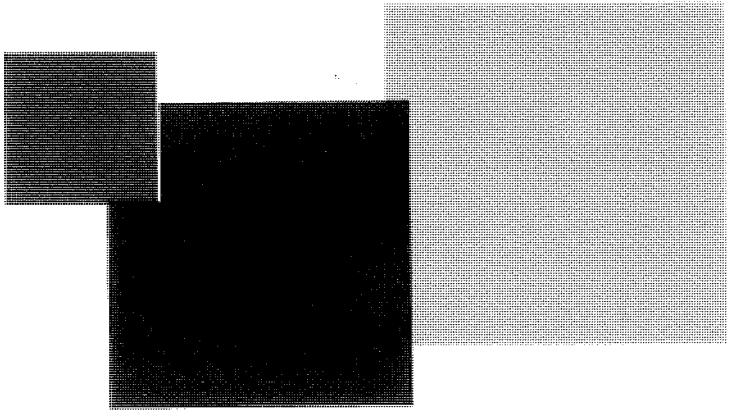
MINISTRY OF ECONOMY OF THE CZECH REPUBLIC

MINERAL COMMODITY SUMMARIES OF THE CZECH REPUBLIC



NATIONAL INFORMATION CENTRE OF THE CZECH REPUBLIC
DEPARTMENT GEOFOND
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MINERAL COMMODITY SUMMARIES OF THE CZECH REPUBLIC

STATE TO DECEMBER 31, 1992

MINISTRY OF ECONOMY OF THE CZECH REPUBLIC
DEPARTMENT OF MINERAL RESOURCES AND GEOLOGICAL SURVEY

NATIONAL INFORMATION CENTRE OF THE CZECH REPUBLIC
DEPARTMENT GEOFOND

May 1993

Dear readers:

A comprehensive summary of mineral resources on the territory of the Czech Republic is presented for the first time in a form quite different from the foregoing publications listing the balances of reserves of mineral resources. The present compilation also pursues a different objective. It is not intended to inform on the changes within any individual deposit; rather, it aims at providing a comprehensive information, including data on the world developments concerning the mineral resources and commodities. The publication conforms to worldwide usage and to accepted standards for presenting this kind of information. It is hoped that the improved mining and geological legislation which is in progress will pave the way to a better acquisition and processing of necessary data and toward an improvement of the Czech public information system.

Karel Dyba
Minister of Economy
of the Czech Republic

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Introduction

According to suggestion of Mineral Resources and Geological Survey Department of Ministry of Economy of Czech Republic the publication has been issued concerning the mineral resources of Czech Republic for the first time in 1993. It contains basic information about the characteristics, quality and extent of mineral resources with data usually set out in internationally recognised yearbooks. The extent of this information is determined by valid legal regulations issued by Government for fulfiling of this demand

The assessment of mineral reserves started in 1959. It was based on Government regulation No. 11/1958 concerning the organization of the Government geological service and a guideline No. 180/1958 - Official Paper, issued for it, concerning the follow-up of the state and changes of mineral reserves.

A Central geological body compiled a national balance of mineral reserves on the basis of submitted statistical statements. After 1969 those balances were, in context with the Act of Czechoslovak Federation, issued separately for Czech Republic and for Slovak Republic. Since 1971 it has been completed by survey of non-reserved minerals, extracted only for local use, in accordance with requirements of the Construction Law.

A last legal amendment of the follow-up and the balance of mineral reserves is represented by the amendment of Act No. 44/88 issued as the Czech National Council Act No. 541/91. Ministry of Economy of Czech Republic was delegated to manage comprehensive follow-up of selected deposite

reserves and on this base also the management of reserve balance. Detailed process is deliminated by the a notice No. 497/92, concerning the follow-up of selected mineral deposits reserves. The balance of mineral reserves for all the selected deposits for needs of state authorities is prepared in accordance with those regulations in this year.

This publication is worked up in addition to this activity. The mineral reserves as recorded here comprise geological reserves, i.e. stocks in original state in the deposit and numerically expressed in accordance with valid classification and conditions for exploitation laid down during preceding period. Starting basis for their management is the calculation of reserves approved or judged by independent authority. Such calculations are binding for all prospecting and production organizations at processing of the basis for recording. Gross output is given in production data.

During last forty years defining of deposits was influenced by a number of negative factors, affecting their extent and the mineral reserves quantity reported in the balance. An economical evaluation and a price policy particulary belong among them as they did not take into account all the necessary costs connected with mineral prospecting and extraction, namely liquidation of extraction consequencies. Those deformations are particularly significant in definition of ore deposits, where the direct state appropriations for the extraction were expected .

The complete review of mineral resources situated on the territory of Czech Republic is being presented to a professional public in form quite different from the past

balances of mineral reserves. And the purpose of this publication is new too. The objective of this publication is not to give the information about reserves increases or decreases in every individual deposit. The objective of this publication is to give more global information concerning each mineral commodity and, if possible, giving the information about world development of this commodity. According to mentioned objective the arrangement of partial chapters has been chosen:

- Mineral Characteristic gives short information concerning mineralogy, petrographic composition, technological qualities, geological and geographical position.
- Domestic Production and Use contents basic information concerning production in 1992 as well as the use of minerals.
- Production Tendency informes about production during the period of 1988 - 1992. The given production data present gross mine outputs.
- Deposits and reserves gives the number of assessed deposits in Czech Republic, including division beetwen used and unused deposits as well as the summary of geological reserves according to individual categories.
- Assumed Trend tries to express an outlook of following mineral commodity development, based on domestic and foreign information.
- Main World Producers are given only in cases of world-wide monitored minerals.
- Possibilities of Substitution are given in cases when the substitution of the mineral by another mineral or

material, e.g. recycled waste, is technologically and economically acceptable.

Data concerning world production and development trends of individual minerals were obtained from various foreign publications and periodicals, particulary Mineral Commodity Summaries 1993, Industrial Minerals, Rock Products, Engineering and Mining Journal etc.

The division of submited publication as described above in general is not without purpose. The authors came out from a necessity to harmonize presentation of information concerning the deposits of this country with methods common all over the world. Therefore the division is very close to that used by U.S. Bureau of Mines in its "Mineral Commodity Summaries" yearbooks. It is obvious that neither the method of division nor the selection of data has been taken over mechanically. The fact has to be taken into account that this publication has been completed under quite different economy and legislative conditions.

The mineral reserves assessment is going to be be gradually revaluated to reflect actual and really utilizable minerals potential.

ORES

IRON ORE

1. Mineral Characteristic:

Iron - the most important metal in the history of mankind - has already been known in primeval ages and human civilisation development has been closely connected with it s consumption. Pure iron occurs in the nature only rarely and for this reason it has been obtained from easy smeltable limonitic ores [FeO(OH).n H_2O] from the very beginning.

Pure iron is grey, highly forgeable metal, melting at the temperature of 1,528^{o}C and having volume mass 7.88. Raw iron with carbon content higher than 1.7% C is not forgeable and so it is converted to steel with lower carbon content and higher content of other metals (alloy steel) in steelmaking furnaces.

In iron production nowadays there have been quite dominating iron ores - magnetite Fe_3O_4 (up to 72% Fe) and hematite Fe_2O_3 (up to 70% Fe).

In the last century and at the beginning of this century sedimentary iron ores were - mainly in Europe - used mostly of oolitic texture (so called "minette ore" and hematite or chamosite ores) with higher content of SiO_2 and increased content of P_2O_5. During the fifties of this century use of those ores was abandoned for the reason of increased costs.

Well-known Central Bohemian Ordovic deposits in Barrandien, which were processed in Bohemia till the end of the sixties using the technology called " Krupp - Rennverfahren Process", belong to this type of ores as well. Besides those sedimentary iron ores, there are well

known magnetite deposits mostly of metamorphic origin (Fe "scarns" and another types) in Bohemian Massif.

2. Domestic Production and Use:

Mining of sedimentary oolitic ore was abandoned at the end of the sixties (one deposit was mined at the beginning of the seventies too) and at the present time this type of ore is not mined.

There was production of 64 thousand metric tons in the Czech Republic in 1992. Manufactured magnetite concentrates were mostly used as heavy media washeries in coal beneficiation, and for purposes other than compaction.

The absolute majority of all extracted iron ore in the world is used for pig iron production (98%), the rest for direct steel production, in a cement production and as heavy media.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Magnetite ore production	100	84	93	102	64

4. Deposits and Reserves:

17 sedimentary iron ore deposits have been registered in the Czech Republic at January 1, 1992, where none of them is extracted, and 12 magnetite deposits, while 2 are utilized. Recorded reserves are given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	demonstrated		inferred		
	free	bound	free	bound	
Iron ore					
- sedimentary	0	0	0	0	461,510
- magnetite	519	0	12,232	0	18,229

5. **Assumed Trend:**

Domestic magnetite production has decreasing tendency and it seems to be terminated in the nearest future. Practically all the iron ore needs of the Czech Republic are covered by import and the same is expected in the future. It is true that an assumed violent decline in needs has appeared, though not in the expected scale, but a total needs will decrease in the future. The world iron ore consumption trend has been permanently decreasing and from 1989 has decreased at about 10% and in 1992 became mildly stabilized.

6. Main World Producers:

World iron ore production reaches nearly 1 billion metric tons per year. The biggest producers produce as follows:

Former U.S.S.R 24%

Brazil 16%

Australia 11%

China 10%

India 5%

7. Possibilities of Substitution:

Substitution of steel by plastic materials , aluminium, but also by glass and ceramic materials goes on; but iron has been and in next decade will be the most important metal.

Iron scrap recycling is very significant. Iron scrap presents an amount of more than 25% in all developed countries.

MANGANESE ORE

1. Mineral Characteristic:

Pure manganese, which is silvery, hard and tough metal, does not occure in the nature. Manganese was discovered only in the 17th century. Manganese melting point is 1,247°C, its volume mass is 7.4.

Nearly all iron ores content manganese addition, which passes during their compaction into the pig iron.

The main sorts of manganese ores are oxides - pyrolusite MnO_2, psilomelane MnO.MnO.n H_2O and amorphous MnO.n H_2O - wad. These ores contain up to 63% of Mn. From large number of other manganese minerals only rhodochrosite $MnCO_3$ and rhodonite (Mn, Fe, Ca) SiO_2 are significant.

The majority of economically important manganese ore deposits is of a sedimentary origin. The Czech deposit of poor manganese ore in Železné hory is of upper proterozoic age. Besides the primary ore, the manganese minerals are present in flotation wastes after the pyrite extraction. Other deposits and occurencies have no significance.

2. Domestic Production and Use:

Production of manganese ore in the Czech Republic has been terminated in the beginning of the fifties. This well-known deposit had been extraced for its pyrite content. At a production of flotation pyrite concentrate the manganese minerals had not been obtained, they had passed into the wastes.

The manganese ore was used as alloying additive. Manganese ore for production of ferromanganese is imported, the needs of manganese oxide for dry batteries production as well as for manganese compounds production are covered by import of rich manganese ore. The technology for utilization of manganese content in flotation wastes by means of chemical method is elaborated; but this process has not been utilized up to now.

3. Production Tendency:

Manganese ore is not extracted at present.

4. Deposits and Reserves:

Two deposits of poor manganese orewere registered in the Czech Republic at January 1, 1993, neither of them is utilized. Registered reserves are given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Manganese ore	0	0	0	0	134,405

The table includes primary deposits as well as the flotation wastes.

5. Assumed Trend:

A domestic demand as well as a world-wide trend show decreasing tendency connected with decrease in manganese steels production.

6. Main World Producers:

The main world producers contribute to the world manganese ore production at about 26 million of tons per year as follows:

Former U.S.S.R 36%
Republic of South Africa.....16%
China 12%
Gabon 10%
Australia.....9%

7. Possibilities of Substitution:

The possibility of substitution of manganese, its compositions and alloys in industry does not exist in majority of cases. Partial recycling of pyrolusite obtained from old dry batteries is expected in the future.

COPPER ORE AND COPPER /METAL/

1. Mineral Characteristic:

Copper is red, soft, forgeable metal known already at prehistorical period. Its volume mass is 8.93 and a melting point at 1,083°C. It is very good electrical conductor.

Although copper occures as a pure material, the absolute majority of copper is produced of sulphide ores - chalcopyrite $CuFeS_2$, bornite $Cu_5Fe_2S_4$, farther of (tetra) thioantimonates, especially of tetrahedrite Cu_3SbS_{3-4} and thioarsenide - enargite $CuCO_3Cu(OH)_2$. Oxygenous ores - cuprite Cu_2O, malachite $CuCO_3Cu(OH)_2$ and azurite $2CuCO_3Cu(OH)_2$- are less common. Concentrates of those minerals, produced from milled ore mostly by flotation, are compacted for raw copper and further treated in an electrolyte bath to form refined copper cathode through electrolysis.

In the Czech Republic sulphide ore deposits in weak metamorphised slates and quartzites of the types "Saxothuringica" and "Silezica" have a significance. Typical deposits of sedimentary oxidic ore in perm are without economy significance. At many polymetalic hydrothermal veins all over the whole Bohemian Massif copper ore is only as a side service component without greater significance. Only one deposit belongs to intramagmatic type of Cu-Ni ore.

2. Domestic Production and Use:

In 1992, copper ore extraction on monomineral deposits was finished. Copper had been obtained only as by-product

during the extraction of magnetite, polymetalic and gold ores. The absolute majority of copper and copper compounds is imported.

Electrotechnical industry leads in the use of copper. Nearly 50% of all the copper is processed for those purposes. Copper products are also used as installing materials and in a production of alloys, brass and bronze above all.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Copper ores production	229	210	121	0	0
Copper, extracted as by- product	1.5	1.2	0.8	0.6	0.5

4. Deposits and Reserves:

In the Czech Republic there were 7 copper ore deposits registered at January 1, 1993. None of those deposits is now utilized. The copper content is registred in other 12 deposits as the side component and in 3 of those deposits copper is utilized. Quantity of registered ore and metal reserves is given in a a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Copper ores	0	0	4,738	0	134,405
Copper - metal in copper ores	0	0	27	0	75.3
Copper - metal in another ores	1.7	0	26.4	0.7	116.8

5. Assumed Trend:

Domestic demand shows a slightly decreasing trend, but rather well-balanced state might be expected in the future. In the world-wide scale, copper consumption neither decreases nor increases.

6. Main World Producers:

The main world producers contribute to the world copper ores production of about 9 million metric tons per year as follows:

Chile.....18%

U.S.A.....17%

Canada..... 8%

Former U.S.S.R..... 7%

Zambia 5%

Poland 5%

7. Possibilities of Substitution:

Copper is substituted by aluminium in installation materials and electrics, by optical fibres in materials for some telecommunications applications , by plastic materials in civil engineering.

But on the contrary, the copper consumption is increasing in sphere of historical buildings reconstructions.

In developed countries the copper recycling reaches the value of 20 - 30%.

POLYMETALLIC ORE – LEAD

1. Mineral Characteristic:

Lead is white, soft, forgeable metal, melting at 327°C, having volume mass 11.34. It does not occur in the nature as a pure metal. All its compounds are poisonous. Lead has been known since antiquity.

The main lead ore is galenite PbS (up to 86% of Pb), oxygenous minerals cerusite - $PbCO_3$ and anglesite - $PbSO_4$ occure less often. Sulphide ores always contain silver admixtures.

The lead deposits in the Czech Republic occure in form of hydrothermal polymetallic veins.

2. Domestic Production and Use:

In 1992, lead was obtained only during a production of polymetallic ore in form of the concentrate. Main lead consumption is evenly spread between production of lead accumulators and production of a petrol with lead admixtures. The lead consumption in cable production and in lead alloys production is also significant. The lead consumption in glass industry and ceramics manufacturing is decreasing, but on the contrary, the lead consumption for radiation shielding is increasing.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Lead production in polymetallic ore	2.6	4.6	2.3	2.1	1.1

4. Deposits and Reserves:

In the Czech Republic 31 polymetallic ore deposits were registered at January 1, 1993, in which lead is as utility component, but only in 3 of those deposits lead was utilized as a side component. Quantity of registered metal reserves in polymetallic ores is given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Lead - metal in polymetallic ore	11.4	6.2	82.0	8.2	163.7

5. Assumed Trend:

Domestic as well as world-wide consumption have been showing invariable decreasing trend.

6. Main World Producers:

The main world producers contribute to the world lead production of about 3.3 million metric tons per year as follows:

Australia.....16%

U.S.A.....15%

Former U.S.S.R.....13%

China 8%

Canada..... 7%

7. Possibilities of Substitution:

Significant lead toxicity leads to intensive substitution of the lead by another metals and plastic materials and to high grade of recycling. In the U.S.A. recycling reaches up to 64%. The production of petrol with lead admixtures has been permanently decreasing.

POLYMETALLIC ORE – ZINC

1. Mineral Characteristic:

Zinc is grey up to white, soft, forgeable metal, melting at 419.4^{o}C, having volume mass 7.2. It was discovered only in the 18th century and it does not occur in the nature as a pure metal.

The most common zinc ore is sphalerite ZnS, having colour from dark red to light yellow with content of 55-67% of Zn.

It always contains admixtures of cadmium, indium, gallium and iron. In the Czech Republic oxygenous or silicate zinc ore does not occure in industrially utilizable quantity.

The zinc deposits in the Czech Republic belong to hydrothermal polymetallic veins or to stratiform deposits of sulphidic ore.

2. Domestic Production and Use:

Zinc is obtained during a production of polymetallic ores in form of the concentrate, which is exported mainly to Poland and West Europe. A plant for hydrometallurgical processing of common concentrates was not completed and its construction was terminated.

Main zinc consumption is going to zinc coating of rolled steel products, other significant consumption being production of various zinc alloys, mainly brass.About one quarter of zinc is consumed in chemical industry in form of zinc salt (zinc white).

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Zinc - metal production from polymetallic ore	6.1	6.5	7.5	8.5	4.4

4. Deposits and Reserves

In the Czech Republic 36 polymetallic ore deposits with zinc contentwas registered at January 1, 1993, but only two deposits were utilized . Quantity of registered reserves is given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Zinc - metal in polymetallic ores	51.3	18.5	375.0	30.6	491.9

5. Assumed Trend:

Domestic zinc ores consumption shows a decreasing trend as well as domestic zinc consumption. The world-wide production and consumption have a mildly increasing trend, which may be expressed by inter-year increase of 0 -3%.

6. Main World Producers:

The main world producers contribute to the world zinc production of approx. 7.5 million of tons per year as follows:

Canada.....16%
Australia.....12%
Former U.S.S.R.....10%
China 8%
U.S.A..... 7%

7. Possibilities of Substitution:

Zinc is substituted by aluminium and its alloys, for substituing of galvanic zincing a wide range of paints and sprays of modern anticorrosive agents is available, but the total substitution does not exit yet. The zinc recycling, with regard to its dispersion during a consumption, reaches maximally 25%.

POLYMETALLIC ORE – SILVER

1. Mineral Characteristic:

Silver is silvery, soft and forgeable metal with very good electric conductance, melting at 960.5°C, having volume mass 7.2.

Silver has been known from the beginning of antiquity, it often ocurres as a pure metal in the nature, but such deposits are already extremely exhausted.

The range of silver ore is very wide though it is not applied in industrial extraction too significantly. The main resource of the silver is rather a silver admixture in galenite, sphalerite and chalcopyrite. The silver is obtained in end phase of metallurgical process. In the Czech Republic hydrothermal polymetallic veins were the main resource of silver.

2. Domestic Production and Use:

Silver is not obtained as a separate concentrate during concentrating of polymetallic ore, but it passes into concentrate of lead, zinc and copper.

The main silver consumption is connected with industry of photographic materials, the other fields of consumption being electronics, jewellery and coin-fabrication. Considerable quantity is consumed in production of mirrors.

3. Production Tendency:

Data in metric tons

	1988	1989	1990	1991	1992
Silver - metal production from polymetallic ore	19.0	20.8	16.2	8.9	6.2

Domestic production of silver shows strongly decreasing tendency.

4. Deposits and Reserves:

In the Czech Republic 39 polymetallic ore deposits have been registered to January 1, 1993, where silver is registered separately, but from that number only 3 deposits are utilized. Quantity of registered reserves is given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Silver - metal in polymetallic ore	18.6	0	375.5	57.3	658.6

5. Assumed Trend:

A domestic silver consumption is stagnating, the world-wide production and consumption oscillates depending to the price, maximally in range of 8%.

6. Main World Producers:

The main world producers contribute to the world silver production of approx. 15,000 metric tons per year as follows:

Mexico.....17%

U.S.A.....13%

Peru 12%

Former U.S.S.R.....10%

Canada..... 9%

7. Possibilities of Substitution:

Though there are many possibilities of substitution, they are economically of a little advantage. Recycling has been varying between 30 - 50% depending on existing prices.

POLYMETALLIC ORE – ARSENIC

1. Mineral Characteristic:

It is greyish metalloid (semi-metal), extremely poisonous in all soluble compounds and gases. It sublimates already at 80°C, the volume mass being 5.8. It has been known already since antiquity.

It occures only rarely in pure form; it is obtained industrially from arsenopyrite FeAsS, realgar As_2S_2 and from diarsenic trisulphide As_2S_3 (auripigment).

In Bohemian Massif arsenic and its minerals occure especially in hydrothermal uranium veins as well as in some polymetallic veins.

2. Domestic Production and Use:

Arsenic minerals are not extracted at present. Main use of arsenic is in a production of herbicides, pesticides and wood preservatives, smaller amount is used in glass industry and for production of some alloys.

3. Production Tendency:

Arsenic minerals were not extracted in 1992, a demand for the arsenic and its compounds is covered by import.

4. Deposits and Reserves:

In the Czech Republic one polymetallic ore deposit is registered to January 1, 1993, where arsenic is registered separately. This deposit is not utilized. The quantity of registered reserves is given in a following table.

Data in metric tons

	Economic				Sub-economic
	Demonstrated		Inferreded		
	free	bound	free	bound	
Arsenic - metal in polymetallic ore	0	0	0	0	6.0

5. Assumed Trend:

The utilization of a domestic deposit is not expected. Trend of the world-wide consumption is mildly decreasing.

6. Main World Producers:

The world production of arsenic (metal) is at about 45,000 metric tons per year. To this production contribute as follows:

China.....22%

Chile.....15%

Former U.S.S.R.....15%

Philippines..... 11%

Mexico.....11%

7. Possibilities of Substitution:

They are not too wide as the arsenic and its compounds have very specific properties. Recycling is not used anywhere.

In view of the fact of great toxicity application of arsenical preparations is suppressed.

POLYMETALLIC ORE - INDIUM

1. Mineral Characteristic:

An indium is white, soft metal.It was discovered only in 1863. Its world-wide production is estimated at 140 metric tons. It regularly accompanies sphalerite and may be obtain by refining of the zinc or zinc wipes. Increased indium contents were registered in one hydrothermal vein of polymetallic deposit in Bohemian Massif.

2. Domestic Production and Use:

The ore with increased indium contents is not extracted. Data concerning utilization of indium in the Czech Republic are not available.

In the world-wide scale the indium is used in the production of special alloys, and together with tin in special surface finishings and solar energy utilization.

3. Production Tendency:

Indium was not extracted in a followed period .

4. Deposits and Reserves:

In the Czech Republic one deposit of polymetallic ore was registered at January 1, 1993, where indium reserves are registered separately. This deposit is not utilized. The

quantity of registered reserves is given in a following table.

Data in metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Indium - metal in polymetallic ore	0	0	0	0	14.7

5. **Assumed Trend:**

The utilization of this deposit is not considered. The development of world-wide consumption seems to be optimistic and depends on the use of indium in a battery industry.

6. **Main World Producers:**

The world production of indium is estimated at approx. 140 metric tons per year. Main producers of indium are: Canada (28%), France, Japan, Belgium and U.S.A.

7. **Possibilities of Substitution:**

It is possible to substitute indium in all cases of use. Recycling is not registered, but it does exist.

POLYMETALLIC ORE - APPENDIX

Data for all types of polymetallic ore:

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Polymetallic ore	418	433	450	471	262

4. Deposits and Reserves:

In the Czech Republic 39 polymetallic ore deposits were registered to January 1, 1993, four of them are utilized. The quantity of registered reserves is given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Polymetallic ore	4,211	1,195	29,025	2,175	35,754

TIN - TUNGSTEN ORE - TIN

1. Mineral Characteristic:

The pure tin - white, extremely glossy, soft, highly forgeable - does not occure in the nature. It has been known in alloys with copper since prehistory. Tin melting point is 231.9°C, volume mass is 7.3.

The esential tin ore is tin dioxide (cassiterite) SnO_2, almost always crystalline, dark, rarely yellow, glossy mineral, containing up to 78% Sn. The cassiterite always contains admixtures of columbium (niobium), tantalum, iron and manganese. The side ore is stannine Cu_2FeSnS_4, containing approx. 27% Sn.

The tin ore deposits, practically always accompanied by tungsten minerals, concetrate in range of "Krušné hory" in the Czech Republic. These deposits belong mostly to the type "greisen". The cassiterite occurs - besides of those deposits - in quartz veins and in metamorphised minerals all over the Bohemian Massif, but only in quantity having no industrial significance.

2. Domestic Production and Use:

Tin production, having great importance in the Middle Ages, has been totally terminated in the Czech Republic nowadays.

The greatest tin consumption, linked with its nontoxicity, is in packing technics, first of all in canning industry (at about 1/3 of production); it is used in

production of alloysbronzes, particulary in electronics and engineering. Tin has a specific use in manufacturing of casted plate-glass and musical instruments.

3. Production Tendency:

Data in metric tons

	1988	1989	1990	1991	1992
Tin - metal in ore	538.8	467.5	590.1	14.7	0

4. Deposits and Reserves:

In the Czech Republic 14 deposits of tin-tungsten ore are registered at January 1, 1993, but none of them is utilized. The quantity of registered reserves is given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Tin - tungsten ore	997	0	16,532	0	69,063
Tin - metal in this ore	3.8	0	37.2	0	162.0

5. Assumed Trend:

Domestic tin consumption is stable in the main. In the world-wide scale the consumption is also stable, but production has been oscillating in accordance with strong price oscillations.

6. Main World Producers:

The world tin production is at about 216,000 metric tons per year. Following countries take part on this amount of production:

Brazil 24%
Malaysia.....13%
Indonesia.....12%
China.....12%

7. Possibilities of Substitution:

The possibilities of further tin substitution are exhausted to the considerable grade with substitutions by plastic materials an by aluminium and its alloys in range of packing technics. There are further possibilities of substitution by plastic materials, ceramic materials and alloy steel in range of engineering. With respect to the considerable dispersion, recycling in industrially developed countries does not exceed 25%.

TIN – TUNGSTEN AND TUNGSTEN ORE – TUNGSTEN

1. Mineral Characteristic:

A tungsten is black, very hard metal with an extremely high melting point - 3,380°C and a volume mass 19.1. It does not occure in nature as a pure metal; it was discovered only in 1783.

The main ores are wolframite (Fe, Mn)WO_4, which is normally accompanying tin ores, and scheelite $CaWO_4$, which, besides common occurance with wolframite, also creates individual deposits of "skarn" type.

In the Czech Republic the tungsten ore occures with tin in range of "Krušné hory" and individually as small deposits of "skarn" type in south Bohemian "moldanubic".

2. Domestic Production and Use:

Nowadays the tungsten ore is not extracted in the Czech Republic. The tungsten is consumed as an alloy composition for special steel production, for production of alloys for cutting materials and finally for production of resistor wires for electric bulbs.

3. Production Tendency:

Data in metric tons

	1988	1989	1990	1991	1992
Tungsten - metal in ore	157.0	74.7	83.6	12.5	0.0

4. Deposits and Reserves:

In the Czech Republic there were 8 deposits of tungsten ore registered at January 1, 1993, but none of them was utilized. The quantity of registered reserves is given in a following table.

Data in metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Tungsten - metal in Sn-W ore	126.7	0	10,913.3	0	37,276.9
Tungsten - metal in tungsten ores	0	0	1,752.0	0	654.2

5. Assumed Trend:

In a domestic and a worldwide scale the tungsten extraction and consumption have permanently decreasing trend in connection with arms restricting.

6. Main World Producers:

The estimated world tungsten production is 44,600 metric tons per year. China produces 51% and former U.S.S.R. 20% of this amount.

7. Possibilities of Substitution:

The possibilities of tungsten substitutions exist especially in numerous materials based on carbides. Industrial recycling in developed countries reaches up to 30%.

LITHIUM ORE - LITHIUM

1. Mineral Characteristic:

A lithium is silvery, light, alcalic metal, subjected to immediate oxidation. For this reason a pure lithium does not occure in the nature. The lithium has melting point of 180.5°C and volume mass 0.53. It was discovered only in 1817.

The main minerals for production of the lithium and its compounds are "spodumene" (lithium aluminium-silicate mineral having content up to 8% Li_2O) and "amblygonite" (complex phosphate Li and Al with fluorine content - $LiAl(F,OH)PO_4$ having content up to 19% Li_2O). A domestic mineral is a lithium mica - "cinvaldite", having rich occurance in deposit Cínovec in region "Krušné hory". The lithium content in "cinvaldite" is varying from 1 up to 4% Li_2O.

2. Domestic Production and Use:

The concentrate of lithium mica was formerly produced in concentrator at Cínovec. This plant is liquidated at present.

The lithium is mainly used in ceramics and lithium glass production, newly also in alloys with aluminium.

3. Production Tendency:

At the present time lithium ore is not extracted.

4. Deposits and Reserves:

In the Czech Republic there was 1 deposit of lithium ore registered at January 1, 1993, which is not utilized. The quantity of registered reserves is given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Lithium ore	0	0	0	0	86,870
Lithium - metal in lithium ore	0	0	0	0	195

5. Assumed Trend:

The utilization of this deposit is not considered. The lithium consumption in the Czech Republic is not registered. The trend of present lithium world consumption has a mildly increasing tendency. The main increase of lithium consumption is expected in a direct nuclear energy conversion in a far future.

6. Main World Producers:

The world lithium production is around 5,500 metric tons per year. Shares of individual producers are following:

Chile 32%

Australia 27%

Former U.S.S.R. 20%

7. **Possibilities of Substitution:**

Possibilities of further lithium utilization are explored.

NICKEL ORE - NICKEL

1. Mineral Characteristic:

Nickel is white, perfectly forgeable metal, which was discovered in 1751. Its volume mass is 8.8 and melting point 1,452°C. Its most important property is the resistance to oxidation.

The most important nickel ores are iron and nickel sulphides - "pentlantite" $(Fe, Ni)_9S_8$ and Ni - "pyrrhotite" (Fe, Ni)S and group of nickel hydrosilicates (the best known is "garnierite"), which form about 1/3 of world extraction.

Both types of nickel ore occure in the Czech Republic, but only reserves of hydrosilicate ore are registered.

2. Domestic Production and Use:

Small deposits in the Czech Republic are not considered for extraction. The consumption is directly connected with a special steel production (almost one half of the world consumption), other use of nickel is found in various alloys and in nickel plating.

3. Production Tendency:

Nickel ore is not extracted.

4. Deposits and Reserves:

In the Czech Republic 2 deposits of nickel orewere registered at January 1, 1993, while none is utilized . The quantity of registered reserves is given in the a following table. .

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Nickel ore	0	0	9,318.0	0	0
Nickel - metal[x)] in nickel ore	0	0	62.4	0	49.4

x) including sulphide ores, registered in terms of copper deposits

5. Assumed Trend:

Utilization of nickel ore deposit in the Czech Republic is not considered. Nickel consumption is covered by import. World nickel consumption is rather stabilized and oscillating around 1 million metric tons per year.

6. Main World Producers:

A world nickel production is around 1 million metric tons per year. Shares of individual producers are following:

Former U.S.S.R. 23%
Canada 22%
New Caledonia 14%
Indonesia 8%
Australia 7%
Cuba 5%

7. Possibilities of Substitution:

There are many possibilities of substitution but they are limited by economical factors. Recycling is developed only in the most developed countries; it reaches up to 30% in the U.S.A.

ANTIMONY ORE – ANTIMONY

1. Mineral Characteristic:

An antimony has been known since the antiquity. It is grey, spalling metal with volume mass of 6.6, melting at 630.5°C. It occures only rarely in pure form in the nature.

The most important antimony ore is an antimonite Sb_2S_3, containing up to 71% of Sn. Sometimes antimony sulphates of lead and copper are utilized.

There are deposits of antimony ore on the periphery of the middle part of central Bohemian Plutonic in form of hydrothermal veins, often accompanied by the gold or, on the contrary, accompaning polymetallic ores.

2. Domestic Production and Use:

An antimonite concentrate enriched with gold is produced from extracted ore and is exported to foreign metallurgical works for processing. In the period between World War I and World War II former Czechoslovakia took part on the world antimony production with value of 2%.

Antimony is utilized mainly in a range of special alloys production (bearing metal - antifriction alloy, type metal, hard lead), in chemistry and pyrotechnics.

3. Production Tendency:

Data in metric tons

	1988	1989	1990	1991	1992
Antimony - metal	244.9	252.6	216.2	383.8	223.9

The acceleration of antimony ore extraction is not considered in the Czech Republic.

4. Deposits and Reserves:

In the Czech Republic 2 deposits of antimony ore were registered at January 1, 1993, one of them is utilized. The quantity of registered reserves is given in a following table.

Data in metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Antimony - metal	0	0	153.3	0	3,855.

5. Assumed Trend:

Antimony consumption has decreasing trend both in the Czech Republic and in the world.

6. Main World Producers:

World antimony production reaches 70,000 metric tons per year. The main world producer is China with more than 50% of world antimony production.

7. Possibilities of Substitution:

Tendency of antimony substitution by various combinations of other metals in alloys is generally applied. Recycling is limited mainly to antimony and lead alloys.

GOLDBEARING ORE – GOLD

1. Mineral Characteristic:

A gold was the first known metal in the mankind prehistory. Its yellow colour, extreme forgeability, gloss and extraordinary beauty have predetermined this element to be the most valuable treasure. It has the volume mass of 19.3, melting point 1,063°C, outstanding electric conductivity and it is resistant to atmospheric influences. The gold occures as a pure metal in the nature and the absolute majority of it is obtained from fine dispersed pure gold particles.

The Bohemian Massif is very rich in goldbearing ore, which occure in all formations, excluding the Cretaceous system and Tertiary. The absolute majority of deposits is formed by quartz - goldbearing veins and by parts of veins with high gold purity. The second most common are the deposits of Au-Ag type with low purity, which are often accompanied by sulphides. The polymetallic sulphidic deposits or antimony deposits with gold are not that common. At last, there are deposits of gold with high purity, which are accompanied by minerals of W (scheelite), Mo and Bi. The secondary gold deposits in dips of Quarternary, Tertiary, and also of Carboniferous system are mostly extracted. Intensive gold extraction in this country has been more than 2,000 years old.

2. Domestic Production and Use:

About one half of all the gold is consumed in industry and dentistry in the Czech Republic. The second half is processed in jewellery and for manufacturing of artistic objects. Jewellery, art and coinage form up to 70% of gold consumption in a world-wide scale.

3. Production Tendency:

Data in kilogrammes

	1988	1989	1990	1991	1992
Gold - metal	65.0	105.2	187.2	564.1	520.6

4. Deposits and Reserves:

In the Czech Republic 20 deposits of goldbearing ores were registered at January 1, 1993, three of them are utilized. The quantity of registered reserves is given in a following table.

Data in kilogrammes

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Gold - metal	51,145.5	0	51,527.9	0	69,895.1

5. Assumed Trend:

A domestic demand shows an increasing trend in the Czech Republic. The world gold consumption is, although very mildly, in the range 1 - 3%, increasing. The domestic consumption is covered predominantly by import.

6. Main World Producers:

The world gold production is at about 2,000 metric tons per year. The main gold world producers are:

Republic of South Africa.....30%
U.S.A. 15%
Former U.S.S.R. 14%
Australia 11%
Canada 8%

7. Possibilities of Substitution:

The possibilities of substitution of gold in the industry and in the dentistry exist especially in a use of other precious metals, in jewellery, in art and in coinage the substitution of gold is impossible.

The gold recycling depends on price relations and in favourable cases can reach up to 50%.

PYRITE

1. Mineral Characteristic:

A common iron sulphide FeS_2 used to be the important raw material for production of sulphuric acid, while roasted pyrites were use as iron ore. But nowadays the significance of the pyrite has decreased significantly as an elementary sulphur is used for the production of sulphuric acid.

2. Domestic Production and Use:

The pyrite extraction was terminated at the beginning of the 1970s.

3. Production Tendency:

Pyrite is not extracted and there is no utilization for it.

4. Deposits and Reserves:

In the Czech Republic one deposit of the pyrite is registered at January 1, 1993, which is not utilized . The quantity of registered reserves is given in a following table.

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Pyrite	0	0	0	0	292,116

5. **Assumed Trend:**

With respect to the low price of elementary sulphur, restoration of pyrite extraction is not expected.

6. **Possibilities of Substitution:**

The pyrite is fully substituted by the elementary sulphur.

TRACE AND RARE ELEMENTS - GERMANIUM

1. Mineral Characteristic:

A coals containing germanium occure in the Czech Republic. A concentration of germanium takes place during the combustion of this kind of coal in the form of so called fly ashes, which are trapped in chimney filters. The germanium is obtained from these fly ashes by chemical methods and then refined by classical method.

2. Domestic Production and Use:

The germanium production from domestic coal and its refining were introduced in a half of 1950s, in the period of an embargo on germanium import. Later on, after liberization of the world trade, domestic germanium production was terminated.

3. Production Tendency:

Domestic minerals are not utilized.

4. Deposits and Reserves:

In the Czech Republic there were 12 deposits of the coal containing germanium registered at January 1, 1993, none of them is utilized. The quantity of registered reserves is given in a following table.

Data in metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Germanium	0	0	619.6	0.7	2,710.1

5. Assumed Trend:

The restoration of utilization of domestic resources is not considered. The world germanium consumption is decreasing and prices of germanium are at a low level.

6. Main World Producers:

The world-wide production of the germanium was at about 76 metric tons in 1990. The data concerning main world producers are not available.

7. Possibilities of Substitution:

Germanium is substituted by metallic silicon in semiconductor technics and by other elements in infrared optics.

FUELS

RADIOACTIVE ORES

URANIUM ORE

1. Mineral Characteristic:

A uranium is a radioactive element with a decay half-life period of $4.5 . 10^9$ years. In a pure state it is white , gloss metal melting at the temperature of $1,133^{o}$ C, with boiling-point $3,500^{o}$ C and volume mass 19.0 - 19.6 g/cubic cm.

The uranium content in earth crust (klark) is $4 . 10^{-4}$%. The important possesion is the natural radioactivity of its isotopes.

In the nature several tens of minerals contain uranium (mostly oxygenous compounds), of them oxides and combined oxides, phosphates and organic compounds are economically the most important ones.

The uranium ore (uranite) was extracted in Bohemia already in the 19th century as a raw material for manufacturing of uranium colours. Later the uranite from Jáchymov served as the resource of Ra (radium). After the World War II the uranium ore became the strategic raw material thanks to military significance and it has been utilized in nuclear energetics, too.

2. Domestic Production and Use:

In the Czech Republic 1,631 metric tons of uranium (total metal content in mined ore) were extracted in 1992.

Approximately 3/5 of given amount were obtained by mining with use of classical mining methods, the rest by means of chemical way - underground leaching in situ.

The whole production is refined by chemical treatment with the chemical concentrate being a final product. In the Czech Republic there are no capacities for production of fuel cells for nuclear power stations.

3. Production Tendency:

Data in metric tons

	1986	1987	1988	1989	1990	1991	1992
Total production (U content in extracted ore)	2,722	2,723	2,618	2,502	2,243	1,827	1,631

4. Deposits and Reserves:

In the Czech Republic 17 uranium ore deposits were recorded at January, 1, 1993 and only 3 of them are utilized. Perspective deposits are concentrated practically in two areas. There are deposits bounded to sandstones of basal chalk measures - extracted deposits Hamr and Stráž and further deposits Osečná - Kotel and Břevniště. The second area is in Western Moravia, where the deposits of so-called zonal type occure. The third extracted deposit "Rožná" is in that area.

Other deposits are in West Bohemia, where the extraction has been stopped within the framework of suppressing programme. There are registered reserves also in a number of

deposits bounded with tertiary sediments in the area near to range "Krušné hory". In a view onf small reserve volume the utilization of those deposits is not assumed in a near future. The volume of recorded reserves of uranium metal is given in a following table:

Data in metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Extracted	46,153	0	30,781.5	101.4	19,031.9
Unutilized	1,613.7	0	19,842.2	93.9	26,122.9

5. Assumed Trend:

The trend of uranium consumption in the Czech Republic derives from the assumption of long-term stabilized operating of nuclear power station Dukovany and introduction of nuclear station Temelín (after 1995). In view of a fact that in former ČSFR uranium was extracted only at the territory of the Czech Republic, it comes to uranium hyperproduction in the Czech Republic after dividing of federation, in comparison with needs of own nuclear energetics. Simultaneously with the programme of suppression of redundant capacities, which should be achieved also by closing of non-effective mines, the Government has decided to purchase a part of uranium production for the state reserves.

The Czech Republic is able to fulfil the demands of its own nuclear power stations by domestic production at least up to year 2000. The following development depends on adopted conception of the energy policy.

HARD COAL

1. Mineral Characteristic:

A hard coal is the sedimentary rock mostly of phytogenic origin, which passed through hard coal stage of carbonizing process. The main components of hard coal are the gloss component (vitrite), the mattly gloss component (clarain) and the matt component (durain). A carbon content in the mass is varying between 75 - 80%.

The hard coal is a coal with heating value (calorific value) at ash-free base higher than 5,700 Kcal/kg, but with impurities and average reflection of vitrainity at least 0.6.

The hard coal with quality making production of coke for metallurgical use possible is defined as the coking coal. Other kinds of hard coal are designated as the steam coal.

Economically the most important hard coal accumulation are located in the Czech part of Upper Silesian coal basin. There are smaller deposits in Middle Bohemia region (basin Kladno - Rakovník), in West Bohemia (basin Plzeň -Radnice) and in Eastern Bohemia region (the Czech part of Lower Silesian coal basin). Mining in "Rosice - Oslavany" coal-field was stopped in 1991.

2. Domestic Production and Use:

In the Czech Republic 24,691 thousand metric tons of hard coal were extracted in 1992; it is 95.81% in comparison with 1991.

Decisive amount of the hard coal (89,66%) was extracted

in the Czech part of Upper Silesian coal basin in mines of stock company (S.C.) "Ostravsko - karvinské doly" and state enterprise (S.E.) "Důl Československé mládeže". Greater part of mined raw material was treated for coking coal, the rest for steam coal. The coal was mined at Mine "Kateřina" and at suppressed Mine "J.Šverma" (S.E. Východočeské uhelné doly) in the Czech part of Lower Silesian coal basin, at Mine "Tuchlovice" and Mine "Kladno" in Middle Bohemian (Kladno - Rakovník) coal basin and by S.E." Západočeské uhelné doly" in Plzeň coal basin. The steam coal was mined in coal-fields named above. The coal suitable for coking (ca 75%) as well as the steam coal are produced after treatment from mined raw material in the Czech part of Upper Silesian coal basin. Approx.34% of total coking coal production was exported (ca 50% of that to Slovak Republic). Sorted kinds of the steam coal are supplied for the household use and for the industry; the steam coal dust is utilized in energetics.

3. Mining Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Hard coal	35,451	34,935	30,714	25,769	24,691

4. Deposits and Reserves:

In the Czech Republic 73 hard coal deposits were registered at January 1,1993 and 26 of them are utilized. A review of the utilization of deposits is given in

a following table:

Basin	Number of Deposits		
	Total	Utilized	Not utilized
Czech part of Upper Silesian basin	41	18	23
Lower Silesian basin	5	1	4
Sub-Krkonoše (Sub-Giant Mountains) basin	1	0	1
Plzeň - Radnice	8	1	7
Middle Bohemian	17	6	11
Mělník	1	0	0

Recorded reserves:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Total	1,913,215	848,159	5,472,737	929,800	3,920,925
Utilized	1,414,446	659,199	2,377,168	564,957	1,206,290

5. Assumed Trend:

Government of the Czech Republic adopted coal industry restructuralization programme in December 1992. Suppressing programmes of several non-profitable mines in Ostrava part of OKR (Ostrava - Karviná coal-field), in the Czech of Lower Silesian and Plzeň basins and in choiced fields of coal-field Kladno were initiated in 1992.

A decrease in domestic metallurgical industry demand for coking coal, except of a decrease in a mining volume, was

compensated partly by export. By 1996 further decrease of production of coaking coal at about 2.0 million metric tons is expected.

A mild increase in a mining volume of steam coal is expected.

6. Main World Producers:

The world-wide production of hard coal in 1991 was 3,423 million metric tons.

This amount was divided among:

OECD Countries	1,240 million metric tons, i.e.	36.22%
from this:		
U.S.A.	822	24.01%
Australia	168	4.91%
Germany	73	2.13%
Countries - Non-members of OECD	2,183 million metric tons, i.e.	63.77%
from this:		
China	1,086	31.73%
former U.S.S.R.	409	11.95%
European Non-members	166	4.85%
from this:		
former Č.S.F.R.	19.5	0.57%
Poland	148	4.32%

In 1992 hard coal was imported to the Czech Republic from Ukraine, Russia and Poland, in majority for prices having dumping character.

7. Possibilities of Substitution:

It is impossible to substitute coal suitable for coking in a production of metallurgical or heating coke.

It is possible to substitute steam coal by other kind of fuel, namely by liquid (crude oil and its derivatives and gaseous ones (natural and synthetic gases).

A decrease of domestic demand higher than expected by scenario of the Czech Republic energetic policy might cause acceleration of an unprofitability reduction programme and consequently suppression and liquidation of mines with low profitability, bringing all economic, technical and social consequences.

BROWN COAL

1. Mineral Characteristic:

The sedimentary rock mostly of phytogenic origin, which passed through brown coal stage of carbonizing process is designated as a brown coal. The three main components of the brown coal humines are the detritic, xylitole and mineral charcoal components. A carbon content in the mass is varying between 65 - 70%.

The brown coal is non-caking coal with heating value (calorific value) less than 5,700 Kcal/kg, containing more than 31% of volatile matter based on dry mineral matter.

The brown coal is used particulary in energetics, sorts with higher quality for household supply and for industrial use.

The most important brown coal deposits in the Czech Republic are in Northern Bohemia and in Sokolov brown coal basins.

2. Domestic Production and Use:

In the Czech Republic 68,100 metric tons of raw material were extracted in 1992; i.e. 89.6% in comparison with the year 1991.

A substantial amount of the brown coal (80.0%) was extracted at mines of Northern Bohemia brown coal basin (SHR). The coal production is provided by 6 state enterprises, 5 of them work by quarrying and 1 by mining.

A mayor part of extracted coal is crushed and as

a single-purpose steam coal creates a final product which is supplied into the system power stations. A part of extracted coal is treated, sorted and then supplied for household use, common range and industry as sorted coal of higher quality (around 22%).

The extraction in Sokolov basin (SR) is provided by two enterprises. Approximately 48% of coal production were determined for energetics, 24% for industry, 18% were supplied into market funds and approx. 10% were exported.

3. Mining Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Brown coal production					
- totally	91,747	86,974	78,391	75,988	68,100
from this SR	18,956	17,774	16,268	15,700	15,022
SHR	72,791	69,200	62,123	61,288	53,078

4. Deposits and Reserves:

In the Czech Republic 83 brown coal deposits were registered to January 1, 1993 and 21 of them are utilized. Review of the utilization of deposits is given in a following table:

Basin	Number of Deposits		
	Total	Utilized	Not utilized
Sokolov basin	15	6	9
Northern Bohemia	65	15	50
Cheb	2	0	2
Žitava	1	0	1

Recorded reserves:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Total	3,092,381	1,461,094	955,253	1,253,307	4,485,884
from that:					
Cheb basin	0	28,731	0	1,036,126	100,077
Sokolov basin	357,247	125,312	136,861	56,194	480,305
North Bohemian basin	2,734,954	1,307,051	818,392	160,987	3,788,961
Žitava basin	0	0	0	0	116,541

5. **Assumed Trend:**

Although volume of brown coal production has permanently decreasing tendency brown coal still remains the dominant primary energetic source after the horizont of the year 2000. According to the Energetic Programme of the Czech Government, the demand in 1995 is expected at the level of 51 - 54 million metric tons, in 2000 at the level of 43 - 48 million metric tons of the brown coal and lignite.

A progress in reconstruction and desulphurization programmes of system power stations in Northern and West Bohemia, coal prices development as well as transport costs will have decisive influence on the development of the demand.

6. Main World Producers:

The brown coal is not tradeable goods in the world-wide scale. Total world-wide production of brown coal in 1991 was at 1,052.2 million metric tons. This amount was divided among:

- OECD countries approx. 559 million metric tons, i.e. 53.1%

European Countries

Non-members OECD approx. 287 million metric tons, i.e. 27.3%

from this:

Bulgaria	approx. 29 million metric tons,	i.e. 2.7%
Czech Republic	approx. 76 million metric tons,	i.e. 7.2%
Poland	approx. 70 million metric tons,	i.e. 6.6%

7. Possibilities of Substitution:

Brown coal has the significant position in the structure of fuel and energetic resources. Scenarios of energetic economy anticipate brown coal and lignite production to be at level of 41 - 54 million metric tons in the year 2005.

Possibilities of brown coal substitution are differentiated according to the kind and the way of utilization. It is possible to substitute it by another primary sources, especially by nuclear fuels, in energetic industry.

But this substitution is associated with considerable investment costs, environmental and other problems.

Substitution of the brown coal by the hard coal in some

power stations and in district heating plants is considered. Chances of increasing the hard steam coal mining in the Czech Republic are , however, limited.

It is possible to substitute brown coal by gaseous and liquid fuels in common range, smaller industrial sources and in household use.

LIGNITE

1. Mineral Characteristic:

A sedimentary rock mostly of phytogenic origin, which passed through the lowest brown coal stage of carbonizing process is designated as a lignite. It is defined as the non-caking coal with heating value (calorific value) less than 4,165 Kcal/kg.

There is a significant accumulation of the lignite in South Moravian basin in the Czech Republic . Smaller deposits in basin Žitava (Northern Bohemia) and in Southern Bohemia basin have already been extracted or their opening would not be profitable nowadays.

2. Domestic Production and Use:

In the Czech Republic 1,419 thousand metric tons of lignite were extracted in 1992; i.e. 94.6% in comparison with 1991. The lignite is extracted at 3 departments of S.E."Jihomoravské lignitové doly Hodonín". Extracted raw material is crushed and sorted. The sorted kinds are utilized in common range and for household use, crushed lignite is utilized as fuel in energetics.

3. Mining Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Lignite production	2,214	1,972	1,814	1,500	1,419

4. Deposits and Reserves:

In the Czech Republic 20 lignite deposits were registered to January 1, 1993 and three of them,being situated in The South Moravian basin are are utilized. The state of reserves is given in a following table:

Data in thousand metric tons

Basin	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
South Bohemian	5,322	1,377	2,101	143	34,508
Žitava	4,386	1,934	4,929	4,931	6,759
South Moravian	153,592	61,118	261,162	97,553	152,655
Total	163,300	64,429	268,192	102,627	193,922

5. Assumed Trend:

The Government of the Czech Republic adopted coal industry restructuralization programme in December 1992. Non-profitable departments of mines in the South Moravian coal-field will be suppressed and liquidated in the nearest future. The major part of extracted raw material is utilized in power station Hodonín. This power station has to be reconstructed and one part of it transferred to combined heat production, so decreased level of demand might be anticipated.

A portion of sorted sorts for household use will be significantly affected by transfer of households and common range to gaseous fuels.

6. Main World Producers:

The lignite is not tradeable goods neither in world-wide scale nor in European scale. Volume of its production is included to the production of the brown coal in some countries.

7. Possibilities of Substitution:

The volume of lignite production forms only a little part of the production of energetic sorts of solid fuels. Its substitution in fuel- energetic balance is possible; partly by the brown , partly by the hard coal. It would be necessary to estimate profitability of transport with respect to regional restrictions of lignite utilization.

Substitution by means of gaseous and liquid fuels is possible, similarly with other kinds of solid fuels.

OXIHUMOLITE

1. Mineral Characteristic:

Oxihumolite is a sedimentary rock mostly of phytogenic origin, which after passing through the carbonizing process was exposed to the influence of external conditions.

It is very little suitable as a fuel. With respect to higher contents of humic matters it is used in production of humic acids and their salts and also as a substrate for reclamations.

The raw material is found in hanging walls of seams in some parts of Northern Bohemia brown coal basin.

2. Domestic Production and Use:

In the Czech Republic two thousand metric tons of oxihumolite were extracted in 1992.

The only deposit, where the raw material is extracted, is at "Želénky" in Northern Bohemia brown coal basin.

Extracted raw material is chemically processed, humic acids are isolated by means of extraction; their solution is used in agriculture (stimulator of growth, rooting, admixtures for fertilization), for production of water-soluble thinning agent and for production of beauty products (cosmetic preparations). With respect to possibilities of wider utilization of humic acids, a research has been carried out of further utilization of preparations in environmental range.

3. Mining Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Oxihumolite production	4	5	7	2	2

4. Deposits and Reserves:

In the Czech Republic only one oxihumolite deposit was recorded at January 1, 1993.

The state of recorded reserves is given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Total	0	139	603	857	250

5. Assumed Trend:

Since 1991 the production has significantly decreased in consequence with reduced demand, particulary in the agricultural sector.

With respect to favourable features of final products increase of the demand up to previous level may be expected, although similar production programs are being developed in Ukraine, Italy and Slovakia.

6. Main World Producers:

The oxihumolite is not tradeable goods on the world market. Its extraction in Ukraine and Scotland is known from literature .

A fertilizer with humins made of lignite is produced at deposit Záhorie (Gbely) in Slovakia.

7. Possibilities of Substitution:

Possibilities of the substitution of oxihumolite have not been researched with respect to very small output volumes and limited possibilities of final products manufacturing.

PETROLEUM

1. Mineral Characteristic:

A petroleum is a liquid, most often yellow-brown, dark brown up to black in colour. Its volume mass is varying between 0.75 and 1.0. Average carbon content varies between 80 and 87.5%, the hydrogen content between 10 and 15%. The heating value (calorific value) varies between 9 and 11 thousands kcal/kg.

The petroleum belongs among liquid hydrocarbons. Petroleums are divided into paraffinic, naphthenic and aromatic ones according to contents of hydrocarbons.

The petroleum occures in the Czech Republic first of all in Vienna basin, where it has been extracted on the Moravia-Slovakia and Moravia-Austria borderland in surroundings of town Hodonín since the beginning of this century. A petroleum of following basic types has been extracted: extra-light paraffinic, light-heavy paraffinic-naphthenic, respectively naphthenic- paraffinic and very heavy naphthenic.

2. Domestic Production and Use:

In the Czech Republic 80 thousand metric tons of petroleum were extracted in 1992; i.e. 112.5% in comparison with the year 1991.

The whole petroleum production is supplied from deposits at Southern Moravia, where the S.C. "Moravské naftové doly Hodonín" (Moravian Petroleum Wells Hodonín) provides the

extraction.

With respect to its higher quality, extracted petroleum is processed in qualified chemistry, cosmetics, pharmacy and others.

Domestic petroleum production presents approx. 1.0 - 1.1% of the whole petroleum consumption.

3. Mining Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Petroleum production	48	45	47	64	80

4. Deposits and Reserves:

In the Czech Republic 17 petroleum deposits were registered at January 1, 1993 and 12 of them are utilized.

A volume of recorded petroleum reserves is given in a following table:

Data in tousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Extracted	7,370	0	492	0	7,351
Not extracted	3,854	0	43,298	0	809
Total	11,224	0	44,090	0	8,160

5. Assumed Trend:

The level of petroleum reserves in demonstrated deposits allows increasing of the present level of utilization.

The state of reserves, however, does not allow to thing about more considerable forcing of domestic resources in liquid fuels balance.

At the present time, liquid fuels form approx.13%stake in structure of primary energetic resources. The Czech Republic is dependent on petroleum import. Approx. Seven million metric tons of petroleum were processed to cover the consumption in the Czech Republic; this level will probably not change in the nearest period. Full covering of heating oils consumption requires supplies from the Slovak Republic. Situation is similar in the range of engine fuels. Processing capacities allow processing of approx.10 million tons of petroleum, therefore the construction of petroleum pipe line from Ingolstadt is being prepared.

NATURAL GAS

1. Mineral Characteristic:

A natural gas is a natural gaseous hydrocarbon. Purely methanic types (more than 90% of methane) prevail in conditions of the Czech part of the Vienna basin, which are connected with petroleum genesis. They occure in deposit accumulations either separately (southern basin part) or accompaning petroleum deposits (central and northern part).

The natural gas of Carboniferous type is extracted in the Czech part of Upper Silesian basin, which is obtained by degasation of coal-bearing rock covers and by degasation of mining parts of mines.

2. Domestic Production and Use:

In Czech Republic 132 million cubic meters of natural gas were extracted in 1992; i.e. 105.6% in comparison with the year 1991. Domestic production presents approx. 2% of the whole consumption.

Total production of domestic raw material is supplied into the network of superior gas-manufacturing system. Degased Carboniferous natural gas is supplied into the network of "Severomoravské plynárny" (North Moravian Gasworks) and for direct consumption in the region Ostrava - Karviná.

3. Mining Tendency:

Data in million cubic meters

	1988	1989	1990	1991	1992
Production	113	125	125	125	132
Import (bil. cubic meters)	11.2+	12.3+	12.3+/ 6.2	6.7	5.94

Note: Data marked "+" are given for former Č.S.F.R.

4. Deposits and Reserves:

In the Czech Republic 44 natural gas deposits of petroleum and Carboniferous types were registered at January 1, 1993 and 17 of them are utilized. The state of recorded reserves is given in a following table:

Data in million cubic meters

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Total	1,552	2,887	15,183	2,516	1,238
Extracted	1,202	851	858	47	330

5. Assumed Trend:

The state of prospected reserves and the state of deposits with the construction of extraction capacities form the assumption for increasing of domestic natural gas production. The energy policy of the Czech Republic, adopted in 1991, anticipates the domestic production of 0.26 billion cubic meters already in 1995. Natural gas import would increase from present level to 8.6 - 9.5 billion m^3 in 1995 and further by 1.8 billion m^3 in the year 2000.

Total natural gas consumption in the Czech Republic will be covered by import from Russia approx. at the level of 70% in the year 2000, by the year 1995 import from Algeria is assumed to begin, and by the import from the Northern Sea region in the period around the year 2000.

At present, possibilities of Carboniferous natural gas extraction in the Czech part of Upper Silesian basin are being researched; this gas would be obtained by means of hydraulic splitting of coal seams.

INDUSTRIAL MINERALS AND ROCKS

FLUORSPAR AND BARITE

1. Mineral Characteristic:

Fluorspar (CaF_2) crystallizes in cubic system. Its specific mass varies between 3.01 - 3.6. Hardness is 4 according to Mohs. Barite ($BaSO_4$) is a rhombic mineral with specific mass up to 4.5 and hardness between 3 - 3.5 according to Mohs.

Both minerals occur in deposits very often together.

In the Czech Republic there are economic significant deposits in regions of Krušné hory, Krkonoše, Železné hory and in region Lužice of the Czech Cretaceous basin. The absolute majority of deposits is of the vein type, exceptionally of impregnation or stratified types.

2. Domestic Production and Use:

In the Czech Republic 42 thousand metric tons of fluorspar-barite raw material and 22 thousand metric tons of fluorspar were extracted in 1992. The whole domestic production as well as imported raw material are processed in Sobědruhy near Teplice by means of gravitational dressing, heavy-media dressing and flotation. The barite output from the Czech deposits has only a little significance. Metallurgy is the main consumer of lump fluorspar, flotated fluorspar is used in a production of hydrofluoric acid , for production of glass, enamels, welding electrodes etc.

Barite is used in glass industry for glaze production, as a filler, radiation shielding, weighting agent in drilling

fluids etc.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
F-Ba raw material	28	113	38	29	42
F- utility component	14.2	44.6	18.5	31.7	22.0
Ba- utility component	0.3	1.8	1.0	1.0	0.0

4. Deposits and Reserves:

In the Czech Republic nine fluorspar-barite raw material deposits were registered to January 1, 1993, four of them are utilized as well as eight deposits of barite, four of them are utilized and eight barite-utility component deposits, two of them are utilized (no mining in 1992),. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
F-Ba raw material	1,673.0	105,0	9,018.0	4.0	1,691.0
F-utility component	900.9	56,5	2,387.0	2.1	283.0
Ba-utility component	43.6	0,0	2,372.5	0.0	911.3

5. Assumed Trend:

Production of the barite is stable worldwide, on the contrary fluorspar production has decreasing tendency.

A stagnation of fluorspar production may be expected. Production of the barite is negligible .

6. Main World Producers:

Main producers contribute to the world fluorspar production of approx. 3,600 thousand metric tons in a following way:

China 36%
Mongolia 11%
Former U.S.S.R. 8%
Mexico 8%
Rep. of South Africa ... 7%

Main producers contribute to the world barite production of approx. 5,200 thousand metric tons in a following way:

China 35%
India 10%
U.S.A. 10%
Former U.S.S.R. 8%
Morocco 7%

7. Possibilities of Substitution:

In metallurgy it is possible to substitute fluorspar by dolomitic limestone or other admixtures in some cases. It is

possible to substitute barite, used as a heavy media, by magnetite or ilmenite, when used as a filler it can be replaced by carbonate, and as a component of special glass it can be replaced by strontium compounds.

GRAPHITE

1. Mineral Characteristic:

Graphite (elementary carbon) crystallizes in hexagonal system. It is an electrical conductor, melting point is 3,650°C, it is stable and chemically inert at a normal temperature. Graphite volume mass varies between 2.1 - 2.3; hardness is between 1 - 2 according to Mohs.

Graphite accumulations having economic significance in the Czech Republic occure in variegated units of Moldanubian and Silesicum.

They are all deposits of metamorphous origin with considerably complicated structure.

2. Domestic Production and Use:

In the Czech Republic 20 thousand metric tons of graphite raw material were extracted in 1992, both amorphous (microcrystalline) graphite with particles size up to 0.1 mm and crystalline (flake) one, mostly small flake (size from 0.1 to 0.2 mm) and middle one (size from 0.2 to 0.3). Number of deposits contains both types of raw material (mixed type).

The graphite raw material is after crushing and grinding beneficiated by multi-stage flotation into concentrates containing 70 - 92% of Graphite. Small part of production is refined and product containing more than 99,5% of Graphite obtained.

Graphite is used in production of electrodes, pots, as refractory material, in foundries, as filler, in production

of coating compositions, pastes, special lubricants for sliding bearings, in manufacturing of pencils etc.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Total graphite production	59	66	39	47	20
From this: amorphous	28	34	13	30	13
crystalline	31	32	26	17	7

4. Deposits and Reserves:

In the Czech Republic six deposits of amorphous graphite were balanced to January 1, 1993, two of them are utilized, and three deposits of crystalline graphite, two of them are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Amorphous graphite	1,277	183	1,110	149	2,090
Crystalline graphite	701	37	2,466	0	6,549

5. Assumed Trend:

Nowadays domestic demand has a decreasing tendency. Export is decreasing too. This fact is in correspondence with the world-wide trend.

6. Main World Producers:

Main producers contribute to the world graphite production of approx.613 thousand metric tons in a following way:

China	approx. 21%	(estimated)
Southern Korea	approx. 16%	
India	approx. 10%	
Brazil	approx. 5%	
Mexico	approx. 5%	

7. Possibilities of Substitution:

There is a number of substituting materials but none of them can substitute natural graphite in the whole scale of use. A kerosene coke is used (e.g. together with olivine) as a substitution in foundries, anthracite, synthetic graphite or recycled materials from carbon electrodes are also used. MoS_2 is used as a lubricant.

PYROPE BEARING ROCK

1. Mineral Characteristic:

Pyrope ($3MgO \cdot Al_2O_3 \cdot 3SiO_2$) became famous , as a Bohemian ruby all over the world , thanks to its flaming red colour. It is a mineral crystalling in the cubic system and having specific mass 3.5-4.0 and hardness about 7 according to Mohs.

It is economically minable only from polygenetic, mostly diluvial - fluvial sediments of Quartenary age. Those sediments are spatially related to Tertiary volcanic activity of basalt chemism. Clayey weathered chimney breccia with pyrope content is also among balanced deposits.

2. Domestic Production and Use:

Pyrope is used exclusively in the jewellery industry. All the pyrope production is processed in the Czech Republic.

After separation and removal of big boulders by sieving, pyrope bearing rocks are treated on jigs to form the concentrate, which is further manually sorted in grain sizes 2.0 - 8.0 mm.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Pyrope bearing rock	80	66	55	31	45

4. Deposits and Reserves:

In the Czech Republic 5 pyrope bearing rock deposits were registered to January 1, 1993, one of them is mined. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Pyrope bearing rock	2,258	1,578	11,661	1,273	2,197

5. **Assumed Trend:**

As it is apparent from the production tendency in a monitored period, the pyrope production is considerably varying. This state is affected by number of factors and it is difficult to judge extent of their influence.

6. Main World Producers:

Pyrope for jewellery fabrication is extracted in several other countries. Volume of their production is not available.

7. **Possibilities of Substitution:**

It is possible to substitute pyrope in jewellery fabrication by several other minerals.

MOLDAVITE BEARING ROCK

1. Mineral Characteristic:

At present hypothesis prevails that moldavites are terrestrial rocks remelted by the impact of big meteors. From the chemical point of view moldavites are silicate glasses with variable composition. They occure with different shades of green colours, in interesting shapes and they have remarkable surface shaping.

Ecomically interesting moldavite accumulations occure in Southern Bohemia either in the upper Miocene sandy clay or in the Pliocene gravel sand, which creates the oldest denudating residues of the river Vltava terraces and its tributaries.

2. Domestic Production and Use:

Organized moldavite extraction has begun in 1991. No production was reported in 1992. Moldavites were collected in tens of localities for a long time in the past.

An attractive look predetermines moldavite for use in jewellery and makes them object of collectors' activity.

3. Production Tendency:

Data in cubic meters

	1988	1989	1990	1991	1992
Moldavite bearing rock	0	0	0	6,480	0

4. Deposits and Reserves:

In the Czech Republic three deposits of moldavite bearing rock were registered to January 1, 1993, none of them is mined. Reserves are given in a following table:

Data in cubic meters

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Moldavite bearing rock	0	0	117,633	0	0

5. Assumed Trend:

With respect to a very short history of organized extraction and the fact that moldavite is positively stylish material, it is very difficult to estimate tendency of its production. It is not possible to estimate what part of the market will be saturated from individual collectings.

6. Main World Producers:

Moldavites have exceptional position in the rank of world tectites. There is no other producer than the Czech Republic.

7. Possibilities of Substitution:

No possibilities of substitution are known.

OTHER PRECIOUS STONES

1. Mineral Characteristic:

As other precious stones, deposits with occurrence of amethyst and opal suitable for jewellery and collectors are registered .

2. Domestic Production and Use:

A raw material suitable for jewellery is not extracted.

3. Production Tendency:

The raw material is not extracted.

4. Deposits and Reserves:

In the Czech Republic two other precious stones deposits were registered to January 1, 1993, none of them is utilized. Reserves are given in a following table:

Data in metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Precious stones	0	0	2,089	0	0

5. Assumed Trend:

The extraction at recorded deposits does not seem to be real in the nearest future.

6. Main World Producers:

It is not possible to obtain data concerning production of comparable raw material types.

7. Possibilities of Substitution:

It is possible to substitute opals and amethysts in jewellery by a number of other natural or synthetic precious stones.

KAOLIN

1. Mineral Characteristic:

Kaolin is usually whitish rock, containing kaolinite - $Al_4Si_4O_{10}$ $(OH)_8$ - triclinic clayey mineral. Its specific mass is 2.62; hardness from 1.5 to 2 , according to Mohs.

Following kaoline types are distinguished according to technological characteristics:

- kaolin for china production
- kaolin for ceramics production
- kaolin for paper manufacturing
- kaolin with high Ti content
- kaolin with high feldspar content

Kaolin accumulations with economic significance in the Czech Republic belong altogether to weathering type of deposits, which is characterized by decreasing of kaolinite content with depth and by passage into partially weathering rock in depths around 30 - 50 m. Granitoids of different ages, metamorphous rocks, Carboniferous arkoses and arkosic sandstones are the parent rocks. The kaolinization took a course in Carboniferous system and in Cretaceous system up to Paleogene of Tertiary era. Some of deposits went through both kaolinization phases.

The kaolin deposits are concentrated - from the geographic point of view - especially in regions Karlovy Vary, Podbořany, Kadaň, Plzeň in Bohemia and in region of Znojmo in Moravia.

2. Domestic Production and Use:

A volume of 2,530 thousand metric tons of raw kaolin was extracted in the Czech Republic during the year 1992. Kaolin, having grain size less than 0.02 mm, is the final product of kaolin treatment, after washing and magnetic separation. The content of drifted particles in rock is varying between 10 - 40%. The use of kaolin rock is extremely wide and depends on specific technological characteristics.

Kaolin is used for manufacturing of china, ceramics, paper, as a filler for rubber, plastic materials, colours and paints, in pharmaceutic, cosmetic and food-stuff industries, in production of refractory materials etc.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Kaolin	3,469	3,642	3,455	2,913	2,530

4. Deposits and Reserves:

In the Czech Republic 130 kaolin deposits of different technological types were registered to January 1, 1993. 19 deposits from this number are mined.

Reserves of individual technological types of kaolin are given in following chapters.

5. Assumed Trend:

The world-wide kaolin production has mildly increasing tendency. The trend is opposite in the Czech Republic during the monitored period . It is possible to expect that kaolin production in the Czech Republic will be conformed to trend of the world kaolin production or - at least - the production stagnation.

6. Main World Producers:

Main producers participate in the world production of approx. 27 million tons of washed kaolin in a following way:

U.S.A 35%
England.....12%
Former U.S.S.R.....8%
Columbia 7%
France 5%

7. Possibilities of Substitution:

There is a number of possibilities for kaolin substitution with respect to its utilization in different manufacturing technologies. These possibilities will be listed with the description of individual technological types.

KAOLIN FOR CHINA MANUFACTURING

1. Mineral Characteristic:

Washed kaolin, utilizable for china manufacturing, may content max. 1.6% of Fe_2O_3 + TiO_2 , the rest on the sieve 0.063 mm 2% max. Tensile strength during bending at least 15 kp/ cm^3 (1,47 MPa) is requested, heat resistance at least 33 (Seger cone test). Other requirements include good kaolin liquidity as well as a high whiteness.

The raw material from region of Karlovy Vary is predominantly evaluated as kaolin for china manufacturing.

2. Domestic Production and Use:

A volume of 419 thousand metric tons of raw material for production of kaolin for china manufacturing was extracted in the Czech Republic during the year 1992. As the name of the raw material suggests, this raw material is used first of all for china manufacturing. It is also important as an export commodity.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Kaolin for china manufacturing	559	495	523	441	419

4. Deposits and Reserves:

In the Czech Republic 30 deposits of kaolin for china manufacturing were registered to January 1, 1993. 5 deposits from this number are being utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Kaolin for china manufacturing	46,370	14,362	62,806	19,616	71,631

5. Assumed Trend:

As apparent from the production tendency in the monitored period, the production of kaolin for china manufacturing has permanently decreasing tendency - with except of the year 1990. The extent of decrease is partially compensated by increased production of titanate kaolin with high Ti content in several last years. Slight increase in the production may be anticipated.

6. Main World Producers:

The world statistics register the kaolin production only as a total, not according to individual technological types.

7. Possibilities of Substitution:

No possibility of kaolin substitution in china manufacturing is known at present.

KAOLIN FOR CERAMICS MANUFACTURING

1. Mineral Characteristic:

Kaolin utilizable for ceramics manufacturing has not exactly defined technological properties. Its use in various formulas for ceramics is very extensive.

Raw materials from all the regions are evaluated as kaolin for ceramics manufacturing. Deposits extracted at present are in regions of Karlovy Vary, Plzeň and Kadaň.

2. Domestic Production and Use:

A volume of 14 thousand metric tons of kaolin for ceramics manufacturing was extracted in the Czech Republic during the year 1992. This kaolin type is used in manufacturing of wall tiles, floor tiles, sanitary ware and further kinds of ceramic products. Both washed and raw ones are used.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Kaolin for ceramics manufacturing	93	81	24	33	14

4. Deposits and Reserves:

In the Czech Republic 41 deposits of kaolin for ceramics manufacturing were registered to January 1, 1993. Of them six

deposits are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Kaolin for ceramics manufacturing	23,709	1,256	64,456	4,515	156,367

5. Assumed Trend:

After remarkable decrease in the production of kaolin for ceramics manufacturing in the years 1989 and 1990 and after mild increase in 1991, the drastic production fall has been continuing. End of the fall is anticipated in the next period.

6. Main World Producers:

The world statistics register kaolin products only as a total, not the production of kaolin for ceramics manufacturing separately.

7. Possibilities of Substitution:

It is possible to partially substitute kaolin by wollastonite, talc and by some types of clays.

KAOLIN FOR PAPER MANUFACTURING

1. Mineral Characteristic:

This type of technological kaolin is used in paper manufacturing partly as a filler, partly as a coating kaolin. It is also used as a filler for rubber and plastic materials.

Kaolin used as a filler has to have whiteness of at least 70 (according to Elreph), while a coating kaolin at least 86 (according to Elreph). It is required for a coating kaolin to have 60% of grains with grain size less than 0.006 mm and low silica content. Kaolinfor rubber manufacturing has to contain less than 0.002% of Mn, 0.001% of Cu and 0.15% of Fe.

Registered deposits of the kaolin for use in paper industry exist in all "kaolin" regions. The majority of the present production has its origin in the region of Plzeň.

2. Domestic Production and Use:

A volume of 2,077 thousand metric tons of the kaolin for paper manufacturind was extracted in the Czech Republic during the year 1992.

The majority of production is consumed in paper manufacturing. The minor part is consumed as a filler in another materials. The export of this kaoline type is of great significance.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Kaolin for paper manufacturing	2,750	2,939	2,896	2,393	2,077

4. Deposits and Reserves:

In the Czech Republic 21 deposits of kaolin for paper manufacturing were registered to January 1, 1993. Of them six are mined. Reserves are is given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Kaolin for paper manufacturing	90,503	3,096	300,582	36,476	90,936

5. Assumed Trend:

More remarkable fall in the production came in 1991, which has been lasting ever since. At the present time it is difficult to estimate whether this decrease is linked to utilization of other materials, especially in case of up-to-now traditional importers, or whether it is only a short-period fluctuation.

6. Main World Producers:

Kaolin for paper manufacturing is not registered separately.

7. Possibilities of Substitution:

A substitution of the kaolin in paper manufacturing is possible by means of extremely fine milled limestone or precipitated calcium carbonate. It is also possible to use wollastonite, talc, mica etc. as a filler.

KAOLIN WITH HIGH TITANIUM CONTENT

1. Mineral Characteristic:

Kaolin is designated as a kaolin with high Ti content when the content of TiO_2 is higher than 0.5% in products of washing up.

This type of kaoline occures exclusively in the region of Karlovy Vary. It came into being by kaolinization of "Mountain" granite, because biotite which is contained in this granite has several times higher content of TiO_2 than biotite, contained in auto-metamorphosed granite.

2. Domestic Production and Use:

A volume of 20 thousand metric tons of the kaolin with high Ti content grade was extracted in the Czech Republic during the year 1992. Accomplished tests show that it is possible to treat a part of this type of kaolin by means of magnetic separation to grades of highest quality, which are suitable for china manufacturing.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Kaolin with high Ti content	8	19	12	46	20

4. Deposits and Reserves:

In the Czech Republic 22 deposits of kaolin with high Ti content were registered to January 1, 1993. Of them only two are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Kaolin with high Ti content	31,942	15,323	109,046	76,355	27,456

5. Assumed Trend:

It is possible to designate the production in the year 1991 as anomalous from the point of view of the production tendency in the monitored period. It is difficult to estimate at present to what degree could this raw material - after certain treatments - substitute a kaolin for china manufacturing.

6. Main World Producers:

Are not registered.

7. Possibilities of Substitution:

Considering the kaolin with high Ti content as the raw material which is - after certain treatments - suitable for china manufacturing, then it is unsubstitable.

KAOLIN WITH HIGH FELDSPAR CONTENT

1. Mineral Characteristic:

Kaolin with high feldspar content is a raw material in which nokaolinised feldspar is present in a significant amount.

Deposits of this raw material occure regions Plzeň and Podbořany in Bohemia, but mainly in the region of Znojmo in Moravia. The feldspar content here is explained by the theory that only basal, less kaolinised part of deposits has been reached.

2. Domestic Production and Use:

This kaolin type has presented till the recent past a raw material important for ceramics manufacturing, especially for sanitary ware. Nowadays this raw material is not used.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Kaolin with high feldspar content	59	108	0	0	0

4. Deposits and Reserves:

In the Czech Republic 16 deposits of kaolin with high feldspar content were registered to January 1, 1993. None of

these deposits are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Kaolin with high feldspar content	7,308	918	37,114	777	32,049

5. **Assumed Trend:**

It is difficult to anticipate restoring of the extraction of the kaolin with high feldspar content in a view of an entire situation in processing industry. Anyway, it is possible to state that the kaolins with high feldspar content present significant raw material base for ceramics manufacturing in the distant future.

6. **Main World Producers:**

Are not registered.

7. **Possibilities of Substitution:**

It is naturally possible to substitute the kaolin with high feldspar content by other grades of kaolin.

CLAYS

1. Mineral Characteristic:

Wide range of technologically very different raw materials is classified in this group, which mostly find use in different lines of ceramics manufacturing. The term "clay" is used rather in technological sense of this term, because this group contents even the rocks, having different names in petrographic classification. The uniting element of all raw materials, which are classified in this group, is high clay rocks content of kaolinite group.

Clays are divided in a following way according to technological characteristics and a way of utilization:

- whiteware clay
- fireclay for grog production
- other fire clay
- ceramic clay
- high alumina clay

Clay accumulations with economic significance occur in all sedimentary units of the Czech Republic, aged from Algonkian through Ordovices, Carboniferous and Cretaceous systems, Tertiary up to Quarternary. Several tech- nological types of this raw material are known in a number of deposits.

2. Domestic Production and Use:

A volume of 903 thousand metric tons of clay with different technological characteristics was extracted in the

Czech Republic during the year 1992. The use of individual technological grades is discussed in following parts.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Clays	1,597	1,476	1,409	947	903

4. Deposits and Reserves:

In the Czech Republic 145 clay deposits of all abovetypes presented were registered to January 1, 1993.

Reserves of individual technological clay types are given in following parts together with the description.

5. Assumed Trend:

The domestic clay production shows decreasing tendency during monitored five-years period with significant failure during years 1991 and 1992. It is practically impossible to express any assumption as each processing branch has quite specific development trends.

6. Main World Producers:

It is practically impossible to ascertain main world-wide clay producers. If any data concerning production of clays occurr, then the bentonite production is assigned to clay production in majority of cases, and sometimes also with

the kaolin production.

7. Possibilities of Substitution:

There exists a number of substitution possibilities for individual ways of utilization. They will be discussed together with description of individual technological types.

WHITEWARE CLAY

1. Mineral Characteristic:

A raw material for ceramics manufacturing, having mostly white or light fire colours at temperatures of the firing in range of 1,250 to 1,300°C, is called a whiteware clay. The rest on 0.09 mm seam may be up to 10%. The porosity after firing at the temperature of 1,250°C can reach up to 19% for raw materials of best quality.

The whiteware clay deposits in the Czech Republic are concentrated in sediments of Cretaceous and Tertiary ages.

2. Domestic Production and Use:

A volume of 22 thousand metric tons of whiteware clay was extracted in the Czech Republic during the year 1992.

Raw material is used practically only as a part of mixtures for manufacturing of non-vitrified wall tiles and sanitary ceramics.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Whiteware clay	31	25	30	20	22

4. Deposits and Reserves:

In the Czech Republic 19 deposits of whiteware clay were registered to January 1, 1993. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Whiteware clay	11,575	1,566	15,507	708	21,788

5. Assumed Trend:

The development of domestic production shows variable tendency during the monitored five-year period. The production is more stable in the comparison with other clay types. A stagnation of the production may be expected in the future.

6. Main World Producers:

A volume of whiteware clay production in the world-wide scale is not registered.

7. Possibilities of Substitution:

A substitution of whiteware clay in mixtures for ceramics manufacturing is not registered.

FIRECLAY FOR GROG PRODUCTION

1. Mineral Characteristic:

This raw material gives - after the firing - material suitable for use as a grog in manufacturing of heat-resistant fireclay goods. The highest content of Al_2O_3, the lowest content of Fe_2O_3, high heat-resistance and lowest absorptivity after firing is required. The raw materials of the best quality content - besides kaolinite - also dickite, eventually hydrargillite and böhmite. Accumulations of the fireclay for grog production having economic significance occur in Central Bohemia Carboniferous system, in Central and East Bohemian and Moravian parts of fresh-water Cenomanian sediments.

2. Domestic Production and Use:

A volume of 420 thousand metric tons of the fireclay for grog production was extracted in the Czech Republic during the year 1992.

A part of the raw material is mined by open pits, another part by underground mining, sometimes together with the hard coal seams. The raw material is fired, after grain size treatment, in rotary or shaft furnaces and if need be in charcoal heaps up to sintering. The raw material is crushed and sorted after the firing.

A fired material is used for manufacturing of refractory bricks and shapes, in metallurgy and energetics, in chemistry and glass and ceramics manufacturing.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Fireclays for grog production	970	849	814	479	420

4. Deposits and Reserves:

In the Czech Republic 37 deposits of fireclay for gorg production were registered to January 1, 1993. Of this number 12 are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Fireclay for grog production	128,885	15,661	154,039	199,649	155,740

5. Assumed Trend:

The production of the fireclay for grog production in monitored periodwas decreasing. It is possible to designate the fall in the period 1990 - 1991 as the drastic one. The decrease corresponds with development in industrial branches utilizing the greatest amount of fireclay, especially in metallurgy. Heavy fall was also registred in export to countries of Eastern Europe. A stagnation might be expected in a following period.

6. Main World Producers:

It is impossible to find out production data and main world producers of this clay type.

7. Possibilities of Substitution:

It is possible to substitute the fireclay for grog production with the ones based on andalusite, synthetic mullite etc. It is also possible to use materials made of heat-resistant mineral fibres as substitutions for classical refractory linings of furnaces for ceramics manufacturing.

OTHER FIRE CLAYS

1. Mineral Characteristic:

This raw material is used as a plastic component in the production of heat-resistant goods. The content of Al_2O_3, Fe_2O_3, heat-resistance and the rest on 0.09 mm, 2 mm and 8 mm seams are monitored at clays of that group, besides of the binding power. Clays of this type are used - besides of described use - also as a binding component in various mixtures in ceramic manufacturing.

Deposits of this raw material having economic significance occure in sediments of Cretaceous and Tertiary systems. At present all the extracted deposits are of Tertiary age.

2. Domestic Production and Use:

A volume of 328 thousand metric tons of other fireclays was extracted in the Czech Republic during the year 1992.

Among raw materials belonging to this technological group ther is a number of clays which belong to the best and most wanted trade marks of the clays used for refractory goods manufacturing as well as for ceramics manufacturing.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Other fireclay	384	388	354	294	328

4. Deposits and Reserves:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Other fireclay	65,155	20,631	883,224	13,314	44,193

5. Assumed Trend:

If we do not take into account a deviation in 1991, then the production in the monitored period shows only slowly decreasing trend. It is caused by more massive use of that clay type in ceramic industry together with simultaneous significant decrease in refractory production.

6. Main World Producers:

It is impossible to find out main world producers.

7. Possibilities of Substitution:

It is possible to substitute a part of clays used as plastic components for refractory production by several other raw materials, which are registered as the fireclay for grog production.

CERAMIC CLAY

1. Mineral Characteristic:

In this group there are clays of different technological properties. There are stoneware clay and tile clays as well as clays which are designated as admixture ones (often firing into different colours) and which are used in different recipes of ceramics manufacturing. Among the most important features of those clay types belong the granulometric composition, sinterability, binding power, temperature of deformation in heat, difference between temperature of sintering and that of deformation in heat as well as the acid-resistance.

This group embraces clay deposits of all sedimentary units of Bohemian Massif - from Algonkium to Quarternary age.

2. Domestic Production and Use:

A volume of 133 thousand metric tons of ceramic clay was extracted in the Czech Republic during the year 1992.

They are used exclusively in ceramics industry, especially in a production of different sorts of stoneware, tiles and as admixtures in other ceramics recipes.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Ceramic clay	212	214	242	174	133

4. Deposits and Reserves:

In the Czech Republic 52 deposits of ceramic clays were registered to January 1, 1993. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Ceramic clay	43,009	4,772	253,832	11,638	41,219

5. **Assumed Trend:**

Decrease in the production lasted during a whole monitored period excluding the year 1990. This decrease will probably turn into stagnation in the nearest future.

6. **Main World Producers:**

It is impossible to find out main world producers.

7. **Possibilities of Substitution:**

It is possible to replace stoneware tubes and tanks by products made of plastic materials, tiles by products made of artificial stone. The described clay is, however, absolutely not substitutable in ceramics manufacturing.

HIGH ALUMINA CLAY

1. Mineral Characteristic:

Aluminium bedrock clays occure in a part "Most" of North Bohemia Brown Coal Basin in bedrocks (footwalls) of coal seams. This is the kaolinitic clay, having sometimes content of free aluminium hydrates hydrargillite, which can contain around 40% Al_2O_2, sporadically 3 - 7% TiO_2 and always considerable amount of siderite.

2. Domestic Production and Use:

This type of clay is not extracted. It was considered to be a non-bauxitic source of Al_2O_3 as the tests proved a possibility of such a usage.

3. Production Tendency:

The raw material is not extracted.

4. Deposits and Reserves:

In the Czech Republic two deposits of high alumina clay were registered to January 1, 1993. None of them is extracted. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
High alumina clay	0	0	56,863	38,006	0

5. **Assumed Trend:**

It seems unreal to consider the extraction of this clay type, with regards to present situation in the North-Bohemia Brown Coal Basin and following development of energetic situation in this country, and with their posibble utilization as Al_2O_3 resources.

6. **Main World Producers:**

The references concerning utilization of non-bauxite sources of Al_2O_3 in the world-wide scale are only sporadic. Besides clays, alkaline syenites are also mentioned. It is impossible to find out the world production volumes.

7. **Possibilities of Substitution:**

The mentioned raw material itself is a substitution for bauxite.

MINERAL PIGMENTS

1. Mineral Characteristic:

Rocks weathered in clayish manner, usually with high content of iron, which came into being mostly as a product of repeated kaolinic weathering, are classified as mineral pigments.

The deposits of mineral pigments occure in Carboniferous system of basin "Plzeň" and in its Proterozoic vicinity, in Northern Bohemia Brown Coal Basin as well as in other localities in the Czech Republic.

2. Domestic Production and Use:

No production of mineral pigments was recorded in the year 1992.

Mineral pigments are suitable as covering components for the production of coating compositions, as a colouring agents in ceramics manufacturing, in cardboard manufacturing, in manufacturing of cement goods and floorings.

3. Production Tendency:

No production of mineral pigments has been recorded during the period of last 5 years.

4. Deposits and Reserves:

In the Czech Republic four deposits of mineral pigments were registered to January 1, 1993. None of them is utilized.

Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Mineral pigments	982	4	1,175	124	3,176

5. **Assumed Trend:**

Restoring of the extraction does not seem to be real, with respect to raw material character and demands of exploiters.

6. **Main World Producers:**

Mineral pigments are not monitored as a mineral commodity in the world-wide scale.

7. **Possibilities of Substitution:**

Natural mineral pigments were practically totally substituted by artificial products, which guarantees better stability of colours as well as stable shade and deep.

BENTONITE

1. Mineral Characteristic:

Bentonite can be defined as a residual clayish rock with considerable sorption ability, which is characterized by high value of cation exchange. The sweeling capacity, high plasticity and bonding power are next characteristic features. They are caused by montmorillonite content.

The bentonite accumulations, which came into being by claying of effusives and pyroclastics are bound with region "České středohoří" and eastern and western borders of range "Doupovské hory" in the Czech Republic. Montmorillonitic clays occure in the region "Plzeň" and in Southern Bohemia.

2. Domestic Production and Use:

A volume of 132 thousand metric tons of the bentonite for purposes of foundry industry and 3,000 tons of the bentonite for other purposes was extracted in the Czech Republic during the year 1992. Around 50 - 60% of bentonite designated as bentonit for foundry industry is processed in foundry industry, about 10% in civil engineering and about 15% of bentonite is exported. The specific bentonite features has been only scarcely used for environmental purposes.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Bentonite total	207	168	159	125	135
from this: foundry	207	168	159	121	132
other	0	0	0	4	3

4. Deposits and Reserves:

In the Czech Republic 17 deposits of bentonite for foundries were registered to January 1, 1993. Four of them are extracted. Also 9 deposits of bentonite for other purposes were registered; one of those is utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Bentonite for foundries	44,736	4,204	102,764	8,115	14,923
Bentonite for other purposes	563	0	22,869	59,061	22,068

5. Assumed Trend:

The bentonite consumption has world-wide decreasing tendency. This fact has been put into connection with a situation in petroleum and natural gas extraction and with that in metallurgy. The situation is similar in the Czech Republic. A cause of decrease lies in metallurgy.It is not

possible to estimate at present what an insignificant production increase in 1992 signalizes.

6. Main World Producers:

The world production of bentonite is about 9,7 million metric tons per year. Main producers participate to this amount in a following way:

U.S.A.	32%
Former U.S.S.R.	30%
Greece	12%
Japan	5%
Italy	2%

7. Possibilities of Substitution:

The possibilities of substitution of natural bentonite are relatively limited. It is possible to replace it in some cases of use by several polymers, sometimes other clay materials might be used for substitution of the bentonite.

FELDSPAR

1. Mineral Characteristic:

Feldspars are aluminosilicates of triclinic and monoclinic systems, containing K, Na and Ca. Their specific mass is varying between 2.56 and 2.64 with hardness between 6 and 6.5, according to Mohs . The greatest practical significance among feldspars have orthoclase, albite, and oligoclase.

It is possible to assign the accumulations with economic significance of the feldspar raw material in the Czech Republic to three genetic types:

- feldspar gravel sand
- leucocratic and autometamorphosed granites
- pegmatite bodies.

2. Domestic Production and Use:

There was production of 152 thousand metric tons of the feldspar raw material (ca 75% of feldspar gravel sand) in the Czech Republic during the year 1992.

The greatest part of feldspar production is processed in various recipes in ceramics and glass manufacturing. Low melting point of feldspar is a benefit in this case (ca 1,100 to 1,200^{o}C).

The raw material refining derives from its genetic type. The main goal treatment is to maximally increase the alkali content and minimalize the content of colouring oxides at the same time.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Feldspar	148	139	115	130	152

4. Deposits and Reserves:

In the Czech Republic 36 deposits of feldspar raw material were registered to January 1, 1993. Six of them are extracted. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Feldspar	39,121	1,316	38,843	1,883	5,767

5. Assumed Trend:

Gradual world-wide increase in the demand is assumed for feldspars. In the Czech Republic the adaptation to a world trend may be expected, even despite the ecological pressures for decreasing of a production of the feldspar gravel sand. It is not possible to estimate at present what an inparticular increase in the production in 1992 means for development of the production.

6. Main World Producers:

The world feldspar production is estimated at approx. 5.3 million metric tons per year. Main producers contribute to this amount in a following way:

Italy	28%
U.S.A.	13%
France	8%
Germany	6%
Thailand	6%

7. Possibilities of Substitution:

There is only one extensively used substitution for feldspars as fluxing agents at present - nephelinic syenites (phonolites in the Czech Republic).

PHONOLITE
(FELDSPAR SUBSTITUTION)

1. Mineral Characteristic:

A raw material having a content of alkalies bounded also with rocks other than the feldspar - mostly nepheline - (Na, K)Al SiO_4., may be designated as a feldspar substitution.

Particulary nephelinic syenites are world - wide utilized. In the Czech Republic phonolites are used.

Phonolites are related to Tertiary volcanism in "České středohoří" Mountains in the Czech Republic.

2. Domestic Production and Use:

There were 16 thousand metric tons of phonolite extracted in the Czech Republic during the year 1992.

The raw material contents about 12% of alkali and approx. 2.5% of iron oxides. It is used as a fluxing agent in the cases where high content of colouring oxides does not mind.

The content of colouring oxides may not be, with respect to raw material grain fineness, decreased in a economical way by means of magnetic separation. With respect to a fact that the part of alkalies in this raw material is bonded with nepheline, phonolite as a fluxing agent acts more intensively than feldspars.

Raw material is refined only by milling.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Phonolite	0	11	15	16	16

4. Deposits and Reserves:

In the Czech Republic 3 deposits of the phonolite as feldspar substitution were registered to January 1, 1993. One of those is utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Phonolite	0	0	200,430	0	0

5. Assumed Trend:

Although increase in the demand is expected for nepheline syenite in world-wide scale, it seems that rather stagnation might be expected in case of phonolite, with respect to its limited usage.

6. Main World Producers:

Phonolite as a fluxing agent is not a common raw material . Smaller production amounts are mentioned in French and German literature. The greatest amounts of nepheline

syenite are produced by Norway and by Canada.

7. Possibilities of Substitution:

It is of course possible to substitute the raw materials designated as feldspar substitutions by the feldspar in glass and ceramics manufacturing.

SILICA RAW MATERIALS

1. Mineral Characteristic:

Silica raw materials are petrografically different sorts of rocks with high content of SiO_2 (usually of min. 96%). Tertiary quartzite (=amorphous), silicificated Cretace- ous sandstone (=crystalline quartzite), Ordovician quart- zite, proterozoic lydite and vein quartz occure in the Czech Republic.

2. Domestic Production and Use:

A volume of 46 thousand metric tons of silica raw materials was extracted in the Czech Republic in 1992. The majority of extracted raw material is used in production of ferrosilicon and similar materials, a minor part is consumpted in a production of gannister. Metallic silicon is not produced in the Czech Republic at the present time.

The silica raw materials for manufacturing of special glass (vein quartz) are not extracted in the Czech Republic at the present time for technological and economical reasons. Use of natural raw materials in manufacturing of silica glass, optical fibres etc. has been constantly decreasing.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Silica raw materials	159	185	169	65	46
Silica raw materials for special glass	0	0	0	0	0

4. Deposits and Reserves:

There were 21 deposits of silica raw materials - two of them are utilized - and two deposits of silica raw materials for special glass (both not utilized) registered in the Czech Republic at January 1, 1993. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Silica raw materials	4,178	2,431	22,922	1,415	16,133
Silica raw materials for special glass	144	0	178	0	63

5. Assumed Trend:

The world production of silica raw materials has been slightly but permanently decreasing. The decrease in the Czech Republic is significant. A drastic production fall in 1991 was the consequence of suppression of those industry branches, which use both gannister and ferrosilicon and similar alloys, enamely of metallurgy. It is possible that the decrease will go on, especially in case that the Slovak Republic will not be interested in the Czech raw material.

6. Main World Producers:

The most important producers participate to the world production of 3.6 million metric tons (recalculated to the

content of SiO_2) in such a way:

Former U.S.S.R.	25%
China	20%
U.S.A.	10%
Norway	10%
Brazil	7%

7. Possibilities of Substitution:

In manufacturing of fibre optics SiO_2 is almost exclusively used ; it is possible to substitute gannister by some other linings.

GLASS SAND

1. Mineral Characteristic:

As a glass sand the raw material is designated suitable for manufacturing of white (colourless) glass after corresponding treatment.

Glass sand deposits in the Czech Republic belong to Turonian or Lower Senonian sediments of the Czech Cretaceous Basin, the sole deposit is bound to a Pliocene gravel sand of "Cheb" Basin.

A part of raw material in deposits, which does not meet glass manufacturing requirements, is utilized as foundry sand.

2. Domestic Production and Use:

Totally 888 thousand metric tons of glass sand were extracted during the year 1992. This sand presents the basic raw material for all branches of glass manufacturing in this country.

The sand is - after crushing and grinding - treated according to grain size by means of water grading and then the content of coloring oxides in utility fraction is reduced by various methods.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Glass sand	1,150	1,045	1,181	918	888

4. Deposits and Reserves:

There were five deposits of glass sand - four of them are utilized - registered in the Czech Republic to January 1, 1993. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Glass sand	88,506	3,465	81,917	1,083	95,576

5. Assumed Trend:

The glass sand production is designated as stagnating in world-wide point of view. It is possible to await stagnation or mild production decrease in the Czech Republic too. It was manifested already in last two years of monitored period.

6. Main World Producers:

The world statistics does not register production of glass sands separately from production of sands for other

use. About 121 million metric tons of quartz sand is produced world-wide per year.

Main producers participate to this production in a following way:

U.S.A.	21%
Netherlands	21%
Argentine	8%
Germany	6%
Japan	4%

7. Possibilities of Substitution:

It is possible to substitute quartz sand eg. by vein quartz in a glass manufacturing.

FOUNDRY SAND

1. Mineral Characteristic:

Raw materials directly or after a treatment suitable for manufacturing of foundry moulds and cores are designated as foundry sands. We may distinguish sands similar with grog, which are completed with plastic components to create the mixture with requested characteristics, and natural sands, which contain sufficient amount of clayish component. Interest in natural sand decreases with respect to their variability.

Deposits of the Czech Cretaceous Basin (see Glass sands) are the moist important source, further the eolian sand, sand fillings of karst sink holes and other find their use.

2. Domestic Production and Use:

Totally 1.075 thousand metric tons of foundry sand were extracted in the Czech Republic during the year 1992. This production belongs to various types of the raw material, with respect to their characteristics and possibilities of usage. Raw material of highest quality, suitable for casting of cast steel is extracted from Turonian and Lower Senonian deposits of the Czech Cretaceous Basin.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Foundry sand	1,848	1,694	1,577	919	1,075

4. Deposits and Reserves:

There were 37 deposits of foundry sand registered in the Czech Republic to January 1, 1993. 13 of them are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Foundry sand	162,002	18,237	129,190	2,981	186,207

5. Assumed Trend:

Further stagnation or mild decrease may be expected after significant fall during years 1990 and 1991 with respect to the situation in metallurgy.

6. Main World Producers:

The production of foundry sands is registered together with the production of other foundry sands (see glass sands).

7. Possibilities of Substitution:

The foundry sand may be replaced by other minerals, for example by olivine, in some cases.

ABRASIVES

1. Mineral Characteristic:

Sedimentary rocks of Cretaceous and Tertiary ages are designated as abrasives in this case. They are, with respect to their mechanical characteristics, suitable for manufacturing of grindstones for glass grinding. From petrographic point of view abrasives are different sorts of sandstone or sponge-spicule rocks.

2. Domestic Production and Use:

In the past, the extraction of raw materials for manufacturing of grindstones was very extended. Grindstones of different mechanical characteristics were used for grinding of chandelier pendants, glass-jewellery stones and other sorts of glass. At the present time, rocks for grindstone manufacturing are not extracted.

3. Production Tendency:

None of balanced deposits is extracted at present nor was utilized in monitored period.

4. Deposits and Reserves:

There were 3 deposits of abrasive rocks registered in the Czech Republic to January 1, 1993. None of them is utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Abrasives	79	6	32	2	0

5. Assumed Trend:

A renaissance of interest in a domestic raw material is not expected.

6. Main World Producers:

Are not available.

7. Possibilities of Substitution:

This raw material is fully substitable (and in the Czech Republic is substituted) by grindstones made of synthetic materials (diamond, corundum, SiC) or by hybride grindstones where natural material (grog) and organic bond are used.

STAUROLITE

1. Mineral Characteristic:

A staurolite - 2 (Al_2SiO_5) . $Fe(OH)_2$ - is a mineral of rhombic system, having specific mass 3.74 - 3.83 and hardness 7 to 8 , according to Mohs. The melting point is 1,537°C. Very low thermal dilatability is characteristic for the mineral.

Economically interesting accumulations of staurolite occure in the Czech Republic in alluvial deposits in the region "Jeseníky Mts.".

2. Domestic Production and Use:

The staurolite was not extracted in the Czech Republic in 1992.

In a world-wide scale, staurolite is used mainly as an abrasive material , for foundry mixtures in bronze and copper casting, as a filler and correcting component in portland cements. In the Czech Republic it was successfully tested as a part of casting powders for metallurgy.

3. Production Tendency:

No staurolite deposit has been extracted in the Czech Republic.

4. Deposits and Reserves:

There was one deposit of staurolite registered at January 1, 1993 in the Czech Republic. It is not utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Staurolite	0	0	21,648	0	1,043

5. Assumed Trend:

The situation of staurolite on a world market is not available. In the Czech Republic interest in this mineral may be anticipated, according to acomplished market studies.

6. Main World Producers:

It is estimated that approx.99% of a world staurolite production come is from U.S.A. and India. It is obtained mostly as a by-product during the separation of an ilmenite.

7. Possibilities of Substitution:

It is possible to replace staurolite by garnet, olivine, silica sand etc.

WOLLASTONITE

1. Mineral Characteristic:

Wollastonite ($CaSiO_3$) is triclinic, needle-like mineral of whitish colour. Its specific mass is varying between 2.8 and 2.9 and hardness between 4.5 and 5.0, according to Mohs. It is chemically inert, melting point is 1,540°C.

All wollastonite deposits in the Czech Republic are of metamorphogenic origin. They occur in skarne types of varied series of Moldanubian, in series of Arzberg and in paragneisses of group Branná, always in proximity of granitic bodies.

2. Domestic Production and Use:

None of wollastonite deposits was mined in 1992. The whole domestic consumption has been covered by import.

Wollastonite is used in ceramics manufacturing, especially for manufacturing of sanitary and wall tiles, both into body and glaze. It is also used as filler for plastic materials, colours and varnishes , for production of heat-resistant mineral fibres, as a component of casting powders etc.

3. Production Tendency:

Wollastonite deposits has not been extracted in the Czech Republic.

4. Deposits and Reserves:

There were 3 deposits of wollastonite registered at January 1, 1993 in the Czech Republic , which have not been utilized up to now. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Wollastonite	0	0	2,506	400	395

5. Assumed Trend:

The world trend of wollastonite consumption has long-term increasing tendency. A considerable interest may be expected in this mineral from domestic deposits in the Czech Republic, in accordance with a investigation of a demand.

6. Main World Producers:

About 310 thousand metric tons of wollastonite are produced world-wide per year. Main producers share in this production in a following way:

U.S.A. 43%

China ..... 22% (estimation)

India 13%

Finland 8%

Turkey 8%

7. Possibilities of Substitution:

Despite some technological differencies, synthetic $CaSiO_3$ is the only complex possibility of subtitution. It is possible to replace wollastonite by carbonates, kaolin, mica, talc, glass fibres etc.to certain extend in individual cases.

BASALT FOR CASTING

1. Mineral Characteristic:

Basalts used for casting are Tertiary igneous rocks workable by melting to basalt castings. Rocks ussually belong to olivinic basalt up to nephelinic basanite. Technological characteristics are very important for rock applicability, especially good crystallization from melt.

2. Domestic Production and Use:

Totally 107 thousand metric tons of this rock were extracted in the Czech Republic during the year 1992. Approx.30% of this production with unfavorably low grain size is utilized as crushed aggregates, the rest is processed by melting to paving bricks, tubes, knees, branch pipes and a number of other casting forms with unique mechanical properties. These properties also determine use of melting basalt as pavements in heavy works, in coke bins, as tube linings for hydraulic and pneumatic transport etc.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Basalt for casting	178	134	142	72	107

4. Deposits and Reserves:

There were 3 deposits of basalt for casting registered in the Czech Republic to January 1, 1992, one of them is utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Basalt for casting	9,602	0	3,295	0	0

5. Assumed Trend:

A drastic fall in the production in 1991 and its continuing in 1992 has been caused mainly by reduced domestic market. Increase of the production may be expected in the future as products made of melting basalt are quite unique.

6. Main World Producers:

Besides the Czech Rebublic melting basalt is produced in the Slovak Republic, Germany and U.S.A. The production volume is not available.

7. Possibilities of Substitution:

It is possible to replace products made of melted basalt by special alloys or by ceramic and metallic materials combination.

DIATOMITE

1. Mineral Characteristic:

Diatomite (diatomaceous earth) is sedimentary rock, formed largely by tests of diatomaceae. These tests having diameter 5 - 1,000 microns are made of opal. The volume mass of dry rock varies between 200 and 900 kg/ m^3. For the raw the highest content of SiO_2 together with lowest contents of Al_2O_3 and Fe_2O_3 are requested.

Only one economy utilizable deposit is known in the Czech Republic, which belongs to Miocene sediments of Třeboň Basin.

2. Domestic Production and Use:

Totally 57 thousand metric tons of different technological types of diatomite were extracted in the Czech Republic during the year 1992.

Diatomite is used for filtering purposes, as a filler, in cosmetics, for glazing and grinding. The grades of lower quality are used for manufacturing of light constructional elements with excellent thermal and sound insulation properties.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Diatomite	85	80	82	68	57

4. Deposits and Reserves:

There was one deposit of diatomite registered in the Czech Republic to January 1, 1992, which is utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Diatomite	4,824	0	320	8	0

5. Assumed Trend:

The mild increase in the demand continues in a world-wide scale. It seems to be real that the same demand tendency will appear, after temporary demand decrease, in the Czech Republic.

6. Main World Producers:

The world diatomite production is around 1.6 million metric tons per year. Volumes in % are as following:

U.S.A. 40%
France..... 15%
Former U.S.S.R..... 12%
Spain 6%
Denmark 4%

7. Possibilities of Substitution:

It is possible to replace diatomite by expanded perlite, calcinated kaolin, talc or different forms of SiO_2 in some cases of use.

HIGH-GRADE LIMESTONE

1. Mineral Characteristic:

A rock with content of at least 96% of carbonates and of that max.2% of $MgCO_3$ is classified as a high-grade limestone.

An absolute majority of this raw material deposits belong by its age to Silurian and previously Devonian units and only exceptionally to Jurassic resp. lower Cretaceous units.

2. Domestic Production and Use:

4,854 thousands metric tons of high-grade limestone were extracted in the Czech Republic in the year 1992.

This raw material is used in chemistry, in food, rubber and paper industry, in glass and ceramics manufacturing and for production of lime of highest quality. It may be used in desulphurizing processes.

A cement is produced from polluted portions.

Limestones are supplied in lump, crushed or milled to different grades including micro-milling depending on the use.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
High-grade limestone	7,552	8,043	7,407	5,651	4,854

4. Deposits and Reserves:

There were 28 deposits of high-grade limestone registered in the Czech Republic to January 1, 1993 , twelve of them is utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
High-grade limestone	797,571	117,190	661,031	541,114	155,110

5. **Assumed Trend:**

The world consumption of limestone is increasing. Stagnation of the production of limestone in the Czech Republic may be expected even after fading of problems caused by restructuring of economics, especially with respect to the suppression of some industrial branches (e.g. metallurgy) and with respect to growing pressures for the environment protection.

6. **Main World Producers:**

Are not available.

7. Possibilities of Substitution:

It is possible to replace high-grade limestone in some branches, but the substitution does not exist in most cases.

LIMESTONE FOR CEMENT PRODUCTION

1. Mineral Characteristic:

Rocks with carbonate content of min.80% and of that $MgCO_3$ content maximally 15% are classified as limestones for cement production.

These limestones form very heterogeneous group by its geological position and age. Besides paleozoic and mesozoic limestones. deposits of proterozoic age, deposits of varied Moldanubian groups, of Branná and Moravic series also belong to this group.

2. Domestic Production and Use:

5,275 thousands metric tons of the limestone for cement production were extracted in the Czech Republic in the year 1992.

The absolute majority of extracted raw material is processed in cement and lime production. Only slight part of the other limestones production is utilized as a filler or for production of crushed materials.

The treatment of absolute majority of extracted raw materials corresponds to their processing for cement and lime.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Limestone for cement production	7,254	6,585	6,739	4,740	5,275

4. Deposits and Reserves:

There were 57 deposits of the limestone for cement production registered in the Czech Republic to January 1, 1993, 16 of them is utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Limestone for cement production	948,420	63,054	936,981	938,362	439,033

5. Assumed Trend:

It is difficult to estimate the world trend of lime and cement production. The consumption of this raw material is stagnating or slightly decreasing in developed countries, on the contrary, it is rapidly increasing in newly developing countries. A dramatic fall in the extraction in 1991 may be considered as an anomaly

caused by privatization of production capacities besides

other reasons. A mild increase might be expected in the following period.

6. Main World Producers:

Neither producers nor production of this raw material are published world-wide. Only the cement production is registered.

7. Possibilities of Substitution:

The substitution practically does not exist.

CLAY LIMESTONE

1. Mineral Characteristic:

A rock with content of $CaCO_3$ around 70% is designated as clay limestone. Content of SiO_2 is varying between 14 and 20%, content of Al_2O_3 between 4 and 5%.

Deposits of this raw material are in absolute majority coupled with Upper Turonian and Senonian of the Czech Cretaceous Basin in the region of Northern Bohemia.

2. Domestic Production and Use:

958 thousands metric tons of clay limestone were extracted in the Czech Republic in the year 1992.

The raw material is used for manufacturing of hydraulic lime and cement and for desulphurization.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Clay limestone	1,112	1,138	1,054	947	958

4. Deposits and Reserves:

There were 10 deposits of clay limestone registered in the Czech Republic to January 1, 1993, 2 of them are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Clay limestone	120,559	14,993	194,077	6,154	140,778

5. **Assumed Trend:**

A practically general production decrease affected clay limestone only slightly. The volume of the production in 1992 may be considered as a sign of starting stagnation.

6. **Main World Producers:**

Are not available.

7. **Possibilities of Substitution:**

They practically do not exist for lime and cement manufacturing.

LIMESTONE FOR AGRICULTURAL PURPOSES

1. Mineral Characteristic:

Rocks utilizable for treatment of agricultural soils are balanced as limestone for agricultural purposes. A content of 70 -75% of carbonate component is requested ($MgCO_3$ is not limited) as well as the content of SiO_2 max.15%.

This group is very diverse according to the age and geological position. Typical - at least for extracted deposits -is the fact that in majority of cases they form small deposits unutilizable in any other way.

2. Domestic Production and Use:

45 thousands metric tons of limestone for agricultural purposes were extracted in the Czech Republic in the year 1992.

As the name of the raw material indicates, the absolute majority of the production is used for treatment of agricultural soils and forest growth. With respect to the state of soils and forest growth in this country we may suppose that agricultural limestones are only occasionally applied.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
limestone for agricultural purposes	371	511	248	123	47

4. Deposits and Reserves:

There were 26 deposits of limestone for agricultural purposes registered in the Czech Republic to January 1, 1993, seven of them are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Limestone for agricultural purposes	15,761	883	103,833	21,071	26,653

5. Assumed Trend:

The consumption of limestone shows increasing trend in agriculture world-wide. Increase in the production may be expected in the Czech Republic with respect to a necessity to improve the state of land fund and forest growth, even despite the fact that the output in monitored period was rapidly falling with respect to decrease in demand.

6. Main World Producers:

Neither main world producers nor extraction volume of limestone for agricultural purposes are available.

7. Possibilities of Substitution:

Do not exist in economically comparable terms.

CORRECTIVE RAW MATERIALS FOR CEMENT MANUFACTURING

1. Mineral Characteristic:

As corrective raw materials for cement manufacturing, rocks, which modify contents of SiO_2, Al_2O_3 and Fe_2O_3 in mixture for clinker firing and which allow arrange the modules to requested levels, are recorded.

This group of raw materials is extremely diverse from petrographic point of view. It includes paleozoic slates, tuffs and diabases, Tertiary and Quarternary clays, but also cretaceous sands.

The deposit of hydraulic (puzzolane) active sponge-spicule rock is also included into the described group.

2. Domestic Production and Use:

741 thousands metric tons of corrective raw material for cement manufacturing were extracted in the year 1992 in the Czech Republic.This raw material is used solely for modifying of a chemical composition of a raw material for clinker firing.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Corrective raw material for cement manufacturing	969	905	796	650	741

4. Deposits and Reserves:

There were 14 deposits of corrective raw materials for cement manufacturing registered in the Czech Republic at January 1, 1993, seven of them are utilized. Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonsrated		Inferred		
	free	bound	free	bound	
Corrective raw material for cement manufacturing	342,332	2,112	264,200	7,121	162,943

5. Assumed Trend:

The development of corrective raw materials is the same as that of cement manufacturing. Mild production increase may be anticipated in the future.

6. Main World Producers:

Neither main world producers nor extraction volume of corrective raw materials for cement manufacturing are available world-wide.

7. Possibilities of Substitution:

Corrective raw materials are very diverse from petrographic point of view, but they must be of corresponding chemical composition.

GYPSUM

1. Mineral Characteristic:

Gypsum ($CaSO_4 \cdot 2H_2O$) is a monoclinic mineral with specific mass 2.38 and hardness 1.5 - 2.0, according to Mohs.

The gypsum deposits occure in evaporitic formation of Opava Basin in the Czech Republic, where they form a continuous layer in sediments of Miocene age.

2. Domestic Production and Use:

660 thousands metric tons of gypsum were extracted in the year 1992 in the Czech Republic. The major part of extracted raw material is used as admixture for cements, especially for modifying of solidification. Only less than 10% of the production is used in manufacturing of calcined gypsum and prefabricated elements.

3. Production Tendency:

Data in thousand metric tons

	1988	1989	1990	1991	1992
Gypsum	720	720	661	569	660

4. Deposits and Reserves:

There were 5 gypsum deposits registered in the Czech Republic to January 1, 1993, one of them is utilized.

Reserves are given in a following table:

Data in thousand metric tons

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Gypsum	104,459	18,471	223,830	80,160	82,137

5. Assumed Trend:

A trend of gypsum consumption on the world market is manufacturing of gypsum plasters, insulating elements and prefabricated elements made of plaster and cardboard prevails world-wide. The gypsum consumption is mostly bonded with cement manufacturing in the Czech Republic. Therefore mild increase of gypsum production may be expected. In case of implementation of desulphurisation of brown coal power plants significant fall of natural gypsum production, caused by production of byproduct gypsum scrubbed from powerplant stack gases has to be expected.

6. Main World Producers:

Nowadays the world production of natural gypsum is at about 108 million metric tons per year. The main producers participate on this amount in a following way:

U.S.A. 15%

Canada 8%

Iran 8%

China 8%

Thailand 7%

7. Possibilities of Substitution:

Gibsum produced as a by-product during a desulphurisation of combusting gases released during the combusting of fossil fuels, is practically the only product, which can compete with a natural gypsum. The lesser quantity of gypsum comes into being also by utilization of other technologies, for example during production of phosphoric acid.

DIMENSION STONE

1. Mineral Characteristic:

Diverse petrographic range of rocks for rough and noble stone-cutting is classified into this sort of a raw material. Light igneous rocks ("granites"), dark igneous rocks ("syenites"), sandstones, marbles, trachytes, marly limestones, travertine, serpentinite and table slate belong among those raw materials.

It is apparent from the enumeration of petrographic types that geological position of deposits for rough and noble stone-cutting is also very different.

2. Domestic Production and Use:

176 thousands cubic meters of raw material of different petrographic types were extracted in the year 1992 in the Czech Republic. The extraction of blocks in the same period reached 5,100 cubic meters.

Blocks of raw material (with exception of slate) are used for noble i.e. grinded and glazed stone- cuting works. A waste from block extraction and raw material, which does not form blocks is used for rough stone- cutting, especially for manufacturing of paving stones, kerb stones, stone structural elements etc.

3. Production Tendency:

Data in thousand cubic meters

	1988	1989	1990	1991	1992
Dimension stone	213	201	176	198	176
From this blocks	20.8	22.3	20.3	12.0	5.1

4. Deposits and Reserves:

There were 178 deposits of dimension stone registered in the Czech Republic to January 1, 1993. Of them 83 are utilized. Reserves are given in a following table:

Data in thousand cubic meters

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Dimension stone	83,794.8	6,506.89	8,207.7	2314,6	29,872.5

5. Assumed Trend:

A mild decrease in the production of dimension stone (with exception of the year 1991) is apparent in the monitored period. A decrease in the block production in last two years is warning. A mild increase of dimension stone production may be anticipated in the future with respect to the expected development of building activity in the Czech Republic. Development of the block production in a following period is problematic.

6. Main World Producers:

Neither production nor main producers of this commodity are available world-wide.

7. Possibilities of Substitution:

It is possible to substitute dimension stone products by concrete ones. It is also possible to replace the stone for noble stone cutting with an artificial stone, by ceramics and other materials. But the popularity of natural materials dominates the tendency for their substitution.

BUILDING RAW MATERIALS

CRUSHED STONE

1. Mineral Characteristic:

Igneous rocks, metamorphosed as well as sedimentary rocks are used for a production of crushed aggregates (compact aggregates for building purposes). Granitoides, basalts, gneisses, amphibolites, carbonate rocks and greywackes are used most frequently. The explored deposits are created by approx. 25 petrographic types. Igneous rocks (approx.70%) prevail over metamorphosed rocks (20%) and sediments (5%).

A geologic position of stone deposits is very diverse. Deposits of this raw material occure in all geological units of the Czech Republic with exception of youngest sedimentary formations.

2. Domestic Production and Use:

8,412 million of cubic meters of building stone were extracted in the Czech Republic in the year 1992 .

The raw material is crushed and graded into number of individual fractions.The fraction with grain size from 0 to 4 mm is designated as a fine aggregate, the one with grain size above 4 mm as the rough one.

The crushed aggregate is utilized mostly into the concrete, for road building and for railway beds. Its technological characteristics are decisive for possibilities of the utilization for individual purposes.

3. Production Tendency:

Data in thousand cubic meters

	1988	1989	1990	1991	1992
Stone for crushing	18,142	18,030	16,127	9,517	8,412

4. Deposits and Reserves:

There were 348 deposits of stone for crushing registered to January 1, 1993 in the Czech Republic. Of them 198 are utilized. Reserves are given in a following table:

Data in thousand cubic meters

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Stone for crushing	1,193,210	59,303	1,025,260	77,529	128,570

5. Assumed Trend:

A significant decrease in the production in 1991 was a consequence of a significant consumption decrease in "big building trade". This decrease was already signalized by decrease of the production in 1990 and it has still been lasting. Mild production increase may be expected in the future.

6. Main World Producers:

Neither main world producers nor the world production volume is available.

7. Possibilities of Substitution:

It is possible to replace crushed aggregate by gravel sands, in some cases by recycling of building waste.

GRAVEL SAND

1. Mineral Characteristic:

Unconsolidated clastic sediments with grain size from 0.063 to 128.0 mm are designated as a gravel sand. Sediments with grain size up to 4 mm are in technical practice designated as a sand, those having grain size over 4 mm as a gravel. A grain size up to 32 mm is as maximum in used practice. Boulders having larger size are either removed or crushed.

The gravel sands are - from genetic point of view - fluvial and fluviolacustrine, glacial, glaciofluvial and glaciolacustrine sediments, locally with eolic admixtures.

An absolute majority of deposits is of Quarternary age, a minor part is of Neogene age.

The deposits of the gravel sand are unevenly spread all over the territory of the Czech Republic.

2. Domestic Production and Use:

12,722 million m^3 of the gravel sand were extrac- ted in the year 1992 in the Czech Republic. Use of a dry extraction, dredging as well as the combination of both ways is usual.

The gravel sand is used for preparing of concrete mixtures, as drain layers, sub-bases, for bottom courses of roadways and for stabilization. The sand fraction is also used for preparation of plasters, for filtrating purposes and as opening material for brick manufacturing.

3. Production Tendency:

Data in thousand cubic meters

	1988	1989	1990	1991	1992
Gravel sand	26,557	24,746	20,711	12,778	12,722

4. Deposits and Reserves:

There were 205 deposits of gravel sand registered to January 1, 1993 in the Czech Republic. Of them 70 are extracted. Reserves are given in a following table:

Data in thousand cubic meters

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Gravel sand	1,136,473	226,194	741,888	171,689	259,006

5. Assumed Trend:

As with the extraction of other building raw materials, drastic fall in the extraction of the gravel sand appeared in 1991, but had signalized itself already before that. It seems that the production of the year 1992 expresses certain stagnation. A proportion in the production of the two raw materials (in comparison with the world-wide trend) has changed, with respect to further significant fall of the production of the stone for crushing. More of the stone for

crushing than of the gravel sand is extracted in a number of countries. The reasons are - besides of others - mainly ecological. It is possible to declare the same kind of development as desirable in this country.

6. Main World Producers:

Neither main world producers nor world-wide production volume of gravel sands are available.

7. Possibilities of Substitution:

It is possible to replace the gravel sand by crushed aggregates. The substitution of sand is problematic.

BRICK EARTH

1. Mineral Characteristic:

Raw materials suitable for brick manufacturing are formed by varied palette of rocks, particulary by loesses, loams, clay residuums and different types of clay and marls. The age of the deposits is very varying, practically from Paleozoic age to Quaternary era.

Deposists of raw materials for brick manufacturing are situated all over the territory of the Czech Republic in dependence on geological structure, but their distribution is very irregular.

2. Domestic Production and Use:

1,913 million of cubic meters of raw materials for brick manufacturing were extracted in the year 1992 in the Czech Republic.

The raw material alone is only seldom suitable for a production of more elaborated products. Usually it is necessary to use technological properties of several raw materials and often to add some artificial materials (ashes, slack, sawdust) or sand as a grog.

The selection of brick products is very wide - it includes different types of bricklaying materials, chimney bricks, different sorts of rooting tiles, ceiling joists, drain tubes, paving tiles, etc.

3. Production Tendency:

Data in thousand cubic meters

	1988	1989	1990	1991	1992
Brick earth	2,411	2,458	2,622	2,166	1,913

4. Deposits and Reserves:

There were 201 deposits of raw materials for brick manufacturing registered at January 1, 1993 in the Czech Republic. Of them 90 are extracted. Reserves are given in a following table:

Data in thousand cubic meters

	Economic				Sub-economic
	Demonstrated		Inferred		
	free	bound	free	bound	
Brick earth	346,873	12,149	306,640	15,008	70,406

5. Assumed Trend:

Even the production of raw material for brick manufacturing showed a decrease, which continued in 1992 too. An increase in the production may be expected, partly with respect to change of methods in building, partly with respect to started manufacturing in a number of smaller brick factories of a local significance.

6. Main World Producers:

The extraction of the raw material for brick manufacturing is not registered world-wide.

7. Possibilities of Substitution:

Raw materials can be combined with artificial products in different ways, but it is impossible to substitute the basic raw material .