4.7.7. LITHOSPHERE DYNAMICS, CRUST DEFORMATION AND NON-TIDAL GRAVITY CHANGES ACROSS MAJOR LITHOSPHERE BOUNDARIES ON THE ROMANIAN TERRITORY

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4.7.7.1. Research infrastructure

Plate boundaries on the Romanian territory and their dynamics have been recently reviewed (Besutiu, 2003, Besutiu et al., 2004) with special emphasize on the role played by the Black Sea opening (Besutiu, Zugravescu, 2004). Short-distance large variations in the lithosphere thickness advocate for the presence of at least three plates/sub-plates in the area. East European plate (EEP), with a lithosphere thickness of more than 150 km, Intra-alpine micro-plate (IaP) with its 80-90 km lithosphere, and Moesian micro-plate (MoP), with 120-150 km lithosphere thickness, meet each other in the Vrancea unstable triple junction, where the asthenosphere was revealed at more than 250 km in depth. Major lithosphere boundaries on the Romanian territory are: Peceneaga-Camena Fault (PCF) between EEP and MoP, Tornquist-Teisseyre Zone (TTZ), between EEP and IaP, and Trans-Getica Fault (TGF) between IaP and MoP.

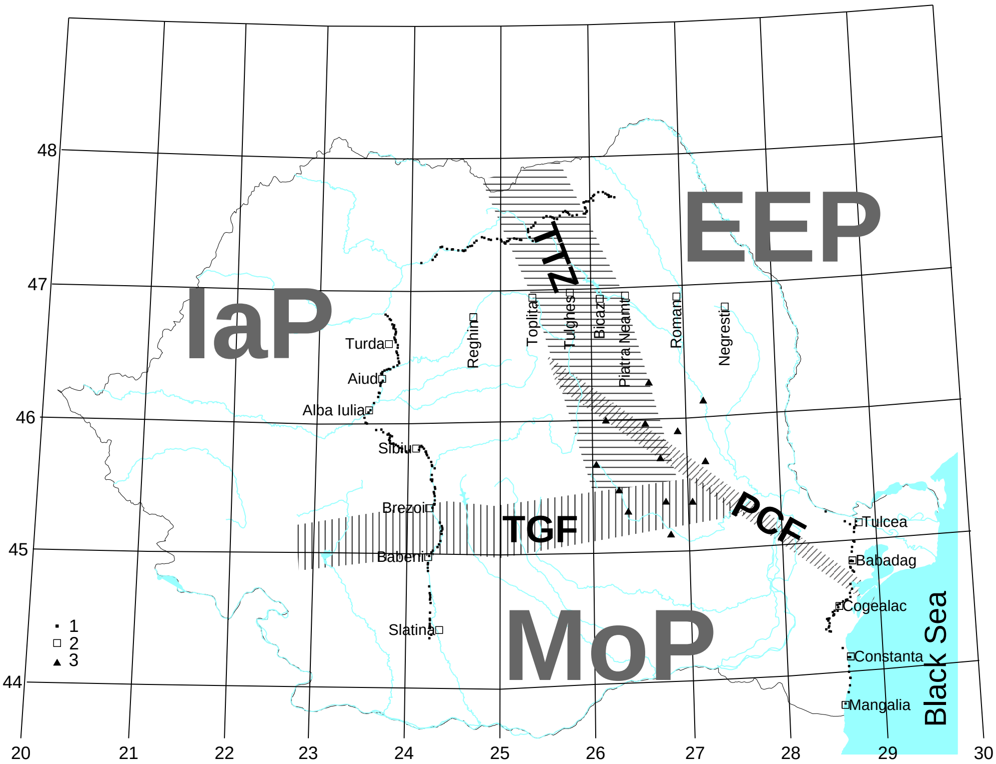

Fig. 4.7.7.1. The design of the Romanian geodynamic network
1, high accuracy geometric leveling benchmarks; 2, RGDN pilars; 3, Vrancea net

To monitor lithosphere dynamics on the Romanian territory, a geodynamic network encompassing three main geo-traverses crossing major lithosphere boundaries (PCF, TGF, and TTZ), and a special micro-net over the Vrancea triple-junction was designed and achieved (Fig. 4.7.7.1.).

Steel-reinforced concrete parallelepiped pillars were grounded 1.20 – 1.50 m in depth at each base station. The upper part, rising above the ground, of each pillar (50 cm x 50 cm x 50 cm) was equipped with a special device for centering the GPS antenna.

4.7.7.2. Data acquisition and processing

Repeated high accuracy relative gravity determinations on the above mentioned pillars were performed by using the LaCoste & Romberg G-1121 meter. Basic idea was to obtain and compare absolute gravity values at each data point for two different epochs. To get that, absolute gravity was transferred from both the Romanian gravity national system (Besutiu et al., 1994), and the UNIGRACE system (Besutiu et al, 2001).
Vertical gradient of the gravity was also observed at each pillar. At least two measuring loops were used for each data point, usually performed in different days, and relative gravity determinations were corrected for tide effect (using the rigid Earth model), and for the instrumental drift.

4.7.7.3. Scaling factor and data consistency

Prior to and after the field campaigns, scale-factor of the L&R G-1121 gravity meter was checked up along the UNIGRACE calibration line Belis – Cluj-Napoca (172.120 mgals). To check up data consistency between UNIGRACE and the Romanian national gravity reference networks, the former calibration line Brasov – Poiana Brasov was also observed with the L&R G-1121 meter providing similar figures with gravity meters used for the achievement of the Romanian national gravity system.

4.7.7.4. Accuracy

As previously mentioned, each location was observed at least twice within independent measuring loops, performed in different days. An average rms better than 0.005 mgals was obtained on the overall within the network, advocating for the high quality of determinations. Whether the second order gravity network of Romania was quoted with an average accuracy of about 0.040 mgals, and absolute gravity within UNIGRACE base stations was determined with accuracy better than 0.010 mgals, it is likely that the average confidence level for absolute gravity in each data point of the geodynamic network should be better than 0.050 mgals.

4.7.7.5. Main results and their interpretation

First of all, it should be stressed that the revealed non-tidal gravity changes are at least twice higher than the confidence level of the observations, which strongly advocates for their reliability. As it can be seen in Fig. 4.7.7.2, non-tidal gravity changes in the RGDN base stations located along the Mangalia – Tulcea line, crossing the contact between MoP and EEP, clearly show distinct gravity behaviour between the two plates. A gravity decrease of about 100 µgal is evidenced south PCF, while about 200 µgal decrease are exhibited for EEP. The same gravity change within MoP is present along the geo-traverse Slatina – Aiud. Similar values were recorded for the RGDN base

stations Slatina, Băbeni and Brezoi (about 100 µgal). Beyond the Brezoi base station, non-tidal gravity change exhibits increased values for the RGDN base stations located within the IaP (more than 200 µgal, except for Sibiu location). Northward TGF geo-traverse, additional observations made by re-occupying the old location of the Turda second order national gravity reference base station also showed a gravity change of about – 200 µgal, thus confirming the level of the gravity decrease within IaP, two times higher than within MoP. As in the case of the PCF, the northern boundary of MoP clearly marks a change in the time evolution of gravity between MoP and IaP.

Non-tidal gravity changes along the line crossing TTZ exhibited a somehow distinct pattern. Both within IaP and EEP, non-tidal gravity change is progressively decreasing towards the TTZ compression zone. Base stations located within the TTZ recorded almost no time variations of gravity during the time span considered.

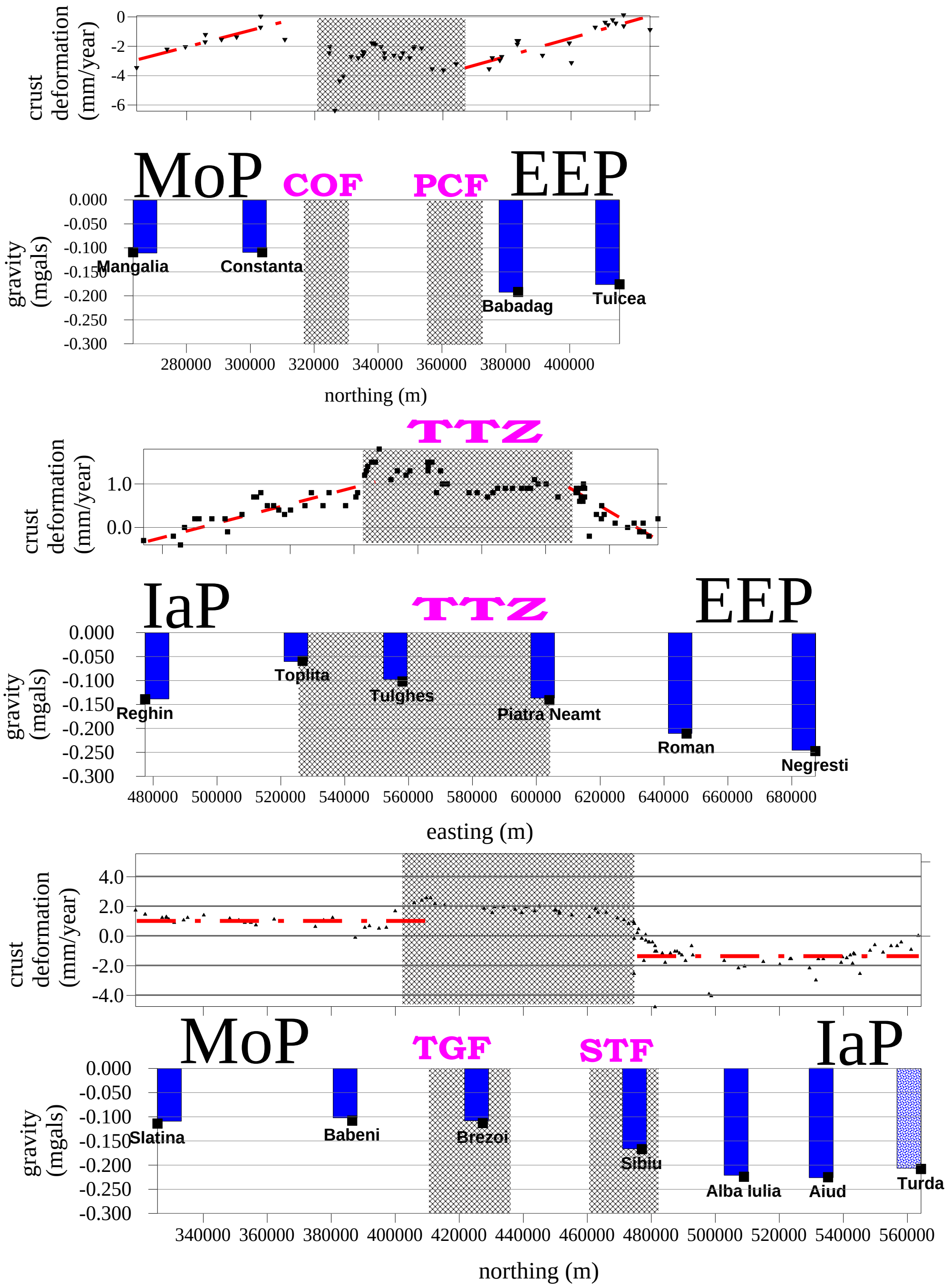

Fig. 4.7.7.2. Non-tidal gravity changes along the RGDN geo-traverses and crust deformation along the high accuracy geometric leveling lines crossing major lithosphere boundaries
COF, Capidava-Ovidiu Fault; STF, South Transylvanian Fault. For additional explanations see the text

4.7.7.6. Crust deformation

To help the interpretation of the gravity data, some synthetic information on the high accuracy repeated geometric levelling performed many years ago (Popescu, Drăgoescu, 1987, 1988) along the gravity observation lines were added. Location of the high accuracy geometric leveling lines is shown in Fig. 4.7.7.1.

Crust deformation along the high accuracy repeated geometric leveling lines crossing the plate boundaries showed the followings aspects:

- **a northward increasing trend along the line crossing PCF; the transient zone between MoP and EEP marks a clear discontinuity by lowering the reference level within EEP;**
- **weak uplift within MoP, and small lowering for IaP are exhibited along the line crossing TGF; a crust uplift of about 2mm/year is recorded within the transient zone between Mop and IaP, very likely related to the isostatic rebound of the crust beneath South Carpathians**
- **a more intricate situation occurs along the line crossing TTZ: an increasing crust uplift towards the plates contact from the both sides, and a stable higher deformation within the transient zone between IaP and EEP.**

4.7.7.7. Concluding remarks

By examining the above-mentioned results, the following aspects should be stressed:

- **presence of reliable non-tidal gravity changes within RGDN base stations for a time span of about twenty years**
- **various gravity time evolution within RGDN base-stations located along the lines crossing major lithosphere boundaries on the Romanian territory**
- **distinct clustering of the non-tidal gravity change values within each of the postulated tectonic plates**
- **full gravity step across PCF and partly across TGF strike-slip plate boundaries**
- **gradual gravity change with constant behavior in the transient zone across TTZ compression contact.**

The high accuracy repeated geometric leveling across the major lithosphere contacts also showed distinct crust deformation within different plates, with stable behavior across all transient zones.

Basically, non-tidal gravity change 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 along TTZ might be due to the slight increase in density of the transient compartment, as a result of the tectonic compression, which would compensate, at least partly, the gravity decrease provoked by the deeper lithosphere dynamics. Consequently, TGF might be interpreted as a dextral transpressive contact,

with a slight compression component towards South Carpathians, while PCF appears as a pure strike-slip plate boundary.

4.7.7.8. References

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