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Causes of basin inversion, Blue Ben, Somerset (photo C. Stevenson)

Palaeostress reconstruction in the Lufilian Arc and the Kundulungu foreland (Katanga, Democratic Republic of Congo): in search of evidence of incipient active rifting

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To the southwest of the central branch of the East-African rift system in the Lake Tanganyika region, morphotectonic evidence (e.g. Lake Mweru), shows seismicity and geothermal activity which indicates incipient active rifting. Our research focused on the brittle deformation structures that can be found in the Neoproterozoic Katangan sedimentary series in the Lufilian Arc and its foreland. These sedimentary series, typically known for their high-grade host copper-cobalt ores, were folded, brecciated and faulted during the Pan-African orogeny (ranging from 560 to 520 Ma). By performing a regional paleostress reconstruction, we intend to determine whether or not the Lufilian Arc is already affected by incipient active rifting and whether or not this has caused any remobilization of the Cu-Co ores.

Fault-slip data have been sampled in open pit mines and occasional outcrops at different sites across the Lufilian Arc and its foreland. We apply a paleostress reconstruction using the Tensor software based on both fault kinematics and field observations in order to comprehend fracture types and their chronology as well as fault behaviour and associated mineralization.

Our interpretation suggests successive brittle tectonic stages with particular stress states postdating the main stage of the Neoproterozoic Pan-African orogeny. For the early fracturing stages, varying stress magnitude and orientation is evidenced. This early brittle compression event is interpreted as syn-orogenic. It can be correlated across all the mine locations in the Arc and predates the Cu-Co remobilization. The cross-cutting relationship and fracture chronology indicate a certain multiphase development of the Cu-sulphide mineralization. We show that this multiphase mineralization is linked to polyphase strike-slip and extension faulting, rather than to compression. Dip-slip sub-vertical faults are typically found in the central part of the Arc. They are sometimes mineralized and mainly reactivate bedding planes.

They occur in both limbs of the major fold structures, as well as within the tectonic breccia that commonly occupy the core of the folds, both suggesting a post-folding brittle extension faulting event. The significance of these brittle structures is discussed in terms of possible, syn-orogenic extension and vertical extrusion, late-orogenic collapse, post-orogenic foreland compression reactivation or later rift-related extension.

The brittle structural data set records different stress solutions of regional importance, leading to a subdivision of the Lufilian Arc into zones of different fracturing behaviour. The southeastern part is dominated by strike-slip and extension stress regimes with significant bedding-parallel normal slip movement; the central part mainly recorded a compression regime, typically with dip-slip vertical faults; the foreland is successively characterized by compression and extension regimes. All these fracturing events successively reflect the Pan-African orogeny, a later compression event of possible Late Paleozoic-Early Mesozoic age, followed by extension. The youngest brittle structure generation complies with a stress field reconstruction that is compatible with recent local earthquake focal mechanisms.