



The use of hybrid fractures in paleostress determinations: test case with the the Palygorskite-bearing fractures in the Kinshasa area, DR Congo

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Hybrid fractures represent the transition from extension fracture to shear fracture (Ramsey and Chester, 2004, Nature 428, 63-66). Although hybrid fractures have long been hypothesized to represent brittle fracture types between the extension and shear fractures end-members, it was only in 2004 that these authors succeeded to demonstrate their existence experimentally. As a consequence, observation of hybrid fractures in naturally deformed rocks remained ambiguous for a long time and only few studies reported their natural existence. Hybrid fractures have also not been considered so far as brittle element in paleostress reconstructions as their kinematic understanding was unclear.

The Paleozoic Inkisi red sandstones of the West-Congo Supergroup in the region of Kinshasa and Brazzaville (Congo) are affected by prominent fracture sets, the most prominent of which are filled by palygorskite veins. They were formed in a strike-slip setting related to intraplate stress field generated by the mid Atlantic ridge push since that became efficient in late Cretaceous. We found an almost continuous range of fracture types, from plume joints to open fractures filled with calcite-palygorskite but without slip striae, and slickensided fractures with only thin films of redeposited palygorskite. The structural data have been analyzed with the Win-Tensor program (version 5.0.1) which has been adapted to consider hybrid fractures. Those are characterized by extension and shear, as opposed to tension fractures, on which no shear movement occurs, and to shear fractures, on which contraction occurs instead of extension. The results obtained suggest that the fractures have been initiated locally as plume joint and developed laterally under hybrid conditions. Later, some of them have been reactivated as strike-slip shear fractures and a new conjugated set appeared. Overall, this illustrates the progressive development with time of the stress state corresponding to an increase in the $\sigma_1 - \sigma_3$ stress difference.