MAGNETIC INVESTIGATION AT VULCANO ISLAND: PRELIMINARY RESULTS FROM A MULTIDISCIPLINARY GEOPHYSICAL SURVEY

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Introduction. From the end of June 2021, changes in the monitored parameters (temperature, gas emission, seismicity, ground deformation) clearly indicate the beginning of a phase of unrest at Vulcano Island (Aeolian Islands, Italy). The anomalies consist in high temperatures of the fumaroles, increase of gas emissions from fumaroles and soils (both CO_2 and SO_2), ground deformation, and increased seismicity (Inguaggiato *et al.*, 2022). In the last decades, this volcano experienced frequent crises: 1978-1980, 1988-1991, 1996, 2004-2007, 2009-2010 (Inguaggiato *et al.*, 2022), while the last eruption occurred in 1888-1890. For its activity, Vulcano represents the source of many potentially interconnected hazards which determine a potentially high risk. (Hazard Selva *et al.*, 2020).

The Vulcano island has been widely investigated to understand its volcanic evolution (Gioncada *et al.*, 1998; Gioncada *et al.*, 2003; De Astis; 2013; Nicotra *et al.*, 2018), the dynamics affecting the plumbing and the hydrothermal systems (Alparone *et al.*, 2010; Cannata *et al.*, 2012; Alparone *et al.*, 2019), and the structure of the of the active "La Fossa" cone (Revil *et al.*, 2008; Barde-Cabusson *et al.*, 2009; Revil *et al.*, 2010). Many studies reveal a complex evolution in which the regional tectonic may play a major role. The occurrence volcanism in the southern Tyrrhenian is generally linked to large scale geodynamic processes, but, the volcanism in the southern sector of Aeolian Islands, where Volcano is located, would be also controlled by a regional-scale, lithospheric NNW-SSE trending right-lateral strike-slip fault system. Even though several evidence suggest its occurrence (Mazzuoli *et al.*, 1995; Ventura *et al.*, 1999, Mattia *et al.*, 2008; Barreca *et al.*, 2014; Cintorrino *et al.*, 2019), the field expression of this system is poorly constrained.

Bruno and Castiello (2009) revealed some faults affecting the SW base of the active cone by means of high-resolution seismic investigations. To better understand these features and

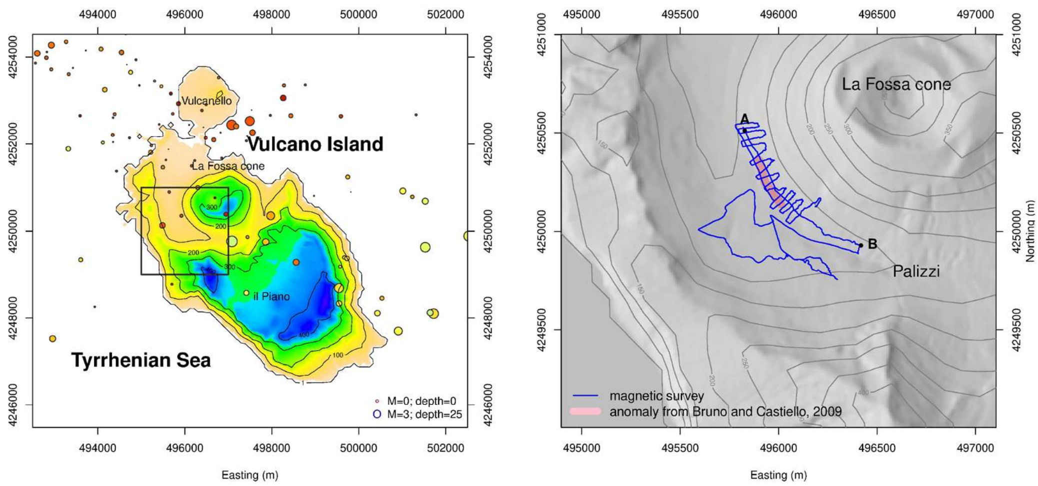

Fig. 1 - Left: relief map of Vulcano Island and the seismicity recorded in the period from January 2020 to April 2022 (Barberi *et al.*, 2020). Right: detail of the study area in the lower southwestern flank of La Fossa cone. The letters A and B indicate the tips of the section shown in Fig. 3.

provide a possible link to the larger scale tectonic framework, a campaign of multi-technique geophysical surveys has been carried out in April 2022. It involved electrical resistivity measurements, thermography, gravimetric and magnetic surveys; this paper presents the preliminary results of the magnetic survey (Fig. 1). In fact, magnetometry has been widely used to detect faults, or geological discontinuity in general, in volcanic contexts and at various scales (Bottari *et al.*, 2018, Napoli *et al.*, 2020).

Data and method. The magnetic survey was performed with the device G-858G produced by Geometrics Inc. The magnetometer was set in gradiometric configuration with the two sensors 2.0 m apart. The magnetometer is equipped with a GPS that provide the position and the time for each magnetic measure, taken every 0.5 s. The survey consists of more than 14,000 measurements taken along different tracks of total length equal to 6.6 km; the average spacing between two consecutive measures is about 0.5 m.

The data processing consists in the spikes removal and in a running average over 40 samples acting as a low-pass filter. The filter attenuates, the shorter wavelength component related to the shallower anomalies, enhancing the components with larger wavelength.

The investigated area extends at the southwestern base of the cone named "La Fossa" which is the active crater located within the caldera of Vulcano Island. In particular, the survey was focused in the area where the seismic investigation by Bruno and Castiello (2009) shows a velocity anomaly interpreted as a possible fault zone. In this area we performed back-and-forward profiles. Data, reduced with respect the International Geomagnetic Reference Field (IGRF), have been interpolated by kriging on a 5x5 m grid.

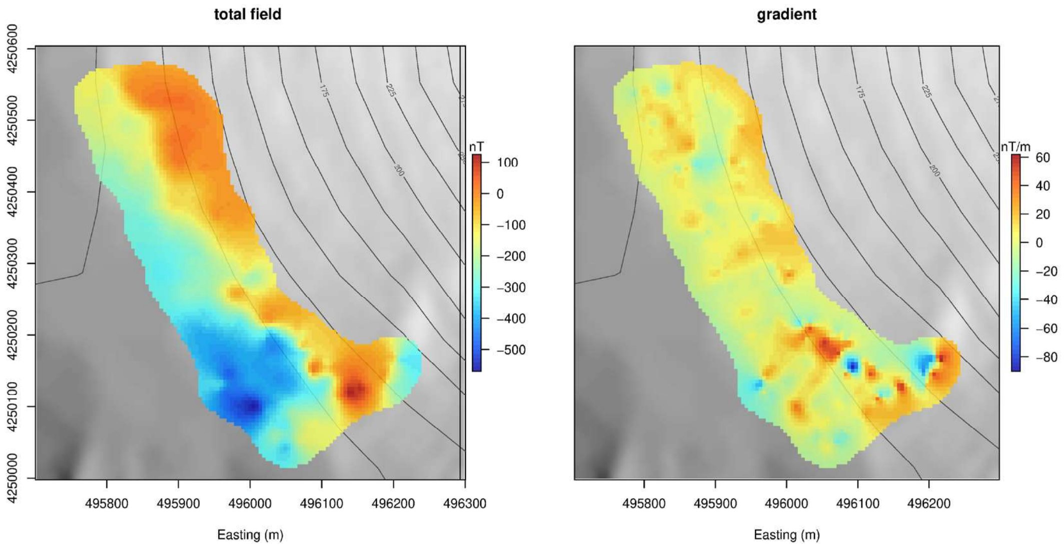

Fig. 2 - Maps of the total magnetic anomaly field (left) and of the vertical gradient (right). Elevation lines are 25 m spaced.

Results. The total-field magnetic anomaly map and the vertical gradient map are presented in Fig. 2. The total field is generally characterized by negative values. This is in agreement with the observations from other magnetic surveys (airborne, shipborne or ground-based) carried out at Vulcano Island (Supper *et al.*, 2004; De Ritis *et al.*, 2005; Okuma *et al.*, 2006; Blanco-Montenegro *et al.*, 2007; Napoli and Currenti, 2016). Those extend over the whole island but are at lower resolution. The total magnetic field shows an almost regular increase in the values moving upslope towards the cone (i.e. SW-NE direction). This can be interpreted with the gradual thinning of the loose deposit at the foot of the slope, which completely disappears moving upwards (see elevation lines in the background). Moving southwards, the negative values reach the minimum roughly in correspondence of the anomaly suggested by Bruno and Castiello (2009) (Fig. 1). This trend is clearly recognizable in the section shown in Fig. 3 (see Fig.1 for the location) which extends even more southeastwards with respect the area displayed in Fig. 2. More to the south, the value of the total magnetic field increases and becomes positive. Again, this is in agreement with the other magnetic investigations previously mentioned.

The map of the vertical gradient (Fig. 2) shows several small-scale peaks (either negative and positive), with wavelengths in the order of some tens of meters. They are especially concentrated in the southernmost part of the surveyed area and recognizable also in the section (Fig. 3). They appear as bipolar anomalies, with adjacent positive and negative peaks and could be the result of some near-surface features.

The results coming from the other geophysical technique will represent the base for the modelling of the magnetic data. Moreover, the integration of all the available information will provide a robust interpretation of this key area of Vulcano Island.

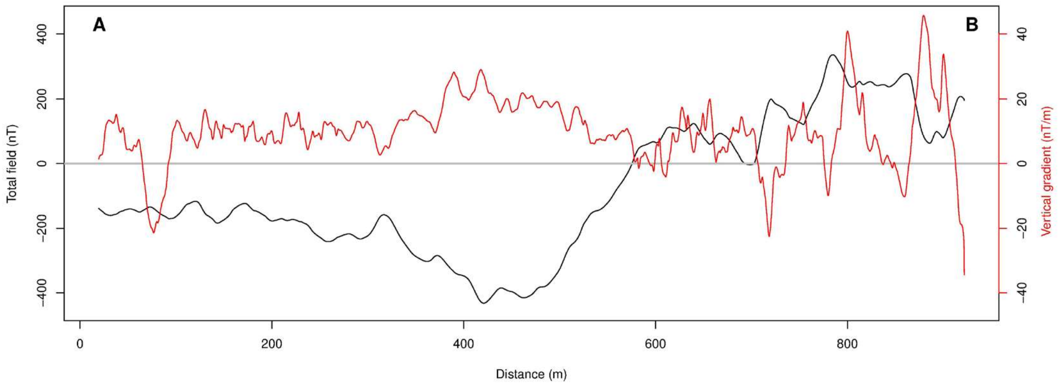

Fig. 3 - Filtered magnetic profile (40 samples running average) showing both the total field and the vertical gradient. See Fig. 1 for the location.

Acknowledgements. The authors thank Vincenzo Sapia (Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma2) who provided the magnetometer and supported the field activities.

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