The role of natrite-normative fluid degassing in the formation of carbonatite and highly peralkaline nephelinite melts at Oldoinyo Lengai, Tanzania

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Oldoinyo Lengai (OL), in Tanzania, is a world-famous volcano owing to its uniqueness in producing natrocarbonatites and because of its extremely high CO_2 flux. The volcano is built up by highly peralkaline nephelinite and phonolites, both of which probable coexisted with carbonate melt and a CO_2-rich fluid before eruption. Our results of a detailed melt inclusion study of the OL nephelinite provides insights into the important role of degassing of CO_2-rich vapor in the formation of natrocarbonatite and highly peralkaline nephelinites. Nepheline phenocrysts trapped primary melt inclusions at 750-800 °C, representing an evolved state of the magmas beneath OL. Raman spectroscopy, heating-quenching experiments, EDS and EPMA analyses of quenched melt inclusions suggest that at this temperature, a dominantly natrite-normative, F-rich (7-14 wt%) carbonate melt and an extremely peralkaline (PI=3.2-7.9), iron-rich nephelinite melt coexisted following degassing of a CO_2+H_2O-vapor. We furthermore assume that the degassing led to re-equilibration between the melt and liquid phases that remained and involved 1/ mixing between the residual (after degassing) alkali carbonate liquid and an F-rich carbonate melt and 2/ enrichment of the coexisting nephelinite melt in alkalis. We recommend that in the geological past similar processes could be responsible for producing highly peralkaline silicate melts in continental rift tectonic settings worldwide.