Geophysical Research Abstracts
Vol. 14, EGU2012-2897, 2012
EGU General Assembly 2012

Exploring seismicity using geomagnetic and gravity data – a case study for Bulgaria

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Seismicity exploration certainly requires comprehensive analysis of location, orientation and length distribution of fault and block systems with a variety of geophysical methods. In the present research capability of geomagnetic and gravity anomalous field data are used for revealing of buried structures inside the earth's upper layers. Interpretation of gravity and magnetic data is well known and often applied to delineate various geological structures such as faults, flexures, thrusts, borders of dislocated blocks etc. which create significant rock density contrast in horizontal planes.
Study area of the present research covers the territory of Bulgaria which is part of the active continental margin of the Eurasian plate. This region is a typical example of high seismic risk area.
The epicentral map shows that seismicity in the region is not uniformly distributed in space. Therefore the seismicity is described in distributed geographical zones (seismic source zones). Each source zone is characterized by its specific tectonic, seismic, and geological particulars.
From the analysis of the depth distribution it was recognized that the earthquakes in the region occurred in the Earth's crust. Hypocenters are mainly located in the upper crust, and only a few events are related to the lower crust. The maximum depth reached is about 50 km in southwestern Bulgaria; outside, the foci affect only the surficial 30-35 km. Maximum density of seismicity involves the layer between 5 and 25 km. This fact determines the capability of potential fields data to reveal crustal structures and to examine their parameters as possible seismic sources.
Results showed that a number of geophysically interpreted structures coincide with observed on the surface dislocations and epicenter clusters (well illustrated in northern Bulgaria) which confirms the reliability of the applied methodology. The complicated situation in southern Bulgaria is demonstrated by mosaics structure of geomagnetic field, complex configuration of gravity anomalies and spatial seismicity distribution. Well defined (confirmed by geophysical, geological and seismological data) are the known earthquake source zones (such as Sofia, Kresna, Maritsa, Yambol) in this part of the territory of Bulgaria. Worth while are the results where no surface structures are present (e.g. Central Rhodope zone and East Rhodope zone, where the 2006 Kurdzhali earthquake sequence is realized). In those cases, gravity and magnetic interpretations proved to be a suitable enough technique which allows determining of position and parameters of the geological structures in depth.