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Reactive Melt Transport Using Porosity Waves Across the Thermal Boundary Layer.

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The lithosphere and the asthenosphere are characterized by different heat transport mechanisms, conductive for the lithosphere, convective for the asthenosphere. The zone associated with the transition between these two distinct mechanisms is known as the "Thermal Boundary Layer" (TBL). How the melt is transported across this zone is an important question regarding intraplate magmatism and for the nature of the seismic *Low-Velocity Zone*. Numerous studies and models suggest that primary magmas from intraplate volcanos are the product of low degree partial melting in the asthenosphere, while the differentiation process takes place in the crust or shallow lithospheric mantle. The question is how low degree melt ascends through the TBL and the lithospheric mantle. The thermal structure of the lithosphere is characterized by a high geothermal gradient, which questions the ability of melt to cross the lithospheric mantle without cooling and crystallizing. Since the base of the lithosphere is ductile, the possible modes of magma transport are porous flow or porosity waves. For these reasons, we would like to understand how melt is transported and what are the implications on the evolution of primitive melt, going from the convective part of the geotherm to the conductive part of the geotherm and further across the lithosphere.

We present the results of a thermo-hydro-mechanical-chemical (THMC) model[1] for reactive melt transport using the finite difference method. This model considers melt migration by porosity waves and a chemical system of forsterite-fayalite-silica. Variables, such as solid and melt densities or MgO and SiO_2 mass concentrations, are functions of pressure, temperature, and total silica mass fraction (C_t^{SiO2}). These variables are pre-computed with Gibbs energy minimization and their variations with evolving *P*, *T,* and C_t^{SiO2} are implemented in the THMC model. We consider *P* and *T* conditions relevant across the TBL. With input parameters characteristic for alkaline melt and conditions at the base of the lithosphere, we obtain velocities between 1 to 150 m yr^{-1},which is a velocity similar to melt rising at mid-ocean ridges[2]. This implies the inability of primary melts to cross the lithosphere. However, melt addition to the base of the lithosphere is important to understand mantle metasomatism, and could, to some extent, contribute to physical properties of the *Lithosphere-Asthenosphere Boundary* and *Mid Lithosphere Discontinuity* observed with geophysical methods. We suggest that the appearance of alkaline magmas at the surface requires multiple stage processes as melts rising in the lithosphere progressively modify the geotherm

allowing new melts to propagate to the surface. Our earlier modeling results[1] demonstrated that a single porosity wave has a minor impact on chemical evolution. In this study, we search for a mechanism responsible for stabilizing porosity wave motion to some lateral location forcing consecutive waves to follow the same ascent path. The passage of a large number of quickly rising porosity waves over a long time through the same path would accumulate large melt to rock ratios and cause significant chemical evolution.

- Bessat et at., 2022, *G*^{3}, *in press*
- Connolly et al. 2009, *Nature* 462, 209-212.