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GR Letter

First documented deep submarine explosive eruptions at the Marsili Seamount (Tyrrhenian Sea, Italy): A case of historical volcanism in the Mediterranean Sea

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ABSTRACT

The Marsili Seamount (MS) is an about 3200 m high volcanic complex measuring 70 × 30 km with the top at ~500 m b.s.l. MS is interpreted as the ridge of the 2 Ma old Marsili back-arc basin belonging to the Calabrian Arc–Ionian Sea subduction system (Southern Tyrrhenian Sea, Italy). Previous studies indicate that the MS activity developed between 1 and 0.1 Ma through effusions of lava flows. Here, new stratigraphic, textural, geochemical, and ^{14}C geochronological data from a 95 cm long gravity core (COR02) recovered at 839 m bsl in the MS central sector are presented. COR02 contains mud and two tephras consisting of 98 to 100 area% of volcanic ash. The thickness of the upper tephra (TEPH01) is 15 cm, and that of the lower tephra (TEPH02) is 60 cm. The tephras have poor to moderate sorting, loose to partly welded levels, and erosive contacts, which imply a short distance source of the pyroclastics. ^{14}C dating on fossils above and below TEPH01 gives an age of 3 ka BP. Calculations of the sedimentation rates from the mud sediments above and between the tephras suggest that a formation of TEPH02 at 5 ka BP MS ashes has a high-K calcalkaline affinity with 53 wt.% < SiO_2 < 68 wt.%, and their composition overlaps that of the MS lava flows. The trace element pattern is consistent with fractional crystallization from a common, OIB-like basalt. The source area of ashes is the central sector of MS and not a subaerial volcano of the Campanian and/or Aeolian Quaternary volcanic districts. Submarine, explosive eruptions occurred at MS in historical times: this is the first evidence of explosive volcanic activity at a significant (500–800 m bsl) water depth in the Mediterranean Sea. MS is still active, the monitoring and an evaluation of the different types of hazards are highly recommended.

1. Introduction

The Marsili Seamount (MS; Southern Tyrrhenian Sea, Italy) is the largest volcano of the Mediterranean area and Europe, measuring about 70 km in length and 30 km in width (Fig. 1a, b, c). MS, which is elongated in a NNE–SSW direction, rises up from the bathyal plain of the Marsili basin at 3500 up to 508 m below the sea level (bsl) (Fig. 1b, c). MS is located in the Marsili back-arc basin, to the north of the Aeolian volcanic Arc, and is associated to the subduction of the Ionian slab below the Calabrian Arc (Fig. 1a) (Malinverno and Ryan, 1986; Rosenbaum and Lister, 2004). MS is believed to represent the super-inflated ridge of the Marsili back-arc, which opened at about 2 Ma (Marani and Trua, 2002; Nicolosi et al., 2006; Cocchi et al., 2009). Recent morphological and volcanological data show, however, that MS could represent a volcanic arc edifice emplaced on the 'relict' back-arc basin (Ventura et al., 2013).

The dredged lavas of MS show a calc-alkaline affinity related to IAB- and OIB-like mantle sources; these lavas range from basalts to basaltic andesites and trachyandesites (Trua et al., 2002). Basaltic lavas show low- to medium-K signatures, whereas more evolved rocks, which have been dredged only on the MS axial zone, show a medium- to high-K character (Peccerillo, 2005; Trua et al., 2005, 2011). Geophysical and geochemical data reveal that MS is affected by active degassing from a deep (mantle) source (Lupton et al., 2011), and by shallow seismicity related to volcanotectonic events and hydrothermal activity (D'Alessandro et al., 2009). Modeling of magnetic and gravity data suggests the occurrence of a magmatic reservoir within the seamount (Caratori Tontini et al., 2010). The above summarized data suggest that MS could be still active. The time evolution of the MS volcanism is barely constrained: based on magnetic data and previous age estimates, Cocchi et al. (2009) proposed that the early vertical accretion of MS started at about 1 Ma, then the growth of the edifice mainly occurred

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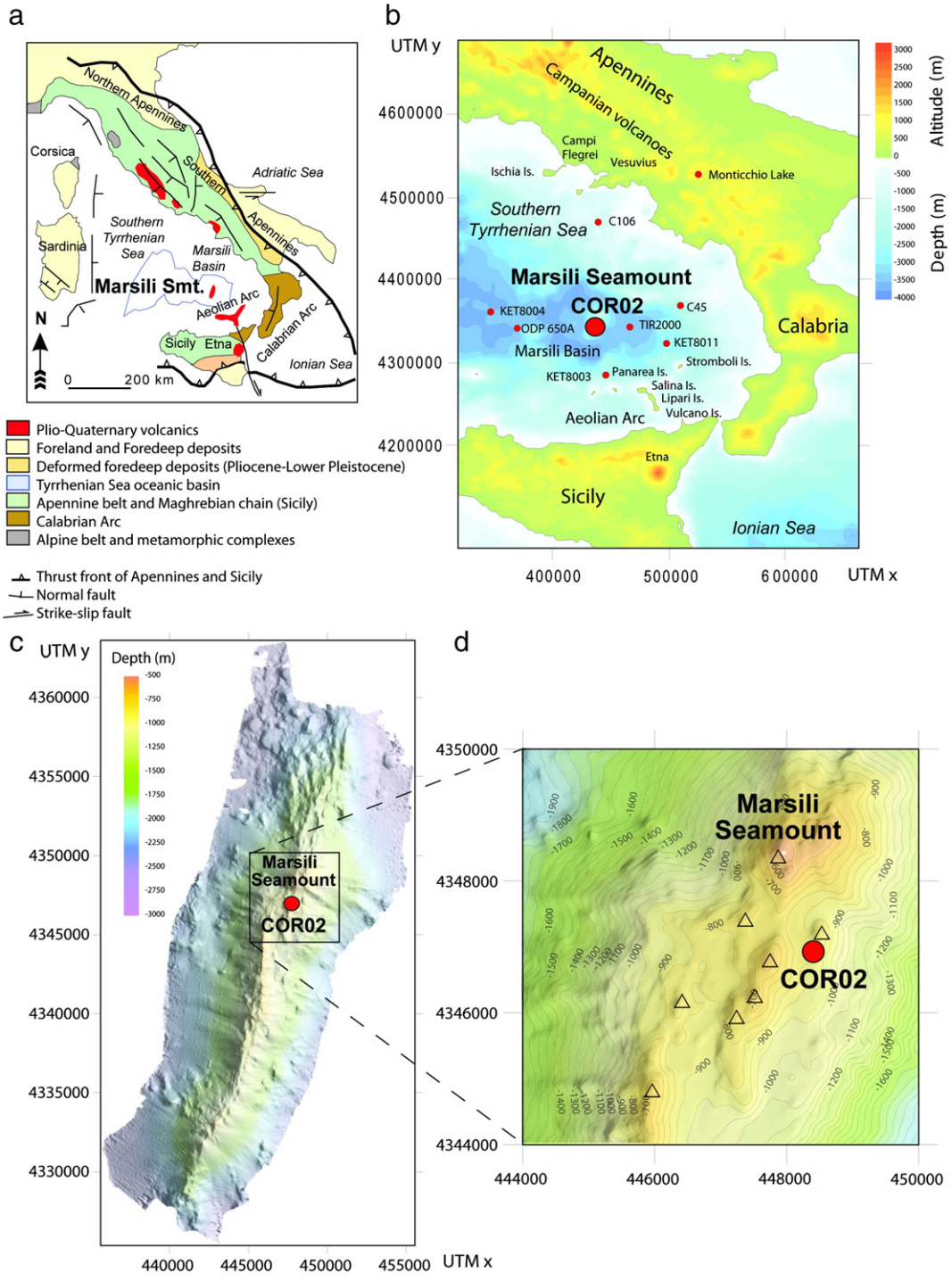

Fig. 1. (a) Geodynamic setting of the Southern Tyrrhenian Sea and location of the Marsili Seamount (modified from De Ritis et al., 2010). (b) Location of the CORE02 log (this study) on the Marsili Seamount and of the other logs (KET8003, KET8004, KET8011, ODP-650A, TIR2000, C45 and C106) in the Tyrrhenian Sea and Apennines (location from Paterne et al., 1988; Calanchi et al., 1994; Munno and Petrosino, 2004; Di Roberto et al., 2008; Wulf et al., 2008). (c) Shaded relief map of the Marsili Seamount and bathymetry (data from Ventura et al., 2013) with the location of the CORE02 log. (d) Bathymetry of the central sector of the Marsili Seamount and location of the volcanic cones (triangles; data from Ventura et al., 2013).

between 0.78 and 0.1–0.2 Ma. 0.1 Ma is assumed to be the youngest age for the MS volcanism (Selli et al., 1977; Peccerillo, 2005). On the basis of the data collected on the flanks and summit of MS, the volcanism appears to be related to effusive activity alone. However, Keller and Leiber (1974) hypothesized a possible explosive activity of the seamount on the basis of two volcanoclastic levels in the Marsili basin. Different volcanoclastic layers have been recognized in the Tyrrhenian Sea and in mainland Italy (Paterne et al., 1988; Calanchi et al., 1994; Munno and Petrosino, 2004; Wulf et al., 2004, 2008; Di Roberto et al., 2008). The characterization of these volcanoclastites is of primary importance for the reconstruction of the activity of the Mediterranean volcanoes and for the estimate of the areal dispersion of the volcanic products.

Here, we document, for the first time, the occurrence of two tephras sampled in a ~1 m long gravity core (COR02) collected at 839 m bsl in the MS central sector (Figs. 1d and 2). These tephras consist of juvenile and pristine ashes. The stratigraphy, texture, and geochemistry of these ashes, along with radiometric age determinations on fossils hosted in the sediments are presented and discussed. Our results put new, unexpected constraints on the age and type of activity of submarine volcanoes in the Mediterranean area and the hazard implications.