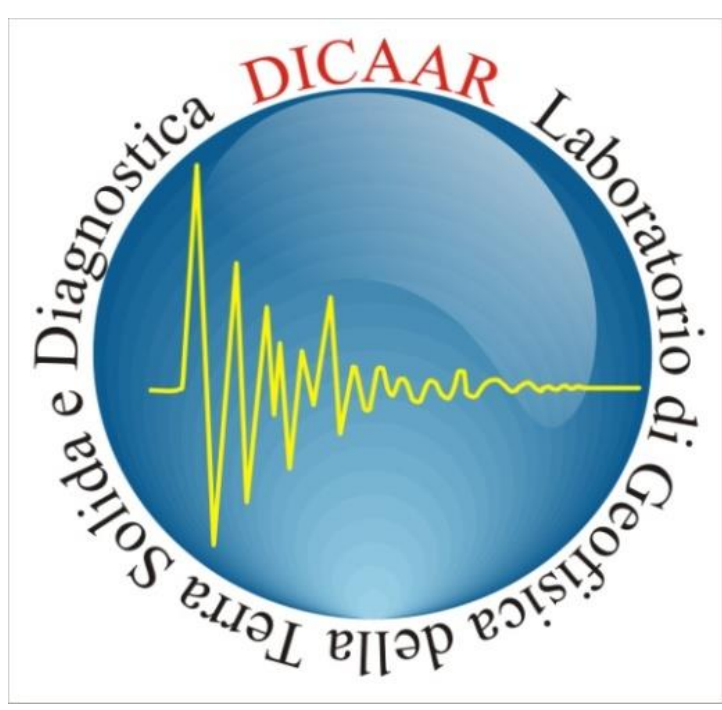
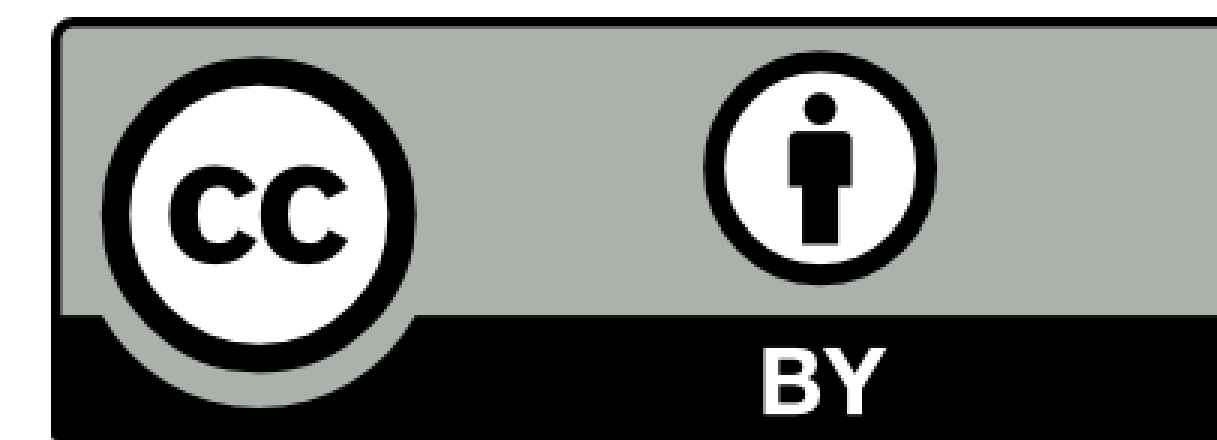


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## Integrated interpretation of reflection seismic and aeromagnetic data in a marine geological complex area: a case study.

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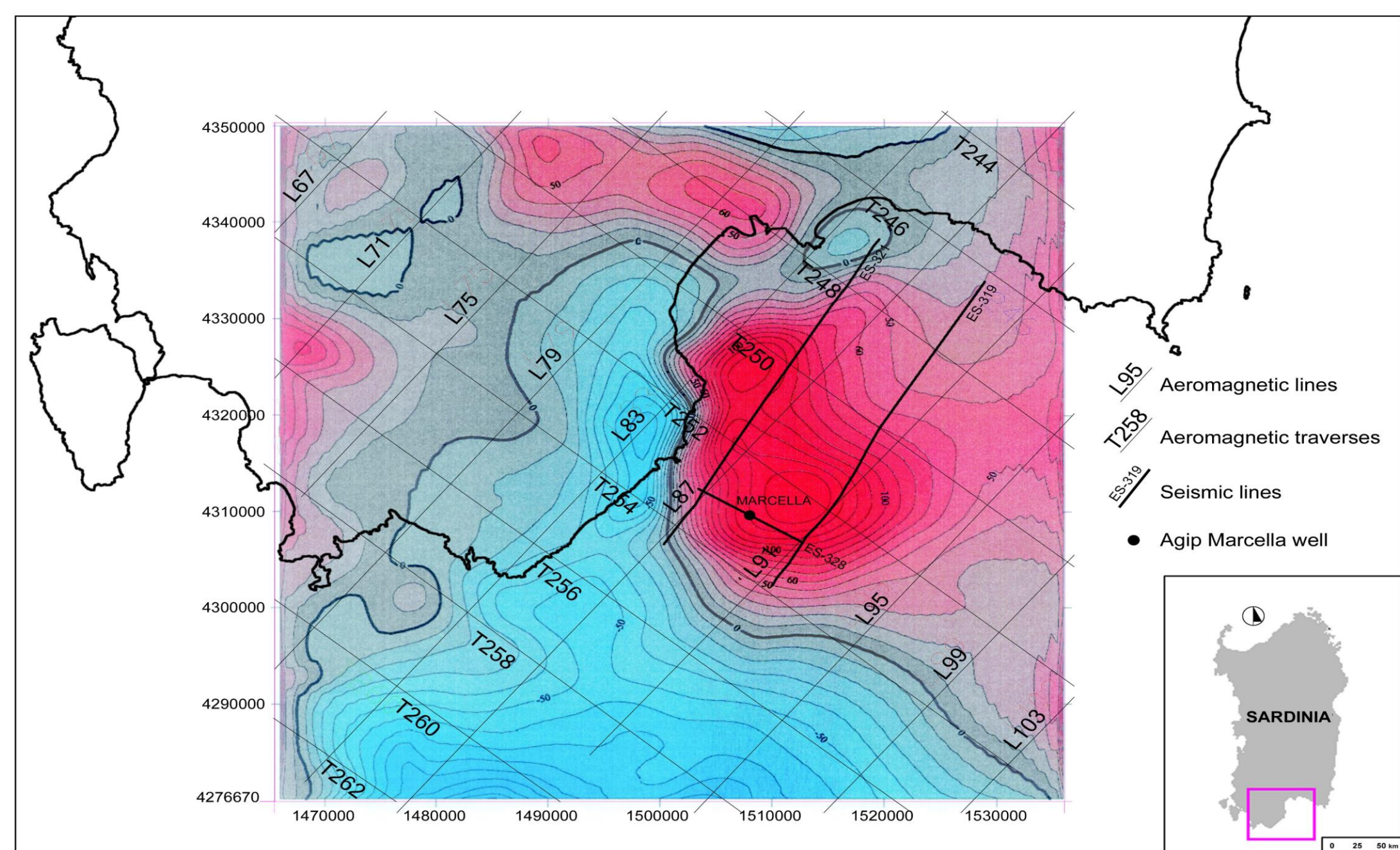
**ABSTRACT:** This paper presents an integrated seismic and aeromagnetic approach applied in the geological complex area of the Cagliari Gulf in the southern Sardinian margin (Western Mediterranean). The investigated area represents the southern extreme part of the main branch of the Sardinian Rift (SR) that is made up here of a sub-basin bounded by approximately NW faults. The study was also integrated by complementary information deduced from the GNSS network in southern Sardinia.

### MAGNETIC METHOD

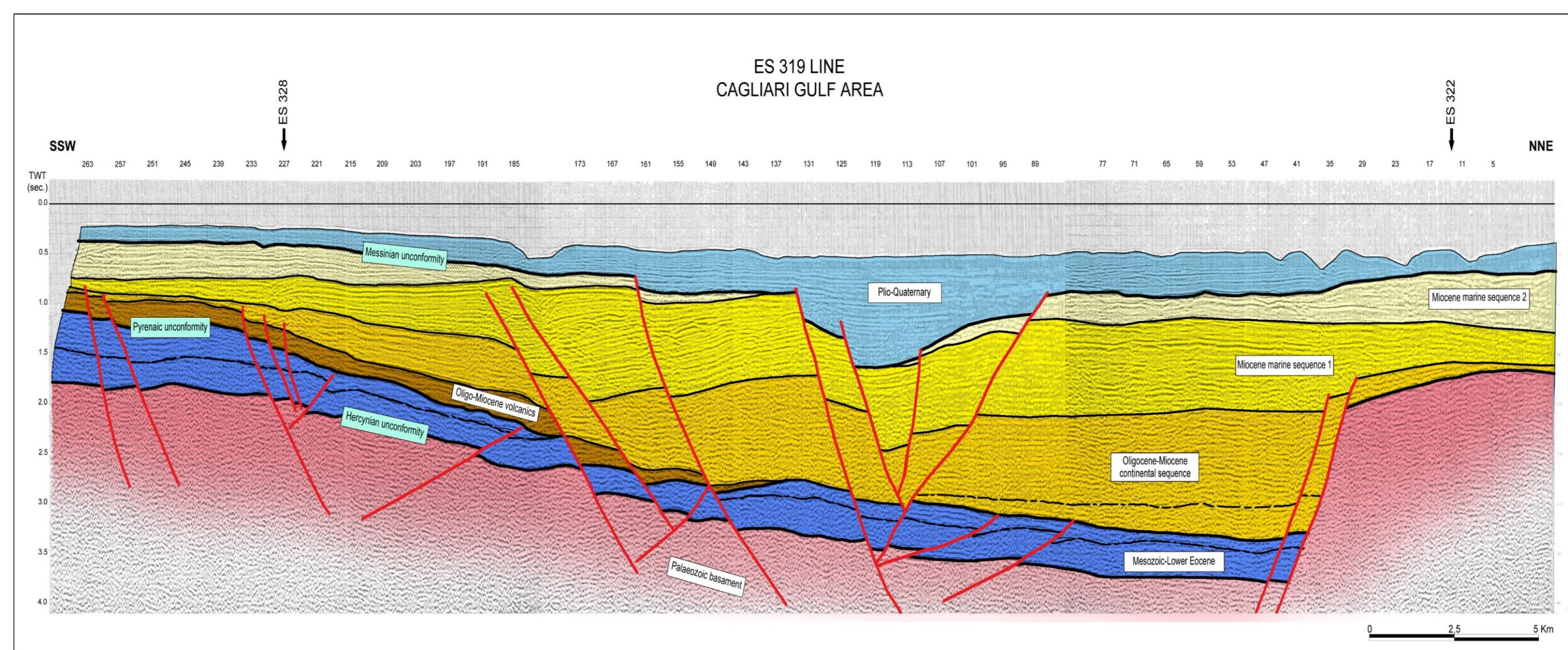
**Magnetic Data:** The magnetic data used for the interpretation of the Cagliari Basin anomalies are part of an aeromagnetic survey carried out in 1976 both on land and offshore Sardinia by the Compagnie Générale de Géophysique on behalf of E.M.Sa. (Ente Minerario Sardo) and Agip S.p.A.. The survey was conducted at a constant flight altitude of 1380 m above sea level along a grid of lines and traverses oriented respectively in NW-SE and NE-SW direction.

The data were collected using an aircraft Cessna 402, equipped with a Caesium steam magnetometer measuring the magnetic field with an accuracy of 0.2 nT at 1 second intervals (corresponding approximately to a sampling interval of 75 m along the flight lines). The aircraft was also equipped with a LORAN C positioning system allowing the determination of the position with an accuracy of 100 m.

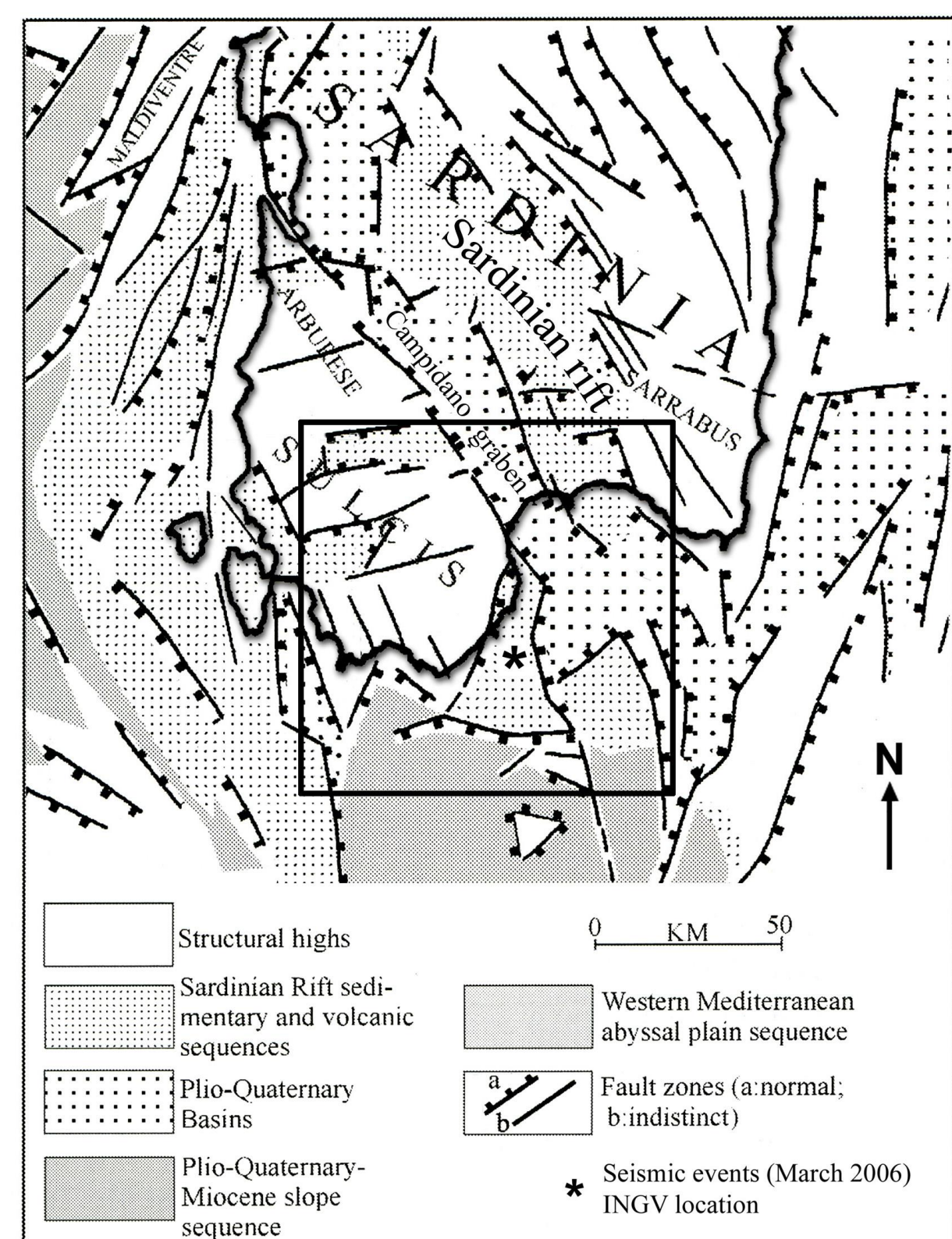
**Method:** The effect of diurnal magnetic variations and the effects of elevation variations and instrument drift were removed from the measured data before compiling the total magnetic field map. In order to obtain a residual anomaly map a regional field with a N-S gradient of 3.250 nT/km and 0.800 nT/km from west to east was removed. The parameters of this field were obtained by least-squares fitting a first order polynomial to the experimental data. The main feature of this magnetic pattern is a positive anomaly of amplitude around 150 nT characterised by stronger gradients on its western side and elongated in approximately N-S direction, quite near on the western coast of the Cagliari Gulf (Fig. 1). In the geological context of the investigated area, the anomalies were interpreted by means of a very effective integrated application of Euler deconvolution technique complemented by 2D and 3D Analytical Signal followed by a delineation technique based on the maxima of the radial horizontal derivative of the total magnetic field.



**Fig. 1** – Magnetic anomalies of the Gulf of Cagliari.



**Fig. 2** – Seismo-stratigraphic interpretation of the seismic sections.



**Fig. 3** – Main tectonic features and location of the study area.

### SEISMIC METHOD

**Seismic Data:** The seismic data used are Aquapulse reflection seismic profiles acquired in 1970 by Western Geophysical on behalf of AGIP within the frame of an Exploration Program which has been concluded with the drilling of the Marcella well that reached the depth of 2250 m and located approximately 10 Km south from the coast of Southern Sardinia (Fig. 2).

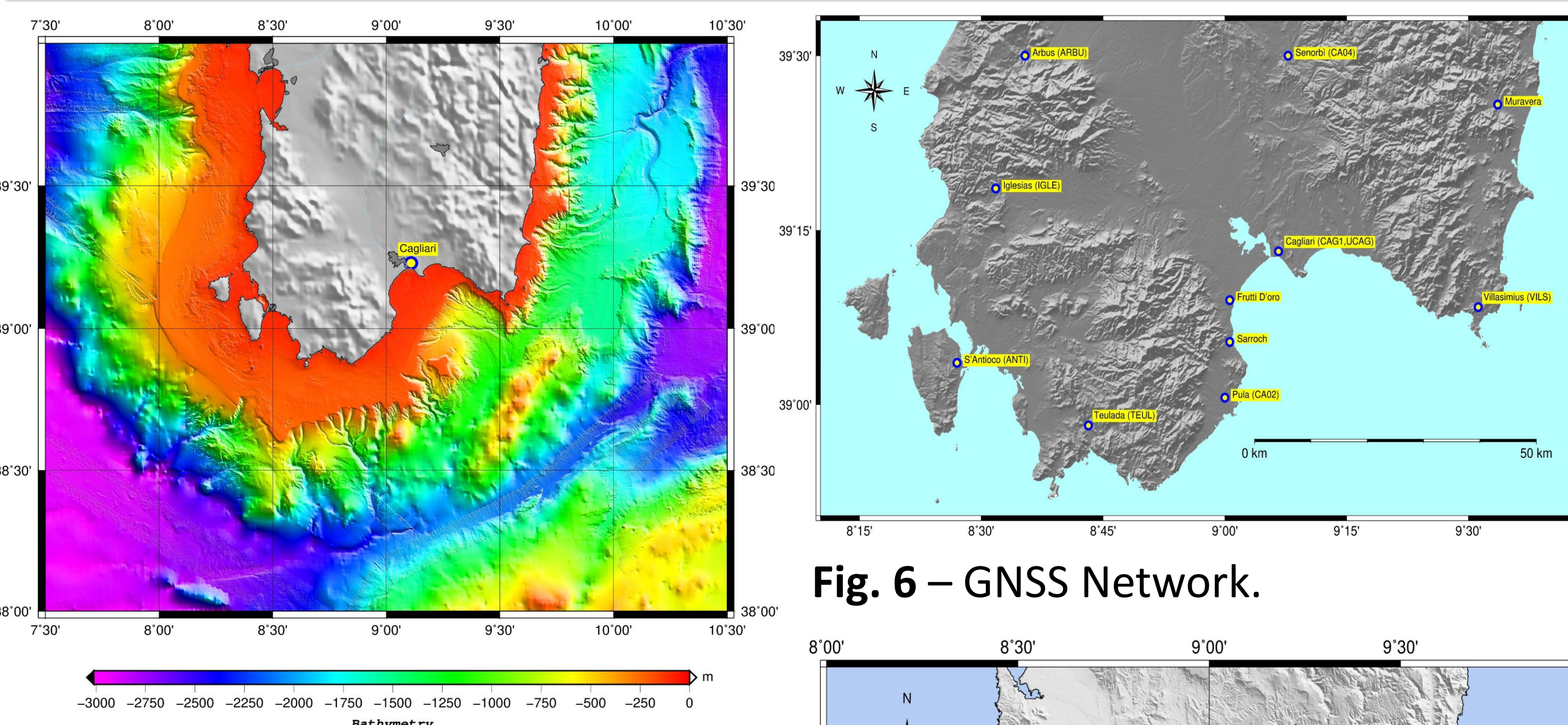
**Method:** The Aquapulse lines (ES 319, 321, 322, 324, 326 and 328) were reinterpreted for the present work and their interpretation was integrated with the aeromagnetic one. In this paper we present, as an example, one of the most significant interpreted seismic sections (ES 319).

During the seismostratigraphic interpretation process of the infilling sequences of the Cagliari Gulf Basin we used the useful information detected by the known stratigraphic sequence of the southern Sardinian Rift deduced from field observations and hydrocarbon drill hole data (Fais and Klingelè; 2007), (Fig. 2, 3). Moreover, also the most recent studies of the south-western sector of onshore Sardinia were utilised, and the new data derived by Barca & Costamagna from detailed stratigraphical and structural surveys on Mesozoic and Cenozoic outcrops are confirmed (see Fais and Klingelè, 2007; and references therein).

### GEODYNAMICAL CHARACTERISATION OF THE STUDIED AREA – GNSS

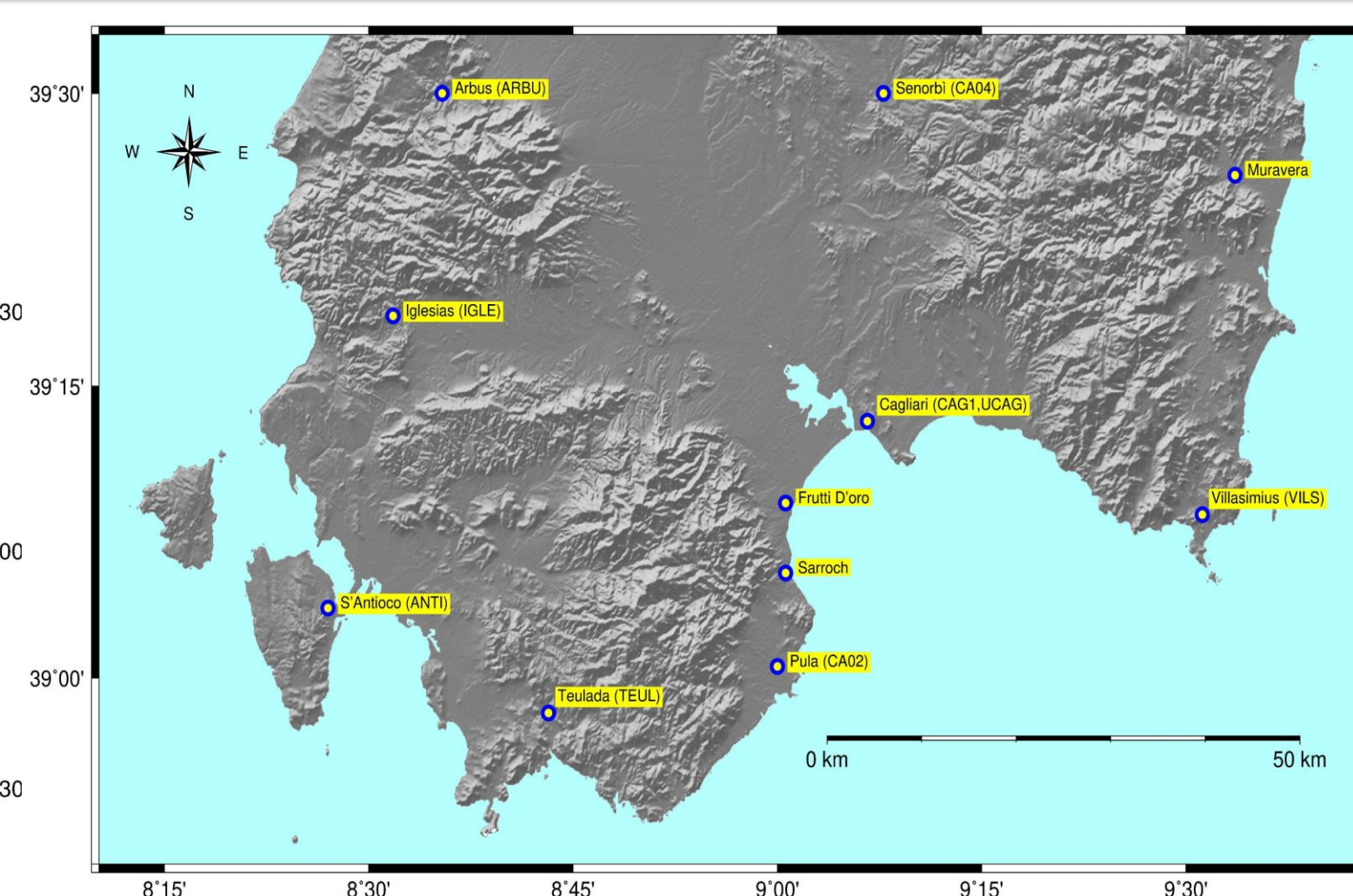
**GPS-GNSS Data:** We used RINEX data distributed by different private and public institutions: Leica-Geosystems for the SmartNet GNSS (Global Navigation Satellite Systems) network, IGS, ASI, and EUREF. We computed coordinates, velocities and position time series of 10 permanents GNSS stations sites all around the Gulf of Cagliari Region: ANTI, IGLE, ARBU, PULA, TEUL, MURA, VILS, CAG1, UCAG and Senorbì (Fig. 6).

**Method:** After a multi-step procedure based on the distributed-sessions approach we computed horizontal and vertical velocity of GNSS sites of Southern Sardinian cluster in the IGS14 core reference frame, and successively Eurasian Intra-Plate residual velocities. As can be observed in Fig. 7 the Cagliari Gulf horizontal intra-plate Eurasian residual velocities are very little and ranges in the interval +/- 0.5 mm/y (Casula, 2016; Casula and Bianchi, 2016; Fais et al. 2019). Finally we can assess that the residual horizontal velocities of the Pula and Villasimius sites are in good agreement with the tectonic structures of the Gulf represented in Fig. 3 and geophysical anomalies evidenced by aeromagnetic and Seismic data (see Fig. 1, 2), (Fais and Klingelè, 2007).

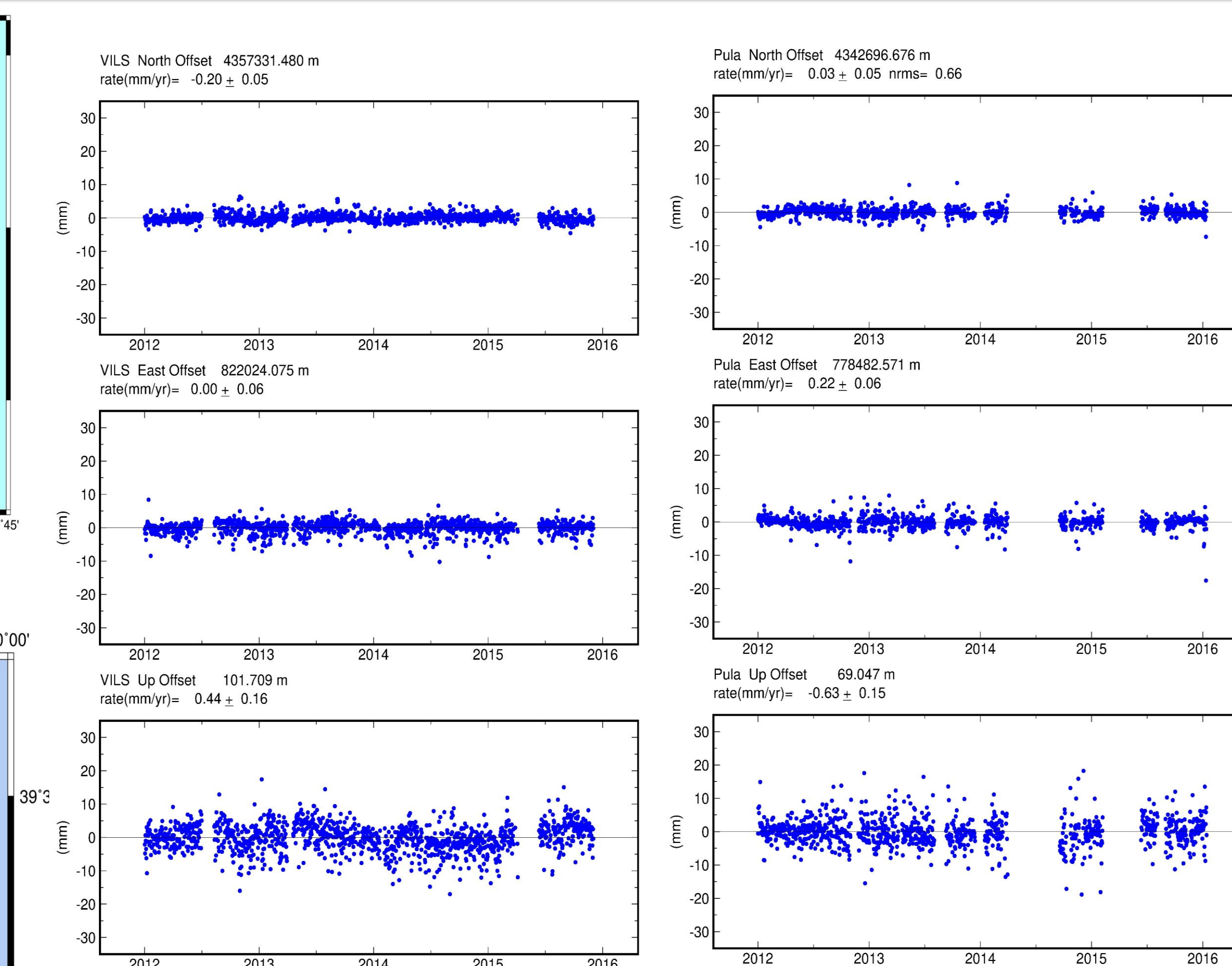
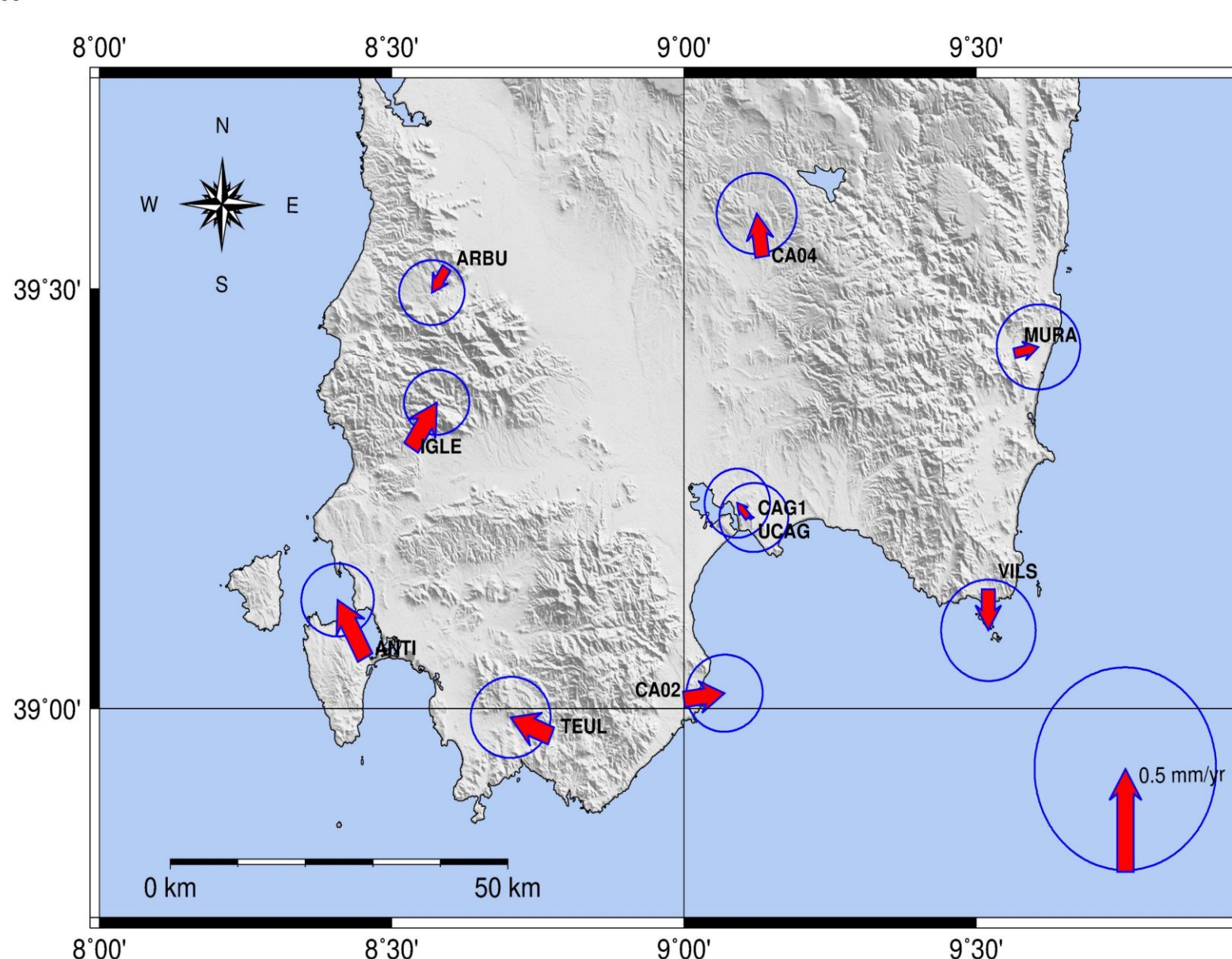


**Fig. 5** – Bathymetry of Cagliari Gulf (Dem courtesy of Gebco).

**Fig. 7** – Residual horizontal intraplate velocities (Eurasia).



**Fig. 6** – GNSS Network.



**Fig. 8** – Time Series of Pula and Villasimius GNSS stations.

### CONCLUDING REMARKS

The integrated interpretation of the aeromagnetic and reflection seismic data allowed us to improve the knowledge of the structure of the Southern Sardinian margin.

We reconstructed the geometry and the volume of the Oligo-Miocene volcanic body in the western sector of the investigated area, that is a consequence of the extensional tectonics that affected the area during the Oligocene - Lower-Middle Miocene. The seismo-stratigraphic interpretation of the seismic sections show presence of eo-alpine tectonic elements connected with the Pyrenean phase (Middle-upper Eocene) in the Southern Sardinian margin. Moreover, the above interpretation supported by GNSS residual velocities and position time series data indicates that the compressional Messinian event represent one of the most important tectonics affecting the study area (Fig. 1, 3, 7, 8).

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