Volatile-rich nephelinites from an early-stage rifting (Hanang, north Tanzania)

C. BAUDOUIN[1*], F. PARAT[1], C.M.M. DENIS[1] AND F. MANGASINI[2]

[1]Géosciences Montpellier, CNRS & Université Montpellier, Place E. Bataillon 34095 Montpellier FRANCE (*correspondence: baudouin@gm.univ-montp2.fr)

[2]Department of Mining and Mineral Processing Engineering, Univercity of Dar Es Salaam, Tanzania

Hanang is the southern volcano of the East branch of the East African Rift and one of the youngest (0.9 Ma) of the northern Tanzania, with Oldoinyo Lengai (natrocarbonatite-phonolite±nephelinite, 0.15 Ma-present) and Kerimasi (calciocarbonatite-phonolite-nephelinite, 1.1 Ma) volcanoes and is a key volcano to constrain volcanism related to rift initiation. Hanang volcano erupted alkaline lava flows with clinopyroxene (cpx), nepheline, Ti-andradite, titanite, apatite, and pyrrhotite. Lava flows have nephelinite composition with low Mg# and high silica content (Mg# =22.4-35.2, SiO_2 =44.15 - 46.66 wt%, respectively) and an alkalinity index (Na+K/Al) ranging from 0.93 to 1.29. Nephelinites have high trace element concentrations (1920-3630 ppm Sr, 1602-2660 ppm Ba) and high La/Yb ratio (38.2-56). They are volatile-rich with 0.3-3.1 wt% CO_2, 1200-4200 ppm F, 150-1060 ppm S, and 63-680 ppm Cl.

Melt inclusions in nepheline have glassy silicate melt with trachytic compositions (50.7-65.5 wt% SiO_2, 5-12.9 wt% Na_2O+K_2O) and a carbonate-rich phase around gas bubble. Silicate melts are CO_2-rich (0.13-6.72 wt% CO_2) and H_2O-free and contain F (0.56-2.79 wt%), Cl (0.28-0.98 wt%), and S (0.33-1.11 wt%) as volatile elements. $S^{6+}/\sum S$ ratios (0.38-0.65) of silicate melts indicate relatively oxidized conditions during magma crystallization (fO_2 = ΔFQM +0.95 to +1.2). Although no water has been analysed in silicate melts, cpx phenocrysts have 6-21 ppm wt. H_2O, indicating that at least 900-3000 ppm of water was present at depth during nephelinite crystallization (P=330-530 MPa and T=1030-1080°C from cpx/melt equilibria).

Both melt inclusions and bulk rock compositions (major and trace elements) indicate that Hanang nephelinites evolved to trachytic composition through fractional crystallization of nepheline at high pressure. Carbonate-rich (+/-Mg) phase (immiscible liquid) together with silicate melt suggest that CO_2-rich and H_2O-poor volcanism dominated at early stage of rifting.