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Diffusion modelling of zoned olivine and magma dynamics at a large mafic underwater volcano (Fani Maoré)

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While submarine volcanoes make up ~80% of volcanism on Earth, our understanding of their eruptions is limited due to the challenges of making direct observations and monitoring underwater in difficult conditions and often remote areas. Nonetheless, the consequences of their eruption can pose significant risks to society (e.g., Tsunamis, [1]). Here we investigate the recent Fani Maoré (FM) eruption in the Comoros Archipelago, ~50 km offshore Mayotte Island [2]. With an erupted volume of ~6.5 km^3, it is the largest submarine eruption monitored to date [2]. FM erupted and was monitored over the course of two years (2018–2020) providing an excellent opportunity to track the growth of the volcanic edifice and the dynamics of the eruption. Moreover, seismicity and emissions of CO_2 fluids continue to occur in a part of the same submarine volcanic chain much closer to Mayotte (~10–15 km), posing a risk to the ~320000 inhabitants. During the eruption, reversely zoned olivine with Fe-rich cores (Fo_{50-60}) surrounded by Mg-rich rims (Fo_{70}) were sampled. They have been interpreted as mixing of the main basanitic magma from depths (>30 km) with a pocket of shallower (near MOHO ~17 km), more evolved magma [3]. We modeled the diffusion of Fo and trace elements in the olivine crystals to calculate a magma interaction time of 1–3 months. Later eruptive units extend to ~10 months, which could imply longer stalling of the basanitic magma during an extended period of interaction. Our results provide a basis for understanding the magma dynamics that drove the fast construction of the massive FM submarine volcano and sets some preliminary timeframes for hazard management at locations with active submarine volcanism, such as Mayotte.

[1] Gusman et al. (2022) Pure *Appl. Geophys.*, 179, 3511-3525. [2] Feuillet et al. (2021), *Nat. Geosci.*, 14, 787-795. [3] Berthod et al. (2021), *EPSL*, 571, 117085.