

## **Escarpment evolution at the Red Sea continental margin of southwestern Saudi Arabia**

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Rifting of the Red Sea started around ~30-32 Ma and resulted in the formation of one of the youngest and best developed escarpments of the world: the Great Escarpment of southwestern Saudi Arabia. The escarpment is perfectly developed over a length of more than 500 km and includes mountains up to 3000 m in elevation. To better understand the geodynamics of Red Sea rifting and to constrain a denudational model for the Great Escarpment, the results of apatite fission track and (U-Th-[Sm])/He thermochronologic techniques are combined with stream power analysis from the central part of this region. Pooled fission track ages (recording cooling through about 110 °C) range from  $13.2 \pm 1.7$  to  $352.1 \pm 17.6$  Ma ( $1\sigma$ ) with all ages that are younger than about 50 Ma (and thus related to the rifting) being from elevations lower than about 500 m (i.e. towards the base of the escarpment). Apatite He ages range from  $2.8 \pm 0.3$  to  $264.5 \pm 19.6$  Ma with a similar age-elevation relationship. The base of the pre-uplift apatite partial annealing zone is interpreted to be lying at ~200 m present-day elevation. Our fission-track data indicate that the amount of exhumation is insufficient to completely reset all the coastal plain samples, but exhumation along the escarpment appears to increase from south towards north. The highest amount of exhumation is confined to two separate regions, one in the north and one in the south, which are separated by a region of non-reset AFT ages and hence lower amounts of exhumation. This interpretation is also supported by stream power analysis from this region. The reset AFT ages indicate about 4.5 km of exhumation which may have started in the early Miocene, but the majority of this exhumation phase occurred after 13 Ma. This interpretation is consistent with a single isolated outcrop of Nubian sandstone at the summit of Saudi Arabia's highest peak. The distributions of AFT and AHe ages across the escarpment and coastal region supports the escarpment development by the established "down-wearing" or "plateau degradation" model of escarpment evolution, which implies that the present drainage divide may have been in its position already in the Miocene. Red Sea rifting may have resulted from the complex interaction of both passive and active rifting models as it did not follow the suggested sequence of events (i.e. rifting-uplift-volcanism or doming-volcanism-rifting) for either of the two rifting models.