Ore formation processes in porphyry Cu deposit revealed by in situ Cu isotope analyses

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The Veliki Krivelj porphyry Cu deposit, East Serbia, is part of the Late-Cretaceous Timok magmatic complex. It has formed in a domain of dyke systems above the quartz diorite plutonic intrusion. Chalcopyrite - pyrite veins or disseminated fine grain mineralization is located in hydrothermaly altered late andesites and volcanoclastic sedimentary rocks. A vertical profile of over 250 m of chalcopyrite mineralization was sampled from the open mining pit.

Trace element contents and copper isotope compositions of chalcopyrite have been measured by (194 nm) deep UV-fs laser ablation ICP-MS coupled with MC-ICP-MS. For Cu isotope measurements instrumental mass bias was corrected by the simultaneously introduced Ni NIST SRM 986 standard solution and δ^{65}Cu values have been determined relative to the NIST SRM 976 Cu standard. A long-term reproducibility of better than 0.08‰ and 0.1‰ (2SD) on the NIST SRM 976 Cu-metal and chalcopyrite in-hause standard, respectively, has been achieved with this technique[1].

The investigated ore sulphides have relatively constant S isotope compositions, indicating a magmatic origin. Although all chalcopyrites are mineralogically primary minerals, they exhibit a range of more than 1.2‰ in δ^{65}Cu between individual samples. Furthermore, trace elements and Cu isotope composition systematically vary along a vertical profile, implying a range of different hydrothermal processes. Signatures of samples from deeper levels indicate preferential transport of light Cu isotopes by a vapour phase, resulting in the development of low δ^{65}Cu, while those from shallower levels are consistent with trasported by a brine phase. Analysed chalcopyrite veins have homogeneous δ^{65}Cu, while disseminated grains display up to 0.4‰ variation on sample scales which may indicate secondary alteration.

[1]Lazarov and Horn 2015, Spectrochim. Acta Part B.