



Deeper Subduction Zone Melting Explains Enrichment of Upper Mantle and Resolves Dehydration Paradox

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We present new volatile and stable isotope data on oceanic basaltic glasses with a range of enriched compositions. Basalt compositions studied here can be modeled by mixing between depleted mantle and various enriched (EM) and prevalent (PREMA) mantle components. We develop a multi-stage metasomatic and melting model for the origin of the enriched components, extending the subduction factory concept to involve melting of different components at different depths, down to the mantle transition zone (660 km), with slab temperature a key variable. EM components are heterogeneous, ranging from wet and heavy (Arctic Ridges) to dry and light (East Pacific Rise), and are derived from the subducted slab at depths of 150 to 250 km by addition of <1 % carbonated sediment-derived supercritical C-O-H fluids to depleted peridotite. PREMA mantle sources have a limited compositional range, and form at depths at and within the transition zone (410 to 660 km) by addition of <1 % carbonated eclogite \pm sediment-derived supercritical fluids to depleted mantle.

The model resolves several problems, including the “dehydration paradox,” referring to the following conundrum. The enriched “prevalent mantle” (PREMA) end-member in mid-oceanic ridge and ocean island basalts requires involvement of a mostly dehydrated slab component to explain trace element ratios and radiogenic isotopic compositions, but a fully hydrated slab component to explain stable isotope compositions. In our model, thermal parameters of slabs control the timing and composition of subduction-derived components. This includes deep release of fluids from subcrustal hydrous phases that may rehydrate previously dehydrated slab, resolving the paradox.