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Crustal structure, seismicity and seismotectonics of the Trentino region (Southern Alps, Italy)

Alfio Viganò (1), Davide Scafidi (2), Silvana Martin (3), Daniele Spallarossa (2), Luca Froner (4), and Oscar Groaz (4)

(1) Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, CRS, Udine, Italy (alfio.vigano@retesismicatrento.org), (2) Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, Università di Genova, Italy, (3) Dipartimento di Geoscienze, Università di Padova, Italy, (4) Servizio Geologico, Provincia Autonoma di Trento, Trento, Italy

The Trentino region is located at the junction between the central and eastern Southern Alps (Italy), at the intersection between the Giudicarie, Schio-Vicenza and Valsugana fault systems. This area is characterized by relevant lithological and structural lateral heterogeneities, both at the crustal and lithospheric scales. A low-to-moderate seismicity is located in the upper crust, where faults are seismically active under a dominant compressive with variable strike-slip component regime. Here we study the crustal structure of this portion of the Southern Alps (Adria plate) from interpretation of local earthquake tomography images, in relation with distribution of relocated seismicity and regional tectonic patterns.

Local earthquake tomography derives from a set of 476 selected earthquakes in the period 1994-2007, with local magnitudes comprised between 0.8 and 5.3. Hypocenter distribution, and number and quality of manually-repicked phases (6322 P and 5483 S) ensure optimal seismic ray coverage. Original recordings are principally from the *Provincia Autonoma di Trento (PAT)*, that manages the Trentino seismic network since 1981, and from other networks (*Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – INOGS*; *Istituto Nazionale di Geofisica e Vulcanologia – INGV*; others available via the European Integrated Data Archive). The code HYPOELLIPSE is used to perform initial earthquake relocations. The code VELEST is then used to calculate a new minimum 1-D velocity model, as input for tomography.

The 3-D tomographic inversion (V_P and V_P/V_S ratio) is obtained via the code SIMULPS, with the implementation of an accurate shooting ray-tracer. The crustal volume is discretized in order to have a regular grid with a homogenous horizontal spatial resolution of 7.5 km. The resolution in depth varies according to the obtained minimum 1-D velocity model. Reliability and accuracy of results are estimated by analyzing the Resolution Diagonal Elements of the resolution matrix and by checkerboard resolution tests.

The distribution of velocity anomalies from tomographic images within the investigated crustal volume shows very good correlations with surface geology and geodynamics. Strong lateral velocity anomalies of the crust are interpreted as due to lithological variations corresponding to different geologic domains (carbonate cover, magmatism, metamorphic basements). V_P/V_S ratios are also significantly variable, with highest values in the range 1.80–1.90 located along major faults (South Giudicarie and Valsugana-Bassano del Grappa-Montello thrusts). These values are interpreted as due to high fracturing and/or presence of fluids in the upper crust.

The obtained 3-D tomographic velocity model is used to relocate not only best-quality earthquakes used as input for tomographic inversion, but also those with an adequate number and quality of phase readings during the same time period. For this purpose we use the code NonLinLoc, with specifically calibrated parameters for the study area. A significant quality improvement in hypocentral solutions can be obtained locating earthquakes using the 3-D V_P and V_S velocity model, rather than a more simplified 1-D velocity model. This procedure represents a critical step to enable high-quality local seismic event (re)locations in the Trentino region (e.g., seismic bulletin), also to perform more reliable seismic hazard maps for civil protection.