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New considerations on the intermediate depth seismicity of the Vrancea zone: the unstable triple-junction

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Located in the bending area of East Carpathians (EC), within full intra-continental environment, Vrancea intermediate-depth seismic zone exhibits some seismic peculiarities almost singular in the world. Among its specific features, mention should be made to the finger-shaped geometry of the seismic body, with a small epicenter area and large in depth extension, strange location of the earthquakes frequency maxima at 90 km, 130 km and 150 km, the large amount of the seismic energy released (quite unexpected for such a small seismogenic volume), the absence of the back arc volcanism usually associated to subduction zones, the extensive Neogene sedimentation rate (5-6 times faster than in the rest of the EC catena), a slight subsidence of the epicenter area against the overall raise of EC unusually associated with a gravity decrease, etc.

Despite more than 30 years of extensive research, Vrancea still represents a challenge for the scientists of the 21st century. During the time, none of the numerous attempts to model the phenomenon has succeeded to comprehensively explain the observed peculiarities.

The paper aims at presenting some geophysical, geodetic and geological evidence for supporting an alternative geodynamic model: the Vrancea FFT unstable triple junction (VTJ) located at the contact between the East European Plate (EEP), Moesian micro-plate (MoP) and Intra-alpine micro-plate (IaP).

Large lateral variations of the lithosphere thickness, as revealed by MTS and seismic data are strong evidence for the presence of three major lithosphere compartments in the area. The geometry and dynamics of the lithospheric contacts joining the VTJ (the Tornquist-Teisseyre Zone, Peceneaga-Camena Fault and Trans-Getica Fault) were previously outlined by various geophysical data (gravity, geomagnetism and EM, seismology, etc.).

The accurate geometry and in depth extension of the seismic body have been relatively recently pointed out by a combined inversion of the gravity and seismic data. Among other aspects, the 10 km resolution seismic tomography revealed a triangularly-shaped seismic body with a progressively increasing section with the depth, in full agreement with an unstable triple-junction structure. It has been assumed that the Black Sea opening provided to MoP the speed excess that created the unstable environment and provoked the collapse of the central compartment. Within such circumstances, the intermediate-depth earthquake may be generated by thermo-baric accommodation phenomena occurring in the sinking colder VTJ central lithospheric compartment into the hotter upper mantle: thermal stress, phase-transforms, dehydration, etc. Numerical modeling of the thermal stress has shown a good correlation with the location of intermediate earthquake hypocenters, and mineral physics studies deny the previously assumed oceanic nature of the sunken lithosphere (unable to provide the large amount of quartz required by the observed seismicity).

Geophysical and geodetic monitoring of the Vrancea zone show VTJ sinking as an ongoing process, that may explain the permanent seismic energy released at various rates.

It seems that the amount of seismic energy depends on the velocity of sinking. The larger is the sunken lithosphere volume, the larger would be the amount of seismicity released. In other words, as long as the sinking maintains at small rates, only small lithosphere volumes are exposed to thermo-baric disequilibrium thus generating a continuous but modest to moderate seismicity. However, if for one or another reason the sinking velocity would suddenly increase, then a large volume of lithosphere will be exposed to thermo-baric disequilibrium and, consequently, a large amount of seismic energy would be released, that might generate a catastrophic event.

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