



Contrasting carbonatite volcanism at the Kerimasi and Oldoinyo Lengai volcanoes, northern Tanzania

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The two neighboring volcanoes, Kerimasi and Oldoinyo Lengai, located 12 km apart in the eastern branch of the East African Rift in northern Tanzania display many similarities but also significant differences in terms of the types of magmas being erupted.

The carbonatites of Kerimasi have a rather large compositional span ($MgO=0-14$ wt.% and $CaO=32-56$ wt.%). This is in sharp contrast to the very uniform Na-carbonatites typically erupted at Oldoinyo Lengai. As a result of this the Kerimasi carbonatites classify as Ca-carbonatites and they are all virtually devoid of alkalis. The trace elements patterns are rather uniform for the Kerimasi carbonatites and the patterns are similar to Ca-carbonatites found elsewhere. They differ to the natrocarbonatites by having considerable higher Zr and Hf concentrations. The slope of the REE ($[La/Yb]_N$) are considerably flatter for the Kerimasi rocks (12 to 45) in comparison to natrocarbonatites (>1000) or even Ca-carbonatite dykes from Oldoinyo Lengai (~ 100). Interestingly, the Trig Point Hill debris avalanche deposit of Kerimasi is dominated by carbonatitic material in the form of blocks comprising intrusions, cumulates and vesicular lava flows (calculated to have a total volume of approximately 0.6 to 1.2 km³). This strongly indicates that the collapsed part of volcanic edifice at Kerimasi is in fact dominated by carbonatitic material with only minor amounts of silicate rocks.

At Oldoinyo Lengai the carbonatitic material mainly occur inside the summit crater as small lava flows (with a combined volume of <0.02 km³) with minor amounts of sövitic intrusions also being present at depth (as indicated by accidental lithics picked-up during explosive eruptions). The effusive to mildly explosive activity characteristic of the Oldoinyo Lengai natrocarbonatites are bracketed by more explosive episodes involving nephelinitic magmas (such as in 1966-67 and 2007-08). It is suggested here that during explosive episodes carbonatite magma mix with the more primitive nephelinitic magma(s), which results in the formation of a hybrid magma in which clinopyroxene resorbs and CO₂ is exsolved and driving the vigor of the explosive eruptions. Similar to Kerimasi, Oldoinyo Lengai has also experienced several generations of large sector collapses but none of the resulting debris avalanche deposits contain lithics of carbonatitic material. This discrepancy is noteworthy, as the location of magma chamber is supposedly shallower at Oldoinyo Lengai (i.e. at a few km depth inside the volcano). Yet none of this is reflected in resulting deposits.

Although much has been learned since Barry Dawson's discovery of the magmatic nature of the natrocarbonatites at Oldoinyo Lengai in the early 1960's, there is still many topics that needs to be resolved in terms of carbonatite petrogenesis and why there are so many Ca-carbonatite occurrences in the world and only a few places where alkali-rich carbonatites have been confirmed.