The anomalous Lu-Hf-Nd isotopic signature of some pelagic sediments

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The anomalous Lu-Hf-Nd isotopic signature of some pelagic sediments (high Lu/Hf; Hf-Nd isotopic compositions that plot above the terrestrial array) give them the potential to be a useful tracer as they pass through the subduction zone and into the mantle. The limitation in their utility as a tracer is that we do not know in any quantitative way the isotopic composition of the global flux of subducting sediments. Therefore, in this study, we are examining a global set of subducting sediments in order to constrain how widespread this signature is, what sediments contribute to this signature, how it varies from trench to trench, and ultimately what causes elevated Lu/Hf and unusual Hf-Nd isotopic compositions.

We have examined two DSDP sites to date: 183 and 595/6, located outboard of the Aleutian and Tonga trenches, respectively. The Aleutian section is dominated by diatomaceous clay and terrigenous turbidite sequences that constitute > 90% of the 516 m thick section. In total, this section has typical crustal Lu/Hf ratios (176Lu/177Hf = 0.008-0.022) and has Hf-Nd isotopic compositions that lie within the Hf-Nd array. However, the 1-4 meter hydrothermal sedimentary unit at the base of the section has highly elevated Lu/Hf (176Lu/177Hf = 0.078) and has a Hf-Nd isotopic composition that plots above the Hf-Nd array and provides evidence for the origin of anomalous Lu-Hf-Nd signatures. This unit has very high REE concentrations (Nd~200 ppm), but average Hf (4 ppm). The anomalous Lu-Hf-Nd signatures appear to be produced by a decoupling of the source of Hf and Nd in these sediments: Nd is derived from scavenging of REEs from seawater and is ultimately of continental origin and Hf is dominated by hydrothermal inputs with a mantle isotopic signature. Although Hf in these sediments has been the focus because of its radiogenic nature, it appears that the weathering of silicates strongly supports the hypothesis that both U and Li isotopes can yield a large range of values, down to ~1 (secular equilibrium). δ6Li for dissolved phases of these rivers range between -16.8‰ and -23.3‰, suggesting that 6Li/7Li ratios for rivers characterised by low U and Li contents, draining old basalt weathering (Huh et al., 2001).

First results show significant variations of (234U/238U) (from 1.65 to 1.07) suggesting that the weathering of silicates can yield a large range of values, down to ~1 (secular equilibrium). δ6Li for dissolved phases of these rivers range between -16.8‰ and -23.3‰, suggesting that Li/7Li ratios fractionate during weathering of the source basalt (δ6Li/~4.5‰). Highest (234U/238U) and lowest δ6Li have been found for rivers characterised by low U and Li contents, draining old basalt (~0.7my) in areas with low weathering rates. By contrast, the lowest (234U/238U) corresponds to the highest δ6Li and the highest U content, in a SW area (Holtsa River), which has previously shown to have the largest weathering rates of Icelandic basins (Gislason et al., 1996).

If these results are confirmed by future data, it would strongly support the hypothesis that both U and Li isotopes can reflect the degree of silicate weathering. The associated analyses of Th and Ra isotopes for the same rivers should also allow us to estimate the role of the last glaciation on chemical weathering of silicates in this area.