Volcanoes of Northern Tanzania

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The volcanoes in northern Tanzania have developed in association with the Eastern Rift Valley. The Rift, which is about 50 km wide in Kenya, diverges into a zone 200 km wide zone with three different orientations through Tanzania. Early faulting in the Neogene produced a tectonic depression in Tanzania, limited to the southeast by the Pangani graben and to the southwest by the Eyasi half graben, each influenced by basement structures. Faulting was accompanied by large shield volcanoes. These, the Older Extrusives (>1.2 Ma), are mainly alkaline basalts with flows that filled and extended beyond the depression. No outcrop is seen where lavas overlie basement rocks, and the earliest dated, a nephelinite on Essimingor, is 8.1 Ma.

Major faulting, at 1.2 - 0.9 Ma, formed the modern north-south Rift in the centre of the older depression. Unlike the narrow graben in Kenya, the central Rift in Tanzania is a half graben with a steep east facing escarpment from the Kenya border, southwards through the Natron, Engaruka and Manyara basins. The floor of older lavas, is broken by tilted fault blocks, horsts and grabens. Faulting was accompanied by explosive Younger Extrusive volcanoes (<1.2 Ma) which are mainly ultrabasic/ultra-alkaline and are accompanied by carbonatites. Pyroclastics and lavas form major volcanoes with steep profiles, and eruption activity continues. Minor volcanic features are widespread.

Arusha to the escarpment

A journey from Arusha to Oldoinyo Lengai starts westwards across a faulted terrain, climbing steep scarps and descending dip slopes towards the escarpment, passing to the north the Younger Extrusive volcanoes, Monduli and Burko; many small tuff cones are asymmetrical because of prevailing east winds. Some are basaltic scoria cones, but others (such as Lashaine rising 200 m above the plain south of Monduli) are

Ketumbeine, an Older Extrusive shield volcano seen from the west. The lower slopes are basaltic lavas, with more viscous trachyandesites and trachytes on the upper slopes; the flat top is due to caldera collapse.

Looking south along the Rift wall towards Lake Manyara. The nearest buttresses are basalts of the Crater Highlands.

carbonatite tuffs with basement and mantle xenoliths. Travelling northwest, Essimingor, the oldest volcano in Tanzania is passed: in the east it has the sharp upstanding outlines of a strato-volcano; to the west, breach of a crater permitted extensive lava flows to emerge with smooth profiles. A further descent leads to the foot of the escarpment with the Manyara basin to the south and the Engaruka and Natron basins to the north. The escarpment here shows faulting through basaltic lava flows from the Older Extrusives of the Crater Highlands to the west.

North along the escarpment

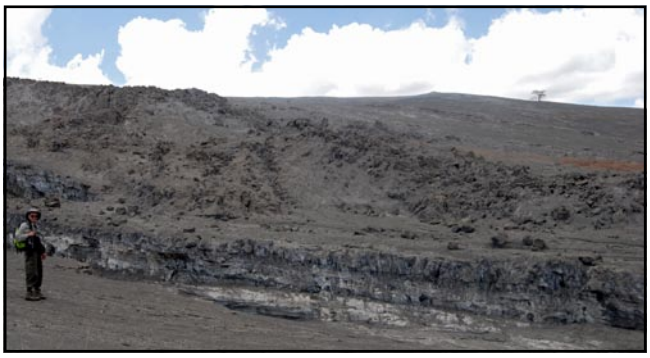
Northwards, the single unsegmented scarp 250-500 m high separates the highly faulted Engaruka block from the Engaruka Basin. This is separated from the Natron Basin by a horst block bordered on the east by the Older Extrusives, with Gelai and Ketumbeine with its distinctive profile, and the Younger Extrusives, with Kerimasi and Oldoinyo Lengai, to the west. The escarpment runs close to Kerimasi and disappears beneath that mountain, buried by nephelinite and carbonatite tuffs from the now inactive volcano, before reappearing close to Oldoinyo Lengai.

The horst block is disturbed by minor volcanic features. There are many tuff cones with greater deposition of tephra to the northwest due to prevailing winds close to the escarpment. Loolmurwak is one of

Kerimasi, a Recent Extrusive volcano seen from the southeast, with pyroclastics overstepping the Rift wall..

Oldoinyo Lengai, looking south from Lake Natron. The white weathering of carbonatites near the summit was misinterpreted as snow in the nineteenth century.

A rainwater gully cuts through bedded carbonatite lapilli tuffs and pyroclastics on the flank of Oldoinyo Lengai. The broken ridge just beyond is aa lava from the 2006 eruption.



many maars, explosion craters rimmed by tuff rings with gently graded outer slopes and vertical inner walls of bedded pyroclastics, which originated when magma came into contact with seasonal surface and subsurface waters. Relationships of the tuff cones to dated debris flows from Oldoinyo Lengai indicate ages of about 2500 years. Many are oriented NNW-SSE, corresponding to faults on the lower slopes of Kerimasi and Ketumbeine.

Oldoinyo Lengai

Close to the escarpment, Oldoinyo Lengai is a classic volcanic cone rising 2090 m above the surrounding plain and dominating the southern Natron Basin. It is the only active carbonatite volcano in the world. Initial phonolitic and nephelinitic tuff deposition began at about 0.37 Ma, with subsequent lava flows from the southern crater. After an inactive period, erosion and slope instability produced massive debris flows to the north and east; those to the east and north of Oldoinyo Lengai extend 16 km across the Natron Basin and form islands in Lake Natron.

Activity from the northern crater began about 125,000 years ago, when nephelinite tuffs and lavas were interbedded with natrocarbonatite flows and ashes. In the 20th century, carbonatite lavas and ashes predominated. Major lava surges in the crater in 2006, fed lava flows down the western slopes. From September 2007, sporadic Vesuvian and Plinian activity continued until April 2008, with widespread airfall ash and fine tephra. The crater is now filled with a major ash cone.

The inner wall of the Loolmurwak maar. The pale lower pyroclastics came from Kerimasi, and through these Loolmurwak erupted with a base surge that deposited the dark tuff with festooned bedding up to the crater rim.

At the col between Oldoinyo Lengai and the escarpment, recent pyroclastics including ash and lapilli tuff were deposited around a lava flow of March 2006. This lava consisted mainly of thick blocky aa and thinner pahoehoe lobes, with a pale grey/whitish exterior colour but black on freshly broken surfaces. These changes are due to the chemistry of the lavas. Natro-carbonatites are unique to Oldoinyo Lengai and the anhydrous lavas contain phenocrysts of the complex Na-K-Ca carbonates nyerereite and gregoryite. These are jet black on extrusion but reaction with atmospheric moisture leads to formation of simpler carbonates and sylvite, with greying of the aa lavas and whitening of the pahoehoe. The white weathering of carbonatites near the summit was misinterpreted in the past. On an 1855 map of East Africa, Oldoinyo Lengai was classified as a "Snow Mountain" together with Mount Kenya and Kilimanjaro.

Magmatism of Northern Tanzania since 1.2 Ma contrasts with that of southern Kenya's Rift Valley, where activity consists largely of extrusive trachytes. This change occurs at about 2º S, and may reflect rifting through contrasting rocks of the Tanzanian Craton and the Neoproterozoic Mozambique fold belt in Kenya.

Reference

Dawson, J.B. 2008. The Gregory Rift Valley and Neogene-Recent Volcanoes of Northern Tanzania. *Geol. Soc. London Memoir*, 33.

We thank Prof. Barry Dawson who led our tour and who, in 1960, when working for the Tanganyika Geological Survey, was the first to descend into the active northern crater.