Paper Number: 5248

Mantle flow under the Seismogenic Zone of Eastern Carpathians? Evidence from complementary geophysical and satellite investigations

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The Carpathian arc plays a suture role between the East European platform and the adjacent continental units. They were probably amalgamated in the last 20 Ma, after the subduction of central eastern Alpine Tethys. Previous mantle tomography research found lithospheric remnants accumulated at the bottom of the upper mantle beneath the Pannonian Basin. Later stages of oceanic subduction (late Miocene?) may be followed by more recent phase(s) of continental collision ending in suturing of south European continental fragments to the older European margins, particularly in the Southeastern Carpathians. Here, the very active, intermediate depth Vrancea seismicity under the Carpathian Bend Zone, the recent unusual volcanism of the inner Carpathians and vertical motions and folding in the Carpathian foreland basin east of Vrancea document an ongoing lithosphere activity. The persistent and strong intermediate depth seismicity and surface deformation at and around the most tightly curved portion of the Carpathian arc in Central – Eastern Europe, (approximate central co-ordinates 45.50N, 25.50E), has been targeted by numerous studies. They supplied a persistent scientific debate on the nature of the processes involved in the lithospheric activity.

In order to add a kinematic constraint to the ongoing studies, we implemented geodesy techniques in order to determine the directions and magnitude of velocity vectors for the area nearby Vrancea [1]. The present outcome shows that the ESE part of the Romanian territory moves away in respect to the stable Eurasia, velocity values reaching no more than 2.0 – 2.5 mm/y. In respect to the stable Carpathian vorland the movements are very slow and have to be confirmed by further investigations. Several sites east of the Carpathian arc show a bit higher velocities and the displacements that are decreasing westwards. These differential displacements cannot be triggered by superficial landslides as they are located in perfect planes. However, the displacements are determined in front of the Carpathian arc, close to the intermediate depth seismogenic zone. The vectors could suggest a rapid displacement of the lithospheric slab with respect to the Moesian Platform. The sites placed at the internal part of the Carpathian arc and within the Transylvanian Basin suggest almost stable behaviour, eventually with a small counterclockwise rotation. If we take into account the southeastward position of the velocity vectors from the central-eastern part of the Moesian Platform, as well as the northwestward position of the velocity vectors at stations in North Dobrogea and east of the prolongation of Peceneaga-Camena crustal fault system, we could estimate a very interesting asthenospheric rotation flow around the Vrancea lithospheric slab.

Finally, taking into account the results from satellite geodesy and previous, complementary studies (seismic attenuation), we shaped the main kinematics of the Carpathian Bend Zone, suggesting an anti-clockwise displacement of the surface as being a result of deep, mantle flow of corkscrew shape, accompanied by an advancement of the melting processes at the asthenosphere-high velocity body transition.

References:

[1] van der Hoeven A et al. (2005) EPSL 239: 177-184
[2] Russo R and Mocanu V (2009) EPSL 287 (1-2):2015-216