An alternative explanation for the Hf-Nd mantle array

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The $^{176}Hf/^{177}Hf$ and $^{143}Nd/^{144}Nd$ of oceanic basalts are significantly correlated and form the so-called Hf-Nd mantle array[1,2]. Model calculations show that such an array is inconsistent with the distinctive isotopic compositions of recycled ancient sediments; the array is also at odds with the observed compositional heterogeneity of the mantle. A current consensus for the origin of the array is that the Lu/Hf and Sm/Nd of ancient sediments in the mantle are decoupled due to their thorough mixing or averaging during subduction[1,3]. Detailed analysis of available data, however, shows that oceanic basalts in ternary $^{176}Hf/^{177}Hf$-$^{143}Nd/^{144}Nd$-$^{87}Sr/^{86}Sr$ and $^{176}Hf/^{177}Hf$-$^{87}Sr/^{86}Sr$-$^{206}Pb/^{204}Pb$ spaces form tetrahedral configurations that are similar to the previously established tetrahedron in the $^{87}Sr/^{86}Sr$-$^{143}Nd/^{144}Nd$-$^{206}Pb/^{204}Pb$ space[4]. The geometric coherence among the Sr-Nd-Pb-Hf isotopes of oceanic basalts indicates that the proposed mantle end-member sources (EM1, EM2, HIMU, DMM) consistently defining the apices of the various isotope tetrahedra have distinctive sources. As the $^{87}Sr/^{86}Sr$-$^{143}Nd/^{144}Nd$-$^{206}Pb/^{204}Pb$ tetrahedron and Pb isotopes clearly indicate that the recycled sediment sources of oceanic basalts are not thoroughly mixed, then the mantle Hf-Nd array may not also be due to homogenization of subducted sediments. The Hf-Nd mantle array most likely represents the bulk of Lu-Hf and Sm-Nd budget in the mantle sources of oceanic basalts. The Hf-Nd isotope correlation is significant because the array may simply be a pseudo-binary mixing line between the variably depleted upper mantle and recycled terrigenous sediments. The latter have inherently decoupled Lu/Hf and Sm/Nd as they are also variable mixtures of detritus from two ancient end-sources: silicic upper continental crust (EM2) and mafic arc as well as intraplate volcanoes (EM1).

[1] Pachett et al. (1984) *EPSL* 69, 365-378; [2] Chauvel et al. (2008) *Nat. Geo.* 1, 64-67; [3] Plank and Langmuir (1998) *Chem. Geol.* 145, 325-394; [4] Hart et al. (1992) *Science* 256, 517-520.