Tracking subduction zone fluxes off slabs, across arcs, and into the mantle: B-Li isotopic evidence

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New light element abundance and B and Li isotopic results from forearc settings and samples reflecting deep recycled mantle soruces have begun to complete the picture of subduction zone chemical cycling for the fluid-mobile elements (FME). Progressive boron and FME declines with increasing metamorphic grade in forearc “subduction complex” massifs (i.e., Bebout *et al* 1999), are complemented by signatures observed in diapiric serpentinites and associated fluids erupting in the Mariana forearc, which preserve dramatic enrichments in B and select FME, but are not elevated in most large-ion lithophiles (Savov *et al* 2005). Declines in B and $\delta^{11}B$ across volcanic arcs point to continued removal from slabs by metamorphism, and depleted B and $\delta^{11}B$ in ocean island lavas suggest deeply recycled slabs are stripped of boron. B isotopic variations in forearcs point to extensive boron removal at low temperatures, as the $\delta^{11}B$ of slab materials (~0 to -3‰ on average) are substantially lower than that of Mariana forearc serpentinites (+13 - +18‰: Benton *et al* 2004) or of B-enriched arc lavas. High $\delta^{11}B$ releases at shallow depths indicate isotopic “lightening” of the slab, such that the $\delta^{11}B$ systematics in arc lavas require inputs both of downdragged forearc mantle materials with high B and $\delta^{11}B$, and of a B depleted, low $\delta^{11}B$ slab component.

Li isotopic variations in the forearc mantle are divergent, with serpentine muds showing uniform δ^7Li indicating equilibrium with high δ^7Li porefluids, while entrained ultramafic clasts record highly variable δ^7Li. Relatively high D_{Li} for mafic minerals (especially Mg-rich sheet silicates) combined with high Li diffusion rates result in exceptionally diverse δ^7Li in mantle-derived ultramafic samples. However, δ^7Li in young volcanic rocks from all tectonic settings are remarkably unifom, ranging from +3‰ to +6‰, indicating buffering by a uniform, Li-rich upper mantle reservoir, and/or limited Li isotopic change due to subduction zone chemical proccesing, despite evidence for Li and δ^7Li depletion in eclogitic rocks (Zack *et al* 2003). Interestingly, substantial δ^7Li changes can occur over time in lavas from “dying” subduction systemss, suggesting that such changes may only be observed when processes that homogenize the mantle (i.e., wedge convection) shut down.

References

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Chemical weathering in the Han River Basin, South Korea: Carbonate and silicate weathering

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This study focuses on the fluvial geochemistry of the Han River, South Korea to determine its chemical weathering rate and associated CO_2 consumption rate. The Han River draining approximately 26,000 km^2 is the largest river in South Korea in terms of water discharge and the total river length, and consists of two major tributaries: the North Han River (NHR) and the South Han River (SHR). A remarkable difference in basin geology (silicate vs. carbonate) between the NHR and the SHR provides a good natural example to understand the processes of weathering and the influence of basin geology on water quality.

In this paper we report dissolved major elements and Sr isotopic compositions of a total of 58 samples collected seasonally from the Han River system for two years (2000 and 2006). A big difference in the concentration of dissolved loads is observed between the NHR and the SHR: the NHR is much lower in total dissolved solids (TDS), Sr, and major ion concentrations relative to the SHR, while higher in Si concentration and $^{87}Sr/^{86}Sr$ ratios.

Using the forward model, it is calculated that the dissolved loads of the NHR are primarily from silicate weathering (55±11%) with relatively smaller portion of carbonate weathering (30±14%), whereas those of the SHR mainly from carbonate weathering (82±3%) with minor portion of silicate weathering (11±4%). These results are consistent with geological characteristics of their drainage basin: silicate rocks in the NHR vs. carbonate rocks in the SHR. Unlike the NHR basin, sulfuric acids derived from sulfide dissolution play an important role in carbonate weathering in the SHR basin because of widely distributed coal-containing sedimentary strata. Silicate weathering rate (SWR) of the NHR basin is much higher than that of the SHR basin, indicating higher CO_2 consumption rate in the NHR basin.