TiO_2 in OIB and the preservation of extreme isotopic signatures

J. PRYTULAK AND T. ELLIOTT

Bristol Isotope Group, Department of Earth Sciences, University of Bristol, UK (J.Prytulak@bristol.ac.uk)

We have examined liquid lines of descent for a large set of ocean island basalts (OIB) using a compilation of major element data from the GEOROC database. We focus on the moderately incompatible element titanium and identify a 'reference' TiO_2 value for each OIB, to reflect approximate primitive lava compositions before significant fractional crystallization or crystal accumulation. High reference values are observed in OIB with low inferred degrees of melt lying above thick lithosphere, whereas low reference values are seen in OIB with larger inferred degrees of melt, atop thinner lithosphere. We find that the reference abundances are in most cases too high to be produced by melting of any plausible peridotitic mantle composition. Therefore, an additional Ti-rich component is required in the source of virtually all OIB. Recycled mafic crust appears to be the most geochemically consistent source for the extra Ti.

The OIB we investigated cover the full range of radiogenic isotopic mantle endmembers. Notably, OIB with low reference TiO_2 values plot in restricted, depleted ranges in Sr-Nd isotopic space, whereas OIB with higher reference TiO_2 values exhibit enriched isotopic signatures and expansive ranges in Sr and Nd isotopic ratios. Since higher reference TiO_2 values likely result from smaller degrees of melting, they may preserve extreme isotopic ratios. Larger degrees of melting may dilute enriched isotopic signatures. Therefore, degree of melting in OIB may be a dominant control on both the observed range of isotopic ratios and the ability to preserve extreme signatures. However, recycled crust does not generally produce extreme isotopic signatures seen in endmembers such as EMI and EMII, making other components necessary to explain the full breadth of isotopic data.

Pt-Re-Os isotope and HSE systematics of Belingwe komatiites

I.S. PUCHTEL[1], A.D. BRANDON[2], R.J. WALKER[1] AND E.G. NISBET[3]

[1]University of Maryland, College Park, MD 20740, USA (ipuchtel@geol.umd.edu, rjwalker@geol.umd.edu)

[2]NASA Johnson Space Center, Houston, TX 77058, USA (alan.d.brandon@nasa.gov)

[3]Royal Holloway, University of London, Egham TW20 OEX, UK (e.nisbet@gl.rhul.ac.uk)

Studies of the origin and evolution of the relative and absolute abundances of the highly siderophile elements (HSE) in the mantle provide information regarding the late accretionary history of the Earth, oceanic crustal recycling, timing of melt extraction from the mantle, and possibly the mechanisms and the extent of core-mantle exchange. We present high-precision data for HSE abundances and Pt-Re-Os isotope systematics for twenty drill-core whole-rock samples and olivine and chromite separates from the ~10-m thick Tony's komatiite flow, which is among the freshest Archean komatiites on Earth. The emplaced lava contained 24% MgO, was depleted in LILE and had $\varepsilon Nd(T) = +2.5$. Re-Os data for two whole-rock samples and corresponding mineral separates define an internal isochron with an age of 2686±11 Ma and a $\gamma^{187}Os(T) = 0.13\pm0.08$. Regression of the data for all samples yields an isochron with an age of 2674±44 Ma and a $\gamma^{187}Os(T) = -0.22\pm0.48$. A single B_2 sample analyzed for Pt-Os has an initial $^{186}Os/^{188}Os = 0.1198324\pm13$, which is identical to the initial $^{186}Os/^{188}Os = 0.1198322\pm8$ determined earlier for the contemporary Pyke Hill komatiite source. Both sources have similar $\varepsilon^{186}Os(T) = 0.05\pm0.11$ and 0.05 ± 0.07, respectively, relative to the bulk solar system initial $^{186}Os/^{188}Os = 0.1198269$. The Belingwe source, thus, evolved with long-term $^{187}Re/^{188}Os = 0.400\pm4$ and $Pt/Os = 1.7\pm0.2$, which are indistinguishable from those in chondritic meteorites. The IPGEs (Os, Ir, Ru) in the whole-rock samples are strongly positively correlated with MgO identifying the Belingwe komatiite as belonging to the Munro-type flows. The PPGEs (Pd, Pt) and Re show strong negative correlations with MgO, coincident with olivine-control lines. The HSE composition of the Belingwe source was calculated from the regressions of HSE abundance data *vs*. MgO for the whole-rock samples and the Pt-Re-Os isotopic data. The source contained (ppb): Re 0.23, Os 2.6, Ir 2.3, Ru 5.2, and Pt and Pd 4.3. The $Ru/Ir = 2.3\pm0.3$ and $Pd/Ir = 1.9\pm0.2$ in this source are higher than those in any known groups of chondrites, but match the recent estimates for the Earth's primitive upper mantle derived from analyses of mantle xenoliths worldwide, or the recently obtained HSE data for some lunar impact melt breccias "fingerprinting" the composition of late accreted materials to the Moon and the Earth. The new data provide further constraints on the evolution of PUM in the Archean and stimulate additional studies of the composition of materials added to the silicate Earth in the form of the "late veneer", as well as chondritic meteorites.