The behaviour of chalcofile elements during UHP metamorphism: evidence from the Kokchetav Massif by LA-ICP-MS imaging of sulfides

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In subduction zones recycling of crustal material results in volcanism and formation of economically important ore deposits. The release of chalcophile elements from subducting slabs is likely controlled by reactions and partitioning of sulphide minerals, however little is known about their fate during high pressure metamorphism.

The matasedimentary rocks of the Kokchetav complex experienced partial melting and loss of silicate melts at pressures over 45 kbar and temperatures about 1000C reaching UHP and UHT conditions. The extraction of granitic melts severely depleted Kokchetav gneisses in the set of key elements (e.g. LREE, Th and U) [1], however the effect of the UHP melting of chalcophile elements is not constrained so far.

The dominant sulfide in the Kockhetav gneisses is pyrite, whereas chalcopyrite and sphalerite occur in much lower abundances. Pyrrhotite and pyrite occur in garnet pyroxene rocks.

We obtained the first data on concentrations of a wide range of chalcofile elements in the Kokchetav rocks by technique of LA-ICP-MS trace element imaging. The images were collected by using small square beam, which scanned across the sample.

The images show that pyrite has significant concentrations of chalcophile elements (Ni, Co, As, Au, Ag, Sb, Se, Cu, Pb), which are higher than typical for metamorphic pyrite. The textural occurrence of the sulfides argues against their formation during late alteration. The results of this study suggest that Kokchetav metasediemtnary rocks retained a significant fraction of their load of chalcofile elements after the extreme conditions of UHP metamorphism and hence raise questions on controls and mechanisms of release of chalcophile elements from the subducting lithosphere.

[1] Stepanov et al. (2014) CTMP, 167. DOI: 10.1007/s00410-014-1002-x