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Dynamics of Continental Rifting: Impact of initial thermal structure

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The initial thermal structure of an incipient continental rift has a first order control on the evolving architecture of rift margins. This project examines the spatial and temporal evolution of continental rifts using finite element thermo-mechanical modeling. We find that four major styles of rifting are defined by the initial thermal structure: Wide and narrow rifts (Buck, 1991), symmetric and asymmetric rifts (Lister et al, 1991).

The initial thermal structure is a product of crustal heat production rates and lithospheric thickness; therefore we explore the impact of varying crustal heat production rates from 0.75 to 2.25 μw/m^3, and lithospheric thicknesses of 100 to 200 km. The model captures a two-layer crust and lithospheric mantle with an orogenic welt geometry of over-thickened crust. The modeled strength, strain field, and thermal structure evolve naturally in response to initial conditions using an iterative time-stepping algorithm (Huerta and Harry, 2007). The model results display the evolution of continental rifting style.

Simulations with initially lower heat production rates result in symmetric rift geometries, while simulations with initially higher heat production rates generally deform asymmetrically. Simulations with initially thicker lithospheres typically evolve as strong, narrow rifts while thinner lithospheres tend to evolve as weak, wide rifts.

Results show that initial thermal structure has a first-order control on the symmetry of rifting, and a second-order control on wide versus narrow extension styles. Models will be compared to rift systems such as the East African Rift System, The West Antarctic Rift System, and the Basin and Range to test the application of the models.