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"A phonolite? From the mantle?": The magmatic system under the phonolitic tuff-rings of Petite-Terre (Mayotte, France, Western Indian Ocean)

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The discovery of a large active submarine volcano offshore Mayotte in 2019 highlighted the existence of significant volcanic hazards in an area long thought to be extinct. Four pristine phonolitic, harzburgite-xenolith bearing tuff-rings of possible Holocene age are exposed on Petite-Terre Island, located in the lagoon of Mayotte, covering older mafic scoria cones. The location of Petite-Terre, at the intersection of the old (20 - 0.1 Ma) extinct shield volcanoes of Mayotte and the Eastern Mayotte submarine volcanic chain extends ends to the recently active volcano, Fani Maoré, raises the question of its affiliation to one or the other system.

Here we present petrological and geochemical characteristics of this magmatic system, integrating data from lava and pyroclastic samples from the subaerial volcanism of Petite-Terre to investigate the link between phonolites and mafic scoria cones. Major and trace element data show that Petite-Terre scoria cones and phonolites belong to two different magmatic series: the scoria cones are linked to the old shield volcanoes while the phonolites are part of the currently active Eastern Mayotte submarine chain.

The presence of harzburgite xenoliths in the phonolites indicates that they evolved in the lithospheric mantle (cpx-opx thermobarometry: 400 MPa/ 1015 °C). Xenocryst of Fe-rich biotite and amphibole, and syenitic xenoliths, show that these hot phonolites (K-feldspar-melt thermometry: 950 °C) crossed the path of a more or less solidified syenitic lens (biotite- and amphibole-only thermobarometry, 200 – 400 MPa, 780 °C). These phonolites also evolved under very reducing conditions (ΔNNO = - 2.3 log unit) which would explain their high iron content (up to 6 wt.%).

These results show that recent phonolitic volcanism on Petite-Terre Island, and likely all the submarine volcanic chain east of Mayotte, is not related to the old shield activity that built Mayotte Island. This recent volcanism takes place in a very dynamic system where most of the magmatic evolution happens at mantle depths (> 17 km). It also shows that recent magmas erupting in the area can interact with melt lenses stored at shallower levels, potentially remobilizing them, with significant implications for the style and dynamics of possible eruptive scenarios.