Monthly bulletin of the Piton de la Fournaise
Volcanological Observatory

A - Piton de la Fournaise activity

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 December 2019, the OVPF recorded at Piton de La Fournaise:

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

The seismic activity at Piton de la Fournaise in December 2019 was low with a mean of less than one shallow volcano-tectonic earthquake per day that were located below the summit craters (Figures 1 and 2). Furthermore, four deep earthquakes were recorded, two of which have been localized below the eastern flank (Figure 2).
Deformation

Since mid-November, no important surface deformation had been detected by OVPF’s ground deformation network, a trend that continued throughout the first three weeks of December. However, edifice inflation resumed and is being recorded since the last week of December.

**Figure 3:** Record of ground deformation over the course of December 2019. 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).
**Gas geochemistry**

**CO₂ concentration in the soil**

*In the far field (Plaine des Cafres and Plaine des Palmistes sectors):* the last year has witnessed the largest soil CO₂ flux anomaly detected on distal stations since the network became operational (corrected data in red on Figure 6a). The period following the eruption on September 15, 2018 was characterized by broadly low to intermediate soil CO₂ flux (Figure 6b). After the October 25-27, 2019 eruptive phase, soil CO₂ flux keeps increasing, reaching low- intermediate 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 December 2019.
Summary

The month of December 2019 was marked by low seismic activity below the summit craters and no significant summit deformation was observed during the first three weeks of the month. However, the resumption of edifice inflation during the last week of December, associated with increasing soil CO₂ flux in the far field, is indicative of an overall resumption of the shallow magma reservoir pressurization (located between 1.5 and 2.5 km deep) due to its refilling by deeper magmatic fluids.
B - Seismic activity on La Réunion and in the Indian Ocean basin

Seismicity

In December 2019, the OVPF recorded:

- 39 local earthquakes (below the island, mainly below the Piton des Neiges edifice, Figure 7);
- 1 regional earthquake (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 December 2019. 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).

January 2 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.