MINISTRY OF ECONOMY OF THE CZECH REPUBLIC

MINERAL COMMODITY SUMMARIES OF THE CZECH REPUBLIC

NATIONAL INFORMATION CENTRE OF THE CZECH REPUBLIC
DEPARTMENT GEOFOND
MAY 1994

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STATE TO DECEMBER 31, 1993

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INTRODUCTION

The handbook "Mineral Commodity Summaries of the Czech Republic", published in extended form, is intended to provide information for professionals and particularly for businessmen in order to assist them in developing small and medium size enterprises in mineral exploration and mining and, at the same time, to avoid violating relevant legislation and interests of mining organizations.
The publication also includes basic data extracted from the "Register of Reserves of Regale Mineral Deposits" which is further elaborated for only a limited number of Governmental Departments.
Information on prices of minerals, their technological parameters and uses, imports and exports, major mining companies and locations of mineral deposits is intended to assist in understanding the mineral potential of the Czech Republic and to stimulate and influence investment activities. The annually updated publication "Mineral Commodity Summaries of the Czech Republic" thus becomes an integral part of the whole information system focused on mineral policy of the Ministry of Economy of the Czech Republic.
Based upon progress in the national information system and international cooperation, the publication will be thoroughly supplied with appropriate statistical data and comments from readers will be taken into consideration when publishing further issues. Consequently, the authors would appreciate any comments on the subject.
The term mineral reserves refers to geological and/or total reserves which means original reserves within individual deposits, calculated according to a valid classification of reserves and conditions of their utilization. The basic data come from calculations of mineral reserves which were approved or verified by the former Commission for Classification of Mineral Resources and/or reserves approved by the Board of Regale Minerals, Exploration and Mining of the Ministry of Economy of the Czech Republic (formerly Commission for Projects and Final Reports) or those approved by former commissions for control and utilization of mineral reserves of individual mining and processing industries or by newly introduced mining companies.
The Ministry of Economy together with the Ministry of Industry and Commerce recently announced a project of recalculation of reserves of regale minerals which will lead in the next 2-3 years to a fundamental economic revaluation of the mineral wealth of the Czech Republic.

The year-book "Mineral Commodity Summaries of the Czech Republic" which is being published for the second consecutive year includes all minerals, i.e. metallic ores, mineral fuels, industrial minerals and building materials which are of economic importance and reserves on the territory of the Czech Republic. Each mineral is presented in an individual chapter which consists of ten parts.
Part 1. **Characteristics and uses** - provides a basic description of the mineral raw material, its abundance in nature, major minerals and general use.
Part 2. **Mineral resources of the Czech Republic** - describes major regions of their occurrence, characteristics of their deposits, types, production and potential use.
Part 3. **Registered deposits of the Czech Republic** - is based upon the register of mineral deposits of the Czech Republic and for the majority of minerals it includes a summary of individual deposits and their location. As for mineral fuels and some industrial minerals only regions are shown rather than single deposits. As for dimension stone and building materials, hundreds of these deposits are distributed over the whole territory of the Czech Republic. Consequently, no summary or location are given in this paragraph.

Part 4. **Reserves as of December 31, 1993.** These data are extracted from the "Reserves register" and give both economic (demonstrated and inferred) and non-economic reserves. These reserves are in many cases classified according to their mineral and technological types.
Part 5. **Domestic production** - includes not only a summary of production during the last five years but also data on imports and exports (based upon reliable data from the Czech Statistical Office), real consumption, dependence on imports and how much production is being exported. The considerable increase in exports of some minerals in 1993 has been attributed to the change of internal trade of the former Czechoslovakia to foreign trade between the Czech Republic and Slovakia, following the separation on January 1, 1993.
Part 6. **Mining companies in the Czech Republic.** This part gives a list of companies which are mining the given mineral on the territory of the Czech Republic. In the case of some minerals, only companies with large production are listed (for details contact Geofond).
Part 7. **World production** gives data on mining and production of commercial products for the last 5 years. Leading world producers and their share of world production are also given for the last statistically completed year.
Part 8. **World prices** - gives a summary of prices and their evolution in the last five years as well as prices based upon quotations whenever available or prices negotiated in contracts in 1993.
Part 9. **Recycling** - gives a brief description of possible recycling methods known in the world.
Part 10. **Substitutes** - this paragraph provides an appraisal of materials which can substitute for the given mineral (worldwide).

Numerous domestic data, foreign publications and even unpublished reports were used when compiling the present yearbook. Among materials consulted only the major ones are cited as follows:

Register of Reserves of Regale Deposits
Registers of the National Information Centre - Geofond
Reports and data on exports and imports of the Czech Statistical Office.
Periodicals : Mining Magazine, Mining Journal, Engineering and Mining Journal, Metal Bulletin, Metal Bulletin Monthly, Gas World International, etc.
UNCTAD reports
Mineral Commodity Summaries 1993, USBM
Minerals Yearbook 1991, USBM
Metal Bulletin's Prices and Data.

ABBREVIATIONS, SYMBOLS AND TECHNICAL UNITS

API	American Petroleum Institute
ATPC	Association of Tin Producing Countries
BGS	British Geological Survey
Btu	British thermal unit
CAD	Canadian Dollar
CFR	Cost and Freight (named port of destination)
CIF	Cost, Insurance and Freight (named port of destination)
DRI	Direct Reduction of Iron
EXW	Ex Works (named place)
FOB	Free on Board (named port of shipment)
GBP	Great Britain Pound
GBp	Great Britain pence
IPE	International Petroleum Exchange (London, UK)
ITGE	Instituto Tecnologico Geominero de Espana
kt	kiloton, 1000 t
lb	pound, 0.4536 kg
LME	London Metal Exchange
mesh	to designate screen size as the number of openings per linear inch
MJ	megajoule, 10^6 J
mtu	metric ton unit, 10 kg
N	not available or not reliable data
NYMEX	New York Mercantile Exchange
OPEC	Organization of Petroleum Exporting Countries
P.C.E.	pyrometric cone equivalent
ppm	parts per million, 0.0001 %
st	short ton, 907.2 kg
troy oz	troy ounce, 31.103 g
T/C	Treatment Charge, the amount per ton by a smelter for converting ore to metal
ÚCS	Central Tariff Board of the Czech Republic
USBM	United States Bureau of Mines
USD	United States Dollar
USc	United States cent
WMS	World Mineral Statistics

IRON ORE

1. Characteristics and use

Iron is a grey, highly malleable metal having specific density of 7.87 t/m^3 and a melting point of 1,536°C. It is the 4th rock-forming element in importance whose abundance in the Earth's crust is about 5 %. The highest concentrations of iron are connected with the occurrence of Precambrian sedimentary formations which are the largest world source of hematite. Another important source of iron is deposits of magnetite which originated either by segregation of magnetite in mafic magmatic bodies or through pyrometasomatic processes. Iron ores occur in the form of oxides, silicates and carbonates. In general, two types of iron oxides are mined worldwide - hematite Fe_2O_3 and magnetite Fe_3O_4 having up to 70 % Fe.

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 is used for other than metallurgical processes, such as heavy media, and the manufacture of cement, ferrites, feed-stuffs, coloring agents, etc.

2. Mineral resources of the Czech Republic

▪ Sedimentary deposits of iron ores occur in the Barrandien zone. These ores are of marine origin and of Ordovician age.

The ore forms mostly lenses. Early Ordovician ores contain mostly hematite (hematite-siderite ores). The content of iron is on average 25 to 30 %. Oolitic texture is characteristic of these ores.

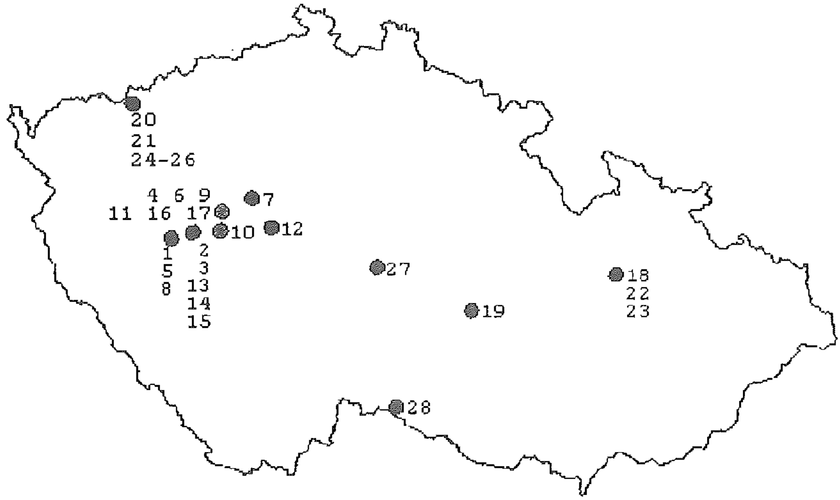
▪ Deposits of the Lahn-Dill type related to the submarine volcanic activities occur in the Moravian-Silesian Devonian. Most abundant is hematite, less abundant is magnetite and Fe-silicates. Magnetite of the Medlov deposit which was still mined in the sixties, similarly to the sedimentary deposits of the Barrandien zone, contained on average 38 % Fe.

▪ Pyrometasomatic deposits of magnetite are characteristic of skarns of the Moldanubicum crystalline unit and the Krušné hory unit. The content of Fe in ore of Měděnec and Přísečnice, which were mined as late as in 1992, was on average 33 %.

Deposits of the above mentioned three genetic types were mined in the past 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 Barrandien zone which were thermally treated through the Krupp-Renn process. Magnetite was mostly used for other than metallurgic processes, such as for production of cement (heavy concrete), as a heavy medium of jigs in coal preparation plants, etc.

The availability of higher-grade and relatively cheaper imported iron ores led to the gradual closing of iron mines on the territory of the Czech Republic.

3. Registered deposits and their location in the Czech Republic



Sedimentary iron ores:

1 Anton de Padua
2 Bechlov
3 Březina
4 Dlouhá Skála-Petrovka
5 Ejpovice
6 Chlustina
7 Chrbina
8 Klabava
9 Knížkovice
10 Komárov
11 Krušná Hora
12 Mníšek pod Brdy
13 Mýto-Cheznovice
14 Pohodnice
15 Rač
16 Velíz
17 Zdice

Magnetite:

18 Benkov-west
19 Budeč
20 Horní Halže
21 Kovářská
22 Králová
23 Medlov-Lazce
24 Měděnec-north
25 Orpus
26 Přísečnice
27 Vlastějovice
28 Županovice

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	519
A part of economic inferred reserves, in kt	12,232
Subeconomic reserves, in kt	479,739

5. Domestic production, imports and exports of the Czech Republic

During the observed 5 year period, two deposits of magnetite were mined in the Czech Republic - Mědĕnec and Přísečnice. Mining operations were terminated in 1992.

Year	1989	1990	1991	1992	1993
Mining output (T) in kt	84.0	93.0	102.0	64.0	0
Index of mining output evolution (1989=100)	100.0	111.0	121.0	76.0	0
Imports (D) in kt [a]	N	N	N	6,657.7	7,533.2
Exports (V) in kt [a]	0	0	0	0	0

Note:

[a] *item 2601 of customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2601	Iron ores and their concentrates incl. roasted pyrites	free	free

6. Mining companies in the Czech Republic

No mining companies were operating in the Czech Republic to extract iron ores.

7. World production

World production of iron ores has been generally on the rise since the nineteen-thirties with an average annual output of approx. 100 million tons, reaching its last peak in 1989 - 1,019 mill. tons. The important iron ore - producing countries are as follows (data in mill. tons, according to UNCTAD for 1992)

China	195.9	i.e.	21.7 %
Former USSR	162.0		17.9 %
Brazil	145.8		16.2 %
Australia	115.0		12.7 %
USA	54.9		6.1 %
India	54.9		6.1 %
other (less than 5 % share)	174.2		19.3 %
Total	902.7		100.0 %

8. World market prices

Prices of the European market are quoted in FOB for calendar year in USc/mtu. Prices FOB are being established with regard to shipping costs of the major suppliers 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.

Average FOB prices of iron ores in 1993 according to their type are as follows:

fines and concentrates	25 - 35 USc/mtu
lump ore	35 - 40 USc/mtu
pellets	45 - 55 USc/mtu

9. Recycling

Metal recycling is widely used. Iron scrap (steel scrap and cast iron scrap) are 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 63 % worldwide in 1990 whereas in the former Czechoslovakia it was only 40 %. 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 whose availability continues to decrease with increasing portion of continuous steel casting. Processing and particularly the still increasing consumer's share of iron scrap does not meet specific requirements of the steel industry. Electric furnaces have the major share consumption of iron scrap allowing as much as 100 % charge of iron scrap.

10. 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.

MANGANESE

1. Characteristics and use

Manganese is a hard, brittle, grey metal melting at 1,244°C and with a specific density of 7.4 t/m^3. Manganese is widely distributed and ranks 12th in abundance among elements in the Earth's crust. There are two principal types of manganese deposits - marine chemical sediments and deposits of oxidation zone enriched in manganese. The former type represents the majority of known reserves of manganese. Proven economic reserves occurring in the Earth's crust are equal to 3,630 mill. tons, of which reserves of high grade ore having over 44 % Mn represent 500 to 600 mill. tons. Inferred reserves confined to deep-sea nodules having an average content of 25 % Mn represent about 358 million tons of metal. Among 300 known manganese minerals only 12 are principal constituents of economic deposits. The following are the most important: pyrolusite, psilomelane, manganite, braunite, hausmannite and rhodochrosite.

More than 90 % of manganese is used in the iron industry in production of pig iron and particularly in the steel industry as a desulphurizing and deoxidizing agent and as an important alloying metal. Manganese is also used in alloys of non-ferrous metals (Al, Cu, Ti, Ag, Au, Bi). Another applications are in the manufacture of dry batteries, coloring matters, soft ferrites, fertilizers, feed for animals, fuel additives, welding electrodes, water treatment, etc.

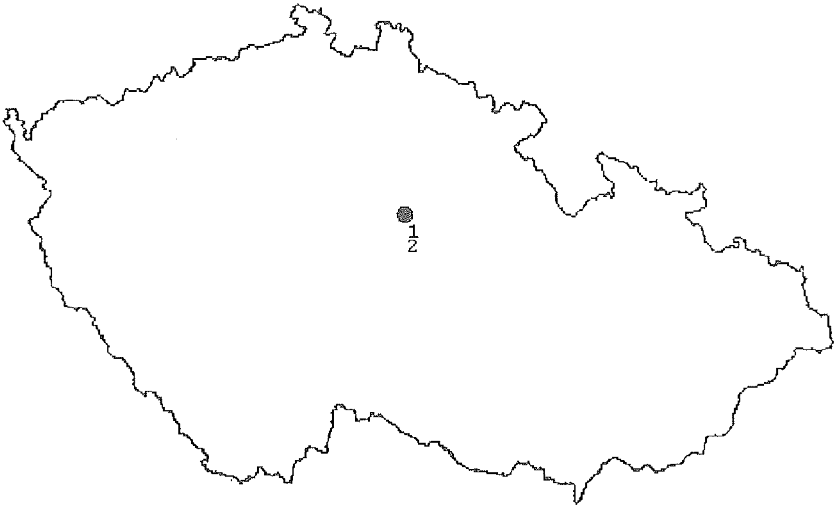
2. Mineral resources of the Czech Republic

Accumulations of Mn ores are known from the Železné hory mountains area where they are confined to volcaniclastic deposits of the Proterozoic. The mineralization is confined to a horizon of graphitic-pyritic slates which are 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 Chvaletice. Fe-Mn ores of the gossan type were mined in the past on the outcrops. Pyrite was mined in the fifties and sixties 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 tailings ponds at the former mineral processing plant.

Other Mn occurrences within the Czech Republic are insignificant. Among them the following can be quoted: hydrothermal veins with Mn oxides at Horní Blatná and Narysov near Příbram and residual ores at Maršov in west Moravia.

3. Registered deposits and their location in the Czech Republic



1 Chvaletice
2 Chvaletice - tailings ponds

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	0
A part of economic inferred reserves, in kt	0
Subeconomic reserves, in kt	134,405

5. Domestic production, imports and exports of the Czech Republic

No manganese deposits were mined on the territory of the Czech Republic during the observed 5 year period.

Year	1989	1990	1991	1992	1993
Imports (D) in kt [a]	91.8	N	16.3	42.7	13.4
Exports (V) in kt [a]	0	0	0	0	0
Apparent consumption (D-V) in kt	91.8	N	16.3	42.7	13.4
Dependence on imports in %	100.0	100.0	100.0	100.0	100.0

Note:

[a] *item 2602 of the customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in %	
		General	Concessionary
2602	Manganese ores and concentrates including Mn-Fe ores and concentrates with 20 wt% Mn or more (calculated on dry substance)	free	free

6. Mining companies in the Czech Republic

No mining companies were operating in the Czech Republic to extract manganese ores.

7. World production

Production of manganese ores is actually copying the production of iron ores because their consumption is connected with the production of pig iron and steel. So far the highest peak of production of manganese ores was reached in 1990 - 25 mill. tons. The major producers of Mn ores and their share on world production are as follows (data in kt according to the International Manganese Institute, 1992):

Former USSR (estimate)	6,500	i.e.	32.3 %
China (estimate)	4,100		20.4 %
South Africa	2,462		12.2 %
Brazil	1,900		9.4 %
Gabon	1,540		7.6 %
India	1,500		7.5 %
Australia	1,300		6.5 %
others (less than 5 % share)	828		4.1 %
Total	20,130		100.0 %

8. World market prices

Basically three types of manganese ore are traded on the world market - metallurgical ore (38 to 55 % Mn) 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 prices are quoted on a USD/mtu basis CFR Europe. The price in the eighties fluctuated on average around USD 1.5 per mtu until 1988. Shortly thereafter was a sharp rise in prices in 1990 and 1991 reaching as much as USD 4 per mtu. A decline to USD 2.15 - 2.25 per mtu occurred at the end of 1993. Prices of other manganese ores are generally negotiated prices as in the case of metallurgical ores.

9. 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 high in Mn as MnO and MnS are recycled to a certain extent. Manganese from used dry cells is also recycled to certain extent.

10. Possible substitutes

No substitute for manganese has yet been found in principal processes. In steel-manufacture, it can be substituted to a certain extent by other deoxidizing additives - silica, aluminium, complex alloys and rare earth oxides.

NICKEL

1. Characteristics and use

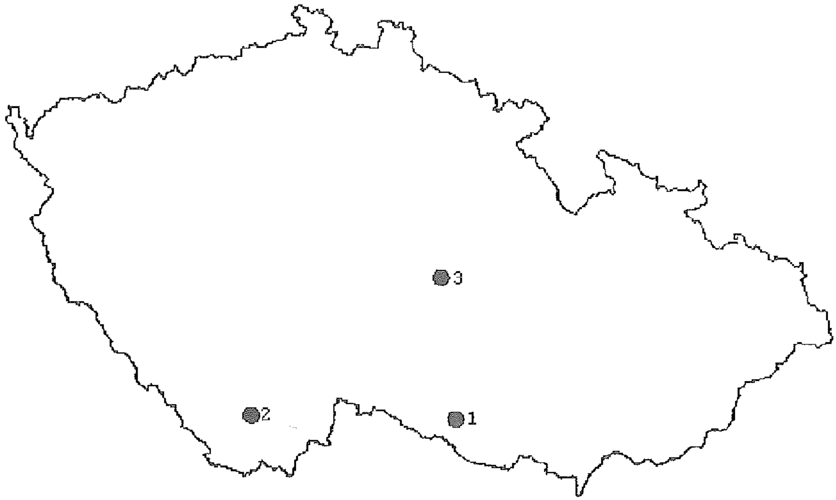
Nickel is a white, malleable and very hard metal melting at 1,455° C and with a specific density of 8.9 t/m^3. Its abundance in the Earth's crust varies between 0.008 up to 0.02 %. The majority of nickel deposits are confined to ultramafic rocks such as peridotite and serpentinite. Economic deposits are represented by sulphide mineral assemblages (40 % of world reserves) and by lateritic deposits (60 % of world reserves). Sulphide deposits are of magmatic or metamorphic origin. Major nickel minerals are pentlandite and nickel bearing pyrrhotite. Both minerals are usually accompanied by Cu minerals which are extracted as a by-product. Proved reserves with an average grade 1 % and higher are equal to 130 mill.tons of nickel metal. Lateritic deposits originated through weathering processes of ultramafic rocks (having max. 0.3 % Ni) exposed to extreme climatic conditions of subtropical and tropical zones with torrential rains. Weathering processes led to enrichment of Ni up to 3.5%. The major Ni mineral of these lateritic deposits is a hydrosilicate of Ni - garnierite $H_2(Ni,Mg)SiO_4$. Some nickel also occurs in the manganese ocean crust and deep sea nodules, particularly in the Pacific Ocean.

Steel mills and iron foundries account for 61 % of total nickel use worldwide (particularly stainless and heat-resisting steels having 7-12 % Ni). Other applications are in the production of common and special alloys (superalloys) used in machine and electrotechnical industries, for nickel electroplating, etc.

2. Mineral resources of the Czech Republic

Lateritic residual deposits of nickel originated by weathering of serpentinite bodies in the Bohemian (Křemže) and Moravian (Bojanovice) parts of the Moldanubicum. Ni mineralization at Křemže occurs in the lower, locally up to 18 m thick, layer of the lateritic body. Ni content of the ore, being on average 0.4 - 0.7 %, is confined to Ni-hydrosilicates, particularly garnierite with an admixture of pimelite, schuchardtite and others. The deposit was mined during and for a short period after World War II. Moravian lateritic deposits have little or no garnierite and nickel contents ranging on average between 0.6 and 1.0 % are confined to Ni-chlorites, Ni-montmorillonite and Ni-nontronite. Sulphide type of Ni-mineralization is represented by Cu-Ni liquid magmatic deposit of Staré Ransko in gabbroid rocks of the Ransko Massif. Disseminated ore having about 0.16 % Ni and 0.2 % Cu consists mostly of pyrrhotite and less abundant chalcopyrite and pentlandite.

3. Registered deposits and their location in the Czech Republic



1 Bojanovice
2 Křemže
3 Staré Ransko

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	0
A part of economic inferred reserves, in kt	62,397
Subeconomic reserves, in kt	49,419

5. Domestic production, imports and exports of the Czech Republic

No manganese deposits were mined on the territory of the Czech Republic during the observed time period. Data on imports and exports (item 2604 of the customs tariff) are not reliable and therefore are not quoted.

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in %	
		General	Concessionary
2604	Nickel ore and concentrates	free	free

6. Mining companies in Czech Republic

No mining companies were operating in Czech Republic to extract nickel ores.

7. World production

World production of Ni ores shows an increase similar to that of iron ores because its major use is in steel manufacture. So far the highest production was reached in 1990 - 1,046 kt of nickel metal. The major producing countries of Ni ores and their share of world production are as follows (data in kt of Ni content according to the USBM, 1992):

Russia	225	i.e.	24.6 %
Canada	214		23.4 %
New Caledonia	95		10.4 %
Australia	70		7.6 %
Indonesia	70		7.6 %
others (less than 5 % share)	242		26.4 %
Total	916		100.0 %

8. World market prices

Nickel ores are not quoted on the world market, and sales are based upon negotiated prices. Prices of 99.8 % Ni metal are commonly quoted at LME. The highest peak price to date was in 1988 - USD 13,797 per t. Since then the price has been decreasing, being USD 5,280.52 per ton (Cash).The decline in prices is due to a decrease in demand because of the decrease in steel production and due to a higher proportion of metal recycling.

9. Recycling

The proportion of recycled metal of its total consumption continues to increase. It reaches up to 30 % of consumption in some countries.

10. Possible substitutes

An effort to find a substitute for nickel was stimulated by its high price and other economic reasons. Present and future possible substitutes include aluminum, metal coated steel and plastics in the building and transport industries, special nickel-free steels in power plants and the petroleum chemical industry, plastics in corrosive environments and platinum, cobalt and copper for catalysts.

COPPER

1. Characteristics and use

Copper is a soft and malleable metal of golden red color, melting at 1,083°C and with a specific density of 8.96 t/m^3. Its average abundance in the Earth's crust is 0.0063 %. Copper deposits can be divided in five groups, according to their origin - porphyry copper deposits, liquid magmatic, contact pneumatolitic, hydrothermal, sedimentary and metamorphic. About 59 % Cu comes from porphyry copper deposits and 24 % from deposits of sedimentary origin. Among 300 known Cu minerals only a few sulphides are of economic importance - chalcopyrite, covellite, Cu-pyrite, chalcocite, bornite, enargite and tetrahedrite, and to certain extent even some oxides (carbonates and silicates). World reserves of Cu in the Earth's crust are estimated at 1.6 billion tons, reserves of Cu in deep sea nodules are estimated at 0.7 billion tons.

Much copper is used in electrotechnics (50 %), in the machine (20 %) and building industries. Majority of copper are used in alloys, particularly in brass and bronze.

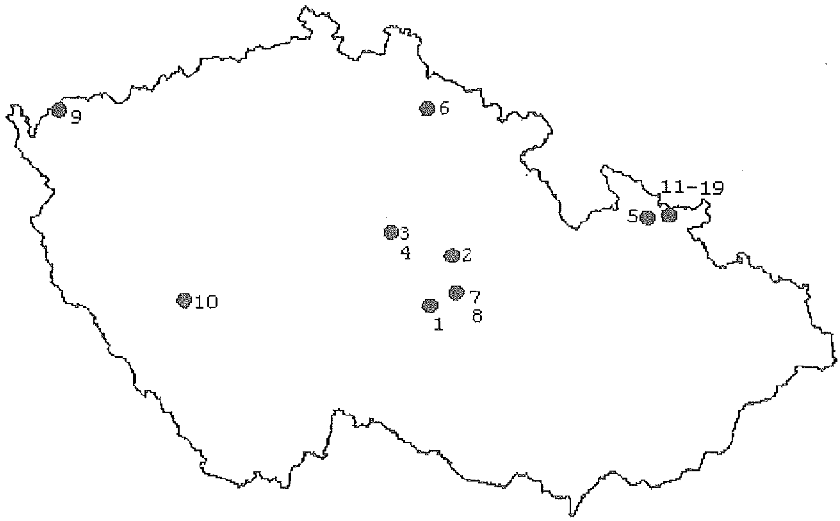
2. Mineral resources of the Czech Republic

Copper deposits of various origin occur in the Czech Republic and were mined in the past.

- Major mining activities were focused on volcaniclastic pyrite deposits of the Zlaté Hory mining district. The mineralization is related to the initial spilite-keratophyre volcanism and is confined to volcaniclastic complex of the Vrbno Formation of the Devonian. Single types of local ores - Cu monometallic, complex Cu-Pb-Zn and Pb-Zn occur separately and show a certain zonation. Out of the total proved reserves about 50 % are confined to complex ores, 25 % to monometallic, and 25-30 % 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. Mining of these ores at the Zlaté Hory deposit was terminated in 1990.
- Stratabound monometallic Cu ores (chalcopyrite) confined to a low-grade metamorphic volcaniclastic complex were discovered and their reserves evaluated and proved in the deposit of Tisová near Kraslice. Mining of local ores, having as much as 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 was temporarily flooded.
- Less important Cu mineralizations and/or Cu-Zn-Pb ores of stratabound type and pyrite formation are known at numerous localities of the Bohemian Massif (e.g. Staré Ransko, Křižanovice, Svržno).
- Hydrothermal (vein) Cu deposits of the Czech Republic are of historical importance only. Similar role plays Cu mineralization confined to Permocarboniferous sediments of the Krkonoše piedmont basin, Lower Silesian basin and the Blanice furrow.

Mining of Cu ores in the Czech Republic was gradually terminated. A small volume of Cu was extracted from complex ores of the Zlaté Hory deposit in 1993.

3. Registered deposits and their location in the Czech Republic



1 Dlouhá Ves
2 Křižanovice
3 Kutná Hora
4 Kutná Hora, Old Bohemian zone
5 Rejvíz
6 Rybnice
7 Staré Ransko-Obrázek
8 Staré Ransko-exploration project
9 Tisová
10 Újezd near Kasejovice
11 Zlaté Hory-Heřmanovice - Cu, Pb, Zn
12 Zlaté Hory-Heřmanovice - Pb, Zn
13 Zlaté Hory-Heřmanovice - Cu
14 Zlaté Hory-Hornické skály
15 Zlaté Hory-Kozlín zone
16 Zlaté Hory-Kozlín above 3rd level
17 Zlaté Hory-east
18 Zlaté Hory-west
19 Zlaté Hory-west 550 m

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt of Cu	0
A part of economic inferred reserves, in kt of Cu	40.5
Subeconomic reserves, in kt of Cu	197.6

5. Domestic production, imports and exports of the Czech Republic

Since 1991, no Cu ore was mined but copper was extracted as a by-product in other deposits. Data on imports and exports (item 2604 of the customs tariff) are not reliable and therefore not quoted.

Year	1989	1990	1991	1992	1993
Mining output (T) in kt	210.0	121.0	0	0	0
Index of mining output evolution (1989=100)	100.0	57.6	0	0	0

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2603	Copper ore and concentrates	free	free

6. Mining companies in the Czech Republic

RD Jeseník s.p., Jeseník

7. World production

Production of Cu ores continues to rise consistently. So far the highest recorded output was in 1991 - 9,142 kt of copper content. The major producing countries and their share of the world production are as follows (data in kt of Cu content according to World Bureau of Metal Statistics, RTZ and USBM, 1992, including copper extracted by leaching):

Chile	1,945	i.e.	21.9 %
USA	1,798		20.2 %
Canada	778		8.7 %
Former USSR	550		6.2 %
others (less than 5 % share)	3,829		43.0 %
Total	8,900		100.0 %

8. World market prices

Copper ores 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 LME. So far reached price peak was recorded in 1988 GBP 1,706.75 per ton (Cash). Since then the price has been decreasing.In 1993, the average price was USD 1,789.49 per ton. The decline in prices was due to a surplus production, particularly due to supplies from the East European countries and because of the decline in consumption resulting from the global economic recession.

9. Recycling

Copper belongs to metals which are recycled on a large scale. The volume of recycled copper reaches up to 42 % of its total consumption (USA). Copper is recovered mainly through pyrometallurgical processes, to lesser extent through hydrometallurgy.

10. Possible substitutes

Aluminium replaces copper in electrotechnics, in the manufacture of car radiators and refrigerators. Titanium and steel substitute for copper in the manufacture of heat exchangers regardless of their worse conductivity. Steel substitutes for copper in the manufacture of ammunition. Other substitutes are represented by optical fibres in telecommunication and plastics in water distribution and the building industry.

LEAD

1. Characteristics and use

Lead is a soft, silvery lustrous metal melting at 327.4° C and with a specific gravity of 11.34 t/m^3. Lead deposits are of four genetic types - sedimentary, metasomatic, contact metamorphic and hydrothermal (veins). Major part of the world production comes from the first type. The principal economic mineral is galena, usually accompanied by sphalerite, pyrite and chalcopyrite. Extracted ores are mostly of polymetallic character with various contents of minor metals - Cd, Ge, Ga, In, Tl, Ag and Au. The ore is marked as lead ore providing the Pb:Zn ratio is >4. Economic demonstrated reserves of Pb metal in the world are estimated at 63 mill.tons, occurring in Australia, USA, China, Canada and former USSR. Much lead is used in manufacture of batteries (63 %) and lead pigments and chemicals (13 %). About 7 % of lead are used in rolled and extruded products, 4 % in shielded cables, 3 % in alloys, 2 % in ammunition, 2 % as anti-nock additive in gasoline. High toxicity of lead leads to a reduction of its consumption in some industries; e.g. consumption index in gasoline production 1990/1985 was equal to 0.64.

2. Mineral resources of the Czech Republic

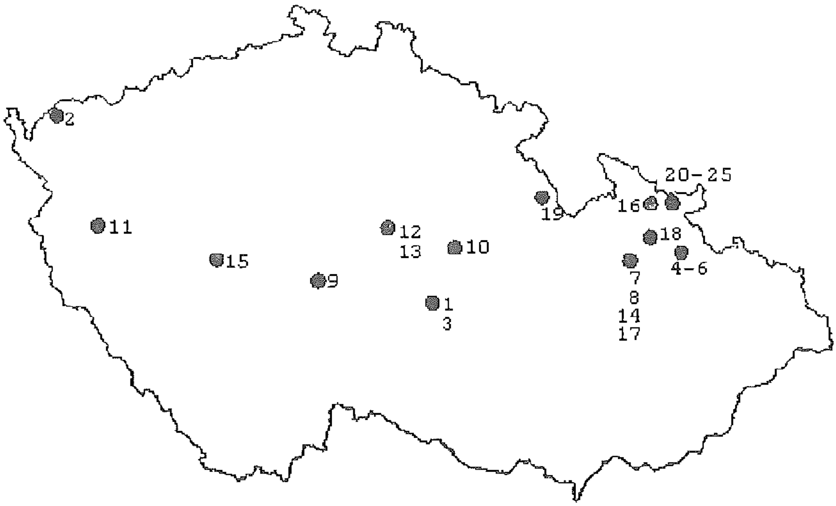
Mining of vein type hydrothermal base metal deposits brought fame and glory to the medieval ore mining in Bohemia. Originally, the glory was due to silver occurring in these ores which were later in 16th century used for extraction of lead and then even for zinc. After World War II, new exploration projects turned the attention to volcaniclastic deposits of the pyrite formation.

■ Hydrothermal base metal mineralizations are abundant in the Bohemian Massif. Besides medieval ore districts of Jihlava, Havlíčkův Brod, the Blanice furrow and others, the mining districts of Příbram, Stříbro and Kutná Hora maintained their significance till the 20th century. The major Pb mineral is galena (more or less Ag-bearing) which represents the principal compound 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 occurs at Harrachov where galena is accompanied by barite and fluorite.

■ Stratabound base metal ores of volcaniclastic 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 and some deposits of the Zlaté Hory ore district. Contents of lead varying around 0.5 % are confined to galena accompanied by banded sphalerite. Mining of some other base metal deposits of similar origin has not started because of reduction of ore mining.

3. Registered deposits and their location in the Czech Republic



1 Bartoušov
2 Bleigrund
3 Dlouhá Ves
4 Horní Benešov
5 Horní Benešov, 11th-13th levels
6 Horní Benešov-revision Cu,Pb,Zn
7 Horní Město
8 Horní Město-Šibenice
9 Hříva near Louňovice
10 Křižanovice
11 Kšice
12 Kutná Hora
13 Kutná Hora-the Grunta zone
14 Oskava
15 Příbram-base metals
16 Rejvíz
17 Ruda-north
18 Soukenná
19 Zdobnice-Čertův Důl
20 Zlaté Hory-Heřmanovice - Cu, Pb, Zn
21 Zlaté Hory-Heřmanovice - Pb, Zn
22 Zlaté Hory-Heřmanovice - Cu
23 Zlaté Hory-east
24 Zlaté Hory-west
25 Zlaté Hory-west 550m

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt of Pb	14.9 [a]
A part of economic inferred reserves,in kt of Pb	61.6 [a]
Subeconomic reserves, in kt of Pb	179.8 [a]

Note:
[a] *in base metal ores*

5. Domestic production, imports and exports of the Czech Republic
No deposit of Pb ores was mined in the Czech Republic. Lead was extracted in the form of concentrate when mining for base metal ores at one deposit in 1993.

Year	1989	1990	1991	1992	1993
Mining output of (T) in kt of Pb	4.60	2.30	2.10	1.10	0.10
Index of mining output evolution (1989=100)	100.00	50.00	45.70	23.90	2.20
Imports (D), in kt [a]	0	0	0	0	0
Exports (V), in kt [a]	1.08	1.02	2.93	0.39	0.16

Note:
[a] *item 2067 of the customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2607	Lead ore and concentrates	free	free

6. Mining companies in the Czech Republic
RD Jeseník s.p., Jeseník

7. World production

The world output since 1968, when the level of 3 mill.tons of metal was exceeded, has been maintained at an average of 3.3 mill. tons a year. So far the largest production was recorded in 1977 - 3.657 mill. tons. The major producing countries and their share of the world production are as follows (data in kt of Pb content according to International Lead and Zinc Study Group and USBM, 1992):

Australia	575	i.e.	18.0 %
USA	404		12.6 %
Former USSR (estimate)	400		12.5 %
Canada	342		10.7 %
China (estimate)	320		10.0 %
Peru	192		6.0 %
Mexico	180		5.6 %
others (less than 5 % share)	787		24.6 %
Total	3,200		100.0 %

8. World market prices

On the world market, the price of lead concentrate of grade 70/80 % Pb is quoted in USD/t, CIF Europe. The price is quoted on T/C basis. The price of concentrate exceeded a limit of USD 100 per ton at the end of 1987 and since then it has been kept above this level. Since 1992, the price stagnates at USD 170-180 per ton. Metal price at LME (refined metal having min. 99.97 % Pb) reached its peak in 1979 - GBP 556 per ton (Cash). An average price in 1993 was GBP 274.18 per ton. The reason for drop in price of pure metal has been the world economic recession and a large surplus and supplies from the East European countries in particular.

9. Recycling

The share of recycled lead in world production of Pb metal continues to increase. This trend leads to a decrease in demand for lead concentrates and also affects their prices. Due to much lead consumption in the battery production, batteries thus represent the most recycled material. Less recycled is scrap from comsumer's and manufacture industries. Recycled lead supplies presently about 55 % of the metal world production.

10. Possible substitutes

Lead used for piping in the building industry and for electric cables is being replaced by plastics. Aluminium, tin, iron and plastics gradually replace lead in packing and preserving of products. Tetraethyl lead used as anti-knock additive in gasoline is replaced by aromatic hydrocarbons. Lead in the manufacture of pigments is also efficiently replaced by other agents. The volume of lead substitutes continues to increase and will include even the manufacture of batteries. Lead in solders is being replaced by tin.

ZINC

1. Characteristics and use

Zinc is a grey, soft and malleable metal melting at 419.5°C, and with a specific gravity of 7.14 t/m^3. 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 >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 origin which are similar to those of lead. Economic demonstrated reserves of Zn content in the world are estimated at 140 mill.tons. Potential source of zinc may be also zinc bearing coal in which the content of zinc is estimated at an order of a few millions of tons.

Much zinc is used in zinc plating (47 %), in alloys (particularly brass - 19 %), in castings (14 %), in rolled materials for the building industry and manufacture of batteries (7 %), etc. As for the volume, zinc represents the 3rd mostly used non-ferrous metal after aluminium and copper.

2. Mineral resources of the Czech Republic

Zinc ores almost exclusively occur as a part of base metal ores Pb-Zn±Ag (±Cu) of hydrothermal or volcaniclastic origin.

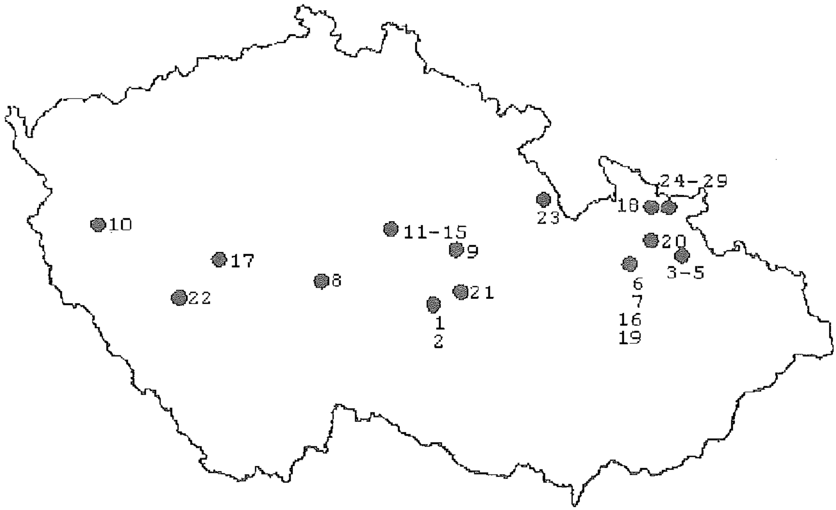
▪ Large volume of zinc ores represented mostly by sphalerite was extracted from the base metal deposits of the Březové Hory, Bohutín and Vrančice ore districts in the vicinity of Příbram. Zinc ores were also verified in historical as well as in newly explored vein type deposits. The grade of these ores varied between 1.0 and 2.9 %.

▪ The most important deposits of volcaniclastic origin occur in the Jeseníky mountains. Disseminated sulphide ores grading 0.7-1.4 % Zn were mined in the deposits of Horní Město (till 1970) and Horní Benešov (till 1992). Mining operations in the Zlaté Hory ore district were terminated in 1993.

▪ The deposit of Staré Ransko - Obrázek is of enigmatic origin. A sphalerite-barite ore, having up to 2 % Zn was mined until 1990. The Křižanovice deposit of Pb-Zn-Cu ores with barite is classified as volcaniclastic mineralization. The ore contained about 6-7 % Zn. The deposit was discovered during execution of an exploration project in the eighties.

The extraction of Zn ores in the Czech Republic was terminated according to the policy of gradual reduction of ore mining adopted by the Government. A composite Pb-Zn concentrate was the final product when mining the base metal ores. The concentrate was exported because there was no smelter in the Czech Republic. Long lasting preparation works and construction of a hydrometallurgical plant at Bruntál which was intended to smelt all base metal complex ores and concentrates of domestic provenience was not completed. Only a pilot plant was finished and some trial tests were done.

3. Registered deposits and their location in the Czech Republic



1 Bartoušov
2 Dlouhá Ves
3 Horní Benešov
4 Horní Benešov, 11th-13th levels
5 Horní Benešov-revision
6 Horní Město
7 Horní Město-Šibenice
8 Hříva near Louňovice
9 Křižanovice
10 Kšice
11 Kutná Hora
12 Kutná Hora, the Grunta zone
13 Kutná Hora, the Hlouška zone
14 Kutná Hora, Old Bohemian zone
15 Kutná Hora, the Turkaňk zone
16 Oskava
17 Příbram - base metals
18 Rejvíz
19 Ruda-north
20 Soukenná
21 Staré Ransko-Obrázek
22 Újezd near Kasejovice
23 Zdobnice-Čertův Důl
24 Zlaté Hory-Heřmanovice - Cu, Pb, Zn
25 Zlaté Hory-Heřmanovice - Pb, Zn
26 Zlaté Hory-Heřmanovice - Cu
27 Zlaté Hory-east
28 Zlaté Hory-west
29 Zlaté Hory-west 550 m

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt of Zn	44.3 [a]
A part of economic inferred reserves, in kt of Zn	234.3 [a]
Subeconomic reserves, in kt of Pb	645.8 [a]

Note:
[a] *in base metal ores*

5. Domestic production, imports and exports of the Czech Republic
Zinc was extracted from one base metal deposit of the Czech Republic in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T) in kt of Zn	6.500	7.500	8.500	4.400	1.500
Index of mining output evolution (1989=100)	100.000	115.400	130.800	67.700	23.100
Imports (D), in kt [a]	N	N	0.126	0.026	N
Exports (V), in kt [a]	4.526	6.110	13.586	9.840	N

Note:
[a] *item 2608 of the customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2608	Zinc ore and concentrates	free	free

6. Mining companies in the Czech Republic
RD Jeseník s.p., Jeseník

7. World production

Production of zinc ores continues to rise slightly. So far the largest output amounting to 7,529 kt of Zn metal was reached in 1991. The major producing countries and their share of world production are as follows (data in kt of Zn content according to the International Lead and Zinc Study Group, 1992):

Canada	1,312	i.e.	17.7 %
Australia	1,013		13.7 %
China	706		9.6 %
Former USSR (estimate)	650		8.8 %
Peru	603		8.1 %
USA	553		7.5 %
others (less than 5 % share)	2,573		34.6 %
Total	7,410		100.0 %

8. World market prices

Two grades of zinc concentrate were quoted on the world market in 1993 - sulphide concentrate grade 49/55 % Zn and sulphide concentrate grade 56/61 % Zn in USD/t of dry substance and on the T/C basis. After a long period of price fluctuation between USD 125 to 165 per ton, the price in 1989 increased up to USD 220 per ton (grade 52/55 % Zn). Prices of concentrate grade 49/55 % Zn and 56/61 % Zn were quoted at the end of 1993 at USD 208-210 per ton and USD 210-214 per ton respectively. The price of pure metal grade 99.995 % Zn at LME also reached its peak in 1989 - USD 1,657.19 per ton (Cash). An average price in 1993 was USD 960.36 per ton. The reasons for drop in prices of zinc are similar to those for lead.

9. Recycling

Zinc scrap - metal scrap, galvanized plate, alloys, flue dust, oxides and chemicals containing zinc - is being reworked by both the pyrometallurgical and hydrometallurgical processes. About 25 % of world production comes currently from recycling.

10. Possible substitutes

Zinc in foundries is replaced by aluminium, plastics and magnesium. Galvanic zinc plating is replaced by coatings of aluminium alloys, pigments, plastics and cadmium. Zinc plates are completely replaced by other materials like stainless steel, aluminium, plastics etc. Aluminium alloys substitute for brass. Zinc is also successfully replaced by other materials in the manufacture of chemicals, electronic devices and pigments.

TIN

1. Characteristics and use

Tin is a soft, silvery white metal melting at 231.9° C and with specific density of 7.3 t/m^3. Tin is relatively rare element whose average abundance in the Earth's crust is 0.0003 %. Tin was concentrated at the end of the magma differentiation and its deposits are related to granitic rocks and their effusive equivalents. The only economic mineral of tin is cassiterite which contains as much as 78 % Sn. The majority of tin come from placer deposits whereas hard rock 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 flowing water over the river bed are most important and the richest ones among the secondary deposits. World economic reserves are estimated at 8 mill.tons of metal.
The majority of tin are used in solders (31 %) and chemicals (7 %), then in alloys (bronze), tin plate and pipes, etc.

2. Mineral resources of the Czech Republic

Tin deposits of the Czech Republic are almost exclusively concentrated in the Krušné hory mountains region where they were mined since 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 granits high in lithium and topaz. The major Sn mineral is cassiterite which is disseminated in the greisen bodies and usually accompanied by wolframite and zinwaldite. The Krupka ore district is also characteristic of abundant hydrothermal quartz veins with cassiterite, wolframite and/or Bi and Mo minerals. Sn-W ores with 0.2 - 0.5 % Sn were mined in greisen type deposits.

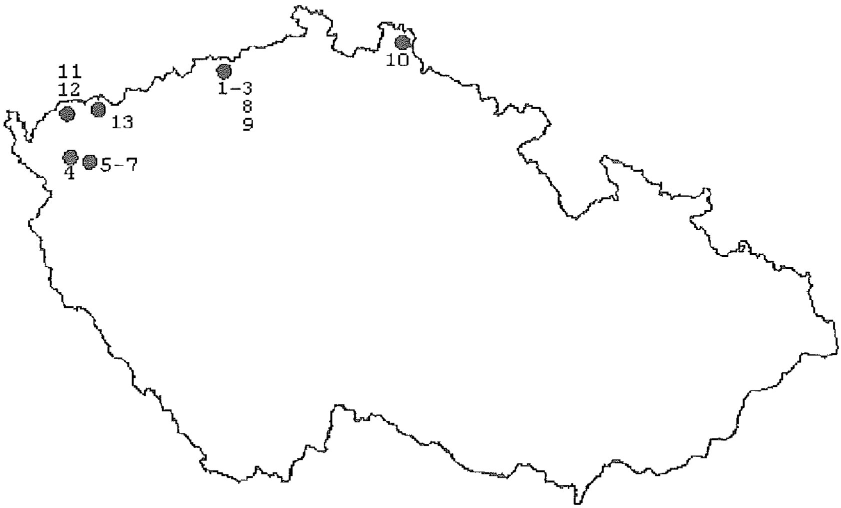
▪ An interesting type of Sn mineralization occurs at Zlatý kopec near Boží Dar where tin minerals are confined to a complex skarn consisting of major magnetite accompanied by minor cassiterite, sphalerite and chalcopyrite. The complex ore shows 0.95 % Sn.

▪ Basically, the only deposit of primary Sn ores outside the Krušné hory 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 showed an average content of 0.23 % Sn in the ore. Sn mineralization consisting of stannite was found to occur at the Old Bohemian zone of the Kutná Hora mining district. Due to the complex character of the ore, the Sn mineralization is of rather scientific importance, particularly from the viewpoint of metallogeny and specific mineral assemblage.

Placer deposits near the primary ores of the Krušné hory region are exhausted. Only some Sn-W placers in the Slavkovský les area have been preserved and appear to be still economic and mineable.

All mining and processing of Sn-W ores in the Czech Republic have ceased.

3. Registered deposits and their location in the Czech Republic



1 Cínovec-south
2 Cínovec-north-open pit
3 Cínovec-old shaft
4 Čistá-Jeroným
5 the Hány elevation
6 Krásno
7 Krásno-Koník
8 Krupka 1
9 Krupka 4
10 Nové Město pod Smrkem
11 Přebuz 1
12 Rolava-east
13 Zlatý Kopec-Boží Dar

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in t of Sn	3,756.8 [a]
A part of economic inferred reserves,in t of Sn	37,265.8 [a]
Subeconomic reserves, in t of Sn	162,064.0 [a]

Note:
[a] *in Sn-W ores*

5. Domestic production, imports and exports of the Czech Republic

Tin ores in the Czech Republic ceased to be mined in 1992. Data on imports and exports are not reliable and therefore not quoted.

Year	1989	1990	1991	1992	1993
Mining output (T) in t of Sn	467.5	590.1	14.7	0	0
Index of mining output evolution (1989=100)	100.0	126.2	3.1	0	0

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2609	Tin ore and concentrates	free	free

6. Mining companies in the Czech Republic

There were no mining companies operating on the territory of the Czech Republic to extract tin ores.

7. World production

The world production of tin concentrates continues to be in long run around 200 kt of Sn metal per year. The major producing countries and their share of the world production are as follows (data in kt of Sn content in concentrate according to USBM, 1992):

China (estimate)	45.0	i.e.	22.5 %
Indonesia	29.4		14.7 %
Brazil	23.2		11.6 %
Bolivia	15.7		7.9 %
Malaysia	14.3		7.1 %
Former USSR (estimate)	14.0		7.0 %
others (less than 5 % share)	58.4		29.2 %
Total	200.0		100.0 %

8. World market prices

Four grades of tin concentrate are quoted on the world market: 20/30 % Sn, 30/50 % Sn, 50/65 % Sn and 65/75 % Sn in GBP/t CIF Europe on the T/C basis. Prices of tin concentrates continue to be stable - 20/30 % Sn GBP 400-530 per ton since 1987, 30/50 % Sn GBP 350-500 per ton since 1988, 50/65 % Sn GBP 300-600 per ton since 1987 and 65/75 % Sn GBP 400-525 per ton since 1988. Price of tin metal grade 99.85 % Sn (A Grade) at LME reached its peak in 1985 - USD 9,475.48 per ton (Cash). An average price of metal in 1993 was USD 5,147.16 per ton. The drop in prices, regardless of export quotas issued by ATPC, is assumed to be due to surplus of supplies. The increase in export from China obviously also affects the prices.

9. Recycling

Only a small quantity of tin is recycled, particularly that of tin removed from tin plate. About 25 % of the tin world production is estimated to be recycled.

10. Possible substitutes

Aluminium, glass, stainless steel, paper and plastic foils are the major substitutes for tin in the food industry. Multicomponent epoxy resins continue to be largely used instead of solders. Tin alloys are replaced by Cu and Al alloys or by plastics. Some chemicals are replaced by Pb and Na compounds.

TUNGSTEN

1. Characteristics and use

Tungsten is a silvery grey and very hard metal exhibiting the highest melting point of all metals - 3,410° C and with a specific density of 19.3 t/m^3. It also shows the highest tensible streght of all metals at temperatures over 1,650° C. High concentrations of tungsten are always related to granites. Tungsten ores are confined to pegmatite, greisen and pneumatolitic deposits related to acid granitoid intrusions. Tungsten ores often occur together with Sn, Mo, Cu and Bi ores. Among the known tungsten minerals, only wolframite (having as much as 75 % WO_3) and scheelite (up to 80 % 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 economic reserves of tungsten ores are estimated at 40 mill. tons, of which 40 % 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 alloyed steels used in heavy machine industry, particularly in the armament industry. Much tungsten is also used in the manufacture of cutting tools and tools for oil and gas exploitation and mining of solid minerals (drilling bits made of tungsten carbide). About 80 % W is consumed in the afore mentioned fields. Some tungsten is used in electrotechnics and electronics.

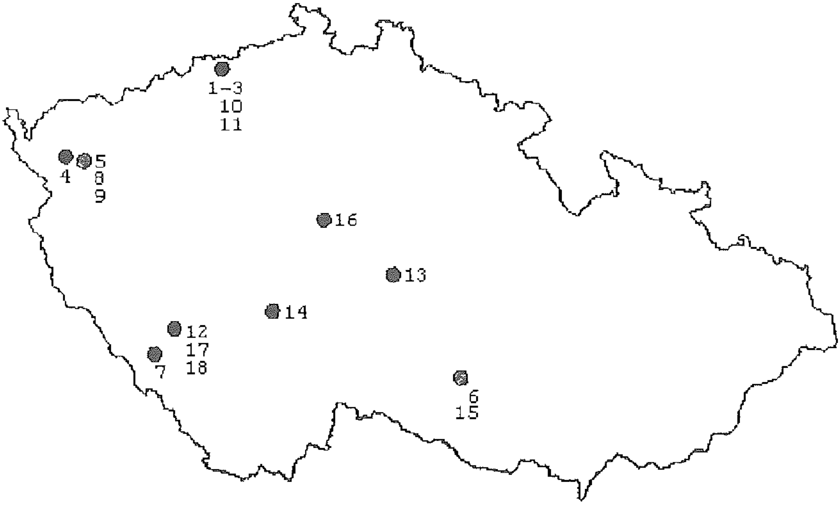
2. Mineral resources of the Czech Republic

Wolframite concentrate was obtained as a by-product during the mining and processing of greisen Sn-W ores of the Cínovec and Krásno mining districts of the Czech Republic. Besides that, numerous occurrences of scheelite and wolframite mineralizations were found and verified in various places of the Bohemian Massif, particularly during the last few years.

- Greisens rich in Sn (Krásno, Cínovec) as well as in W (Krupka IV) occur in the Krušné hory Mts region. Greisen ores have usually contents ranging between 0.02 and 0.07 % W. Only ores of the Krupka IV deposit showed up to 0.1 - 0.2 % W. A tungsten mineralization is known from quartz veins and stringers at Rotava and disseminated scheelite in erlans of Vykmanov near Perštejn.
- Typical contact metasomatic scheelite mineralization occurs in the exocontact of the Krkonoše-Jizerské hory and Žulová plutons. However, known localities of Obří důl and Vápenná are of no economic importance.
- Numerous localities of W-ores were found in the Moldanubicum of the Bohemian Massif. They are represented by quartz veins with wolframite and/or scheelite which mostly occur along the exocontacts of the Variscan granitoids and disseminated or vein scheelite confined to erlans. Some localities represent rather larger strataboud deposits of scheelite bearing crystalline schists and/or skarns. So far the most important stratabound deposit of Au-W ores is located at Kašperské Hory. Disseminated and banded scheelite occurs there in silicified layers overlying gold bearing quartz veins. An average W content of the ore is 1.32 %.
- Introduction of more sophisticated exploration methods allowed to discover numerous localities of W ores in the Czech Republic, mostly of enigmatic origin. In contrast to

previous 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.

3. Registered deposits and their location in the Czech Republic



1 Cínovec-south
2 Cínovec-north-open pit
3 Cínovec-old shaft
4 Čistá-Jeroným
5 the Hány elevation
6 Hostákov
7 Kašperské Hory
8 Krásno
9 Krásno-Koník
10 Krupka 1
11 Krupka 4
12 Malý Bor-k.462
13 Nezdín
14 Sepekov
15 Slavice
16 Tehov
17 Týnec-Hliněný Újezd-E
18 Týnec-Hliněný Újezd-W

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in t of W	126.7 [a]
Part of economic inferred reserves,in t of Wn	52,488.3 [a]
Subeconomic reserves, in t of W	39,683.1 [a]

Note:
[a] *in Sn-W and W ores*

5. Domestic production, imports and exports of the Czech Republic
Mining for tungsten ores ceased in 1992. Data on imports and exports are not reliable and therefore not quoted.

Year	1989	1990	1991	1992	1993
Mining output (T) in t W	74.7	83.6	12.5	0	0
Index of mining output, evolution (1989=100)	100.0	111.9	16.7	0	0

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2611	Tungsten ore and concentrates	free	free

6. Mining companies in the Czech Republic
There were no mining companies on territory of the Czech Republic to extract tungsten ores.

7. World production
World production of tungsten metal in ores and concentrates exceeded 40 kt/year in 1970 and reached the peak in 1989 - 51.122 kt. The major producing countries and their share of world production are as follows (data in kt of W content according to the USBM and Mining Magazine, 1992):

China (estimate)	18.0	i.e.	60.8 %
Former USSR (estimate)	7.0		23.7 %
Austria	1.6		5.4 %
Portugal	1.0		3.4 %
Peru	0.9		3.0 %
Bolivia	0.8		2.7 %
others (less than 2 % share)	0.3		1.0 %
Total	29.6		100.0 %

8. World market prices

Among all on the world market traded W raw materials (ores, concentrates, oxides, hydroxides, tungstenites, FeW, tungsten carbide and raw W), the ores and concentrates represent the major share of the trade - 30.6 % in 1992. The price of wolframite on the world market is quoted in USD/mtu WO_3, CIF Europe. Quotation of scheelite was abandoned in 1992 due to small scope of trade. Quoted price now includes both types of ore. The price peak was reached in 1977 - USD 180 per mtu WO_3. A considerable drop in prices to USD 37 per mtu WO_3 was recorded in 1993. The drop in price is assumed to have been caused by global economic recession and particularly by a surplus of cheep Chinese wolframite whose import was restricted in some countries which imposed high antidumping import taxes.

9. Recycling

Recycling of W is carried out only in the USA, Japan and western Europe. According to incomplete data, recycling accounts for 20-30 % of the total metal production.

10. 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 electrotechnics. Some attempts were made during the period of the tungsten price rise to replace W by molybdenum 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 particularly in less exposed fields where the price of tungsten and tungsten carbide plays a decisive role.

ANTIMONY

1. Characteristics and use

Antimony is a silvery white metal characteristic of poor electric and heat conductivity, melting at 630° C, and with a specific density of 6.68 t/m^3. Its abundance in the Earth's crust varies between 0.2 and 0.5 ppm. Its behavior is chalcophile and it occurs mostly together with sulphur, copper, lead and silver in hydrothermal low temperature sulphide deposits. Among more than 100 known antimony minerals only stibnite Sb_2S_3 is of economic importance. The minerals occurs either separately or in complex deposits together with pyrite, arsenopyrite, cinnabar, scheelite, antimony sulphosalts and sulphides of Cu, Pb, Zn and Ag. Complex ores are mined particularly for Au, Ag, Pb, Zn and W. The content of Sb in extracted ores is as much as 60 %. World economic reserves are estimated at 5 mill. tons and their largest volume is in China.

Much antimony is used in the manufacture of compounds for production of plastics where it acts as stabilizing agent and self-extinguishing additive (10 % of total consumption). Another application of antimony is in alloys with lead which are used in batteries, ammunition, solders, building materials, cables, bearings, type metal, ceramics and glass.

2. Mineral resources of the Czech Republic

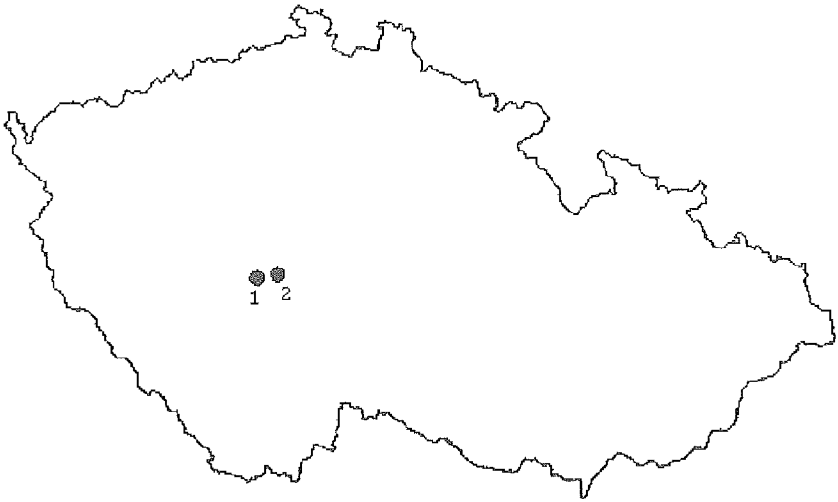
Occurrences of Sb ores in the Bohemian Massif are spatially bound to the Central Bohemian pluton. Hydrothermal Sb mineralization is confined to quartz veins or silicified mylonite zones or eventually forms fillings in fractures of lamprophyric dike rocks.

▩ Quartz veins with massive stibnite, accompanied with native gold and aurostibite occur in the Krásná Hora-Milešov ore district. The ore contains about 2.2 % Sb and 4 ppm Au. The content of Au varies considerably and appears to be increasing with depth whereas the content of Sb decreases. Medieval mining for gold was followed by extraction of Sb-Au ores which started in the second half of 18th century and which continued, with some breaks, until 1992.

▩ Poor mineralization (0.3 % Sb) is known from the neighboring Příčov ore district (the Deštno deposit) which was mined in the previous century. Economic and important concentrations of Sb occurred in the Klement vein of the abandoned deposit of Bohutín near Příbram. Other Sb occurrences of the Bohemian Massif are subeconomic and represent rather mineral indications.

Antimony ores in the Czech Republic are not mined anymore, following the termination of mining activities at Krásná Hora. The only potential source of antimony is represented by the Deštno deposit which was explored in 1983.

3. Registered deposits and their location in the Czech Republic



1 Krásná Hora
2 Deštno

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in t of Sb	0
Part of economic inferred reserves, in t of Sb	153.3
Subeconomic reserves, in t of Sb	3,855.6

5. Domestic production, imports and exports of the Czech Republic

No antimony deposit was mined 1993. Data on imports and exports are not reliable and therefore not quoted.

Year	1989	1990	1991	1992	1993
Mining output (T) in t Sb	252.6	216.2	383.8	223.9	0
Index of mining output evolution (1989=100)	100.0	85.6	151.9	88.6	0

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2617.10.00	Antimony ore and concentrates	free	free

6. Mining companies in the Czech Republic

No mining companies were operating on the territory of the Czech Republic to extract antimony ores in 1993.

7. World production

The world output of Sb metal in ores and concentrates , in Pb and Pb-Zn concentrates reached so far its highest peak in 1989 - 69.283 kt. The major producing countries and their share of the world production are as follows (data in kt of Sb content according to the Mining Magazine, 1992):

China (estimate)	25.0	i.e.	39.2 %
Former USSR (estimate)	11.0		17.2 %
Bolivia	7.5		11.8 %
South Africa	4.5		7.1 %
USA	3.2		5.0 %
others (less than 5 % share)	12.6		19.7 %
Total	63.8		100.0 %

8. World market prices

Three grades of antimony ores are quoted on the world market - pure sulphide concentrate 60 % Sb, lump sulphide ore 60 % Sb and Chinese concentrate 60 % Sb (Se 60 ppm, Hg 30 ppm max.). Prices are quoted in USD/mtu Sb, CIF Europe. Prices of all three grades fluctuate in long run between USD 13 and 20.5 per mtu. Prices of all three grades at the end of 1993 were USD 14-15 per mtu, USD 14.50-15.50 per mtu and USD 11.50-12.50 per mtu, respectively. Price of pure metal (Regulus 99.6 % Sb) on the European free market was quoted in 1993 on average at USD 1,662.44 per ton and was rather stable.

9. Recycling

Mostly antimonial lead used in the manufacture of batteries, type metal and antifriction metal are recycled.

10. Possible substitutes

Antimony can be replaced by compounds of titanium, zinc, tin and strontium in production of chemicals, pigments, fritted glass and glazes. Combinations of calcium, strontium, tin, copper, selenium, sulphur and cadmium can be used for hardening of lead instead of antimony. Selected organic compounds and hydrated alumina can be used to replace antimony in the manufacture of self-extinguishing additives.

SILVER

1. Characteristics and use

Silver is a white, relatively soft metal melting at 960° C and with specific density of 10.5 t/m^3. It exhibits the highest heat and electric conductivity among all metals and it is extra resistant against atmospheric oxidation and against corrosion in diluted acids. 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 Cu and Pb-Zn deposits of various origin. About 80 % of primary silver is recovered as a by product in processing and smelting of base metal ores. Remaining 1/3 of Ag occurs in hydrothermal vein deposits where it is the major economic element. The major silver bearing minerals are argentite, hessite, Ag-galena, kerargyrite, polybasite, pyrargyrite, stromeyerite, sylvanite and tetrahedrite (freibergite). World economic reserves of silver metal are estimated at 280 kt at present prices. Majority of silver are used in photography (43 %), in jewelry and table plate ware (18 %), in electrotechnics and electronics (15-17 %), in mints, in alloys for brazing, in batteries, mirrors and special reflecting surface coatings (to absorb solar energy), in catalysts (for production of formaldehyde from methanol and conversion of ethylene to ethylenoxide). Silver is also used in medicine and in nuclear power generation to produce control rods for water reactors (an alloy consisting of 80 % Ag, 15 % In and 5 % Cd).

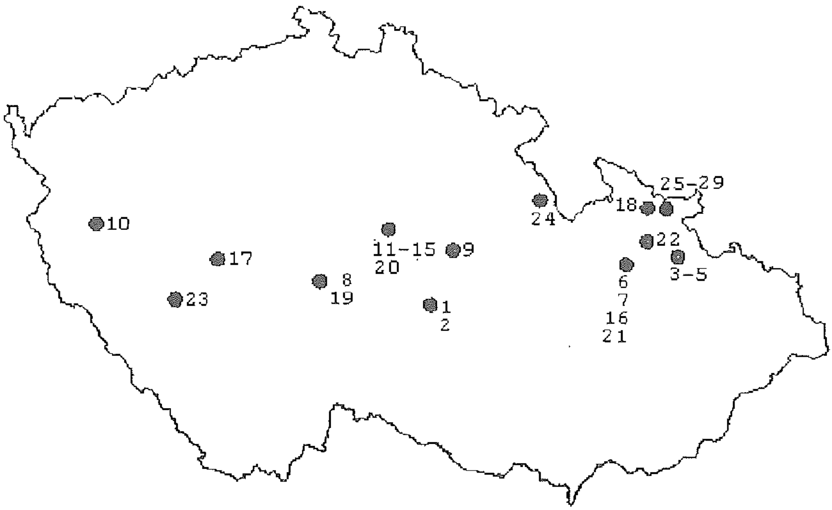
2. Mineral resources of the Czech Republic

Mining for silver played a decisive role in medieval ore mining in Bohemia and in prosperity of old mining towns.

■ The major portion of silver reserves in the Czech Republic occurs in base metal sulphide deposits where it forms an isomorphous admixture particularly in galena. Minimum Ag grade was found to occur in all base metal deposits, e.g. 8-20 ppm Ag in base metal ores of the Horní Benešov deposit, 15 ppm Ag at Zlaté Hory - east, 15-22 ppm Ag at Horní Město, 30-50 ppm at Kutná Hora, etc. Some Ag was extracted as a by-product when mining for high grade base metal 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-base metal deposit until the mining operations were reduced or ceased completely in the early nineties.

■ Numerous recently abandoned deposits of Pb-Zn-Ag and deposits of so-called five element assemblage in medieval mining districts of Kutná Hora, Jihlava, Příbram, Jáchymov and Stříbro were an important source of European silver in the past. The deposits represent classic types of base metal and other metallic deposits.

3. Registered deposits and their location in the Czech Republic



1 Bartoušov
2 Dlouhá Ves
3 Horní Benešov
4 Horní Benešov 11th-13th levels
5 Horní Benešov-revision
6 Horní Město
7 Horní Město-Šibenice
8 Hříva near Louňovice
9 Křižanovice
10 Kšice
11 Kutná Hora
12 Kutná Hora-the Grunta zone
13 Kutná Hora-the Hlouška zone
14 Kutná Hora-Old Bohemian zone
15 Kutná Hora-the Turkaňk zone
16 Oskava
17 Příbram-base metals
18 Rejvíz
19 Roudný-Aleška
20 the Roveň zone
21 Ruda-north
22 Soukenná
23 Újezd near Kasejovice
24 Zdobnice-Čertův Důl
25 Zlaté Hory-Heřmanovice - Cu, Pb, Zn
26 Zlaté Hory-Heřmanovice - Pb, Zn
27 Zlaté Hory-Heřmanovice - Cu
28 Zlaté Hory-Kozlín
29 Zlaté Hory-west

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in t of Ag	8.3 [a]
Part of economic inferred reserves, in t of Ag	402.6 [a]
Subeconomic reserves, in t of Ag	679.0 [a]

Note:
[a] *in base metal ores*

5. Domestic production, imports and exports of the Czech Republic

Silver was extracted at only one base metal deposit in 1993. Silver was exported as a constituent of Pb and Zn concentrates.

Year	1989	1990	1991	1992	1993
Mining output (T) in t Ag	20.8	16.2	8.9	6.2	0.5
Index of mining output evolution (1989=100)	100.0	77.9	42.8	29.8	2.4

5a. Tariff rates according to the Customs tariff of ÚCS 1993

		Tariff rates in %	
Code	Commodity	General	Concessionary
2616.10.00	Silver ore and concentrates	free	free

6. Mining companies in the Czech Republic

RD Jeseník s.p., Jeseník

7. World production

The world output exceeded 10 kt per year in 1976. Since then it was increasing and reached its peak in 1989 (14.752 kt). The major producing countries and their share of the world production are as follows (data in t of Ag metal according to the World Bureau of Metal Statistics, 1992):

Mexico	2,180	i.e.	15.4 %
USA	1,770		12.5 %
Peru	1,770		12.5 %
Canada	1,240		8.8 %
Former USSR (estimate)	1,200		8.5 %
Australia	1,120		7.9 %
others (less than 5 % share)	4,859		34.4 %
Total	14,139		100.0 %

8. 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. An average price in 1993 was GBp 287.2 per troy oz (Spot) or USc 430.17 per troy oz (Handy/Harman). Fluctuations in silver world prices reflect political situation and result from speculations on the market.

9. Recycling

Recycling of silver which is technologically a very simple operation, dramatically dropped in the early nineties to about one half of recycled Ag in the same period of the eighties. The drop in recycling is attributed to low prices of silver, its lower content in secondary raw materials and restrictive measures in stockpile policy. About 25 % of the total Ag consumption is assumed to have come from recycling, worldwide.

10. Possible substitutes

Silver is efficiently replaced in numerous fields. Photomaterials are produced with lower content of silver or without silver at all. Photography continues to be largely replaced by xerography and electronic displays. 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 dental alloys are replaced by ceramic materials. Sterling silver was, except memorial mints, replaced by common metals, particularly by Cu alloys.

GOLD

1. Characteristics and use

Gold is a yellow, malleable metal melting at 1,063° C and having a specific density of 19.3 t/m^3. It exhibits an excellent electric conductivity and resistance against atmospheric corrosion. Its abundance in the Earth's crust is on average 0.0034 g/t Au. Gold tends to concentrate in late magmatic products during the magmatic evolution. It occurs in hydrothermal, hydrothermal-metamorphic, metamorphic and metasomatic deposits. Secondary deposits - recent and fossil placers - resulted from chemical and physical weathering processes. Gold occurs in the form of native metal, in a natural alloy with silver (electrum) and other metals and/or in the form of tellurides. It occurs in sulphides of antimony, arsenic, copper, iron and silver. During their processing and smelting, gold is recovered as a by-product. The grade or fineness of gold is given in carats or in 1000 units (fine gold 24 carats = 1000, 10 carats = 10/24 = 41.7 % = 417/1000). Total economic world reserves are estimated at 75 kt of Au, of which 15 to 20 % occur as a minor constituent in other ore deposits. The majority of reserves (50 %) are concentrated in South Africa.

Much gold (1992) is used in jewelry (86 %, Czech Republic 63.2 %), then in electrotechnics (5 %, Czech Republic 1 %), in medals and coins (4.1 %, Czech Republic 0 %), in dentistry (2.1 %, Czech Republic 13.4 %), in special alloys for the aircraft (particularly armament) industry, in reflectors of infrared radiation, etc.

2. Mineral resources of the Czech Republic

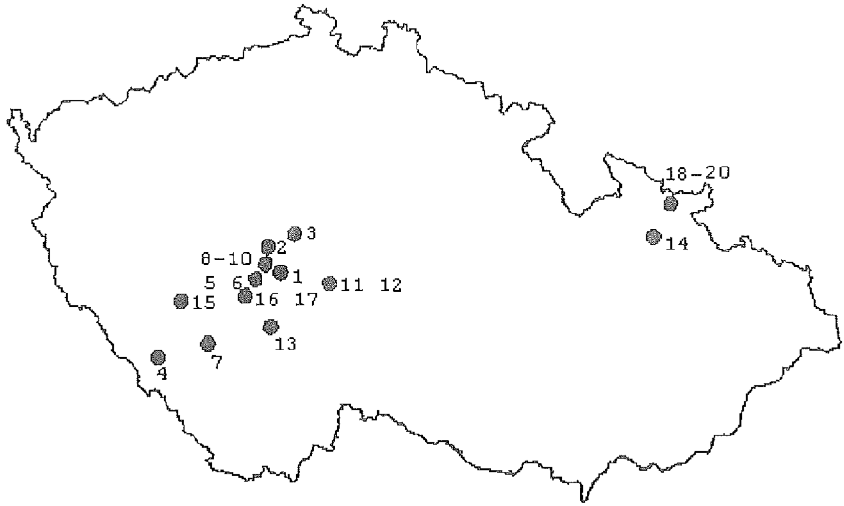
The tradition of mining for primary and secondary gold in the Bohemian Massif dates back almost three millennia. Bohemia used to be one of the most important producers of gold in Europe in the Middle Ages.

■ The major part of gold mineralization is confined to regionally metamorphosed volcaniclastic complexes locally penetrated by Variscan granitoids. Such a complex in the central Bohemian region is represented by the Jílové zone of the Proterozoic age. The zone is characteristic of abundant gold-quartz mineralization which occurs in the 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-west).

■ Some hydrothermal quartz veins with gold as well as stratabound gold mineralization with scheelite (Kašperské Hory) and quartz veins and stringers with Ag (Roudný) occur in the crystalline complex of the Moldanubicum.

■ Placer gold deposits are close to the primary gold deposits. Permocarboniferous paleoplacers occur in western Bohemia (Křivce) as well as in the Krkonoše piedmont and in the Intrasudeten basins. The largest areas of Quaternary placers are located in the foothills of the Šumava mountains and in northern Moravia. 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 termination of mining operations at the Krásná Hora Au-Sb deposit in 1992 and at the Zlaté Hory-west base metal deposit in 1993. However, recently discovered and explored gold deposits of Mokrsko, Kašperské Hory and others represent a good potential for rejuvenation of gold mining in the Czech Republic.

3. Registered deposits and their location in the Czech Republic



1 Deštno
2 Dražetice-adit no. IV
3 Jílové near Praha
4 Kašperské Hory
5 Krásná Hora
6 Libčice
7 Modlešovice
8 Mokrsko
9 Mokrsko-east
10 Prostřední Lhota-Čelina
11 Roudný-Aleška
12 Roudný
13 Sepekov
14 Suchá Rudná-central part
15 Újezd near Kasejovice
16 Voltýřov
17 Voltýřov-placer
18 Zlaté Hory-east
19 Zlaté Hory-west
20 Zlaté Hory-west 550 m

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kg of Au	48,740.0
Part of economic inferred reserves, in kg of Au	84,750.7
Subeconomic reserves, in kg of Au	80,990.9

5. Domestic production, imports and exports of the Czech Republic

Gold was extracted at one base metal deposit in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T) in kg Au	105.2	187.2	564.1	520.6	511.6
Index of mining output evolution (1989=100)	100.0	177.9	536.2	494.9	486.3
Import (D), kg Au [a]	3,349.0	3,029.0	425.0	6,320.0	N

Note:

[a] *import of gold metal*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

		Tariff rates in %	
Code	Commodity	General	Concessionary
2616.90.00	Precious metals ores and concentrates - Others	free	free

6. Mining companies in the Czech Republic

RD Jeseník, s.p., Jeseník

7. World production

World production of gold, following a slight decrease in the early seventies, continues to rise steadily and reached its peak so far in 1992 with an output of 2,216.5 tons of metal. The major producing countries and their share in world production are as follows (data in t of Au metal according to Gold Fields Mineral Services Ltd, 1992):

South Africa	614.1	i.e.	27.7 %
USA	322.2		14.6 %
Australia	240.0		10.8 %
Former USSR	237.0		10.7 %
Canada	157.4		7.1 %
China	118.0		5.3 %
others (less than 5 % share)	527.8		23.8 %
Total	2,216.5		100.0 %

8. World market prices

As for prices, gold represents a special metal in this respect. Its price is affected by many factors among which speculative trade and global political climate are the most important. Gold is very sensitive to the global political situation. Consequently, the major world stock exchanges 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 average price during the last 25 years was reached in 1980 - actual price USD 614.63 per troy oz, real price USD 1,046.65 per troy oz (price base 1992 = 100). This highest price was due to the global political situation which reflected the revolution in Iran, the Soviet invasion of Afghanistan, the petroleum shock, peak inflation and the onset of the Iraqi Iranian war. Later a drop in price down to USD 400 per troy oz again occurred. This price was temporarily exceeded in August 1993 (USD 409 per troy oz) but the annual mean price at LME was USD 359.93 per troy oz and that of Handy/Harman (USA) was USD 359.83 per troy oz.

9. Recycling

About 60 tons of gold in the USA comes from the reworking of gold fractions which accounts for about 60 % of the total domestic production. Gold in other countries is also widely recycled from jewelry and other industries. Recycling may reach as much as 50 % worldwide, even though the data on recycling are rather difficult to obtain.

10. Possible substitutes

The consumption of gold and its alloys in jewelry and electrotechnics is decreasing due to the introduction of parts made of common but gilded metals. Gold can be replaced by palladium, platinum and silver. Gold for monetary storage can be replaced by rhodium which is the most valuable metal. In classic jewelry, however, gold and its alloys are indispensable.

URANIUM

1. Characteristics and use

Uranium with its atomic weight of 238.03 represents the heaviest natural element of the periodic table. It is radioactive with a half-life period of decay equal to 4.5 x 10^9 years. Pure uranium is a white, lustrous metal melting at 1,133° C and exhibiting a specific density of 19.05 t/m^3. Its characteristic property is natural radioactivity of all its isotopes. Relative proportions of single isotopes are as follows: U^{238} = 92.2739 %, U^{235} = 0.7204, U^{234} = 0.057 %. The average abundance of uranium in the Earth's crust is 4 x 10^{-4} %. Uranium constitutes several tens of minerals (exclusively oxidic compounds) of which economically most important are oxides (uraninite - pitchblende), phosphates (torbernite, autunite), silicates (coffinite) and organic compounds (anthraxolite). The most important uranium deposits occur in Canada, USA, Zaire, South Africa and Australia. World reserves are estimated at 2.1 mill.tons of uranium metal.

2. Mineral resources of the Czech Republic

Two major periods of the origin of uranium deposits can be distinguished in the Bohemian Massif: - Late Variscan and Alpine. The deposits can be classified in 6 morphogenetic types:

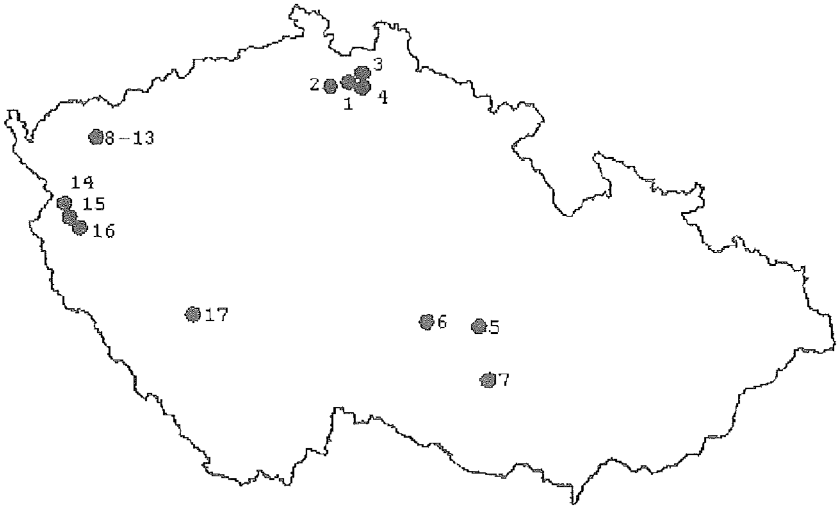
- crushed zones with graphite and disseminated uranium ores in crystalline rocks of the Bohemian Massif (Rožná, Zadní Chodov),
- veins and vein systems - hydrothermal deposits related to Variscan granitoids (Jáchymov, Slavkov, Příbram),
- metasomatic mineralization in chloritized granitoids of the Borek massif (Vítkov II, Lhota) and Central Bohemian pluton (Nahošín),
- stratabound mineralization confined to the Late Paleozoic sediments- in coal seams of the Intrasudeten and Kladno-Rakovník basins,
- uranium mineralization in Cretaceous sediments - ore bodies confined to Cenomanian sediments of the Laussicum development of the Bohemian Cretaceous basin,
- stratabound mineralization in Tertiary basins - small deposits in sediments high in organic matter in the broader vicinity of Karlovy Vary.

Deposits of economic grade and/or historical important deposits are concentrated in the following regions, including brief characteristics of the mineralization:

- north Bohemian region - mineralization in Cretaceous sediments
- Moravian region - mineralized fracture zones and hydrothermal veins
- Krušné hory region - mineralization in Tertiary sediments and exhausted hydrothermal veins (Jáchymov, Slavkov)
- west Bohemian region - metasomatic mineralization
- central Bohemian - metasomatic and already exhausted hydrothermal veins (Příbram).

A total of 17 uranium deposits were registered on the territory of the Czech Republic as of January 1, 1994. Currently mined deposits are only the deposits Hamr and Stráž in the Bohemian Cretaceous basin and mineralized fracture zone at Rožná. Underground mining takes place at Hamr and Rožná whereas the Stráž deposit, representing almost 2/5 of the total uranium production, has been extracted by means of underground in situ leaching. All extracted ore was chemically processed to provide chemical concentrate (yellow cake). No fuel elements for nuclear power plants are produced in the Czech Republic.

3. Registered deposits and their location in the Czech Republic



North Bohemian region
135,817.0 t of U
- 1 Hamr
- 2 Stráž
- 3 Břevniště
- 4 Osečná-Kotel

Moravian region
4,729.0 t of U
- 5 Rožná
- 6 Brzkov
- 7 Jasenice-Pucov

the Krušné hory region
1,095.1 t of U
- 8 Hájek
- 9 Hájek-S
- 10 Hroznětín
- 11 Kocourek
- 12 Mezirolí
- 13 Ruprechtov 1

West Bohemian region
1,547.6 t of U
- 14 Zadní Chodov
- 15 Vítkov 2
- 16 Lhota

Central Bohemian region
132.6 t of U
- 17 Nahošín

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in t of U	47,135.7
Part of economic inferred reserves, in t of U	50,575.6
Subeconomic reserves, in t of U	45,610.0

5. Domestic production, imports and exports of the Czech Republic

Three uranium deposits were mined in 1993. Data on imports and exports are not reliable and therefore not quoted.

Year	1989	1990	1991	1992	1993
Mining output (T) in t U	2,502.0	2,243.0	1,827.0	1,631.0	1,018.0
Index of mining output evolution (1989=100)	100.0	89.6	73.0	65.2	40.7

5a. Tariff rates according to the Customs tariff of ÚCS 1993

		Tariff rates in %	
Code	Commodity	General	Concessionary
2612.10	Uranium ore and concentrates	free	free

6. Mining companies in the Czech Republic

DIAMO s.p., Stráž pod Ralskem

7. World production

Large increase in world production of uranium ores began in the fifties due to nuclear arms race and later due to large development in nuclear energy facilities which followed the first "oil shock" in 1973. A record production exceeding 44,000 tons of uranium was reached in 1980. Major uranium producing countries and their share of the world production are as follows (in metric tons of uranium metal according to the Mining Magazine, 1992):

Canada	9,385	i.e.	26.7 %
Former USSR	8,250		23.4 %
Niger	2,965		8.4 %
Australia	2,334		6.6 %
France	2,127		6.0 %
USA	1,808		5.1 %
South Africa	1,769		5.0 %
others (less than 5 % share)	6,582		18.8 %
Total	35,220		100.0 %

8. World market prices

There are two categories of uranium prices: prices for spot sales and future delivery prices (negotiated). Prices of spot sales in the seventies were still higher than those of future delivery contracts. Recently, however, the ratio is reversed and majority of sales is materialized in spot prices. Until 1992, only two companies - NUEXO and NUKEM were revealing the spot prices. Since then the source of information on prices has increased. Prices for spot sales of ores and concentrates are given in USD/lb U_30 separately for regulated and unregulated market. So far the highest price was reached in 1978 - USD 43 per lb U_8O (NUEXO). Since then there was a drop in prices, and starting 1989 the average prices of spot sales continue to be under USD 10 per lb U_3O_8. Prices of spot sales (NUEXCO) on restricted market were as much as USD 9.85 per lb U_3O_8 and those on unrestricted market were USD 7/lb U_3O_8. Prices for spot sales and future deliveries are different for US and European markets (market of the EUROATOM member countries), particularly after 1989 when US market prices dropped down to 50 % of those of the European market. Prices for future delivery on the European market are treble the prices for spot sales.

General fall in prices is due to global political relaxation and economic changes. There is a surplus of uranium due to nuclear disarmament (large supplies from the former USSR), reduction of consumers stockpiles and declining nuclear energy generation, etc.

9. Recycling

Theoretically, the burned-up fuel elements of nuclear reactors which still contain 80 % of uranium could be reprocessed. However, due to hygienic and economic reasons, burned-up fuel elements are not recycled but stored.

10. Possible substitutes

Problems related to nuclear power generation vs. energy generation from fossil fuels are widely discussed worldwide. Replacement of U^{235} by Th^{238} or U^{238} cannot be materialized because of the Treaty for non-proliferation of nuclear weapons. When using so-called reactors with fast neutrons (i.e. in case of Th and U^{238}), the fission products could be misused for the production of nuclear weapons.

HARD COAL

1. Characteristics and use

Hard coal is a phytokaustobiolite exhibiting a higher degree of coalification, i.e. more than 73.4 % carbon, less than 50 % volatile matter and dry (ash free) caloric value exceeding 24 MJ/kg. The internationally recognized boundary between lignite and hard coal is the value of vitrinite reflectance (R=0.5 %) which in the case of hard coal is higher than 0.5 %.

Coking coal by definition is a hard coal which allows to produce coke for blast-furnace production of pig iron and/or for heating. Other coal is marked as steam coal (40 % of electric energy is generated by burning of coal).

2. Mineral resources of the Czech Republic

Both the coking coal and the steam coal occur on territory of the Czech Republic.

- Coking coal occurs mostly in the Bohemian (Moravian) part of the Upper Silesian basin. The major fault, called the Orlová fault, divides the Moravian part of the Upper Silesian basin into the western section (the Ostrava part) which is older and of paralic character of sediments and coal seams and the eastern section (the Karviná part) which exhibits limnic character of the sediments as well as of coal. The western part consists of several tens of thin coal seams of high grade coking coal whereas the eastern part is characteristic of abundant thick seams consisting of mixed and high volatile steam coal.

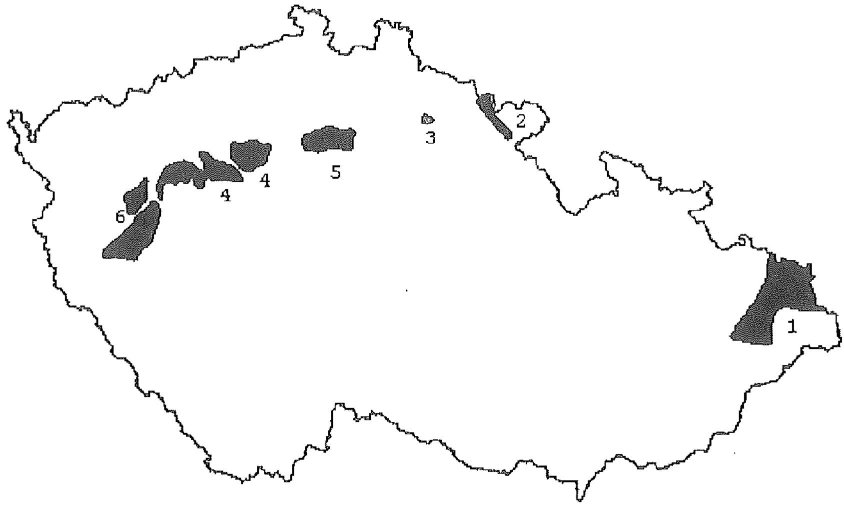
Mining in the Ostrava part reached the depth of about 1,000 m which together with complex and unfavorable mining and geological conditions makes economic mining extremely difficult. Consequently, the Ostrava mines continue to be gradually abandoned. Some mines in the eastern part have enough reserves which can be extracted with much lower costs. However, this coal is of lower grade, as far as coking properties are concerned. 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.

- Another area with reserves of hard coal occurs in central Bohemia, west of Prague. The majority of coal reserves of the Kladno-Rakovník basin (steam coal) were already mined and remaining two mines, still in operation, have limited volume of mineable reserves. Another deposit of coking coal was discovered and explored in the fifties and sixties near Slaný. It extends NE from the Kladno basin and has about 223 mill. tons of coal which occurs at depths of 1,000 to 1,300 m. The deposit was developed by two main shafts which were later closed.

- NE of Prague, there has been explored the so-called Mšeno (Mělník) basin having 1,268 mill.tons of reserves of steam coal. However, conflicts of interest prevent to develop this deposit (overlying Cretaceous sandstones represent a source of potable water for central Bohemia).

- Some other deposits of hard coal in the Plzeň (Pilsen) and Trutnov regions and near Brno are either almost exhausted or due to anticipated mining cost become subeconomic.

3. Registered deposits and their location in the Czech Republic



1 the Upper Silesian basin	-	72 deposits of which 18 are mined, total reserves 11,423 mill. t mineable reserves 1,357 mill. t
2 the Intrasudeten basin	-	6 deposits of which 1 is mined, total reserves 290 mill. t mineable reserves 4 mill. t
3 the Krkonoše piedmont basin	-	not mined deposit, total reserves 48 mill. t
4 the Central Bohemian basin	-	19 deposits of which 6 are mined total reserves 425 mill. t mineable reserves 120 mill. t
5 the Mělník basin	-	total reserves 1,268 mill. t
6 the Plzeň and Radnice basin	-	8 deposits of which 1 is mined, total reserves 54 mill. t mineable reserves 10 mill. t

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	2,323,137
Part of economic inferred reserves, in kt	6,098,169
Subeconomic reserves, in kt	5,090,425

5. Domestic production, imports and exports of the Czech Republic

A total of 26 deposits were mined in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T) in kt	34,935.0	30,714.0	25,769.0	24,691.0	23862.0
Index of mining output evolution (1989=100)	100.0	87.9	73.8	70.7	68.3
Imports (D) in kt [a)]	N	N	3,714.0	3,112.5	1,939.7
Exports (V) in kt [a)]	2,230.4	N	2,499.7	3,013.2	4,510.1
Apparent consumption (T+D-V) in kt	N	N	26,983.3	24,790.3	21,291.6
Dependence on imports in %	N	N	13.8	14.6	9.1
Exports share of mining output in %	6.4	N	9.7	12.2	18.9

Note:

[a)] *item 2701 of the customs tariff*

5a.Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in %	
		General	Concessionary
2701	Hard coal, briquets and similar solid fuels made of hard coal	free	free

6. Mining companies in the Czech Republic

Ostravsko-karvinské doly a.s., Ostrava
Českomoravské doly a.s., Kladno
Západočeské uhelné doly, s.p., Zbůch
Východočeské uhelné doly, s.p., Trutnov

7. World production

World production of hard coal exceeded 3,000 mill. tons in 1985 and reached its peak in 1989 - 3,561 mill. tons. The output of steam coal exceeds presently the production of coking coal and production ratio of both types of coal is expected to be 2:1 in favor of steam coal in near future. The major producing countries and their share of world production are as follows (data in mill.tons according to the Shell Co., 1992):

China	1,020	i.e.	29.5 %
USA	607		17.5 %
Former USSR (of which Russia 218)	469		13.6 %
India	224		6.5 %
Australia	177		5.1 %
South Africa	174		5.0 %
others (less than 5 % share)	790		22.8 %
Total	3,461		100.0 %

8. World market prices

Prices for spot sales and future delivery prices are quoted on the coal world market. Prices of both major technological types of coal (coking and steam coal) are further divided according to the contents of volatile constituents, sulphur and ash.

Decisive prices are those of the Australian and US coal since this coal represents 55 % of the world sales. Prices are quoted in USD/t FOB (according to Coal Week International). Prices of overseas coal on the European market (CIF) during the last decade were fluctuating between USD 36 and 50 per ton of steam coal and between USD 50 and 80 per ton of coking coal. Price variations were due to fluctuation in supplies and demands and also due to oscillations in sea transport costs. Low prices of overseas coal lead to a gradual reduction of coal mining in Europe where mining cost is considerably higher.

9. Recycling

Coal is not recycled.

10. Possible substitutes

Coking coal is possible to replace by steam coal due to introduction of new technologies in production of pig iron (Corex). Coal can be replaced by other mineral fuels in power generation.

LIGNITE

1. Characteristics and use

Lignite is a phytokaustobiolite showing lower degree of coalification, i.e. having less than 73.5 % carbon, more than 50 % volatile matter and dry (ash free) caloric value less than 24 MJ/kg. Internationally recognized boundary between lignite and hard coal is the reflectance value of vitrinite (R=0.5 %) which in case of lignite is lower than 0.5 %. The boundary between lignite and high volatile lignite is usually not recognized because, in practical terms, lignite generally includes high volatile lignite. However, in the Czech Republic both types of lignite are treated separately.

2. Mineral resources of the Czech Republic

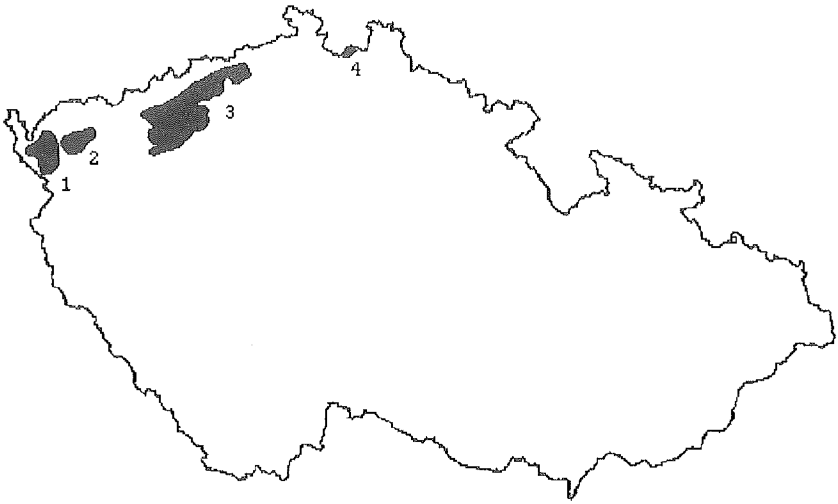
The majority of lignite in the Czech Republic are still used for power generation. The major Bohemian lignite basins originated and are located in the furrow along the Krušné hory Mts which follow NW boundary of the Czech Republic. The total area of the coal-bearing sedimentation is 1,900 km^2 large. Underlying sediments are of the Oligocene to Early Miocene age. The lignite seams are mostly of the Middle Miocene age whereas overlying sediments which are as much as 400 m thick and even more, are of the Late Miocene age. The sedimentation in the Cheb basin was terminated as late as in the Pliocene. The following single basins are recognized in the whole area of the Krušné hory furrow (from NE to SW): North Bohemian, Sokolov and Cheb basins. The largest North Bohemian basin is then divided in three partial basins. It used to be a still is the major source of lignite which is now extracted by huge open pit mining operations.

- In SW part of the basin, in the so-called Chomutov basin, there are several coal seams which, in the major part of the basin, are close to each other to allow open pit mining for all of them. Lignite shows a low degree of coalification and high content of ash (up to 50 %). Burning of this lignite in large power plants inflicts environmental problems because it is high in sulphur and arsenic. Due to low caloric value, a part of reserves exceeds the earlier used norm specifying the amount of sulphur in grams related to a unit of net caloric value.
- Lignite in the Most partial basin shows higher degree of coalification and a lower content of ash. Locally, however, is very high in sulphur and arsenic. The depth of open pit mines continues to increase being currently about 150 m.
- Shallow parts of the Teplice partial basin were already mined. Remaining reserves of almost sulphur free lignite located under the Chabařovice township are likely to be abandoned because of the conflicts of interest. Similar conflicts may occur even in other parts of the basin.
- The Sokolov basin west of Karlovy Vary has two lignite seams. The major reserves are confined to the thickest and the uppermost seam called Antonín. The lignite is of xylitic character, it is high in water and relatively low in sulphur. The seam is extracted by open pit mining and is used in power generation (sorted lignite, burning in power plants, lighting gas production).
- The Cheb basin has about one billion of reserves of stratigraphically latest lignite characteristic of high content of water (about 50 to 55 %), high in liptodetrite, and consequently high in mineral tar. It is a lignite suitable for chemical processing. Mining

operations in this basin were not allowed because they are likely to affect sources of mineral water for nearby Františkovy Lázně spa.

■ The Zittau basin extends into the Czech Republic from Poland and Germany. The upper seam was already mined. Remaining two lower seams are difficult to be mined underground because of overlying quicksand and tectonic problems.

3. Registered deposits and their location in the Czech Republic



1 the Cheb basin	-	total reserves 1,164 mill. t
2 the Sokolov basin	-	15 deposits of which 6 are mined, total reserves 1,143 mill. t mineable reserves 421 mill. t
3 North Bohemian basin	-	61 deposits of which 13 are mined, 1 deposit of oxihumolite total reserves 8,691 mill. t mineable reserves 1,748 mill. t
4 the Zittau basin	-	total reserves 116 mill. t

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	4,200,406
Part of economic inferred reserves, in kt	1,930,676
Subeconomic reserves, in kt	4,984,417

5. Domestic production, imports and exports of the Czech Republic

A total of 19 deposits were mined in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T) in kt	86,974.0	78,391.0	75,988.0	68,100.0	66,891.0
Index of mining output evolution (1989=100)	100.0	90.1	87.4	78.3	76.9
Imports (D) in kt [a]	N	N	N	N	24.6
Exports (V) in kt [a]	2,248.5	N	2,667.6	3,147.4	4,557.9
Apparent consumption (T+D-V) in kt	N	N	N	N	62,357.7
Dependence on imports in %	N	N	N	N	0
Exports share of mining output in %	2.6	N	3.5	4.6	6.8

Note:

[a] *item 2702 of the customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

		Tariff rates in %	
Code	Commodity	General	Concessionary
2702	Lignite, including agglomerated lignite, except gagatite	free	free

6. Mining companies in the Czech Republic

Sokolovská uhelná a.s., Vřesová

Mostecká uhelná a.s., Most

Severočeské doly Chomutov a.s., Chomutov

Palivový kombinát s.p., Ústí nad Labem

7. World production

World production exceeded 1,000 mill. tons in 1980 and reached its peak in 1991 - 1,358 mill. tons. Data on production include also high volatile lignite which is in the Czech Republic treated separately. The major producers of lignite and their share of the world output are as follows (data in mill.tons according to the British Petroleum Statistical Review of World Energy, 1992):

USA	295	i.e.	22.6 %
Germany	242		18.5 %
Former USSR (of which Russia 117)	135		10.3 %
China	90		6.9 %
Czechoslovakia	79		6.0 %
Poland	68		5.2 %
others (less than 5 % share)	399		30.5 %
Total	1,308		100.0 %

8. World market prices

Lignite sales represent only negligible volume of the total world trade and are usually materialized only between neighbouring countries based upon individual contracts and negotiated prices considering the grade and transport costs. Data on prices on international market are not available.

9. Recycling

Lignite is not recycled.

10. Possible substitutes

Possible substitutes differ according to the type of lignite and its use. In power generation, it can be replaced by other fuels, particularly by nuclear fuel. This substitution, however, is connected with large investment, environmental and other problems.

HIGH VOLATILE LIGNITE

1. Characteristics and use

High volatile lignite is a variety of lignite which exhibits the least degree of coalification, is of xylitic character with preserved tree trunks and with large or small fragments of wood. From the geochemical and petrological viewpoints, it is a high volatile lignite. Its dry (ash free) caloric value is less than 17 MJ/kg.

No boundary between regular lignite and high volatile lignite has been established and high volatile lignite is generally included in regular lignite. In the Czech Republic, however, is treated separately.

High volatile lignite is used in power generation and for heating. Among mineral fuels it represents the least quality fuel whose consumption gradually declines.

2. Mineral resources of the Czech Republic

▪ Largest deposits of high volatile lignite occur along the northern margin of the Vienna basin which extends from Austria into southern Moravia. There are two lignite seams in the latest sediments of the Pannonian and Pliocene age. Reserves of the northern Kyjov seam are already exhausted whereas reserves of the southern Dubňany seam are currently mined by two shafts. Economic reserves are registered at another deposits but their extraction is not anticipated. South Moravian high volatile lignite is of xylodetrital character with numerous tree trunks. It is high in water (45-50 %) and its caloric value is less than 10 MJ. The content of sulphur is about 3-4 % which is above the ecological norm. The lignite is burnt in the Hodonín power plant. Regardless of relatively large reserves of high volatile lignite in the basin, further development of mining operations is unlikely due to various reasons.

▪ There are seven deposits of high volatile lignite in southern Bohemia which are registered. They occur in narrow lobate extensions of the České Budějovice basin. These deposits are not mineable because of very low grade of the local lignite. Moreover, the Mydlovary power plant, the major consumer of the local lignite, was closed.

▪ Isolated occurrences of lignite are in the vicinity of Liberec in northern Bohemia. It is a Pliocene xylite.

3. Registered deposits and their location in the Czech Republic

1 the Vienna basin	-	11 deposits of which 2 are mined, total reserves 721 mill. t mineable reserves 98 mill. t
2 South Bohemian basin	-	total reserves 43 mill. t, 7 deposits, none is mined
3 the Zittau basin	-	total reserves 22 mill. t, 22 deposits, none is mined

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	180,690
Part of economic inferred reserves, in kt	359,145
Subeconomic reserves, in kt	247,800

5. Domestic production, imports and exports of the Czech Republic

Two deposits were mined in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T) in kt	1,972.0	1,814.0	1,500.0	1,419.0	1,263.0
Index of mining output evolution (1989=100)	100.0	92.0	76.1	72.0	64.0
Imports (D) in kt	0	0	0	0	0
Exports (V) in kt	0	0	0	0	0
Apparent consumption (T+D-V) in kt	1,972.0	1,814.0	1,500.0	1,419.0	1,263.0
Dependence on imports in %	0	0	0	0	0
Exports share in mining output in %	0	0	0	0	0

5a. Tariff rates according to the Customs tariff of ÚCS 1993

		Tariff rates in %	
Code	Commodity	General	Concessionary
	Not quoted in customs tariff		

6. Mining companies in the Czech Republic

Jihomoravské lignitové doly s.p., Hodonín

7. World production

World output of high volatile lignite is included in the lignite production.

8. World market prices

High volatile lignite is generally not traded on the world market.

9. Recycling

High volatile lignite is not recycled.

10. Possible substitutes

High volatile lignite exclusively used as a fuel can be replaced by other mineral fuels.

CRUDE OIL

1. Characteristics and use

Oil (petroleum)is a natural mixture of gaseous, liquid and dissolved solid hydrocarbons and their derivatives. Its specific gravity fluctuates between 0.75 and 1.0 t/m^3, the average content of carbon is between 80.0 and 87.5 %, hydrogen between 10.0 - 15.0 % and its calorific value ranges between 38.0 and 42.0 MJ/kg. Principal source of hydrocarbons is represented by an organic material originating from subaqual anaerobic decaying of plants and/or animals under specific conditions. The crude oil originates at temperatures between 60.0 and 140.0°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 and porous reservoir rocks. Principally 4 types of crude oil can be recognized based upon its chemical composition - paraffin-base petroleum, asphalt-base petroleum, naphtene petroleum, and mixed bases (aromatic) petroleum.

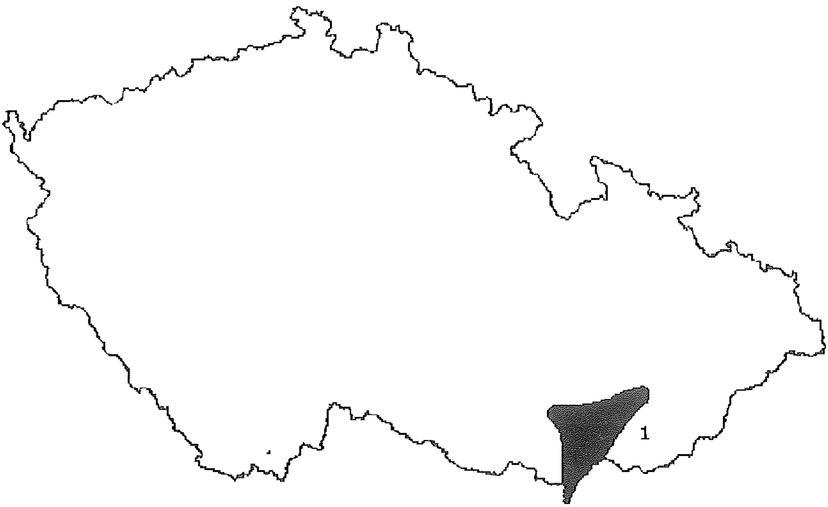
All-round oil industrial use is evident and new applications are still under way. Nevertheless, power generation, petrochemical and chemical industries are the principal oil consumers.

2. Oil resources of the Czech Republic

▨ Oil deposits of the Czech Republic are confined to the Vienna - Moravia oil and gas-bearing province. The deposits are distributed over a great number of individual oil-bearing structures and producing horizons situated at the depth going down to 2,800 m. The most productive oil-bearing rocks are represented by sands of the Middle and/or the Upper Badenian. The largest deposit of this area (Hrušky) whose major part has already been extracted, serves as an underground gas storage.

▨ Another region in which oil is anticipated to occur lies in the Moravian part of the Carpathian foredeep where oil exploration still continues. The most important accumulations occur particularly in the weathered crystalline and Paleozoic rocks. Light, sulphur free, paraffin to paraffin - naphtene oil prevail in this field. Uhřice and Kloboučky (in the Ždánice region) are the only oil deposits in this area.

3. Registered deposits and their location in the Czech Republic



1 **the Vienna basin and Carpathian foredeep**

- 20 deposits of which 14 are exploited
- total reserves - 63 mill. t
- mineable reserves - 10 mill. t

4. Oil reserves as of December 31, 1993

Economic demonstrated reserves, in kt	10,745
A part of economic inferred reserves, in kt	44,090
Subeconomic reseves, in kt	8,536

5. Domestic production, imports and exports of the Czech Republic

A total of 14 oil deposits were exploited in the Czech Republic in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt	45.0	47.0	64.0	80.0	107.0
Index of mining output evolution (1989=100)	100.0	104.4	142.2	177.8	237.8
Imports (D), in kt [a)]	6,678.0	6,435.0	6,510.0	7,049.0	N
Exports (V), in kt	0	0	0	0	N
Apparent consumption (T+D-V), in kt	6,723.0	6,482.0	6,574.0	7,129.0	N
Dependence on imports in %	99.3	99.3	99.0	98.9	N
Exports share in mining output %	0	0	0	0	N

Note:

[a)] Both 1989 and 1990 figures are based on MPO (Ministry of Industry and Trade) data, remaining years on ČSÚ data (Czech Statistical Bureau) - including item No. 2709.00.10 of the customs tarrif (Natural Gas Liquids).

5a. Tariff rates according to the Customs tariff of ÚCS 1993

		Tariff rates in %	
Code	Commodity	General	Concessionary
2709.00.90	Mineral oils and oils from bituminous minerals, crude - Others	free	free

6. Mining companies in the Czech Republic

Moravské naftové doly s.p., Hodonín

7. World oil production

World crude oil output was relatively stable during the last few years being 66.5 mill. barrels a day (1 barrel = 158.984 litres). Production is more or less controlled or affected by the OPEC quotas. However, these quotas are tenaciously disobeyed by some OPEC members (Nigeria, Iran, Kuwait). Consequently, the agreed production of 23.6 mill barrels a day has been exceeded in 1993 by as much as 1 mill. barrels. The OPEC members accounted for more than 40.0 % of the world crude oil output. Crude oil production in the former USSR continued to decline considerably. Thus, non - OPEC members share of the total world outpup also decreased. The following countries represent the major producers of crude oil in the world (in mill. bbls/day, crude oil including condensates and liquified natural gas, Mining Magazine, 1992):

USA	9.0	i.e.	13.5 %
Former USSR	9.0		13.5 %
Saudi Arabia (OPEC)	8.3		12.5 %
Iran (OPEC)	3.4		5.1 %
Mexico	3.0		4.5 %
China	2.8		4.2 %
United Arab Emirates (OPEC)	2.3		3.5 %
Venezuela (OPEC)	2.3		3.5 %
Norway	2.2		3.3 %
others (less than 2 % share)	24.3		36.4 %
Total	66.6		100.0%

An average production of crude oil was 59.720 mill. bbls/day in 1993 (Oil and Gas Journal Energy Database). Thus, the former USSR has become the third world major oil producer.

8. World crude oil market price

Crude oil represents a commodity which is extremely sensitive to the global political climate and development. The last considerable increase in prices occurred in 1990 , during the Gulf war. The crude oil price then exceeded USD 40.0/bbl .The major world exchange stock exchanges (IPE, NYMEX) quote prices of direct sales (Spot) and prices of long termed contracts in USD per barrel, FOB. Daily quotations regularly include prices of the North Sea Brent, the American West Texas Intermediate (WTI), the Arab Light and the Dubai crude oil. Sharp decrease in oil prices occurred shortly after the Gulf war cease-fire:

1991 - average Brent USD 20.10/bbl, WTI USD 21.60/bbl,
OPEC basket USD 18.66/bbl and Arab Light USD 17.49/bbl

1992 - average Brent USD 19.30/bbl, WTI USD 20.55/bbl,
OPEC basket USD 18.41/bbl and Arab Light USD 17.89/bbl

Further fall in crude oil prices occurred in 1993 due to global oil surplus. The level of USD 20.0 per barrel had exceptionally been exceeded by WTI crude oil. In general, the prices decreased below USD 15 per barrel and this trend appears to continue. The following prices were quoted as of December 31, 1993: Brent USD 13.15 per barrel, Arab Light USD 12.40 per barrel and Dubai USD 12 per barrel. The Russian crude oil was quoted at USD 12.35 per barrel (Spot).

Different crude oil prices reflect its grade which is expressed in degrees of API (Brent 38.0°, WTI 34.5°, Arab Light 34.0°, Dubai Fateh 32.0°, Russia - mixture 32.0°).

9. Oil recycling

Crude oil is not recycled.

10. Oil substitutes

Oil may be successfully substituted to certain extent by other types of fuels in power generation. As for gasoline or other oil derivatives, these can be substituted by fuel based on plants.

NATURAL GAS

1. Characteristics and use

Natural gas is a mixture of low-molecular-weight paraffin series hydrocarbons, principally methane, ethane, propane, and butane, with small amounts of higher weight hydrocarbons. Natural gas also frequently contains nitrogene, carbon dioxide, and hydrogene sulfide. Methane (CH_4) is normally the major constituent. There is also some admixture of crude oil, water and sand when extracting natural gas. Three principal grades of natural gas are recognized in the Czech Republic: dry gas (containing 98 - 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).

Natural gas world reserves are estimated at 7 trillions of m^3.

2. Natural gas resources of the Czech Republic

▪ Natural gas deposits are in reservoirs that contain oil. The deposits are mostly located in south Moravian part of the Vienna basin. Northern part of the basin contains rather oil deposits. Natural gas contains more than 93.0 % of methane , up to 5.0 % of higher weight hydrocarbons and max. 1.0 % of hydrogen and carbon dioxide . The Carpathian foredeep is considered as a promising area for the occurrence of natural gas. The composition of local gas deposits varies considerably. The Dolní Dunajovice deposit is characteristic of high content of methane (98 %) whereas the deposit Kostelany-west contains only 70 % methane and is high in helium and argon which can be extracted on industrial scale.

▪ In northern Moravia, specifically between Příbor and Český Těšín, the gas deposits are mostly confined to the weathered and tectonically affected Carboniferous paleorelief. The origin of these gas deposits being developed close to the top of the Carboniferous morphological elevations has not been deciphered yet. Ideas about the gas to have originated during coalification of the local coal seams has little support and its origin is considered to be connected with the neoid movements which led to the origin of natural hydrocarbons. This applies particularly to the gas deposits of Žukov, Bruzovice and Příbor. Part of the Příbor gas deposit is used as an underground gas storage .

▪ Natural gas of obviously Carboniferous origin and age is extracted during so-called degasification of coal seams of the Czech part of the Upper Silesian coal basin. Its quality varies considerably depending on the method of extraction and technical limitations related to degasification.

3. Registered deposits and their location in the Czech Republic

1 **South Moravian region**
- 20 deposits of which 14 are mined
- total reserves 20,504 mill. m^3
- mineable reserves 14,034 mill. m^3

2 **North Moravian region**
- 17 deposits of which 10 are mined
- total reserves 3,273 mill. m^3
- mineable reserves 2,122 mill. m^3

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in mill. m^3	4,702
A part of economic inferred reserves, in mill. m^3	17,789
Subeconomic reserves, mill. m^3	1,286

5. Domestic production, imports and exports of the Czech Republic

A total of 24 natural gas deposits were exploited in the Czech Republic in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T), in bill. m^3	0.125	0.125	0.125	0.132	0.106
Index of mining output evolution (1989=100)	100.000	100.000	100.000	105.600	84.800
Imports (D) in bill. m^3 [a]	6,056.000	6,361.000	6,787.000	5,945.000	6,981.000
Exports (V) in bill. m^3	N	N	N	N	N
Apparent consumption (T+D-V) in bill. m^3	N	N	N	N	N
Dependence on imports in %	N	N	N	N	N
Exports share in mining output in %	N	N	N	N	N

Note:

[a] *item 2711.21 of the customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2711.21	Natural gas (in gaseous state)	15.0	free

6. Mining companies in the Czech Republic

Moravské naftové doly a.s., Hodonín

Důlní průzkum a bezpečnost a.s., Paskov

7. World production

World natural gas production continues to rise and it is not expected to be affected by the decrease in production in the former USSR, the major world producer of natural gas because it is compensated by increased output in other countries, particularly in Canada, the Middle East countries, and elsewhere. The major producing countries and their share of world production are as follows (in billions m^3 according to CEDIGAZ, 1992):

Former USSR	780.5	i.e.	36.8 %
USA	505.0		23.7 %
Canada	130.6		6.1 %
The Netherlands	83.2		3.9 %
Algeria	55.5		2.6 %
Great Britain	54.4		2.6 %
Indonesia	53.0		2.5 %
others (less than 2 % share)	460.8		21.7 %
Total	2,123.1		100.0 %

8. World market prices

General increase in natural gas consumption was accompanied by decrease in costs of transport payed by consumers for imported gas (approximately 75 % of gas is transported through pipelines and about 25 % in tankers in liquified state). Natural gas prices are negotiated and are quoted in USD per mill. Btu. Natural gas price at a customer in Europe that had been still fluctuating between USD 3.6 and 4.0 per mill. Btu in 1985, had decreased down to USD 2.0 - 2.5 per mill.Btu in 1990. The American natural gas price was USD 1.98 per mill. Btu (Spot) in 1993.

9. Recycling

Natural gas is not recycled.

10. Natural gas substitutes

Natural gas can be successfully substituted to a certain extent by other types of fuel in energetics. However, natural gas itself represents economically and ecologically effective substitute for all other mineral fuels.

FLUORSPAR

1. Characteristics and use

Fluorspar - CaF_2 is by far the most common natural compound of fluorine. Fluorspar (also fluorite) is a transparent or translucent, glossy mineral, varying in color from white, amber, green, black, and blue to purple. The wide range of colors is caused by minor impurities and displacements in the crystal structure. The color can be changed when exposed to X-rays, UV radiation, heat, and pressure. The mineral crystallizes in the cubic system. Tiny inclusions of gas and liquids, pyrite, muscovite, chalcopyrite and other minerals are relatively common in fluorite. It occurs in the form of crystalline, massive or rodlike aggregates and also well developed crystals in fractures and cavities. It is rated as 4 on Mohs' scale of hardness. Majority of fluorspar deposits are of hydrothermal origin and may be further classified as low, medium and high temperature hydrothermal systems. Fluorspar deposits which originated by infiltration or residual, pegmatite and sedimentary deposits are much less abundant.

More than half of the fluorspar output is used in chemical industry for production of fluorine (F), hydrofluoric acid (HF), NaF, synthetic cryolite and in oil refineries. Fluorine is an important component of chloroflourocarbons and other chemicals used in refrigerants and other agents. Metallurgical industry also consumes relatively large volumes of fluorspar (1/3 of the total fluorspar output). Another applications are in cement production, in glass industry (glass with 10 to 30 % CaF_2 is milky, opaque and opalescent) for enamels, etc. Complex chemicals with fluorine and bromine are used in fire extinguishers and anaesthetics. Absolutely pure, transparent fluorite is used in microscope lenses, spectrograph prisms and plates for devices emitting short-wave rays.

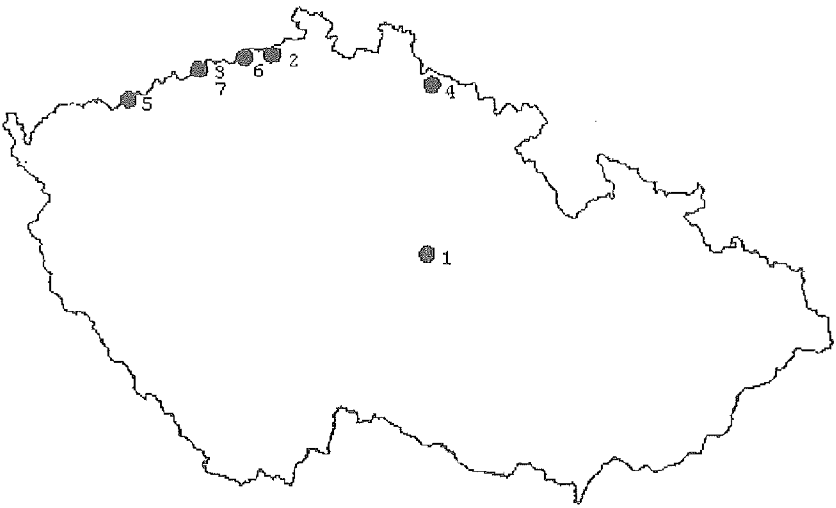
2. Mineral resources of the Czech Republic

All Czech fluorspar deposits are of hydrothermal origin, i.e. vein, stockwork and rarely even metasomatic types. They are mostly located in marginal parts of the Bohemian Massif occuring along major fault zones of the Krušné hory (NE-SW) and the Labe-Lužice (NW-SW) lineaments. Based on the principal mineral assemblages, these deposits can be divided into the following types: hematite-quartz-fluorspar, quartz-fluorspar, barite-fluorspar, barite-fluorspar with sulphides and barite-fluorspar-carbonates.

However, relative proportions of single minerals are changing considerably in individual deposits and even within single veins.

Majority of fluorspar deposits exhibit vertical zonation. Primary zonation is characteristic of abundant barite in upper parts and increasing content of fluorite with depth. However, this primary zoning is preserved only in relatively small layers or bodies because it is overlapped by secondary zonation which exhibits a pulsation character. The secondary zonation is due to an influx of fluids along fractures and faults and after re-opening of the old vein filling. Secondary zonation results in upgrading or reduction of the vein filling as far as the content of fluorite is concerned. The Moldava deposit, for instance, shows considerable enrichment in fluorspar.

3. Registered deposits and their location in the Czech Republic



1 Běstvina
2 Jílové near Děčín
3 Moldava
4 Harrachov
5 Kovářská
6 Krásný Les-Špičák
7 Moldava-Vápenice

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	886.8
A part of economic inferred reserves, in kt	2,400.1
Subeconomic reserves, in kt	283.0

5. Domestic production, imports and exports of the Czech Republic

Three fluorspar deposits were mined in the Czech Republic in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt	44.60	18.50	31.70	22.00	22.10
Index of mining output evolution (1989=100)	100.00	41.50	71.10	49.30	49.50
Imports (D), in kt [a]	0	0	19.80	2.40	19.34
Exports (V), in kt [a]	0	0	1.07	5.89	12.99

Note:

[a] *items No. 2529.21 and 2529.22 of the customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2529.21	Fluorspar with 97 % CaF_2 or less	free	free
2529.22	Fluorspar with more than 97 % CaF_2	free	free

6. Mining companies in the Czech Republic

Rudné doly Příbram s.p., Příbram

7. World production

The world production has been increasing since 1987 till 1989 when 5,529 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 freons production). The major producers and their share of world production are as follows (in kt according to USBM, 1992):

China	1,300	i.e.	36.1 %
Mongolia	400		11.1 %
Former USSR	320		8.9 %
Mexico	300		8.3 %
others (less than 5 % share)	1,280		35.6 %
Total	3,600		100.0 %

8. World market prices

Fluorspar prices were recently affected not only by fall in demand but also by supplies of cheap Chinese fluorspar on the world market. The Chinese supplies caused economic losses to traditional western producers and consequently led to reduction of their production capacities. Most countries applied antidumping measures in 1993. 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 following quotations were published in December 1993 for selected fluorspar grades:

Metallurgical, min. 70 % CaF_2, GBP/t, ex- UK mine	90 - 95
Acidspar, dry basis, 97 % CaF_2, bagged, GBP/t, ex-works UK	160 - 170
Acidspar Chinese dry bulk, USD/t, CIF Rotterdam	110 - 112
South African acidspar dry basis, USD/t, FOB Durban	90 - 105

9. 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. Not too much fluorspar is recycled in metallurgy when producing aluminium.

10. Substitutes

Fluorspar is virtually a 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, nitrogene, air, mechanical sprays, etc.). Fluorohydrocarbons are replaced by hydrocarbons in production of foamed plastics. Fluorspar can be substituted by cryolite (incl. synthetic) to certain extent in metallurgy when producing aluminium. Fluorspar can be also substituted by dolomite, limestone and/or olivine in ferrous metallurgy.

BARITE

1. Characteristics and use

Barite, chemically barium sulphate - $BaSO_4$, is the most common and abundant orthorhombic mineral exhibiting shades of white to dark grey and black depending on impurities and having a specific gravity of 4.3 - 4.7 t/m^3. Minor to trace amounts of other metals occur in barite crystal structure (Sr, Ca, Ra and Pb). Barite can be also contaminated by heterogenous iron oxides or clay minerals and organic matter.

Barium which is the major constituent of barite occurs in igneous rocks. It is released during their weathering and transferred in sediments and residual rocks. Barite deposits, in general, can be divided in fissure veins, replacement, residual and volcaniclastic (stratabound) deposits. World barite reserves are estimated at 210 mill. t.

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 glassmaking 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 weighting agent in well-drilling muds.

2. Mineral resources of the Czech Republic

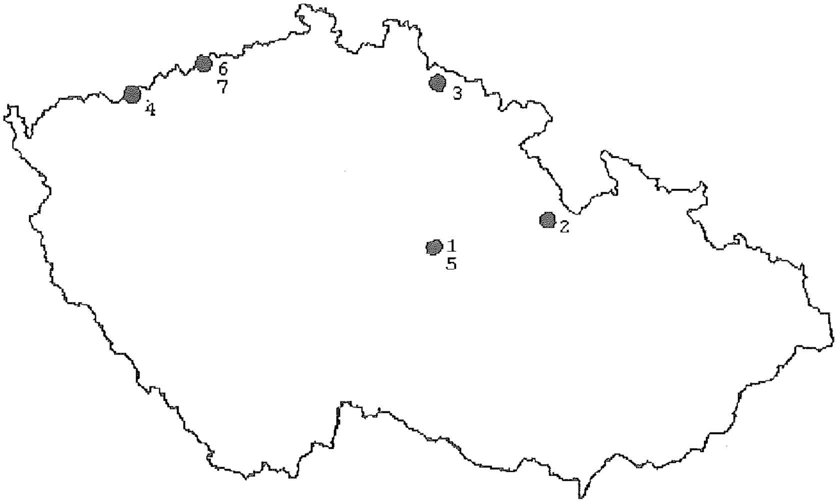
Barite deposits of the Czech Republic belong to the vein, stockwork, metasomatic or stratabound types. These deposits are randomly distributed over the Bohemian Massif depending on a great number of barite-bearing formations of various age and origin.

▪ Hydrothermal veins, locally with base metals, are tens to hundreds metres, exceptionally even 1 km, long, and having 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 orders trending mostly NW-SE and NWN-SES which are often filled with an older quartz or quartz-hematite mineral assemblage. Locally occur younger polymetallic (base metal) and the latests quartz mineralizations which downgrade the vein filling in deeper parts (e.g. the Mackov and Bohosouvá deposits). The deposits are mostly of the early Alpine or Variscan age and to much lesser extent of Precambrian or late Alpine age. Earlier mined deposit of Pernárec (1924-1960), then the deposits Mackov, Moldava-Vápenice and Kovářská in the Krušné hory mountains or Bohousová, Harrachov,and Běstvina belong to the above mentioned type of the deposit.

▪ Stratabound barite deposits originated from submarine hydrothermal solutions ascending along the faults at sea floor. These stratiform deposits in the Bohemian Massif are represented by layers and lenses in sediments of the Barrandien zone and the Železné hory Proterozoic (Krhanice in the Sázava river basin, Křižanovice) and in the Devonian of the Jeseníky mountains (Horní Benešov, Horní Město-Skály).

▪ A barite mineralization is known from the Květnice deposit near Tišnov in the Moravicum where barite was mined during World War II. Calcite - barite veins also occur in granites of the Svratka Dome and in the Květnice limestones. The filling of the major vein consists of calcite whereas barite is much less abundant.

3. Registered deposits and their location in the Czech Republic



1 Běstvina
2 Bohousová
3 Harrachov
4 Kovářská
5 Křižanovice
6 Mackov
7 Moldava-Vápenice

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	43.6
A part of economic inferred reserves, in kt	2,372.5
Subeconomic reserves, in kt	911.3

5. Domestic production, imports and exports of the Czech Republic

No barite deposit was exploited in the Czech Republic in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt	1.80	1.00	1.00	0	0
Index of mining output evolution (1989=100)	100.00	55.60	55.60	0	0
Imports (D), in kt [a]	N	N	N	23.70	31.71
Exports (V), in kt [a]	N	N	0.20	N	0.45

Note:

[a] *item 2511.10 of the customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2511.10	Natural barium sulphate (heavy spar)	free	free

6. Mining companies in the Czech Republic

Rudné doly Příbram s.p., Příbram

7. World production

Since 1987, the world barite production was gradually increasing till 1989 when 5,700 kt of barite were extracted. Then the barite output declined mostly due to global economic recession which affected major barite consuming sectors (both crude oil and natural gas exploitation and chemical industry). The major producers of barite and their share of world output are as follows (in kt, according to USBM, 1992):

China	1,800	i.e.	34.6 %
India	525		10.1 %
USA	410		7.9 %
Former USSR	400		7.7 %
Morocco	350		6.7 %
Turkey	300		5.8 %
others	1,415		27.2 %
Total	5,200		100.0 %

8. World market prices

Barite prices were under pressure of surplus offer, particularly regarding the offer of cheap Chinese and Indian barite. Chinese barite acquired the leading position in world production already in the seventies being used not only in drilling muds but also in other sectors of various industries. Prices of barite of various grade and origin are quoted monthly in the Industrial Minerals magazine in GBP/t or USD/t at various transport rates and conditions.

The following prices of selected grades were quoted in December 1993:

▪ API, Chinese lump, USD/t, CIF Gulf Coast	40 - 45
▪ API, Indian lump, USD/t, CIF Gulf Coast	35 - 40
▪ Micronized, white, paint grade, 96 - 98 $BaSO_4$, 99 % 350 mesh, GBP/t, del UK	180 - 200
▪ Unground, OCMA/API bulk, SG 4.22 t/m^3, USD/t, FOB Morocco	42 - 45
▪ Ground, bagged, USD/t, FOB Morocco	85

9. Recycling

Barite is actually continuously recycled in drilling muds. In other applications (chemicals, paints, enamels, glass, rubber etc.) is not recycled.

10. Substitutes

Magnetite, hematite (incl. synthetic), ilmenite, celestite and other heavy minerals can be alternatively used instead of barite in drilling muds. However, it is just a marginal alternative only. Barite can be replaced by other fillers (e.g. by limestone, dolomite, soot) in production of rubber and in glassmaking partly by strontium salts, in lithopone by other whites (e.g. zinc white) etc. However, all these substitutes were found not as good as barite.

GRAPHITE

1. Characteristics and use

Graphite is one of two polymorphs of natural carbon. Graphite is an important technical mineral exhibiting perfect basal cleavage, fair electric and heat conductivity, refractoriness and resistance to acids. Graphite occurs in two polymorphs - hexagonal and rare rhombohedral. Graphite forms hexagonal flakes of light or dark steel grey color, occasionally completely black with metallic or dull lustre.

All rocks which contain considerable amounts of graphite that can be recovered are be 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. The latter looks like a dull solid matter.

World deposits can be divided into several types: 1. early magmatic, 2. contact metasomatic - skarns, 3. vein type deposits 4. metamorphogenic - a) metamorphic, b) metamorphosed, 5. residual. World reserves of graphite are estimated at 21 mill. tons. Uses of graphite are based upon its physical and chemical properties. It is used in foundry industry, electrotechnics, chemical and nuclear industries, in manufacture of refractory materials, lubricants, protective coatings and pencils.

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 western part of the Bohemian Massif in Moldanubicum, then in the Moravicum and Silesicum.

▪ The most important deposits occur in the western part of Modanubicum, particularly in the so-called variegated series of Český Krumlov (mined deposits: Bližná, Český Krumlov-Městský vrch, Lazec, not mined deposits: Spolí, Český Krumlov-Rybářská street). Other less important deposits occur in the Votice-Sušice variegated series (not mined deposit at Koloděje nad Lužnicí-Hosty) and in the Chýnov mica schists (Černovice subeconomic deposit). South Bohemian graphitic rocks have a character of graphite rich gneisses, quartzites and carbonates.

▪ Deposits in the Moravian-Silesian region occur in an area affected by lower grade metamorphism. Local graphite shows lower degree of crystallization and contains much more sulphur which is confined to pyrite and pyrrhotite. The whole region is characteristic of higher contents of volatile constituents and less sulphur in graphitic layers in limestones than those in schists and phyllites. The major deposit of graphite in the Moravicum is Velké Tresné which was abandoned in 1966. It occurs in the Olešnice group of the Svratka dome. The major deposit in the Silesicum is Velké Vrbno-Konstantin which is a part of a graphitic zone belonging to the western margin of the Velké Vrbno dome.

3. Registered deposits and their location in the Czech Republic

Amorphous graphite:

1 Barbara
2 Bližná
3 Konstantin
4 Český Krumlov - Rybářská street
5 Lesná
6 Malé Vrbno

Crystalline graphite:

7 Český Krumlov-Městský vrch
8 Lazec
9 Koloděje on Lužnice-Hosty

Combined graphite:

10 Spolí

4. Reserves as of December 31, 1993

	amorphous	crystalline	total
Economic demonstrated reserves, in kt	1,504	709	2,213
Part of economic inferred reserves, in kt	1,149	2,466	3,615
Subeconomic reserves, in kt	2,134	6,546	8,680

5. Domestic production, imports and exports of the Czech Republic

Four deposits of graphite were mined in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T) in kt	66.0	39.0	47.0	20.0	27.0
Index of mining output evolution (1989=100)	100.0	59.1	71.2	30.3	40.9
Imports (D) in kt [a]	14.8	1.4	0.3	0.2	0.7
Exports (V) in kt [a]	5.5	2.9	1.2	0.9	2.1

Note:

[a] *item 2504 (import and export of dressed mineral raw material) of the Customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2504	Graphite	free	free

6. Mining companies in the Czech Republic

Grafit a.s., Netolice

RD Jeseník s.p., Jeseník

7. World production

World production of graphite remains stable for long time and is around 650 kt/year. Some world statistics on graphite production (BGS, WMS), however, provide data by 45 to 75 % higher since 1989. World major graphite producing countries and their share of the world production are as follows (in kt, according to the Mining Magazine and USBM, 1992):

China	180	i.e.	26.8 %
Korean Republic	80		11.9 %
Former USSR	80		11.9 %
Brazil	40		6.0 %
Mexico	40		6.0 %
DPR Korea	40		5.9 %
others	212		31.5 %
Total	672		100.0 %

8. World market prices

Prices of graphite were at the end of eighties influenced by its surplus on the world market. Prices of graphite of all 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 former Soviet graphite on the world market. Prices of natural graphite are published monthly in the Industrial Minerals magazine and quoted in USD/t CIF British ports. Prices of traded grades of graphite were in December 1993 as follows (in USD/t):

▪ crystalline, lump, 92/95 % C	650-850
▪ crystalline, large flake, 85/90 % C	400-600
▪ crystalline, medium flake, 85/90 % C	300-500
▪ crystalline, small flake, 80/95 % C	250-500
▪ amorphous, powder, 80/85 % C	220-440

9. Recycling

Recycling of graphite in major fields of its use is virtually impossible (refractory materials, break lining, foundry industry, lubricants). Little recycling of graphite electrodes is rather an exception.

10. Possible substitutes

Natural graphite is replaced by artificial graphite in the foundry industry (artificial soot and/or oil coke mixed with olivine or staurolite), by MoS_2 in lubricants, partly by magnesite in steel production. All alternative materials, however, have limited use.

GEMSTONES

1. Characteristics and use

The designation "gemstone" refers to such minerals or rocks which are mostly used for personal adornment. The most important qualities of gemstones are beauty, durability, color, transparency, high lustre, brilliance, attractiveness, rarity, etc. The price of gemstones depends on their quality, size, rarity and also last fashion may strongly affect the price of individual gemstones. Gemstones and gem materials occur in a large variety of rocks and mineral deposits. Among gemstones are elements, oxides, silicates, alumosilicates, borosilicates and other compounds.

Some low-quality gemstones are used in various sectors of industry, mostly as abrasives and in instruments requiring precision elements - knife edges for balances, jewel bearings in timing devices, etc.

Recently, there is relatively large production of synthetic crystals, particularly those of corundum, spinels, emeralds and diamonds. The latter are rather dark and are being used as abrasives. Manufactured crystals, in general,include applications in transistors, infrared optics,bearings, lasers, etc.

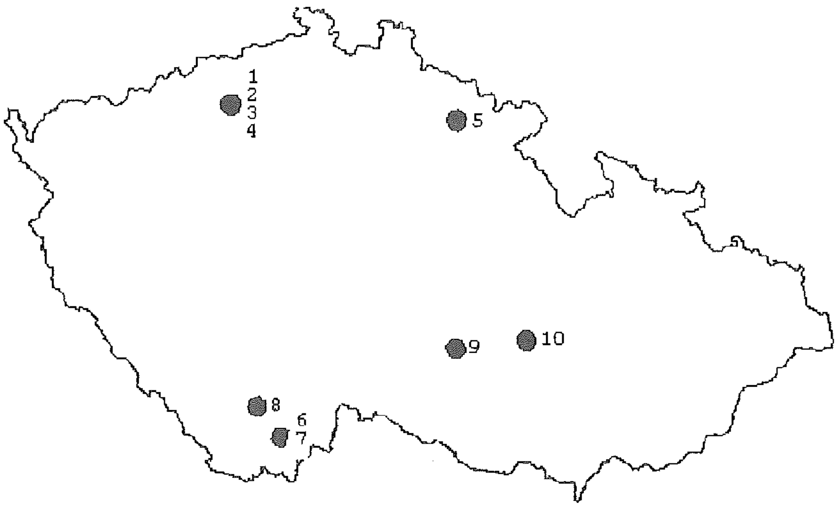
2. Mineral resources of the Czech Republic

Complex and varying geology of the Czech Republic is suitable for the occurrence of large selection of gemstones which were known and mined for since time immemorial. At present, the most significant gemstones in the Czech Republic are represented by so-called Bohemian garnet (pyrope) and tectite called moldavite.

- Pyrope, the most famous Czech gemstone is relatively complex Mg and Al silicate of varying chemistry, always containing low concentrations of Fe and Cr. Primary source of pyrope are ultramafic rocks. The mineral also occurs in serpentinites and placer deposits. The latter are most important for industrial mining for garnet. There is only one deposit of gemstones which is being recently mined in the Czech Republic. The deposit Podsedice is located on the southern slopes of the České středohoří mountains where pyrope-bearing placers are mined. Some more reserves of pyrope-bearing sediments and rocks were evaluated in the neighboring Dřemčice, Třebívlice and Starý localities. Pyropes are also known from other areas such as the Krkonoše piedmont basin where the Vestřev deposit has been discovered and where the mining operations are scheduled to start in 1994.
- The moldavites seem to represent an example to what extent the fashion trends may influence the popularity of certain gemstones. The moldavites are tectites whose origin is still enigmatic. They occur in loose Tertiary and Quaternary alluvial sands in southern Bohemia, in a belt which extends from Písek to České Budějovice and the Kaplice region. Brown moldatives occur in southern Moravia, along the Jihlava river, in a belt extending from Telč to Třebíč and further to Moravský Krumlov. Moldavites, particularly those from southern Bohemia, due to their attractiveness, are used in jewelry (mostly in their natural form). Industrial accumulations were verified at Besedice, Ločenice and Vrábče in southern Bohemia.
- Increasing interest and demand for gemstones initiated some survey aimed at search for some other gemstones (varieties of SiO_2) in the Czech Republic. Amethyst was found to occur in relatively large volumes in some quartz veins penetrating a porphyry syenite of

the Třebíč massif, particularly at the Bochovice and Hostákov localities. Geodes with crystals of amethyst and morion occur in these veins. The crystals exhibit zonal structure which is particularly well developed at Bochovice where the vein quartz envelopes so-called barrier amethyst. An opal deposit has been discovered in a fault zone NE of Rašov. A lenticular body of opal, about 60 m long occurs in a tectonic breccia confined to the Bíteš gneiss which shows some hydrothermal alteration.
It seems to be obvious that industrial mining for gemstones will never play any important role in economy of the Czech Republic but it may bring some profit on local scale.

3. Registered deposits and their location in the Czech Republic



Pyrope-bearing rock:
1 Podsedice
2 Linhorka-Staré
3 Podsedice-Dřemčice
4 Třebívlice
5 Vestřev

Moldavite-bearing rock:
6 Besedice
7 Ločenice
8 Vrábče-Nová Hospoda

Other gemstones:
9 Bochovice
10 Rašov

4. Reserves as of December 31, 1993

	Pyrope-bearing rock	Moldavite-bearing rock
Economic demonstrated reserves, in kt	3,793.0	0
A part of economic inferred reserves, in kt	12,934.0	305.8
Subeconomic reserves, in kt	6,444.0	0

5. Domestic production, imports and exports of the Czech Republic

Only one pyrope deposit was exploited in the Czech Republic in 1993. Other gemstones are not mined systematically.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt [a]	172.0	143.0	97.5	117.0	34.0
Index of mining output evolution (1989=100)	100.0	83.1	56.7	68.0	19.8

Note:

[a] *These figures stand for mining for both pyrope and moldavite-bearing sands.*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Tariff rates in % Concessionary
7103	Gemstones and semi-precious stones	5.0	0.2

6. Mining companies in the Czech Republic

Rudné doly Příbram s.p., Příbram

7. World production

World production of gemstones is not recorded except diamonds.

8. World market prices

Market prices of gemstones depend on their type, size and quality.

9. Recycling

Gemstones in jewelry are not recycled. Recycling is basically possible in some sectors of their industrial applications.

10. Substitutes

Generally, individual gem stones in jewelry can be combined and replaced but any substitutes can hardly reach the quality of original stones. Pyropes can be replaced by almandines, amethysts or similar looking minerals. Moldavites are irreplaceable. Gemstones in mineral collections are also irreplaceable. Natural abrasives are being replaced by synthetic materials (boron carbide, carborundum, fused Al_2O_3, etc). Pyrope is irreplaceable in jet cutting of metals.

KAOLIN

1. Characteristics and use

Kaolin is mostly residual (primary), less often sedimentary (secondary) whitish rock, containing substantial amount of kaolinite minerals. It always contains quartz, and it may contain 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, like granitoids, arkoses, gneisses, etc. These so-called residual kaolins could then be transported, thus originating sedimentary kaolins. The deposits are concentrated in feldspar rocks in which the kaolinization had occurred.

Kaolin is used for various purposes and the required grade depends on the use. Most often it is used as a raw material in the ceramic industry - in production of porcelain and other clay ware, then as a filler in the production of paper, rubber, plastics and pigments, in production of refractory materials, and in cosmetics, pharmaceutical, food, and other industries. Production of kaolin is often classified among production of clays.

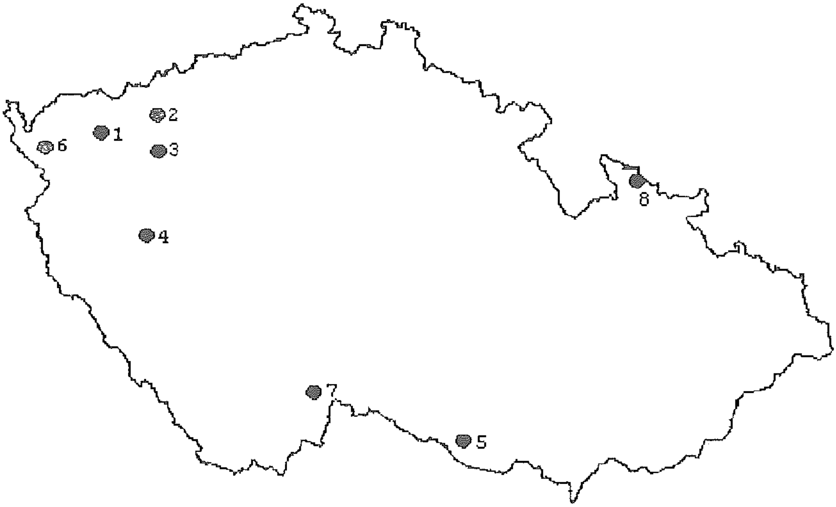
2. Mineral resources of the Czech Republic

All kaolin deposits in the Czech Republic originated by weathering (kaolinization) of feldspar rocks. The major kaolin deposits are located in the following areas:

- 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 (codes are explained in paragraph 4);
- The Kadaň region - kaolins of this area originated from granulite orthogneiss of the Krušné hory crystalline complex. This kaolin is of the KK and KP grades;
- The Podbořany region - parent rock is feldspathic sandstone of the Líně formation belonging to the Central Bohemian Permocarboniferous. There occur all aforesaid grades of kaolin here. The KJ kaolins are used as an additive into the Karlovy Vary kaolins in production of porcelain because of their rheological properties;
- 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), less of the KK grade, and only negligible part of the reserves is of the KZ and KJ grades.
- The Znojmo region - these kaolins originated mostly from granitoids of the Dyje massif, less from the Bíteš orthogneiss of the Dyje dome of the Moravicum. These kaolins are of the KZ grade and less of the KP grade.
- The Cheb basin - these kaolins originated through kaolinization of granites of the Smrčiny massif. There is only one deposit here (KK, KP);
- The Třeboň basin - less important deposits, local kaolins originated from granites and biotite paragneisses of the Moldanubicum. Only ceramic kaolins (KK) are present.

All kaolin deposits of the Czech Republic are extracted by open-pit mining operations.

3. Registered deposits and their location in the Czech Republic



1 **The Karlovy Vary region** - total reserves: 120 mill. tons of kaolin for production of porcelain (KJ - over 90 % of reserves, however, is rather of the KK grade due to its lower quality), 147 mill. tons of kaolin for the ceramic industry (KK), 238 mill. tons of titanium-bearing kaolin (KT), 4 mill. tons for the paper industry (KP).
There are 36 deposits, 5 of them are mined (Hájek, Jimlíkov, Osmosa-south, Otovice-Katzenholz, Podlesí 2).

2 **The Kadaň region** - total reserves are 115 mill.tons of KK grade and 29 mill. tons of KP grade.
There are 4 deposits, one of them is mined (Kadaň).

3 **The Podbořany region** - total reserves are 115 mill. tons of KJ grade kaolin (90 % of the reserves, however, is rather of KK grade), 37 mill. tons of KK grade, 47 mill. tons of KP grade and 25 mill. tons of feldspar-bearing kaolin (KZ).
There are 10 deposits, one of them is mined (Krásný Dvůr).

4 **The Plzeň region** - total reserves: 324 mill. tons of KP grade, 80 mill. tons of KK grade, 1 mill. tons of KJ grade and 6 mill. tons of KZ grade. There are 10 deposits, 3 of them are mined (Chlumčany-Dnešice, Horní Bříza, Lomnička-Kaznějov).

5 **The Znojmo region** - total reserves: 46 mill.tons of KZ grade and 3 mill. tons of KP grade. Altogether 14 deposits, one is mined (Únanov-north 3).

6 **The Cheb basin** - 1 deposit with total reserves 2 mill. tons of KK grade and 118 mill. tons of KP grade.

7 **The Třeboň basin** - total reserves are slightly under 5 mill. tons of KK grade in 2 deposits.

8 **Vidnava** - this deposit of kaolin is classified as refractory clays (JZ).

4. Reserves as of December 31, 1993

Technological suitability of kaolin is assessed according to properties of the water washed kaolin. In the Czech Republic, kaolins are classified according to their use:

- Kaolin for production of porcelain and fine ceramics (KJ); requirements: purity, rheological properties, strength after drying, pure white-fired colour (content of $Fe_2O_3+TiO_2$ max. 1.6 %), refractoriness min. 33 P.C.E. (1730° C), screen residue on the screen 0.063 mm max. 2 %;
- Kaolin for ceramics manufacturing (KK) has no specifically defined parameters and is used according to many ceramic recipes. Specially appreciated are white-fired colour, low content of colorant oxides, etc;
- Kaolin used as a filling in paper industry (KP) is used both as a filling and for coating. Required properties are high whiteness and low content of abrasive particles. It is also used as a filling in 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 %) and in plastics;
- Titanium-bearing kaolin (KT) - contains over 0.5 % TiO_2 and this type of kaolin occurs only in the Karlovy Vary region. Tests have proven a possibility to reduce TiO_2 content by high intensity electromagnetic separation after which most of these kaolins can be used as KJ or KK 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.

	Economic demonstrated reserves	A part of economic inferred reserves	Subeconomic reserves
Total kaolin reserves in kt	255,279	691,037	401,741
of which			
KJ grade, kt	64,030	80,674	92,822
KK grade, kt	26,988	91,816	142,546
KP grade, kt	108,780	309,025	108,628
KT grade, kt	47,255	171,631	25,696
KZ grade, kt	8,226	37,891	32,049

5. Domestic production, imports and exports of the Czech Republic

In 1993, there were 18 kaolin deposits mined in the Czech Republic.

Year	1989	1990	1991	1992	1993
Total mining output (T) in kt	3,642.0	3,455.0	2,913.0	2,530.0	2336.0
Index of mining output (1989=100)	100.0	94.9	80.0	69.5	64.1
Mining output of single grades					
KJ in kt	495.0	523.0	441.0	419.0	343.0
KK in kt	81.0	24.0	33.0	14.0	84.0
KP in kt	2,939.0	2,896.0	2,393.0	2,077.0	1,900.0
KT in kt	19.0	12.0	46.0	20.0	9.0
KZ in kt	108.0	0	0	0	0
Imports (D) in kt [a]	2.3	0.1	0.9	1.4	1.1
Exports (V) in kt [a]	570.0	487.8	374.6	691.1	421.3

Note:

[a] *item 2507.00 (water washed kaolin) of the Customs Tariff*

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Tariff rates in % Concessionary
2507.00	Kaolin and other kaolinitic clays	free	free

6. Mining companies in the Czech Republic

KSB, s.r.o., Božíčany
Kaolin Hlubany a.s., Hlubany
Západočeské kaolinové a keramické závody a.s., Horní Bříza
Chlumčanské keramické závody a.s., Chlumčany
Poštorenské keramické závody a.s., Břeclav-Poštorná
Keramost a.s., Most

7. World production

Data on the world production of kaolin vary considerably; the statistics quote alternately dry or wet weight, raw or refined kaolin, exact figures on mined and produced volumes of saleable product or their estimates. In spite of these misleading facts we can estimate that the world production since 1984 is in the range of 20 mill. tons per year, and in 1989 it obviously reached its top with about 25 mill. tons. Since 1989 there has been a decrease caused by general economic recession. In the statistically closed year 1991, the highest production was in the following countries (data in kt from various sources):

USA (sold or worked by producers)	9,575	i.e.	38.8 %
Great Britain (refined, dry)	2,911		11.8 %
Colombia	1,800		7.3 %
Korean Republic	1,755		7.1 %
Brazil (saleable, raw and refined)	900		3.6 %
India (saleable, raw and refined)	738		2.9 %
others (less than 2 % share)	7,054		28.5 %
Total (minimum reported 22,000 kt)	24,700		100.0 %

8. World market prices

Prices of kaolin on the world market - in spite of the lasting surplus of the supply - keep at the generally steady level. The Industrial Minerals magazine quotes each month prices of British and US kaolin, and during the last five years they either have not changed at all, or shown only minimum fluctuations. Issue 12/1993 quotes prices of British refined kaolin in GBP/t, EXW Cornwall, according to individual quality grades, as follows:

- Filler grade 50 - 75
- Coating grade 75 - 120
- Ceramic grade 40 - 80
- Porcelain grade 80 - 125

Similar prices were listed for the US kaolin, quoted in USD/st, FOB plant Georgia.

9. Recycling

From all various uses of kaolin, only recycling of paper filled with kaolin can be considered. But the volume of this paper is negligible.

10. Possible substitutes

Depending on the use, the situation is as follows:

- In production of porcelain, kaolin is irreplaceable;
- In ceramic recipes, in some cases kaolin can be partially substituted by clays, talc, wollastonite, or mullite (also synthetic mullite), but mostly these substitutions are inevitable from the viewpoint of technology;
- In production of paper (which consumes almost a half of the 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 a filler (insulation materials, pigments, glass fibres), the situation in analogous;
- In production of refractory materials and applications in the building industry, kaolin can be successfully substituted by other materials with adequate properties.

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, then 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, etc. They can be also secondarily consolidated (claystones) or recrystallized (argillite).

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 virtually in 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.

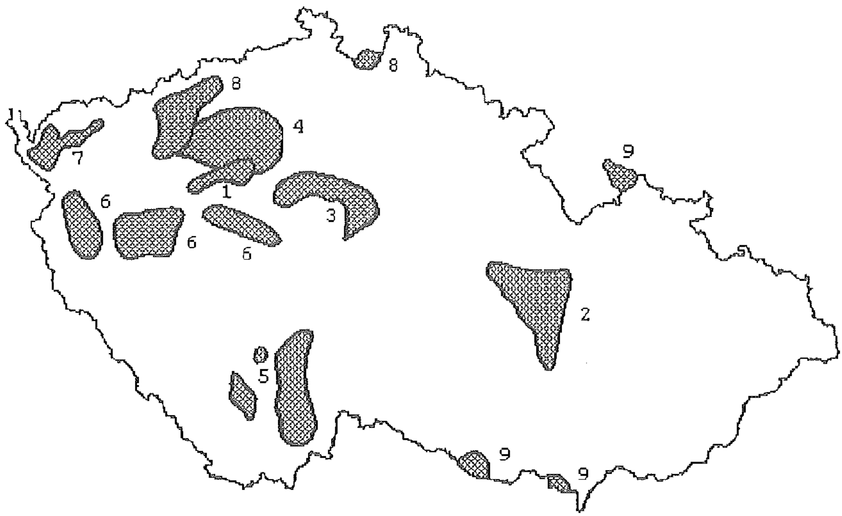
2. Mineral resources of the Czech Republic

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) (JZ), which are used in production of refractory opening materials. Less common are deposits of red-burning tile clays and grey non-refractory claystones (JN). For code explanations consult paragraph 4;
- Moravian and east Bohemian Cretaceous sediments - this is the area of the largest clay reserves (JZ grade), with the same use as the ones from the previous area (but with slightly lower quality);
- Cretaceous sediments in the vicinity of Prague - these clays are suitable as a highly refractory opening material (JZ) and refractory bond clays (JO), as well as whiteware clays (JP);
- The Louny Cretaceous - these clays are suitable as whiteware clays (JP) and other refractory clays (JO), but particularly as ceramic clays (JN);
- South Bohemian basins - medium or high grade refractory clays, suitable for use as bond clays (JO), whiteware clays (JP) and non-refractory clays (JN);
- The Plzeň basin and Tertiary relics of Central and Western Bohemia - mostly medium grade refractory clays, classified as bond clays (JO) and ceramic clays for production of floor and wall tiles, as well as for stoneware (JN);
- The Cheb and Sokolov basins - more significant is the Cheb basin containing important bond clays (JO), whiteware clays (JP), refractory and sintering clays (JO, JN), etc.;
- North Bohemian and the Zittau basins - apart from high aluminous underlaying clays (JA), there are also overlaying ceramic (mostly sintering and tile) clays (JN);
- Tertiary and Quaternary sediments in Moravia - mostly ceramic (sintering and tile) clays (JN). A very special position has the kaolin deposit at Vidnava classified as a clay deposit of JZ grade. Other deposits are of only local importance.

Clays in the Czech Republic are extracted by open-pit mining operations.

3. Registered deposits and their location in the Czech Republic



1 **The Kladno-Rakovník Permocarboniferous** - there are 16 deposits here, total reserves in this are slightly over 100 mill. tons of refractory clays (JZ) and 14 mill. tons of non-refractory ceramic clays (JN).

2 **Moravian and East Bohemian Cretaceous sediments** - 9 deposits, total reserves of refractory clays (JZ) exceed 400 mill. tons.

3 **Cretaceous sediments around Prague** - 8 deposits, total reserves: 6 mill. tons of whiteware clays (JP), 76 mill. tons of refractory clays (JZ), 2 mill. tons of other refractory clays (JO).

4 **The Louny Cretaceous** - 7 deposits, total reserves: 3 mill. tons of whiteware clays (JP), 12 mill. tons of refractory clays (JO) and slightly over 100 mill. tons of non-refractory ceramic clays (JN).

5 **South Bohemian basins** - 10 deposits, total reserves: 21 mill. tons of whiteware clays (JP), 98 mill. tons of refractory clays (JO), and 25 mill. tons of non-refractory ceramic clays (JN).

6 **The Plzeň basin and Tertiary relics of Central and Western Bohemia** - 25 deposits, total reserves: 17 mill. tons of refractory clays (JO) and 45 mill. tons of non-refractory ceramic clays (JN).

7 **The Cheb and Sokolov basins** - 20 deposits, total reserves: 20 mill. tons of whiteware clays (JO), 64 mill. tons of refractory clays (JO) and 21 mill. tons of non-refractory ceramic clays (JN).

8 **North Bohemian and the Zittau basins** - 8 deposits, total reserves confined only to the North Bohemian basin are 96 mill. tons of non-refractory ceramic clays (JN).

9 **Tertiary and Quaternary sediments in Moravia** - 6 deposits, total reserves are 20 mill. tons of non-refractory ceramic clays (JN).

4. Reserves as of December 31, 1993

According to technological properties and use, the clays are classified in the Czech Republic as follows:

- Whiteware clays (JP) - they are used as a raw material for 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 clasts is low;
- Refractory clays for grog (JZ) - after firing, these clays are suitable as an opening material for production of fireclay products. The material is required to contain maximum Al_2O_3 and 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);
- Other refractory clays (JO) - used as bond (plastic) clays in production of mainly refractory products. Besides high binding properties they should contain a minimum of Fe_2O_3 and clasts;
- Non-refractory ceramic clays (JN) - the raw material of wide spectrum of technological properties and uses (production of floor and wall tiles, additives, etc.);
- Aluminous underlaying clays (JA) - 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 to be a potential source of Al_2O_3 (non-bauxite). They were successfully tested to extract alumina.

	Economic demonstrated reserves	A part of economic inferred reserves	Subeconomic reserves
Total clays, in kt	269,134	801,885	267,879
of which			
JP grade, in kt	13,121	17,251	22,191
JZ grade, in kt	135,849	351,238	148,284
JO grade, in kt	71,696	92,280	44,553
JN grade, in kt	48,468	269,747	52,851
JA grade, in kt	0	71,369	0

5. Domestic production, imports and exports of the Czech Republic

In 1993, altogether 35 deposits of all technological grades, except JA grade, were mined in the Czech Republic.

Year	1989	1990	1991	1992	1993
Total mining output (T), kt	1,476.0	1,409.0	947.0	903.0	1,018.0
Index of mining output evolution (1989=100)	100.0	95.5	64.2	61.2	69.0
Mining output of single grades					
JP in kt	25.00	30.00	20.00	22.00	18.00
JZ in kt	849.00	814.00	479.00	420.00	383.00
JO in kt	388.00	354.00	294.00	328.00	291.00
JN in kt	214.00	242.00	174.00	133.00	326.00
Imports (D) in kt [a]	N	N	0.24	0.94	4.65
Exports (V) in kt [a]	N	N	176.52	168.64	227.43

Note:

[a] *items of the customs tariff, see paragraph 5a.*

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2508.30.00	Fireclay	free	free
2508.40.00	Other clays	free	free
2508.70.00	Chamotte or dinas earth	free	free
2508.20.00	Decolorizing and fuller's earth	free	free

6. Mining organizations in the Czech Republic

Keramost a.s., Most
KEMA Skalná s.p., Skalná
Rakovnické keramické závody a.s., Rakovník
Moravské šamotové a lupkové závody a.s., Velké Opatovice
České lupkové závody a.s., Nové Strašecí
RAKO - Lupky s.r.o., Lubná u Rakovníka
Calofrig a.s., Borovany
Moravské keramické závody a.s., Rájec-Jestřebí
Chlumčanské keramické závody a.s., Chlumčany
Západočeské kaolinové a keramické závody a.s., Horní Bříza
Poštorenské keramické závody a.s., Břeclav-Poštorná
Mostecká uhelná společnost a.s., Most
Palivový kombinát,s.p., Ústí n. Labem

7. World production

Overall data on the world production of clays are not available. There are some partial statistics on certain types of clays; according to these, the production of clays is slowly but steadily growing.

8. World market prices

Average prices of most of the clays were steadily growing. Prices of some of the clays are quoted each month in the Industrial Minerals magazine, in USD/st, GBP/t or DEM/t. The overview of prices in December 1993:

■ Attapulgite, granular, bulk, USD/st, FOB plant Georgia, USA	75 - 210
■ Attapulgite, commodity gel, bagged, USD/st, FOB plant Georgia, USA	200 - 450
■ Ball Clay, air dried, shredded, bulk, GBP/t, FOB Great Britain	20 - 65
■ Ball Clay, refined, noodled, bulk, GBP/t, FOB Great Britain	50 - 65
■ Ball Clay, pulverized, bagged, GBP/t, FOB Great Britain	75 - 115
■ Westerwald Ball Clay, dried & ground, bulk, DEM/t, FOB Germany	80 - 220
■ Westerwald Ball Clay, shredded, bulk, DEM/t, FOB Germany	25 - 90
■ Calcined refractory clay, US and French, GBP/t, CIF Europe	65 - 90

9. Recycling

The material is not recycled.

10. Possible substitutes

Majority of the clays are used in various fields of ceramics production. According to the use, the following substitutes are possible:

- Whiteware clays used in ceramic recipes - here the clays are irreplaceable. On the contrary, the selection of used clays is still wider, depending on local resources and new recipes;
- Clays for opening materials - especially in production of fireclay and similar materials, the clays can be successfully substituted by a number of refractory materials - andalusite, mullite (including synthetic mullite), etc. - depending on the use and local availability;
- The same applies for clays used in production of other refractory products; there are numbers of possible substitutes, which depend on the purpose and use of these products, economic considerations, 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 buff-burning clays, cast basalt), another 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.

BENTONITE

1. Characteristics and use

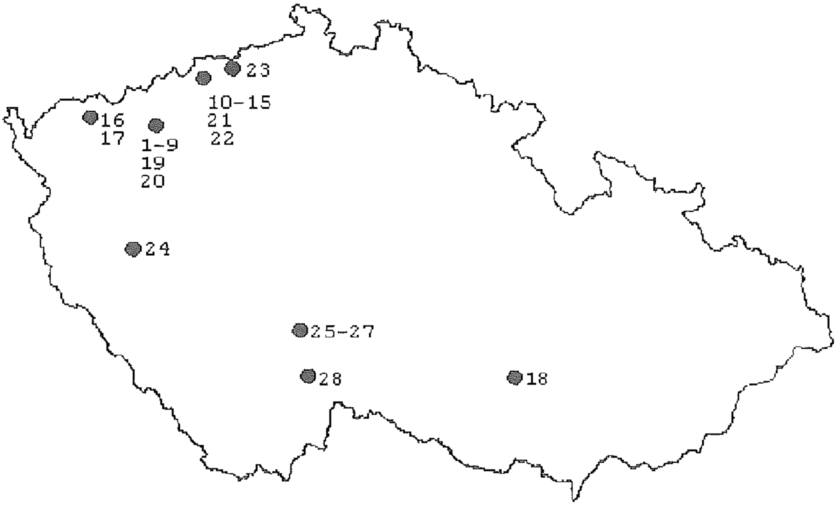
Bentonite is a soft, very fine-grained heterogeneous alterite of various colours, composed mostly of clay mineral montmorillonite which originated mostly by submarine or atmospheric weathering of basic (to a smaller extent also of acid) volcanic rocks (mainly tuffs). Montmorillonite gives to bentonite 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 alkali metals); 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 power. Bentonite also contains other clay minerals (kaolinite, illite, beidellite), pyroclastic rocks and clastic sediments, Fe compounds, quartz, feldspars, volcanic glass, etc., which represent impurities and if possible they are removed during the mineral processing.

Bentonite has many uses, which depend upon its mineralogical composition and technological properties. It is mostly used in foundry industry, for pelletizing of iron ores, as an adsorbent (decolorizing mineral, catalysis, refining, filtration, drying, waste water treatment, pesticide carrier), in drilling muds, as a filler (dyes, varnishes, pharmaceutical and cosmetic products), a suspension (lubricating oils), in the building industry (sealing material), in agriculture, etc. In recent years, the bentonite is still more used as a pet waste adsorbent ("catlite").

2. Mineral resources of the Czech Republic

The most important bentonite deposits in the Czech Republic are in the eastern (The Kadaň and Podbořany region) and western margin (Hroznětín region) of the Doupovské hory and České středohoří mountains (particularly the Most region). These areas include almost all bentonite deposits and reserves of the Czech Republic. Less important are deposits in Tertiary basins (The Plzeň region, South Bohemian basins, the Cheb and Sokolov basins) and Miocene sediments of the Carpathian Neogene in southern Moravia, with their mostly montmorillonite clays. All bentonite and montmorillonite clay deposits in the Czech Republic originated by weathering of volcanic rocks. Mining, mineral processing and use of bentonite in the Czech Republic started only in the late fifties, particularly due to its use in the foundry industry. The mining culminated at the beginning and end of the eighties, and since then it has a decreasing trend. Large portion of bentonite from deposits of the Doupovské hory and České středohoří mountains 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.

3. Registered deposits and their location in the Czech Republic



Foundry bentonite:
The Kadaň and Podbořany regions:
1 Blov-Krásný Dvoreček
2 Blšany 2
3 Horní Ves
4 Krásný Dvůr-Vys. Třebušice
5 Nepomyšl
6 Nepomyšl-Velká
7 Podbořany-Letov
8 Rokle
9 Vlkaň

The Most region:
10 Braňany
11 Černý vrch
12 Liběšice
13 Stránce
14 Střimice 1
15 Střimice 2-Braňany

The Hroznětín region:
16 Velký Rybník 2
17 Všeborovice
18 Ivančice-Réna

Other bentonite:
The Kadaň and Podbořany regions:
19 Račetice
20 Vysoké Třebušice

The Most region:
21 Obrnice-Vtelno-Rudolice
22 Střimice 2-Braňany
23 Modlany

The Plzeň region:
24 Dnešice-The Plzeň south

South Bohemian basins:
25 Maršov
26 Rybova Lhota
27 Skalice
28 Třeboň

4. Reserves as of December 31, 1993

	foundry	others	total
Economic demonstrated reserves, in kt	48,911	563	49,474
A part of economic inferred reserves, in kt	110,868	78,289	189,157
Subeconomic reserves, in kt	14,923	22,068	36,991

5. Domestic production, imports and exports of the Czech Republic

There were 4 bentonite deposits mined in 1993.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt	168.00	159.00	125.00	135.00	63.00
Index of mining output evolution (1989=100)	100.00	94.60	74.40	80.40	37.50
Imports (D), in kt	N	N	0.30	0.10	4.30
Exports (V), in kt	N	N	9.46	10.08	13.51
Apparent consumption (T+D-V), in kt	N	N	115.80	125.00	53.80
Dependence on imports in %	N	N	0.30	0.10	8.00
Exports share of mining output in %	N	N	7.60	7.50	21.40

5a. Tariff rates according to the Customs tariff of ÚCS 1993

		Tariff rates in %	
Code	Commodity	General	Conces-sionary
2508.10.00	Bentonite	free	free

6. Mining companies in the Czech Republic

Keramost a.s., Most
Calofrig a.s., Borovany
Bentonit Moravia s.r.o., Ivančice

7. World production

Annual world production of bentonite is about 10 mill. tons. The production has been for a long period higher than 9 mill.t/year, and the highest output was in 1990 - 9.7 mil. t. After 1990 the production slightly decreased due to a lower demand for the drilling mud and for pelletizing of iron ore (drop in production of pig iron since 1990). The world's leading producers are (data in kt, according to USBM, 1991):

USA (1992: 3,271 kt)	3,422	i.e.	37.0 %
Former USSR	2,400		25.9 %
Greece	1,000		10.8 %
Japan	554		6.0 %
Germany	230		2.5 %
France	230		2.5 %
others (less than 2 % share)	1,418		15.3 %
Total	9,264		100.0 %

8. World market prices

Bentonite prices have been slightly increasing in the last few years. According to quotation of the Industrial Minerals magazine, in December 1993, there were the following prices on the world market:

- Wyoming, foundry grade, 85 % <200 mesh, bagged, GBP/t, del UK 130 - 140
- Wyoming, crude, bulk, USD/st FOB plants 25 - 40
- Wyoming, foundry grade, bagged, USD/st FOB plants 40 - 50

9. Recycling

Bentonite used as a bonding agent for pelletizing of iron ores and as a compound of moulding sand cannot be recycled at all, in other uses only on a very limited scale.

10. Possible substitutes

In moulding sands, bentonite can be replaced by bonding agents containing graphite, synthetic polymers, or other clay minerals. Drilling muds can use similar substitutes, fillers can use chalk, dolomite, limestone, etc., in ecological applications bentonite can be replaced by zeolites. In production of iron ore pellets, bentonite is replaced by burnt lime and other binders.

FELDSPAR

1. Characteristics and use

Feldspar raw materials are rocks with the prevalent portion of minerals of the feldspar group or their mixtures in such a form, quantity and quality, which allow their industrial processing. Feldspars are a group of monoclinic (orthoclase, sanidine) and triclinic (microcline, plagioclases) anhydrous potassium and sodium-calcium alumosilicates, and together with quartz they represent the most common rock forming minerals. For industrial use are suitable potassium feldspars (orthoclase, microcline) and acic plagioclases (albite, oligoclase, andesite). Suitable feldspar resources are dike rocks (pegmatites, aplites), igneous rocks (granites), metamorphic rocks (gneisses), sediments (feldspar bearing sands and gravel), eventually also residues of incompletely kaolinized rocks. The major impurities is high content of iron in the feldspar structure (unremoveable) or in the form of admixture (removeable).

Because of their low melting point, feldspars are used as a melting agent in ceramic mixtures, glass batches, glazes, enamels, etc.

For the same purposes there are also used feldspar substitutes, which are rocks with alkali metals confined to some other minerals (mostly nepheline - anhydrous sodium-potassium alumo-silicate). Nepheline syenites are particularly used abroad to substitute for feldspar raw materials.

2. Mineral resources of the Czech Republic

Feldspar deposits in the Czech Republic are represented mostly by feldspar gravel sands, leucocratic granitoids and pegmatite bodies.

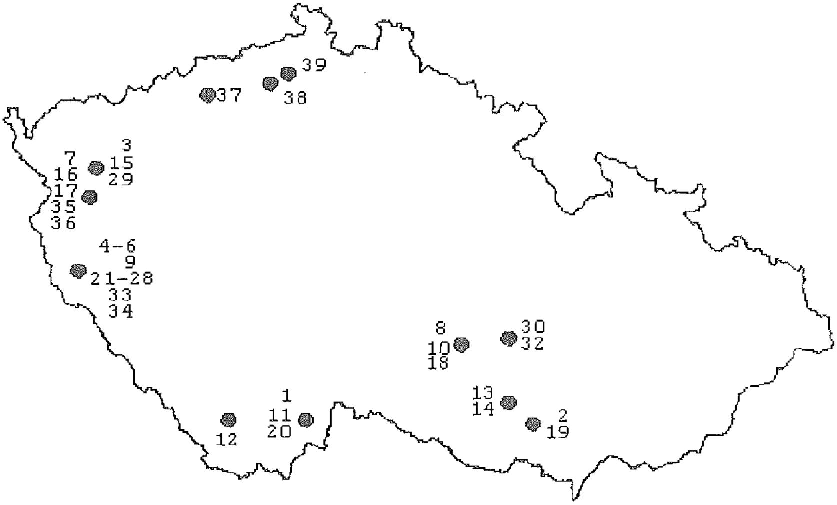
▪ Recently, the most significant are feldspar deposits originated in source areas of granitic rocks high in feldspar phenocrysts. The most important of them are the area along the upper course of the river Lužnice and the area south of Brno (sediments of the river Jihlava). The sediments are Quaternary fluvial feldspar gravel sands, suitable for production of glazes, household china, sanitary ceramics, glass, etc;

▪ Very important source of feldspar are leucocratic granitoids (granites and granite porphyries, diorites), mostly fine- to medium-grained. They have been explored at many localities occurring in various granite massifs (Chvaletice, Blanice region, Babylon, Blatno, etc.). Besides potential deposits (western Moravia), this category also includes already mined deposits (western Bohemia - Krásno, Mračnice). The material is used in production of sanitary ceramics, colored glass, porcelain, grinding wheels, etc;

▪ In the past, the only source of feldspars used to be pegmatite deposits occurring in many regions. The Poběžovice - Domažlice region is characteristic of pegmatites with an admixture of dark minerals. These pegmatites exhibit a balanced proportion of sodium and potassium feldspars. The material is medium to low grade. But there are also sodium feldspar deposits which can be used in production of glazes and clear glass. In other areas, prevailing minerals in pegmatites are potassium feldspars. Pegmatites of the Dolní Bor area are a source of glaze and other feldspars. The Tepelské vrchy region, with quite large deposits of high grade feldspars and low content of impurities seem to be very promising. Quite promising is also the Písek region, with zoned pegmatites, only slightly affected by metasomatic processes. Smaller deposits are known in the area of Humpolec, in western Moravia, etc;

▪ As a substitute for feldspars in the Czech Republic, there are used mainly Tertiary volcanic rocks of the České středohoří mountains - nepheline phonolites. Because of high content of coloring oxides they are used in the glass and ceramics industry only as a melting agent for color mixtures.

3. Registered deposits and their location in the Czech Republic



Feldspar raw materials:

1 Halámky
2 Hrušovany near Brno
3 Krásno-granite
4 Luženičky
5 Mračnice
6 Ždánov
7 Beroun-Tepelsko
8 Bory-Olší
9 Březinka
10 Dolní Bory
11 Halámky-Tušť
12 Chvalšiny
13 Ivančice-Letovisko
14 Ivančice-Němčice
15 Krásno-Vysoký Kámen
16 Křepkovice
17 Křiženec
18 Lavičky
19 Ledce-Hrušovany near Brno
20 Majdaléna
21 Mašovice
22 Meclov 2
23 Meclov-airfield
24 Meclov-west
25 Ohnišťovice
26 Ohnišťovice-west
27 Otov-Červený vrch
28 Otov-east 2
29 Přílezy
30 Smrček
31 Srby
32 Velké Tresné
33 Zámělíč
34 Zámělíč 2
35 Zhořec 1
36 Zhořec 2-Hanov zone

Feldspar substitutes:

37 Želenice
38 Tašov-Rovný
39 Valkeřice-Zaječí vrch

4. Reserves as of December 31, 1993

	felspars	felspars substitutes
Economic demonstrated reserves, in kt	40,115	0
A part of economic inferred reserves, in kt	216,296	200,410
Subeconomic reserves, in kt	5,767	0

5. Domestic production, imports and exports of the Czech Republic

In 1993, there were mined 6 feldspar deposits and 1 deposit of the nepheline phonolite in the Czech Republic.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt (feldspars)	139.00	115.00	130.00	152.00	203.00
Index of mining output evolution (1989=100)	100.00	82.70	93.50	109.40	146.00
Imports (D), in kt [a]	N	N	0.56	2.46	0.52
Exports (V), in kt [a]	N	N	27.78	43.09	63.40
Apparent consumption (T+D-V), in kt[a]	N	N	102.80	111.40	140.10
Dependence on imports in % [a]	N	N	0.50	2.20	0.40
Exports share of mining output in % [a]	N	N	21.40	28.30	31.20
Mining output (T), in kt (phonolite)	11.00	15.00	16.00	16.00	20.00
Index of mining output evolution (1989=100)	100.00	136.00	145.00	145.00	182.00

Note:
[a] *item 2529.10 of the customs tariff*

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2529.10	Feldspar	free	free

6. Mining companies in the Czech Republic

Calofrig a.s., Borovany
Chlumčanské keramické závody a.s., Chlumčany
KMK Granit s.r.o., Sokolov
Keramost a.s., Most

7. World production

Annual world production (including nepheline syenite and aplite) is about 6 mill. tons. In the statistically closed years (until 1992), the highest production was in 1992 - 5.3 mill. tons, when production capacities were used only at 88 %. The largest world producers are (data in kt, according to USBM, 1992):

Italy	1,500	i.e.	28.3 %
USA	696		13.1 %
France	400		7.6 %
Germany	330		6.2 %
Thailand	330		6.2 %
others (less than 5 % share)	2,044		38.6 %
Total	5,300		100.0 %

8. World market prices

Prices had been slowly rising until 1991, then there came a slight decrease, due to a high supply and recession in the glass and ceramics industries. Prices are quoted each month in the Industrial Minerals magazine, separately for feldspar, nepheline syenite and aplite. Prices in December 1993 were as follows:

▪ Feldspar, ceramic grade, powder, 300 mesh, bagged, GBP/t, ex-store UK	160
▪ Feldspar, sand, glass grade, 28 mesh, GBP/t, ex-store UK	85
▪ Feldspar South African, ceramic grade, bagged, USD/t, FOB Durban	135
▪ Feldspar South African, micronised, bagged, USD/t, FOB Durban	225
▪ Nepheline syenite, Norwegian, glass grade, 0.5 mm bulk, GBP/t, CIF UK port	70
▪ Nepheline syenite, Norwegian, ceramic grade, 0.045 mm bulk, GBP/t, CIF UK port	81
▪ Ditto, bagged	110
▪ Aplite, glass grade, bulk 100 % +200 mesh, GBP/t, FOB Montpelier (USA)	25.75

9. Recycling

Feldspar material is not recycled.

10.Possible substitutes

Feldspar substitutes are materials having alkali metals confined to other minerals than feldspars, like nepheline syenites or nepheline phonolites in the Czech Republic. These replace feldspars as a melting agent. In other applications (fine abrasives, filler in rubber, plastics and paints), feldspars can be replaced by clays, talc, spodumene, pyrophyllite or their mixtures.

QUARTZ

1. Characteristics and use

Silica raw materials are represented by various rocks high in SiO_2 (usually min. 96 %). These are various quartzites (sedimentary or metamorphosed rocks, consisting mostly of quartz and originated through silicification of sandstones or by cementing of quartz sandstones by siliceous cement; the shape of original grains cannot be usually recognized), silicified sandstones, siliceous rocks, quartz sand and gravel, and vein and pegmatite quartz. Vein quartz and rock crystal (abroad) are used for production of special glass. The grade is established by various standards. The observed parameters are the content of SiO_2 and refractoriness. Impurities are represented by high Al_2O_3, Fe_2O_3, and/or other oxides. Silica raw materials are used in production of ferroalloys in the metallurgical industry, silicon metal (in metalurgy,in semiconductors), refractory building materials (silica - bricks, mortars, ramming masses), porcelain and ceramics. Vein quartz, rock crystal and quartz boulders are used in production of pure silica glass, UV glass and optical glass (fibre).

2. Mineral resources of the Czech Republic

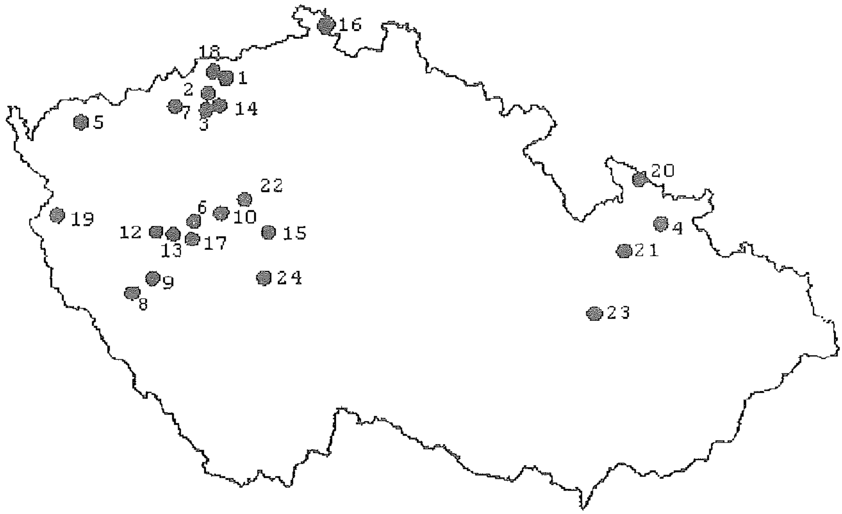
In the Czech Republic, silica raw materials are classified into two groups - silica raw materials, and silica raw materials for production of special glass. Silica deposits are confined especially to the occurrences of the Tertiary "amorphous" quartz, Cretaceous "crystalline" quartz and Ordovician quartz, to lesser extent to the occurrences of vein quartz and lidites of the Upper Proterozoic.

- Vein quartz deposits can be found almost all over the territory of the Czech Republic, and they can be divided into the following genetic groups:

1) Quartz deposits in pegmatites (the Poběžovice region and N. Moravia) - suitable for production of porcelain, ferrosilicon, silicon;
2) Quartz dikes (silicified fault zones) - suitable for ceramic industry (the Tachov region, S. Bohemia, the Jeseníky mountains);
3) Quartz veins related to granitoid massifs (the Karlovy Vary massif, the Žulová massif)

- Deposits of "amorphous" quartzite (quartz grains are cemented by a very fine quartz matrix) originated through silicification of Tertiary and Upper Cretaceous sediments in northern and western Bohemia (The Most region - mined deposit of Stránce, the Chomutov and Podbořany regions). Quartzite is a traditional material for production of dinas and can be also used for production of silicon metal;
- Neoid silicification of Cretaceous sandstones gave origin to important deposits of "crystalline" quartzites (isometric grains of quartz) in the Teplice region (mined deposit of Jeníkov-Lahošť). Quartzites are suitable for metallurgy but also for production of dinas;
- Among Paleozoic quartzites, the Ordovician quartzites of the Barrandien zone appear to be the most important. They are classified as of a lower grade for production of ferrosilicon and dinas;
- Because of their size and grade, very promising seem to be deposits of the Upper Proterozoic lydites, especially in the Rokycany and Přeštice regions. Tests showed the material is suitable for production of siliceous alloys, and to lesser extent for production of dinas;
- As a potential source of silica are considered to be also quartz sands and gravels in alluvial deposits of the Labe and Dyje rivers, and in the Cheb region;
- Only milky white vein quartz (after mineral processing) is considered to be suitable for production of special glass. It occurs in the Central Bohemian pluton (The Příbram region - metamorphosed island zone), and in hydrothermal veins which were metamorphosed together with the country rocks (phyllites) in the Prostějov region.

3. Registered deposits and their location in the Czech Republic



Quartz - Quartzite:

1 Jeníkov-Lahošť
2 Stránce
3 Bečov
4 Bílý Potok-Vrbno
5 Černava-Tatrovice
6 Drahoňův Újezd-Bechlov
7 Horní Ves
8 Kaliště
9 Kbelnice
10 Kublov-Dlouhá Skála
11 Kublov-Velíz
12 Kyšice-Pohodnice
13 Litohlavy-Smrkový vrch
14 Lužice-Dobrčice
15 Mníšek pod Brdy
16 Rumburk
17 Sklená Huť
18 Střelná
19 Světecká Hora
20 Velká Kraš
21 Vikýřovice
22 Železná

Quartz for special glass:

23 Dětkovice
24 Krašovice

4. Reserves as of December 31, 1993

	for special glass	others	total
Economic demonstrated reserves, in kt	144	7,177	7,321
A part of economic inferred reserves, in kt	178	31,453	31,631
Subeconomic reserves, in kt	63	16,133	16,196

5. Domestic production, imports and exports of the Czech Republic
In 1993, there were mined 2 quartz deposits.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt	185.0	169.0	65.0	46.0	23.0
Index of mining output evolution (1989=100)	100.0	91.4	35.1	24.9	12.4
Imports (D), in kt [a]	2.1	0.1	0.6	0.9	2.5
Exports (V), in kt [a]	N	N	N	29.3	17.0
Apparent consumption (T+D-V), in kt	N	N	N	17.6	8.5
Dependence on imports, in %	1.1	0.1	0.9	5.1	29.4
Exports share of mining output, in %	N	N	N	63.7	73.9

Note:
[a] *item 2506 of the customs tariff*

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Tariff rates in % Concessionary
2506	Quartz (except natural sand); raw or worked quartzite	free	free

6. Mining companies in the Czech Republic
Keramost a.s., Most

7. World production

Among many known silica raw materials (except sands), special attention is paid to materials for production of synthetic quartz crystals for use in electronics and optics, and then to mining for natural quartz crystals for direct use in industrial applications. Mining for natural crystals is limited and 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 are Brazil and Namibia. Average production in the USA since 1989 has been 440 t/year.

8. World market prices

Silica materials (except for glass and foundry sands) 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 and the price has been at this level until now.

9. Recycling

Silica material is not recycled.

10. Possible substitutes

Quartz had been, as a strategic mineral, irreplaceable until the fifties. Today it is being still more replaced, both in electronics and optics, by synthetic crystals. Synthetic quartz competes with natural quartz also in production of clear silica glass.

In production of ferrosilicon, the quartz is irreplaceable, but the final product, ferrosilicon, can be replaced by other materials. Also dinas can be replaced by other types of lining.

GLASS AND FOUNDRY SANDS

1. Characteristics and use

Glass sands are granular, pale or even white coloured rocks (quartz sands or sandstones), which are used, after beneficiation, as a raw material for production of glass. Required parameters (grain size, mineral and chemical composition) vary according to the type of glass. Sands of required grade do not usually occur in the nature, therefore the sands have to be dressed by crushing, washing (removes floating particles) and sorting (to reach the required grain size). To obtain high grade glass sands it is necessary to apply more sophisticated methods of mineral dressing (electromagnetic separation, flotation, etc.); it is of utmost importance to reduce the content of colorant oxides (Fe_2O_3, TiO_2, Al_2O_3) and heavy minerals in order to meet rigid specifications with respect to purity of silica and its maximum content. Sands for glass melting are used for preparation of glass batches for production of sheet glass, packing glass and some technical glasses (max.content of Fe_2O_3 0.0023 % - 0.0040 %), and utility glass (up to 0.0021 % Fe_2O_3); glass sands of higher grade are used for production of non-transparent silica glass (max. 0.0020 % Fe_2O_3) and the top quality sands (max. 0.0012 % and 0.0015 % Fe_2O_3) are used for production of crystal glass, semi-optical glass and some special technical glasses.

Foundry sands are similar rocks as glass sands, being used directly or after mineral dressing for production of foundry moulds and cores. The required properties include sufficient resistance to high temperatures and strength (depends on quality and quantity of the binding elements), and suitable grain size (the average grain size and its regularity). Because of their variability, natural foundry sands are still more being replaced by quartz sands, mixed with suitable amount of binding agents (mostly bentonite).

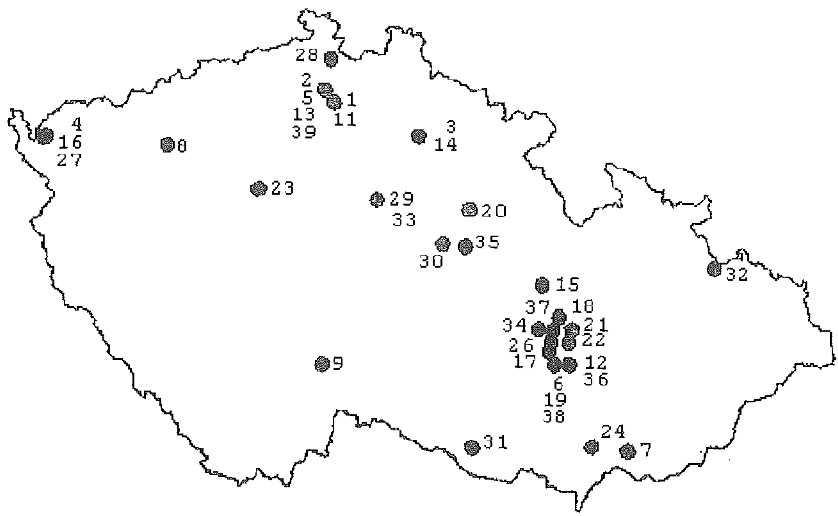
2. Mineral resources of the Czech Republic

■ The largest and most important deposits of glass sands in the Czech Republic are located in the Lužice (Srní, Provodín) and Jizera (Střeleč) regions of the Bohemian Cretaceous basin. The raw material consists of weakly consolidated quartz sandstones of the Coniacian (Střeleč) and Middle Turonian (Provodín, Srní) age. The Střeleč glass sand is of top world quality. Other deposits within the Bohemian Cretaceous basin are less important, or they are located in areas with special environmental considerations. Unconventional deposit at Velký Luh is composed of Pliocene gravel sands of the Cheb basin (redeposited material from the kaolinized Smrčina granite). Sands from all aforesaid deposits require mineral dressing in order to meet rigid specifications (washing, sorting, electromagnetic separation, flotation, etc.);

■ Foundry sand deposits are more abundant. They always accompany glass sands (material of lower grade), but they can also form their own deposits in other parts of the Bohemian Cretaceous basin (Cenomanian sandstones of the Orlice-Žďár region which are often glauconitic sands). Less important are wind blown sands (the Labe river basin and the Lower Moravian depresion) and Pliocene sands of the Cheb basin; only of local importance are fluvial sands (Lžín), glacial sands (Palhanec), etc. Foundry industry also uses sands which are a waste product of kaolin refining(Krásný Dvůr).

All deposits of glass and foundry sands in the Czech Republic are extracted by open-pit mining operations (in the past exceptionally also by underground mining - Dolní Lhota).

3. Registered deposits and their location in the Czech Republic



Glass sands:

1 Provodín
2 Srní 2
3 Střeleč
4 Velký Luh
5 Srní

Foundry sands:

6 Blansko 1-Jezírka
7 Bzenec-Vracov
8 Krásný Dvůr
9 Lžín
10 Nýrov
11 Provodín
12 Rudice-Seč
13 Srní 2
14 Střeleč
15 Svitavy
16 Velký Luh
17 Voděrady
18 Babolky
19 Blansko 2-Mošná
20 Bohumileč-Rokytno
21 Boskovice
22 Boskovice-Chrudichromy
23 Břve
24 Čejč-Hovorany
25 Deštná-Dolní Smržov
26 Kunštát-Zbraslavec
27 Lomnička
28 Mlýny
29 Mostkový Les
30 Načešice
31 Nový Šaldorf
32 Palhanec-Vávrovice
33 Polabí-Zvěřínek
34 Prostřední Poříčí
35 Rabštejnská Lhota
36 Rudice-Novinky, Na Kalu
37 Rudka near Kunštát
38 Spešov-Dolní Lhota
39 Srní

4. Reserves as of December 31, 1993

	glass sand	foundry sand	total
Economic demonstrated reserves, in kt	91,287	163,704	254,991
A part of economic inferred reserves, in kt	83,000	123,734	206,734
Subeconomic reserves, in kt	95,510	212,113	307,623

5. Domestic production, imports and exports of the Czech Republic

In 1993, there were mined 4 glass sand deposits and 14 foundry sand deposits in the Czech Republic.

Year	1989	1990	1991	1992	1993
Mining output (T) total, in kt	2,739.0	2,758.0	1,837.0	1,963.0	1,735.0
of which					
glass sand, in kt	1,045.0	1,181.0	918.0	888.0	781.0
foundry sand, in kt	1,694.0	1,577.0	919.0	1,075.0	954.0
Index of mining output evolution (1989=100)	100.0	100.7	67.1	71.7	63.3
Imports (D), in kt [a)]	N	N	0.4	1.5	101.1
Exports (V), in kt [a)]	N	N	242.9	297.3	534.6
Apparent consumption (T+D-V), in kt	N	N	1,594.5	1,667.2	1,301.5
Dependence on imports, in %	N	N	0	0.1	7.8
Exports share of mining output, in %	N	N	13.2	15.1	30.8

Note:

[a)] *item 2505.10 of the customs tariff*

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Tariff rates in % Concessionary
2505.10	Natural sand of all kinds, also colored, except sand containing metals - Silica sands	35.0	5.0

6. Mining companies in the Czech Republic

Provodínské písky a.s., Provodín
Sklopísek Střeleč - Eximos a.s., Mladějov v Čechách
KEMA Skalná s.p., Skalná
Moravské keramické závody a.s., Rájec-Jestřebí
Kaolin Hlubany a.s., Hlubany
Písek Lžín - Dr.F.Dusbábek, České Budějovice
Moravské šamotové a lupkové závody a.s., Velké Opatovice

7. World production

World statistics provides data on production of gravel sands for industrial uses (glass production, foundry industry, abrasives etc.). The production had been rising until 1989, when 146.1 mill. tons were produced. Since then the production was decreasing due to general economic recession. The major world producers are (data in mill. tons, according to USBM, 1992):

The Netherlands	29.8	i.e.	22.3 %
USA	28.8		21.5 %
Argentina	10.9		8.1 %
Germany	8.3		6.2 %
Japan	5.2		3.9 %
Italy	5.1		3.8 %
Great Britain	4.7		3.5 %
Brazil	4.4		3.3 %
France	4.4		3.3 %
others (less than 3 % share)	32.2		24.1 %
Total	133.8		100.0 %

8.Worldmarket prices

Average price of quartz sand for industrial use in the USA had been rising until 1990, when it reached USD 15.36 per t (EXW), after 1990 it slightly dropped. On the contrary, prices on the European market, quoted each month by the Industrial Minerals magazine (in GBP/t EXW Great Britain), have been steady in the last 5 years:

▪ Glass sand, flint, container	10 - 12
▪ Foundry sand, dry, bulk	9.50 - 10

9. Recycling

Glass sands, for obvious reasons, cannot be recycled; but it is possible to use sorted glass waste in a glass batch, which is being done.

Foundry sands used in moulding are mixed with bentonites, water glass, etc; having been exposed to high temperatures, their properties change to such extent which makes their full recycling impossible. Many countries, including the Czech Republic, carry out research projects intended to increase the portion of recycled sand in new mixtures.

10. Possible substitutes

In glass production, the sand is basically the only source of SiO_2, therefore it can be replaced by sorted vein quartz, waste glass, synthetic SiO_2, etc. Foundry sands for moulding mixtures, especially in precision casting and few other uses, can be replaced by crushed olivine, staurolite, or chromite with graphite binder. Further substitutes are being studied.

WOLLASTONITE

1. Characteristics and use

Wollastonite ($CaSiO_3$) is triclinic, acicular mineral with chain structure of SiO_2tetrahedrons, of whitish colour, chemically very stable. Its specific density varies between 2.8 - 2.9 t/m^3, Mohs' hardness is 4.5 - 5, it melts at 1,540°C. It is a typical metamorphic and common mineral occurring particularly in contact metamorphosed limestones and erlans (with acid intrusions). It is associated with garnet (grossular , andradite) and vesuvian, eventually with pyroxenes and amphiboles. These rocks are usually called skarns. Sometimes the wollastonite content in the rock is so high (as much as 90 %) that we can speak of wollastonitite. Wollastonite (concentrate) is extracted from the rock by mineral dressing (grinding, flotation, high intensity electromagnetic separation, etc.), which also removes impurities.

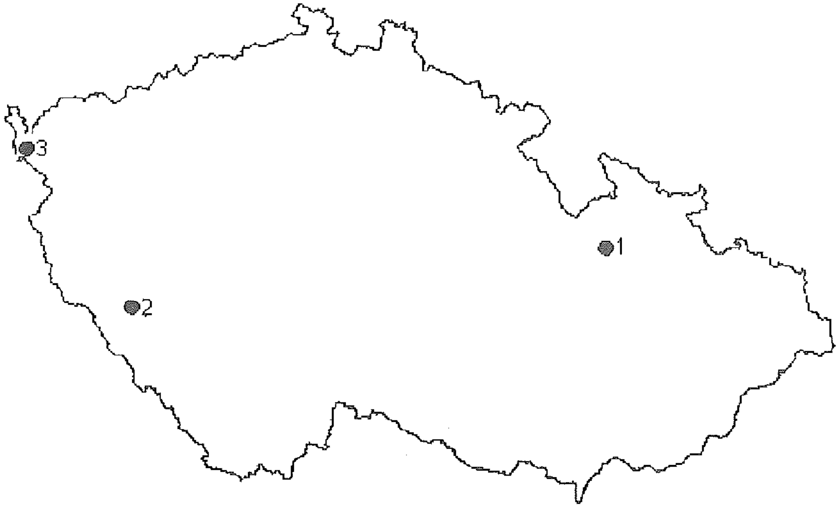
The mineral is a new, uncoventional but very promising raw material. Wollastonite is used in ceramics to manufacture tiles, sanitary ceramics, etc., both in the bodies and glazes, then as a filler in plastics and paints, as a refractory material, as a substitute for asbestos, in production of mineral fibres, in foundry industry for production of casting powders and slag for continuous casting, etc. Wollastonite can be produced also synthetically.

2. Mineral resources of the Czech Republic

Three explored and evaluated wollastonite deposits in the Czech Republic are of metamorphic origin and they have not been mined yet.

- Deposit at Bludov consits of two lenses of garnet-pyroxene- wollastonite skarn confined to a crystalline complex consisting of paragneisses, mica-schists with bodies of quartzite gneisses of the Branná group at its contact with the Šumperk granodiorite . The wollastonite content in rocks varies between 20 - 50 %. The rock also contains on average 15 - 25 % of garnet (andradite - grossular), which could be also extracted;
- The Mochtín deposit is composed of lenticular body of wollastonite skarn confined to a strongly migmatitized paragneisses of the Šumava Moldanubicum near its contact with granodiorites of the Central Bohemian pluton. Average content of wollastonite is 40 - 50 % (locally even 90 %);
- The Skalka deposit is formed by tectonically sunken block of garnet-pyroxene-wollastonite skarn with vesuvian in neighboring metamorhic rocks (paragneisses, mica-schists, hornfels) of the Arzberg group near its contact with granites of the Smrčiny massif. Three separate blocks have been discovered showing on average 31 % of wollastonite in the rock (varies between 10 - 90 %);
- There are also known rocks rich in wollastonite (42 - 87 %, almost wollastonitite) at Lazy near Kynžvart but because of conflicts of interest this locality could not have been evaluated.

3. Registered deposits and their location in the Czech Republic



1 Bludov
2 Mochtín
3 Skalka

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	0
A part of economic inferred reserves, in kt	2,906
Sub-economic reserves, in kt	395

5. Domestic production, imports and exports of the Czech Republic

Wollastonite has not been mined in the Czech Republic in the last 5 years. Data on imports are not reliable and therefore not listed.

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2530.90	Minerals not listed elsewhere		
	- Others	free	free

6. Mining companies in the Czech Republic

There were no organizations in the Czech Republic mining for wollastonite in 1993.

7. World production

Until 1976, leading producer of wollastonite were the USA, which produced 85 % of the world output. China started to develop its production in the seventies, and reduced the US share to 30 % in 1993. The world production in 1982 (without China) was 126 kt/year, in 1985 (including China) 270 kt/year, and in 1992 as much as 385 kt/year. It is expected that in 1995 the world production will reach up to 500 kt/year, and in 2000 even up to 750 kt/year. About 65 % of the wollastonite should be used as a substitute for asbestos. The largest world producers are China, the USA, India, Finland and Turkey. Reportedly the largest wollastonite producing company is the American NYCO.

8. World market prices

Larger increase of wollastonite prices was recorded in the eighties. In the last 5 years, the prices fluctuated very little (with both ups and downs). In December 1993, Industrial Minerals magazine quoted the following prices:

▪ Finnish, 325 mesh, GBP/t ex-store UK	275
▪ American, acicular, minus 200 mesh, USD/st EXW	176
▪ American, acicular, minus 325 mesh, USD/st EXW	220
▪ American, acicular, minus 400 mesh, USD/st EXW	243
▪ American, acicular, 15:1 - 20:1 aspect ratio, USD/st EXW	297
▪ American, ground, 0.01 mm, USD/st EXW	608
▪ American, ground, 200 mesh, bulk, USD/st FOB	166
▪ American, ground, 325 mesh, bulk, USD/st FOB	210

9. Recycling

The material is not recycled.

10. Possible substitutes

Wollastonite itself is often used as a substitute for other materials (asbestos in brake lining; limestone, dolomite and other materials in production of plastics; basalt in production of mineral fibres, etc.). Thus the wollastonite can be replaced by the materials it substitutes. Generally, the wollastonite can be replaced by synthetic $CaSiO_3$, which in refractory products, in spite of some technological differences, can even surpass natural wollastonite.

DIATOMITE

1. Characteristics and use

Diatomite or diatomaceous earth is a sedimentary rock, consisting mostly of the microscopic cells of fresh-water or marine diatoms. This rock shows various degree of consolidation - it is either loose (diatomaceous earth) or consolidated (diatomaceous shales or chert). Loose rocks has a form of a very fine grained sediment. During diagenetic processes there occurs partial dissolving of shells and impregnation of the sediment by released opal which leads to consolidation into a shale. Depending on the degree of porosity we speak of polishable or "absorbing" shales, sometimes even of opal cherts. Chemically, diatomite is essentially amorphous hydrated or opaline silica with varying amounts of contaminants. The silica content of diatomite will range from about 58 to 91 %. From the technological point of view, important parameters are porosity, acid resistance , refractoriness, thermal and electric conductivity, apparent density, moisture content, chemical composition, etc. Contaminants are silica sands, clay minerals, organic particles (sponges) or higher content of Al_2O_3, Fe_2O_3 and CaO. Deposits originated in water basins with low content of $CaCO_3$ and dissolved silica. The most suitable conditions exist in cool, clear, well-lighted water near volcanic areas. The world reserves are estimated at 800 mill. tons.

Filtration is the major end use of diatomite (the highest grades); it is used in production of industrial fillers (rubber, paper, cosmetics), as abrasives, as carrier for catalysts, thermal and sound insulating elements or light building elements.

2. Mineral resources of the Czech Republic

Diatomite deposits in the Czech Republic are confined to areas with Tertiary or Quaternary sediments in the South Bohemian basins and to volcanites of the České středohoří mountains. Smaller deposits occur also in other parts of the Bohemian Massif and in the Neogene of the Carpathian foredeep.

- The largest diatomite deposits in Bohemia are in the South Bohemian basins. In the Budějovice basin, there occur spongy diatomites and diatomaceous clays together with lignites. The only evaluated and registered deposit at Borovany is located in the Třeboň basin. Tertiary sediments were deposited in structurally narrow space of the Moldanubicum basement. Diatomites, diatomaceous clays and spongy diatomites occur in the upper layer of the Mydlovary formation. Diatomites are of whitish grey to ochre colour, unconsolidated, and in horizontal position. Average thickness is about 8.5 m (max. 15 m). Mining at this deposit dates back to the beginning of this century. High grade diatomites are used after processing and product preparation, for filtration or as fillers in food, chemical and pharmaceutical industries, etc. Diatomite of lower grade is used in production of building and insulating elements;
- In the České středohoří mountains, there are known many outcrops of diatomites which were occassionally mined even in the first half of the last century as a material for production of abrasives;
- Quaternary diatomites are located around Most (together with lake mud high in organic matter) and Františkovy Lázně (deposit Hájek - earlier extracted together with peat, nowadays it is a natural preserved area).

3. Registered deposits and their location in the Czech Republic

1 Borovany

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	4,780
A part of economic inferred reserves, in kt	320
Sub-economic reserves, in kt	0

5. Domestic production, imports and exports of the Czech Republic

In 1993, there was mined only one deposit of diatomite.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt	80.00	82.00	68.00	57.00	39.00
Index of mining output evolution (1989=100)	100.00	102.50	85.00	71.30	48.80
Imports (D), in kt	1.57	1.53	1.01	1.54	1.48
Exports (V), in kt	7.13	7.32	5.63	5.95	5.78
Apparent consumption (T+D-V), in kt	74.40	76.20	63.40	52.60	34.70
Dependence on imports, in %	2.10	2.00	1.60	2.90	4.30
Exports share of mining output, in %	8.90	8.90	8.30	10.40	14.80

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Tariff rates in % Concessionary
2512	Diatomite	free	free

6. Mining companies in the Czech Republic

Calofrig a.s., Borovany

7. World production

Production of diatomite has been at the level of about 1,600 kt/year for many years. The highest production was reached in 1988 - 1,672 kt. Leading position have 4 countries, which produce 75 % of the world output (data in kt, according to USBM, 1992):

USA	647	i.e.	40.4 %
France	250		15.6 %
Former USSR	200		12.5 %
Spain	100		6.3 %
others (less than 5 % share)	403		25.2 %
Total	1,600		100.0 %

8. World market prices

World market quotes only prices of American diatomite. Monthly quotations of the Industrial Minerals magazine (in GBP/t, CIF Great Britain) show stability of prices in the last 5 years. In December 1993, the prices were as follows:

- US calcined, filter-aids 325-350
- US flux-calcined filter-aids 340-380

Average price of American diatomite in period 1988-1992, according to USBM, was USD 220 per t FOB.

9. Recycling

The material is not recycled.

10. Possible substitutes

Filtration is the major use of diatomite where it can be replaced by quartz sand, asbestos, expanded pearlite, fritted glass, etc. However, in general, the parameters of diatomite have not been reached. In other applications, diatomite can be replaced:

- As a filler by talc, mica, quartz sand, clays, perlite, vermiculite, limestone;
- As an insulating material in building industry by regular bricks, asbestos, mineral wool, expanded perlite and vermiculite.

LIMESTONES AND CORRECTIVE SIALIC COMPONENTS FOR CEMENT PRODUCTION

1. Characteristics and use

Limestones are sedimentary rocks containing $CaCO_3$ (calcite or aragonite). Primary and secondary admixtures in limestones are dolomite, silicates, phosphates, etc. Limestones originated through chemical, biological and mechanical processes or their combinations. Limestones of different origins show variaitons in physical characteristics, texture, hardness, color, weight, and porosity, ranging from loosely consolidated marls through chalk to compact limestones and hard crystalline marbles. Limestones originated in sediments of virtually every geologic age, worldwide. However, their volume seems to increase in later periods.

Limestones are used for production of building elements (lime, cement, mortar mixtures, granulated gravel, dimension and building stone, etc.), in the metallurgical, chemical and food processing industries, recently also for desulphurization, in agriculture, glass and ceramic industries, etc.

This group of raw materials also includes corrective sialic additives for production of cement, e.g. shales, clays, loess, loams, sands, etc., which correct the content of SiO_2, Al_2O_3 and Fe_2O_3 in the basic raw material for burning of clinker in production of cement. These corrective materials mostly accompany deposits of portland limestones or occur in their close neighbourhood.

2. Mineral resources of the Czech Republic

Limestone deposits in the Czech Republic are concentrated in the following main areas:

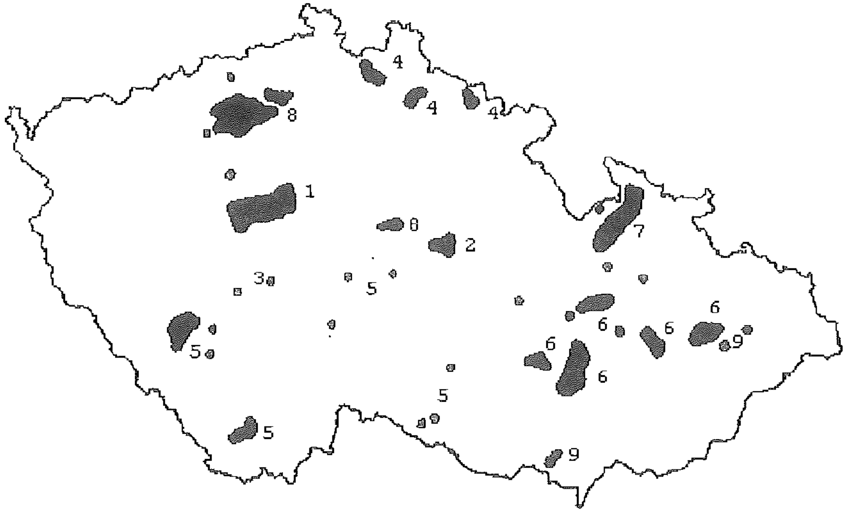
- The Barrandien zone Devonian - the most important and largest deposits are located in this area. Almost all types of limestones occur there,particularly those of VV and VO grades but also VZ and CK grades (see paragraph 4 for explanation). Limestone deposits are confined to sediments of mostly Lower Devonian age, and consist of several lithological types. The Upper Koněprusy limestones are of the highest grade (average content of $CaCO_3$ is about 98%).
- The Paleozoic of the Železné hory mountains - relatively small area with important deposits. The local material is composed of the Podolí crystalline limestones (VV grade, 95 % $CaCO_3$) and less pure darker marbles of VO grade (90 % $CaCO_3$);
- Central Bohemian metamorphosed "islands" - small isolated areas with quite pure metamorphosed limestones (mostly VV a VO grades);
- Crystalline complex of the Krkonoše-Jizerské hory mountains - medium size deposits, mostly in the form of lenses confined to phyllites and mica-schists. These are crystalline limestones, often with various contents of $MgCO_3$ and SiO_2 (mostly VO and VZ grades);
- Moldanubicum - small size deposits of crystalline limestones, forming bands or lenses in metamorphic rocks. They occur particularly in the Šumava part of the Moldanubicum. Dolomitic limestones or dolomites usually accompany the limestones here. The majority of local limestones are of VZ and VO grades ;
- The Moravian Devonian - represents the most important region with limestone deposits of various size in Moravia. The Vilémovice limestones (VV grade, 96-97 % $CaCO_3$) occur in almost all deposits. Less abundant are the Křtiny, Hády and Lažánky limestones (VO).

- The Silesicum (the Branná group) and the Zábřeh group - smaller deposits of crystalline limestones forming bands in metamorphic rocks. Local 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);
- The Bohemian Cretaceous basin (The Ohře and Kolín regions) - large and medium size deposits. Deposits contain clayey limestones and marls with contents of $CaCO_3$ ranging between 80 and 60 % (the most important deposits of clayey limestones - VJ);
- Outer nappes zone of the West Carpathians - limestones form structurally isolated blocks in surrounding rocks (so-called "clippen").The limestones are very high grade, with an average content of $CaCO_3$ 95-97 %, and $MgCO_3$ less than 1 % (VV). Also clayey limestones (VJ) are mined here.

Other deposits are only of local importance, as far as production and reserves are concerned.

All deposits of limestones and raw materials for production of cement are extracted in the Czech Republic by open-pit mining and quarrying.

3. Registered deposits and their location in the Czech Republic



1 **The Barrandien zone Devonian** - 15 deposits, total reserves are 805 mill. t of high grade limestones (with very high $CaCO_3$ content, grade VV), of which about 20 % are rather limestones for the cement production (VO). There are also 14 mill. t of limestones for use in agriculture (VZ) and 230 mill. t of corrective sialic additives for cement production (CK).

2 **The Paleozoic of the Železné hory mountains** - 2 deposits, total reserves: 62 mill. t of high grade limestones (VV), 108 mill. t of limestones for cement production (VO), and 1 mill. t of corrective sialic additives for cement production (CK).

3 **Central Bohemian "islands" zone** - 2 deposits, total reserves: 30 mill. t of high grade limestones (VV), 10 mill. t of limestones for cement production (VO).

4 **The Krkonoše-Jizerské hory crystalline complex** - 21 deposits, total reserves: 1 mill. t of high grade limestones (VV), 495 mill. t of limestones for cement production (VO), 56 mill. t of limestones for use in agriculture (VZ).

5 **Bohemian, Moravian and the Šumava part of the Moldanubicum** - 24 deposits, total reserves: 398 mill. t of limestones for cement production (VO), 63 mill. t of limestones for use in agriculture (VZ).

6 **The Moravian Devonian** - 24 deposits, total reserves slightly over 1,000 mill. of high grade limestones (VV), 1,813 mill. t of limestones for cement production (VO), 3 mill. t of clayey limestones (VJ), 95 mill. t of limestones for agriculture (VZ), and 428 mill. t of corrective sialic raw materials for cement production (CK).

7 **Silesicum (the Branná group), the Orlické hory-Kladsko crystalline complex and the Zábřeh series** - 8 deposits, total reserves: 130 mill.t of high grade limestones (VV), 17 mill.t of limestone for cement production (VO).

8 **The Bohemian Cretaceous basin** - 3 deposits, total reserves: 493 mill. t of clayey limestones (VJ), 54 mill. t of corrective sialic additives for cement production (CK).

9 **Outer nappe zone** - total reserves: 200 mill. t of high grade limestones (VV), 270 mill. t of limestones for the cement production (VO), 3 mill. t of corrective sialic raw materials (CK).

4. Reserves as of December 31, 1993

According to use, the limestones are classified in the Czech Republic into the following grades:

- Limestones with very high percentage of $CaCO_3$ (VV), containing at least 96 % of carbonate (with max. 2 % $MgCO_3$). These limestones are used mostly in chemical, glass, ceramics, rubber, food processing and metallurgical industries, for desulphurization, and for production of the top quality lime;
- Clayey limestones (VJ) - with $CaCO_3$ content over 70 % and higher content of SiO_2 a Al_2O_3. These limestones are used for production of cement, all kind of lime, and for desulphurization;
- Carbonates for use in agriculture (VZ) - with the content of carbonates at least 70-75 %. They are used for dressing of agricultural land and forest soils;
- Other limestones (VO) - with carbonate content at least 80 % - they are used mostly for production of cement, then for production of lime, desulphurization, etc. Also dolomites and dolomitic limestones are included in this group in the Czech Republic.
- Corrective sialic additives for cement production (CK) - are represented by lithologically various types of rocks (see paragraph 1), which are used for correction of chemical composition of the raw material for cement production.

	Economic demonstrated reserves	A part of economic inferred reserves	Subeconomic reserves
Total limestones, kt	2,410,509	3,707,346	913,373
of which			
VV grade, in kt	910,386	1,202,018	155,030
VJ grade, in kt	135,632	200,231	140,778
VZ grade, in kt	16,537	218,896	26,657
VO grade, in kt	1,012,123	1,872,846	422,600
CK grade, in kt	335,831	213,355	168,308

5. Domestic production, imports and exports of the Czech Republic

In 1993, there were mined altogether 33 deposits of limestones of all grades and 7 deposits of corrective sialitic raw materials for cement production in the Czech Republic.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt (without CK)	16,277.0	15,448.0	11,461.0	11,134.0	10,491.0
Index of mining output evolution (1989=100)	100.0	94.9	70.4	68.4	64.5
Imports (D), in kt	N	N	0.2	0.3	16.2
Exports (V), in kt	N	N	109.3	142.5	177.4
Apparent consumption (T+D-V), in kt	N	N	11,351.9	10,991.8	10,336.8

Dependence on imports, in %	N	N	0	0	0.2
Exports share of mining output, in %	N	N	1.0	1.3	1.7
Mining output of single grades					
VV grade, in kt	8,043	7,407	5,651	4,854	4,590
VJ grade, in kt	1,138	1,054	947	958	833
VZ grade, in kt	511	248	123	47	101
VO grade, in kt	6,585	6,739	4,740	5,275	4,974
CK grade, in kt	905	796	650	741	616

Note:
[a] *item 2521 of the customs tariff*

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2521	Limestone (fluxing agent); limestones for production of lime and cement	free	free

6. Mining companies in the Czech Republic

Pragocement a.s., Radotín
Velkolom Čertovy schody a.s., Tmaň
ČEZ a.s., Praha
Cementárny a vápenky a.s., Prachovice
Hasit-ŠVO a.s., Velké Hydčice
Krkonošské vápenky Kunčice a.s., Kunčice n. Labem
Cementárny a vápenky Mokrá a.s., Mokrá
Cement Hranice a.s., Hranice na Moravě
Čížkovická cementárna a.s., Čížkovice
Teramo Vápenná a.s., Vápenná
Vitoul Měrotín v.o.s., Měrotín
Agrochemický podnik Sedlčany
Kotouč Štramberk s.r.o., Štramberk
Vápenka Vitošov s.r.o., Leština
Lom Skalka s.r.o., Ochoz u Brna
GMS a.s., Praha 7

JHF Heřmanovice s.r.o., Heřmanovice
ZD Sloup v Moravském krasu
Agrostav Znojmo a.s., Znojmo

7. World production

Overall data on production of limestones in the world are missing. The major producing areas can be characterized by production of cement, which consumes most of the mined limestone. The largest world producers then might be (data in mill.t of cement, according to USBM, 1992):

China	268	i.e.	21.7 %
Former USSR	130		10.5 %
Japan	93		7.5 %
USA	71		5.7 %
others (less than 5 % share)	676		54.6 %
Total	1,238		100.0 %

World production of lime in the same period of time was 133 mill. tons

8. World market prices

Prices of limestones are not quoted. Since the limestones are generally well available in a wide assortment of grades, prices are set upon agreement. Average price of limestones on the US market in 1992 was USD 4.8 per t, sorted limestone (in lumps) for metallurgical works in Germany was sold in 1988 for DEM 12.85 per ton.

9. Recycling

The material is not recycled.

10. Possible substitutes

Limestones of all grades have various uses. Limestones can be replaced in many applications. Limestones, dolomites and various burnt lime are often mutually replaceable (e.g. in agriculture). Also in the desulphurization, the limestones can be replaced by various mixtures of carbonates.

Yet the limestones are irreplaceable in many of their uses - for instance in production of cement and lime, or in the metallurgical industry (melting agent for production of pig iron).

GYPSUM

1. Characteristics and use

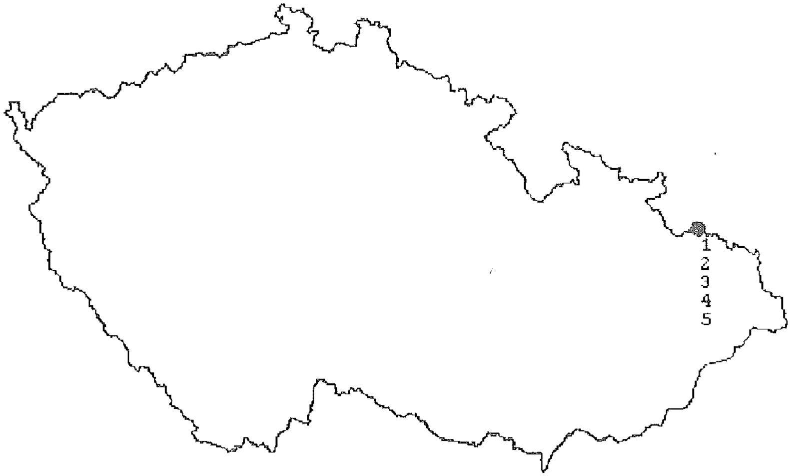
Gypsum is a sedimentary rock, consisting mostly or completely of monoclinic mineral gypsum ($CaSO_4.2H_2O$) which is usually colorless or white. The rock often contains impurities (clay minerals, quartz, iron oxides, limestone, dolomite, anhydrite, etc.). The majority of gypsum deposits were formed as evaporites from marine or lake waters in arid areas. Deposits which have different origin (weathering and decomposition of sulphides, hydration of anhydrite, metasomatic processes, etc.) are of no economic importance. Anhydrite $CaSO_4$ with no water of crystallization is often classified into the gypsum group. It is usually changed into gypsum by wet grinding. Present world reserves of gypsum are estimated at 2.4 billion tons.

Gypsum is used mostly for production of building materials (calcined gypsum, 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. Average content of gypsum in the rock is 70-80 %. The impurities are mostly clays and locally sands. Layers near the surface 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-south. The production is declining. There are 4 other explored and evaluated deposits. The production of natural gypsum is expected to decrease also due to production of good quality "energogypsum", which is produced during desulphurization process (limestones used for this purpose in the Czech Republic contain on average 86.5-96 % $CaCO_3$).

3. Registered deposits and their location in the Czech Republic



1 Kobeřice-south
2 Kobeřice-north
3 Rohov-Strahovice
4 Sudice
5 Třebom

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in kt	122,274
A part of economic inferred reserves, in kt	302,290
Subeconomic reserves, in kt	82,137

5. Domestic production, imports and exports of the Czech Republic

In 1993, gypsum was mined only at one locality in the Czech Republic.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt	720.00	661.00	569.00	660.00	560.00
Index of mining output evolution (1989=100)	100.00	91.80	79.00	91.70	77.80
Imports (D), in kt	N	N	12.27	4.460	0.05
Exports (V), in kt	N	N	53.94	10.37	108.95
Apparent consumption (T+D-V), in kt	N	N	527.30	654.10	451.10
Dependence on imports, in %	N	N	2.30	0.70	0
Exports share of mining output, in %	N	N	9.50	1.60	19.50

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in %	
		General	Concessionary
2520.10	Gypsum	5.0	5.0

6. Mining companies in the Czech Republic

Sádrovcové doly Kobeřice s.p., Kobeřice

7. World production

World production of gypsum (including anhydrite) has been for a long time in the range of 90 - 100 mill. t, with the highest output in 1989 - 98.5 mill. t. The production is closely related to building activities and the reduction of construction works after 1989 caused also a reduction of mining for gypsum. The largest world producers are (data in kt, according to USBM, 1992):

USA	14,787	i.e.	15.1 %
Canada	8,165		8.4 %
China	8,165		8.4 %
Iran	7,983		8.1 %
Thailand	7,258		7.4 %
Mexico	5,625		5.7 %
France	5,625		5.5 %
Spain	4,990		5.1 %
others (less than 5 % share)	35,380		36.1 %
Total	97,978		100.0 %

8. World market prices

Prices of natural gypsum have been steady in 1993, as well as in the last 5 years. Even in times of more extensive building activities the prices were stable, which was also caused by a supply of waste gypsum (desulphurization of thermal power stations, chemical industry), production of which highly exceeds the demand. Average annual prices of natural gypsum in the USA were about USD 6.5 per t FOB. European market quoted prices of British gypsum (monthly quotations of the Industrial Minerals magazine), with bottom prices at GBP 6 per t EXW and the top, (excpetionally, in 1993) at GBP 12 per ton EXW.

9. Recycling

The material is not recycled.

10. Possible substitutes

Gypsum is an irreplaceable and indispensable component of the traditional Portland cement. Other substitutes are not economical, as the desulphurization of power stations produces large amounts of waste "energogypsum" (similarly also production of phosphoric fertilizers produces large volume of gypsum), which has not adequate use yet. Consequently, there is a trend to use gypsum as a substitute.

DIMENSION STONE

1. Characteristics and use

Rock which has been specially cut or shaped for use in buildings, curbing or other construction or special uses is termed "dimension stone" and/or "decorative stone". Archictectural specifications for dimension stone apply primarily to esthetic qualities such as design, surface appearance, etc. Important requirements include mineralogical composition, strenght, weather resistance, color fastness, porosity, texture, structure, etc. Dimension stone includes all kind of solid rocks of magmatic, sedimentary or metamorphic origin which can be quarried in the form of blocks suitable for cutting to specific dimensions. Weathered surface, altered or crushed zones or inclusions of unfitting rocks represent undesirable imperfections.

2. Mineral resources in the Czech Republic

- Dimension stone used in buildings, curbing and other applications mostly involves igneous rocks, much less other rocks (basalt columns, dike rocks, sandstones). Deposits, similarly as those of crushed and broken stone are confined to the Central Bohemian pluton and Moldanubian pluton, the Nasavrky massif, eventually other plutonic bodies of the Bohemian Massif (Štěnovice massif, Žulová pluton, etc.);
- Architectural and sculpture dimension stone also use mostly abyssal igneous rocks - granites and granodiorites, which occur in the Central Bohemian and Moldanubianc plutons,the Štěnovice, the Krkonoše-Jizerské hory, the-Jeseníky and Nasavrky massifs in Bohemia, and in Moldanubian and Žulová massifs in Moravia. Less important are dark igneous rocks - diabases, diorites and gabbros, which also occur in the Central Bohemian Pluton,then in the Kdyně and Lužice massifs, (eventually serpentines in W.Bohemia and Moravia). Aforesaid 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 and Doupovské hory mountains 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 then from Hořice and Broumov regions. Less important are Triassic and red Permian sandstones from the Krkonoše piedmont basin. In Moravia, there are the Těšín Cretaceous 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 Barrandien zone and of the Moravian karst (wall lining, terrazzo, etc.). Pleistocene travertines, used for interior wall lining, terazzo and conglomerates, are quarried in the Přerov region. Lower Carboniferous schists of the Moravian-Silesian Paleozoic are used as lining, covering and paving material, and as expanded materials;
- Mostly used metamorphic rocks are crystalline limestones and dolomites (polished wall linings, paving materials, terrazzo, conglomerates, sculptures). Large deposits are in the Šumava region and Czech part of the Moldanubicum, in the Krkonoše-Jizerské hory crystalline complex and Orlické hory-Sněžník crystalline complex,the Svratka anticline,in the Silesicum, and in the Branná group (Silesia). Proterozoic phyllites of western Bohemia (the Střela valley) and the Železný Brod crystalline complex are used for roofing and wall lining (the waste as a filler).

3. Registered deposits in the Czech Republic

There is a vast amount of dimension stone deposits (regale and regular) in the Czech Republic and therefore they are not listed.

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in thousand m^3	93,351.9
A part of economic inferred reserves, in thousand m^3	212,716.2
Subeconomic reserves, in thousand m^3	32,384.9

5. Domestic production, imports and exports of the Czech Republic

In 1993, there were quarried 83 deposits of dimension stone in the Czech Republic.

Year	1989	1990	1991	1992	1993
Mining output (T), in kt	522.60	457.60	514.80	457.60	460.20
Index of mining output evolution (1989=100)	100.00	87.60	98.50	87.60	88.10
Imports (D), in kt [a]	38.38	1.05	14.99	18.03	N
Exports (V), in kt [a]	51.66	86.91	135.88	97.34	108.81
Apparent consumption (T+D-V), in kt	509.30	371.74	393.90	378.30	N
Dependence on imports, in %	7.50	0.28	3.80	4.80	N
Exports share of mining output, in %	9.90	19.00	26.40	21.30	23.60

Note:

[a] *items of the customs tariff according to paragraph 5a*

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
2514	Slate incl. roughly shaped	free	free
2515	Marble, travertine and other carbonaates for sculptures and buildings	free	free
2516	Granite, porphyry, basalt, sandstone and other stone for sculpture or buildings	free	free
2518	Dolomite roughly shaped or sawed up	free	free
6801	Block paving, curbing, natural stone paving	32.0	6.8

6802	Worked and shaped stone for sculpture and buildings	30.0	8.1
6803	Worked roofing slate and products made of natural or agglomerated slate	19.0	4.4

6. Mining companies in the Czech Republic

Průmysl kamene Příbram a.s., Příbram
Českomoravský průmysl kamene a.s., Hradec Králové
Slezský kámen a.s., Jeseník
Kamenoprůmyslové závody s.r.o., Šluknov
Kavex Group s.r.o., Plzeň
Liberecký průmysl kamene s.p., Liberec
Teramo Vápenná a.s., Vápenná
Mramor s.r.o., Dobřichovice

Only the largest producers are listed.

7. World production

Estimated world production in 1990 was 32 mill.t of dimension stone, the largest world producers are (data in mill.t, according to ITGE):

Italy	7.25	i.e.	22.7 %
Spain	4.25		13.3 %
Greece	1.85		5.8 %
USA	1.70		5.3 %
France	1.10		3.4 %
China	1.00		3.1 %
Brazil	0.90		2.8 %
Portugal	0.75		2.3 %
others (less than 2 % share)	13.20		41.3 %
Total	32.00		100.0 %

8. World market prices

Prices of dimension stone are set upon agreement and they are usually not quoted.

9. Recycling

The material is not recycled.

10. Possible substitutes

Individual types of dimension stone are mutually replaceable. All types can be replaced by synthetic materials, ceramics, metals, glass, etc. There is an opposite tendency in the last few years - the interest in natural materials is steadily growing.

BUILDING STONE

1. Characteristics and use

Building stone (also called crushed and broken stone) are all kinds of solid magmatic, sedimentary or metamorphic rocks, which have suitable properties to be used in construction works. They must have certain physical and chemical properties based on their 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. Some basalt and phonolite rocks are used for production of cast basalt or phonolite. Impurities consist of fractured, crushed, weathered or altered zones, inclusions of technologically unsuitable rocks, higher content of sulphur, amorphous SiO_2, etc. The world reserves are virtually inexhaustible.

2. Mineral resources in the Czech Republic

Commercially usable deposits of building stone can be found throughout the whole Bohemian Massif, except its platform cover. The latter, however, includes important deposits of neovolcanic rocks. West Carpathians are rather poor in building stone.

- The major source of building stone are igneous rocks (particularly granites and quartz-diorites). Various types of igneous rocks (including accompanying swarms of dike rocks) are quarried at many localities in the Central Bohemian pluton, Moldanubian pluton, the Železné hory pluton (the Nasavrky massif), the Brno massif and in other plutonic bodies. Single deposits of dike rocks are rather of little importance;
- Volcanic rocks represent the major source of stone for production of crushed aggregates in the Czech Republic. Paleovolcanic (pre-Tertiary) deposits occur only in the Barrandien zone (including consolidated pyroclastics), in the Krkonoše piedmont basin and in the Intrasudeten depression. They locally envelope also layers or bodies of pyroclastics or altered rocks. Important are also mafic rocks - spilites, diabases, etc. Among neovolcanic rocks, mafic (especially basaltic) varieties appear to be most important. They are most abundant in the České středohoří and Doupovské hory mountains, less abundant are in the neovolcanic area of the Cretaceous basin and eastern Sudeten or in the Železný Brod region. Outside of the Bohemian Massif, only the Magura group of nappes has some suitable volcanic rocks for building stone;
- Among the sedimentary rocks there prevail clastic sediments (siltstones, greywackes, etc.) as a suitable building stone. Culmian greywackes of the Nízký Jeseník mountains and the Drahanská vrchovina plateau are the most inportant source of building stone. Similar rocks also occur in the Algonkian of the Barradien zone, Moravian Devonian and the flysh belt of the West Carpathians;
- Deposits of chemical and organic origin are represented by carbonates (the Early Paleozoic of the Barrandien zone, the Moravian-Silesian Devonian) and siliceous rocks (lydites or cherts) in the Algonkian of the Pilsen region);
- Also important from the viewpoint of suitable building stone are metamorphic rocks represented by crystalline schists or gneisses, which are exclusively confined to crystalline complexes of the Bohemian Massif - the so-called Moldanubicum, Moravicum, Silesicum, crystalline series of the Slavkovský les, W. Sudeten, Kutná Hora and Domažlice, granulite massif of southern Bohemia and the Bor granulite massif, etc. Besides technologically very suitable rocks (e.g. orthogneisses, granulites, amphibolites, serpentines, crystalline limestones, etc.) there occur also some less suitable rocks (mica-schists, paragneisses, quartzites);
- Less important are deposits of contact metamorphosed rocks (hornfelds, schists) occurring along the contact of the Central Bohemian and the Nasavrky plutons with Algonkian and Paleozoic sediments.

3. Registered deposits in the Czech Republic

Because of vast number of building stone deposits in the Czech Republic, they are not listed.

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in thousand m^3	1,249,894.8
A part of economic inferred reserves, in thousand m^3	1,882,330.3
Subeconomic reserves, in thousand m^3	1,125,736.0

5. Domestic production, imports and exports of the Czech Republic

There were quarried 198 deposits of the building stone in 1993 in the Czech Republic.

Year	1989	1990	1991	1992	1993
Mining output (T), in thousand m^3	18,030.0	16,127.0	9,517.0	8,412.0	7,488.0
Index of mining output evolution (1989=100)	100.0	89.4	52.8	46.7	41.5

Import and export of building stone and gravel is quoted together under the Item 2517.10 of the Customs Tariff and therefore both commodities are listed together also in the chapter on SAND AND GRAVEL.

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Tariff rates in % Concessionary
2517.10	Gravel, crushed and broken stone	free	free

6. Mining companies in the Czech Republic

Západokámen a.s., Plzeň
Wimpey - Severokámen a.s., Liberec
Středokámen Praha s.p., Praha
Pražský průmysl kameme s.p., Praha
Štěrkovny a pískovny a.s., Veselí nad Lužnicí
STRABAG Bohemia a.s., České Budějovice
Štěrkovny a pískovny Brno a.s., Brno
Štěrkovny a pískovny Olomouc a.s., Olomouc
Kámen a písek s.r.o., Český Krumlov
Kamenoprůmysl Skuteč s.p., Skuteč
Silnice a.s., Hradec Králové

Only the largest producers are listed.

7. World production

World production of the building stone is not observed.

8. Prices on the world market

Prices of the building stone are set upon agreement and they are rarely quoted (except the USA): average prices of the building stone in the USA in the last 5 years fluctuated between USD 4.39 - 4.83 per ton (crushed stone).

9. Recycling

Because of low price of the raw material, recycling is of minimum importance. Construction waste can be recycled following sorting and/or screening and washing.

10. Possible substitutes

Building stone (crushed and broken stone) can be replaced, according to their use and grade, by gravel sands, synthetic aggregates, slags and various waste materials.

SAND AND GRAVEL

1. Characteristics and use

Sand and gravel has been and will continue to be the principal construction material worldwide. Sand and gravel represent loose sediments originated by transport and deposition of more or less worn rock fragments of certain size (gravel 2 to 128 mm, sand 0.063 to 2 mm) which are products of the weathering of rocks. They mostly consist of pebbles and boulders of resistent rocks and minerals (quartz, feldspar, quartzite, granite, etc.), to a smaller extent of less resistent rocks and minerals (mostly of crystalline or metamorphic and sedimentary rocks). Sand and gravel also contains silty and clayey fractions. Major impurities are humus, clay intercalations, higher content of floatable particles and sulphur, high content of unsuitable (shape wise) or weathered grains. Gravel and sand deposits are common all over the world and they are not registered.

The ultimate use of sand and gravel determines the ratio of combination of sand and gravel size, their shape, rock type and composition. Sand and gravel are used mostly in the building industry in concrete mixtures, as drainage and filtration layers, road base, fill and for foundation stabilization, etc. Sands are used in the building industry in mortar and concrete mixtures, as an opening material in production of bricks, in plasters, as a filling of abandoned stopes in mines, etc.

2. Mineral resources of the Czech Republic

Most of the deposits in the Czech Republic are of fluvial origin and of Quaternary age; less often of fluvio-lacustrine, fluvioglacial, glacio-lacustrine and eolian origin. Industrially usable deposits occur particularly in river basins of large streams.

The Labe river basin - deposits along the right bank of the middle course (important deposits for central and eastern Bohemia) and lower course are characteristic of 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 exist conflicts of interest. 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 confined to 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 of soils.

Less important are deposits of glacial origin in northern Bohemia (The Frýdlant region) and in the Ostrava and Opava regions. Wind-blown sands 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. Facially changing Tertiary sands in the Cheb region, in north Bohemian basins, in the Plzeň region (mortar sands), and particularly in Moravia (e.g. the Prostějov and Opava regions) are utilized more often. Weathered sandstones of the Bohemian and Moravian Cretaceous sediments and sands from washing of kaolin are used in construction works.

3. Registered deposits in the Czech Republic

Because of their large number, deposits of sand and gravel are not listed.

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in thousand m^3	1,415,203
A part of economic inferred reserves, in thousand m^3	2,573,666
Subeconomic reserves, in thousand m^3	533,670

5. Domestic production, imports and exports of the Czech Republic

In 1993, there were mined 70 deposits of sand and gravel in the Czech Republic.

Year	1989	1990	1991	1992	1993
Mining output (T), in thousand m^3	24,746.0	20,711.0	12,778.0	12,772.0	12,245.0
Index of mining output evolution (1989=100)	100.0	83.7	51.6	51.4	49.5
Imports (D), in kt [a)]	N	N	3.0	9.0	339.0
Exports (V), in kt [a)]	N	N	1,466.0	3,257.0	2,143.0

Note:

a) items 2505.90 and 2517.10 of the customs tariff

5a. Tariff rates according to the Customs Tariff of ÚCS 1993

		Tariff rates in %	
Code	Commodity	General	Concessionary
2505.90	Natural sand of all kind incl. dyed sand, except sand containing metals - Others	35.0	free
2517.10	Pebbles, gravel, broken or crushed stone	free	free

6. Mining companies in the Czech Republic
Pražský průmysl kamene s.p., Praha
Wimpey - Severokámen, a.s., Liberec
Štěrkovny a pískovny Olomouc a.s., Olomouc
Štěrkovny a pískovny Brno a.s., Brno
Štěrkovny a pískovny a.s., Veselí nad Lužnicí
Hradecké pískovny Václavice s.p., Václavice
Pískovny Bratčice - Hrušovany s.p., Bratčice
Firma Hájek Josef, Velvary
Štěrkopískovny Dobřín s.p., Dobřín

Only the largest producers are listed.

7. World production
The world production of sand and gravel is not statistically observed.

8. World market prices
Prices of sand and gravel are set upon agreement and they are not (except the USA) quoted; the average price of sand and gravel in the USA in the last 5 years fluctuated between USD 3.39 - 3.64 per ton.

9. Recycling
Similar to all building materials, recycling is problematic and is of little importance.

10. Possible substitutes
Coarser fractions of sand and gravel can be replaced by crushed aggregate, artificial aggregate, slags, etc. Finer fractions, i.e. sands, cannot be replaced because of reduced strenght of the final products. Substitution of sand and gravel on large scale is questionable also from the economic point of view.

BRICK CLAYS

1. Characteristics and use

Raw materials for production of bricks include a variety of mostly sedimentary rocks such as loess, loams, clays and claystones, marls, weathered shales, etc. The raw material must contain two main components - plastic and opening - which are proportional in the material itself, or optimum ratio is reached by their mixing. The prevailing component in the mixture forms the base whereas the complementary component, which is correcting the properties of the material,serves as a plasticizing agent or an opening component. Harmful substances in production of bricks are mostly carbonates, gypsum, siderite, organic matter, larger fragments of rocks, etc. Deposits of materials for brick production are common all over the world and they are not registered.

2. Mineral resources of the Czech Republic

Quaternary loams of various origin represent the basic material for brick production in the Czech Republic. The source of natural corrective materials are mostly pre-Quaternary sediments.

- Deposits of Quaternary raw materials (loess and loess loam, loam, sand, sandy-clayey residues) are common all over the country and they are mined in great numbers. The most important of them are confined to sediments of eolian, deluvio-eolian and/or glacial origin (N.Bohemia and Silesia). Impurities in wind-blown sediments are represented by buried soil horizons, clastics and calcareous nodules, in deluvial sediments detritus of hard rocks. Eolian 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 materials, or directly for production of thick-walled elements;
- Neogene pelites are a common pre-Quaternary material in the Bohemian limnic basins and in the Vienna basin. They are characteristic of sandy admixture and locally also of higher content of montmorillonite or detrital minerals, in the Vienna basin and the Carpathian foredeep also of higher content of soluble salts. They have been utilized for a very long period of time. They are suitable also for production of exacting thin-walled bearing and shaped elements but unsuitable for production of roof tiles;
- Paleogene claystones (also calcareous) are utilized in E and SE Moravia. They represent weathered parts of flysch layers of outer nappes of the West Carpathians. Impurities are efflorescence-forming salts and layers of sandstones. They are used for production of solid or perforated bricks;
- Upper Cretaceous clays and claystones (often calcareous) are used as a raw material for brick production in areas of the Bohemian Cretaceous basin and in south Bohemian basins. Marls, marlstones and sands are used as corrective materials. The material is suitable even for production of the most exacting perforated bricks and ceiling elements. In southern Bohemia, because of contamination by limonitized sandstone only for production of less exacting building elements.
- Permocarboniferous pelites and aleuropelites are used for brick production in Permocarboniferous basins and furrows of Bohemia and Moravia. These deposits are characteristic of the occurrence of sandstones and of complex structure. The material can be used also for production of roof tiles and thin-walled elements;
- the Late Proterozoic and Early Paleozoic weathered slates and their residues are used for production of bricks around Prague, in the Plzeň and Rokycany regions, etc.

Impurities are solid detritus and pyrite. They are not suitable for production of exacting brick elements.

3. Registered deposits in the Czech Repunblic
There are vast numbers of brick clay deposits registered in the Czech Republic and thus they are not listed in this overview. Their distribution over the Czech territory is rather random and consequently some regions are short of these materials (e.g. Českomoravská vrchovina plateau).

4. Reserves as of December 31, 1993

Economic demonstrated reserves, in thousand m^3	470,083
A part of economic inferred reserves, in thousand m^3	1,059,800
Subeconomic reserves, in thousand m^3	142,993

5. Domestic production, imports and exports of the Czech Republic
Raw materials for production of bricks are mined in 103 deposits.

Year	1989	1990	1991	1992	1993
Mining output (T), thousand m^3	945.4	1,008.5	833.1	735.8	776.9
Index of mining output evolution (1989=100)	100.0	106.7	88.1	77.8	82.2
Apparent consumption in thousand m^3	945.4	1,008.5	833.1	735.8	776.9

5a. Tariff rates according to the Customs tariff of ÚCS 1993

Code	Commodity	Tariff rates in % General	Concessionary
	Materials for brick production are not listed in the customs tariff and their import and export have not been observed		

6. Mining companies in the Czech Republic
Jihočeské cihelny a.s., České Budějovice
Brněnské cihelny s.p., Brno
CIDEM Hranice a.s., Hranice
Severočeské cihelny a.s., Teplice
Later Chrudim a.s., Chrudim
Pražské cihelny s.p., Praha
P.W.S. s.r.o., Stod

Only the largest producers are listed.

7. World production
Output of brick clays is not observed on the global scale.

8. World market prices

Brick clays are not a subject of the world trade.

9. Recycling

Brick clays cannot be recycled, but the final products - bricks, tiles, blocks - can be reused.

10. Possible substitutes

In production of conventional brick elements, this material is irreplaceable. Other types of bricks can be produced from other materials (calcareous-acid bricks, agloporite, gas silicates, etc.). Various natural and artificial materials can be used for production of the afore mentioned building elements - quartz, lime, powder aluminium, artificial aggregates, cinder and flue ashes of thermal power plants, tailings, etc.