EVIDENCE OF THE SEISMO-VOLCANIC AND HYDROTHERMAL ACTIVITY OF THE MARSILI SEAMOUNT FROM NEW GEOPHYSICAL AND GEOCHEMICAL DATA

G. D'Anna[1], P. Favali[1], F. Italiano[1], D. Paltrinieri[2], P. Signanini[3], N. Agnello[1], A. D'Alessandro[1], R. D'Anna[1], D. Luzio[4], G. Mangano[1], G. Passafiume[1], S. Speciale[1]

1 Istituto Nazionale di Geofisica e Vulcanologia, Italy
2 Eurobuilding SpA, Servigliano, Italy
3 Università G. D'Annunzio, Chieti, Italy
4 Università degli Studi di Palermo, Italy

Marsili is a back-arc volcano with a dominant tholeitic petrochemical affinity. The opening of the Marsili basin was related to a sharp acceleration of the roll-back of the Ionian lithosphere subducting below the Southern Tyrrhenian Basin. This seamount, having an elevation of about 3000 m above the sea floor, an approximate length of 60 km in a NNE-SSW direction and a mean width of 16 km, is the biggest European volcano.

Former exploration programs of the Marsili seamount, suggest the presence of a hydrothermal activity testified by oxy- and hydroxide-deposits predominantly made up of Fe- and Mn-rich sediments, crusts and nodules (Marani et al., 1999; Dekov and Savelli, 2004; Dekov et al., 2006). A high heat flow (250 mW/m^2) is measured at the uppermost portion of the volcano, reaching the maximum value (500 mW/m^2) in the central parts (Verzhbitskii, 2007). It coincides with gravity and magnetic anomalies, suggesting the presence of magmatic bodies intruding within shallow and thinned crustal levels (Faggioni et al., 1995; Cella et al., 1998).

With the aim of better define the presence of active hydrothermalism both geochemical and geophysical studies have been carried out in recent years. The collected information and the data interpretations will be useful to develop the first project of offshore geothermal drilling under the responsibility of an Italian company.

In November 2007 and July 2011, water-column studies were carried out aboard of the R/V Urania and Astrea (Fig. 1). Isotope analyses of the gases dissolved in water samples collected at the top the Marsili have evidenced that the $^3He/^4He$ isotope ratio, i.e. a clear indicator of hydrothermal input, is in excess with respect to the background and it is also associated with the anomalous behavior of hydrothermal-derived gases (CO_2, CO, CH_4). Although some hydrothermal emissions are known to occur offshore the Aeolian subaerial volcanoes, results from our isotope analyses are

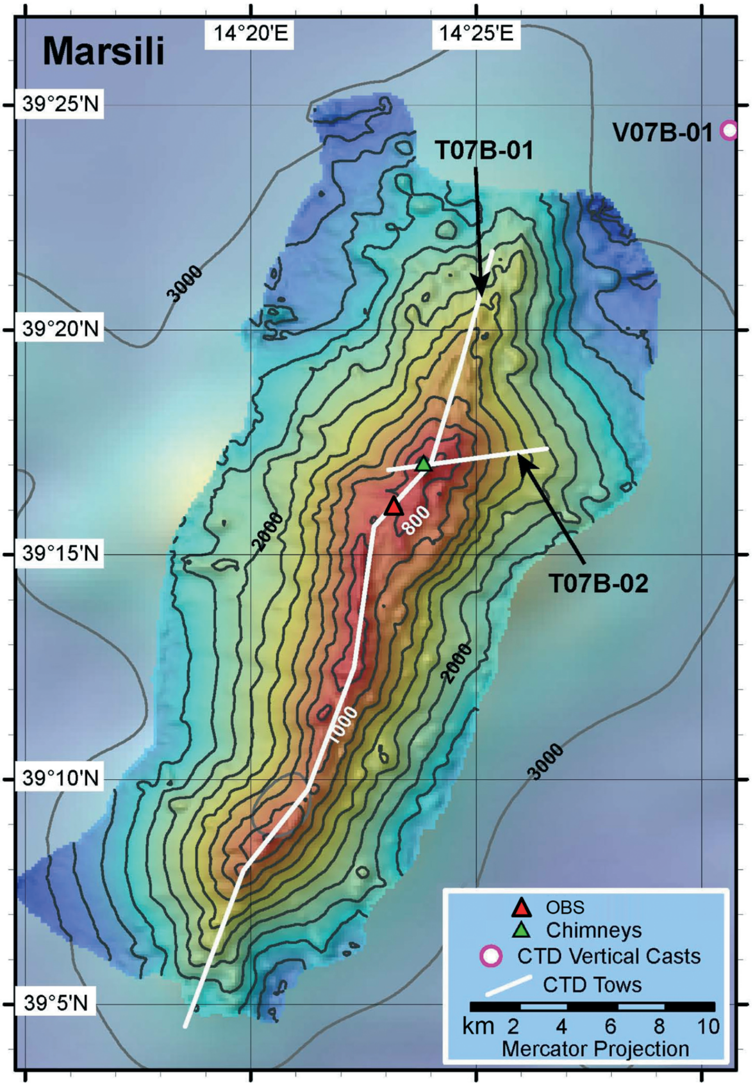

Fig. 1 - Bathymetric map of the Marsili Seamount with reported the measurement points (modified after Lupton et al, 2011).

the first to confirm the hydrothermal activity of Marsili. The highest ^{3}He values were measured over the shallowest part of the seamount, where hydroxide deposits were found (Lupton et al., 2011). The chemical composition of the dissolved gases clearly shows the presence of CO_2 and CH_4 over a wide water column depth range. The same anomalies were found in 2007 and 2011, depicting the presence of a persistent plume related to the deep hydrothermal activity of Marsili.

In 2006 the INGV's staff placed a broadband OBS/H (Ocean Bottom Seismometer with Hydrophone, Mangano et al., 2011) on Marsili's flat top (39° 16,383' N, 14° 23,588' E, D'Alessandro et al., 2009) at a depth of 790 m (Fig. 1, D). For this experiment the OBS/H operate from July 12 to 21, 2006. In only 9 days the submarine station recorded more than 1000 seismo-volcanic and hydrothermal signals. By comparing the signals recorded with typical volcanic seismic activity, we group the recorded signals into: Volcano-Tectonic type A (1 VT-A), Volcano-Tectonic type B (817 VT-B) events, occurrences of High Frequency Tremor (159 HFT) and quasi-monochromatic Short Duration Events (32 SDE).

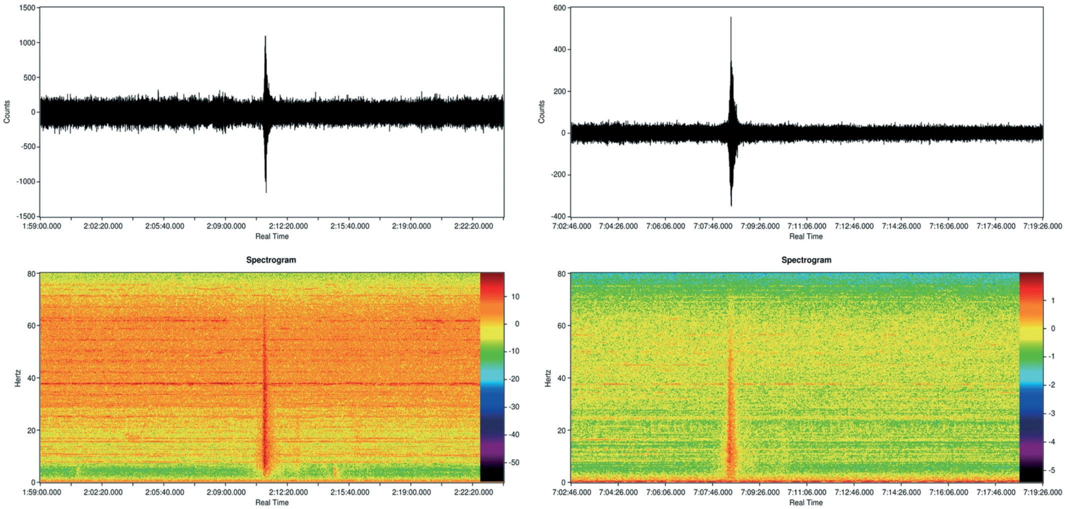

Fig. 2 - Waveforms and spectrograms of the VT-A (left) and VT-B (right) events recorded on Marsili Seamount.

On February 14 2010, about three years and half after the first monitoring campaign another OBS/H was deployed in the same point for a long monitoring campaign (9 mouths). During the nine months of the monitoring experiment the OBS/H recorded some thousand of little magnitude events very similar to that of the first experiment (589 VT-A, 1952 VT-B, 98 SDE). We applied spectral analysis to better characterize its frequency content. We also applied a single station location technique to locate its hypocenters.

The VT-A events show a very high frequency content (Fig. 2) and a clear P and S phases arrival times. These earthquakes have a local magnitude between 0.5 and

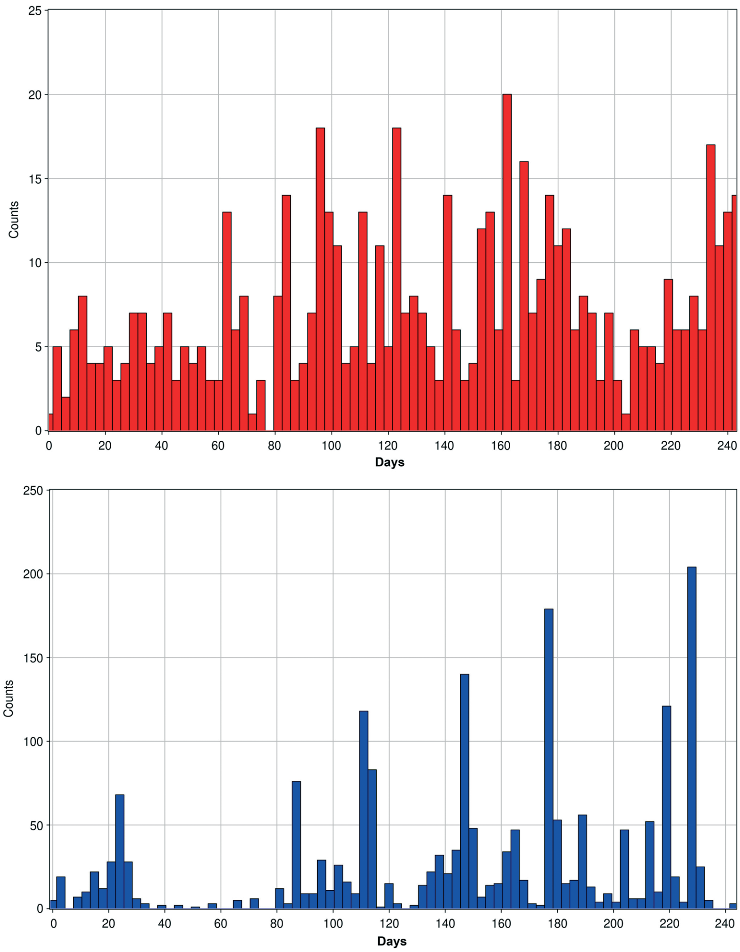

Fig. 3 -Time distribution of the VT-A (Red) and VT-B (Blue) events recorded on Marsili Seamount

3 and a depth of about 1 to 20 km. The VT-A are generally take place previous to and in the first stage of eruptive activity. The VT-B events show a limited frequency content (1-8 Hz), a mean length of about 30 seconds and a local magnitude between -0.5 and 1.5. The hypocenters are limited to an little area in the NW sector of the Marsili volcano, probably very near to an active crater. These event are very shallow (0-5 km) and don't show any clear S wave arrivals. Despite the VT-A events, the VT-B take place in swarms (Fig. 3) with an average recurrence time of about 10 minutes. The pressure signal recorded in the first experiment shows the occurrence of HFT. This events shows a boxfold envelope with sudden beginning and ending, a time duration of a few minutes and a dominant frequency of between 40 and 90 Hz. Similar signals were recorded at the Satsuma–Iwojima hydrothermal system (Ohminato, 2006) and ascribed to sudden vapor emission from water-filled underground pockets when the water temperature exceeded the ebullition point. We model the SDE events as transient waves excited by the normal modes of vibration of a resonator. In order to estimate their characteristic complex frequencies and improve the frequency spectra resolution, we applied the Sompi method. We found that this type of events are quasi-monochromatic and are probably generated by oscillations of a steam-filled crack by unsteady choked flow.

The collected information coherently show the persistence of active hydrothermal activity probably located in the central portion of the volcanic edifice. Further investigations are needed to better constrain the relationships between the volcanic and the hydrothermal activities of the Marsili seamount also considering the evaluations in terms of both volcanic and industrial risks

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