SEISMOTECTONIC AND CRUSTAL-STRESS CONTEXT OF THE SOUTHERN KAROO BASIN: IMPLICATIONS FOR ARTESIAN GROUNDWATER RESOURCES AND TRIGGERED-EARTHQUAKE HAZARD

Chris J. H. Hartnady[1]

[1]Umvoto Africa (Pty) Ltd, Muizenberg, Cape Town, South Africa (email: chris@umvoto.com)

ABSTRACT

The Southern Karoo Basin (SKB) is located along the foreland of the Permo-Triassic Cape Fold Belt (CFB), which is transected by major Jurassic-Early Cretaceous fault systems related to the break-up of West Gondwanaland. CFB faults now experience neotectonic reactivation within a present-day Cape Stress Province (CSP) characterized by a dominant strike-slip regime with roughly E-W principal horizontal stress. A ~90 km segment of the Cango Megafault, around Toorwater east of Oudtshoorn, ruptured ~11 kyr ago in a major (Mw7+) surface-breaking earthquake and the Groenhof segment of the same system produced the 1969 Sep 29 Mw6.2 Tulbagh-Ceres earthquake and its (ongoing) aftershock sequence. The Toorwater rupture is associated with a hot spring flowing from fractured Table Mountain Group (TMG) quartzites in the footwall of the fault zone. Many other CFB thermal springs have a similar non-volcanic setting linked to TMG damage zones along reactivated major faults. These CFB hydro-geothermal phenomena reflect deep, active, artesian groundwater circulation, under control of the neotectonic stress field, from erosion-resistant, topographically prominent, TMG mountain ranges to the intermontane faults.

The intraplate CSP is marginal to the Nubia-Lwandle plate boundary, within a broad Nubia-Somali (NU-SO) plate boundary zone. The southern NU-SO boundary transitions from ultra-slow (<2 mm/yr) continental interplate extension along the East African Rift System to oceanic interplate transpression between south-eastern Africa and the South-West Indian Ridge. Finite-element lithospheric stress modelling indicates the CSP as a western extension of one of the Earth's largest "vertical integrated stress anomaly" (VISA) features. Better understanding of this crustal stress anomaly is important to the explanation of natural intraplate earthquakes within the SKB-CFB region and to the quantification of the geohazard potential for significant anthropogenically induced or triggered earthquakes related to hydraulic fracturing and possible wastewater-injection operations in the context of unconventional hydrocarbon development.