

## The post-war history of Czechoslovak uranium from Jáchymov (Joachimsthal)

### *Summary of the Czech text*

The origin and development of the Czechoslovak uranium industry after 1945 were connected with the intrusion of Soviet methods into local national economy. The Soviet Union faced an enormous problem in the uranium resources for the production of first nuclear weapons and thus it was ready to govern all the possible uranium resources in the Soviet block.

As soon as by the end of 1944 the Soviet experts started to evaluate uranium ores in Bulgaria. In 1945 the Soviet Union controlled all the uranium resources in the Czechoslovakia and in the Soviet occupation zone in Germany and later also in Poland, Rumania and Mongolia. In all the mentioned countries with the exception of Czechoslovakia so called joint venture companies for the exploration and exploitation of uranium resources were established in which the Soviet share represented fifty per cent. In the East Germany the income from the uranium exploitation came on the account of war reparations up to 1954.

The Iron Curtain in Europe fell on 11. September 1945. In Jáchymov, according to the report of policeman Hefner "the Russian troops numbered sixty led by a higher officer occupied three radium mines. Only mine workers were admitted to enter these mines".

From August 1945 talks between the Czechoslovak Prime Minister Zdeněk Fierlinger and the Soviet diplomatic agent I. Bakulin about the mining of uranium and its exclusive export to the Soviet Union took place. During the negotiations the Soviet representatives stated that this uranium is needed for the production of an atomic bomb.

These talks were finished on 23. November 1945, when the Memorandum was signed, called "The Memorandum of understanding between the governments of the Soviet Union and Czechoslovakia about the extension of the exploitation of radium-bearing uranium and concentrates in Czechoslovakia and their delivery to the Soviet Union". This Memorandum contained also an attachment (Protocol) which proclaimed this Memorandum to be highly confidential.

From the Soviet viewpoint this Memorandum was in fact a compromise which manifested an urgent need of uranium and took into the consideration the present political situation in Czechoslovakia. According to the Memorandum the enterprise Jáchymovské Doly State Enterprise (Jáchymov Mines) was founded. Leading posts in this enterprise were taken over by the Soviet experts the number of which increased step by step. According to the Memorandum also the bilateral Czechoslovak-Soviet Committee was nominated in order to supervise the Jáchymovské Doly enterprise. The

Committee had two Czechoslovak and two Soviet members. The Memorandum, however, did not specify the costs of exported uranium. This problem was progressively discussed between 1949 and 1952.

Shortly after the Second Great War the Jáchymov mines represented the only available uranium source on the territory of the Soviet block where uranium could be exploited immediately. The Soviets faced enormous problems with the uranium supply. On the beginning of 1945 the Head of the Soviet nuclear project I. Kurčatov had only 1 kg of metallic uranium at his disposal together with several tons of the uranium compounds. The data about the uranium reserves in the Soviet occupation zone in Germany are contradictory. According to V. Pičugin, who described the history of the Soviet uranium between 1942 and 1946, only 100 kg of uranium ores were found there. There are different sources, however, speaking about as much as 100 metric tons of uranium.

The uranium of Jáchymov was mentioned already in the report of the Soviet geologists from 1942 and also the KGB statement passed to Berija by Merkulov spoke about possible Jáchymov resources. First direct Soviet contact with the Jáchymov ore district was the visit of a group of Soviet officers, led by general Mikhailov on 26. and 27. August 1945. NKVD Colonel Alexandrov was also member of this group and later was entitled to guide the talks with the Czechoslovak government. The visitors went down into the mines, checked the procession plant and dumped uranium concentrates.

The Soviets were not too optimistic in 1945 about the reserves of uranium in Jáchymov district. Colonel Alexandrov estimated the reserves at "about 1 000 tons of uranium ores in Jáchymov, 2 700 tons in the Belgium Congo and between 6 000 and 7 000 tons in Canada. Taking these estimates into account the Jáchymov resources seem not to be so impressive, but, nevertheless, uranium is necessary raw material for the production of an atomic bomb."

The Soviet attitude influenced plans of exploitation in the first post-war years. It is interesting to compare the Jáchymov data with those from the Saxonian part of the Krušné hory (Erzgebirge) Mts.

The tables show that the uranium production in the East Germany increased considerably in 1947 and 1948. In 1946 new uranium deposits on the territory of the Soviet Union started to be exploited together with deposits in Bulgaria. Thus the uranium problem stopped to exist for the Soviet Union. First Soviet atomic bomb was tested on 29. August 1949 near Semipalatinsk town and that time the Soviets were more interested in the uranium costs than amount.

The exploitation of uranium from the Jáchymov ore district (tons of U)

year	mining plan	mined	dumps, tailings, old reserves	total	East Germany*
1945	-	0.92	29.92	30.84	-
1946	15.0	14.51	3.53	18.04	17.2
1947	60.0	44.70	15.37	60.07	150.0
1948	100.0	84.18	18.55	102.73	321.0
1949	120.0	135.0	12.20	147.2	766.0

\*the production of uranium in the East Germany (Saxonian part of the Krušné hory Mts)

Quite independently on the Soviet activities, immediately after May 1945, uranium mines in Jáchymov were also in centre of interest of the Czechoslovak Ministry of Industry and Jáchymov mines were visited by the Czechoslovak geologists from the State Geological Survey dr. J. Koutek and dr. V. Zoubek. Their reports were presented to the Minister of Industry B. Laušman on 1. October 1945. On 8. November 1945 a large scale conference with participation of representatives of the Ministry of National Defence, Ministry of Finances, Foreign Trade and Health was organized. The reopening of radium production in the Czechoslovak Republic was a main issue of this conference. The Technical Director Ing. Koblíček presented important proposals at this meeting and later contacted the Governmental Office with the request of protection of uranium exploitation in order not to affect the radioactive waters. He also suggested to export only processed uranium concentrates. A similar suggestion contained the "Memorandum of the representatives of Czechoslovak industry" from August 1946. This Memorandum was criticized and refused by B. Reicin from the Headquarters of the Czechoslovak army. Later on, some other activities were observed on the meeting on the State Planning Committee on 25. November 1946. It was agreed on that the solution of the problems of Czechoslovak nuclear energy was not premature. At the same time Ing. Kovář contacted the Vice-chairman Z. Fierlinger with the requirement to keep the amount of 10 % of mined uranium in Czechoslovakia. He referred to the project of a construction of nuclear power station in Great Britain.

In 1946 the new establishment Jáchymovské doly faced enormous problems connected with lack of workers, housing, financing of works and technology. That is why the problem of payment for the delivered ore was extremely urgent. The two-years-plan 1947-1948 allocated 160 millions of Czechoslovak crowns (Kčs) for the investments to the Jáchymov Enterprise. Shortly after that this budget proved to be highly insufficient and the need of at least of 230 millions of Kčs appeared. The Soviet Union offered a loan of 200 millions Kčs. The

mixed Committee discussed continuously the costs of the uranium and it was agreed on to calculate it from the mining costs and income. There were, however, no criteria for the two issues. Soon after the war the Czechoslovak experts had no idea about the world prices of uranium. It was said that United States paid for the uranium ore from the Belgium Congo as much as 300 USD for 1 kg uranium in the ore. In fact, in 1950 according to market principles the Americans paid 2-5 USD for the 1 kg of uranium in the ore with extracted radium.

As for the Jáchymov ore the price was fixed in 1948 but the talks continued up to 1958.

An attempt to keep a control on the Jáchymov uranium ores could be observed in post-war years. The activities of the State Geological Survey with Ing. Dr. L. Čepek as Director belonged to them. Unfortunately, many written documents from that time are not preserved in the archives but the remaining ones prove this statement. As already mentioned, the Czechoslovak geologists from the State Geological Survey visited Jáchymov soon after the war in August 1945. Their report gives an overview on mineralization, veins with uranium and also recommendations. They observed that the mining during the war was concentrated only on the already driven mine works. New first drivings were not executed. In the second half of 1946 the Survey geologists carried out prospecting in the surrounding of the Cech sv. Víta near Drmoul settlement, not far from the Mariánské Lázně spa. There, a lens of uranium ores was mined near the surface in 1923. It was recommended to concentrate the prospecting to the close vicinity of this lens and not to plan large scale exploratory works, as suggested by the Jáchymovské doly Enterprise. On November 1945 V. Zoubek carried out exploration of three levels at the Enterprise Bratrství in the Jáchymov district. There is also another group of reports which concerns the wider surroundings of Jáchymov. J. Paulíček, staff member of the State Geological Survey, described the geological situation in mine galleries near Boží Dar (Gottesgab), Abertamy and Potůčky with negative results concerning the mineralization by so-called five-element-formation. In 1946 F. Fiala worked near Horní Slavkov, his Report is unfortunately no more available.

Real culmination of mentioned research can be seen in the study called "Tectonic and metallogenic conditions of the Bohemian Massif with a special attention to the occurrences of uranium ores". This study was written by V. Zoubek and J. Koutek in June 1947. After short chapter on the geology of the Bohemian Massif the uranium mineralization is analysed according to its known genetic types. Pegmatites are discussed in detail and the authors mean that they are uranium-poor as to their geochemical character. Pneumatolytic and hydrothermal deposits are subdivided into ten ore provinces. Krušné hory Mts and Císařský les Mts province are described most thoroughly, a little less was written about the prov-



ince of Krkonoše Mts and Jizerské hory Mts and ore aureole of the Central Bohemian Pluton. Remaining provinces are characterized as without uranium mineralization. The sediments were evaluated, too, special attention was laid on sandstones and bituminous rocks and their occurrences in the Lower Silesian, Cheb and Sokolov basins. Graphitic crystalline rocks were supposed not to bear uranium mineralization. The conclusion of the mentioned report was as follows:

1. Krušné hory (Erzgebirge) Mts ore province is most promising related to the uranium mineralization.

2. The Krkonoše-Jizerské hory Mts province can be considered as promising as well.

3. Some sedimentary formations should be taken into consideration, as organic-rich sediments in the Cheb and Sokolov Tertiary basins, Cu-bearing Permo-Carboniferous sediments in the Krkonoše Piedmont basin and also Proterozoic alum shales. Radiometric and laboratory examinations should be executed on these sediments.

4. Příbram area should not be forgotten, namely Janská and Černojanská veins at the Lill shaft and broader area around the active shaft in Třebosko. In these places, however, only sporadic lenses could be found and exploitation is not probable in the future.

In all the other metallogenic provinces of the Bohemian Massif the finds of exploitable uranium resources are highly improbable according to the authors.

The future has shown, however, that some crystalline provinces were underestimated from the uranium mineralization viewpoint. This holds also for the Příbram ore district. Generally speaking, however, the analysis corresponded to the contemporaneous views and the authors in fact mentioned in their report both the Příbram district and Krkonoše Mts Piedmont basin which were later in the centre of attention for uranium prospecting and mining.

Czech geologists also presented "The attachment to the list of known uranium ores in Bohemia" which was passed to the Division of the Ministry of Trade on October 25, 1947. This document was later delivered to the Jáchymovské Doly Enterprise. Thirteen localities were mentioned in this list, among them also Zadní Chodov, where the ore deposit was exposed as late as in 1952, and also Lhota near Příbram and Třebosko. The report, to which "The attachment" belonged, was not preserved, nevertheless, it is quite clear that both documents were written by geologists from the State Geological Survey. That time already the friction between the Jáchymovské Doly Enterprise and the State Geological Survey culminated as documented by the exchange of letters between L. Čepěk and the director of Jáchymovské Doly Enterprise Bohumil Hegner. Ing. Kolář was quite aware of the fact that Jáchymovské Doly refused to supply the State Geological Survey with new data on the distribution of quality of uranium ores and that these data were pro-

claimed as highly confidential. Last report by the geologists of the State Geological Survey was written by J. Paulíček in winter 1947–1948 and unfortunately only the map is preserved with the last page of the text. In this map sixty points and numbers are given where prospecting and mining take place. After February 1948 the cooperation between the Jáchymovské Doly and the State Geological Survey was interrupted for many years, later this cooperation was renewed but subject to strict regulations concerning top secret issues.

The contribution of the Soviet Union to the development of the uranium exploitation followed the agreement anchored in "Memorandum" as to the delegation of experts and import of techniques. Efficient techniques, however, was not disponible neither in Czechoslovakia nor in the post-war Soviet Union. There was also lack of qualified experts and manpower at all. The only solution was to replace the techniques by manpower and the low productivity of individual mines by a drastic increase of a volume of mine workings. The political situation until February 1948 was respected by the Soviet Union and more than standard salary and housing conditions were granted to Jáchymov workers. Far before 1948 German war prisoners started to work in Jáchymov mines, later during 1949 they were replaced by political and other prisoners sentenced to hard labour.

The works in Jáchymov continued according to the state plan which specified both production and volume of mining works. The production could be increased only by an immense increase of places with deposit opening and rapid advance of mine galleries. All these works were evaluated by the Geological Service of Jáchymovské doly Enterprise which was established.

In 1945 the knowledges on the uranium deposits were still limited and not all the types of mineralization were known. Most of exploited resources belonged to so called five-element-formation and some occurrences in clastic sediments, bituminous shales and pegmatites were also known. The criteria for the industrial and market evaluation of uranium deposits were still lacking. In the Soviet Union the uranium deposits were not exploited until 1945 and even not explored. The change of views and strategy can be dated to August 1945 when a "Special Council for the Atomic Bomb" was founded.

In Czechoslovakia the mining has a long tradition and uranium occurrences were known as early as by the end of 18th century. The exploitation of uranium ores started in the second half of the 19th century in the Jáchymov ore district. The paper by M. Kraus from 1915 described the geology, ores and mining in Jáchymov ore district in detail. In the "Topographic Mineralogy of Bohemia" by Kratochvíl 37 localities with occurrences of uranium minerals were registered and described.

First Soviet experts in Czechoslovakia in 1946 were freshmen in the Jáchymov area and not specially trained

Uranium production in the Saxonian and Bohemian part of the Krušné hory (Erzgebirge) Mts in 1945–1990 in tons of uranium

Saxonian part		tons of uranium
Western Krušné hory		94 026
out of this	Niederschlemma-Albenrode	80 545
	Oberschlemma	7 407
	Johanngeorgenstadt	3 595
	others	2 479
Central and Eastern Krušné hory Mts		2 073
out of this	Annaberg	1 590
	others	483
Bohemian part of Krušné hory Mts		7 422.2
out of this	Jáchymov district	7 199.8
	others	222.4
Total		103 521.2

Uranium production in the Jáchymov district and its export to the Soviet Union

Year	produced (tons of U)	mining losses (%)	produced including losses (tons of U)	on market (tons of U)	the share of Jáchymov on uranium export to Soviet Union (%)
1853–1913	150.5	–	150.5	–	–
1913–1938	275.0	–	275.0	–	–
1939–1944	44.0	–	44.0	–	–
1945	0.9	–	0.9	0.9	–
1946	14.4	–	14.4	18.0	80
1947	39.3	–	39.3	49.0	100
1948	67.4	–	67.4	93.0	90.5
1949	96.9	–	96.9	113.0	76.8
1950	155.4	46.1	288.4	175.0	72.5
1951	288.0	44.2	516.1	306.9	58.4
1952	387.7	24.8	515.5	411.1	50.9
1953	554.2	15.1	652.8	548.0	47.5
1954	662.3	9.0	727.8	649.0	41.7
1955	798.5	8.2	869.8	777.0	37.7
1956	804.6	8.2	876.4	764.0	32.1
1957	769.5	10.7	861.3	759.0	27.6
1958	690.6	6.4	738.0	713.0	24.4
1959	587.2	7.9	637.6	673.0	22.5
1960	578.9	5.5	612.7	584.0	19.2
1961	282.4	5.1	297.6	273.0	9.5
1962	119.8	6.5	128.1	112.0	3.8
1963	–	–	–	75.0	2.6
1964	–	–	–	97.0	3.4
1946–1962	6 873	–	7 940.1	7 189.0	–
1853–1964	7 539.5	–	–	–	–

for the geological conditions in Bohemia. There are no reports about their cooperation with Czech geologists between 1946 and 1948. Their main role was to assure a drastic augmentation of uranium production from the only disponible Soviet resource of uranium – Jáchymov district. The objective of their work was also to check already known other exploitable occurrences of uranium. They revised radiometrically all the active and abandoned mine works. Systematic field prospecting was not so urgent.

In the Jáchymov district many ore veins with uranium mineralization were known on several levels in many galleries. Uranium compounds occurred also on the surface on dumps, relics of old mining works. Radiometric devices, imported from the Soviet Union, played main role in the exploration. The data about the exploited uranium from several veins were known together with parameters of a productivity of veins expressed in kg of U on one square metre. Four veins exhibited such productivity values from 0.47 up to 6.12 kg U/m<sup>2</sup>. The increase of mining works in Jáchymov in the first post-war years was really remarkable. In 1945 there was 3 564 metres of mine galleries, later in 1947 already more than 11 407 metres, in 1949 47 665 metres and in 1957 124 631 metres. Seven years later the works in the district were stopped. Methods of exploitation can be easily documented by the amount of exploited uranium related to one metre of advanced mine works. In 1946 it was 4.04 kg of uranium for one metre, later this value dropped to 2.03 kg U/metre. Following increase could be observed which reached 8.00 kg U/metre. Average reserve productivity was low and later in 1954 reached 0.97 kg U/m<sup>2</sup>. Up to 1950 only such mines were exploited which were mostly described already by Kraus in 1915. Prognostic evaluation of the Jáchymov district was carried out by Soviet geologists in 1948. As to them the reserves amounted to 5 300 tons of uranium. This was less than the resulting exploitation but only about 40 per cent of the area of the district was taken into account. Such prognosis in 1948 was for the Soviet Union strategically very interesting and was more optimistic than assessments done in 1945–1946. In 1946 the group called “Prospective Geology Group” was established and later this group evolved into the independent organization. The expedition of 30 Soviet geologists became a nucleus of this Group. According to territorial responsibilities the Group was subdivided into seven subgroups. Organizational structure of this Group changed several times after that and new enterprises originated step by step.

The Horní Slavkov area proved to be very promising and first works were initiated based on the reports of geologists from the State Geological Survey. The system with a great amount of mining works led to the opening of production in 1948 and its termination in 1962. From this district the amount of 2 530 tons of ura-

nium in the ore was gained, 15 shafts were bored and 550 000 metres of mine galleries driven. Many other localities, mainly in the Krušné hory Mts and West Bohemia, were explored but up to the beginning of fifties with negative results.

Revisional works executed during 1947 checked many active and abandoned ore and coal deposits and they brought about two interesting results important for the future uranium industry. First one concerned the evaluation of known uranium ores in the Příbram ore district, 50 km to the SW of Prague where polymetallic Pb, Zn, Ag ores were mined in so called Březové Hory-Bohutín ore district. Old dumps SE from Příbram yielded some finds which later led to the delimitation and opening of one of the largest vein uranium ore district in the whole world. Between 1950 and 1990 more than 50 000 tons of uranium in the ore was exploited there.

Second discovery in 1947 concerned the North Bohemian Žacléř-Svatoňovice Permocarbiniferous coal basin. Bituminous sediments exhibited increased radioactivity and reserve calculation in 1948–1949 led to the amount 500–800 tons of uranium in poor ores. The mining started as late as in 1953 when first chemical processing plant was opened in Czechoslovakia.

In the period 1948–1949 the Soviets started to be more interested in the uranium production costs. The costs increased from 1 300 Kčs in 1945 up to 2 400 Kčs in October, 1949 for one kg of uranium in ore. The calculated production costs served as a basis for the price which the Soviet Union paid for uranium. Economic results of the Jáchymovské doly enterprise were affected by a high volume of mining works in the district. The amount of mining works increased up to 1952 far more quickly than the uranium production.

The history of Jáchymov district started with the silver mining on the beginning of the 16th century. That time small settlement Konradsgrün developed into one of the largest cities in Bohemia. Jáchymov (German name Joachimsthal) became famous later when Mr. and Mrs Curie, Nobel Price winners, extracted radium and polonium from the Jáchymov uranium ore. Jáchymov ores belong genetically to the so called five-element-formation containing Ag-Bi-Co-Ni-U mineralization. Geologically Jáchymov belongs to the Saxonian-Thuringian ore province which as to the amount of produced vein uranium is on the first place in the world. In the period 1945–1990 the production of uranium on the German (Saxonian) part of the Krušné hory Mts exceeded markedly that on the Bohemian side, as seen in the attached table.

In 1985 J. Komínek and T. Veselý described geological and mining situation in the Jáchymov ore district in IAEA Proceedings (Vienna). They analysed the distribution of uranium and factors affecting it. Published data were subject to censorship not to break security regulations.

Average number of employees in Jáchymov district and percentage of prisoners

Year	Total number of workers	Number of prisoners	Percentage of prisoners
1946	1 429	64	4.47
1947	5 565	1 739	31.24
1948	7 966	3 663	45.98
1949	13 653	4 630	33.91
1950	17 781	6 779	38.12
1951	24 867	10 748	43.22
1952	33 320	13 374	40.14
1953	40 317	13 821	34.28
1954	44 368	11 970	26.98
1955	46 351	9 214	19.88
1956	43 897	7 125	16.23
1957	42 848	6 316	14.74
1958	37 167	6 603	17.77
1959	30 244	4 993	16.51
1960	25 633	2 923	11.40
1961	23 956	2 168	9.05
1962	23 004	1 988	8.64
1963	22 399	2 060	9.20
1964	22 036	1 796	8.15

Note: Up to 1949 all the prisoners were German war prisoners

The following table gives an overview of production of uranium ores in Jáchymov ore district from 1853 up to 1964:

According to various sources in the whole history of the Jáchymov ore district total amount of about 7 200 tons of uranium was exploited and utilized in industry. The rest is represented by mining losses.

Jáchymov ore district is typical by a presence of thick fracture zones of several directions and many mineralized structures. In the course of exploration and mining the district was subdivided into seven areas which were called "vein concentrations". Some of them were attached one to the other, remaining were separated by the areas of negligible mineralization. Each "vein concentration" was characterized qualitatively and quantitatively, area covered by ore veins and productivity in kg U/m<sup>2</sup> vein area and also by total amount of exploited uranium. The area covered by "vein concentrations" makes 27.9 km<sup>2</sup> with 8.2 mil.m<sup>2</sup> worked out and productivity 0.87 kg U/m<sup>2</sup>, which represents total amount of 7 200 metric tons of uranium. In the Jáchymov district 22 main shafts were active, several way shafts and old and reopened mine galleries. 1.1 millions of metres of mine works were driven. Number of exploited ore structures was more than 400. From 46 ore veins more than 40 tons of uranium were mined, but only 20 veins exhibited greater productivity than 2.00 kg U/m<sup>2</sup>. In seven mining blocks covering an area from 1 600 to 4 600 m<sup>2</sup>



the productivity was greater than 10 kg of uranium on square metre. In the district mostly the veins with lower productivity than 2.0 kg U/m<sup>2</sup> were mined. That is why the production costs were enormous and up to now not exactly known.

After 1946 hard labour of prisoners represented one of methods how to achieve large volume of planned mining works. Included table indicates the number of workers and also number of sentenced prisoners.

L. Petrášová (1996) wrote that until 1961 in Jáchymov concentration camps worked as much as 65 000 prisoners. The ratio between political and other prisoners changed time at time. In 1952 out of 13 500 prisoners were 8 000 political ones. From 11 Jáchymov concentration camps specially that one called Vykmánov II. was notorious where prisoners, mainly priests, worked in the processing plant without any antiradiation facilities. Up to the half of fifties all the miners were exposed to the radiation without protection.

Many V.I.P. persons of the Jáchymovské doly enterprise from 1946–1948 were later imprisoned. First director B. Hegner was condemned to life imprisonment. Also known geologists J. Hettler, J. Švenek and J. Krupička were sentenced to hard labour in Jáchymov concentration camps.

The economic situation of the Soviet controlled Czechoslovak uranium industry improved drastically by

the favourite conditions in the Příbram ore district and its development after 1950. The opening of the exploitation there made possible to lower the total production costs for 1 kg of uranium from 1993 Kčs in 1949 down to 272 Kčs in 1960. Up to 1955 the Jáchymov uranium was very expensive from all the viewpoints. In the total balance of uranium export the Jáchymov uranium made only seven per cent.

The methods of the Soviet planned economy manifested itself drastically in the development of the Czechoslovak uranium industry, specially after February 1948. Soviets recompensed the delivered uranium by commodities and to be quite objective, in the very beginning, quite generously. Soviet interests in Czechoslovak uranium developed a huge mining industry in Czechoslovakia which survived until 1990. Sponsored by a state, uranium exploitation and export took place up to 1990.

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Note: Figures in the text mostly illustrate graphically the data given in the tables.

Attachments consist of copies of original documentation including "Memorandum of Understanding".