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Plate boundaries and lithosphere dynamics in the non-tidal gravity change on the Romanian territory

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Large lateral variations in the lithosphere thickness advocate for the presence of at least three tectonic plates/sub-plates on the Romanian territory: East European plate (EEP), Intra-alpine Micro-plate (IaP), and Moesian micro-plate (MoP). However, geometry and nature of their boundaries are still debated. Previous integrated research, mainly based on geophysical data interpretation, brought some evidence on the location and nature of their contacts: the Tornquist-Teisseyre compression zone (TTZ) between EEP and IaP, the dextral strike-slip Peceneaga-Camena Fault (PCF) between EEP and MoP, and the dextral strike-slip Trans-Getica Fault (TGF) between MoP and IaP. To monitor lithosphere dynamics on the Romanian territory, a network consisting of several geo-traverses crossing these major lithosphere boundaries along with a denser micro-net over the Vrancea active zone was designed and achieved. Steel-reinforced concrete pillars (0.5 x 0.5 x 2.0 meters) providing facilities for both gravity and GPS determinations were grounded at each base station of the network. High accuracy repeated gravity observations were performed on each pillar by using the L&R G-1121 meter. The scale factor of the gravity meter was checked up along the national calibration line (Brasov-Poiana Brasov) and UNIGRACE calibration line (Cluj Napoca - Belis) prior and after the gravity campaigns providing similar figures. Absolute gravity was transferred to the geodynamic network from both national gravity system (providing values for the epoch 1980), and the UNIGRACE reference base stations (valid for 2000). This way a pair of absolute gravity values separated by a time span of 20 years was obtained and compared on each base station of the network. The following aspects should be stressed: (i) reliable non-tidal gravity changes were outlined (ranging between 100 to 250 microgals); (ii) distinct gravity time-evolution on base-stations located along the lines crossing plate boundaries was revealed; (iii) non-tidal gravity change within each of the assumed tectonic plates has a distinct behavior;

this fingerprint changes across the assumed plate contacts; (iv) there is a sharp gravity change across PCF, or relatively sharp across TGF strike-slip contacts, but a gradual gravity change, with constant behavior in the transient zone, across TTZ compression contact. The high accuracy repeated geometric leveling along the lines crossing the major lithosphere boundaries also showed distinct crust deformation within different plates, but stable behavior within all transient zones. On the overall, non-tidal gravity changes and crust deformation across major lithosphere boundaries support previous hypotheses claiming for the existence of at least three tectonic plates on the Romanian territory, and the different nature of their contacts (compression along TTZ and strike-slip character for PCF and TGF). The relatively unchanged gravity across TTZ might be due to a slight increase in density of the transient compartment, following horizontal compression, which would compensate, at least partly, the gravity decrease provided by the deeper lithosphere dynamics. Consequently, TGF might be interpreted as a right lateral transpressive contact, with a slight compression component towards South Carpathians, while PCF appears as a pure strike-slip contact. Within the Vrancea active seismic region, a general decrease in gravity was pointed out for the above-mentioned time span. The lowest gravity low was revealed for the epicenter area, in correlation with a negative deformation in topography. That was interpreted in terms of the crust stretching pulled down by the sinking of the still attached denser seismic body. High accuracy geometric leveling and repeated gravity observations within the geodynamic polygon Tulnici-Valea Sarii-Vrancioaia (located in the epicenter area) prior and after the significant earthquake on 27 October 2004 (Mw = 6) seem to confirm the hypothesis.