THE MINERALIZATIONS OF THE RECSK DEEPS AND LAHÓCA – SHORT GEOLOGICAL OVERVIEW

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Abstract: The Recsk Deeps and Lahóca is a significant ore complex in Central-Eastern Europe. In this introduction we would like to summarize the most important aspects of the multi-stage mineralization, and give guidance to the latest quality information in geology. Many of the geological features are discussed in this volume; many other aspects are not addressed. The most integrated information is summarized in several geological summary reports. Many of them, however, is not published and found only in the different archives. It is also attempted to guide the interested reader to these sources for further details. Those points, which are covered with a detailed study in this volume, are only briefly mentioned here.

1. INTRODUCTION

The Recsk Lahóca area was mined for copper ore from 1852 until 1980. Small scale 30,000 tonnes per year underground copper ore mine and a flotation plant worked until 1979. In 1970 a new orebody (Lejtakna) was also found in the northern foreground of the Lahóca and an underground mine was opened, which worked until 1984. The total historic ore production of the Lahóca was about 3.1 million tonnes of copper ore, with average grade of 0.61 % Cu and 2.5 mg/kg Au (Baksa et al. 1980). These ores, along with the later discovered epithermal gold, are grouped as Lahóca mineralization, and discussed in a separate study.

Both the Lahóca and the Recsk Deep facilities were operated and kept maintained by different state owned companies during most of the lifetime of these mine works (Fig.1).

In the broad area of Recsk we can find several different genetic type of ores, which have become known during a century long history of mine works and surface explorations. In this review those are summarized which were linked to the Recsk Deeps ores.
2. HISTORY OF EXPLORATION AND MINE DEVELOPMENTS

2.1. Surface exploration works (1957-1978)

With the objective of exploring the roots of the Lahóca mineralization a drilling program of five boreholes along a N-S profile was completed, the individual holes were 1000-1200 meters deep. After this initial step, two other profiles perpendicular to this first one were drilled in East-West direction, with 18 deep drillholes, until 1965.

Both initial tests were successful. The N-S section discovered metasomatic Pb-Zn ores (Rm-5 borehole), the other two profiles hit porphyry copper ores (Rm-16, Rm-17) and skarn copper ores (Rm-32). These drillholes demonstrated at the first time the three main types of deep-level mineralization. During the ongoing surface explorations the grid was gradually densified up to 250x250 meters, then at places to 175x175 meters.

The first geological evaluation of the Recsk Deeps has been summarized in a final report (Gagyí-Pálffy id. et al. 1971), described in a separate volume of the Földtani Közlöny (Cseh-Németh et al. 1975 and other studies), and described in several publications (for example Baksa et al., 1980, Baksa, 1986).

2.2. Underground explorations (1975-1986)

After the decision of continuing the exploration with a detailed underground program, two 1200 m deep (8 m internal diameter) concrete lined vertical shafts, and a two-level connecting drift system (at 900 m and 1100 m depth from the surface, normally it was called as -700 m and -900 m levels respectively) was de-
The mineralizations of the Recsk Deeps and Lahóca... developed as preparation for the explorations. The main drifts which linked the two shafts enabled the implementation of an extensive exploration program. The objective was to obtain detailed geological information from the most important weight-points of the ore zones. Hardcopy reports and assay data of these drillholes are also archived, and the duplicate samples are preserved.

The underground explorations provided useful information for those main zones of the mineralizations, which lie between the -500 m and -1100 m levels b.s.l. About 70% of the meterage was targeted on getting information on the porphyry copper mineralization. The rest of the underground drillholes aimed to explore the skarn copper zone. None of the holes targeted, although accidentally hit other base metal ores, like zinc skarns. The program has been stopped, because the drift network necessary for the exploration project has not been completed due to growing financial problems at the beginning of the 1980's.

The development of the main drift at the -900 meter level has been concluded in the early 1980s. The access to the NW portion of the best copper skarn zone (E-
area) has been finished and its detailed underground exploration started in 1983. The project was successful and demonstrated that in apart from skarn copper ores, there are continuous, large and high grade zinc skarn ore-bodies as well.

In 1984 the Central Geological Office (the state geological agency at that time) has requested the preparation of an final geological report and reserve estimation summarizing the existing information. The final version of this report - incorporating results of the new morphogenetical research as well - has been finished four years later (Baksa et al., 1988).

2.3. Care and maintenance (1986-1999)

2.3.1. The period 1986-1989

The operator Recski Ércbánya Vállalat (Recsk Ore-Mining Company) was a division of the state-owned OÉÁ (Hungarian Ore Mining Company). This company was responsible initially for the explorations and developments, later for safeguarding the facilities during the suspension of the development project. It has not received funds for the continuation of the exploratory works. All the underground openings and machinery was kept open and maintained, ventilation and water pumping was continuous (at about 1.5 cu.m/min rate). Between 1987 and 1989 business negotiations have been taken place between the company and several foreign partners, among others Austrian, Chinese and Soviet firms investigating the possibilities of joint development and production of the Recsk ore resources.

2.3.2. The period 1989-1999

Following 1989, the Recski Ércbánya Vállalat (RÉV) has become independent company (still 100 % state-owned), with a view of gradually decreasing the state contribution to the funding of the maintenance of the facilities and privatizing the property. This has opened the possibility of negotiations with foreign investors.

In 1992 the RÉV has established a business arrangement with the DCI (Austria) to promote the project. Two years later this group has been dissolved and the Recski Ércbányák Rt., a new 100 % state owned company has been created as a preparation for the privatization. Several foreign companies have received information and data about the deep level ore resources of Recsk. Two public tenders were announced but concluded without successfully closing with business agreements.
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Due to the failure of the subsequent privatization attempts, at the end of 1998 the company finished the pumping of water and the mine was flooded with water.

2.4. Long-term suspension (from 1999)

The Recski Ércbányák Rt. Company has been dissolved in 2005, and its rights and obligations were delegated to the Mecsekérc Rt, and later to the Mecsek-Öko Rt (both 100% state owned companies working in mining-enviromental industry). Today the Recsk II (Deeps) mine plot is managed by the Mecsek-Öko Zrt., a state-owned company under the control of the Hungarian Privatization and State Holding Company.

At present, the mining rights are still alive; the mine is in 'long-term suspension of exploitation' status. In the period of suspension, most of the existing mining equipments and plants were sold and works for the protection of the environment were implemented.

3. RESULTS OF EXPLORATION AND MINE DEVELOPMENTS

3.1. Surface exploration drilling program

134 deep diamond drillholes, to an average depth of 1200 meters, 156,000 m total length, the grid covered an area of 13 square kilometers. The detailed records, assays and geophysical logs, hydrogeology of the drillholes, as well as the duplicate samples of the assayed intervals are found in the MFBH archive.

The exploration pattern consisted of N-S (350-170) and W-E (260-80) profiles. A grid of 500 x 500 meters is completed in the whole area, and 350 x 350 m and 250 x 250 m was finished in the northern and central part of Recsk exploration area. 175 x 175 m was completed in the central zone of the northern half of the exploration area, above the mine development zone (with the objective to densify the surface sampling) (Fig. 2). Three drillholes (R356 – R358) were made to explore the shallow stratiform Pb-Zn mineralization.

The majority of surface drillholes have intersected the near surface layers above the Triassic basement in rotary mode (no-core), taking 3 m long core samples at every 50 m interval.

In the ore zone normally 1 m sample length was applied, and the whole intrusive rock interval sampled. In the skarn ores and sedimentary environment only
the visibly sulphide rich varieties were sampled with 1 m sample length, from the other intervals 5 m sample length was applied.

Each sample has been assayed for Cu, and every fifth sample assayed for Cu, Fe, Pb, Zn, Mo, Se. Au and Ag was assayed in the >0.8 % Cu samples.

3.2. Underground explorations

3.2.1. Exploration shafts

Two shafts were made: Shaft 1 (down to 1200.6 meters depth) and Shaft 2 (down to 1195.0 m depth) (Fig.3). Both shafts are 8 m in internal diameter, with monolithic concrete lining, flooded but accessible after dewatering (Fig.4).

The shafts and drifts were continuously mapped and logged geologically, and samples were taken from each 4m leg, and assayed if geology assumed ore grade mineralization. One raise has been bored between the -700 m and -900 meters levels (diameter 2.1 m).
Fig. 4 The concrete sealing of the No1. and No2. vertical shafts.
3.2.2. Horizontal drifts

Horizontal drifts were made:
- at -500 m level b.s.l. (cross sectional area 8 - 56 sq.m) - total 85 m;
- at -700 m level b.s.l. (cross sectional area 6 - 74 sq.m) - total 6057 m;
- at -900 m level b.s.l. (cross sectional area 6 - 74 sq.m) - total 3113 m;
- at -906 m level sump-dewatering plant (7.6 - 23.5 sq.m) - total 291 m;
- at -700 m level (porphyry copper ore), and at -900 level (skarn ore), approximately 1800 meters in total (this is also included in the shaft measures described in the previous sections).

The drifts were channel sampled, taking four meters long horizontal samples on both walls, opponent samples unified. Approximately 6000 analytical data from the mining drifts were stored.

3.2.3. Underground drilling program

The drillholes were collared at -700 and -900 m levels, inclined horizontally, upwards and downwards. The number of drillholes was 552, with an average length of 200 meters. The drillings placed initially within the 62 x 62 meters square grid blocks, later in fans at 62 m spacing.

Total length was 92,000 meters (comprising the correcting and morphogenetic drillings as well). Approximately 87,000 assay data records have been processed. The documentation and the sampling pattern were similar to that of the surface drillholes.

3.3. Outline of geology

The ore field of Recsk and Lahóca is located in the Carpatho-Balkan Metallogenic Zone, in the Inner-Carpathian Volcanic Belt. It forms part of a Paleogene (primarily Oligocene) volcanic chain. The ore-field sits within the Darnó structural zone.

The pre-volcanic basement is built from Mesozoic carbonate (limestone, dolomite, marls) and fine grained detrital sedimentary rocks (shales, siltstones). The Mesozoic-Paleogene boundary, a major unconformity, lies between 35 and 1200 m from the present surface. The large differences in altitude can be attributed partially to tectonic and erosional processes preceding the volcanism, as it is shown by the Mesozoic stratigraphy. Its present position provides valuable infor-
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formation about the development of volcanic and sedimentary rocks and the related structural evolution (Fig. 5).


At Recsk the Paleogene magmatic activity was controlled by a complex, nearly N-S directed fault/shear zone in the axis of an horst/anticline. This zone hosts a series of multiple-phase diorite porphyry intrusives. These remained in increasingly greater depth towards the southern and northern edges of the volcanic area. These intrusives penetrated into and in many places contactised the limestones, dolomites, marls and shales of the country rock Mesozoic series. The activity has also produced volcanic andesites and dacites, which can be found in large areas at the present surface.

Contact-metasomatic and hydrothermal-metasomatic rock alterations and ore mineralization forming concentric zonal structures are connected to the independent, single intrusions. On this basis we can outline the location of the optimum concentration of ore resources in the Recsk Deeps.

At the base of the stratovolcanic series, in its intercalations and overlying formation Eocene-Oligocene fossiliferous sediments (bituminous reef limestones,
marls, sandstone, reworked tuffs) have been accumulated. Deeper basin filling sediments, i.e. Oligocene claystones, (with subordinate conglomerates and reworked tuffs) form the younger cover.

At the south younger Miocene volcanic rocks and clastic sediments cover the Eocene volcanic series.

3.4. Characteristics of the ore mineralizations

The variable structural position, petrology and the intensive rock alteration processes, the presence of large scale fluid circulation have caused the formation of ore mineralizations of different genetic type and chemical composition. Supposedly all these are the products of the same mineralizing system at different vertical levels.

3.4.1. Ore types

On genetic basis and practical considerations the following major ore types can be distinguished (starting from the surface going downwards)(Fig.5):

(1) Cu-Au, enargite-luzonite, high sulphidation epithermal gold mineralization. The mineralizations are known in the Lahóca and its northern foreground.

(2) Au-Ag, tetrahedrite-gold-tellurides, low sulphidation gold mineralization, in the southern part of the volcanic zone.

(3) Pb-Zn metasomatic mineralization. Near the basis of the volcanic complex, or in the upper shale-sandstone unit stratiform semi-continuous orebodies were developed, with sphalerite, galena, pyrite, chalcopyrite assemblage. These are completely hidden, and intersected only by a few drillholes near the No2 shaft, at 150-400 m depth. Its average combined sulphide content (Pb + Zn) is near 4 % (Szabó 1985).

(4) Cu-Au-(Mo) porphyry copper ores. These mineralizations are hosted in shallow small intrusive quartz porphyry bodies, in the associated dike complexes and in their metasomatically altered surroundings. The depth of the main enrichment zone is 700-900 m, the top of the enrichment zone is at 500 m depth from the surface. Annular and columnar shaped enrichment zones have several hundred meters height and 100-300 m width, with disseminations and veins of sulfides. The copper grade averages at 0,4 %, the high grade zones (over 0,8 Cu % cut-off) have 1,1 % Cu average grade. These high grade enrichments are transitional to the skarn environment. Certain sub-types of mineralization are gold-
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Bearing. The gold grade, where occurs, varies between 0.2 and 1.5 g/t. The host rocks of the high grade zones are diorite porphyry with quartz-sericite alteration and endoskarns (with magnetite). The main ore minerals are chalcopyrite, molybdenite, pyrite, magnetite. Good characterization of this ore type is found in Cseh-Németh (1975), Csongradi (1975), Baksa et al. (1980).

(5) Cu-Au skarn copper ores. The ore forms disseminations, veins, patches, semi-massive lens like bodies for enrichments in lime-skarn rocks. The ore minerals are pyrite, magnetite, chalcopyrite (occasionally sphalerite). The ores are preferably enriched on the triple contacts of diorite porphyry and siltstones with limestone, dolomite sediments, where the rocks were frequently brecciated prior to the emplacement of the igneous material. The characteristic ore grades reach 2.3 % Cu, 1.1 ppm Au. The sulphide content is normally over 10 wt% of the rock. There are two main depth intervals of skarn mineralization, at 500-700 m depth (poorly known, unexplored) and at 900-1100 m depth. Concise description of these ores are presented by Cseh-Németh (1975), Csillag 1975 Csongrádi (1975), Baksa et al. (1980), Gagyí-Pálffy ifj. and Horkel (1991).

(6) Zn-Cu skarn zinc ores. At the outer margin of the contact zone disseminations or massive, patchy irregular orebodies were formed with complex internal structure. The main ore minerals are sphalerite (marmatite), pyrite, pyrrhotite, melnicovite, chalcopyrite, less frequently galena. The typical host rocks are similarly the triple contacts of altered diorite porphyry dikes with siltstones and carbonate sediments. The shape and extent of orebodies are not exactly known. The average Zn grade exceeds 7 %. More data about this ore type is found in Szebényi et al. (1988) and Gagyí-Pálffy ifj. and Horkel (1991).

(7) Zn-Pb peripheral metasomatic mineralizations. These important ore types are poorly known. Their main enrichment zone is found in the SW periphery of the mineralized complex at 800-1000 m depth. They occur in two main forms: (a) disseminated stratabound lens like conformable metasomatic lead-zinc orebodies. These frequently occur in the non-skarn metasomatically altered sedimentary rocks, peripheral to the above mentioned ore types; (b) lead-zinc ore veins, mostly in the upper portions central porphyry ore zone.

Other ore types occur, though remain relatively unexplored, like magnetite skarns, copper rich semi massive veins, molybdenite enrichments. The best information source of these mineralizations is Gagyí-Pálffy, A. sen. et al. (1971) and Cseh-Németh, J. et. al. (1984).
3.4.2. Ore resources

There have been several estimations, which attempted to characterize the Recsk ore resources. The safest to cite those data which are registered as state ore resources by the Hungarian Mining and Geological Bureau (MGSZ 2006).

Copper ores: Geological resource (cut-off 0.4% Cu, 2 m minimum thickness, 3 m maximum subgrade dilution), made by manual polygonal block estimation, C1 and C2 (indicated plus inferred) resource category is 779.3 Million tonnes at 0.65% Cu, 0.19 g/t Au. These figures include both high grade (average 2.3% Cu skarn ores and lower grade porphyry ores).

Lead-zinc ores: Geological resource (1.3 Pb equivalent, 1 m minimum interval thickness, 2 m maximum allowable subgrade dilution), C1 and C2 (indicated plus inferred) resource category: 84.6 Million tonnes at 1.01% Pb, 2.68% Zn.

The registered data are based on the resource estimation made in 1984 using polygonal blocks for the final geological report of the surface explorations.

Separate estimation were made for +1.50% Cu cut off grade copper ores and +2.5% Zn zinc-lead ores in 1991-1992 for the underground drilled mineralized portions (Gagyí-Pálffy if, and Horkel 1991). The explored portion of the Northern-1 ore zone gave the following results:

<table>
<thead>
<tr>
<th>Resource category</th>
<th>Type</th>
<th>Tonnage (Mt ore)</th>
<th>Grade (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicated</td>
<td>Copper</td>
<td>7.3</td>
<td>2.25</td>
</tr>
<tr>
<td>Indicated</td>
<td>Zinc</td>
<td>2.7</td>
<td>7.67</td>
</tr>
<tr>
<td>Inferred</td>
<td>Copper</td>
<td>42.8</td>
<td>2.34</td>
</tr>
<tr>
<td>Inferred</td>
<td>Zinc</td>
<td>11.5</td>
<td>5.53</td>
</tr>
</tbody>
</table>

3.4.3. Other research results since 1980

Surprisingly few results have become publicly known since the 1980s related to the Recsk Deeps ore complex. Mineralogical studies, like Dódony et al. (1996) have targeted on certain mineral species characteristics. Student project and thesis works like Czuppon (2003), or Vámos (2004) have dealt with details of igneous petrology or paleogene stratigraphy. The occurrence has appeared in metallogenic synthesis reviews (Heinrich and Neubauer 2003). Methane and radon emanation provoked research on fluid mobility and geochemistry (e.g. Tóth et al. 1994). Substantial advances have been recorded in the environmental research related to the ore complex (M.Tóth and Farsang 2003, Rikezo 2003).
4. CONCLUSIONS

The Recsk Deeps and Lahóca mineralization remains a giant target of geological exploration and research despite of decades of intensive work of several generations of scientists and economic geologists. Its possible revival in the present boom of mineral explorations brings the opportunity to revise, evaluate and summarize its geology, mineralogy, structure, age in new contexts. Some of these objectives are met in the present series of articles and studies. Other questions are raised only and remain as problems to be solved by the present and future generation of earth scientists.

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