"Tectonic boundaries: A modeling perspective"

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Tectonic boundaries form crucial connections between Earth’s interior and the surface where exchanges of energy, volatiles etc occurs. Magmatism at mid-ocean ridges generates new ocean crust and accounts for 90% of global volcanism. The oceanic crust is emplaced in a narrow neo-volcanic region, whereas basaltic melt is generated in a wide region beneath mid-ocean ridges as suggested by a few geophysical surveys. A number of focusing mechanisms have been proposed such as ridge suction (Spiegelman and McKenzie, 1987) and decompaction layers (Sparks and Parmentier, 1991). The purpose of this work is to demonstrate and highlight melt focusing mechanisms present in melt in the mantle two phase formulation with viscous deformation. I present results from a suite of two-phase models applied to the mid ocean ridges, varying half spreading rate and background permeability using a new openly available model. M3LT models solve for the magma migration equations (McKenzie, 1984) with thermal evolution, non-linear rheology and melting that depends on pressure and temperature. The results suggest that models with similar melting patterns can have significant differences in melt transport patterns due to changes in background permeability. Three distinct melt focusing mechanisms are recognized in the M3LT models: 1) Melting pressure focusing, 2) Decompaction layers and 3) Ridge suction, which is small and only affects the area around the ridge axis.

At subduction zones, seafloor sediments and altered oceanic crust are subducted into the mantle. We combine thermodynamic and two-phase flow to understand carbon transport at subduction zones with a suite of models. CO_2 released at subduction zone volcanoes constitute a large amount of the budget and affect long term global climate. Most of the subducted carbonate comes from sediments and altered oceanic crust. The traditional view was that this carbonate subducts into the deep mantle but new laboratory and modeling studies show otherwise. First, I use thermodynamic modeling and aqueous geochemistry to establish the maximum carbonate solubility in slab fluids. This will allow the identification of areas with high carbonate dissolution and precipitation and how it correlates with the thermal structure at each subduction zone. The n, I analyse carbon transport using various P-T paths for a global suite of subduction zone model outputs.