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Geodynamic Environment by Satellite Geodesy, Seismic Attenuation and S-wave Splitting. Example from Vrancea Seismogenic Zone, SE Carpathians

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In the Vrancea seismogenic zone (SE Carpathians), where very strong earthquakes (Mw > 7) are reported several times a century, the seismotectonics is very complex. It develops beneath the contact between the Moldavian East European Platform, the Scythian Platform, and the Moesian Platform, to the east and southeast, and terranes of the Transylvania Basin lying within the Carpathian arc. Several hypothesis have been considered by scientists in order to explain the clustered foci of crustal and intermediate events (as deep as 200 km). However, until now, there is no tectonic scenario which could explain all geological and geophysical observations. We try to integrate long-term permanent and campaign GPS outcomes with contributions from seismic attenuation and S-wave splitting results. GPS contributions mainly refer to determination of velocity vectors. 15 campaigns and seven permanent stations are being used in order to determine the detailed kinematics of an area characterized by very small velocities (1-2 mm/y), bringing the satellite technique to almost its limit. The results suggest a counterclockwise mantle flow around the Vrancea seismogenic zone, which is a high velocity body developed in an almost vertical position, developing deeper than 200 km. This results is also supported by seismic attenuation studies. We found that models like delamination and subduction could be supported by seismic attenuation studies in this zone. The delamination model implies strong upwelling and horizontal inflow of asthenosphere into the gap between the delaminating and remnant lithosphere. The other model implies downwelling and perhaps lateral-horizontal inflow along the slab detachment or tear. The models imply different distributions of density and rheological properties associated with the different lithosphere - asthenosphere structures. We use the ratio of spectral amplitudes of P and S waves from vertical and transverse seismograms to estimate the S to P ratio in the frequency domain, and then we calculate Qs, the relative shear wave attenuation via two complementary techniques: We find that stations located near and above the Vrancea zone and in the Transylvanian Basin, attenuation is high (low Q). Stations situated on the East European, Moesian, and Scythian Platforms are characterized by higher Qs (low attenuation). We interpret the high attenuation in the Vrancea and Transylvanian Basin is the result of shallow hot asthenosphere present in this area. Observations of source-side shear wave splitting clearly show that upper mantle anisotropy is strongly variable in the region of the tightly curved Carpathian Arc: shear waves taking off from Vrancea along paths that sample the East and Southern Carpathians have fast anisotropy axes parallel to these ranges, whereas those leaving the source region to traverse the upper mantle beneath the Transylvanian Basin (i.e., mantle wedge side) trend NE-SW. Shear waves sampling the East European and Scythian Platforms are separable into two groups, one characterized by fast shear trends to the NE-SW, and a second, deeper group, with trends to NW-SE; also, the majority of null splits occur along paths leaving Vrancea in these NE-E azimuths. Deeper fabric with E-W trend marking asthenospheric flow beneath the craton's base. This more complex anisotropy beneath the western edge of the East European Platform would account for both the variability of observed splitting of waves that sample this volume.