TKS1

Tectonics and Petroleum Systems of East African Rifts

D. Macgregor* (Macgeology Ltd)

SUMMARY

East Africa represents the most rifted portion of crust on the planet. The first rift phase commenced in the Permian as the ‘Karroo’ set of half grabens in Kenya and Ethiopia. These propagate into a set of younger rifts with peak rifting phases in the Early Triassic.

A further phase of rifting is seen in the Early Jurassic, concentrated along what will later become the East African passive margin. This phase ends in the Kimmeridgian break-up between Africa and Madagascar. A Late Jurassic rift population also extends from Yemen across to Somaliland. Another population of latest Jurassic-earliest Cretaceous age is interpreted in onshore and offshore southern Mozambique.

Multiphase Cretaceous rifting is concentrated along NW-SE trends. A focus in recent years has been the Anza Graben of Kenya, where events do not correlate well to the Sudan rifts.

The East African Rift System (‘EARS’) commenced in the Lokichar Basins of northern Kenya in the Late Eocene to Oligocene. At various times during the Mid-Late Miocene, a series of small rifts and depressions formed between Ethiopia and Malawi, heralding the main regional rift subsidence phase and further rift propagation in the Plio-Pleistocene.
East Africa represents the most rifted portion of crust on the planet. The first rift phase commenced in the Permian as the ‘Karroo’ set of half grabens. Half-grabens along NE-SW trends have a transtensional origin, being later subject to a later phase of inversion, while a series of simpler half-grabens is developed perpendicular to the shear system. Maximum rifting appears to be of early Late Permian age. In Kenya and Ethiopia, these propagate into a set of younger rifts with peak rifting phases in the Early Triassic.

A further phase of rifting is seen in the Early Jurassic, concentrated along what will later become the East African passive margin. Many of these rifts are simple half-grabens and seem to overlie older rifts. As most of these lie below thick overburdens offshore, this population of rifts is the least well delineated. This phase ends in the Kimmeridgian break-up between Africa and Madagascar, which creates a transform margin. Pull-apart basins are observed in Mozambique, which are inverted at end Jurassic and also in Tanzania at various times during transform movement. A Late Jurassic rift population also extends from Yemen across to Somaliland, although some proposed Late Jurassic rifts in this region have been found to have been wrongly interpreted when drilled. Another population of latest Jurassic-earliest Cretaceous age is interpreted in onshore and offshore southern Mozambique, extending to the eastern offshore of South Africa and is speculated to have resulted in the split of the ‘Limpopia’ microcontinent.

Multiphase Cretaceous rifting is concentrated along NW-SE trends. A focus in recent years has been the Anza Graben of Kenya, where events do not correlate well to the Sudan rifts. Maximum rifting here occurs in Late Cretaceous, associated with the building of rift shoulders kilometres in height, this in itself being suggestive of a rift over a mantle plume rather than one controlled by the shear systems of Sudan.

The East African Rift System (‘EARS’) commenced in Lokichar Basins of northern Kenya in the Late Eocene to Oligocene, though there seem to be few further deep rifts of this age other than those immediately adjoining these. At various times during the Mid-Late Miocene, a series of small rifts and depressions formed between Ethiopia and Malawi, heralding the main regional rift subsidence phase and further rift propagation in the Plio-Pleistocene. The majority of fault activity, structural growth, subsidence, and associated uplift of East Africa seem to have occurred in the last 5-9 Ma, and particularly in the last 1-2 Ma. The EARS rifts are again characterised by high and extensive rift shoulders.

Assessment of the petroleum potential associated with these rifts relies not only on an accurate assessment of each in terms of their age and affinity to working systems, but also considerations of the relationships between sedimentation, subsidence and palaeoclimate. It is also clear that the mechanisms controlling rifting differ, with a spectrum observed between mantle derived and shallow crustal processes.
Figure 1 Interpreted patterns of East African rifting through time.