^{186}Os-^{187}Os systematics of Gorgona komatiites and Iceland picrites

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Lavas from the Hawaiian and Siberian (Noril'sk) plume systems show coupled enrichments in ^{186}Os/^{188}Os and ^{187}Os/^{188}Os (Walker et al. l997, Brandon et al. 1998. Picrites from Hawaii also display a positive correlation between ^{186}Os/^{188}Os and He isotopes (R/Ra), consistent with a lower mantle source for the radiogenic ^{186}Os signal. This Os signal cannot be derived from ancient recycled crust which will have R/Ra of 1 or less. New data on Os-rich alloys from ophiolites (Meibom and Frei 2002) and new data presented here on Gorgona komatiites erupted at 89 Ma, also display coupled enrichments in ^{186}Os/^{188}Os and γ_{Os} (γ_{Os} = % deviation from average chondrite ^{187}Os/^{188}Os at T). The data for each suite appear to lie on linear mixing lines distinct from the Hawaiian regression line (Brandon et al. 1999), all three of which converge to a common component having ^{186}Os/^{188}Os of ~ 0.119865 and γ_{Os} of ~17. The coupled Os enrichments in these plumes has been attributed to core-mantle chemical exchange. If this model is correct, the point of convergence in ^{186}Os-^{187}Os space represents the Os isotopic composition of the present day outer core component. Different cooling models for the Earth could account for a core crystallization rate over time that will result in such an isotopic composition for the outer core.

In contrast, Iceland picrites show a range of γ_{Os} from ~0 to 9 similar to the Hawaiian picrites but have uniform ^{186}Os/^{188}Os similar to most upper mantle materials of 0.1198365±30. In addition, there is a positive correlation between γ_{Os} and R/Ra in these picrites (Brandon et al. 2001), indicating a mantle source with radiogenic γ_{Os} and high R/Ra that did not have a long term elevated Pt/Os. This may represent the composition of the lowermost mantle following core formation and prior to the addition of a late veneer, and indicates that not all plumes originating in the deepest mantle carry the proposed 'outer core' Os isotopic signature.

The combined data from these plume systems show that if He is degassing from the core, then the process of core-mantle exchange for Os is least partly decoupled from He. In addition, at least 3 different sources of radiogenic Os exist in the present mantle in order to account for the diverse isotopic systematics in plume-derived systems.

References

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Microbial extraction of Ni, Mo, and Fe micronutrients from earth materials

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Trace metals such as Fe, Mn, Cu, Zn, V, Mo, Ni, and Co are used by bacteria for enzymes, coenzymes, and cofactors. Although many bioessential metals are found only in low concentrations in rocks, soil solutions, and seawater, microbially enhanced extraction of these elements from minerals by metal-specific high-affinity ligands has only been documented for Fe. For example, two soil micro-organisms (*Bacillus* sp. and *Streptomyces* sp.) produce siderophores that extract Fe from hornblende and goethite. Neither of these micro-organisms is known to have a special need for Ni or Mo for their growth or metabolism, and neither is capable of enhancing the rate of release of these metals to solution when grown in the presence of a Ni-, Fe-, Mo-silicate glass.

However, extraction of Mo and Ni from the silicate glass (a mineral analogue) is accelerated by the N_2-fixing soil bacterium *Azotobacter vinelandii.* This bacterium synthesizes enzymes that utilize Mo and Ni cofactors, and is known to secrete siderophores. One of these siderophores may extract Mo from the glass as well as Fe. The azotobacter thus grows robustly in metal-deficient media when the metal-containing glass powder is added. In preliminary experiments, a strain of *A. vinelandii* that cannot produce any known siderophores did not grow in metal-deficient media, even when metal-containing glass was added to the flask.

Methanobacterium thermoautotrophicum, a methanogen with a requirement for Ni, enhances release of Ni from another glass. The mechanisms of metal-specific dissolution by both the diazotroph and the methanogen is under investigation.

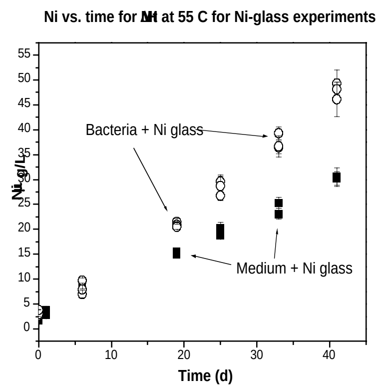

Fig. 1. Dissolved Ni as a function of time measured in metal-deficient growth medium with Ni-containing glass in flasks with and without a growing methanogen.

Preliminary evidence suggests that this methanogen may produce a ligand with metal-binding capacity similar to that of a siderophore. Comparison of the isotopic signatures of metals released to solution in biotic and abiotic systems may also elucidate mechanisms of metal extraction. Many ligands secreted by prokaryotes for extraction of bioessential metals, their effects on earth materials, and their possible utility in recovery of economic metals remain to be discovered.