

## Hydrogen Isotopic Composition of Enriched Mantle Sources: Resolving the Dehydration Paradox

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We present new volatile and hydrogen isotopic data on oceanic basaltic glasses with a range of enriched compositions. Basalt compositions 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-type basalts are heterogeneous, ranging from wet and heavy (Arctic Ridges:  $H_2O/Ce \sim 300 \pm 50$ ,  $\delta D_{SMOW} \sim -60\%$ ) to dry and light (East Pacific Rise 15-17°N:  $H_2O/Ce = 100 \pm 20$ ,  $\delta D_{SMOW} = -85 \pm 6\%$ ). EM-type sources are derived by addition of <1 % carbonated sediment-derived supercritical C-O-H fluids to depleted peridotite at depths of 150 to 250 km. PREMA-type basalts have a limited compositional range ( $H_2O/Ce = 220 \pm 30$ ,  $\delta D_{SMOW} = -35 \pm 5\%$ ). PREMA-type sources form by addition of <1 % carbonated eclogite- ± sediment-derived supercritical fluids to depleted mantle at depths at and within the transition zone (410 to 660 km).

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 in cooler slabs that may rehydrate previously dehydrated slabs, resolving the paradox.