Tracing the formation of polymetallic deposit using Fe and Cu isotopes

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The Čoka Marin polymetallic (Cu-Au-Ag-Zn-Pb) deposit, hosted by Late Cretaceous andesitic volcanic rocks, belongs to the east Serbian part of the Banatitic magmatic and metallogenic belt. The ore bodies of this deposit are predominantly composed of pyrite (Py) and barite containing veins and nests of enargite, luzonite, bornite, chalcopyrite (Cpp), sphalerite, galena and other minor phases. The genesis of these Cu and Fe minerals was explored by analizing their Cu and Fe isotope compositions applying in situ fsLA-MC-ICP-MS [1]. Based on these analyses several conclusions can be made about the formation of the polymetallic ore deposit.

Pyrite, the dominant mineral, occurs as fine- to coarse-grained crystals and in different types of aggregates diversly enriched in Cu, Pb and Ag. In accord with a variety of textures [2], three generations of pyrite were identified by their Fe isotope composition. Coarse grains with δ^{56}Fe of ~ 0 ‰ indicate a magmatic origin, while spongy agregates have lower values (~ -0.6 ‰), and pinkish rims enriched in Cu have even lower values (~ -1.6 ‰). While coarsed-grain pyrites are crudly in equilibrium with coexisting Cpp, other pyrite generations display kinetic Fe isotope fractonation. This is in accord with the suggestion of [2] that spongy aggregates were rapidly crystallized during the abrupt precipitation in a subsurface volcanic environment. According to estimates based on Fe isotope fractionation between coarse-grained Py - Cpp pares, deposit formation temperatures were around 340°C.

Successive deposition of bornite and chalcopyrite shows restricted Fe and Cu isotope fractionation, which imply no redox-induced isotope effects during crystallisation at high temperatures. Initially formed, mostly Cu-rich minerals (dominantly bornite) tend to have heaviour Cu and Fe isotope compositions, compared to those which formed later in an Fe-rich environment (dominantly Py). Finally, minor (~ 0.15 ‰) isotope fractionation towards positive δ^{65}Cu and δ^{56}Fe values is observed for secondary, exsolved chalcopyrite and digenite.

[1] Lazarov, Horn (2015) *Spectroch. Acta Part B* **111**, 64-73.
[2] Pačevski et al. (2012), *Canadian Mineral.* **50**, 1-20.