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Geochemical and mineralogical features of ultra alkaline rocks: Nyiragongo and Nyamuragira volcanoes (Virunga Province D.R. Congo)

silvia minissale (1), leone melluso (1), ciro cucciniello (1), vincenzo morra (1), charles muhigirwa balagizi (2), and dario tedesco (3)

(1) Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse; Università di Napoli Federico II , (2) Département de Géochimie et Environnement, Observatoire Volcanologique de Goma, Nord-Kivu, RD Congo , (3) Dipartimento di Scienze Ambientali, Seconda Universita di Napoli

The Virunga Volcanic Province (VVP) is located in the western segment, the Albert Rift, of the East African Rift System (EARS). The volcanism there started about 11 Ma ago and continuing to the present. The two active volcanoes of VVP, Nyamuragira and Nyiragongo lie along the seismically active sector of the western rift. Nyiragongo is a stratovolcano (3469 a.s.l.) characterized by rock types such as melilitite, melilite nephelinite, pyroxene nephelinite, leucite nephelinite, leucitite and leucite tephrite. Nyamuragira (3058 a.s.l.) located only 15 km to the north of Nyiragongo, is compositionally less extreme but is one of the most effusive global volcanoes erupting several times in the past few decades, with rocks ranging from basanite to tephrite and basalt. Samples include parasitic cones and lava fields of the volcanic complexes from 1938 eruption until the last one in 2016, with products sampled from the proximal vent area to the distal outcrops.
The mafic rocks of Nyamuragira are porphyritic with phenocrysts of olivine and clinopyroxene. Basanites have MgO (12.05-13.60 wt.%), Cr (790-926 ppm) and Ni (245-309 ppm) contents within the ranges expected for mantle-derived liquids. The transitional basalts have higher MgO (> 15 wt.%), Cr (> 969 ppm) and Ni (> 750 ppm) than basanites. Such enrichment in these elements is probably due to excess of olivine phenocrysts. Nyamuragira basanites have Zr/Nb (3.9-4.0), Ba/Nb (11-12) and La/Nb (0.86-0.9) ratios typical of mantle or OIB values. The primitive mantle-normalized incompatible element patterns of Nyamuragira show positive peaks at Ba and Nb and smoothly decreasing normalized-abundances from Nb to Lu and a high Lan/Ybn ratio (18).
The Nyiragongo melilite nephelinites and olivine melilitites have a porphyritic fabric as well as Nyamuragira products. Olivine ranges from forsterite-fayalite to kirschsteinite, clinopyroxene is diopside and melilite has akermanite composition. All samples are feldspar-free. The composition of the glass is often rich in Ba content (up to 5 wt.% BaO). These rocks have higher CaO (∼16.3 wt.%) and lower SiO_2 (∼ 40 wt.%), MgO (8.7-9.1 wt.%) and compatible elements concentrations (Cr = 380-395 ppm; Ni = 155-169 ppm) than Nyamuragira basanites. Their incompatible element patterns are also more enriched than those of Nyamuragira basanites with high LREE/HREE (Lan/Ybn = 42); in general they present a low heavy REE contents. The low Zr/Nb (2.1) of the olivine melilitites indicate that the Nyiragongo olivine melilitites are melt products of an incompatible element-enriched source.
Based on the major and tracers elemental compositions of these volcanic rocks, a bimodal characther emerges between the foiditic Nyiragongo lavas and the Nyamuragira basanites which suggest that the foidite lavas have an indipendent origin.