Mapping the Stress Field in Southern Africa: a Tool to Unravel the M5.5 Earthquake of 5 August 2014 near Orkney

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The 5th August 2014 event with epicentre near Orkney, the strongest recorded in South Africa in 45 years, received much attention by the press and the seismological community; and the analysis of the seismic data, including those of the aftershocks, revealed some intriguing facts. Focal mechanism solutions computations provided evidence for a NW-oriented, sub-horizontal σ_1 and a left-lateral, predominantly strike slip movement along a cryptic fault plane oriented NNW to N. Adding to the puzzle, the aftershock data also indicated that most of the seismogenic displacement happened below the gold-bearing reef [1]. Prompted by these results, an international effort is being planned to study *in situ* the slippage zone with an inclined borehole drilled from one of the adjacent mines [2]. Our companion approach aims to capture data on the tectonic stresses that acted on the southern African crust for the past 130 Ma and to model their effects on the Witwatersrand basin. For this, the more reliable stress data are computed from borehole breakouts measurements (mainly offshore exploration wells [3] and fault plane solutions from seismic events recorded by multiple stations. Less reliable are instead stress and strain release structures in mines and tunnels as they may reflect in varying degrees anthropogenic influences. Further stress data were obtained from the structural analysis of fault displacing Late Cenozoic sediments; however, the difficulty to date the last age of movement severely constrains the applications of this technique. Available observations consistently indicate a NNW - N orientation of the maximum horizontal compressive stress (σ_H) that prevails across most of South Africa, and in Namibia up to the Angola border. An early compilation of our data was adopted by G. Viola et al. [4] and P. Bird et al. [5] to produce kinematic models of stress and strain rate across southern Africa. In particular, Bird's best fit model (AF-SO- 013) is based on realistic rates of remote boundary conditions and generates a belt of strike slip stress (strain rate tensor, E3-E1 = ~10^{-17}units) that extends from the Northern Natal basin, through N Natal and the eastern side of the Witwatersrand region to Central Botswana. Given the coarseness of the AF-SO- 013 model, minor changes in model input parameters would easily allow the strike slip belt to include the western sector of the Witwatersrand basin; whereas the orientation of the conjugate faults and their sense of movement already match within error those computed for the Orkney event. To conclude, the recognition of neotectonic activity in the Witwatersrand basin is consistent with other finds within 100km from Orkney, namely the undated thrust faults cutting calcrete at Bultfontein, and the proposed Late Pleistocene seismites in hot spring deposits at Florisbad [6]. The dearth of data precludes a quantitative assessment of the seismic hazard in the Orkney area, however greater insights might be obtained from more work at Bultfontein and Florisbad, and from a forensic scrutiny of the major tremors swarms in the wider Witwatersrand basins [6], starting from those between Orkney and Welkom with M >2 x the Standard Deviation of the area average.

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