Ring faulting and piston collapse in the mantle sustained the largest submarine eruption ever documented

Eric Jacques*†[1], Roser Hoste-Colomer[2], Nathalie Feuillet[1], Anne Lemoine[2], Jerome Van Der Woerd[3], Wayne C. Crawford[1], Carole Berthod[4], and Patrick Bachèlery[5]

[1]Université Paris Cité, Institut de Physique du Globe de Paris, Equipe de Géosciences Marines, CNRS – Ministère de l'enseignement supérieur, de la recherche et de l'innovation – France

[2]BRGM, French Geological Survey, Direction Risks and Prevention, Orléans – Ministères en charge de la Recherche, de l'Écologie et de l'Économie. – France

[3]Institut Terre et environnement de Strasbourg, UMR 7063, CNRS, Université de Strasbourg, ENGEES – Ministère de l'enseignement supérieur, de la recherche et de l'innovation – France

[4]Observatoire volcanologique et sismologique de Guadeloupe, Institut de Physique du Globe de Paris, Gourbeyre – Ministère de l'enseignement supérieur, de la recherche et de l'innovation – France

[5]Université Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans – Ministère de l'enseignement supérieur, de la recherche et de l'innovation – France

Résumé

The basaltic submarine eruption offshore the island of Mayotte between July 2018 and January 2021 is one of the largest documented underwater eruptions. One of the most striking differences between this eruption and most documented eruptions is the exceptional depth of the associated seismicity, which is limited almost exclusively to the lithospheric mantle. This seismicity probably outlines magma reservoirs and dyking zones.

In order to better understand the deep processes driving the eruption, we analyze precise earthquake locations and focal mechanisms associated with this event. We present a set of **2677** accurate earthquake relocations and **300** focal mechanisms determined from data collected over the first 9 months of ocean bottom seismometer deployments, starting in February 2019.

Our relocations refine the structure of two swarms (Proximal and Distal with respect to Mayotte), and reveal well-defined mantle structures between 20 and 50 km below sea level, which we interpret as a ring-fault zone and a dyke, respectively. The Proximal swarm outlines a ring-fault zone as the locus of a large piston collapse caused by the deflation of an underlying magma reservoir. Deformation around the piston is driven by normal faulting on a set of inward dipping patches surrounding the piston. Locally, collapse of the conical shaped piston causes a radial extensional stress field with strike-slip and normal faulting ruptures accommodating the relaxation of the damaged zone around the piston.

This piston collapse allowed the transfer of lava to the eruption site via the dyke highlighted by the Distal earthquake swarm. The link between the swarms is thus magmatic, in agreement with petrological analyses of lava from the new volcano.

*Intervenant

†Auteur correspondant: jacques@ipgp.fr

This is the first time that piston collapse and localized dyking have been documented in the mantle. The pattern of deformation documented here could apply to shallower, crustal piston collapses, such as in Iceland.

Mots-Clés: Mayotte, Basaltic submarine eruption, Mantle earthquakes, Volcano, tectonic seismicity, New piston collapse model, Magmatic plumbing system