



## Mawsonite from the Asarel porphyry copper deposit, Central Srednogie, Bulgaria: Mineral assemblage and chemical composition

### Моусонит от медно-порфирното находище Асарел, Централно Средногорие, България: минерална асоциация и химичен състав

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**Keywords:** mawsonite, high-sulphidation environment, sulfur fugacity.

#### Introduction

Mawsonite with theoretical formula  $\text{Cu}_6\text{Fe}_2\text{SnS}_8$  is normally established in massive to disseminated hydrothermal copper ores within highly altered volcanic rocks, in skarns, disseminated in altered granites or rarely in porphyry copper deposits. Its appearance is typically as rounded to irregular inclusions exsolved from bornite (Anthony et al., online). In Bulgaria mawsonite was first described in the Chelopech high-sulphidation Cu-Au deposit (Kovalenker et al., 1986). Later it was also reported from the Radka deposit (Tsonev et al., 2000).

This study represents the first find of mawsonite in the Asarel deposit, alongside with its mineral assemblage and chemical composition.

#### Geological setting

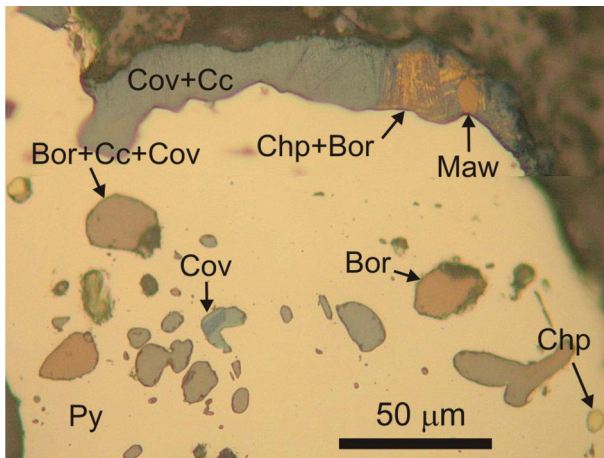
The Asarel porphyry copper deposit is located in the Panagyurishte ore region, Central Srednogie, where significant number of porphyry copper and high-sulphidation epithermal deposits, related to Late Cretaceous Cu-Au mineralizing processes are revealed. The hydrothermal alteration manifested in the host rocks of the deposit consists of K-silicate to K-silicate propylitic, propylitic, sericitic and advanced argillic alteration. The ore mineralization is developed in five successive mineral assemblages: Qz-Mt-Hem, Qz-Py-Chp, Qz-Mol, Qz-Py and Qz-Gal-Sph. Distinct supergene enrichment blanket of copper minerals is observed also (Strashimirov et al., 2002 and references therein). Characteristic for the deposit is the presence of high-sulphidation polyelemental ore mineral association, established in upper levels (Petrunov et al., 1991).

#### Materials and methods

Materials used for this research were provided by “Asarel-Medet JSC” in accordance to an assignment aimed on investigation of the final technological waste for remaining valuable elements. The material was collected from the crusher monthly mean samples with particle size of over 1 cm. The samples were investigated by optical and electron microscopy. The mineral composition was determined by X-ray diffraction using HUBER Image Plate Guinier Camera G670, while chemical composition of the minerals was detailed by JEOL JSM-6390 microprobe.

#### Results and discussion

The sample in which mawsonite was established belongs to the secondary Cu mineralization zone, well developed in the upper parts of the deposit where chalcocite and covellite are mostly presented. Chalcocite is redeposited in veinlets or nests or along with covellite and bornite replaces chalcopyrite almost entirely. Preserved chalcopyrite is observed as impregnations and thin veins or often surrounds fine to coarse grained pyrite. According to X-ray diffraction data the gangue phases are quartz and muscovite. Mawsonite was observed as very fine rounded inclusions up to 7–8  $\mu\text{m}$  among strongly altered chalcopyrite associated with bornite, chalcocite and covellite (Fig. 1). Considering the mineral relationships mawsonite is formed probably after chalcopyrite and before chalcocite and covellite. Where mawsonite associates with bornite it is difficult to conclude whether bornite belongs to the primary quartz-chalcopyrite assemblage or it is part of the secondary chalcocite-covellite mineralization. In polished sections the mineral is brownish orange, with



**Fig. 1.** Microphotograph of fine rounded mawsonite inclusion among secondary Cu minerals as chalcocite (Cc), covellite (Cov) and bornite (Bor). Fine relics of primary chalcopyrite (Chp) are also observed. Py – pyrite

strong pleochroism from orange to brown and very strong anisotropism from bright straw-yellow through bright royal blue to dark blue.

Common impurities in natural mawsonites as Zn and Se are often. The chemical composition of the studied mineral is very close to stoichiometry without any impurity detected. The content of Cu is 43–45 wt%, Fe – 11.5–11.9 wt%, Sn – 10.5–10.8 wt% and S – 32–34.5 wt% that coincides well with the data published in Handbook of Mineralogy (Anthony et al., online).

According to Lee et al. (1975) mawsonite precipitation needs higher sulfur fugacity and temperature

below 390 °C. Above this temperature stannoidite and stannite would be expected. This consideration is in good accordance with the temperature data for chalcopyrite deposition from Asarel – nearly 300 °C (Strashimirov et al., 2002). The higher sulfur fugacity needed for mawsonite formation supports the assumption that the studied mineral is part of the polyelemental mineralization including Cu-Sn-V association established in the upper levels of the deposit and typical for a high-sulphidation environment (Petrunov et al., 1991).

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