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Inheritance and magmatic processes as the main controls of the evolution of a polyphase rift system: the example of the Mozambique Channel

Simon Tomasi (1), Nick Kuznir (2), Frank Despinois (3), and Gianreto Manataschal (1)

(1) Institut de Physique du Globe de Strasbourg, Université de Strasbourg, Strasbourg, France (simon.tomasi@unistra.fr), (2) School of Environmental Sciences, Liverpool University, Liverpool, United Kingdom, (3) Total, R&D, Pau, France

The role of lithosphere inheritance and deeper-seated mantle processes has been intensively studied in the past, however how they interact and control the evolution and final breakup of rifted margins is yet little understood. The aim of this study is to better constrain when, where and how magma is formed before, during and after breakup and how the structural, compositional and thermal inheritance may have controlled the evolution of the conjugate Mozambique-Antarctica margins. More recent studies demonstrating the thermal, compositional and structural influence on the evolution of a rift system (e.g., Manatschal et al., 2015; Chenin et al., 2015) proposed that a lithosphere enriched during previous Wilson cycle stages could lead to a higher magmatic budget during following rift events.

In this study we describe and map rift domains, and propose a new rift domain map of the conjugate Mozambique-Antarctica margins based on a large seismic reflection data set. This map examines pre-breakup restoration pin-points and their uncertainties that allow us to investigate different plate kinematic scenarios corresponding to different rift and breakup histories with variable budgets of magma and different implications for the reactivation of inherited structures and composition. Geophysical methods (including gravity inversion and subsidence analysis) are used to quantify the thickness of magmatic addition and the amount of stretching in the Limpopo area. Although the available data do not favour one particular scenario, it enables the limitations of different interpretations to be constrained and the consequences and implications of the various interpretations to be discussed.

Our results show that the evolution of the conjugate Mozambique-Antarctica margins seems to be an interplay between a decreasing magmatic budget from its peak during the Karoo mantle plume syn-rift to a steady-state regime during sea-floor spreading creating accommodation space for the magma. Understanding how the magmatic system related to mantle plume activity is linked to extension and how the two interact during rifting and breakup is a key to understanding the formation of the Mozambique-Antarctica margins and magma-rich rifted margins in general.