Observatoire volcanologique du Piton de la Fournaise
INSTITUT DE PHYSIQUE DU GLOBE DE PARIS

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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). Such eruption 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 8, 2018)

(see table in appendix)

Seismicity

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

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

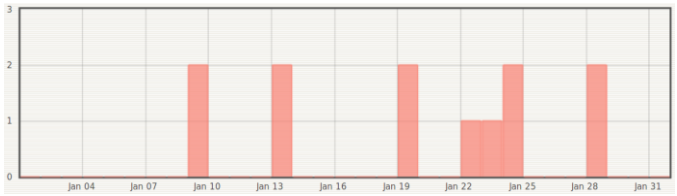

***Figure 1**: Daily number of shallow volcano-tectonic earthquakes recorded in January 2019 (© OVPF-IPGP).*

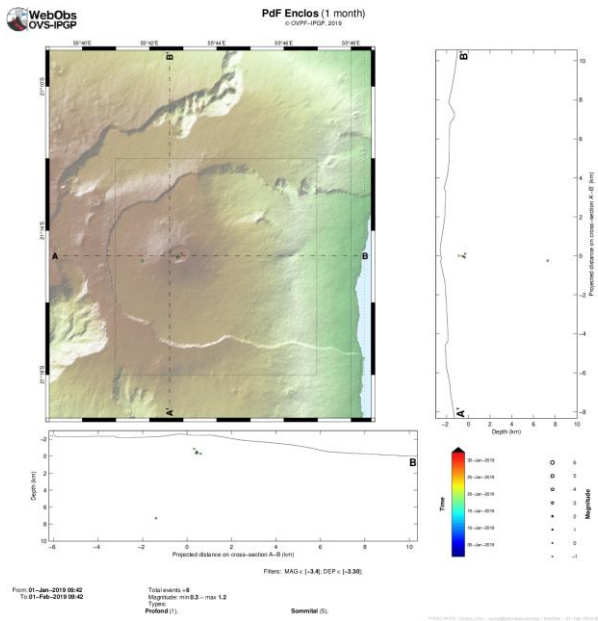

***Figure 2**: Location map (epicentres) and north-south and east-west cross-sections (hypocentres) of earthquakes at Piton de la Fournaise as recorded by OVPF-IPGP in January 2019. Only localizable earthquakes are shown on the map, while the observatory records more seismic events that are not localizable due to their low magnitude (© OVPF-IPGP).*

The volcano-tectonic activity below the volcano's summit remained low in January 2019 (with 12 summit volcano-tectonic earthquakes and only 1 deep earthquake in one month, Figures 1 and 2).

Deformation

The OVPF deformation networks did not record any significant deformation over the course of January 2019 (Figure 3) even if a slight inflationary trend seems visible on the long-term pattern (Figure 4).

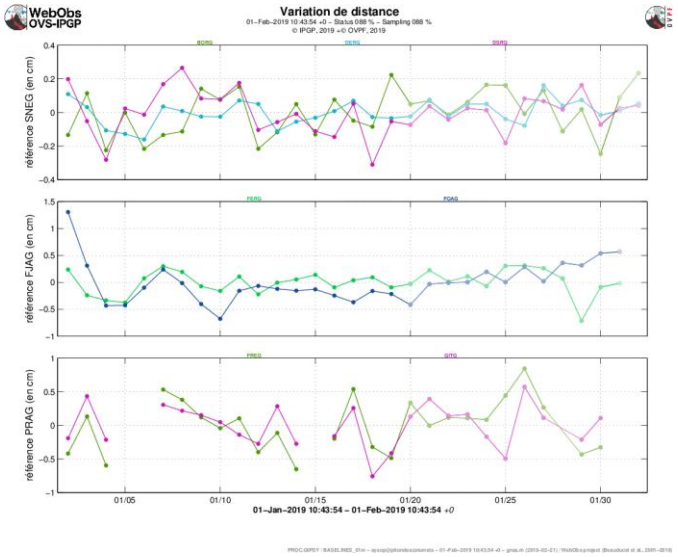

***Figure 3**: Illustration of the ground deformation in January 2019. The time series plots show the distance changes between pairs of GPS stations crossing the Dolomieu crater, the terminal cone and the Enclos Fouqué caldera, from north to south (see location in Figure 5). Increasing distances (or 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.*

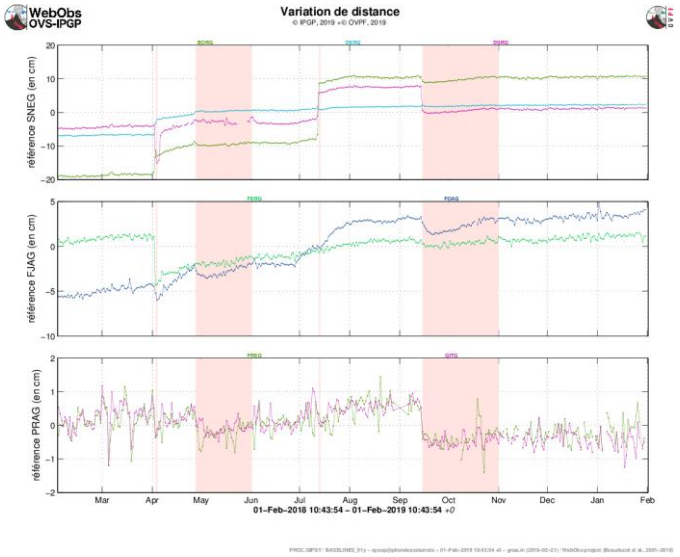

***Figure 4**: Illustration of the ground deformation over the last twelve months (red shaded areas represent the eruptive periods). The time series plots show the distance changes between pairs of GPS stations crossing the Dolomieu crater, the terminal cone and the Enclos Fouqué caldera, from north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

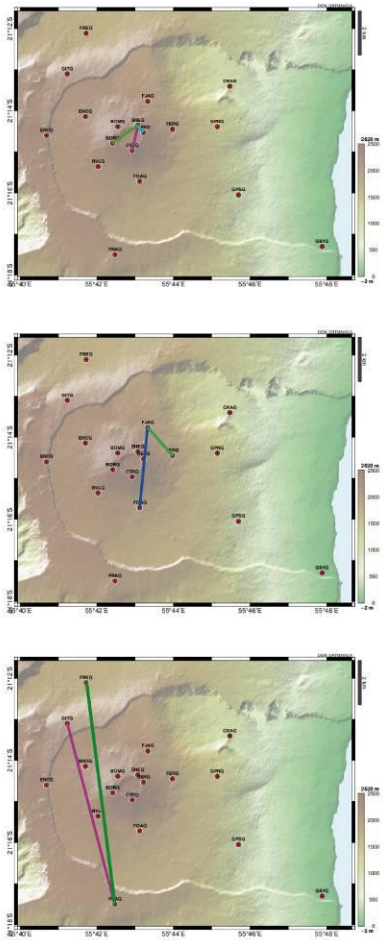

***Figure 5**: Location map of GPS stations and baselines as discussed in the text and shown in Figures 3 and 4 (© OVPF-IPGP).*

Gas geochemistry

CO_2 concentration in the soil

In the far field (Plaine des Cafres and Plaine des Palmistes sectors): the CO_2 flux was broadly constant in January 2019 with low values (Figure 6).

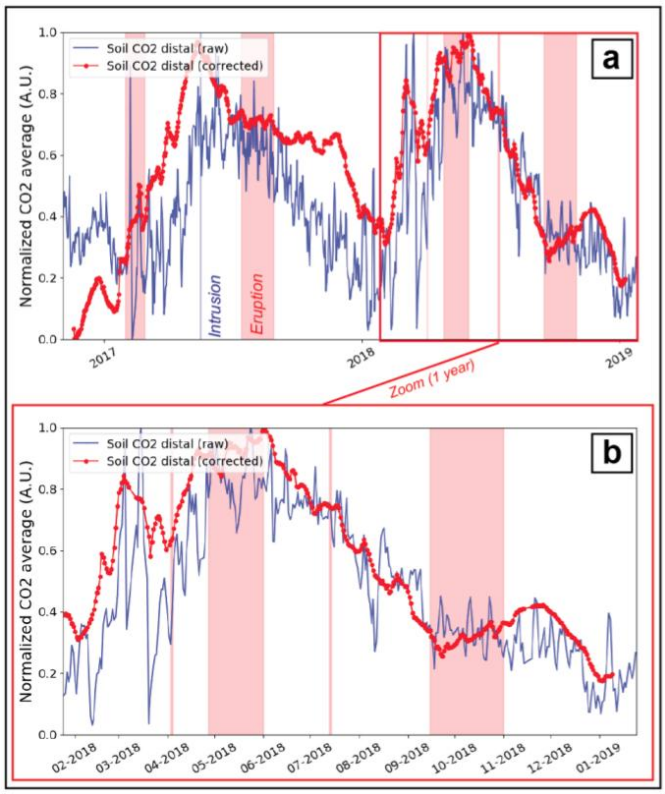

***Figure 6**: Comparison between the normalized average of raw (in blue) and corrected (in red) soil CO_2 flux from distal stations (a) since October 2016 (last station set) and (b) for one year. (© OVPF-IPGP).*

** Glossary: CO_2 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

The station is currently out of service.

** Glossary: The MultiGaS method allows measuring the concentrations of H_2O, H_2S, 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 C / S ratio (carbon / sulfur).*

SO_2 flux in the air 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 January 2019.

Summary

The month of January 2019 was marked by low seismic activity below the summit craters, no significant summit deformation and broadly constant low soil CO_2 flux in far field. This indicates no (or minor) magma influx from deeper zones into the shallow magma feeding system.

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

Seismicity

In January 2019, the OVPF recorded:

- 11 local earthquakes (below the island, mainly in the Piton des Neiges area, Figure 7);
- 17 regional earthquakes (in the Indian Ocean basin).

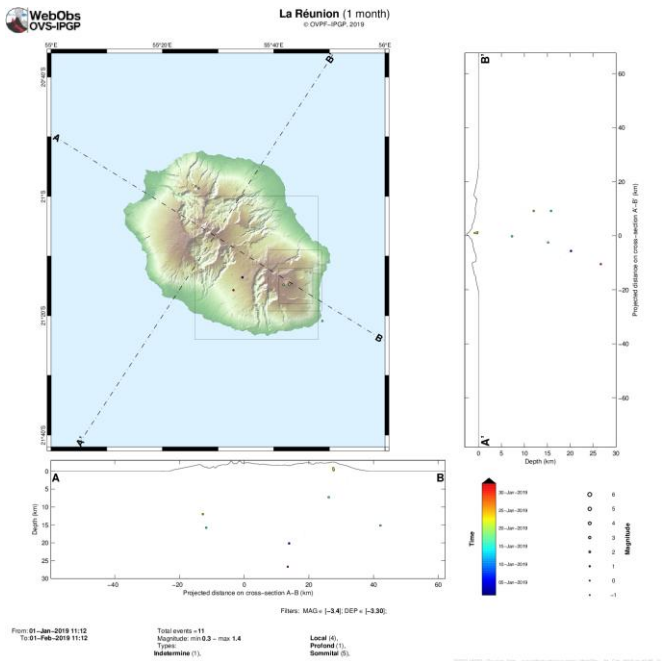

***Figure 7**: Location map (epicentres) and north-south and east-west cross-sections (hypocentres) of earthquakes below La Réunion Island as recorded by OVPF-IPGP in January 2019. Only localizable earthquakes are shown on the map, while the observatory records more seismic events that are not localizable due to their low magnitude (© OVPF-IPGP).*

Seismic crisis in Mayotte

Seismic activity is recorded off shore the island of Mayotte since the beginning of May 2018. These earthquakes form a swarm located 30 to 60 km east of the coast of Mayotte. The majority of these earthquakes are of low magnitude, but several events of moderate magnitude (maximum M5.9) were felt by the population and damaged a few buildings. Since July the seismic activity is weaker but remains with a few events felt by the population. The month of January was particularly active with notably 21 earthquakes of magnitude > M4. Data from the Teria GPS network installed on Mayotte, and distributed by the RGP of the Institut Géographique National (IGN), still indicates since July a continuous displacement to the east (about 12 cm since July) and a subsidence (about 5-10 cm depending of the sites since July; Figures 8 and 9). Automatic and daily calculations have been set up at the OVPF to follow this deformation (via the Gipsy software), as well as the source at its origin. Thus for the last 3 months, the source of "depressurization" at the origin of these displacements could be located about thirty km east of Mayotte and about 35-45 km deep (Figure 10).This suggests that fluid transfers in the crust are still on-going.

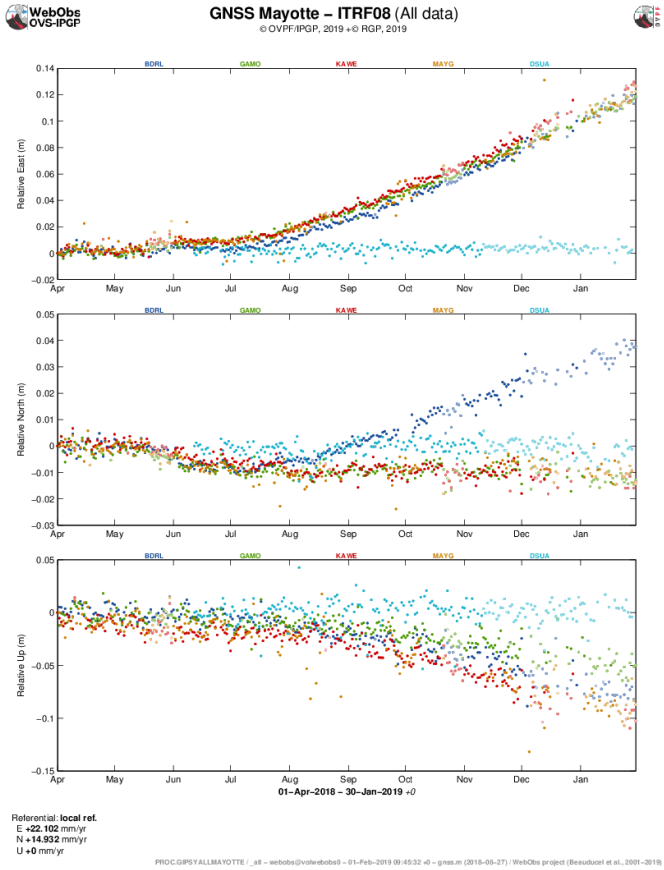

***Figure 8**: Displacements (in m) recorded on 4 GPS stations located in Mayotte (BDRL, GAMO, KAWE, MAYG) and one station north of Madagascar to Diego Suarez (DSUA), on the east (top), north (middle) and vertical (bottom) components, between April 2018 and January 2019. The data from the 4 Mayotte stations come from the Teria network and are distributed by the RGP of the Institut Géographique National (IGN), and data from the Diego Suarez station in Madagascar were obtained by LACy (Université de la Réunion) under the INTERREG-5 Indian Ocean 2014-2020 project "ReNovRisk Cyclones and Climate Change", funded by Europe, the Region of La Réunion and the State. Post-processing of this data by OVPF-IPGP (©OVPF-IPGP).*

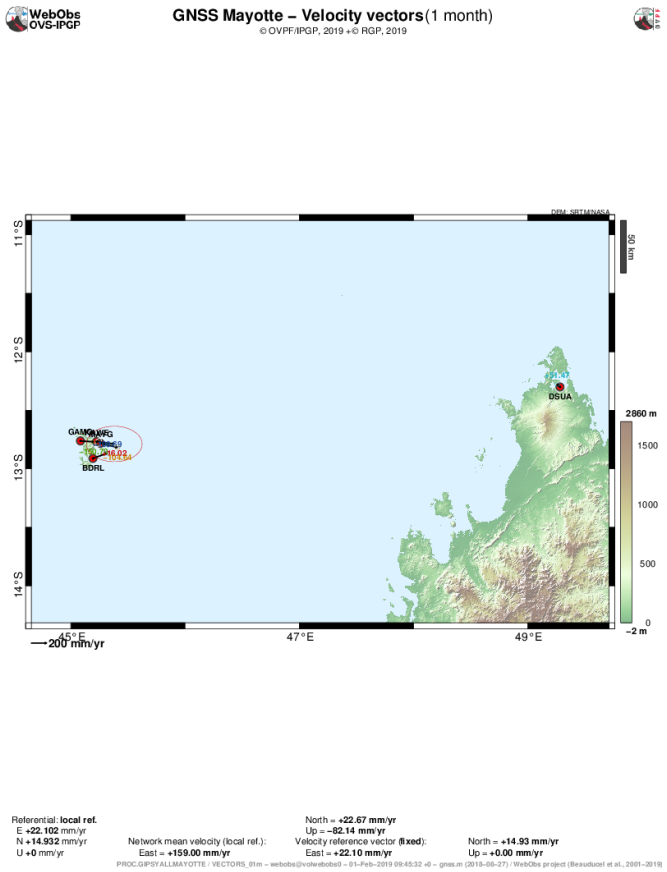

***Figure 9**: Ground displacements recorded around the seismic swarm on the GPS stations of Mayotte and Madagascar in January 2019.The data from the 4 Mayotte stations come from the Teria network and are distributed by the RGP of the Institut Géographique National (IGN), and data from the Diego Suarez station in Madagascar were obtained by LACy (Université de la Réunion) under the INTERREG-5 Indian Ocean 2014-2020 project "ReNovRisk Cyclones and Climate Change", funded by Europe, the Region of La Réunion and the State. Post-processing of this data by OVPF-IPGP (©OVPF-IPGP).*

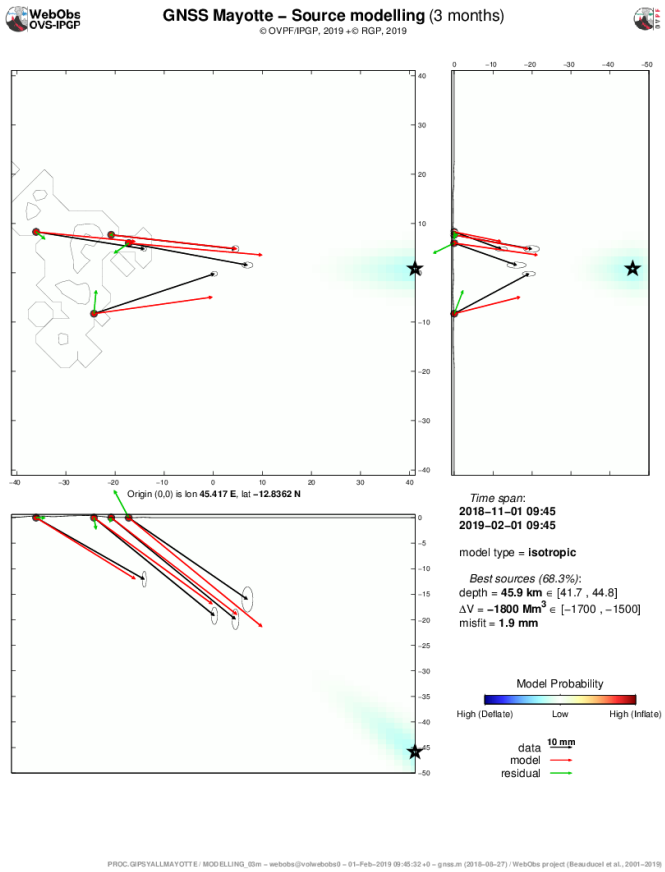

***Figure 10**: Location of the source (best model resulting from a "Mogi" source) at the origin of the displacements recorded during the last 3 months on the GPS stations of Mayotte (© F. Beauducel (IPGP/IRD) and OVPF-IPGP).*

More information:

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

- ENS website: *http://volcano.iterre.fr/mayotte-seismo-volcanic-crisis*
- BCSF website: *http://www.franceseisme.fr/*
- *"Préfecture de Mayotte" website: http://www.mayotte.pref.gouv.fr/*
- *GEOSCOPE website: http://geoscope.ipgp.fr/index.php/fr/actualites/actualite-des-seismes*
- *NEIC / USGS website: https://earthquake.usgs.gov/earthquakes*

February, 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 informationon 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.