

## **Immiscibility of silicate, carbonate, fluoride and chloride melt at Oldoinyo Lengai**

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The only example of active carbonatite magmatism is the natrocarbonatite lava being erupted at Oldoinyo Lengai volcano (Tanzania). These natrocarbonatites have an unusual mineralogy, enriched in the alkali elements, sodium and potassium, as well as sulphur, chlorine, phosphorous, and fluorine. Samples from the June 1993 eruption contain phenocrysts and microphenocrysts primarily of alkali carbonates, nyerereite and gregoryite, along with wollastonite, nepheline, schorlomite, fluorapatite, and hedenbergite. These minerals are surrounded by a groundmass of gregoryite-like sodium carbonate, with patches of halite and sylvite crystals and an unusual quenched calcium fluoride melt phase.

The fluoride melt is intergrown with the sodium carbonate and consists primarily of calcium (49-52 wt%) and fluorine (45-50 wt%), with minor quantities of Na (up to 3 wt%), Si (up to 2 wt%), K (up to 3 wt%), and Sr (1-3.6 wt%). The observed texture is highly irregular and complex, producing both granophyre-like and 'leaf-like' flows with 'liquid-like' forms, most likely caused by the rapid quench rate of the lava.

The wollastonite-hosted melt inclusions contain an alkali-rich silicate melt with co-trapped minerals of gregoryite, potassium-rich iron silicate and pyrrhotite. The schorlomite-hosted melt inclusions contain a silicate melt phase similar to wollastonite, and rounded carbonate melt globules consisting of crystallised nyerereite and gregoryite. This is evidence for silicate-carbonate liquid immiscibility. The fluorapatite melt inclusions contain alkali-rich carbonate melt with co-trapped minerals of khanneshite, cuspidine, nepheline, and iron oxide.

The silicate melt trapped in the inclusions is not present in the groundmass, signifying the loss of the silicate phase during crystallisation of the phenocrysts. The groundmass composition and textural features indicate these melts were immiscible liquids prior to crystallisation. These samples provide evidence of liquid immiscibility between silicate, carbonate, fluoride, and chloride liquids during the crystallisation of this natrocarbonatite lava.