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ACTIVE FAULT SYSTEMS IN THE SHABLA REGION (BULGARIA) AS INTERPRETED ON GRAVITY, MAGNETOMETRIC AND SEISMICITY DATA

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Introduction

Shabla region is located in NE Bulgaria and belongs from tectonic point of view to the south-eastern part of the Moesian Platform. The study area covers parts of the eastern slope of the North Bulgarian arch, from the Bulgarian – Romanian border to the north, to the Cape Kaliakra to the south and from Dobrich city to the west, to the Black Sea continental slope to the east. Block faulting, horsts and grabens of different rank are the typical structural features (Dabovski et al., 2002, Zagorchev et al., 2009). It is characterised by an active seismicity, with very strong earthquakes recordings (Oncescu et al., 1999, updated; http://www.emsc-csem.org, 2016).

The crustal Intramoesian Fault (Săndulescu, 1984; Visarion et al., 1988), considered to act as a regional tectonic contact (Ioane & Caragea, 2015) separating the Moesian Platform in two main domains, referred to as: Danubian and Dobrogean (Paraschiv, 1979) or Vallachian/Vallachian-Prebalkan and Dobrogean sectors (Săndulescu, 1984; Visarion et al., 1988), reaches the Black Sea continental shelf in Shabla region. Its path was ambiguously located on maps, as it does not outcrop. Shanov et al. (2005) emphasize the importance of the precise interpretation of the Intramoesian Fault's path in this area: it has a critical importance for evaluation of the maximum expected earthquake magnitudes. Failing this approach may lead to overestimation or underestimation of the seismic risk both in Bulgaria and Romania.

Analysis of regional seismicity data available from ROMPLUS Earthquake Catalogue (Oncescu et al., 1999 updated) and EMSC Earthquake Catalogue (www.emsc-csem.org, 2016), integrated with published geotectonic and geophysical data, offers the possibility to interpret active fault systems within the study area and build the grounds for a much more comprehensive understanding of seismic risk in this region and adjacent areas.

Geophysical data

Gravity data

The anomalies contoured on the Bouguer Gravity Map of Bulgaria illustrate a gravity horizontal gradient trending WNW-ESE west of Shabla and north of Dobrich (less seen in Figure 1 due to the replacement in this gravity map of isolines with color shading), considered to be due to significant density contrasts in the sedimentary cover, possibly involving the crystalline basement along this regional fault, as recently interpreted by Stanciu et al. (2016).

The composite map of the gravity anomaly (Bouguer gravity onshore, Free Air gravity offshore) of the Shabla region and adjacent areas was extracted from Dimitriu et al. (2016) composite map of the gravity anomaly of the western Black Sea continental margin and represented in Figure 2.

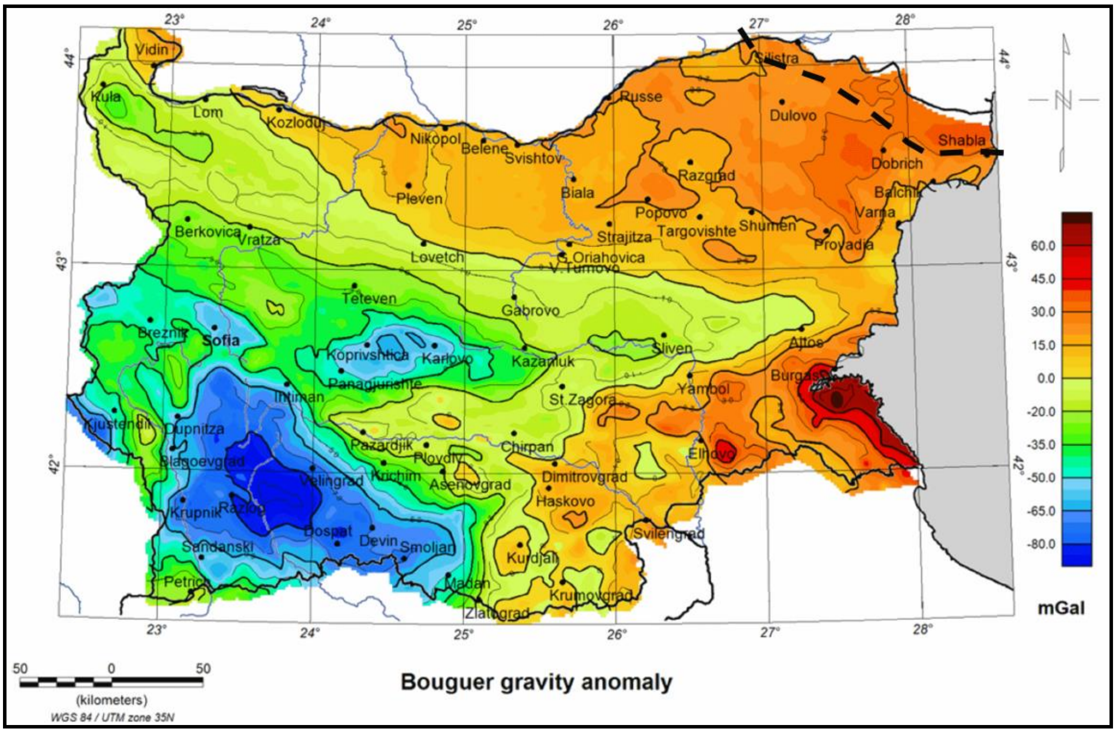

Figure 1. Map of the Bouguer gravity anomalous field of Bulgaria (Trifonova et al., 2013). Colors represent the observed intensity (minimum in blue and maximum in red). Black dashed line: interpreted transect of the Intramoesian Fault (after Stanciu et al., 2016)

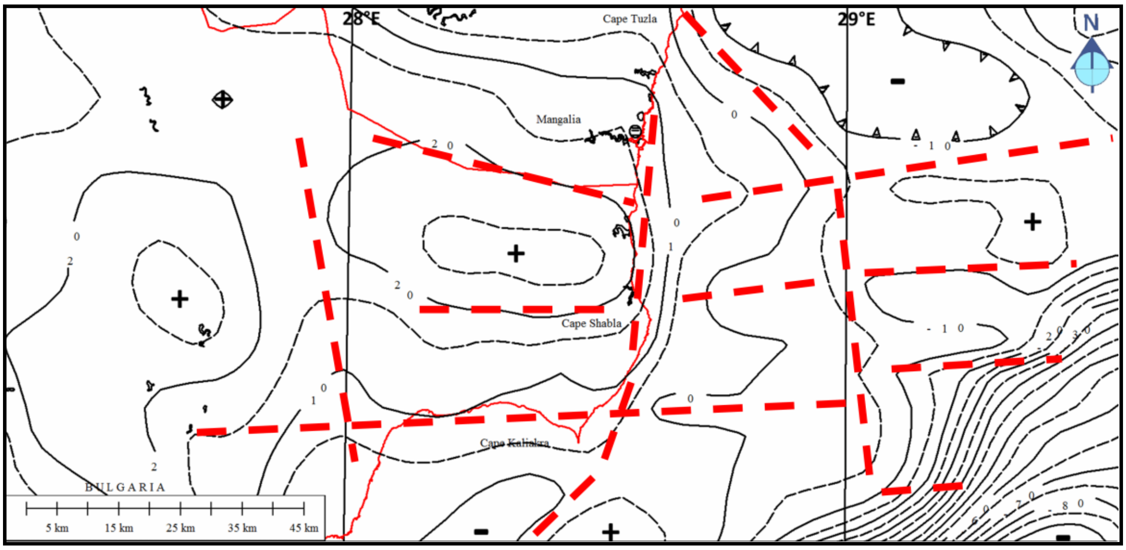

Figure 2. Lineaments (red dashed lines) of steep transitions of the gravity anomaly intensity depicted on the composite map of the gravity anomaly (Bouguer gravity onshore, Free Air gravity offshore) of the Shabla region and adjacent areas (modified after Dimitriu et al., 2016)

A number of lineaments of steep transitions of the gravity anomaly intensity having mainly N-S and W-E orientations were depicted and delineated on the composite map of the gravity anomaly of the Shabla region, here interpreted as caused by rapid variations of density due to faults, flexures or/and other dislocation structures. A block-faulted pattern is generated for the entire area.

Magnetometric data

A map of the magnetic anomaly (total geomagnetic field) of the Shabla region and adjacent areas was extracted from Dimitriu et al. (2016) composite map of the magnetic anomaly of the western Black Sea continental margin and represented in Figure 3. The steep transitions of the magnetic anomaly intensity were delineated on the composite map of the magnetic anomaly of the Shabla region and interpreted as caused by rapid variations of magnetic properties due to faults, flexures or/and other dislocation structures.

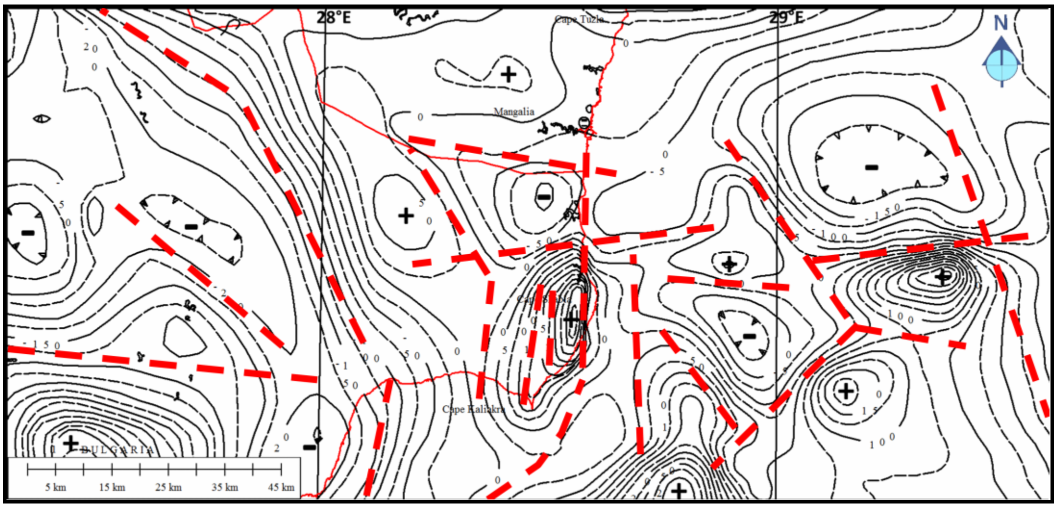

Figure 3. Lineaments (red dashed lines) of steep transitions of the magnetic anomaly intensity depicted on the composite map of the magnetic anomaly (total geomagnetic field) of the Shabla region and adjacent areas (modified after Dimitriu et al., 2016)

Seismological observations

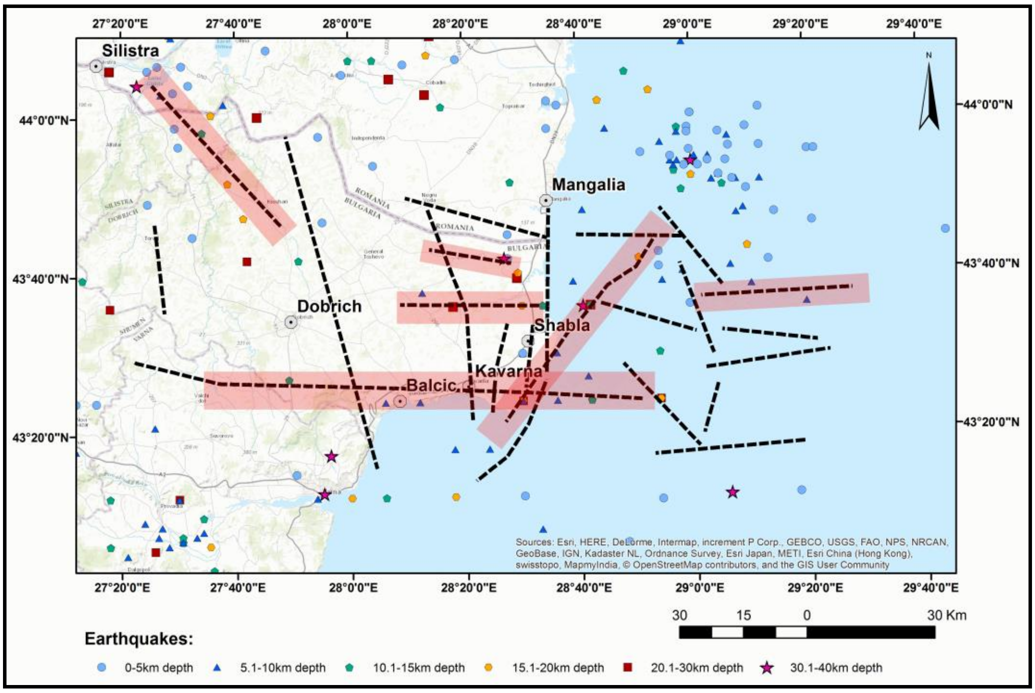

Figure 4. Active faults (wide red lines) in the Shabla region interpreted on geophysical and seismicity data. Black dashed lines: faults, flexures or/and other dislocation structures interpreted on gravity and magnetic data

On the basis of the density of epicenters, associated with faults, flexures or/and other dislocation structures lineaments depicted on the gravity and magnetic anomaly maps shown in Figures 2 and 3, interpreted active faults are drawn with red lines in Figure 4, on the epicentral map of earthquakes recorded in the Shabla region, compiled from ROMPLUS (Oncescu et al., 1999, updated) and EMSC (http://www.emsc-csem.org, 2016) earthquake catalogues.

The scientific literature describes Shabla region as a major seismic zone with impact both on the territory of Bulgaria and Romania. The active seismicity of the area stands out with more than 7 magnitude earthquake catalogues recordings (i.e. 544, 1901).

Earthquakes in the Shabla region have been recently related to the prolongation of Intramoesian Fault into the Black Sea by Bâlă et al. (2015). Active segments of this concealed tectonic feature are interpreted in Figure 4 on the NW – SE Silistra lineament, on the W – E Dobrich – Shabla lineament, as well as on the W – E offshore lineament. The deep hypocenters (up to 34 km, the maximum recorded depth within the study area) associated with the Intramoesian Fault represent a good argument on its trans-crustal character.

Conclusions

The anomalies contoured on the Bouguer Gravity Map of Bulgaria (Trifonova et al., 2013) illustrate a gravity horizontal gradient trending WNW-ESE west of Shabla and north of Dobrich, considered to be due to significant density contrasts in the sedimentary cover and possibly involving the crystalline basement along this regional fault, as recently interpreted by Stanciu et al. (2016).

Lineaments of steep transitions of the gravity and magnetic anomalies intensities depicted and delineated on the composite map of the gravity anomaly as well as on the composite map of the magnetic anomaly of the Shabla region (modified from Dimitriu et al., 2016) are interpreted as caused by faults, flexures or/and other dislocation structures.

Seismological recordings show an active seismicity in front of the Bulgarian Black Sea coast, generating the strongest earthquakes within the Moesian Platform.

Active segments of the Intramoesian Fault are interpreted on the NW – SE Silistra lineament, on the W – E Dobrich – Shabla lineament, as well as on the W – E offshore lineament. The deep hypocenters (up to 34 km, the maximum depth recorded within the study area) associated with the Intramoesian Fault represent a good argument on its trans-crustal character.

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