Contribution of gravity data interpretation to the seismotectonic model compilation – an example from Bulgarian EC8 implementation

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Capability of gravity anomalous field data for revealing of deep structures in the earth's crust is well known and often applied to delineate various geological structures such as faults, flexures, thrusts, borders of dislocated blocks and vast intrusions, horsts and grabens, and others, which create significant rock density contrast in horizontal planes. Calculation of Directional derivatives of the Bouguer gravity anomalous field of Bulgaria was used to constrain the geological information for compilation of seismotectonic model which has been implemented in the recently released seismic zoning of the country according to EC8 standards.

For the present research a grid of 1.5x1.5 km from the Bouguer gravity database was prepared. The density of this grid is less than the density of observation points but sufficient for the regional scale of investigation and helps the filtration of existing noise. Using these data and the Fourier techniques, the total horizontal gradient and vertical gravity gradient have been calculated and analyzed.

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 surveys, the THG tends to place narrow ridges over abrupt changes in density and locating maxima can be done by simple inspection or automated procedure.

The calculated Vertical Gravity Gradient (VGG) reflects in other pattern the mentioned above transition anomalies. The vertical derivative of gravity field is similar in its space distribution to the vertical component Z of magnetic anomalies caused by the same structures in case of their vertical magnetization, according to Poisson's theorem. Thus, the vertical gradient of a transition anomaly is a dipolar anomaly with its negative part to the horizontal direction of density decreasing of a vertical or inclined dislocation.

Delineated gravity anomalies wit their amplitude, width, length and coordinates have been compared with the spatial distribution of seismicity, epicentre density function and map of the active faults of the Bulgarian territory. In most of the cases, outlined gravity transitions are characterised with increased seismicity and accompanied by faults drawn according to geological evidences.

Natural aggregate resources in Serbia – an overview

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Aggregate rock industry in Serbia had a turbulent history in the past 20 years, as it had to survive severe political and economical changes in the country and the whole SEE area. The economic crisis resulted in dramatic decrease of aggregate rock production during the beginning of the last decade of the 20 century, to the level of approximately 20-30 % compared to the year of 1990 (all data are from the USGS Minerals Yearbooks, based on Serbian Statistical Reports). Production level remained low but relatively stable until 2004. Since 2005, production of aggregate rocks is steadily increasing, with sand and gravel, and

cement output reaching the level of the 1990. Unfortunately, statistics for crushed rock are unreliable from 2005, as production volume is in fact much larger than officially presented. Lime is the only commodity with the current production at the level of ~45 % compared to the year 1990, due to the old equipment, old technology and low standards of limestone quality which are not accepted for the production of high quality industrial lime.

In the last ten years geological exploration was rather intensive, with more than 30 new aggregate rock deposits explored and prepared for exploitation. Currently, there are 141 aggregate rock deposits in Serbia, out of which 113 have exploitation license, and 28 are still under exploration. These statistics exclude deposits of sand and gravel for construction industry, which are still not completely under jurisdiction of the Ministry of Energy and Mining (MEM), which is in charge for exploitation and exploration licenses for all other mineral commodities.

There are several petrological varieties of rocks used in aggregate industry in Serbia. The majority of deposits are limestone and dolostone (77 in total), 30 deposits consists of magmatic rocks, and 34 deposits of metamorphic rocks, mostly marble (usually calcitic and, subordinately, dolomitic).

The basic factor influencing promotion of aggregate rock industry in the last ten years was road construction, resulting in exploration of all 7 diabase deposits; similar situation is with basalt, andesite, and dacite. Two deposits, one of basalt and one of diabase are used for mineral wool production. Quite contrary, almost all of granite deposits are used as ornamental stone, and several in ceramic industry.

Sedimentary rocks are almost exclusively used in aggregate rock industry (73 out of 77 deposits), predominantly in construction industry (54 deposits). Five deposits are used by cement factories, 7 by lime producers, but all of those 7 quarries also produce aggregate rock. There are several deposits which supply by some specific end-users, like Bor copper smelter, filler industry, or production of metal magnesium from dolostone.

Metamorphic rocks are mainly used as filler (calcite varieties, 15 deposits), or as construction aggregate (dolomitic marbles, 8 deposits). Lime is produced from one calcite marble (which is most probably recrystalized limestone). Marble is also used as ornamental stone (10 deposits), although some recrystalized limestone deposits are also included.

Spatial distribution reflects the geology of Serbia, leaving Vojvodina almost without aggregate rock resources except sand and gravel along the main rivers, which will require sustainable supply mix to maintain long-term construction activities.

The lack of sustainable aggregate resources management in the past caused some problems, like unprecise definitions of exploitation of quarries within National parks and other protected areas (which are much younger than quarries), absence of mineral resources maps on the national and regional levels which should and must be base documents for land use planning. Complicated legal procedures during exploration and exploitation periods also imposes an unnecessary burden on the investor (license holder), which shall require simpler procedure in the near future. Some analytical standards should be revised.

In the recent years a WEB-GIS was established by the MEM, which enables all interested investors to check the available areas for exploration. Some improvements of the Mining Law were also performed, but the new law concerning geological exploration and mining is necessary. Environmental laws and regulations are modeled according to the EU standards. Nevertheless, it is still impossible to get borders of protected areas online.

Permanent education at all levels is also important for future expansion of all sectors of aggregate rocks industry.

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