Geophysical Research Abstracts
Vol. 12, EGU2010-4381, 2010
EGU General Assembly 2010

Capability of combined gravity and seismological data analysis for more detailed resolution of structures and faults parameters

Dimcho Solakov (1), Stela Simeonova (1), Petar Stavrev (2), and Petya Trifonova (1)

(1) Geophysical Institute of Bulgarian Academy of Sciences, Sofia, Bulgaria (p.trifonova@abv.bg), (2) University of Mining and Geology "St. Iv. Rilski", Sofia, Bulgaria

Performance of seismic hazard evaluation certainly requires comprehensive analysis of location, orientation and length distribution of fault systems with a variety of geophysical methods. The main objective of this research is to use the capability of gravity anomalous field data for revealing of deep structures in the earth's crust and to examine the possible correlation between regions marked with high gravity gradients and increased seismicity.

The earthquakes over Bulgarian territory are concentrated in certain epicentral areas (source zones) which jointly with its great number make the spatial pattern of seismicity significantly nonuniform. It considerably obscures the comparison with located gravity anomalies. For this reason, the epicenter's density function was used as parameter of the analysis.

As a density function of the epicenters is considered the function:

$$\Phi(x,y) = \sum_i P(E_i \in Q(x,y)), \tag{1}$$

where E_i is the i-th earthquake and $Q(x,y)$is a square with central point (x,y) and size km^2. In this application it is selected a square of size 10 x10 km, i.e. A=100 km^2. To calculate the density function only earthquakes with surface magnitude $M_S \geq$4.0 occurred in and near Bulgaria after 1900 are considered. The time period is chosen according to estimated completeness of the catalogue for quakes with M greater than or equal to 4.0. The density function is calculated at a grid interval of 0.01^0 latitude and 0.01^0 longitudes. The number of $M_S \geq$4.0 earthquakes/per 100 years/per 100 km^2 is assign to the center of each cell.

The gravity anomalies of transition type are well distinguished after a data transformation to the magnitude (modulus) of the Total Horizontal Gradient (THG). The horizontal derivatives along two orthogonal axes have been calculated and geometrically summed. When applied to two dimensional survey, the THG tends to place narrow ridges over abrupt changes in density and locating maxima can be done by simple inspection or automated procedure (Blakely and Simpson, 1986).

The calculated vertical gravity gradient (VGG) reflects in other pattern the mentioned above transition anomalies. While the THG reflects intensity and orientation of the transition anomalies, VGG map in addition points out on the direction of transition and respective structures' slope down (or slope up to the positive part of the vertical derivative). In case of normal increasing of rock densities with depth, this property of VGG can be used to show the direction of structure deepening.

A visual analysis of the gravity and seismological data and their comparison over the territory of Bulgaria shows that the positive correlation between position of gravity gradient anomalies and increased epicenters density prevails. This is the case in the Srednogorie structural zone, including Sofia region. The coincidence between the epicenters density maxima and a number of elongated gradient anomalies is typical for such areas having heterogeneous and fractured young basements.

In other areas, a high epicenters density corresponds to a lower density and intensity of the gradient anomalies like in NE Bulgaria (up to 1.5-2 mGal/km). Although the gradient intensities are smaller, the locations of those anomalies correspond to regions with increased seismicity (e.g. near Dulovo and Shabla).

The third case of relations we find in areas where the observed gradient anomalies are not accompanying with high seismic activity, like in the Central Balkan and East Srednogorie units. There are a lot of minor intrusions or plutonic bodies but they seem to have captured hardly the structures they had formed.

The observed specific relations between distribution of gravity anomalies and spatial seismic parameters help for more reliable estimation of the seismogenic potential of fault and thrust structures in the Earth's crust of Bulgaria. The obtained results have been successfully applied for the purposes of seismic hazard evaluation of Bulgaria in conformity with the requirements of Eurocode 8.