Li-Pb and U-Th-Ra isotope systematics in metasomatised harzburgite xenoliths from Batan Island, Philippines

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Subduction delivers sediment and hydrated oceanic lithosphere into the convecting mantle. Some of these materials are involved in magma generation and returned to the surface as arc volcanism. The remainder continues into the deeper mantle contributing to long-term heterogeneity that may be later sampled by mantle plumes. In order to understand the global cycling of volatiles in subduction zones it is essential to understand the physical and chemical processes of fluid release and melting. Significant debate remains on the role of aqueous fluids versus wet melts and the release of fluids and melting are both strongly dependent on slab temperatures. Metasomatised xenoliths from Batan Island, Philippines, represent unique samples of the sub-arc mantle. They have incompatible trace element and radiogenic isotope characteristics typical of their host lavas and arc lavas in general. Li concentrations in the xenoliths and host lavas range from 1.2 to 8.2 ppm whilst Li isotopes show a significant range from -1.3 to 2.2 and correlate positively with Sr isotopes. Pb isotopes range from 18.37 to 18.50, from 15.60 to 15.72 and from 38.48 to 38.75. These data cannot be explained by addition of a single subduction component to the mantle wedge but arguably require both fluid and sediment addition. The xenoliths also, remarkably, preserve extreme U-Th-Ra disequilibria. These disequilibria do not result from either infiltration by the host magma, steady-state diffusion in the mantle or subsequent crustal level processes. Rather, the xenoliths provide the first direct evidence that such signatures originate in the mantle and that contributions from both wet sediment melts and aqueous fluids were separately delivered from the slab. The data also require that metasomatism was ongoing at the time of their incorporation in the host magmas.