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Recent seismicity and crustal stress field in the Lucanian Apennines and surrounding areas (Southern Italy): Seismotectonic implications

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ABSTRACT

We analyzed the instrumental seismicity of Southern Italy in the area including the Lucanian Apennines and Bradano foredeep, making use of the most recent seismological data base available so far. *P*- and *S*-wave arrival times, recorded by the Italian National Seismic Network (RSNC) operated by the Istituto Nazionale di Geofisica e Vulcanologia (INGV), were re-picked along with those of the SAPTEX temporary array deployed in the region in the period 2001–2004. For some events located in the upper Val d'Agri, we also used data from the Eni-Agip oil company seismic network. We examined the seismicity occurred during the period between 2001 and 2006, considering 514 events with magnitudes $M \geq 2.0$. We computed the V_P/V_S ratio obtaining a value of 1.83 and we carried out an analysis for the one-dimensional (1D) velocity model that approximates the seismic structure of the study area. Earthquakes were relocated and, for well- recorded events, we also computed 108 fault plane solutions. Finally, using 58 solutions, the most constrained, we computed regional stress field in the study area.

Earthquake distribution shows three main seismic regions: the westernmost (Lucanian Apennines) characterized by high background seismicity, mostly with shallow hypocenters, the easternmost below the Bradano foredeep and the Murge with deeper and more scattered seismicity, and finally the more isolated and sparse seismicity localized in the Sila Range and in the offshore area along the northeastern Calabrian coast. Focal mechanisms computed in this work are in large part normal and strike-slip solutions and their tensional axes (*T*-axes) have a generalized NE–SW orientation. The denser station coverage allowed us to improve hypocenters determination compared to those obtained by using only RSNC data, for a better characterization of the crustal and subcrustal seismicity in the study area.

1. Introduction

The Southern Apennines belong to the complex geodynamic setting characterizing the Central Mediterranean region, which is dominated by the NNW–SSE convergence between the European and African plates (Argus et al., 1989; De Mets et al., 1990). The tectonics of this area is accommodated by the collision between the Adriatic microplate and the Apenninic belt (Fig. 1). The eastward migration of the extension-compression system derived by the subduction process of the Adriatic microplate is related to the opening of the Tyrrhenian basin (Barberi et al., 2004). Seismological studies and recent geodetic observations reveal that the Apennines are undergoing a NE-trending extension, with seismic deformation rates higher in the southern portion (Di Luccio et al., 2005).

Highly energetic events in the last four centuries are historically well documented. The strongest events are localized in the Apenninic chain as, e.g., the 1694 earthquake that hit the Irpinia area and the 1857 Basilicata earthquake, located in the upper Val d'Agri and Vallo di Diano, both with effects of the XI degree on the Mercalli–Cancani–Sieberg (MCS) scale. The latest strong earthquake hit the Irpinia area in 1980 with effects of the X degree MCS and normal mechanism of rupture (Boschi et al., 1990) (Fig. 2). On the contrary, the foredeep and foreland areas to the South of the Ofanto river do not show considerable historical earthquakes with the exception of the 1560 event that hit the towns of Barletta and Bisceglie with effects of the VIII degree MCS.

From the instrumental seismic catalogue 1981–2002 (Castello et al., 2005) it appears that most of the background seismicity is located along the Apenninic chain (Fig. 2). Three main clusters of earthquakes are observable. The first, in the Potentino area, wherein which concentrated the earthquakes of the two seismic sequences occurring in the years 1990 (Azzara et al., 1993; Ekström, 1994) and 1991 (Ekström, 1994), both produced by E–W oriented strike-slip structures, and the second, in the Irpinia region. Finally, the last cluster in the Castelluccio area (1998 seismic sequence) with pure normal focal mechanism, close to the North-western border of the Pollino range

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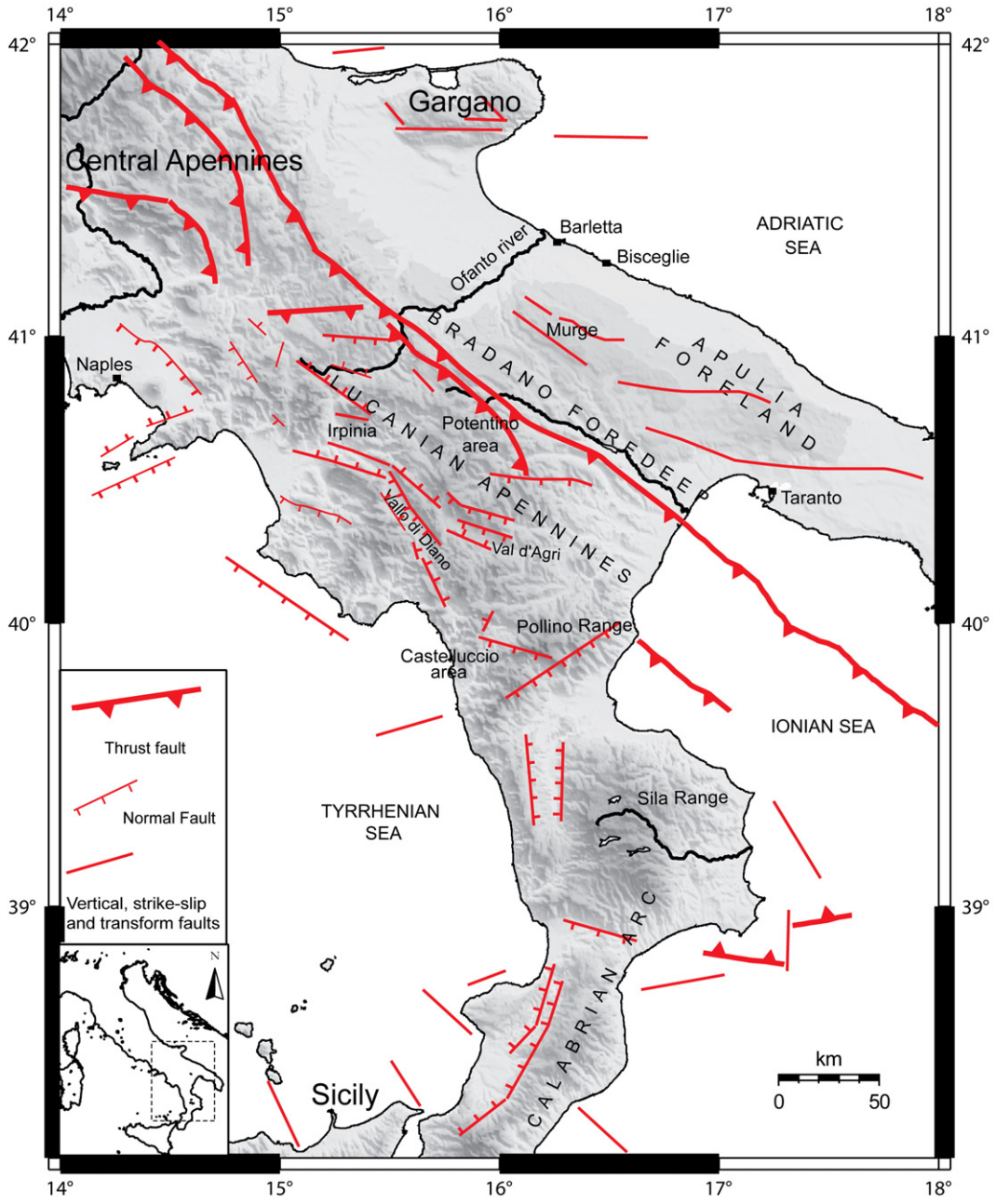

Fig. 1. Structural-kinematic map of Southern Italy (simplified from the "Structural map of Italy"; Bigi et al., 1990).

(Michetti et al., 2000; Pondrelli et al., 2002). The seismicity in the area between the Vallo di Diano and the upper Val d'Agri is sparse as in the external areas of the Bradano foredeep and the Apulia foreland.

The area of the Lucanian Apennines is one of the main seismically active regions of Southern Italy. The main goal of this paper is to provide new insights on the seismotectonic in this portion of the Apenninic chain through a careful analysis of background seismicity and active stress field information retrieved from fault plane solution inversion. Present-day stress field data are important for the seismotectonic zonation, a basic tool for seismic hazard evaluation, and are helpful to predict the behaviour of seismogenic faults. Taking advantage of the availability of a denser coverage of seismic stations in the area, we created a high quality database of local earthquake waveforms recorded during 2001–2006 by the RSNC, the SAPTEX temporary array (2001–2004) (Cimini et al., 2006), and the local ENI-AGIP network in the upper Val d'Agri (Fig. 3). This work is subdivided into four steps: (1) *Vp*/*Vs* ratio computation using a modified Wadati method, (2) application of the VELEST code (Kissling et al., 1995) to find the best one-dimensional (1D) velocity model for the study area, (3) relocation of the well-recorded events with the HYPOELLIPSE code (Lahr, 1989) to obtain a detailed seismicity distribution of earthquakes; and (4) focal mechanisms and regional stress field computation.

2. Data selection and *Vp*/*Vs* ratio computation

We re-picked arrival times of earthquakes recorded by the RSNC seismic network and picked those recorded by the temporary SAPTEX network in the period between June 2001 and December 2006. The ENI-AGIP network data were used only for some events located in the upper Val d'Agri and surrounding areas. During the observing period, the permanent network RSNC improved significantly in Southern Italy, increasing both the station coverage and the number of three-component extended band (Lennartz 5 s) or broad band (Trillum 40 s) sensors, which replaced the Kinemetrics S-13 short period sensors.