EPITHERMAL GOLD DEPOSIT IN LAHOCA: MINING HISTORY AND PROSPECTS

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Abstract

Epithermal gold deposits form in hydrothermal systems in which the gold mineralization occurs within 1 to 2 km of surface. The Lahoca epithermal Cu-Au deposit is spatially and genetically associated with the Eocene Recsk porphyry. Mining activity in the area lasted from 1852-1979 producing copper with gold and silver. The exploration of the deeper Cu-porphyry-skarn system began in 1968 but the mining for the ore has not been started. Drilling exploration of the epithermal gold started in 1994. According to the recent results, biooxidation technology would be the most economic exploitation method.
1. INTRODUCTION

The Lahoca 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 Lahoca have the potential to became a significant producer of gold in Central-Europe.

2. HISTORY OF MINING AND EXPLORATION

The first discovery in the area of Recsk-Parádfiirdö was made by MARKHOT in 1763 who mentioned Cu-Ag ores near the alum outcrops in Parádfürdö. More than 30 years later, KITAIBEL (1799) described the rocks in the surroundings of Recsk as "porphrys". He also mentioned traces of oil near Recsk. Until the middle of the XIX. century, smaller adits were opened that are still known (Antal, Etelka, Irma, József, Orczy).

The discovery of the famous native copper in Bajpatak (HAIDINGER, 1850; KUBINYI, 1852) gave a new impulse to exploration. The smaller drifts of Fehérkö 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. They also dealt with the rock alterations in connection with the ore mineralization and the separation of different volcanic rock types (HAIDINGER, 1850; KUBINYI, 1852). SZABÓ (1875) distinguished three rock types: "amphybole-trachyte" in Nagykő, "quartz-trachyte" in Fehérkö and propilitic rocks in Lahóca. He discovered, that the volcanic rocks were covered by limestone beds in Lahóca. As regards to ore minerals, he realized the difference between the enargite and the sphalerite-pyrite-tetrahedrite mineralization.

The volcanic rocks of Lahóca were first described as "biotite-amphibole-andesites" by MAURITZ (1909). In 1912 Senior NOSZKY stated that the andesites of Lahóca were laccolithes. He examined the quartzite in Hegyeshegy and originated it from the geyser activity.
In 1926 the Recsk mine were transferred into state ownership and the production increased. It resulted the reviving of the exploration work as well. It was also the time of the more intensive oil-exploration in the Biikkszék-Parad area, revealing new data about the basement and Terciary rocks. LOW (1925) made a parallelization between the geological situation and mineralization of Bor mine, Yugoslavia and Recsk mine. He also described the oxidation-cementation zone in Lahoca.

In 1937 TELEGDY-ROTH made a geological mapping in the surroundings of the Darno-line. ROZLOZSNIK (1939) first realized the important role of the Darno-line in the tectonic setting of Hungary. He also gave a description about the stratovolcanic formations in the Lahoca-Kanazsvar-Feherko area. The first detailed paragenetic examinations of ore minerals were made by PAPP (1938) and SZTROKAY (1940).

After the 2nd World War SCHRETER (1949) and SZENTES (1951) made geological mapping in the NE part of the Matra Mountains. That time the production of Lahoca mine was suspended because the ore reserves seemed to be worked out. Due to the intensive exploration by drillholes and drifts, new reserves of ore became known. The local exploration was managed by Senior GAGYI-PALFFY (1950) who determined the shape of the newly discovered ore bodies and made reserve calculations. The mining of the new ore bodies was continuous until 1979.

The geological reambulation and geological mapping of the North-Matra started in 1958. VARROK (1962) described the andesites in Recsk as laccoliths and similarly to the main andesitic mass of the mountain, put them into the Miocene epoch. The ore-exploration was also re-started by VIDACS (1958) looking for the deeper connections of the Lahoca 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, than 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. The economic rentability of the deep-seated copper ore was

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proved by Senior GAGYI-PÁLFFY (1975). The geological situation of the deep-seated ore deposit was described by CSEH-NÉMETH (1975). 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.

In 1975, during the exploration for the porphyry and skam 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.

In 1981, BAKSA stressed the clear connection between the Paleogene volcanic activity and the Darnó tectonic zone. While the significant mineralization at Recsk was connected to the andesite-diorite intrusives, the surficial andesitic volcanism was associated by the copper-pyrite mineralization. The role of the Darnó-line in the Recsk mineralization was also pointed out by ZELENKA at al. in 1983. FÖLDESSY (1984) outlined a horst-structure formed prior to the volcanism along a N-E trend shear zone that disappeared because of the Paleogene intrusive and volcanic events. The horst-structure kept its relatively uplifted position during the Paleogene and Neogene geological evolution.

Based on the new recognition 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 along the Balaton-Darnó line, the main part of ore mineralization was connected to the hydrothermal phases of the diorite-porphyrte intrusion, and two, younger volcanic phases produced younger, re-mobilized ore mineralizations near surface.

In relation to the porphyry and skarn copper deposits, two deep shafts, 7.5 km drifts and 95 km underground drillings were completed until 1986. The necessity of the continuous exploration in the deep-seated complex was reasoned by CSEH-NEMETH (1986). The results of the morphogenetic explorations were summarized by GASZTONYI, KATONA, POLGÁR and SZEBÉNYI (1989). As concerning the late Eocene tectonic pattern in the
Carpatho-Pannonian region, BALLA gave a new interpretation of the tectonic situation of the area in 1988.

The Australian Rhodes Mining NL, Perth acquired the ownership of the Lahoca epithermal deposit in 1993. 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 Lahoca zone in 1994. It was realized a few years before, that the model of epithermal gold deposits perfectly fitted to the Lahoca area (FOLDESSY, 1997). The exploration program was carried out in three steps. During three years, 57 drillholes were made with a total length of 8220 m.

3. GEOLOGICAL CHARACTERISTICS OF THE LAHOCA GOLD MINERALIZATION

Geology of the Recsk complex

The Lahoca gold mineralization is a part of the Recsk complex. The Recsk complex can be considered unique as ore formations of different genesis in connection with a shallow, sub-volcanic intrusion are situated in one, relatively small occurrence, and a complete porphyry Cu formation has been preserved in one system.

The Damo-line, the major tectonic zone of Hungary proved to be continued in the pre-Tertiary basement of the Matra Mountains. The structural differences between the two units separated by the tectonic zone have been maintained throughout the Tertiary period.

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 Matra 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 the Nummulites fabianii horizon.

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The Paleogene volcanic cycle comprises four stages (Fig. 2): 1. subaqueuous andesitic lavaflows, agglomerates and tuffs; 2. stratovolcanic 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 transgressions. Volcanic intercalations have been found even in the Lower and Middle Oligocene sediments.

**Mineralization of the Recsk complex**

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

In connection with the shallow intrusive porphyric body in the Triassic limestone, 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 by pyrite, chalcopyrite, galena and magnetite. The porphyry copper ore body shows 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 (CSONGRADI, 1975).
Mineralization of Lahóca

The Upper Eocene Recsk porphyry has a close spatial and genetical association with the Lahoca epithermal Cu-Au deposit. The mineralization appears in the second and third stages of the Paleogene volcanic cycle (Fig. 2), and some indications suggest that it was continued until the Middle Oligocene (FOLDESSY, 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 of the silicified breccia dikes and veins penetrating the dacite. The gold appears in Au-Ag tellurides and in native form (NAGY, 1983). This unit is found in the peripheral 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 unconformably or penetrating them. The third-stage volcanics can be divided into three units upward from below: 1. shallow-seated subvolcanic hornblende diorite porphyry; 2. thick, southerly dipping breccia, 3. hornblende andesite forming plugs, dikes or blankets on the breccia (FOLDESSY, 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 form of impregnations and veins in quartzite. The breccia also contain 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 accessorial minerals in the lower parts. Several Pb, Bi and Te sulfoalts 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; FOLDESSY, 1996).

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. 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 (FOLDESSY, 1997).
Mineral resource of Lahoca

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 thickness of the gold-bearing breccia blanket is 30-50 meters, the horizontal extension is about 2 km². The main part of the ore is between 50-100 m below 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 (FOLDESSY, 1997).

As concerning the dressing, the ore responds to flotation with low gold recoveries. Heap biooxidation of crushed ore seems to be the best method because of the very fine Au dissemination in the collomorph pyrite.

Until now, the Lahoca gold project has demanded about 3 million USD. The completion of the exploration program and the start of mining need a sum of approximately 50 million USD. With an annual production capacity of 2 million tons, the costs would be refunded in five years, with an estimated 4 tons of metal-gold (FOLDESSY, 1997). Although the ore itself is the property of Rhodes Mining NL, it is a great advantage for Hungary that mining activity in the Lahoca area would highly ease the difficulties of unemployment in this part of Heves county, and the central and local budget would be increased by an estimated 1800 million HUF/year by the different taxes.
References


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Fig. 1  Vertical section by LOW (1925) showing the adits in Lahoca
1: oxidized ore, 2: lower level of oxidized ore, 3: mineralized parts

Fig. 2 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, laccoliths (4. stage),
9: Middle and Upper Oligocene siltstone, clay
Fig. 3 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
Fig. 4 Section of the Lahoca-type ore deposits (after BAKSA, 1975)
Fig. 5 Schematic cross section of the Recsk complex (after FOLDESSY, 1996)

1: Oligocene clastics, 2: Eocene andesite, 3: gold deposits, 4: Mesozoic basement, 5: mineralized copper porphyry, 6: fault, 7: copper skarn, 8: zinc skarn