Paper Number: 4681

Low deformation rate in an « incipient rifting zone »: the Okavango Basin

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In northern Botswana lies one of the largest wetlands in Southern Africa, the Okavango Delta. Gathering from the Angolan highlands, the Okavango river spreads into an alluvial fan when meeting the break in slope due to a NE trended half-graben. This tectonic structure, the Okavango Rift Zone (ORZ), is classically assumed to be an extension of the East African Rift System's southwestern branch [1] because of its location and fault orientation, its seismic activity, gravimetric anomaly and heat flux. A recent seismic study questioned this consensus by showing no significant crust thinning beneath the basin [2].

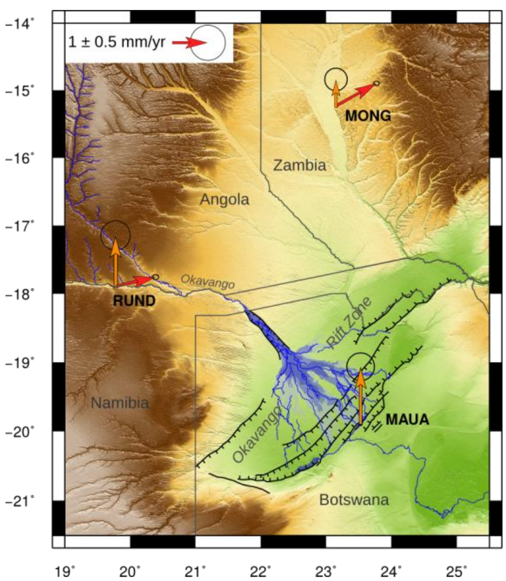

Figure 1: Topographic map of the Okavango Delta with horizontal (red) and vertical (orange) displacement rates derived from GPS records.

The Delta yearly receives about $10^{10}m^3$ of water mostly from an annual flood coming from its vast drainage area [3]. On its distal part, water is stopped by small but significant bounding fault scarps. Topography combined with a high evapotranspiration rate (96%) forms a unique pure soft water endoreic system. This flood cycle results in one of the highest groundwater variations system in the world [4], which could induce ground deformation. The Delta deformation is thus under the influence of both tectonic constraints and loading effects.

To characterize the deformation field, time series from three permanent GPS stations from the Africa Array (MAUA, MONG and RUND, cf. Figure 1) surrounding the ORZ were processed with GAMIT/GLOBK [5]. Horizontal finite displacement rates between stations in the northern part and the southern border fault station show no extension in the half-graben but a slight finite strike-slip component (about 1mm/yr), questioning the active nature of the ORZ. The small difference between MONG and RUND could confirm the fault-controlled morphology of the panhandle. A yearly seasonal signal is clearly visible on the time series, particularly on the vertical component, revealing the stronger influence of the hydrologic regime on local deformation. Surface deformation modelling based on GRACE data with a priori rheological parameters already confirms independently these displacements at a wider scale.

The future focus for this study consists of improving surface deformation numerical modelling from GRACE with better-constrained rheological parameters for the lithosphere. This would enable quantification of hydrological and tectonic influences giving access for instance to the vertical tectonic movements. Then, simple numerical modelling of processes at play in the area will permit us to understand influences and feedbacks in this dynamically balanced system.

References :

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