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The Interplay Between Extensional Rate and Heat Flux in Asymmetric Rift Systems

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The thermal and deformational history of a rift are directly correlated. Increased stretching, whether by faulting or by lower crustal flow, results in elevated heat flux, which has significant implications for the asymmetrical evolution of the heat distribution in the basins (Lescoutre et al., 2019). Since the extensional rate also controls the amount of stretching, it also becomes an important parameter for understanding the thermal evolution. In natural rift systems, acceleration is a kinematic evolution inherent to all rifting processes (Brune et al., 2016). However, the role of the extensional rate in the evolution of the thermal flux is not clear. Ten thermo-mechanical numerical models were developed using a weak and decoupled rheology for the lithosphere. The models were run with extension rates varying from 1 to 5 cm/year with intervals of 0.5 cm/year, and one model with acceleration was simulated with values estimated by Araujo et al., 2022 for the Santos-Benguela conjugates, between Brazil and Africa. Results show that the heat flux values along the widest margin of the conjugated pair increases as the constant velocity rises. In contrast to the wide margins, the narrow margins show a simple thermal evolution. The thermal evolution of the wide margin cools from the necking zone to the end of the distal domain in velocities of 2 cm/year, following the rift migration evolution. In the models with 2.5 cm/year or higher, the thermal flux evolves similarly to the deformation process described in Souza et al., 2025 - where rift migration is not well established and two rifting sites are active simultaneously. In the acceleration model, thermal flux remains high throughout the distal domain of the widest margin, driven by rift migration. In all constant velocity cases, rifting time decreases with increasing velocity, as expected. However, the acceleration model yields a rifting duration consistent with that observed in the Santos region, where the extension rates were based.

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