Chromitites from the Andriamena greenstone belt, Madagascar: Hints of a mid-Archean ophiolite?

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The Andriamena greenstone belt of Madagascar contains massive chromitite bodies of likely ophiolitic affinity, composed of about 90% chromite and 10%, mostly secondary, gangue minerals (talc, green amphibole, orthopyroxene, Ca and Mg carbonate). Arguments in favor of an ophiolitic origin for the chromitite include the high Cr# (0.67-0.74), coupled with relatively high Mg# (0.6-0.78) of the constituent chromite. In addition, these phases display very low TiO_2 contents (<0.25%), which are also characteristic of ophiolites and possibly suggestive of an arc environment. Though in most places the chromitite is in tectonic contact with a variety of igneous lithologies, remnants of apparently cogenetic ultramafic rock types, including dunites, harzburgites, and some pyroxenites are sometimes immediately juxtaposed with the chromitite. The very high Fo content of the olivine in the dunite, as high as 0.95, also attests to an ophiolitic provenance.

Platinum group element (PGE) and Os isotopic analyses were performed on several chromitite samples. Chondrite normalized PGE spectra display marked depletions in PPGE relative to IPGE, with $(Pt/Ir)_N$ ranging from ~0 to 0.09, though Pd contents are somewhat less depleted than those of Pt. The observed PPGE depletion is another feature characteristic of ophiolitic chromitites. The IPGE enrichment is consistent with the presence of laurite microinclusions in the chromite revealed by SEM. Os isotopic compositions are tightly clustered, with $^{187}Os/^{188}Os$ ranging from 0.1057 to 0.1059, corresponding to T_{RD} model ages of ~ 3.2 Ga, assuming primitive upper mantle parameters [1]. $^{186}Os/^{188}Os$ measurements are in progress.

If the ophiolitic nature of the chromitites is confirmed, our results might imply that mechanisms similar to present-day tectonic processes may already have been active in the mid-Archean.

[1] Meisel, Walker, Irving & Lorand (2001), *Geochim. Cosmochim. Acta* **65**, 1311 – 1323.

Biogeochemical cycling of Au and Pt - Integrating field studies, micro-analyses and molecular biology

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The biosphere catalyzes a variety of biogeochemical reactions that transform Au and Pt. Studying these interactions from the nano- to the macro-scale requires a well-integrated set of tools ranging from field studies to micro-analytical, synchrotron- and omic approaches. Gold and Pt grains are rare, hard to find and getting access to prospecting sites often requires a great deal of 'field diplomacy'. To study biofilms living on grain surfaces, Au and Pt grains need to be collected under field-sterile conditions and frozen, refrigerated or fixed immediately after collection for genomic-, culturing- or electron microscopic studies, respectively. In particular, FIB-SEM-EBSD/EDXA has been useful in understanding the distribution and structure of biominerals and biofilms, as well as their effect on the (trans)formation of Au and Pt grains. In addition, FIB-SEM has been used to study analogue Au and Pt biominerals formed in laboratory experiments by organisms (i.e., *Cupriavidus metallidurans*) identified on Au grains. Synchrotron spectroscopy techniques (μXRF, μXANES and μEXAFS) allow us to map the distribution and speciation of Au and Pt in individual *C. metallidurans* cells. This has led to an understanding of the fate of environmentally important mobile Au- and Pt-complexes (identified with HPLC-ICP-MS), upon contact with cells. To understand the reaction of cells to the toxic complexes transcriptome microarrays and 2-D SDS-PAGE was used. Important determinants of Au and Pt resistance and sensitivity were studied using deletion mutagenesis and (LA)-ICP-MS analyses of cells and proteins enriched in Au. Specific Au-binding proteins have been identified with MALDI-TOF-TOF, and can be used as biosensors for in field quantification of Au. To investigate the distribution of these important determinants in surface to depth environments high-density phylogenetic and functional microarrays (e.g., PhyloChip, GeoChip) are used. Understanding the determinants of biogeochemical cycling of Au and Pt may explain the formation of large supergene deposits have formed, and provide the basis for novel approaches in exploration, bio-hydrometallurgy and bio-remediation.

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