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A crustal model of the region interested by the 2016 Central Italy seismic sequence, by integrating local earthquake tomography and Bouguer gravity anomalies data

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The 2016-2017 Central Italy seismic sequence struck with three M6+ normal-faulting earthquakes the junction zone between the Central and Southern Apennines. The area is characterized by a complex geological structure due to the occurrence of multiphased contractional (Mio-Pliocene) and extensional (Quanternary) deformation. Although the region was the target of geophysical investigation mainly motivated by the intense seismicity, large uncertainties remain about the deep architecture of the thrust-and-fold belt. Three-dimensional Vp and Vp/Vs models determined by local earthquake tomography surveys (Carannante et al., 2013, Chiarabba et al., 2018) suffer from limited lateral resolution (5 km x 5 km) restricted to the epicentral area, and limited vertical penetration (12-15 km). Besides, deep seismic reflection profiles totally lack in the area, while hydrocarbon exploration is concentrated in the southern region between the zones interested by the 2016-2017 Amatrice and 2009 L'Aquila seismic sequences. In order to obtain crustal images of the epicentral region with improved spatial resolution and exploration depth, we propose the joint inversion of passive seismic and gravity data.

We exploit earthquake arrival times recorded by 50 permanent and 20 temporary seismic stations deployed soon after the occurrence of the first, August 24, 2016 Amatrice mainshock (Moretti et al., 2016) together with Bouguer gravity data assembled for the Italian Geoid (Barzaghi et al., 2002). The tomographic Vp and Vs models (Chiarabba et al., 2018) are the input of the Sequential Integrated Inversion algorithm (Tondi et al., 2012), which enables us to recover a new 3-D density-velocity integrated model. The update to the density model is transformed into the update to the velocity model through the optimized linear relationships, and the two models are checked for gravity and seismic data misfit. The model that covers a wide region (12.5-14.2 in longitude and 42.2-43.2 in latitude), extends down to 25 km depth and provides inferences on the lithology and main structures in the upper and mid crust. With respect to the local earthquake tomography survey (Chiarabba et al., 2018), the density-velocity integrated model resolves a low-density, low-velocity wedge in the eastern region that relates to a thick (> 5 km) sequence of Plio-Qaternary clastic foredeep sediments. In axial zone of the range (i.e. in the epicentral region), a low-density, low-velocity zone at about 10 km may be interpreted as a low-metamorphic phyllitic basement sandwiched between two high-density, high-velocity regions. The upper region corresponds to the Umbria-Marche carbonate multilayer mainly consisting of Mesozoic limestone, dolostone and evaporites, while the lower one likely relates to the crystalline basement. The low-density, low-velocity zone delimits at depth the seismogenic layer and marks the brittle-ductile transition.