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Electromagnetic sounding of the crustal structure in Sicily within the SI.RI.PRO. project

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The main goal of the SI.RI.PRO. (Sismica a RIflessione PROfonda- Deep reflection seismic exploration) project is to develop an exploration methodology aimed at studying in detail the crustal structure and the deep mantle-crust discontinuity. The framework within which this project is being developed is defined as to use different geophysical and geological data sets in terms of reference models through a software platform able to handle different kind of data.
Such project is currently developed in Sicily, whose geological structure is is well known by mean of a number of deep geologic profiles crossing both Western and Eastern Sicily from North to South. The geological sections integrate the recent interpretations of several reflection seismic profiles with the existing paleomagnetic, stratigraphic, and structural surface data, as well as data deriving from hydrocarbon exploration well logs. These data well illustrate the Sicily mainland setting, but are neither able to anchor the thrust pile at depth nor to define deep crustal geometries, due to the lacking of well defined crustal information. Hence, the aim is to implement a methodology in order to built a set of geological/geophysical crustal two dimensional models along a north -south 100 km transect crossing the Neogene fold-and-thrust belt, the narrow foredeep depression in the Caltanissetta basin, and finally the Hyblean foreland. In particular, along this profile, different kinds of data have already been collected within the SI.RI:PRO project: multichannel-reflection and refraction seismic, gravimetric and magnetotelluric data.
Within this multidisciplinary project, our task is to address whether electromagnetic induction methods based upon the use of magneto-telluric data are capable to provide geophysical information pertaining the crustal geological structure complementary to the other methods. To this end, we have carried a magnetotelluric field campaign along the above mentioned profile. During two different periods of the last year (February and August/September) magnetotelluric data have been collected over 27 stations (with a relative distance of about 3 km between two nearby stations), using two different kind of instruments so as to cover a wide frequency band (1000-0.001 Hz). Very low natural signal was recorded in the two fieldwork and electromagnetic noise has been always an issue. Remote-reference technique and long (3-6 days) observation times have been used in order to reduce effects related to low frequency electromagnetic environmental noise. The electromagnetic signal measured during February 2008 is characterized by a daily periodic variation by which the amplitude of harmonic components in the frequency range 0.1 -1 Hz is reduced during the night hours. On the other hand, the signal measured during August 2008 shows a significant thermal drift due to the electrodes stabilization and an amplitude – at frequencies greater than 0.01 Hz .-comparable with the instrumental noise.
Despite of those features of the measured signal, a preliminary analysis - carried out using a robust algorithm designed to extract magnetotelluric signals from electric and magnetic time series highly contaminated by correlated noise sources - shows that the quality of the data (coherency, signal-to-noise ratio) turns out to be quite good especially along the North-South direction, thus indicating a significant channelling of the current along this direction, which is bound to be related to some geological features of the area.

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