Geophysical Research Abstracts
Vol. 15, EGU2013-370, 2013
EGU General Assembly 2013

The complex post-rift evolution of the South Atlantic margin, South Africa: new insights from joint inversion of apatite (U-Th)/He and fission track thermochronometry.

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The continental edge of southwestern Africa has long been seen as a type example of a high elevation passive margin, with its characteristic topography forming during or shortly after rifting (c. 130 Ma). Recent work along the South Atlantic passive margin has highlighted the importance of interactions between rift-tectonics, mantle flow and dynamic topography on controlling margin evolution, however, the temporal relationship between these processes is still poorly understood. There is now increasing evidence from satellite imagery, onshore field observations (e.g. Viola et al., 2012) and offshore sedimentary basin analysis (e.g. Hirsch et al., 2010) that suggests that these processes have resulted in a much more complex structural and thermal history along the margin than previously thought. A critical step towards developing a better understanding of the post-rift evolution of this margin is to quantify the surface response (i.e. uplift and erosion) to these major structural and thermal events.

Apatite fission track analysis (AFTA) has been used world-wide as a powerful means of extracting quantitative constraints on the timing and rate of major episodes of onshore denudation. Previous AFTA studies in SW Africa have identified two distinct cooling events occurred during early and late Cretaceous, respectively. However, in places AFT ages vary significantly over relatively short distances and this has been interpreted to indicate local differential erosion levels controlled by tectonic displacements related to fault reactivation. A limitation of the AFT system is that it is sensitive to a temperature range of c. 120-60°C and therefore is unable to evaluate the magnitude of denudation episodes where the amounts are less than c. 1.5-2 km. So while the Cretaceous history of erosion is well established from existing AFTA data, the details of the timing and amount of erosion occurring during the Cenozoic remain relatively poorly constrained. The apatite (U-Th)/He (AHe) method with a lower temperature range (c. 40-75°C) will therefore be more sensitive to more recent and smaller amounts of erosion, and offers a new opportunity to constrain small scale erosion (c. 1-3 km) during the Cenozoic, provide more robust thermal histories and assess the effect of fault reactivation within the region.

Here we present new AFTA and AHe data from southwest Africa combined with the structural history of the margin. The new suite of AFTA and AHe data come from a suite of outcrop samples across the entire margin and samples from three deep boreholes located on the elevated interior plateau. We use joint inversion modeling techniques to extract thermal histories of and constrain the temporal and spatial distribution of denudation. Our preliminary data show that AHe dates range between 234 and 17 Ma and that the pattern of age dispersion implies complex cooling from the Mid-Cretaceous through to the Cenozoic. The joint inversion thermal histories require rapid cooling shortly after rifting in the early Cretaceous but the data currently do not require a major Tertiary cooling event. Through these direct empirical measurements of onshore denudation we re-evaluate the extent to which the initial rifting event has influenced the development and longevity of South Africa's characteristic topography.

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