CONSIDERATIONS ON THE GEODYNAMIC SETTING OF THE BLACK SEA OPENING AND SEISMOTECTONIC CONSEQUENCES

Lucian Beşuţiu
Institute of Geodynamics of the Romanian Academy, 19-21, Jean-Louis Calderon St., sector 2, 020032 Bucharest, Romania

During the time, various hypotheses were postulated concerning genesis and development of the Black Sea basin. The full intracontinental setting and some uncertainties on the oceanic nature of the crust within its central part left room to various interpretations and speculations. The paper is aimed at revealing some specific tectonic and geodynamic peculiarities of the region mainly inferred from the potential fields analysis. Regional DSS lines and recent seismic tomography are added in order to strengthen the interpretation and/or deepen the depth of investigation.

Crust structure and dynamics

Among the features revealed by the geophysical information interpretation the following aspects should be mentioned:

1) the presence of the oceanic crust in the central part of the basin is well reflected in the geomagnetic anomaly pattern;
2) unlike some previous hypotheses postulating the existence of an unique east-west rifting, up to date filtering techniques applied to the available data pointed out an unexpected pattern of the gravity and geomagnetic anomalies, trending almost perpendicular each-other within eastern and western basin, thus advocating for a distinct opening of the W and E Black Sea;
3) correlation between the geomagnetic anomalies of the Black Sea bottom and the magnetostratigraphic scale revealed a geomagnetic reversal and seems to indicate a later opening of the eastern basin; off-shore seismics confirm this model by showing a slight overthrusting of the East Pontides over West Pontides;
4) it seems that the W Black Sea opening split the Moesian Plate into several slivers by creating or reactivating some old faults trending northward;
5) crust expelled by the Black Sea opening accommodated in various circumstances:
   (i) East Carpathians it met the inclined outer flank of the TTZ and came into an oblique subduction to which specific peculiarities of the South Harghita Mts volcanism might be associated;
   (ii) South Carpathians, crustal slivers facing the vertical contact of the Intra-alpine sub-plate could not subduct but went into a lithosphere buckling to which the lowest gravity low on the Romanian territory, located in front and not beneath the highest mountains in Romania, seems to be related;
   (iii) within the bending area of East Carpathians, where three tectonic plates were assumed to met each other, the speed excess provided by the W Black Sea opening created an stable triple junction that provoked the collapse of a lithosphere segment into the upper mantle.

Upper mantle echoes

One of the major questions would be how deep was going the rifting process. Fingerprints of the Black Sea opening are well reflected in some recent seismic tomography studies. A higher velocity body is associated to the active seismic zone extending to about 300 km in depth. The tomography pictures also clearly show in depth extension of several well-known faults into the upper mantle. It seems that W Black Sea rifting affected not only the lithosphere, but part of the upper mantle has been also expelled towards Carpathians.

Seismotectonic consequences

Looking at the seismicity of the SE Carpathians foreland two aspects connected to the W Black Sea opening should be stressed:

- the unusual seismicity of the Moesian Platform, that seems to be determined by present dynamics along its NW trending faults
- the intermediate-depth earthquakes within the bending area of East Carpathians (Vrancea zone) that hardly might be associated to a subduction process.

After the Black Sea opening ended, the displacement of the NW inland towards Carpathians continued due to the active rifting within SW Arabian Plate (Red Sea and Aden Bay rifts). Crustal slivers created within the foreland are pushed towards Carpathians and stay together by friction. However, from time to time, they may relatively move each to other thus generating (at least) crustal earthquakes along their wedges.

Concerning the Vrancea zone, an alternate mechanism for the unusual intermediate-depth seismicity is proposed: the unstable triple junction. Geophysical data (seismology and magnetotelluric soundings) advocate for the presence of three tectonic plates/subplates on the Romanian territory: East European Plate (EEP), Moesian Microplate (MoP) and Intra-Alpine Microplate (IaP) that met each other within Vrancea area.

The Black Sea opening provided the necessary speed excess to the MoP that could determine the occurrence of an unstable transform-transform-compression triple junction within the bending zone of East Carpathians. The penetration of the central lithospheric segment of the triple junction into the hotter upper mantle would be followed by thermo-baric accommodation phenomena (such as thermal stress, phase-transform processes, dehydrations, etc.) to which intermediate-depth earthquakes might be related.

Tight connection between the maximum frequency occurrence of earthquakes and location of the highest temperature gradients seems to support the hypothesis.