Geophysical Research Abstracts, Vol. 7, 07789, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07789


# Comparison of the seismic structure of rift zones: DonBas in Ukraine, Baikal, Kenya, and the North Sea area.

C. Nielsen, S.B. Lyngsie, A. Sandrin, L. Nielsen and H. Thybo
Geological Institute, University of Copenhagen, Denmark
(alsa@geol.ku.dk, thybo@geol.ku.dk / Fax: +45 33148322)

We present a comparison of structural styles of continental rift zones based, primarily, on deep refraction/wide-angle reflection seismic surveys. Our comparative study of tectonically active rifts, palaeo-rifts and passive margin rift basins, reveals several interesting characteristics that genetically relate extension of continental lithosphere at different tectonic settings. The study is based on results from the following projects: KRISP90, BEST, DOBRE and ESTRID.

KRISP90: The active East African Rift System, a continental rift developed since the Late Oligocene, is considered the archetype of a rift in the initial stage of continental breakup. The rift system stretches over 3000 km from the Afar triple junction in the Gulf of Aden to the Zambesi River in southern Africa and bifurcates around the East African Plateau. The rifting is believed to have been initiated by a mantle plume (active rifting), and it is associated with intense volcanism and seismicity. Modelling of the KRISP90 data shows an asymmetric rift basin, a lower crustal layer that thickens from west to east and high P-wave velocities (7.0-7.1 km/s) but only a small amount of crustal thinning (1-2 km). The lower crust beneath the rift axis shows high amplitude reflections of low frequency, whereas weak reflections of high frequency are observed outside the rift zone.

BEST: The Late Cenozoic Baikal Rift Zone, located on the Siberian Craton, is composed of several individual topographic depressions and half grabens with the deep Lake Baikal at the centre of the rift. In contrast to other continental rift zones, the Baikal rift, which spans nearly 1500 km along its axis, is more than 2000 km from

the nearest active plate boundary and is one of the most seismically active rifts in the world. The recorded magmatic activity is small for such a major rift system and far field stresses caused by the collision of India and Asia are proposed as the rift inducing factor. Modelling of the BEST data shows an asymmetric rift basin consisting of deep half grabens, no significant crustal thinning beneath the rift axis but a highly reflective lower crust beneath the rift.

DOBRE: The 2000 km long, Devonian Pripyat-Dniepr-Donets rift (PDD) is located in the southern part of the East European Craton (Ukraine). The PDD is wide (100-150 km) compared to other rifts and shows maximum depths of almost 20 km. Wide-angle reflection seismic data shows indications of a crust cutting listric fault system. In contrast to the East African Rift System, the PDD initially formed in a thick (over 100 km), cold lithosphere yet widespread volcanism is associated with the rifting. Modelling of the DOBRE data shows an asymmetric deep basin, well defined three layered crust in the adjacent massifs but a lack of a mid-crustal layer beneath the rift axis. Significant stretching ($\beta \approx$2.3) was followed by underplating and intrusion processes which led to lower crustal thickening beneath the basin. The modified lower crust is highly reflective and of high density. Back-arc rifting in response to subduction of the Proto-Thetys Ocean may be the cause of the rifting.

ESTRID: The Mesozoic sedimentary Danish Basin is located at the margin of the Precambrian Baltic Shield within the former Baltic Plate. Extensional regimes and intensive magmatic activity occurred during the Carboniferous and early Permian. The ESTRID project investigates the middle/lower crust and the main features of the Moho in the area. Seismic tomography studies show a high velocity zone ($>$6.5 km/s) with its top located at $\sim$11 km depth. It is interpreted as a gabbroic intrusion. High P-wave velocities ($\sim$7.5 km/s) are found below the intrusion through seismic travel-time modelling. A westward Moho upraise from 34 km to 29 km is observed across the 160 km ESTRID profile. Variability in the character of the reflection from the Moho (PmP) is seen along the profile. A "ringing" PmP is observed approximately below the intrusive body may be related to a layered structure at the crustal-mantle boundary.

All four rift scenarios are situated in different tectonic environments, yet, common for all are a lack of crustal thinning despite high values of calculated crustal extension.

We find that all the continental rift zones show lower crustal reflectivity which may be related to magmatic intrusion during rifting. However, the extent of reflectivity is highly variable, with a degree that appears to correlate with the total volume of volcanic material observed at the surface. As such the intrusions may obscure direct observation of the extension rate. This reflectivity often is offset from the main rift axis, indicative of lateral, depth-dependent variation of the location of the extension during rifting. We also find indication that the deepest rift grabens occur where there is least volcanism.