



Monthly bulletin of the Piton de la Fournaise Volcanological Observatory



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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).

Piton de la Fournaise 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).

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), from Institut de Physique du Globe de Paris (IPGP).

Volcano Alert level: VIGILANCE

(see table in appendix)

Seismicity

In August 2018, the OVPF recorded at Piton de La Fournaise:

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

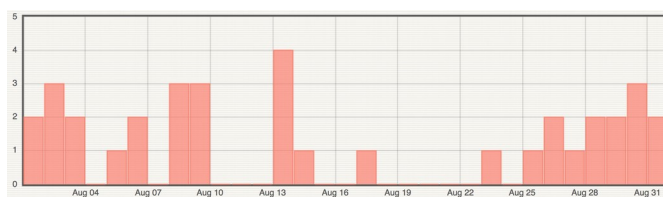


Figure 1: Daily number of shallow volcano-tectonic earthquakes recorded in August 2018 (© OVPF-IPGP).

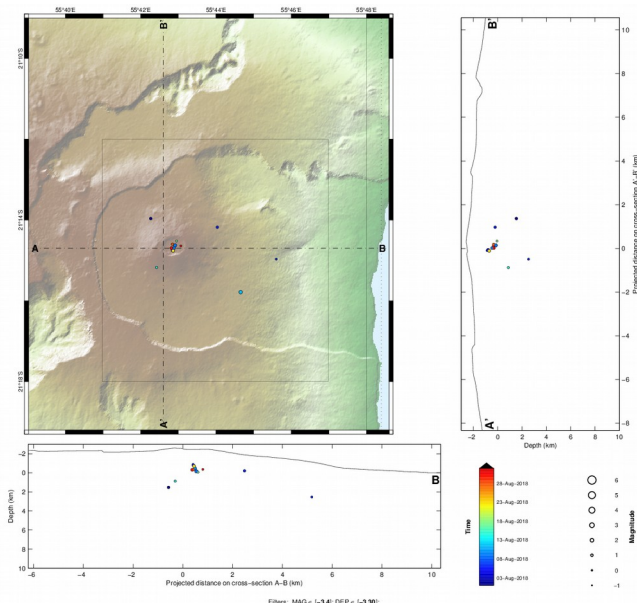


Figure 2: Location map (epicentres) and North-South and East-West cross-sections (hypocentres) of earthquakes Piton de la Fournaise as recorded by OVPF-IPGP in August 2018.

Only localizable earthquakes are shown on the map, while the observatory records more seismic events that are not localizable due to their low magnitude (© OVPF-IPGP).

The volcano-tectonic activity below the Piton de la Fournaise summit remained low in August 2018 (36 summit volcano-tectonic earthquakes and 2 deep earthquakes in one month, Figure 1).

Deformation

The edifice inflation, which was recorded since the end of the July, 13 2018 eruption, stopped at the beginning of August. Since then, the OVPF deformation networks did not record any significant deformation (Figures 3 and 4).

and the Enclos Fouqué caldera, from the north to the south (see location in Figure 5). Increasing distances (or baseline elongation) indicate volcano inflation, while decreasing distances (or baseline contraction) show 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.

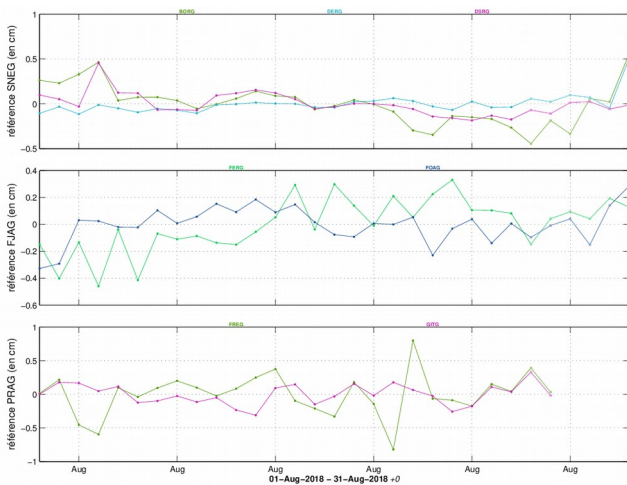


Figure 3: Illustration of the deformation in August 2018. The time series plots show the distance changes between pairs of GPS stations crossing the Dolomieu crater, the terminal cone and the Enclos Fouqué caldera, from the north to the south (see location in Figure 5). Increasing distances (or baseline elongation) indicate volcano inflation, while decreasing distances (or baseline contraction) show an edifice deflation (© OVPF-IPGP).

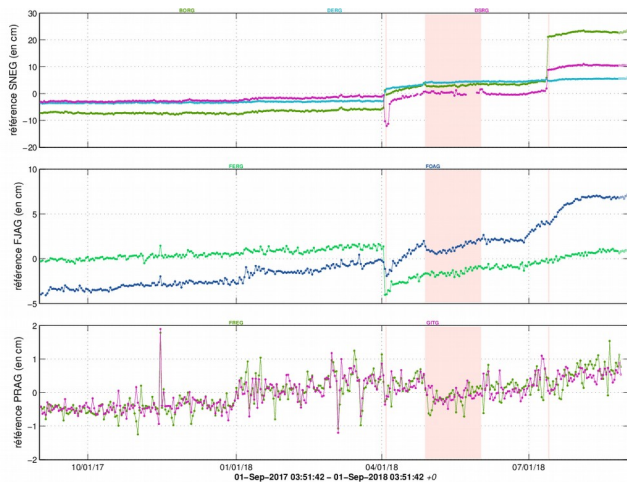


Figure 4: Illustration of the deformation over the last twelve months (red shaded areas represent the eruptive periods). The time series plots show the distance changes between pairs of GPS stations crossing the Dolomieu crater, the terminal cone

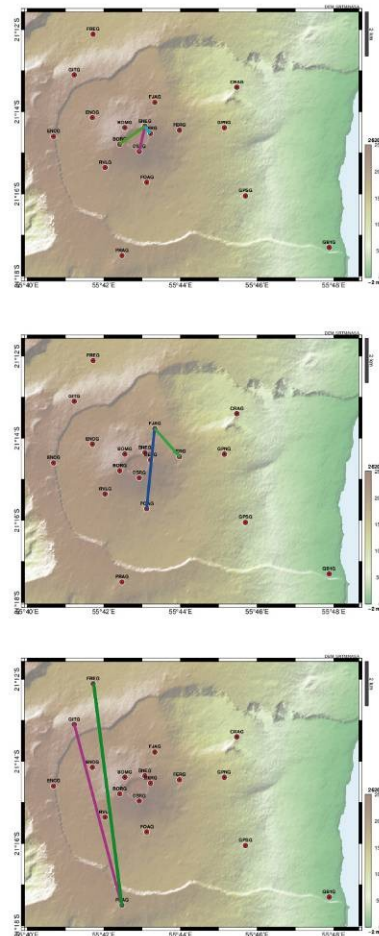


Figure 5: Location of GPS stations and baselines as discussed in the text and shown in Figures 3 and 4 (© OVPF-IPGP).

Gas geochemistry

CO₂ concentration in the soil

- In the far field (i.e. at the Plaine des Cafres and Plaine des Palmistes sectors): in August, CO₂ concentrations in the soil were stable at intermediate values (Figure 6);
- In the near field (i.e. at the « Gîte du volcan » sector): the CO₂ concentrations in the soil were stable at low values (except the last measurements on August 29).

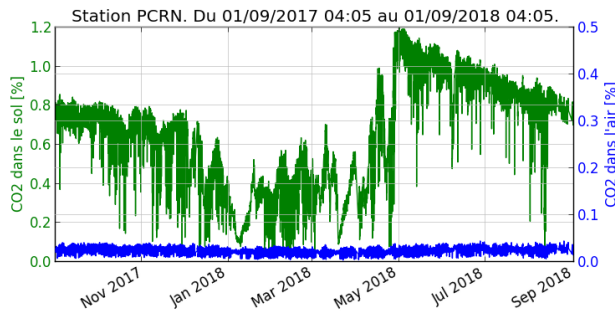


Figure 6: Concentration of CO₂ in the soil recorded on the Plaine des Cafres station, located at the observatory, over the last twelve months (© OVPF-IPGP).

* *Glossary:* CO₂ is the first gas to be released from deep magma (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 by MultiGas method

- SO₂ content: sporadic detections;
- H₂S content: sporadic detections;

Main trend to a decrease in CO₂ and an increase in water vapour.

* *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 C / S ratio (carbon / sulfur).

SO₂ flux in the air by DOAS method

In August, the SO₂ flux was closed 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 eruption reported in August 2018.

Summary

Deep magma recharge and pressurization of the shallow magma reservoir that had resumed following the end of the July 13 eruption appear to have stopped after early August.

Nevertheless, the soil CO₂ concentrations in the far-field (Plaine des Cafres, Plaine des Palmistes) are still high, which are signs of magma being present at great depth.

Note that since 2016, deep magma recharge below Piton de la Fournaise is discontinuous and occurs in pulses. For example, several periods ranging from 15 to ~80 days that were characterized by no deformation and low seismic activity have been observed in 2016 and 2017. Given the amount of magma that is already stored within the shallow magma reservoir, any new influx of magma from depth into the reservoir could potentially trigger the onset of a new eruption, as observed in 2016 or 2017. At that time, a high state of initial reservoir pressurization is thought to be the reason for relatively short time spans (of only 1-25 days) between evidence of deep magmatic feeding (from seismicity and ground deformation) and the onset of a new eruption.

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

Seismicity

In July 2018, the OVPF recorded:

- 101 local earthquakes (below the island, underneath the Piton des Neiges area, Figure 7);
- 2 regional earthquakes (in the Indian Ocean basin).

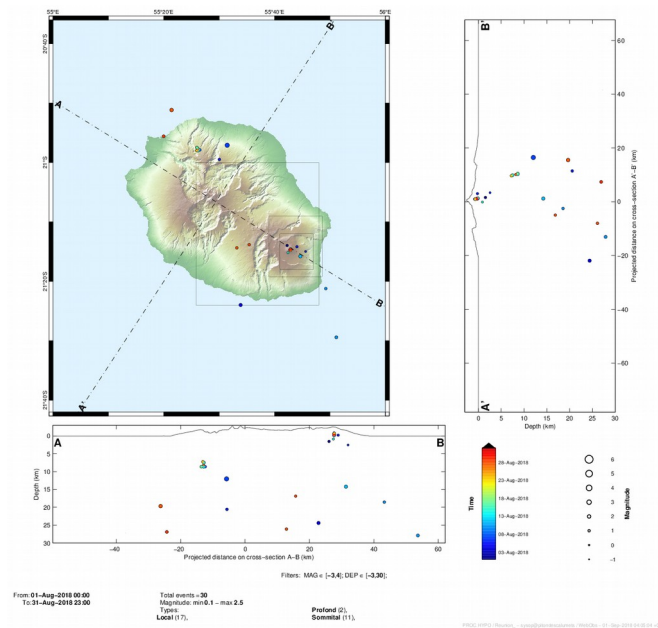


Figure 7: Location map (epicentres) and North-South and East-West cross-sections (hypocentres) of earthquakes below La Réunion Island as recorded by OVPF-IPGP in August 2018. Only localizable earthquakes are shown on the map, while the observatory records more seismic events that are not localizable due to their low magnitude (© OVPF-IPGP).

Seismicity below La Roche Ecrite

On August 7, 2018, 07h50 local time (03h50 UTC), an earthquake was felt by inhabitants, mainly in the North of La Réunion (Figure 8).

This earthquake was recorded by the seismometers of the Piton de la Fournaise Volcanological Observatory (OVPF). The earthquake was located at a depth of 15 km below sea level, in the North of the island, 5 km southeast of Sainte-Clotilde. Its magnitude was measured at 2.5 on the Richter scale. Events that are felt by the population are recorded several times a year.

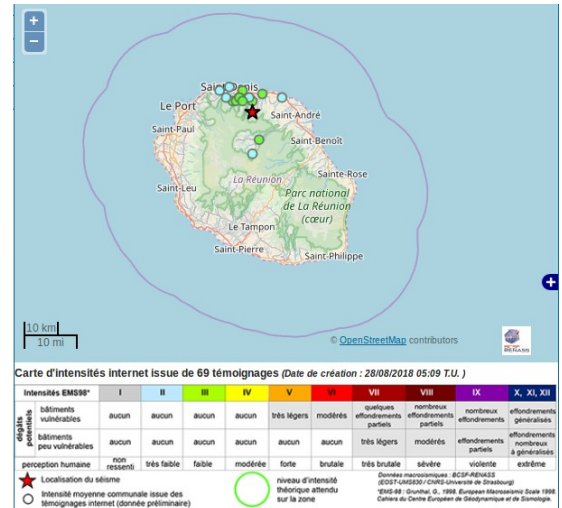


Figure 8: Intensity map deduced from 69 depositions (© franceseisme), <http://www.franceseisme.fr/nseisme.php?IdSei=775>.

This earthquake occurred in continuation of a series of earthquakes recorded by OVPF since the installation of a seismic station at Providence, Saint Denis (PRO) in 2012.

The number of visible earthquakes on the PRO seismic station (Figure 9) has increased in recent months, including two earthquakes of magnitude ~ 2, which were felt in Saint Denis on July 16 and August 7, 2018.

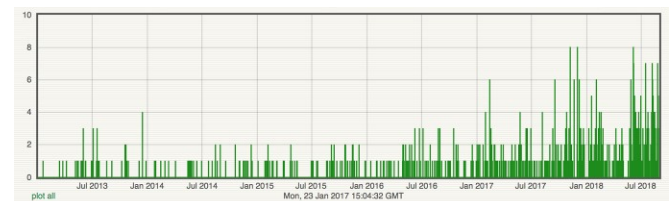


Figure 9: Daily number of local earthquakes that occurred between 2013 and August 2018 and that were first recorded by the PRO seismic station (Providence - Saint Denis) (© OVPF-IPGP).

Waveform correlation detections, which identify barely visible earthquakes on the raw traces of seismic records, confirm the increase in seismic activity in this sector. More than 3700 earthquakes have been detected in the north of the island since 2013 that allow us to identify three main periods (Figure 10):

2013-2016; 2016-May 2018; June 2018-now, with approximately 400, 800 and 1700 detected earthquakes per year, respectively.

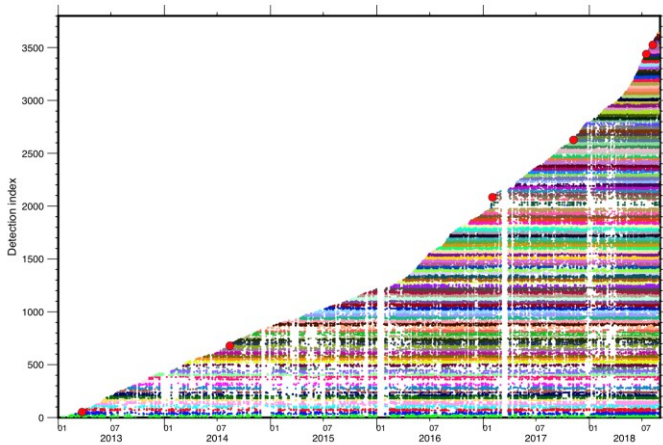


Figure 10: Cumulative seismicity below the massif of La Roche Ecrute between 2013 and August 2018. Each event is identified by an index in chronological order. For each event the waveform (10.24sec) of the vertical component of the PRO seismic station is correlated with all the waveforms of the following events and each pair of events that has a correlation coefficient greater than 0.7 is shown on the graph by a coloured point. The colour change is done every 30 events. The earthquakes felt by the population are represented by red circles (© OVPF-IPGP).

The correlation between the 2013 and 2018 earthquakes implies few waveform changes over time. The normalized waveforms of the most recent earthquakes confirm this trend (Figure 11).

Although the origin of these earthquakes remains unknown, their source does not seem to migrate over time.

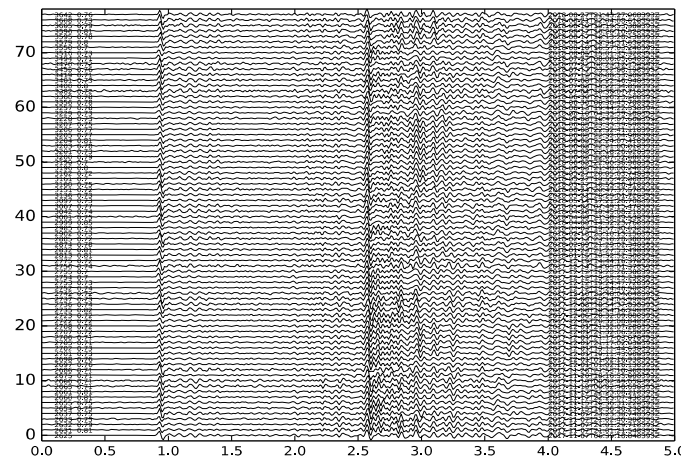


Figure 11: Normalized waveforms associated with the earthquake of 2017-11-07 at 06:39 (index 2625 of Figure 10). The earthquake index, the correlation coefficient, and the date and time of the earthquake are indicated on each trace.

Seismic crisis in Mayotte

Seismic activity is recorded offshore the island of Mayotte since the beginning of May 2018. These earthquakes form a swarm located about 50 to 60 km east of Mayotte. The majority of these earthquakes are of low magnitudes, but several events of moderate magnitudes (maximum 5.9), also recorded on the OVPF seismic network, were felt by the population and damaged a few buildings. As observed in July, the seismic activity continues at weaker intensity in August until August 26, when a dozen of events of magnitude > 4 has been recorded and for some felt by the population.

More information:

- BRGM website:
www.ipgp.fr/fr/essaim-simique-a-lest-de-mayotte-mai-juin-2018

- http://www.brgm.fr/content/essaim-seismes-mayotte-faq-scientifique?pk_campaign=twitter&pk_kwd=2018-06_seismes-mayotte-faq

- BCSF website:
<http://www.franceseisme.fr/>

- “Préfecture de Mayotte” website:
<http://www.mayotte.pref.gouv.fr/>

- Dedicated webpage on the IPGP website:
<http://www.ipgp.fr/fr/essaim-simique-a-lest-de-mayotte-mai-juin-2018>

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 website (<http://www.ipgp.fr/fr/ovpf/actualites-ovpf>) twitter (<https://twitter.com/obsfournaise?lang=fr>) and facebook (<https://www.facebook.com/Obsvolcanopitonfournaise-2173450076232968/>).

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