Past and possible future of the Lahóca mine, Recsk, Hungary - a historical review

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História bane Lahóca a jej možná budúcnosť (Maďarsko)

Epitermálne zlatonosné zrudnenia sa viažu k takým hydrotermálnym systémom, v ktorých sa minerály, obsahujúce zlato, objavujú v hĺbke 1-2 km pod povrchom. Epitermálne Cu-Au nosné ložisko v Recsku (Maďarsko) sa priestorovo a geneticky viaže k recsskému eocénnemu porfyrickému systému. Na tomto území sa dobývala meď s menším podielom zlata a striebra, v rokoch 1852 - 1979. Výskum Cu-porfýrového skarnového systému hlbších obzorov sa začal v roku 1968, bez praktického dobývania. Vrtný prieskum sa začal v r. 1994 a trvá dodnes. Podľa terajších výsledkov a poznania ložiska, je možné zlato v oblasti Lahóca ekonomicky využívať pomocou biooxidačnej technológie.

Key words: epithermal deposit, Cu-porphyry, collomorph pyrite.

Introduction

The Lahóca mine is situated in Recsk, NE part of Hungary. It was the main producer of copper in the country for many decades. Although the main time of mining can be ascribed to the years 1930-70, the history of mining and exploration lasted for more than 230 years. The epithermal gold mineralization that was revealed by the newest explorations make Lahóca have the potential to became a significant producer of gold in Central-Europe.

History of mining and exploration

The first discovery in the area of Recsk-Parádfürdõ was made by Markhót in 1763 who mentioned Cu-Ag ores near the alum outcrops in Parádfürdõ. More than 30 years later Kitaibel (1799) described the rocks in the surroundings of Recsk as "porphyrs". He also mentioned traces of oil near Recsk. Until the middle of the XIX. century, smaller adits were opened that are still known.

The discovery of the famous native copper in Bajpatak (Haidinger, 1850; Kubinyi, 1852) gave a new impulse to exploration. The smaller drifts of Fehérkõ were re-opened, and the mining in Lahóca started. By a few fits and starts, mining activity was carried here until 1979. At the beginning of mining, Austrian geologists worked in the area. They described the ore bodies as impregnated stocks. As regards to ore minerals, Szabó (1875) realized the difference between the enargite and the sphalerite-pyrite-tetrahedrite mineralization.

In 1926 the Recsk mine was transferred into state ownership and the production increased. It resulted the revival of the exploration work as well. It was also the time of the more intensive oil-exploration in the Bükkszék-Parád area, revealing new data about the basement and Terciary rocks. Löw (1925) put in parallel the geological situation and mineralization of Bor mine, Yugoslavia and Recsk mine. He also described the oxidation-cementation zone in Lahóca.

Rozlozsnik (1939) first realized the important role of the Darnó-line in the tectonic setting of Hungary. He also described the stratovolcanic formations in the Lahóca-Kanázsvár-Fehérkõ area. The first detailed paragenetic examinations of ore minerals were made by Papp (1938) and Sztrókay (1940).

After the 2nd World War the production of Lahóca mine was suspended because the ore reserves seemed to be exhausted. Due to the intensive exploration by drillholes and drifts, new reserves of ore became known in the fifties. From that time, the mining of the new ore bodies was continuous until 1979.

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The ore-exploration was re-started in 1958 looking for the deeper connections of the Lahóca ore bodies. The drilling exploration was made in three steps. At first, a metasomatic Pb-Zn mineralization was revealed by four, 1000 m deep drillholes in a N-S section. Following this, 12 deep drillholes were made, in two E-W sections. Besides the ore indications above, porphyry copper ore was found in intrusive rocks. In the third step, 1200 m deep drillings in networks of 500x500 m, 350x350 m, and 175x175 m were made. During this, the skarn mineralization was discovered with chalcopyrite, pyrite, sphalerite and magnetite minerals. Based on the results above, a deep underground mine started to be built in 1970, in the northern part of the area. Meanwhile, the drilling exploration was continued in the southern part. Zelenka (1975) sketched the structural-magmatic setting of the ore bodies. The subvolcanic andesite was described by Baksa (1975), the stratovolcanic andesite group was examined by Földessy (1975). The hydrothermal alterations and the skarn-hydrothermal-metasomatic processes were studied by Csillag (1975).

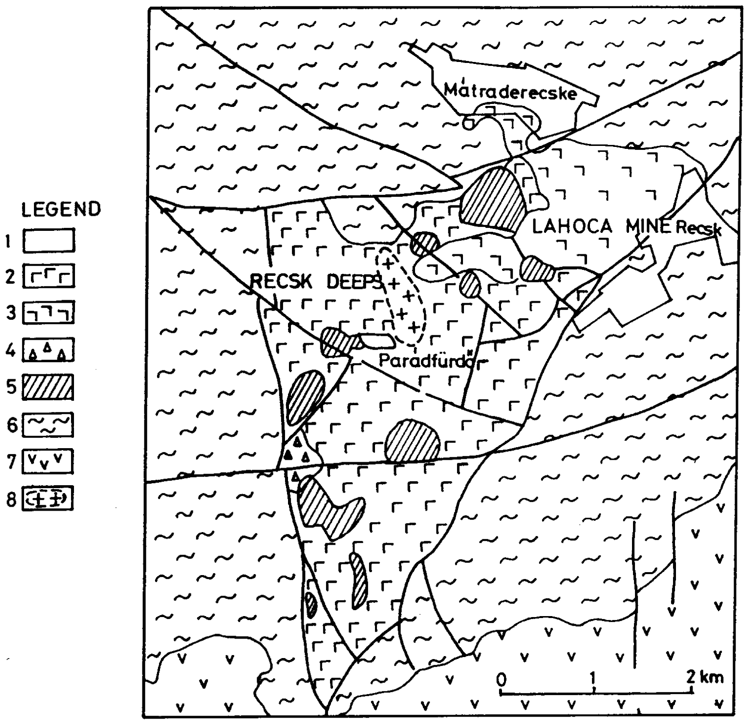

Fig.1. Geological sketch of the Lahóca area (after Földessy, 1996). 1-settlement, 2-Upper Eocene andesite and dacite (1. and 2. stage), 3-Upper Eocene-Oligocene andesite (4. stage), 4-Upper Eocene diorite-porphyry breccia (3. stage), 5-Extreme hydrothermal alteration, 6-Middle and Upper Oligocene siltstone, clay, sandstone, 7-Miocene volcanic and sedimentary series, 8-hidden Upper Eocene diorite-porphyry intrusion.

Based on the new recognitions due to the intense exploration activities in the former two decades, Baksa gave an outline of the Recsk mineralized complex in 1984. He pointed out that the Recsk complex was a part of the Eocene island arc system which now can be traced along the Balaton-Darnó line, and the main part of the ore mineralization were connected to the hydrothermal phases of the diorite-porphyrite intrusion, and two, younger volcanic phases produced younger, re-mobilized ore mineralizations near surface.

In 1975, during the exploration of the porphyry and skarn copper ore a new enargite-luzonite-pyrite mineralization was found in the northern foreground of the Lahóca hill by Baksa. He divided the mineralization into three genetically interrelated groups. The so-called "gold-pyrite” occured in lenses and small ore-bodies on the top of the lava-breccias.

While the significant mineralization at Recsk was connected to the andesite-diorite intrusives, the surficial andesitic volcanism was associated to the copper-pyrite mineralization. The role of the Darnó-line in the Recsk mineralization was pointed out by Zelenka at al. in 1983.

In relation to the porphyry and skarn copper deposits, two deep shafts, 7.5 km drifts and 95 km underground drillings were completed in 1986.

The Australian Rhodes Mining NL, Perth acquired the exploration licence of the Lahóca epithermal deposit in 1991. According to the growing interest for gold in the world and based on the gold discoveries in the eighties, the drilling exploration was re-started in the Lahóca zone in 1994. It was realized a few years before, that the model of epithermal gold deposits perfectly fitted to the Lahóca area (Földessy, 1997). The exploration program was carried out in three steps. During three years, 57 drillholes were made with a total length of 8220 m.

General features of epithermal gold deposits

Epithermal gold deposits, which contribute significantly to the world's gold supply occur in volcano-plutonic arcs (both island- and continental arcs) associated with subduction zones of similar ages to those of volcanism. The temperature of the hot carrying fluids range between 100-300 C°

during the formation of the deposit. The gold mineralization appears at shallow depths (less than 2 km) and the host rocks are mainly volcanic rocks.

According to their alteration mineralogy, epithermal gold deposits can be divided into two main types: high sulphidation (HS) and low sulphidation (LS) deposits. The two types are formed from chemically different fluids in contrasting volcanic environments.

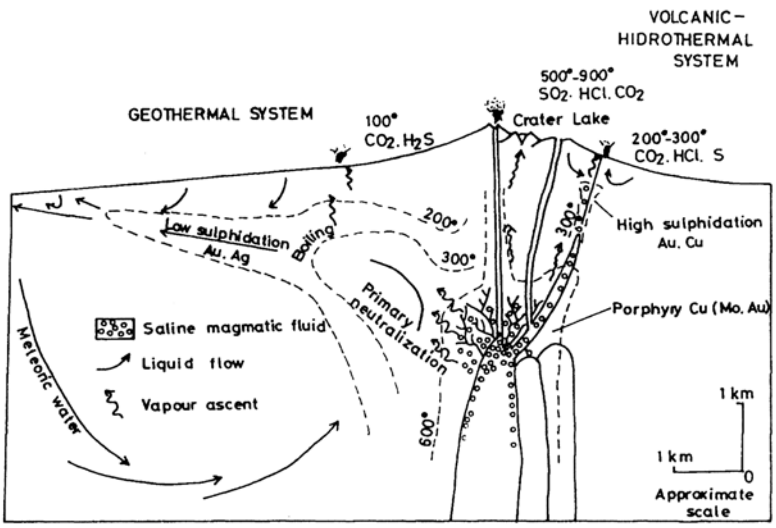

Fig.2. Schematic cross section showing the environments of a porphyry Cu and the associated low sulphidation and high sulphidation epithermal ore deposits (After Hedenquist, 1997).

The low sulphidation deposits (also called adularia-sericite type) are formed at distal positions relative to the intrusive heat source. The LS fluids are a mixture of rainwater that percolated into thesubsurface, and the rising magmatic fluids. The ore minerals are pyrite, electrum, native gold, sphalerite and arsenopyrite appearing in veins, stockworks, cavity fillings or breccias. Gangue minerals are quartz, chalcedony, calcite, adularia, illite and carbonates. This style of mineralization is characteristic in many active geothermal systems. Some significant low-sulphidation deposits are: McLaughin, California; Hishikari, Japan and Kelian, Borneo.

The high sulphidation deposits (also called the acid-sulphate type) appear closer to the magmatic heat source. The HS fluids are derived from the magma and deposit gold near the surface where the solution was cooled. The gold may come either directly from the magma source or it may be leached out of the host volcanic rocks as the fluids travel through them. The ore minerals are pyrite, enargite, chalcopyrite, tennantite, covellite, native gold and tellurides appearing as fine disseminations, replacements or hydrothermal breccia bodies. Stockworks and veins are subordinate.

The high sulphidation deposits can be characterized by the alteration zoning outward from the ore body. Alteration minerals outward from the pathway of acidic fluid flow are: vuggy quartz, alunite and kaolinite (sometimes with pyrophyllite or diaspore), argillic alteration of illite, then to propilitic alteration of montmorillonite to chlorite. The total thickness of the advanced argillic alteration is generally less than 10 m. Among others, important HS deposits are Lepanto, Philippines; Goldfield, Nevada; Nansatsu, Japan; Choquelimpie, Chile and Rodalquilar, Spain. The Lahóca area in Recsk, Hungary is also a typical example of the high sulphidation deposits (Hedenquist, 1997).

The HS mineralization has a close genetical and spatial association with the porphyry copper deposits. Porphyry Cu (Au) deposits commonly form at depths of 2-5 km. The mineralization is dominated by magmatic fluid in the early stage and the deposit appears as dissemination and veinlets located within and adjacent to a porphyritic, silicic-intermediate-composition intrusion.

The alteration mineralization shows zoning as follows: K-silicate zone, quartz-chlorite-sericite zone, propilitic zone, and argillic alteration extending to the paleosurface. The high-temperature Cu-mineralization accompanied by magnetite is connected to the boundary of the K-silicate and sericite zones.

Geological characteristics of the Lahóca gold mineralization

Geology of the Recsk complex

The Lahóca gold mineralization is a part of the Recsk complex, that can be considered an unique as giving a broad sprectum of mineralizations laterally and vertically zoned around a porphyry intrusivesystem, with a stratovolcanic counterpart.

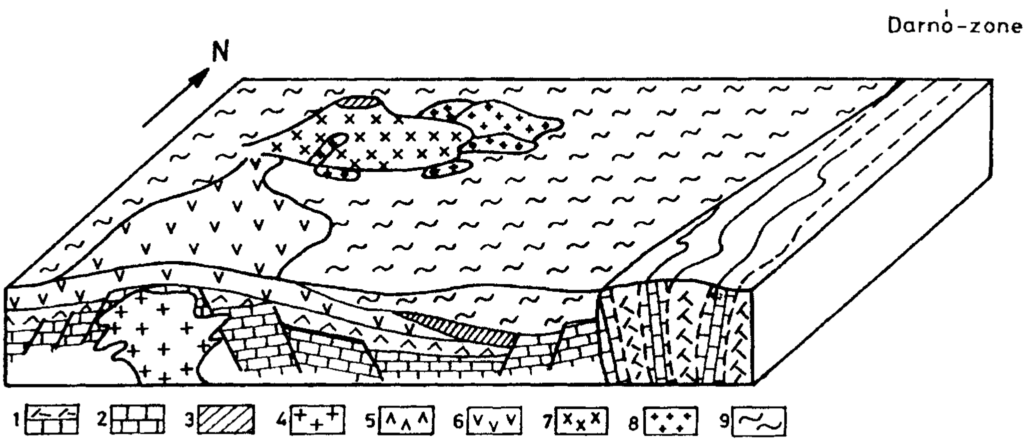

Fig.3. Schematic block diagram of the Recsk area showing the four stages of the Upper Eocene volcanic activity (after Baksa, 1981). 1-Triassic folded limestone, shale with ophiolites, 2-Triassic limestone, quartzite, shale, 3-Upper Eocene limestone, marl, clay, 4-shallow dioritic intrusion (3. stage), 5-lower biotite-hornblende andesite series (1. stage), 6-quartz-biotite-hornblende andesites, dacites (2. stage), 7-biotite-hornblende andesites (3. stage) 8-biotite-pyroxene-hornblende andesite dykes, extrusions, laccolits (4. stage) 9-Middle and Upper Oligocene siltstone, clay.

The Darnó-line, the major tectonic zone of Hungary is the dominant structure which was already active and produced strike-slip faulting in the pre-Tertiary period. The structural differences between the two units separated by the tectonic zone have been maintained throughout the Tertiary.

The oldest formations of the Recsk area are Triassic limestone, quartzite and shales. After a long gap, the Paleogene series starts with Upper Eocene marine limestone and marl.

The formation of these sediments was followed by intrusive and volcanic events. Opposite to the main part of the Mátra Mountains, where Neogene events produced volcanic mass, the igneous activity took place during the Paleogene period, along a N-S trend shear zone in the Recsk area. The age of the magmatism is determined to be Upper Eocene by the underlying, intermingling and overlying sediments of Eocene fossiliferous horizons.

The Paleogene volcanic cycle comprises four stages (Fig.3): 1. subaqueuos andesitic lavaflows, agglometares and tuffs; 2. stratovolcanic and extrusive products in a gradual shift from submarine to subaerial environments, with a dacitic chemical character; 3. stratovolcanic sequence of biotite-hornblende andesites and breccia and an intrusive dioritic body (in smaller regional extension) with highly intensive hydrothermal alteration; 4. development of the central explosive caldera, andesite dykes, extrusions and laccoliths (Baksa et al., 1981).

The Eocene volcanics are covered by reef limestones and other lacustrine sediments. The subsidence of the area reached its maximum in the Middle Oligocene when only the central horst escaped the marine transgression. Reworked volcanic intercalations have been found even in the Lower and Middle Oligocene sediments.

Mineralization of the Recsk complex

The Upper Eocene volcanic activity is associated with very significant mineralizations composed of mesothermal and epithermal zones.

In connection with the shallow intrusive porphyric body emplacement in the Triassic limestone and quartzite series, the mesothermal zoning of the Recsk complex is a porphyry copper mineralization overprinted by the skarn reactions. The high grade copper appears in the propylitic zone of the intrusive body and is associated with gold mainly in the areas where the propylitic zone underwent the skarn processes.

The skarn copper ores were formed in the limestone along the contact with the intrusive. In the outer parts of the skarn zinc ores were developed. In the higher horizons of the Triassic series, stratabound metasomatic lead-zinc ores are found.

The basic copper-bearing mineral is chalcopyrite accompanied by pyrite, pyrrhotite, magnetite and hematite in the skarnous association of the deep horizons. In the skarnous polymetallic deposits sphalerite is essential, associated with pyrite, chalcopyrite, galena and magnetite. The porphyric copper ore body shows a chalcopyrite dissemination with pyrite. In the peripheral parts of the body molybdenite occurs in siliceous-anhydritic veins. In the zones of the hydrothermal-metasomatic alterations the polymetallic ore deposits contain dominantly sphalerite beside pyrite, galena and chalcopyrite (Csongrádi, 1975).

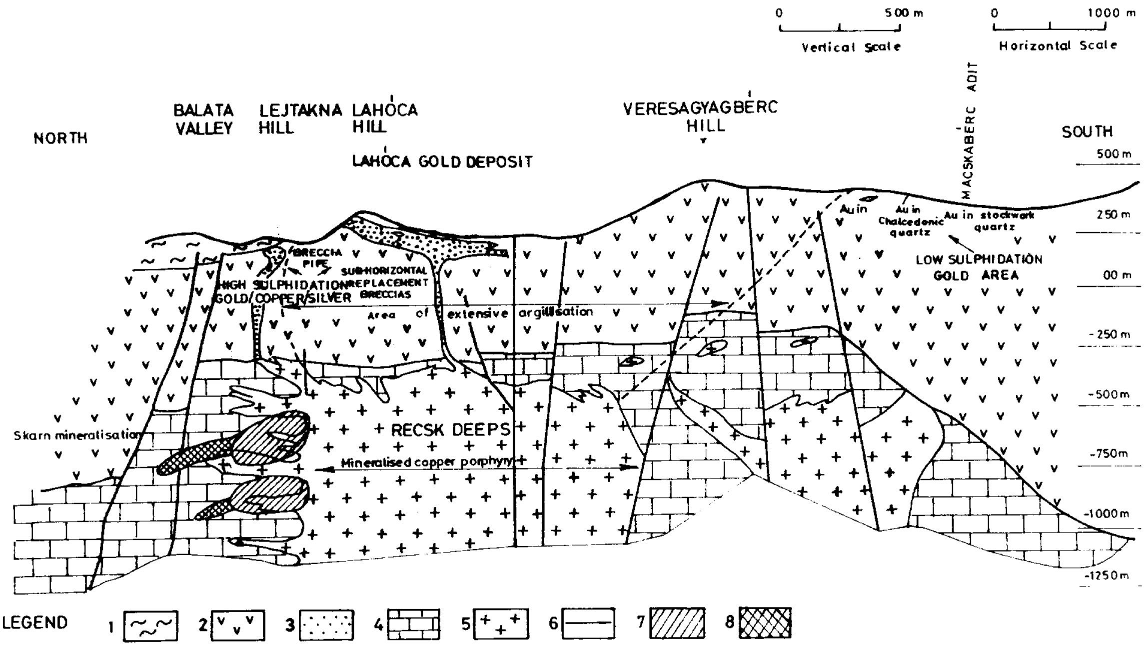

Fig.4. Schematic cross section of the Recsk complex (after Földessy, 1996). 1-Oligocene clastics, 2-Eocene andesite, 3-gold deposits, 4-Mesosoic basement, 5-mineralized copper porphyry, 6-fault, 7-copper skarn, 8-zinc skarn.

Mineralization of Lahóca

The Upper Eocene Recsk porphyry has a close spatial and genetical association with the Lahóca epithermal Cu-Au deposit. The mineralization appears in the second and third stages of the Paleogene volcanic cycle and some indications suggest that it continued until the Middle Oligocene (Földessy, 1996).

In the second-stage dacites, a typical low sulphidation mineralization occurs with a quartz-sericite-adularia-alunite alteration. The dominant ore minerals are tetrahedrite and pyrite as dissemination in the silicified breccia dikes and veins penetrating the dacite. The gold appears in Au-Ag tellurides and in the native form (Nagy, 1993). This unit is found in the peripherial part around the high sulphidation system.

The high sulphidation mineralization is associated with the third-stage volcanics. These volcanic products are in the center of the second-stage volcanics, lying uncomformably or penetrating them. The third-stage volcanics can be divided into three units upward from below: 1. shallow-seated subvolcanic hornblende diorite porhyry, 2. thick, southerly dipping breccia, 3. hornblende andesite forming plugs, dikes or blankets on the breccia (Földessy, 1996).

The high sulphidation mineralization is connected to the breccia blanket which has a high fractuation on the top and lower fractuation at the bottom. The gold enrichment has a sharp upper boundary at the covering blueschist and weakens downwards. Ore minerals appear in both the matrix and clasts. The enargite and luzonite occur in theform of impregnations and veins in quartzite. The breccia also contains enargite and luzonite. The main Au-bearing mineral is the collomorph pyrite in dissemination and fine impregnation. The coarse grained euhedral pyrite is usually free of gold. Enargite and luzonite also contain gold. About 25% of the gold is free. Sphalerite and tetrahedrite are common accesorial minerals in the lower parts. Several Pb, Bi and Te sulfosalts also occur. The ore appears in the matrix of vuggy siliceous breccias, as breccia cement, clasts, veins or stockwork. Barite and chalcopyrite are present in the pipe breccias (Koch, 1985; Nagy,1993).

The silification shows close correlation with the gold content. Advanced argillic alteration (kaolinite, dickite, pyrophyllite) and less silification are linked to lower, subeconomic Au grades. The smectite-illite alteration indicates barren zones. Propylitization is related to late plugs along the central N-S line, in places as overprints on argillic alteration zones (Földessy, 1997).

Mineral resource of Lahóca

The formerly mined enargite-luzonite copper ore and the gold mineralization appear in the same area, although the gold extends well beyond the copper borders. The tickness of the gold-bearing breccia blanket is 30-50 meters, the horizontal extension is about 2 km^2. The main part of the ore is between 50-100 m below the surface.

The new resource estimations presume 35.5 million tons of gold with an average 1.4 g/t Au at 0.5 g/t Au cut-off. In case of higher cut-off the resource decreases: it is 16.5 million tons of gold with 2.01 g/t Au at 1.0 g/t Au cut-off. The average silver content is merely 1-5 g/t, but it can be important in certain parts as a premium over the gold (Földessy, 1997).

Concerning the ore-dressing, the ore responds to flotation with low gold recoveries. According to company reports, bio-oxidation of crushed ore seems to be the best method because of the very fine Au dissemination in the collomorph pyrite.

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