

## Trace elements vectors in molybdenite from porphyry-copper deposits of Bulgaria

### Елементи-примеси вектори в молибденит от медно-порфирни находища в България

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### Introduction

Molybdenite occurs in the ore shells of many porphyry-copper deposits (PCD) developed in subduction related magmatic arc settings in the Tethyan-Eurasian copper belt (Sillitoe, 2010), including Elatsite, Medet, Asarel, Tsar Asen, Vlaykov Vrah and Studenets PCD in the Central Srednogie, Bulgaria in particular (Popov et al., 2012). The complicated geochemistry of porphyry-copper systems explains the limited number of studies testifying the trace elements in sulphide minerals including molybdenite in particular as geochemical vectors and pathfinders for PCD. Quartz-molybdenite veins as a rule are developed after chalcopyrite rich “B” type veins (Fig. 1) that commonly occur in the above mentioned PCD’s in Bulgaria. Quartz-molybdenite veins in most important PCD in Bulgaria have been studied for 32 elements by means of LA-ICP MS (Perkin-Elmer ELAN DRC spectrometer with New Wave UP193FX LA device, Geol. Institute, BAS) for the purpose of discriminating the trace elements vectors and pathfinders for porphyry-copper systems.

### Results and discussion

Re, Se, Cd, Ti and V are common trace constituents in all the molybdenites (45 samples) from Elatsite, Medet, Asarel, Vlaykov Vrah and Studenets PCD, while Mg, Cr, Fe, Co, Cu, Ge, Sr, Ag, Te, W, Pb and Bi are variable. The recorded Re content varies from minimum of 122 ppm in Studenets to maximum of 5791 ppm in Elatsite (Fig. 2). The Re content in molybdenite for the individual PCD varies from 519 to 5791 ppm in Elatsite, while in Medet is between 553 and 1201 ppm, in Asarel from 692 to 3213 ppm, in Vlaykov Vrah from 1674 to 2055 ppm and in Studenets from 122 to 285 ppm (Fig. 2), that could be due to the different depths and

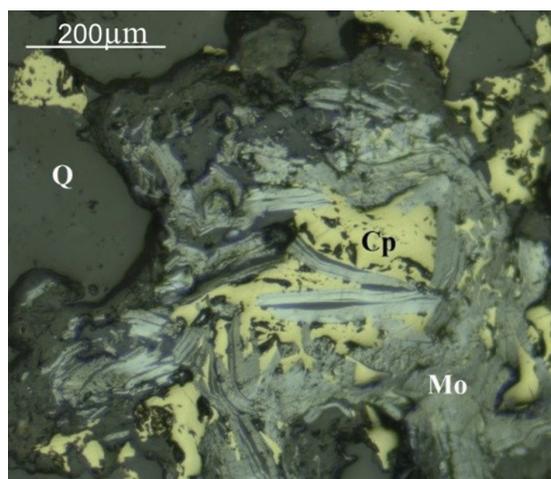


Fig. 1. Quartz (Q)-molybdenite (Mo) vein associated with “B” type chalcopyrite (Cp) vein in Elatsite PCD

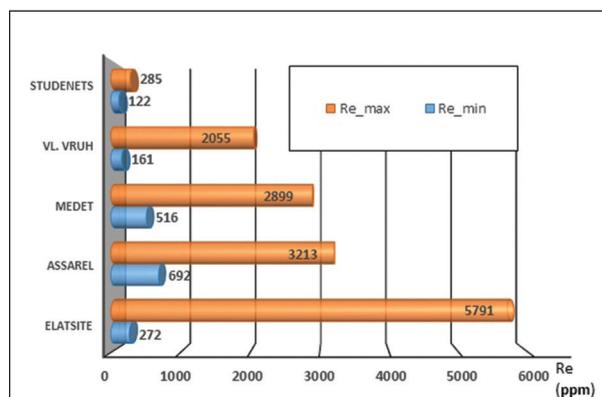


Fig. 2. Re content in molybdenite from PCD of Bulgaria

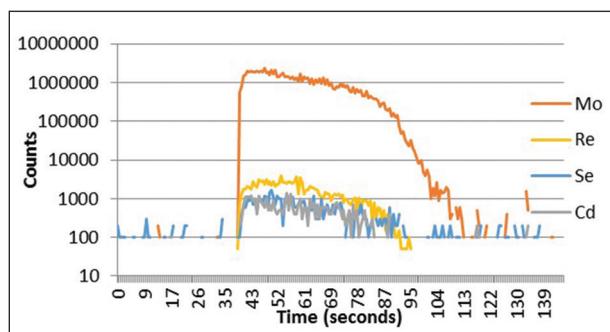


Fig. 3. LA-ICP-MS spectra for Mo, Re, Se and Cd

erosional levels of the molybdenite formation. Very good positive correlation ratio ( $R=0.75-0.97$  for 22 samples) has been obtained for the couples Ge-Cu, Pb-Co, Bi-Cu and Bi-Ge. Re, Cd, Ti, V, Co, Cu and Ge in addition to Se and Te seem to be incorporated in the molybdenite structure as indicated by LA-ICP MS spectra (Fig. 3), while Mg, Sr, Pb, Bi, W and part of Fe and Cu could be possibly due to microinclusions of calcite, chalcopyrite and scheelite.

In the Elatsite PCD molybdenite mineralization is separated in two ore-bodies that are fault controlled (Fig. 4) and partly coincide with the shape of the copper-rich ore bodies. On the other hand there is a trend for decreasing of the average Re content in molybdenite hosted in quartz-monzodiorite porphyries ( $>3700$  ppm) as compared with the granodiorites ( $>1150$  ppm) of the Vezhen pluton in the deeper parts of the deposit.

## Conclusions

The recent study suggests a trace element trends in molybdenite from PCD in Bulgaria as follows:

- There is a trend for more high Re grade in molybdenite from more older and fertile PCD (Elatsite, Medet, Asarel – 92.2–91.0 Ma Re/Os age) as compared with relatively more younger and small in volume one (Vlaykov Vrah, Studenets – 87–86 Ma) that could be a potential pathfinder for PCD.
- Y (0.4–2.5 ppm) and Nb content (6.04–10.5 ppm) in molybdenite from PCD in Bulgaria correspond to un-

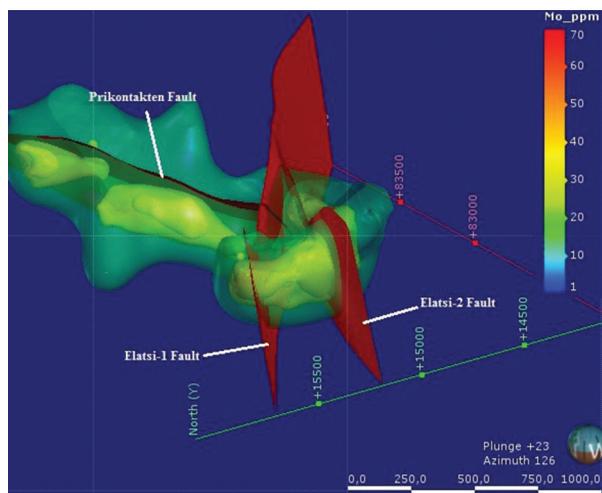


Fig. 4. 3D model of molybdenite fault controlled ore bodies in Elatsite PCD

dersaturated in Mo magmas generated in volcanic arcs (Audetat et al., 2011).

- According to Cu/Mo ratio (37–200) and average Au grade (0.1–0.5 g/t) and Re content (122–5791 ppm) in molybdenite the studied PCD in Bulgaria could be attached to porphyry-Cu, porphyry-Cu-Au, and porphyry Cu-Mo type.

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