Focusing of upward fluid migration due to mineral grain size variation

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In this study, we use numerical models to quantify the effect of mineral grain size on the migration path of aquous fluids in the mantle wedge. Grain size affects grain-scale permeability of the mantle and fluid migration, which is an important factor that controls the location of hydrous melting in the wedge. By coupling a subduction zone thermal model with a laboratory-derived grain size evolution model, we predict that the spatial variation in grain size in the flowing part of the mantle wedge is large; grain size increases from 10–100 μm in the shallowest part of the region beneath the forearc to a few cm in the hottest part of the mantle beneath the arc. Based on our preliminary modeling results, we find that aqueous fluids that migrate into the shallow fine-grain-size region become trapped in the down-going mantle due to low permeability and dragged downdip until permeability becomes high enough for the fluids to migrate upward. Thus, the grain size distribution can play an important role in controlling the location of hydrous melting by focusing the upward fluid migration. We plan to further develop our model by incorporating the effect of dynamic pressure gradients and accounting for the variation in fluid influx at the wedge base. Our modelling results will then be compared with the locations and degrees of hydrous melting inferred from geophysical and geochemical data for various arcs worldwide.

Metal-silicate partitioning of Mo and W at high pressures and temperatures: Applications to core formation on Earth and Mars

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In order to place better constraints on the conditions of core formation on Earth and other terrestrial planetary bodies we have performed experiments to determine the partitioning of Mo and W between liquid Fe-rich metal and liquid silicate at pressures of 1.5-24 GPa and temperatures of 1803-2723K. Experiments performed in MgO capsules at 1.5 GPa/1923 K indicate that Mo is in the +4 oxidation state in the silicate at oxygen fugacities >2 log units below the IW (Fe-FeO) buffer. In contrast W^{6+} is the dominant tungsten oxidation state in the silicate at 1.9-3.2 log units below the IW buffer

Mo metal/silicate partitioning is strongly dependent on pressure and silicate melt composition, but temperature has no detectable effect. In contrast, we find that W partitioning is strongly dependent on silicate melt composition and temperature, but the role of pressure is minor.

Applying these and earlier results to the Earth and Mars indicates that the Mo content of the terrestrial mantle is consistent with core segregation at pressures of 20-40 GPa, in agreement with earlier work on Ni and Co partitioning. The Mo content of silicate Mars is about half that of silicate Earth and is consistent with much lower pressures of core formation (~11 GPa) on the smaller planet. In contrast to these results, the W content of silicate Mars (~50 ppb) is insensitive to conditions of core formation while that of silicate Earth (~12 ppb) is inconsistent with a single stage of core formation at any pressure. Since metal-silicate partitioning of W is strongly influenced by light element (S, Si, O) contents of the metal, we consider it likely that the “light” element in the core is largely responsible for the inconsistency in core-mantle partitioning of this element.