Geological Study Collection of the Mercury Mine in Idrija

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The collection and classification of various geological samples has a long tradition in the Idrija Mercury Mine. In the second half of the 19th century geological collection was prepared and arranged by M.V. Lipold. In 1956, a rich petrographic-palaeontological collection was created at the Municipal Museum in Idrija. Due to the exceptional genesis and development of the Idrija ore deposit, many of the petrological, structural and ore samples are, from the professional aspect, quite unique. The collected materials, which were mostly unclassified and deposited in the quarters of the former mine geological service, were formed into a Mine Geological Collection comprised of 7 thematic collections presenting an overview of all aspects of the geological structure and genesis of the ore deposit, and testify to its exceptionality and complexity. During the arrangement, structural classification and naming of rocks, consideration was given to those classifications that have been tested and internationally recognized as the best existing classifications. The mine geological collection of the Idrija Mercury Mine and the accompanying documents are arranged in the form of a study collection, and the displayed samples have been collected, arranged and presented in a manner that will also prove interesting to the general public and tourists.

Contents

Historical overview

Although no written records exist of possible 'fossil' collections (minerals, rocks, fossils and ores) at the Idrija Mine up to the second half of the 18th century, there is no doubt that the mine administrators of the time already had reference collections of Idrija minerals and ores. Perhaps even one or more unusual rocks from the Idrija ore deposit could be found among the selected ore samples (Čar & Pišljar, 1999).

J.A. Scopoli, the first mine physician and an acclaimed, European natural scientist, who spent sixteen years in Idrija, had quite an extensive and, for that time, well-arranged collection (Scopoli, 1761). Scopoli used the samples of minerals, rocks and ores in his lessons at the Idrija secondary technical school, where he taught chemistry and metallurgy from 1763 to 1769.

Idrija rocks and ores also occupied an important place in the impressive naturalist collection of Baltazar Hacquet. In the second volume of his extensive, encyclopaedic book *Oryctographia Carniolica*, Hacquet (1781, p. 133) said the following about the Idrija Mine; "I collected all the generations, types and classes of rocks and ores from the Idrija Mine described so far over a period of 12 or more years, and everyone is welcome to come and see them; every mine official of the said mine is acquainted with them. That is why I must mention this, so no-one will have any doubts as to the genuineness of these beautiful and unusual samples." After his departure from Idrija, Hacquet took his naturalist collection, which also comprised samples from the Idrija Mine, to Ljubljana and later to Poland, where he lectured at the Krakow University (Pilleri & Mušič, 1984).

In the second half of the 18th century, amateur rock collecting began to flourish in Idrija. A report published by B.F. Hermann (1784) informs us that he visited two collections of minerals and ores during his visit to Idrija. The first collection, which was the larger and more impressive, was owned by mine administrator Schaber, and the second, which in Hermann's opinion was "nothing special", was kept by forester Leitner.

In the period from 1853 to 1858, the respected Slovene geologist M.V. Lipold conducted his first geological expeditions to the surroundings of Idrija and collected several rock samples still preserved today, as well as the first fossil specimens (Lipold, 1874). These formed the basis of the palaeontological part of the mine's geological collection (Čar & Pišljar, 1999).

In the years that followed, numerous fossil remains were collected in the broader surroundings of Idrija and the mine by the then director, Sigmund von Helmreichen (1853-1867). When M.V. Lipold took over the administration of the Idrija Mine in 1867, a rich collection of fossils and rocks already existed. Over the next few years, Lipold considerably enriched the petrographic-palaeontological collection (Fig. 1), which, by its size and content, acquired national importance. Thirty years later, the mining engineer J. Kropáč (1912), who was primarily interested in the geology of the Idrija Mine, wrote that it was largely owing to Lipold that the mine had a valuable palaeontological collection. Lipold's collection included, of course, numerous samples of various minerals, rocks and ores. That part of Lipold's collection which survived the First World War, 25 years of Italian occupation and the Second World War is today unclassified, and is kept at the Munipical Museum in Idrija.

In 1956, a new, extensive, stratigraphic-lithological and palaeontological collection and an impressive collection of mercury ores were set up by mine experts at the Municipal Museum in Idrija. Over the next few decades the collection was enriched with several new samples and today comprises over 2000 specimens. In 1992 the collection was expertly renewed, considerably enriched and set up in newly renovated rooms in the Idrija Castle (Čar & Pišljar,1999).

Professional basis for the creation of the Study Geological Collection

The first geological investigations in the mine and surroundings of Idrija, whose data still have validity today, were conducted by M.V. Lipold in the second half of the 19th century (Lipold, 1874). In the decades preceding the First Word War, new and interesting views on the geological structure of the ore deposit were contributed by

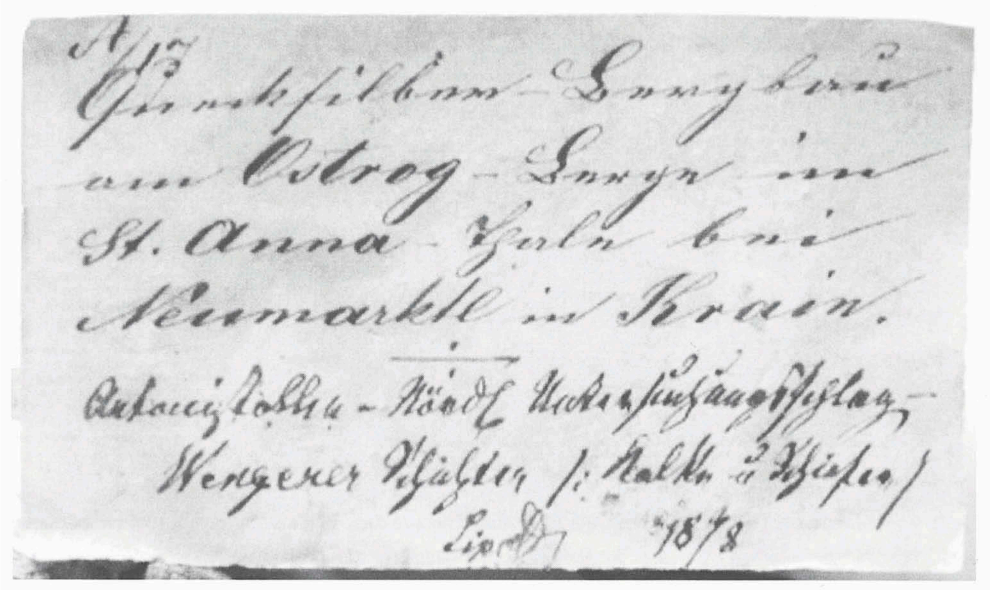

Fig. 1. Original inventory list from Lipold's collection.

Kossmat (1899,1911) and Kropáč (1912), and on the genesis of the mercury ore deposit by Schrauf (1891). Their investigations of the Idrija ore deposit and the broader surroundings of Idrija were continued in the period from 1955–1985 by a team of mine geologists in collaboration with external experts.

As early as in 1959, I. Mlakar resolved all the major open lithostratigraphic problems remaining in the Idrija region. In 1967 the same author presented completely new and original views on the structure of the Middle Triassic Ladinian layers in the Idrija ore deposit (Mlakar, 1967). In Mlakar (1969), he explained the complicated thrust structure of western Slovenia and determined the position of the Idrija ore deposit within this structure. Two years later, Mlakar and M. Drovenik explained the structural and genetic particularities of the Idrija ore deposit (Mlakar & Drovenik, 1971). They discovered that the ore deposit had been formed in the Middle Triassic, approximately 235 million years ago. The mercury ore deposit is partly syngenetic (sedimentary) and partly epigenetic in origin. Mlakar and Drovenik investigated the origin of individual types of mercury ores and described the characteristics of the ore deposit.

This was followed by a reconstruction of the Idrija Middle Triassic tectonic system with the central fault trough in which the Idrija ore deposit was formed. The positions of all ore bodies in the area during the Middle Triassic were also determined (Placer & Čar, 1975, 1977). Finally, the origin and formation of the Idrija Middle Triassic tectonic system was reconstructed on the basis of sedimentological and lithostratigraphical investigations (Čar, 1985), and the development of the former Middle Triassic structure of the ore deposit into its extremely complicated, present-day state (Fig. 2) was explained on the basis of structural analyses (Placer, 1982). The results of these investigations were supported by numerous lithostratigraphical, sedimentological, structural, tectonic and mineralogical studies, and studies of mercury ores. The investigations

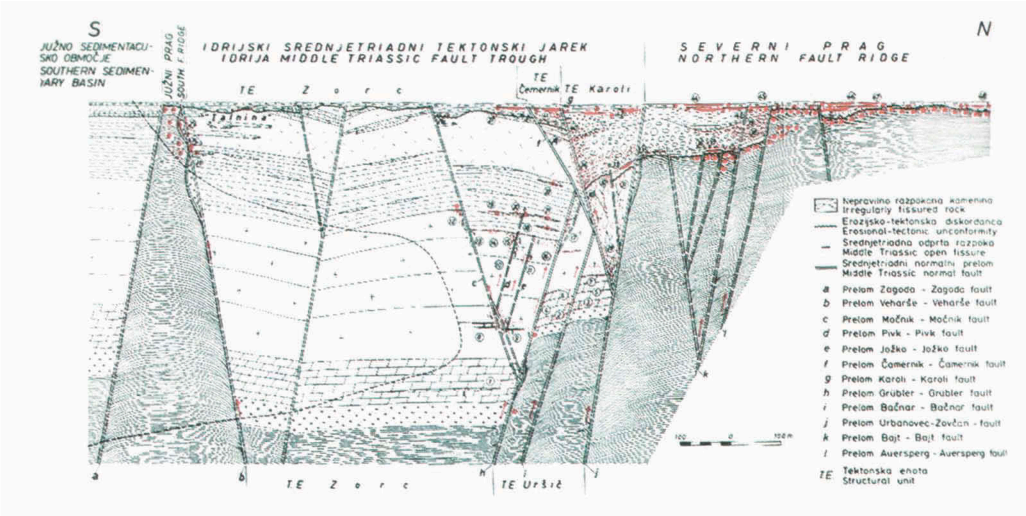

Fig. 2. Cross-section of Middle Triassic structure of the Idrija ore deposit showing position of ore bodies.

Fig. 3. Middle Triassic erosional unconformity. Ladinian pyritized kaolinite sandstone lying on eroded Anisian dolomite (light).

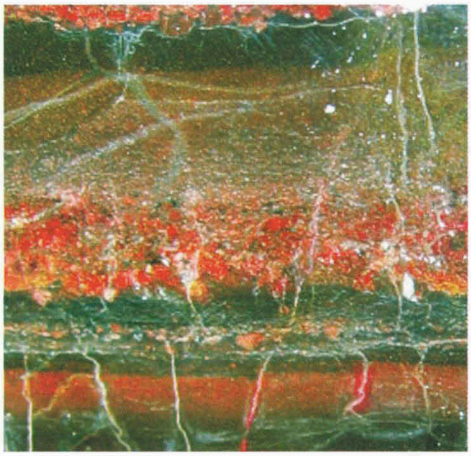

Fig. 4. Typical sedimentary (syngenetic) ore in tuffite. Light grains: chalcedony intercalated with cinnabar.

were accompanied by the extensive collection of samples. The findings of mine geologists are collected in three doctoral dissertations and over 30 geological papers.

In the opinion of numerous, internationally recognized experts who have visited it during the past fifty years, the Idrija ore deposit is one of the most structurally and genetically complex metal ore deposits in the world. As Mlakar (1990) reported, the Russian Academician Professor V.I. Smirnov wrote; "I have seen many ore deposits in various parts of the world, and some of them were very complicated. But I must admit that I have not yet seen an ore deposit with such a complex structure as the one in Idrija, which, from the structural aspect, is undoubtedly one of the most complicated endogenous ore deposits in the world." Professor Matija Drovenik, a leading expert on the world's ore deposits, also had some interesting remarks about the situation in Idrija; "Everything that occurred in the Idrija ore deposit has been assessed by scientists as an unusual, extremely interesting creation of nature." (Drovenik, 1989). The main contributions on the Idrija ore deposit include the following: Čadež (1980), Čar (1975, 1985, 1989, 1990), Čar *et al.* (1980), Drovenik & Čar (1975), Drovenik *et al.* (1990), Mlakar (1967, 1969, 1975), Mlakar & Drovenik (1971), Placer (1974-75, 1976, 1982) and Placer & Čar (1977).

Geological Study Collection

Owing to the exceptional Triassic tectonic structure and genesis of the Idrija ore deposit, and the subsequent tectonic development into the present-day extremely complicated structure, it is understandable that all of the geological particularities of Idrija could not be displayed in a single, uniform collection, particularly since numerous samples are, from the professional aspect, quite unique. It was therefore decided that the collected study materials, which were mostly unclassified and stored in the quarters of the former mine geological services, would be arranged into seven thematic collections. These collections present an overview of all aspects of the geological structure of the ore deposit, and testify to its exceptionality and complexity.

The names and descriptions of samples are in line with the classifications and nomenclature used in Slovenia, as explained to students in lectures at the Geology Department of the Faculty of Natural Sciences and Technology in Ljubljana. The classifications used are the same as those employed in other countries of the world (for carbonate and volcanoclastic rocks), or have been enriched and adapted to the present situation (clastic rocks).

Lithostratigraphic collection of rocks in the Idrija and Cerkno regions — In the Idrija and Cerkno regions, specific conditions prevailed in a uniform area of sedimentation up to the beginning of the Middle Triassic. In the Middle and Upper Triassic, rocks began to be deposited on the shallow-water Carboniferous platform in the Idrija region, and in the deep-water basin in the Cerkno region. The collection comprises 60 of the most important lithostratigraphic samples from both sedimentation areas. Detailed mineralogical, petrological and geochemical analyses were made for all samples.

Collection of rocks of the Idrija ore deposit — The Idrija mercury ore deposit was formed in a fault trough in the central part of the so-called Idrija Middle Triassic tectonic system. The development of the fault trough and the formation of rocks in it were accompanied by complicated tectonic and extensive volcanic activity. These conditions allowed for the formation of special, highly specific rocks, which are a particularity of the ore deposit and cannot be found elsewhere in Slovenia (e.g., various kaolinite rocks, gravels, bog layers ('Skonca'), etc.). The collection is comprised of 108 types of rocks.

Collection of samples of structural and tectonic characteristics of the Idrija ore deposit — The present-day extremely complex structure of the ore deposit is the result of intensive tectonic activity in the Middle Triassic period (erosion, tensile tectonics) and the complicated Tertiary tectonics (overthrusts and strike-slip faulting). The tectonic phases strongly 'mixed' the rocks from different geological periods, creating various contacts (erosive surfaces, contacts of tensile and strike-slip faults, thrust deformations), which are well-preserved in the present-day structure of the ore deposit (Fig. 3). The collection is comprised of 40 samples.

Collection of minerals of the Idrija ore deposit — From the aspect of mineral composition, the Idrija ore deposit has a very simple structure. Only 18 minerals were found. Elemental mercury (native Hg) and cinnabar (HgS) are present in economically important quantities, while other minerals are very rare. From the mining and geological standpoint, the Idrija ore deposit is therefore a monometal and monomineral deposit. In addition to the very rich cinnabar forms, there is also an interesting mineralogical peculiarity, a crystalized, pistaccio green, aromatic hydrocarbon called idrialin (idrijalin).

Ore collection — The Idrija ore deposit was formed as the consequence of the degasification of the Earth's mantle. The hydrothermal solutions enriched with mercury, which flowed through open faults and fractures from the interior of the Earth 235 million years ago (Middle Triassic), had a temperature of only about 100° C. Owing to the faults and numerous fractures, some of the thermal waters passed through older layers. The rocks were partly replaced by cinnabar, which led to the formation of more or less rich epigenetic ore bodies in Carboniferous, Permian, Scythian, Anisian and older Langobardian layers. Part of the rich hydrothermal solutions flowed out in the form of hot springs directly into the marsh that existed there at the time, where synsedimentary syngenetic ores were formed. Extremely rich and attractive gel ores (up to 78% Hg) were formed from the cinnabar gels, and numerous varieties of sedimentary cinnabar ores were deposited from the disintegrated, richly mineralized chalcedonous layers in the Middle Triassic bog.

The ore collection is divided into two parts. The first part comprises 96 samples of the basic types of syngenetic (sedimentary) ores in Ladinian rocks, particularly 'Skonca' layers (Fig. 4). The second part features 95 samples of epigenetic cinnabar ores arranged in a stratigraphic overview of mineralized rocks, from the oldest Carboniferous lithological rocks to the youngest Cordevolian dolomite. The richest cinnabar ores have typical 'mining' names such as 'jeklenka' (steel ore), 'opekovka' (brick ore), 'jetrenka' (liver ore), 'coral ore', layered ore and rich ore. Carboniferous shales intercalated with economically important quantities of native mercury represented another particularity of the ore deposit. This ore was named 'shale ore'.

Collection of ores from various ore bodies of the Idrija ore deposit — One hundred and fifty eight ore (mineralized) areas were found in the Idrija ore deposit and have been partly or fully investigated. Experts at the Idrija Mine traditionally named these areas ore bodies (OB). The 141th OB was primarily comprised of cinnabar ores (syngenetic and epigenetic), while the 17th OB contained only native mercury (epigenetic ore). In 14 of the cinnabar OB, only or predominantly syngenetic cinnabar ores were extracted, while in the remaining 127 OB, only or predominantly epigenetic ores were extracted.

Different ore types appeared in specific or similar patterns depending on how they were formed, and where they were situated in the lithostratigraphic rocks and tectonic structures. The mercury content in individual ore bodies varied considerably. Very poor ores (0.05% Hg) to extremely rich ores (over 70% Hg) were excavated. In the period after the Second World War, ores were classified according to quality into the following categories; very poor ore (0.05 to 0.1% Hg), poor ore or 'ba l perh' (0.1 to 0.5% Hg), rich ore (0.5 to 5% Hg) and steel ore (>5% Hg).

Syngenetic ores were located in various Ladinian layers, e.g., kaolinitic sedimentary rocks, conglomerates, bog layers (local name; 'Skonca' layers) and in the lowest part of volcaniclastic rocks. Epigenetic ores appeared in all rocks from Carboniferous to Cordevolian. Numerous mining fields extended through various structural units or ore areas in a manner enabling the excavation of both syngenetic and epigenetic ores within the same mining field. The sixth collection represents ore specimens from fourteen ore bodies (174 samples) and 26 samples from various ore bodies in the same lithostratigraphic rocks.

Collection of Special Samples — The thematic collection of special samples is comprised of various specimens collected or obtained by mine geologists on various occasions. The collection features samples from other ore deposits around the world, some ores from the Idrija mine, various lithological-palaeontological and special tectonic samples, souvenirs and demonstration samples. The samples of ores from the Idrija ore deposit are mostly large in format and intended for special presentations. The remaining samples are only partly related or unrelated to the ore deposit, and were therefore not directly included in the thematic collections.

Conclusions

The extreme complexity of the Geological Study Collection and its seven thematic groups is apparent. The collection not only presents the genetic aspects of all geological elements participating in the ore deposit structure (mineralogy, petrology, sedimentology, ore geology, structure and tectonics), but also their development in time and space from the Middle Triassic to the present (Tertiary transformation of ore deposit into the present state). All the genetic and structural occurrences are professionally and comprehensively explained. The professional decisions required for the classification of the collection are based on extremely detailed and fully preserved geological documents. Some of the key documents are also exhibited and of course the mercury itself (Fig. 5).

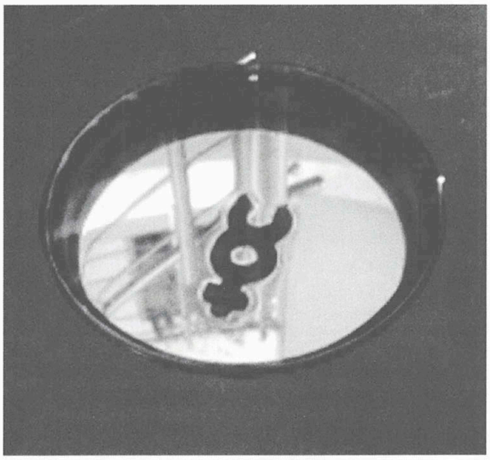

Fig. 5. Vessel (stone bowl built into the floor) contatinig mercury, exhibit on the ground floor of the new mine collection.

The entire geological collection has also been prepared in computer form.

Visitors can facilitate their work by searching for individual samples from the database in a special computer file containing the entire mine collection. The database of samples includes professional descriptions and information on the particularities and location (coordinates, map) of each sample. Photos of each sample have been added. The geological collection of the Idrija Mine represents a unique resource of Slovenia. No doubt there are very few such detailed and precisely classified geological collections in the world devoted to a single geological phenomenon, in our case the Idrija Mercury Mine.

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