5.1.16

Hafnium and neodymium isotopes in oceanic basalts

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We have determined the trace element and isotopic compositions of Walvis Ridge basalts to better determine the geochemical characteristics of the enriched mantle endmember which is thought to include a significant contribution from recycled pelagic sediments. Characteristic for pelagic sediment contribution is a shallow slope on a Hf-Nd isotope correlation diagram.

For Walvis Ridge basalts epsilon-Hf varies from –3 to +12 while epsilon-Nd varies from –4 to 6. This range is larger than previously published results and results in a well-correlated array (R^2=0.97) with a steeper slope than the general ocean island basalt (OIB) array. This new data clearly indicates that pelagic sediment involvement in the source is not what creates these endmember characteristics.

Previously we have shown that Samoa shows a large range in Sr-Nd and Hf compositions with epsilon-Nd ranging from –2.2 to 3.5 and epsilon-Hf ranging from 2.2 to 7.5 and extreme Sr-isotopic composition with values up to 0.7088. Hf-isotopic composition is well correlated with both Sr and Nd isotopic composition with a slope of 0.97 on an epsilon Hf-Nd isotope diagram. Based on the Pb-isotopic composition and the trace elements a pelagic sediments can be ruled out as a component in the source of the Samoan basalts.

These data together show that internal mantle differentiation might be a more important process than we previously assumed.

5.1.21

Preferential U recycling does not resolve the kappa conundrum

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Galer and O'Nions [1] argued that to account for the difference between present $^{232}Th/^{238}U$ ratios (κ) and the time-integrated $^{232}Th/^{238}U$ calculated from Pb isotope ratios (κ_{Pb}) in MORB, the residence time of Pb in the depleted mantle must be short (~ 600 Ma). Others [2, 3] have argued instead that low present-day κ in the depleted mantle reflects post-Archean preferential recycling of U through uptake in the oceanic crust and subduction. To test this hypothesis, we have calculated the extent to which U, Th, and Pb are recycled into the mantle in subduction zones using a mass balance approach. We calculate 'deep mantle flux' by subtracting the flux of material to island arc volcanism from the subducting slab (the 'arc flux') from the flux of oceanic crust and sediment into the subduction zone at the trench (the 'trench flux').

The 5 arcs examined so far show considerable variation in the composition of this 'trench flux', the fraction of U, Th, and Pb extracted from the subducting slab, and the Th/U and U/Pb ratios in the residual slab. However, the average κ of the subducting slab, 2.6, is very close to that of depleted mantle. Uranium and Th are extracted (by island arc volcanism) with nearly equal efficiency, so that the κ of the subducting slab changes very little. Pb is extracted from the slab with greater efficiency so that the U/Pb ratio of the 'deep mantle flux' is greater than that of the 'trench flux'. Using this calculated value of κ in recycled material in a numerical model of Pb isotopic evolution of the Earth [4], we find that preferential recycling of U alone does not explain the difference between the present and time-integrated κ of the depleted mantle. However, models in which the depleted mantle residence time of Pb is short and Th is partitioned preferentially over U into crust-forming partial melts, *and* U is preferentially recycled into the mantle, can reproduce the present U-Th-Pb systematics of the depleted mantle, including low present κ and high κ_{Pb}.

References

[1] Galer, S. J. G. & O'Nions, R. K. (1985) *Nature* **316**, 778-782.
[2] Elliott, T., A. Zindler and B. Bourdon (1999) *E.P.S.L.*, **169**, 129-145.
[3] Collerson, K. D. & Kamber, B. S. (1999) *Science* **283**, 1519-1522
[4] Paul, D., White, W. M. & Turcotte, D. L. (2002) *Phil Trans R Soc Lond.* ***A*** **360**, 2433-2474.