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 November 1, 2019)
(cf. table in the appendix)
Seismicity

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

- 258 shallow volcano-tectonic earthquakes (0 to 2 km depth) below the summit craters;
- 15 deep earthquakes (>2 km depth);
- 167 rockfalls (inside the Cratère Dolomieu or along the cliff of the Enclos Fouqué caldera).

Increased seismicity compared to background levels was observed at Piton de la Fournaise during the first half of January with 258 shallow volcano-tectonic earthquakes recorded below the summit craters between January 1 and 16, 2020 (Figures 1 and 2). Two short-lived and low-intensity seismic crises occurred on January 7 and 12. Between January 17 and 31 the seismicity was lower with an average of 1 earthquake per day. In addition, 15 deep earthquakes were recorded in January 2019, the majority of which occurred between January 18 and 20 below the north-western part of the Enclos Fouqué caldera (1-1.5 km bsl; Figures 1 and 2).

Figure 1: Daily number of shallow volcano-tectonic earthquakes recorded in January 2020 (top panel).
Daily number of shallow volcano-tectonic earthquakes recorded in January 2020 (bottom panel) (© 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 January 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).
Deformation

The recorded edifice inflation that was observed during the last week of December 2019 continued throughout the month of January 2020 (Figures 3 and 4). This phase of inflation is thought to be linked to the pressurization of the shallow magma reservoir located at about 1.5-2 km depth below the summit.

No rapid ground deformation was recorded during the two short seismic crises of January 7 and 12, indicating that magma had not left the reservoir.

Since January 18, only distant stations continue to record inflation reflecting the involvement of a deeper source (Figures 3 and 4).

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

Figure 4: Record of ground deformation over the past six months (wherein red and green bars represent eruptions and intrusions, respectively). The time series plots show the changes in distance between pairs of GPS stations crossing the Dolomieu crater (reference: SNEG; top), the terminal cone (reference: FJAG; middle) and the Enclos Fouqué caldera (reference: PRAG; bottom), from north to south (see location in Figure 5). Increasing distances (or baseline elongation) indicate volcano inflation, while decreasing distances (or baseline contraction) reflect an edifice deflation (© 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): over the course of the year 2019, the soil CO₂ flux remained at low to intermediate levels on distal stations as compared to the signal obtained since the network became operational (corrected data in red on Figure 6).

The period following the eruption of October 25-27, 2019 was marked by an increase of soil CO₂ flux (Figure 6). The last monthly update indicates that the soil CO₂ flux continues to increase, reaching intermediate to high values.

* 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 raw (in blue) and corrected (in red) soil CO$_2$ flux from distal stations (a) since October 2016 (last station set) and (b) over the course of one year. (© 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 H$_2$O, H$_2$S, SO$_2$, and CO$_2$ 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 SO$_2$ concentrations and in the C/S ratio (carbon/sulfur).

**SO$_2$ flux in the air obtained by DOAS method**

Flux below the detection threshold.

* Glossary: During rest periods, SO$_2$ flux at Piton de la Fournaise is below the detection threshold. The SO$_2$ 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 eruption has occurred in January 2020.
Summary

The continuous edifice inflation recorded since the end of December 2019, in combination with increased seismicity levels throughout the first half of January 2020, and a soil CO$_2$ flux reaching intermediate to high levels in the far field, is indicative of deep magma refilling and the pressurization of the shallow magma reservoir throughout the first half of January.

Deep seismicity, the continuous increase of soil CO$_2$ flux, and deeper sources of deformation detected throughout the second half of January 2020 all suggest that a new episode of deep magma refilling had started, but magmas from depths have not necessarily yet reached the shallow reservoir.
B - Seismic activity on La Réunion and in the Indian Ocean basin

Seismicity

In January 2020, the OVPF recorded:

• 63 local earthquakes (below the island, mainly below the Piton des Neiges edifice, Figure 7);
• 9 regional earthquakes (in the Indian Ocean basin).

![Figure 7: Location map (epicenters) and north-south and east-west cross-sections (hypocenters) of earthquakes below La Réunion Island as recorded by OVPF-IPGP in January 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).](image)

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/reseau-de-surveillance-volcanologique-sismologique-de-mayotte)
- [http://www.ipgp.fr/fr/actualites-reseau](http://www.ipgp.fr/fr/actualites-reseau)

February, 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.