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Essential clues from CO_2-rich fluid inclusions into the complex origin of carbon at the natrocarbonatite volcano of Oldoinyo Lengai, Tanzania.

JOAO LAGES[1], GUILLAUME BOUDOIRE[2,3], ANDREA LUCA RIZZO[4], PROF. ALESSANDRO AIUPPA[5], VALENTIN CASOLA[6] AND LYDÉRIC FRANCE[7]

[1]University of Palermo
[2]Université Clermont Auvergne
[3]Istituto Nazionale di Geofisica e Vulcanologia, INGV, I-153 Palermo,
[4]Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo
[5]University of Palermo, Dipartimento di Scienze della Terra e del Mare
[6]CRPG CNRS
[7]Université de Lorraine, CNRS, CRPG

Presenting Author: joaopedro.nogueiralages@unipa.it

Recent studies on the carbon cycle in the lithospheric mantle far from typical subduction-related settings emphasize the enrichment of CO_2-rich fluids originating from the recycling of carbonate materials [1]. However, whether these products are directly responsible for the formation of carbonatitic melts is still a matter of debate. At present, Oldoinyo Lengai, in north Tanzania, is the only active volcano where carbonatite magmatism occurs. The CO_2-rich nature of its lavas poses the question of whether mantle-derived fluids are formed from (i) a typical mantle assemblage; or (ii) an unusual carbon-rich mantle source. Olivine and clinopyroxene phenocrysts from 2007 erupted products exhibit a very large compositional range (Mg# in olivine and clinopyroxene between ~80-94 and ~48-97, respectively), and markedly distinguish shallow and deep cumulates, from mantellic enclaves. Isotopically, however, our new dataset shows little variability across our sample group. $^3He/^4He$ ratios yield averages of 6.3 (n=8) and 6.5 R_A (n=6) in olivine and clinopyroxene, respectively. These are in the range of previously reported helium isotope ratios in Oldoinyo Lengai fumaroles and mineral inclusions [2], suggesting recycling of crustal material from which radiogenic-^4He is produced. On the other hand, preliminary $\delta^{13}C$ analysis (n=4) of fluid inclusions in clinopyroxene phenocrysts suggest a lighter carbon isotope composition of the mantle source (down to -5‰), in comparison to those previously reported for volcanic gases at Oldoinyo Lengai [3]. This line of evidence contributes new information to the genesis of Oldoinyo Lengai carbonatites and the complex chemical and isotope heterogeneities amongst geochemical reservoirs on Earth.

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2. Goldschmidt, Mollex, G. et al. (2018), Chemical Geology 480, 66–74.
3. Goldschmidt, Fischer, T.P. et al. (2009), Nature 459, 77–80.