## DEPTH OF THE BRITTLE-DUCTILE TRANSITION IN THE GARGANO AREA (ITALY) INFERRED FROM A THERMO-RHEOLOGICAL MODEL

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The mountainous promontory of Gargano is, from a structural point of view, part of the Apulia foreland that protudes into the southern Adriatic sea (Fig. 1). The promontory and its surrounding area are subjected to a frequent seismic activity although they lie out of the Apennine axis, which is the main Italian seismogenic area (Milano *et al*., 2005).

In fact, at least 11 events, having an estimated $M_W$>5.5, struck the Gargano and neighboring areas in the past (Del Gaudio *et al*., 2007). Nevertheless, the present understanding of the regional tectonics is considered incomplete (Camassi *et al*., 2008), as demonstrated by the $M_w$=5.8) Molise earthquake in 2002 (CPTI Working Group, 2004), of magnitude greater than it would be expected from the seismological knowledge of the region available at the time.

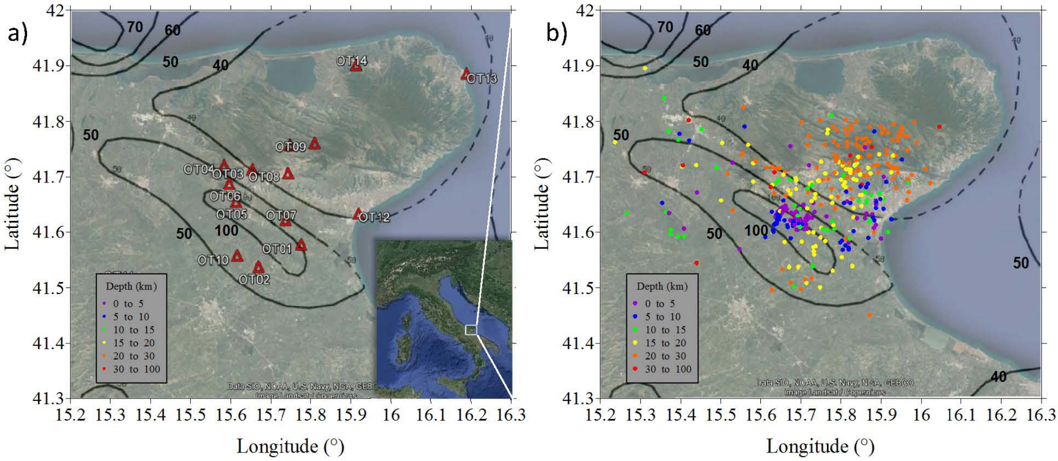


Fig. 1 - Geographic map of the Gargano area (southern Italy). Isolines of heat flow density (mWm$^{-2}$) (Della Vedova *et al.*, 2001), are superimposed. a) The stations of the OTRIONS local seismic network are shown as red triangles; b) epicenters of seismic events (de Lorenzo *et al.*, 2017) are shown as dots colored according to depth.

Before 1995, very few seismic stations were installed in the area causing a lack of reliable information about hypocenter location and focal mechanisms. Over the years, the number of stations has progressively increased with a significant growth in the years 2004 to 2008 thanks to the implementation of the National Seismic Network in central and southern Italy.

With the main aim of reducing the gap of geophysical knowledge in this part of Italy, on April 2013 a local seismic network was installed in the Gargano and Capitanata area in the frame of a scientific cooperation between Greece and Italy, funded by INTERREG programs, the OTRIONS project (Tallarico, 2013).

The OTRIONS seismic network is operational since April 23, 2013. It consists of 12 seismic stations, installed on the Gargano promontory and surroundings, each of them composed of a 24-bit SL06/SARA data-logger equipped with a short-period Lennartz 3D–V seismometer. Details on data acquisition and their management are described in de Lorenzo *et al.*, 2017.

Thanks to a scientific collaboration and agreement with the Istituto Nazionale di Geofisica e Vulcanologia (INGV), the seismic data recorded by the OTRIONS seismic Network are available to the INGV in real time. As future development of the collaboration between University of Bari (Italy) and INGV, the OTRIONS seismic network can be integrated with the National Seismic Network with the aim of improving the network coverage in the Gargano area for civil protection purposes. In Fig. 1a, the map of the OTRIONS seismic network is shown. In Fig. 1b, we plotted the seismicity recorded by the OTRIONS seismic network in the period from April 2013 to June 2014 (de Lorenzo *et al.*, 2017): about 400 events, confined in a rectangle with latitude ranging between 41.5°N and 41.8°N and longitude between 15.3°E and 16°E. The final errors in the location of the events are of the order of 1 km both in the horizontal and in the vertical directions (Fig. 10 in de Lorenzo *et al.*, 2017).

The Italian National Geothermal Database was recently revised and updated (Trumpy and Manzella, 2017). The geothermal data are currently stored in a client-server relational database management system, which is the core of a web application hosted in a dedicated website named Geothopica (http://geothopica.igg.cnr.it/). The Geothopica website provides a useful platform for interactive and efficient queries, analysis, and visualization of geothermal dataset. The Italian National Geothermal Database has two different versions of the surface heat flux density. In particular, the heat flow map (Della Vedova *et al.*, 2001) also reports the most important factors influencing surface heat flow distribution such as deep meteoric water infiltration areas or upflow of thermal fluids through fractures. In Fig.1 we plotted the downloaded isolines of surface heat flow.

The overlapping between recorded seismicity (de Lorenzo *et al.*, 2017) and heat flow map (Della Vedova *et al.*, 2001) in the Gargano area, shown in Fig. 1b, highlights an evident correspondence that we investigated using a thermo rheological model (Dragoni *et al.*, 1996).

We subdivided the Gargano area in two zones $Z_{NE}$ and $Z_{SW}$ with different surface heat flux. In correspondence of these two zones:

1) we observed the hypocenter depth distribution from the recoderd seismicity;
2) we inferred two different geotherms from the surface heat flow values to built a thermo-rheological model that can fit the sismogenic layer depth.

The seismic activity in the $Z_{NE}$ can be observed down to a maximum depth of about 28 km with very few deeper events, while the maximum frequency is observed at a depth of about 23-24 km.

The seismic activity in the $Z_{SW}$ can be observed down to a maximum depth of about 9 km with a dozen deeper events while the maximum frequency in this case is observed at a depth of about 7 km.

The thermo-rheological model (Dragoni *et al.*, 1996), using the two proposed geotherms, is able to reproduce the depth of the brittle-ductile transition from which we can infer the thickness of the seismogenic layer beneath the Gargano area. The comparison between the model results and the hypocenter depths allows us to find a match between the heat flow surface anomalies and seismicity.

The results indicate that the brittle/ductile transition in the western zone $Z_{SW}$ is significantly shallower than it is in the eastern zone $Z_{NE}$.

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