

Observatoire
volcanologique
du Piton de la Fournaise

INSTITUT DE PHYSIQUE DU GLOBE DE PARIS



ISSN 2610-5101

A - Piton de la Fournaise activity

PITON DE LA FOURNAISE (VNUM #233020)

Latitude: 21.244°S

Longitude: 55.708°E

Summit elevation: 2632 m

Piton de la Fournaise is a basaltic hot spot volcano located in the southeast of La Réunion Island (Indian Ocean). The volcano first erupted about 500,000 years ago. Its volcanic activity is characterized by frequent effusive eruptions (with emissions of lava fountains and lava flows) that occur on average twice a year since 1998. More rarely, larger explosive eruptions (with blocks covering the summit area and ash emissions that can disperse over long distances) have happened in the past with a centennial recurrence rate.

Most of the current eruptive activity (97% during the last 300 years) occurs from vents inside the Enclos Fouqué caldera. A few eruptions, however, have occurred from vents outside the caldera (most recently in 1977, 1986, and 1998). Such eruptions can potentially threaten communities.

Since late 1979, the activity of Piton de la Fournaise is monitored by the Piton de la Fournaise Volcanological Observatory (Observatoire Volcanologique du Piton de la Fournaise - OVPF), which belongs to the Institut de Physique du Globe de Paris (IPGP).

Volcano Alert level: Vigilance
(since May 14, 2020)

(cf. table in the appendix)

Seismicity

In June 2020, the OVPF recorded at Piton de La Fournaise:

- 77 shallow volcano-tectonic earthquakes (0 to 2.5 km depth) below the summit craters;
- 5 deep earthquakes (2.5-5 km depth);
- 275 rockfalls (inside the Cratère Dolomieu or along the cliff of the Enclos Fouqué caldera and the Rivière de l’Est rempart).

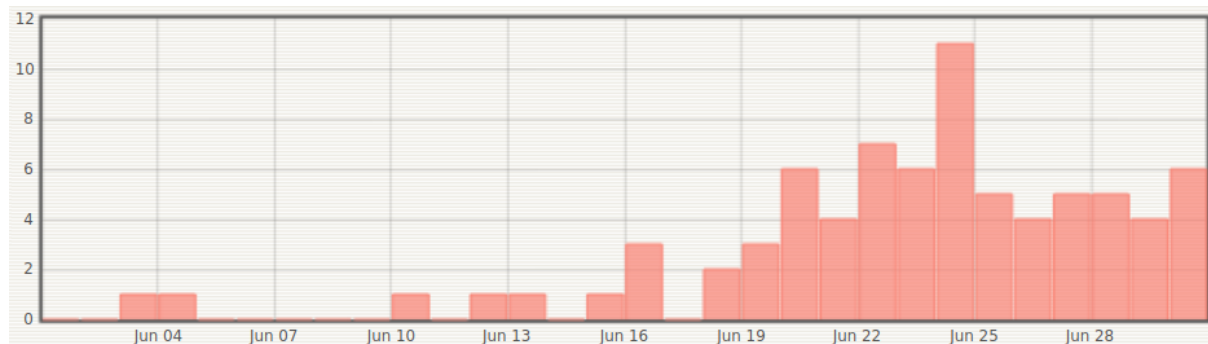


Figure 1: Number of shallow volcano-tectonic earthquakes recorded in June 2020 (© OVPF-IPGP).

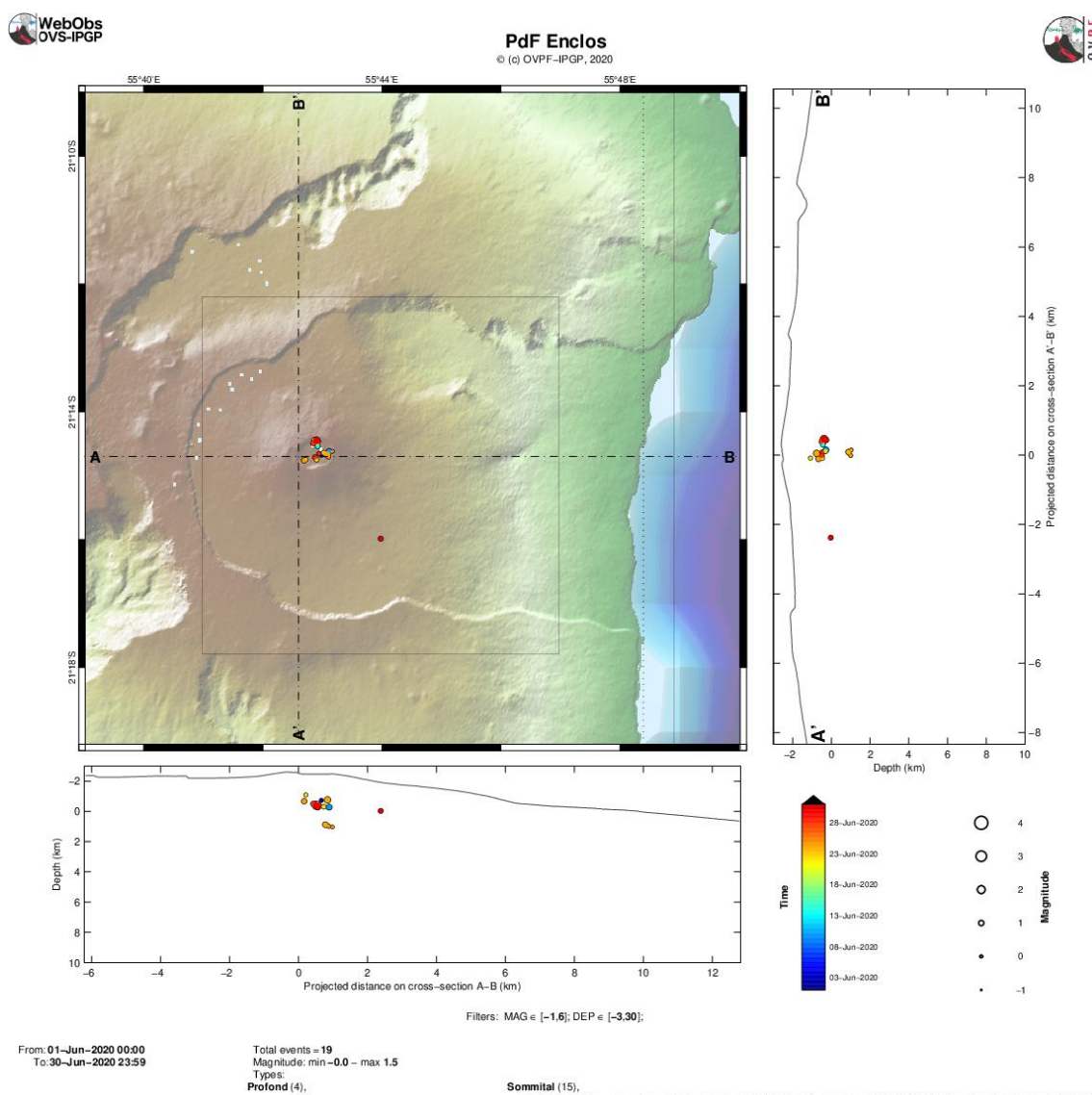


Figure 2: Location map (epicenters) and north-south and east-west cross-sections (hypocenters) of earthquakes at Piton de la Fournaise as recorded by OVPF-IPGP in June 2020. Only localizable earthquakes are shown on the map, while the observatory records more seismic events that are not localizable due to their small magnitude (© OVPF-IPGP).

The seismic activity at Piton de la Fournaise during the first 15 days of June 2020 was low with a mean of less than 1 shallow volcano-tectonic earthquake per day located below the summit (Figures 1 and 2).

However, from June 16, an increase in the seismic activity was recorded with a mean of 5 shallow volcano-tectonic earthquakes per day and a maximum of 11 events recorded on June 24 located below the summit (Figures 1 and 2).

Deformation

In June 2020, the OVPF deformation networks recorded a re-start of the edifice inflation around June 16 (Figures 3 and 4). Thus, between June 20 and 30 the GPS stations located at the summit of the volcano indicated a baseline elongation of about 2.5 cm max., while a basal elongation of about 3.3 cm max. was observed. Numerical modelling of this deformation shows the activation of a pressure source located at around 1.5 km deep beneath the Dolomieu crater, corresponding to the pressurization of the shallow magmatic reservoir.

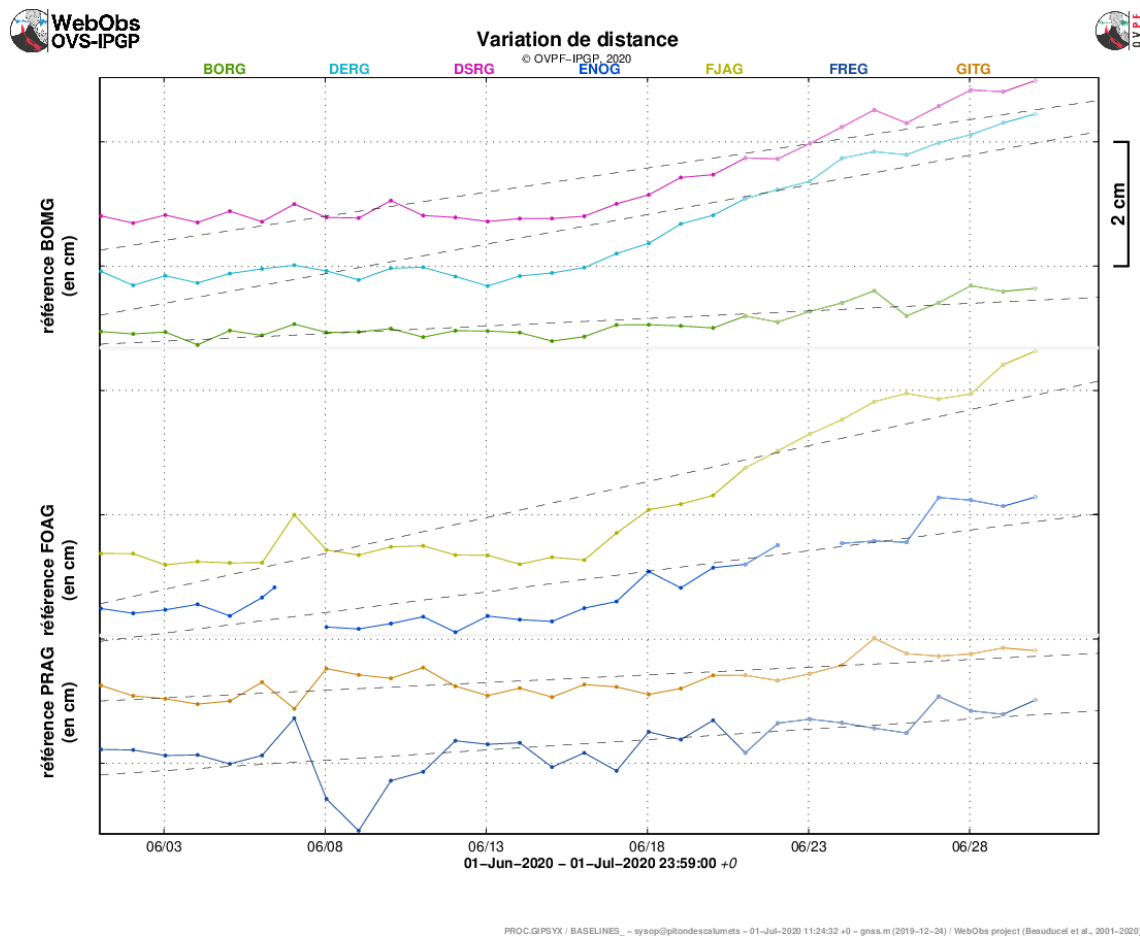
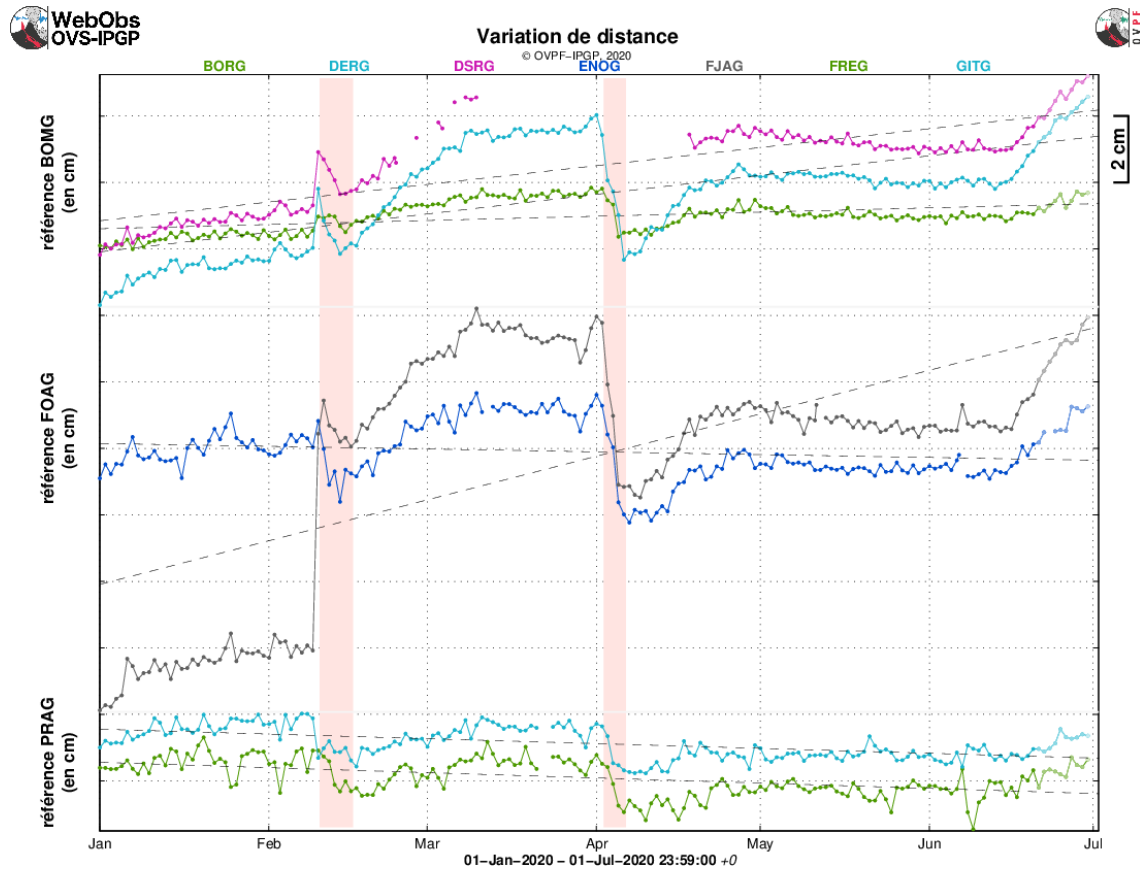


Figure 3: Record of ground deformation over the course of June 2020. The time series plots show the changes in distance between pairs of GPS stations located around the Dolomieu summit crater (reference: BOMG; top graph), the terminal cone (reference: FJAG; middle graph) and the Enclos Fouqué caldera (reference: PRAG; bottom graph), from north to south (see location in Figure 5). Increasing distances (or baseline elongation) indicate volcano inflation, while decreasing distances (or baseline contraction) reflect edifice deflation (© OVPF-IPGP).



PROC.GIPSYX / BASELINES_... - sysop@ipgfondescalmetis - 01-Jul-2020 11:12:46 +0 - gss.m (2019-12-26) / WebObs project (Beauducel et al., 2001-2020)

Figure 4: Record of ground deformation over the past six months (wherein red bars represent eruptions). The time series plots show the changes in distance between pairs of GPS stations located around the Dolomieu summit crater (reference: BOMG; top graph), the terminal cone (reference: FJAG; middle graph) and the Enclos Fouqué caldera (reference: PRAG; bottom graph), from north to south (see location in Figure 5). Increasing distances (or baseline elongation) indicate volcano inflation, while decreasing distances (or baseline contraction) reflect edifice deflation (© OVPF-IPGP).

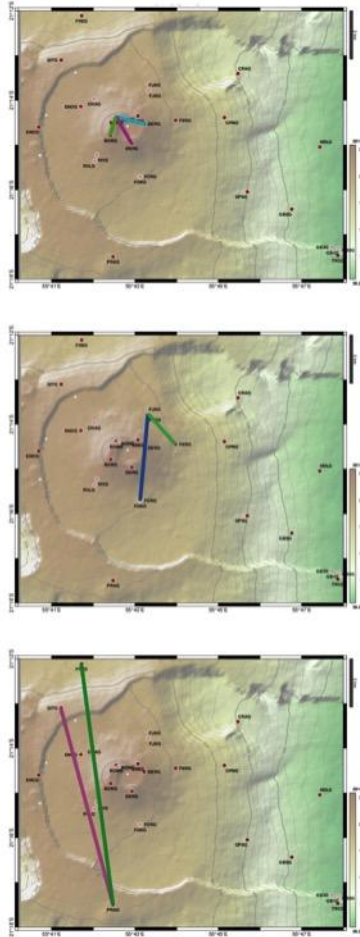


Figure 5: Location map of GPS stations and baselines as discussed in the text and shown in Figures 3 and 4 (© OVPF-IPGP).

* *Glossary:* The summit GPS signals indicate the influence of a shallow pressure source below the volcano, while distant GPS signals indicate the influence of a deep pressure source below the volcano. Inflation usually means pressurization; and conversely deflation usually means depressurization.

Gas geochemistry

CO₂ concentration in the soil

In the far field (Plaine des Cafres and Plaine des Palmistes sectors): the period following the eruption of October 25-27, 2019 was marked by a new increase of soil CO₂ flux (Figure 6), which attained a first peak just before the February 10-16, 2020 eruption. Before the April 2-6, 2020 eruption, soil CO₂ flux has increased significantly and has reached the highest values since the network became operational in the two weeks following the eruption.

Since April 21, the network records a continuous decrease in CO₂ soil emissions on the volcano flanks. In spite of this decrease, the CO₂ fluxes remain in the high range in both the distal (Figure 6) and the proximal areas (Gîte du volcan" sector).

* *Glossary:* CO₂ is the first gas to be released from deep magma (rising from the mantle), so its detection in the far field often means a deep rise of magma. Its near-field evolution may be related to magmatic transfer in the shallowest part of the feeding system (< 2-4 km below the surface).

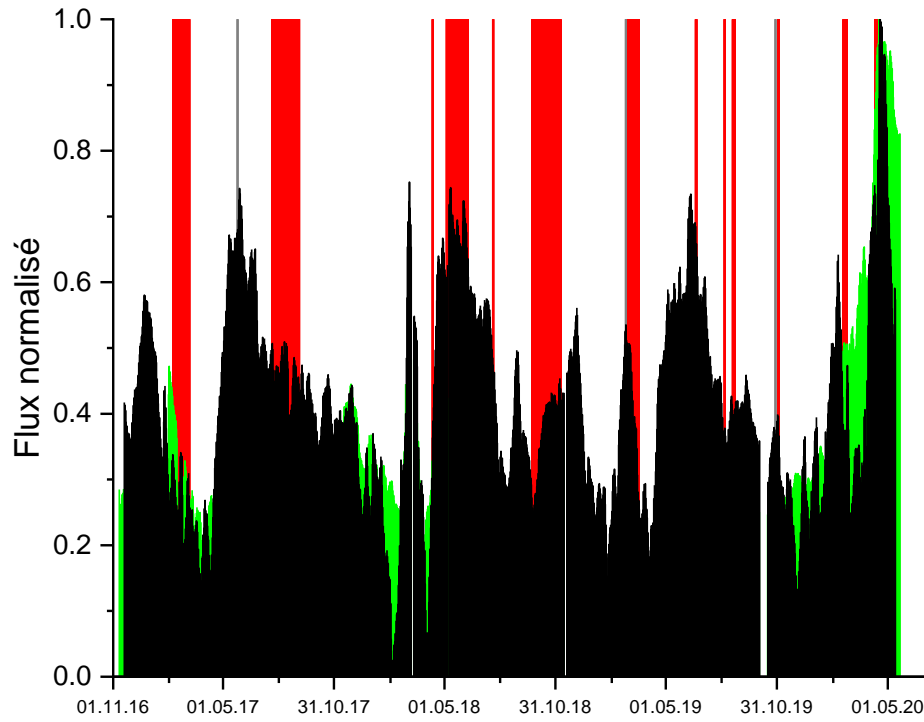


Figure 6: Comparison between the normalized average of uncorrected (15 days moving average; in green) and corrected for influence of environmental parameters (in black) soil CO₂ flux from distal stations since October 2016 (last station set). Red bars: eruptions; Gray bars: intrusions. (© OVPF-IPGP).

Helium isotopy (³He/⁴He) in the Cilaos thermal spring waters

A continuous increase in R/Ra (He isotopic ratio in gases normalized to that in atmosphere) in CO₂-dominated gas from Cilaos thermal spring waters preceded the current phase of high eruptive frequency observed since 2018.

* Glossary: Since 2016, OVPF periodically monitors the composition of the gas phase of the Cilaos thermal springs on the Piton des Neiges massif; this gas phase is mainly composed of CO₂ and contains small amounts of other elements, such as noble gases. In many volcanoes, the increase in the helium isotope ratio (3He / 4He) is linked to phases of deep magma transfer from the mantle.

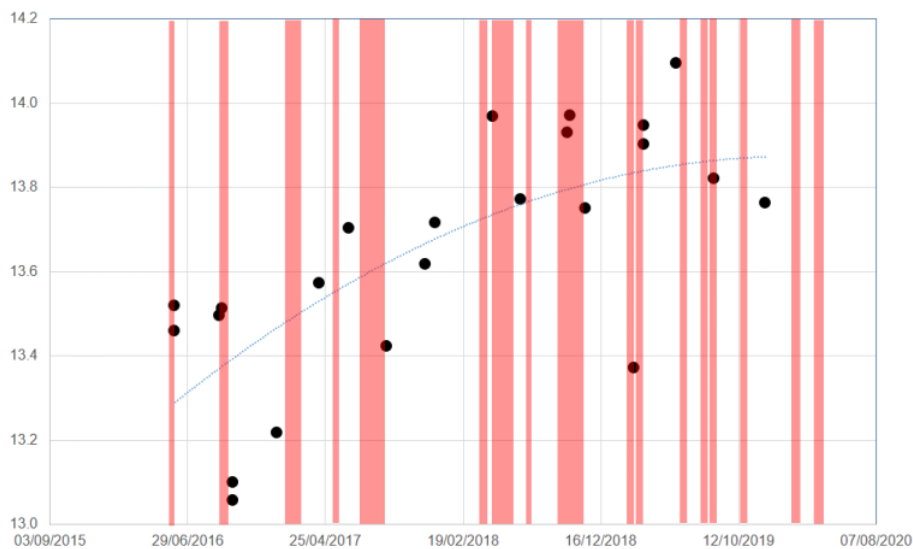


Figure 7: Evolution of the R/Ra ratio in CO₂-dominated gas from Cilaos thermal spring waters (Irénée source) (© OVPF-IPGP).

Summit fumaroles composition obtained by the MultiGas method

The MultiGas station is currently out of service.

** Glossary: The MultiGas method allows measuring the concentrations of H₂O, H₂S, SO₂ and CO₂ in the atmosphere at the summit of the Piton de la Fournaise volcano. Magmatic transfer in the Piton de la Fournaise feeding system can result in an increase in SO₂ concentrations and in the C/S ratio (carbon/sulfur).*

SO₂ flux in the air obtained by DOAS method

SO₂ flux close or below the detection threshold.

** Glossary: During rest periods, SO₂ flux at Piton de la Fournaise is below the detection threshold. The SO₂ flux may increase during magma transfer in the shallowest part of the feeding system. During eruptions, it is directly proportional to the amount of lava emitted at the surface.*

Phenomenology

No eruptive activity reported in June 2020.

Summary

Re-start of the seismic activity and edifice inflation from June 16, together with high soil CO₂ flux (despite a slight decrease) were signs of recharge and pressurization of the shallow reservoir by deep magma.

B - Seismic activity on La Réunion and in the Indian Ocean basin

Seismicity

In June 2020, the OVPF recorded:

- 37 local earthquakes (below the island, mainly below the Piton des Neiges edifice, Figure 8) ;
- 2 regional earthquakes (in the Indian Ocean basin).

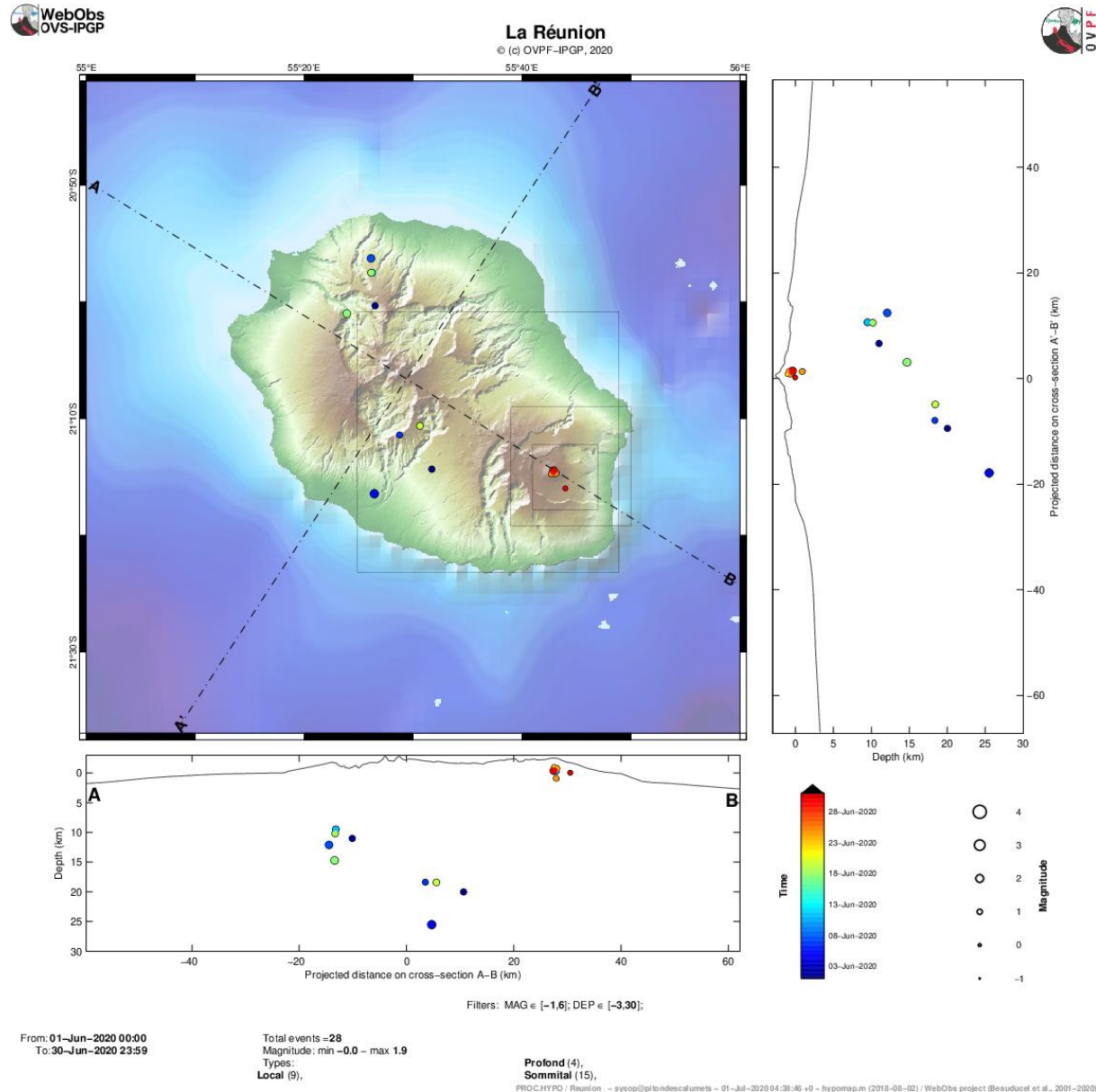


Figure 8: Location map (epicenters) and north-south and east-west cross-sections (hypocenters) of earthquakes below La Réunion Island as recorded by OVPF-IPGP in June 2020. Only localizable earthquakes are shown on the map, while the observatory records more seismic events that are not localizable due to their small magnitude (© OVPF-IPGP).

Seismic-volcano crisis in Mayotte

The « REseau de surveillance VOlcanologique et SISMologique de MAYotte (REVOSIMA) » is the structure in charge of the volcano and seismic monitoring of Mayotte. IPGP operates this network through the Piton de la Fournaise Volcanological Observatory in La Réunion with the support of the BRGM regional office in Mayotte. REVOSIMA is supported by a scientific and technical partnership including Ifremer, CNRS, BRGM, IPGS and RENASS, IRD, IGN, ENS, Reunion University, Clermont Auvergne University, CNES, Météo France, and SHOM.

All information on the REVOSIMA and the activity in Mayotte can be found on the dedicated webpages:

- <http://www.ipgp.fr/fr/reseau-de-surveillance-volcanologique-sismologique-de-mayotte>
- <http://www.ipgp.fr/fr/actualites-reseau>
- <https://www.facebook.com/ReseauVolcanoSismoMayotte/>

July, 1 2020
OVPF-IPGP Director

C - Appendix

Definition of Volcanic Alert Levels for Piton de la Fournaise

from : *dispositif ORSEC974 – D.S « Volcan du Piton de la Fournaise »*

Emergency plan set up by the department responsible for the protection of the population in the event of unrest or activity of the Piton de la Fournaise

• **“Vigilance”**: possible eruption in medium term (a few days or weeks) **or** presence of risks on the sector (rockfalls, increase of gas emissions, still hot lava flows...).

Access to the Enclos Fouqué caldera and to the summit volcano are allowed with restrictions.

• **“Alert 1”**: probable or imminent.

Access to the Enclos Fouqué caldera and to the summit are closed and prohibited.

• **“Alert 2”**: ongoing eruption.

Alert 2-1: ongoing eruption in the Dolomieu crater.

Alert 2-2: ongoing eruption inside the Enclos Fouqué caldera.

Alert 2-3: ongoing eruption outside the Enclos Fouqué caldera.

Access to the Enclos Fouqué caldera and to the summit are closed and prohibited.

• **“Sauvegarde”**: end of eruption or eruption stabilized.

Evaluation of a partial reopening of the Enclos Fouqué caldera access.

Thank you to organizations, communities and associations for publicly posting this report for the widest dissemination.

All information on the Piton de la Fournaise activity can be found on the OVPF-IPGP media:

- ***website (<http://www.ipgp.fr/fr/ovpf/actualites-ovpf>)***
- ***Twitter (<https://twitter.com/obsfournaise?lang=fr>)***
- ***Facebook (<https://www.facebook.com/ObsVolcanoPitonFournaise/>)***

The information in this document may not be used without explicit reference.
