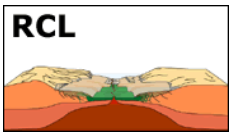
Deciphering the Role of Melt Segregation and Strain Partitioning in Rifted Continents



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Holtzman, in collaboration with Takei, Gaherty, Kohlstedt and Kendall, is developing models to assess the melt distribution in the upper mantle of divergent margins. They calculate elastic and viscous properties of multi-scale distributions of melt, to quantify the seismic signatures and the viscosity gradients in partially molten regions in a range of configurations. These models will be incorporated into the inversion process for seismic observations from the East African Rift and Gulf of California settings. Takei has developed grain-scale models for both elastic (Takei, JGR, 1998) and viscous (diffusion creep) properties of partially molten rocks, the latter just submitted to JGR. As shown in Figure 1, the granular model predicts that elastic properties are insensitive to very small melt fractions but viscous properties are very sensitive, with significant reductions (> factor of 5) at <0.1% melt, which would be virtually undetectable by seismic waves unless the effect on attenuation is strong. Furthermore, 1% melt, if aligned and segregated, can easily cause an order of magnitude reduction in effective viscosity, which would have significant consequences for the dynamics of rifting.

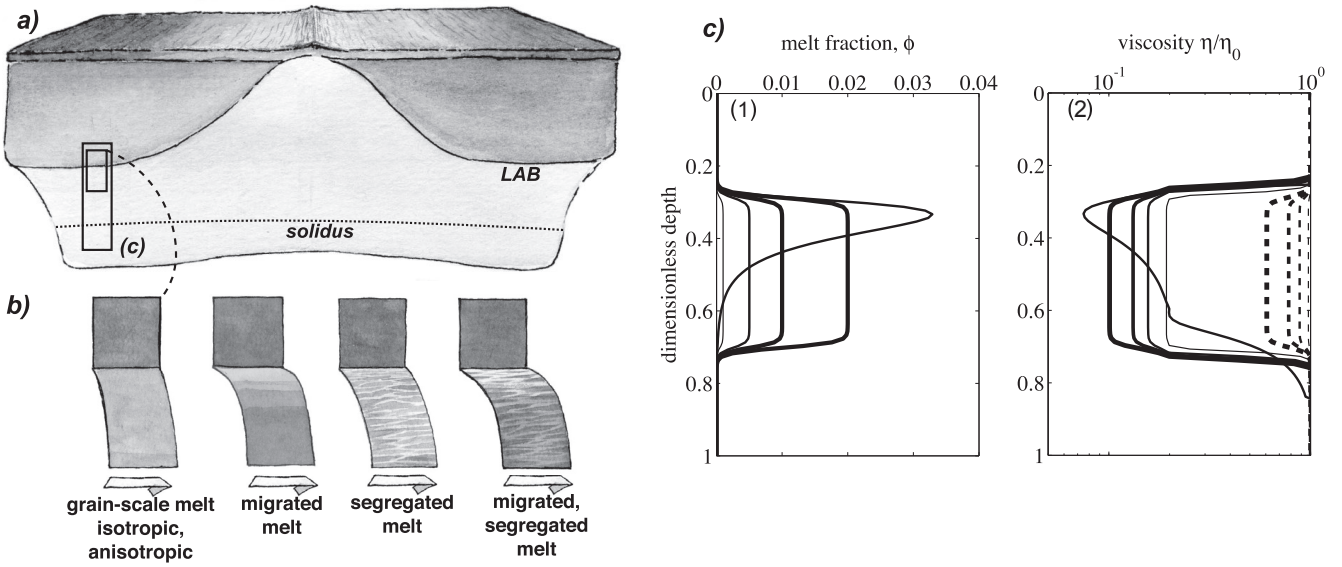

Figure: An idealized oceanic plate and example viscosity profiles for different melt distributions. a) an idealized mid-ocean ridge and lithosphere/asthenosphere system. b) four possible melt distributions and schematic flow velocity profiles. c) Calculated isotropic perturbations to viscous mantle material due to isotropic grain-scale melt distributions. c.1) melt fraction profiles with depth, c.2) viscosity profiles for the melt distributions shown in c.1.

B.K. Holtzman and J.-M. Kendall, "Organized Melt, Seismic Anisotropy, and Plate Boundary Lubrication", in revision, Geophysics, Geochemistry, and Geosystems

Y. Takei and B. Holtzman, "Viscous constitutive relations of solid-liquid composites in terms of grain boundary contiguity I: Grain boundary diffusion-control model", submitted to JGR.

Y. Takei and B. Holtzman, "Viscous constitutive relations of solid-liquid composites in terms of grain boundary contiguity II: Compositional model for small melt fractions", submitted to JGR.

Y. Takei and B. Holtzman, "Viscous constitutive relations of solid-liquid composites in terms of grain boundary contiguity III: Causes and consequences of viscous anisotropy", submitted to JGR.