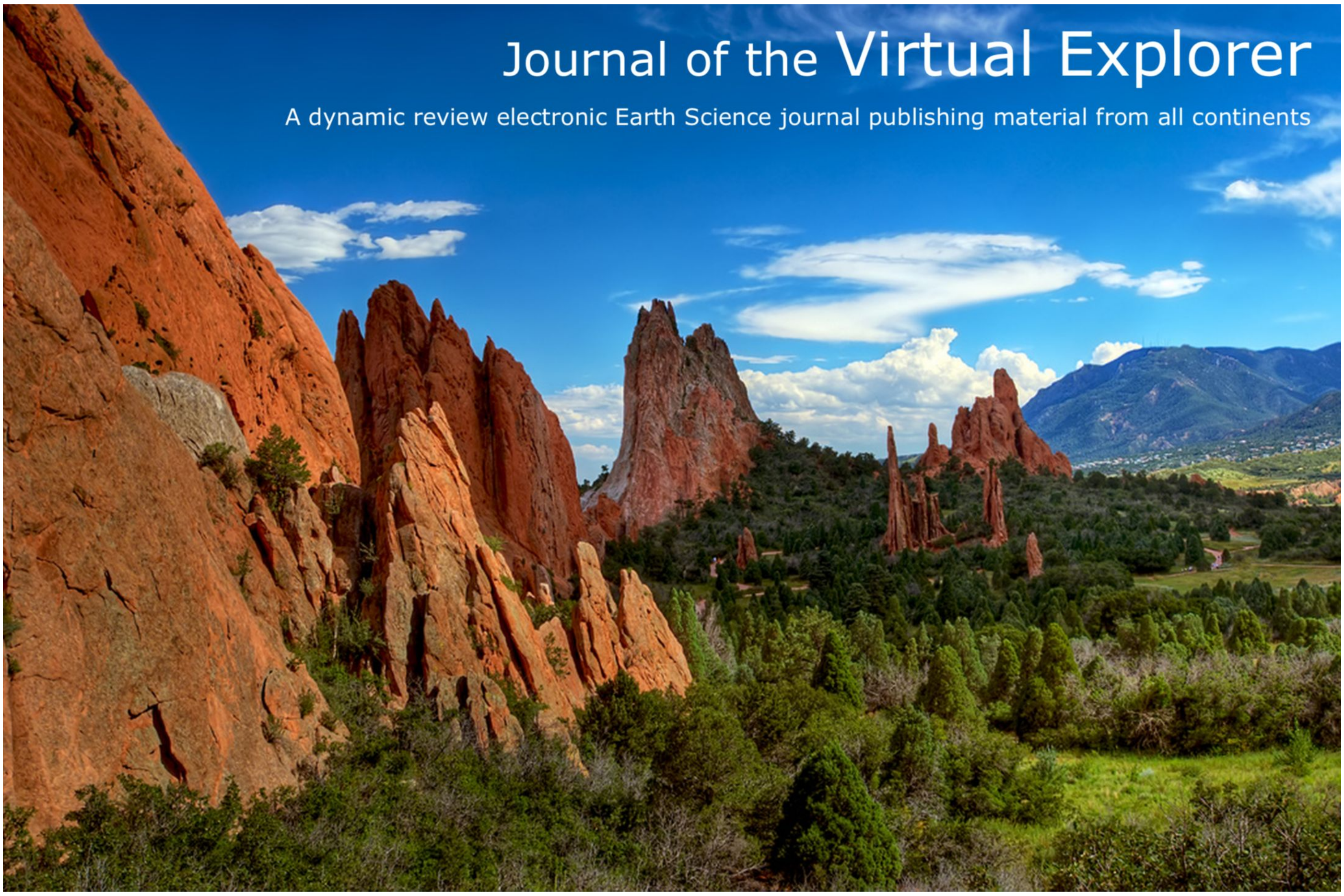


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# Magma chamber elongation as an indicator of intraplate stress field orientation: "borehole breakout mechanism" and examples from the Late Pleistocene to Recent Kenya Rift Valley

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**Abstract:** Quaternary volcanism and faulting in the Kenya rift valley are focused in a narrow zone along the rift axis. Beginning ~1 Ma, large trachytic volcanoes were built within an E-W to ENE-WSW extensional stress field. Volcanic fissures and associated pyroclastic cones were aligned ~N-S, parallel to the maximum horizontal stress (SHmax). Mt. Suswa, a large volcano located ~1°S latitude, collapsed sometime between 240 and 100 ka, and the resultant caldera is elongate N83°E, parallel to the minimum horizontal stress (Shmin). At the time of Suswa's collapse, or shortly thereafter, the regional stress field rotated 45° in a clockwise direction. After ~100 ka, the trachytic volcanoes in the northern rift also began large-scale caldera collapse. The calderas of Kakorinya, Silali, Emuruangogolak and Paka formed at about 92, 64, 38 and 10 ka, respectively (Dunkley et al., 1993). The calderas of these volcanoes are oriented N75°W, N58°W, N56°W and N55°W, progressively rotating toward parallelism with the new N45°W Shmin. Likewise, some of the youngest fissures and trains of small-scale cones on the flanks of the northern volcanoes are aligned NE-SW, parallel to SHmax.

We suggest that the magma chambers beneath each of the trachytic volcanoes grew to an elliptical shape by stress-induced spalling of the chamber walls, analogous to the formation of breakouts in boreholes and tunnels. The caldera long axes therefore represent the time-averaged shallow crustal Shmin direction during the life of the underlying magma chambers. The actual collapse of the calderas, beginning with Suswa, may have been triggered by the sudden rotation of the stress field, which formed new fracture systems and increased the ease with which magmas could be ejected from flank eruptive centers or fissures. The link between stress field rotation and catastrophic caldera collapse may have implications for geologic risk assessment in the East African rift and other volcanically active areas.

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