# The role of magma mixing in the explosive 2007-2008 eruption of Oldoinyo Lengai, Tanzania

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Oldoinyo Lengai in northern Tanzania is best known for its natrocarbonatitic effusive activity, alternating with highly explosive eruptions. The most recent explosive eruption which terminated 25 years of mildly explosive to effusive natrocarbonatitic activity started on the night between September 3rd and 4th 2007 and lasted until April 2008.

We sampled tephra fallout on September 7th 2007 (i.e. three days after the onset of the eruption), on September 24th 2007 and then later in May 2011, when we also measured the dominating grain size and overall thicknesses of tephra layers deposited at 140 locations around the volcano. At most locations three layers defined by variations in grain size could be identified, but on the western side of the volcano, where a larger amount of ash has been deposited (due to the overall wind direction from east to west), up to seven individual layers are present. All pyroclasts, independently of sampling location, are well-rounded with a core of euhedral silicate minerals (commonly nepheline, pyroxene, garnet or wollastonite), coated by a moderately vesiculated melt film.

From geochemistry, it is clear that the first tephra fall sampled on September 7th represents an incomplete mixing between a natrocarbonatitic and a nephelinitic magma. This tephra (sampled at three different locations) consists of variable amounts of silicate fragments, natrocarbonatite droplets and a mixture between the two magmas. Two weeks later (i.e., on 24th September 2007) the composition of this tephra is consistent with being a hybrid between a nephelinite and a natrocarbonatite. At this stage of the eruption, the natrocarbonatitic magma is completely assimilated into the new hybrid magma and components of the typical natrocarbonatitic composition can no longer be observed.

Geochemical data support mixing between natrocarbonatitic and nephelinitic magma: decreasing $CO_2$ and alkali content with increasing $SiO_2$ supports $CO_2$ exsolution from natrocarbonatitic melt during mixing. The $CO_2$ solubility is lower in the hybrid than in the natrocarbonatite, which thus leads to gas exsolution and bubble nucleation. We suggest that this forced exsolution of $CO_2$ from the hybrid magma (in a crustal magma reservoir) is the driving force for the surprisingly explosive, mixed eruptions of Oldoinyo Lengai. The pyroclast shapes indicate that they were erupted in a similar way as an aerosol (i.e., as melt droplets carried by a gas stream), and that fragmentation may have occurred at depth within the conduit of the volcano when the gas volume-fraction was sufficiently high.