The chemical state of gold in the Fe-As-S system studied via analysis of synthetic minerals

E. V. KOVALCHUK[1*], D. A. CHAREEV[2], V. D. ABRAMOVA[1], A. V. MOKHOV[1] AND B. R. TAGIROV[1]

[1]Institute of geology of ore deposits IGEM RAS (*correspondence: elena7kovalchuk@gmail.com)

[2]Institute of experimental mineralogy IEM RAS

Arsenopyrite (FeAsS) is the most important mineral that concentrates Au in the 'invisible' (syb-micrometer size, or refractory) state in many types of hydrothermal ore deposits. The aim of the present study is to synthesize Au-bearing minerals in the system Fe-As-S at contrast T-P-$f(S_2)$ conditions, and, by analysis of the chemical composition of synthesized phases, determine the Au distribution coefficients, its maximum concentration, and conditions that favour the formation of 'invisible' Au.

The plate-like single crystals and asterisk-like aggregates of FeAsS in equilibrium with metallic Au were grown in silica glass ampoules using the $AlCl_3$/KCl/NaCl, CsCl/NaCl/KCl, CsCl/NaBr/KCl, CsCl/NaCl/KI, and CsCl/NaBr/KI flux technique. At high temperature the ampoules were kept in a permanent temperature gradient (450 – 600 °C at the hot ampoule end, 50 °C temperature gradient). At low temperature (350 °C) the experiments were performed using a furnace without temperature gradient, where ampoules were periodically agitated. After experiment the grains morphology and chemical composition of synthesized phases were determined using SEM, EPMA, and LA-ICP-MS techniques. Arsenopyrite, loellingite $FeAs_2$, pyrrhotite $Fe_{1-x}S$, pyrite FeS_2, and assemblages of these minerals were obtained as synthesis products. The LA-ICP-MS line/spot analyses and mapping showed that Au is more enriched in loellingite than in arsenopyrite, whereas the lowest Au concentrations were determined in pyrrhotite. The Au concentration profiles suggest that in arsenopyrite it presents in the form of sub-micrometer size particles and homogeneously distributed admixture, and the concentration of homogeneously distributed Au falls within n·1 ppm to ~ 200 ppm range. In contrast to arsenopyrite, Au in pyrhotite is mostly homogeneously distributed within the mineral matrix, and its concentration is n·0.1 ppm. Arsenopyrite grains, synthesized at 450 - 550 °C, reveal zonal structure. The EPMA maps and LA-ICP-MS analyses of these grains showed that higher concentration of Au is localized within the As-rich zones. This suggests close correlation between 'invisible' Au concentration in arsenopyrite and As/S activity ratio in the ore system.