



Elliptical caldera formation throughout the Kenyan Rift

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Many of the world's calderas are elliptical in shape, and their orientation is often used as a proxy for the local stress regime. However, in some rift settings, pre-existing structural trends have been shown to control caldera orientation. We test these competing hypotheses in the Kenyan Rift, which consists of two distinct rift segments, with different tectonic and magmatic characteristics. Of the fourteen Quaternary volcanoes lying along the central rift axis, seven have undergone caldera collapse and six are highly elliptical.

We present a remote-sensing study that investigates the structural and tectonic control on caldera ellipticity and orientation within the Kenyan Rift. Satellite-based mapping using ArcGIS on imagery derived from ASTER and GDEM data to identify the orientations of the main East African Rift border faults, intra-rift faults and the geometry of Kenyan calderas to determine the extensional setting, horizontal compressive stress orientations and the pre-existing rift fabric direction. Other data sources included the GPS-derived plate-kinematic model of East Africa and information from the literature.

We find that deformation in the Kenyan Rift is characterised by orthogonal extension in the north and oblique opening in the south, suggesting that both tectonic stresses and magmatic pressures drive intra-rift fault formation. The long axis elongation of calderas are orientated NW-SE in the north, aligned with pre-existing structures and perpendicular to recent rift-faults. In contrast, the long axes are aligned NE-SW in the southern group of volcanoes, at an angle which is highly oblique to the recent rift faults, but aligned with pre-existing structures. Thus we conclude that in oblique continental rifts, pre-existing structures play a dominant role in the rise of magma through the crust.

Understanding the geometry of caldera systems gives us important information as to the structural controls on magmatic and tectonic behaviour in extensional settings and the mechanisms by which continental rifts evolve from fault-controlled basins into mid-ocean ridges.