

Osmium partitioning behavior between metal and silicate melt at high pressure and temperature: A new experimental approach

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Constraining partitioning behavior of the highly siderophile elements (Re, Os, Ir, Ru, Rh, Pt, Pd, Au: $D_{\text{met/sil}}^{\text{met/sil}} > 10^4$ at 1 atm) may play a key role in elucidating whether mantle abundances of these elements were established by metal-silicate partitioning at the base of a magma ocean, or by accretion of ~0.5% of Earth's mass subsequent to core segregation. Osmium is an important element in discriminating between these processes, owing to the utility of the ¹⁸⁷Re-¹⁸⁷Os isotope system. Yet data for $D_{\text{Os}}^{\text{met/sil}}$ for high P - T conditions are generally lacking. We have devised a new methodology to determine $D_{\text{Os}}^{\text{met/sil}}$ at high P - T conditions while utilizing natural Os abundances in the experiments. Paired samples of iron meteorite (¹⁸⁷Os/¹⁸⁸Os = 0.14; Os = 8.5 ppm) and komatiitic basalt (¹⁸⁷Os/¹⁸⁸Os = 2.2; Os = 64 ppt) are placed in graphite capsules and processed at 10 kbar-1450°C or 20 kbar-2000°C. The ¹⁸⁷Os/¹⁸⁸Os and Os concentrations in several small (<10 mg) portions of quenched glass from each experimental charge are measured by physical separation, chemical separation of Os from the glass and analysis of Os by negative thermal ionization mass spectrometry. The data for 10 kbar-1450°C experiments show variable ¹⁸⁷Os/¹⁸⁸Os ratios (0.14-2.1) which span the range defined by the starting metal and silicate. The data show linear correlations in ¹⁸⁷Os/¹⁸⁸Os vs. 1/¹⁸⁸Os diagrams that converge at one end at the composition of the starting metal, suggesting variable contribution of metal micronuggets entrained in silicate glass. The other end-component has a ¹⁸⁷Os/¹⁸⁸Os ratio close to that of the starting silicate, but with an Os concentration that is lower than the starting silicate (43 ppt). This is likely caused by a draw down of Os from the silicate into the metal micronuggets, albeit without accompanying isotopic exchange. In the 20 kbar-2000°C experiments, the quenched glass retains Os concentrations lower than the starting silicate (<30 ppt) but have much lower ¹⁸⁷Os/¹⁸⁸Os ratios (<0.4) suggesting that isotopic exchange is more rapid at higher P - T conditions. Our experimental data give $D_{\text{Os}}^{\text{met/sil}} > 3 \times 10^5$, similar to prior 1 atm experiments ($D_{\text{Os}}^{\text{met/sil}} = 10^6$).

Experimental investigation of the hydrothermal geochemistry of Gold deposition associated with aluminosilicate: The formation process of epithermal Gold deposits

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In order to discuss the formation mechanism of epithermal gold deposits, synthetic experiment of aluminosilicate containing gold at 30°C and high temperature (<250°C) is demonstrated. As a preliminary experiment, coprecipitation of gold with aluminum hydroxide is investigated at 30°C. The gold complex, $[\text{Au}(\text{S}_2\text{O}_3)_2]^{3-}$ is selected as model gold species in solution for convenience. The results show that the amount of gold coprecipitated with aluminum hydroxide decreased with increasing pH. Uptake of gold by aluminum hydroxide effectively occurred at near neutral pH, while almost no uptake by silicate. This result indicates that the electrostatic force between gold complex ions with three negative charges and aluminum hydroxide or silicate is the main factor for controlling the uptake of gold. The gold coprecipitation by aluminum hydroxide in the presence of various concentration of silicate is also examined. The amount of gold coprecipitated was affected toward decrease by addition of silicate. The detail investigation has to be done by NMR to discuss more in terms of coordination environment of aluminum or silicon with or without gold.

Since a boiling is recognized as a one of the key factor for the precipitation of gold associated with silicate from the ore-forming fluid, the model experiment at high temperature is designed. The sample solution containing gold, aluminum and silicon with a given concentration is prepared in a reactor. The reactor is constantly agitated and heated with monitoring temperature and pressure. At designed temperature, the valve is opened and the makes the sample solution boiled as a function of the decompression rate. The obtained product of solid material is characterized by XPS, XRD, NMR and SEM/EDX to discuss the relationship between change in chemical state of gold and distribution of other elements. The formation mechanism of epithermal gold deposit will be proposed based on the obtained results.