RECONNAISSANCE ORE PROSPECTING IN NORTHEAST HUNGARY – IN CO-OPERATION OF ACADEMY AND COMPANY

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1. Introduction

The northeastern region of Hungary has rich exploration potential for base metals. Active involvement in mineral exploration is an efficient tool to teach earth sciences to engineering students. The Institute of Mineralogy and Geology of the University of Miskolc entered into scientific cooperation with Rotaqua Ltd. in 2006 in starting exploration programs in the region. The results of this work by now: a great number of theses, student projects and research programs, not only from the University of Miskolc, but also from Eötvös Loránd University in Budapest. These are now summarised briefly by this review.

2. Western Mátra

The largest Pb-Zn mine in Hungary, Gyöngyösoroszi, has been closed since 1986. The ore forms a sub-vertical array of veins, which can be traced several km in length and up to 4 m in width. The ore bodies were followed down to 350 m depth from the surface. The old sealed drifts of the Mátraszentimre and Gyöngyösoroszi Pb-Zn mines have been reopened recently to backfill the abandoned stopes and drifts. The project has been coupled with exploration of greater depths. The geological model is based on seismic profiles made by the ELGI Geophysical Institute, which indicated the possible presence of five hidden sub-volcanic intrusives in shallow position [1]. Pecsenye [2] has processed four sets of surface geochemical sampling data and correlated the geochemical anomalies with the revised geological information. The geochemical anomalies showed good coincidence with the assumed hidden intrusive centres. Stream sediment geochemical anomalies were also checked and evaluated near Parádsasvár by Gaburi [3]. Csuhanics [4] has carried out an environmental geochemical survey with a view to assessing the impact of Cd anomalies derived from the abandoned, non-reclaimed sulphide ore dumps in Parádsasvár. Students have participated in a comprehensive rock chip sampling program in the re-opened main haulage drift of the Gyöngyösoroszi mine at the +400 m a.s. level. The program aimed at revealing alteration and enrichment halos in the surroundings of the ore veins. In the study several penetrating sub-volcanic dikes were identified which were previously considered to be lava flows. No substantial enrichment halo was detected in the vicinity of the ore vein intersections. A pronounced potassic alteration zone had already been mapped on the surface earlier [5]. This was also identified in the underground sections, characteristically linked to the northern parts, near Mátraszentimre. Subsequently a vertical hydro-geological monitoring drill-hole was further deepened to 400 m for exploration, and the top alteration zone of a shallow diorite-porphyry intrusive body has been reached in one of the centres forecast by the seismic survey. The geochemical assay data of the drill-core samples were evaluated and successfully correlated with the main haulage drift samples [6][7]. The cores have also been tested by using systematic laboratory acoustic measurements [8], providing evidence of different petrophysical properties between the fresh unaltered andesites and

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those of the alteration halo. Sulfide enrichment was restricted to the immediate vicinity of intersections of known ore veins. In contrast, the Mátraszentimre vein samples have shown extensive alteration in both the mineralized zone and its surrounding exhibiting dispersed low-grade gold enrichment halo. Paprika [9] carried out fluid inclusion microscopy of the same set of samples and gave paleo-thermometry and salinity data from the lithologies of the main-haulage level. In the final summary evaluation [10] it is assumed that two temporally separated stages of ore mineralization are found superimposed in the area. The older one (Gyöngyösoroszi central vein system) is in uplifted position, where the lower portions of the hydrothermal system are exposed. The younger system postdates and hydrothermally affects the rocks belonging to the Tar Dacite Tuff horizon, and represents the higher epithermal portion of a hydrothermal system with signs of HS type gold mineralization.

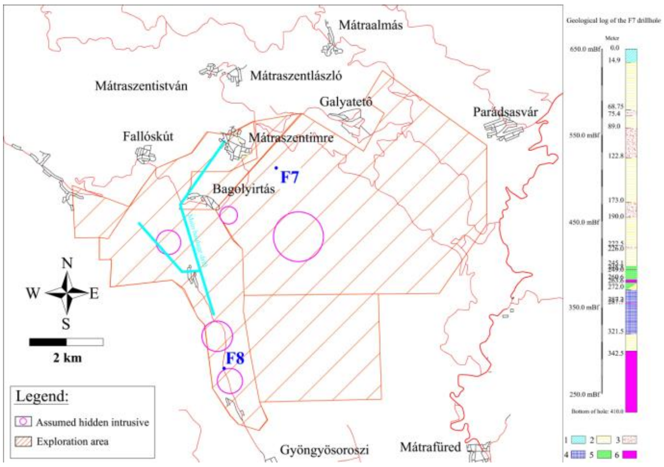

Figure 1. Western Mátra exploration blocks projected on the assumed hidden intrusive centres. The F7 drillhole log shows intersection of the cupola zone of a hidden intrusive body (modified from [7])

3. Rudabánya

Rudabánya was the largest iron ore mine in Hungary until the 1980s. Its comprehensive geological characterisation was given by Pantó [11]. The iron ore-bodies formed by metasomatic processes in Triassic limestones and dolomites, and subsequently fractured, deformed during the later structural deformations related to repeated overthrusts and to the displacement activity along the Darnó Zone. The explorations of the Rotaqua were aimed at localising the ore-bodies of the scarcely known lead and copper mineralization. The historic drill-holes, underground geology, geological profiles were interpreted and built into an integrated 3D geological model by Majoros [12]. Field explorations started with reambulation mapping, surface sampling and soil and rock chip geochemistry [13]. Soil sample assays outlined several multi-element soil anomalies also in areas untouched by previous mining. The statistical analysis of these data was carried out by Boros [14].

Kemény [15] studied carbonate metasomatism, which was the main ore forming process of the iron ores. He defined a complex successive alteration of limestone to dolomite and siderite and vice versa. Bodor [16][17] is working on the lithological characteristics of the siliciclastic rocks of the zone, with special focus of early stage siderite ore indications hosted by these rocks. Several details of the ore genesis are still unknown, but an early stage Lower Triassic sedimentary exhalative Pb-Zn-Ba deposit is now distinguished and separately interpreted from the already known later-stage Pb-Cu-Ba ores [13][18]. The optical study supporting this distinction was carried out in cooperation with the University of Oviedo by Kupi [19]. Mineralogical evidence of similar Pb-Zn mineralization in the nearby Martonyi ore occurrence has been given by Boros [20]. The silver-bearing phases were in the focus of the research done by Lukács [21]. She verified the presence of pyrargirite (Ag-Sb sulphide) in the sulphide enrichment zone. Other minerals, like Cu-amalgams in native copper or cuprite, were also found by Kupi [22][23]. The lignite resources have been studied with a new resource estimation of the overlying lignite seams by Kazai [24]. The project brought advancements in the methodology of exploration, too. The drilling works encountered serious initial problems due to the extreme fracturing of rocks. This has largely been eliminated by the use of Geobor triple-tube drilling. The method was compared to conventional techniques by Kasó [25]. Field detection techniques to reveal the presence of mercury in soils were tested and reported by Lux [26].

The century-long iron ore mining has left significant environmental legacies. The proposed new mining stage will also produce impacts. The different ore and waste dumps were sampled and volumetrically assessed by Tóth [27]. The hydrological properties of the lake formed in the central largest open pit were monitored and its water quality tested by Németh [28] and Balázs [27].

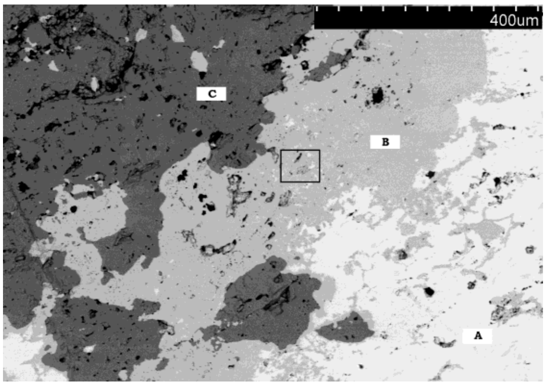

Figure 2. Backscattered scanning electron microprobe image of an ore sample from Rudabánya, baritic rim facies of the siderite. Sample RbLA003, A: galena, B: cerussite, C: barite [21]

4. Cserehát

Near Irota earlier uranium ore prospecting works have shown the presence of sulphide enrichment in Paleozoic metamorphic rocks [30]. The works re-started in 2010, with the reambulation of the previous exploration information and outcrop mapping. By reviewing the historic drillcores, an intensive hydrothermal alteration halo has been revealed. This has been followed by the re-interpretation of the underlying deep magnetic anomaly, using high sensitivity ground magnetic gradient mapping. Its interpretation was carried out by Czeglédi [31], who has worked out a high-resolution 3D anomaly model of the possible source rock-mass. The explorations are still under way.

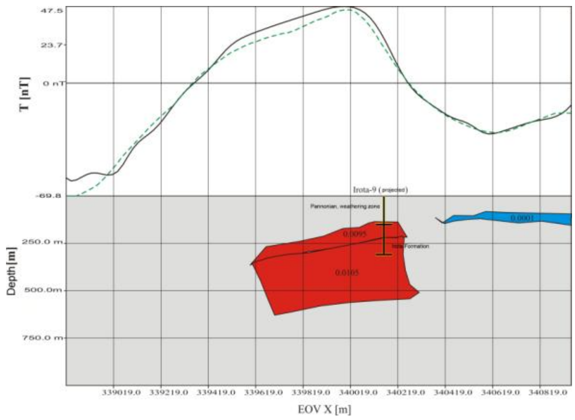

Figure 3. Interpretation of ground-magnetic measurements at Irota (at the Irota-9 dirllhole); bodies of enhanced susceptibility used in the model result in the fitted curve along a surveyed section [31]

5. Conclusions

Early-stage explorations require a great deal of data collection, transformation and preparation work, frequently beyond the possibilities of industrial companies. The capabilities of universities may give a substantial added value to exploration programs.

Participation in industrial projects offers the opportunity to students to solve real exploration problems, which are seldom provided by academic coursework. During these programs nine studies on the undergraduate level and 16 studies on graduate level were prepared, some of them published, providing a multi-faceted impression about the nature, depth and volume of works in mineral explorations.

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