The Lu-Hf-Nd isotopic signature of subducting 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 sed-iments 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 (^{176}Lu/^{177}Hf = 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 (^{176}Lu/^{177}Hf = 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 REE inputs also have an important influence on the development of the anomalous Hf-Nd signature and high Lu/Hf ratios.

The Tonga section, in contrast, is characterised by a very slow accumulation rate and is dominated by authigenic phases and red/brown clays. Preliminary data indicate that this section in total is characterised by very high Lu/Hf ratios (^{176}Lu/^{177}Hf = 0.040-0.185; avg. = 0.107) and radiogenic Hf, in contrast to the more crustal character of the Aleutian section. Although the sediment column here is thin (~70 m), it nonetheless represents an important flux of a distinctively anomalous Lu-Hf-Nd signature into the subduction zone and mantle.

Constraints on basalt erosion from Li isotopes and U-series nuclides measured in Iceland rivers

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Weathering of Ca-Mg silicates is considered as a significant sink of atmospheric CO_2, and the importance of basalt weathering, particularly on the seafloor and in volcanic islands, has been recently demonstrated (Louvat and Allègre, 1998; Brady et Gislason, 1997). Nevertheless, because of the lack of convenient proxies, no consensus exists on the paleovariations and controlling factors of silicate weathering rates. U-series measured for the weathering products carried by rivers can be linked to both the age and the degree of chemical erosion at the scale of a watershed (Vigier et al., 2001). Li isotope ratios measured in rivers may also reflect the intensity of silicate weathering (Huh et al., 2001).

About 30 rivers have been sampled in Iceland in 2001. Despite low-levels of trace elements for the dissolved phases of these rivers (U and Li contents range from 0.5 to 75ng.l^{-1} and from 0.03 and 4.5µg.l^{-1} respectively), recent developments with the Multicollection ICP-MS 'Nu-Instrument' allow (^{234}U/^{238}U) and δ^{6}Li to be analysed precisely.

First results show significant variations of (^{234}U/^{238}U) (from 1.65 to 1.07) suggesting that the weathering of *silicates* can yield a large range of values, down to ~1 (secular equilibrium). δ^{6}Li for dissolved phases of these rivers range between -16.8‰ and -23.3‰, suggesting that ^{6}Li/^{7}Li ratios fractionate during weathering of the source basalts (δ^{6}Li$_{MORB}$~-4.5‰). Highest (^{234}U/^{238}U) and lowest δ^{6}Li have been found for rivers characterised by low U and Li contents, draining old basalts (>0.7my) in areas with low weathering rates. By contrast, the lowest (^{234}U/^{238}U) corresponds to the highest δ^{6}Li and the highest U content, in a SW area (Holsa 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.

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