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THE URANIUM INDUSTRY IN THE HISTORY OF THE CZECH REPUBLIC AND RECENT DEVELOPMENTS

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Abstract

Uranium industry in Czech Republic was established on January 1, 1946 at the old Jáchymov silver and uranium deposit under the name Jáchymov Mines. Following its start in 1946, exploration and mining grew rapidly and developed into a significant branch of industry. During 50 years of uranium industry activities 194 uranium deposits and occurrences have been explored and 74 of them have been extracted. Due to the geochemical properties of uranium, U accumulations occur in the whole crystalline basement of the Bohemian Massif and in all stages of its platform cover. The Variscan tectogenesis was significant for the formation of the U ore deposits. The uranium resources of the Czech republic can be assigned to the following 2 ore types: vein deposits and sandstone deposits. The peak production of about 3000 t U was reached in about 1960 in the Czech Republic and production remained between 2500 and 3000 t U/year from 1960 until 1989, when it began to decline. During the period 1946–1996 a cumulative production of 104 748 tU was produced in the Czech Republic. 86 per cent of the total was produced by conventional mining methods while the remainder was recovered using in situ leaching (ISL). Eighty-one per cent of the known uranium resources (RAR + EAR-I) are tributary to existing production centres in Rozná, Hamr and Stráz, remainder occurs in Brzkov and Osecná-Kotel deposits. EAR-II are associated with the Rozná, Brzkov and Hvzzdov deposits.

1. INTRODUCTION

Uranium industry in the Czech Republic was established on January 1, 1946 at the old Jáchymov silver and uranium deposit under the name Jáchymov Mines. Uranium industry has been engaged in the exploration, mining and processing of uranium on the whole territory of Czechoslovakia. State enterprise DIAMO, the successor organization of the Czechoslovak Uranium Industry is the exclusive producer of uranium in the Czech Republic at present.

Following its start in 1946, exploration and mining grew rapidly and developed into a significant branch of industry. During 50 years of uranium industry activities 194 uranium deposits and occurrences were explored and 74 of them were extracted. Uranium industry carried out 550 shafts, 324 adits and 16 open pits in the Czech Republic and 8 mills operated intermittently.

These activities left behind numerous sites — mines, open pits, waste dumps, tailings impoundments and mill sites — requiring rehabilitation in order to transfer the areas into land for public use.

The restructuring of the Czech Republic uranium industry carried out since 1989 includes a substantial reduction in production capability. Currently, only two mines remain in operation: the Rozná underground mine in Western Moravia and the Stráz ISL facility. Employment in the Czech uranium industry has declined from 12 200 in 1990 to some 3600 as of the end of 1996.

2. GEOLOGY OF URANIUM DEPOSITS IN THE CZECH REPUBLIC

The Bohemian Massif is a heterogenous, polycyclic metallogenic province [1]. Due to the geochemical properties of uranium, U accumulations occur in the whole crystalline basement of the Bohemian Massif and in all stages of its platform cover (Fig. 1), [2].

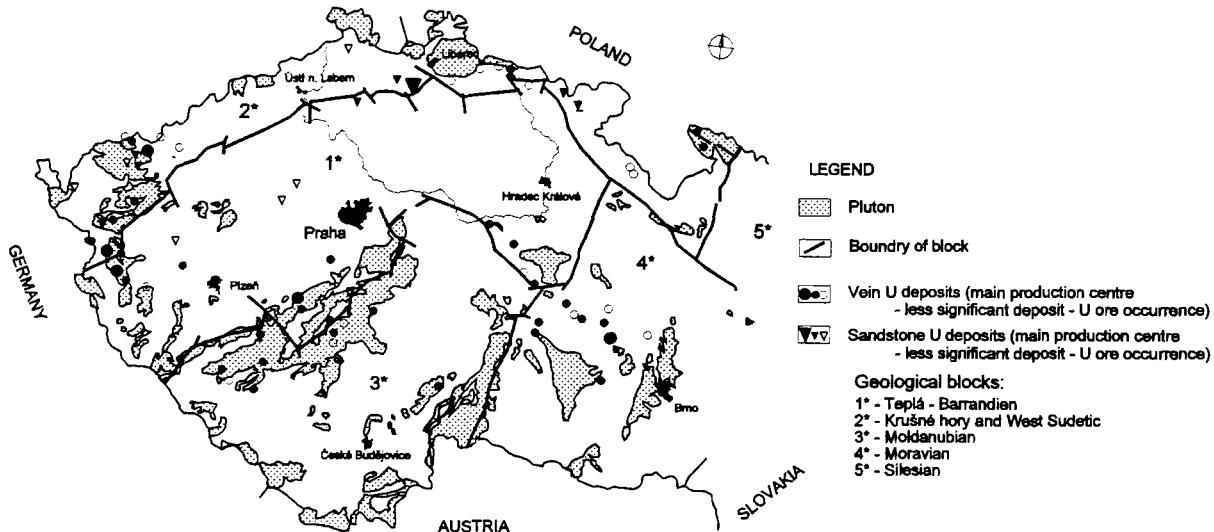


FIG. 1. Uranium mineralization in the Czech Republic.

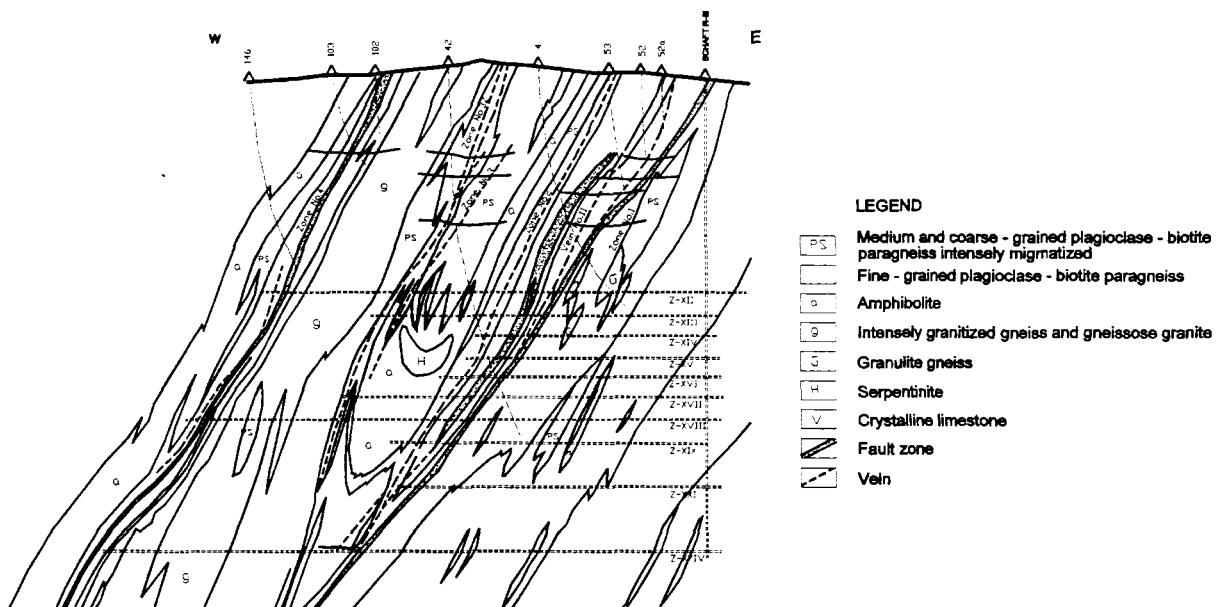


FIG. 2. Rozná uranium deposit, cross section and development system.

The uranium resources of the Czech Republic can be assigned on the basis of their geological setting to the following 2 ore types:

- vein deposits
- sandstone deposits

Vein deposits occur mostly in metamorphic complexes of Precambrian and early Paleozoic age, the smaller part occurs in Variscan granitoids (Vítkov and Nahošín-Mecichov deposits). Uranium ores are accumulated in typical veins (Príbram, Jáchymov, Slavkov, Predborice, Slavkovice etc.) or form thick zones (Rozná, Zadní Chodov, Dylec, Okrouhlá Radoun etc. — Fig. 2). The isotopic age of vein deposits mineralization was determined as late Variscan (265

± 5 Ma) and Kimerian (185 ± 15 Ma and 150 ± 20 Ma). The mineralization is characterized mostly by carbonate — uraninite and albite — chlorite — coffinite — hydromica associations, smaller amount of sulphides Fe, Pb, Zn and Cu and selenides, occurring in some veins. The Jáchymov deposit is typical for its vein Ag-Bi-Co-Ni-As-U mineralization, in some deposits the mineralization is also formed of uranium-organic complex [3, 4].

The most significant deposits of the sandstone type occur in Upper Cretaceous sedimentary rocks of the Bohemian Cretaceous Basin in Northern Bohemia (Figs 3, 4). The major uranium deposits in this area are Hamr, Stráz, Brevniště, Osecná-Kotel and Hvžzdov. Mineralized beds are developed in the freshwater Cenomanian and predominantly in the lower parts of the marine Cenomanian. Characteristic features of U mineralization are its link with the sedimentary complexes with organic substance and pyrite and its occurrence in the vicinity of the boundaries of different lithological rock types. The mineralization is characterized by U-Zr-Ti-P element assemblage [5].

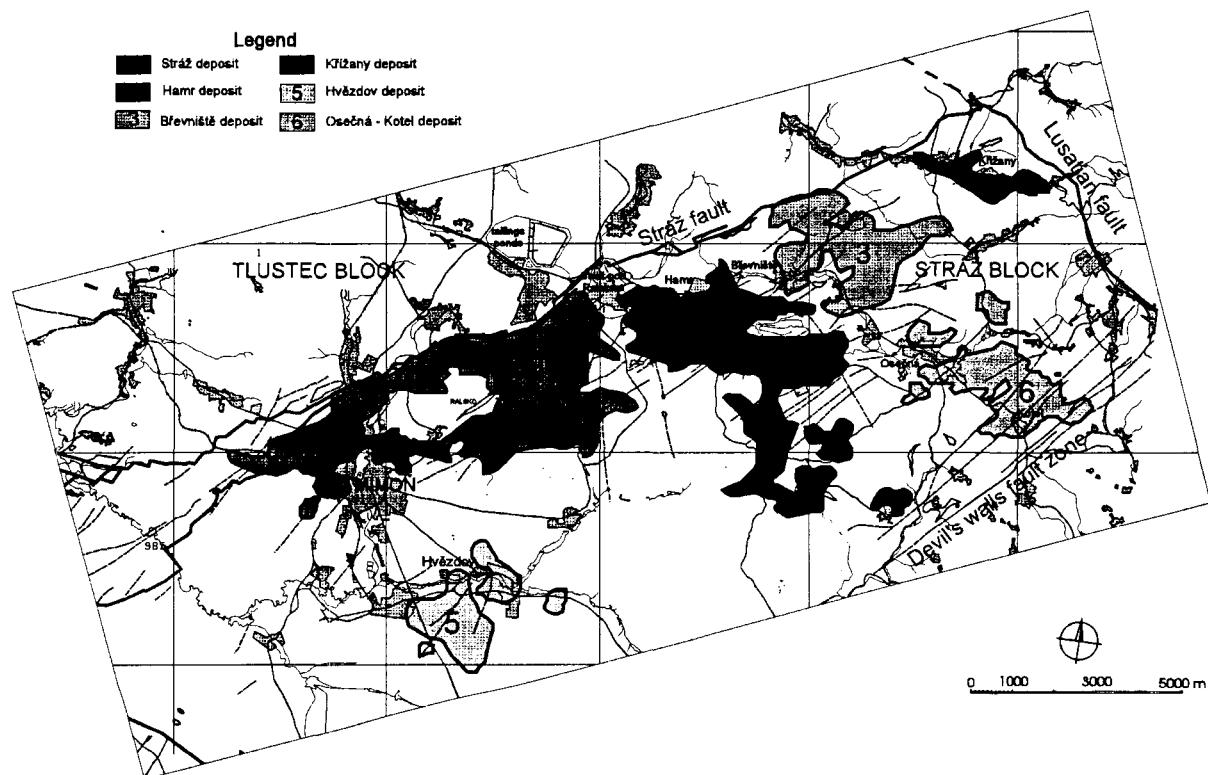


FIG. 3. Uranium deposits in Stráz block.

Uranium mineralization in the Permian-Carboniferous basins is mostly developed in coal beds and coal clays and their environment. The assemblage U-Pb-Zn-Cu-Mo is typical. The uranium mineralization occurs at Rybníček, Radvanice and Svatonovice in Northern Bohemia.

Uranium accumulations in the Tertiary sedimentary rocks of the Sokolov basin, NW Bohemia, are concentrated in areas where the basement and environment of the sedimentary rocks is formed of Variscan granites. The uranium accumulation occurs in sandstones, coal clays, tuffs and tuffites. There are several small deposits there: Odec, Ruprechtov, Hroznztín, Hájek, Mecírolí and Kocourek (Fig. 5).

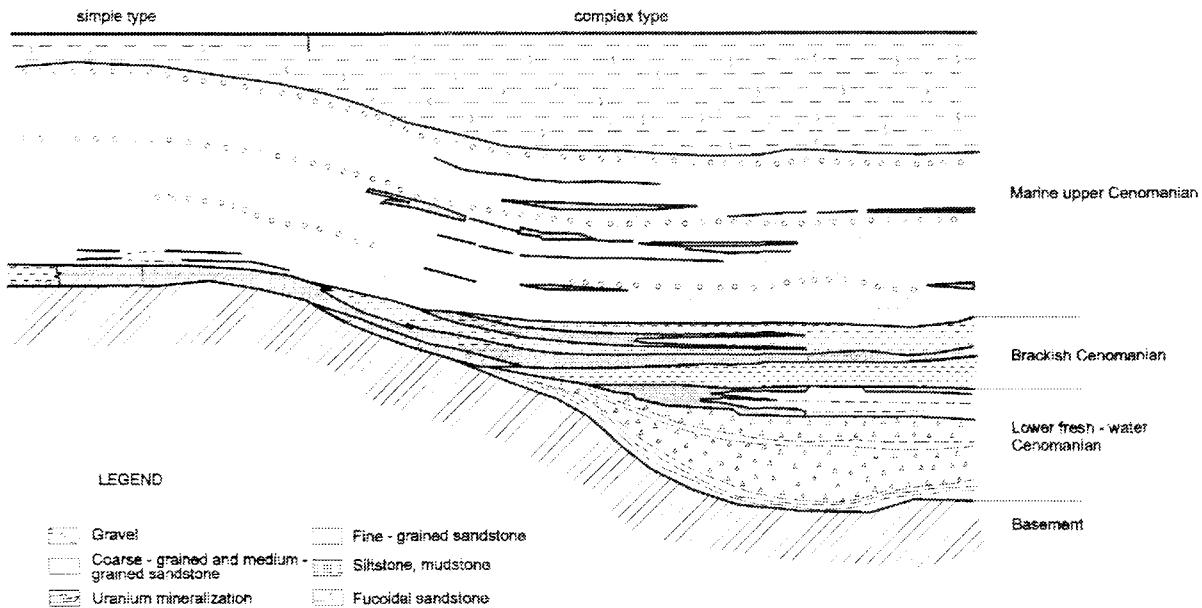


FIG. 4. Uranium mineralization in Cenomanian sediments of Stráz block — schematic cross section.

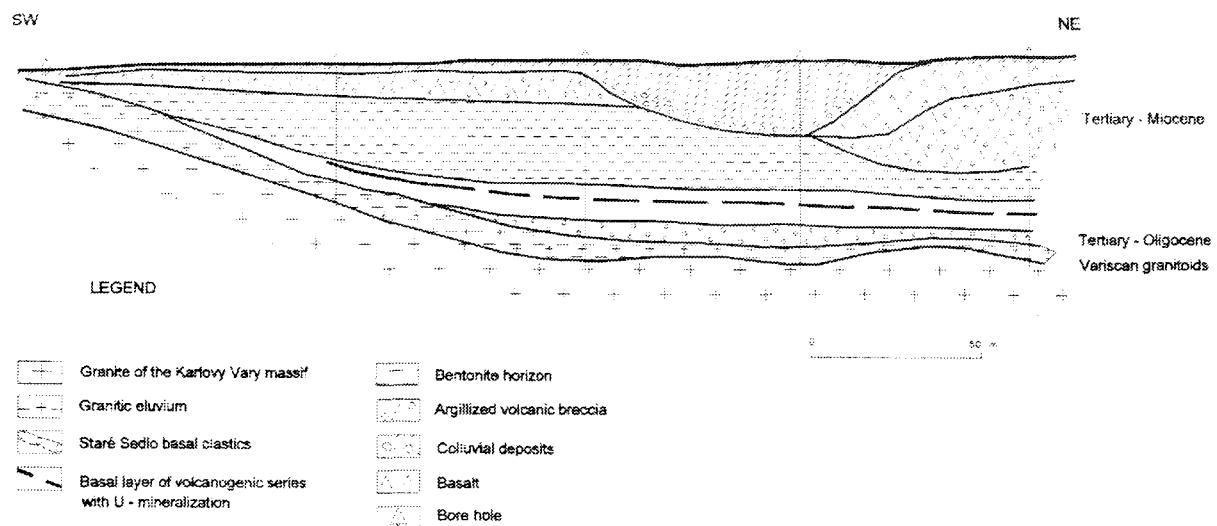


FIG. 5. Hájek Uranium Deposit — cross section through the southern part.

3. EXPLORATION AND PRODUCTION

3.1. Exploration

Systematic exploration programme including geological, geophysical and geochemical surveys and related research, was carried out to assess the uranium potential of the entire Czech Republic. Areas with identified potential were explored in detail using drilling as well as underground workings.

The exploration activity initiated in 1946 in the Jáchymov ore district extended in a short time to other prospective areas defined predominantly in crystalline rocks of the Bohemian Massif. Regional geological and geophysical survey and its results showed the significance of the Variscan tectogenesis for the origin of uranium deposits.

Exploration continued in a systematic manner through 1989 with annual exploration expenditures in the range of \$ 10–20 million and an annual drilling effort in the range of 70–120 km.

3.2. Production

Along with the exploitation of the Jáchymov deposit, the mining was started at the deposits Horní Slavkov (1948), Príbram (1950), Zadní Chodov (1952), Rozná-Olší (1957), Vítkov II (1962), Dylec (1965), Okrouhlá Radoun (1972) and other vein deposits occurring in crystalline rocks, and at the deposits Stráz (1967) Hamr (1967) and Brevnište (1983) with U accumulations in sedimentary rocks.

The peak production of about 3000 t U was reached in about 1960 and production remained between 2500 and 3000 t U/year from 1960 until 1989, when it began to decline (Fig. 6). During the period 1946–1996, a cumulative production of 104 748 t U was produced in the Czech Republic. Eighty-six per cent of the total was produced by conventional mining methods while the remainder was recovered using in situ leaching (Fig. 7).

Between 1946 and the dissolution of the Soviet Union all uranium produced in Czechoslovakia was exported to the Soviet Union. At present the uranium production of the Czech Republic covers the whole domestic reactor — related uranium requirements, no production is exported.

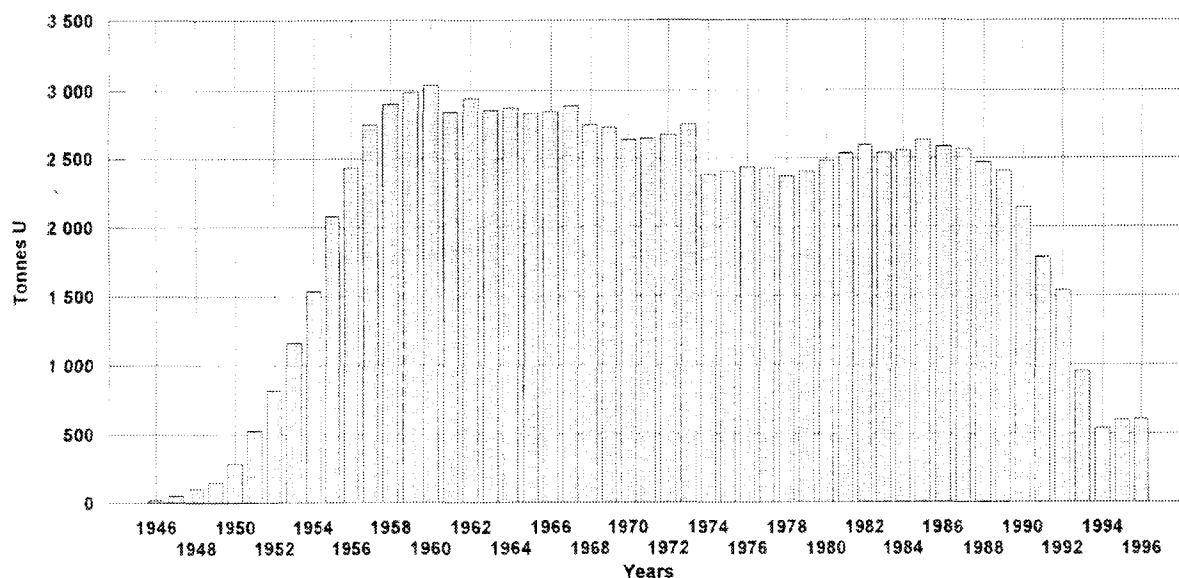
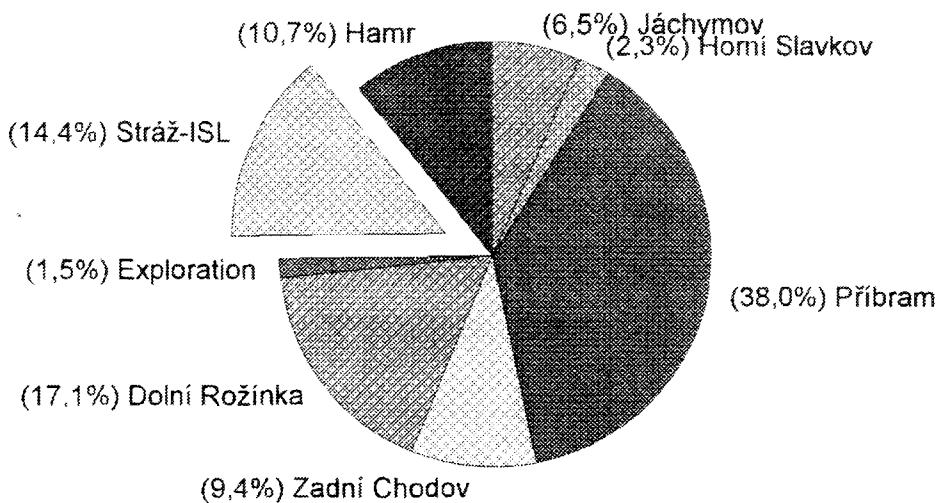


FIG. 6. Trends in uranium production of the Czech Republic, total in 1946–1996.



Notes :

1. Z.Chodov includes production from Zadní Chodov, Vítkov II, Dyleň, Okrouhlá Radouň, Hájek, Odeř and Ruprechtov
2. Hamr includes production from Hamr and Břevniště
3. D.Rožinka includes production from Rožná, Olší, Javorník-Zálesí, Chotěboř, Slavkovice-Petrovice, Rybníček and Radvanice

FIG. 7. Uranium production by districts: 1946–1996.

4. URANIUM RESOURCES, PRODUCTION CAPABILITY AND REQUIREMENTS

4.1. Uranium resources

Uranium resources of the Czech Republic as of 1.1.1997 shows Table I.

TABLE I. URANIUM RESOURCES IN THE CZECH REPUBLIC

Category	Cost ranges	
	< \$ 80/kg U	< \$ 130/kg U
RAR	6 630	30 220
EAR-I	1 180	18 960
EAR-II	5 480	8 480

Eighty-one per cent of the known uranium resources (RAR + EAR-I) are tributary to existing production centres in Rozná, Hamr and Stráz, remainder occurs in Brzkov and Osecná-Kotel deposits. No new areas favourable for the discovery of resources have been identified in the last ten years. EAR-II are associated with the Rozná, Brzkov and Hvzzdov deposits. The speculative resources are believed to exist in the Stráz block, Tlustec block and Hecmánky region, all in the Cretaceous basin of the Northern Bohemia.

4.2. Production capability

The restructuring of the Czech Republic's uranium industry carried out since 1989 includes a major reduction in production capability. Since 1989, the following mines were closed: Olší (1989), Vítkov II (1990), Okrouhlá Radoun (1990), Brevnište (1990), Príbram (1991), Dylec (1991), Zadní Chodov (1992) and Hamr (1995).

Currently, only two mines remain in operation: the Rozná underground mine in Western Moravia, and the Stráz ISL facility.

The closure of the mines listed above was accompanied by a decrease in uranium production from 2500 t U in 1989 to 604 t U in 1996.

4.3. Requirements

Installed nuclear generating capacity will be increased in 2000 to 3516 MWe (Net.) and annual reactor-related uranium requirements will increase to 700 t U in 2000 and following years. The whole uranium requirements for next ten years are expected to be covered by domestic production.

5. FUTURE PRODUCTION POSSIBILITIES

Future production centre could be reactivated at Brzkov deposit. Brzkov is a vein type deposit with known resources in the RAR and EAR-I categories. It is located in the western part of the Moldanubian of Moravia. The mine was closed but could be reopened under more favourable market conditions.

Based on a prefeasibility study, elaborated in 1996, the Hvzzdov deposit with EAR-II in sandstones of Northern Bohemian Cretaceous Basin is not economically viable for the exploitation in the near future.

The Osecná-Kotel sandstone-type deposit in the Northern Bohemian Cretaceous Basin with RAR and EAR-I resources is also under consideration for mining after 2005. But complex hydrogeological conditions will make developing and mining of these resources at cost below \$ 130/kg U difficult.

6. ENVIRONMENTAL ASPECTS OF URANIUM PRODUCTION

Mining and milling of uranium ores in the Czech Republic led to substantial impacts into the environment, the removal of which will require a long-lasting remediation procedure.

The main environmental impacts to the biosphere caused by uranium mining and processing facilities include the following:

- waste dumps with an aggregate volume of over 46 million m³
- surface tailing ponds totalling 584 ha
- approximately 600 ha disturbed by the ISL operation at Stráz deposit
- contamination with chemicals used in the ISL operation of about 186 million m³ Cenomanian and 80 million m³ Turonian groundwater [6].

The total area affected by uranium mining and milling in the Czech Republic involves approximately 19 km². The removal of impacts into the environment will continue for many years later than 2000 and will need considerable financial resources.

7. CONCLUSIONS

The Uranium industry in the Czech Republic developed after the World War II into a significant branch of industry with the peak of production of about 3000 t U in 1960. Due to the excess supply in the uranium market and the termination of uranium export to the former Soviet Union, the uranium production in the Czech Republic declined substantially after 1989. The restructuring of the Czech uranium industry was carried out and recent national strategy balances uranium production with domestic reactor related uranium requirements.

Nowadays, parallel with the continuing reduction of uranium production, the decommissioning and restoring activities are becoming the main programme of the state enterprise DIAMO. Since 1993 all decommissioning and restoring measures are funded from the state budget of the Czech Republic.

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