Which ligand is the most important for gold transport in hydrothermal fluids? An *in situ* XAS study in mixed-ligand solutions

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Gold transport and deposition in hydrothermal ore fluids is dependent on the identity and stability of predominating aqueous gold complexes. Gold(I) bisulfide (e.g., $Au(HS)_2^-$) and in some instances Au(I) chloride complexes are widely acknowledged to account for Au transport in ore fluids.

This study investigates the potential of the unconventional ligands Br^- and NH_3 to increase Au mobility. This was achieved by determining the predominant Au species in hydrothermal fluids with binary mixed ligands (Br^- - Cl^-, Br^- - HS^-, HS^- - NH_3), and measuring their structural properties using in situ Synchrotron X-ray Absorption Spectroscopy (XAS). The capacity of XAS to follow the progress of ligand exchange reactions was demonstrated at room temperature, where the $Au(III)Br_4^-$ complex was found to predominate in mixed Br^-/Cl^- solutions (Br^-/Cl^- = 0.1-1), with average ligand numbers derived from XAS in good agreement with a recent UV-Vis study (Usher *et al*.., 2009, Geochim. Cosmochim. Acta 73, 3359-3380). At temperatures up to 400 °C and at 600 bar, the XAS measurements show that Au(I) – HS^- complexes are the only stable Au species in mixed HS^-/Br^- and HS^-/NH_3 fluids (HS^-/Br^- = 0.1; HS^-/NH_3 = 0.2), indicating that hydrosulfide is the most important ligand for Au transport in the hydrothermal fluid under our experimental conditions, i.e., hydrosulfide complexes outcompete bromide and ammine complexes in S-bearing fluids. These results are comparable to solubility and speciation calculations based on the available thermodynamic data.

Li isotope geochemical study on weathering of granite in Longnan, Jiangxi Province, South China

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Li isotope has been newly demonstrated to be a powerful tool in studying silicate weathering in a weathering profile, catchment, and even continental scale. In this study, we focus on variation in Li isotope geochemical features along soil and weathering profiles of three sites along a mountain ridge slope, which was developed on granite in Longnan, Jiangxi Province, South China. The studied profiles include JLN-S4 (mountain top, 120 cm deep soil profile); JLN-S3 (middle slope, 120 cm deep soil profile); and JLN-S1 (valley floor, about 1100 cm deep weathering profile). Li content and δ^7Li of bulk samples, along with major element composition and CIA (chemical index of alteration) values of the bulk samples from weathering and soil profiles were determined.

JLN-S4 profile samples have CIA values between 97.63 and 98.32,with δ^7Li values from -2.50‰ to -3.90‰; JLN-S3 profile samples have CIA values varing from 94.42 to 96.12 and δ^7Li values from -0.73‰ to -1.55‰; The weathering profile JLN-S1 at valley floor has a generally descending CIA values (57.77~92.44) with increasing depth. Its δ^7Li values vary with CIA, showing a two stage relationship: persistent increase from -14.92‰ to 0.66‰ when CIA increasing from 57.77 to 74.56, and δ^7Li variation in a range of -4.74~3.62‰, with no obvious relationship with CIA change. Li contents in JLN-S4 vary between 3.84 and 15.03 μg/g, in JLN-S3 between 1.43~8.03 μg/g, and in JLN-S1 between 6.95~22.27 μg/g. In JLN-S1, Li contents decrease with increasing CIA (57.77~74.56), no regular tendency in Li abundance was observed in samples with higher CIA values. Two granite bedrock samples have δ^7Li value of -0.23 and 0.39‰, Li abundances of 38.58 and 34.22μg/g, respectively.

The Li isotope geochemical features of the profiles in this study indicate that Li isotope behavior was dominantly determined by weathering extent during incipient weathering of granite, while much complicated factors, such as mineral phases, adsorption and desorption of different clay minerals control Li isotope geochemical features as weathering and pedogenesis progressing.

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