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 Vulcanologique du Piton de la Fournaise - OVPF), which belongs to the Institut de Physique du Globe de Paris (IPGP).

Volcano Alert level: Vigilance
(since September 4, 2019)
(see table in appendix)
Seismicity

In September 2019, the OVPF recorded at Piton de La Fournaise:

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

The seismic activity at Piton de la Fournaise in September 2019 was low with a mean of one shallow volcano-tectonic earthquakes per day (Figures 1 and 2). Four deep earthquakes were also recorded below the eastern flank (Figure 2).

Figure 1: Daily number of shallow volcano-tectonic earthquakes recorded in September 2019 (© 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 September 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).
Deformation

The edifice inflation, which had re-started after the end of the August 11-15, 2019 eruption, stopped at the beginning of September (Figures 3 et 4).

**Figure 3**: Illustration of the ground deformation in September 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**: Illustration of the ground deformation over the past twelve months (wherein red shaded areas represent eruptions). 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)*: following the June 11-13, 2019 eruption, soil CO₂ flux has decreased reaching very low values during the last month (Figure 6).
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).

* Glossary: CO$_2$ 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).

**Summit fumaroles composition obtained by the MultiGas method**

Since its resettlement on September 6, the MultiGas station at the summit shows a continuing trend of increasing CO$_2$ concentrations and a decrease in the CO$_2$ / SO$_2$ ratio. This could indicate a gradual degassing of the magma at decreasing pressure.

* 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 been reported in September 2019.

Summary

The month of September 2019 was marked by low seismic activity below the summit craters and no significant summit deformation. This indicates no or minor magma influx (increase of CO$_2$ concentration at the summit) from deeper zones into the shallow magma feeding system.
**B - Seismic activity on La Réunion and in the Indian Ocean basin**

**Seismicity**

In September 2019, the OVPF recorded:

- 61 local earthquakes (below the island, mainly below the Piton des Neiges edifice, Figure 7);
- 6 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 September 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).*

October, 1 2019
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.