Gas geochemistry at Gran Comore and Mayotte Islands, Indian ocean: first results

Liuzzo M.*[1-2], Di Muro A.[3-4], Rizzo A.L.[1-5], Caracausi A.[1], Grassa F.[1], Boudoire G.[1-6] & Coltorti M.[1-2]

[1] INGV, Palermo. [2] Dipartimento di Fisica e Scienze della Terra, Universita di Ferrara. [3] Institut de physique du globe de Paris, CNRS, Université de Paris (France). [4] Observatoire volcanologique du Piton de la Fournaise, Institut de physique du globe de Paris, La Plaine des Cafres (France). [5] INGV, Milano. [6] Laboratoire Magmas et Volcans, Université Clermont Auvergne, CNRS, IRD, OPGC, Clermont-Ferrand (France).

Corresponding author e-mail: marco.liuzzo@ingv.it

Keywords: He-Ne_Ar, CO_2 & isotopic-signature.

Located within the Mozambique Channel, Comoros archipelago is situated within a complex geodynamic system of great interest owing to recent and ongoing volcanic and seismic activity. While knowledge of the region in terms of petrography and geophysics is well-developed, very little research has been conducted regarding gas geochemistry. Two particular islands of the archipelago, Grande Comore and Mayotte, show significant evidence of active volcanism. Situated on Grande Comore is Karthala volcano, a basaltic shield volcano that has erupted regularly over the last century. It is the most active volcano in the western Indian Ocean after Piton de la Fournaise in La Reunion. In contrast, Mayotte, the oldest island in the archipelago, has witnessed no eruptions since that documented around 2050 BC ± 500; volcanic activity associated with Mayotte is still very much present, however, in the form of a large area of subaerial and underwater degassing on the small island of Petite Terre, just off the north-east coast. This island was recently (2018) affected by an important seismic crisis that lasted several months, and was accompanied by the formation of the largest submarine volcano in recent centuries.

This work presents the first findings of pilot geochemical surveys undertaken in the above locations between 2018 and 2020, and provides results regarding the main components and isotopic characteristics of sampled gas emissions. Our results reveal helium isotopic ratios in the range of ~6 ≤ Rc/Ra ≤ ~7.5 at Petite Terre, and ~4.6 ≤ Rc/Ra ≤ ~5.8 at Karthala (Liuzzo et al., 2021). While both of these ranges are comparable to existing data in values found in fluid inclusions of Karthala lavas (Class et al., 2005), they are markedly different to OIB volcanoes where a lower mantle component is clearly present. Thus, the hypothesis of a deep plume interacting with the oceanic lithosphere characterised by a low-He signature (Class et al., 2009) remains a matter of debate. An alternative conjecture of a possible mixing between a homogeneous deep plume source (EM1 component), plus a variable contribution of the shallower heterogeneous and old metasomatised oceanic lithosphere finds a better match with our results. A further output of our results is the evaluation of the temporal variations recorded in the Rc/Ra ratio at Petite Terre. In detail, the increased $^3He/^4He$ ratios between 2008 and 2018-19, may be ascribed to a magma input from the mantle that lead to the recent submarine volcano activity offshore Petite Terre. The findings of this research address an existing gap in current knowledge of the gas geochemistry of the Comoros archipelago, not only allowing a correlation between the gas emissions measured at the surface and the related deep source connected to a potential SCLM mantle component, but also improving the understanding of the present state of magmato-volcano activity.

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Liuzzo M., Di Muro A., Rizzo A.L., Caracausi A., Grassa F., Fournier N., Shafik B., Boudoire G., Coltorti M., Moreira M. & Italiano F. (2021) - Gas geochemistry at Grande Comore and Mayotte volcanic islands (Comoros archipelago), Indian Ocean. Geochem. Geophys. Geosys., 22, e2021GC009870. https://doi.org/10.1029/2021GC0.