The Fate of Deeply Subducted Volatiles
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Carbon and water are volatile components crucial for surface habitability through deep time. Most, if not all, of these components were plausibly outgassed during the hot, Hadean magma ocean stage but have been recycled back into the the deep Earth via subduction. Understanding where, in what amount and in what form they reside in the mantle and how they affect mantle geochemistry and geodynamics is critical for modeling their control on the surface environment. Here I will present our 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, samples that provide direct evidence for recycled carbon and water subducted into the deep mantle. Diamonds and their inclusions from Juina, Brazil have carbon and oxygen isotopic compositions conistent with an origin in subducted oceanic crust and the mineralogy and geochemistry of many mineral inclusions indicate an origin involving a carbonated (and likely hydrarted) partial melt of oceanic crust in the deep upper mantle and transition zone. If carbonate does escape melting in cold slabs and is transportrd into the lower mantle it awaits a final fate of reacting with silica at mid-lower mantle depths. Thermal models for the slab moho in comparison to dehydration phase equilibra indicate that a significant amount of water can be subducted past the volcanic front and transition zone diamonds indicate a recycled hydrous component. Our recent computational results on the effect of water on mineral elasticity indicate a moderately hydrated transition zone such that low-degree hydrous melting is expected at its upper and lower boundaries. Using new results on the behavior of hydrated and carbonated melts at deep upper mantle and transition zone conditions I will explore the fate of such melts.