Modeling Flow and Melting within Subduction Zones

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A number of models for flow and transport within the mantle wedge above subducting slabs have been developed based on geochemical data. Specifically, models have been advanced which appeal to a pre- existing condition for mantle material entering the wedge. Here melting and chemical depletion at a back-arc spreading center (BASC) is used to explain characteristically low concentrations of high field strength elements (e.g., Nb, Ti, Zr, Hf) in arc volcanics. Results are presented from two- dimensional numerical experiments which include both flow and melting of the upper mantle at subduction zones in order to test geochemically based models. Variable viscosity experiments incorporate effects of both a dynamic slab and back- arc spreading. Experiments characterize slab and wedge temperature distributions for a range in subduction and back-arc parameters including subduction rate, retrograde versus down-dip slab motion, viscosity structure and trench-back-arc separation distance. Experiments also include the generation and tracking of melt within the mantle matrix using distributed tracer particles. Both batch and fractional melting models are employed for extracting melts from beneath the BASC and within the arc. The average degree of depletion for material in the wedge is recorded over a range in subduction and extraction parameters. Interestingly, the largest depletion effect is seen for intermediate back-arc spreading rates. Models also include the role of melting and melt extraction on mantle viscosity within the wedge and related subduction evolution.