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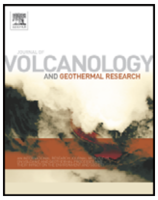

New behaviour of the Piton de La Fournaise volcano feeding system (La Réunion Island) deduced from GPS data: Influence of the 2007 Dolomieu caldera collapse

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ABSTRACT

After 15 months of summit deflation, the unrest of Piton de La Fournaise renewed in August 2008 with several seismic crises and the re-pressurization of the plumbing system. The successive seismic crises, sometime accompanied by ground displacements detected by GPS, were associated with inter-eruptive dyke intrusions. It was the first time since the implementation of the observatory that such successive inter-eruptive magma migrations, not reaching the surface, were observed at Piton de La Fournaise. The change in the volcano activity, with an increase in the frequency of pure dyke intrusions, have followed the Dolomieu caldera collapse of April 2007 and reveals its strong influence on the new eruptive regime. Stress changes in the volcanic edifice have, temporarily at least, favoured the arrest of dykes in depth. During these successive dyke intrusions, magma stopped at shallow depth to form transitory magma storages before to erupt during three successive small summit eruptions (September 21st–October 2nd, 2008; November 27th; and December 14th, 2008–February 4th, 2009). The same kind of change in the pre-eruptive and eruptive behaviour can be expected on other volcanoes having experienced a summit caldera collapse.

1. Introduction

The probability of a volcanic eruption is linked to the capability of a magma to propagate from shallow reservoirs to the surface. Understanding the mechanisms leading to the rupture of the magma reservoir and to the propagation of a dyke toward the surface are crucial to forecast eruptions and their dynamisms. Dyke propagation, location and arrest strongly depend on the local stresses in the individual rock layers that constitute the volcano. On basaltic volcanoes, dyke propagate easier through a multi-layers lithology and requires less energy to reach the surface than on stratovolcanoes (Gudmundsson, 2009). Local stresses are determined by the mechanical properties of the rock layers but also by the depth, the shape and the loading conditions of the magma reservoir and they can be disturbed by consequences of the eruptive activity as the dyke injections and the crater or caldera collapses (Gudmundsson, 2006; Marti and Gudmundsson, 2000).

Piton de la Fournaise, has one of the highest eruption frequencies in the world, and is thus considered as an excellent study case where dyke propagation and dyke arrest mechanisms can be assessed. In April 2007, Piton de La Fournaise experienced one of its major eruptions of the last century. In 1 month, more than 140×10^6 m^3 of lava flows (ten times larger than during its typical eruption) had been emitted from a distal eruptive fissure located on the southeastern flank. After only 4 days of eruptive activity the Dolomieu summit crater collapsed on April 5th and 6th to form a new caldera (Michon et al., 2007a; Peltier et al., 2009a; Staudacher et al., 2009). The large withdrawal of the magma reservoir at the beginning of the eruption led to the Dolomieu crater collapse (340 m deep; Michon et al., 2007a; Urai et al., 2007; Peltier et al., 2009a; Staudacher et al., 2009). During the collapse, new structures appeared with the formation of concentric fractures on the caldera rims (Michon et al., 2009) and the weakness of the rock column located between the magma reservoir (~2200 ± 500 m depth) and the surface (Peltier et al., 2009a). Following the April 2007 eruption, the volcano remained dormant during 16 months. This was the longest repose time period recorded at Piton de La Fournaise since 1998. Eruptive activity restarted inside the new Dolomieu crater from September 21st to October 2nd 2008 and continued with two other eruptions, located also in the Dolomieu crater, on November 27th 2008 and between December 14th 2008 and February 4th 2009. In this paper, we study the different phases of the 2008 volcanic unrest by analyzing the ground deformation recorded by the continuous GPS network of the Piton de la Fournaise volcano observatory. GPS is a well known tool in volcano-

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geodesy to investigate the dynamics of the magma feeding system on active volcanoes (e.g. Nunnari and Puglisi, 1995; Dvorak and Dzurisin, 1997). In our study, analysis of GPS data provided useful information to discuss the magma supply processes leading to the 2008 intrusions and eruptions and to evaluate the influence of the new collapse structure formed in April 2007 on the following eruptive activity.

2. Volcanic activity at Piton de La Fournaise

2.1. General view

Piton de La Fournaise is an oceanic basaltic shield volcano located on La Réunion Island (Fig. 1a,b). With a mean of 1–2 eruptions per year since the first observations during the 18th century, it is one of the most active basaltic volcanoes in the world (Peltier et al., 2009b). Piton de la Fournaise recent activity has been fully described in several papers published in the Journal of Volcanology and Geothermal Research special issue (vol. 184, issue 1–2, 2009). Eruptions occurred mainly either at the summit, inside the Dolomieu crater, or along the N25-30 and N120 rift zones defined by Michon et al. (2007b) (Fig. 1c). From 1970 to 2000, eruptions were fed by the progressive drainage of an occasionally recharged shallow magma reservoir with no long-term (weeks/months) ground deformation precursors, whereas from 2000 to 2007, eruptions were fed by a continuous filling in magma of the plumbing system which generated long-term (weeks/months) ground deformation precursors (Peltier et al., 2009b). From 2000 to 2007, eruptive activity took place in cycles of successive eruptions (Peltier et al., 2009b). Each eruptive cycle was characterized by a sequence (3 to 10 months in duration) of summit and near-summit, proximal, eruptions, and ended with a distal, low-elevation, eruption on the eastern flank of the volcano. Each eruptive cycle was preceded by 100–130 days of slight summit inflation (0.4–0.7 mm day^{-1}) and typically followed by 30–90 days of summit deflation (0.3–1.3 mm day^{-1}). During a same cycle, the summit inflation is continuous and is only interrupted by large short-term displacements (~0.2–1 m) recorded during dyke propagations toward the surface. Modelling of the long-term summit pre-eruptive inflation using a 3D-Mixed Boundary Element Method combined with a Monte-Carlo exploration algorithm (Cayol and Cornet, 1997; Fukushima et al., 2005) evidenced the involvement of a single over-pressurized magma reservoir for each pre-eruptive period, located at around 2200 ± 500 m depth (Peltier et al., 2007, 2008, 2009a,b).

2.2. The 2008–2009 eruptive activity

After the major distal eruption of April 2007 during which the Dolomieu crater collapsed to form a new caldera (Michon et al., 2007a; Staudacher et al., 2009), an unusual summit deflation was recorded during 15 months as a consequence of the edifice destabilization and the large withdrawal of the magma reservoir. The first signs of a new volcanic unrest were recorded in August 2008 with an increase of the seismicity below the Dolomieu crater (up to 50 volcano–tectonic earthquakes per day; $M<3$). Seismic activity associated with the volcano unrest has been described in detail by Staudacher (in press). Between August and September 2008, six major seismic crises, not followed by an eruption, occurred (August 4th, 15th, 31st and September 7th–8th, 8th–9th, 15th with more than 100 volcano–tectonic earthquakes recorded in a few hours). On September 12th, a tremor was recorded between 06:00 and 07:20 (UTC) and between 11:50 and 16:00, revealing the presence of magma at shallow depth below the summit. But except SO_2 degassing, no eruptive activity was observed in surface (Garofalo et al., 2009). On September 21st, after a short seismic crisis of about 10 volcano–tectonic events, eruptive tremor appeared at 11:35. The eruptive vent was located in the western wall of the Dolomieu crater. The eruption continued until October 2nd and emitted 0.8–1 × 10^6 m^3 of lava. Following this eruption, seismic crises were recorded on October 20th and 31st (with 191 and 226 events respectively) and on November 6th and 21st (114 and 239 events respectively). On November 27th the seismic crisis was followed by the resumption of the eruptive activity at 07:49 from the same vent as

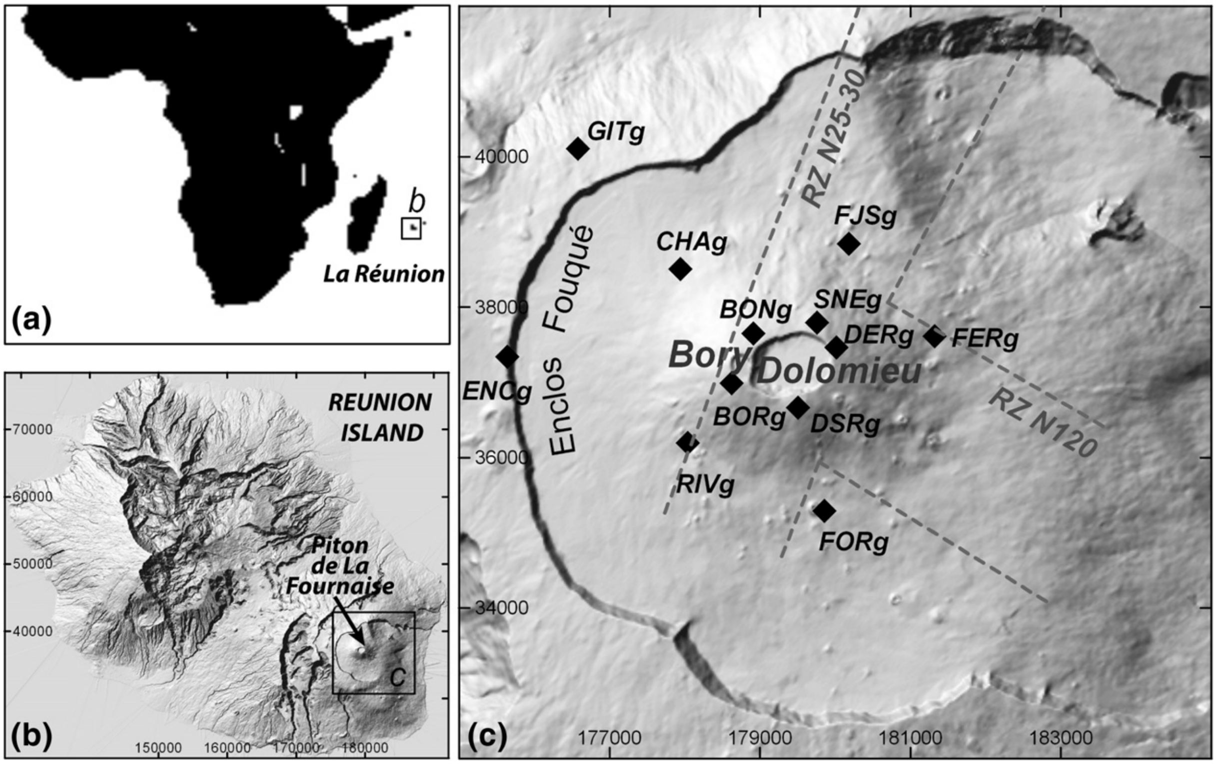

Fig. 1. Location of (a) La Réunion Island, and (b) Piton de La Fournaise volcano. (c) Location of the rift zones (grey dotted lines; after Michon et al., 2007a) and permanent GPS stations (diamonds) (Gauss Laborde Réunion coordinates, in meters).

September 21st. The eruption lasted only 26 h and emitted less than 0.1×10^6 m^3 of lava. The third eruptive sequence started on December 14th at 23:00, after a 18-hour long seismic crisis below the summit craters. Two eruptive fissures were located in the eastern and northern walls of the Dolomieu crater, respectively. After few hours of simultaneous activity, only the northern vent remained active until February 4th and emitted 1.2×10^6 m^3 of lava (Staudacher, in press).

3. GPS data

3.1. GPS network

Piton de La Fournaise is monitored by the Piton de La Fournaise volcano observatory (Institut de Physique du Globe de Paris). Currently, the GPS network of the observatory is composed of twelve permanent stations. Five stations are located around the summit craters (BONg, BORg, DERg, DSRg and SNEg), five at the base of the cone (CHAg, FERg, FJSg, FORg and RIVg) and two reference stations are located outside of the cone on the Enclos Fouqué caldera rim (ENCg and GITg), 4 km away from the summit (Fig. 1c). Measurements of their position are performed in differential mode with dual frequency receivers at 30 s sampling rate. One station (RIVg) is equipped with an Ashtech Zextrem receiver, eight (BONg, BORg, DERg, DSRg, FERg, FJSg, FORg and SNEg) with Topcon GB-1000 receivers and three (CHAg, ENCg and GITg) with Trimble NetRS receivers. Data of the BONg, BORg, DSRg, ENCg, FJSg, FORg, GITg and SNEg stations are transmitted in real-time to the observatory, whereas data of the CHAg, DERg, FERg and RIVg stations are stored in the field and recovered every month (or more frequently in the case of volcanic unrest). The position of each station is calculated relative to the reference stations using the Winprism software. Six stations (BONg, BORg, DSRg, FORg, FJSg and SNEg) are in RTK (Real-Time Kinematic) survey mode and send their position to the observatory every second.

3.2. Ground deformation in 2008

In 2008, and as usually observed since 2000, the resumption of the eruptive activity was preceded by a pre-eruptive summit inflation. After 15 months of summit deflation following the April 2007 Dolomieu caldera collapse (e.g. 0.15 mm day^{-1} on the NS component of SNEg, Figs. 2a, 3a), the deformation trend switched from summit deflation to inflation at the beginning of August 2008 (Figs. 2, 3). From August 2008 to February 2009, several deformation trends succeeded:

(1) From August to September 21st 2008, slight summit inflation occurred (Figs. 2, 3b). Horizontal displacement vectors of GPS stations pointed away from the summit and reveal a pressure source centred below the western part of the Dolomieu crater. The largest horizontal surface displacements were recorded on the SNEg station with 40 mm in 51 days (0.8 mm day^{-1}; Fig. 3). At the base of the cone, horizontal displacements were comprised between 29% (on the western flank) and 75–80% (on the northern and southern flanks) of the SNEg horizontal displacements (at the summit; Fig. 3b). Contrary to the horizontal displacements, the vertical displacements remained very low on each GPS station. Nevertheless, a global uplift trend can be highlight in the background noise (~0.2 mm day^{-1} on SNEg; Fig. 2). On September 9th, 1 h of seismic crisis was accompanied by a slight peak of ground displacements recorded by the SNEg and BONg stations (6 and 3 mm recorded on the NS and EW components of the SNEg station, respectively).

(2) The eruption which began on September 21st in the western wall of the Dolomieu crater did not disturb the GPS signal. Only a slight summit deflation was recorded during the eruption (Fig. 2).

(3) After the September 21st–October 2nd eruption, summit inflation renewed but at a lower rate than in August–September (e.g. 0.2 mm day^{-1} on horizontal components of SNEg; Fig. 2). Compared with the August–September period, the horizontal displacement vectors of the western summit stations rotated (Fig. 3c), revealing a change in the shape of the pressure source in depth.

(4) On November 27th at 07:49, eruptive activity re-started from the same location as in September, in the western wall of the Dolomieu crater. Contrary to the first eruption, 24 min before the beginning of the surface activity, ground deformation was recorded by the summit stations at the same time as the beginning of the seismic crisis (Figs. 2, 4). The cumulated horizontal displacements recorded between 07:25 and 10:00 reached up to 75 mm on DSRg. In detail, continuous data recorded between 07:25 and 10:00 reveal a rotation of the displacement vectors; they converged first to the west of the crater before to progressively converge to the east (Fig. 4). Neither significant horizontal displacement on the basal stations nor vertical displacement on each station can be highlighted in the background noise.

(5) After this short eruption lasting only 26 h, the summit inflation renewed at a higher rate than in October–November (e.g. 1.3 mm day^{-1} on SNEg; Fig 3). Contrary to the summit inflation preceding the two first eruptions, the orientation of the GPS displacement vectors indicates the presence of a pressure source located below the eastern part of the Dolomieu crater (Fig. 3d). The amplitude of horizontal ground displacements recorded at the base of the cone was lower than during the two other pre-eruptive periods. At the base of the northern flank, horizontal displacements represented around 56% of the SNEg summit horizontal displacements, whereas they represented 75 to 83% for the two previous pre-eruptive inflation periods (i.e. August–September 2008 and October–November 2008; Fig. 3b,c,d).

(6) Apart a very slight signal recorded on the DERg and SNEg GPS stations (< 10 mm), located close to the eruptive vents, no significant ground deformation accompanied the 16.5-hour long seismic crisis preceding the onset of the December 14th eruption (22:45).

(7) During the December 14th–February 4th eruption, a summit contraction was recorded. Summit displacement vectors pointed toward the eastern part of the Dolomieu crater. No deformation was detected during the eruption by the stations located at the base of the cone.

(8) Four months after the end of the third eruption, summit deflation was always observed and occurred at the same rate as observed in January–July 2008 (e.g. ~0.15 mm day^{-1} on the NS component of SNEg; Figs. 2a, 3f).

4. Discussion

4.1. Comparison with the previous ground deformation behaviour

As for the 2000–2007 eruptions, the 2008 eruptions were preceded by a slight summit inflation centred below the summit. But contrary to the deformation pattern previously observed after a long period of summit deflation, the resumption of eruptive activity on September 21st was preceded by only 51 days of summit inflation; namely only half of the time observed before volcano unrests in 2000–2007 (Fig. 5; Peltier et al., 2009b). Thus, even if the rate of horizontal displacements recorded in August–September 2008 was slightly higher than the rates observed in 2005 and 2006, the pre-eruptive cumulated displacements reached only 30 mm on the eastern and northern components of the SNEg station, whereas ~50–60 mm was typically observed before the previous eruptive cycles (Fig. 5).

The other main change between 2000–2007 and 2008 is the lack of rapid ground deformation recorded in the minutes or hours preceding the opening of the eruptive fissures in September and December 2008.

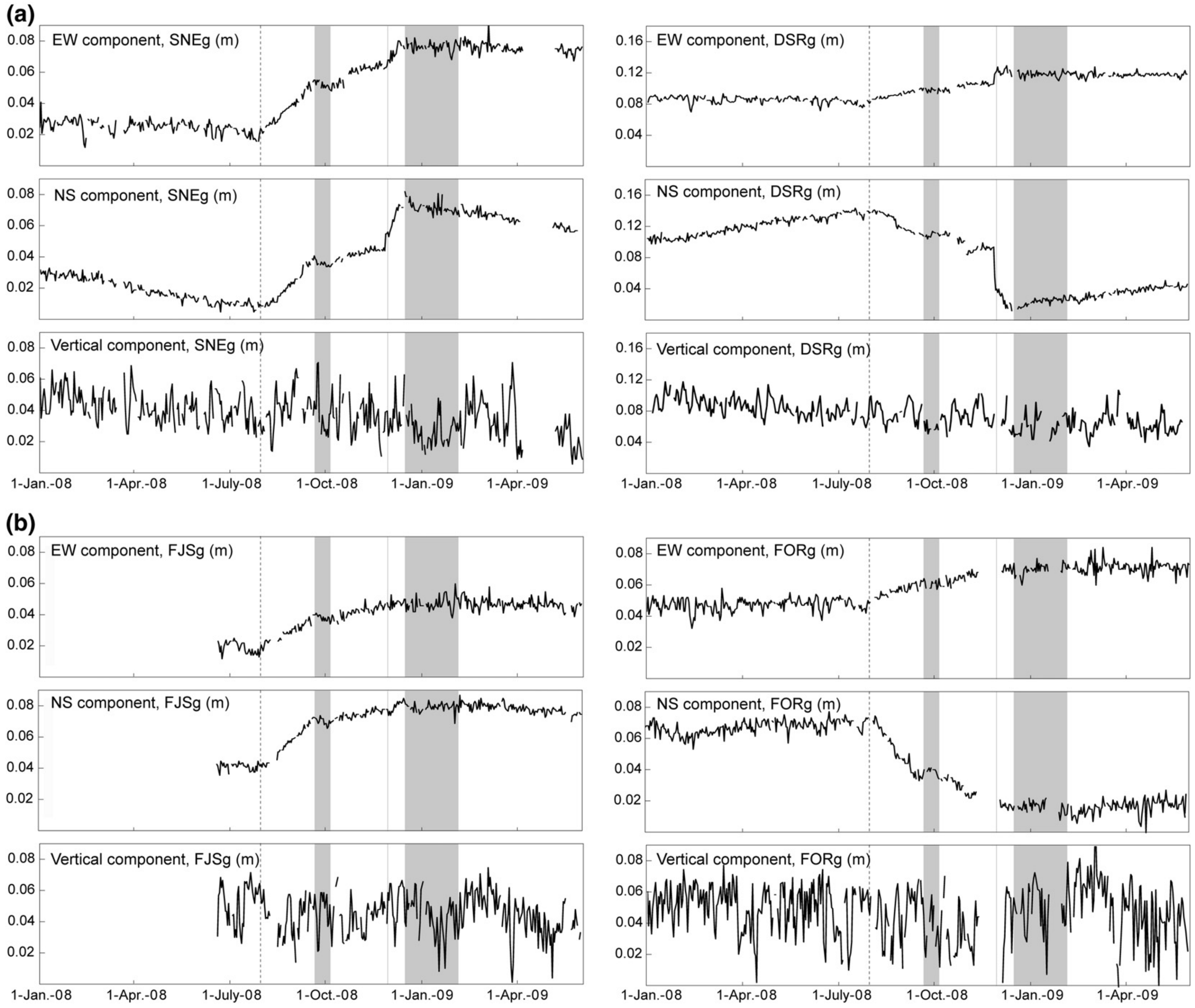

Fig. 2. Evolution of ground displacements recorded by (a) two summit GPS stations, SNEg and DSRg, and (b) two basal GPS stations, FJSg and FORg, between January 2008 and May 2009.

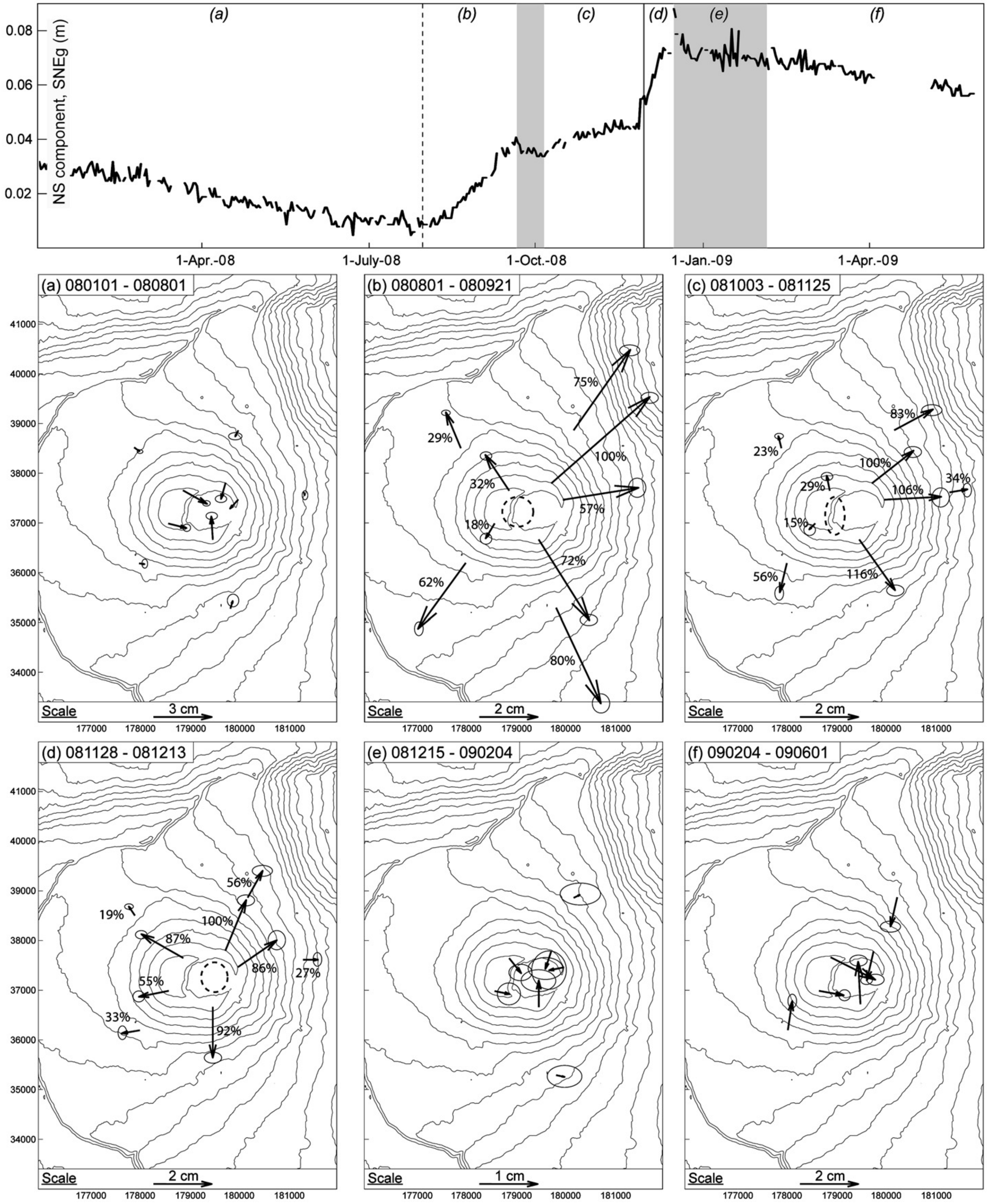

Fig. 3. (top) Cumulative displacements recorded on the NS component of the SNEg GPS station between January 2008 and May 2009. Shaded areas represent eruptive periods. Letters refers to periods displayed on the bottom. (bottom) Cumulative horizontal displacements recorded on the GPS network (a) between January 1st and August 1st 2008, (b) between August 1st and September 21st 2008, (c) between October 3rd and November 25th 2008, (d) between November 28th and December 13rd 2008, (e) between December 15th 2008 and February 4th 2009 and (f) between February 4th and June 1st 2009. Error ellipses are shown. For the three long-term pre-eruptive inflation periods (b, c and d), the displacement amplitude percentage of each station relative to the SNEg station is reported (Gauss Laborde Réunion coordinates, in meters).

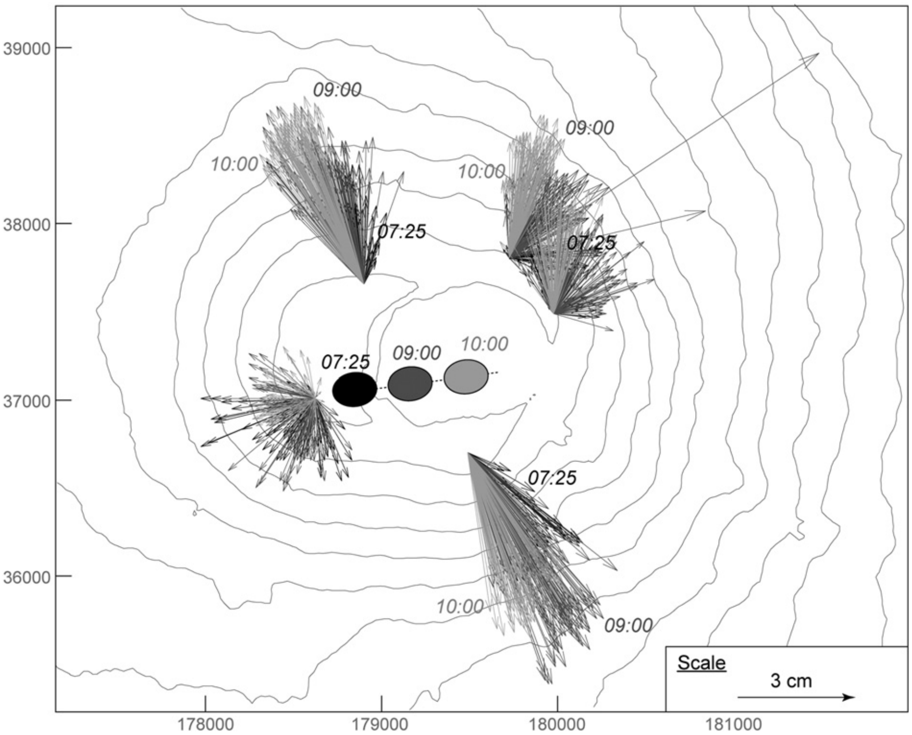

Fig. 4. Cumulative horizontal displacements recorded on November 27th 2008 by the summit GPS within 10 min time windows between 07:25 (black) and 10:00 (light grey).

Thus inter-eruptive displacements represent most of the ground deformation recorded between August and December 2008 (Fig. 2). By contrast, in 2000–2007, most of the ground deformation occurred during dyke propagations feeding the eruptions (min–hours before an eruption) and not between the eruptions as observed in 2008 (weeks–days before an eruption; Peltier et al., 2007, 2008). On September 21st 2008, it was the first time since the implementation of the volcano observatory that no significant ground deformation accompanied the onset of an eruption at Piton de La Fournaise.

All these information highlight a major change in the functioning of the shallow magma feeding system of Piton de La Fournaise in 2008.

4.2. Origin of the ground deformation pattern observed in 2008

On basaltic volcanoes, the few min–hours of ground deformation preceding the beginning of an eruption are related to the propagation of a dyke toward the surface (Cervelli et al., 2002; Peltier et al., 2007, 2008; Palano et al., 2008). The lack of significant ground deformation associated with the September 21st and the December 14th dyke injections indicates that the magma supplying these eruptions was already at very shallow level and reached the surface through a more or less open conduit. The successive seismic crises, sometimes associated with ground deformation, recorded the days and weeks before the three eruptions reveal that successive magma intrusions occurred. These magma intrusions could led to the formation of transitory magma storages at shallow levels from which magma started to directly feed the eruptions. The existence of small transitory magma storage is in agreement with the low volume of magma emitted in surface (~2.2×10^6 m^3 for the three eruptions) and the low pre-eruptive ground deformation. The continuous summit inflation observed between each seismic crisis and eruption could be generated by magma crystallization and/or by degassing of the magma stored in these transitory reservoirs (Tait et al., 1989) and/or by their slow continuous filling (Blake, 1981). GPS data reveal that the summit cone deformed mostly with horizontal displacements. For each GPS station, the vertical displacements did not reach the background noise (>20 mm), which imply a ratio between horizontal and vertical displacements always higher than 1. This ratio and the comparison of the horizontal displacements between the summit and the base of the cone provide further information to estimate the shape of the inflation source (Dieterich and Decker, 1975). The ratio of ~1.5 between horizontal displacements at the summit and the base of the cone and the lack of significant vertical displacements during pre-eruptive periods suggest most likely the presence of elongated vertical sources below the Dolomieu crater compatible with a vertical filling of the shallow plumbing system (Dieterich and Decker, 1975). Unfortunately,

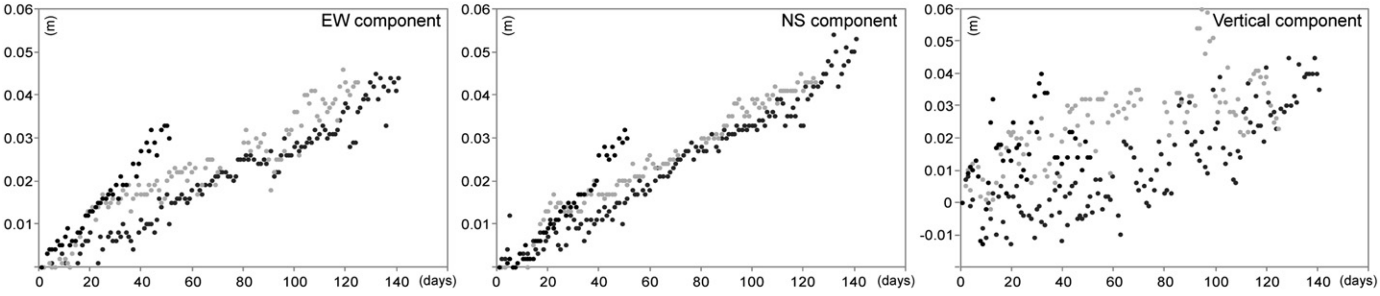

Fig. 5. Cumulative long-term displacements recorded at the SNEg GPS station before the beginning of three eruptive cycles: in light grey, before October 4th 2005 eruption (125 days); in dark grey, before July 20th 2006 eruption (141 days) and in black, before September 21th 2008 eruption (51 days).

because of the short duration (less than 2 months) of each deformation stage, previously described, and the high background noise on the vertical components, no inversion modelling of these data can be made with precision. However, regarding only the horizontal displacement pattern, we can deduce the involvement of distinct pressure sources for the successive deformation periods. This allowed us to discuss how the magma was injected inside the edifice between August and December 2008 (Fig. 6):

(1) The August–September 21st 2008 summit inflation reveals the re-pressurization of the plumbing system. During this period, six seismic crises, sometimes accompanied by ground deformation, occurred and would be associated with successive magma intrusions not reaching the surface. These successive magma intrusions would form shallow magma storage below the western part of the Dolomieu crater (Figs. 3, 6a). The volcanic tremor recorded on September 12th without any eruptive surface activity attests the presence of magma at shallow depth during this period.

(2) Less than 2 months after the resumption of summit inflation, an eruption began on September 21st. The lack of significant ground deformation associated to the opening of the eruptive fissure (to the west of the Dolomieu crater; Figs. 1, 6b) confirms that the magma feeding this eruption was already stored at shallow level below the western part of the Dolomieu crater and that the dyke has easily intruded the surrounding weakened rocks.

(3) After the eruption of September 21st–October 2nd, the summit inflation renewed. During this period, the displacement vectors still suggest the involvement of a pressure source located below the western part of the Dolomieu crater but elongated NS compared to the August–September one. The location of this elongated pressure source correspond to the dyke pathway emplaced during the September 21st–October 2nd eruption. This could reveal the presence of a more or less open conduit below the western part of the crater at this time with a continuous feeding of the dyke which led to the November 27th eruption (Figs. 4, 6b).

(4) On November 27th, the overall summit horizontal displacements suggest an inflation source elongated east–west through the Dolomieu crater (Fig. 4). In detail, continuous data recorded between 07:25 and 10:00 reveal the propagation of a pressure source in depth from west to east. Even if the eruptive activity renewed in the same vent as in September (the western wall of the Dolomieu crater), a dyke starting from the western part of the Dolomieu crater emplaced toward the east but did not reach the surface (Fig. 6c). The lack of horizontal displacement on the basal stations associated with a lack of vertical displacement on each station highlight a shallow starting point of the dyke (Dieterich and Decker, 1975).

(5) After the November 27th eruption, the summit inflation renewed from a pressure source which has shifted below the eastern part of the Dolomieu crater (Fig. 3). The dyke emplaced on November 27th allowed magma to migrate at shallow depth toward the east and led to the formation of a transitory magma storage below this part of the crater. This magma was the source of summit inflation recorded between November 28th and December 14th (Fig. 6d). Amplitude of the horizontal ground displacements recorded at the base of the cone was lower than during the two previous pre-eruptive inflations revealing most probably a shallower inflation source (Fig. 3d).

(6) On December 14th, eruptive activity renewed in the eastern and northern walls of the Dolomieu crater. The source of deflation recorded during the December 2008–February 2009 eruption is located in the same area as the source of inflation recorded two weeks before the eruption (Fig. 3). The common location of the pre and co-eruptive sources and the lack of ground deformation recorded on December 14th reveal that the December 2008–February 2009 eruption was directly fed by the magma stored at shallow depth below the eastern part of the Dolomieu crater, described on (5).

(7) Since the end of the eruption, on February 4th, the summit deflation continued at the same rate as observed in January–July 2008 and highlights the persistence of the edifice contraction recorded since the April 2007 Dolomieu caldera collapse. The April 2007 Dolomieu caldera collapse generated a low cohesion of the rock column below the crater (Michon et al., 2009; Peltier et al., 2009a; Staudacher et al., 2009), which needed to be readjusted.

4.3. Influence of the collapse structure

Although inter-eruptive magma intrusions, not reaching the surface, were frequent on active volcanoes (Puglisi and Bonforte, 2004; Palano et al., 2008), they were rare at Piton de La Fournaise before 2008; only seven intrusions have been detected by the monitoring networks of the observatory between 1981 and 2007 (Peltier et al. 2009b). At Piton de La Fournaise, the inter-eruptive deformation data recorded between 2000 and 2007 revealed the influence of a same inflation pressure source, a magma reservoir located at ~2200 m depth, and did not detect any magma storage at shallower levels (Peltier et al., 2009b). From 2000 to 2007, magma migration from the magma reservoir toward the surface started only few min–hours before the beginning of an eruption. The well established pre-eruptive pattern observed for the 2000–2007 period seems to have been disturbed after the April 2007 Dolomieu crater collapse. The effects of a caldera collapse on the local stress field have been discussed by Marti and Gudmundsson (2000) with the example of the Las Cañadas caldera (Tenerife, Canary Islands). A collapse, particularly along normal fractures as observed at Piton de La Fournaise (Michon et al., 2009; Peltier et al. 2009a), temporarily relaxes the tensile stress in its surroundings and may increase the horizontal stress, so as to make sigma 2 or even sigma 1 horizontal for a while in the vicinity of the collapse. At Piton de La Fournaise, dyke always start below the Dolomieu summit crater, so such a change in the horizontal compressive stress in the summit area could have favoured the arrest of dykes in depth as observed during the volcano unrest in 2008. Similar arrests of dykes have been observed in Iceland (Gudmundsson, 2003).

The low volumes of magma involved in the dykes also favoured the arrest of dykes in depth. Taisne and Tait (2009) suggested that the progression of a buoyant propagating dyke of finite volume can be stopped in depth by an effective three-dimensional fracture toughness of the host medium. At the curved dyke front, horizontal cracking is necessary to allow the vertical propagation of the dyke. As the dyke elongates and thins at the front, the former becomes progressively harder and impossible to fracture. This predicts that a minimum volume of magma must be released in the dyke in order to lead to an eruption. After the large eruption of April 2007 which largely emptied the shallow feeding system of Piton de La Fournaise, the volume involved in the following dykes were low and did not allow them to reach the surface. The successive dyke intrusions of 2008 stopped at shallow depth and formed small transitory magma storages in the weakness rock column formed during the April 2007 caldera collapse, before to erupt.

The volume of the “old” magma reservoir located at ~2200 m depth was estimated at about 0.3 km^3 (Albarède, 1993; Peltier et al., 2007, 2008; Sigmarsson et al., 2005) and it has been partly emptied and damaged by the major April 2007 eruption and the Dolomieu caldera collapse. The consecutive changes in the local stress field could favour the formation of a new magma reservoir at one side of the previous one, as proposed for Tenerife (Marti and Gudmundsson,

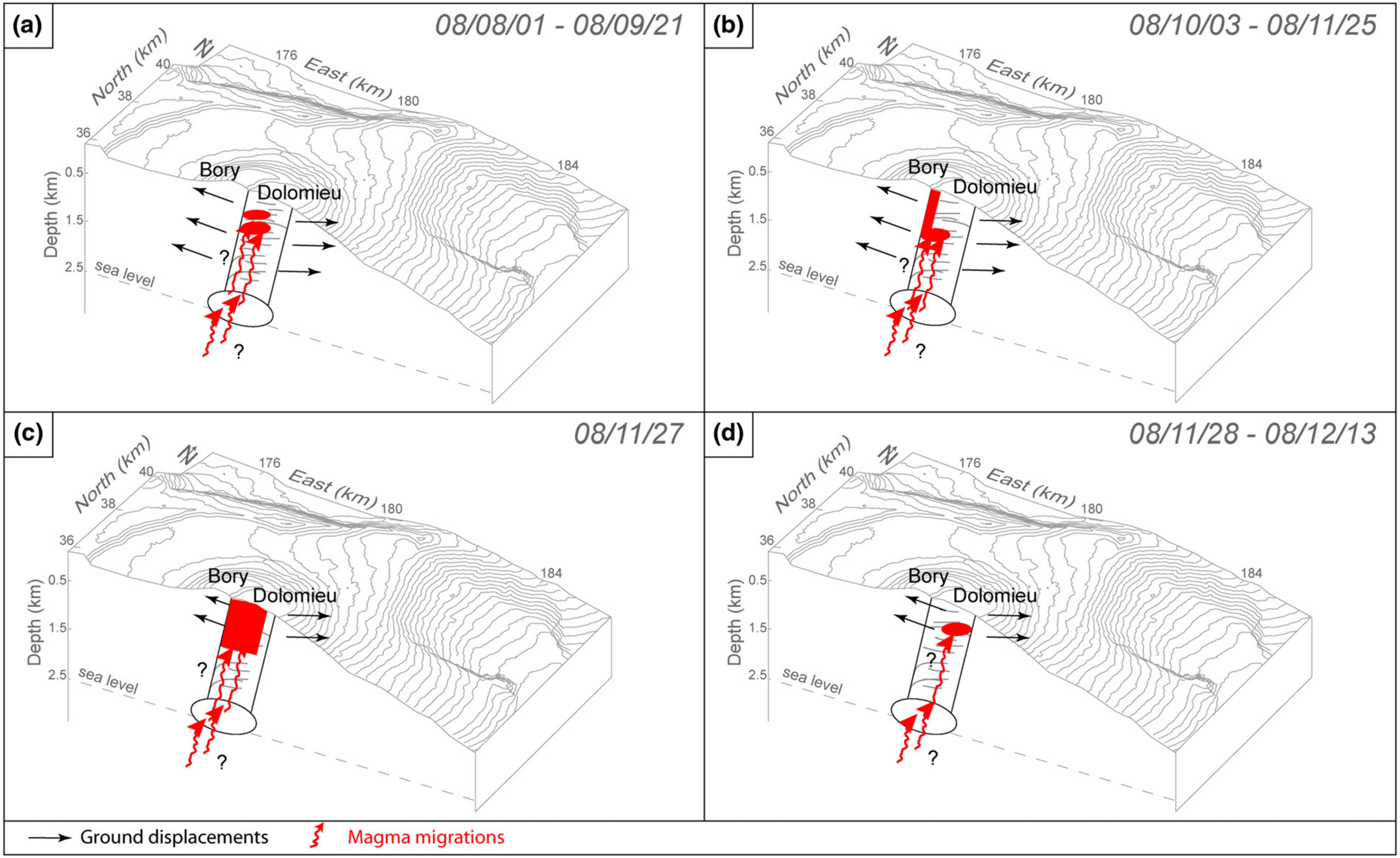

Fig. 6. Schematic representation of magma migrations between August and December 2008.

2000). We can suppose that a long time period will be necessary to completely rebuild a new main magma reservoir and that its initiation could begin by the formation of small magma storages at various levels, as observed in 2008, before to form a large and single structure.

5. Conclusion

After the Dolomieu summit crater collapse in April 2007, a major change in the functioning of the shallow magma feeding system was observed at Piton de La Fournaise leading to a change in its activity. Stress changes in the volcanic edifice generated by the summit crater collapse have, temporarily at least, favoured the arrest of dykes in depth. Successive magma intrusion, not reaching the surface, led to the formation of temporarily shallow magma storages directly feeding the following eruptions. The same kind of pre-eruptive and eruptive behaviour change can be expected on other volcanoes having experienced a summit crater collapse.

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