets, 9. – Range of prices of the most important gemstones, 10., 11.)

1. Characteristics and use

The designation "gemstone" refers to such natural materials, which can be used in jewellery. These can be minerals, rocks, natural glasses as well as organic material (e.g. pearls or ivory). Beauty (mainly an interesting colour, type of cutting, etc.), durability (hardness, toughness) and rarity represent their main properties. Gemstones were formerly classified according to their hardness (diamond, corundum, chrysoberyl, beryl, spinel, topaz, etc), because hardness of 7 and more is ideal for use in a gem. Mineralogical system based on chemical composition is used at present. The most important gemstones belong to elements (diamond), oxides (corundum, spinel, chrysoberyl, quartz, etc.), and silicates (beryl, tourmaline, topaz, etc.). As gemstone formation and geological environment concerns, they occur in volcanic rocks (diamond, corundum, olivine, amethyst in geods), pegmatites (beryl, tourmaline, topaz, chrysoberyl, rose quartz), hydrothermal veins (emerald, quartz), metamorphic rocks (corund, spinel, emerald) as well as sediments (almost all given above, through erosion of the primary rocks).

Gemstones represent raw material differing completely from the others presented in these Summaries. They offer an extreme range of prices depending on quality. Old classification as precious and semi-precious stones has not been used anymore in modern literature, because e.g. high-quality amethyst can be more expensive than low-quality ruby or emerald. For the most part, precious (used in jewellery when cut) and decorative stone classifications (e.g. agates, malachite, etc., primarily used only when polished) are used. Waste after gemstone processing can be in some cases (mainly garnets and corundum) used as an abrasive.

Technically speaking, stones used in jewellery must be classified into four categories as follows:

1. natural stones, not processed
2. natural stones processed by man (heating at high temperatures, irradiation, filling of cracks by a foreign material, artificial colouring and many others)
3. synthetic stones (they have similar properties as natural ones)
4. imitation stones (e.g. glass, they have different properties than natural stones)

The correct identification of the gemstone and its classification in these categories is however possible only by an experienced expert disposing a very good instrumentation and knowledge. Moreover, new treatment methods appear every year. Differences in price (hereinafter, approximate wholesale prices in spring 2009 are presented) are huge. A red transparent cut ruby of about 2 carats (i.e. about 9×7 mm in size) can serve as an example. Its glass imitation is practically valueless. Synthetic stone can cost USD 2–400 depending on the method of synthesis. Treated natural stone can cost USD 20–8 000 depending on the treatment method and its intensity. Completely untreated natural ruby of a top quality and weight of 2 carats can however cost up to USD 45 000!

Diamond, by far the best known gemstone financially representing major part (> 90 %) of gemstones market, can serve as another example. Diamonds are evaluated according to four C´s: carat (weight in carats), colour (from the most expensive completely colourless to cheap yellowish and brown stones), clarity (judged by a 10× loupe), and cut (quality of the cut). Depending on these parameters, a diamond of 1 carat in weight (in case of a round brilliant cut it has 6.4 mm in diameter) can cost USD several hundred to 20 000, intensively coloured natural diamonds even much more. However, a number of modifications is known for diamond as well as almost all other gemstones, which markedly improve an appearance of the stone, which logically have to result in a lower price than that of the similar natural stones. Synthetic cut diamonds are common as well on market nowadays (so far mainly coloured, as it is much more difficult to produce the colourless ones) and their proportion will rapidly increase in future.

It has to be pointed out once more that both examples given above represent stones which can appear very similar to an amateur. For this reason, statistical data which follow have to be taken with caution, as they do not say anything about quality of the stones.

2. Mineral resources of the Czech Republic

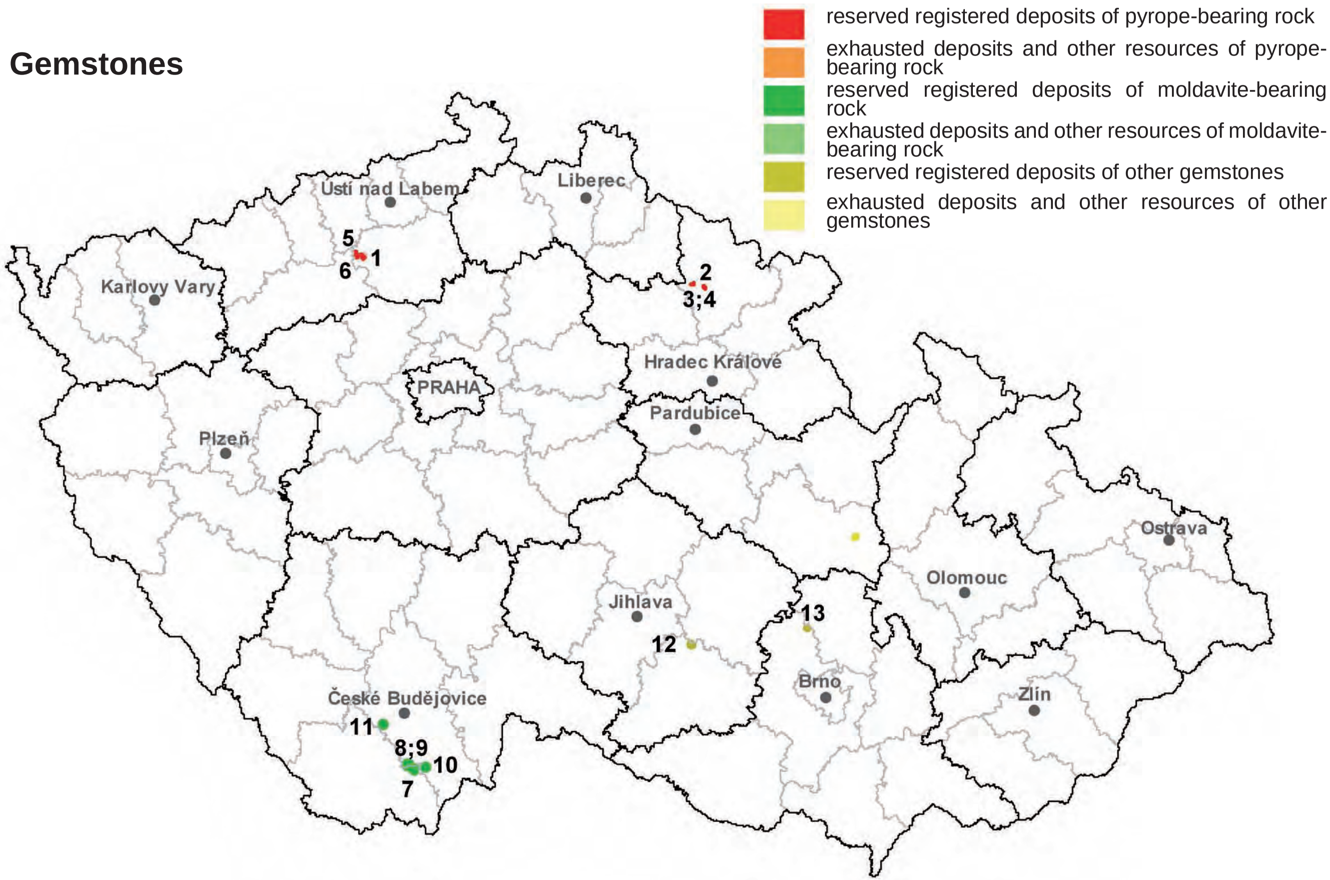
The Czech Republic is very poor in gemstone occurrences, despite its complex geology and abundance of various types of deposits. Only pyrope (Bohemian garnet) and moldavite deposits are of an international importance. Occurrences of some types of decorative quartz (crystal and smoky quartz in pegmatites in Velké Meziříčí and Liberec surroundings), agates in the Krkonoše Mts. piedmont, amethyst and jasper in the Krušné hory Mts., so-called porcelanite (original clay minerals burned at the contact with basalt) in southern Moravia, opals from Křemže surroundings in southern Bohemia, etc., have no economic importance.

Pyrope is a mineral from garnet group with the composition $Mg_3Al_2[SiO_4]O_3$, but always with an Fe admixture and coloured by Cr . The so-called Bohemian garnet, world-known bloody-red pyrope, has been mined at the České středohoří Mts. piedmont for several centuries in Quaternary sand and gravel. Xenoliths of ultrabasic rocks enclosed in Tertiary volcanics represent their parent rock.

The Podsedice deposit in the České středohoří piedmont is the only one exploited at present. Mining of a small Vestřev deposit in the Krkonoše Mts. Piedmont was stopped in the end of 2007. Contents of pyrope of more than 2 mm in diameter fluctuate between 20 and 100 g per tonne of the rock. Genuine Bohemian garnets are always small; raw stones of more than 4 mm in diameter are rare. Much larger and more abundant almandine imported from abroad, which have however a brownish or violet shade, has been therefore used as a central stone in jewels.

Moldavite represents a unique Czech gemstone. It belongs to tectites, i.e. natural glasses, which occur in several places in the world. Their origin remained enigmatic for centuries but it is now agreed that they are terrestrial rocks, molten in the course of a large meteorite impact with the melt sprayed over a large distance. A crater after the meteorite impact has been identified for majority of the world tectite occurrences. Czech moldavites come from the Ries crater by Nördlingen in Bavaria, dated 15.1 million years ago. They occur in southern Bohemia

Gemstones



reserved registered deposits of pyrope-bearing rock
exhausted deposits and other resources of pyrope-bearing rock
reserved registered deposits of moldavite-bearing rock
exhausted deposits and other resources of moldavite-bearing rock
reserved registered deposits of other gemstones
exhausted deposits and other resources of other gemstones
Ústí nad Labem
Liberec
Karlovy Vary
Hradec Králové
PRAHA
Pardubice
Plzeň
Ostrava
Olomouc
Jihlava
Brno
Zlín
České Budějovice
1
2
3;4
5
6
7
8;9
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11
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13

in Tertiary and Quaternary placers, mainly in southern vicinity of České Budějovice. They typically have a green colour and uneven surface with many corrugations, which formed by natural etching. Moldavites usually reach 1–3 cm in size, larger ones are rare. They are used in jewels either in natural state or cut. Smaller moldavite occurrences can be found in southern Moravia in Třebíč surroundings; these however have an unattractive brown-green colour and can not be used as gemstones. Several small deposits were exploited in south Bohemia until recently. Of these, Besednice deposit was closed in 2007, and Ločenice deposit (with sand and gravel as major and moldavites as minor raw materials) is mined at present. Moldavite contents in the deposits are very variable, ranging mostly between 8 and 15 g per 1m^3 (5–8 g per one tonne) of the rock.

3. Registered deposits and other resources in the Czech Republic

(see map)

Names of mined deposits are indicated in **bold type**

Pyrope-bearing rock:	Moldavite-bearing rock:	Other gemstones:
1 **Podsedice-Dřemčice**	7 **Besednice**	12 Bochovice *
2 **Vestřev**	8 **Ločenice**	13 Rašov **
3 Horní Olešnice 1	9 Chlum nad Malší-východ	
4 Horní Olešnice 2	10 Slavče-sever	
5 Linhorka-Staré	11 Vrábče-Nová Hospoda	
6 Třebívlice		* amethyst, ** opal

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	11	11	13	13	13
exploited [b)]	4	4	4	4	3
Total *reserves, kt [a)]	19 198	19 162	19 196	19 155	19 131
economic explored reserves	3 469	3 444	3 412	3 384	3 360
economic prospected reserves	12 840	12 829	12 895	12 882	12 882
potentially economic reserves	2 889	2 889	2 889	2 889	2 889
Mine production, kt [a)]	42	43	39	34	24
Mine production, ths m^3 [c)]	114	74	95	114	99
Mine production, kt [c)] (1 m^3 = 1.8 t)	205	133	171	205	201

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

a) pyrope-bearing rock

b) two deposits of pyrope, two deposits of moldavite till 2007, one deposit of pyrope, two deposits of moldavite in 2008

c) moldavite-bearing rock

Approved prognostic resources P_1, P_2, P_3

Year	2004	2005	2006	2007	2008
P_1	–	–	–	–	–
P_2, [a] t	100	100	100	100	100
P_2, [b] kt	749	749	749	749	749
P_2, [c] tis. m^3	66 000	66 000	66 000	66 000	66 000
P_3	–	–	–	–	–

Notes:
[a] jasper
[b] pyrope-bearing rock
[c] moldavite-bearing rock

5. Foreign trade

7102 – Diamonds, also finished but unassembled, unmounted

	2004	2005	2006	2007	2008
Import, kg	138	140	175	317	322
Export, kg	26	44	43	185	46

7103 – Precious (other than diamond) and semi-precious stones, also finished, sized but unstrung, unassembled, unmounted

	2004	2005	2006	2007	2008
Import, kg	51 882	95 925	45 963	147 541	222 338
Export, kg	2 965	3 960	1 925	2 230	601

251320 – Emery, natural corundum, garnet and other natural abrasives

	2004	2005	2006	2007	2008
Import, t	3 089	2 882	2 662	4 037	2 240
Export, t	1 063	354	246	347	155

Detailed data on geographical structure of diamond import in volume (kg)

	2004	2005	2006	2007	2008
Belgium	14	14	26	158	137
South Africa	51	63	110	105	106
USA	1	5	5	7	24
Israel	18	12	8	10	14
Thailand	4	5	6	7	12

Table from page 253 continued

	2004	2005	2006	2007	2008
India	4	4	4	5	7
Germany	23	26	8	11	6
United Kingdom	21	8	3	8	2
others	2	3	5	4	14

Detailed data on geographical origin of precious (other than diamond) and semi-precious stone import in volume (kg)

	2004	2005	2006	2007	2008
Brazil	19 581	16 492	33 102	125 096	191 136
China	89	427	2 979	5 951	7 475
Namibia	0	1 220	0	0	6 192
India	6	1 560	29	735	5 919
Tanzania	1 026	985	301	1 134	2 224
Mozambique	0	920	90	601	1 036
Nigeria	197	277	288	110	219
Thailand	102	169	189	210	215
Hong Kong	147	1 561	1 781	591	152
Pakistan	0	102	183	0	119
Morocco	0	0	204	438	60
Russia	0	62	451	81	30
South Africa	30 422	71 072	5 677	10 323	0
Uruguay	0	0	405	2 137	0
USA	3	732	23	90	0
Germany	45	216	206	19	0
Mongolia	29	0	0	0	0
others	235	130	55	25	397

Detailed data on territorial structure of emery, natural corundum and garnet import in volume (t)

	2004	2005	2006	2007	2008
Australia	2 543	2 206	1 822	2 845	1 282
India	527	568	561	1 021	864
Germany	10	8	274	111	28
others	9	100	5	60	66

The customs item 7103 includes a large spectrum of precious stones (ruby, sapphire, emerald etc.), imported from many countries, such as Mozambique, Brazil, Namibia, Tanzania, Hong Kong, China, Germany, Niger, Russia etc. Export is by order lower and is directed to Russia, USA and Hong Kong. Emery, natural corundum and garnets are imported especially from Australia and India.

6. Prices of domestic market and foreign trade

International trade with gemstones has been so globalized recently, that no substantial differences in their prices wherever in the world including the Czech Republic exist. The only difference is that imported are rather gemstones of a lower quality due to the lower purchasing power as well as lower knowledge of both jewellers and customers; stones of a high quality are rare.

7102 – Diamonds, also finished but unassembled, unmounted

	2004	2005	2006	2007	2008
Average import prices (CZK/kg)	284 370	439 379	442 023	410 814	977 435
Average export prices (CZK/kg)	294 077	354 886	452 209	109 135	2 850 022

7103 – Precious (other than diamond) and semi-precious stones, also finished, sized but unstrung, unassembled, unmounted

	2004	2005	2006	2007	2008
Average import prices (CZK/kg)	243	233	508	199	205
Average export prices (CZK/kg)	3 363	1 635	3 391	4 060	12 156

251320 – Emery, natural corundum, garnet and other natural abrasives

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	4 455	3 784	5 773	5 513	6 535
Average export prices (CZK/t)	5 362	6 767	11 490	7 858	8 800

7. Mining companies in the Czech Republic as of December 31, 2008

Granát – družstvo umělecké výroby, Turnov

FONSUS první těžební a.s., Praha

8. World production

Diamond represents the only gemstone for which relatively reliable data on annual production exist. There are practically no estimates for any other gemstone. This is mainly because mostly small deposits mined by primitive methods are concerned, as well as a large range of prices as explained above. On each locality in general major proportion of the extracted material is of a low quality; stones that can be cut commonly make up only several percent of the total mine production and financially only one top-quality stone can represent major part of the annual profit.

The most important gemstones and mining countries are as follows:

diamond – Botswana, Russia, Canada, Australia, South Africa, Congo Dem. Rep. (former Zaire)
ruby – Myanmar (Burma), Madagascar, Kenya, Tanzania, Pakistan, Vietnam
sapphire – Sri Lanka, Madagascar, Tanzania, Australia, Thailand
emerald – Columbia, Brazil, Zambia, Zimbabwe, Pakistan
alexandrite – Brazil, Russia, Zimbabwe, India
opal – Australia, Brazil, Ethiopie
spinel – Myanmar (Burma), Sri Lanka, Vietnam, Tajikistan
aquamarin – Brazil, Madagascar, Mozambique, Pakistan
tanzanite – Tanzania (the only known deposit)
topaz – Brazil, Pakistan
tourmaline – Brazil, Madagascar, Pakistan, Afghanistan, Mozambique, Nigeria
olivine – USA, Pakistan
amethyst – Brazil, Uruguay, Zambia, Bolivia, USA

World production of industrial diamonds (with reference to MCS) reached about 75 mill carats in 2008. The main producer was Congo D.R. (former Zaire) – 30 %, followed by Australia – 23 %, Russia – 20 %, South Africa – 12 % and Botswana – 10 %. These countries covered roughly 95 % of the world production.

World production of gem-quality diamonds (with reference to WBD) was estimated at about 101 mill carats in 2007. In this case it was Botswana – 25 % - in the first place, followed by Russia – 23 %, Canada – 17 %, Australia – 9 %, Angola – 6 %, South Africa – 6 %, Congo D.R. (former Zaire) – 6 %. These seven countries covered roughly 94 % of the world production.

World mine production of garnet (mostly for industrial use) was about 352 kt in 2008 (with reference to MCS). The largest mining capacity was in Australia – 45 %, other producers were India – 19 %, the USA – 17 % and China – 9 %.

World diamond mine production

Industrial diamonds	2004	2005	2006	2007	2008e
Mine production, ths carats (MCS)	67 000	81 000	80 000	77 000	77 000
Mine production, ths carats (WBD)	65 608	83 766	93 291	69 140	N

Gem-quality diamonds	2004	2005	2006	2007	2008
Mine production, ths carats (WBD)	74 106	85 211	101 520	100 522	N

World industrial garnet mine production

Industrial garnets	2004	2005	2006	2007	2008e
Mine production, ths carats (MCS)	302	324	325	352	352

9. World market prices

Market prices of gemstones depend on their type, size and quality. Garnet (almandine) used as abrasive is quoted in the Industrial Minerals magazine monthly as 8–250 mesh class, FOB mine Idaho, USA. The average prices in USD/t for minimum 20 t lots at the end of the year were as follows:

The average prices of traded garnet commodity at year-end

Commodity/Year		2004	2005	2006	2007	2008
Garnet (almandine), 8–250 mesh, FOB mine Idaho, USA	USD/t	210	210	210	210	210

Range of prices of the most important gemstones

(spring 2007, in all cases cut stones of 2 carats in weight, whole-market price per piece in USD):

aquamarine	10–1 000
alexandrite	500–15 000
amethyst	2–45
diamond colourless	1 000–70 000
diamond pink	50 000–400 000
emerald	50–14 000
garnet almandine	5–40
olivine	10–150
ruby	50–50 000
sapphire blue	50–10 000
tanzanite	150–1 100
topaz blue	5–30
topaz orange	30–1 500
tourmaline red	50–400
tourmaline green	20–400

10. Recycling

Gemstones retain their value; those from older jewel are therefore often used in a new one. The stone has to be re-cut in some cases, especially when the cut is damaged. Technical stones are commonly recycled – this concerns first of all abrasives.

11. Possible substitutes

Imitation stones exist since the oldest times. Either similarly coloured natural stones (e.g. garnet or red spinel as a ruby imitation) or synthetic stones (e.g. green or light blue synthetic spinel as olivine and aquamarine imitation or changeable synthetic corundum as an alexandrite imitation) are used. Synthetic gemstones are common on market. Approximate dates of the first syntheses are as follows: alexandrite – 1973, diamond – technical 1955, gemmy – 1971, ruby – 1891, sapphire – 1910, emerald – 1956, spinel – 1930. On global scale, synthetic gemstones and imitations even predominate over the natural stones, and untreated natural stones are very rare.

1. Characteristics and use

Glass sand is granular, light or even white-coloured rock (quartz sand or sandstone), which is used, after processing, as a raw material for production of glass. Required parameters (grain size, mineral and chemical composition) vary according to the type of glass. Sand of required grade does not usually occur in nature; therefore the sand has to be processed by crushing, washing (to remove floating particles) and grading (to reach the required grain size). To obtain high grade glass sand, it is necessary to apply more sophisticated methods of mineral processing (electromagnetic separation, flotation, etc.); it is of utmost importance to reduce the content of colouring oxides (Fe_2O_3, TiO_2, Al_2O_3) in order to meet rigid specifications with respect to purity of silica and its maximum content. Sand for glass melting is used for making of glass batches for production of flat glass, package glassware and some technical glasses (max. content of Fe_2O_3 0.023–0.040 %), and utility glass (up to 0.021 % Fe_2O_3); glass sand of higher grade is used for production of non-transparent silica glass (max. 0.020 % Fe_2O_3) and the top quality sand (max. 0.012 % and 0.015 % Fe_2O_3) are used for production of crystal glass, semi-optical glass and some special technical glasses.

Natural quartz sand is after washing, separation and drying often coloured by inorganic pigments and used for plasters, as gunite sand and for other decorative purposes.

2. Mineral resources of the Czech Republic

The largest and most important deposits of glass sand in the Czech Republic are located in the Bohemian Cretaceous Basin, smaller ones occur in the Cheb Basin. Some potentially interesting areas of the Bohemian Cretaceous Basin are of no perspective especially due to nature protection reasons – this concerns for instance Lužické hory Mts., Český ráj (The Bohemian Paradise), Adršpašsko-teplické skály (Adršpach-Teplice Rocks) etc.

- The Střeleč deposit in the Jizera facies development area of the Bohemian Cretaceous Basin represents the most important deposit of the Czech Republic. The mined raw material consists of weakly consolidated quartz sandstone of the Coniacian age and its quality meets world specifications. A reserve deposit Mladějov v Čechách has been evaluated in its southern foreland.
- Southern surroundings of Česká Lípa in the Lužice facies development area of the Bohemian Cretaceous Basin represent the second most significant deposit area. The raw material consists of weakly consolidated quartz sandstone of the Middle Turonian age. Srní 2-Veselí and Provodín deposits which are exploited at present will be soon mined out and they are gradually replaced by Srní-Okřešice deposit, opened in 2004.
- Non-traditional deposit of Velký Luh consists of the Pliocene sand and gravel of the Cheb Basin (redeposited material from kaolinic weathered Smrčiny granite). The raw material is used in technical, ceramic and filtering sand for water-plants, most of the potentially economic raw material as building sand. No glass sand is produced here, as it would require a complex processing (abrasion, electromagnetic separation, grinding).

3. Registered deposits and other resources in the Czech Republic

(see map)

Names of mined deposits are indicated in **bold type**

1 **Provodín***	3 **Srní-Okřešice***	5 **Velký Luh***
2 **Srní 2-Veselí***	4 **Střeleč***	6 Mladějov v Čechách*

* deposits of glass and foundry sands

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	6	6	6	6	6
exploited	4	5	5	5	5
Total* reserves, kt	268 876	265 673	260 917	254 871	260 440
economic explored reserves	96 595	93 283	92 382	91 391	90 231
economic prospected reserves	15 305	26 077	25 947	25 892	25 781
potentially economic reserves	156 976	146 313	142 588	137 588	144 428
Mine production, kt	828	920	963	942	1 151

✦ See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	21 750.00	21 750.00	21 750.00	21 750.00	21 750.00
P_2,	kt	14 926.56	14 926.56	14 926.56	14 926.56	14 926.56
P_3		–	–	–	–	–

Industrial glass production

Glaverbel Czech a.s.

Moravské sklárny Květná

Speglass s.r.o

Sklárna Heřmanova huť

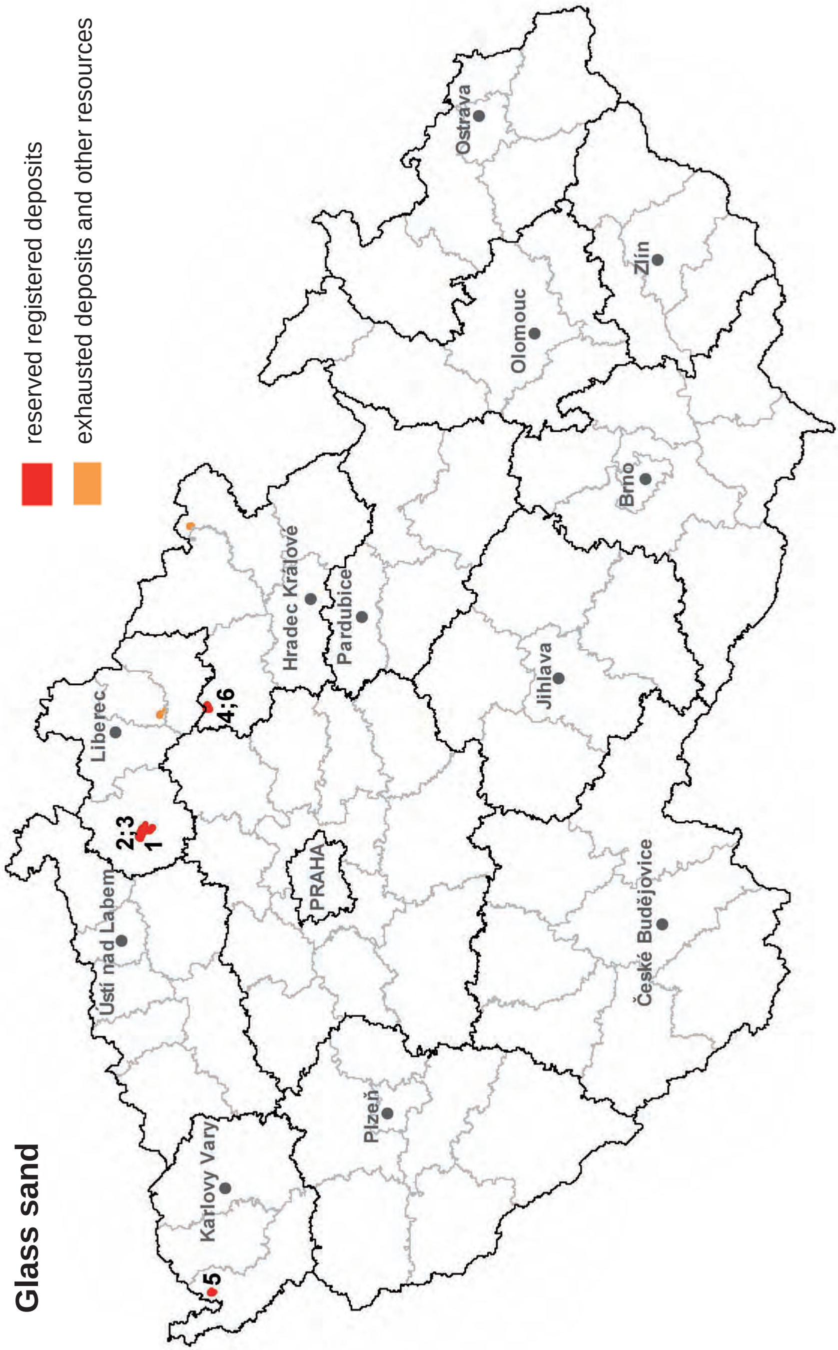
Sklárny Kavalier a.s.

Sklárna Slavia s.r.o.

Nižborská sklárna RÜCKL CRYSTAL a.s.

VITRUM, s.r.o. Sklárna Janov

Glass sand



reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Jihlava
Liberec
4;6
2;3
1
PRAHA
Ústí nad Labem
České Budějovice
Plzeň
Karlovy Vary
5

Glaverbel Czech a.s. produces flat glass, a large assortment of security glass both glued and toughened, sun glass, thermal insulating glass, metallized glass, antifire glass etc. Moravské sklárny Květná company produces sodium and potassium-bearing glass in traditional ways in pot furnaces. It specializes in blown, hand-made products. Special, primarily bent glass and various types of security glass are produced by Speglass s.r.o. Glass works Heřmanova Huť produces among others glass for beverages. Glass works Kavalier produces boiling glassware, technical and laboratory glass and borosilicate glass.

There is a number of traditional glass works in the Czech Republic, products of which are commonly renowned in many countries. Glass works Slavia in Nový Bor specializes in hand glass production, glass works RÜCKL CRYSTAL in Nižbor produces cut lead crystal, Sklárna Janov of the Vitrum s.r.o. focuses on pressed, hollow and hand-painted glass.

The years 2007–2088 and the first half of the year 2009 represented a very complex period for the Czech glass producers. The companies first faced very high energy prices (natural gas, electric power), and subsequently they belonged to the first victims of the world financial and economic crisis. It caused the steep decrease in demand for quality goods that became non-essential for number of customers. Some of the Czech glassworks, commonly with decades-long tradition, got into serious existential problems, and they were adjudged bankrupt or proclaimed financial failure.

5. Foreign trade

250510 – Silica sand and quartz sand

	2004	2005	2006	2007	2008
Import, t	245 139	263 151	360 174	322 259	333 862
Export, t	555 118	516 770	564 608	516 050	515 810

Detailed data on silica sand and quartz sand imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	124 302	147 997	150 434	132 549	131 117
Poland	48 413	52 427	95 842	97 289	99 807
Austria	53 496	41 568	88 439	48 609	61 291
Germany	16 332	17 181	18 526	33 058	31 364
others	2 596	3 978	6 933	10 754	10 283

Detailed data on silica sand and quartz sand exports (t)

Country	2004	2005	2006	2007	2008
Austria	261 065	4 790	230 075	198 915	200 140
Slovakia	96 014	99 366	115 553	125 378	106 815
Germany	100 032	87 853	111 690	78 755	95 913

Table from page 262 continued

Country	2004	2005	2006	2007	2008
Croatia	66 836	67 889	67 584	66 203	74 032
Slovenia	23 950	27 150	31 000	35 650	33 000
others	7 221	3 288	8 706	11 149	5 910

7001 – Cullet and other waste and scrap of glass; massive glass in pieces

	2004	2005	2006	2007	2008
Import, t	77 588	79 321	71 259	75 965	80 781
Export, t	11 959	3 485	8 542	13 007	14 455

Unfortunately, it is evident that the customs tariff item 250510 combines glass and foundry sand and also a part of sand and gravel. In general, data of the ČSÚ on foreign trade with items sand and construction minerals have to be taken only as information on the main trends in this field, not as precise data. For instance, atypical numbers for export in 2005 document, that the remaining volume of export to Austria was shown only under a different item of the customs tariff than usual.

Roughly half of silica sand and quartz sand import shown is declared as import from Slovakia. Import from Poland markedly increased in 2003–2008, import from Austria increased only until 2006. Czech quartz sand was exported to more than 50 countries in 2004–2008. The largest volume of export is directed logically to neighbouring countries (Austria, Slovakia, Germany), but also to the area of Balkan etc. Whereas in case of export to Austria and especially to Germany sand and gravel is concerned, glass or foundry sand is exported to Slovakia and Slovenia. Financially, the export value has been oscillating between CZK 200 and 300 mill per year.

Volume of cullet import has been oscillating between 65 and 80 kt per year since 2003. Valuable secondary raw material has been imported mainly from Germany, Austria, Hungary, but also from Great Britain, France, the Netherlands and China. The fact that this material is not exported in large amounts – unlike many other secondary raw materials – is positive since its recycling in the Czech Republic represents significant energy savings.

6. Prices of domestic market and foreign trade

Prices of glass sands are differentiated according to their properties and their quality. Domestic prices of wet glass sand oscillate between CZK 300 and 600 per tonne. Prices of dry glass sand (not bagged) are about CZK 800–1,050 per tonne, of the bagged ones at CZK 1,300–1,660. Prices of very finely milled sand oscillate between CZK 3,000 and 4,600 depending on the quality. Prices of filtration sand are as follows: wet CZK 530–690 per tonne; dry CZK 1,050–1,350 per tonne.

Average import prices of silica and quartz sand have been very stable on a long term – they oscillated in a narrow interval of 500–520 CZK/t between 2003 and 2006. In 2007, the average import price increased to approximately 630 CZK/t especially due to high import prices of the German, Indian and Turkish mineral. The average import price for 2008 returned back to the usual limits. The average export price of the Czech sand increased slowly between 2003 and 2006. In 2007, the price jumped due to export of the high-quality quartz sand to Slovakia, Slovenia, Hungary and the United Arabian Emirates. In 2008, the average export price decreased back to the level of 500 CZK/t. Both import and export prices of cullet and waste and scrap of glass increased in 2004; the atypical average export price in 2005 was caused by a small volume of trade.

250510 – Silica sand and quartz sand

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	518	517	501	626	552
Average export prices (CZK/t)	472	524	528	590	508

7001 – Cullet and other waste and scrap of glass; massive glass in pieces

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	1 740	1 736	1 640	2 807	2 884
Average export prices (CZK/t)	2 676	4 174	2 360	1 786	1 225

7. Mining companies in the Czech Republic as of December 31, 2008

Sklopísek Střeleč, a.s., Mladějov

Provodínské písky, a.s., Provodín

LB Minerals a.s., Horní Bříza

8. World production

World statistics provide data only on total production of sand for industrial use (glass production, foundry industry, abrasives etc.). These numbers are incomplete by the fact that they are not available for all countries. The world mine production had been rising until 1988 (119 mill t). Since then the production was decreasing due to general economic recession. The volume of production returned back to the level of about 120 mill t in 1995. World production slowly increased between 1996 and 2002. The change did not arrive until 2003 when world production increased again to about 110 mill tonnes. Mine production continued to rise up above the limit of 120 mill tonnes in 2004–2006 in relation to the worldwide economic growth. Numbers on world mine production according to Mineral Commodity Summaries (MCS):

World silica sand for industrial use mine production

Year	2004	2005	2006	2007	2008 e
Mine production, mill t (MCS)	115	118	118	126	127

Main producers' share in the world mine output (2007; according to MCS):

USA	23.8 %	Australia	4.2 %
Italy	11.1 %	Spain	4.0 %
Germany	6.1 %	France	4.0%
Austria	5.4 %	Japan	3.4 %
United Kingdom	4.4 %	South Africa	3.0 %

9. World market prices

Quartz sand for industrial use was traded on European market at average price GBP 11.00 per tonne at the first half of the 1990s. The price increased to GBP 13.50 per tonne in 1995. The prices increased again to GBP 15.00 per tonne in 2000 and to GBP 16.00 per tonne in 2001. The price stagnates since 2001. Prices of sand quoted by the Industrial Minerals magazine in GBP/t EXW GB at year-end were as follows:

The average prices of traded commodity at year-end

Commodity/Year		2004	2005	2006	2007	2008
Glass sand, flint, container, EXW GB	GBP/t	16.00	16.00	16.00	16.00	16.00

10. Recycling

Glass sand, for obvious reasons, cannot be recycled; however, it is possible to use sorted glass waste in a glass batch, which is being done on a long term. However, demand of glass works on the input quality of glass scrap has been increasing recently. Another problem is, that there is a demand first of all for scrap of separated colours (white, green, brown) in glass industry. Interest in mixed cullet is minimal. Surplus of supply of mixed processed cullet from foreign recycling companies (first of all from Germany and Austria, where glass recycling is strongly supported) over demand results in permanent pressure on decrease of sale price of recycled glass on the territory of the Czech Republic. Price of mixed unprocessed glass on the territory of the Czech Republic has been oscillating between CZK 650 and 1,100 per tonne (EUR 22–37) including transport to the recycling facilities. At these prices on the input on the recycling line, the output price is unfortunately markedly higher than in the EU countries. Glass works ask from the Czech processing companies for a price comparable with that paid abroad. They refuse to take all the mixed glass collected on the territory of the Czech Republic and they prefer to buy a substantial part abroad.

The highest proportion of recycling of sorted glass scrap in 2006 was reported in Switzerland (96 %), Sweden (94 %), Germany and Belgium (88 % each), Austria and Norway (both 86 %). Contrastingly, the proportion was very low in Turkey (22 %), Greece (29 %), Great Britain (32 %), Spain and Portugal (38 % each). The largest volume of collected glass has been reported in Germany, France and Italy. A large part of common glass for package is produced from recycled waste glass. Average production of glass scrap on citizen reaches roughly 77 kg in the Czech Republic. 65 % of the sorted glass scrap was used again (recycled) in 2004; in 2005 it was already 68 % and in 2006 almost 70 %. Three glass works in the Czech Republic manufacture waste glass: SKLÁRNY MORAVIA, a. s. Úsobrno, Vetropack Moravia Glass a.s. Kyjov and Avirunion a.s. Teplice.

11. Possible substitutes

In glass production, the sand is in fact only a source of SiO_2, therefore it can be replaced by sorted vein quartz, waste glass, synthetic SiO_2, etc.

1. Characteristics and use

Graphite represents one of the forms of carbon (C) occurring in the nature. Graphite is an important technical mineral exhibiting perfect basal cleavage, very good electric and heat conductivity, high refractoriness (crucibles and furnace lining, e.g.) and resistance to acids, alkalies, molten metals, etc.

All rocks, which contain considerable amount of graphite that can be recovered, are considered as a graphite raw material. Graphite is graded primarily on the size of flakes – "crystalline" flake graphite with flakes exceeding 0.1 mm and "amorphous" graphite with flakes smaller than 0.1 mm, which appears like a massive material. The latter looks like a dull solid matter. There are no general rules about the division of crystalline graphite into large, medium, and small flake, and individual producers have different criteria.

Graphite deposits can be divided into early magmatic, contact metasomatic, metamorphogenic (metamorphic and metamorphosed) and residual deposits. According to the USGS, world reserves of graphite are given at 290 mill tonnes (reserve base), out of which about 86 mill t represent reserves. More than three quarters of reserves are located on the territory of China (76 %), more important reserves are also on the territory of India, Mexico, Sri Lanka and the Czech Republic (where the deposits are though largely sub-economic).

Use of graphite is based upon its physical and chemical properties. It is used in foundry industry, electricity and electronics uses, electrochemistry, chemical, rocket, armament and nuclear industries, in manufacture of refractory materials, lubricants, protective coatings, pencils, threads, production of synthetic diamonds etc.

2. Mineral resources of the Czech Republic

All graphite deposits in the Czech Republic belong to the metamorphogenic type. They originated during regional metamorphism of clayey sandy sediments high in organic matter, which is also indicated by higher concentrations of S, P, V and abundant limestones. The deposits occur in the Bohemian Massif in the Moldanubicum, Moravicum and Silesicum regional geological units.

- The most important deposits occur in the Modanubicum, particularly in the so-called Varied Group of Český Krumlov (deposits: Český Krumlov-Městský vrch, Lazec, where the mining was terminated in the middle of the year 2003; further deposits: Bližná, Spolí, Český Krumlov-Rybářská ulice). Other less important deposits occur in the Votice-Sušice Varied Group (a single, until 1967 mined deposit at Koloděje nad Lužnicí-Hosty) and in the Chýnov mica schists (Černovice – mined-out former deposit). South Bohemian graphitic rocks have a character of graphite-rich gneisses, quartzites and carbonates. Smaller occurrences, which are of no economic importance at present, are known also from the Moravian part of Moldanubicum (e.g. Lesná, Lubnice, Louka, Římov et al.).
- Deposits in the Moravian-Silesian region occur in an area affected by lower grade metamorphism. Graphite shows lower degree of crystallization and contains much more sulphur, which is confined to pyrite and pyrrhotite. The whole region is characterized by higher contents of combustibles and lower sulphur content in graphitic layers in lime-

stones than those in graphitic schists and phyllites. The deposit Tresné, already mined out, was considered the largest graphite deposit of the Moravicum. It is located in the Olešnice group of the Svratka dome. The major deposit in the Silesicum is Velké Vrbno-Konstantin, which makes a part of a graphitic zone at the western margin of the Velké Vrbno dome. Since the second half of the year 2003, this deposit remains the only one to be mined in the Czech Republic. Other 8 small deposits in Branná and Velké Vrbno surroundings were registered until 2006, of which only one has remained after revaluation.

Underground mining of graphite deposits in the Czech Republic is economically unprofitable and it is on decline, as there is a sufficient supply of cheaper, especially Chinese mineral, similarly to fluorite and barite. On the other hand, open-pit mining in Velké Vrbno surroundings still continues and its mine production is rather stable.

3. Registered deposits and other resources in the Czech Republic

(see map)

Names of mined deposits are indicated in **bold type**

Amorphous graphite:

1 **Velké Vrbno-Konstantin**
2 Bližná-Černá v Pošumaví
3 Český Krumlov-Rybářská ulice
4 Velké Vrbno-Luční hora 2

Crystalline graphite:

5 Český Krumlov-Městský vrch
6 Lazec-Křenov
7 Koloděje nad Lužnicí-Hosty

Mixed (from amorphous to crystalline) graphite:

8 Spolí

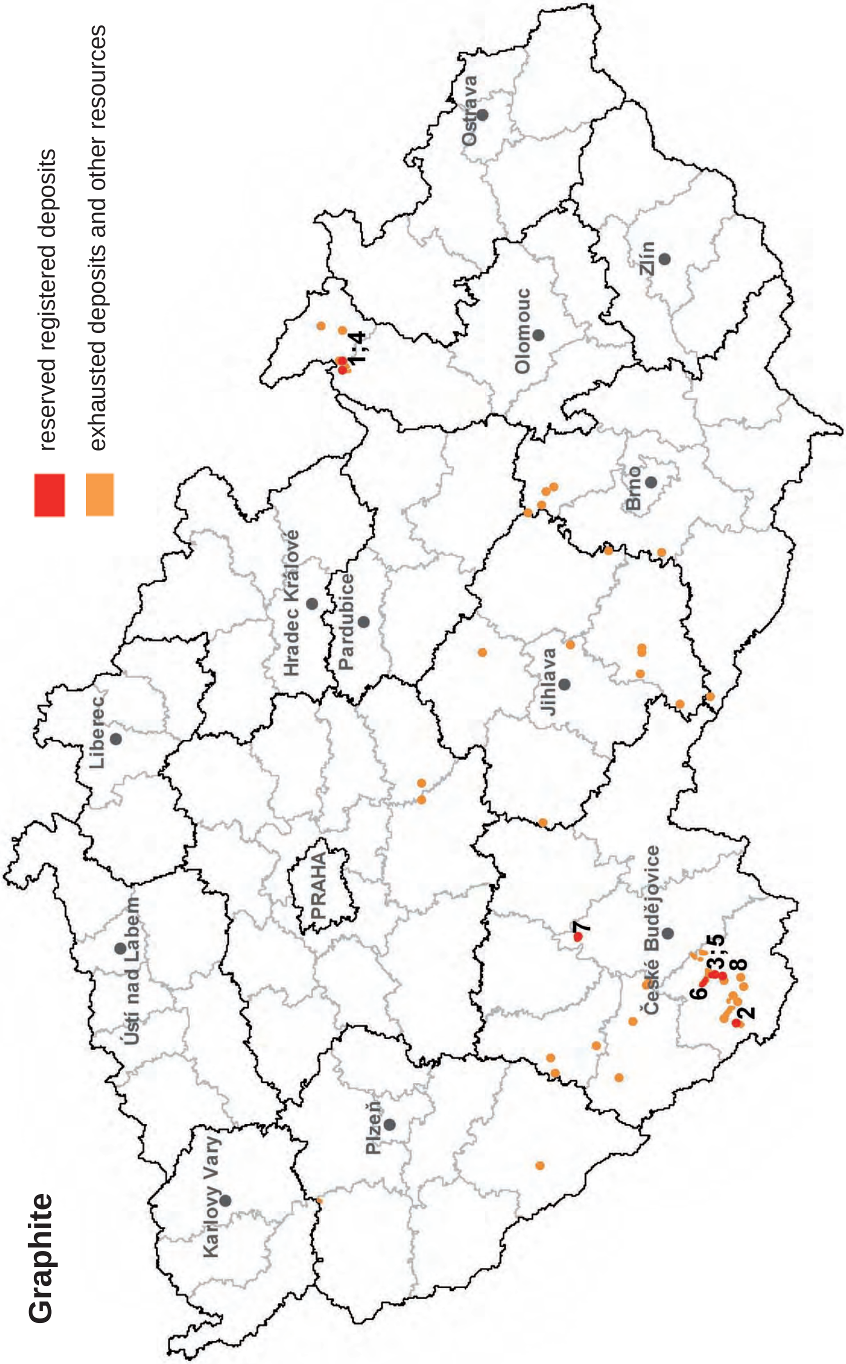
4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	15	15	8	8	8
exploited	1	1	1	1	1
Total *reserves, kt [a)]	14 350	14 347	14 165	14 162	14 159
economic explored reserves	1 339	1 336	1 327	1 324	1 321
economic prospected reserves	4 154	4 154	4 041	4 041	4 041
potentially economic reserves	8 857	8 857	8 797	8 797	8 797
Mine production, kt [a)]	5	3	5	3	3

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

a) Reserves and mine production are given for crude graphite (graphite “ore”); average graphite contents in the raw material range between 15 and 20 % (crystalline grade) and 25–35 % (amorphous grade), respectively


Graphite
reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Jihlava
Liberec
PRAHA
Ústí nad Labem
České Budějovice
Plzeň
Karlovy Vary
1;4
7
3;5
6
8
2

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	3 878	3 878	3 878	3 878	3 878
P_2,	kt	5 279	5 279	5 279	5 279	5 279
P_3,	kt	1 505	1 505	1 505	1 505	1 505

Processing of graphite

Graphite Týn, spol. s r.o.

Graphite Týn s.r.o. (before March 2007 Maziva Týn s.r.o.) produces highly refined natural graphite, micro-ground graphite, expandable graphite, graphite dispersions and pressed graphite. The tradition of graphite processing in Týn nad Vltavou dates back to 1965. The company has been a member of the international concern Graphit Kropfmühl AG since 1999. Graphite vessels, graphite stoppers and graphite nozzles are produced also by Moravské keramické závody a.s.

5. Foreign trade

2504 – Natural graphite

	2004	2005	2006	2007	2008
Import, t	3 668	4 858	3 601	5 353	6 235
Export, t	3 924	3 614	3 518	4 031	4 076

Detailed data on territorial structure of graphite import in volume (t)

Country	2004	2005	2006	2007	2008
Germany	1 098	2 027	1 177	2 686	2 077
China	1 862	2 265	1 912	2 367	1 621
Great Britain	373	382	177	87	116
others	335	184	335	213	2 421

Detailed data on territorial structure of graphite export in volume (t)

Country	2004	2005	2006	2007	2008
Germany	2 179	2 017	2 272	2 725	2 732
Italy	719	601	381	418	378
Poland	553	481	265	284	249
Hungary	185	196	227	281	280
Slovakia	166	172	211	162	155
others	122	147	162	159	282

3801 – Synthetic graphite and graphite products; colloidal, semicolloidal graphite

	2004	2005	2006	2007	2008
Import, t	2 740	3 799	2 780	4 402	7 376
Export, t	829	673	369	565	999

6903 – Refractory ceramics products

	2004	2005	2006	2007	2008
Import, t	5 707	5 767	7 744	11 211	10 473
Export, t	12 186	12 470	14 062	16 385	16 484

After the domestic mining at south Bohemian deposits was terminated in mid-2003, the volume of imported graphite increased up to 5 kt in 2005 and 6 kt in 2008. Graphite is imported to the Czech Republic first of all from China; imports reported as from Germany often contain Chinese raw material from deposits run in China by German companies. On the other hand, volume of exported graphite has been rather stable, oscillating between 3.5 and 4 kt per year. The raw material is directed mainly to neighbouring countries. Products made of the Czech refractory graphite ceramics were exported to more than 60 countries in and outside Europe in 2008.

6. Prices of domestic market and foreign trade

2504 – Natural graphite

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	19 849	23 849	36 198	23 628	20 620
Average export prices (CZK/t)	22 121	23 520	28 661	26 661	27 092

Prices of domestic flotation concentrates of natural graphite oscillated between CZK 12 and 17 thousands per tonne depending on the content of combustion matters, sulphur and moisture. Flotated crystalline graphite with synthetic flake is sold for CZK 15,000 per tonne. Graphite product (petroleum coke powder) has been offered for approximately CZK 12,000 per tonne in 2004. A wide spectrum of final graphite products, including chemically treated, micro-ground, expandable, pressed graphite and graphite lubricants, is offered by Graphite Týn, s.r.o. (formerly Maziva Týn nad Vltavou, s.r.o.). Prices of chemically treated graphite (purity above 99.5 % C) oscillate between CZK 54,000 and CZK 100,000 per tonne (according to the granular composition). Prices of further processed micro-ground graphites start from CZK 62,000 per tonne.

7. Mining companies in the Czech Republic as of December 31, 2008

Grafitové doly Staré Město, s.r.o.

8. World production

World production of graphite remained consistently around 1 mill t/year till 1992, then it markedly decreased. Graphite mine production has been increasing again in the last five years, during which many changes on the world market occurred: the Chinese dominant role was further strengthened whereas the mine production on Madagascar decreased significantly and that of Mexico, Zimbabwe and India. Mine production of Brazil has been increasing during the last two years. In Europe, graphite is mined only in Ukraiine, Norway, Czech Republic and in negligible amounts in Romania. Mine production in the Czech Republic reached 16 kt in 2002, i. e. around 2 % of the world production, about 1.2 % in 2003, and it can represent about 0.5 nowadays. Data in individual international yearbooks are variable and they are often backward-corrected. Data according to Mineral Commodity Summaries (MCS) and the Welt Bergbau Daten (WBD):

World graphite mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt (MCS)	982	1 060	1 030	1 110	1 110
Mine production, kt (WBD)	577	675	762	1 098	N

Main producers' share in the world mine output (2007; according to MCS):

China	72.7 %	Canada	2.5 %
India	11.7 %	Madagascar	1.4 %
Brazil	6.8 %	Mexico	1.2 %
North Korea	2.7 %	Ukraine	0.7 %

9. World market prices

Prices of graphite were at the end of eighties influenced by its surplus on the world market. Prices of graphite of majority of grades dropped in 1993 down to 50 % of those in 1990. Prices were affected particularly by supplies of cheap Chinese graphite and by introduction of Russian graphite on the world market. World prices of graphite stagnate since the second half of the 1990s until 2004. The situation changed just during the year 2005, when prices of individual quotations increased by 10–20 %. Prices of the high-quality raw material continued to rise in 2006–2007. In 2008, the price rise concenred also lower-quality quotations. Prices of natural graphite are published monthly in the Industrial Minerals magazine and quoted in USD/t, CIF UK ports.

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Crystalline large flake, 94–97 % C, + 80 mesh, CIF UK ports	USD/t	660	728	875	935	950
Crystalline medium flake, 94–97 % C, + 100–80 mesh, CIF UK ports	USD/t	600	670	770	850	850

Table from page 272 continued

Commodity/Year		2004	2005	2006	2007	2008
Crystalline small flake, 94–97 % C, + 100 mesh, CIF UK ports	USD/t	525	583	675	725	650
Crystalline large flake, 90 % C, + 80 mesh, CIF UK ports	USD/t	515	613	613	613	750
Crystalline medium flake, 90 %, + 100–80 mesh, CIF UK ports	USD/t	390	468	468	468	730
Cystalline small flake, 90 % C, –100 mesh, CIF UK ports	USD/t	375	443	443	443	600
Amorphous powder, 80/85 % C, CIF UK ports	USD/t	–	250	250	250	460

In 1993–2001, the magazine Industrial Minerals has quoted also synthetic graphite with 99.93 % content of C, later with 99, 95 % content of C. Its price was USD 2.23 per kg at year-end 1993; it was continuously increasing and reached USD 2.55 per kg FOB Swiss border at year-end 1996. In the following years, the price oscillated between USD 2.23–2.55 per kg FOB Swiss border. Synthetic graphite was traded for USD 1.94 per kg at year-end 2000 and for USD 2.07 per kg at year-end 2001. Price quoting was reintroduced in the end of 2005 at price of USD 2.07 per kg. The price oscillated in a large interval of 3–10 USD/kg in 2006. Prices increased up to 3.5 and 12.5 USD/kg in 2007. The large range of prices pertained also in 2008, when they oscillated between 5.5 and 17.9 USD/t.

10. Recycling

Recycling of graphite in major fields of its use is virtually impossible (refractory materials, break lining, foundry industry, lubricants). Recycling of graphite electrodes is rather an exception of a limited importance.

11. Possible substitutes

Natural graphite is replaced by synthetic graphite in the foundry industry (artificial soot and/or oil coke mixed with olivine or staurolite), by lithium, mica, talc and molybdenite in lubricants, by calcined petroleum coke, anthracite coal, used carbon electrodes and magnesite in steel production. All alternative materials, however, have only limited use.

Gypsum

1. Characteristics and use

Gypsum is a sedimentary rock, consisting mostly or completely of monoclinic mineral gypsum ($CaSO_4.2H_2O$), which is usually colourless or white. The rock often contains impurities (clay minerals, quartz, iron oxides, limestone, dolomite, anhydrite, etc.). The majority of gypsum deposits was formed as evaporites from marine or lake water in arid areas. Deposits of different origin (weathering and decomposition of sulphides, hydration of anhydrite, metasomatic processes, etc.) are of no economic importance. Anhydrous $CaSO_4$ (anhydrite) is often classified in the gypsum group. It is usually transformed to gypsum by wet grinding. Present world reserves of gypsum are estimated at 2,600 mill tonnes.

Gypsum is used mostly for production of building materials (calcined gypsum, cement, plasters, prefabricated elements) and small amount for other purposes (in agriculture, glass and paper manufacturing, in pharmacy, also as a filler, etc.).

2. Mineral resources of the Czech Republic

Gypsum deposits in the Czech Republic are confined to the Miocene (Badenian-Wieliczkien) sediments of the Opava Basin (marginal part of the Carpathian Foredeep). Larger part of the productive Badenian is on the Polish side of the basin. The average content of gypsum in the rock is 70–80 %. The impurities are mostly clay and to a smaller extent sand. Close to surface deposit parts are often karstified. The mining for gypsum (in the past there were also underground mines) in the Opava region has been going on continuously since the second half of the 19th century. At present, there is only one open-pit mine at Kobeřice ve Slezsku-jih deposit. After 1994 mining began to drop fastly and it stabilized on about 5 % to 10 % level of 80s and 90s of the 20th century after 2000. Mainly doe to high power station and heating plant flue gas desulphurization (FGD) gypsum production.

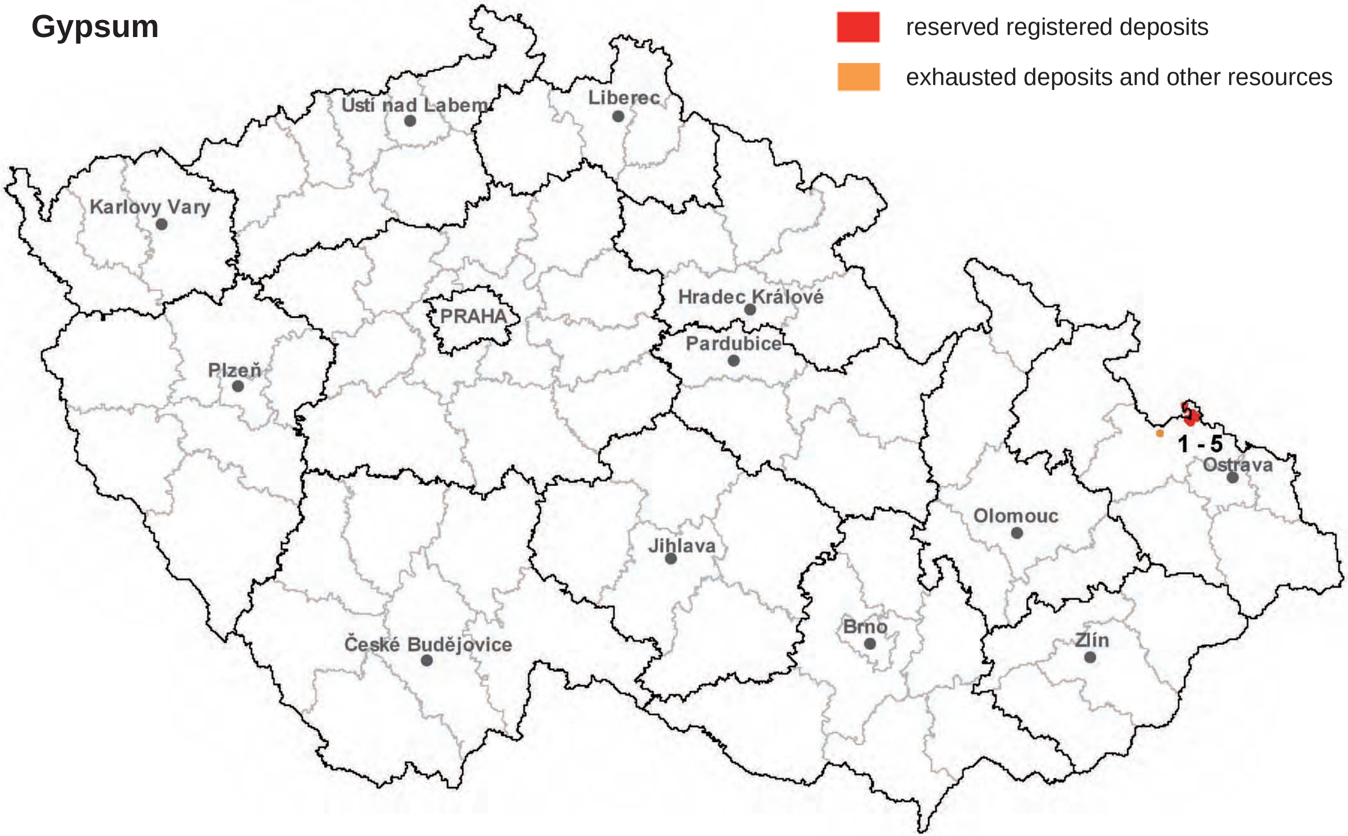
3. Registered deposits and other resources in the Czech Republic

(see map)

Names of mined deposits are indicated in **bold type**

1	**Kobeřice ve Slezsku-jih**	3	Rohov-Strahovice	5	Třebom
2	Kobeřice ve Slezsku-sever	4	Sudice		

Gypsum



reserved registered deposits
exhausted deposits and other resources
Ústí nad Labem
Liberec
Karlovy Vary
Hradec Králové
PRAHA
Pardubice
Plzeň
1 - 5
Ostrava
Olomouc
Jihlava
Brno
Zlín
České Budějovice

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	5	5	5	5	5
exploited	1	1	1	1	1
Total *reserves, kt	504 527	504 502	504 470	504 349	504 295
economic explored reserves	119 400	119 375	119 343	119 222	119 168
economic prospected reserves	302 990	302 990	302 990	302 990	302 990
potentially economic reserves	82 137	82 137	82 137	82 137	82 137
Mine production, kt	68	24	16	66	35

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Domestic production of selected intermediate products

Year	2004	2005	2006	2007	2008
Plaster boards (ths m^2)	38 698	36 410	41 793	40 660	40 719
Gypsum (kt)*	145	127	163	112	N

* inclusive byproduct gypsum

Production of byproduct gypsum

ČEZ, a.s.

Precheza, a.s.

H_2SO_4-bearing waste water formed during titanium white production, which is the main activity of Precheza a.s. Free H_2SO_4 is neutralized by limestone and the remaining sulphates by lime. White gypsum PREGIPS, used in the construction industry for cement or plaster production, and brown gypsum PRESTAB – granulate added for technical reclamation result from this process. 60–80 kt of the white and roughly the same amount of the brown gypsum are produced per year.

Production of plasterboards

KNAUF (závod Počerady)

Rigips, s.r.o. (závod Horní Počaply)

KNAUF s.r.o. has been active on the Czech market in the branch of plasterboard construction systems and materials since 1992. The construction plasterboards and supporting sections have been produced since 1994 in KNAUF Počerady plant. Rigips s.r.o. operates a plant for the plasterboard production in Horní Počaply by Mělník. The plant has a yearly capacity of 20 mill m2 of plasterboards.

5. Foreign trade

252010 – Gypsum, anhydrite

	2004	2005	2006	2007	2008
Import, t	29 194	19 619	39 679	60 027	77 315
Export, t	90 803	33 306	46 837	107 180	100 038

Detailed data on gypsum imports (t)

Country	2004	2005	2006	2007	2008
Germany	28 653	19 305	38 752	58 260	72 627
others	541	314	927	1 767	4 688

Detailed data on gypsum exports (t)

Country	2004	2005	2006	2007	2008
Poland	0	0	5 230	88 987	81 475
Slovakia	90 803	33 305	41 606	18 169	18 555
others	0	1	1	24	8

Gypsum foreign trade, the same way as domestic production of natural gypsum, has been significantly influenced by over-production of synthetic, waste gypsum, which originates as a desulphurization by-product of flue gas in thermal power stations. Surplus of the waste gypsum on Central European market resulted in a pronounced decrease of the domestic mine production of natural gypsum and of volume of gypsum exported from the Czech Republic, especially in 2005 and 2006. Czech gypsum from Kobeřice has been exported traditionally especially to Slovakia. Export to Poland started in 2005 and its volume has been steeply increasing since 2007. Gypsum import has been oscillating between 20 and 70 kt per year and imported raw material comes predominantly from Germany.

6. Prices of domestic market and foreign trade

252010 – Gypsum, anhydrite

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	1 441	1 814	2 118	2 124	1 860
Average export prices (CZK/t)	296	361	416	181	213

As an unusually high amount of gypsum was exported to Poland at 116 CZK/t, the average gypsum export prices decreased significantly in 2007. This resulted in decrease of the average annual price of all contracts. The average export price of a standard contract to Slovakia was approximately 500 CZK/t. Export price to Poland was similarly low (130 CZK/t) in 2008, whereas the average export price to Slovakia was about 570 CZK/t.

The average prices of traded commodities on the domestic market

Product specification	2006	2007	2008
gypsum mined out, CZK/t	300	300	330
plaster binder grey, packages of 30 kg, pallets, CZK/t	2 600	2 700	2 720
plaster binder white, packages of 30 kg, pallets, CZK/t	4 400	4 500	4 600

In 2008, the average price of domestically mined gypsum fluctuated around CZK 330 per tonne depending on the quantity purchased. Gypstrend s.r.o. offers also plaster binder the prices of which differ according to the quantity and colour of the material. Price of grey plaster binder in packages of 30 kg on pallets with foil oscillated around CZK 2,720 per tonne and price of white one was about CZK 4,600 per tonne in 2008. Gypsum blocks represent a new product, which can substitute plasterboard at construction of internal partition walls. Their advantage compared to gypsum plasterboards is a higher surface rigidity. Their prices oscillate around CZK 370 and 480 per m^2.

7. Mining companies in the Czech Republic as of December 31, 2008

GYPSTREND, s.r.o., Kobeřice

8. World production

World production of gypsum (including anhydrite) has been in the range of 80–100 million tonnes for a long time, however, the estimates increased up to 130-150 mill tonnes in the last 10 years. According to the yearbook Welt Bergbau Daten (WBD), the highest mine production was in the year 2006 (about 115 mill tonnes). In its last issue, the WBD increased the mine production estimates of some of the Third World countries, especially China, but also Egypt or Laos. The estimated volumes of mine production for the last years were increased also by the Mineral Commodity Summaries (MCS). The production is closely related to building activities, the fluctuations of which is also reflected in the changes of volume of the world mine production. Mine production in Algeria, Guatemala, Laos, Thailand, and from European countries e.g. Ukraine, Moldavia and Croatia has significantly increased recently. The so-called "synthetic gypsum", a byproduct of desulphurising (flue gas desulphurisation – FGD) of thermal power stations, has become a serious competitor of natural gypsum in some countries in recent years.

World gypsum mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt (MCS)	109 000	118 000	125 000	154 000	151 000
Mine production, kt (WBD)	138 245	141 116	150 852	146 595	N

Main producers' share in the world mine output (2007; according to MCS):

China	24.0 %	Canada	5.0 %
USA	11.6 %	Mexico	4.0 %
Iran	7.8 %	Japan	3.8 %
Spain	7.5 %	Italy	3.6 %
Thailand	5.6 %	France	3.1 %

9. World market prices

Prices of natural gypsum have been steady in the last years. Even in times of more extensive building activities, the prices were stable, which was also caused by a supply of waste gypsum (desulphurization byproduct of flue gas in thermal power stations, chemical industry), production of which highly exceeded the demand. Crude gypsum prices were quoted by the Industrial Minerals magazine until 2001 and it oscillated around 9.00 GBP/t EXW UK. Crude gypsum prices ranged between 7 and 9 USD/t on the US market in 2003–2008, prices of the calcined mineral ranged between 17 and 21 USD/t exhibiting a decreasing trend.

10. Recycling

Waste gypsum wallboards from construction sites are recycled in a limited volume.

11. Possible substitutes

Natural gypsum is replaceable to some extent by byproduct gypsum for example from production of phosphoric acid, titanium dioxide and flue gas desulphurisation (FGD). The latter is the main type of by-product gypsum used (wallboards, cement production).

Kaolin

1. Characteristics and use

Kaolin is mostly a residual (primary), less often a sedimentary (secondary) white or whitish rock, containing substantial amount of the kaolinite group clay minerals. It always contains quartz and it may contain other clay minerals, micas, feldspars, and other minerals, depending on the nature of the parent rock.

Kaolin originated mostly through weathering or hydrothermal alteration of various rocks, rich in feldspar, as granitoids, rhyolites, arkoses, gneisses, etc. These so-called residual (primary) kaolins can be transported, thus forming sedimentary (secondary) kaolins. The deposits are concentrated in areas with feldspar rocks presence in where the kaolinization had occurred. World economic reserves (resources) of kaolin are estimated at about 12,000 – 14,000 mill tonnes. They are concentrated in the U.S.A. (53 %), Brasil (28 %), Ukraine and India (7 % each).

A most of the crude kaolin is processed in dry (air-float) or wet (water-wash) way to increase the kaolinite content and produce a saleable product (refined kaolin). Kaolin is used for various purposes and the required grade depends on the use. A major amount (about 45 %) of kaolin is used in paper industry (coating and filling) and as a raw material in the ceramic industry – in production of porcelain and other whiteware (about 20 %). Kaolin is being used also as a filler in the production of rubber, plastics, paint and pigments, manufacture of reinforcing fibreglass, in production of refractory materials, and in cosmetics, pharmaceutical and food industries. Kaolin is also used in the production of synthetic zeolites. Production of kaolin is often classified among the production of clays and vice versa.

2. Mineral resources of the Czech Republic

Technological suitability of kaolin is assessed according to properties of the refined (water-washed) kaolin. In the Czech Republic, kaolins are classified according to their use:

- Kaolin for production of porcelain and fine ceramics (KJ) – the highest quality kaolin with high requirements on purity, rheological properties, strength after drying, pure white-fired colour (content of Fe_2O_3 + TiO_2 without high-intensity electromagnetic separation up to 1.2 %), refractoriness min. 33 PCE (1,730 °C).
- Kaolin for other ceramics manufacturing (KK) has no specifically defined parameters and is used in many ceramic recipes. Specially appreciated are white-fired colours, low content of colorant oxides, etc.
- Kaolin used in paper industry (KP) is employed both for fillers and coatings. Required properties are high whiteness and low content of abrasive particles. It is also used as filler in the production of rubber (requires minimum content of the so-called "rubber poisons" – Mn max. 0.002 %, Cu max. 0.001 % and Fe max. 0.15 %), in plastics, paints, fibreglass etc.
- Titanium-bearing kaolin (KT) contains over 0.5% TiO_2 and this type of kaolin occurs only in the Karlovy Vary region, where it formed from granites with high content of Ti-minerals. Both tests and experience proved that in some cases TiO_2 content can be reduced by high-intensity electromagnetic separation, after which part of these kaolins can be used as KJ or KK and even KP grades.

- Feldspar-bearing kaolin (KZ) contains higher amount of non-kaolinized feldspars and has been used mostly in ceramics for production of sanitary and technical ceramics.

All kaolin deposits in the Czech Republic originated by kaolinitic weathering of feldspar rocks. Decrease of kaolinization with increasing depth and transition into non-weathered parent rock are characteristic of these deposits. Kaolinite is a strongly predominant clay mineral. The major regions with kaolin deposits are as follows:

- The Karlovy Vary region – parent rocks are represented by autometamorphosed and younger granites of the Karlovy Vary massif. This is the most important source of the top quality kaolins for the production of porcelain (KJ) or their eventual substitutes (KT). There are also deposits of the KK, less of the KP grades. The most important deposits are Božičany, Jimlíkov, Mírová and in 2005 opened deposit Ruprechtov, where the KJ, KT and KK are mined together. KP is mined at the Otovice-Katzenholz deposit.
- The Kadaň region – kaolins of this area originated from granulite gneiss of the Krušné hory Mts. crystalline complex. This kaolin is of the KK and KP grades. Kralupy u Chomutova-Merkur (KP) deposit was mined out in 2003, other deposits were mined out already earlier (e.g. Kadaň, Prahly). KP at the large Rokle deposit, where bentonite has been mined for a long time, has been exploited since 2003.
- The Podbořany region – parent rock is subarkose of the Líně formation belonging to the Central Bohemian Permocarboniferous. All grades of kaolin given above occur here. However, some of the kaolins classified as KJ have a lower quality (rather KK even KZ grade) and their use as an additive into the Karlovy Vary kaolins in production of porcelain is rather restricted due to their rheological properties. Large Krásný Dvůr-Podbořany deposit of the KJ kaolin grade represents the most important deposit.
- The Plzeň region – parent rock is represented by Carboniferous arkoses of the Plzeň Basin. Kaolins of this area are of the KP grade (the largest reserves of the best quality kaolin) and the KK grade, and only a negligible part of the reserves is of the KZ and KJ grades. Horní Bříza, Kaznějov-jih and Lomnička-Kaznějov deposits north of Plzeň and Chlumčany-Dnešice south of Plzeň represent the most important large mined deposits of KP and KK. The major portion of the KP grade was converted into KK grade due to revaluation in 2005.
- The Znojmo region – these kaolins originated mostly from granitoids of the Dyje massif, to a lesser extent from the Bíteš orthogneiss of the Dyje dome of the Moravicum. These kaolins are of the KZ grade and less of the KP grade. A small deposit of KP Únanov-sever was mined out in 2007.
- The Cheb Basin – these kaolins originated from granites of the Smrčiny massif. A single deposit in this area – Plesná-Velký Luh (KK, KP) – has not been mined yet.
- The Třeboň Basin – less important deposits, local kaolins originated from granites and biotite paragneisses of the Moldanubicum. Only ceramic kaolins (KK) at two small deposits Kolenec and Klikov are evaluated here. The raw material is not mined and its exploitation is not foreseen due to its low quality.
- Vidnava – kaolins formed from granites of the Žulová Massif. The raw material of a single, until now not mined deposit Vidnava has been alternatively evaluated as KP and KK. In The Register it is however listed under refractory clays for grog production to ensure its best use.
- The other smaller kaolin occurrences have been either mined out (Lažánky) or not explored yet (Žlutice, Toužim, Javorník areas).

The kaolin deposits of the Czech Republic are important also on a world scale, the most important areas being Plzeň, Karlovy Vary, Podbořany and Kadaň. All Czech kaolin deposits are extracted by open-pit mining operations at present.

3. Registered deposits and other resources in the Czech Republic

(see map)

Principal areas of deposits presence:

(Names of areas with mined deposits are indicated **in bold**)

1 **Karlovy Vary region**
2 **Kadaň region**
3 **Podbořany region**
4 **Plzeň region**
5 Znojmo region
6 Cheb Basin
7 Třeboň Basin
8 Vidnava

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	65	66	67	69	70
exploited	15	14	14	14	13
Total *reserves, kt	1 120 869	1 104 330	1 204 349	1 220 325	1 212 123
economic explored reserves	215 787	195 550	191 326	249 703	244 494
economic prospected reserves	494 164	486 686	567 110	497 185	497 356
potentially economic reserves	410 918	422 094	445 913	473 437	470 273
Mine production, kt [a)]	3 862	3 882	3 768	3 604	3 833
Beneficiated (water-washed) kaolin production, kt	596	649	673	682	672

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

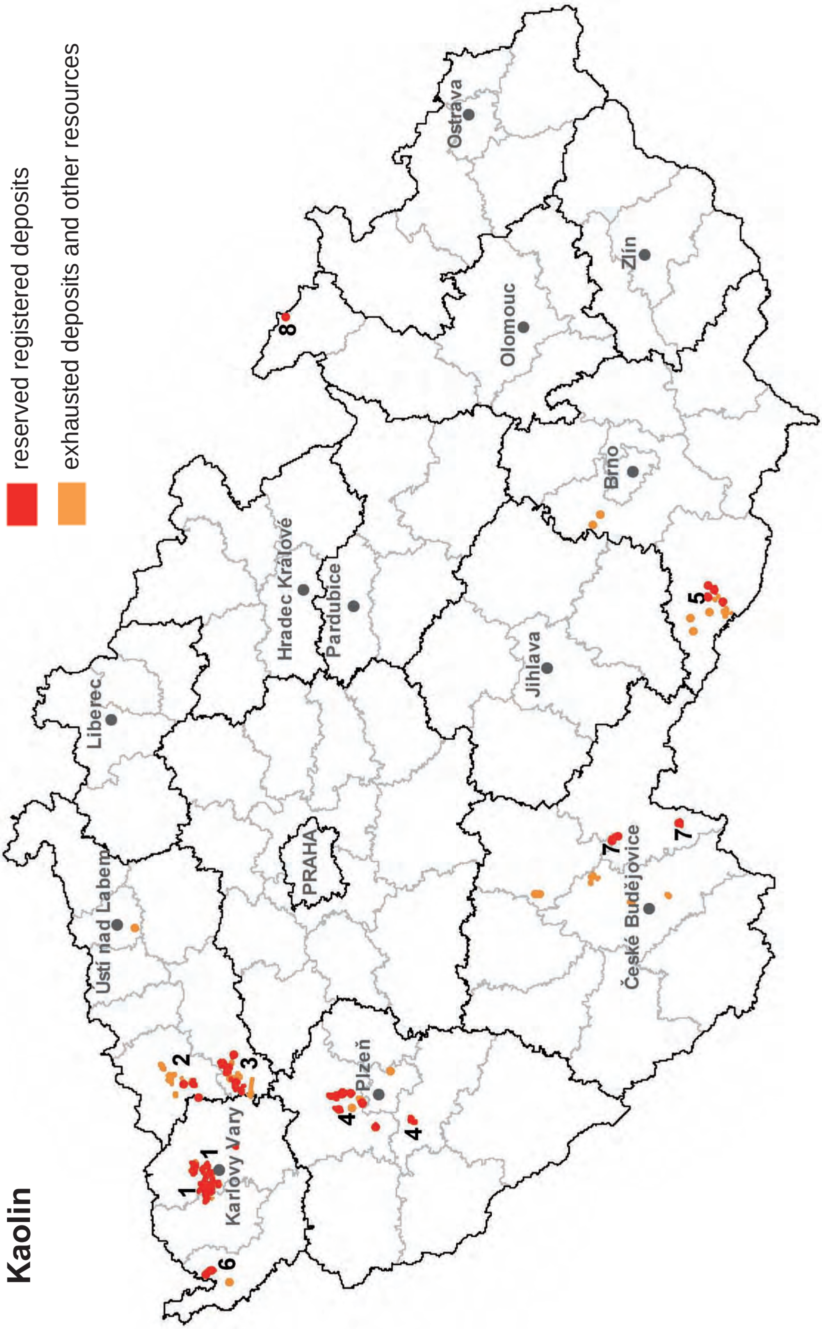
a) Raw kaolin, total production of all technological grades;

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	24 627	24 627	24 627	24 627	24 627
P_2,	kt	4 998	4 998	4 998	4 998	4 998
P_3		–	–	–	–	–

The data of kaolin for production of porcelain and fine ceramics (KJ) and kaolin used as fillers in paper industry (KP) have been stated separately due to great varieties of end use and prices of the individual kaolin types.

Kaolin


reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Liberec
Jihlava
Ústí nad Labem
PRAHA
České Budějovice
Plzeň
Karlovy Vary
1
1
2
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6
7
7
8

Number of deposits; reserves; mine production

Kaolin for production of porcelain and fine ceramics (KJ)	2004	2005	2006	2007	2008
Deposits – total number	29	29	29	30	34
exploited [a)]	7	7	7	6	6
Total *reserves, kt	257 119	256 232	255 331	259 416	256 317
economic explored reserves	56 008	55 491	54 965	54 054	53 042
economic prospected reserves	107 762	107 762	107 762	111 858	111 713
potentially economic reserves	93 349	92 979	92 604	93 504	91 562
Mine production, kt	448	429	449	383	331

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

a) Exploited deposits of KJ: Božičany-Osmosa-jih, Jimlíkov, Krásný Dvůr-Podbořany, Mírová, Podlesí 2, Ruprechtov

Number of deposits; reserves; mine production

Kaolin for paper industry (KP)	2004	2005	2006	2007	2008
Deposits – total number	22	22	23	23	24
exploited [a)]	8	7	7	7	6
Total *reserves, kt	365 127	266 832	349 689	312 105	310 982
economic explored reserves	77 365	32 462	31 228	57 019	55 980
economic prospected reserves	185 975	176 074	231 906	185 205	185 205
potentially economic reserves	101 787	58 296	86 555	69 881	69 797
Mine production, kt	3 181	1 023	1 013	1 021	969

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

a) Exploited deposits of KP: Horní Bříza-Trnová, Chlumčany-Dnešice, Kaznějov-jih, Lomnička-Kaznějov, Otovice-Katzenholz, Rokle, Únanov-sever 3

Porcelain production

Karlovarský porcelán a.s.
Český porcelán a.s. Dubí
Porcelánová manufaktura Royal Dux Bohemia a.s.
Leander, Porcelán Loučky s.r.o.
G. Benedikt Karlovy Vary
Haas & Czjzek, První porcelánová manufaktura v Čechách, s.r.o.
Starorolský porcelán Moritz Zdekauer a.s.

Industrial production of special ceramic materials

Glazura s.r.o., Roudnice nad Labem
Elektroporcelán Louny a.s. – výroba keramických izolátorů
Technická keramika a.s.
Jizerská porcelánka s.r.o.

Karlovarský porcelán a.s. is the biggest Czech producer of household porcelain. It comprises the following plants: Concordia a.s. (yearly production of 1,000 tonnes of porcelain), Chodov (traditional pink china production, about 100 tonnes per year), Klášterec (production of 4,500 tonnes per year), Nová Role (production of 4,000 tonnes of china per year) and Thun Studio. Český porcelán a.s. Dubí is one of the producers of known china with onion décor. Apart from this, it produces other white china types, decorated china and hotel china. Český porcelain a.s. is the major share-holder of the Porcelánová manufaktura Royal Dux Bohemia in Duchcov, the traditional producer of figural and decorative china. Fine white ornamental and household china and a big assortment are produced by the Leander, Porcelán Loučky s.r.o. G. Benedikt Karlovy Vary Company specializes in the china production for hotels and gastronomy. Haas & Czjzek, První porcelánová manufaktura v Čechách, s.r.o. operates a plant in Horní Slavkov, which produces hand-painted china dining sets. Starorolský porcelán Moritz Zdekauer a.s. is engaged in household, hotel and ornamental porcelain as well.

Glazura s.r.o. from Roudnice nad Labem is an important producer of ceramic frits and fluxing agents. It produces namely a large variety of ceramic glazes which improve the surface of ceramic products by primarily ensuring their impermeability, increasing their chemical resistance and mechanical resistance and improving their aesthetic properties (colouring, lustre etc.). Elektroporcelán Louny a.s. specializes in the production of porcelain insulators and products from special ceramic materials which show extraordinary resistance to abrasion and mechanical and thermal stress. The assortment offered by Technická keramika a.s. includes production of technical oxide ceramics for the electrotechnical industry. Laboratory and technical porcelain is produced e.g. by Jizerská porcelánka s.r.o. seated in Desné in Jizerské hory Mts.

5. Foreign trade

2507 – Kaolin and other kaolinitic clays, also calcined

	2004	2005	2006	2007	2008
Import, t	14 046	16 901	23 023	24 161	20 869
Export, t [a)]	483 720	268 715	261 065	248 673	234 499

[a)] *Export of kaolin of the highest quality Sedlec Ia was limited by Ministry of Industry and Trade*

As kaolin is a very important Czech export commodity, foreign trade numbers are given in detail below:

25070020 – Kaolin

	2004	2005	2006	2007	2008
Import, t	6 888	11 697	12 289	15 239	15 626
Export, t [a)]	482 251	265 195	259 395	247 076	233 867

[a)] *Export of kaolin of the highest quality Sedlec Ia was limited by Ministry of Industry and Trade*

25070080 – Kaolinic clay (other than kaolin)

	2004	2005	2006	2007	2008
Import, t	7 158	5 203	10 735	8 922	5 243
Export, t	1 469	3 520	1 670	1 597	632

Detailed data on kaolin imports (t)

Country	2004	2005	2006	2007	2008
Ukraine	3 278	7 193	5 690	9 713	9 570
Great Britain	7 585	5 122	11 270	8 036	5 663
Germany	2 162	3 334	4 201	4 129	4 048
others	1 021	1 252	1 862	2 283	1 588

Detailed data on kaolin exports (t)

Country	2004	2005	2006	2007	2008
Slovakia	75 045	80 819	82 555	68 939	73 507
Germany	152 135	60 803	50 801	45 934	32 384
Poland	27 895	26 027	29 056	30 180	31 388
Italy	30 834	23 098	22 391	22 650	21 894
Romania	14 610	13 425	12 200	10 909	14 751
Austria	44 543	16 542	14 226	10 860	10 008
United Arab Emirates	7 612	6 986	8 406	8 351	9 606
Hungary	10 005	8 564	5 745	5 197	5 450
Slovenia	7 525	6 952	5 992	8 479	4 912
Croatia	2 827	3 334	3 497	3 750	3 859
Turkey	0	0	1 924	5 558	3 249
Iran	2 528	7 940	4 209	6 673	2 497
Serbia	0	1 556	2 755	3 183	3 095
the Netherlands	40 310	9	49	45	130
Belgium	50 356	271	0	0	0
others	16 026	8 869	15 589	16 368	17 137

Kaolin belongs traditionally to the most attractive items of the Czech foreign trade with raw materials – the fact that Czech kaolin was exported to more than 40 European and non-European countries during the last five years documents this. Both the neighbouring countries (Slovakia, Germany, Poland, Italy or Austria) and distant and exotic ones (United Arab

Emirates, Iran, Bangladesh, Malaysia etc.) represent the traditional and large consumers. During the last 3 years, however, the export volume of Czech kaolin decreased markedly; this concerns especially exports to Germany, Austria, Belgium and the Netherlands. The fall in export to Slovakia and Austria continued in 2007. By contrast, Czech kaolin found new markets in Serbia and Turkey.

The Czech export drop is primarily caused by strong competition of cheaper Chinese chinaware in Europe. At present, China produces approximately one half of the world production of chinaware. By contrast, production of many European countries is decreasing. Secondarily, the interest of better situated classes has gradually shifted to other values (electronics, real properties) at the expense of luxurious porcelain sets. Cheap competition manifests itself also in the case of electroporcelain, whose production is much cheaper in India and China thanks to energy prices subventions and low wages, compared with those in Europe, North America and Japan.

Import volumes are significantly lower; however, they have been increasing slightly every year. A minor part of the imported raw material is represented by high-quality British and German kaolins.

6. Prices of domestic market and foreign trade

The average prices of ceramic grade on the domestic market oscillated depending on quality, between CZK 2,200–3,000 per tonne. The average export prices were CZK 2,400–2,600 per tonne. Paper-filling kaolin has been sold at CZK 1,700–2,500 per tonne. Only a small part exceeded the price of CZK 2,500 per tonne (bulk kaolin). Prices above CZK 3,000 per tonne were attained only for products for the chemical industry, produced by grinding of paper kaolin. Crude kaolin for building ceramics was sold for CZK 200–300 per tonne. Beneficiated (water-washed) kaolin from Podbořany was sold on the domestic market at CZK 1,800 per tonne, kaolin for fine porcelain and glazes production roughly at CZK 2,200 per tonne and activated kaolin at CZK 2,700 per tonne.

The average prices of traded kaolin on the domestic market

Product specification	2006	2007	2008
kaolin of ceramic grade, CZK/t	2 000–3 500	2 000–3 500	2 200–2 950
paper-filling kaolin, CZK/t	1 400–2 200	1 500–2 200	1 700–2 500
kaolin for chemical industry, microground, CZK/t	above 3 000	above 3 000	above 3 000
kaolín for porcelain production from Sedlec, CZK/t	3 000–3 300	3 000–3 500	N
beneficiated kaolin from Podbořany KD, CZK/t	1 500	1 640	1 800
kaolin for fine porcelain and glazes production from Podbořany KDG, CZK/t	2 000	2 100	2 200
activated kaolin from Podbořany KDA, CZK/t	2 400	2 500	2 700

25070020 – Kaolin

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	5 278	4 085	4 456	4 819	4 304
Average export prices (CZK/t)	2 352	2 426	2 393	2 608	2 441

Average import prices have been about twice as high as the export prices especially because high-quality British and German kaolin for the most demanding use has been imported into the Czech Republic. Average export prices for Czech kaolin have been rather stable, between 2,300 and 2,700 CZK/t.

7. Mining companies in the Czech Republic as of December 31, 2008

LB MINERALS a.s., Horní Bříza

Sedlecký kaolín a.s., Božičany

Kaolin Hlubany a.s., Podbořany

KERAMOST, a.s., Most

KSB s.r.o., Božičany

8. World production

Data on world production of kaolin vary considerably; the statistics quote alternately dry or wet weight, raw or refined (floated) kaolin, exact figures on mined and produced volumes of saleable product or their estimates. Considerably different numbers are quoted also in single year's volumes of the same publications. Despite of these facts it can be estimated that world production since 1984 ranged above 20 mill tonnes per year, and in 1990 according to the Welt Bergbau Daten (WBD), it reached its top (27.7 mill t). After a fall to 21 mill t in 1993, world production of kaolin has been slowly increasing again. Numbers in British yearbook World Mineral Statistics (WMS) are somewhat higher, and those in the Mineral Commodity Summaries (MCS) are markedly higher as they include some types of clays. The data were markedly overestimated in 2009. In general, an increase of kaolin mining production in rapidly emerging countries (China, Brazil, Republic of Korea, Malaysia) and stagnation or decrease of mine production in developed countries (Great Britain, the USA) can be observed. Mine production of Brazil, Iran, Algeria, Chile, Malaysia and Vietnam, and in Europe of Spain, Germany and Bulgaria increased markedly during the last five years; by contrast, it decreased in Thailand, South Africa, Jordan and Columbia.

World kaolin mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt (MCS)	44 500	44 700	44 800	39 000	38 700
Mine production, kt (WBD)	26 314	27 149	26 460	26 112	N

Main producers' share in the world mine output (2007; according to the WBD):

USA	27.2 %	Republic of Korea	4.0 %
Germany	14.5 %	Czech Republic	3.2 %
China	10.7 %	Iran	2.7 %
Brazil	9.7 %	Turkey	2.3 %
Great Britain	6.4 %	Malaysia	2.3 %

Note:
Data on production share of the Czech Republic vary between the yearbooks. Welt Bergbau Daten gives about 3.2 % for 2007. The Industrial Minerals HandyBook quotes 8 % as the Czech share on the world production for 1997.

9. World market prices

Prices of kaolin on the world market – in spite of a lasting surplus of supply – kept at a steady level. The Industrial Minerals magazine quotes each month the prices of British and US kaolin. However, the range of quotations was changed in 2002 and the prices of the British Cornwall kaolin have ceased to be published.

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Kaolin refined, filler, Ex Georgia plant, USA	USD/st	90.00	90.00	90.00	90.00	90.00
Kaolin refined, coating, Ex Georgia plant, USA	USD/st	135.00	135.00	135.00	135.00	140.00
Kaolin refined, calcined, Ex Georgia plant, USA	USD/st	348.00	348.00	348.00	348.00	348.00
Kaolin refined (water-washed), ceramic grade, bulk, EXW France	GBP/t, since 2005 EUR/t	70.00	116.50	116.50	116.50	116.50
Kaolin refined (water-washed), ceramic grade, bulk, FOB Rotterdam	GBP/t	80.00	80.00	80.00	80.00	80.00

10. Recycling

In ceramic production, a part of the shards is recycled. Increasing recycling of paper has little influence on kaolin consumption, since recycled mineral fillers and coating pigments are separated and slurry is discarded. The recycled paper – used mainly for newsprint and wrapping – uses little if any kaolin.

11. Possible substitutes

Depending on the use, the following holds:
- In production of porcelain, kaolin is irreplaceable.

- In ceramic formulations, kaolin can in some cases be partially substituted by clays, talc, wollastonite or mullite (also synthetic mullite), but in most cases these substitutes are uncompetitive.
- In production of paper (which consumes almost half of total production of kaolin), the possibilities for substitution are the highest – kaolin as a filler can be replaced by extra finely pulverized limestone, dolomite (also synthetic – precipitated), mica (muscovite), talc, wollastonite, etc.
- In other cases, where kaolin is used as filler (insulation materials, pigments, glass fibres), the situation is analogous.
- In production of refractory materials and applications in the building industry, other materials with adequate properties can successfully substitute kaolin.

Limestones and corrective additives for cement production

1. Characteristics and use

Limestones as a mineral are sedimentary (limestones) and metamorphic rocks (crystalline limestone or marble) containing $CaCO_3$ (calcite or aragonite). Limestones originated through chemical, biogenic and mechanical processes or their combination. Primary and secondary admixtures in limestones are dolomite, silicates, phosphates, etc. Limestones of different origin show variations in physical characteristics, texture, hardness, colour, weight, and porosity, ranging from loosely consolidated marls through chalk to compact limestones. Their colour depends on sort of admixture (pyrite and organic substance – black, pure – light to white). Calcitic marble (crystalline limestone) is a metamorphic rock formed of limestone under increased temperature and pressure. Limestones occur in practically all the sedimentary geological formations and their metamorphosed equivalents worldwide.

Limestones are used for production of building materials (lime, cement, mortar mixtures, granulated gravel, dimension and crushed stone, etc.), in the metallurgical, chemical and food industries, recently also for desulphurization of industrial flue gas (e.g. in thermal power stations), in agriculture, glass and ceramic industries, etc.

This group of minerals also includes corrective additives for cement production (CK), e.g. shales, clays, loess, loams, sand, etc., which correct the content of SiO_2, Al_2O_3 and Fe_2O_3 in the basic raw material for clinker mix. These corrective materials mostly occur directly in deposits of portland limestones or separately in their close neighbourhood.

2. Mineral resources of the Czech Republic

According to use, the limestones in the Czech Republic are classified in the following grades:

- Limestones with very high percentage of $CaCO_3$ (VV), containing at least 96 % of carbonate component (with max. 2 % $MgCO_3$). These limestones are used mostly in chemical, glass, ceramics, rubber, food and metallurgical industries, for desulphurization, and for production of the top quality lime (quick lime);
- Other limestones (VO) – with carbonate content at least 80 % – are used mostly for production of cement, further for production of lime, desulphurization, etc. Also dolomites and dolomitic limestones were included in this group in the Czech Republic until 1997.
- Clayey limestones (VJ) – with $CaCO_3$ content over 70 % and higher content of SiO_2 and Al_2O_3. These limestones are used for production of cement, all kinds of lime, and for desulphurization;
- Carbonates for use in agriculture (VZ) – with the content of carbonates at least 70–75 %. They are used for agricultural land and forest soils conditioning;
  Above this limestones are suitable for dimension stones and crushed stone (see this chapters below).

Limestone deposits in the Czech Republic are concentrated in the following main areas:

- The Devonian of the Barrandian area – the most important and the largest mining district in Bohemian part of the Czech Republic. Almost all types of limestones occur there, particularly those of VV and VO grades, but also VZ and CK grades. Limestone deposits are hosted by sediments of mostly Lower Devonian age, and consist usually of several lithological types. The Upper Koněprusy limestones are of the highest grade (average content of $CaCO_3$ is about 98 %). A considerable part of reserves and hypothetical resources is however located in Protected Landscape Area Český kras, hence cannot be accessed. The most important deposits are Koněprusy (VV), Kozolupy-Čeřinka (VV+VO), Kosoř-Hvížďalka (VO), Loděnice (VO), Radotín-Špička (VO) and Tetín (VV+VO).

- The Paleozoic of Chrudim region (of the Železné hory Mts.) – relatively small surface area with important deposits. They are composed of the Podolí crystalline limestones (VV grade, 95 % $CaCO_3$) and less pure darker marbles of VO grade (90 % $CaCO_3$). Mined deposit Prachovice (VV+VO) represents the only and decisive deposit.
- Central Bohemian metamorphosed "islands" (Islet Zone) – small isolated areas with rather pure metamorphosed limestones (mostly VV a VO grades). Skoupý deposit (VV) is the most important one.
- Crystalline complex of the Krkonoše–Jizerské hory Mts. – medium and small-size deposits, mostly in the form of lenses within phyllitic and mica schistous rocks. Limestones are crystalline, often with variable contents of $MgCO_3$ (dolomitic limestones to calcitic dolomites) and SiO_2 (mostly VO and VZ grades). Apart from dolomite deposit Lánov, the almost exhausted Černý důl deposit (VO) is the only exploited deposit.
- Moldanubicum – small-size deposits of crystalline limestones, forming bands or lenses in metamorphic rocks. Dolomitic limestones or dolomites usually accompany the limestones here. The majority of local limestones are of VZ and VO grades. The highest number of deposits and amount of reserves is concentrated in the Šumava part of the Moldanubicum, with an important exploited deposit Velké Hydčice-Hejná (VO).
- The Moravian Devonian – represents the most important and very large region with limestone deposits of various sizes in Moravian part of the Czech Republic. The Vilémovice limestones (VV grade, 96–97 % $CaCO_3$) represent the major mineral in almost all deposits. Further types represented are the Křtiny, Hády and Lažánky limestones (VO). They are mostly registered as corrective additives for cement production. The largest and the most important deposits are concentrated in particular areas of the Moravian Karst with a large mined deposit Mokrá u Brna (VV+VO+CK) and of the Hranice Devonian with a large mined deposit Hranice-Černotín (VO+CK). Other mostly not mined deposits occur in the Konice-Mladeč Devonian, Čelechovice-Přerov Devonian and in the Devonian of the Boskovice Graben.
- The Silesicum (the Branná Group), the Zábřeh Group and the Orlické hory Mts.–Kłodzko Crystalline Complex – smaller deposits of crystalline limestones forming bands in metamorphic rocks. Limestones are often of high grade (VV grade, up to 98 % $CaCO_3$, less of VO grade) and in the northern part of the area there are limestones suitable for dimension stones (KA). Horní and Dolní Lipová (VV+VO) in the Silesicum and Vitošov (VV), located at the border of the Desná Dome and the Zábřeh Group, represent the most important mined deposits of this type.
- The Bohemian Cretaceous Basin (the Ohře and Kolín regions) – large and medium-size deposits. Deposits contain clayey limestones and marls with content of $CaCO_3$ ranging between 80 and 60 % (the most important deposits of clayey limestones – VJ). Exploited deposit Úpohlavy-Chotěšov (VJ) is of a fundamental importance.
- Outer Klippen Belt of the Western Carpathians – limestones form tectonically isolated blocks in surrounding rocks (so-called "klippen"). The limestones – Štramberk lime-

stones in the NE and Ernstbrunn limestones in the SW – are of a very high grade, with an average content of $CaCO_3$ 95.0–98.0 %, and $MgCO_3$ about 1.0 % (VV). Štramberk (VV+VO) is the most important mined deposit of this type. It has been the only mined deposit since 2005, when the operation of the Mikulov deposit was terminated.

Other regions with carbonate rocks occurrences, such as Krušné hory Mts. Crystalline Complex, the Culm of the Nízký Jeseník Mts., Moravicum, the Tertiary of the southern and central Moravia etc. are mostly of just local interest. Deposits of limestones, additives for cement production and dolomites are extracted by open-pit mines.

3. Registered deposits and other resources in the Czech Republic

(see map)

Principal areas of deposits presence:

(Names of areas with mined deposits are indicated **in bold**)

1 **Devonian of the Barrandian area**

2 **Paleozoic of the Železné hory Mts.**

3 **Central Bohemian Islet Zone**

4 **Krkonoše Mts.-Jizerské hory Mts. Crystalline Complex**

5 **South-Bohemian and Moravian Moldanubicum**

6 **Moravian Devonian**

7 **Silesicum (Branná Group), Orlické hory Mts.-Kłodzko Crystalline Complex and Zábřeh Group**

8 **Bohemian Cretaceous Basin**

9 **Outer Klippen Belt of the Western Carpathians**

4. Basic statistical data of the Czech Republic as of December 31

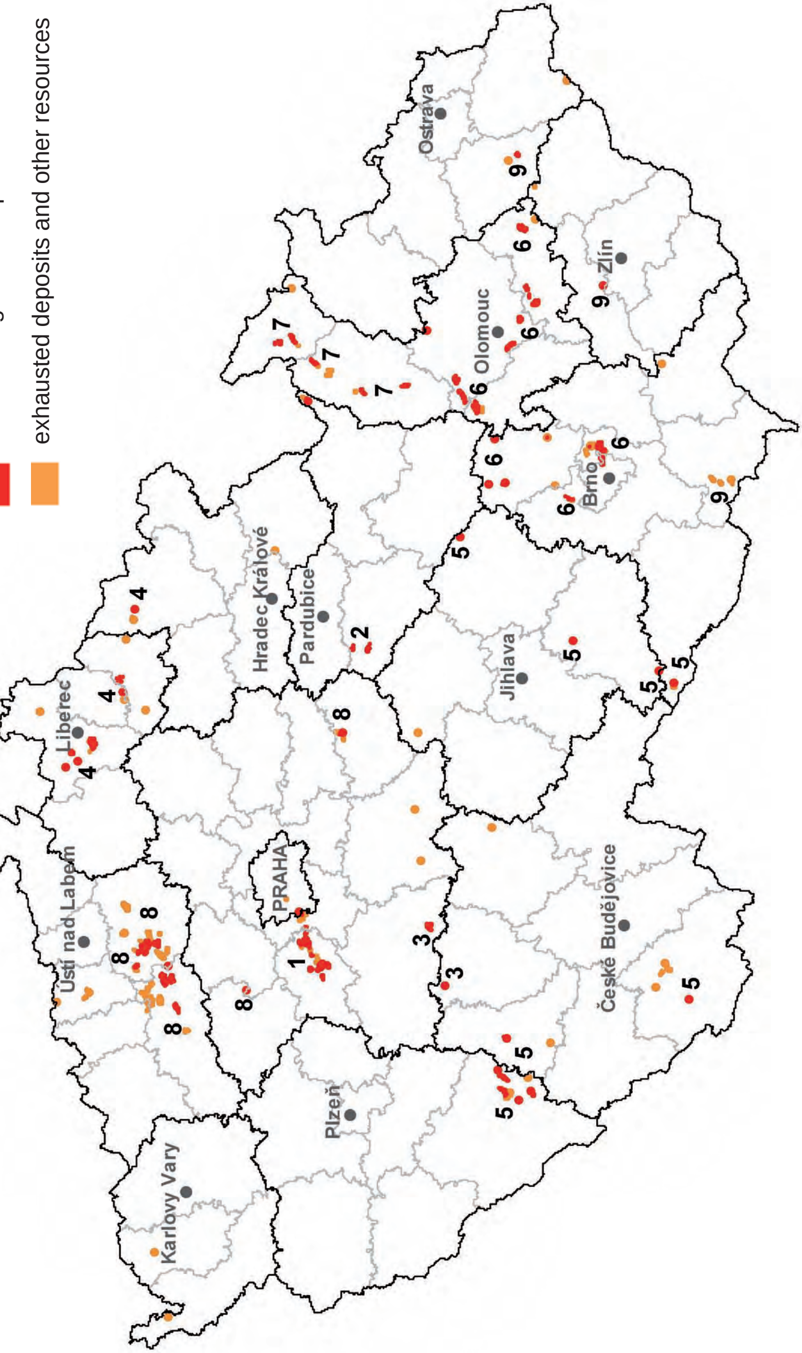
Limestones – total number

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	95	91	88	87	100
exploited	25	25	23	22	29
Total *reserves, kt	4 447 004	4 453 558	4 295 554	4 279 084	4 265 039
economic explored reserves	1 845 807	1 709 724	1 699 360	1 755 091	1 742 662
economic prospected reserves	1 931 626	1 912 168	1 804 009	1 778 279	1 777 976
potentially economic reserves	669 571	831 666	792 185	745 714	744 401
Mine production, kt	10 568	9 912	10 193	11 279	10 958

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Limestones


reserved registered deposits
exhausted deposits and other resources
Karlovy Vary
Plzeň
Ústí nad Labem
Liberec
PRAHA
Hradec Králové
Pardubice
České Budějovice
Jihlava
Brno
Olomouc
Ostrava
Zlín
1
2
3
4
5
6
7
8
9

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	63 725	63 725	63 725	63 725	63 725
P_2,	kt	444 131	444 131	444 131	444 131	444 131
P_3		–	–	–	–	–

Owing to the importance and considerable differences in technological use and prices, high-percentage limestones (VV), corrective additives for cement production (CK) and other limestones (VO) are monitored separately.

High-percentage limestones containing 96 % or more of $CaCO_3$ (VV)

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	30	30	28	28	27
exploited	12	11	11	11	10
Total *reserves, kt	1 426 550	1 423 616	1 388 433	1 355 031	1 349 890
economic explored reserves	685 191	648 966	626 781	622 492	617 467
economic prospected reserves	572 009	565 040	553 972	546 162	546 096
potentially economic reserves	169 350	209 610	207 680	186 377	186 327
Mine production, kt	4 629	4 199	4 386	4 885	4 602

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	5 400	5 400	5 400	5 400	5 400
P_2,	kt	26 345	26 345	26 345	26 345	26 345
P_3		–	–	–	–	–

Other limestones (VO)

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	50	46	47	47	48
exploited	15	15	14	14	16
Total *reserves, kt	2 362 640	2 375 637	2 258 386	2 283 330	2 277 099
economic explored reserves	993 551	894 967	908 015	970 282	964 288

Table from page 295 continued

Year	2004	2005	2006	2007	2008
economic prospected reserves	919 718	907 242	814 494	796 574	796 337
potentially economic reserves	449 371	573 428	535 877	516 474	516 474
Mine production, kt	4 666	4 500	4 643	5 138	5 198

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	52 503	52 503	52 503	52 503	52 503
P_2,	kt	93 174	93 174	93 174	93 174	93 174
P_3		–	–	–	–	–

Corrective additives for cement production (CK)

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	16	16	15	15	15
exploited	5	5	5	4	3
Total *reserves, kt	778 372	778 089	628 591	628 191	622 440
economic explored reserves	342 722	342 439	342 187	341 787	341 245
economic prospected reserves	224 300	224 300	159 688	159 688	156 785
potentially economic reserves	211 350	211 350	126 716	126 716	124 410
Mine production, kt	232	278	248	391	507

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	kt	86 880	86 880	86 880	86 880	86 880
P_2		–	–	–	–	–
P_3		–	–	–	–	–

In many limestone deposits, VV and VO are extracted together. Six out of fifteen CK deposits make part of VO deposits.

Domestic production of selected intermediate products

Year / kt	2004	2005	2006	2007	2008
Cement	3 709	3 978	4 105	4 767	4 710
Quicklime	1 084	1 049	1 016	1 074	1 011
Lime hydrate	180	162	170	146	139

Source: Svaz výrobců cementu (Union of cement producers), Svaz výrobců vápna (Union of lime production)

Cement production:

Cementárna Praha-Radotín
Cementárna Mokrá
Cementárna Prachovice
Cementárna Čížkovice
Cementárna Hranice

Cementárna (cement works) Praha-Radotín and cementárna Mokrá produce Portland cement, Portland slag cement and so-called cement with modified properties. Cementárna Prachovice and cementárna Čížkovice produce Portland cement, Portland slag cement and Portland mixed cement. The assortment of the Hranice cement works involves Portland cement, Portland slag cement and Portland cement with limestone.

Lime production:

Vápenka Čertovy schody a.s.
Vápenka Vitošov s.r.o.
Vápenka Vitoul s.r.o.
KOTOUČ ŠTRAMBERK, spol. s r. o.
CARMEUSE CZECH REPUBLIC s.r.o.
HASIT Šumavské vápenice a omítkárny, a.s.
Krkonošské vápenky Kunčice, a.s.

The product mix of the vápenka (lime works) Čertovy schody involves apart from natural products (lump and ground limestone and lump and grinded dolomite) also burnt products (lump and ground lime, lime hydrate) and special products. Vápenka Vitošov produces lump lime, lime briquettes (used for iron production), lime hydrate and also mortar and plaster mixtures SALITH®. Vápenka Vitoul produces ground and finely ground limestones, used for instance at desulphurization of flue gases from thermal power stations, as a filler in rubber-making industry or at production of plastics. KOTOUČ ŠTRAMBERK, spol. s r. o. produces a large variety of products, e.g. lump sorted limestone, ground limestone, lump lime, ground lime, lime hydrate. HASIT Šumavské vápenice a omítkárny, a.s. produces e.g. lime hydrate, magnesium-lime fertilizers, fillers, plaster mixtures etc. The product mix of Krkonošské vápenky Kunčice includes e.g. dry mortar and plaster mixtures, maintenance plaster, masonry mortar.

5. Foreign trade

2521 – Limestone flux, limestone and other calcareous stone, for lime or cement manufacturing

	2004	2005	2006	2007	2008
Import, t	398 670	170 303	215 210	580 545	497 764
Export, t	133 184	123 299	161 380	97 417	99 305

2522 – Quicklime, slaked and hydraulic lime

	2004	2005	2006	2007	2008
Import, t	104 807	95 014	123 068	124 159	113 720
Export, t	171 160	155 322	145 260	157 850	153 359

2523 – Portland, aluminous, slag, supersulphate and similar hydraulic cements also coloured or in the form of clinkers

	2004	2005	2006	2007	2008
Import, t	1 308 919	1 206 097	1 138 064	1 055 695	1 095 620
Export, t	674 149	554 803	495 128	644 974	653 920

Detailed data on limestone imports (kt)

Country	2004	2005	2006	2007	2008
Slovakia	394 663	168 669	214 175	579 351	497 063
Germany	310	214	408	592	539
Poland	2 871	948	371	10	44
others	826	472	256	592	118

Detailed data on limestone exports (kt)

Country	2004	2005	2006	2007	2008
Poland	96 564	85 303	102 145	60 215	61 018
Germany	21 604	31 097	44 826	22 514	26 319
Austria	1 077	2 064	14 110	13 397	4 899
Slovakia	1 667	1 061	299	691	7 066
others	12 272	3 774	0	600	3

Volume of foreign trade with cement (more than 1 million tonnes per year imported since 2003) has been the most important. About two thirds are imported from Slovakia, the rest namely from Germany and Poland. Czech cement export has been ranging between 0.45 and 0.7 million tonnes and is directed in Germany and other neighbouring countries. The long-term trend of the Czech export being several times higher than the import turned into a completely opposite situation in 2002 and since than the foreign trade balance has been unfavourable for the Czech Republic.

Natural limestone has been imported to the Czech Republic almost exclusively from Slovakia. The imported volume has been gradually decreasing before 2006 (to almost one half during 2004–2006), as the trade was shifting rather to intermediate products. Almost 0.5–0.6 mill tonnes of mainly Slovak limestone was imported again in 2007–2008. The Czech limestone export has been fluctuating between 100 and 200 kt per year; the export to Poland at the expense of Germany has increased in recent years. Trade with lime represents the smallest volume – import has been oscillating around 100 kt on a long term and it comes traditionally mainly from Slovakia. The lime export decreased from 225 kt in 2001 to 150 kt in 2006–2008.

6. Prices of domestic market and foreign trade

Prices are influenced by quality requirements. Prices of high percentage limestones used especially in metallurgy and in chemical and sugar industries are the highest. The average prices of lump high-purity limestone oscillated between CZK 200–500 per tonne during the last years. Prices of bulk cement oscillated, depending on the quality, between CZK 2,100–2,500 per tonne, cement on pallets between CZK 2,450 and 2,800 per tonne. Prices of ground lime were CZK 1,300–2,800 per tonne, lump lime CZK 2,300–2,500 per tonne. Lime hydrate was sold at CZK 2,300–2,600 per tonne. Prices of crushed limestone were CZK 150–250 per tonne depending on $CaCO_3$ content. Prices of ground limestones were CZK 400–1,200 depending on the end-use and grain fraction.

The average prices of traded commodities on the domestic market

Product specification	2006	2007	2008
cement CEM I, 42,5 R, on pallets, CZK/t	N	2 560	2 560
cement CEM I, 42,5 R, on pallets, covered with foil, CZK/t	N	2 640	2 650
cement CEM III A, 32,5 R, on pallets, CZK/t	N	2 260	2 260
cement CEM III A, 32,5 R, on pallets, covered with foil, CZK/t	N	2 340	2 340–2 400
lime hydrate dolomitic, CZK/t	N	2 300–2 565	2 300–2 600
quicklime, ground, CZK/t	N	1 290	1 320

2521 – Limestone flux, limestone and other calcareous stone, for lime or cement manufacturing

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	243	237	182	160	169
Average export prices (CZK/t)	507	506	437	427	453

2522 – Quicklime, slaked and hydraulic lime

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	1 371	1 419	1 403	1 529	1 607
Average export prices (CZK/t)	1 588	1 571	1 640	1 657	1 790

2523 – Portland, aluminous, slag, supersulphate and similar hydraulic cements also coloured or in the form of clinkers

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	1 492	1 593	1 646	1 744	1 727
Average export prices (CZK/t)	1 161	1 219	1 191	1 415	1 493

7. Mining companies in the Czech Republic as of December 31, 2008

Limestones:

Českomoravský cement a.s., nástupnická společnost (succession company), Mokrá
Velkolom Čertovy schody a.s., Tmaň
Holcim (Česko), a.s., člen koncernu (trust member), Prachovice
Cement Hranice, a.s.
Lafarge Cement, a.s., Čížkovice
Vápenka Vitošov s.r.o., Leština
Lomy Mořina, s.r.o., Mořina
OMYA CZ s.r.o.
HASIT Šumavské vápenice a omítkárny, a.s., Velké Hydčice
Lom Skalka, s.r.o., Ochoz u Brna
Krkonošské vápenky Kunčice, a.s.
Vápenka Vitoul s.r.o., Mladeč
Kalcit, s.r.o., Brno
LB Cemix a.s., Borovany
AGIR s.r.o., Petrovice
PRACTIC 99 s.r.o., Brno
Kamenolom a vápenka Malá dohoda, s.r.o., Holštejn

Corrective additives for cement production:

Českomoravský cement a.s., nástupnická společnost (succession company), Mokrá
Cement Hranice, a.s.
Holcim (Česko), a.s., člen koncernu (trust member), Prachovice

8. World production

Overall data on production of limestones in the world are not available. Accessible are data on mine production in some of the neighbouring countries – the average annual mine production in Slovakia (high-percentage limestones and other limestones) oscillated between 6.5 and 7.5 mill t in the last years. The annual mine production in Poland (including limestones used as crushed stone) has been roughly between 33 and 42 mill t. The major producing areas can be indirectly traced based on production of cement and lime, which consumes most of the mined limestone. In the last five years, the largest world producers were China (China accounts for more than 50 % of the world cement production) then, India, the USA, Japan, Rep. of Korea, Spain, Russia, Brazil, Turkey and Italy, which together produced more than 70 % of the world production of cement. China, the USA, Japan, Russia,,Germany, Brazil and Mexico produced about four fifths of the world lime production (81 % in 2007).

World production of cement

Year	2004	2005	2006	2007	2008 e
Production, mill t (MCS)	2 130	2 310	2 550	2 770	2 900

World production of lime

Year	2004	2005	2006	2007	2008 e
Production, mill t (MCS)*	126	127	271	283	290

* compilers of the MCS yearbook revaluated radically lime production in China and increased the originally given volume of approximately 25 mill tonnes to approximately 160–170 mill tonnes (this is reflected by the data since 2006).

9. World market prices

Prices of limestone are not quoted. Prices of lime on the US market oscillated between USD 65 and 90 per tonne in 2004–2008, prices of lime hydrate were between USD 90 and 106 per tonne. The Industrial Minerals magazine has been publishing prices of calcium carbonate of various grades.

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Calcium carbonate ground (GCC), coated fine grade, EXW UK	GBP/t	91.50	91.50	91.50	91.50	91.50
Calcium carbonate precipitated (PCC), coated fine grade, EXW UK	GBP/t	358.50	358.50	385.00	385.00	385.00
Calcium carbonate precipitated (PCC), fine (0.4–1.0 microns), FOB USA	USD/st	260.00	260.00	260.00	260.00	260.00
Calcium carbonate precipitated (PCC), very fine (0.02–0.36 microns), FOB USA	USD/st	562.50	562.50	562.50	562.50	562.50

10. Recycling

The material is not recycled. Just some products of glass industry, construction materials, etc. are recycled.

11. Possible substitutes

Limestones of all grades have various uses. Limestones can be replaced in many applications. Limestones, dolomites and variously burnt lime are often mutually replaceable (e.g. in agriculture). Also in the desulphurization, various mixtures of carbonates can replace limestones. Limestone and products made of limestone (lime, hydrated lime) used for acid neutralization can be replaced by MgO minerals, natural and synthetic zeolites and anaerobic bacteria; biological technologies are successfully used in acid rain effects suppression and acid mine water neutralization.

Yet the limestone are irreplaceable in many of their uses – for instance in production of cement and lime, or in the metallurgical industry (melting agent (flux) for production of pig iron and steelmaking too).

1. Characteristics and use

Silica minerals are represented by various rocks high in SiO_2 (usually min. 96 % but > 99 % for high quality glass and silicon production). These are various quartzites (sedimentary or metamorphosed rocks, consisting mostly of quartz and originated through silicification of sandstones or by cementing of silica sand by siliceous cement), silicified sandstones, siliceous rocks, quartz sands and pebbles, and vein and pegmatite quartz. The grade is established by various standards. The observed parameters are the content of SiO_2 and refractoriness. High Al_2O_3, Fe_2O_3 and possibly other oxides represent impurities.

Silica minerals are used in production of ferrosilicon for the steel industry, pure silicon metal (in semiconductors and for solar photovoltaic panels), refractory building materials (silica - bricks, mortars, ramming masses), porcelain and ceramics. Vein quartz, rock crystal and quartz pebbles are used in production of pure silica glass, UV glass and optical glass (fibre).

2. Mineral resources of the Czech Republic

In the Czech Republic, silica raw materials are classified into two groups**:** common silica minerals, and silica minerals for production of special glass. Silica mineral deposits are formed especially by the occurrences of the Tertiary “amorphous” quartz, Cretaceous “crystalline” quartz and Ordovician quartz, to lesser extent by the occurrences of vein quartz and lydites of the Upper Proterozoic. These minerals are practically not mined in the Czech Republic anymore with the exception of the Vrábče-Boršov deposit. They are mostly replaced by quartz sand (that completely replaced the previous materials in ceramic and glass industry), of which there is a sufficient amount at the market and which are moreover less variable and cheaper.

- Vein quartz deposits can be found almost all over the territory of the Czech Republic. The raw material is suitable for ferrosilicon and silicon production and for ceramics and glass. Vein quartz accumulations are not economic at present due to their low and variable quality and they are gradually eliminated from The Register. Deposits and occurrences can be divided into the following genetic groups:
  1. Deposits of a very pure quartz in pegmatites (Dolní Bory) – of no significance at present
  2. Quartz dikes (silicified fault zones) in Tachov region (Tachov-Světecká hora), in northern (Rumburk) and southern (Římov-Velešín) Bohemia and in the Jeseníky Mts. (Bílý Potok-Vrbno, Žárová)
  3. Quartz veins related to granitoid massifs (the Žulová Massif – Velká Kraš, the Karlovy Vary Massif – Černava-Tatrovice, the Lužice Massif – Rumburk et al.)
- Deposits of “amorphous” quartzite (quartz grains are cemented by a very fine quartz matrix) originated through silicification of Tertiary and Upper Cretaceous sediments in the Most region (Lužice u Mostu-Dobrčice, Stránce, Skršín) and Chomutov region (Chomutov-Horní Ves). In the Podbořany (Skytaly, Vroutek) and Žlutice regions this quartzite occurs only as relic boulders. Quartzite is a traditional material for production of silica bricks and

the quartzite of the highest purity is suitable even for silicon metal production. Quartzites in the Podbořany region were used also for ceramic manufacture.

- Tertiary silicification of Cretaceous sandstones gave origin to important deposits of “crystalline” quartzites (isometric grains of quartz) in the Teplice (mined deposit of Jeníkov-Lahošť, Střelná) and Most (Bečov) regions. Quartzites are suitable mostly for metallurgy and partly also for production of silica bricks and silicon metal.
- The Ordovician quartzites of the Barrandian zone (Kublov, Mníšek pod Brdy, Drahoňův Újezd-Bechlov, Sklenná Huť, Železná) were the most important of the Paleozoic quartzites. They are usually classified as of a lower grade for production of ferrosilicon and to a lesser extent silica bricks. Other larger accumulations of quartzites occur in the Devonian rocks of the Silesicum (Vikýřovice) et al. These quartzites are of a low grade and they are suitable after processing for production of silica bricks of a lower quality.
- Deposits of the Upper Proterozoic silicites (lydites) might be promising for future industrial use because of their reserves and quality. This concerns especially the Rokycany (Litohlavy, Kyšice-Pohodnice) and Přeštice (Kaliště, Kbelnice) regions. Tests showed that the material might be suitable for production of siliceous alloys, and to a lesser extent perhaps for production of silica bricks.
- Quartz pebbles from sand and gravel mined in alluvial deposits of the Labe and Dyje rivers and in the Cheb region used to be considered as a potential source of silica, too. Fraction 16–50 mm at Vrábče-Boršov deposit in the České Budějovice Basin is used this way at present. This fraction is formed almost exclusively just by quartz pebbles; other rocks, limonitized pebbles and other impurities are taken out by hand. Gravel is exported to Germany (about 20–30 kt per year) as a silica mineral for ferrosilicon production.
- Only milky white vein quartz (after mineral processing) is suitable for production of special glass. It is associated with the Central Bohemian Pluton in the Příbram region (Krašovice in the metamorphosed islet zone) and with hydrothermal veins, which were metamorphosed together with the country rocks (phyllites) in the Prostějov region (Dětkovice).

3. Registered deposits and other resources in the Czech Republic

(see map)

Names of mined deposits are indicated in **bold type**

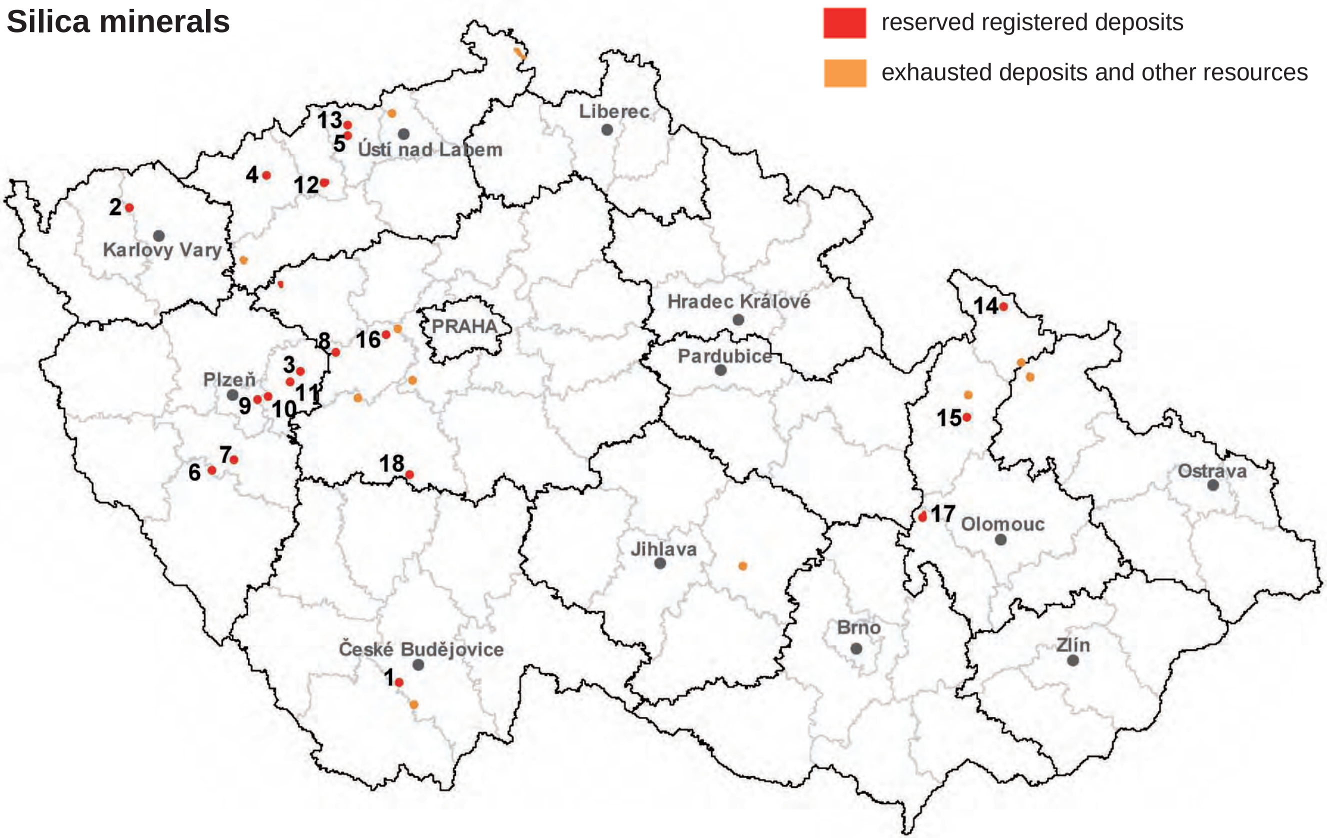
Quartz – quartzites:

1 Vrábče-Boršov	7 Kbelnice	13 Střelná
2 Černava-Tatrovice	8 Kublov-Dlouhá Skála	14 Velká Kraš
3 Drahoňův Újezd-Bechlov	9 Kyšice-Pohodnice	15 Vikýřovice
4 Chomutov-Horní Ves	10 Litohlavy-Smrkový vrch	16 Železná
5 Jeníkov-Lahošť	11 Sklená Huť	
6 Kaliště	12 Stránce	

Quartz for special glass:

17 Dětkovice	18 Krašovice

Silica minerals



4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	19	18	18	18	16
exploited	1	1	1	1	1
Total *reserves, kt	31 379	28 455	28 455	28 673	28 655
economic explored reserves	4 607	4 463	4 463	907	907
economic prospected reserves	26 063	23 283	23 283	23 014	22 996
potentially economic reserves	709	709	709	4 752	4 752
Mine production, kt	10	15	17	19	18

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Approved prognostic resources P_1, P_2, P_3

Year	2004	2005	2006	2007	2008
P_1, kt	4 533	4 533	4 533	4 533	4 533
P_2	–	–	–	–	–
P_3	–	–	–	–	–

Production of ground quartz

Minorit s.r.o.

Since 2000, quartz powder has been produced by Minorit s.r.o. Company, which is a daughter company of Provodínské písky a.s. and Fluorit Teplice s.r.o. Companies, based in Teplice, Quartz powders are produced by silica sand grinding in iron-free ball mills and subsequent air sorting. Their SiO_2 content is above 98 %.

Domestic production of selected intermediate products

year / kt	2004	2005	2006	2007	2008
ganister	8.7	8.8	10.5	11.2	11.5

Ganister production

P-D Refractories CZ a.s.

Ganister producing plant with annual capacity of up to 30 kt was founded in 1985 in Svitavy. Refractory products of high quality and complex shape can be produced in this modern factory.

Company Dinas Banská Belá, a.s. in Slovakia, which has been mining its own deposit Šobov, belong to important Central European producers of ganister and other refractory materials.

5. Foreign trade

2506 – Quartz (except natural sand), crude quartzite, also dressed

	2004	2005	2006	2007	2008
Import, t	18 329	19 352	14 372	16 560	18 225
Export, t	384	653	36	24	31

Detailed data on quartz and quartzites imports (t)

Country	2004	2005	2006	2007	2008
Slovenia	8 874	9 828	7 360	8 604	12 504
Germany	3 808	4 146	4 218	5 095	4 500
Poland	4 986	4 785	2 217	1 799	0
others	661	593	577	1 062	1 221

720221 – Ferrosilicon

	2004	2005	2006	2007	2008
Import, t	30 471	31 682	34 114	39 658	34 527
Export, t	7 120	5 157	6 233	8 208	8 842

Detailed data on ferrosilicon imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	7 027	8 839	8 970	8 556	9 346
Poland	10 852	10 179	5 020	11 204	8 002
Russia	1 006	1 395	3 586	3 416	3 735
Ukraine	3 637	1 579	3 938	2 216	3 048
Macedonia	3 075	4 827	6 525	2 091	2 674
China	270	203	1 030	4 366	994
others	4 604	4 660	5 045	7 809	6 728

6. Prices of domestic market and foreign trade

2506 – Quartz (except natural sand), crude quartzite, also dressed

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	2 713	2 411	2 722	2 837	2 776

720221 – Ferrosilicon

	2004	2005	2006	2007	2008
Average export prices (CZK/t)	20 281	18 561	19 570	22 367	31 633

Lump quartz has been sold at CZK 50–200 per tonne on domestic market. Import prices of quartzites oscillate in a rather narrow interval of 2,400–2,800 CZK/t. The average import prices of ferrosilicon oscillated between 17 and 22 ths CZK/t in period 2003–2007 and they exceeded 30 ths CZK/t in 2008. Ferrosilicon imported from Macedonia and Poland is cheaper than that from Slovakia.

7. Mining companies in the Czech Republic as of December 31, 2008

Budějovické štěrkopísky spol. s r.o., Vrábče

8. World production

Among many known silica raw materials (except sand), special attention is paid to materials for production of synthetic quartz crystals for use in electronics and optics, and then to mining for (finding) natural quartz crystals for direct use in industrial applications. Mining for natural crystals is limited (Brazil, China, Namibia and the USA) and that is why a number of countries have built plants for production of synthetic crystals – the largest factories are in the USA and Japan, smaller ones are in Belgium, Brazil, Bulgaria, France, Germany, South Africa and Great Britain. Among the largest exporters of raw material for production of synthetic crystals were Brazil and Namibia. Production in the USA reached its peak 778 t in 1992; in 1993 the production decreased to 500 t. The production in the USA became stabilized in the following years: 1995 – 435 t, 1996 – 435 t, 1997 – 450 t. Then it decreased till its end in 2003. During the years 1998–2003 the production was not published in the international reviews. World production of silicon (combined totals of silicon content of ferrosilicon and silicon metal) is described in the following table:

World silicon production

Year	2004	2005	2006	2007	2008 e
Production, kt (MCS)	4 900	4 720	4 970	5 590	5 700

Main producers' share in the world mine output (2007; according to MCS):

China	59.0 %	Norway	4.0 %
Russia	11.4 %	France	2.9 %
Brazil	4.7 %	the USA	2.8 %

9. World market prices

Silica materials (except for glass and foundry sand) are not quoted. Prices of raw material for production of synthetic quartz crystals dropped in the USA from USD 1.43 per kg in 1988 to USD 0.85 per kg in 1990. The price stagnated on a level of USD 1.20 per kg. The magazine Industrial Minerals has been publishing quotations of silicon carbide since 2002. Prices of silicon carbide have been rather stable for many years; they increased steeply to almost a double value only in 2008.

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
Silicon carbide, 99 % SiC, grade 1, CIF UK	GBP/t	825	825	825	825	1 900
Silicon carbide, min. 98 % SiC, refractory grade, CIF UK	USD/t; EUR/t since 2005	745	1 000	1 000	1 000	1 900
Silicon carbide, min. 95 % SiC, refractory grade, CIF UK	USD/t; EUR/t since 2005	540	875	790	790	1 700

10. Recycling

Silica material is not recycled.

11. Possible substitutes

Natural quartz had been, as a strategic mineral, irreplaceable until the fifties. At present it is being more and more replaced, both in electronics and optics, by synthetic crystals. Synthetic quartz competes with natural quartz also in production of clear silica glass. More accessible glass sand represents the major source of quartz for ceramics and pellucid quartz glass production at present. Other types of lining can replace silica bricks.

CONSTRUCTION MINERALS
– geological reserves and mine production

There are very high geological reserves of construction minerals – dimension stone, crushed stone, sand and gravel and brick clays and related minerals (brick minerals) – in the Czech Republic. The volume of mine production of construction minerals decreased significantly – to about one half – in 1991 and remained very stable (typically for dimension stone and sand and gravel) in the years afterwards. The change did not arrive until 2003, when the demand for construction minerals increased in relation to reparation of damages after the destructive flood which affected a substantial part of the Czech Republic in August 2002. In connection with the economic growth of the country, mine production remained at a high level also in 2004–2007. A higher consumption (especially of crushed stone) has been mainly used at the renovation of transport infrastructure and railway constructions.

Mining of construction minerals in reserved deposits (decrease of mineral reserves volume by mining)

Mineral	Unit	2004	2005	2006	2007	2008
Dimension stone	ths m^3	273	288	242	242	229
Crushed stone	ths m^3	11 966	12 822	14 093	14 655	14 799
Sand and gravel	ths m^3	8 859	9 075	9 110	9 185	8 770
Brick minerals	ths m^3	1 554	1 543	1 286	1 433	1 242

Thousands of m^3 converted to kt:

- dimension and crushed stone 1,000 m^3 = 2.7 kt
- sand and gravel and brick minerals 1,000 m^3 = 1.8 kt

Mineral	Unit	2004	2005	2006	2007	2008
Dimension stone	kt	737	778	653	653	618
Crushed stone	kt	32 308	34 619	38 051	39 569	39 957
Sand and gravel	kt	15 946	16 335	16 398	16 533	15 786
Brick minerals	kt	2 797	2 777	2 315	2 579	2 236

Lifetime of industrial reserves

(economic explored disposable reserves) based on the decrease of reserves by mining including losses in registered i.e. reserved deposits per year 2008 (A) and on the average annual decrement of reserves in period 2004–2008 (B) was as follows:

Mineral	Lifetime A (years)	Lifetime B (years)
Dimension stone	> 100	> 100
Crushed stone	70	77
Sand and gravel	99	97
Brick minerals	> 100	> 100

Data on construction mineral production presented by the Czech Geological Survey – Geofond were distorted to a certain extent before 1999 due to the classification of deposits as reserved and non-reserved. Producers were not obliged to submit the state statistical statement Geo (MŽP) V3-01 when non-reserved deposit was exploited and therefore their production could not be recorded. The actual production of construction minerals was therefore higher than data presented.

Since 1999, the non-reserved deposit production has been recorded by means of the state statistical statements Hor (MPO) 1-01. These data give a much more precise idea on total building material production (dimension stone included) in the Czech Republic. As the response rate was about 90 to 95 % until 2006, the actual mine output of non-reserved deposits is about 5 to 10 % higher than shown in the table. The response rate has been close to 100 % since 2007.

Mine production of construction minerals in non-reserved deposits is as follows:

Mineral	Unit	2004	2005	2006	2007	2008
Dimension stone	ths m^3	65	55	55	50	40
Crushed stone	ths m^3	960	1 270	1 300	1 350	1 600
Sand and gravel	ths m^3	4 900	5 100	6 000	6 450	6 400
Brick minerals	ths m^3	330	220	300	300	260

Thousands of m^3 converted to kt:

- dimension and crushed stone 1,000 m^3 = 2.7 kt
- sand and gravel and brick minerals 1,000 m^3 = 1.8 kt

Mineral	Unit	2004	2005	2006	2007	2008
Dimension stone	kt	176	149	149	135	108
Crushed stone	kt	2 700	3 500	3 510	3 645	4 320
Sand and gravel	kt	8 820	9 180	10 800	11 610	11 520
Brick minerals	kt	594	396	540	540	470

Brick clays and related minerals

1. Characteristics and use

Minerals for production of bricks are all varieties of minerals applicable to a brick manufacture separately or in a mixture. For this purpose following types of rocks are used: loess, loams, clays and claystones, marls, weathered shales, etc. The brick manufacturing material itself (under common term “brick clay”) contains two main components – plastic and non-plastic (grog) in correct proportions either directly in the material, or alternatively their optimum ratio can be reached by their mixing. The prevailing component in the mixture forms the base whereas the complementary component, which is correcting the properties of the base, serves as a plasticizing agent or a non-plastic component. Harmful substances in brick minerals are mostly carbonates, gypsum, siderite, organic matter, larger fragments of rocks, etc.

Deposits of brick minerals are common all over the world and usually they are not registered.

2. Mineral resources of the Czech Republic

Quaternary loams of various origins prevail among brick minerals in the Czech Republic. Mostly pre-Quaternary sediments represent the source of corrective minerals.

- Deposits of Quaternary brick minerals (loess and loess-loam, loam, sand, sandy-clayey residues) are common all over the country and they are mined extensively. The most important of them are formed by sediments of aeolian, deluvio-aeolian or glacial origin (northern Bohemia and Silesia). Impurities in aeolian sediments are represented by buried soil horizons, clastics and calcareous nodules, in deluvial sediments by detritus of hard rocks. Aeolian materials are suitable (usually in a mixture) for production of exacting thin-walled elements. Deluvial materials can be used as corrective components for more plastic soils, or directly for production of thick-walled brick elements.
- Neogene pelites are a common pre-Quaternary brick mineral in the Bohemian limnic basins and in the Vienna Basin. They are characterized by sandy intercalations and locally also by a higher content of montmorillonite or clastics, in the Vienna Basin and the Carpathian Foredeep also by a higher content of soluble salts. They have been exploited for a very long period of time. They are suitable also for production of exacting thin-walled bearing and shaped elements.
- Paleogene claystones (also calcareous) are exploited in eastern and south-eastern Moravia. They represent weathered parts of flysh layers of outer nappes of the Western Carpathians. Efflorescence-forming salts and layers of sandstones are their major harmful substances. They are used for production of solid or perforated bricks.
- Upper Cretaceous clays and claystones (often calcareous) are used as the base in brick manufacturing material in areas of the Bohemian Cretaceous Basin and in South Bohemian Basins. Marl, marlstone and sand are used as corrective materials. The material is suitable for production of the most demanding perforated bricks and ceiling elements. In southern Bohemia, because of contamination by limonitized sandstone, it can be used only for production of less demanding building elements.

- Permocarboniferous pelites and aleuropelites are used for brick production in Permocarboniferous basins and grabens of Bohemia and Moravia. These deposits are characterized by the occurrence of sandstones and by complex structure. The minerals can be used also for production of roof tiles and thin-walled elements.
- The Late Proterozoic and Early Paleozoic weakly weathered slates and their residues are used around Prague, in the Plzeň and Rokycany regions, etc. Harmful substances are clastics and pyrite. They are not suitable for production of exacting bricks.

3. Registered deposits in the Czech Republic

(see map)

There are large numbers of brick mineral deposits registered in the Czech Republic and thus they are not listed in this overview. Their distribution over the Czech territory is rather uneven and consequently in some regions there is a shortage of these minerals (e.g. Českomoravská vrchovina Highlands).

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	143	144	141	142	136
exploited	40	39	33	37	29
Total *reserves, ths m^3	567 069	571 144	566 217	559 324	549 753
economic explored reserves	238 408	232 879	229 270	220 955	217 782
economic prospected reserves	241 152	241 390	240 315	238 341	232 729
potentially economic reserves	87 509	96 875	96 632	100 028	99 242
Mine production in reserved deposits, ths m^3	1 554	1 543	1 286	1 433	1 242
Mine production in non-reserved deposits, ths m^3 [a)]	330	220	290	300	270

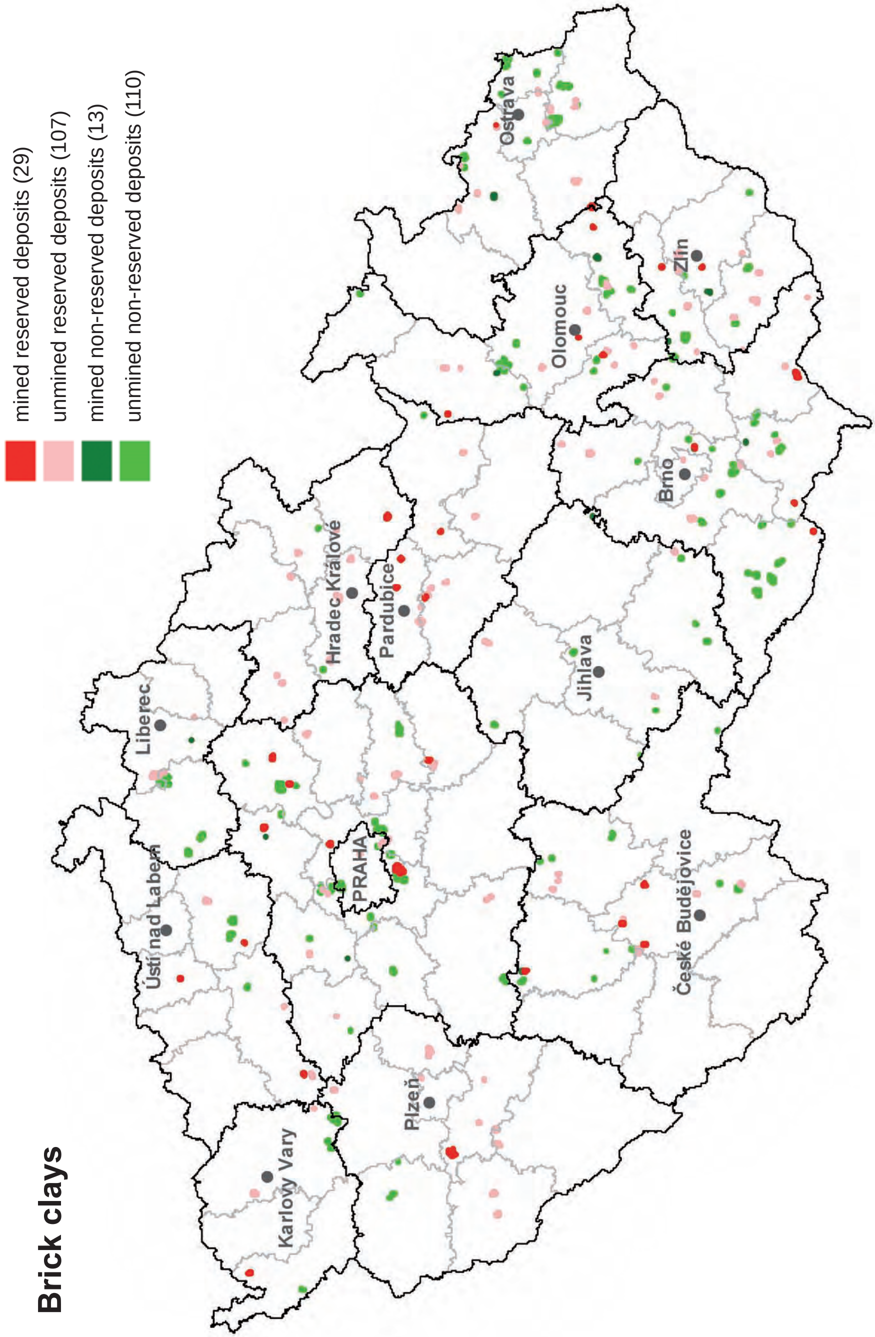
* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

[a)] estimate

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	ths m^3	27 121.74	27 121.74	27 121.74	27 121.74	27 121.74
P_2,	ths m^3	245 493.93	245 493.93	245 493.93	245 493.93	245 493.93
P_3		–	–	–	–	–

Brick clays


mined reserved deposits (29)
unmined reserved deposits (107)
mined non-reserved deposits (13)
unmined non-reserved deposits (110)
Ostrava
Zlín
Olomouc
Brno
Jihlava
Hradec Králové
Pardubice
Liberec
PRAHA
Ústí nad Labem
České Budějovice
Plzeň
Karlovy Vary

Domestic production of selected intermediate products

Year	2004	2005	2006	2007	2008
Burnt bricks (kt)	1 379	1 450	1 317	1 400	N
Burnt roof tiles (kt)	204	242	230	250	N

5. Foreign trade

690410 – Building bricks

	2004	2005	2006	2007*	2008*
Import, t	213 831	174 275	209 194	51 403	40 298
Export, t	23 262	6 487	25 185	14 461	17 982

* *given in ths pcs, not tonnes, since 2007*

Detailed data on building bricks imports (t)

Country	2004	2005	2006	2007*	2008*
Germany	108 238	61 819	144 588	34 460	26 117
Belgium	62 915	84 095	40 795	4 727	5 099
Austria	27 264	15 737	9 491	5 559	2 557
Poland	7 283	7 879	7 900	1 585	1 278
others	8 131	4 745	6 420	5 072	5 247

* *given in ths pcs, not tonnes, since 2007*

690510 – Roof tiles

	2004	2005	2006	2007*	2008*
Import, t	12 087	10 890	12 964	6 708	6 252
Export, t	102 697	93 578	82 148	75 581	43 174

* *given in ths pcs, not tonnes, since 2007*

Detailed data on roof tiles exports (t)

Country	2004	2005	2006	2007*	2008*
Slovakia	38 079	29 168	24 776	27 561	22 884
Poland	31 741	37 113	29 981	29 643	12 477
Germany	20 234	17 208	19 490	18 106	7 686
Austria	7 853	7 582	6 851	143	36
others	4 790	2 507	1 050	128	91

* *given in ths pcs, not tonnes, since 2007*

Goods with higher value added, i.e. final products (bricks, roof tiles), not the brick minerals are traded on foreign market. Trading partners are nevertheless mainly neighbouring countries. A typical feature of foreign trade with bricks is that the Czech Republic turned into a pure importer from exporter in 2002–2004. Contrastingly, roof tiles export has been roughly 7 (in 2006) to 12 (in 2003) times higher then their import.

6. Prices of domestic market and foreign trade

Domestic prices of brick products

Product specification	2006	2007	2008
Full brick; CZK/piece	5–10	6–12	5–12
Honeycomb brick; CZK/piece	6–12	7–14	8–15
Facing bricks; CZK/piece	N	10–16	10–17
Brick blocks Porotherm; CZK/piece	35–110	40–130	35–135

Price of brick crude material on domestic market has been about CZK 500/t, brick clay roughly about CZK 80–180/t. Clay (ground clay bricks for tennis courts) is offered at CZK 1,100–1,800 per tonne. Prices of full bricks oscillate between CZK 5 and 12 apiece, depending on their quality (especially resistance against frost) and producer. The average price is CZK 8 apiece. Lightened full bricks were sold at about CZK 6 apiece. Honeycomb bricks were sold at CZK 8–15 apiece, on average for CZK 12 apiece. Prices of roof tiles fluctuated depending on type and surface finish (fair-face, engoba, glaze) within the limits CZK 20–40 apiece, prices of special types, e.g. ventilating, boundary tile, have been between CZK 80–170 apiece. Prices of classical shingle tile oscilated between CZK 11–20 apiece. Brick blocks "Porotherm" are offered at CZK 35 to 95 apiece. Prices of grinding Porotherm perlite-filled elements have been CZK 67–134 per tonne. Evolution of the average import and export prices are contained in the following tables.

690410 – Building bricks

	2004	2005	2006	2007*	2008*
Average import prices (CZK/t)	1 460	1 858	1 472	15	15
Average export prices (CZK/t)	1 350	1 545	1 216	14	17

* *given in CZK/piece, not tonnes, since 2007*

690510 – Roof tiles

	2004	2005	2006	2007*	2008*
Average import prices (CZK/t)	4 637	4 329	5 687	16	15
Average export prices (CZK/t)	4 717	4 574	4 558	5	6

* *given in CZK/piece, not tonnes, since 2007*

7. Mining companies in the Czech Republic (reserved deposits) as of December 31, 2008

WIENERBERGER Cihlářský průmysl a.s., České Budějovice

TONDACH Česká republika s.r.o., Hranice

HELUZ cihlářský průmysl, v.o.s., Dolní Bukovsko

Cihelna Kinský s.r.o., Kostelec nad Orlicí

Cihelny KRYRY a.s., Plzeň

Zlínské cihelny s.r.o., Zlín

Cihelna Hodonín s.r.o.

Cihelna Polom, s.r.o.

Cihelna Vysoké Mýto s.r.o.

PARALAX a.s., Praha 8

Bratři Řehounkové – cihelna Časy s.r.o.

LB Minerals, s.r.o., Horní Bříza

Cihelna Hlučín s.r.o., Ostrava

The most important mining organization in non-reserved deposits as of December 31, 2008

WIENERBERGER cihelna Jezernice, spol. s.r.o.

WIENERBERGER Cihlářský průmysl, a.s., České Budějovice

STAMP s.r.o, Náchod

GEOPOS spol. s.r.o., Dřínov

Vlastimil Bělák, cihelna Bořinov

PARALAX a.s., Praha 8

Ing. Jiří Hercl, cihelna Bratronice, Kyšice

8. World production

Production of brick clays is not recorded on the global scale. The annual mine production in Slovakia oscillates roughly between 300 and 600 ths m^3, in Poland it has been between 2.5 and 3.5 mill m^3 during the last five years.

9. World market prices

Brick clays and related minerals are not subjects of the world trade.

10. Recycling

Brick clays and related minerals cannot be recycled, but the final products – bricks, tiles and blocks – can be reused. It is possible to recycle construction detritus and mixed construction waste (for instance recycled material “Remexit”).

11. Possible substitutes

In production of conventional brick elements, brick minerals are irreplaceable. Other types of bricks can be produced from other materials (e.g. calcareous-acid bricks, sintered light ashes, foamed concrete), of course. In such a case, various natural and artificial materials (quartz, lime, powder aluminium, artificial aggregates, cinder and flue ashes of thermal power plants, tailings, etc.) can be used as substitutes.

Crushed stone

Mimoza Allaraj, Jörg Heimburg, Thomas Heise, Günter Tiess
Montanuniversität Leoben, Chair of Mining Engineering, Leoben, Austria
(subchapters 8., 9.)

1. Characteristics and use

Crushed stone involve all kinds of solid magmatic, sedimentary, or metamorphic rocks, which have suitable technical properties to be used in construction works. They must have certain physical and mechanical properties based on their origin, mineralogical and petrographic composition, structure, texture, secondary alterations, etc. The rocks are used in the form of quarried stone or mostly in the form of crushed and broken aggregates. Impurities are represented by fractured, crushed, weathered or altered zones, inclusions of technically unsuitable rocks, higher content of sulphur, amorphous SiO_2, etc. The world resources are virtually inexhaustible.

2. Mineral resources in the Czech Republic

Commercially usable deposits of stone suitable for crushing can be found throughout the Bohemian Massif, but much less frequently in its basin regions. Western Carpathians are rather poor in stone suitable for crushing.

- Volcanic rocks represent the major source of stone for production of crushed aggregates in the Czech Republic. Deposits of paleovolcanic rocks (pre-Tertiary volcanites) occur only in the Barrandian area (consolidated pyroclastics are also suitable), in the Krkonoše Mts. Piedmont Basin and in the Intra-Sudetic Depression. They locally enclose also layers or bodies of pyroclastic or altered rocks. Especially important are deposits of mafic rocks – spilites, diabases, etc. Among neovolcanic rocks (post-Cretaceous volcanites), mafic (especially basaltic) varieties appear to be the most important, too. They are most abundant in the České středohoří and Doupovské hory Mountains, less abundant in the neovolcanic area of the Bohemian Cretaceous Basin, eastern Sudetes and in the Železný Brod region. Share of basic volcanic rocks in the total mine production of crushed stone in the Czech Republic is about 25 %.
- Igneous rocks (particularly granites and quartz-diorites) represent an important source of crushed stone. Various types of igneous rocks (including accompanying swarms of dike rocks) are quarried at many localities in the Central Bohemian Pluton, Central Moldanubian Pluton, the Železné hory Mts. Pluton (the Nasavrky Massif), the Brno Massif and in other plutonic bodies. Single deposits of dike rocks are of small importance. Share of deep-seated igneous rocks in the total mine production of crushed stone in the Czech Republic is about 21 %.
- Deposits of consolidated clastic sediments (siltstones, greywackes, etc.) predominate in the sedimentary rock deposits. Culmian greywackes of the Nízký Jeseník Mountains and the Drahanská vrchovina Highlands represent the most important source of crushed stone. Similar rocks also occur in the Proterozoic of the Barrandian area, Moravian Devonian and the flysh belt of the Western Carpathians. Clastic sedimentary rocks

(mainly greywackes) make about 27 % of the crushed stone production in the Czech Republic.

- Carbonates (the Lower Paleozoic of the Barrandian area, the Moravian–Silesian Devonian) and siliceous rocks (lydites or cherts in the Upper Proterozoic of the Plzeň region) represent deposits of chemical and biogenic origin. They constitute approximately 3 % of the total crushed stone production in the Czech Republic.
- Regionally metamorphosed rock deposits, represented by crystalline schists or gneisses, which occur exclusively in crystalline complexes of the Bohemian Massif in Moldanubicum, Moravicum, Silesicum, crystalline areas of the Slavkovský les, West Sudetes etc. are of a high importance, too. Besides technologically very suitable rocks (orthogneisses, granulites, amphibolites, serpentinites, crystalline limestones, etc.) there occur also some less suitable rocks (mica-schists, paragneisses, quartzites).
- Less important are deposits of contact metamorphosed rocks (hornfelses, schists) occurring along the contact of the Central Bohemian and the Nasavrky Plutons with Late Proterozoic and Paleozoic sediments. Metamorphosed (both regionally and contact) rocks contribute to more than 25 % in the total mine production of crushed stone.
- A small proportion of suitable clays of the Cypris formation, representing the overburden of the Sokolov coal basin, have been used for expanded stone production (commercial name LIAPOR).

3. Registered deposits in the Czech Republic

(see map)

Because of the large number of crushed stone deposits in the Czech Republic, they are not listed.

4. Basic statistical data of the Czech Republic as of December 31

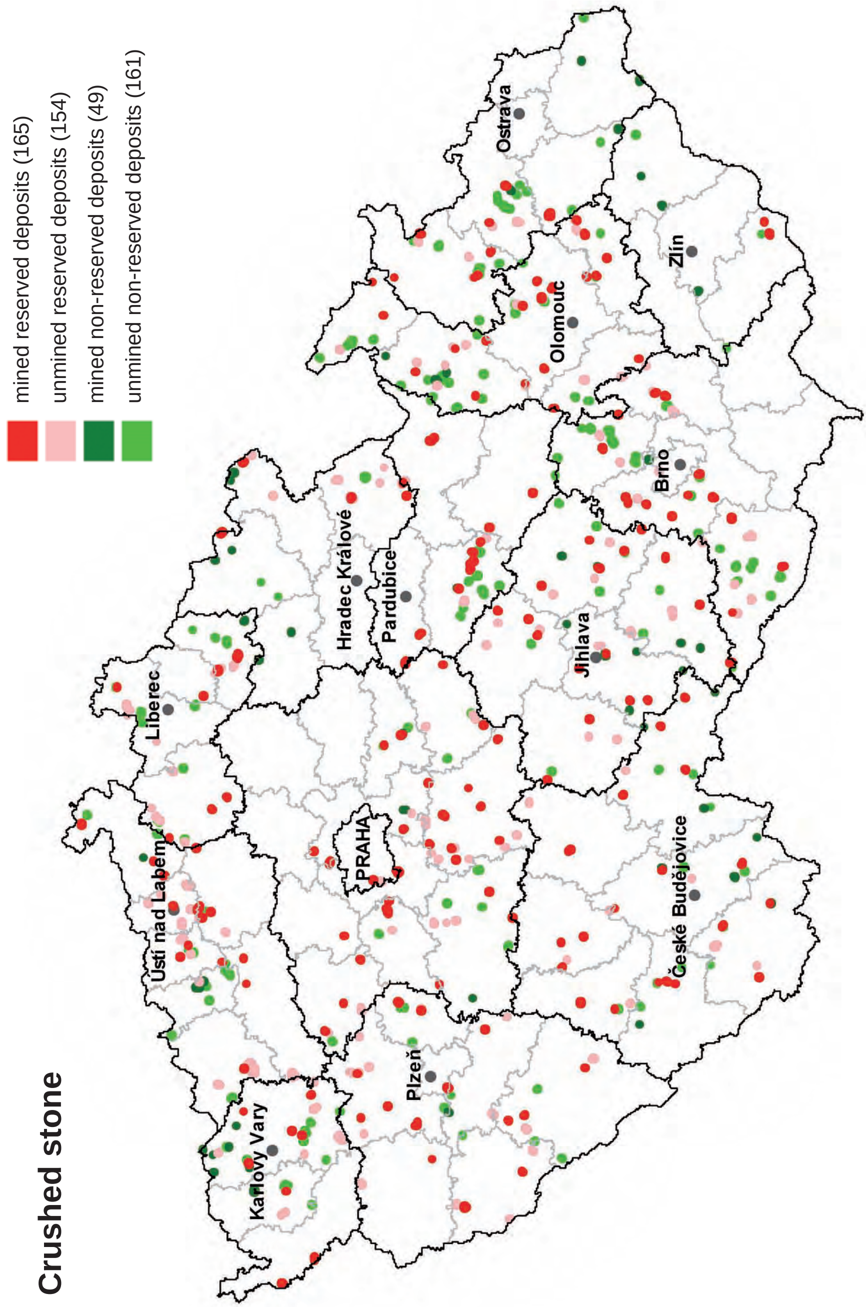
Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	324	319	319	319	319
exploited	168	169	170	169	165
Total *reserves, ths m^3	2 281 082	2 315 902	2 254 873	2 266 643	2 290 511
economic explored reserves	1 142 528	1 166 229	1 130 527	1 129 149	1 138 025
economic prospected reserves	983 239	1 014 798	996 531	1 005 144	1 017 433
potentially economic reserves	155 315	134 875	127 815	132 350	135 053
Mine production in reserved deposits, ths m^3	11 966	12 822	14 093	14 655	14 799
Mine production in non-reserved deposits, ths m^3; [a)]	960	1 270	1 300	1 350	1 600

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

[a)] estimate

Crushed stone



Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	ths m^3	78 950.00	78 950.00	78 950.00	78 950.00	78 950.00
P_2,	ths m^3	399 314.39	399 314.39	399 314.39	399 314.39	399 314.39
P_3		–	–	–	–	–

5. Foreign trade

251710 – Pebbles, gravel, broken or crushed stone

	2004	2005	2006	2007	2008
Import, kt	455	480	632	246	266
Export, kt	210	340	599	471	486

Definition of the item 251710 of the customs tariff clearly shows that not only crushed stone but also sand and gravel and other sand types are included in this item. However, especially in case of Slovakia the import does not concern crushed stone in the literal sense. Customs tariff items in the group of construction materials characteristically overlap or they are not unequivocally specified. Given data, as well as the territorial structure of foreign trade, should be understood rather as information on trends rather than exact numbers.

Detailed data on crushed stone imports (kt)

Country	2004	2005	2006	2007	2008
Slovakia	397	397	553	158	191
Germany	26	62	38	49	31
Poland	19	16	31	27	25
other	13	5	10	12	19

Detailed data on crushed stone exports (kt)

Country	2004	2005	2006	2007	2008
Austria	190	196	254	209	218
Slovakia	2	138	322	184	186
Germany	16	6	18	55	43
other	2	0	5	23	39

6. Prices of domestic market and foreign trade

251710 – Pebbles, gravel, broken or crushed stone

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	293	284	237	378	413
Average export prices (CZK/t)	266	234	221	220	148

Crushed stone prices oscillate depending on the rock quality, grain size and also on availability of the mineral in certain region. In 2008 size fraction 4–8 mm was offered at following prices in CZK/t: spilite – approximately 310, amphibolite – approximately 319, granite – approximately 317, gneiss and porphyry – approximately 314, granodiorite – approximately 339, greywacke – approximately 307, basalt – approximately 240, chert – approximately 275, limestone – approximately 248. In size fraction 8–16 mm, the prices in CZK/t were as a whole lower: spilite – approximately 260, amphibolite – approximately 266, basalt – 221, chert and gneiss – approximately 243, granodiorites – 266, greywacke – 252, granite – 249, limestone – approximately 210. Prices of crushed stone in size fraction 16–32 mm were still lower (in CZK/t): spilite – approximately 265, basalt – approximately 215, amphibolite – approximately 230, gneiss – approximately 230, chert and porphyry – approximately 240, granodiorite – 220, greywacke – approximately 230, granite – 230, limestone – approximately 170. Prices of crushed stone in size fraction 32–63 mm as a whole were between 160 and 230 CZK/t in 2008; the cheapest was again limestone and the most expensive amphibolite.

As classification according to the region concerns, prices of crushed stone have been higher in Liberec, South Bohemian and Plzeň (Pilsen) Regions. Relatively low prices were noted in Moravian-Silesian, Olomouc and Karlovy Vary Regions.

Domestic prices of crushed stone

Product specification	2006	2007	2008
crushed stone, spilite, fraction 4–8mm, CZK/t	310	310	315
crushed stone, amphibolite, fraction 4–8 mm, CZK/t	295	310	319
crushed stone, granite, fraction 4–8 mm, CZK/t	290	303	317
crushed stone, gneiss and porphyry, fraction 4–8 mm, CZK/t	288	300	314
crushed stone, granodiorite, fraction 4–8 mm, CZK/t	282	295	339
crushed stone, greywacke, fraction 4–8 mm, CZK/t	270	288	307
crushed stone, basalt, fraction 4–8 mm, CZK/t	260	275	240
crushed stone, chert, fraction 4–8 mm, CZK/t	250	260	275
crushed stone, limestones, fraction 4–8 mm, CZK/t	215	230	248
crushed stone, spilite, fraction 8–16 mm, CZK/t	280	292	260
crushed stone, amphibolite, fraction 8–16 mm, CZK/t	245	255	266
crushed stone, granite, fraction 8–16 mm, Kč/t	222	236	249
crushed stone, gneiss, fraction 8–16 mm, Kč/t	230	242	243
crushed stone, granodiorites, fraction 8–16 mm, Kč/t	227	237	266
crushed stone, greywacke, fraction 8–16 mm, Kč/t	224	235	252
crushed stone, basalt, fraction 8–16 mm, Kč/t	240	253	221
crushed stone, chert, fraction 8–16 mm, Kč/t	230	242	248
crushed stone, limestones, fraction 8–16 mm, Kč/t	185	195	210

7. Mining companies in the Czech Republic (reserved deposits) as of December 31, 2008

TARMAC CZ a.s., Liberec
Českomoravský štěrk a.s., Mokrá
KAMENOLOMY ČR s.r.o., Ostrava – Svinov
EUROVIA Lom Jakubčovice s.r.o.
Kámen a písek s.r.o., Český Krumlov
M – SILNICE a.s., Pardubice
Hanson ČR a.s., Mokrá
KÁMEN Zbraslav, spol. s.r.o.
COLAS CZ a.s., Praha
Lomy s.r.o., Brno
BÖGL & KRÝSL k.s., Praha
Basalt s.r.o., Zabrušany
Stavby silnic a železnic a.s., Praha 1
Berger Bohemia a.s., Plzeň
Kámen Brno, s.r.o.
Granita s.r.o., Skuteč
Štěrkovny spol. s r.o., Dolní Benešov
DOBET s.r.o., Ostrožská Nová Ves
Stone s.r.o., kamenolom Všechlapy
Kamenolom Císařský a.s., Brno
ZAPA beton a.s., Praha 4
Žula Rácov s.r.o., Batelov
SHB s.r.o., Bernartice
Lom Klecany, s.r.o., Praha 9
PIKASO s.r.o., Praha 4
ROSA s.r.o., Drásov
ATS – Silnice spol. s r.o., Zabrušany
LOMY MOŘINA spol. s.r.o., Mořina
RENO Šumava a.s., Prachatice
Stavební recyklace s.r.o., Sokolov
CEMEX Sand, s.r.o., Napajedla
Silnice Čáslav – Holding, a.s.
Formanservis s.r.o., Nebřenice
BES s.r.o., Benešov
Železniční průmyslová stavební výroba Uherský Ostroh, a.s.
HUTIRA – OMICE, s.r.o., Omice
Ludvík Novák, Komňa
Skanska DS a.s., Brno
ZD Šonov u Broumova
František Matlák, Mochov
IS-VPAS s.r.o., Ústí nad Labem
PETRA – lom Číměř, s.r.o.
VH PROSPEKT Olomouc s.r.o.
EKOZIS, spol. s.r.o., Zábřeh
PEDOP s.r.o., Lipovec

Froněk s.r.o., Rakovník
OLZ a.s., Olomouc
Kozákov – družstvo, Záhoří
Weiss s.r.o., Děčín
Madest s.r.o., Šafov
Pavel Dragoun, Cheb
JHF Heřmanovice spol. s.r.o.
Kamenolom KUBO s.r.o., Malé Žernoseky
Thorssen s.r.o., Kamenolom Mladecko
Daosz, s.r.o., Jesenec
NATRIX a.s., Bojkovice
KATORGA s.r.o., Praha
Jan Hamáček – Stavby Prunéřov

The most impotrant mining organizations in non-reserved deposits as of December 31, 2008

Sokolovská uhelná, právní nástupce, a.s., Sokolov
LOMY MOŘINA spol. s.r.o., Mořina
BÖGL & KRÝSL – SILNICE MORAVA s.r.o., Krnov
Hanson ČR, a.s., Mokrá
KÁMEN Zbraslav, spol. s.r.o.
COLAS CZ a.s., Praha
Stavoka Kosice, a.s.
Kamenolom Žlutava s.r.o.
Kámen a písek s.r.o. Český Krumlov
Vršanská uhlená a.s., Most
ZETKA Strážník a.s., Studenec
KAMENOLOMY ČR s.r.o., Ostrava-Svinov
ZUD, a.s., Zbůch
SENECO, s.r.o., Polná
Kalcit s.r.o., Brno
Granita, s.r.o., Skuteč
RENO Šumava s.r.o., Prachatice
TS služby, s.r.o., Nové Město na Moravě
Valašské lesotechnické meliorace, a.s.
Jihočeské lesy České Budějovice, a.s.
EKOZIS spol. s.r.o., Zábřeh
Lesy České republiky, s.p., Hradec Králové
Obec Hošťálková
Lesostavby Frýdek Místek, a.s.
Petr Vaněk – Lomstav, Horní Maršov
BAK a.s., Trutnov
LB, s.r.o., Mezirolí
Bohumil Vejvoda – obchodní činnost VEDA CS, Krakovany
Zemní a dopravní stavby Hrdý Milan, s.r.o., Dobrná
Vojenské lesy a statky ČR, s.p., Praha 6
Kamena, výrobní družstvo Brno
TATI s.r.o., Praha 6

8. World production

Mine production of the crushed stone is frequently reported together with sand and gravel under the term aggregates. In Europe Spain and France are the biggest producers of aggregates (total of srushed stone and sand and gravel), representing about one third of the European Union production. Germany is on the third place with nearly the same production as France (in percent). The following tables show up the production of crushed stone.

Production of crushed stone in European Union (present EU-27 countries) in 2006 (t)

Rank	Country	Production [t]
1	Spain	295 000 000
2	France	233 090 000
3	United Kingdom	145 578 000
4	Germany	132 700 000
5	Irish Republic	96 000 000
6	Italy	70 887 571
7	Sweden	70 517 845
8	Finland	46 000 000
9	Norway	45 280 000
10	Belgium	39 937 651
11	Poland	38 835 618
12	Czech Republic	34 815 503
13	Austria	26 791 067
14	Hungary	17 944 036
15	Slovakia	15 337 749
16	Slovenia	14 213 319
17	Cyprus	12 198 513
18	Estonia	8 322 300
19	Bulgaria	8 230 249
20	Switzerland	5 700 000
21	Lithuania	5 259 535
22	Latvia	582 081
23	Denmark	372 000
24	Others	N
	Sum	1 363 593 037

Source: British Geological Survey

Production of crushed stone in the USA in 2008 e (mill t), by division

West	142
Midwest	372
South	650
Northeast	186
Total	* 1 340

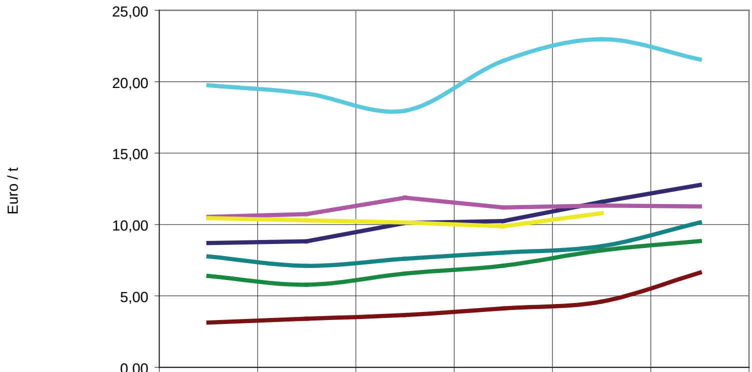
Source: USGS

* *Data may not add to totals because of independent rounding and differences between projected totals by States and divisions*

9. World market prices

Crushed stone prices are not formed on the international market. Neither indicative regional prices are quoted. Foreign trade exchange takes place mostly between neighbouring countries. The prices of aggregates are different all over Europe and can even alternate locally for some percent of the average price. For example a ton of crushed stone will be much cheaper in the south than in the north of Germany because of the existence of hard rock deposits in the southern mountainous areas and the lack of them in the flat parts of Germany.

In regard of a long term price development from 2003 to 2008 it can be noticed that in every country under consideration (Austria, Germany, United Kingdom, France, Poland, Slovakia and Hungary) the prices settled on a higher level in 2008 than in 2003. (see figure 1).



	2003	2004	2005	2006	2007	2008
Austria	8.70	8.82	10.11	10.24	11.59	12.77
Germany	10.54	10.73	11.88	11.19	11.33	11.27
France	10.45	10.29	10.14	9.87	10.79	
United Kingdom	19.75	19.17	17.97	21.46	22.97	21.56
Poland	6.40	5.79	6.57	7.12	8.19	8.84
Slovakia	3.14	3.41	3.66	4.13	4.60	6.63
Hungary	7.76	7.11	7.60	8.03	8.48	10.14

Figure 1: Comparison of prices for crushed stone in European countries (Source: Market evaluation conducted by University of Leoben)

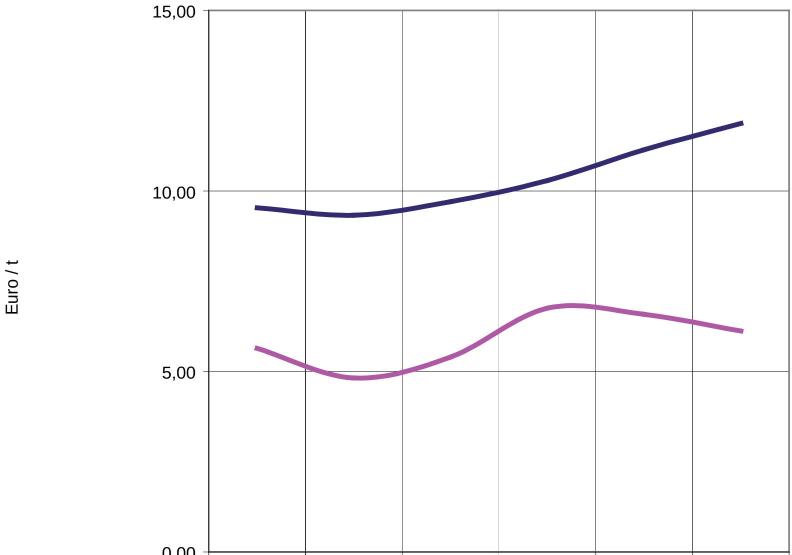
In the short term development from 2007 to 2008 prices in two countries settled on a lower level:

- Germany by -0.53 %
- United Kingdom by -6.14 %

Average prices in the residual countries under consideration (Austria, Poland, Slovakia and Hungary (price data of France were not available in adequate quantity and quality)) increased in comparison to 2007:

- Austria by 10.18 %,
- Poland by 7.94 %
- Slovakia by 44.13 %
- Hungary by 19.57 %

Figure 2 illustrates the average prices for crushed stone in above-mentioned European countries and the USA. Unlike for sand and gravel, the development of prices in the USA and Europe shows opposing trends. Until 2006 the prices in both regions increased. While European prices showed a further upward tendency since then, US price level dropped by -9.33 % till 2008. In a long term point of view average prices in Europe increased by 24.55 %, in the USA by 8.51%.



	2003	2004	2005	2006	2007	2008
Central European average	9.53	9.33	9.70	10.29	11.14	11.87
USA average	5.64	4.82	5.40	6.75	6.58	6.12

Figure 2: Comparison of prices for crushed stone in European countries and the USA (Source: Market evaluation conducted by University of Leoben; USGS)

The collected European price lists have been converted into Euro. For the comparison of the European aggregate prices the unity Euro per tone was used. The Hungarian, Polish, Slovak, British and USA prices had to be converted into Euro. The exchange rates resulted from the daily information of the Austrian National Bank, August 12, 2009.

Exchange rates

1 Euro	273.60 HUF
1 Euro	4.1813 PLN
1 Euro	0.8597 GBP
1 Euro	30.126 SKK
1 Euro	1.4170 USD

10. Recycling

Because of low prices of the mineral, recycling has been of minimum importance Construction waste can be recycled following crushing up, sorting and/or screening and washing The "Association for Recycling of Building Materials Development" (Asociace pro rozvoj recyklace stavebních materiálů – ARSM) is active in the Czech Republic, which associates persons and organizations dealing with problems in waste building materials processing. Apart from other activities, the association regularly organizes expert seminars and popularises usage of recycled building materials

11. Possible substitutes

Crushed stone can be replaced, depending on their use and grade, by gravel sand, synthetic aggregates, slag and various waste materials

Dimension stone

1. Characteristics and use

Rock, which has been specially cut or shaped for use in buildings, curbing or other construction or special use, is termed “dimension stone” or “decorative stone”. Architectural specifications for dimension stone concern primarily aesthetic qualities such as design, surface appearance, etc. Important requirements include mineralogical composition, strength, weather resistance, colourfastness, porosity, texture, structure, etc. Dimension stone includes all kinds of solid rocks of magmatic, sedimentary or metamorphic origin which can be quarried in the form of blocks and which are suitable for cutting to specific dimensions. A weathered surface, altered or crushed zones or intercalation of unsuitable rocks represent undesirable imperfections.

2. Mineral resources in the Czech Republic

Mostly deep-seated igneous rocks (predominantly granitoids), forming about 70 % of exploited reserved deposits, are used as dimension stone in the Czech Republic at present. Their share of the total geological reserves is higher than 50 %. Their share of the total mine production of dimension stone is 65 % at reserved and 60 % at non-reserved deposits of dimension stone. Higher than 20 % share of the mine production at reserved deposits have shales and slates and about 8 % sandstones. In the case of non-reserved deposits, more than 30 % of the mine production is represented by sandstone. The share of marbles is low – around 1 %.

- Dimension stone used in buildings, curbing and other applications (paving cubes, curb stones, guard stones, stairs etc.) mostly involves igneous rocks, much less other rocks (basalt columns, dike rocks). Deposits, similarly to those of crushed and broken stone, are bounded to the Central Bohemian Pluton and Moldanubian Pluton, the Nasavrky Massif, eventually other plutonic bodies of the Bohemian Massif (Štěnovice massif, Žulová Pluton, etc.).
- Mostly marbles and plutonic rocks are exploited for architectural and sculpture dimension stone production. Light granites and granodiorites, which occur in the Central Bohemian and Central Moldanubian plutons, the Štěnovice, the Krkonoše Mts.-Jizerské hory Mts., the Jeseníky Mts. and Nasavrky massifs in Bohemia, and in Třebíč and Žulová massifs in Moravia, are mostly used. Less important are dark igneous rocks – diabase, diorite and gabbro, which also occur in the Central Bohemian Pluton, further in the Kdyně and the Lužice massifs. These rocks are used for wall lining (also polished), paving, for building of monuments and in sculpture, etc.
- Neovolcanic rocks are not very suitable, apart from some trachytes of the České středohoří Mts. and Doupovské hory Mts., which are used in sculpture and as a polished lining.
- Among sedimentary rocks in Bohemia, the most important are Cenomanian sandstones from the area east of Prague and from Hořice and Broumov regions. Less important are Triassic and red Permian sandstones from the Krkonoše Mts. Piedmont Basin. In Moravia, there are the Cretaceous Těšín sandstones or red Permian sandstones of the Tišnov region. Sandstones are used for production of cut and polished wall linings. Very suitable are also Devonian limestones of the Barrandian area and of the Moravian Karst

(wall lining, terrazzo, etc.). Pleistocene travertines, used for interior wall lining, terazzo and conglomerates, were quarried in the Přerov region. Slates of the Moravian–Silesian Paleozoic are used as lining, covering and paving material, and as expanded materials. Greywackes of the Culm were often used, too.

- Crystalline limestones and dolomites – marbles – are the most widely used metamorphic rocks (polished wall linings, paving materials, terrazzo, conglomerates, and sculptures). Large deposits are in the Šumava region and the Czech part of the Moldanubicum, in the Krkonoše Mts.-Jizerské hory Mts. Crystalline Complex and the Orlické hory Mts.-Kłodzko Crystalline Complex, the Svratka Anticline, in the Silesicum, and in the Branná Group (Silesia). Proterozoic phyllites (slates) of the western Bohemia (the Střela River valley) and the Železný Brod Crystalline Complex are used for roofing and wall lining (the waste as a filler). Serpentinites of Moravia and Western Bohemia are used, too.

3. Registered deposits in the Czech Republic

(see map)

There are many registered dimension stone deposits in the Czech Republic and therefore they are not listed.

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	164	163	162	163	162
exploited	72	73	72	70	57
Total *reserves, ths m³	197 503	192 984	191 821	190 993	187 131
economic explored reserves	84 537	84 287	83 667	83 262	81 864
economic prospected reserves	68 440	68 249	67 998	66 778	66 464
potentially economic reserves	44 527	40 448	40 156	40 954	38803
Mine production in reserved deposits, ths m³ [a)]	273	288	242	242	229
Mine production in non-reserved deposits, ths m³ [b)]	65	55	55	50	45

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

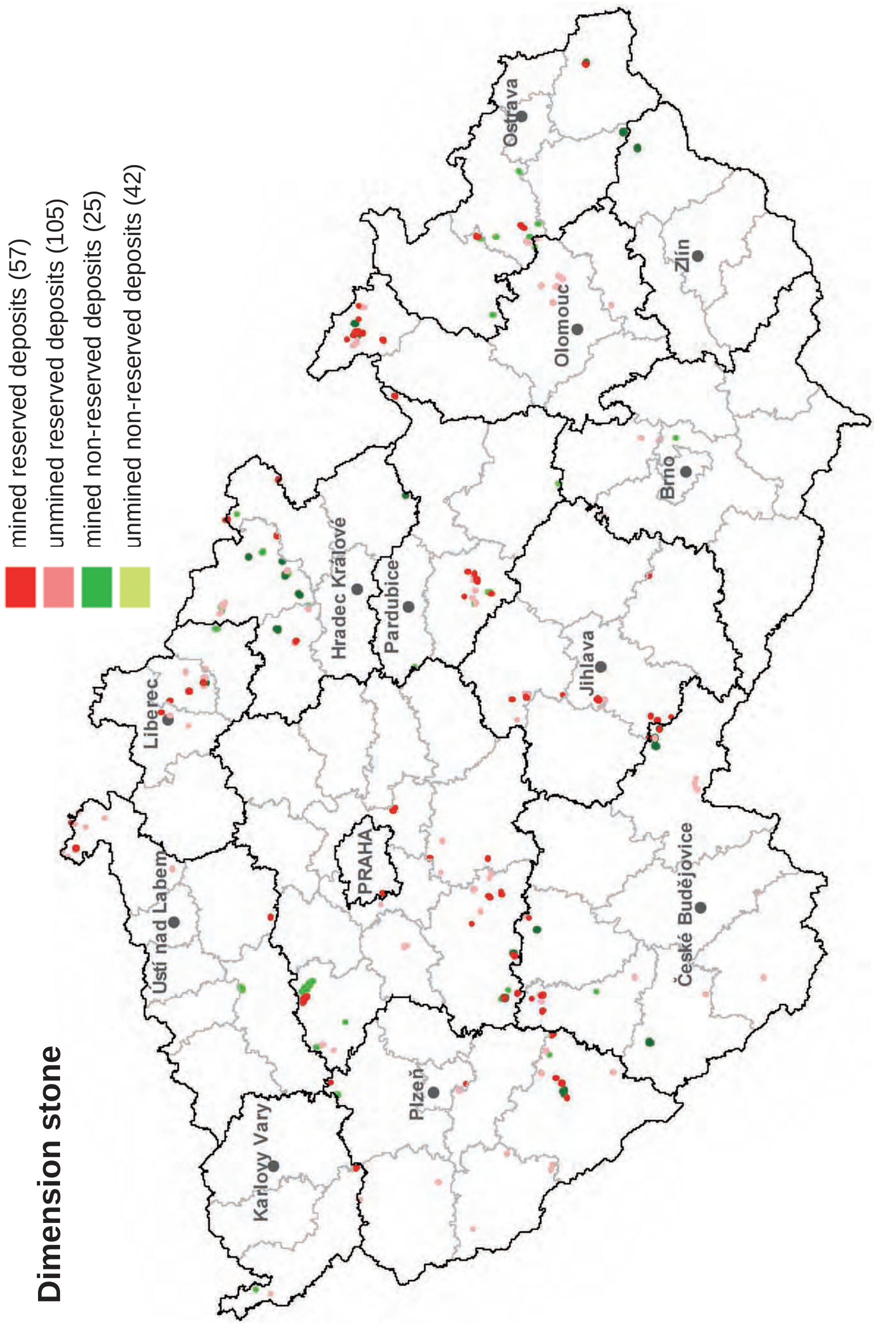
a) decrease of mineral reserves by mine production

b) estimate

Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	ths m³	5 043.39	5 043.39	5 043.39	5 043.39	5 043.39
P_2,	ths m³	12 701.00	12 701.00	12 701.00	12 701.00	12 701.00
P_3		–	–	–	–	–

Dimension stone



5. Foreign trade

2514 – Slate, also roughly worked or cut

	2004	2005	2006	2007	2008
Import, t	836	2 094	5 376	5 075	4 460
Export, t	50 134	50 694	56 668	59 005	47 851

Detailed data on slate exports (t)

Country	2004	2005	2006	2007	2008
Poland	20 058	29 378	39 252	38 591	33 065
Ukraine	12 672	13 334	10 291	12 143	10 099
Lithuania	4 664	2 956	3 745	5 609	3 960
Russia	11 182	4 166	2 530	2 098	665
others	1 558	860	850	564	62

2515 – Marble, travertine, ecaussine and other calcareous stone

	2004	2005	2006	2007	2008
Import, t	1 203	1 168	1 521	2 635	5 233
Export, t	34	21	6	4	15

Detailed data on marble imports (t)

Country	2004	2005	2006	2007	2008
Italy	358	517	536	852	4 246
Croatia	43	138	312	257	241
Turkey	0	6	22	28	239
Germany	36	63	79	905	53
Spain	168	113	165	28	5
Greece	250	43	10	0	0
others	348	288	397	565	449

2516 – Granite, porphyry, basalt, sandstone and other stone

	2004	2005	2006	2007	2008
Import, t	7 423	8 640	8 015	11 604	13 736
Export, t	10 043	11 392	7 704	9 433	11 973

Detailed data on granite and rocks like that imports (t)

Country	2004	2005	2006	2007	2008
Italy	1 387	1 150	1 413	5 389	5 330
Germany	285	651	392	1 208	2 300
India	1 296	1 485	1 118	775	1 260
South Africa	1 357	1 535	911	713	564
others	3 098	3 819	4 181	3 519	5 322

Detailed data on granite and rocks like that exports (t)

Country	2004	2005	2006	2007	2008
Germany	8 315	10 241	6 776	6 939	8 296
Slovakia	580	537	512	1 733	2 060
Poland	345	359	200	283	252
others	803	255	216	478	1 365

6801 – Setts, curbstones and flagstones of natural stone (except slate)

	2004	2005	2006	2007	2008
Import, t	3 919	4 487	2 366	3 039	6 383
Export, t	125 789	123 759	116 169	106 490	90 934

6802 – Worked monumental and crushed stone (except slate) and stonework

	2004	2005	2006	2007	2008
Import, t	22 895	26 428	29 898	35 533	38 113
Export, t	46 004	54 381	73 529	91 642	82 776

6803 – Worked slate and articles of slate or of agglomerated slate

	2004	2005	2006	2007	2008
Import, t	1 738	1 817	2 098	2 294	2 232
Export, t	136	384	548	254	301

Dimension stone represents a typical raw material which can be in some cases sold worldwide for its unique appearance and qualities. Foreign trade with dimension stone is divided into many customs tariff items, which however do not respect the common petrographic classification of the rocks. The Czech export of slate experienced strong growth, for rough items in 2002–2004 (item 2514) and growth again in 2005–2006 after a marked decline in 2004 for worked slate (item 6803); export goes mainly to Eastern Europe. Various types of marble are imported to the Czech Republic from traditional producer countries like Italy, Greece, Spain, but also Croatia, Macedonia, Portugal or Albania. Large spectrum, covered by the customs tariff item 2516 (granite, porphyry, basalt, sandstone etc.), is imported to the Czech Republic from many countries. Export of the Czech dimension stone goes mainly to neighbouring countries, especially Germany. It declined sharply for both marbles (item 2515) and granites (2516) in 2006. In the case of granites, the export volume returned back to the previous level in 2007–2008. Customs tariff items 6801, 6802 and 6803 include worked dimension stone. Various types of setts, are exported to about 20 countries annually, especially to Germany, Austria and Slovakia. Worked stones for artistic or construction purposes are imported to the Czech Republic especially from Italy and China, on the contrary Czech stones are exported mainly to Central European countries (Poland, Slovakia, Russia, Lithuania, Ukraine). Worked slate is imported to the Czech Republic mainly from Spain, Italy, India and China.

6. Prices of domestic market and foreign trade

Prices of dimension stone products depend on mineral quality and on the level of processing. For example: prices of granite cobblestone of greyish blue Hlinec granite ranged depending on type within the limits CZK 2,700–3,400 per tonne, prices of granite margin stones of the same material range from CZK 340 to 440 per linear meter, cut granite panels made of it about CZK 2,400/m^2, granite curbs about CZK 1,250–1,400 per linear meter. Prices of Hlinec granite slabs ranged depending on a slab thickness and finish. It holds generally that polished slabs are the most expensive (CZK 1,800–3,800/m^2 for slabs thick from 2 to 8 cm), granite slabs with scoring finish were little less expensive (CZK 1,600–3,600 m^2) and even less expensive granite slabs with sand blasted finish (CZK 1,400–3,100 m^2). Hlinec granite formatted slabs, suitable as pavement or lining, 3 cm thick, ranged CZK 1,560–2,200/m^2 depending on finish again. Prices of cobblestone of light Silesian granite ranged CZK 1,750–3,000/m^2) depending on size, margin stone prices of the same material were within the limits CZK 290–320 per linear meter and prices of cut slabs of light Silesian granite ranged CZK 1,100–1,800/m^2. Prices of granite pavement slabs made of Mrakotín type granites range depending on thickness CZK 1,300–2,400/m^2 with sand blasted finish, CZK 1,500–2,600/m^2 with scoring finish and CZK 1,600–2,700/m^2 with polished finish. Prices of granite blocks are very variable, basically they start at CZK 5,000/m^2.

Prices of sandstone products vary also depending on degree of treatment and specific type of sandstone. Prices of cut sandstone slabs 5 cm thick ranged CZK 1,400–1,900/ m^2, 10 cm thick CZK 2,800–4,000/m^2, 15 cm thick CZK 4,200–6,100/m^2 depending on type of sandstone (Hořice, Božanov, godul).

Prices of domestic marble (from Supíkovice, Lipová) vary according to thickness and degree of treatment of products. For example cut marble pavement at 3 cm of thickness has price range CZK 300–1,080/m^2 (Supíkovice marble) or CZK 300–1,180/m^2 (Lipová marble). Prices of smoothed marble pavement are little more expensive: CZK 400–1,200 m^2 (Supíkovice), CZK 400–1,340/m^2 (Lipová) and prices of polished marble pavement are even more expensive: CZK 440–1,500/m^2 (Supíkovice) or CZK 440–l,630/m^2.

2514 – Slate, also roughly worked or cut

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	5 339	3 120	2 423	2 306	2 508
Average export prices (CZK/t)	1 362	1 063	1 032	1 078	1 056

2515 – Marble, travertine, ecaussine and other calcareous stone

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	17 347	12 907	16 203	10 302	5 212
Average export prices (CZK/t)	11091	28 848	19 240	17 303	44 452

2516 – Granite, porphyry, basalt, sandstone and other stone

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	6 875	7 896	7 068	6 413	5 839
Average export prices (CZK/t)	2 727	2 921	2 557	2 661	2 718

7. Mining companies in the Czech Republic (reserved deposits) as of December 31, 2008

REVLAN s.r.o., Horní Benešov
Granit Lipnice s.r.o., Dolní Město
Slezský kámen a.s., Jeseník
HERLIN s.r.o., Příbram
MEDIGRAN s.r.o., Plzeň
Průmysl kamene a.s., Příbram
Bohumil Vejvoda, obchodní činnost VEDA CS, Krakovany v Čechách
Česká žula s.r.o., Strakonice
DCK – Družstvo cementářů a kameníků Holoubkov Bohemia, a.s.
GRANIO s.r.o., Chomutov
RALUX s.r.o., Uhelná
Těžba nerostů a.s., Plzeň
COMING PLUS a.s., Praha 4
Jindřich Zedníček, Kamenná
Kámen Ostroměř s.r.o.
Ligranit a.s., Liberec
Granit Málkov s.r.o., Blatná
Obec Studená
Josef Máca, Třešť
Pražský kamenoservis s.r.o., Praha 10
Kamenoprůmyslové závody s.r.o., Šluknov
Kámen Hudčice s.r.o.

SATES Čechy, s.r.o., Telč
SLEZSKÁ ŽULA s.r.o., Javorník
Anna Mrázová, Mukařov
Krákorka a.s., Červený Kostelec
Kamenolom Nová Červená Voda s.r.o., Praha
Lom Matula Hlinsko a.s.
Granit – Zach s.r.o., Prosetín
BÖGL & KRÝSL, k.s., Praha
M.& H. Granit s.r.o., Plzeň
JIHOKÁMEN, výrobní družstvo, Písek
Mšenské pískovce s.r.o., Mšené - lázně
K – Granit s.r.o., Jeseník

The most important mining organizations in non-reserved deposits as of December 31, 2008

HERLIN s.r.o., Příbram
KOKAM s.r.o., Kocbeře
Lom Horní Dvorce s.r.o., Strmilov
Jiří Sršeň – TEKAM, Záměl
K – Granit s.r.o., Jeseník
RENO Šumava a.s., Prachatice
Profistav s.r.o., Litomyšl
Obec Studená
Žula, spol. s r.o., Praha
Josef Máca, Třešť
Ing. Danuše Plandorová, Hážovice
Lesostavby Frýdek - Místek, a.s.
Alfonz Dovičovič, Hořice
Kamenolom Javorka s.r.o., Lázně Bělohrad
KAJA – TRADING, spol. s r.o., Praha
JIHOKÁMEN, výrobní družstvo, Písek
Krákorka a.s., Červený Kostelec

8. World production

Precise statistics on a worldwide basis are lacking, since often producers are not required to record dimension stone production. Data when available are either given in tonnes or in m^3. According to the USGS Mineral Yearbook, world production was estimated at 105 mill t in 2007. Main producers were China, India, Iran, Italy and Turkey. These countries produced about 70 % of the world production. Annual production of the USA has been approximately 1.3–1,5 mill tonnes in the recent years. Carbonate represents 35 %, granite 32 %, sandstone 12 %, marble 3 %, slate 1 % and other types 17 % of the total amount. Annual production of the architectural and sculpture dimension stone in Poland has been oscillating between 600 and 1,100 ths m^3. Mining production in Slovakia fluctuates between only 10 and 20 ths m^3 per year (the only mined deposit Spišské Podhradie – travertine).

9. World market prices

Prices of dimension stone in international market depend on mineral quality and degree of working. In general they are not officially published. Price level on the US market can give a certain idea. The average prices in 2007 were as follows: granite 233 USD/t, limestone 189 USD/t, marble 278 USD/t, sandstone 129 USD/t and shale 649 USD/t.

10. Recycling

The material is recycled to a limited extent (setts, worked slate, worked building stone etc.).

11. Possible substitutes

Individual types of dimension stone are mutually replaceable. Synthetic materials, ceramics, metals, glass, etc can replace all types. However, an opposite tendency has been evident recently – a growing interest in natural materials.

Sand and gravel

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Montanuniversität Leoben, Chair of Mining Engineering, Leoben, Austria
(subchapters 8., 9.)

1. Characteristics and use

Sand and gravel belong to the principal construction minerals worldwide. Sand and gravel represent loose sediments originated by transport and deposition of more or less reworked rock fragments of certain size (gravel e.g. 2 to 128 mm, sand e.g. 0.063 to 2 mm), which are products of the weathering of rocks. They consist mostly of pebbles and boulders of resistant rocks and minerals (quartz, feldspar, quartzite, granite, etc.), to a smaller extent of less resistant rocks and minerals (mostly of crystalline or metamorphic and sedimentary rocks). Sand and gravel also contain silty and clayey fractions. Major impurities are humus, clay intercalations, higher content of floatable particles and sulphur, high content of unsuitable (as shape concerns) or weathered grains. Other impurities are opal, chalcedony, chert and diatomite – hydrous compounds of silicon react with alkalies from feldspars to form a siliceous gel, which adsorbs water and causes fracturing of concrete.

Gravel and sand deposits are common all over the world.

The ultimate use of sand and gravel is determined by gravel particles size, their shape and type and composition of particle forming minerals and rocks. Sand and gravel are used mostly in the building industry in concrete mixtures, as drainage and filtration layers, road base, fill, etc. Sand is used in the building industry in mortar and concrete mixtures, as a filler material in production of bricks, in plasters, as a backfill of abandoned stopes in mines, etc.

2. Mineral resources of the Czech Republic

Most of the deposits in the Czech Republic are of the Quaternary age mainly of fluvial origin, less often of fluviolacustrine, fluvioglacial, glaciolacustrine and eolian origin. Industrially exploitable deposits occur particularly in large river basins.

- The Labe (Elbe) River basin – deposits along the right bank of the middle course (important deposits for central and eastern Bohemia) and lower course are characterised by well rounded pebbles and boulders, varying ratio of gravel and sand and suitability for concrete mixtures. Other important deposits are in basins of the rivers Orlice and Ohře, along the lower course of the rivers Cidlina and Jizera, and along the middle course of the Ploučnice River. The material requires processing when used for concrete.
- The Vltava River basin – important deposits are at lower course but there are common conflicts of interests. Important deposits are along the Berounka River, too. Major deposits in the southern Bohemia occur along the Lužnice River. The right bank of the Nežárka River shows good prospects for extraction of sand and gravel.
- The Morava River basin – along the upper and middle course of the Morava River there are deposits of gravel and sand with prevailing coarse fraction, which are after processing

suitable for concrete mixtures. Deposits in the Hornomoravský úval (Upper Moravian Depression) contain abundant fine fractions. Reserves are parts of the flood plains; the material is suitable for road construction and for mortar mixtures. Important deposits of sand and gravel in southern Moravia occur along the middle and lower course of the Dyje River and its tributaries, particularly the Dyje–Svratka Depression and area around Brno (Svitava, Svratka).

- The Odra River basin – important deposits of sand and gravel are at the middle course of the Opava River and near confluence of rivers Opava and Odra. The material is suitable for reinforcing of road shoulders and stabilization.

Less important are deposits of glacial origin in northern Bohemia (the Frýdlant region) and in the Ostrava and Opava regions. Eolian sand of the Labe River basin and those located in southern Moravia are used mostly in mortar mixtures. Proluvial sediments of northern Bohemia, the Ostrava region, the Olomouc region, etc., are only of local importance. Variable facies of Tertiary sand in the Cheb region, in north Bohemian and south Bohemian basins, in the Plzeň region (mortar sands), and particularly in Moravia (e.g. the Prostějov and Opava regions) is exploited more often. Weathered sandstones of the Bohemian and Moravian Cretaceous sediments and sand from washing of kaolin are used in construction works.

3. Registered deposits in the Czech Republic

(see map)

Because of their large number, deposits of sand and gravel are not listed.

4. Basic statistical data of the Czech Republic as of December 31

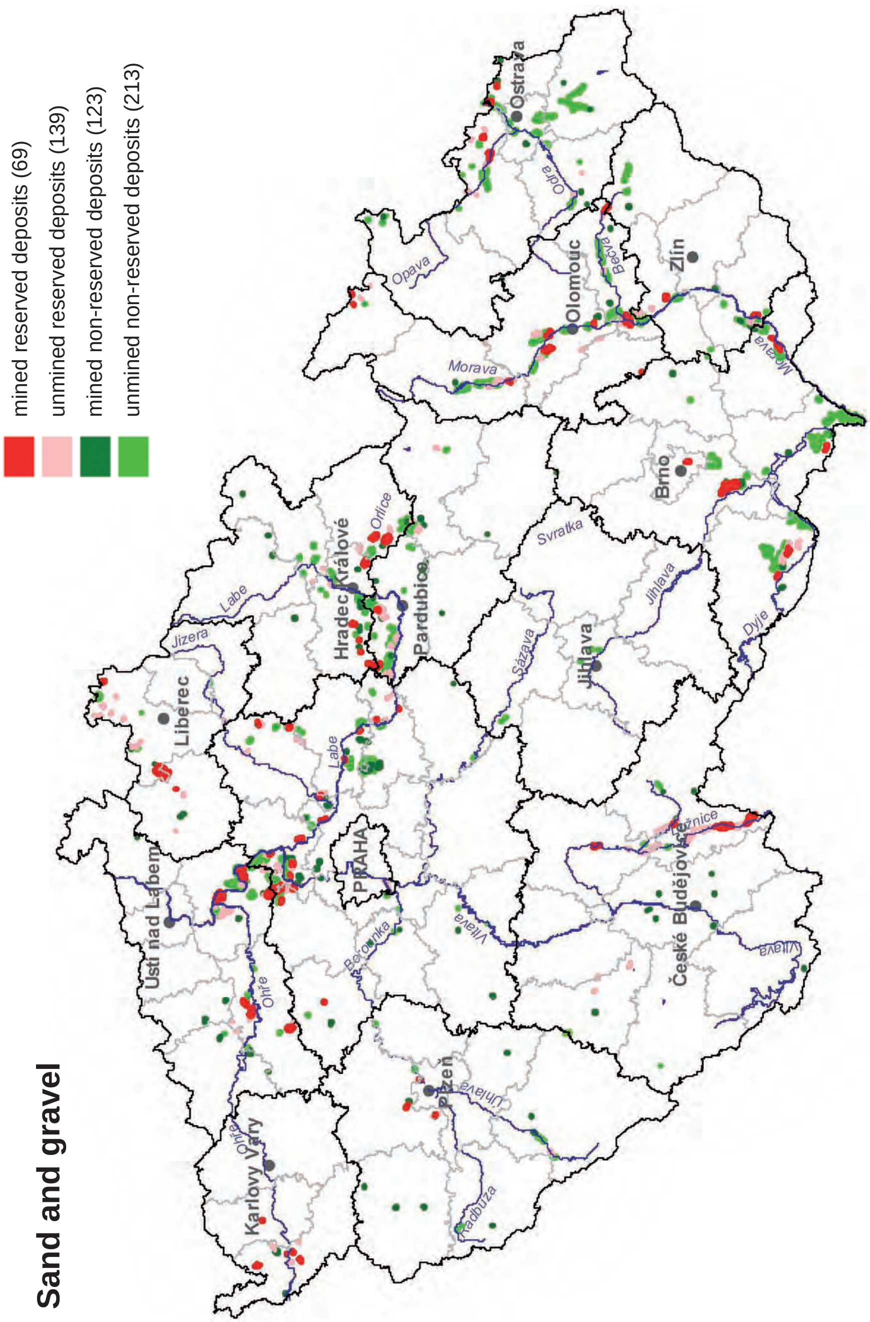
Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	210	211	209	208	208
exploited	77	78	79	78	69
Total *reserves, ths m³	2 201 697	2 180 635	2 151 237	2 145 835	2 125 644
economic explored reserves	1 178 495	1 165 983	1 150 463	1 141 041	1 132 411
economic prospected reserves	792 129	783 676	772 580	777 699	765 844
potentially economic reserves	231 073	230 976	228 194	227 095	227 389
Mine production in reserved deposits, ths m³	8 859	9 075	9 110	9 185	8 770
Mine production in non-reserved deposits, ths m³ [a)]	4 900	5 100	6 000	6 450	6 350

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

[a)] estimate

Sand and gravel



Approved prognostic resources P_1, P_2, P_3

Year		2004	2005	2006	2007	2008
P_1,	ths m³	146 177.18	146 177.18	146 177.18	146 177.18	146 177.18
P_2,	ths m³	1 007 984.77	1 007 984.77	1 007 984.77	1 007 984.77	1 007 984.77
P_3		–	–	–	–	–

5. Foreign trade

250590 – Other sand (natural sand of all kinds, also coloured, except sand containing metals and except silica sand and quartz sand)

	2004	2005	2006	2007	2008
Import, kt	42	73	52	50	50
Export, kt	1	0	0	2	1

251710 – Pebbles, gravel, broken or crushed stone

	2004	2005	2006	2007	2008
Import, kt	455	480	632	246	266
Export, kt	210	340	599	471	486

Detailed data on the territorial structure of import and export of the customs tariff item 251710 are given in chapter crushed stone. Volume of trade with item 250590 is negligible. However, imports and in recent years particularly exports of 251710 item have seen a large increase.

6. Prices of domestic market and foreign trade

Sorted products of gravel-pits are markedly cheaper than washed products. Regional prices of sorted products are very stable and do not show bigger differences (e.g. size fraction 0–4 mm: state average 94 CZK/t, average of South Moravian Region 96 CZK/t, average of Central Bohemian Region 96 CZK/t in 2008). By contrast, prices of washed products differ quite a lot depending on the region. Average price of the mined stone in size fraction 4–8 mm was about 225 CZK/t, size fraction 8–16 mm cost 210 CZK/t in 2008. The lowest prices were reached for instance in Central Bohemia, the highest in the Zlín Region, where there is a deficit of construction materials resources.

7. Mining companies in the Czech Republic (reserved deposits) as of December 31, 2008

Českomoravský štěrk a.s., Mokrá
KÁMEN Zbraslav, spol. s.r.o.
Holcim (Česko) a.s. člen koncernu, Prachovice
LB Minerals, a.s., Horní Bříza
TARMAC CZ a.s., Liberec

CEMEX Sand, s.r.o., Napajedla
Družstvo DRUMAPO, Němčičky
Hanson ČR a.s., Mokrá
TVARBET Moravia a.s., Hodonín
DOBET s.r.o., Ostrožská Nová Ves
S-MOST s.r.o., Hradec Králové
Žula Rácov, s.r.o., Batelov
Štěrkovny Olomouc a.s.
Václav Maurer, Lužec nad Vltavou
PIKASO s.r.o., Praha 4
ILBAU s.r.o, Praha
Městské lesy Hradec Králové a.s.
Písky – J. Elsnic s.r.o., Postoloprty
Štěrkovny spol. s r.o., Dolní Benešov
Pískovna Sojovice, s.r.o.
František Jampílek, Lázně Toušeň
Lubomír Kruncl, Travčice
Budějovické štěrkopísky spol. s.r.o., Vrábče
Zemědělské obchodní družstvo Zálabí, Ovčáry
Těžba štěrkopísku s.r.o., Brodek
Jana Lobová, Pardubice
BUILDING SP s.r.o., Nymburk
KAMENOLOMY ČR s.r.o., Ostrava-Svinov
Pískovna Černovice s.r.o., Brno
KM Beta Moravia s.r.o., Hodonín
Zechmeister s.r.o., Valtice
BÖGL & KRÝSL, k.s., Praha
NZPK s.r.o., Podbořany
Oldřich Psotka, Mikulovice u Jeseníka
Kaolin Hlubany, a.s.
Ladislav Šeda, Turnov
Zemědělské obchodní družstvo Brniště
UNIM s.r.o., Všestudy u Veltrus
Písek – Beton a.s., Veltruby-Hradišťko
František Dvořák, Dolní Dunajovice
Sokolovská uhelná, právní nástupce, a.s., Sokolov

The most important mining companies in non-reserved deposits as of December 31, 2008

České štěrkopísky spol. s r.o., Praha
Vltavské štěrkopísky s.r.o., Chlumín
Pískovny Hrádek, a.s., Hrádek nad Nisou
CEMEX Sand, s.r.o., Napajedla
František Jampílek, Lázně Toušeň
ZEPIKO,spol. s .r.o., Brno
ROBA štěrkovny Nové Sedlo, s.r.o.
TEKAZ s.r.o., Cheb

realma-pískovna dolany s.r.o., Zlín
Písek – Beton a.s., Veltruby-Hradištko
Písek Žabčice, s.r.o.
AGRO Brno-Tuřany, a.s.
Lubomír Kruncl, Travčice
Rovina Písek a.s., Písek u Chlumce nad Cidlinou
Písník Kinský, s.r.o., Kostelec nad Orlicí
ZS Kratonohy a.s.
Agropodnik Humburky, a.s.
TAPAS Borek, s.r.o., Stará Boleslav
AG Skořenice, a.s.
BEST a.s., Rybnice
SABIA s.r.o., Bohušovice nad Ohří
Luděk Měchura, Kyjov
ACHP s.r.o., Hradec Králové
Sušárna a.s., Kratonohy
Plzeňské štěrkopísky s.r.o., Plzeň
Pískovny Morava spol. s r.o., Brno
MPC s.r.o., pískovna Račiněves
Agrodružstvo Klas, Staré Ždánice
BÖGL & KRÝSL, k.s., Praha
Ladislav Šeda, Turnov
Hradecký písek a.s., Brno
Ladislav Peller – Těžba a úprava surovin, Praha 4
Ing. Milan Tichý – Inženýrské stavby VOKA, Zahrádky
ZEPOS a.s., Radovesice
STAVOKA Kosice a.s.
Silnice Klatovy, a.s.
Pískovna Klíčany HBH s.r.o.
Ing. Václav Luka, Český Brod
Kobra Údlice, s.r.o.
Obec Police
Vlastimil Beran, Daleké Dušníky
Ladislav Mazura, Písty
Vratislav Matoušek, Tursko
DOBET s.r.o., Ostrožská Nová Ves
Radomír Kopecký, Suchdol nad Odrou
Obecní lesy Bludov s.r.o.
INGEA realizace s.r.o., Ostrava – Svinov
Technické služby města Strakonice s.r.o.
UNIGEO a.s., Ostrava-Hrabová
Václav Merhulík, prodej a těžba písku, Lety
Jiří Zach, Markvartice
META Servis s.r.o., Černošice
Rynoltická pískovna s.r.o.
Ing. Josef Novák – NOBI, Praha 5
Mgr. Milan Roček, Turnov

Obec Polešovice
LIKOD s.r.o., Lípa
Písky – Skviřín, s.r.o. Tachov
AGROSPOL Hrádek, spol. s.r.o.
MORAS a.s., Moravany
Štěrkopísky Milhostov s.r.o., Sokolov
Václav Mašek, Hýskov
Ilona Hejzlarová, Jetřichov
Služby Frýdlant nad Ostravicí s.r.o.
Pražské vodovody a kanalizace a.s.
Lesy České republiky, s.p., Hradec Králové
Správa a údržba silnic Jihočeského kraje, České Budějovice
Ing. František Klika, Kladno
STAVOKA Hradec Králové, a.s.
Obec Rabštejnská Lhota
Zemědělské družstvo Kokory
ZD v Pňovicích
Jiří Bartoš, Dolní Újezd
Městské lesy Jaroměř s.r.o., Proruby
HYDROSPOL spol. s.r.o., Staré Město u Bruntálu
Vladislav Durczok – pískovna Petrovice
II. severočeská stavební spol. s.r.o., Okounov
Jiří Řezáček, Postřekov
Technické služby města Úpice
Stavby silnic a železnic a.s., Praha 1

8. World production

The world production of sand and gravel is not statistically monitored. Mine production of the crushed stone is frequently reported together with sand and gravel under the term aggregates. The following tables show up the production of sand and gravel.

Production of sand and gravel in European Union (present EU-27 countries) in 2006 (t)

Rank	Country	Production [t]
1	Germany	266 000 000
2	Italy	177 625 321
3	France	174 360 000
4	Spain	120 000 000
5	United Kingdom	92 107 000
6	Poland	90 000 000
7	Netherlands	72 200 000
8	Denmark	72 060 000
9	Irish Republic	64 000 000
10	Finland	54 000 000
11	Switzerland	50 000 000

Table from page 345 continued

Rank	Country	Production [t]
12	Hungary	46 458 296
13	Austria	27 589 904
14	Sweden	21 488 963
15	Slovenia	17 873 000
16	Czech Republic	16 931 536
17	Norway	13 380 000
18	Bulgaria	11 698 613
19	Belgium	8 636 966
20	Lithuania	7 633 311
21	Slovakia	7 522 034
22	Latvia	5 202 061
23	Estonia	4 210 280
24	Romania	1 600 000
25	others	N
	Sum	1 422 577 285
		Source: British Geological Survey

Production of sand and gravel in the USA in 2008 e (mill t), by division

West	384
Midwest	266
South	231
Northeast	112
Total	* 1 040

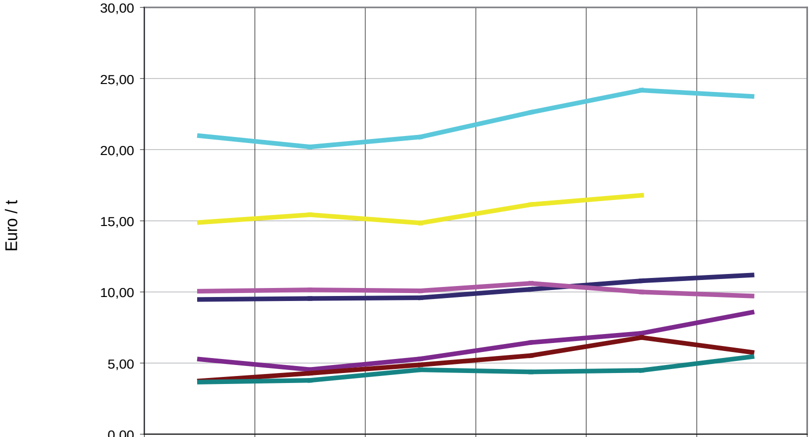
Source: USGS

* *Data may not add to totals because of independent rounding and differences between projected totals by States and divisions*

9. World market prices

Sand and gravel prices are not formed on the international market. Neither indicative regional prices are quoted. Trade exchange takes place mostly between neighbouring countries. For example a ton of sand will be much cheaper in the north of Germany where big sand deposits can be found than in the south of Germany where less sand deposits can be extracted. In Austria a difference can be observed in a less distant dimension. The production of sand and gravel in the flat parts of Austria (e.g. Lower Austria) can be executed in a more extensive way than in the mountainous regions of Salzburg, Tyrol, Vorarlberg and parts of Carinthia and Styria. The method of the production of sand and gravel gives important information and effects on the product. The production below ground water table bears several advantages to sand and gravel mining on the surface. The next economic factor considers the transportation of the produced material. Normally the transportation radius is 30 kilometers before the transportation costs raises over the product return. In several cases of products with special chemical or physical attributes this radius may increase. To summarize the mentioned affects on the prices it is important to notice that average prices of a country may differ in an enormous scale from local prices. The bigger the country the more the prices may fluctuate.

The market prices of sand and gravel are strongly influenced by conditions of the local market. Average prices of selected European countries are shown in figure 1. In general prices increased since 2003, apart from Germany where they settled on a lower level in 2008.



	2003	2004	2005	2006	2007	2008
Austria	9.47	9.53	9.59	10.19	10.78	11.19
Germany	10.05	10.15	10.08	10.61	9.99	9.71
France	14.89	15.42	14.85	16.14	16.79	
United Kingdom	20.98	20.19	20.89	22.62	24.18	23.75
Poland	5.27	4.54	5.29	6.44	7.09	8.57
Slovakia	3.74	4.28	4.88	5.52	6.79	5.75
Hungary	3.66	3.78	4.53	4.37	4.49	5.44

Figure 1: Development of prices for sand and gravel in European countries (Source: Market evaluation conducted by University of Leoben)

Compared to the last two years, three countries (Austria, Poland and Hungary) showed rising sand and gravel prices:

- Austria by 3.80 %
- Poland by 20.87 %
- Hungary by 21.16 %

Average prices in the residual countries under consideration [Germany, United Kingdom and Slovakia (price data of France were not available in adequate quantity and quality)] dropped in comparison to 2007:

- Germany by -2.80 %
- United Kingdom by -1.78 %
- Slovakia by -15.32 %

Between 2003 and 2008 prices for sand and gravel showed the following development:

- Austria: 18.16 %
- Germany: -3.38 %
- United Kingdom: 13.20 %

- Poland: 62.62 %
- Slovakia: 52.74 %
- Hungary: 48.63 %

Figure 2 illustrates the prices for sand and gravel in above-mentioned European countries and the United States of America. The average level of prices in the USA is nearly twice as low as in Europe. In a long term point of view the US prices did not change significantly (from 4.92 EUR/t to 4.95 EUR/t). In a short term period from 2007 to 2008 prices dropped by -6.95%.

	2003	2004	2005	2006	2007	2008
Central Europe average	9.72	9.70	10.02	10.84	11.44	10.73
USA average	4.92	4.23	4.34	5.44	5.32	4.95

Figure 2: Comparison of prices for sand and gravel in European countries and the USA (Source: Market evaluation conducted by University of Leoben; USGS)

The collected European price lists have been converted into Euro. For the comparison of the European aggregate prices the unity Euro per tone was used. The Hungarian, Polish and British prices had to be converted into Euro. The exchange rates resulted from the daily information of the Austrian National Bank, August 12, 2009.

Exchange rates

1 Euro	273.60 HUF
1 Euro	4.1813 PLN
1 Euro	0.8597 GBP
1 Euro	30.126 SKK
1 Euro	1.4170 USD

10. Recycling

Similar to all construction minerals, recycling is economically problematic and is significant in case of concrete only.

11. Possible substitutes

Crushed aggregate, artificial aggregate, slags, etc can replace coarser fractions of sand and gravel. Finer fractions, i.e. sand, cannot be replaced because of reduced strength of the final products. Substitution of sand and gravel on large scale is questionable also from the economic point of view.

MINERALS CURRENTLY UNMINED IN THE CZECH REPUBLIC

MINERALS MINED IN THE PAST WITH RESOURCES AND RESERVES

Deposits of Mn, Cu, Pb, Zn, Ag, Sn, W, Li, Au and Ge were registered in the Register to 31. 12. 2008 on the Czech territory. Geological reserves of metallic ores represent mostly potentially economic resources. More significant volume of economic reserves was presented only for gold bearing ores. As far as the most common metal ores are concerned, there were no deposits of Al, Ti and Cr ores mined in history and no deposits occurred on Czech territory.

There is a very old tradition of ore mining on the territory of the Czech Republic. The oldest archaeological evidence on gold panning dates back to the 9th century B.C. In the Middle Ages Bohemia became the centre of European gold, silver and tin mining. Continued mining activities have nearly exhausted the resources. With a few exceptions (e.g. the Au-W deposit of Kašperské Hory), only low-grade ores remain on the territory of the Czech Republic. The mining industry´s last boom occurred in the cold war period after 1948, when ore deposits were exploited, even at considerable economic loss, to ensure the independence of the communist state from mineral imports from western countries. After 1989 there were many closures and cutbacks; with the closure of mining in the polymetallic deposit with gold Zlaté Hory, the mining of metallic ores on the territory of the Czech Republic terminated in 1994. State subventions for closure programs directed towards social costs, technical liquidations, health and safety activities (maintenance) and reclamation in 1990–2008 are the object of the chapter *Eliminating negative consequences of mining in the Czech Republic – main methods and financial resources* in this yearbook.

All deposits of Fe ores, Ni ores and Sb ores, majority of Ge ores deposits, a large number of Cu ore, base metal (Pb, Zn, Ag) and Sn-W ores deposits were revaluated and gradually eliminated from The Register in the course of the revaluation carried out since 1993. The majority of small deposits of scheelite W ores was eliminated from the Register in 2006.

A strong trend of increase in prices of base metals (Cu, Pb, Zn, Sn, Ni and Al) and Ag has been observed between 2003 and 2008. Prices of Fe and W have been increasing since 2004 and 2005, respectively. The most important rise in this period showed prices of Cu, W, Pb and Zn, iron ores, Al, Ag, Sn, Mn and Ni. Prices of rare metals such as Pt and Au have increased significantly, too. Aside the trend stands Pd, the price of which steeply increased more than three times by the end of 2000. Its price decreased back to the original level the next year and has been rather stable since then. During 2007 prices of most metal commodities did not grow on – either they relatively maintained their higher levels or slightly decreased. More remarkable metal prices decline came in connection with commencing global financial and economic crisis and steep slump of stock markets. After the steep decrease of prices of majority of metallic commodities, there was a moderate increase in the first half of 2009. However, present price levels are still low compared to the historical maxima reached in 2006–2008. Decrease of metal commodity prices resulted even in suspension of some of the new mining projects. It can be expected, that fundamental growth factor will predominate after economic crisis and prices of non-ferrous ores will increase.

The Au-W ores deposit Kašperské Hory, from the European viewpoint exceptionally large and rich, is the most important and perspective ore deposit in the Czech Republic. Large deposits mineable by open pits like e.g. Mokrsko or Vacíkov are very promising at present high Au prices, too. Exploitation of all these deposits is however excluded at present time due to the unsolvable conflicts with the nature protection.

Copper

1. Characteristics and use

Copper deposits can be divided into five main groups (according to their origin) – porphyry copper deposits with Mo, stratiform, stratabound (sulphides in greenschists), magmatic with Ni (Pt) and deposits of massif ores formed by veinlets, stockworks and lenticular bodies with prominent subtype of Fe-Cu-Au(U). Only a few sulphides out of 300 known Cu minerals are of economic importance: chalcopyrite, covellite, Cu-pyrite, chalcocite, bornite and enargite. Economic world reserves of Cu in ore are estimated at more than 3 billion tonnes (MCS 2008), whereas additional approximately 700 mill tonnes of resources are estimated in deep-sea nodules.

According to the Copper Development Association, 37 % of copper was used in building industry, 26 % in electronics, 15 % in the engineering industry, 11 % in consumer goods production and 11 % in transport in 2003. Important amount of copper is used in alloys, particularly in brass and bronze.

2. Mineral resources of the Czech Republic

There are no economically exploitable Cu ore deposits in the Czech Republic. Cu ores of various genetic types occur here and were exploited in the past.

- Major mining activities were focused on volcanosedimentary sulphide deposits (stratabound) of the Zlaté Hory mining district. The mineralization is associated with the spilite-keratophyre volcanism and is localized in volcanosedimentary complex of the Vrbno Formation of the Devonian. Individual types of local ores – Cu monometallic, complex Cu-Pb-Zn with Au and Pb-Zn – occur separately in space and show a certain zonation. About 50 % of the economic reserves have been confined to complex ores, 25 % to monometallic, and 25 % to Pb-Zn ores. Monometallic ores consist of chalcopyrite with varying admixture of pyrite or pyrrhotite. Their grade ranges between 0.4 % and 0.7 % Cu. These ores were mined at deposits Zlaté Hory-jih and Zlaté Hory-Hornické skály. Mining of these ores at the Zlaté Hory deposit was terminated in 1990. 5,808 kt of ore containing 34,741 t of copper were mined in 1965–1990 period.
- Stratabound monometallic Cu ores (chalcopyrite) confined to a low-grade metamorphosed volcanosedimentary complex were discovered and their reserves evaluated and explored in the former deposit of Tisová near Kraslice. Mining of local ores, having about 1 % Cu, was terminated in 1973. A mineral exploration project was then executed in the ore district in the eighties, but mining was not resumed and the deposit (mine) was temporarily flooded.
- Less important Cu mineralizations and/or Cu-Zn-Pb ores of stratabound type pyrite formation are known at numerous localities of the Bohemian Massif (e.g. Staré Ransko, Křižanovice, Svržno).
- Hydrothermal (vein) Cu abandoned deposits (Rybnice, Rožany, Tři Sekery) and sedimentary Cu ores (Krkonoše Mts. Piedmont Basin) were of a historical importance only. A very poor deposit Horní Vernéřovice–Jívka was exploited here in 1958–1965.

Mining of Cu ores in the Czech Republic was terminated in 1990 and the deposits have been gradually eliminated from The Register.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

Reserved registered deposits:

1 Křižanovice
2 Kutná Hora
3 Zlaté Hory-Hornické Skály
4 Zlaté Hory-východ

Exhausted deposits and other resources:

5 in Krušné hory Mts. (Erzgebirge Mts.) and Tisová
6 Tři Sekery and surroundings
7 in Krkonoše Mts. Piedmont Basin and Intrasudetic Basin
8 Staré Ransko

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	5	5	5	4	4
exploited	0	0	0	0	0
Total *reserves, kt Cu	51	51	51	49	49
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	51	51	51	49	49
Mine production, kt Cu	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

[a)] *deposits with registered Cu content*

Copper and copper alloys processing

Měď Povrly, a.s.

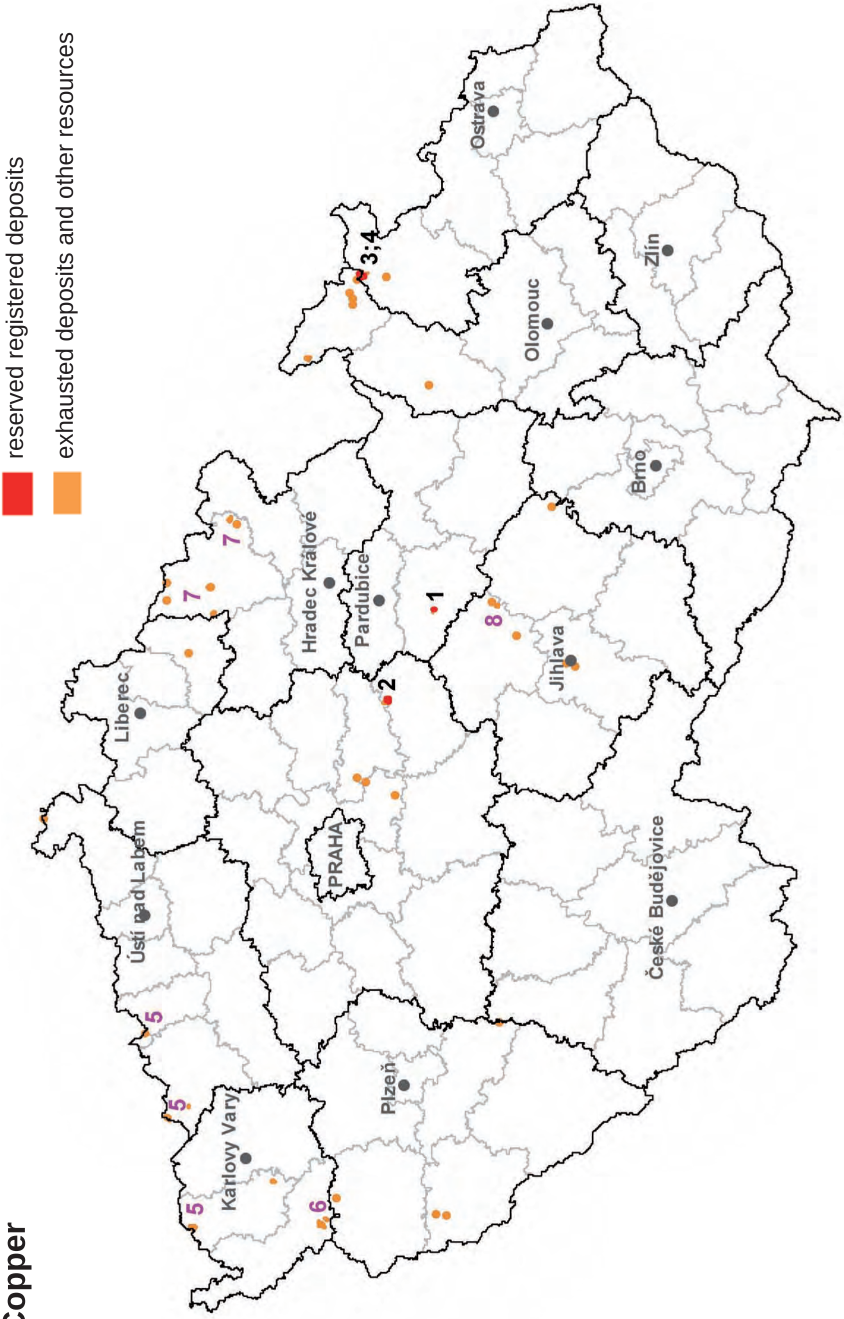
Kovohutě Čelákovice, a.s.

Kovohutě Rokycany, a.s.

Slévárna Vysoké Mýto s.r.o.

Měď Povrly a.s. located in northern Bohemia close to Ústí nad Labem is engaged in copper and brass (copper-zinc base alloys) processing into rolled intermediate products. The

Copper



reserved registered deposits
exhausted deposits and other resources
Ostrava
3;4
Zlín
Olomouc
Brno
7
7
Hradec Králové
Pardubice
1
8
Jihlava
2
Liberec
Ústí nad Labem
PRAHA
České Budějovice
5
5
Plzeň
Karlovy Vary
5
6

company produces wires, bars, tubes and other products from copper and brass. These products are used e.g. in the production of imitation jewellery and fancy goods, artistic objects, musical instruments, keys and locks, ammunition, electro-technical goods, instruments and machinery, shower hoses and bathroom fixtures, car equipment, lights, in welding or in construction industry in roofing production, drainage of roofs and façades.

Production of metallurgical intermediate products (bars, tubes, wires) of copper and its alloys represents the major activity of Kovohutě Čelákovice, a.s., as well. It produces intermediate products made of pure copper, intermediate products made of copper alloyed with other elements (Ag, Mn, Si, Ni, P, As), intermediate products of brass and of bronze. Apart from the main assortment, the company produces roughly 40 highly sophisticated alloys.

Intermediate products made of copper make part of the assortment of Kovohutě Rokycany, a.s., as well. The company produces namely strips and sheets of pure copper and of copper alloys, bars and tubes of bronze, bars and tubes of continually cast copper and wires of copper and its alloys. The company produces in addition wires, strips and sheets of nickel and its alloys.

Vysoké Mýto s.r.o. foundry specializes in castings of copper alloys (brass, bronze) of small size. Monthly production is about 15 tonnes of castings of Cu alloys.

5. Foreign trade

2603 – Copper ores and concentrates

	2004	2005	2006	2007	2008
Import, t	0	4	2	0	1
Export, t	21	0	3	0	0

7402 – Unrefined copper

	2004	2005	2006	2007	2008
Import, t	915	210	677	2 234	1 633
Export, t	2	0	0	0	1

7403 – Refined copper and copper alloys

	2004	2005	2006	2007	2008
Import, t	4 648	4 248	7 597	16 625	14 069
Export, t	7 804	4 240	12 659	10 002	7 835

Detailed data on refined copper and copper alloys imports (t)

Country	2004	2005	2006	2007	2008
Germany	1 402	1 731	4 135	5 662	7 390
Slovakia	53	521	1 003	5 398	4 274
Poland	1 944	1 342	1 017	2 270	1 644
Austria	884	91	114	1 287	344
Italy	233	66	26	115	87
Russia	0	382	1 200	0	0
Chile	6	1	1	1 512	0
others	126	114	101	381	330

7404 – Copper waste and scrap

	2004	2005	2006	2007	2008
Import, t	4 027	6 094	8 372	8 980	8 773
Export, t	45 571	54 198	57 417	59 548	60 709

Detailed data on copper waste and scrap imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	1 380	2 073	4 688	5 385	5 049
Poland	1 621	2 445	1 451	1 845	1 515
Germany	732	528	484	638	1 047
Austria	4	212	1 207	44	223
Hungary	191	769	376	768	208
others	99	67	166	300	731

Detailed data on copper waste and scrap exports (t)

Country	2004	2005	2006	2007	2008
Germany	24 926	27 094	33 776	33 876	32 086
Slovakia	4 306	5 760	5 349	5 294	13 558
Austria	3 750	3 708	4 098	6 948	3 317
Poland	4 412	852	958	2 341	2 684
Belgium	2 616	5 390	4 143	2 808	2 118
Italy	2 151	1 704	4 559	3 325	1 525
China	1 875	3 660	1 758	1 577	697
others	1 535	6 030	2 776	3 379	4 724

Foreign trade with refined copper, copper alloys and copper waste and scrap is the most important of the above given items of the customs tariff. Unrefined copper has been imported traditionally from Germany and Poland. Copper waste and scrap migrates from the East to the West, similarly to other non-ferrous metals. Amount of the copper waste leaving the Czech Republic is alarming (about 55–60 kt in 2005–2008). Recent years have seen a gradual shift of the main traded volume from unrefined metal and intermediate products to final copper products (wires, sheet metal, rods etc.)

6. Prices of domestic market and foreign trade

740311 – copper cathodes and sections of cathodes unwrought

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	66 938	81 329	138 886	149 878	133 158
Average export prices (CZK/t)	70 788	82 123	144 661	161 575	135 195

740321 – copper-zinc base alloys, unwrought

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	82 075	86 257	173 779	37 393	126 192
Average export prices (CZK/t)	59 741	60 702	97 061	37 896	122 189

740322 copper-tin base alloys, unwrought

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	383 785	355 912	233 643	300 148	219 019
Average export prices (CZK/t)	67 120	90 763	113 971	113 122	510 587

7404 – copper waste and scrap

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	43 633	52 967	100 977	106 825	91 525
Average export prices (CZK/t)	45 958	53 974	97 067	101 869	85 026

Evolution of the average import and export prices of copper,copper-zinc and copper-tin base alloy and copper waste and scrap in the last five years documents well the pronounced rise of non-ferrous metal prices before autumn 2008.

7. Mining companies in the Czech Republic as of December 31, 2008

No companies were extracting Cu ores in the Czech Republic in 2008.

8. World production

Production of Cu ores continues to rise and it conforms to the increasing world consumption (industrial countries show an increase in copper consumption by 3 % per year on average in the last decade). World production represents roughly between 15 and 16 mill tonnes per year at present. Mining production of Chile continued to increase in the last years (from 2.2 mill tonnes in 1994 to about 5.4 mill tonnes in 2004–2006, and 5.6 mill t in 2007). Mine production of Peru, China and since 2004 in Brazil has been increasing with similar dynamics. On the contrary, mine production of the USA before 2005 was decreasing. Mine production of Indonesia, which had been dynamically growing in 1995–2000, has been stagnating during the recent years. Mine production of Poland, the European largest producer, has been stable around 450–530 kt per year, however, it was slowly decreasing in the last years. Bulgaria, Portugal and Sweden represent other significant copper producers within EU.

World production data are adopted from Mineral Commodity Summaries (MCS), the International Copper Study Group (ICSG) database and the yearbook Estadísticas del Cobre y otros Minerales published by a renowned institute Comisión Chilena del Cobre (COCHILCO).¨

World copper mine production

Year	2004	2005	2006	2007	2008
Mine production, kt Cu (MCS)	14 600	15 000	15 100	15 400	15 700
Mine production, kt Cu (ICSG)	14 594	14 924	14 990	15 464	15 450
Mine production, kt Cu (COCHILCO)	14 721	15 188	15 210	15 650	15 591

Main producers' share in the world mine output (2008; according to COCHILCO):

Chile	34.2 %.	Russia	5.0 %
USA	8.6 %	Indonesia	4.2 %
Peru	8.1 %	Canada	3.9 %
China	6.0 %	Zambia	3.8 %
Australia	5.7 %	Poland	2.8 %

According to the International Copper Study Group, the largest world deposits based on annual mine capacity are: Escondida (Chile; 1.311 mill t), Codelco Norte (Chile; 0.957 mill t), Grasberg (Indonesia; 0.75 mill t), Collahuasi (Chile; 0.45 mill t), Morenci (the USA; 0.43 mill t), Taimyr Peninsula (group of mines, Russia; 0.43 mill t), El Teniente (Chile; 0.418 mill t), Antamina (Peru; 0.4 mill t), Los Pelambres (Chile; 0.335 mill t) and Batu Hijau (Indonesia; 0.3 mill t). The first European deposit Rudna in Poland with the yearly capacity of 0.22 mill t, exploited by KGHM Polska Miedź S.A., occupies the 16th position.

The largest metallurgical works in the world are located apart from Chile mainly in Asia. The largest production capacity have following metallurgical works: Birla Copper (India; 0.5 mill t), Norddeutsche Affinerie (Germany; 0.45 mill t), Saganoseki Ooita (Japan; 0.45 mill t), Codelco Norte (Chile; 0.4 mill t), Guixi (China; 0.4 mill t), Norilsk (Russia; 0.43

mill t), KGHM (Poland; 0.43), El Teniente (Chile; 0.391 mill t), Besshi Ehime (Japan; 0.365 mill t), Jinchuan (China; 0.350 mill t) and Yunnan (China; 0.350 mill t), Huelva (Spain; 0.32 mill t).

9. World market prices

Copper ore concentrates are not quoted on the world market; sales are based upon negotiated prices only. Prices of Cu metal (Grade A Electrolytic Copper) are commonly quoted at London Metal Exchange (LME). Copper price reached high values in 1973 and 1974 and another local maximum was reached in 1989 (annual average USD 2,847 per tonne). The following temporary decrease in prices was caused by a surplus production, particularly due to supplies from the East European countries and by the decrease in consumption resulting from the global economic recession. The prices hit twelve-year minimum in the first part of the year 1999. This trend has not changed until the second half of the year 2003, by the end of which the prices reached the limit of USD 2,300 per tonne. Prices of all non-ferrous metals on the world market significantly hardened during the year 2004. Copper prices increased up to 3,300 USD/t in this period, the cause being especially a high demand from the side of rapidly growing economies of Asia. For instance, the copper consumption in China increased according to ICSG by 9.3 % in 2004. Continual rise in copper price on the world market during the year 2005 had similar causes: whereas the price was below USD 3,100 per tonne in January 2005, it reached USD 4,650 per tonne in the end of the year. The price rose by about 50% just during the year 2005. Price of copper, as of a number of other metals, was to a certain extent also under influence of speculators, attracted by the high price rise. The prices slowly decreased back to the limit of 6,000 USD/t in the second half of the year 2006. However, already in April 2007 they increased back to the level of 8,000 USD/t. The price subsequently stabilized between 7,000 and 8,000 USD/t until November 2007. A temporary drop below 7,000 USD/t was followed by another price rise above 8,000 USD/t already in February 2008. The prices have remained above the 8,000 USD/t level, even approaching the 9,000 USD/t limit since February 2008. Historical maxima are still caused mainly by economical growth in the Asian region. Copper consumption in Asia increased from 450 kt to approximately 8 mill tonnes per year between 1960 and 2006. The last few years have seen the biggest increase of consumption. This trend changed and non-metallic ore prices decreased steeply in autumn 2008 in relation to the global financial and economical crisis. Copper prices dropped temporarily even below the limit of 1,500 USD/t at the end of 2008 and beginning of 2009. The prices subsequently slowly increased (to 2,400 USD/t in July 2009), present copper prices are, however, low compared to the historical maxima of the last years. Metal commodity price drop resulted even in temporary suspension of some of the new mining projects. It can be expected, that after the economical crisis, fundamental growth factors will predominate again and prices of non-metallic ores will increase.

The average annual metal price at LME in USD per tonne (Cash) was as follows

Commodity/Year		2004	2005	2006	2007	2008
Cu metal at the LME, Grade A Electrolytic Copper, cash	USD/t	2 868	3 684	6 727	7 126	6 952

10. Recycling

Copper belongs to metals which are recycled on a large scale. The proportion of recycled copper in the metal consumption reaches 30–40 % according to the International Copper Study Group. This proportion is even higher in developed countries, e.g. in Germany it exceeds 50 %. Copper is recovered mainly through pyrometallurgical processes, to lesser extent through hydrometallurgy.

11. Possible substitutes

Aluminium replaces copper in electrical and electronics uses, in the manufacture of car radiators and refrigerators. Titanium and steel despite their worse conductivity substitute for copper in the production of heat exchangers. Optical fibres in telecommunication and plastics in water distribution (lines) and the building industry are other substitutes.

Germanium

Germanium, from a geochemical perspective, is an uncommon trace element of siderophile character with a weak chalcophile and lithophile tendency. Commercially, it is classified among minor metals. Isolated minerals of germanium are very rare (e.g. germanite $Cu_{26}Fe_4Ge_4S_{32}$), and there are approximatelly 15 of them. Germanium usually forms an isomorphous admixture in more than 70 minerals. Germanium-bearing minerals are predominantly silicon, tin, lead, zinc, copper, arsenic, and gallium minerals, half of which are silicates and then mostly sulphides. Relatively high concentration of germanium in brown and bituminous coal occurs during weathering, sedimentation and sorption.

According to the MCS 2009, germanium is most often used for optical fibers (30 %), infrared optics (25 %), polymerisation catalysts (25 %), electronics and solar cell production (15 %), and other uses (metallurgy, chemotherapy, etc.) (5 %).

The following are industrially important types of deposits in terms of germanium production:

1. Coal – e.g. coking coal from the Donbas and Lviv-Volynskiy Basins (Ukraine),
2. Lead-zinc-copper, and arsenic sulphide ores – e.g. the Red Dog deposit (Canada), Middle Tennessee Zinc Mining Complex (USA),
3. Iron oxide ores – e.g. Kremenchug iron ore district (Ukraine)

The mine production of individual countries is not sufficiently known. The data on germanium production of individual countries and the world differ considerable depending on the source used: the MCS 2008 lists world production in 2006 at 90 tonnes, the MCS 2009 lists world production in 2007 at 100 tonnes and at 105 tonnes in 2008; the WBD (*Welt-Bergbau-Daten*) 2009 lists world production in 2007 at 32 tonnes, production in China at 25 tonnes, in Russia at 2 tonnes and in the USA at 5 tonnes; the WMP (*World Mineral Production*) 2003–2007 lists production in the USA and in 2007 at 5 tonnes, in China at 100 tonnes, and in Japan at 1 tonne; according to the Minerals Yearbook 2007, the USGS estimated Chinese production in 2007 at 100 tonnes of germanium from lead-zinc ores and germanium-bearing coal, and world production at 145 tonnes including 30 % of recycled germanium. On a global scale, the level of germanium production greatly depends on the situation on the zinc market, which is the principal product of germanium-bearing zinc ore processing.

The MCS 2009 lists world reserves at an estimated 450 kt (sulphide ores only).

Registered deposits and basic statistical data of the Czech Republic, as of December 31

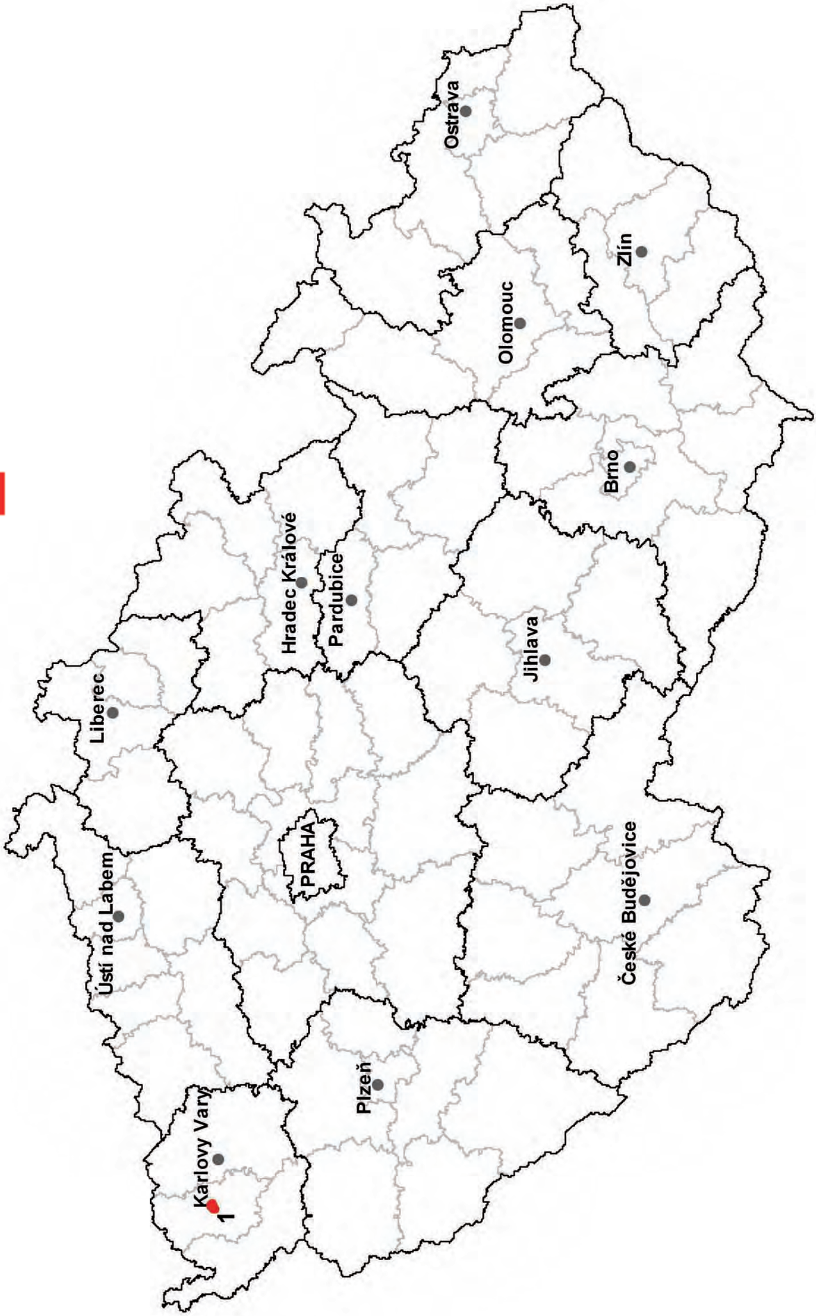
(see map)

The registered deposit is not exploited

1 Lomnice u Sokolova

Germanium

reserved registered deposits



Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number *	2	1	1	1	1
Exploited	0	0	0	0	0
Total ** reserves, t Ge	2 112	489	480	479	479
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	2 112	489	480	479	479
Mine production, t Ge	0	0	0	0	0

Note:
* Germanium-bearing brown coal, a decrease in its reserves is due to brown coal production and cancellation of coal reserves
** See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Germanium and GeO_2 were produced in the Czech Republic at the Lachema chemical plant (J. Fučík facility) in Kaznějov in 1955–1980. Industrial production from domestic resources was based on (according to data of the former Institute of Minerals at Kutná Hora) the burning of germanium-bearing coal in suitable power plant furnaces followed by the separation of germanium-bearing flue ashes (containing usually 0.1–0.3 % Ge) and flue gases in dry electrofilters. In 1955–1971, germanium was produced by burning bituminous coal from the Plzeň, Radnice and Kladno-Rakovník Basins (with Ge contents of 14–38 ppm). With the closure of mines that produced this type of coal, the bitumonous coal fly ash used for germanium production was substituted, after 1966, with brown coal fly ash generated by burning coal from the Jiří Opencast Mine in the Sokolov Basin (containing 40–150 ppm Ge). However, germanium production from fly ash, which peaked in 1966 with 773 kg, was terminated entirely in 1972.

In 1960–1980, a total of 54 tonnes of germanium and 4 tonnes of GeO_2 were produced at Lachema Kaznějov. The majority of this production came from imported GeO_2 (44.7 % of total production) and germanium (25.8 % of total production), and from recycled waste (22.7 % of total production). Domestic fly ash accounted for only 3.7 tonnes, which were produced in 1961–1971 (6.8 % of total production). The production capacity at Lachema Kuznějov never reached the annually planned 10 tonnes of germanium. However between 1965–1975, the territory of the Czech Republic (then part of Czechoslovakia) accounted for around 5–10 % of world germanium production annually.

Foreign trade

81129295 – Unwrought germanium, germanium powders; excluding waste and scrap

	2004	2005	2006	2007	2008
Import, kg	0	0	0	0	3
Export, kg	0	0	0	0	0

World market prices

Commodity/Year		2004	2005	2006	2007	2008
Germanium metal, zone refined *	USD/kg	600	660	950	1 240	1 600
GeO_2 **	USD/kg	358	393	537	720	962

Notes:
* Year-end, according to the MCS 2009
** annual averages according to Metal Bulletin quotes

Gold

1. Characteristics and use

Primary gold deposits can be divided into three large groups according to their origin: volcano-hydrothermal, plutonic-hydrothermal and metamorphic. Secondary deposits – recent and fossil placers – resulted from physical weathering processes. Gold occurs in the form of native metal, in a natural alloy with silver (electrum) or other metals or in some cases in the form of tellurides and selenides too. It occurs in sulphides of antimony, arsenic, copper, iron and silver. During their processing and smelting, gold is recovered as a byproduct. The grade or fineness of gold is given in carats or in 1,000 units (fine gold 24 carats = 1,000, 10 carats = 10/24 = 41.7 % = 417/1,000). Total economic world reserves are estimated at about 90 kt of Au (MCS 2008). 15 % to 20 % of this amount occurs as a minor constituent in ores of other metals (first of all Cu). More than 40 % of the world reserves is located on the territory of South Africa, even though the share of this present largest gold producer in the world gold mining has been decreasing in the recent years.

The major use of gold worldwide has been in jewellery (80 %) and as a hoarded metal. It is further used in electrotechnical industry, in medal and coin stamping, in dentistry, in producing special alloys for the aircraft (especially military) industry, in infrared reflectors etc.

2. Mineral resources of the Czech Republic

The tradition of mining for primary and secondary gold in the Bohemian Massif dates back almost three millennia. Bohemia used to be one of the most important producers of gold in Europe in the Middle Ages.

- The major part of gold mineralization is associated with regionally metamorphosed volcanosedimentary complexes locally penetrated by Variscan granitoids. Such a complex in the central Bohemian region is represented by the Jílové zone of the Proterozoic age, with abundant gold-quartz mineralization (deposits of Jílové, Mokrsko, Čelina and some others). Gold mineralization in the Jeseníky Mountains area is confined to stratabound base metal deposits related to Devonian volcanism (Zlaté Hory-západ). Gold ores mining was terminated in 1994 by closure of the Zlaté Hory-západ deposit. 1,524 kg Au was mined at this deposit in 1990–1994. Mokrsko deposit represents an explored deposit containing substantial Au reserves – 98 t Au in ores exploitable by open pit mining with average content of economic disposable reserves of 1.9 g/t Au and further more than 20 t Au exploitable by underground mining. Other 12.5 t of Au reserves exploitable by underground mining of Au with 1.6 g Au/t has been registered in a near-by deposit Prostřední Lhota-Čelina. There is therefore more than 131 t Au in whole Psí hory district (Čelina, Mokrsko). Vacíkov deposit SW of Příbram, were more than 33 t Au in ores containing 1.1 g Au/t, exploitable by open-pits, is similar.
- Some hydrothermal quartz veins with gold as well as stratabound gold mineralization with scheelite (Kašperské Hory) and quartz veins and stockworks with Ag (Roudný) occur in the crystalline complex of the Moldanubicum. Deposit Kašperské Hory, where the exploration was not completed, contains 189 t Au (officially 55 t of average content

4.7 g Au/t of ore) in potentially economic reserves of average content of 3.44 g/t of ore.

- Placer gold deposits are spatially and genetically linked to the primary gold deposits. Permo-Carboniferous paleoplacers occur in western Bohemia (Křivce) as well as in the Krkonoše Mts. Piedmont and in the Intra-Sudetic basins. The largest areas of Quaternary placers are located in the foothills of the Šumava Mountains and in northern Moravia and Silesia. Still recognizable remnants of placer gold panning indicate extensive mining for gold, which goes back to Celtic times.

No gold mining is currently taking place in the Czech Republic, following the end of mining operations at the Krásná Hora

Au-Sb deposit in 1992 and at the Zlaté Hory-západ base metal deposit in 1994. Unsolved conflicts of interests with nature protection and from the world aspect an unusual prohibition of the cyanide process in mining in the Czech Republic block the use of the explored Au reserves at Mokrsko and Kašperské Hory deposits.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

1	Břevenec	6	Mokrsko	11	Suchá Rudná-střed
2	Jílové u Prahy	7	Mokrsko-východ	12	Vacíkov
3	Kašperské Hory	8	Podmoky	13	Voltýřov
4	Mikulovice u Jeseníka	9	Prostřední Lhota-Čelina	14	Zlaté Hory-východ
5	Modlešovice	10	Smolotely-Horní Líšnice	15	Zlaté Hory-Zlatý potok

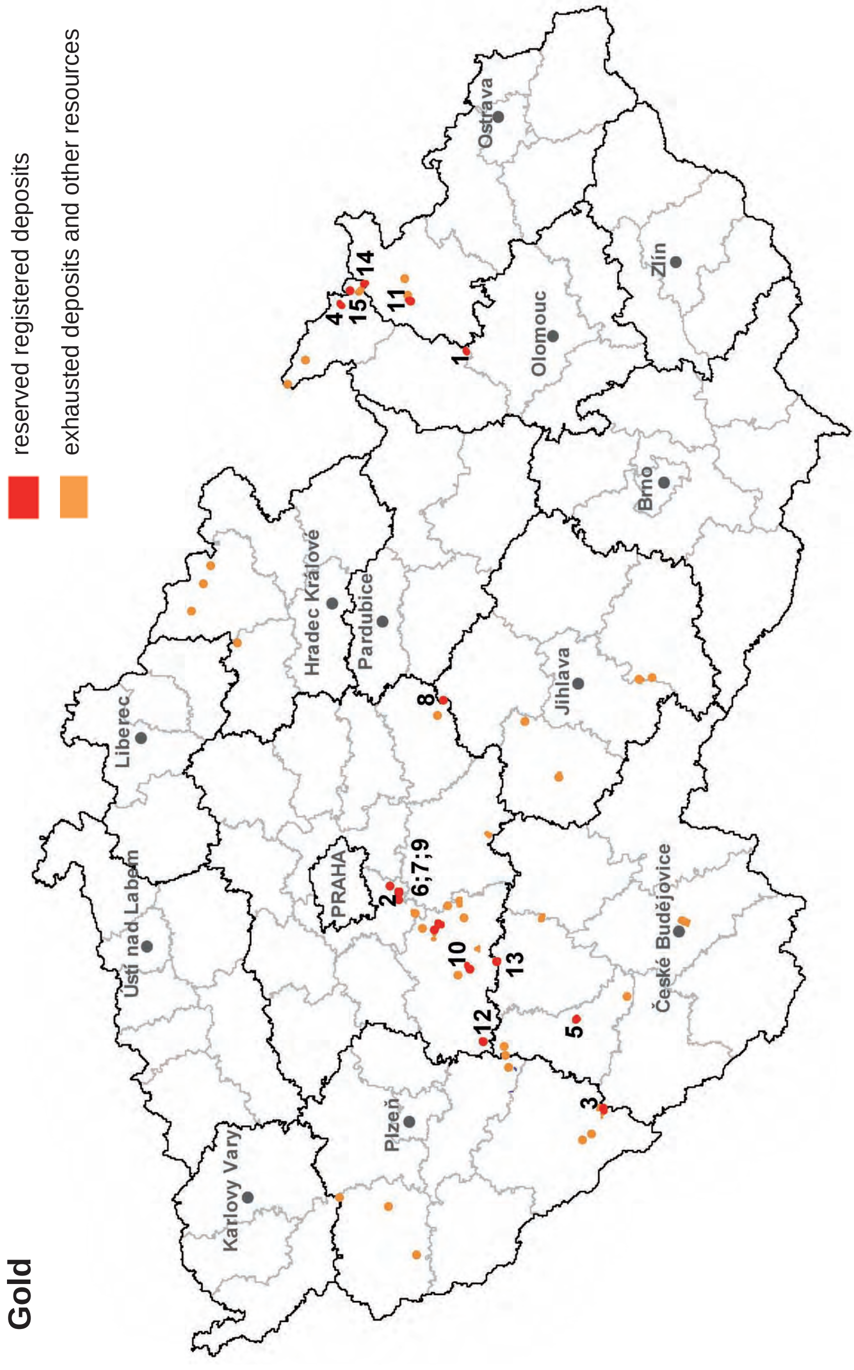
4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	20	20	19	15	15
exploited	0	0	0	0	0
Total *reserves, kg Au	240 677	240 677	239 518	238 890	238 890
economic explored reserves	48 740	48 740	48 740	48 740	48 740
economic prospected reserves	35 777	35 777	34 618	28 644	28 644
potentially economic reserves	156 160	156 160	156 160	161 516	161 516
Mine production, kg Au	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Gold


reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Liberec
Jihlava
Ústí nad Labem
PRAHA
České Budějovice
Plzeň
Karlovy Vary
1
2
3
4
5
6;7;9
8
10
11
12
13
14
15

Approved prognostic resources P_1, P_2, P_3 (untill 2004) and their conversion to prognostic resources P (R), Q valid since 2004

Au metal in ores

Year		2004	2005	2006	2007	2008
P_1,	kg	23 161	23 161	23 161	23 161	23 161
P_2,	kg	52 246	52 246	52 246	52 246	52 246
P_3		–	–	–	–	–

Au ore

Year		2004	2005	2006	2007	2008
P_1,	kt	4 144	4 144	4 144	4 144	4 144
P_2,	kt	10 800	10 800	10 800	10 800	10 800
P_3,	kt	2 850	2 850	2 850	2 850	2 850

5. Foreign trade

7108 – Gold in unwrought or semi-manufactured form, gold powder

	2004	2005	2006	2007	2008
Import, kg	1 624	N	N	1 929	2 652
Export, kg	5 831	5 715	4 722	4 631	5 153

Detailed data on gold imports (kg)

Country	2004	2005	2006	2007	2008
Switzerland	4 542	4 561	276	308	3 538
Slovakia	10	785	4 076	3 861	978
Germany	190	233	155	208	376
others	1 089	136	215	254	261

About 1.2–2.5 tonnes of gold per year were traditionally imported in the Czech Republic. Data of the Czech Statistical Institute on gold imports in 2005 and 2006 are not reliable. Gold has been imported mainly from Germany, Austria, Switzerland and Italy. About 4–6 t per year has been exported traditionally to Germany; since 2006, majority goes to Switzerland. Gold-bearing ores are not imported in the Czech Republic.

6. Prices of domestic market and foreign trade

Customs tariff item 7108 include so variable products and intermediate products, that it would be misleading to give average import or export prices.

7. Mining companies in the Czech Republic as of December 31, 2008

No mining companies were extracting Au ores on the territory of the Czech Republic in 2008.

8. World production

World production of gold, following a slight decrease in the early seventies, continued to rise steadily and reached its peak so far in 2001–2003 (about 2,500 to 2,600 t in metal content). According to the statistics of the Gold Survey yearbook, published by renowned company GFMS Limited, world consumption of gold was 3,851 t in 2005. Roughly 64 % of this amount came from the primary metal production and about 22 % was recovered; the remaining came from central banks selling and private disinvestment. Based on the information from Peter Hambro Mining Company, average world expense on Au production from deposits reach 224 USD/t oz, whereas average expenses on production from deposits in Russia represent only 166 USD/t oz (MBM, Febr. 2004, p. 12). Data on bulk production of Au from mined ores slightly differ depending on the source (according to Mineral Commodity Summaries-MCS and the Welt Bergbau Daten-WBD):

World gold mine production

Year	2004	2005	2006	2007	2008 e
Mine production, t Au (MCS)	2 430	2 470	2 460	2 380	2 330
Mine production, t Au (WBD)	2 406	2 468	2 345	2 328	N

Main producers’ share in the world mine output (2007; according to MCS):

China	11.6 %	Peru	7.1 %
South Africa	10.6 %	Russia	6.6 %
Australia	10.3 %	Indonesia	5.0 %
the USA	10.0 %	Canada	4.2 %

The first three countries produce roughly one third of the world production. More than 60 % of world reserves are concentrated on their territories. China became the biggest world gold producer for the first time in 2007, when its mine production of about 270 tonnes competed that of the long-term leader, South Africa. Gold mining production is concentrated in the eastern provinces Shandong, Henan, Fujian and Liaoning. Large deposits are located also in the western provinces Guizhou and Yunan. At the same time, China occupies the fourth position in gold consumption in the world (share of about 9 %).

According to The Gold Institute, following mines belonged to those with the highest gold mine production in the last years: Grasberg (Indonesia), Yanacocha (Peru), Muruntau (Uzbekistan), Betze Post (USA), Driefontein (South Africa), Twin Creeks (USA), Carlin (USA), Kloof (South Africa), Cortez (USA), Great Noligwa (South Africa), Porgera (Papua New Guinea), Randfontein (South Africa), Pierina (Peru), Meikle (USA), Kalgoorlie Consolidated Gold Mines Pty. Ltd. (Australia), Kumtor (Kyrgizstan), Obuasi (Ghana), Round Mountain (USA), Sadiola (Mali) and Lihir (Papua New Guinea).

Barrick (production in 2006: 268.8 t), Newmont (184.9 t), AngloGold Ashanti (175.3 t), Gold Fields (126.3 t), Harmony (72.9 t), Navoi Metals & Mining (58.2), Freeport McMoran (53.9 t), Gold Corp. (52.7 t), China Nacional Gold Group (49.3 t) and Fujian Zijin Mining (49.3 t) belong to ten most important mining companies (according to USGS).

9. World market prices

As for prices, gold represents a special metal. Its price is affected by many factors, among which speculative trade and global political climate are the most important. Consequently, the major world gold market centres quote gold prices twice a day (morning and afternoon fixing) in USD/troy oz. The price development is observed in actual and real prices using deflator of USD. The highest yearly average price during the last 25 years was reached in 1980 – USD 614.63 per troy oz (actual price). This highest price was due to the global political situation, which reflected the revolution in Iran, the Soviet invasion of Afghanistan, the petroleum shock, high inflation and the onset of the Iraqi–Iranian war. The average annual prices were below USD 400 per troy oz in London in the last 5 years (average p.m. fixing) and fell under USD 300 per troy oz in the end of 1997. Prices of gold hit twenty-years´ minimum in 1999. Low gold prices (along with the attempt of banks to diversify their portfolios) represented one of the reasons why a number of the National Banks began to sell parts of gold reserves, which resulted in further price decrease. No significant price changes followed in 2000. Agreement among the most important national banks about co-ordination and limitation of gold sale of their reserves caused only a short-term price increase. Gold prices remained on a very low level major part of the year. The low prices were characteristic also for 2001, when the metal prices were oscillating between 255 and 295 USD/troy oz. This trend changed during 2002, when the price of gold started to increase from about 280 USD/troy oz up to 350 USD/troy oz in the end of the year. World price oscillated between 320 and 400 USD/troy oz for major part of the year 2003 and it reached its highest level since February 1996, i.e. 411.70 USD/troy oz (1 troy oz = 31.1035 g), in December 2003. In 2004, in line with the increasing trend of other raw materials, a marked increase of gold prices occurred. The prices oscillated between 375 and 455 USD/troy oz, which represented the highest maxima since 1988. Rise of the world gold prices continued also in the year 2005, especially its second half, when prices increased from about 420 to 540 USD/troy oz. Gold price increased also in the first half of 2006, when it reached 725 USD/troy oz. The price fluctuated between 550 and 650 USD/troy oz in the rest of the year. In the first half of 2007, gold prices were still higher, between 610 and 690 USD/troy oz. Gold prices increased significantly by 100 USD/troy oz righ up to the limit of 800 USD/troy oz during September and October 2007. The yearly maximum of 840 USD/troy oz was reached in the first November decade. Gold price increased significantly also in the first quarter of 2008, when the magical limit of 1,000 USD/troy oz (1017 USD/troy oz in mid-March 2008) was broken. Gold price oscillated between 850 and 1,000 USD/t oz also in the second quarter of 2008. In September and November 2008, the gold price temporarily returned back to the limit of 700 USD/t oz in relation to the global financial and economical crisis. However, very soon many investors started to perceive precious metals as a good alternative to not very safe shares with unstable prices. As a result, gold prices increased back to about 900 USD/t oz. Gold price fluctuations are related to the US dollar exchange rate trend, in which gold – the same way as most of the other mineral commodities – is quoted.

Gold price, average p.m. London fixing

Commodity/Year		2004	2005	2006	2007	2008
Gold, London, average p.m. fixing	USD/t oz	410	445	603	699	900

10. Recycling

Gold is widely recycled from jewellery, coinage and other industries. Recycling may reach as much as20–25 % worldwide, even though the data on recycling are rather difficult to obtain.

11. Possible substitutes

The consumption of gold and its alloys in jewellery and electricity and electronics uses is decreasing due to the introduction of parts made of common but gold plated metals. Gold can be replaced by palladium, platinum and silver. Gold could be replaced by rhodium or other precious metals only in a very limited extent. In classic jewellery, however, gold and its alloys are indispensable.

Lead

1. Characteristics and use

Lead ores make usually part of base metal ores, formed predominantly by sulphides of Pb, Zn, in places Cu and accompanied by exploitable contents of silver and gold and many trace elements (e.g. In, Cd, Bi etc.). Galenite and sphalerite usually with pyrite and often with chalcopyrite represent major minerals of these ores. Ideas on genesis of many of base metal ore deposits are variable, even contradictory, as even several genetic processes contributed to their formation and final form. As far as industrial use is concerned, deposits of various genesis can be grouped into 6 main types. Large to huge stratified and lenticular concordant bodies in metamorphic rocks, large and medium-sized deposits of disseminated galena-sphalerite ores in limestones and dolomites (stratabound), large and medium-sized massive sulphide deposits, medium-sized deposits of irregular shape with massive and disseminated mineralization, medium-sized and small deposits of skarn ores, medium and small vein deposits of relatively rich ores.

Automotive industry is the main branch which uses lead. Even except production of batteries it is still essential in various seals, weights on wheels, solders, bearings etc. production. About 20 % of lead consumption covers electrotechnics, electronics, production of explosives, protective coatings etc.

2. Mineral resources of the Czech Republic

Mining of vein-type hydrothermal base metal deposits brought fame and glory to the medieval ore mining in Bohemia. Originally it was due to the silver contents in ores of these deposits; additional extraction of lead and later also zinc ores started in the 16th century. After World War II, new exploration projects turned the attention to volcanosedimentary deposits of the sulphide formation.

- Hydrothermal vein base metal mineralization is abundant in the Bohemian Massif. Besides medieval ore districts of Oloví, Jihlava, Havlíčkův Brod, Stříbro, the Blanice Graben and others, the mining districts of Příbram, Stříbro and Kutná Hora maintained their significance till the 20th century. The major Pb-bearing mineral was galena (more or less Ag-bearing), which can be as abundant as sphalerite in the majority of Pb-Zn deposit. Only the Kutná Hora ore district shows considerably lesser contents of galena relative to sphalerite in the majority of veins.
- A distinct type of hydrothermal vein mineralization occurred at Harrachov, where galena is accompanied by barite and fluorite.
- Stratabound base metal ores of volcanosedimentary origin related to Devonian volcanism were explored in the fifties through to eighties in northern Moravia. Extensive mining was focused on the deposits of Horní Město, Horní Benešov, Zlaté Hory-východ and Zlaté hory-západ. Contents of lead varying up to 0.5 % are bound in galena, accompanied in ore bands by sphalerite. Mining of any other base metal deposits of similar origin has not started because of reduction of ore mining.

Mining of base metal deposits in the Czech Republic was terminated at the beginning of 1994. A complex Pb-Zn concentrate represented a final product of mining. This concentrate was exported, as there was no domestic capacity for its smelting. Reserves of base metal ores are in the process of being gradually eliminated from The Register.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

Reserved registered deposits:

1 Horní Benešov
2 Horní Město
3 Horní Město-Šibenice
4 Křižanovice
5 Kutná Hora
6 Oskava
7 Ruda u Rýmařova-sever
8 Zlaté Hory-východ

Exhausted deposits and other resources:

9 Březové Hory + Příbram-Bohutín
10 Oloví
11 Stříbro
12 Havlíčkův Brod (Dlouhá Ves + Bartoušov + Stříbrné Hory)
13 Ratibořské Hory + Stará Vožice
14 Černovice

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	8	8	8	8	8
exploited	0	0	0	0	0
Total *reserves, kt Pb	152	152	152	152	152
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	152	152	152	152	152
Mine production, kt Pb	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

a) Deposits with registered Pb content

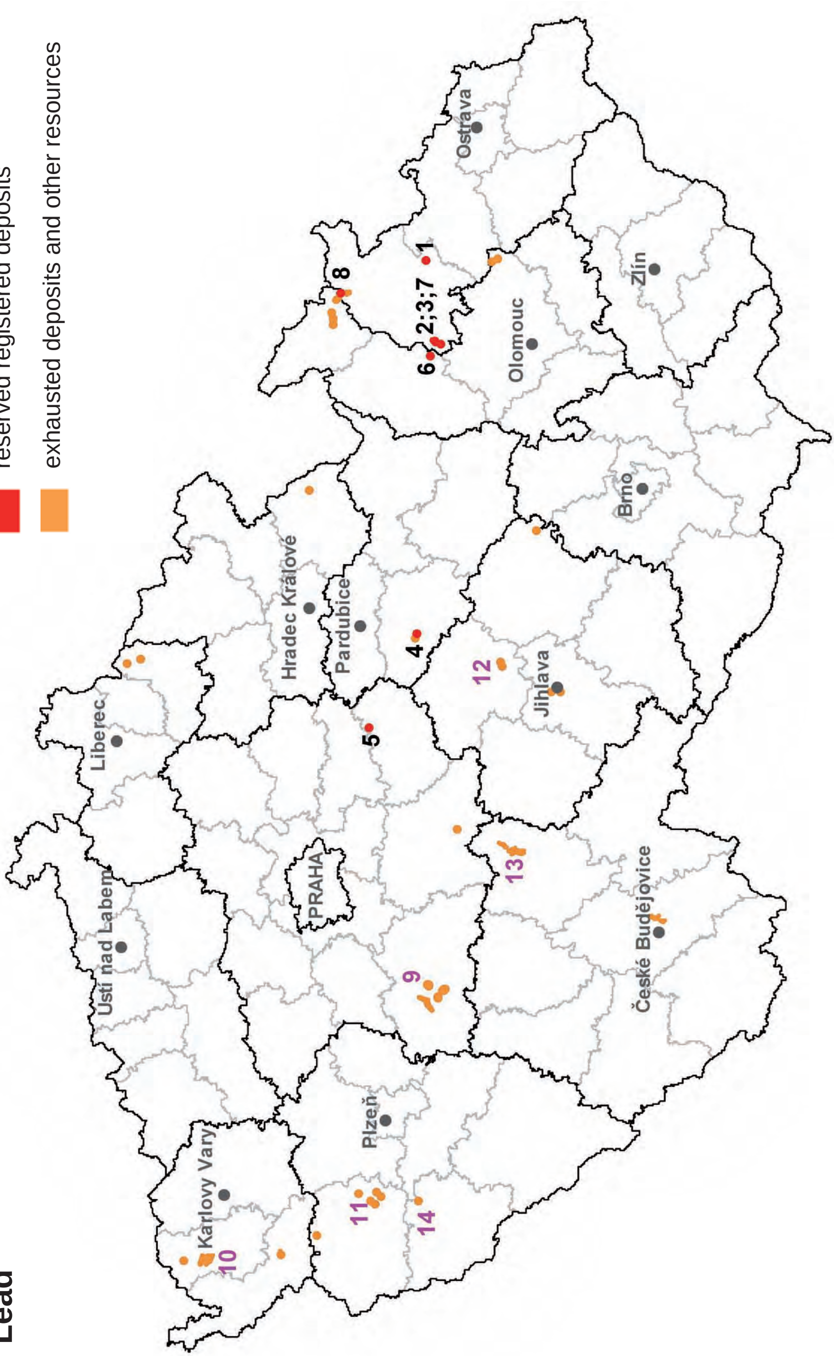
Approved prognostic resources P_1, P_2, P_3

Pb – Zn ± Cu ores

Year		2004	2005	2006	2007	2008
P_1,	kt	786	786	786	786	786
P_2,	kt	5 340	5 340	5 340	5 340	5 340
P_3		–	–	–	–	–

Lead

reserved registered deposits
exhausted deposits and other resources



Recycling and lead production

Kovohutě Příbram nástupnická a.s.

Activity of Kovohutě Příbram nástupnická a.s. can be divided into four main branches. Recycling division is engaged with bulk buying and recycling of waste and scrap of lead and its alloys, 80 % of which represent old scrap lead accumulators. Its production consists of lead and its alloys in pigs. The products division is engaged with the production and sale of a large range of about 2,000 products based on lead, tin and antimony. These are used e.g. in construction industry, electro-technics, electronics, chemical industry, health services, engineering in measuring technique and at ammunition production. Lead plates, lead stripes and sections, lead wires and bars, lead seals etc. belong to main products. Electric waste division is engaged with ecological processing of collected electrical equipment and separately collected electric waste. Precious metals division is engaged with bulk buying and ecologically harmless usage and recycling of waste – secondary raw materials containing precious metals.

5. Foreign trade

2607 – Lead ores and concentrates

	2004	2005	2006	2007	2008
Import, t	0	0	1 741	0	0
Export, t	0	0	0	0	0

7801 – Unwrought lead

	2004	2005	2006	2007	2008
Import, t	73 472	N	67 924	68 661	59 319
Export, t	7 230	8 666	10 430	19 625	18 714

Detailed data on unwrought lead imports (t)

Country	2004	2005	2006	2007	2008
Germany	50 101	N	42 696	37 309	27 677
Sweden	10 976	14 600	16 510	15 913	9 872
Poland	4 899	1 093	809	5 133	9 731
Romania	2 416	N	3 124	5 351	3 641
Austria	1 381	2 161	2 740	2 470	2 183
others	3 699	N	2 045	2 485	6 215

7802 – Lead waste and scrap

	2004	2005	2006	2007	2008
Import, t	1 348	4 104	4 411	6 502	4 773
Export, t	3 032	4 948	6 648	6 894	8 161

Detailed data on lead waste and scrap imports (t)

Country	2004	2005	2006	2007	2008
Germany	224	946	934	2 646	1 818
Poland	391	1 244	1 455	1 444	1 426
Belorussia	0	0	195	151	557
Hungary	586	732	636	945	531
Bosnia and Herzegovina	0	671	956	736	0
others	146	509	235	580	441

Detailed data on lead waste and scrap exports (t)

Country	2004	2005	2006	2007	2008
Germany	3 023	4 948	6 583	6 539	7 999
others	9	0	65	347	162

Foreign trade with unwrought lead, the import of which represents 55 to 70 kt per year, i.e. CZK 1.5–3.3 billion, is the most important of the above given customs tariff items. Unwrought lead is imported traditionally from Germany and Sweden. Gradual decrease of unwrought lead import from Poland in favour of lead waste and scrap in 2005 and 2006 is interesting. Import of lead waste and scrap increased more than twenty times in 2002–2005 and the import-export balance equilibrated for the first time in 2006. In 2008, lead waste and scrap export again predominated over import. Almost all lead waste and scrap is exported to Germany. Volume of trade with lead ores and concentrates is negligible.

6. Prices of domestic market and foreign trade

7801 – Unwrought lead

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	21 355	N	30 936	48 451	39 848
Average export prices (CZK/t)	25 728	22 338	34 420	43 480	44 525

7802 – Lead waste and scrap

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	18 540	18 883	24 028	44 658	34 373
Average export prices (CZK/t)	12 294	23 566	23 470	27 716	26 265

7. Mining companies in the Czech Republic as of December 31, 2008

In 2008, no companies exploiting ores with Pb content were operating in the Czech Republic.

8. World production

The world production exceeded the level of 3 mill tonnes of metal content first in 1968. The largest production so far was recorded in 1977 – 3,657 kt.

Since the second part of 1990s until 2003, the world mine production had been oscillating around 3,000 kt. The last three years have seen a repeated rise in mine production, especially in case of two largest world producers – Australia and China. The Chinese production increased from 640 kt in 2002 to 950 kt in 2004 and about 1,360 kt in 2007. Metal lead export from China decreased steeply in 2006-2008, and in the middle of 2008 the country became its pure importer. The mine production of the USA and Peru has been stagnating during the last years. Data according to Mineral Commodity Summaries (MCS), International Lead and Zinc Study Group (ILZSG) database and yearbook Welt-Bergbau-Daten (WBD):

World lead mine production

Year	2004	2005	2006	2007 e	2008
Mine production, kt Pb (MCS)	3 150	3 270	3 470	3 770	3 800
Mine production, kt Pb (ILZSG)	3 130	3 421	3 525	3 610	3 915
Mine production, kt Pb (WBD)	3 139	3 313	3 536	3 563	N

Main producers' share in the world mine output (2007; according to MCS):

China	39.8 %	Mexico	3.2 %
Australia	17.0 %	Poland	2.3 %
the USA	11.8 %	Canada	2.2 %
Peru	8.7 %	India	2.1 %

Metal production

Year	2004	2005	2006	2007	2008
Metal production, kt Pb (according to ILZSG)	6 998	7 632	7 925	8 122	8 671

9. World market prices

On the world market, mines receive the lead metal price *less* a treatment (inclusive refining) charge (per unit of contained lead), with some adjustments for their lead concentrates (recoverable byproducts such as Ag, Ge, In). The treatment charge (T/C) for lead concentrate grading 70–80 % Pb is quoted in USD/t, CIF Europe. It exceeded a limit of USD 100 per tonne at the end of 1987 and since then it was gradually increasing by almost 100 %. Then it decreased again and it stabilized at about USD 110 per tonne during the last years.

The metal has been traditionally traded on the London Metal Exchange (LME) in GBP/t until the end of June 1993 and since then in USD/t. Metal price at LME (refined metal having minimum 99.97% Pb) reached local maximum in 1979 – GBP 556 per tonne. The price of lead was oscillating below the level of USD 500 per tonne in 2000 to 2002. This trend dramatically changed in the second half of the year 2003, during which the prices increased up to the limit of USD 700 per tonne. Prices of all non-ferrous metals on the world market significantly hardened during the year 2004. Lead prices increased up to the extraordinary level of 1,040 USD/t in this period. It was again a high demand from the side of rapidly growing economies of Asia, especially China and India, which caused this increase. The lead prices were high also in 2005, where they ranged between 820 and 1,160 USD/t. World price of lead markedly increased in 2006, especially in its second half, when the price increased to as much as 1,800 USD/t. This rise was caused by continuing high demand especially of the Asian region, which contributed to the low level of the metal reserves on world stock exchanges. Prices continued to rise in the first half of 2007 as well, when the price temporarily increased to a record-breaking value of 3,500 USD/t. In the summer months of 2007, lead prices again levelled off between 3,000 and 3,500 USD/t. The lead price reached a record value of 3,980 USD/t in October 2007, however, it subsequently returned back to the level around 2,500 USD/t due to the increase of stock reserves. Price increased up to 3,500 USD/t, i.e. nominally seven-fold of 500 USD/t usual on a long term, in the first quarter of 2008. However, lead prices were decreasing for the rest of the year 2008, and therefore their trend to a certain extent marked the rapid decrease of non-metallic ore prices in relation to global financial and economic crisis. Lead prices (still under influence of high stock reserves) decreased first back to the level of 1,500 USD/t (July 2008) and subsequently down to the level of 1,000 USD/t in the end of 2008. The first half of the year 2009 has seen increase of lead prices to the limit of 1,700 USD/t.

Treatment charge (T/C) of lead concentrates and lead metal LME price

Commodity/Year		2004	2005	2006	2007	2008
Lead concentrate, 70–80 % Pb grade, T/C basis, CIF Europe	* USD/t	110	110	110	N	N
Refined metal, 99.97 % Pb minimum, LME	**USD/t	888	976	1 291	2 588	2 141

* Average price of commodity at year-end

** Average annual price

10. Recycling

The share of recycled lead in world production of Pb metal has been continuously increasing. This trend leads to a decrease in demand for lead concentrates and it also affects their price. Due to the high lead consumption in the accumulator and battery production, batteries represent the most recycled material. Less recycled is scrap from consumer's and manufacture industries. Recycled lead has supplied 59 % of the metal world production according to the UNCTAD data. Mainly Japan, Germany, France, Great Britain, the USA and Canada took part in the recycling. It is at the same time estimated, that about 85 % of products made of or containing lead were recycled in 2004. According to the Battery Council International, 97 % of lead accumulators are recycled at present in the USA.

11. Possible substitutes

Lead used for piping in the building industry and for electric cables is being replaced by copper and polymers. Aluminium, tin, iron and plastics gradually fully replace lead in packing and preserving of products. Tetraethyl lead used as anti-knock additive in gasoline is replaced by aromatic hydrocarbons. Other agents are also efficiently replacing lead in the manufacture of pigments. The volume of lead substitutes continues to increase and will include even the manufacture of accumulators and batteries. Lead in solders is prohibited (in EU) and efficiently replaced by tin and other low melting point metals.

1. Characteristics and use

Manganese is one of the most abundant elements in the Earth´s crust and it forms easily various compounds in nature due to its chemical character. There are basically two types of manganese deposits as their industrial use concerns: of sedimentary or volcano-sedimentary and of metamorphic origin, enriched as a result of weathering or hydrothermally. Among 300 known manganese minerals only 12 are principal constituents of economic deposits. Of these, pyrolusite, psilomelane, manganite, braunite and hausmannite are the most important. Known reserves on continents exceed 5 billion tonnes of metal in ores. Additional huge amounts of Mn are bound to deep sea nodules, occurring at the bottom of oceans. It is estimated that these nodules contain roughly 2.5 x 10^{12} tonnes of manganese. Projected resources confined to deep-sea nodules having an average content of 25 % Mn represent about 358 million tonnes of metal. More than 90 % of manganese is used for production of manganese ferro-alloys for the iron industry, both in production of pig iron and particularly in the steel industry as a desulphurizing and deoxidizing agent, and as an important alloying metal. The average world consumption of manganese is 10 kg in 1 tonne of crude steel, in up-to-date steel-works the minimum is 6 kg. Manganese is also used in alloys with non-ferrous metals (Al, Cu, Ti, Ag, Au, Bi). Another applications are in the manufacture of dry batteries, colouring agents, soft ferrites, fertilizers, feed for animals, fuel additives, welding electrodes, water treatment, etc. Manganese raw materials are classified into metallurgical, chemical and batteries grades, based on the quality of ores or concentrates required in the main uses.

2. Mineral resources of the Czech Republic

The Czech Republic has no Mn ore reserves other than the Chvaletice deposit with low-grade ores, exploitation of which is problematic. Mn contents in currently mined ores in the world are about 30–50 % in primary, mainly metamorphic ores, and significantly over 10 % in sedimentary ores.

- The most significant accumulations of Mn ores are known from the Železné hory Mts. area, where they are confined to volcano-sedimentary deposits of the Proterozoic. The mineralization is associated with a horizon of graphitic-pyritic slates, which have been metamorphosed together with neighbouring rocks. The ore horizon extending from Chvaletice to Sovolusky is composed of a mixture of Mn and Fe carbonates (mainly Fe-rhodochrosite), quartz, graphite and Fe-sulphides. Silicates of Mn originated during the regional metamorphic processes. The ore contains up to 13 % Mn.
- Major mining operations were executed at the Chvaletice deposit. First, only Fe ores of the gossan type (since the 17th century) and since World War I also experimentally Mn ores were mined on the outcrops. Pyrite was mined from the 1950s until the termination of mining operations in 1975 as a raw material for the chemical industry. Mn ores were extracted along with pyrite but due to incomplete technology were not processed and were deposited in tailing ponds at the former mineral processing plant. An average Mn content in the tailing pond No 3 is 9–11 % and in the tailing ponds No 2 and 3 between 5 and 8 %. Desulphurization of combustion products could represent a potential use of these ores.

- Other occurrences of Mn ores in the Czech Republic (e.g. Horní Blatná, Arnoštov, Maršov near Veverská Bítýška et al.) were not of any economic importance.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

1 Chvaletice 2 Chvaletice-tailing ponds Nos 1 & 2 3 Řečany-tailing pond No 3

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	3	3	3	3	3
exploited	0	0	0	0	0
Total *reserves, kt ores	138 801	138 801	138 801	138 801	138 801
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	138 801	138 801	138 801	138 801	138 801
Mine production, kt Mn	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

No ferro-alloys were produced in the Czech Republic in 2008. The most important producer of ferro-alloys in the central European region is OFZ a.s., formerly Oravské ferozliatinárske závody Istebné, in Slovakia. This company produces a large assortment of ferroalloys on the basis of manganese, silicon and chromium – FeMnC, FeSiMn, FeSi 45%, FeSi 65%, FeSi 75%, FeSiCa, FeCrC.

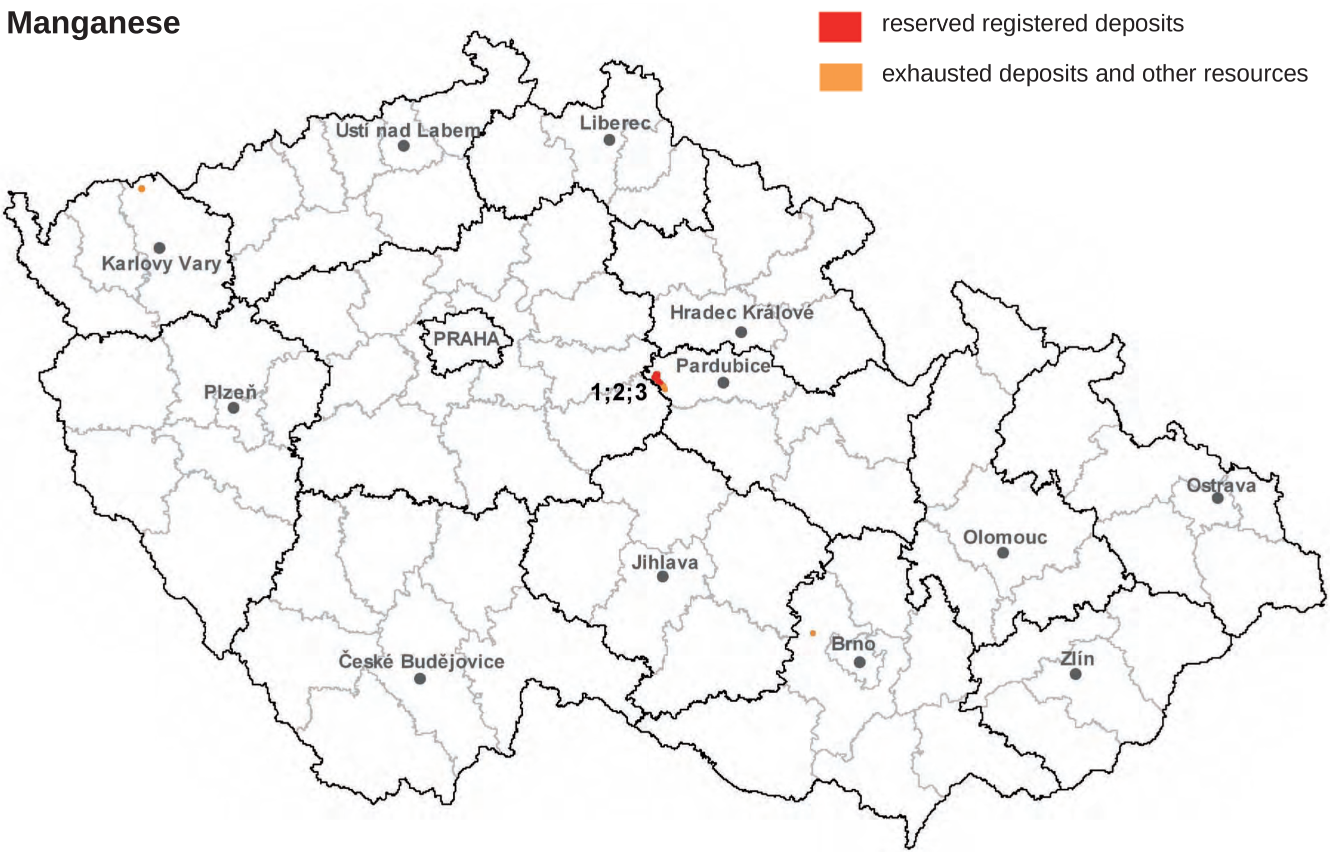
Huta Łaziska S.A. in Poland (ferrosilicium, ferrosilicomanganese) and Treibacher Industrie AG in Austria (ferrovanadium, ferromolybdene) belong to important ferro-alloys producers in the Central Europe region.

5. Foreign trade

2602 – Manganese ores and concentrates

	2004	2005	2006	2007	2008
Import, t	11 665	13 846	14 375	15 902	15 714
Export, t	558	54	45	43	101

Manganese



reserved registered deposits
exhausted deposits and other resources
Ústí nad Labem
Liberec
Karlovy Vary
Hradec Králové
PRAHA
Pardubice
1;2;3
Plzeň
Ostrava
Olomouc
Jihlava
Brno
Zlín
České Budějovice

Detailed data on manganese ore imports (t)

Country	2004	2005	2006	2007	2008
Ukraine	2 642	9 721	4 559	13 274	12 058
the Netherlands	2 154	3 432	1 978	2 537	2 180
Georgia	6 292	510	5 673	0	1 211
Australia	48	5	11	4	5
South Africa	0	7	1 881	0	0
others	529	171	273	91	265

720211; 720219 – Ferro-manganese

	2004	2005	2006	2007	2008
Import, t	27 028	31 728	32 371	35 668	33 703
Export, t	2 032	4 089	4 113	2 996	3 375

720230 – Ferrosilicomanganese

	2004	2005	2006	2007	2008
Import, t	59 361	58 142	57 855	52 199	48 962
Export, t	2 040	9 320	9 122	2 803	5 658

Detailed data on ferrosilicomanganese imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	30 624	27 852	33 491	33 787	33 740
Ukraine	10 769	20 026	12 355	11 388	8 723
Norway	7 324	4 579	1 017	1 923	2 338
Romania	2 020	1 815	2 134	1 237	1 861
Poland	6 950	1 095	0	0	0
others	1 674	2 775	8 864	3 864	2 300

8111 – Manganese and articles thereof, including waste and scrap

	2004	2005	2006	2007	2008
Import, t	593	629	674	804	2 542
Export, t	9	24	5	135	108

2820 – Manganese oxides

	2004	2005	2006	2007	2008
Import, t	888	787	1 316	1 058	1 476
Export, t	318	294	413	668	728

Ferrosilicomanganese import, oscillating steadily between 5-05 and 60 t per year in the last years, represents the most important volume. Ferrosilicomanganese has been imported namely from Slovakia, Ukraine and Norway. Imports of ferromanganese into the Czech Republic are about 30 kt per year. Manganese ores represent a traditionally important item; between 12 and 16 million tonnes per year is imported, mainly from Ukraine and the Netherlands; import from other countries is irregular.

6. Prices of domestic market and foreign trade

2602 – Manganese ores and concentrates

	2004	2005	2006	2007	2008
Average import prices	5 504	5 702	4 960	4 640	10 112

7. Mining companies in the Czech Republic as of December 31, 2008

No mining companies were extracting manganese ores in the Czech Republic in 2008.

8. World production

Production of manganese ores moves in line with the production of iron ores, because their consumption is connected with the production of pig iron, steel and ferroalloys. The individual yearbooks differed significantly as the estimates of the world production concerns: whereas mine production of about 8–12 mill tonnes was given in Mineral Commodity Summaries (MCS), the mine production was considerably higher in individual years according to the Welt Bergbau Daten (WBD). Differences between data of the two yearbooks are smaller since 2009. In the past five years, manganese production has been decreasing in Australia, China, Gabon and India, and it stagnated in Kazakhstan, Ukraine and the RSA. Mining production decreased in Brazil.

World manganese mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt Mn (MCS)	9 350	10 500	11 900	12 600	14 000
Mine production, kt Mn (WBD)	10 875	11 604	11 919	12 699	N

Main producers' share in the world mine output (2007; according to MCS):

South Africa	20.6 %	Brazil	7.4 %
Australia	20.2 %	India	7.1 %
China	15.9 %	Ukraine	4.6 %
Gabon	11.8 %	Mexico	1.0 %

Operating technologies of manganese nodules offshore mining were by the end of the 2008 at disposal in France, Japan, Germany, the USA, Russia, Republic of Korea, India and China. Czech Republic as a member of the international Interoceanmetal (IOM), established in 1987 with the main aim to utilize mineral resources from the seabed, has one fifth share in about 75,000 km^2 IOM lease of the ocean bottom in the north-eastern part of the tectonic zone Clarion–Clipperton in the subtropical part of the northern Pacific, where nodules with promising contents of Mn, Cu, Co, Ni but also Zn, Pb, Mo et al. occur. Currently, a second stage of the geological survey is being conducted, which aims to predict really perspective locations in the area of interest.

9. World market prices

Basically three types of manganese ore are traded on the world market – metallurgical ore (38 to 55 % Mn), raw material with a content of 48–50 % Mn as a standard for production of manganese ferro-alloys, and chemical and battery grade ores with 70 to 85 % Mn. Only metallurgical ore of grade 48–50 % Mn with maximum 0.1 % P is quoted on a long-term basis on the world market. The price is quoted on an USD/mtu basis CFR Europe. Final price of 1 tonne of ore is a multiple of the unit price in mtu and the metal content in the relevant ore. E.g. at price of 2.03 USD/mtu for 48 % manganese ore of metallurgical grade the final price is 97.44 USD/t. The price in the eighties fluctuated on average around USD 1.5 per mtu until 1988. Then price increased and reached its peak in 1990 and 1991 (USD 4 per mtu). Since this period the prices had been decreasing for a number of years. The major cause was decline in market demand owing to a world economic recession and continuous reduction of Mn content in pig iron. The change didn't come until during the year 2005 in relation to price rise of iron ores and other metal commodities. Prices continued to rise also during the following years. World prices doubled from 6 to 16 USD per mtu only in the period June 2007–June 2008. This was caused primarily by a high demand of the Asian steel sector. Whereas the world steel production in 2007 decreased by 2.9 %, production of the Asian continent increased by 6.3 % and production of China even by as much as 36 %. Nowadays, 60 % of the world steel production comes from Asia. Prices of manganese ores increased until Semptember 2008, when they reached 17–18 USD/mtu. Similarly to other metal commodities, the prices subsequently decreased and reached 14–16 USD/mtu in the end of 2008.

The average prices of the given manganese ore grade at year-end

Commodity/Year		2004	2005	2006	2007	2008
metallurgical ore of grade 48–50 % Mn with maximum 0.1 % P, CFR Europe	USD/mtu	1.97	2.40	2.60	8.00	15.00

10. Recycling

Recycling of manganese is of only minor importance because of easy availability and relatively low price of primary manganese raw materials. Only scrap from iron and non-ferrous metals production and particularly steel slag rich in Mn in form of MnO and MnS are recycled to a certain extent. Manganese from used electric dry batteries is also recycled to a lesser extent.

11. Possible substitutes

No substitute for manganese in principal areas of use exists. In steel manufacture, other deoxidising additives – silicon, aluminium, complex alloys and rare earth elements – can substitute it to a certain extent, conditioned by economic parameters.

Silver

1. Characteristics and use

Silver is an element of chalcophile character, which during the magmatic differentiation tends to concentrate in minerals of late stages or hydrothermal fluids. About 2/3 of the silver world reserves occur in polymetallic (Cu and Pb-Zn) deposits of various origin. The major silver-bearing mineral is Ag-bearing galena, the other ones are mainly sulphides and sulphosalts of Ag, such as e.g. argentite, proustite, kerargyrite, polybasite, pyrargyrite, stromeyerite and tetrahedrite (freibergite). Silver fineness is expressed in thousandths of total alloy; sterling silver, its commonest alloy, contains 92.5 % silver (fineness of 925/1,000). World reserves of silver metal in various deposit types are estimated at 5702 kt of metal (according to MCS 2008).

Although the amount of silver used in photographic industry strongly decreases due to development of digital photograph, its consumption does not decrease substantially. Traditional use in jewellery remains well-oriented. This metal finds a new usage in many industrial and consumer branches like electrotechnics and electronics, colour printing, deodorant production, health care etc. Silver is also used in water purification, battery production, production of glasses and special reflecting surfaces (solar energy acquisition), catalyser production and in nuclear power generation for control rods manufacture for water reactors (an alloy consisting of 80 % Ag, 15 % In and 5 % Cd).

2. Mineral resources of the Czech Republic

Mining for silver played a decisive role in medieval ore mining in Bohemia and in the prosperity of old mining towns.

- The major portion of silver resources in the Czech Republic occurs in polymetallic (Pb-Zn and Cu) deposits, where it forms an isomorphous admixture particularly in galena. Some Ag was extracted as a byproduct when mining high-grade polymetalic ores (58–70 ppm Ag) and U-Ag ores (high grade Ag ores with native silver and Ag minerals exhibiting around 480 ppm Ag) of the Příbram uranium-polymetallic deposit, until the mining operations were reduced and ceased completely in the early nineties. Polymetallic ores of the Horní Benešov and Horní Město deposits contained obtainable amount of Ag, too. The 50 % lead concentrate showed average Ag content of 846 g/t, the 49 % zinc concentrate contained 86.6 g/t Ag on average in 1963–1992. Deposit Zlaté Hory-východ was the one containing silver in polymetallic ores in the Zlaté Hory district. The Pb-Zn concentrate produced from the ores of this deposit in 1988–1992 displayed average Ag content of 0.19 g/t.
- Numerous recently abandoned deposits of Pb-Zn-Ag and deposits of so-called five element assemblage (U-Bi-Co-Ni-Ag) in medieval mining districts of Kutná Hora, Jihlava, Příbram, Jáchymov, Stříbro, Rudolfov, Havlíčkův Brod, Stará Vožice etc. were an important source of European silver in the past. The deposits represent classic deposit types.

Silver reserves are in the process of being gradually eliminated from The Register in connection with the revaluation of polymetallic ores.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

Reserved registered deposits:

1 Horní Benešov
2 Horní Město
3 Horní Město-Šibenice
4 Kutná Hora
5 Oskava
6 Ruda u Rýmařova-sever
7 Zlaté Hory-východ

Exhausted deposits and other resources:

8 Příbram surroundings
9 Jáchymov surroundings
10 Havlíčkův Brod surroundings
11 Jihlava surroundings
12 Ratibořské hory + Stará Vožice
13 Rudolfov
14 Stříbro
15 Hrob + Mikulov
16 Nalžovské hory
17 Vejprty + Hora sv. Kateřiny

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	8	8	8	7	7
exploited	0	0	0	0	0
Total *reserves, t Ag	533	533	533	532	532
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	533	533	533	532	532
Mine production, t Ag	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

a) Deposits with registered Ag content

Approved prognostic resources P_1, P_2, P_3

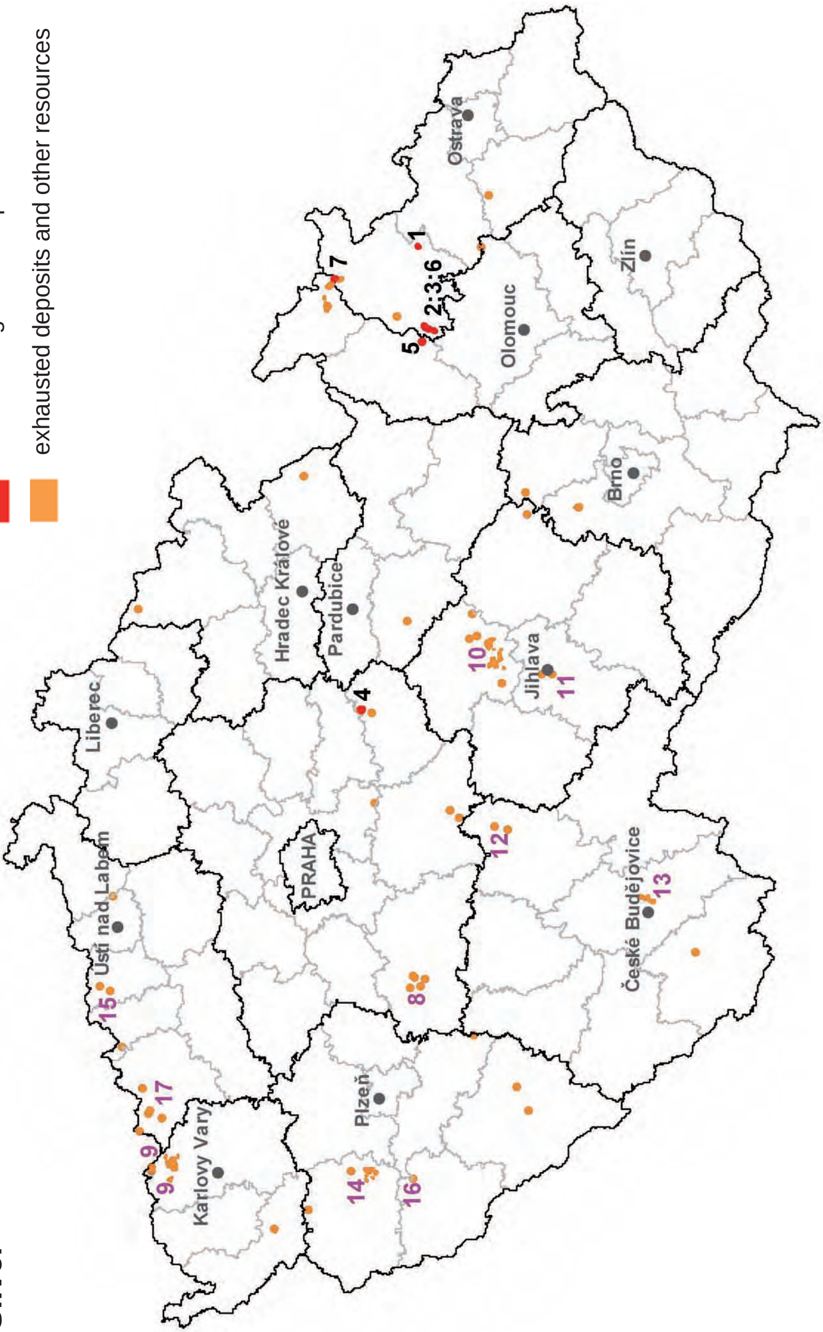
Ag metal in ores

Year		2004	2005	2006	2007	2008
P_1,	t	33.01	33.01	33.01	33.01	33.01
P_2,	t	3.77	3.77	3.77	3.77	3.77
P_3		–	–	–	–	–

Silver

reserved registered deposits

exhausted deposits and other resources



Refining and processing of precious metals

SAFINA, a.s.

SAFINA, a.s. is engaged in refining of precious metals [up to 3N (99.9 %) – 4N5 (99.995 %) purity], with production of intermediate products and products of precious metals, production of alloys of precious metals for jewellery and dentistry, production of chemicals containing precious metals, bulk buying and refining of waste containing precious metals and recycling of electric waste.

5. Foreign trade

261610 – Silver ores and concentrates

	2004	2005	2006	2007	2008
Import, kg	38	0	0	0	0
Export, kg	5	1	0	2	0

7106 – Silver, unwrought or in semi-manufactured or powder form

	2004	2005	2006	2007	2008
Import, kg	257 623	103 373	N	N	N
Export, kg	285 526	N	N	N	N

6. Prices of domestic market and foreign trade

Since data of the Czech Statistical Institute (ČSÚ) are not reliable, neither these data nor import and export prices have been reported since 2005. Foreign trade with silver ores and concentrates was negligible.

7. Mining companies in the Czech Republic as of December 31, 2008

No mining companies were extracting Ag ores on the territory of the Czech Republic in 2008.

8. World production

The world production exceeded 10 kt per year in 1976. Since then it was increasing and reached its peak in 1989 – 15.8 kt. Mining production was gradually decreasing and reached 13.8 kt (1994). Since 1996, the world production of silver has been increasing again and it oscillated between 18.5 and 20 kt in the last five years. The high mine production was one of the causes of low silver prices in 1998–2003. Mine production of silver increased the most in China and Peru during the last five years, although data on Chinese mine production are not easily accessible and differ considerably. Mine production of Mexico and Australia increased significantly, too. The increase in Mexico probably represents a long-term trend, whereas in the case of Australia it is only a short-term fluctuation. Mine production in Chile, Canada and Kazakhstan has not shown big variations. In contrast, mine production of the USA and Poland decreased. In 2008, mine production of Bolivia increased significantly, mine production of Peru continued to rise, whereas mine production in Chile decreased. Data on silver production according to Mineral Commodity Summaries (MCS), Silver Institute (SI) and the yearbook Estadísticas del Cobre y otros Minerales published by Comisión Chilena del Cobre (COCHILCO):

World silver mine production

Year	2004	2005	2006	2007	2008 e
Mine production, t Ag (MCS)	19 700	19 300	20 200	20 800	20 900
Mine production, t Ag (COCHILCO)	18 758	19 510	19 065	19 790	19 809
Mine production, t Ag (SI)	19 352	20 083	20 096	20 858	21 420

Main producers´ share in the world mine output (2008; according to COCHILCO):

Peru	18.6 %	Poland	6.1 %
Mexico	16.4 %	USA	6.1 %
China	10.1 %	Bolivia	5.4 %
Australia	9.7 %	Canada	3.7 %
Chile	7.1 %	Kazakhstan	3.4 %

According to the Silver Institute (SI), only 25-30 % of silver came from the mine production and processing of silver ores in 2008. Majority of silver was a by-product of dressing of lead-zinc (35 %), copper (25 %) and gold-bearing (15 %) ores. Extracted silver covered about 60 % of consumption, the remaining 40 % being offered from recycling and disinvestment. Jewellery represents an important consumer of silver.

Following companies belonged to ten most important silver world producers in 2008: BHP Billiton (Australia), KGHM Polska Miedź (Poland), Fresnillo (Mexico), Cia. Minera Volcan (Peru), Pan American Silver (Canada), Cia. de Minas Buenaventura (Peru), Polymetal (Russia), Hochschild Mining (Peru), Kazakhmys (Kazakhstan), Southern Copper Corporation (USA). Following localities ranked among 10 most productive world silver deposits in 2008: Cannington (Australia), Fresnillo (Mexico), Dukat (Russia), Uchucchacua (Peru), Arcata (Peru), Greens Creek (the USA), Imiter (Morocco), Alamo Dorado (Mexico), San José (Argentina), Pallancata (Peru).

9. World market prices

Only price of pure metal 99.9 % Ag is quoted on the world market. It is quoted in GBp or USc/troy oz. The highest price since 1880 (London Brokers' Official Yearly Average Prices) was recorded in 1980 – GBp 905.2 per troy oz (speculative buying into the USA by the Hunt family). World price of silver reached an important maximum exceeding 9 dollars in spring 1987. Silver prices than oscillated basically between USD 4 and 6 per troy oz. Local maximum from February 1998, when the price temporarily increased to USD 7.8 per troy oz, represented the only exception. Qualitative change did not arrive until during the year 2004, when the prices were between 5.5 and 8.5 USD/troy oz. The price almost reached the level of 9 USD/troy oz by the end of the year 2005. Price rise continued also in the first half of 2006, when the prices reached the limit of 15 USD/troy oz. The prices oscillated between 10 and 14 USD/troy oz in the second half of 2006 and between 12 and 14.5 USD/troy oz in the first half of 2007. The price started to increase systematically up to the level of 16 USD/troy oz since September 2007. During the first quarter of 2008, the price continued to rise up to the record values of 21 USD/troy oz (March 2008). High demand from the side of rapidly developing economies of the third world, significantly exceeding supply, caused the price rise. Price dropped down to the limit of 9 USD/t oz in the second half of 2008 in relation to the global financial crisis and economic recession. In the first quarter of 2009, when part of investors started to perceive precious metals as an alternative to other uncertain investments, prices increased again to 12-14 USD/t oz. Price fluctuations of silver on the world market reflect among others political situation and speculations, similarly to the other precious metals. An average annual price trend in USD/troy oz is given in a summary as follows:

Handy & Harman silver price, yearly average

Commodity/Year		2004	2005	2006	2007	2008
Silver, Handy & Harman	USD/t oz	6.66	7.31	11.55	13.38	15.85

10. Recycling

Recycling of silver, which is technologically a very simple operation, dramatically dropped in the early nineties to about one half of Ag recycled during the same period of the eighties. The drop in recycling was attributed to low prices of silver, its lower content in secondary raw materials and restrictive measures in government stockpile policy and changes in the photographic industry (switch to digital cameras etc.). Share of the recycled silver in the offer of the world market was estimated at 20 % in 2004.

11. Possible substitutes

Silver is efficiently replaced in numerous fields. Photo materials are produced with lower content of silver or without silver at all. Photograph continues to be largely replaced by xerography and electronic displays. Digital photograph has marked a violent rise especially during recent years. Aluminium and rhodium substitute for silver in the manufacture of special mirrors and other reflecting surface coatings, tantalum and special steels are now used in surgical tools and artificial joints. Silver is being also replaced in batteries and ceramic materials replace dental alloys. Sterling silver was, except memorial mints and several exceptions (e.g. Mexico put again in circulation silver coins in 1992), replaced by common metals, particularly by Cu alloys.

Tin

1. Characteristics and use

Tin minerals are concentrated at the end of the magma differentiation and its deposits are related to granitic rocks and their vein and effusive equivalents. Tin mineralization is known also from skarns, developed close to contacts with granitoids. Tin minerals occur often in tin-tungsten, tin-silver and tin-base metal deposits. Cassiterite SnO_2, containing as much as 78 % Sn, represents the major economic mineral of tin. Stannite is a less common component of the tin-bearing ores. Cassiterite is resistant to weathering and forms placer deposits. Hydrothermal (vein) tin is mined rather exceptionally. More than 50 % of placer deposits occur in SE Asia. River (alluvial) placers, where heavy minerals were naturally sorted by water flowing over the riverbed, are the most important and the richest ones among the secondary deposits. World economic reserves of tin in ores are estimated at 11 mill tonnes of metal according to MCS 2008.

The majority of tin is used in solders (35 %), tin plates (25 %) and production of chemicals (20–25 %). From old times tin has been used in alloy (bronze) etc. production. A recent tendency of unleaded solder production has lead to tin consumption increase.

2. Mineral resources of the Czech Republic

Tin deposits of the Czech Republic are almost exclusively concentrated in the Krušné hory Mts., Slavkovský les and their piedmont, where they were mined since the beginning of the medieval times.

- The most important type of tin mineralization is represented by greisen deposits of Sn-W-(Li). These deposits occur in both the eastern part (Cínovec, Krupka) and the western part (Rolava, Přebuz) of the Krušné hory Mts. as well as in the Slavkovský les area (Krásno-Horní Slavkov). The origin of these deposits is connected with greisenization and silicification of the Late Variscan domes of granites high in lithium and topaz. The major Sn mineral is cassiterite, which is disseminated in the greisen bodies and usually accompanied by wolframite and zinnwaldite. The Krupka and Cínovec ore districts are also rich in hydrothermal quartz veins with cassiterite, wolframite, prospectively Bi and Mo minerals. Sn-W ores with 0.2–0.5 % Sn were mined in greisen and vein-type deposits.
- An interesting type of Sn mineralization occurs at Zlatý Kopec near Boží Dar, where tin minerals are constituents of a complex skarn, consisting of major magnetite accompanied by minor cassiterite (with hulsite, schoenfliesite), sphalerite and chalcopyrite. Presumably polygenetic complex ore contains 0.95 % Sn.
- Basically, the only deposit of primary Sn ores outside the Krušné hory Mts. region is a stratabound mineralization of cassiterite and sulphides at Nové Město pod Smrkem. An exploration project was carried out after World War II, which proved an average content of 0.23 % Sn in the ore.
- Sn mineralization consisting of stannite was found in deeper levels at the Staročeské pásmo zone of the historical Kutná Hora mining district. Due to the complex character of the ore and mainly its uneconomic accumulation, the Sn mineralization (occurrence) is of scientific importance only, particularly from the viewpoint of metallogeny and specific mineral assemblage.

The tin mining focused first at secondary (placer) deposits and gradually passed to the primary ones. Placer deposits near the primary ores of the Krušné hory Mts. region and their piedmont are in principle exhausted. Only small primary and secondary accumulations of cassiterite and wolframite in the Slavkovský les area and its piedmont have been preserved. Majority of the reserves of the primary deposits has been mined out, too, the remaining ones do not have any economic significance at present. Sn ores mining in the Czech Republic was terminated in 1991 by closing down the Krásno deposit. Mining at Cínovec deposit was terminated one year earlier. Larger resources of low-grade ores remained just at Krásno and Cínovec deposits. These could represent even a possible source of trace and rare elements (e.g. Li, Rb, Cs, Nb, Ta, Sc etc.) in future.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

1 Cínovec-jih   2 Krásno   3 Krásno-Horní Slavkov

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	3	3	3	3	3
exploited	0	0	0	0	0
Total *reserves, t Sn	163 809	163 809	163 809	163 809	163 809
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	163 809	163 809	163 809	163 809	163 809
Mine production, t Sn	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

[a)] Sn-W ore deposits

Approved prognostic resources P_1, P_2, P_3

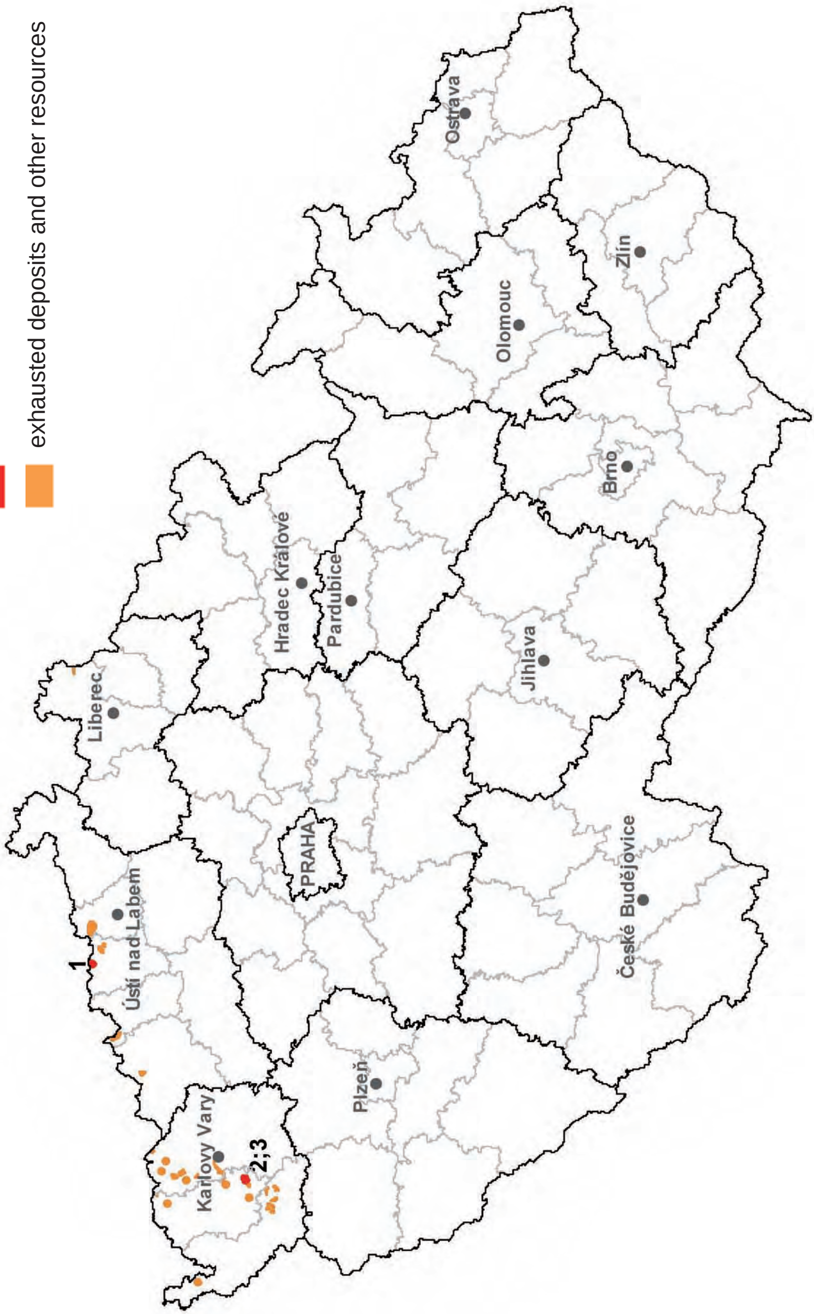
Sn-W ores

Year		2004	2005	2006	2007	2008
P_1,	kt	2 195	2 195	2 195	2 195	2 195
P_2		–	–	–	–	–
P_3		–	–	–	–	–

Tin

reserved registered deposits

exhausted deposits and other resources



Production of tin intermediate products and tin-bearing alloys

Kovohutě Příbram nástupnická, a. s.

COMAX, spol. s r. o.

Kovohutě Příbram nástupnická a.s. produces tin products and intermediate products, e.g. tin foil, tin plates, pressed tin stripes and pressed tin tubes apart from a number of other products. It produces in addition a big assortment of printing metal of tin, lead and antimony alloy. COMAX, s.r.o. produces among others tin bronzes.

5. Foreign trade

2609 – Tin ores and concentrates

	2004	2005	2006	2007	2008
Import, t	0	1	1	2	1
Export, t	0	0	0	0	0

8001– Unwrought tin

	2004	2005	2006	2007	2008
Import, t	550	634	665	1 070	855
Export, t	191	242	74	256	86

Detailed data on unwrought tin imports (t)

Country	2004	2005	2006	2007	2008
Poland	0	0	7	46	265
Germany	155	137	159	171	186
China	246	235	159	249	138
Peru	0	0	0	60	110
Indonesia	37	145	140	10	87
France	12	11	3	44	34
Bolivia	0	0	99	25	5
Austria	3	10	0	1	0
Thailand	80	20	40	0	0
Malaysia	0	20	20	0	0
Others	17	56	38	464	30

8002 – Tin waste and scrap

	2004	2005	2006	2007	2008
Import, t	63	69	75	13	44
Export, t	105	70	249	988	87

Detailed data on waste and scrap imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	63	69	73	12	43
other	0	0	2	1	1

Detailed data on waste and scrap exports (t)

Country	2004	2005	2006	2007	2008
Belgium	47	36	230	125	45
Germany	19	25	18	850	32
the Netherlands	24	0	0	0	0
Austria	5	7	2	2	2
others	10	2	0	10	1

Unwrought tin import has been rather stable, amounting at roughly 550–650 t per year, until 2007 when it started to increase significantly. Unwrought tin has been imported traditionally from China, Germany and Indonesia, in the recent years also from Bolivia and Peru. An important part of the imported tin was re-exported to third countries in some years. Volume of tin waste and scrap was relatively balanced, however, in 2006 export was three times as high as import and it predominated completely in 2007. Tin waste and scrap has been imported to the Czech Republic almost exclusively from Slovakia, export is directed to western Europe. Foreign trade with the item tin ores and concentrates is negligible.

6. Prices of domestic market and foreign trade

8001– Unwrought tin

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	194 066	185 732	200 185	292 984	334 765
Average export prices (CZK/t)	193 066	189 772	229 421	265 399	301 801

8002 – Tin waste and scrap

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	115 387	73 018	115 963	104 517	112 233
Average export prices (CZK/t)	141 174	116 025	56 871	12 587	126 181

7. Mining companies in the Czech Republic as of December 31, 2008

No mining companies extracted Sn ores on the territory of the Czech Republic in 2008.

8. World production

For a long time the world production of tin concentrates was about 200 kt of Sn metal per year. This level has been significantly overstepped each year since 2000. According to statistical data, the production reached its peak in 2005 – roughly 290 kt. In contrast to decreasing mine production of Brazil, Indonesia and Portugal, production in China, Indonesia and Bolivia has been increasing, whereas that of Brazil and Peru has been stagnating. Yearbook MCS nevertheless substantially corrected its data on the Chinese and Peruvian mine production in 2003. Data according to Mineral Commodity Summaries (MCS) and from Welt Bergbau Daten (WBD):

World lead mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt Sn (MCS)	264	290	302	320	333
Mine production, kt Sn (WMS)	270	289	289	300	N

Main producers' share in the world mine output (2007; according to MCS):

China	42.2 %	Brazil	3.1 %
Indonesia	31.9 %	Vietnam	1.1 %
Peru	12.2 %	Congo (Zair)	1.1 %
Bolivia	5.0 %	Malaysia	0.8 %

In the past, tin concentrate production and its export quotas were to a large extent affected by ATPC, the members of which were Indonesia, Bolivia, Malaysia, Australia, Thailand, Nigeria, Zaire, China and Brazil. ATPC originated one year after the tin world market crisis in autumn 1985. China intervenes in the price evolution significantly recently, influencing the amount of the commodity on world market by means of export licences.

Following companies belonged among 10 most important tin producers in 2008 (according to ITRI – International Tin Research Institute): Yunnan Tin (China), PT Timah (Indonesia), Minsur (Peru), Malaysia Smelting Corp. (Malaysia), Thaisarco (Thailand), Yunnan Chengfeng (China), Liuzhou China Tin (China), Metallo Chimique (Belgium), EM Vinto (Bolivia), PT Koba Tin (Indonesia). There are 7 Asian companies in the top ten world tin producers.

World metal production

Year	2004	2005	2006	2007	2008
Smelting production, kt Sn (according to WMS; EIU)	308	335	352	337	360

9. World market prices

Treatment charges (T/C) for three grades of tin concentrates were quoted on the world market in the past: 40–60 % Sn , 60–70 % Sn and 70–75 % Sn in USD/t CIF Europe. Subject to certain adjustments tin mines receive the price for pure tin metal *less* these treatment charges. Pure metal grading 99.85 % Sn (A Grade) Cash has been quoted at London Metal Exchange (LME). The metal was formerly quoted in GBP/t, since 1989 it has been quoted in USD/t. Prices of all non-ferrous metals on the world marked significantly hardened during the year 2004. Tin prices oscillated between 6,200 and 10,200 USD/t, reaching roughly fifteen years´ maxima. The cause of this was again a high demand from the side of rapidly growing Asian economies. Whereas world tin prices decreased from the level of 8,500 USD/t to roughly 6,000 USD/t in 2005, further rise of demand caused a continual price increase as high as the level of 12,000 USD/t. World tin consumption increased to 189 kt only in the first half of the year 2006, which was by 30 kt more than in the preceding year (China has seen a year-by-year consumption increase by 34 %). Price oscillated even between 13,000 and 15,000 USD/t in the first half of the year 2007. The world price increased up to about 17,000 USD/t during the summer months. This record price level was reached also in the end of 2007. The tin prices steeply increased up to 25,000 USD/t in the first half of the year 2008. This was caused by a significant demand increase from the Asian region, the same way as in the case of other non-metallic ores. The second half of the year 2008 has seen steep drop in prices, first down to about 15,000 USD/t in October and November, then down to the limit of 11,000 USD/t already under the influence of the global economic recession. Tin prices oscillated between 10 and 14,000 USD/t also in the first half of 2009. The world consumption was 30.5 kt in 2007. The consumption in China increased by 19.5 % whereas the consumption in the USA decrease by full 36 %. Kuala Lumpur Tin Market represents the fundamental platform for the tin marketing and quotations.

Average annual price of metal:

Commodity/Year		2004	2005	2006	2007	2008
99.85 % Sn (LME, A Grade), Cash	USD/t	8 495	7 370	7 982	13 535	7 308

10. Recycling

The last decades have seen a significant increase in the amount of recycled tin. The secondary production of the metal gained by recycling reached about 48,000 tonnes in 2006. Rate of recycling of tinplate scrap oscillates in developed countries between 50 and 75 %; the share of recycled metal in total consumption of the commodity is however considerably lower.

11. Possible substitutes

Aluminium, glass, stainless steel, paper and plastic foils are the major substitutes for tin in the food industry. Multicomponent epoxy resins are more and more used instead of solders. Tin alloys are replaced by Cu and Al alloys or by plastics. Pb and Na compounds replace some Sn chemicals.

1. Characteristics and use

Higher concentrations of tungsten are nearly always associated to granites. Primary tungsten ores are confined the most often to pegmatite and greisen deposits genetically associated with wolframite in acid granitoid intrusions and with scheelite in skarn deposits. Tungsten ores often occur together with Sn, Mo, Cu, Au and Bi ores. Among the known tungsten minerals, only wolframite (having as much as 76.5 % WO_3) and scheelite (up to 80.5 % WO_3) are of economic importance. Wolframite contains besides Fe and Mn also some minor or trace concentrations of Nb and Ta. Tungsten placers occur in close vicinity of primary ores. World reserves of tungsten ores are estimated at more than 6 mill tonnes of metal (according to MCS 2008), more than 66 % of which occur in China.

Tungsten ores and concentrates are processed to obtain intermediate products – ammonium paratungstate (APT), tungstic acid, sodium tungstate, metal powder and powder tungsten carbide. Much tungsten is consumed in steel alloying used in heavy engineering, particularly in the armaments industry, and in the manufacture of metal-cutting tools and tools for oil and gas drilling and for mining of solid minerals (drilling bits made of tungsten carbide). About 80 % W is consumed in the aforementioned fields. Some tungsten-based alloys are used in electricity and electronics.

2. Mineral resources of the Czech Republic

Wolframite concentrate was obtained as a by-product during the mining and processing of vein and greisen Sn-W ores of the Cínovec (where also an important Li mineralization – zinwaldite – occurred) and Krásno mining districts of the Czech Republic. Besides that, numerous occurrences of scheelite and wolframite mineralization were found and verified in various places of the Bohemian Massif, particularly during the last few years. Tungsten ores mining was terminated along with the Sn ores in 1990 at Cínovec deposit and a year later at deposit Krásno. Some small occurrences in the Moldanubicum were mined out during the exploration in the end of 1980s and beginning of 1990s (Malý Bor-Vrbík, Nekvasovy-Chlumy).

- Quartz veins and greisens mainly rich in Sn (Krásno, Cínovec), less frequently rich in W (Krupka 4) occur in the Krušné hory Mts. region. Greisen ores have usually contents ranging between 0.02 and 0.07 % W. Only ores of the former deposit Krupka 4 showed up to 0.1–0.2 % W. A tungsten mineralization is known from quartz veins and stockworks at Rotava and disseminated scheelite in calc-silicate rocks (so-called erlans = Ca-pyroxenic gneisses) of Vykmanov near Perštejn.
- A typical contact metasomatic scheelite mineralization occurs in the exocontact of the Krkonoše Mts.–Jizerské hory and Žulová plutons. However, known localities of Obří důl and Vápenná are of no economic importance.
- A number of mainly small new localities of the W-ores was found in the Moldanubicum. They are represented by both quartz veins with wolframite eventually scheelite which mostly occur along the exocontacts of the Variscan granitoids and disseminated or vein scheelite in calc-silicate rocks (erlans – Ca-pyroxenic gneisses). Some bodies represent bigger stratabound deposits of scheelite-bearing crystalline schist or skarn type. So far the most important stratabound deposit of Au-W ores is located at Kašperské Hory. Dis-

seminated and banded scheelite occurs there in silicified layers underlying gold-bearing quartz veins. The average W content of the ore is as high as 1.32 %. Even though all reserves are subeconomic due to conflicts of interests with nature protection, the Kašperské Hory deposit nowadays represents the only economically exploitable deposit of W ores in the Czech Republic. As a complex Au-W deposit it is large and important even from European viewpoint.

- Introduction of more sophisticated exploration methods allowed discovering numerous localities of W ores in the Czech Republic, mostly of enigmatic origin. In contrast to former ideas about the common occurrence of Sn-W ores, it was proved that wolframite or scheelite ores occur mostly as separate mineralizations, and only a minor part belongs to combined Sn-W assemblages.

After the Sn-W ores mining was terminated in 1991, the remaining reserves have been revaluated and gradually eliminated from The Register. This concerned also 8 small deposits in the Moldanubicum, which were revaluated and eliminated from The Register in 2006.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

1 Cínovec-jih
2 Kašperské Hory
3 Krásno-Horní Slavkov
4 Krásno-Horní Slavkov

4. Basic statistical data of the Czech Republic as of December 31

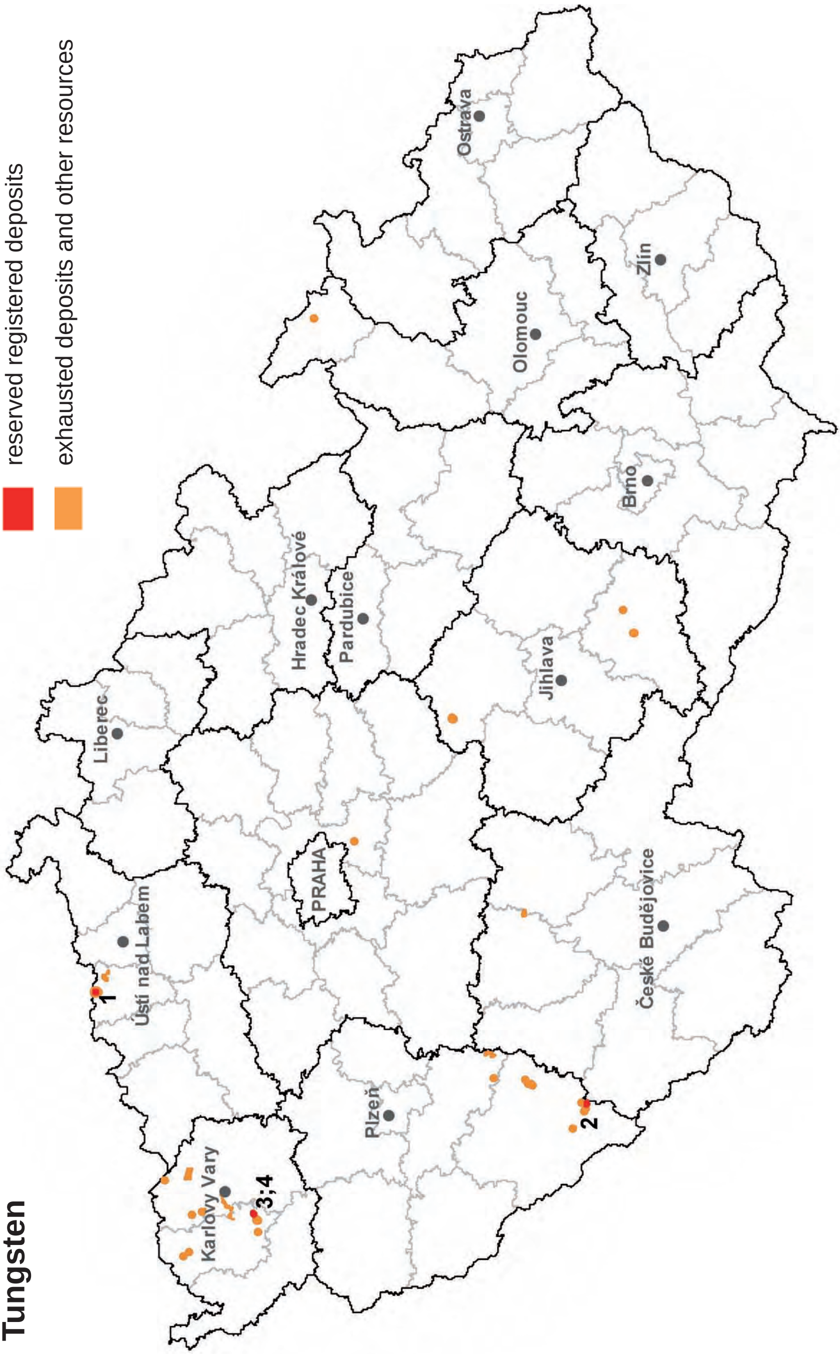
Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	12	12	4	4	4
exploited	0	0	0	0	0
Total *reserves, t W	72 740	72 740	70 253	70 253	70 253
economic explored reserves	0	0	0	0	0
economic prospected reserves	1 752	1 752	0	0	0
potentially economic reserves	70 988	70 988	70 253	70 253	70 253
Mine production, t W	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

[a)] Sn-W and W ore deposits

Tungsten



reserved registered deposits
exhausted deposits and other resources
Liberec
Ústí nad Labem
Hradec Králové
Pardubice
PRAHA
Ostrava
Olomouc
Zlín
Brno
Jihlava
České Budějovice
Plzeň
Karlovy Vary
1
2
3;4

Approved prognostic resources P_1, P_2, P_3

W metal in ores

Year	2004	2005	2006	2007	2008
P_1, t	3 252	3 252	3 252	3 252	3 252
P_2, t	10 703	10 703	10 703	10 703	10 703
P_3	–	–	–	–	–

Production of tungsten intermediate products

OSRAM Bruntál spol. s r.o.

OSRAM Bruntál s.r.o. produces tungsten powder and powder tungsten carbide, which is used as an intermediate product in the production of instruments of sintered carbides. The company was founded by the transformation of the former Hydrometalurgické závody a.s. (HMZ). New owner of the HMZ Company since October 2000 is the German company OSRAM GmbH, which is a subsidiary of the German concern Siemens A.G. The enterprise in Bruntál became this way the European basis for tungsten and tungsten-carbide powders, fine wires and coils.

5. Foreign trade

2611 – Tungsten ores and concentrates

	2004	2005	2006	2007	2008
Import, t	0	2	0	0	0
Export, t	0	0	0	1	0

8101– Tungsten and its products, including waste and scrap

	2004	2005	2006	2007	2008
Import, t	116	175	199	840	206
Export, t	131	179	157	104	89

720280 – Ferro-tungsten and ferrosilicotungsten

	2004	2005	2006	2007	2008
Import, t	56	44	34	35	20
Export, t	8	136	0	2	4

Detailed data on ferro-tungsten and ferrosilicotungsten imports (kt)

Country	2004	2005	2006	2007	2008
China	50	30	28	17	18
Germany	3	4	2	0	1
Slovakia	0	6	0	1	1
Poland	0	3	1	13	0
others	3	1	2	4	0

6. Prices of domestic market and foreign trade

Tungsten ore and concentrates import from the Netherlands or Germany is negligible. Crude tungsten (including waste and scrap), the import of which increased three times between 2002 and 2006, represents the largest volume. The year 2007 has seen another steep import increase, however this was just a temporary fluctuation and import volume returned back to about 200 tonnes in 2008. Tungsten wires, to a lesser extent tungsten powder, make predominant part of the import. Crude tungsten and its intermediate products are imported mainly from Germany, the USA, Spain and China, export goes back to Germany or to Great Britain and Poland. 20–60 tonnes per year of ferro-tungsten and ferro-silico tungsten is imported on a long term. Ferro-alloys are imported mainly from China and Slovakia, recently also from Germany and Poland. Unusual export was directed to the Netherlands in 2005.

810196 – Tungsten wires

	2004	2005	2006	2007	2008
Average import prices (CZK/kg)	2 557	2 824	1 838	284	1 318
Average export prices (CZK/kg)	10 458	5 053	5 455	5 900	4 972

720280 – Ferro-tungsten and ferrosilicotungsten

	2004	2005	2006	2007	2008
Average import prices (CZK/kg)	212	441	564	580	465

Customs tariff item 8101 tungsten and its products, including waste and scrap, covers such variety of goods, that it makes no sense to give import prices of the item as a whole. Only prices of sub-item 810196 tungsten wires are therefore presented. Big difference between import and export prices is given among others by substantially lower volume of export of this sub-item compared to its import. Markedly lower import prices in 2007 are caused by a large amount of the delivered commodity of a lower quality. Average import prices of ferro-tungsten and ferrosilicotungsten document increase of tungsten world prices of the last years.

7. Mining companies in the Czech Republic as of December 31, 2008

No mining companies were extracting W ores on territory of the Czech Republic in 2008.

8. World production

World production of tungsten metal in ores and concentrates exceeded 40 kt in 1970 and reached its peak – 52 kt at the end of 1980s. The subsequent drop in prices was related to restriction of demand on the world market resulting from the economic recession and from structural changes in major consumer branches. The world production has been again slowly increasing since 2000. China is the dominant world producer, and also has the greatest potential for increasing its mine output. The data on the world mining production in individual yearbooks as a rule differ from each other: According to Mineral Commodity Summaries (MCS), the world production was higher and it has increased significantly in the last years. However, in its 2009 issue the MCS has significantly revaluated past estimates downwards, by which data of both renowned yearbooks became closer again.

World tungsten metal mine production

Year	2004	2005	2006	2007	2008 e
Mine production, t W (MCS)	73 700	70 100	90 800	54 500	54 600
Mine production, t W (WBD)	67 325	60 620	57 650	55 687	N

Main producers' share in the world mine output (2007; according to MCS):

China	75.2 %	Bolivia	2.0 %
Russia	5.9 %	Portugal	1.6 %
Canada	5.0 %	Korea. D.P.R. of	1.1 %
Austria	2.2 %		

9. World market prices

Among all W raw materials traded on the world market (ores, concentrates, oxides, hydroxides, tungstates, FeW, tungsten carbide and raw metal), the ores and concentrates represented traditionally the major share of the trade. The price of wolframite – standard, grading min. 65 % WO_3 – on the world market has been quoted in USD/mtu WO_3, CIF Europe. Final price of 1 t of the ore is a multiple of the unit price in mtu and the metal content in the relevant ore. Quotation of scheelite was abandoned in 1992 due to small extent of trade. Quoted price now includes both types of ore. The local maximum of the average wolframite price peak was reached in 1977 – USD 180 per mtu WO_3. The subsequent drop in price was caused by global economic recession and particularly by a surplus of cheap Chinese wolframite, import of which was restricted in some countries, which imposed high antidumping import taxes. Wolframite prices increased again from 42–50 USD/mtu up to 62–64 USD/mtu in the beginning and end of the year 2004, respectively. Prices continued to rise up to the limit of 100 USD/t in 2005 and very high prices were reached in 2006, too. Prices remained high in 2007 as well, when they oscillated around USD 160/mtu. High prices of tungsten ore pertained for whole year 2008 and decreased moderately to 150 USD/mtu in the first half of 2009.

As other W raw materials concerns, an intermediate product ammonium paratungstate (APT) powder – quoted on the European free market in USD/mtu W – has been achieving more and more significant position. The year 2005 has seen dramatic price rise. High ATP prices between 240–260 USD/mtu pertained also for whole year 2008, and did not decrease until the first half of 2009. Especially in the last years, majority of trading has been based on ATP. The average annual prices of the ore and the average price of the APT at year-end were as follows:

Average annual prices of the tungsten ore and the average price of the APT at year-end

Commodity/year		2004	2005	2006	2007	2008
Ore, grading min. 65 % WO_3, CIF Europe	USD/mtu WO_3	55	123	166	165	165
Ammonium paratungstate (APT) powder, European free market	USD/mtu W	92	262	245	255	248

10. Recycling

Recycling of W (especially alloys containing tungsten) is carried out only in Japan, the USA and Western Europe. According to incomplete data, recycling roughly accounts for 30 % of the total metal production.

11. Possible substitutes

The metal remains irreplaceable in the steel-making industry as an alloying additive, in the manufacture of armament, cutting and drilling tools and electricity and electronics uses. Some attempts were made during the period of the tungsten price rise to replace W by molybdenum in armoured tank ammunitions or even by depleted uranium showing large surplus worldwide. Replacement of W by ceramic materials is reasonable in some fields and replacement of W by Mo in automobile industry is more than equivalent. Sintered tungsten carbide used in the manufacture of cutting and drilling tools can be partly replaced by carbides of other metals or by nitrides and oxides and/or new composite materials or synthetic diamond, particularly in less exposed fields and where the price of tungsten and tungsten carbide plays a decisive role.

Zinc

1. Characteristics and use

The major economic mineral of zinc is sphalerite, which is usually accompanied by galena, pyrite and chalcopyrite in base metal deposits. The ore is marked as zinc ore providing the Zn:Pb ratio is higher than 4. Sphalerite usually contains cadmium, whose concentrations vary from traces up to 2 %, then germanium, gallium, indium and thallium. Zinc ores occur mostly in base metal deposits of various origins, the same way as lead ores. World reserves of Zn are estimated at 1.9 billion tonnes. Explored and prospected reserves make about 480 mill tonnes of metal. About 21 % of this amount is located in Australia, 19 % in China and 18.8 % in the USA, Approximately 55 % of zinc consumption is used in zinc galvanizing, about 17 % in alloys. Roughly 13 % makes brass and bronze production and about 15 % is used for other purposes.

2. Mineral resources of the Czech Republic

Zinc ores almost exclusively occur as a part of polymetallic ores [Pb-Zn±Ag (±Cu)] of hydrothermal or volcanosedimentary origin.

- A large volume of zinc ores represented mostly by sphalerite was extracted from the vein-type base metal deposits of the Březové Hory, Bohutín and Vrančice ore districts in the vicinity of Příbram (until 1962). The grade of these ores ranges between 1.0 and 2.9 %. Other base metal deposits were explored and partly mined in the period after World War II: in the northern part of the Kutná Hora district (Rejské pásmo, Turkaňské pásmo and Staročeské pásmo zones), in the Havlíčkův Brod district (Stříbrné Hory, Dlouhá Ves, Bartoušov) and in western Bohemia (Stříbro, Kšice).
- The most important base metal deposits of volcanosedimentary origin occur in the Jeseníky Mountains. Disseminated sulphide ores grading 1.1–1.8 % Zn were mined in the deposits of Horní Město (1967–1970) and Horní Benešov (1963–1992). 6,561 kt of ore containing 39,210 t of lead and 90,711 t of zinc were mined from both deposits in 1963–1992. Mining of the Au-Zn ores at Zlaté Hory-východ deposit in the Zlaté Hory ore district was terminated in 1994. 771.6 kt of base metal ores containing 9,111 t Zn, 395 t Pb and 1,559 kg Au were mined at Zlaté Hory-východ and Zlaté Hory-západ deposits in 1988–1994.
- The potential deposit of Staré Ransko-Obrázek is probably of polygenetic origin. Sphalerite-barite ore, having up to 1.8 % Zn, was mined here until 1990. The Křižanovice deposit of Pb-Zn-Cu ores with barite belongs to deposits of unclear genesis, too. The ore contained about 4–6 % Zn. The deposit was discovered during an exploration project in the eighties.

The production of Zn ores in the Czech Republic was terminated at the beginning of 1994, in line with the policy of a gradual reduction of ore mining adopted by the Government. A mixed Pb-Zn concentrate was the final product of the base metal ores mining. The concentrate was exported because there was no smelter in the Czech Republic. Base metal reserves are in process of being gradually eliminated from The Register.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

Reserved registered deposits:

1 Horní Benešov
2 Horní Město
3 Horní Město-Šibenice
4 Křižanovice
5 Kutná Hora
6 Oskava
7 Ruda u Rýmařova-sever
8 Zlaté Hory-východ

Exhausted deposits and other resources:

9 Březové Hory + Příbram + Bohutín
10 Stříbro
11 Havlíčkův Brod (Dlouhá Ves + Bartoušov + Stříbrné Hory)
12 Staré Ransko

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	9	9	9	8	8
exploited	0	0	0	0	0
Total *reserves, kt Zn	477	477	477	472	472
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	477	477	477	472	472
Mine production, t Zn	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

[a)] Deposits with registered Zn content

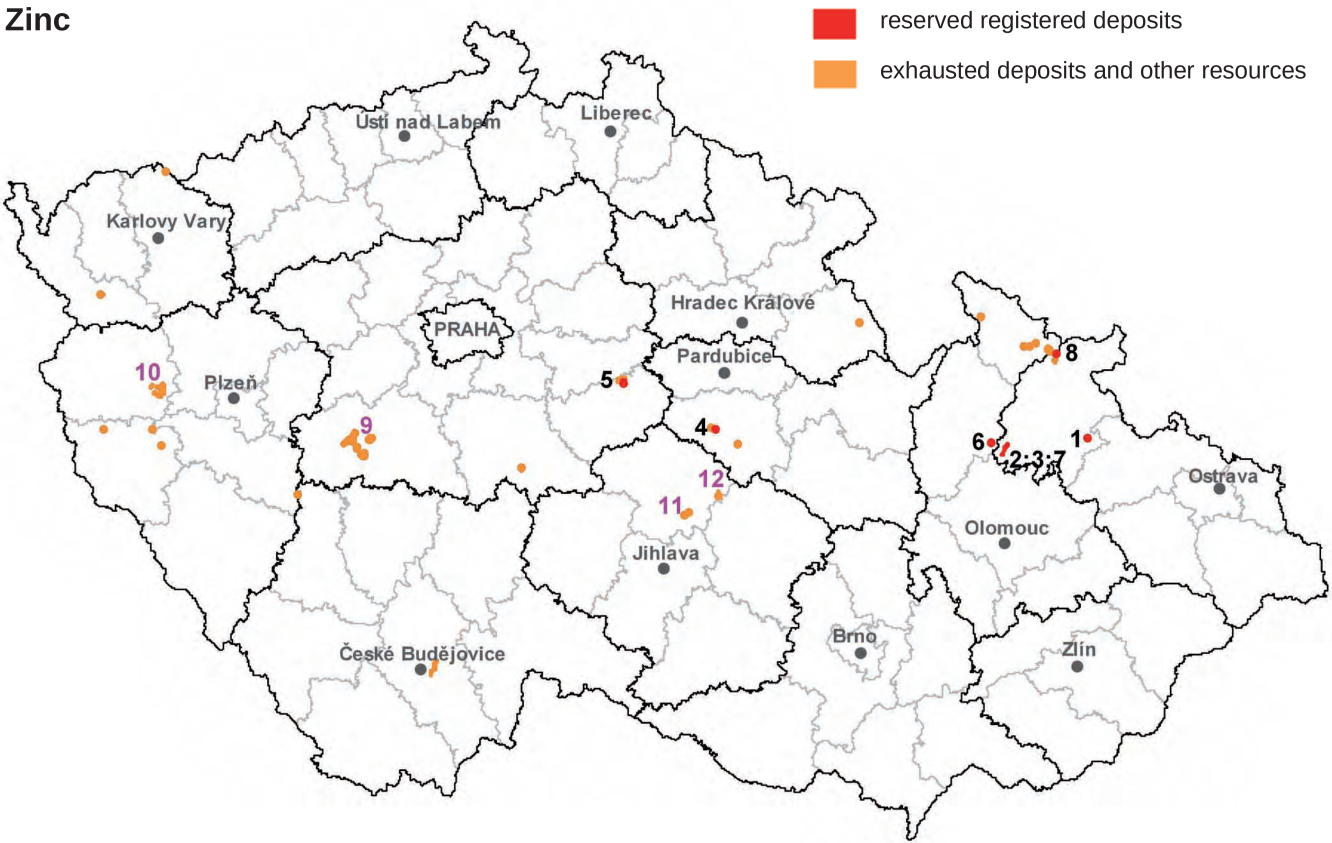
Production of zinc alloys and castings

COMAX, spol. s.r.o.

ALFE Brno, s.r.o.

Casting of both iron and non-ferrous metals, production of painted steel and aluminium stripes, plates and its forming represents the main activity of COMAX s.r.o. (formerly Kovohutě Velvary). Metallurgical part produces various alloys including Zn alloys. These are continually cast intermediate products – bronzes (tin, lead, aluminium, red), brasses (casting, modified), alloys (aluminium, zinc) and master alloys. ALFE Brno, s.r.o. ensures

Zinc



reserved registered deposits
exhausted deposits and other resources
Ústí nad Labem
Liberec
Karlovy Vary
Hradec Králové
PRAHA
Pardubice
Plzeň
10
9
5
4
8
6
1
2;3;7
12
11
Ostrava
Olomouc
Jihlava
Brno
Zlín
České Budějovice

production of precise castings of zinc and modern technology of centrifuge casting in rubber forms apart from classical casting production.

5. Foreign trade

2608 – Zinc ores and concentrates

	2004	2005	2006	2007	2008
Import, t	0	1	17	5	1
Export, t	21	0	0	0	0

7901– Unwrought zinc

	2004	2005	2006	2007	2008
Import, t	34 205	36 444	40 641	47 755	48 088
Export, t	5 659	8 110	6 382	18 764	17 257

Detailed data on unwrought zinc imports (t)

Country	2004	2005	2006	2007	2008
Slovakia	1 566	1 038	4 483	13 937	18 454
Germany	5 160	6 785	8 364	7 535	7 807
Poland	17 110	19 115	12 899	10 493	6 800
Belgium	2 925	3 383	4 589	4 741	4 190
Romania	1 773	1 003	1 187	1 333	2 493
the Netherlands	1 309	1 033	924	1 440	1 119
China	12	0	196	2 385	25
Kazakhstan	376	21	2 335	298	0
Russia	49	0	942	55	0
others	3 926	4 066	4 822	5 538	7 200

7902 – Zinc waste and scrap

	2004	2005	2006	2007	2008
Import, t	104	565	334	4 008	2 791
Export, t	2 517	2 739	3 041	2 934	2 919

Detailed data on zinc waste and scrap exports (t)

Country	2004	2005	2006	2007	2008
Germany	846	777	1 006	1 074	1 266
Austria	625	642	520	700	728
Poland	101	128	412	577	524
Italy	0	0	152	52	100
Belgium	286	487	537	421	96
India	261	379	183	21	0
others	398	326	231	89	205

Foreign trade with zinc is materialized through two main commodities – unwrought metal and zinc waste and scrap. Volume of unwrought zinc import has been increasing continuously in recent years and it oscillates around 40 kt in present. Substantial part of unwrought zinc has been traditionally imported from Poland and Germany. The share of Belgium and Slovakia has been increasing recently, on the contrary share of Poland has been decreasing. 15–40 % of zinc is re-exported into other countries. In contrast, zinc waste and scrap has been mostly exported from the Czech Republic in volume of about 2–3 kt per year. Export is directed mainly to Germany, Austria and Belgium, and also Poland became a more important market in 2006–2008. An unusually high amount of zinc waste and scrap has been imported from Slovakia since 2007.

6. Prices of domestic market and foreign trade

7901– Unwrought zinc

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	30 233	35 139	64 717	75 794	40 863
Average export prices (CZK/t)	27 754	31 777	71 185	73 792	39 161

7902 – Zinc waste and scrap

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	20 201	34 229	38 454	72 547	34 915
Average export prices (CZK/t)	16 795	20 004	43 394	47 537	23 793

The average import prices of unwrought zinc increased from about 27 ths CZK/t in 2002–2003 to more than twice as much in 2006 and to 2.5 times as much in 2007. They decreased to about a half in 2008. This illustrates well the zinc price trend on the world market.

By contrast, imported prices of zinc scrap decreased from 2002 (CZK 62,500/t) to CZK 38,500/t in 2006 and in the same time exported scrap prices tripled.

7. Mining companies in the Czech Republic as of December 31, 2008

No companies were extracting Zn ores in the Czech Republic in 2008.

8. World production

Production of zinc contained in ores exceeded 7 mill tonnes in 1985. Increase in production terminated in 1992 and in the next years mine production was decreasing. High increase in stock and increase of recycled metal proportion in the total production, covering increase of demand, were the cause of the above mentioned decline. The production has been increasing again since 1994. It was higher than 8 mill t in 1999; the 9 mill tonne limit was according to the international statistics exceeded in the 2002–2003 period. While the Canadian production has been decreasing, mine production of China and Peru has been increasing in the recent years. The most significant increase in mine production was monitored in China (1,000 kt in 1995; 1,476 kt in 1999; 1,700 kt in 2001; 2,200 kt in 2003; 2,550 kt in 2005; 3,000 kt in 2006; 2,950 kt in 2007). Mine production of Australia and the USA has been more or less stagnating during last years. Data come from Mineral Commodity Summaries (MCS), International Lead and Zinc Study Group (ILZSG) database and the yearbook Welt Bergbau Daten (WBD). According to WBD, India (4.8 %), Ireland (3.7 %) and Sweden (2.0 %) rank to the front producers in addition.

World zinc mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt Zn (MCS)	9 600	9 800	10 000	10 900	11 300
Mine production, kt Zn (ILZSG)	9 709	10 146	10 444	11 137	11 772
Mine production, kt Zn (WBD)	9 504	9 903	10 290	10 765	N

Main producers' share in the world mine output (2007; according to MCS):

China	26.6 %	Canada	5.7 %
Australia	13.9 %	Mexico	3.9 %
Peru	13.2 %	Kazakhstan	3.6 %
the USA	7.4 %		

World zinc metal production

Year	2004	2005	2006	2007	2008 e
Metal production, kt Zn (according to ILZSG)	10 392	10 224	10 655	11 360	11 666

9. World market prices

Zinc mines are paid the price for pure metal less treatment and refining charges (T/C) under complex formulae which allow for assumed losses during smelting and refining, for the content of by-products and for changes in metal prices from the basis set out in the contracts.

The price of pure metal grading 99.995 % Zn has been quoted at LME in USD/t since September 1988 (before in GBP/t). The pure metal prices were very low in the years 2001 and 2002 – about half compared to the year 1997. The world prices of the pure zinc started to increase again only in the second half of the year 2003. Prices of all non-ferrous metals on the world market significantly hardened during the year 2004. Zinc prices oscillated between 940 and 1,220 USD/t in 2004. The increase of prices was caused by an increasing demand from the side of rapidly developing (mainly Asian) economies. World prices of zinc continued to rise also in 2005, especially in its second half, when they continually increased from 1,150 to 1,900 USD/t. The growth trend continued during all the year 2006 and the price increased from the level of about 2,000 USD/t up to the record value of 4,500 USD/t towards the end of the year. The price rise was caused by durable high demand from the Asian economies in combination with low reserves at LME and insufficient smelting capacities (compared with mining capacities) throughout the world. Zinc represented one of a few commodities whose prices gradually decreased during 2007, which is documented also by a lower annual average value. Prices fluctuated between approximately 3,000 and 4,000 USD/t in the first third of 2007 but gradually decreased to the 2,500 USD/t level before the end of the year. The limit of 2,000 USD/t was reached in the first half of the year 2008. The relatively low price was caused by the doubling of the metal stock in LME warehouses as well as the increase of production due to the previous high prices of the commodity. Zinc price gradually decreased to the level of 1,000 USD/t in the second half of the year 2008. This was caused by the extensive global recession which happened since autumn 2008, which resulted in general decrease of demand and steep slump of both share and commodity prices. The prices increased slowly and continually to the limit of 1,600 USD/t during the first half of the year 2009.

Since 1992 basic treatment charges for two grades of zinc concentrate have been quoted on the world market – sulphide concentrate grade 49–55 % Zn and sulphide concentrate grade 56–61 % Zn in USD/t of dry substance, in transport parity CIF main European ports. However, zinc concentrate quotations do not have a much importance for the actual trade between mines and smelters. Treatment charges for sulphide concentrates (different in quality than above mentioned) and prices of pure metal reached their local maxima in 1989. Treatment charges for zinc concentrates decreased below the level of USD 150 per tonne in 2003. This decline continued in the years 2005–2006 to USD 60 per tonne and then growth trend followed and price exceeded USD 330 per tonne in 2008.

Zinc price at LME

Commodity/Year		2004	2005	2006	2007	2008
* Zn metal, 99.995 % Zn, LME	*USD/t	1 047	1 382	3 264	3 041	1 842

Note: * annual average

10. Recycling

Zinc scrap – metal scrap, galvanized plates, alloys, flue dust, oxides and chemicals containing zinc – is being reworked by both the pyrometallurgical and hydrometallurgical processes. An increase of share in recycled metal consumption has reached 35 % of the whole consumption in the world according to the UNCTAD data. According to other data, about 70% of metal produced comes from primary ores, whereas 30 % comes from recycling. According to the Zinc Association, the proportion of recovered zinc in the US consumption was about 40 % in 2000.

11. Possible substitutes

Aluminium, plastics and magnesium replace zinc in foundry work. Coatings of aluminium alloys, pigments, plastics and cadmium replace galvanic zinc plating. Zinc plates are completely replaced by other materials like stainless steel, aluminium, plastics etc. Aluminium alloys substitute for brass. Other materials in the manufacture of chemicals, electronic devices and pigments also efficiently replace zinc.

Industrial minerals

1. Characteristics and use

Barium, which is the major constituent of barite, occurs in igneous rocks. It is released during their weathering and transferred into sediments and residual rocks. Barite deposits, in general, can be divided in fissure veins, metasomatic, residual and volcanosedimentary (stratabound) deposits. According to the USGS, world barite reserves are given at 740 mill t (reserve base), about 200 mill t of which represent reserves. Almost half of reserves is located in China (48 %), further in India (11 %) and the USA (more than 7 %).

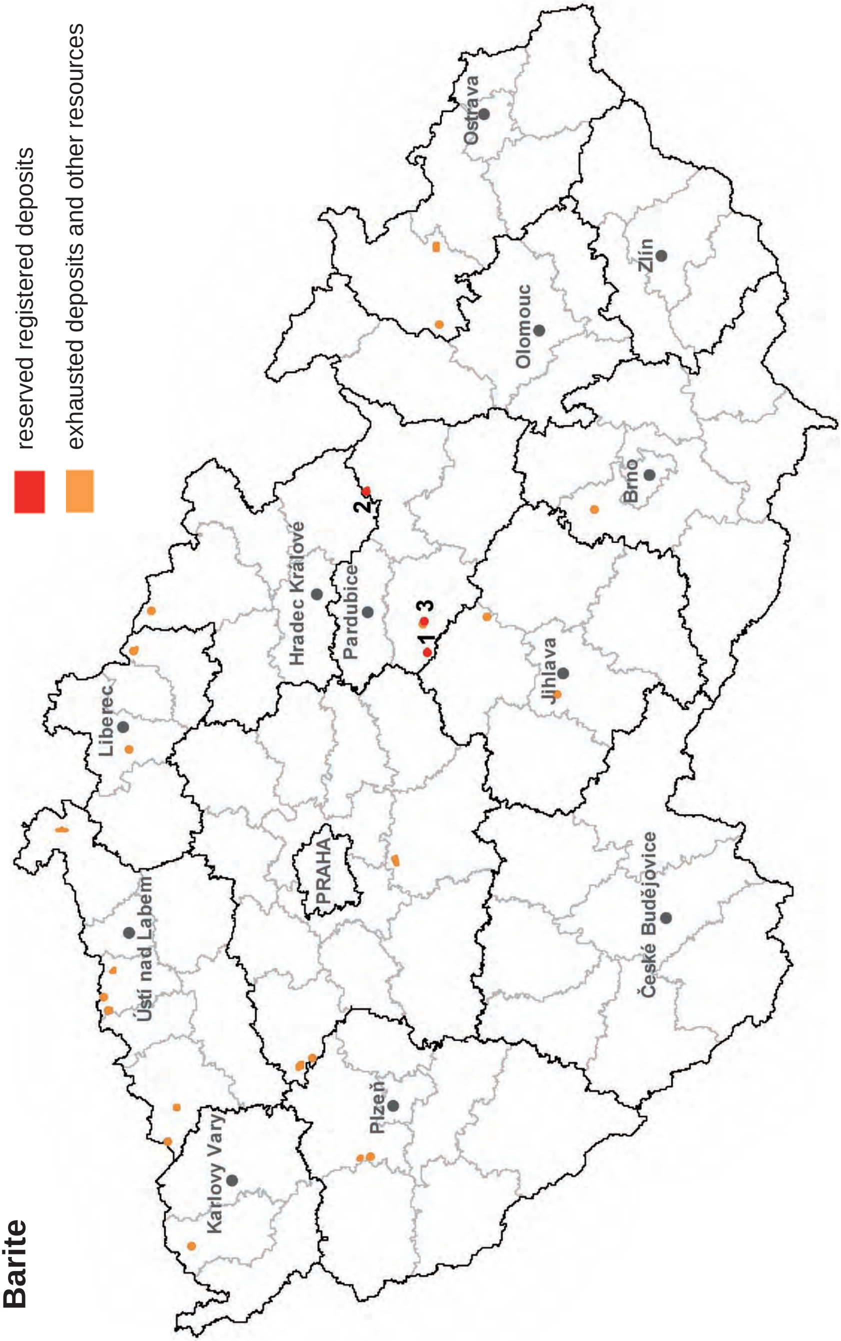
Barite is widely used because of its specific properties such as whiteness, high density, chemical resistance, absorption of X-rays and gamma radiation, etc. Barite is used in glass-making to produce special glass, in ceramic glazes, porcelain enamels, paints, plastics, fireworks (signal flares, detonators, etc.), for radiation shielding, in insecticides, etc. The major use of barite, however, is as high-weight mud for petroleum and natural gas exploration and production drilling.

2. Mineral resources of the Czech Republic

Barite deposits of the Czech Republic are of hydrothermal origin, mainly of the vein or stockwork type, to a lesser extent of the metasomatic or stratabound types. These deposits are randomly distributed over the Bohemian Massif, which is caused by a great number of barite-bearing formations of various age and origin. The most important deposits were located in the Krušné hory Mts. (e.g. Kovářská, Mackov), Železné hory Mts. (e.g. Běstvina), Krkonoše Mts. (e.g. Harrachov); smaller deposits and occurrences are known from the Jeseníky Mts. (e.g. Horní Benešov), from the Proterozoic of the western (e.g. Pernárec) and central Bohemia (e.g. Krhanice), Orlické hory Mts. (e.g. Bohousová), Čistá-Jesenice Massif (e.g. Otěvěky) etc.

- Hydrothermal veins, locally with base metals, are tens to hundreds metres, exceptionally even 1 km, long, and have thickness between a few decimetres to several meters. The vein filling consisting of barite is in the form of lenses or columns. These veins are mostly confined to regional faults or faults of lower order trending mostly NW-SE and NWN-SES. Younger polymetallic (base metal) and the latest quartz mineralization, which downgrades the vein fillers in deeper parts, are common, too (e.g. the Mackov and Bohousová deposits). Mined out deposit of Pernárec (1924–1960), further the deposits and occurrences Mackov, Bohousová etc., belong to the deposit type where barite is sole or predominating mineral. Fluorite is present in substantial amount along with barite at deposits Běstvina, Moldava, Kovářská, Harrachov etc. A barite mineralization is known from the Květnice deposit near Tišnov in the Moravicum, where barite was mined in 1905–1908 and during World War II.
- Stratabound barite deposits originated from submarine hydrothermal solutions ascending along the faults at sea floor. These deposit types are in the Bohemian Massif represented by layers and lenses in the Proterozoic sediments of the islet zone (Krhanice nad Sázavou), Železné hory Mts. (Křižanovice) and in the Devonian of the Jeseníky Mountains (Horní Město-Skály, Horní Benešov, where barite was mined as a by-product in 1902–1914 and 1955–1960).

Barite


reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Jihlava
Liberec
PRAHA
Ústí nad Labem
České Budějovice
Plzeň
Karlovy Vary
1
2
3

Barite was exploited in Czech Republic until 1990 from Běstvina deposit and, until 1991, from Harrachov deposit. Renewal of mining is not foreseen in the near future. The deposits lost their industrial importance; their remaining reserves are gradually revaluated and in majority of the cases written off from The Register. Also, as with fluorite, there is a sufficient amount of higher-quality and less expensive raw material, first of all from China.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

1 Běstvina 2 Bohousová 3 Křižanovice

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	3	3	3	3	3
exploited	0	0	0	0	0
Total *reserves, kt	569	569	569	569	569
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	569	569	569	569	569
Mine production, kt	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

a) Deposits with registered barite reserves

5. Foreign trade

251110 – Natural barium sulphate (barite)

	2004	2005	2006	2007	2008
Import, t	7 386	8 552	7 536	6 616	7 254
Export, t	405	512	277	284	237

251120 – Natural barium carbonate (witherite)

	2004	2005	2006	2007	2008
Import, t	1 399	0	0	0	134
Export, t	211	49	0	0	0

Volume of the imported barite has been ranging roughly between 6 and 10 kt on a long term, only a negligible amount has been re-exported. Import in the Czech Republic comes traditionally from Germany, Slovakia, Great Britain and China.

6. Prices of domestic market and foreign trade

251110 – Natural barium sulphate (barite)

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	6 403	6 392	5 649	5 832	5 532
Average export prices (CZK/t)	N	N	N	N	N

Import price of barite increased during the first half of the year 2007 and it reached roughly 290 USD/t. In the second half of the year, it oscillated between 297 and 312 USD/t. Average import prices ranged in a bigger interval of 300–400 USD/t during 2008.

7. Mining companies in the Czech Republic as of December 31, 2008

No mining companies were extracting barite on the territory of the Czech Republic in 2008.

8. World production

World production of barite was gradually increasing until 1990 (8,209 kt). It then dropped down, mainly because of global economic recession, which affected not only major barite consuming sectors (both crude oil and natural gas exploration), but also chemical industry. Then the barite production was increasing till 1997 (6,930 kt). Since 1999, the world production was increasing again until 2006. The increase of the world production is caused particularly by the increase of the Chinese mine production. Mine production in Morocco, Algeria, the USA and in India has been increasing in recent years, too. On the contrary, mine production decreased e.g. Brazil, Bulgaria, Canada, France and Mexico. In 2006, the limit of almost historically highest production of 1990 was reached, which documents well the world boom in the mineral sector in 2002–2008. Data on the world mine production according to Mineral Commodity Summaries (MCS) and Welt Bergbau Daten (WBD):

World barite mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt (MCS)	7 240	7 870	7 960	7 630	7 770
Mine production, kt (WBD)	7 715	7 865	8 827	7 851	N

Main producers´ share in the world mine output (2007; according to MCS):

China	57.7 %	Mexico	2.4 %
India	13.1 %	Turkey	2.0 %
Morocco	6.4 %	Vietnam	1.6 %
USA	6.0 %	Kazakhstan	1.2 %
Iran	3.1 %	Germany	1.2 %

9. World market prices

Barite prices were in the past under pressure of oversupply, particularly of cheap Chinese and Indian barite. Chinese barite acquired the leading position on the world market already in the seventies, being used not only in drilling mud but also in other sectors of various industries. As in the case of fluorite, world prices of barite of Asian provenance increased significantly in 2004. Prices of barite from China and India increased also in 2006, and markedly also during the year 2007. Prices were corrected by 10–20 % during the year 2008. Prices of various grade and origin are quoted monthly in the Industrial Minerals magazine in GBP/t or USD/t.

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
API, Chinese lump, CIF Gulf Coast	USD/t	63.50	59.00	72.50	115.00	102,50
API, Indian lump, CIF Gulf Coast	USD/t	70.00	70.00	83.50	143.00	118,00
API, Moroccan lump, CIF Gulf Coast	USD/t	63.50	68.00	68.00	N	N
Micro-ground white < 20 microns, paint grade, min. 99 %, UK	GBP/t	145.00	145.00	145.00	145.00	145,00

10. Recycling

Barite is actually continuously recycled when used in drilling mud. In other applications (chemicals, paints, enamels, glass, rubber etc.) it is not recycled because in its use is too dispersed to be economically recyclable.

11. Possible substitutes

Magnetite, hematite (incl. synthetic), ilmenite, celestite and other heavy minerals can be alternatively used instead of barite in drilling mud. Barite can be replaced by other fillers (e.g. by limestone, dolomite, soot) in production of rubber, in glassmaking partly by strontium salts, in lithopone by other whites (e.g. zinc white) etc. However, none of these substitutes are as good as barite.

Fluorspar

1. Characteristics and use

Fluorspar is the commercial term of the mineral fluorite. Most fluorspar deposits are veins of hydrothermal origin. Fluorspar deposits which originated by infiltration, metasomatism and sedimentation are much less abundant. Other minerals like quartz, barite, calcite, etc. usually accompany fluorspar. According to the USGS (MCS), world economic reserves of fluorspar are given at 480 mill t (reserve base), about 230 mill t of which represent reserves. The largest part of the reserves is located on the territory of China (23 %), South Africa (17 %) and Mexico (more than 8 %). Phosphate rock deposits containing about 3 % of fluorine on average could represent a potential fluorine source in future.

Three basic grades of fluorspar can be distinguished according to their quality and specification:
a) metallurgical grade (min. 85 % CaF_2, max. 15 % SiO_2);
b) acid grade (min. 97 % CaF_2, up to 1.5 % SiO_2, 0.1–0.3 % S);
c) ceramic grade (80–96 % of CaF_2, up to 3 % SiO_2).

More than half of the mined fluorspar is used in chemical industry for production of fluorine (F), hydrofluoric acid (HF), NaF and synthetic cryolite. Fluorine is contained in teflon and refrigerants (Freons). Metallurgical steel and aluminium industries also consume relatively large volumes of fluorspar (1/3 of the total fluorspar production) as flux to reduce melting temperatures. Other applications are for example in cement production, in glass industry (glass with 10 to 30 % CaF_2 is milky, opaque and opaline), in enamels, etc. Complex chemicals with fluorine and bromine are used in fire extinguishers and anaesthetics.

2. Mineral resources of the Czech Republic

All Czech fluorspar deposits are of hydrothermal origin, i.e. vein, stockwork and rarely even impregnation or metasomatic types. They are mostly located in marginal parts of the Bohemian Massif, associated with major fault zones of the Krušné hory Mts. (NE-SW) and the Labe-Lužice (NW-SE) lineaments direction. The most important deposits are located in the Krušné Hory Mts. (e.g. Moldava, Kovářská), less important ones in the Lužice area of the Bohemian Cretaceous Basin (Jílové u Děčína), Železné hory Mts. (Běstvina). Smaller deposits and occurrences are also in other parts of the Bohemian Massif (e.g. Krkonoše Mts. – Harrachov, Ještěd Mts. piedmont – Křižany et al.)

- Fluorite accumulations are most often associated with a considerable proportion of barite (for instance registered deposits Běstvina, Kovářská, and mined out deposits Krásná Lípa, Hradiště u Vernéřova, Harrachov, Křižany u Liberce et al.).
- Smaller part of fluorite accumulations contains almost no barite (e.g. registered deposit Jílové u Děčína and mined out deposits Blahuňov u Chomutova, Kožlí u Ledče et al.) or there are just subordinate barite contents (e.g. registered deposit Moldava, mined-out deposit Vrchoslav et al.).

Industrial mining of fluorite in the Czech Republic started in the beginning of the 1950s (apart from a small mine in Kožlí u Ledče nad Sázavou during both of the world wars) and continued until the first quarter of 1994, when extraction from Jílové, Běstvina and Moldava deposits was terminated. Resumption of mining is not foreseen, as there is sufficient amount of raw material of higher quality and lower price especially from China. Czech deposits are of no economic use at present.

3. Registered deposits and other resources in the Czech Republic

(see map)

Registered deposits and other resources are not mined

1 Běstvina
2 Jílové u Děčína
3 Kovářská
4 Moldava

4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number [a)]	4	4	4	4	4
exploited	0	0	0	0	0
Total *reserves, kt	2 033	2 033	2 033	2 033	2 033
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	2 033	2 033	2 033	2 033	2 033
Mine production, kt	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

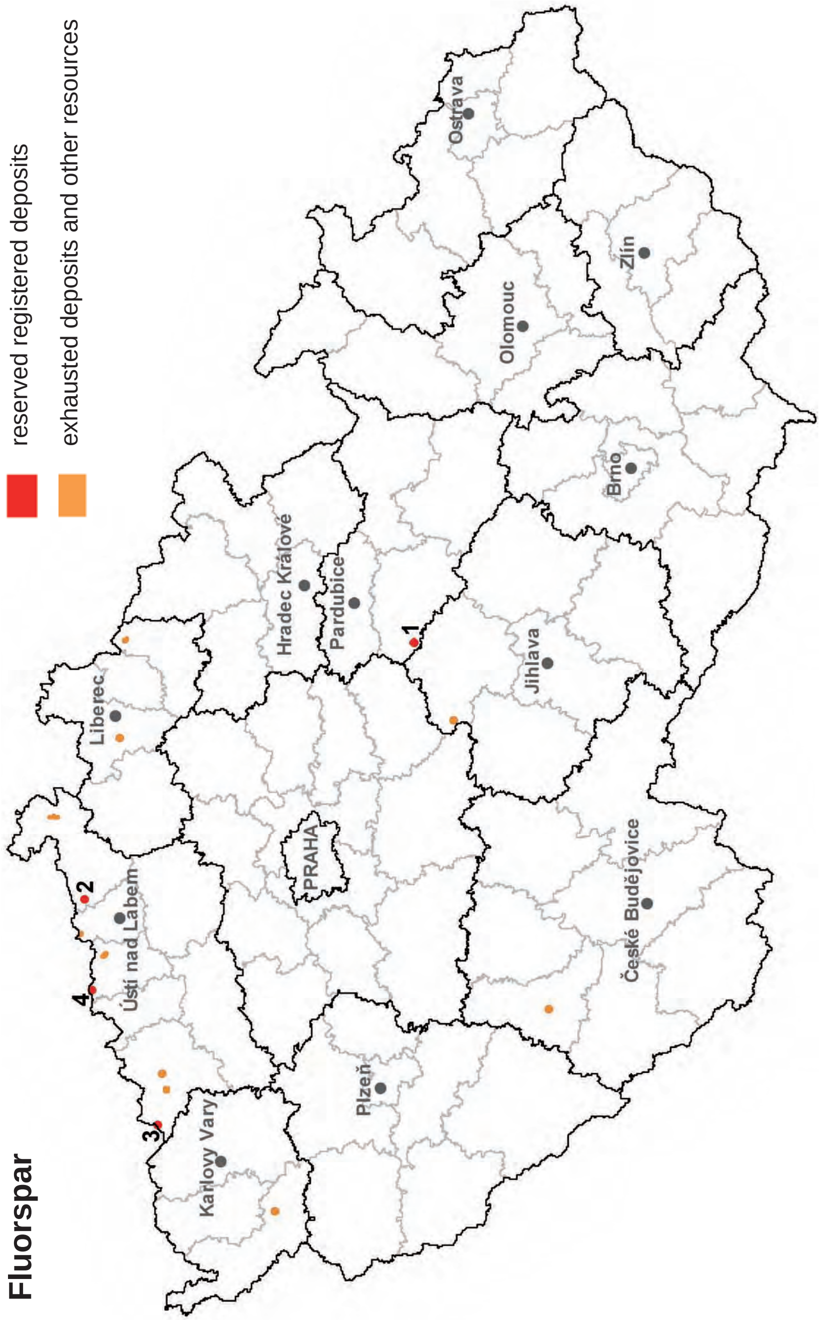
[a)] Deposits with registered fluorspar reserves

Fluorspar processing, production of fluorspar concentrate

FLUORIT Teplice s.r.o.

FLUORIT Teplice s.r.o. started its activity in 1954, when the flotation lines for fluorite concentrate production for chemical industry in Teplické rudné doly in Sobědruhy went into operation. Fluorit Teplice s.r.o. founded in 1992 became a successor in fluorite and fluorite concentrates production in Sobědruhy. After the domestic fluorite exploitation was terminated in 1994, the company re-oriented to processing of imported mineral. Drying, grinding and sorting of the flotation fluorite concentrate represents the basic process of the production. The company produces various concentrates and also metallurgical fluorite. Almost half of the production is exported, especially to Slovakia, Germany, Hungary and Bulgaria.

Fluorspar


reserved registered deposits
exhausted deposits and other resources
Ostrava
Zlín
Olomouc
Brno
Hradec Králové
Pardubice
Jihlava
Liberec
Ústí nad Labem
PRAHA
České Budějovice
Plzeň
Karlovy Vary
1
2
3
4

5. Foreign trade

252921 – Fluorspar, containing 97 wt % or less of calcium fluoride

	2004	2005	2006	2007	2008
Import, t	8 342	8 487	8 879	11 700	1 873
Export, t	3 620	1 641	1 578	3 936	1 944

Detailed data on metallurgical fluorspar (252921) imports (t)

Country	2004	2005	2006	2007	2008
Mexico	2 917	1 617	1 259	6 198	1 450
China	198	0	1 052	3 305	0
Germany	5 597	6 665	6 403	24	422
Slovakia	0	120	85	369	0
others	4	85	80	1 805	0

252922 – Fluorspar, containing more than 97 wt % of calcium fluoride

	2004	2005	2006	2007	2008
Import, t	19 516	15 891	15 759	11 532	1 567
Export, t	6 454	7 036	8 566	6 210	2 544

Detailed data on chemical fluorspar (252922) imports (t)

Country	2004	2005	2006	2007	2008
Mexico	1 002	0	0	6 257	1 547
China	17 253	2 014	5 553	3 479	0
South Africa	0	7 708	0	1 114	0
Germany	1 352	6 122	10 207	570	0
others	108	47	0	112	20

Metallurgical fluorspar (customs item 252921) has been imported in a rather stable volume of between 7 and 9 kt per year. Almost twice as much was imported in 2007. This raw material type was imported traditionally almost exclusively from Mexico; since 2004, however, its major part has been imported from Germany and since 2006 also from China. Chemical fluorspar (customs item 252922) represents a similar case – the original Chinese raw material has been newly imported via Germany. The import volume of the chemical fluorspar has been fluctuating more during the past five years, roughly between 10 and 20 kt per year during the past five years. The slump in the imported fluorspar volume in 2008 was not so deep as shown in customs statistics, probably due to a wrong interpretation of the data by the Czech Statistical Office. According to the information of the manufacturer, the import of both commodities was roughly 21 kt in 2008. Major part of the exported fluorspar is a product of the Fluorit Teplice, s.r.o. which deals with processing of imported mineral.

6. Prices of domestic market and foreign trade

252921 – Fluorspar, containing 97 wt % or less of calcium fluoride

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	4 014	4 192	4 173	4 347	4 584
Average export prices (CZK/t)	4 469	5 958	6 311	7 122	7 625

252922 – Fluorspar, containing more than 97 wt % of calcium fluoride

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	4 690	4 762	5 017	4 870	5 045
Average export prices (CZK/t)	7 416	7 343	7 398	8 030	8 595

7. Mining companies in the Czech Republic as of December 31, 2008

No mining companies were extracting fluorspar on the territory of the Czech Republic in 2008.

8. World production

The world production was increasing until 1989 when 5,925 kt of fluorspar were extracted. Since then, there was a sharp fall in the production due to reduction of fluorspar consumption in steel and aluminium production and in chemical industry (reduction of Freon production). World mine production gradually increased from the minimum of 4,031 kt in 1993 to 4,670 kt in 1998. World production increased slowly from 4.4 to 5.3 mill tonnes during the last five years. In addition to China and Mexico, mine production has increased also in Mongolia and Iran. Production of South Africa has been rather stagnating, whereas mine production in Russia has been decreasing recently. In Europe, Spain, Italy and Great Britain show rather stable mine productions; by contrast, mine production in Germany markedly increased in 2006. Data according to Mineral Commodity Summaries (MCS) and the Welt Bergbau Daten (WBD):

World fluorspar mine production

Year	2004	2005	2006	2007	2008 e
Mine production, kt (MCS)	5 060	5 260	5 330	5 690	5 840
Mine production, kt (WBD)	5 165	5 253	5 430	5 777	N

Main producers' share in the world mine output (2007; according to MCS):

China	56.2 %	Spain	2.6 %
Mexico	16.4 %	Namibia	2.1 %
Mongolia	6.7 %	Morocco	1.6 %
South Africa	5.0 %	Kenya	1.4 %
Russia	3.2 %		

9. World market prices

Fluorspar prices were recently affected not only by fall in demand but also by supplies of Chinese fluorspar on the world market. Prices of majority of quoted types significantly increased in 2004. Price rise continued also during the year 2005 (by roughly 20 % year-on-year in case of the African and Chinese mineral; on the other hand, prices of the Mexican fluorspar declined). Prices of the Mexican fluorspar increased in 2006 and the prices of the South African raw material increased as well. In 2007, the decreasing US dollar value influenced mostly the prices of the Chinese fluorspar, which increased year-on-year by nearly one third. A sharp rise in world prices of fluorspar in 2008 (year-on-year price increase by 30–75 %) was caused by the high demand in rapidly industrialising Asian economies and by the weak US dollar. Fluorspar prices valid for various fluorspar grades and place of origin are monthly quoted in the Industrial Minerals magazine in GBP/t or in USD/t and at different transport rates.

The average prices of traded commodities at year-end

Commodity/Year		2004	2005	2006	2007	2008
chemical quality, South Africa, dry, bulk, FOB Durban	USD/t	137.00	162.00	182.00	189.50	250.00
chemical quality, Mexico, filtration cake, FOB Tampico	USD/t	173.00	140.00	190.00	190.00	287.50
chemical quality, China, dry, CIF US Gulf Port	USD/t	200.00	235.00	235.00	307.50	540.00

10. Recycling

In chemical industry where fluorspar consumption prevails, fluorspar recycling is virtually impossible because of its dissociation during acid leaching. However, maximum effort is evident to recycle or reduce the consumption of saturated fluorohydrocarbons (freons) due to their negative environmental impacts. Little fluorspar is recycled in metallurgy when producing aluminium.

11. Possible substitutes

Fluorspar is virtually an unique source of fluorine for chemical industry and thus irreplaceable. However, an extensive replacement of fluorohydrocarbon derivatives is under way when using new agents and methods in cosmetics and refrigerants (fluorine and its compounds are replaced by carbon dioxide, nitrogen, air, mechanical sprays, etc.). Fluorohydrocarbons are replaced by hydrocarbons in production of foamed plastics. Fluorspar can be to a certain extent substituted by cryolite (incl. synthetic) in metallurgy when producing aluminium. Fluorspar can also be substituted by dolomite, limestone and/or olivine in ferrous metallurgy.

MINERALS MINED IN THE PAST WITHOUT RESOURCES AND RESERVES

Iron

1. Characteristics and use

Precambrian ferruginous quartzites (event. jaspillites, itabirites, taconites), commonly enriched as a result of supergene processes, represent the dominant type of industrial iron deposits as their mine production as well as reserves concerns. Magmatic deposits, to which belong titanomagnetites and ilmenite-titanomagnetite ores, are another important industrial deposit type. Iron ores are mostly formed by hematite Fe_2O_3 and magnetite Fe_3O_4 containing up to 72 % Fe, in less extent by limonite $Fe_2O_3.nH_2O$ (48–63 % Fe), eventually siderite $FeCO_3$ (48,3 % Fe) and sometimes also by other minerals such as Fe-silicates (27–38 % Fe). Over 90 % of mining production has been obtained by surface mining. World resources exceed 800,000 billion tonnes of ore containing more than 230 billion tonnes of iron.

Iron ores are used for the production of pig iron either in the form of crude lump ore or in the form of fines or sintered or pelletized concentrates. Modern technologies of iron manufacturing such as DRI process, COREX®, etc. enable the use of fines and concentrates without sintering or pelletization.

A very small amount of iron (approximately 2 %) is used for other than metallurgical purposes, such as heavy media, and the manufacture of special (underwater works, e.g.) cement, ferrites, animal feed, colouring agents, etc.

2. Mineral resources of the Czech Republic

There are no economically exploitable iron ore deposits in the Czech Republic. Ores occurring on the territory of the republic are of a low grade, altogether having Fe contents below 40 % and in the majority of cases workable by underground mining. Deposits of much richer ores with Fe contents around 50 % and more are exploited mainly by open pit mining in the world at present. The average grade of iron ores traded on the world market is 60 % and more. The availability of much higher-quality and relatively cheaper iron ores from import led to gradual cessation of iron ore mining on the territory of the Czech Republic. At the same time, reserves of these ores were gradually eliminated from The Register as completely non-economic.

- Sedimentary iron ores occur in the Barrandian. These are Paleozoic ores of marine origin in sediments of the Ordovician age. The deposits have mostly a form of rather extensive lenses. The ores consist mainly of hematite, siderite and Fe-silicates (leptochlorites). The content of iron is on average 25 to 30 %. Oolitic texture and high SiO_2 content characterize these ores. These ores were intensively mined on many sites (e.g. Nučice, Ejpovice, Mníšek pod Brdy, Zdice etc.) mainly in the 19th and the first half of the 20th century. The mining was definitely terminated in the beginning of the 1960s and the remaining reserves of all the sedimentary deposits of Fe in the Czech Republic were written off from the Register in 1997–1999.
- Volcano-sedimentary former deposits of the Lahn-Dill type occur in the Moravian–Silesian Devonian. The ores, containing mainly hematite, magnetite and to a lesser extent Fe-silicates, form smaller lense-shaped bodies, which are often intensively folded. Magnetite ores had average Fe contents around 35 to 40 % Fe; ores with predominance of hematite slightly lower (about 30 %). The ores were mined on many places (Medlov,

Benkov, Králová, Horní Město etc.). Mining activity reached its climax in the 19th century and it was definitely terminated in the mid-sixties of the 20th century. All remaining reserves of deposits of the Lahn-Dill type were written off the Register in 1997–1999.

- Small magnetite lenses are typical of skarns of the Moldanubicum (Vlastějovice, Županovice, Malešov, Budeč etc.) and Saxothuringicum (Měděněc, Přísečnice, Kovářská) of the Bohemian Massif, Krkonoše Mts.-Jizerské hory Mts. crystalline unit etc. Fe contents of the ores were mainly about 33 to 38 %. The mining activity was terminated largely already in the sixties, at Přísečnice and Měděnec deposits in 1992. The remaining reserves of these deposits were to a large extent cancelled before the 1990s.
- Other genetic types of Fe mineralization were of only a marginal importance. This concerned for instance banded ores of Sydvaranger type (Sobotín et al.), hydrothermal ores (Krušné hory Mts. et al.), stratabound (Hraničná et al.), sedimentary (except the Ordovician ones), residual, metasomatic ores etc.

Iron ore deposits were mined in the past (peak in the 19th and beginning of the 20th century) on a large scale and the ore was dressed at high cost and used mostly for pig iron production. This applies particularly for low-grade and siliceous sedimentary ores of the Barrandian, which were thermally treated through the Krupp-Renn process. Magnetite was mostly – and in 1970s to 1990s almost exclusively – used for other than metallurgic purposes, such as for production of cement (heavy concrete), as a heavy medium of jigs in coal processing plants, etc.

3. Registered deposits and other resources in the Czech Republic

(see map)

Principal areas of deposits presence:

1 Barrandian

2 Silesicum + Moravo-Silesian Devonian

3 Krušné hory Mts. (Erzgebirge Mts.) Crystalline Complex

4 Moldanubicum

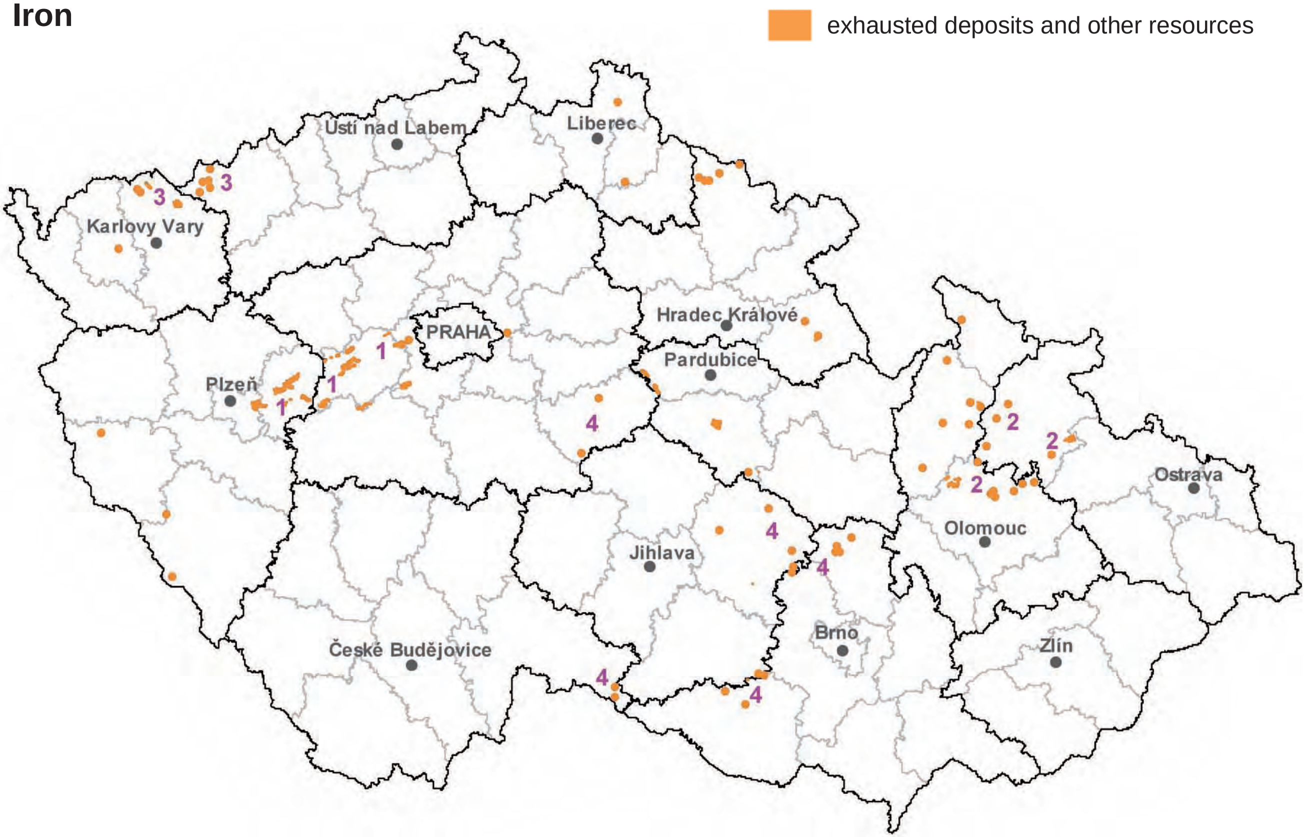
4. Basic statistical data of the Czech Republic as of December 31

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	0	0	0	0	0
exploited	0	0	0	0	0
Total *reserves, kt ores	0	0	0	0	0
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	0	0	0	0	0
Mine production, kt Fe	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

Iron


exhausted deposits and other resources
Ústí nad Labem
Liberec
Karlovy Vary
Hradec Králové
PRAHA
Pardubice
Plzeň
Ostrava
Olomouc
Jihlava
Brno
Zlín
České Budějovice
1
2
3
4

Domestic production of selected intermediate products

Year/ths t	2004	2005	2006	2007	2008
Pig iron	5 385	4 627	5 192	5 287	4 737
Crude steel	7 033	6 189	6 862	7 059	6 387
Rolled stock	6 395	5 782	6 273	6 101	5 801
Tubes	706	707	786	777	719

Source: Hutnictví železa, a.s.

Iron ore consumption in the Czech Republic (only blast furnaces)

Year/ths t	2004	2005	2006	2007	2008
consumption	7 872	6 914	7 775	7 888	7 048

Source: Hutnictví železa, a. s.

Crude iron production

Arcelor Mittal Ostrava a.s.

Třinecké železárny, a.s.

Steel production and processing

Arcelor Mittal Ostrava a.s. (Ispat – Nová huť)

Třinecké železárny, a.s.

Vítkovické železárny – EVRAZ Vítkovice Steel a.s.

FERROMET GROUP s.r.o. (železárny Hrádek, Veselí a Chomutov)

Vítkovice Heavy Mashinery a.s.

ŠKODA TVC s.r.o.

ŽDB a.s.

Arcelor Mittal Ostrava a.s. represents the largest metallurgical enterprise in the Czech Republic. Its production includes long products, flat products, tubes and engineering products. Steel works of the Mittal Steel a.s. produce about 3 million tonnes of steel per year. Třinecké železárny a.s. makes crude iron and steel long rolled products. It was founded already in 1839. It has about one-third share in present steel production in the Czech Republic. EVRAZ Vítkovice Steel a.s. produces namely crude steel both noble and not, long products, thick plates, iron bars and rolled material. This company represents the biggest Czech producer of thick plates.

FERROMET GROUP s.r.o. operates three steel works which re-process iron scrap – Železárny Hrádek a.s. (rolled and drawn steel), Železárny Veselí a.s. (drawn steel) and Železárny Chomutov a.s. (drawn steel). Vítkovice Heavy Machinery a.s. produces castings, ingots, steel constructions, machines, equipment and investment units of heavy engineering. ŠKODA TVC s.r.o. (Škoda Plzeň) is engaged in metal working and metal components production. ŽDB a.s. produces shaped iron and iron bars, ingots, steel wire ropes, steel lining of tyres and wire netting. This company represents an important central European producer of high-C and low-C wires.

Demand and successively also production of crude steel, crude iron and whole spectrum of metallurgical products decreased significantly due to global financial and economic crisis in the fourth quarter of 2008. Global economic crisis influenced also metallurgical companies operating in the Czech Republic. Many of them got into serious economic problems caused by the rapid decrease of sales, and they therefore had to reduce production.

5. Foreign trade

2601 – Iron ores and concentrates

	2004	2005	2006	2007	2008
Import, kt	7 638	6 803	7 985	6 591	6 802
Export, kt	0	0	0	0	0

Detailed data on iron ore imports

Country	2004	2005	2006	2007	2008
Ukraine	4 622	3 700	3 852	3 293	4 256
Russia	2 552	2 437	3 597	2 846	1 553
others	464	666	536	452	993

7201 – Crude iron

	2004	2005	2006	2007	2008
Import, kt	88	89	150	109	112
Export, kt	56	16	18	31	30

7204 – Ferrous waste and scrap, remelted scrap ingots or iron or steel

	2004	2005	2006	2007	2008
Import, kt	549	385	559	524	502
Export, kt	1 447	1 738	1 498	1 680	1 842

Detailed data on ferrous waste and scrap imports (kt)

Country	2004	2005	2006	2007	2008
Poland	293	204	338	333	293
Slovakia	235	143	191	179	192
others	21	38	30	12	17

Detailed data on ferrous waste and scrap exports (kt)

Country	2004	2005	2006	2007	2008
Germany	804	1 133	831	883	932
Austria	345	276	342	341	338
Poland	195	172	208	229	228
Italy	18	85	68	128	203
Slovakia	58	27	29	69	99
others	27	45	19	30	42

The Czech Republic imports 7–8 mill t of iron ores per year, mainly from Ukraine and Russia. Whereas volume of import from Ukraine predominated in the past, the ratio was more or less balanced in 2006. Import of iron ore from Ukraine prevails again in the last two years. Ferrous waste and scrap represents the second most important item. Export of this item is 2–4 times higher than import, which shows that in this case the secondary raw material in not economically used as to the energy balance of the Czech Republic. That is to say that iron production from ferrous waste and scrap represents savings of about 60 % of energy compared to production from iron ore. Iron waste and scrap for CZK 12.2 billion (EUR 440 mill) was exported from the Czech Republic in 2007, in 2008 even for CZK 14.8 billion (EUR 600 mill). Ferrous waste and scrap is exported mainly to Germany and Austria, and imported namely from Poland and Slovakia.

6. Prices of domestic market and foreign trade

2601 – Iron ores and concentrates

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	1 748	1 867	1 717	1 862	2 333
Average export prices (CZK/t)	N	N	N	N	N

7204 – Ferrous waste and scrap, remelted scrap ingots or iron or steel

	2004	2005	2006	2007	2008
Average import prices (CZK/t)	5 671	5 476	5 603	6 127	7 655
Average export prices (CZK/t)	6 119	4 261	6 458	7 232	8 037

Import prices of iron ore increased significantly during the year 2004, when the average nominal import prices almost doubled from 30–40 USD/t to 70–90 USD/t. Import price increase reflected the rise of iron ore world prices.

7. Mining and processing companies in the Czech Republic as of December 31, 2008

As in the preceding years, no mining companies were extracting iron ores in the Czech Republic in 2008.

8. World production

World production of iron ores rose since the 1930s' average of approx. 100 million tonnes to exceed the 1 bill t level by the mid 1990s. It stagnated for the next ten years and has recently increased sharply. The increase is related to an important increase of pig iron and steel consumption in populated, rapidly developing countries (China, India, Brazil et al.). The limit of 1.5 billion tonnes was overstepped according to some sources in 2005. Based on preliminary data, world production increased by about 10 % between the years 2005 and 2006. Asian production of iron ores doubled in 2002–2006, that of China itself almost tripled. World mine production has been still rising during the last two years; it reached 2 billion t in 2007 according to MCS. Mine capacities for iron ore increased by 70 mill t only during 2006 (UNSTAD sources). The International Iron and Steel Institute (IISI) predicts that world demand for iron ore will increase by another 236 mill t between 2006 and 2009. However, these optimistic estimates will be corrected in future in regard to global financial crisis and economic recession. Chinese decrease of iron ore import by 21% in October 2008 can be considered as a first sign of deceleration.

World mine production of iron ores

Year	2004	2005	2006	2007 e	2008
Mine production, mill t (according to MCS)	1 340	1 540	1 690	2 000	2 200
Mine production, mill t (according to WMS)	1 184	1 320	1 483	1 600	N

Main producers' share in the world mine output (2007, according to MCS):

China	35.4 %	Russia	5.3 %
Brazil	17.8 %	Ukraine	3.9 %
Australia	15.0 %	USA	2.6 %
India	9.0 %	South Africa	2.1 %

Brazil and Australia reached also high share in the world export of iron ores.

World production of pig iron

Year	2004	2005	2006	2007	2008 e
Production, mill t (according to MCS)	712	825	865	947	958
Production, mill t (according to IISI)	724	801	875	949	N

Main producers of pig iron (2007, according to MCS):

China	49.5 %	USA	3.8 %
Japan	9.2 %	Brazil	3.8 %
Russia	5.5 %	Germany	3.3 %
Ukraine	3.8 %	South Korea	3.1 %

World production of steel

Year	2004	2005	2006	2007	2008 e
Production, mill t (according to MCS)	1 050	1 130	1 170	1 340	1 360
Production, mill t (according to IISI)	1 069	1 147	1 251	1 351	N

Main producers of crude steel (2007, according to MCS):

China	36.5 %	South Korea	3.9 %
Japan	9.0 %	Germany	3.7 %
the USA	7.3 %	Ukraine	3.2 %
Russia	5.4 %	Brasil	2.4 %

According to the International Iron and Steel Institute (IISI), following companies ranked among the ten biggest world producers of crude steel in 2007: Arcelor Mittal, Nippon Steel, JFE, POSCO, Baosteel, Tata Steel, Anshan-Benxi, Jiangsu Shagang, Tangshan and US Steel. These 10 companies covered more than 25 % of the world production of crude steel.

9. World market prices

Prices of iron ore on the European market are quoted in FOB for calendar year in USc/mtu. The final price of 1 tonne of the ore is a multiple of the unit price in mtu and the metal content in the relevant ore. Prices FOB are being established with regard to shipping costs of the major importers in order to maintain similar prices of ores having a similar grade in CFR North Sea ports. This is why the FOB prices of ores of similar grade of suppliers from various regions differ from each other.

A steep increase in world iron ore prices occurred in 2004, as a result of an elevated demand from the side of China, which, though the biggest world producer, has become an important iron ore importer recently, too. Companhia Vale do Rio Dolce (CVDR) company, the biggest world producer of iron ores, announced in February 2005, that it concluded an agreement on raw material supply for Japan (Nippon Steel Corporation), Taiwan and Australia at prices by 71.5 % higher than those of the year 2004. Prices reached 79.58 USc/mtu (Carajás Lump) and even 115.51 USc/mtu (Blast Furnace Pellets) in the first half of the year 2005. Total year-on-year rise in iron ore prices was 70–90 %. Iron ore prices were high also in 2006-2007 and in some cases they continued to rise. The price increase was related to a huge increase in steel production, which roughly represented a 10 % year-on-year increase in 2006/2005 and 2007/2006. Prices of input raw materials – iron ore – increased of course as well due to the high demand. Nominal prices of the “fines” and “lump” types increased on average by 10 %, prices of Brazilian iron-ore pellets on average by 5 % in 2007. Iron ore prices continued to rise in 2008 as high as unusual maxima. Year by year increase of individual quotations was 40–100 %. However, prices of majority of commodities, including iron ore, dropped since the end of summer 2008 in relation to global financial and commodity crisis. This feature is not yet reflected by the table, as contracts on iron ore supplies are usually negotiated for whole year.

Quoted prices of staple traded iron ores:

Commodity/Year		2004	2005	2006	2007	2008
Brazilian fine ore CJF (Carajás Fines)	USc/mtu	37.90	65.00	77.35	84.70	140.60
Brazilian lump ore CJL (Carajás Lump)	USc/mtu	44.46	79.58	94.70	100.46	197.40
Australian fine ore (Mt. Newman Fines)	USc/mtu	35.99	61.72	73.45	81.95	147.51
Mauretanian fine ore TXF (Tazadit Fines)	USc/mtu	41.35	70.92	78.15	91.00	152.88
Brazilian pellets BFP (Tubarão Blast Furnace Pellets)	USc/mtu	61.88	115.51	112.04	117.96	220.20
Brazilian pellets DRP (Tubarão Direct Reduction Pellets)	USc/mtu	66.52	126.06	123.25	129.76	242.22

Costs for imports of iron ores from Western Australia and Brazil to Europe depend on cargo volume. In case of 100 to 150 ths tonnes cargo they are about 12 USD per tonne.

10. Recycling

Metal recycling is widely used. Iron scrap (steel scrap and cast iron scrap) is widely used in production of crude steel but very little in production of pig iron. The share of iron scrap in production of crude steel was 40 % worldwide in the last twenty years (according to UNCTAD) and the same share of iron scrap has been reached in the Czech Republic. The reason for the high recycling ratio is in particular the reduction of fuels and energy consumption by as much as 80 % versus energy consumption when using pig iron as a charge in steel-making furnaces. Production of steel requires mostly chemically pure and high-grade iron scrap, i.e. scrap availability of which continues to decrease with increasing proportion of continuous steel casting. Processing scrap and particularly the increasing proportion of consumer’s iron scrap does not meet specific requirements of the steel industry. Electric furnaces have the major share in consumption of iron scrap, allowing as much as 100 % charge of iron scrap.

11. Possible substitutes

Iron ore in pig iron production can be substituted by iron scrap up to 7 % of the charge. Steel products can be substituted to a certain extent by products of other metals, alloys, glass, ceramics and composite materials. Prices of substitutes are nevertheless higher, and therefore, such a substitution has to be justified by better properties of new material (e.g. lower weight of aluminum compounds used in cars helps fuel saving).

MINERALS UNMINED IN THE PAST WITH RESOURCES AND RESERVES

Lithium, rubidium and cesium

Lithium, rubidium and cesium occur together, have similar chemical properties, and may be used interchageably in many uses. They belong to typical alkali metals. They form nearly 30 minerals. Spodumene $LiAl(Si_2O_6)$, which contains 6–7.5 % Li_2O, as well as petalite $LiAl(Si_4O_{10})$ (4.5 % Li_2O) and the lithium mica lepidolite (3–5.5 % Li_2O) have practical importance. Cesium is contained in pollucite, i.e. sodium and cesium aluminosilicate, which contains 30–42 % Cs_2O. Rubidium does not form minerals of its own.

Lithium is used mostly in electronics for the manufacture of lithium batteries, and also in ceramics, the glass industry, for electrolysis of aluminium, as well as in the production of lightweight alloys and high-quality antifreeze grease. The most important use of cesium is as drilling fluids with a density of 2.3 in crude oil and natural gas drilling under high temperature and pressure conditions (North Sea, Argentina). Rubidium is used in photoelectric devices, in the manufacture of specialty glasses and pyrotechnics, and also in electrical technology due to its high dielectric capacity.

Lithium raw materials form deposits of two industrial types:

1. Bodies of pegmatite and greisen associated with granitoid magmatism, such as the deposits of Bernick Lake (Canada), Black Hills (USA), Bikita (Zimbabwe), Greenbushes (Western Australia), and Cínovec (Czech Republic).
2. Lithium brines forming lakes (playas, salars) such as Searles Lake (USA), Salar de Atacama (Chile) or underground reservoirs such as are known to occur in Clayton Valley (USA).

World lithium production (excluding the USA) in 2008 is listed at 27.4 kt, and comes primarily from brines. The world´s leading producer is Chile (43.8 % of world lithium production), followed by Australia with 25.2 %, China (12.8 %) and Argentina (11.1 %). Identified world resources are estimated at 11 million tonnes of lithium, of which 49 % are in Bolivia, roughly 27 % in Chile, 10 % in China and a little over 8 % in Brazil. The principal raw material for lithium salt production are precisely lithium brines. Rubidium is most often obtained from the processing of lepidolite concentrates, and cesium from pollucite ores. The Canadian Lac du Bonnet deposit contains roughly 300 thousand tonnes of pollucite with 24 % cesium and elevated tantalum contents. Other identified resources are listed for Zimbabwe and Namibia.

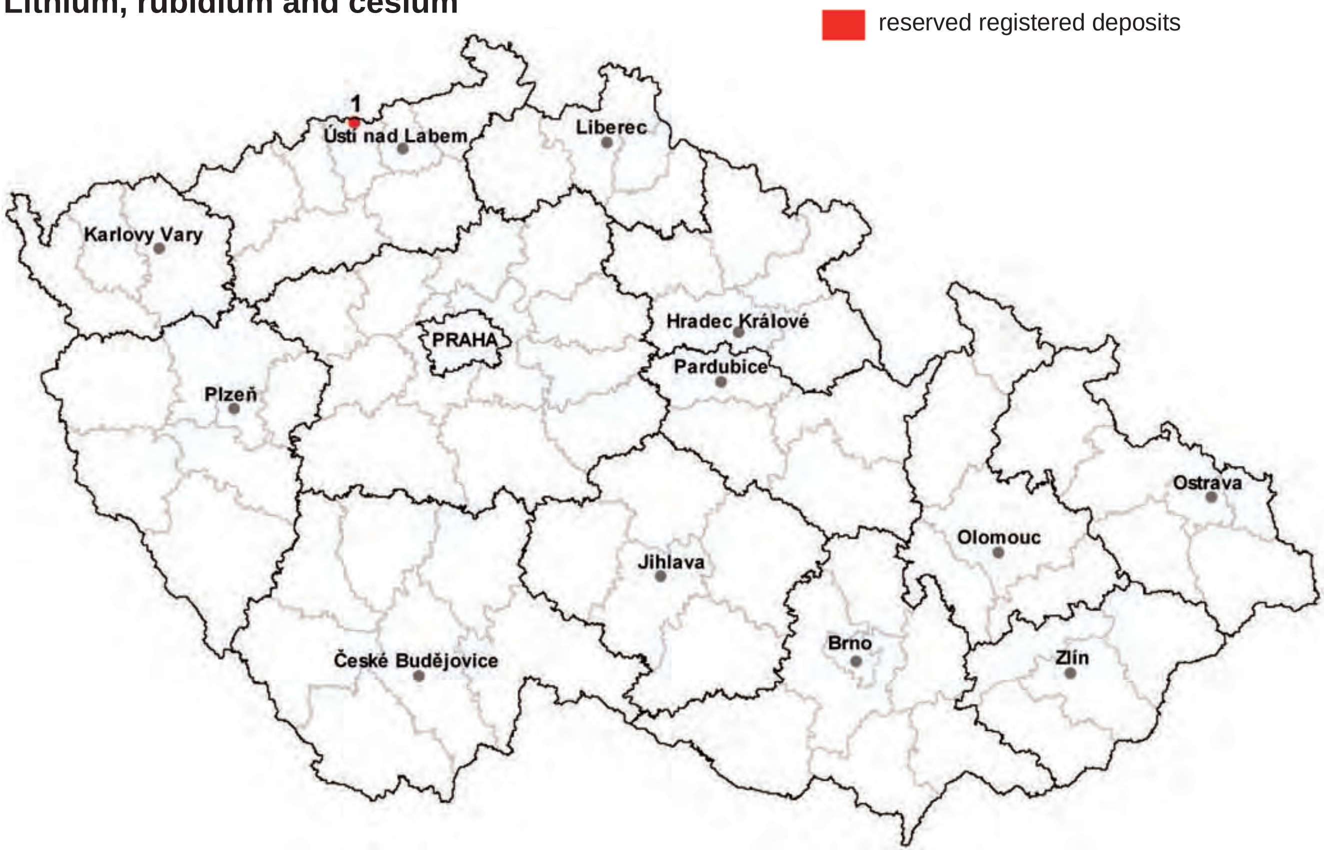
According to the WMMR (*World Metals & Minerals Review*) 2005, the lithium content in lithium mineral production (thus excluding brines) in 2003 reached 14.1 kt, of which nearly 40 % came from Australian production of spodumene concentrates, 15.1 % came from Chile, 12.7 % from China, 8.9 % from Portuguese lepidolite production, 8.7 % from Zimbabwe, 8.1 % from Canada, and 3.5 % came from spodumene concentrates in Brazil.

Registered deposits and basic statistical data of the Czech Republic, as of December 31

(see map)

The registered deposit is not exploited

Lithium, rubidium and cesium



1 Cínovec-jih*

Note:
* Deposit of also potentially economic reserves of Sn-W ores and contents of Ta and Nb in experimental concentrates

Number of deposits; reserves; mine production

Year	2004	2005	2006	2007	2008
Deposits – total number	1	1	1	1	1
Exploited	0	0	0	0	0
Total *reserves, t Li	112 775	112 775	112 775	112 775	112 775
economic explored reserves	0	0	0	0	0
economic prospected reserves	0	0	0	0	0
potentially economic reserves	112 775	112 775	112 775	112 775	112 775
Mine production, t Li	0	0	0	0	0

* See ***NOTE*** in the chapter ***Introduction*** above on a terminological difference between Czech official application of the term reserves and standard international application of the term. The relationship of domestic and foreign classifications of mineral reserves and resources is described in the separate chapter ***Mineral reserve and resource classification in the Czech Republic*** of this yearbook

In the Czech Republic, it is possible to consider the entire Krušné hory Mts. as a lithium province. Around 300 million tonnes of ore with elevated lithium contents were identified in Cínovec and its surroundings alone. As for the potentially economic deposit of tin-tungsten ores of Cínovec-jih, 112,775 tonnes of lithium in 53.4 million tonnes of ore with an average lithium content of 0.117 % are recorded in the *Balance of Reserves of Reserved Mineral Deposits of the Czech Republic*. In addition, byproduct amounts of 56 kt of rubidium and 1.8 kt of cesium were also evaluated in this deposit.

Brine reserves with anomalous bromine and lithium contents were calculated at 453.6 million m³ in the mining lease of the Slaný deposit of bituminous coal. These groundwater reserves contain 123 kt of bromine, 15 kt of lithium and more than 18 million tonnes of NaCl.

Foreign trade

280519 – Lithium, potassium, rubidium, cesium

	2004	2005	2006	2007	2008
Import, kg	55 691	44 868	N	N	N
Export, kg	1 826	10 148	N	N	N

38369100 – Lithium carbonates

	2004	2005	2006	2007	2008
Import, kg	0	0	0	0	0
Export, kg	0	0	0	0	0

World market prices

Commodity/Year		2004	2005	2006	2007	2008
Petalite, 4.2 % Li_2O, big bags, FOB Durban	USD/t	212.5	212.5	212.5	212.5	212.5
Spodumene, concentrate >7.25 % Li_2O, FOB W. Virginia, bulk	USD/s.t.	340	340	430	487	650
Lithium carbonate, delivery continental USA, large contracts	USD/lb	1.14	1.58	2.38	2.85	2.85

Note: annual averages according to Industrial Minerals quotes

Molybdenum

Molybdenum is dispersed in the Earth´s crust to a considerable extent. It mostly concentrates in quartz- and alkali-rich magmatites. The principal mineral is molybdenite MoS_2 (60 % Mo); wulfenite $PbMo_4$ (46 % Mo) and powellite $CaMo_4$ (60 % Mo) occur most often as secondary minerals.

Molybdenum is one of the most important alloying agents in steel. Around 75 % of molybdenum is used in metallurgy, and it also finds usage in electronics, thermal technology, the chemical industry etc.

Identified world resources of molybdenum in ores are roughly estimated at 19 million tonnes, of which 85 % are located in the territories of the USA, China and Chile. While porphyry molybdenum ores account for most of the reserves in the territory of the USA, the molybdenum reserves of Chile occur almost exclusively in porphyry copper ores. In both cases, these deposits are relatively large deposits of disseminated ores with low molybdenum contents (0.05–0.4 %), which are genetically very similar**.** Yet in terms of industrial importance, they are subdivided into deposits where molybdenum occurs as the principal component and into those where, during exploitation, molybdenum occurs as a byproduct mineral. Industrial types of molybdenum ore deposits may be defined as follows:

1. Large quartz-molybdenite stockwork of porphyry ores with average molybdenum contents of 0.2–0.4 %. This type accounts for 40–50 % of world reserves and for around 35–40 % of world production. Examples: Climax, Henderson (USA), Shorskoye (Kazakhstan)
2. Large deposits of disseminated porphyry copper ores, whose molybdenum to copper ratios range on a scale of 1:10 to 1:150. This type represents about 40 % of world reserves and more than 50 % of world production. Examples: El Teniente, Andina, La Escondida (Chile), Bingham, Morenci (USA), Mont Porphyre (Canada), La Granja (Peru), Kadzaran, Agarak (Armenia), Kounrad (Kazakhstan), Zhongtiaoshan (China), Erdenet (Mongolia)**.**
3. Medium and small deposits of disseminated skarn ores and quartz–molybdenite veins with molybdenum contents of up to around 1 % or more. This type accounts for up to 10 % of world reserves, and probably for nearly 10 % of world production. Examples: Tyrny-auz (Russia), Yangjiazhangzi, Xihuashan (China), Preissac (Canada).

In the Czech Republic, 80 million tonnes of prognostic resources (unapproved) of molybdenum ores with an average molybdenum content of 0.176 %, i.e. 14 037 tonnes of molybdenum, were estimated in the Hůrky locality in the Čistá-Jeseník Massif (L. Kopecký 1983).

According to the MCS (2009), molybdenum ore mines produced around 212 thousand tonnes of metal in ores in 2008. The USA (29 %) ranked first in molybdenum ore production, followed by China (28.2 %) and Chile (21.2 %). Peru (8 %) ranked fourth and Canada (5.7 %) was fifth. The following countries generally have a share of 1–2 % of world production: Armenia and Mexico (1.9 % each), then Russia (1.7 %), Iran (1.2 %) and tenth-placed Mongolia has a 0.6 % share of world mine production.

Foreign trade

81029400 – Unwrought molybdenum, including bars, rods obtained by simple sintering

	2004	2005	2006	2007	2008
Import, kg	198	372	21 000	67 914	195 700
Export, kg	0	0	0	175	18 316

Rare Earths

A total of 16 elements belong to the rare earths group. They can be subdivided into two sub-groups or series. In addition to yttrium (Y), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb) and lutetium (Lu) also belong to the yttrium group. The cerium group includes cerium (Ce), lanthanum (La), praseodymium (Pr), neodymium (Nd), promethium (Pm) and samarium (Sm). Scandium is sometimes also classified among rare earth elements. Rare earth elements (REE) are also collectively referred to as lanthanoids (Ln) or terrae rarae (TR).

In terms of the most important minerals containing lanthanoids, it is necessary to at least mention monazite, xenotime, bastnäsite, apatite, loparite, gadolinite, cerite, brannerite and euxenite. Other TR bearers may be some zircons, wolframites and scheelites.

Rare earth compounds, even small admixtures, give many materials new and often unique properties. Early in the 21st century, the majority of TR oxides of the cerium group were used worldwide in glass polishing and ceramics (about 30 % of total TR compound consumption). TR compounds are also used in automotive catalytic converters (about 14 %), as petroleum refining catalysts, and generally in the chemical industry (about 28 %). Tr compounds are also widely used in metallurgy (19 %). Around 3 % are used in the production of television and computer monitors, lighting and radar technology etc. The production of high-performance permanent magnets today is unthinkable without samarium compounds or other TRs (Tb, Dy), and represents about 3 % of the total consumption of rare earths.

Major raw material sources of rare earth oxides belong to the following industrial types:

1. Bastnäsite ores most often in carbonatites. They represent more than 70 % of world production and about 60 % of world reserves. Examples: Bayan Obo (China), Mountain Pass (California, USA), Araxá (Brazil), Palabora (South Africa).
2. Deposits of lateritic clays in granites and carbonatites. About 25 % of world production and 20-25 % of world reserves. Examples. Xunwu, Longnan (Jiangxi Province, China), Mount Weld (Western Australia, with a 15.4 % content of rare earth oxides [REO]), Araxá (Brazil, 13.5 % REO content).
3. Deposits of nephelinic syenites with apatite, loparite and euxenite. This type accounts for about 2–3 % of world production and for nearly 15 % of world reserves. Example: Chibiny (Russia).
4. Intertidal marine placers with monazite and xenotime. They account for up to 5 % of world production and for roughly 6-8 % of world reserves. Examples: Australian coast, India (the most important monazite producer), Malaysia (the leading xenotime producer), Sri Lanka, Brazil.

World production of lanthanoids in 2008 is listed at 124 tonnes of oxides (REO). By far the world´s leading producer (96.8 % of world mine production in 2008) and exporter of rare earth elements is China, which produces them from both the bastnäsites of the Bayan Obo deposit and from the deposits of cerium ores in the Jiangxi Province. Even though it has not been mined since 2003, the Mountain Pass deposit produces concetrates generated during the processing of heaps.

According the MCS 2009, identified world resources of rare earth elements are estimated at 150 kt of oxides (REO). China accounts for 59 % of these resources, the countries of the former Soviet Union for 14 %, the USA for 9.3 % and Australia for 3.9 %. Inferred world resources of rare earth oxides include various mineralisation types and are apparently much larger than the assumed demand.

In the Czech Republic, there are also descriptions of estimated resources (unapproved) of rare earth oxides from various mineralisations and geological formations. For example, the cerium content in uranium ores of uranium-bearing sandstone of the Stráž block in the Bohemian Cretaceous Basin was evaluated at 4,750 tonnes of cerium. Anomalous rare earth oxide contents are also assumed to occur in the Hůrky locality in the Čistá-Jeseník Massif (along with resources of Mo, Ta, Nb, Zr, and Hf), in alkaline volcanic rocks in the České Středohoří, in volcanic rocks of the Šternberk-Horní Benešov belt in the Nízký Jeseník Mts., in graphitic phyllites of the Železné Hory Mts. Proterozoic, in argillitised tuffs of the Upper Silesian Basin etc.

Foreign trade

28461000 – Cerium compounds

	2004	2005	2006	2007	2008
Import, kg	4 220 313	166 999	196 630	174 438	120 469
Export, kg	5 853	7 801	7 507	5 547	3 228

28053010 – Rare earth metals, scandium and yttrium, intermixed or interalloyed

	2004	2005	2006	2007	2008
Import, kg	675	601	1 460	2 783	100
Export, kg	0	50	25	50	0

28053090 – Rare earth metals, scandium and yttrium, not intermixed or interalloyed

	2004	2005	2006	2007	2008
Import, kg	16	12	8	37	26
Export, kg	12	0	0	0	0

Selenium, tellurium

Selenium and tellurium are elements of chalcophile character with chemical properties and affinity similar to those of sulphur. During secondary alterations, selenium often separates from sulphur and its enrichment occurs, for example, in some stratiform uranium deposits. Selenium is toxic to animals. Clausthalite, ferroselite and berzelianite belong to its most important minerals. In contrast with selenium, tellurium is not in the lattice of sulphide minerals, but forms grains of individual minerals disseminated in sulphides. Important minerals are hessite, nagyagite, sylvanite and tetradymite, and generally tellurides, which occur primarily in gold ore deposits.

Selenium is used in glass production to decolourise glass bottles (about 37 %), in chemistry and the manufacture of paint (20 %), in electronics (10 %) and other industries, including agriculture (33 %). Amorphous selenium (aSe) detectors represent a new application of selenium. These detectors allow for direct conversion of X-rays to digital signals. Tellurium is used mainly as an additive in the manufacture of free-machining steel (roughly 50 %), in catalysts and chemical production (about 25 %), as an additive in nonferrous alloys (10 %), as a photoreceptor, in thermoelectric devices (about 8 %), and elsewhere (around 7 %).

Both metals are recovered from anode slimes generated in the electrolytic refining of copper, and tellurium also forms lead refinery skimmings. World resources of selenium are estimated at 172 kt and those of tellurium at 48 kt and, in both cases, are based on reserves of economically recoverable copper deposits. Elevated, yet practically unrecoverable concentrations of both elements are known to occur in coal deposits and, in the case of tellurium, also in deposits of gold and lead. The sandstone-type uranium ores of the Colorado Plateau (USA) belong to important deposit sources of selenium. Furthermore, other richer sources include or included deposits of copper-selenide-tellurium associations such as Akjilga (Kyrgyzstan), selenide associations (such as Sierra de Umango, Argentina), uranium-selenide associations such as the area of Lake Athabasca (Canada), and gold-telluride associations (Romania). In the Czech Republic uranium mineralization of mined deposit Rožná is accompanied by selenides.

World refinery production of selenium (excluding the USA) in 2007 is listed at 1 550 tonnes (MCS 2008) and 1 590 tonnes in 2008 (MCS 2009). Japan (47.7 %), Canada (19.4 %), Belgium (12.9 %) and Chile (5.4 %) are the leading producers.

According to the MCS (2008), a total of 135 tonnes of refined tellurium were produced worldwide, excluding the USA, in 2007. Three countries account for the total production: Canadu (55.6 %), Peru (25.9 %) and Japan (18.8 %).

Foreign trade

811212 – Selenium

	2004	2005	2006	2007	2008
Import, kg	22 242	21 337	117 101	11 775	10 679
Export, kg	1 400	1 800	601	30	819

811212 – Tellurium

	2004	2005	2006	2007	2008
Import, kg	3	4	2	39	15
Export, kg	0	25	0	1	0

Tantalum, niobium

Tantalum and niobium (columbium) are two chemically related elements, which occur together in nature. They have a lithophile character and concentrate naturally at a late stage of magma crystallisation, most often in pegmatites, and also in carbonatites. Columbite, tantalite, pyrochlore and microlite belong to the most important minerals of niobium. In terms of tantalum content, mossite, tapiolite, euxenite and fergusonite are also significant.

Tantalum is used mostly in electronics (more than 60 %), primarily in tantalum capacitors in computer technology and in portable telephones. The majority of niobium is consumed in the manufacture of ferronobium for steel and niobium superalloys for use in the aerospace and aviation industries.

In terms of types, major resources of tantalum and niobium raw materials can be subdivided into two groups:

1. Primary deposits in magmatic rocks such as carbonatites, pegmatites and nephelinic syenites. These account for 70–80 % of primary world production and for around 90 % of world reserves. Examples: Araxa (Brazil), Chibiny (Russia), Tanco (Canada), Dajishan and Limu (China).
2. Placers of stable minerals such as columbite, tantalite, pyrochlore etc. This type accounts for 15–20 % of world production and for nearly 10 % of world reserves. Examples: Bukuru (Jos Plateau, Nigeria), Ngulla (Tanzania), Mtoko (Zimbabwe).

According to the MCS 2009, primary production of tantalum worldwide reached 815 tonnes in 2007 and 2008. More than 53 % of this production comes from Australia, and 22 % from Brazil. The world´s primary production of niobium is estimated at 60 kt, and 95 % comes from Brazil. Niobium and tantalum are also recovered from metallurgical slag after melting tin ore. This is a significant source mainly in the case of tantalum. It is estimated that more than 60 % of recovered tantalum comes from this slag.

Identified world resources of tantalum are estimated at 180 kt, of which 50 % are in Brazil and 46.7 % in Australia. In the case of niobium, 87 % of identified resources in the amount of 3 million tonnes are located in the territory of Brazil.

In the Czech Republic, prognostic resources (unapproved) were evaluated at 3,238 tonnes in uranium deposits and uranium-bearing sandstone of the Stráž block in the Bohemian Cretaceous Basin (along with TR, Zr and Hf), and another 568 tonnes in the Hůrky locality in the Čistá-Jeseník Massif (along with Mo, TR, Zr and Hf), where 57 tonnes of prognostic tantalum resources were also calculated. Recoverable contents of tantalum and niobium are also known to occur in tungsten and tin concentrates, which were recovered experimentally during the exploration of the tin-tungsten ore deposit of Cínovec-jih (along with Li, Rb and Cs).

Foreign trade

26159010 – Tantalum and niobium ores and concentrates

	2004	2005	2006	2007	2008
Import, kg	101	1 000	0	0	0
Export, kg	50	0	0	0	0

810320 – Unwrought tantalum

	2004	2005	2006	2007	2008
Import, kg	231 912	131 782	N	N	N
Export, kg	61 475	39 271	N	N	N

Zirconium, hafnium

Zirconium is a lithophile element, which mostly occurs naturally in the mineral zircon, which occurs as an accessory in the majority of magmatic rocks. In addition to zircon, baddeleyite and eudialyte also have practical importance. Hafnium exhibits identical chemical behaviour and occurrence. No independent hafnium minerals are known. The constant zirconium-to-hafnium ratio of 50:1 is typical for both elements in terms of occurrence in ore.

Zircon is used primarily in the ceramics and glass industries, in the production of refractories, and to fabricate forms in the foundry industry. Other uses of zirconium include abrasives, production of chemicals, metal alloys, welding rod coatings and sandblasting sand. The majority of hafnium is consumed in the production of superalloys for nuclear energy purposes and by the chemical industry.

World zirconium production (excluding the USA) ranged around 1,400 kt in 2007 and 2008 (MCS 2009).

Global deposits may be subdivided into two types:

1. Primary ores composed of baddeleyite in carbonatites and nepheline syenites with apatite. Examples: Kovdor (Kola, Russia), Palabora (South Africa), Jacupiranga (Brazil). Their share of reserves and production is minor with estimates of global indicators ranging up to 5 %. However, these are richer ores with zirconium contents of up to tens of percent.
2. Placers of zircon sands, mostly beach placers. Examples: Eastern Coast of Australia (Murray Basin), Ukraine, Brazil, India, South Africa (Richards Bay). This type accounts for up to around 95 % of world production of both elements, and for around 75 % of world reserves. The advantage of this raw material, in spite of the low zirconium and hafnium contents, are its low production costs due to the use of suction dredges during mining.

Identified world resources of zircon, the principal mineral for the production of zirconium and hafnium, were estimated at 60 million tonnes.

In the Czech Republic, prognostic resources of zirconium and hafnium in uranium ores in uranium deposits of uranium-bearing sandstone of the Stráž block in the Bohemian Cretaceous Basin (along with TR, Ta, Nb) were estimated at 71,800 tonnes of zirconium and 2,520 tonnes of hafnium. Another 122,370 tonnes of zirconium and 2,446 tonnes of hafnium are assumed to occur in fenites in the Hůrky locality in the Čistá-Jeseník Massif (along with Mo, TR, Ta, Nb). All the resources are unapproved.

Foreign trade

26151000 – Zirconium ores and concentrates

	2004	2005	2006	2007	2008
Import, kg	1 635 505	655 340	1 498 388	1 543 397	750 512
Export, kg	26 175	10 200	4 500	4 000	4 000

81129210 – Unwrought hafnium, hafnium waste and scrap, hafnium powders

	2004	2005	2006	2007	2008
Import, kg	1	5	0	0	1
Export, kg	0	0	0	12	0

MINERALS UNMINED IN THE PAST WITHOUT RESOURCES AND RESERVES

Metallic ores

Aluminium

Bauxite deposits form industrial exploitable Al-resources. Bauxite is an impure mixture of Al-minerals – gibbsite ($Al_2O_3.3H_2O$), boehmite ($Al_2O_3.H_2O$) and diaspore ($Al_2O_3.H_2O$). From a genetic standpoint bauxite is divided in type “terra rossa” alias genuine bauxite, associated with carbonate rocks weathering (for example Jamaica, Haiti, Dominican Republic, Hungary), and lateritic bauxite, formed by lateritic weathering of various rocks with Al-contents (Guyana, Guinea, Surinam, Brazil, India, Ghana, Australia). Al-clays were registered in the North Bohemian (brown coal) Basin (deposit Ležáky) in the Czech Republic until recently.

World production of primary Al reached almost 38 mill t in 2008. The most important world producers are China (33 %), Russia (10 %), Canada (8 %), the USA (7 %), Australia (5 %), Brazil (4.5 %) and Norway (4 %).

Foreign trade

2606 – Aluminium ores and concentrates

	2004	2005	2006	2007	2008
Import, t	21 204	25 147	24 840	26 867	17 698
Export, t	502	13	20	595	475

281820 – Aluminium oxide (other than synthetic corundum)

	2004	2005	2006	2007	2008
Import, t	26 908	28 481	24 151	29 581	28 250
Export, t	126	195	297	136	196

281830 – Aluminium hydroxide

	2004	2005	2006	2007	2008
Import, t	17 279	10 997	9 754	7 838	6 917
Export, t	140	139	61	50	53

7601 – Raw (unwrought) aluminium

	2004	2005	2006	2007	2008
Import, t	165 980	166 877	180 599	204 104	193 149
Export, t	48 646	48 077	46 007	54 515	53 865

7602 – Aluminium waste and scrap

	2004	2005	2006	2007	2008
Import, t	27 606	34 049	49 358	63 959	58 686
Export, t	37 746	39 388	54 472	61 161	58 438

Antimony

Antimony belongs to chalcophile elements. It occurs naturally either as native antimony or along with sulphur and metals (Pb, Ag, Cu) in hydrothermal sulphide deposits. It forms 75 minerals, the most important of which is antimonite Sb_2S_3 (71.4 % Sb). Antimony is recovered from antimony, mercury-antimony and gold-antimony ores. It is produced as a byproduct metal during the processing of polymetallic, tin and tungsten ores.

Antimony is most often used in alloys with lead, copper and zinc to impart strength, hardness and anti-corrosive properties. Its flame-retardant compounds, which are used in the manufacture of flame-retardant formulations, account for the majority of antimony consumption. Substantial amounts (around 10–15 %) are used in the manufacture of batteries and also in the chemical, ceramics and glass industries.

Total world resources of antimony in ores are estimated at roughly 5,700 thousand tonnes. Nearly 60 % of these reserves are located in the territory of China. Around 13 % of world reserves are in Russia, and more than 11 % in Bolivia.

In terms of industrial classification, it is possible to subdivide antimony ore deposits into two groups:

1. Large tabular bodies of massive and disseminated antimonite ores, most often in carbonates and sandstones (sometimes with gold or mercury), with antimony contents of 2–5 %, sometimes up to around 10 %. This type accounts for around 75 % of world reserves and for about 60–70 % of world production. Examples: Gravelotte, United Jack (South Africa), Xikuangshan (Hsi-Kuang-shan, China), Sarylach (Russia), Kadamzhay (Kyrgyzstan), Costerfield (Australia).
2. Medium and small deposits of lode, stringer and disseminated polymetallic ores predominantly with antimonite, as well as with mercury, tin and tungsten ores with antimonite. These types account for 20–30 % of world reserves and for roughly 40 % of world production. Examples: Xian (China), Sunshine (USA), Bohutín (Czech Republic), Dúbrava, Rudňany (Slovakia), Baia Mare (Rumania).

According to the MCS 2008, world mine production of antimony in ores in 2007 reached 135 kt, of which 110 kt or 81.5 % was produced by China. Other important producers worth mentioning are Bolivia (5.2 %) and South Africa (4.4 %).

Foreign trade

261710 – Antimony ores and concentrates

	2004	2005	2006	2007	2008
Import, kg	20	30	N	N	N
Export, kg	0	0	N	0	0

8110 – Antimony and articles thereof, including waste and scrap

	2004	2005	2006	2007	2008
Import, t	14	72	N	N	N
Export, t	4	2	N	N	N

Arsenic

Arsenic is a chalcophile element that occurs naturally, most often in the form of sulphosalts and arsenides. The most important minerals are arsenopyrite (46 %) and lollingite (72.8 %). It is mainly obtained from complex ores (Cu, Pb, Zn) and sulphide ores.

Arsenic is used in the chemical industry, in the production of preservatives and pesticides and, in small amounts, also in the production of some special alloys. Due to its high toxicity, its use is restricted and primarily involves preservation of construction timber.

World reserves of arsenic in copper and lead ores are estimated at about 11 million tonnes. Deposits of copper ores in northern Peru and the Philippines, and deposits of copper-gold ores in Chile contain substantial reserves of arsenic. Canadian gold ore deposits also contain substantial amounts of arsenic.

Currently no deposit is known, where arsenic ores are mined as the principal raw material. The following are examples of world-renown deposits, whose ores contain substantial amounts of arsenic: Boliden (Sweden – 6–8 % As), Złoty Stok (Poland – 7–35 % As), Bou Azzer (Morocco), Kounrad (Kazakhstan), Shuikoushan (China), Lupin Mine, Hemlo (Canada), Nchanga (Zambia), Lepanto (Phillipines), El Indio (Chile).

The MCS 2008 lists world production of arsenic in stockpiled ores in 2007 at 59 kt. The majority (50.8 %) of this production comes from China. Other important producers are Chile (19.5 %), Morocco (11.7 %) and Peru (5.9 %).

Foreign trade

280480 – Arsenic

	2004	2005	2006	2007	2008
Import, kg	8 158	16 432	N	N	N
Export, kg	0	0	0	0	N

Beryllium

Beryllium belongs mainly to lithophile elements with a high affinity for flourine. It is known for its light weight (1.847 g/cm³) and, at the same time, for its substantial hardness, high elasticity and thermal conductivity, as well as also for the lowest thermal neutron capture cross section. During magmatic differentiation, it concentrates in late-stage products, primarily in pegmatites. The most important minerals are beryl $Be_3Al_2Si_6O_8$ (10–12 % BeO), phenakite Be_2SiO_4 (40–44 % BeO), bertrandite $Be_4Si_2O_7(OH)_2$ (40–42 % BeO), chrysoberyl Al_2BeO_4 (18–20 % BeO) and helvine $(Mn,Fe)_4BeSiO_4)_3S$ (12–13 % BeO).

Due to its exceptional physical properties, beryllium is widely used in the nuclear industry, aerospace and aviation, in the manufacture of ballistic missiles, and in submarine construction despite its toxicity. Beryllium alloys with copper, zinc, lead and tin are non-sparking, and alloys with aluminium and magnesium belong to ultra-lightweight materials. Beryllium-copper alloy is in great demand and has the specific designation BCMA (beryllium-copper master alloy). The above-mentioned applications account for roughly 80 % of the world´s production of beryllium metal and alloys.

World reserves are not exactly known and are estimated roughly at 80 kt of beryllium, predominantly in nonpegmatite deposits. Around 65 % of these are located in the USA. From an industrial perspective, beryllium deposits can be subdivided into two basic groups:

1. Pegmatite deposits mostly with beryl, from which mainly beryl is recovered simultaneously with muscovite and with tantalum and lithium minerals. The deposits are mostly small to medium-sized lens-shaped bodies with BeO contents of up to 10 %. Examples: Bernick Lake (Canada), Black Hills (South Dakota, USA), Bikita (Zimbabwe), Malakialina (Madagascar), Nerchinsk (Russia), Darahhe-Pech (Afghanistan), Travancore (India).
2. Extensive plutogenic, volcanogenic and metasomatic bodies mostly composed of bertrandite, and also of phenakite, helvine etc. Reserves are estimated at up to tens of thousands of tonnes with BeO contents of 0.4–1.5 %. Examples: South Indian Lake (Canada), Spor Mountain and Gold Hill (Utah, USA – bertrandite with 18 kt of beryllium reserves), Seward Peninsula (Alaska, USA).

According to the MCS 2008, world production of beryllium in 2007 reached about 130 tonnes, of which 77 % came from deposits of the USA, 15.4 % from China and 4.6 % from Mozambique.

So far, the only Chinese producer with a production capacity of 150 metric tonnes per year (t/y) of BeO and of 1,500 t/y of beryllium-copper master alloy is based in Changning City (Hunan). A new facility, with a capacity of 100 t/y of BeO and 800 t/y of beryllium-copper alloy, is being built in the Uygur Autonomous Region, which will process raw material from the Keketuohai mine (Fuyun, Xinjiang).

Foreign trade

811212 – Unwrought beryllium, beryllium powders

	2004	2005	2006	2007	2008
Import, kg	0	0	600	0	9
Export, kg	0	0	0	0	0

Bismuth

Bismuth is a white metal with a pink tinge, shiny, almost brassy to brightly coloured. It occurs naturally in native form and in a number of minerals, of which more than 90 are known.

Native bismuth, bismuthinite Bi_2S_3 and bismite (bismuth ocher) Bi_2O_3 have practical importance. Bismuth is most often used in fusible (low melting) alloys for the manufacture of special solders etc. A new zinc-bismuth alloy is used in galvanising. Bismuth is also used in the production of lubricants, particularly for extreme pressure, and also in the fabrication of ceramic glazes, and in the production of crystal glass and pigments. Superconducting ceramics are composed of bismuth-strontium-calcium- and copper-oxides. Bismuth compounds are used in the pharmaceutical industry. Bismuth is also used as an additive in metallurgy and is finding multi-purpose application as a nontoxic subsitute for lead.

More than 90 % of bismuth is recovered during the processing of lead, tungsten, tin, copper and silver ores. Isolated deposits of bismuth ores are mined in China and Bolivia.

World bismuth reserves are estimated at about 680 kt and are found mostly in lead deposits. From an industrial perspective, bismuth ore deposits can be subdivided into two groups:

1. Deposits of lead ores, ores of the five-element association, copper ores, tungsten ores and copper-gold ores, from which bismuth is recovered as a byproduct. These account for about 90 % of world production and for about 70–75 % of world reserves. Examples: Adrasman (Cu-Bi, Kazakhstan), Salsigne (Au-Ag-Bi-As, France), Sangdong (W-Bi, South Korea), Xihuashan (W-Bi, China), Mt. Pleasant (W-Mo-Bi-Sn, Canada), Tennant Creek (Au-Bi-Cu, Australia), Bonfim (Brazil), Nui Phao (Vietnam).
2. Deposits of bismuth ores of various genetic types, which account for less than 10 % of world production and for about 30 % of world reserves. Examples: China, Tasna (Bolivia), Ustarasay (Kazakhstan).

The MCS 2008 lists world mine production of bismuth in 2007 at 5,700 t. The leading producer is China with a 52.6 % share of world production, followed by Mexico with 21.1 % and Peru with 16.8 %. Consequently, the world´s three leading producers account for more than 90 % of world bismuth production.

Foreign trade

81060010 – Unwrought bismuth, including waste and scrap, powders

	2004	2005	2006	2007	2008
Import, kg	53 316	43 673	67 028	63 999	59 569
Export, kg	400	0	0	1	437

81060090 – Wrought bismuth, articles of bismuth, excluding unwrought bismuth, waste, scrap and powders

	2004	2005	2006	2007	2008
Import, kg	11 121	9 994	10 046	13 392	18 073
Export, kg	115	5 979	484	2 599	2 882

Cadmium

Cadmium is a typical chalcophile element, which is most often associated with zinc minerals, primarily sphalerite. In oxidised zones of zinc ore deposits, cadmium forms its own minerals that are, however, practically insignificant.

Part of the produced cadmium is used to protect metal surfaces against corrosion. However, it cannot be used for articles that come into contact with food because it easily reacts with acids, and because soluble compounds of cadmium are highly toxic. Until recently, the majority of cadmium was used in the manufacture of nickel-cadmium accumulators, and cadmium-silver and mercury-cadmium cells (around 83 %). However from an environmental protection perspective, their use is being systematically restricted. Lesser amounts of cadmium are used to stabilise plastics, and also in the manufacture of pigments, solder alloys and low melting metals (e.g. Wood´s metal). As of 2006, various measures, which systematically restrict the use of cadmium in electrical engineering and electronics, are gradually coming into effect in the European Union.

World reserves of cadmium are estimated at 490 kt of metal in proved reserves and another 1,200 kt in the reserve base. The MCS 2008 lists total world resources at 6 million tonnes, based on zinc ore reserves whose average content is thought to be around 0.3 % cadmium. Cadmium is recovered as a byproduct of the metallurgical processing of zinc concentrates. In the USA for example, the majority of cadmium comes from ores of the polymetallic Red Dog deposit.

In terms of the total reserve base of cadmium ores, China ranks first with a 23.3 % share, followed by Australia with a 21.7 % share, Kazakhstan with 7.4 %, Peru with 7.3 %, and then Canada (7 %), the USA (5.6 %), India (4.1 %) and Mexico (3.3 %). Another potential source of cadmium is the cadmium content in many bituminous coal deposits.

According to the MCS 2008, the Republic of Korea was the leading producer of refined cadmium in 2007 with a share of 18.1 % of world production, followed by China (17.1 %), then Canada and Japan (10.6 % each), and Kazakhstan (10.1 %).

Foreign trade

810720 – Unwrought cadmium, cadmium powders

	2004	2005	2006	2007	2008
Import, kg	261	1 927	N	N	N
Export, kg	0	1	0	0	0

Chromium

In nature, chromium is associated with ultrabasic and basic igneous rocks, and 25 minerals containing chromium are known. Chromium ores are formed by chromites (chrome-spinellids), whose general formula is $(Mg,Fe)O.(Cr,Al,Fe)_2O_3$. Depending on their composition, chromites contain 18-65 % of Cr_2O_3, and titanium, manganese, vanadium, nickel, cobalt, zinc etc. are usually also present.

Chromium is an important alloying additive in steelmaking (about 65 % consumption) and around 20 % of chromites are used in the production of refractories, and slightly less is consumed by the chemical industry.

World resources of commercial chromites are estimated at about 12 billion tonnes. Around 95 % are found in the Bushveld Igneous Complex in South Africa, and in Kazakhstan. The subdivision of chromite ores into metallurgical, chemical and refractory raw materials is important in terms of industrial use. A minium Cr_2O_3 content of 48 % is required for metallurgical purposes, at least 44 % of Cr_2O_3 for chemical industry purposes, and 32 % of Cr_2O_3 for refractory industry purposes.

Chromite deposits are generally formed by disseminated ores in ultrabasic and basic igneous rocks. Average Cr_2O_3 contents range between 25-50 %. Examples: deposits in the Bushveld Igneous Complex (South Africa), deposits in the Great Dyke (Zimbabwe), Kempirsai Massif (Kazakhstan), Saranovskoye (Ural), Kemi (Finland), Coobina (Australia).

According to the MCS 2008, world mine production of chromite reached about 20 million tonnes of chromite ore. South Africa accounted for 37.5 % of the production, and India and Kazakhstan for 18 % each.

Foreign trade

2610 – Chromium ores and concentrates

	2004	2005	2006	2007	2008
Import, t	11 431	12 717	N	N	N
Export, t	236	570	N	N	N

811881 – Unwrought chromium

	2004	2005	2006	2007	2008
Import, kg	54 201	75 873	N	N	N
Export, kg	58	15	N	N	N

Cobalt

Cobalt often occurs naturally in combination with nickel associated with basic and ultrabasic igneous rocks and their products of weathering. It is also present in a number of copper ore deposits and in deposits of the so-called five-element assemblage (along with Ag, Ni, Bi and U). The principal minerals of primary ores are cobalt-bearing pentladite $(Fe,Ni,Co)_9S_8$ (up to 3 % Co), linnaeite Co_3S_4 (57.96 % Co), cobaltite CoAsS (35–41 % Co), glaucodot (Co,Fe)AsS (23.85 % Co) and safflorite $(Co,Fe)As_2$ (28.23 % Co). In terms of secondary minerals, the most important are asbolane $(Co,Ni)O_2.MnO.nH_2O$ (up to 19 % Co) and erythrine $Co_3(AsO_4)_2.8H_2O$ (11–29 % Co).

Cobalt is used in metallurgy for the production of so-called superalloys, magnetic alloys and heat-resistant tool steel. It is also used in the chemical, ceramics and glassmaking industries, and in the manufacture of paints.

Known world reserves of cobalt contained in ores are estimated at about 13 million tonnes, of which around 36 % is in Congo (Kinshasa) and about 13–14 % each in Cuba and Australia. In the case of Congo and Zambia, cobalt is present in stratiform copper ore deposits. In Cuba, cobalt is contained in lateritic ores and, in Australia, in primary as well as residual ores. On a global scale, reserves of lateritic ores are more abundant than those of sulphide ores.

In terms of industrial importance, cobalt ore deposits may be subdivided into two basic types:

1. Large and medium deposits of mainly disseminated primary copper-cobalt sulphide and copper-nickel sulphide ores in various rocks with cobalt contents above 0.5 %. This type accounts for 35–40 % of the world reserves and for more than 65–70 % of world production. Examples: Konkola (Zambia), Kipushi (Congo-Kinshasa), Kobalt (Canada), Jáchymov (Czech Republic), Alligator River (Australia), Norilsk (Russia), Bou Azzer (Morocco).
2. Extensive residual nickel-cobalt ore deposits with cobalt contents of around 1 % and more. Although lateritic ores prevail in terms of reserves and resources (more than 60–65 %), they only represent around 30 % of world production. Examples: Moa (Cuba), Bulong (Australia), Poum (New Caledonia).

The MCS 2008 lists mine production of cobalt ore in 2007 at 62.3 kt of metal. The largest producer is Congo (Kinshasa) with a share of 36.1 % of world mine production. Canada (12.8 %), Australia (12 %) and Zambia (11.2 %) are next, followed in fifth place by Russia (8 %) and in sixth by Cuba (6.4 %). China ranks seventh (3.7 %), New Caledonia eighth (3.2 %), Morocco ninth (2.4 %), and Brazil tenth (1.9 %). Consequently, the first seven countries account for more than 90 % of global cobalt ore production.

Foreign trade

2604 – Cobalt ores and concentrates

	2004	2005	2006	2007	2008
Import, kg	1 550	455	N	N	N
Export, kg	29 565	1 000	N	N	N

8105 – Cobalt mattes and other intermediate products of cobalt metallurgy; cobalt and articles thereof, including waste and scrap

	2004	2005	2006	2007	2008
Import, t	81	77	N	N	N
Export, t	10	3	N	N	N

Gallium

Gallium is an element of lithophile character and its behavior in nature is similar to that of aluminium. It does not form economically important independent minerals. Easily obtainable amounts of gallium occur as an admixture in bauxites and zinc concentrates.

The highest amount of gallium (98 % in the USA in 2006) is used in the form of GaAs (gallium arsenide) and GaN (gallium nitride) in optoelectronics for the manufacture of light-emitting diodes, laser diodes, photodetectors and solar cells.

The majority of world gallium production comes from the processing of bauxites, and the rest is recovered from technological residues from the processing of zinc concentrates. Contents exceeding 50 ppm in bauxites or zinc ores are considered to be significant. World reserves of recoverable gallium in bauxite are estimated at approximately 1 million tonnes, and the reserves in zinc ores also reach a respectable level.

Detailed data on world producers are not published. World primary production in 2007 is estimated at 80 tonnes (according to the MCS 2008). The leading producers are China, Germany, Japan and Ukraine, followed by Hungary, Kazakhstan, Slovakia and Russia.

Foreign trade

81129289 – Unwrought gallium, gallium powders

	2004	2005	2006	2007	2008
Import, kg	2	0	0	0	0
Export, kg	0	0	0	0	0

Indium

Indium is an element of chalcophile character, which concentrates in significant amounts during hydrothermal processes mainly in association with tin. Even though it forms several minerals, primarily its concentrations in the form of solid solutions in sphalerite are of practical importance, whereby iron-rich, black sphalerites are known for their elevated indium concentrations.

The leading use of indium is in electronics, where it is used to produce thin-film coatings in liquid crystal displays and electroluminescent lamps. Indium semiconductor compounds are used in infrared detectors, high-speed transistors and in high-efficiency photovoltaic devices. In the past year, a slight increase in consumption occurred in semiconductor applications and the consumption volume of other applications remained stable in technologically advanced countries: coatings around 45 %, solder and alloys about 30 %, electronic components and semiconductors around 15 %, other uses about 10 %.

World resources are estimated at 16 000 tonnes. Indium is recovered almost exclusively as a byproduct of the processing of zinc ores, in which recoverable amounts range between 1–100 ppm. Although the highest indium concentrations are known to occur in vein and metasomatic deposits of tin-bearing ores, this type is generally economically unviable.

US statistics for 2007 (MCS 2008) list world refinery production of indium at 480 tonnes. The largest share of the production belongs to China (49 %), followed by the Republic of Korea (16.7 %), Japan and Canada (9.8 % each).

Foreign trade

81129281 – Unwrought indium, indium powders

	2004	2005	2006	2007	2008
Import, kg	29	12	56	2	25
Export, kg	0	0	0	0	0

Magnesium

Magnesium is an element of lithophile character and is one of the most abundant elements in the Earth´s crust. Ultrabasic rocks are known for their elevated magnesium content. Magnesium occurs in seawater and is also abundant in brines and evaporite rocks. A substantial amount of world production comes from seawater and brines. The rest is recovered from deposits of magnesite ($MgCO_3$), dolomite [$(Ca,Mg)CO_3$], brucite [$Mg(OH)_2$], olivine [$(Mg,Fe)_2SiO_4$] and evaporites, which contain magnesium salt (carnallite, bischofite).

The majority of magnesium compounds are used in the production of refractories*. In addition, various applications exist in agriculture, chemistry, construction and in environmental care. Alloys of magnesium with aluminium, zinc and manganese are known for their high strength and low weight.

The annual world production volume of magnesium ranges around 4 million tonnes. The deposits in the Earth´s crust can be subdivided into three industrial groups:

1. Underground brine deposits and, in some cases, surface deposits. Nearly a third of world production comes from these deposits, and reserves are estimated at billions of tonnes of magnesium. Examples: Manistee (Michigan, USA), Great Salt Lake (Utah, USA), Laguna del Rey (Mexico), Dead Sea (Israel).
2. Extensive bodies of dolomite, magnesite and brucite. World reserves of magnesite are estimated at 12 billion tonnes of magnesium, at hundreds of millions of tonnes of brucite, and at tens of billions of tonnes of dolomite. World mine production of magnesium from these deposits exceeds half of the world´s production. Examples: Dashiqiao (China), Konya (Turkey), Satka (the Urals), Euboea island (Greece), Veitsch (Austria), Dúbrava (Slovakia).
3. Deposits of evaporite salts, from which magnesium is recovered together with mainly potassium salts. In this case, magnesium most often is a constituent of multi-compound industrial fertilisers and its production is not listed separately. Examples: Stassfurt (Germany), Solikamsk (Russia).

Another exploited source of magnesium metal is seawater.

According to the MCS (2007), a total of 4 050 kt of magnesium contained in magnesite was produced globally in 2006. China, which occupies the lead position, accounts for 34.6 % of this production. The share of second placed Turkey, which is also substantial, reached 21 % followed by North Korea (8.6 %) and Russia (8.1 %). The magnesite mined in these four countries represents 72.3 % of world mine production. The next group of producers is led by Austria in fifth (4.9 %) followed by Brazil in sixth (4.1 %), Spain in seventh (3.7 %), Greece in eighth (3.6) and Slovakia in ninth place (3.2 %). India rounds out the top ten (2.6 %) and Australia is eleventh (2.5 %). According to the MCS (2007), the reserve base reaches 3 600 000 kt of magnesium in magnesite, more than 60 % of which is found in three countries: China, South Korea and Russia (more or less 20 % each). These are followed by Slovakia with nearly a nine percent share of the reserve base volume.

According to the MCS (2008), primary production of magnesium metal was estimated at 670 kt. More than 80 % of the production came from the territory of China. Russia was second with a 7.5 % share and Israel third with 4.2 %.

* Note: Also see the chapter *Magnesite* in this yearbook.

Foreign trade

810411 – Unwrought magnesium, containing at least 99.8 % by weight of magnesium

	2004	2005	2006	2007	2008
Import, t	746	761	1 171	2 168	1 634
Export, t	0	0	0	74	138

810419 – Unwrought magnesium, containing less than 99.8 % by weight of magnesium

	2004	2005	2006	2007	2008
Import, t	284	407	55	1 336	2 119
Export, t	9 702	9 326	9 162	9 709	10 545

Mercury

Mercury has specific properties that differ from those of other metals. It evaporates at normal temperatures, its volume expands upon warming, and it dissolves other metals such as gold, silver, zinc, lead and aluminium and forms amalgams with them. Cinnabar (HgS) and native mercury belong to its principal minerals. It is produced from mercury, mercury-antimony, mercury-arsenic and mercury-gold ores.

Mercury was frequently used in medicine, the chemical industry, electronics, in the manufacture of explosives, the power industry and agriculture. Its use is being restricted due to its toxicity.

World resources of mercury in ores are estimated at about 600 kt, of which 47 % are concentrated in the unique Almaden deposit in Spain, nearly 20 % in Italy, and around 6 % in Kyrgyzstan.

Industrially important deposits can be subdivided into two basic groups:

1. Unique and large deposits of disseminated ores formed by stratiform bodies with mercury contents of up to 10–12 %. This type accounts for about 75 % of world reserves and for more than 75 % of world production. Examples: Almaden (Spain), Nikitovka (Ukraine), Chajdarkan (Kyrgyzstan), Wanshan (China).
2. Large and medium deposits of varying morphology often with antimony, gold-silver, tungsten-arsenic, tin and polymetalic ores. This type accounts for around 25 % of world reserves and about 25–30 % of world production. Examples: Monte Amiata (Italy), Idrija (Slovenia), Plamennoye (Chukchi Peninsula, Russia), Aktas (Altai, Russia), Islaim (Algeria), Rudňany (Slovakia).

Due to the low demand for mercury caused by its toxicity, fundamental changes in mercury ore mining have taken place in recent years. Even though mining at the unique world-renown Almaden deposit was stopped in 2003, Spain still remained the leading mercury exporter, evidently due to stockpiled reserves. A substantial part of world mine production, which the MCS 2008 lists at 1,500 t for 2007, comes from Chinese deposits (75.3 %). As far as other producers are concerned, only Kyrgyzstan is mentioned with a 16.7 % share of world production. However, these data do not include mercury produced during the processing of gold and silver ores, and possibly others.

Foreign trade

280540 – Mercury

	2004	2005	2006	2007	2008
Import, kg	7 311	1 116	N	N	N
Export, kg	22 183	8 376	N	N	N

Nickel

Natural concentrations of nickel in the Earth´s crust are associated with deep basic and ultrabasic magmatism. Nickel also concentrates during the weathering process of these rocks. There are 45 known nickel minerals. The most industrially important minerals in sulphide ores are pentladite (Fe,Ni)S (22–42 % Ni), millerite NiS (65 %) and nickelin NiAs (44%), and garnierite $NiO.SiO_2H_2O$ (46 % NiO) in silicate ores. Nickel is produced from nickel, copper-nickel and cobalt-nickel ores.

Nickel is known for its high chemical, thermal and mechanical stability and is, therefore, used as an alloying additive in the manufacture of stainless steel, which is responsible for two thirds of the world´s primary consumption of nickel. Nickel is also used in the automobile industry (NiMH batteries), aviation, nuclear industry, power industry, chemical industry etc.

The total resources of nickel in ores on the continents are estimated at about 150 million tonnes, of which known reserves with a nickel content above 1 % amount to roughly 130 million tonnes. In all, nearly 50 % of these reserves are in Australia, Cuba, New Caledonia and Canada. In Cuba and New Caledonia they are silicate ores, in Canada sulphide ores, and reserves of both ore types have been proved in Australia. On a global scale, laterites account for about 60 % of reserves and sulphide ores for 40 %. Apart from land-based reserves, extensive reserves of nickel occur in deep-sea manganese crusts and nodules, primarily at the bottom of the Pacific Ocean. In terms of industrial importance, mined deposits of nickel ores are subdivided into sulphide and silicate ores. Sulphide ores are technologically more suitable. The minimum average content is considered to be 0.5–1 % nickel; in the case of silicate ores, the requirements are higher: 1–2 % nickel.

As a result, two industrial types of nickel ore deposits can be classified:

1. Large to medium deposits of disseminated to massive sulphide ores in basic and ultrabasic magmatites. This type accounts for about 55–60 % of world production and for roughly around 40 % of the reserve base. Examples: Sudbury, Voisey's Bay (Canada), Norilsk, Monchegorsk (Russia), Emily Ann (Australia), Flying Fox (Western Australia – 1.3 million tonnes of ore at 4.8–6.8 % nickel!), Outokumpu (Finland), Aguablanca (Spain).
2. Gigantic to large deposits of lateritic ores in basic and ultrabasic massifs, primarily with contents of cobalt. This type accounts for 40–45 % of world production and for around 70 % of world reserves. Examples: Moa (Cuba), Falcondo (Dominican Republic), Goro (New Caledonia), Petea (Indonesia), Murrin Murrin, Ravensthorpe, (Australia), Shevchenko (Kazakhstan – 104 million tonnes of reserves at 0.79 % nickel).

World reserves of nickel ores reached 23 billion tonnes with an average grade of 0.97 %, therefore around 220 million tonnes of metal, of which 10.5 billion tonnes with an average content of 0.58 % nickel come from sulphide ores, while 12.6 billion tonnes of lateritic ores have an average grade of 1.28 %. Of the lateritic ore reserves, 4 billion tonnes with a metal content of 1.55 % nickel are suitable for pyrometallurgy and 8.6 billion tonnes with an average metal content of 1.15 % for hydrometallurgical processing.

According to the MCS 2008, world mine production of nickel ores peaked in 2007 and is listed at 1,660 kt of metal. Russia ranks first with a share of 19.4 %, Canada second

(15.5 %) and Australia third (10.8 %), followed by Indonesia (8.7 %), New Caledonia (7.2 %), Columbia (6 %), the Philippines (5.3 %), China (4,8 %), Cuba (4.6 %), and Brazil is tenth (4.5 %).

Foreign trade

2604 – Nickel ores and concentrates

	2004	2005	2006	2007	2008
Import, t	12	8	8	13	10
Export, t	323	400	208	166	135

7502 – Unwrought nickel

	2004	2005	2006	2007	2008
Import, t	2 576	2 483	N	N	N
Export, t	967	73	N	N	N

Thallium

Thallium is a soft, shiny and white-coloured metal. Thallium and its compounds belong to highly toxic materials. The radioactive isotope 201 is used in medicine for cardiovascular disease imaging. Thallium is also used as a activator in scintillation counters. High-temperature superconductors contain thallium-barium-calcium and copper oxides. Thallium-arsenic-selenium crystals are part of acousto-optical measuring device. An alloy with thallium and mercury is used for low-temperature measurements. Thallium is also added to glass to increase its refractive index and density and is also used as a catalyst in organic compound synthesis and in the preparation of high-density liquids used for sink-float separation of minerals.

Thallium is recovered by processing flue dusts and residues produced by the smelting of copper, zinc and lead ores. According to the MCS (2009), world resources of thallium contained in zinc ores reach 17 kt, most of which are located in the USA, Canada and Europe. Another 630 kt of thallium are contained in world coal reserves.

According to the same source, world mine production of thallium in 2007 was estimated at 10 tonnes.

Foreign trade

811251 – Unwrought thallium

	2004	2005	2006	2007	2008
Import, kg	1	1	0	N	N
Export, kg	0	0	0	0	0

Thorium

Thorium is a slightly radioactive metallic element (α-emitter) that does not, however, have any stable isotope. Pure thorium is a silvery-white radioactive metal, yet oxidises relatively quickly. This element is found in rocks of the Earth´s crust and is a potential fuel in nuclear power engineering due to its very long half-life. Of all oxides, ThO_2 oxide has the highest melting point, 3,300 °C. Thorium also has the highest liquid range, between the melting point and boiling point, of any element, specifically 2,946 K. Thorium occurs in a number of minerals, the most industrially important of which is monazite, which contains 12 % ThO_2. Less common minerals with thorium include those, in which thorium is the principal component such as thorianite (70 % ThO_2) and thorite ($[Th,U]SiO_4$), and those such as euxenite, polycrase, zirkelite etc., which contain thorium in addition to a number of other elements, most often lanthanides.

Magnesium alloys with thorium produce high-strength and high-temperature metal. Thorium is considered to be a prospective alternative fuel for nuclear reactors. In addition to power engineering, thorium is used in many forms in demanding ceramic production, in welding electrodes, and because of its catalytic properties.

Practically the only source of thorium are monazite concentrates, which mainly contain lanthanides and from which thorium is recovered only as a byproduct. The mining of other minerals with an elevated ThO_2 content would only come into question in the case of a considerable increase in thorium demand, which is not expected for the time being.

Sources of thorium can be subdivided into two industrial types:

1. Gigantic and large monazite placers in recent and buried intertidal marine deposits in Australia, Egypt, India, South Africa, Malaysia and in the USA (Powderhorn, Colorado).
2. Large and medium-large deposits of monazite in primary ores, most often in pegmatites (e.g. Nellur, Travancore, India, South Dakota, Brazil, China), in carbonatites (e.g. Oka, Canada) or in uranium ores (e.g. Sunnyside Inglewood, Australia). Also included are occurrences of thorianite (Madagascar, Sri Lanka), thorite (e.g. Bancroft, Canada) and zirkelite ores (e.g. Jacupiranga, Brazil).

World production data for thorium are not available.

Foreign trade

28443061 – Thorium bars, rods, angles, shapes, sections, wire, sheets, strips

	2004	2005	2006	2007	2008
Import, kg	118	516	1 490	0	0
Export, kg	0	0	2	0	0

28443069 – Thorium other, not crude, waste, scrap, bars, rods, shapes, wire, sheets

	2004	2005	2006	2007	2008
Import, kg	0	0	1	1	0
Export, kg	0	0	0	1	0

28443099 – Thorium salts

	2004	2005	2006	2007	2008
Import, kg	1	45	0	0	0
Export, kg	0	0	0	0	0

Titanium is an element of lithophile character. It accumulates naturally during magmatic differentiation of basic magmas. Around 70 titanium minerals are known, of which ilmenite ($FeTiO_3$ – 31.6 %) and rutile (TiO_2 – 60 %), which have very frequent admixtures of vanadium, scandium, tantalum and niobium, are of highest practical importance. Other industrially important minerals are leucoxene (67.96 % TiO_2), anatase (TiO_2) and loparite (Na, Ce) TiO_3 (26.6 % Ti).

The largest consumer is the aerospace industry (72 % in the USA). TiO_2 is mostly used in the manufacture of titanium white. Titanium is also used to coat welding electrodes and during the production of carbide, chemicals and metal.

Deposits of primary titanium ores form magmagenetic bodies in anorthosites and gabbros (Canada, Russia) as well as in alkali rocks, where they are usually enriched by weathering (Brazil, South Africa, India). Industrially significant deposits can be subdivided into two groups:

1. Large and medium deposits of titanomagnetites in basic rocks and of titanite in apatite ores often with a TiO_2 content above 10 %. Examples: Gusevogorsk (the Urals), Chibiny (Russia), Damiao (China), Allard Lake (Canada), Powderhorn (USA), Campo Formosa (Brazil), Magnet Hill (South Africa).
2. Gigantic and large placers of ilmenite, rutile and zircon in recent as well as buried intertidal marine deposits and in weathered rocks with contents of tens and hundreds of kg/m^3. Examples: Irshinskoye (Ukraine), Murray Basin (Australia), New Zealand, Truro (Canada), Florida (USA), Corridor Sands, Moma (Mozambique), Sierra Rutile (Sierra Leone), Fort Dauphin (Madagascar), South Africa, India.

However, the most industrially important types are placer deposits, specifically beach placers (Australia, India). Australian beach sands, which contribute significantly to titanium mineral production, account for about a fourth of the world´s ilmenite concentrate ($FeTiO_3$) production (1.4 million tonnes), for nearly half of the world´s rutile (TiO_2) production (300 kt), and for basically the entire world production (35 kt) of leucoxene (a mixture of Fe-Ti oxides). Another significant producer is the Republic of South Africa (Richards Bay Minerals company). World production of ilmenite in 2007 amounted to roughly 5.7 million tonnes and is estimated to be 5.6 million tonnes in 2008. About 92 % of global titanium consumtion (2007) comes from ilmenite concentrates. In terms of the leading producers of ilmenite, Australia (24 %) is followed by South Africa (19 %), Canada (14 %), China (10 %), India (7 %) and Norway (7 %). World production of rutile is considerably lower. In 2007, it amounted to 0.564 million tonnes, and the estimate for 2008 stands at about 0.61 million tonnes. Australia (53 %) and South Africa (19 %) also belong to the leading producers of rutile, followed by African Sierra Leone (14 %) and Ukraine (10 %).

World reserves of ilmenite are estimated at roughly 1 billion tonnes of TiO_2. Known world reserves of rutile (including anatase) reach about 230 million tonnes of TiO_2.

Foreign trade

2614 – Titanium ores and concentrates

	2004	2005	2006	2007	2008
Import, t	75 101	80 407	149 924	179 322	195 808
Export, t	873	340	492	745	641

8108 – Titanium and products of it, including waste and scrap

	2004	2005	2006	2007	2008
Import, t	800	1 045	1 157	1 097	1 125
Export, t	191	338	434	148	118

Vanadium

Vanadium occurs naturally in magmatic rocks along with iron and titanium, and, under exogenetic conditions, accumulates in the pigment of black shale and also in sedimentary iron ores, bauxites, phosphates, and in coal and crude oil deposits. The principal minerals are titanomagnetites with V_2O_5 contents of 0.3–10 %, and also roscoelite $KV_2AlSi_3O_{10}(OH)_2$ (19–29 %), carnonite $K_2(UO_2)_2(VO_4)_2.3H_2O$ (20 %), vanadinite $Pb_5(VO_4)_3Cl$ (19 %), decloizite (Zn,Cu)Pb $(VO_4)OH$ (20–23 %) and patronite VS_4 (29 % V_2O_5). Apart from naturally occurring minerals, steel slag (14–27 % V_2O_5) and slag and fly ash from oil-burning power stations as well as degraded vanadium catalysts are important sources of vanadium.

Vanadium is an important alloying additive in iron metallurgy, most often supplied in the form of ferrovanadium. Metallurgy consumes 80–90 % of vanadium. In the chemical industry, vanadium is used as a catalyst for the cracking of crude oil, in the manufacture of some acids and paints, and in rubber processing.

World reserves of vanadium are estimated at 63 million tonnes, of which China accounts for more than 37 %, South Africa for more than 29 %, and Russia for 23.5 %. However, these numbers are not very decisive because substantial amounts of vanadium are recovered as a byproduct of various raw materials that are, in addition to iron slag, primarily residues from the cracking of crude oil, from spent catalysts, from various types of fly ash etc. Oil shale and tar sands are also known to contain elevated contents of vanadium.

Industrially important deposits of vanadium-bearing ores can be subdivided into two groups:

1. Medium-large and small deposits of titanomagnetite ores with elevated contents of titanium, vanadium and, sometimes, also of platinoids. Examples: Kachkanar (the Urals), Lac Doré (Chibougamau mining district, Canada), Bushveld Igneous Complex (South Africa), Otanmäki (Finland), Panzhihua (China), Balla Balla (Australia).
2. Large and medium deposits of black shale, oil shale and tar sands with elevated contents of vanadium and possibly of uranium. Examples: Kafferskraal (South Africa), Grants, Lisbon Valley, Uravan (USA), Athabasca (Alberta, Canada), Minas Ragra (Peru)*.

In terms of individual industrial types, it is impossible to estimate world reserves much less the global vanadium production due to the above-mentioned diverse sources for vanadium recovery.

The MCS 2008 lists the mine production of vanadium ores in 2007 at 58.6 kt, nearly all of which is split between South Africa (39.2 %), China (31.6 %) and Russia (27.3 %).

* The Minas Ragra deposit is formed by patronite with a substantial admixture of bitumen, and its ores contain up to 47 % vanadium, 1.87 % nickel and 0.18 % molybdenum. The deposit lies in the Peruan Andes at an altitude of 5,500 m, and was the world´s principal source of vanadium up to 1956.

Foreign trade

81129291 – Unwrought vanadium, vanadium powders, excluding waste and scrap

	2004	2005	2006	2007	2008
Import, kg	0	0	0	0	0
Export, kg	0	0	0	628	0

Industrial minerals

Andalusite, kyanite, sillimanite, mullite

Andalusite, kyanite (formerly named also disthen) and sillimanite are mutually polymorph minerals with a high Al content. Andalusite is a typical mineral of metamorphosed rocks. Kyanite occurs especially in crystalline schists (micaschists, gneisses) rich in Al, less frequently also on contacts, in granulites and eclogites. Locally, it forms even individually exploitable deposits of the practical importance. Sillimanite occurs in metamorphic rocks and in pegmatites, too. Mullite – the main component of special refractory materials – is formed at temperatures above 1,100 °C. Mullite ($2Al_2O_3.2SiO_2$) is a mineral, which forms by heating of all aluminosilicates. Elongated acicular crystals, which form from small crystals during cooling of the melt, penetrate the melt and strenghten the burnt material. Mullite gives the most important technological properties to a number of refractory products (e.g. fireclay). Refractoriness, heat resistance, resistance against temperature changes etc. increase with increasing mullite content. All the sillimanite group minerals represent a very valuable raw material appreciated especially for its toughness, resistance against high temperatures, low expansion, and excellent isolation properties as well as resistance against corrosion. It serves for production of special types of porcelain, furnace lining etc. World mine production is estimated at 400 ths tonnes per year. South Africa (andalusite, sillimanite), the USA, France and India represent the main producers.

Foreign trade

250850 – Andalusite, kyanite and sillimanite

	2004	2005	2006	2007	2008
Import, t	3 333	3 184	5 248	4 570	5 830
Export, t	0	15	0	0	0

250860 – Mullite

	2004	2005	2006	2007	2008
Import, t	446	549	1 502	1 037	857
Export, t	72	192	608	117	0

Asbestos

Term asbestos is used for technically utilizable solid mineral fibres of variable mineralogical composition. The asbestos of the highest quality is formed by flexible chrysotile fibres, less commonly by amosite and crocidolite. Brittle fibres have usually composition of anthophyllite. Less important is amphibole asbestos formed by tremolite or actinolite.

Asbestos deposits originate by hydrothermal processes connected with metamorphism of ultramafic rocks, dolomitic limestones or ferruginous sedimentary formations.

The asbestos quality is given by length of fibres and their flexibility. The most expensive is so-called textile asbestos; the raw material of the lowest quality is used in production of asbestos-concrete products. The extent of asbestos use (e.g. in brake lining in car industry) has been restricted for health and ecological reasons during the last years. Chrysotile asbestos covers about 90 % of the world production; two thirds of the remaining 10 % are represented by crocidolite and one third by amosite. World mine production of asbestos was estimated at 2,200 kt in 2007; 925 kt of this amount was produced in Russia, approximately 380 kt in China, 350 kt in Kazakhstan, approximately 230 kt in Brazil, approximately 185 kt in Canada and 100 kt in Zimbabwe.

Foreign trade

2524 – Asbestos

	2004	2005	2006	2007	2008
Import, t	2 891	0	0	1	1
Export, t	248	1	0	0	0

Magnesite

Magnesite ($MgCO_3$) is the most important mineral of magnesium*. It occurs in crystalline and massive (crypto-crystalline) form. Crystalline magnesite grain size is below 10 mm. Massive magnesite is characterised by grain size of 0.004 to 0.01 mm and conchoidal fracture resembling porcelain. Magnesite deposits are associated with rocks rich in magnesium – dolomites and serpentinites. Crystalline magnesite originates by hydrothermal Mg influx into carbonate rocks; massive magnesite originates by CO_2 addition to serpentinite, it can be however also of sedimentary origin. Magnesite usually contains various admixtures of CaO, Fe_2O_3, MnO, Al_2O_3, SiO_2 and others, which affect the quality of the material. The mineral is considered as magnesite providing it has MgO content above 40% and CaO content up to 4%. Both magnesite types are used for caustic clinker production for refractory materials, insulations and special cements. Magnesite is also used in chemical industry and in paper and synthetic silk production. Magnesite world mine production has been oscillating around 17 mill t in recent years (source Welt Bergbau Daten). The major producer of magnesite is China (39 %), followed by Russia (17 %), Turkey (12 %), Slovakia (9 %), DPR Korea (6 %), and Austria (6 %).

Foreign trade

251910 – Natural magnesium carbonate (magnesite)

	2004	2005	2006	2007	2008
Import, t	5 973	6 860	5 440	9 935	4 193
Export, t	1 033	1 586	48	39	29

251990 – Magnesia, fused, dead-burned, other magnesium oxides

	2004	2005	2006	2007	2008
Import, t	42 411	43 534	51 974	52 631	54 318
Export, t	2 758	4 695	4 067	3 930	1 107

* Note: Also see the chapter *Magnesite* in this yearbook.

Perlite

Perlite is a natural volcanic glass (hyaloclastite) formed largely by SiO_2 (65–78 %), mainly of rhyolite and sometimes andesite composition. It originates by lava disintegration in contact with water. Heating up to temperatures of about 1,000 °C results in abrupt expansion and formation of glass foam. During this process, the volume increases four to twenty times so that the density reaches values of 0.08 to 0.2 t/m^3. Expanded perlite is used in building industry for its both heat and sound insulation properties, for production of light weight concrete and in adsorption mixtures used for removing of oil slicks on the water surface. Adsorption properties of perlite are used also in production of feeding mixtures and litter. World mine production of perlite was estimated at 1,760 kt for the year 2007. The largest producers are Greece (about 520 kt), the USA (400 kt) followed by Turkey (270 kt), Japan (240 kt) and Hungary (70 kt). Slovakia with its deposit Lehôtka pod Brehy represents an important producer, too.

Foreign trade

25301010 – Perlite

	2004	2005	2006	2007	2008
Import, t	4 626	5 115	5 615	7 585	5 782
Export, t	61	73	36	83	99

Rock salt

Rock salt (halite) is a sedimentary rock composed mostly or completely of sodium chloride (NaCl). It usually originates by chemical sedimentation (evaporation) from true solutions. Two genetic types of halite deposits (in solid state) are distinguished: fossil stratified deposits and salt domes. New hypotheses on evaporate sedimentation presume sedimentation both on coastal supratidal mud platforms, or sabkhas and in deep sea basins that did not ever dry up and were not salt basins. Rock salt is used mainly in chemical industry for production of chlorine, soda and some inorganic salts (60 %), in the food industry as preservative (23 %), for roads sprinkling in winter (8 %), in rubber, paints, ceramics and agriculture. Salt is produced in more than 120 countries in the world; world mine production of rock salt reached about 260 mill t in 2007 Leaders in salt production are the China (23 %), the USA (17 %), Germany (8 %), India (6 %), Canada (5 %) and Australia (5%).

Foreign trade

2501 – Salt (inclusive table and denaturated salt), and pure sodium chloride; also in water solution

	2004	2005	2006	2007	2008
Import, t	909 965	840 204	1 152 750	563 061	610 947
Export, t	12 986	15 424	30 656	19 324	15 671

Sulphur

Sulphur resources are represented by native sulphur deposits and sulphide (or sulphate) deposits. Sulphur deposits are of volcanic, biogenous, oxidation or thermogenetic origin. Sulphur is mainly extracted as a by-product during crude oil, natural and industrial gas processing. Sulphur world production reached about 68 mill t in 2007. According to MCS, world sulphur leaders in 2007 were the USA (13 %), followed by Canada (13 %), China (12 %), Russia (10 %) and Japan (5 %). Germany (2.3 mill t in 2007) and Poland (1.3 mill t) are important native sulphur producers as well.

Foreign trade

2503 – Sulphur of all kinds, other than sublimed, precipitated and colloidal

	2004	2005	2006	2007	2008
Import, t	35 037	17 016	40 147	55 066	43 676
Export, t	10 207	9 296	11 719	5 579	16 670

2802 – Sulphur, sublimed or precipitated; colloidal sulphur

	2004	2005	2006	2007	2008
Import, t	70 158	89 614	70 555	57 410	65 241
Export, t	1 581	503	113	132	658

2807 – Sulphuric acid

	2004	2005	2006	2007	2008
Import, t	52 490	51 004	54 426	47 271	57 750
Export, t	47 490	50 224	62 666	59 839	69 069

Talc

Talc is a soft, white (without admixtures), flaky magnesium silicate $Mg_3Si_4O_{10}(OH)_2$ of melting-point from 1,200 to 1,500 °C. All admixtures containing Fe^{3+}, pyrite and Mn oxides represent undesirable impurities. Talc is characterised by chemical (acid and lye) resistance, low electric and heat conductivity, high sorption ability, perfect basal cleavage and pure white colour (some high grade varieties). Talc originates by SiO_2 addition to rocks rich in magnesium (dolomites, dolomitic limestones, magnesites and ultrabasic rocks) during the hydrothermal processes and regional metamorphism. Well-workable massive cryptocrystalline talc variety with high electric resistance is called steatite. Also rock mixtures of talc and magnesite, often with high chlorite content, called soapstone, have similar properties like talc. World mine production reached about 8.9 mill t in 2006 according to Mineral Commodity Summaries. The major producer of talc is China (34 % including pyrophyllite), followed with a large gap by the USA (10 %), South Korea (10 %), India (8.5 %), Brazil (5 %) and Japan (4 %).

Otherwise for pure talc, France's Rio Tinto Luzenac orebody remains one of the biggest producer in the world.

Foreign trade

2526 – Natural steatite; talc

	2004	2005	2006	2007	2008
Import, t	9 446	10 213	10 898	13 061	11 009
Export, t	172	292	201	340	386

Other raw materials used in industrial fertilizers production

The raw materials used in production of industrial fertilizers, either singly, or in combination, are divided in nitrogenous, phosphatic and potassic. Also microelements needful for sustenance of organisms (Ca, Mg, B, Cu, Fe, Mn, Mo and Zn) are included into this group. World demand of industrial fertilizers reached about 130 mill t N, 43 mill t P_2O_5 and 29 mill t K_2O in 2007.

Natural nitrates are known as the Chile saltpetre, they form a 100 km long, narrow deposit zone in the Atacama Desert in Chile. Production capacity of the Chile saltpetre reaches 1 mill t, whereas world production capacity of synthetic NH_3 is fluctuating around 150 mill t. The most used fertilizers with N contents are $(NH_4)_2HPO_4$ (diammonium hydrogenphosphate), $Ca(NH_2)_2$ (calcium amide) and $CO(NH_2)_2$ (urea).

There are two genetic types of natural phosphorus resources – endogenous and exogenous one. Exogenous deposits in sea sediments (about 80 % of the world production) and endogenous apatite deposits in alkaline igneous rocks (almost the total remaining production) are the most important resources for industrial fertilizer production. World production of phosphates oscillates around 48 % according to Welt Bergbau Daten. The most important producers of sedimentary phosphorites are the USA (about 25 %), China (about 20 %) and Morocco (about 20 % including the Western Sahara area). The major world apatite supplier is Russia.

Resources of potassic raw materials are represented almost exclusively by evaporite deposits occurring together with rock salt. There are two chemical types of evaporite deposits: deposits rich in Mg-sulphates (main minerals are carnallite, polyhalite and epsomite) and deposits poor in Mg (main minerals are sylvite and carnallite). World K_2O production reached about 33 mill t in 2007. The major producer Canada (33 %) is followed by Russia (190 %), Belarus (15 %) and Germany (11 %).

Foreign trade

3102 – Nitrogenous fertilizers

	2004	2005	2006	2007*	2008*
Import, t	515 058	518 701	522 851	175 393	211 841
Export, t	600 230	533 128	537 115	168 684	160 970

* since 2007 in tonnes of N

2510 – Natural phosphates

	2004	2005	2006	2007	2008
Import, t	24 282	22 634	28 141	33 954	20 928
Export, t	33	545	726	732	1 023

2809 – Phosphoric oxides and acids

	2004	2005	2006	2007*	2008*
Import, t	15 456	19 712	12 899	7 534	2 270
Export, t	30 520	43 789	43 382	21 623	20 781

* *since 2007 in tonnes of* P_2O_5

3103 – Phosphatic fertilizers

	2004	2005	2006	2007*	2008*
Import, t	14 466	14 763	13 575	7 004	8 036
Export, t	1 074	1 985	2 113	778	1 136

* *since 2007 in tonnes of* P_2O_5

3104 – Potassic fertilizers

	2004	2005	2006	2007*	2008*
Import, t	14 466	14 763	13 575	7 004	81 060
Export, t	1 074	1 985	2 113	778	1 665

* *since 2007 in tonnes of* P_2O_5

3105 – Fertilizers containing several elements

	2004	2005	2006	2007	2008
Import, t	117 648	105 612	118 939	160 925	154 614
Export, t	29 228	32 553	23 895	36 671	18 995