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Neotectonic stress orientation in the Kaapvaal Craton, South Africa derived by the Dihedra method.

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Neotectonic stress directions are generally obtained from borehole overcoring and seismic focal mechanisms. The Dihedral method has long been used to estimate the orientation the three axes of palaeotectonic stress ellipses by stereographic projection [1], and relies on gathering orientation data from a large and variously-oriented population of slickensided surfaces with well-developed slickenside lineations, where the sense of movement can be readily determined. The data from this methodology can be difficult to interpret in ancient strata, due to the possibility of superimposed sets of slickensides from numerous tectonic events, though can be considered more reliable in younger strata where the likelihood of multiple events is limited, and thus a population of slickensides most likely formed as a result of a single event. This methodology relies upon the presence of slickensided surfaces, exposed along the trace of the fault, which may not form readily in poorly consolidated strata. Also the best resolution for the orientation of the stress axes can be gained if a variety of differently-orientated planes are (re-) activated during the faulting. Thus this methodology may not be appropriate along some neotectonic fault scarps with poorly consolidated strata that lack pre-existing planar structures.

Despite these potential constraints, we have successfully applied this methodology (using Fabric 8 software) to faults cutting Miocene to Recent gravels and calcrete in South Africa, in order to determine the likely orientation of neotectonic principle stress axes. Despite the generally poor consolidation and presumably low confining pressures associated with such young deposits, slickensided fault planes and some folding have been preserved in areas affected by neotectonic activity. This methodology has the advantage of being cheap, though often it is difficult to constrain the timing of the neotectonic event.

Results from slickensided surfaces recovered from calcrete near Bultfontein, northern Free State, suggest a stress ellipsoid with a sub-horizontal NNW-SSE orientated σ_1, ENE-WSW sub-horizontal σ_2, and a sub-vertical σ_3 although the almost oblate spheroid ($\sigma_1 \geq \sigma_2 > \sigma_3$) [2] suggests that this deformation partly relates to swelling in the calcrete. Results from upper and middle benches of diamond-bearing gravels adjacent to the Orange River between Kimberley and Douglas in the Northern Cape suggest a similarly orientated stress field with σ_1 orientated N-S, with a vertical σ_3. Interestingly, both these results suggest a neotectonic stress regime associated with thrust faulting, both close to the edge of the Kaapvaal Craton (Douglas) and within the craton (Bultfontein). This suggests that neotectonic activity in southern Africa is not restricted to mobile belts, and the properties of the stress field are in contrast to both the predicted direction of maximum horizontal stress (NW-SE) and the stress regime (normal faulting, locally strike-slip) predicted by the current world stress map and recent geodynamic models [3, 4] .

References

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