



Post-caldera faulting of the Late Quaternary Menengai caldera, Central Kenya Rift (0.20°S, 36.07°E)

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A structural geological analysis of young caldera volcanoes is necessary to characterize their volcanic activity, assess their geothermal potential, and decipher the spatio-temporal relationships of faults on a larger tectonic scale. Menengai caldera is one of several major Quaternary trachytic caldera volcanoes that are aligned along the volcano-tectonic axis of the Kenya Rift, the archetypal active magmatic rift and nascent plate boundary between the Nubia and Somalia plates. The caldera covers an area of approximately 80 km² and is among the youngest and also largest calderas in the East African Rift, situated close to Nakuru – a densely populated urban area. There is an increasing interest in caldera volcanoes in the Kenya Rift, because these are sites of relatively young volcanic and tectonic activity, and they are considered important sites for geothermal exploration and future use for the generation of geothermal power. Previous studies of Menengai showed that the caldera collapsed in a multi-event, multiple-block style, possibly as early as 29 ka.

In an attempt to characterize the youngest tectonic activity along the volcano-tectonic axis in the transition between the Central and Northern Kenya rifts we first used a high-resolution digital surface model, which we derived by structure-from-motion from an unmanned aerial vehicle campaign. This enabled us to identify previously unrecognized normal faults, associated dyke intrusions and volcanic eruptive centers, and transfer faults with strike-slip kinematics in the caldera interior and its vicinity. In a second step we verified these structures at outcrop scale, assessed their relationship with known stratigraphic horizons and dated units, and performed detailed fault measurements, which we subsequently used for fault-kinematic analysis.

The most important structures that we mapped are a series of north-northeast striking normal faults, which cross-cut both the caldera walls and early Holocene lake shorelines outside the caldera. These faults have similar strikes as Pleistocene faults that define the left-stepping, north-northeast oriented segments of the volcano-tectonic axis of the inner trough of the Central Kenya Rift. In the center of the caldera, these faults are kinematically linked with oblique-slip and strike-slip transfer faults, similar to other sectors in the Central Kenya Rift. The structural setup of Menengai and the faults to the north and south of the eruptive center is thus compatible with tectono-magmatic activity in an oblique extensional tectonic regime, which reflects the tectonic and seismic activity along a nascent plate boundary.