Are subduction zones dry below 400 km?

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Two recently popular hypotheses in the subduction zone literature are: (1) recycling of H_2O into the deep interior; (2) triggering of transition-zone earthquakes by phase-transformation-induced faulting in metastable olivine. Unless deep subduction zones are colder than currently believed, these themes are incompatible because even small amounts of H_2O enhance the kinetics of olivine breakdown sufficiently to make preservation of metastable olivine into the transition zone impossible [1-3]. Despite seismic evidence for metastable olivine now in 3 deep subduction zones [4-6], skepticism remains. To provide an empirical resolution to this important question, here I compare predictions inherent in both hypotheses with the observed distribution of subduction-zone earthquakes. At depths < 300km, the earthquake distribution correlates strongly with the pattern to be expected if the earthquakes are produced by laboratory-verified shearing instabilities associated with dehydration under stress of hydrous phases compatible with slab chemistry, strongly supporting hypothesis #1 at those depths. However, at greater depths, the known conditions under which hydrous phases might release fluid show no correlation with the earthquake distribution whereas predictions based on metastable olivine correlate extremely well with the earthquake distribution observed, including the increase in abundance at ~400 km and total elimination just above the prominent seismic discontinuity that defines the top of the lower mantle. Disproving metastable olivine would not resolve the problem.

[1] Marton *et al.* (2006) *EOS* **87***(52)* Abs. MR11A-0106. [2] Green (2007) *doi,10.1073/pnas.0608045104*. [3] Du Frane *et al.* (2007) *EOS* **88***(52)* Abs. DI53A-1104. [4] Iidaka & Suetsugu (1992) *Nature* **356**, 593-95. [5] Chen & Brudzinski (2001) *Science* **292**, 2475-2479. Kaneshima *et al.* (2007) *EPSL* **258**, 219–227.

Wrangellia flood basalts in Alaska: A record of plume-lithosphere interaction in a Late Triassic accreted oceanic plateau

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The Wrangellia flood basalts are part of one of the best exposed accreted oceanic plateaus on Earth and provide important constraints on the construction of oceanic plateaus and the source and temporal evolution of magmas for a plume head impinging on oceanic lithosphere. Wrangellia flood basalts (~231-225 Ma) extend ~450 km across southern Alaska (Wrangell Mountains and Alaska Range) where ~3.5 km of mostly subaerial flows are bounded by Late Paleozoic arc volcanics and Late Triassic limestone.

The vast majority of the flood basalts are LREE-enriched high-Ti basalt (1.6-2.4 wt % TiO_2) with uniform OIB-type Pacific mantle isotopic compositions [εHf(t)= +9.7 to +10.7; εNd(t)= +6.0 to +8.1; t=230 Ma]. However, the lowest ~400 m of stratigraphy in the Alaska Range is LREE-depleted low-Ti basalt (0.4-1.2 wt % TiO_2) with pronounced negative-HFSE anomalies and Hf isotopic compositions [εHf(t)= +13.7 to +18.4] that are decoupled from Nd (εNd(t)= +4.6 to +5.4) and displaced well above the OIB mantle array ($\Delta\varepsilon$Hf=4-8).

The radiogenic Hf of the low-Ti basalts indicates involvement of a component that evolved with high Lu/Hf over time, but not with a correspondingly high Sm/Nd. The radiogenic Hf and HFSE-depleted signature of the low-Ti basalts suggest pre-existing arc lithosphere was involved in the formation of flood basalts that erupted early in construction of part of the Wrangellia plateau in Alaska. Thermal and mechanical erosion of the base of the lithosphere by the impinging plume head may have led to melting of arc lithosphere or interaction of plume-derived melts and arc material. The high-Ti lavas dominate the main phase of construction of the plateau and were derived from a depleted mantle source distinct from the source of MORB and compositionally similar to the source of ocean islands (e.g. Hawaii) and plateaus (e.g. Ontong Java) in the Pacific Ocean.