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EAST AFRICAN RIFT KINEMATICS AND STRESS FIELD: GEOLOGICAL & FOCAL MECHANISM DATA

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Since the late stages of the Pan-African orogeny, the evolution of East Africa was dominated by the progressive dismembering of the Gondwana continent, in a dominantly extensional setting but sometimes interrupted by compressional tectonic inversion. In the still cratonic part of East Africa, a succession of several rifting stages is known since the late Carboniferous-Permian Karoo stage, separated by periods of tectonic quietness and basin inversion. For each of these stages, the kinematic evolution is guided by different order sources of tectonic stress. This is well exemplified for the late Cenozoic East African rift system, where the kinematics of the different rift segments is influenced by its local tectonic setting in relation to the dynamics of the microplates involved.

The subsurface expression of the tectonic deformation related to this late Paleozoic to Recent evolution has been recorded dominantly in a brittle way by slickensided faults and fractures of various types. The Present-day deformation is highlighted by sismotectonic, geodetic and paleoseismic data. Geological fault-slip data and earthquake focal mechanisms have been inverted to derive the past and present tectonic stress using the now well established tectonic stress inversion procedure. We used the stress inversion methodology developed in the TENSOR program (Delvaux and Sperner, 1993), using the Win-Tensor program (available at http://users.skynet.be/damien.delvaux/Tensor/tensor-index.html). Geological fault-slip data have been collected during field campaigns over a period of 20 years, in Western and Central Tanzania, North Zambia, North Malawi and in Katanga (DRC). Our data base on earthquake focal mechanisms has been compiled recently by Delvaux and Barth (2010), and completed by the recently available data.

The stress inversion results highlight the stress field evolution of a series of tectonic stages that have been illustrated by our data. Unfortunately, this recording is far from complete, in both a temporal and spatial way. The results are expressed in terms of horizontal principal stress directions (S_{Hmax} and S_{hmin}, orthogonal to each other) and stress regime (quantified by the Stress Regime Index R').

The first brittle tectonic stage for which the stress field could be derived corresponds to the late compressional stage of the Pan-African orogeny. The Karoo basins of South Tanzania, Malawi and North Mozambique have been initiated in an extensional stress field during the late Carboniferous-Permian. Probably at the Permo-Triassic transition, a major compressional inversion was recorded among others in the Karoo basins aligned along the NW-trending Ubende belt in the area of Lake Rukwa. In the same belt, extension resumed in the late Cretaceous and was active during several parts of the Paleogene and Neogene, giving rise to volcanism and sedimentation in active tectonic grabens. The Present-day stress field is spatially the best known thanks to the large repartition of focal mechanism data in the East African rift. This allows to access the first, second, and even third-order of stress field. The present-day stress field appears controlled a.o. by the large-scale topography of East Africa, the major rift structures and the configuration of the kinematic plates involved.

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