Hf isotope records of mélange mixing and blueschist-facies metamorphism within the Catalina Schist

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Progade metamorphic mélange zones developed within the Catalina Schist (CA, USA) record progressive digestion and assimilation of peridotites, basalts, and sediments into a hybridized composition that is probably characteristic of the subduction zone slab/mantle interface (Bebout, 1991; Bebout and Barton, 1993, 2002). Of the isotopic records available, most reflect some degree of fractionation or mixing due to the effects of fluid flow or mineral partitioning attending metamorphism (Bebout, 1991; King *et al.*, 2006, 2007). We present new Hf isotope data for zones of lawsonite-albite (LA) and lawsonite-blueschist (LB) facies metamorphic mélange matrix with the goals of reconstructing sources and patterns of mass transfer occurring during prograde mélange formation as well as recognizing potential mobility of HFSE such as Hf along and across the slab/mantle interface.

The syn-metamorphic Hf-Nd isotopic array defined by the LA-LB mélange matrix is broadly similar to modern arc data (εHf= +12 to -2, εNd= +12 to +2). These compositions predominantly reflect mechanical mixtures dominated by MORB vs. terrigenous components, with a minor influence of high Lu/Hf pelagic sediment. Within the LA-LB mélange dataset, high Hf concentrations (>2ppm) define a restricted Hf isotopic composition (εHf= +6 to +8); this is most likely the signature of the coeval Peninsular Ranges Batholith, as PRB trench fill dominates detrital zircon age spectra for LA-LB mélange (Grove *et al*. 2007; King *et al*. 2007).

LA-LB mélange samples bearing lower Hf concentrations (<2ppm) preserve more varied isotopic compositions. Most notable are a suite of high Mg-Cr samples (MgO >14wt.%; Cr >1000ppm) with surprisingly low Hf isotopic ratios (εHf= +4 to -2). Association of this more continental isotopic signature within mélange matrix dominated by Mg-Cr-rich mantle material suggests that redistribution of Hf by metamorphic fluids occurs and is recorded by these more “receptive” ultramafic mélange zones. Petrologic descriptions and geochemical analyses of similar types of ultramafic rock within metamorphic subduction complexes represent the most promising target for recognitition of metasomatic processes occurring during subduction.

References

Bebout, G. (1991), *Science* **251**, 413-416.
Bebout, G. and Barton, M. (1993), *Chem. Geol.* **108**, 61-92.
Bebout, G. and Barton, M. (2002), *Chem. Geol.* **187**, 79-106.
Grove, M., *et al*. (2007) *GSA Special Paper*, in press.
King, R.L. *et al*. (2006), *Earth Planet. Sci. Lett.* **246**, 288-304.
King, R.L. *et al*. (2007), *Chem. Geol.* **239**, in press.

The chemistry of Earth's dynamic surface

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Physical erosion and chemical weathering shape many aspects of the living environment: the topography of the surface, the fertility of soils, the chemistry of natural waters, and, over long time scales, the composition of the atmosphere and thus the climate of the Earth.

Researchers studying the physics and chemistry of the Earth's surface are currently exploring questions such as: What processes regulate rates and patterns of physical erosion and chemical weathering? How episodic are erosion and weathering, over timescales from minutes to millions of years? How sensitive is chemical weathering to variations in climate, and thus how strong are the feedbacks regulating climate through geologic time? How much do chemical weathering rates depend on rates of mineral supply from physical erosion? And conversely, how much does physical erosion depend on weakening of rocks by chemical weathering?

Questions like these are now being probed using a range of geochemical techniques. Cosmogenic nuclide methods, in particular, have proven useful for studying rates and patterns of surface denudation over thousands of years, at spatial scales ranging from individual outcrops to small catchments. When coupled with the bulk composition and mineralogy of parent materials and the soils that are formed from them, cosmogenic nuclide measurements can also be used to infer rates of chemical weathering over millennial time scales.

These geochemical techniques are opening new windows through which we can observe the evolution of the Earth's surface. These methods have recently shown, for example, that denudation rates are surprisingly episodic over a wide range of time scales. They have also shown that chemical weathering rates may be closely coupled with rates of physical erosion, and may be relatively insensitive to climatic variations. This presentation will outline these and other insights into the physics and chemistry of Earth's surface, as revealed within the past decade by cosmogenic nuclide methods and related geochemical techniques.

References

Bierman P.R. and Nichols K.K., (2004), *Ann. Rev. Earth and Planet. Sci*. **32**, 215-255.
Granger D.E. and Riebe C.S., Cosmogenic nuclides in weathering and erosion. In *Treatise on Geochemistry*, 2nd edition (H.D. Holland and K. Turekian, eds.), in press.
Heimsath A.M., Dietrich W.E., Nishiizumi K. and Finkel R.C., (1997), *Nature* **388**, 358-361.
Kirchner J.W. *et al.*, (2001), *Geology* **29**, 591-594.
Riebe C.S., Kirchner J.W. and Finkel R.C., (2004), *Earth and Planet. Sci. Lett.* **224**, 547-562.
von Blanckenburg F., (2005), *Earth and Planet. Sci. Lett.* **237**, 462-479.