# Investigating Potential Melt Sources for the Magma-Poor Albertine-Rhino Graben of the East African Rift System Using 3D Geodynamic Modeling with ASPECT

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The leading paradigm for rift formation suggests magma is required to weaken strong lithosphere thereby reducing the tectonic stresses needed for rupture to occur. There is no surface expression of magma along the 300 km long Albertine-Rhino Graben, which is the northernmost rift in the Western Branch of the East African Rift System, making it a magma-poor rift. The two leading models for magma-poor rifting are: 1) Melt/fluids are present at depth, weakening the lithosphere, but may not have reached the surface. 2) Far-field forces driving extension are accommodated along weak pre-existing structures without melt/fluids at depth. The goal of this study is to use the 3D finite element code ASPECT to test the hypothesis that melt is generated below the Albertine-Rhino Graben by Lithospheric Modulated Convection (LMC), even if this melt has not yet manifested at the surface. We created a regional model of a rigid lithosphere (crust and mantle lithosphere) and an underlying convecting sub-lithospheric mantle with dimensions of 1556 by 1333 by 660 km along latitude, longitude, and depth. We solved the Stokes system using the extended Boussinesq approximation for an incompressible fluid, which accounts for the effects of adiabatic heating and frictional heating. We used latent heating to test for melt generation from LMC in the sublithospheric mantle. To constrain the initial temperature, we used two lithospheric thickness models, LITHO1.0 and Fishwick model. Our results show that Lithospheric Modulated Convection does not generate melt beneath the Albertine-Rhino Graben, even for high mantle potential temperatures typical of plume materials. This finding implies that a sublithospheric melt source is likely not the weakening mechanism allowing the Albertine-Rhino Graben to rift, which hints that pre-existing structures may play a dominant role in rift formation of the Albertine-Rhino Graben. These results provide a better understanding of magma-poor rifting in the Albertine-Rhino Graben.