Journal of Volcanology and Geothermal Research 191 (2010) 60–68

Contents lists available at ScienceDirect

Journal of Volcanology and Geothermal Research

journal homepage: www.elsevier.com/locate/jvolgeores

Field observations of the 2008 summit eruption at Piton de la Fournaise (Ile de La Réunion) and implications for the 2007 Dolomieu collapse

Thomas Staudacher

Observatoire Volcanologique du Piton de la Fournaise (OVPF), Institut de Physique du Globe de Paris, CNRS, UMR 7154 – Géologie des Systèmes Volcaniques, 14 RN3, le 27ème km, 97418, La Plaine des Cafres, La Réunion, France

ARTICLE INFO

Article history:
Received 22 July 2009
Accepted 8 January 2010
Available online 21 January 2010

Keywords:
Piton de la Fournaise
summit eruptions
lava flow emplacement
lava temperature
dyke emplacement
caldera ring fault

ABSTRACT

More than one year after the most important eruption ever observed at Piton de la Fournaise in April 2007, a new eruption started in 2008 at Piton de la Fournaise, with three different eruptive phases in September, November and December. They were located within the 340 m deep Dolomieu crater. Due to the steep (dip angle 45–80°) and unstable walls of the new crater formed in April 5, 2007, no measurements *in situ* of the 2008 eruption had been possible. Only observations from the Dolomieu crater rim and from helicopter were performed, using an infrared camera, a portable rangefinder and numerous photographs. These field observations allowed precise monitoring of the setting up of the lava flows with time. The total erupted volume of lava of the three phases was 2.2×10^6 m^3 and the average flow rates ranged between 0.3 and 1 m^3 s^{-1}. Lava temperatures of up to 1150 °C have been measured by an infrared camera. Overall, infrared images of the Dolomieu crater illustrate the control of the eruptive vents by the structure of the April 2007 Dolomieu collapse.

1. Introduction

Piton de la Fournaise is the active volcano in the South-East of Ile de la Réunion in the western Indian Ocean. It is located within the 8 km wide and 13 km long U-shaped Enclos Fouqué caldera, which is open to the sea (Fig. 1). Two craters crown the summit, the about 250 m wide Bory crater and the 1 km wide Dolomieu crater. Piton de la Fournaise produced over the last century about 150 eruptions and emitted more than 1000x 10^6m^3 of lava (OVPF compilation). The last decade was particularly active with 27 eruptions producing 367 x 10^6m^3, about 1/3 of the estimated volume emitted during the last century (Peltier et al., 2009; Staudacher and Peltier, 2010). Amongst this eruptive sequence, the April 2–May 1, 2007 eruption represents a major event. It was with >140 x 10^6m^3 of lava flows the most voluminous and intense eruption for at least two centuries (Staudacher et al., 2009; Peltier et al., 2009). This voluminous eruption, which took place at a low elevation of 590 m in the Grand Brûlé area (Fig. 1), was the cause of the simultaneous Dolomieu caldera collapse. The rock column between the Dolomieu crater and the magma chamber collapsed into the latter on April 5 and 6. In 24 hours, a 1 km long, 800 m large and 340 m deep funnel-shaped caldera was formed (Urai et al., 2007; Michon et al., 2007; Staudacher et al., 2009). Even though the April 2007 eruption emptied between 30 and 40% of the shallow magma reservoir (Sigmarsson et al., 2005; Peltier et al., 2007, 2008) Piton de la Fournaise erupted again in 2008 within the Dolomieu crater. Three eruptive phases formed a 420×220 m large and about 75 m deep lava flow on the crater floor.

2. Overview of the 2008 summit eruption

2.1. September 21 eruptive phase

Following the April 2007 eruption and the collapse of the central Dolomieu crater the whole Piton de la Fournaise massif was destabilized and needed to find a new state of structural stability. One of the consequences was the structural readjustment of the Dolomieu crater; its dimensions reduced about 3 m and 1.2 m in north–south in east–west directions respectively, and a subsidence of 40 to 99 cm of its border was recorded by the permanent GPS network (Staudacher et al., 2009). This subsidence lasted from April 2007 to July 2008. Between March and July 2008, a normal background seismicity of less than 10 volcano-tectonic seismic events per day was observed beneath the summit (OVPF internal report, 2008). On July 28 the general trend of subsidence reversed. The permanent GPS network recorded a new inflation of the summit cone (Fig. 2), with a crater elongation of about 5.6 cm on a north–south axis and 3.3 cm on a west–east axis. No significant tiltmeter or extensometer variations were recorded. The inflation was accompanied by an increase of seismicity beneath the summit and by repeated, 30 min to 3 h lasting seismic crises on August 4, 15 and 31 with 46, 471 and 241 events, and on September 8, 9, and 15 with 104, 514 and 296 events, respectively. Magnitudes of the seismic events ranged between −0.3

E-mail address: thomas.staudacher@univ-reunion.fr.

0377-0273/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.jvolgeores.2010.01.012

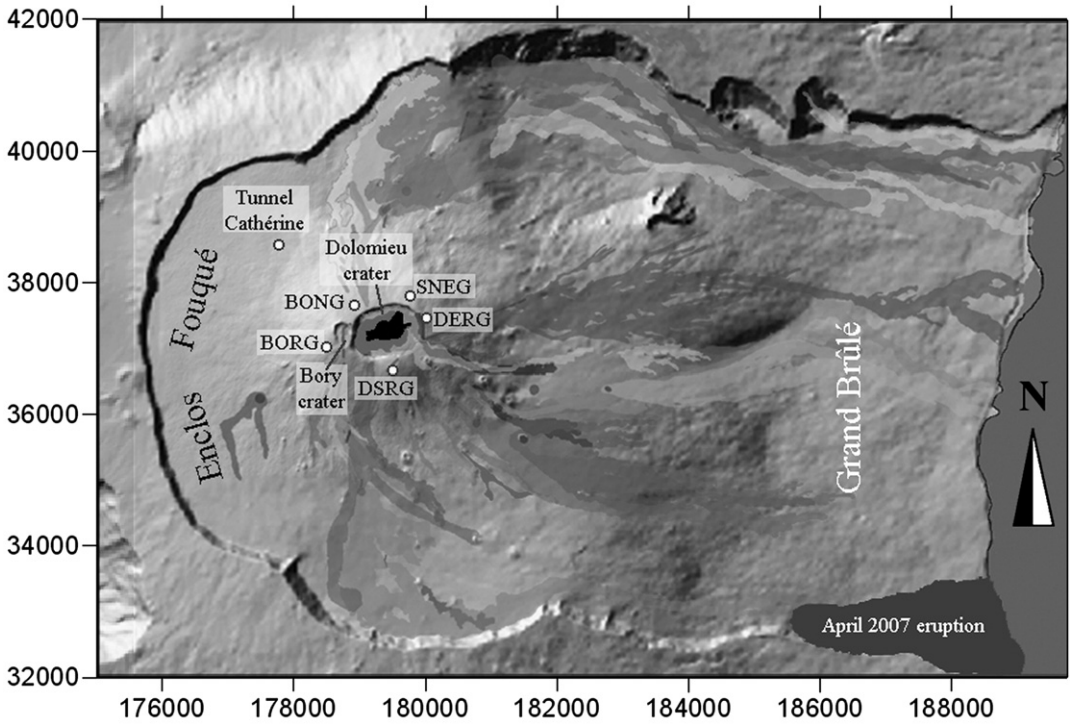

Fig. 1. Map of Piton de la Fournaise volcano inside of the Enclos Fouqué caldera. Shown are the Bory and Dolomieu summit craters and the summit permanent GPS stations BONG (Bory north), SNEG (Soufrière north-east), DERG (Dolomieu east), DSRG (Dolomieu south) and BORG (Bory), as well as the Tunnel Cathérine tiltmeter station. Other tiltmeter stations are close to the corresponding GPS stations. The April to May 2007 lava flow is shown in dark grey in the Grand Brûlé and the 2008 lava flow is shown in black within the Dolomieu crater. Coordinates are Gauss Laborde in meters.

and 2.6, but most were smaller than Md 1 (OVPF internal report, 2008).

The first appearance of new activity was a short period of volcanic tremor on September 12, between 6:00 and 16:00 (GMT). No magma arrived at the surface, but simultaneous release of gas from the south-western Dolomieu crater wall at about 2350 m elevation was observed. SO_2 was detected by the 3 km distant NOVAC network on the Enclos Fouqué caldera (Garofalo et al. 2009).

On September 21, at 11:05, a 30 min seismic crisis preceded a new eruption in the Dolomieu crater. Only insignificant GPS horizontal and vertical variations of <1 cm accompanied this seismic crisis. The eruptive vent was located on the western crater wall about midway between the floor and the top of the crater at 2340 to 2380 m elevation (Gauss Laborde coordinates [m]: 179080/37260–179110/37200). After a peak of intensity on the first day of the eruption, the tremor decreased strongly and reached a somewhat constant value (Fig. 3a). A higher and irregular eruption tremor was recorded on September 25. The eruption ceased on October 2, with the disappearance of the eruption tremor at 01:30.

The lava flow, emitted during the nine days of eruption accumulated on the Dolomieu crater floor (Fig. 4a) and stretches to about 300×160 m (Fig. 5a). The elevation of the surface was measured from the Dolomieu crater border with a *TruPulse 200* laser rangefinder to 2205 m above sea level (Fig. 6b). These measurements had been made from different sites around the Dolomieu crater on bright rocks lying on the lava flow or on gravel adjacent to the lava flow border. Successive measurements allowed us to estimate an error of ±3 m. Based on the depth of 340 m of the Dolomieu crater measured after the April 2007 collapse (Staudacher et al., 2009), this technique allowed us to estimate the maximum thickness of the lava flow to about 50 m. The emitted volume was estimated between 0.8 and 1.0×10^6 m^3 and the average flux was 0.9 m^3 s^{-1} (Section 4). As the lava flow was inaccessible for direct sampling, Pele's hairs have been collected for geochemical analysis (Di Muro et al., in

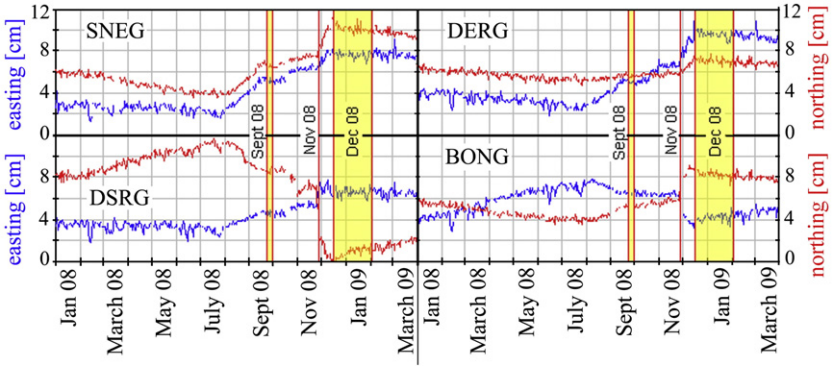

Fig. 2. Curves of four permanent summit GPS stations, showing pre, co- and post eruptive ground variations between January 2008 and April 2009. Data points are daily averaged values and show an uncertainty of about ±0.5 cm. Eruptions are shown in red straight lines and yellow background. Easting is represented in blue, northing in red. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)