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Low-temperature evolution of the Morondava rift shoulder in western Madagascar

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Separation of Madagascar from eastern Africa resulted in the development of sedimentary basins covering the west coast of Madagascar. The largest and oldest of these basins, the Morondava basin, is bound to the east by crystalline basement of Precambrian age and stretches into the Mozambique Channel to the west. The evolution of the sedimentary sequence is mainly influenced by (I) a Permo-Triassic continental failed rift (e.g. Clark, 1998), also referred to as the Karroo rift (e.g., Montenat et al., 1996) and (II) the early Jurassic separation of Madagascar from eastern Africa (Geiger et al., 2004). Deposits related to the Karroo rift are restricted to a narrow corridor along the basement-basin contact. The rift locus shifted to the west before final separation and relative southward displacement of Madagascar commenced in early Jurassic times (Geiger et al., 2004).

In the central part of the basin, the basement-basin contact features a steep escarpment with an altitude difference of greater than 1000 m from the sedimentary plains to the crystalline basement. Here, apatite fission-track analysis of a series of both basement and sediment samples across the escarpment provides the possibility to study the low temperature evolution of the exhuming Precambrian basement in the rift basin shoulder and the associated thermal evolution of the sedimentary succession.

The timing of basement surface exposure is constrained by the stratigraphic ages of the overlying sediments and modelling of the thermal evolution indicates post-depositional thermal overprinting of basement and Karroo age sediments with partial annealing of fission tracks related to burial by Mesozoic sediments. The temperatures of this heating / reheating of the basin shoulder increase towards the west in the presently exposed sequences. The westernmost sample experienced almost complete resetting of the detrital apatite grains. The general younging of the apparent apatite fission-track ages towards the west indicates activity of faults, re-activating inherited Precambrian structures along the present basin-basement contact during Karroo sedimentation. Furthermore, our data show that onset of final exhumation can be correlated with (I) the end of Madagascar's drift southward relative to Africa along the Davie Ridge in the Mozambique Channel during the Early Cretaceous (Coffin and Rabinowitz, 1988), (II) activity of the Marion hot spot beneath southern Madagascar and associated Late Cretaceous break-up between Madagascar and India (Storey et al., 1995), and (III) the collision of India with Eurasia and subsequent re-organization of transform faults and spreading ridges.

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