Bulletin of Volcanology (2019) 81:17
https://doi.org/10.1007/s00445-019-1274-0

RESEARCH ARTICLE

The Graham and Terrible volcanic province (NW Sicilian Channel): gravimetric constraints for the magmatic manifestations

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Received: 23 August 2018 / Accepted: 21 January 2019

Abstract
A few kilometres off the SW coast of Sicily lie the shallow banks of Graham, Terrible and Nerita. These morphological reliefs are affected by two lithospheric scale, N–S trending tectonic lineaments known as Capo Granitola to the west and Sciacca to the east. Within the Graham and Terrible banks, several volcanic edifices have been documented and mapped using high-resolution bathymetry and seismic profiles. Three groups of volcanic features can be distinguished: (i) a cluster of N–S aligned volcanic cones in the Graham Bank, generally developed along the Capo Granitola fault, (ii) a series of poorly developed volcanic constructs roughly positioned along the northern edge of the Terrible Bank, and (iii) a few isolated volcanic centres located north of the Terrible Bank, within an undeformed zone. Here we present a 2-D gravimetric model, constrained at shallow levels by an integrated seismic dataset, which we use to interpret the distribution of magmatic manifestations in this sector of the Sicilian Channel. At the Graham Bank, where there are no significant positive gravity anomalies, the magmatic material seem to migrate to the surface along the Capo Granitola lithospheric fault, without the presence of a shallow magma source. In the Terrible Bank, where there is a well-defined positive gravity anomaly, the model implies the presence of a shallow magma chamber from which sea-floor volcanic constructs are fed upwards along cracks. The origin for the volcanic cones located between the two fault systems is more problematic, as no significant structural discontinuities were identified in this area from the available seismic data. However, the presence of a potential wide sill complex suggests that it facilitated lateral magma flow from source to surface over lateral distances of tens of kilometres.

Keywords Sicilian Channel · Graham and Terrible banks · Volcanic manifestations · Seismic data · Gravity model

Introduction

The occurrence of volcanic manifestations in intraplate settings has been traditionally thought to require regional extensional tectonics because this stress state allows magma upwelling along vertical fractures perpendicular to the regional principal stress (e.g. Nakamura 1977; Takada 1994). However, more recent investigations have shown that the emplacement of shallow crustal-level intrusions and volcanism can also occur in contractional tectonic settings (Legrand et al. 2002; Musumeci et al. 2005; Tibaldi 2005; Galland et al. 2007). In some strike–slip dominated settings, volcanism is associated with local extension occurring at releasing bends and pull-apart basins (Petrinovic et al. 2006; Busby and Bassett 2007). A transcurrent regime would allow magma to ascend and produce vertical dykes parallel to the direction of the regional deformation. This is consistent with numerical models (Shaw 1980) that suggest composite systems of tensional and shear fractures for dyke propagation, and it is also consistent with field data (e.g. Tibaldi and Romero-Leon 2000; Pasquarè and Tibaldi 2003; Lara et al. 2006) and geophysical information (Roman et al. 2004).

In this study, we relate the presence of sea-floor volcanic constructs in the north-western Sicilian Channel with two major, mostly strike-slip tectonic structures—the Capo Granitola and Sciacca fault systems—through a detailed analysis of gravimetric data and a 2-D forward model. The study area is

Editorial responsibility: S. Vergniolle

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00445-019-1274-0) contains supplementary material, which is available to authorized users.

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Published online: 15 February 2019