EGU24-20036, updated on 21 Jul 2024
https://doi.org/10.5194/egusphere-egu24-20036
EGU General Assembly 2024

Petrology and fluid inclusions geochemistry of ultramafic xenoliths from Mayotte and the origin of the Comoros Archipelago

Barbara Faccini[1], Luca Faccincani[1], Andrea Luca Rizzo[2,3], Federico Casetta[4], Nicolò Nardini[5], Marco Liuzzo[6], Andrea Di Muro[7], and Massimo Coltorti[1,6]
[1]Department of Environmental and Prevention Sciences, University of Ferrara (fccbbr@unife.it)
[2]Department of Earth and Environmental Sciences, Università degli Studi di Milano-Bicocca
[3]Istituto Nazionale di Geofisica e Vulcanologia (INGV) Sezione di Milano
[4]Department of Lithospheric Research, University of Vienna
[5]Department of Physics and Earth Sciences, University of Ferrara
[6]Istituto Nazionale di Geofisica e Vulcanologia (INGV) Sezione di Palermo
[7]Laboratoire de Géologie de Lyon: Terre, Planétes, Environnement (LGL-TPE), Université Claude Bernard Lyon 1

Ultramafic xenoliths provide valuable insights into the physico-chemical, compositional and thermal characteristics of Earth's mantle along with its heterogeneities. Integrating petrography and mineral chemistry data with the determination of volatile concentrations and isotopic fingerprints in fluid inclusions (FI) in these xenoliths has become the state-of-the-art approach, as it provides not only important information on the nature and evolution of the lithospheric mantle, in terms of melting and metasomatic processes, but also illustrates the storage and migration pathways of volatiles throughout the lithosphere. This tandem approach makes the Comoros Archipelago (Mozambique Channel, Western Indian Ocean) ideal candidates to explore, because the characteristics of the local lithosphere are intimately tied to the complex regional geodynamic setting. Indeed, the origin of the Comoros magmatism remains enigmatic and controversial despite extensive documentation in the literature, as it has been attributed to either a plume-related hot spot or to a passive response to lithospheric break-up.

In this study, we investigate a unique suite of ultramafic xenoliths from Mayotte island by combining petrographic observation, mineral phase major and trace element analysis with the geochemistry of noble gases (He, Ar, Ne) and CO_2 hosted in olivine (ol), orthopyroxene (opx) and clinopyroxene (cpx) FI. Mineral major elements results show refractory compositions in terms of MgO ($Mg\#_{Ol}$ > 90.5, $Mg\#_{Opx}$ > 91 and $Mg\#_{Cpx}$ > 91.5) and Al_2O_3 contents (ranging from about 1.60 to 3.00 wt.% for opx and from 2.50 to 3.60 wt.% for cpx, respectively), with Cr# of spinel falling between about 0.4 and 0.55. Overall, these features indicate that the local lithosphere experienced relatively high degrees of melting, from ~20% to 25%. This is also supported by highly depleted chondrite-normalized rare earth element (REE) patterns for cpx, where HREE are roughly $(1.5)_N$.

Volatile concentrations and isotopic fingerprints in FI hosted in Mayotte xenoliths are variable, with CO_2 standing out as the most abundant gas species. The air-corrected $^3He/^4He$ isotopic ratios

(5.6 to 6.8 Ra) are intermediate between the typical signatures of MORB (8±1 Ra) and the SCLM (6.1±2.1 Ra) mantle, as measured in local subaerial (Liuzzo et al., 2021) and submarine (Fani Maoré Seamount, Mastin et al., 2023) gas emissions. The relationships between $^{3}He/^{4}He$ and the extrapolated air-free mantle $^{21}Ne/^{22}Ne$ ratios, together with $^{40}Ar/^{36}Ar$ versus $^{3}He/^{36}Ar$ systematics, suggest a dominating MORB-like component in the upper mantle below the Comoros archipelago, mixed with recycled crustal and atmospheric components, in agreement with recent data of ultramafic xenoliths from Grande Comore island (Ventura Bordenca et al., 2023).

References

Bordenca, C.V., Faccini, B., Caracausi, A., et al., 2023. Geochemical evidence for a lithospheric origin of the Comoros Archipelago (Indian Ocean) as revealed by ultramafic mantle xenoliths from La Grille volcano. Lithos, 462, 107406.

Liuzzo, M., Di Muro, A., Rizzo, A.L., et al., 2021. Gas geochemistry at Grande Comore and Mayotte volcanic islands (Comoros archipelago), Indian Ocean. Geochemistry, Geophysics, Geosystems, 22, e2021GC009870.

Mastin, M., Cathalot, C., Fandino, et al., 2023. Strong geochemical anomalies following active submarine eruption offshore Mayotte. Chemical Geology, 640, 121739.