

Gold contents of the cratonic sub-continental lithospheric mantle: Implications for orogenic gold deposits

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The occurrence of many orogenic gold deposits within Archaean cratons suggests that the gold could be sourced from the sub-cratonic lithospheric mantle. The model has been difficult to test because the available cratonic mantle samples consist almost entirely of kimberlite-borne xenoliths, few of which have been analysed for Au. Furthermore, Au levels in mantle rocks tend to be close to the detection limit of current analytical methods. In the present study we have determined Au contents in 81 kimberlite borne peridotite and MARID mantle samples from the southern Africa, using ICP-MS after Ni-sulfide fire assay and Te co-precipitation at Cardiff University. The blank contained 0.11 ± 0.03 Au, resulting in a procedural detection limit of 0.1 ppb Au and a quantification limit of 0.33 ppb Au. On average, the Kaapvaal xenoliths contain 1.09 ppb Au, broadly in the range of primitive upper mantle estimates. In order to exclude the possibility that the xenoliths could be non-representative of the SCLM we have also analysed Au in 24 samples of the Jormua massif in Finland, interpreted to represent Archean cratonic SCLM that was obducted onto the Karelian craton margin at ca 1.95 Ga. The average Au content of 23 Jormua samples is 1.01 ppb, with one additional highly talc-carbonate replaced sample containing more than 100 ppb Au.

Our samples, as well as many other samples from non-cratonic lithospheric mantle, show high primitive-mantle normalized Au/Pd ratios, due to pervasive Pd depletion.

We infer that introduction of Au during contamination with host kimberlite is unlikely to account for the observed positive anomalies. One could alternatively suggest that Au is stabilized in refractory alloys during mantle melting, based on the observation that Au does not enter into mantle sulfides. However, the Au enrichment in magmatic sulfide ores clearly indicates that Au behaves incompatible during mantle melting, consistent with the high D values of Au with regard to sulphide liquid ($D \sim 1000$, Barnes and Lightfoot, 2005). The formation of distinct Au-rich phases associated with sulfides can be explained by the fact that the ionic radius of Au is too large to fit into the structure of mss or iss. As the solubility of Au in basaltic magmas is >10 ppm, Au will be released to the magma during partial melting of the mantle. In conclusion, our preferred model is that the relative Au enrichment in the cratonic SCLM formed through metasomatic introduction of Au, implying mobility of Au in the mantle. This is consistent with derivation of at least some orogenic gold from the SCLM.

Local structure of poorly ordered nanosized iron oxides. Implications for contaminants scavenging

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Iron (oxyhydr)oxides nanoparticles are ubiquitous in natural environments (soils, rivers, sediments...), as well as in impacted systems such as acid mine drainage, where they strongly impact the mobility of most trace elements. Among these (oxyhydr)oxides, the poorly crystalline minerals ferrihydrite and schwertmannite are the most efficient in the scavenging of toxic solutes such as arsenic, either via sorption or coprecipitation mechanisms. The knowledge of the structure of these compounds is a prerequisite to the understanding of their surface reactivity. However, due to their nanoparticulate nature and to the lack of well-crystallized isomorph compounds, their structure remains poorly constrained. Recent X-ray scattering studies [1, 2] have yielded unique information on the medium-range order in these materials. However, for such disordered nanomaterials, scattering techniques that yield average periodic structural models may fail at accurately describing the local coordination sphere of cations. To overcome this difficulty, we have used Extended X-ray absorption fine structure (EXAFS) spectroscopy to determine the local coordination and arrangement of cations in these poorly ordered solids. Using EXAFS data recorded at liquid helium temperature over a wide energy range, we will particularly discuss the presence of tetrahedral iron in ferrihydrite [3], and the structural specificities of natural and synthetic schwertmannites coprecipitated in the presence of arsenic. The structural information derived from these data will be compared with existing structural models, and yield clues for better understanding the reactivity of these materials.

[1] F.M. Michel *et al.* (2007) *Science* **316**, 1726–172.

[2] A. Fernandez-Martinez *et al.* (2010) *Am. Mineral.* **95**, 1312–1322. [3] F. Maillot *et al.* (2011) *Geochim. Cosmochim. Acta* **75** 2708–2720