

Slab components in the Mariana arc: Light, heavy and novel

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The isotopic composition of Li promised huge potential as a tracer of slab components in arcs. Altered oceanic crust and most sediments entering the subduction zone are heavy, fractional dehydration processes should only accentuate this signature in fluids released from the slab and arc lavas are elementally enriched in Li. Surprisingly, very few arcs show any indication of a heavy Li isotope signature. We have analysed several arcs in detail and find no evidence for a heavy slab component. Yet this negative result is important as it indicates considerable exchange between slab-derived fluids and the mantle wedge, likely aided by the high diffusivity of Li and the large Li reservoir represented by mantle olivine.

Interaction of slab derived components with the mantle is an important consideration in accounting for the notable U-series disequilibria seen in island arc lavas and the Marianas in particular. A key observation is that the “fluid” component, linked by Pb isotope measurements to the mafic oceanic crust, has extreme (²²⁶Ra-²³⁰Th) and ²³⁸U-²³⁰Th excesses coupled with ²³⁵U-²³¹Pa deficits. This ensemble of features can be modelled as a result of interaction of a slab component with the mantle at low porosities, although the magnitude of the (²²⁶Ra-²³⁰Th) excesses is not readily explained. Alternatively, residual accessory phases present during slab-dehydration may well have a key but currently poorly constrained role in shaping the U-series disequilibria of the “fluid” component. Such a process has been plausibly invoked to control many element budgets and likely plays a major role for the actinides, but currently there is dearth of information on the partitioning of Pa in key phases such as monazite or allanite.

To this already heady cocktail of light stable and heavy, radiogenic isotopes, the future offers novel insights from transition element isotope measurements. Initial data in Mariana lavas show a range in $\delta^{97}\text{Mo}/^{95}\text{Mo}$, with “fluid” rich samples some 0.3‰ heavier than sediment rich counterparts. Since pelagic sediments are typically heavier than Fe/Mn crusts on altered mafic crust, this sense of difference in Mo isotopes is intriguing and may attractively be related to the process of element transport.

A comparison of Cs/K mass ratios in select micas, soils and kaolins from the Southern Appalachian Piedmont and coastal plain

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Concentrations of K and stable Cs were determined for detrital muscovites separated from Cretaceous and Tertiary Georgia kaolin deposits and for the interlaboratory reference materials KGa-2 (Georgia kaolin), Bern-4M (muscovite from gneiss) and SCo-1 (Cody Shale). Values obtained for the geochemical reference material SCo-1 confirm the accuracy of the analytical methods used. The Cs/K mass ratios measured for two muscovite samples separated from the Georgia kaolins, each about 1.3×10^{-5} , are close to the Cs/K ratio of the Bern-4M muscovite but are an order of magnitude less than the Cs/K ratio for the upper continental crust. The Cs/K ratio of KGa-2 is similar to published values for SCo-1 and other shales, which are a little greater than the ratio for the upper continental crust. Cs/K ratios determined elsewhere for five samples of sandy soil from the Savannah River Site (SRS), whose clay fractions consist mostly of kaolinite and hydroxy-interstratified vermiculite (HIV), are larger than the Cs/K ratio for the muscovites separated from Georgia kaolin. Those muscovites are believed to represent generally the muscovite eroded and transported from the Appalachian Piedmont to be incorporated in coastal-plain sediments. The Cs and K in the SRS soils are thought to be mostly in weathered micaceous phases, HIV in particular. That the Cs/K ratios of the soils are higher than that of the muscovite deposited in the parent sandy sediments suggests that stable Cs has been retained preferentially by the weathered micaceous phases during the genesis of the SRS soils. This finding is consistent with the demonstrated high ion-exchange selectivity of weathered mica (illite in particular) for Cs relative to K and is relevant to construct models describing the sorption and transport of anthropogenic and radioactive Cs-137 in the SRS soils.