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CONSIDERATIONS ON THE LITHOSPHERE COMPARTMENTS AND THEIR DYNAMICS ON THE ROMANIAN TERRITORY, AS INFERRED FROM GEOPHYSICAL DATA

Lucian BESUTIU, Gelu GHIOCA, Luminița ZLAGNEAN & Dorel ZUGRAVESCU

Institute of Geodynamics of the Romanian Academy, 70201 Bucharest, 19-21, Jean Louis Calderon St., ROMANIA, e-mail: besutiu@geodin.ro

Plate geometry

Both seismic and magnetotelluric soundings (MTS) revealed large variation in the lithosphere thickness on the Romanian territory, which are not consistent with some previous ideas concerning the existence of a unique tectonic plate. There is an 80 km thick lithosphere for the Transylvanian Depression, 120-150 km within the Moesian Platform, and more than 150 km within the Moldavian Platform, that is part of the East European Platform. Consequently, a three-plate tectonic model for the Romanian territory was considered. East European Plate (EEP), Moesian micro-plate (MoP), and the Intra-alpine micro-plate (IaP) met each other within Vrancea active seismic area, where MTS data pointed out the asthenosphere even deeper, at about 250 km. Large lithosphere discontinuities, well outlined by geophysical investigations, such as Tornquist-Teisseyre (TTZ) compression zone, Peceneaga-Camena Fault (PCF) and the Trans-Getica Fault (TGF) strike-slip contacts separate the above-mentioned plates.

Plate dynamics

Past to recent dynamics of the above mentioned lithosphere compartments is further discussed in the paper with special emphasize on the consequences of the Black Sea opening. It seems that during the Late Paleozoic – Early Triassic, very likely associated to the large geodynamic event that split the SW margin of EEP and generated the East Carpathians rifts, an important segment of the EEP was pushed westward along TGF, as a first stage in creating the MoP. Evidence to support this hypothesis are Archean granodiorite rocks and basic Lower Triassic effusives, rather similar to rocks occurring within EEP, met by deep drillings in the western MoP basement.

Next major geodynamic event, which could be partly coeval to the Cretaceous flysch ocean closure, started during Late Cretaceous, when crust extension related to the W Black Sea basin opening partly removed the above mentioned EEP derived terranes and created the Dobrogean sector of the Moesian Platform. MoP was split into several crustal slivers, by re-activating or creating major crustal faults such as: St. Gheorghe, Peceneaga-Camena, Ostrov-Sinoe, Capidava-Ovidiu, Intramoesian fault, Varna-Giurgiu, etc.

Crust shortening took place in various circumstances. East Carpathians, crust expelled met the inclined boundary of TTZ and came into an oblique subduction to which peculiarities of volcanism in the southernmost Harghita Mts seem to be related. South Carpathians, crustal slivers faced the vertical margin of the IaP, and provoked a lithosphere buckling, well reflected in the lowest gravity low on the Romanian territory, which lies in front and not beneath the highest mountains in the country.

It seems that the W Black Sea opening also induced an excess in the velocity of MoP that broke the geodynamic equilibrium and created circumstances for the genesis of an unstable triple junction in the bending area of East Carpathians. The strange peculiarities of the intermediate-depth seismicity within Vrancea area, with its strictly confined, nearly vertical hypocenters location, could be easily explained by the presence of an unstable transform-transform-compression triple junction.

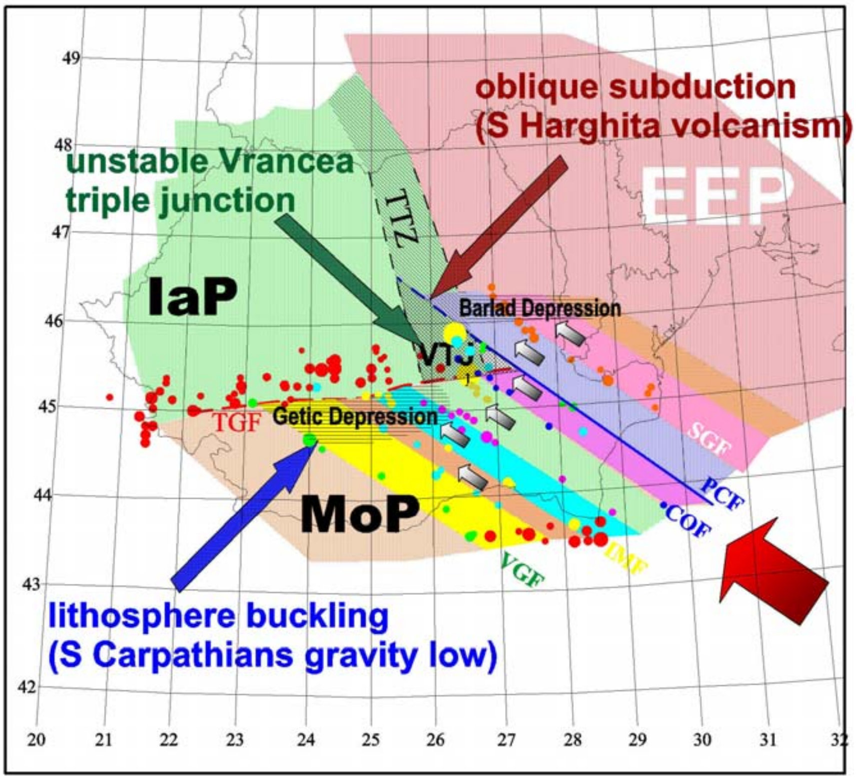

Fig. 1 Crust shortening consequences related to the W Black Sea opening and recent dynamics within SE Carpathians. Dots mark epicenters of normal earthquakes along major faults within MoP: SGF, St. Gheorghe Fault; COF, Capidava-Ovidiu Fault; IMF, Intramoesian Fault; VGF, Varna-Giurgiu Fault

Tectonic forces driving the three plates pushed down the lithosphere block squeezed between MoP, EEP and IaP wedges. High rate of sedimentation (six times higher in the Vrancea region than in the rest of East Carpathians) and subsequent overthrusting of the East Carpathians nappes accented the collapse. The penetration of a colder lithosphere block into the hotter upper mantle led to an obvious thermodynamic disequilibrium. Temperature accommodation phenomena such as thermal stress, convective cells, phase transform processes, and devolatilization add new sources to the intermediate-depth seismicity in the area.

Looking at the map of Europe seismicity, two main seismic belts are outlined on the Romanian territory. One of them is located along PCF, advocating for a relative displacement between MoP and EEP. The other one is located within South Carpathians, confessing about the active strike-slip nature of the MoP northern boundary. It seems that northwestward displacement along PCF, generated by active rifting in SW Arabian plate, transforms in a westward movement along TGF, in a similar manner to the tectonic escape along North Anatolian fault. The hypothesis seems to be well supported by the change in strike of the regional stress tensor (from NW along PCF to WSW along TGF). Actually, after the Black Sea ended its evolution, active rifting in SW Arabian Plate seems to offer driving forces for the present dynamics in the area. Under their action, the above mentioned MoP crustal slivers relatively move each to another, thus generating normal earthquakes along their wedges, which explain the unusual seismicity within Moesian Platform. The rather singular intermediate-depth seismicity within Vrancea zone could be conveniently explained by dynamics of the postulated unstable triple junction. Statistics for the time span 1940-2000 clearly show how center the seismic activity is moving slowly from NE to SW with a slight deepening. Earthquake frequency analysis discriminated three vertical clusters located at various depths: 60-100 km, 100-150 km, and 150-220 km. Distinct time increasing offsets of these compartments with the depth correlates well with the assumed differentiated effect of the convective currents in the asthenosphere, acting at the bottom of the collapsed lithosphere block.

Gravity experiment

During the year 2004 a gravity experiment to reveal non-tidal gravity change across major lithosphere contacts on the Romanian territory was conducted. Special concrete pillars have been implemented along three geo-traverses crossing the three main lithosphere contacts: PCF, TGF and TTZ. Absolute gravity values were transferred with an L & R gravity meter on these pillars by using both Romanian national gravity reference network and absolute gravity stations belonging to European UNIGRACE network. This way two sets of absolute gravity values achieved after 20 years at the same location could be compared. A significant difference between them has been pointed out. For instance, gravity change north PCF is two times higher than south PCF. The distinct gravity behavior for lithosphere compartments advocates for different geodynamic processes within each tectonic plate. High accuracy repeated leveling along the three geo-traverses also revealed a distinct crust deformation across plate boundaries, thus strengthening the postulated existence of major active lithosphere boundaries in the areas.

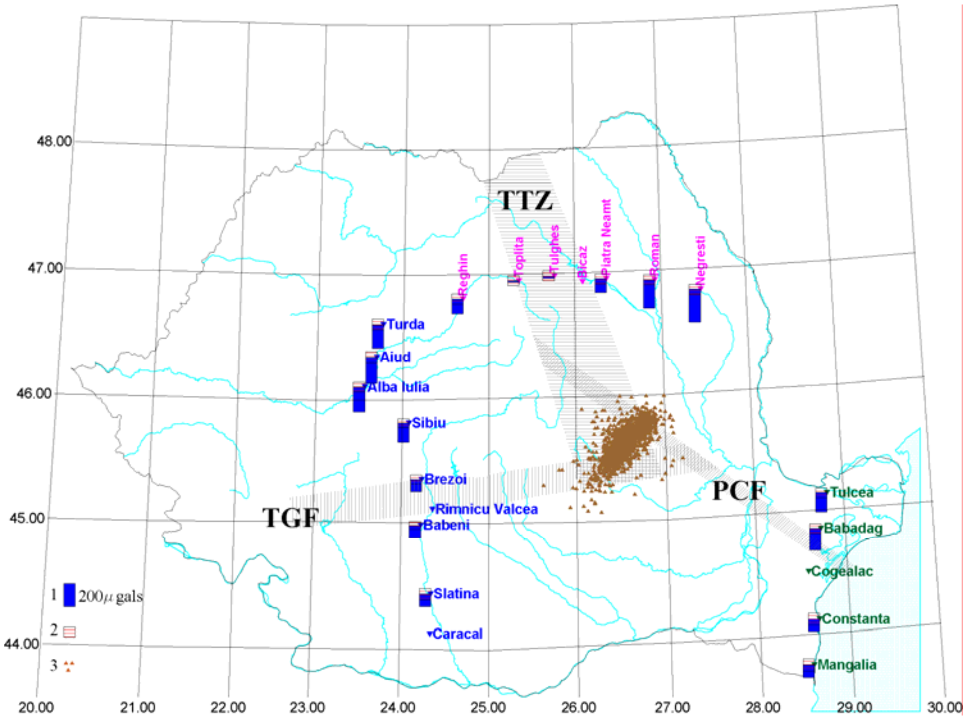

Fig. 2: Vrancea intermediate-depth seismicity and non-tidal gravity changes across major lithosphere contacts on the Romanian territory for a time-span of about 20 years. 1, gravity change; 2, error bar; 3, epicenters