Journal of Volcanology and Geothermal Research 182 (2009) 145–154

Contents lists available at ScienceDirect

Journal of Volcanology and Geothermal Research

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

Field observations on the initial lava flow and the fracture system developed during the early days of the Stromboli 2007 eruption

G. Giordano *, M. Porreca

Dipartimento di Scienze Geologiche, Università Roma Tre, Largo S. L. Murialdo 1, Roma, Italy

ARTICLE INFO

Article history:
Received 16 April 2008
Accepted 19 November 2008
Available online 3 December 2008

Keywords:
Stromboli
volcano-tectonic fractures
lava flow
dyke
pit

ABSTRACT

The February-April 2007 Stromboli eruption was followed by numerous scientists and well documented from an integrated geophysical analysis. By contrast, direct visual observations on the summit craters and Bastimento area were difficult during the first three days of the eruption because of bad weather conditions. In this paper we report field observations on the fracture system after the crisis of February 27th and before the summit explosion on March 15th. The observations were focused on the early lava flow emplacement and deformation at elevations between 400 and 700 m a.s.l., i.e. between the summit crater area and the lateral fissure eruption, along the Sciara del Fuoco (SdF).

1. Introduction

Stromboli island (927 m a.s.l.) is the emergent portion of a continuously active volcano, part of the Aeolian Island arc (Ferrari and Manetti, 1993; De Astis et al., 2003). The normal and continuous mild explosive activity is interrupted on average every 5–15 years by major explosions, which generally involve prolonged lava effusions and may also produce variable size landslides along the flanks of the active cones, known as Sciara del Fuoco (SdF) (Barberi et al., 1993; Rosi et al., 2000). During the last few years, the volcano has undergone some important changes of morphology and eruptive style. The 2002–2003 eruption initiated with a tsunamigenic landslide and had gone through both constructive and destructive phases, which mostly affected the north-eastern flank of the summit cones and the SdF (Bonaccorso et al., 2003; Ripepe et al., 2005; Tommasi et al., 2005; Rosi et al., 2006; Falsaperla et al., 2008). This same area is the site of the eruption that occurred between February 27th and April 2nd, 2007 (INGV, Internal reports 2007, available at http://www.ct.ingv.it/stromboli2007/main.htm; Barberi et al., 2009-this issue). The 2007 eruption under many aspects is similar to the 2002–2003 eruption for its location (Neri et al., 2008), evolution in time and explosive character. The 2007 volcanic crisis has been well monitored thanks to the presence of a large number of instruments displayed on the island after the 2002–2003 eruption (Barberi et al., 2009-this issue). Visual observations in the field during the first hours of the eruption on February 27th were performed by the volcano guide Mario "Zazà" Zaia, who was climbing the summit crater area. The same day, thermal images and photos from the helicopter were taken. After that, during the successive first three days of the eruption only instrumental observations of the summit crater area were possible because it was completely covered by clouds.

Direct field observations were again possible from the 3rd of March, four days after the beginning of the eruption. The visual documentation of the initial deformation field is very important, because the summit area has been partly modified and covered by pyroclastic material after the summit explosion occurred on March 15th.

In this brief communication we report the available documentation on the early lava flows and the fracture system along the north-eastern flank of the Crater 1 down to the SdF (Fig. 1).

2. Brief chronology of the 2007 Stromboli eruption

We briefly summarise the main events of the volcanic activity between February 27th and April 2nd, 2007 (see Barberi et al., 2009-this issue; Marchetti et al., 2009-this issue).

The 2007 eruptive crisis at Stromboli volcano started on February 27th, when a NE-SW eruptive fissure propagated at 11:16 GMT along the NE crater (Crater 1, Fig. 1), from which lava flows issued at 12:48 GMT (Ripepe et al., 2009-this issue). The fracture propagated downslope, to the so called "Pianoro" area (Fig. 1), at 700–650 m a.s.l. (above sea level), and later in the evening down to an elevation of ~400 m a.s.l. (Fig. 1), changing its strike from NE-SW to NW-SE, where lava vented at 18:26 GMT (Ripepe et al., 2009-this issue). During the propagation of the fractures, the highest portion of the Pianoro area collapsed forming a NE-SW trending half graben-like structure and the vent at 400 m a.s.l. drained magma at several cubic metres per second (INGV internal reports 2007, available at http://www.ct.ingv.it/stromboli2007/main.htm). The summit crater area progressively

* Corresponding author.
E-mail address: giordano@uniroma3.it (G. Giordano).

0377-0273/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.jvolgeores.2008.11.023

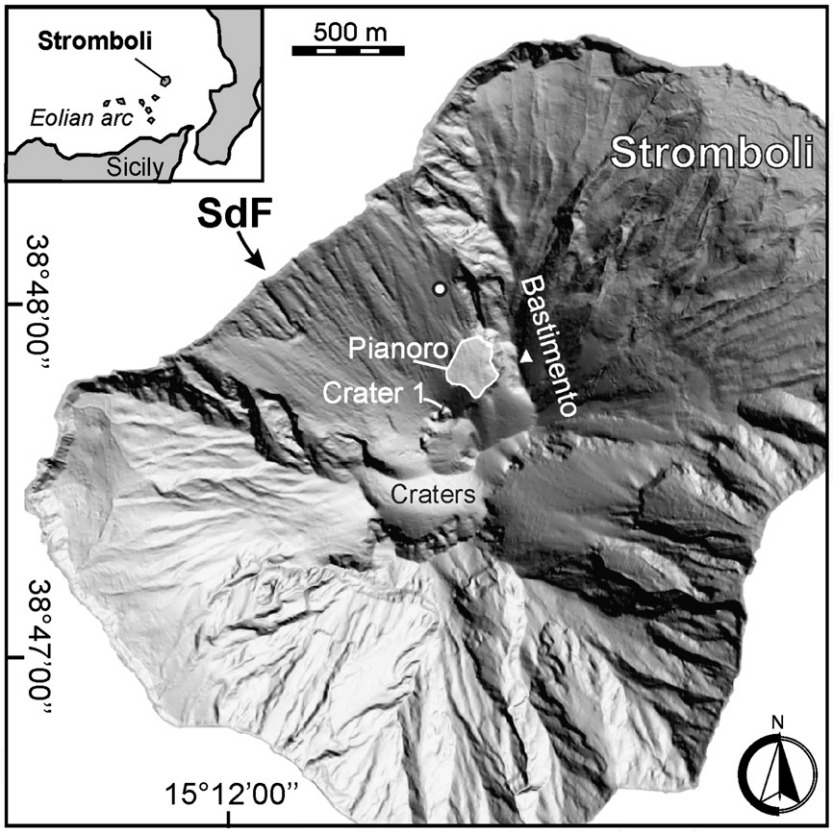

Fig. 1. Shaded relief of the digital elevation model of Stromboli island. The white dot indicates the position of a vent at 400 m a.s.l. and the triangle the point of view.

increased in size by subsequent collapses of the central conduit. The magma withdrawal from the vent at 400 m a.s.l. was interrupted for a few hours on March 8th. A progressive ground deformation of the upper part of the SdF was instrumentally observed during this temporary obstruction (see the reports edited by INGV at http://www.ct.ingv.it/stromboli2007/main.htm). On March 9th a new eruptive vent opened at about 500 m a.s.l. and the 400 m a.s.l. eruptive fissure was reactivated. On March 15th, a violent explosion, similar to that which occurred on the 5th of April 2003, occurred at 20:37 GMT, disrupting the summit cone and covering of lapilli, bombs and blocks the summit area. The eruption ended on April 2nd, with the progressive decrease of the magma output at the 400 m a.s.l. vent.

3. Field observations

Our first visual observations in the field were possible on March 3rd and 4th, 2007, i.e. four days after the onset of the eruption. We climbed to the observation points together with the volcano guide "Zazà" and Alessandro Tibaldi (University of Milan-Bicocca). "Zazà" had witnessed the lava field that developed on February 27th in the early afternoon around 14.00 local time (13.00 GMT), i.e. before the opening of the vent at 400 m a.s.l. At 14.00 (local time) two main, fast lava flows were seen crossing the Pianoro area, and reached the sea. The Pianoro area was covered by the lava but no fractures were as yet observed. After a major explosion likely from the Crater 1 "Zazà" left the observation point. The vent at 400 m a.s.l. opened soon thereafter (18.26 GMT).

Our observations were made between 400 m and 700 m a.s.l., from the eastern margin of the Bastimento rim, about 500 m away from Crater 1 (Fig. 1). From this point of view it was possible to observe and analyse the fracture systems exposed along the north-eastern flank of Crater 1 and the features of the lava flow which covered the Pianoro area during the very early phase of the eruption.

We divide the observations in sectors: the cone flank, the Pianoro area, the collapsed area, the Sciara del Fuoco from the Pianoro down to 400 m a.s.l.

3.1. The cone flank

The most evident structural feature along the north-eastern flank of Crater 1 is the presence of a very narrow, V-shaped and deeply incised canyon which cuts through the summit carter rim and the entire steep upper flank (Fig. 2). The canyon is ~30–60 m wide. The canyon flanks are defined by a set of conjugate fractures, steeply inclined and oriented between N15°E and N20°E. The main fracture is subvertical to steeply seaward directed (WNW), whereas the conjugate fracture is 60°–70° inclined and dips towards the ESE (Fig. 2). Other secondary fractures have been observed parallel to the main fracture (N15-20°E) and plunging toward northwest, i.e. seaward (dashed lines in Fig. 2). The two sets of fractures converge and join at the base of the canyon. Intense degassing was observed along these fractures (Fig. 2), from blue to yellow and white in colour, indicating high temperature degassing and different gas compositions. The rapid accumulation of rock debris at the base of the canyon was, at the time of the observation, building a coarse grained debris fan (Fig. 2).

3.2. The Pianoro area at 650 m a.s.l.

At 650 m a.s.l., the cone flank abruptly changes in slope, from the average 30° of the upper reaches to almost sub-horizontal. This area is known as "Il Pianoro" ("The flat plain") and was formed by the emplacement of lava (Fig. 3), which progressively filled the scarp of the major landslide (known as scarp of the α landslide in Tommasi et al., 2005), which occurred on the 30th December 2002 at the beginning of the 2002–2003 eruption. The Pianoro area is about 4×10^4 m^2 and has a semicircular shape abruptly confined uphill by