Re–Os Age and Gold Source for Mayskoe Quartz-Vein Deposit (Northern Karelia, Baltic Shield)

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Mayskoe deposit located in Northern Karelia within the Svecofennian orogen near the boundary with the Belomorian–Lapland orogen is the only known gold deposit of the quartz–vein type in the Karelian–Kola region. The host Paleoproterozoic volcanogenic–sedimentary rocks metamorphosed from greenschist to amphibolite facies within the Svecofennian time. Metamorphic rocks are strongly scheared and metasomatized, where early quartz and late gold-bearing quartz veins are located. Ore association in quartz veins is represented by native gold, chalcopyrite, pyrrhotite, galena, pyrite, and sphalerite, as well as Se and Te minerals.

We investigated the Re–Os isotope system of native gold and syngenetic chalcopyrite from the eastern lode-gold quartz vein. Gold grains and chalcopyrite were manually collected from two gold-bearing milky–white quartz samples. Re and Os contents in the analyzed gold range from 1.8 to 13.8 and from 0.2 to 2.3 ppb, which is comparable with the concentrations measured in syngenetic chalcopyrite: 0.5–2.1 ppb Re and 0.1–1.0 ppb Os. According to the Os concentration, the studied samples differ significantly from hydrothermal sulfide gold deposits and are comparable with those associated with conglomerates [1]. The correlation between Re/Os and Os isotope composition for the studied samples corresponds to the age of 397 ± 15 Ma and $(^{187}Os/^{188}Os)_i = 0.1469 \pm 0.0051$ ($\gamma Os = +18$).

The measured Os composition of gold and chalcopyrite ($^{187}Os/^{188}Os = 0.2160–0.4376$) differs significantly from typical crustal (> 1.0) and mantle values (0.1296), and may be obtained either by mixing of Os from these sources or as a result of in situ Re decay. The age character of obtained trend is provided by the model Re–Os age of the samples: from 430 to 515 Ma, similar to the isochron one. Thus, the ore-forming fluid may have been formed in the Early Paleozoic by mixing of 75% upper mantle material and 25% Proterozoic crust and have come to quartz veins 400 m.y. ago. The primitive upper mantle (Os = 2.5 ppb and $^{187}Os/^{188}Os = 0.1239$), in this case, was the main source of gold. Alternatively, formation of gold-bearing mineralization was plausible realised under the influence of the Caledonian mantle plume due to remobilization of basic–ultrabasic matter (or mantle restites) of Paleoproterozoic rocks (2.0–2.2 Ga) of the Karelian–Kola region characterized by high concentrations of gold and PGEs.

[1] Kirk *et al.* (2002) *Science* **297**, 1856 – 1860.

Experimental and computational spectra and thermodynamics of biogeochemical interfaces

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The molecular-level chemistry of biogeochemical interfaces influences dissolution of minerals, transport of bacteria and degradation of contaminants. Detailing these interactions is problematic, however, because surfaces are difficult to characterize and biological compounds can be complex. Significant advances have been made by collecting spectra (e.g., ATR-FTIR, NMR, etc.) of samples representing key biogeochemical reactions and interpreting the spectra with quantum mechanical calculations. Generally, these experimental studies are performed on simplified binary systems with one substrate and one adsorbent. Predictions of biogeochemistry in the field may be erroneous because competing reactions are not considered in the laboratory-based studies.

A missing component of these types of studies is the thermodynamics of the adsorption reactions. One can model surface complexes and the spectroscopic properties observed, but without knowledge of the thermodynamic favorability of the surface complexes, one cannot estimate their prevalence or dominance in natural systems.

This talk will focus on progress in developing methods to calculate spectroscopic properties and thermodynamics of adsorption in biogeochemical systems. The incorporation of thermodynamic data from flow-adsorption calorimetry into modeling of these adsorption reactions will also be discussed. Examples of test systems such as goethite-phosphate will be used as the basis for more complex reactions with biological compounds.

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