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Monitoring deep geodynamic processes within Vrancea intermediate-depth seismic zone by geodetic means

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Background
Located in the bending zone of East Carpathians, the so-called Vrancea zone is one of the most active seismic regions in Europe. Despite many years of international research, its intermediate-depth seismicity within full intra-continental environment still represents a challenge of the 21st century.
Infrastructure
In the attempt to join the above-mentioned efforts, the Solid Earth Dynamics Department (SEDD) in the Institute of Geodynamics of the Romanian Academy has developed a special research infrastructure, mainly devoted to gravity and space geodesy observations. A geodetic network covering the epicentre area of the intermediate-depth earthquakes has been designed and implemented for monitoring deep geodynamic processes and their surface echoes. Within each base-station of the above-mentioned network, a still-reinforced concrete pillar allows for high accuracy repeated gravity and GPS determinations.
Results
Starting from some results of the previously run CERGOP and UNIGRACE European programmes, to which additional SEDD repeated field campaigns were added, an unusual geodynamic behaviour has been revealed in the area.
1) Crust deformation: unlike the overall uprising of East Carpathians, as a result of denudation followed by erosion, their SE bending zone, with Vrancea epicentre area exhibits a slight subsidence.
2) Gravity change: more than 200 microgals non-tidal gravity decrease over a 20 years time-span has been noticed within the subsiding area. Extended observations showed the gravity lowering as a nowadays continuing process.
Interpretation
This strange combination of topography subsidence and gravity lowering has been interpreted in terms of crust stretching in the Vrancea epicentre zone due to the gravity pull created by densification of the lower crust as a result of phase-transform processes taking place in the lithospheric compartment sunken into the upper mantle. The occurrence of crust earthquakes with vertical-extension focal mechanism exclusively in the Vrancea seismic zone support the assumption. Recent studies on the Vrancea echoes of 2013 Galati-Izvoarele quake swarm have also confirmed our hypotheses.
Based on numerical modelling of the geodynamic process, an estimate of the stretching rate has been obtained, fully consistent with results inferred from studies on the seismic energy released by the Vrancea intermediate earthquakes.
Concluding remarks
Looking further, the sinking of the Vrancea lithosphere into the upper mantle (and consequent crust stretching, appropriately reflected in the non-tidal gravity change) appears as an ongoing geodynamic process, tightly connected to the intermediate-depth seismicity generated within the lithosphere penetrating the upper mantle by thermo-baric accommodation phenomena.
Time series provided by repeated gravity observations conducted on the above-mentioned infrastructure for about ten years have clearly revealed: (i) the persistence of the gravity lowering, and (ii) some apparent connection between the rate of the gravity change, and the amount of seismic energy released by intermediate-depth earthquakes.
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