Magmatic-Hydrothermal Systems of Bulgaria

SEG Student Chapter of the University of Geneva

Bulgaria, June 4–10, 2023

Authored by: Hugo Carrasco (President) and Ivano Gennaro (Vice-President)

Group picture at Dzorkovo Pb-Zn mine, Laki-Bulgaria.

INTRODUCTION

In early June, 2023, the SEG Student chapter of the University of Geneva conducted a field trip to the Panagyurishte district of the central Sredne Gore region and to the central Rhodope core in Bulgaria. The field trip was focused on the magmatic-hydrothermal systems and associated ore deposits found in the region and was generously funded by both the SEG Stewart R. Wallace Fund and the Fonds Générale de l'Université de Genève. The field trip lasted one week and contained 11 participants including professor Kalin Kouzmanov, who led the trip, and Stoyan Georgiev, a local expert working as researcher in the University of Sofia. Despite some major setbacks due to the cancellation of some mine visits because of safety closures, the chapter was still able to provide a fruitful experience to students and to explore

all aspects of the mining process, from exploration, to open pit and underground mining, and even ore processing. The localities visited, as well as the budget of the trip, are detailed below.

List of Participants:

- Kalin Kouzmanov (Professor, University of Geneva)
- Stoyan Georgiev (Researcher, University of Sofia)
- Ivano Gennaro (PhD student, University of Geneva)
- Hugo Carrasco (PhD student, University of Geneva)
- Alexander Cugerone (PostDoc, University of Geneva)
- Stefan Farsang (PostDoc, University of Geneva)
- Luis Krampert (MSc student, University of Geneva)
- Julien Sfalcin (MSc student, University of Geneva)
- Damian Braize (MSc student, University of Geneva)
- Safak Sonmez (PhD student, University of Geneva)
- Zsofi Pálos (PhD student, University of Geneva)

Program during the field trip:

Day	Date	Activity
Sunday	June 4	Arrival and regional geology
Monday	June 5	Elatsite mine
Tuesday	June 6	Aurubis smelter (morning) Mapping exercise in volcanic and volcanoclastic deposits (afternoon)
Wednesday	June 7	Assarel Mine
Thrusday	June 8	Vlaykov Vruh +/- Tsar Assen deposits for alteration mapping (morning) Magma mingling outcrops (afternoon)
Friday	June 9	Djurkovo deposit (Laki ore field)
Saturday	June 10	Bachkovo Monastery (morning) Gold panning exercise (afternoon)

DESCRIPTIONS DAY-BY-DAY

June 4 – Arrival and regional geology

On the 4th of June, participants arrived in Bulgaria, gathering in the Sofia airport to begin the trip. Once the rental cars were picked up, the group began the journey to Etrepole, but not without some geologic stops along the way. Two stops were made on the way to explain the regional geology, geologic history, and mines found in the Panagyurishte region where the group would spend the next few days (Fig. 1). The first stop was an outcrop of monzogranodiorite, the most primitive in the transect of major mines in the Panagyurishte district, giving everyone an idea of the types of magmatism in the area. It was also explained that magmatism in the area, and also ore deposit formation, gets younger moving southwards (from 92–78 Ma). This has been explained by slab rollback, where a deepening slab angle changes the location of the Benioff zone, and thus the major location of magmatism, during ocean closure.

Figure 1: Top. Regional Geology on the first day of the field trip, Etropole-Bulgaria. Bottom. Stefan Farsang, postdoc, highlighting the contact between the slate (dark, right) and porphyritic intrusion (left, light).

The second stop was a contact zone between a magmatic pluton and slate. The purpose of this stop was twofold: to see some of the host metamorphic rocks prominent in the area, and to observe the interaction between magmas and metamorphic rocks. This outcrop was a good spot to observe reaction rims, local veining, and localized crystallization induced by element transfer between metasedimentary host rocks and intermediate intrusions (Fig. 1).

After a long journey, the group was finally treated to dinner at a barbeque restaurant, a much-appreciated welcome to Bulgaria.

June 5 – Elatsite Porphyry Cu deposit

On the 5th of June, the group left Etrepole for its first mine visit of the trip: the Elatsite porphyry Cu deposit (Fig. 2). The source pluton is a granodiorite which intruded into basement schists and hornfels at about 92 Ma and the entire system is crosscut by a thrust fault. Mineralization is mainly localized in the igneous and hornfels units and is present as chalcopyrite. Molybdenite is also easily visible in some areas, but the Mo grade is too low overall to be economically exploited. Visitors got the chance to tour the open pit and have a look at some core in the core shack, getting a glimpse at all the units and alteration related to this magmatic-hydrothermal deposit.

Figure 2: Open pit Elatsite mine

June 6 – Aurubis Smelter

Due to an unfortunate incident at the Chelopech mine, the original mine visit was cancelled due to concerns over safety. Such an incident, however, did not stop the SEG chapter, with heavy help from professor Kalin Kouzmanov and his contacts, from finding an alternative plan. A visit was conducted at the Aurubis smelter in the Panagyurishte district, which processes copper ore from the local mines into high-purity copper cathodes. Not only this, but the by-products of the smelting process are also refined and sold, the major by-products being sulphuric acid, mainly used in the chemical industry, and iron silicate (fayalite) used for construction (Fig. 3). Visitors got to tour the facility, getting a look at both the smelting process and also the research and development currently underway at the facility. The smelting process

is something often overlooked by ore geologists as the primary goal is typically to find and produce a deposit. As such, this unique experience presented students with a valuable opportunity to see the treatment of ore once it is separated, and to learn about some of the challenges behind processing ore concentrates and processing them to acquire pure metals.

Figure 3: Group picture in the Aurubis smelting facility, in the bottom it is displayed the immense height of the smoke stack.

June 7 – Asarel Cu-Au deposit

The final mine visited in the Panagyurishte region was the Asarel Cu-Au mine. This mine exploits a telescoped system which experienced about 200,000 years of continuous mineralization activity in the Cretaceous. The deposit shows all major alteration styles related to porphyry and epithermal deposits, from potassic to advanced argillic, and because of the telescoped nature of the system chalcopyrite mineralization can be found in all alteration zones. Visitors got to see the open pit (Fig. 4) and have a look at core, giving participants an excellent example of the exploration of a heavily telescoped system and also a look at alteration styles and alteration overprints seen in these systems.

After the visit, the group made a quick cultural stop to the town of Panagyurishte, where they visited the golden treasure of Panagyurishte. This is a collection of nine artifacts crafted

of pure gold dating back to 300–400 BC. The treasure was found by three brothers who lived in the area and is housed at a cultural museum in Panagyurishte.

Figure 4: Panoramic view of the open pit at the Assarel Mine.

June 8 – Abandoned mines and magmatic textures

On the 8th of June the group left the Panagyurishte region to head south to the Rhodope mountains. Once again, a far drive did not mean a lack of geological education. The group started the day visiting some abandoned open pits in the southern Sredne Gore. This was more of a somber experience, detailing the destruction which can occur without proper care when closing a mine site (Fig. 5). The old mines were abruptly abandoned while Bulgaria was under Soviet occupation, with no restorative measures made once the mines closed. As a result, heavy acid-mine drainage led to red, acidic waters and heavy environmental damage in the area. This was a good chance for all to see why current mining and remediation practices are important and also to discuss challenges and remediation possibilities in older sites already greatly affected by acid-mine drainage.

The second stop was much less grave, a set of outcrops displaying amazing magmatic mixing and mingling textures (Fig. 6). The group visited an outcrop of the Bushula Varshilo pluton with an age of 78 Ma, one of the youngest in the area. Here, coarse-grained granodiorite and fine-grained diabase units interact, with outcrops displaying excellend examples of enclave formation and magmatic hybridization. Pegmatite veins filled with large (5 cm) amphiboles also cross-cut the area.

Figure 5: Abandoned open pit mine severely affected by acid-mine drainage. The slope in the back is from the weathering of the old pit while the water, turned red from the presence of metals, has a pH of ~2.

Figure 6: Mixing of coarse-grained granodiorite with fin-grained diabase.

June 9 – Dzorkovo Pb-Zn mine, Laki

The highlight of the trip for most participants came on the 9th of June with a visit to the Dzorkovo mine. The deposit here hosts amazing galena and sphalerite mineralization all present in one vein which is exploited by the underground mine here. Faulting in the region allowed for the mobilization of metal-rich fluids through the crust. The marble which is cross-cut by this large-scale fault is rich in organic matter and sulphur, providing the perfect sulphur source and trap for metal precipitation. Interestingly, the vein is only mineralized above a certain depth, a phenomenon which has been related to boiling-related precipitation of ore minerals. This stop provided participants with the rare opportunity to visit an underground mine and also witness centimetre-sized crystals of sphalerite and galena, along with epidote and other minerals found in the associated skarn.

Figure 7: Group picture at the entrance of the Dzorkovo Pb-Zn underground mine.

June 10 – Bachkovo Monastery and panning exercise

After a long trip packed full of interesting hydrothermal deposits, it was time for the group to head back to Sofia and return to Geneva. Before this, one more stop awaited the group – a cultural stop – to the Bachkovo Monastery. The 11th century monastery is home to frescoes, shrines, and a vast history spanning almost 1000 years, making it a truly inspiring reminder of the rich history found in Bulgaria. Participants were able to witness, read about, and appreciate this history before heading back to Sofia to make the journey home the next day.

It was followed by a panning exercise where the participants were able to practice in the field how to concentrate heavy minerals and gold minerals, which is an important task for prospecting (Fig. 8).

Figure 8: Panning exercise in the main river of Sofia, Bulgaria

BUDGET

The trip was funded by two main funding sources: the SEG Stewart R. Wallace Fund and the Fonds Générale de l'Université de Genève. The SEG Student Chapter of the University of Geneva is greatly appreciative of the funding received from both of these grants. A breakdown of the expenses paid is listed below.

Budget	**CHF**
SEG Stewart R. Wallace Fund	1733.89
Fond General, University of Geneva	5000
TOTAL	**6733.89**

Expenses	**CHF**
Transportation	
Car rental 1	469.4
Car rental 2	245.34
Insurance 1	277.58
Insurance 2	238.01
Accommodation	1279.564
Food	1614.747
Gas	264.63
Common Luggage	91.34
No receipts expenses	185.06
Flight tickets (70%)	1953.602
TOTAL	**6619.274**

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