The Fate of Deeply Subducted Volatiles

MICHAEL J. WALTER

Geophysical Laboratory, Carnegie Inst. for Science, 5251 Broad Branch Road NW, Washington, DC 20015, USA

Carbon and water are volatile components that are crucial for long-term surface habitability. These components are transported into the deep earth at subduction zones and understanding where and in what form they can reside in the mantle is important for modeling their control on the surface environment through deep time. Here I will present recent work using natural samples, experiments and theory to place constraints on the fate of these volatile components when subducted into the deep upper mantle. transition zone and lower mantle. Perhaps most revealing are so-called superdeep diamonds and their mineral inclusions, many of which provide direct evidence for recycled carbon and water. Diamonds and their inclusions from Juina, Brazil have carbon and oxygen isotopic compositions coniustent with an origin in subducted oceanic crust [1]. The mineralogy and geochemistry of many mineral inclusions indicate an origin involving a carbonated, likely hydrated, partial melt of oceanic crust in the deep upper mantle and transition zone – indeed, such partial melting is impossible to avoid considering the shape of the solidus of carbonated basalt and the temperature of the slab top based on thermal modeling [2]. Any carbonate that does escape melting and is transported into the lower mantle will eventually react with silica to form either CO_2 or diamond at mid-lower mantle depths [3]. Thermal models for the slab moho in comparison to dehydration phase equilibra also indicate that a significant amount of water can be subducted past the volcanic front consistent with superdeep diamonds that indicate a recycled hydrous component [4]. Computational modeling of volatile-rich partial melts indicate they are buoyant and inviscid at transition zone and upper mantle depths and can be effective vehicles for transport of volatile and other components to the shallower upper mantle through flow and reactive transport.

[1] Burnham et al (2015). EPSL 472, 374-380. [2] Thomson et al (2016) Nature 529, 76-79. [3] Drewitt et al (2019) *EPSL* 511, 213-222. [4] Pearson et al (2014) Nature 507, 221–224.