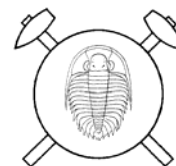


# History of the Jáchymov (Joachimsthal) ore district

## Historie jáchymovského rudního revíru (Czech summary)



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Jáchymov was founded in 1516 in place of the former abandoned village Konradsgrün, following discovery of a rich silver deposit. During the first twenty years, the town witnessed a remarkable boom, becoming in 1534 the second largest town in Bohemia, second only to Prague. Jáchymov became an important cultural centre, hosting Agricola, Mathesius and many outstanding personalities of the time. Latin school was founded in Jáchymov; a major part of library assembled in this school was preserved till present. The coins minted in Jáchymov were named after the German name of the town "Thaler", later "tolar", the name which during time was adopted as the name of the USA currency. A mining school was founded in Jáchymov in 1716. The history of the town witnessed periods of expansion and episodes of decline due to wars, fires, plague epidemic waves, and economic problems. The original interest in silver was substituted by mining of cobalt and nickel, later on, uranium was used for production of uranium colours and separation of radium compounds for medical application. The last major mining expansion took place after the Second World War, with extensive mining and ore dressing of uraninite and its exports to USSR. The ore district was exhausted and mining terminated by 1964. Springs of radioactive water tapped in the mines are used since 1906 for curative application in local spa.

*Key words:* Jáchymov, history, mining, production

### Introduction

Mining history of the Jáchymov (Joachimsthal) district was surveyed in detail by Kraus [119], Majer [72], Kořan [74], Horák [215] and especially Šternberk [300]. At the site of the present town Jáchymov, there was a settlement Konradsgrün, which was based approximately in the year 1300 and ceased to exist in the middle of the 15th century.

The village was named after count Konrad from Vohlburg in Bavaria, who settled in Cheb (Eger) [186]. At the beginning of the 16th century, the region of the Krušné hory Mts. (Erzgebirge) was strongly forested. There were few settlements, as the harsh climate and short vegetation season made the region prohibitive for early farming settlers in the 12th and 13th century. The Haslov family were the major land owners in the region. Towards the end of the 13th century, the Schlick family gained prominence in western Bohemia and at the beginning of the 15th century owned extensive land in the Krušné hory Mts., including the adjacent Ostrov nad Ohří property (Schlackenwerth).

Colonisation by medieval miners reached the region relatively early. On the Czech side, there were several mining locations of lesser importance, including tin mines in Krupka (Graupen) (1297) and Cínovec (Zinnwald) (1305), iron ore mines near Kadaň (Kaaßen) (15th century), and copper mining at Měděnc (Kupferberg) (1510).

On the German side of the Krušné hory Mts., in Saxony, there were several important silver mining locations, including Freiberg (1168), Schneeberg (1470), and Annaberg (1496).

### The silver period

Miesl, who took information from memoir written by mining officer Heinrich Könnertitz, mentions that an old,

abandoned drift was discovered in 1512 [318]. The first discovery of vein with minor silver mineralization took place in a location, which is at present in the very centre of the town Jáchymov behind the former house No. 496, which was lately demolished. A short adit was made in this place by Kaspar Bach from Geyer in Saxony and by the old Oser from Ostrov nad Ohří. The work was abandoned for shortage of funding without positive results [308], however, Mathesius does not mention year of this development. The drift was named *Heilig drei König*. When Stefan Schlick learned about this attempt, he founded a mining group [308] and in the year 1516 continued work on the abandoned drift, named later *Fundgrubner* [63]. Here, the landowner Stefan Schlick scored a major silver discovery after driving the adit only 2 metres forward. The vein yielding rich pieces of native silver was named *Discovery vein* (Fundgrubner). This development started a strong mining fever, resulting in founding a settlement named first *Thal* to be re-named with much festivity in 1517 to *Thal des heiligen Joachims* (valley of the Saint Joachim) [186], later modified to Joachimsthal.

The highly successful silver mining resulted in foundation of several mining settlements in the region - Hora Sváté Kateřiny (Katharinaberg) (1528), Abertamy (Abertham) (1529), Pernink (Barringen) (1532), and Boží Dar (Gottesgab) (1533). In the Jáchymov district, discovery and mining of rich veins resulted during the period 1516 to 1577 in pure profits near 30%, in spite of the loss of silver owing to simple methods of ore dressing. The method of wet ore crushing involved loss of 20 to 25 % of silver. Nevertheless, according to a report dated 1564, ore containing 0.7 % Ag was payable [300]. Ores were classified to very low-grade (< 0.7 % Ag), low-grade (2 to 9 % Ag), and high-grade (8 to 16 % Ag). Very rich ores contained > 60 % Ag; they were sorted by hand, since silver content in the main silver minerals is not much higher - pyrargyrite 59.8 %, proustite 65.3 %,

stephanite 68.3 %, argentite 87 %. During the first half of the 16th century, mining in the cementation zone produced large pieces of native silver. The largest recorded piece was 280 kg in weight. The newly discovered veins used to be named after landowners who leased the property, after saints and exceptionally in a non-religious way.

Several circumstances supported quick and efficient mining in the Jáchymov district. The mining started during the third stage of silver mining [73], marked by introduction of new methods in mining mechanisation, ore mining and water pumping. There was an increased demand for silver. There were sufficient numbers of miners, because mines in nearby Schneeberg were flooded in 1511, followed somewhat later by a decline of mining in Annaberg.

To improve mining regulation, Schlick landlords introduced on August 2, 1518 a mining law, which remained in power until 1854. It represented a modification of the Annaberg law and became also known as the Schlick's law. On January 6, 1520, the royal majesty Ludwig Jagelon elevated the settlement Konradsgrün-Thal to the status of a free royal mining town named St. Joachimsthal (valley of the Saint Joachim) [63], [215]. The introduction of the name of Saint Joachim (the husband of the Saint Ann) followed the same pattern as used for important mining towns in Saxony: Annaberg, Josephstadt, Marienberg, named after members of the holly family [308]. Population was quickly increasing - 5000 settlers in 1520, 13500 in 1525, 18000 in 1534. By the time of its highest fame (1534), the population of Jáchymov reached the number of 18200, ranking thus as the second largest town in Bohemia and Saxony. This compared to population of 50000 in Prague, 40000 in Nürnberg, 15000 in Cheb, 6500 in Dresden, 3300 in Plzeň and 600 in Karlovy Vary. The following popular saying of that time was introduced: *Ins Thal, ins Thal, mit Muttern mit all*, i.e., approximately, *rush to Jáchymov at any price*.

The Schlick family purchased the land in Jáchymov from the Haslov family in 1519 and started minting coins, to improve their profits. Their minting privilege was supported by referring to the decree issued by the king Wladislaw, dated 1489. The decree dedicated the Loket (Elbogen) region to Mathias Schlick from Lažany (Ober Losau) and mentioned the right of minting coins without other specification. A minting privilege, valid for the whole empire and for minting both silver and gold coins, given by the emperor Zikmund to Kaspar Schlick as early as 1437 (where surprisingly, mining of silver in Jáchymov is mentioned) was apparently a falsum. The Schlicks continued coin minting and sale until 1528, when the minting rights were obtained by the emperor Ferdinand I., who obtained by confiscation the whole Jáchymov property in 1547 [300].

The silver coins minted by Schlick were known after the place of production as Thaler and later tolar. Later on, this name was modified to the name of the USA currency. Minting of coins in Jáchymov probably began in 1519 in the cellar of the Schlick's castle Freudenstein, i.e., before a permit was granted by the Czech convent in 1520. The coin production was later transferred to the house of Kunz Eirolt. New minting building was con-

structed during the decade following 1530. Based on agreement with Saxony, the Schlick family used to deliver the silver coins to Leipzig, an important European trading centre of the time. The agreement was tied to the condition of matching the purity and value of the coins to the Saxonian coin (Guldengrosch). The success of the coins produced from Jáchymov silver was caused by the circumstance that gold coins were in short supply to satisfy needs for large-scale and long-distance trade transactions, as well as limited supply of silver to produce coins corresponding in value to the Rheingulden and the Austrian gold coin Guldiner. Another aspect of the success was the quantity. During the years 1519 to 1528 the Schlick family exported to Saxony coins corresponding to the value of 2.2 millions tolar. The Jáchymov coin production was three-times higher compared to Annaberg. There is no record available, indicating final profit of the Schlick family from these exports. The Gresham's law, saying that valuable coins are gradually forced out from circulation by coins of lesser value, prevailed also with respect of the Jáchymov coins [311]:

year of minting	weight of the coin [g]	content of silver [g]	fineness
1519	29.23	27.20	0.931
1547	29.23	26.16	0.895
1561	24.62	22.89	0.930

Jáchymov developed as an important cultural centre during its best period. Renowned artist and scientists brought here the influence of renaissance and humanism. Important scripts of Georg Agricola (1494-1555) and Johann Mathesius (1504-1565) were written here and Lazar Ercker, Andreas Pfeil, Mathes Enderlein and Georg Hochreuter were active in Jáchymov. The famous painter Lucas Cranach and musician Nicholas Hermann, mathematician Michael Neander, inventor in mechanics Hans Praetorius, chroniclers Hans Rudhart and David Hütter also came here. The list of important personalities included the experienced mining and minting officer Heinrich Könnerritz, town scrivener Bartholomeus Bach, scrivener Lorenz Bermann, rector of the Latin school Peter Plateanus, doctor Johann Naevius and many other [31]. The church built during the years 1534-40 was the first protestant church of this type in the world.

The Latin school was introduced in the first years of the boom. In 1532, as Mathesius was appointed the rector (he came to Jáchymov in 1517) the school had the rank of a secondary school. A school library including theological, humanistic and practical topics was assembled from donations by local citizens. The school was closed in 1625 as a consequence of political and religion changes following anti-reformation and decline in silver mining. A catalogue of the library, written in 1671 on the occasion of transfer of the coin minting to Prague, included a total of 353 books [298].

The tomb of Mathesius, who died in Jáchymov in 1565, was decorated in 1574 by a tombstone paid from contributions by miners. The tombstone was not preserved. It was used in the base of newly constructed altar, for it reputedly carried engraved inscription offending the pope [295].

During the following 200 years the fate of the library was unknown and some people search for it in vain. In 1871, the archivist Karel Siegel found remains of the library, including 200 volumes, in the attic of the town hall, covered by sand, bricks and litter. This discovery occurred just in time to save the book from a major fire, which in 1873 damaged not only the town hall but also a large part of the town. The collection of books represents a unique set, as there are reputedly only two other comparable books collections on the world-wide scale [298].

The decline of Jáchymov was as quick as was its expansion. The population shrank to 4000 in 1574 and to 2177 in 1601 [215]. Fires, epidemic plague and wars also contributed to diminishing the importance of the town.

By the middle of the 16th century, the mining in Jáchymov was declining, as a consequence of exhausting of the richest veins and an unfavourable politic and economic situation. The emperor won a local war in 1518 and gained a small territory, but re-catholization efforts resulted in exodus of a strong protestant population to Saxony. A 50 % price increase followed soon and it adversely affected activities in Jáchymov, which depended entirely on food imports. The king supported mining activities by a central organisation of activities. Mining continued at that time on average 100 m below surface. The mountainous topography and construction of drainage drifts made possible extension of mining to a depth of 400 m below surface in the second half of the 16th century. Two major drainage adits, i.e., Barbora and Daniel, started in 1518 and 1520, were driven to total length 10 km and 7 km respectively by 1589. A triplicate increase in prices of goods in the last decade of the century brought mining nearly to a standstill. In the year 1601 the population declined to 2177. Compared to work of 10000 to 15000 miners in 900 mines and prospects during the mining boom, only 70 miners were employed in 1613. The total silver production in Jáchymov during the 16th century is estimated at 200 to 300 tons. During the period 1631 to 1655 the total production was only 838 kg. Minting of coins in Jáchymov was terminated approximately in 1671 [298], [317].

In the year 1564, a certain indebted person offered to the king Ferdinand I his collection of minerals as an instalment. The debtor suggested a price of 7000 tolar for the collection but in the opinion of the king, the value did not exceed 3000 tolar. For comparison with price of silver, 3000 tolar would buy 90 kg metal silver. Again, for comparison, the Kraslice dominion was valued at that time at 10000 tolar and the Loket dominion at 55000 tolar. As early as July 11, 1570, the emperor Maximilian issued a decree on foundation of mineral collection in the Emperor's palace [300], which should include also specimens from Jáchymov. The first documented supply of a Jáchymov mineral specimen for this collection is dated 1596. It was a specimen of *silver ore*, approximately 1.4 kg in weight, collected in the Geschieber vein, St. Dorota mine [295].

### The cobalt-silver period

Towards beginning of the 17th century, mining in Jáchymov turned to other metals, besides silver. The first

mill producing cobalt colour started operation in 1611. Profit from production of this colour was near 60%. Bismuth mining also increased, the metal was in demand until 1873 and 1894, when imports of cheap bismuth from America brought prices down. Kraus [119] presented the following production review of variety of metals:

metal	production period	weight [kg]
silver	1517-1900	554 436
Co ores used in enamel	1775-1851	1 824 227
Co and Ni oxides	1855-1894	33 429
lead	1775-1893	20 771
arsenic	1868-1894	20 928
bismuth oxide	1868-1883	10 305
bismuth	1859-1894	11 363

As mining conditions turned to be more demanding, need for a professional school became obvious. J. F. Lauer, the administrator of the Czech mining and minting office, was appointed in October 1716 to establish a state mining school in Jáchymov. By that time, there was a private mining school, founded by J. F. Weyr, head of the Mining office in Jáchymov [296]. On January 13, 1717, the state school was founded [215], though only three or four students enrolled per year. The study taking two to three years included first theoretical study followed by practical activities in the mine and visits to various mining districts in Europe. Since the school and its scheme of education received positive response, similar schools were founded in 1725 in Banská Štiavnica (Schemnitz) [297], 1747 in Smolník (Szomolnok) (both in Slovakia) and 1747 in Oravica (in Romania) [296]. The role of the mining school in Jáchymov declined after a higher level mining school was opened in Prague (1763) and in Banská Štiavnica [297].

In the middle of the 18th century, a new systematic mining financed by government was started. It was shown that poorly organised mining in the past periods left some ore reserves. During the period 1755 to 1810 silver production reached a total of 60 tons. A strong decline in mining activity followed this episode nearly until 1850, when growing interest in uranium colours used in glass and porcelain production led to uraninite exploitation.

### The period of uranium mining

#### A. Uranium compounds used as colours

Mining during the 16th to 18th century can be classified according to the main type of ores extracted as the silver period, followed by the cobalt-silver period. The third period, which began shortly before 1850, is the uranium period. As the mode of uranium utilisation changed, the uranium period included episode of uranium use for colour production, followed by radium extraction from uraninite and finally the episode of uranium exploitation as nuclear material.

Uraninite, the most widespread ore mineral in the district and the most valued one during the last decades, received little attention for centuries. As such, it was

disposed of on dumps and included in fill of exploited sections. Its name *Bechblende* was known prior to 1565. On September 24, 1789, M. J. Klaproth announced at the meeting of the Royal Academy in Berlin discovery of a new semi-metallic element, which he named *uranit* in allusion to the then newly discovered planet Uranus. He separated the substance from uraninite from the mine Georg Wagsfort in Johanngeorgenstadt (Saxony). He established the presence of *uranit* also in the associated green micaceous mineral (*chalkolit* - see torbernite) and a yellow earthy material [94]. In fact, the material separated by Klaproth as *uranit* was the oxide  $UO_2$ . The element uranium was separated in 1841 by the French chemist Peligot [310]. He studied also *black uranium ores*, i.e., *pitchblende* from Jáchymov. Before the work of Klaproth, uraninite was considered a zinc ore or an iron ore. Though uraninite was not valued, its presence in the veins used to be documented since about 1750. Thus already Ferber in 1774 [315] recorded pitchblende in the Geyer vein and in the veins opened in the drift named *Saxon-noble-men* (*Edelleutestollen*).

Following discovery of the use of uranium compounds as bright colours, pitchblende was searched for in dumps already in early 19th century, according to Kořán [312]. Later digging for uraninite in old dumps was recorded in 1843; in 1865, digging in the dump of the Emperor Josef mine produced 200 kg uraninite. Probably since 1830, occasional underground mining took place according to demand. Since the price of uranium ores kept rising, mining officials considered re-opening of deep levels of several existing shafts: Svornost, Werner's mine (Rovnost) and Bratrství (drift of *Saxon-noble-men*).

Chemist-metallurgist Adolf Patera (born 1819 in Vienna, died 1894 in Český Těšín (Teschen) [235]) played an important role for utilisation of uranium in colour production. He presented his work on use of uranium to the Imperial Academy of Science in 1847 [310] and he also proposed a method of vanadium extraction from the uranium ores [204], [324]. In 1853, Patera produced 1500 kg of yellow uranium colour, which proved to have good quality. Following his proposal, a colour factory started operation in October 1855. In 1871, the factory was transferred to the former metallurgical plant for silver extraction and it was named *The Imperial and Royal factory for production of uranium yellow colour* (*K.k. Urangelbfabrik*). The program covered eight various types of yellow colour and production of orange colour started in 1858. The ore used in the factory was high-grade hand-sorted pitchblende containing 57 wt. %  $U_3O_8$  and concentrate containing 52 wt. %  $U_3O_8$ . Uranium use was nearly quantitative, the refuse contained only 0.25 wt. %  $U_3O_8$  [313]. In view of high quality, the colours were in demand, with exports to Great Britain and France. At that time, colour production was the main and profitable program of the Jáchymov mines. From 1868, colours remained as the single product. Other ores from small-scale mining were transported for processing to Příbram or exported abroad. For example, colour production in 1886 totalled 11062 kg valued at 266627 gold coins [313].

The glut of thermal waters on March 13, 1864 below the 12th level in the mine Svornost was estimated at 705  $m^3$ .

## B. Uranium compounds used for radium extraction

The discovery of radioactivity in 1896 by Becquerel and the discovery of polonium and radium by Marie Skłodowska - Curie and Pierre Curie in uranium-bearing material from Jáchymov heralded a new period of interest in this district, dated since the beginning of this century. Curies ordered 10 tons of refuse material from the Jáchymov uranium colour factory in 1898 as the raw material, from which they extracted the new elements. The following discovery of the healing effects of radium provided impetus for opening some of the closed mines in Jáchymov and opening new ones. First, the Werners mine was reopened and mining started on the Geister, Schweitzer and Bergkittler veins, followed by work on the *Saxon-noble-men* drift.

First works utilised the colour factory refuse material for production of radium compounds. The process of radium chloride production was developed by M. Curie and Debier. Until 1905, the refuse material from colour production was imported to Germany by the company Buchler and Co. in Braunschweig for concentration of Ra. On June 17, 1907, production of Ra started in newly equipped section of the colour factory in Jáchymov [314]. First recorded Ra production in the factory is dated 1909. Until 1913, it held monopoly for radium salts, which was bringing important income to the government of the Austrian-Hungarian Empire. In 1913, income for this commodity exceeded 1 million gold coins. Concurrently with processing of refuse material of the colour factory (until 1924), mining and dressing of uranium ores continued for colour production and for Ra extraction.

The organisation *State radium, and uranium mines* was founded in 1918. The Werners mine and the drift *Saxon noble men* were in operation, while mines Svornost (Einigkeit) and the Emperor Josef I were flooded. Gradual modernisation of the old mines included introduction of electric transport, pumping and compressors. The mine Svornost was re-opened in 1923-24 after water pumping and a central dressing plant was constructed at the drift of *Saxon-noble-men*. The dressing process included some hand-sorting after crushing, followed by milling and gravity separation. The annual production of the uranium and radium factory increased to 30 to 35 tons of pure U and 3 to 4 grams of Ra. Uranium was used in production of yellow and orange colours containing 72 to 83 wt. %  $U_3O_8$ . Insoluble residues were processed via repeated crystallisation to almost pure radium chloride.

The competition by producers in USA, felt since 1914, and especially processing of Congo ores in Belgium (since 1923), resulted in quantity of relatively cheap radium. This brought the Jáchymov mines again in a difficult situation. Following Urban [314], during the period 1918-1937 profitable operation was achieved only in the years 1919-22, 1926, 1928, 1931. The total loss during this period was 40 million Czech crowns. For this reason, Czechoslovak government permitted exports of uranium ores since 1928 and no systematic exploration for potential uranium mineralization was conducted.

After annexation of Jáchymov in 1938 to Germany, the uranium mines as former property of Czechoslovak

Republic became the property of Nazi Germany. Three German companies producing Ra founded the company *St. Joachimsthaler Bergbaugesellschaft*, which obtained 90 years lease of the mines from the government on the condition that they will pay 100 crowns per ton of mined uranium ore and that the state will buy all Ra which could not be sold on free market and will provide funds for covering operation loss up to 90% level [316]. As the open parts of the deposit were rather exhausted, the company continued new work in the Werner mine up to 12th level and on the *Saxon-noble-men* drift, exploited mainly uranium ore and only limited quantity of Bi-Co-Ni ores. The Svornost mine was operated exclusively for pumping thermal water for the spa [314].

Besides the above mentioned company, some other firms participated on production of radium. Part of the Ra production was used in preparation of phosphorescent colours.

The Jáchymov colour factory, located opposite the present spa house Radium, was demolished in 1938 as being beyond modernisation.

### C. Uranium used as nuclear material

The last and the most extensive period of mining in the district took place after the Second World War. On June 14, 1945, representatives of the Czechoslovak Republic took over the property of Jáchymov mines. At that time, the mines had 122 employed persons, one personal car, one pair of horses, one carriage, two farm-type transport vehicles, one load-sledge and one personal sledge [314]. On August 30 and 31, 1945, J. Koutek and V. Zoubek from the Central Geological Institute, Prague, conducted a preliminary inspection of the mines Svornost, Rovnost and Bratrství. They noted that the exposed veins were largely exploited and recommended exploration on other veins and in outer parts of the district. In summer 1945, the idea of continued uranium mining and Ra extraction, probable production of uranium and phosphorescent colours prevailed, including possible mining of Bi, Co, Ni [316].

On November 23, 1945, a treaty on government level was signed between the Czechoslovak Republic and the USSR on co-operation in prospecting, exploitation and supplies of radioactive materials. A decree of the Ministry of Industry, dated January 1, 1946, founded the National enterprise *Jáchymov mines, Jáchymov*. This was a fundamental step for future extensive uranium prospecting and production of uranium for nuclear purposes, including many regions beyond the Jáchymov district.

The revision and exploration works resulted soon in location and opening of new mineralised vein clusters. During the early activity, exploration was carried out at levels of old mining. Since 1950, new shafts provided access to veins of the majority of mining fields. Unlike in the historical periods, even the deepest parts were exploited and the veins were followed downwards up to the granite floor. The quick prospecting activity is documented by the following comparison: in 1945 the uranium reserves were estimated at 59 tons U, on January 1, 1954 total geologic reserves were 3404 tons U (by that time, some of the veins were already completely exploited).

In 1946, mining started on re-opened mines Rovnost I and Bratrství, followed by re-opening the mines Svornost and Eliáš in 1947. 14.4 tons of U were mined in 1946. In the following years, other mining fields were opened for mining so that 9 mines were in operation in 1952: Rovnost I, Eliáš, Eduard, Svornost, Rovnost II, Eva, Barbora, Bratrství and Plavno. Panorama and Popov mines were in exploration stage. The mining culminated during the period 1955-57, characterised by opening 102 to 125 km of underground works per year, exploitation of 755000 to 812000 m<sup>2</sup> of veins (in projection on the wall) and extraction of 830 to 870 tons of uranium.

Processing of ores included first hand sorting and gravity enrichment in the old dressing plant at the mine Bratrství. A new dressing plant was completed at the Eliáš mine in 1948. A plant for chemical processing was opened in 1952 in Nejedek near Karlovy Vary, which included technology of acid leaching, and production of uranium concentrates.

A gradual decrease in mining started in 1959, as individual mining fields were completely exploited. The pit Jeroným belonging to the Abertamy mine was the last one to be handed over for closing in 1964. This terminated the period of uranium mining in the district, which continued over 100 years, and closed the 450 years long history of ore mining in the Jáchymov district.

As to estimates of uranium production before 1945, there is a good agreement for the early period. Most sources use the data given by Kraus [119]:

period	uraninite [kg]	amount of U [kg]
1853-1900	98315	83400
1901-1913	52265	44300

For the following decades, various data are presented in various sources. Thus the plant report for 1947 gives average annual production for the period 1901 to 1940 as 7.7 t U per year, for the period 1941 to 1945 as 9.0 t U per year. Another report used the numbers of 7.7 and 9.0 tons as total production for the whole period and this error was repeated in some other texts. The quantity of mined uranium is approximately indicated by the weight of Ra production. During the years 1909 to 1936, 61.683 g of Ra was produced [312] and during the years 1939 to 1945 15.813 g of Ra [314]. An occasional postal cancellation stamp contains an erroneous information on achievement of total production of 100 g Ra in 1936. Professional publications of that time were correct in mentioning *celebration of mining of 100 g of Ra in Jáchymov*, i.e. total content of Ra in all mined uranium ores.

After consideration of the cited sources and other data, the total production of uranium during the period 1853 to 1945 can be estimated at 550 tons.

During the years 1946 to 1964, 9600 m of shafts, 180 km of vertical ore chutes, 855 km of horizontal adits were excavated and a total of 6550000 m<sup>2</sup> of veins (in projection on the wall) was exploited. Total mining exploitation (including U extracted + loss) reached 7950 t of U. After addition of data for the period before 1946,

the total quantity of uranium exploited reaches 8500 t of U.

In the register of mining operations in the Jáchymov ore district, there are 33 shafts, 163 adits and 50 small and prospecting shafts, including old-time works as well as those excavated during 1946-1964 period.

Utilisation of radioactive waters for curation represents activities of its own character. The healing effects of Jáchymov mining waters were known to miners long time ago and the waters were used for curation of rheumatic conditions. After discovery of radium, uranium-bearing refuse materials were used for artificial preparation of radioactive water.

H. Mache and S. Meyer, physicists from the University of Vienna discovered the high radioactivity of some of the mine springs in 1905. At the suggestion of the mining director J. Štěp, the first radioactive spa was opened in 1906 in the house No.282, belonging to the local baker J. Kühn. At the modest beginning, water was carried from the mine Werner in 40 litre wooden containers. Miner J. Prennig supplying the water served the nick-name *Donnerkheil*. Expansion of spa followed. During one month in 1908, 4 km long water pipe line was constructed. The number of patients as well as the number of spa houses kept increasing [215].

Three periods in the history of mine springs are recognised. The first period, or rather event, represents the

glut of mining waters in 1863. This proved to have negative effects on ore mining. The second period began with utilisation of cold radioactive springs in the Daniel level of the Werner mine, so-called Štěp's springs. The Curie spring on the 12th level of the Svornost mine was utilised since 1924, the Becquerel spring was discovered in 1928 and in 1952 the Evangelist and Prokop springs were opened. A common feature of all these springs is that they were found or opened incidentally in the course of ore mining. The third period is marked by sinking the hydro-geological prospecting borehole HG-1, from a site at the 12th level of the Svornost mine. The borehole tapped a thermal high-capacity Rn-bearing spring, which provides the main supply of thermal water for the Jáchymov spa. After the last ore mine was closed in 1964, the only mine utilised is the Svornost mine supplying radioactive water. The Josef mine serves only as ventilation and escape route. At present, reconstruction of both shafts was completed including installation of new head frames. Drilling prospecting for additional supply of radioactive water is taking place at the 12th level of the Svornost mine.

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#### Historie jáchymovského rudního revíru

Jáchymov byl založen r. 1516 na místě zaniklé obce Konradsgrün v době, kdy zde bylo objeveno bohaté ložisko stříbra. Prvních 20 let, kdy těžba stříbra stoupala, se Jáchymov rozvíjel přímo explozivně, takže 1534 byl druhým největším městem v Čechách po Praze. V té době byl Jáchymov i důležitým kulturním centrem. Pobýval zde Agricola, Mathesius a mnoho dalších známých osobností. Existovala zde latinská škola, jejíž knihovna se z velké části zachovala dodnes. Mince, které zde byly raženy, byly nazývány podle německého názvu města "Thaler", později "tolar", daly jméno pozdější americké měně. R. 1716 zde bylo založeno státní hornické učiliště, první ve střední Evropě. Vývoj města se odehrával ve vlnách - období rozvoje se střídala s hlubokými úpadky následkem válek, požárů, epidemií nebo ekonomických potíží. Zájem těžby se postupně přesouval ze stříbrných rud na rudy kobaltu a niklu a později uranu a radia. Vyráběly se zde uranové barvy i radiové sloučeniny. Poslední velký rozvoj Jáchymova nastal po druhé světové válce, kdy se vydolovaná a upravená uranová ruda vyvážela do Sovětského svazu. Dolování skončilo r. 1964. Od roku 1906 se využívají důlní prameny pro lázeňskou činnost.