REGIONAL SEISMICITY IN THE MOESIAN PLATFORM AND THE INTRAMOESIAN FAULT

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Abstract. The Moesian Platform is considered to consist of two main compartments, with different geological age and petrographic features at the crystalline basement level, separated by the NW-SE trending Intramoesian Fault. Seismological data compiled from published local, regional and global earthquakes catalogues was used to illustrate and analyze the distribution of seismicity within the Moesian Platfom. A number of profiles across the Intramoesian Fault with the earthquake hypocenters are presented, aiming at detecting the tectonic contact between the Moesian Platform compartments.

Key words: seismological data analysis, crustal seismicity, Intramoesian Fault, regional tectonics

1. INTRODUCTION

The Moesian Platform is located in the Carpatho-Balkan foreland and represents a quite small continental tectonic structure amalgamated at the south-western margin of the East European Platform. It was, and is still involved, in the relative movements between the large tectonic plates of Eurasia *versus* Africa & Arabia.

The Moesian Platform is considered to consist of two main compartments, with different geological age and petrographic features at the crystalline basement level, separated by the NW-SE trending Intramoesian Fault (*e.g.* Săndulescu, 1984; Visarion *et al.*, 1988). This regional scale crustal fault was represented on numerous geological and tectonic maps during the last 4-5 decades, even if it was not geologically mapped, since the deep geological structures do not outcrop and the crystalline basement was not investigated by boreholes along its transect. The geophysical detection of the Intramoesian Fault proved to be very difficult, as, until recently (Stanciu et al., 2016), no projects that use relevant geophysical methods with adequate acquisition and data processing techniques had been dedicated to this tectonic target.

When analyzing the distribution of seismicity within the Moesian Platfom its NW-SE trending delineation of the compartments is easily observed, the eastern part being characterized by a larger number of seismic events as compared to the western one. This observation might be normally correlated with the tectonic model involving two compartments separated by the Intramoesian Fault. However, there is a problem which does not allow such a simple interpretation, the limit between the areas with different seismicity being located some tens of kilometres westward from the Intramoesian Fault.

Trying to understand the geological support of the difference between the location of the Intramoesian Fault and that offered by regional crustal seismicity, seismological information from different sources was compiled, analyzed and interpreted, aiming at detecting the tectonic contact between the compartments of the Moesian Platform and aspects related to the fault systems crossing the platform.

2. METHODS AND RESULTS

For summing up information on the earthquakes of the Moesian Platform, seismological data have been obtained from published local, regional and global earthquakes catalogues: ROMPLUS Earthquake Catalogue (Oncescu *et al.*, 1999 updated); EMSC Earthquake Catalogue (http://www.emsc-csem.org, 2017); ISC-GEM Global Instrumental Earthquake Catalogue (http://www.isc.ac.uk/iscgem/download.php, 2017); European-Mediterranean Earthquake Catalogue (EMEC) (Grünthal and Wahlström, 2012); Earthquake Catalogue for Central and Southeastern Europe 342 BC - 1990 AD (Shebalin *et al.*, 1998); SHARE European Earthquake Catalogue (SHEEC) 1000–1899 (Stucchi *et al.*, 2013); SHEEC Earthquake Catalogue 1900 – 2006 (http://sheec-1900-2006.gfz-potsdam.de/, 2017); USGS Earthquake Catalogue (https://earthquake.usgs.gov/earthquakes/search/, 2017); UNDP/UNESCO Survey of the Seismicity of the Balkan Region – Catalogue of Earthquakes (Shebalin *et al.*, 1974).

A seismicity data-base has been built, earthquake recordings being verified in order not to duplicate the seismic events, and the crustal seismicity (0-40 km depth) of the Moesian Platform was represented within a georeferenced framework (Fig. 1).

Seismological data analysis shows that the eastern part of the Moesian Platform is the place of an active seismicity, with frequent occurrences of low to moderate magnitude earthquakes, most of the hypocentres depth ranging from 5 to 20 km.

Eastern Moesia shows frequent scattered seismic activity, with local groups of earthquakes displaying a specific NE-SW trending. Western Moesia is characterized by a scarce seismicity, earthquakes being generally associated with the Pericarpathian Fault and the North Prebalkan Fault, or scattered in the North-Bulgarian Uplift area. Seismic events grouped along NE-SW lineaments are also observed, especially between the Danube and the Balkans.

The high seismicity boundary set on Pitești – Ruse lineament (Fig. 2), first discussed by the authors in 2016 (Stanciu and Ioane, 2016), is now analyzed on seismicity depth W-E sections, ranging from 43.8 N latitude to 44.8 N latitude.

Considering the compiled catalogue is from sources with different time window of the records and it is very possible that the accuracy of the hypocenters determinations is different, only one earthquake catalogue has been used when building the seismicity sections: the ROMPLUS Earthquake Catalogue (Oncescu *et al.*, 1999 updated), with 984 – August 2017 records. The selected W-E sections were represented on graphs based on 0.1 degree of latitude wide sections, which illustrate the in-depth distribution of seismic events up to 40 km depth in Romania and northern Bulgaria. In a few cases the highest depth goes beyond 40 km, reaching a maximum of 70.6 km.

3. DATA INTERPRETATION

Recent studies on the regional tectonics of the Moesian Platform interpret the Intramoesian Fault as a deep tectonic contact between the platform compartments (Ioane and Caragea, 2015) and consider as main fault systems those trending NW-SE, N-S and NE-SW (Ioane *et al.*, 2014).

The interpretation of the W-E trending sections showing crustal seismicity had several main tectonic targets:

- The location and inclination of the Intramoesian Fault;
- The "transition zone" (Stanciu and Ioane, 2017), situated between Intramoesian Fault and the western boundary of platform seismicity;
- Regional crustal or transcrustal faults.

When analyzing the seismicity sections, built on W-E 0.1 degree of latitude wide sections located between 43.8 N and 44.8 N latitudes across the Moesian Platform in Romania and northern Bulgaria, the crustal seismicity clearly illustrates the difference between the eastern, high seismicity compartment, and the western, low seismicity one.

The seismicity data shown in Figure 4 allow the following tectonic interpretations: a) the tectonic contact between the two compartments of the Moesian Platform, in the area of the boundary between Romania and Bulgaria, is inclined; considering the NW-SE trending of this regional tectonic contact, its inclination should be towards NE; b) the geometry of the tectonic contact suggests a "soft collision" between these two continental tectonic blocks at crustal depths.

The seismicity data shown in Figure 5 allows the following tectonic interpretations: a) the tectonic contact between the two compartments of the Moesian Platform is inclined; b) the "transition zone" between the Intramoesian Fault and the western boundary of high seismicity represents a western development of the eastern compartment at low crustal depths, overlapping the western compartment at higher crustal depths; c) the almost vertical succession of seismic events observed at 26.6° longitude up to 10 km depth may represent a fault, within the Intramoesian Fault System. Its in-depth change in inclination between 10 and 15 km may be due to an old compressional regime whose intensity was variable with depth, and determined the inclined contact between the platform compartments.

The seismicity data shown in Figure 6 allow the following tectonic interpretations: a) the two compartments of the Moesian Platform are clearly illustrated by the crustal seismicity; b) the tectonic contact between the platform compartments is not continuously inclined, the position of the western compartment beneath the eastern one being shaped as steps-like structures. The compressional regime seems to be more intense at deep crustal levels, determining eastward horizontal displacement of the tectonic contact at the depth of 20 km.

The seismicity data shown in Figure 7, including all seismic events occurred within one degree of latitude (43.8 N – 44.8 N) in the Moesian Platform, allow the following tectonic interpretations: a) the Moesian Platform compartments are clearly characterized by the different seismicity regime; b) the tectonic contact between the two compartments of

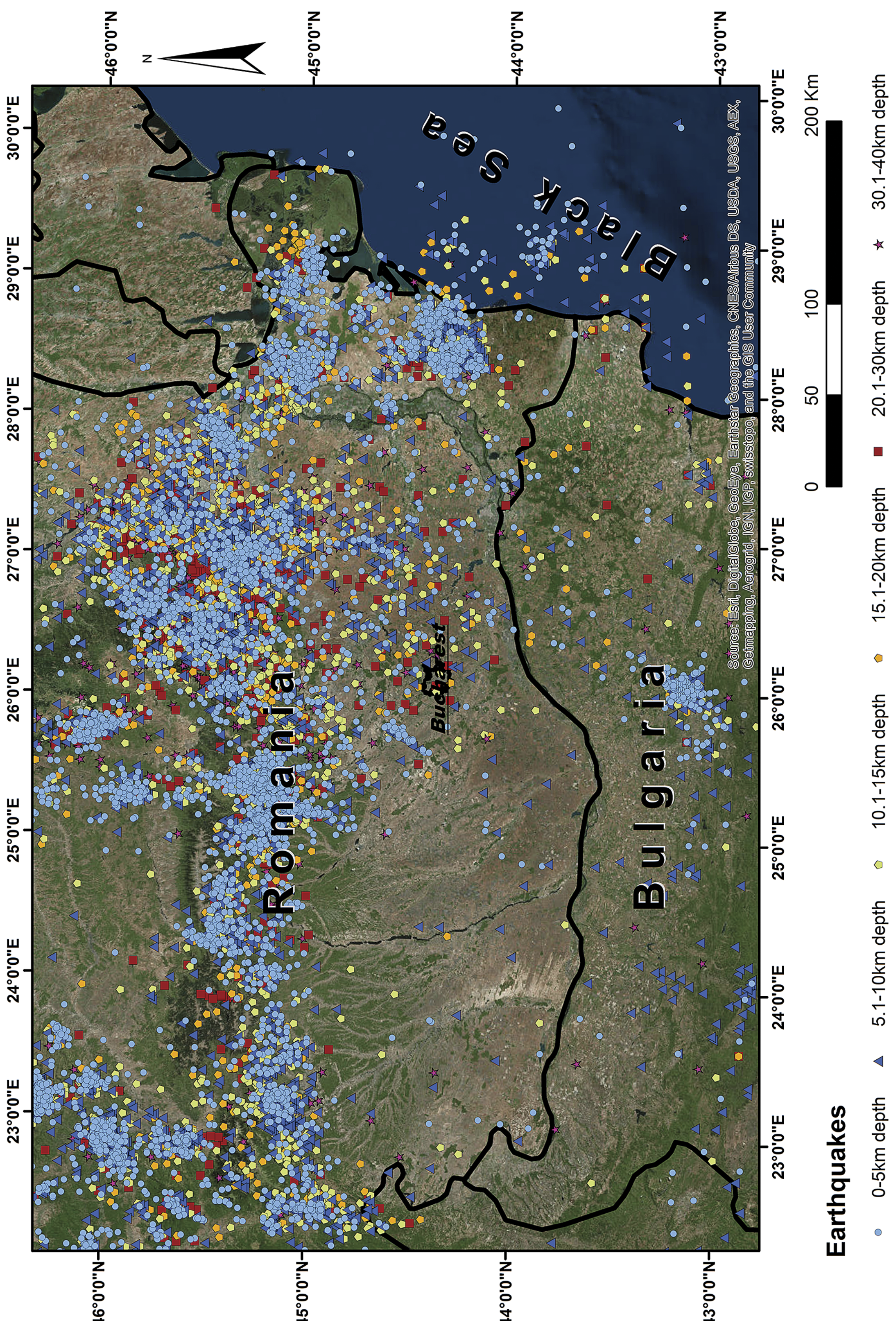

Fig. 1. Regional distribution of the crustal seismicity (0-40 km depth) of the Moesian Platform compiled from published local, regional and global earthquakes catalogues

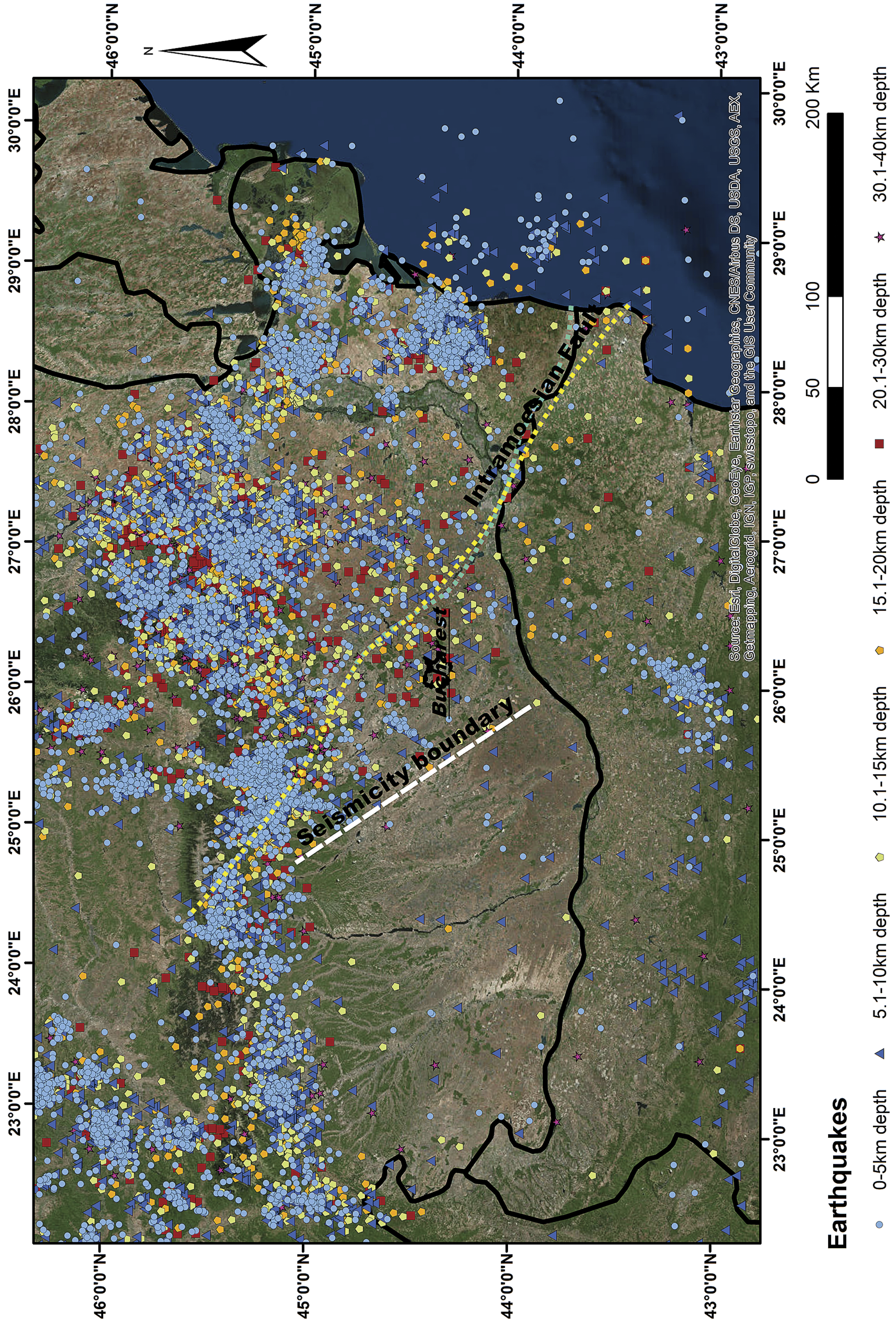

Fig. 2. Seismicity boundary (white dashed line) within the Moesian Platform. The crustal seismicity (0 – 40 km depth) of the Moesian Platform compiled from published local, regional and global earthquakes catalogues. Green dotted line illustrates the path of the Intramoesian Fault according to Săndulescu (1984). Yellow dotted line illustrates the Intramoesian Fault's path according to Visarion *et al.* (1988).

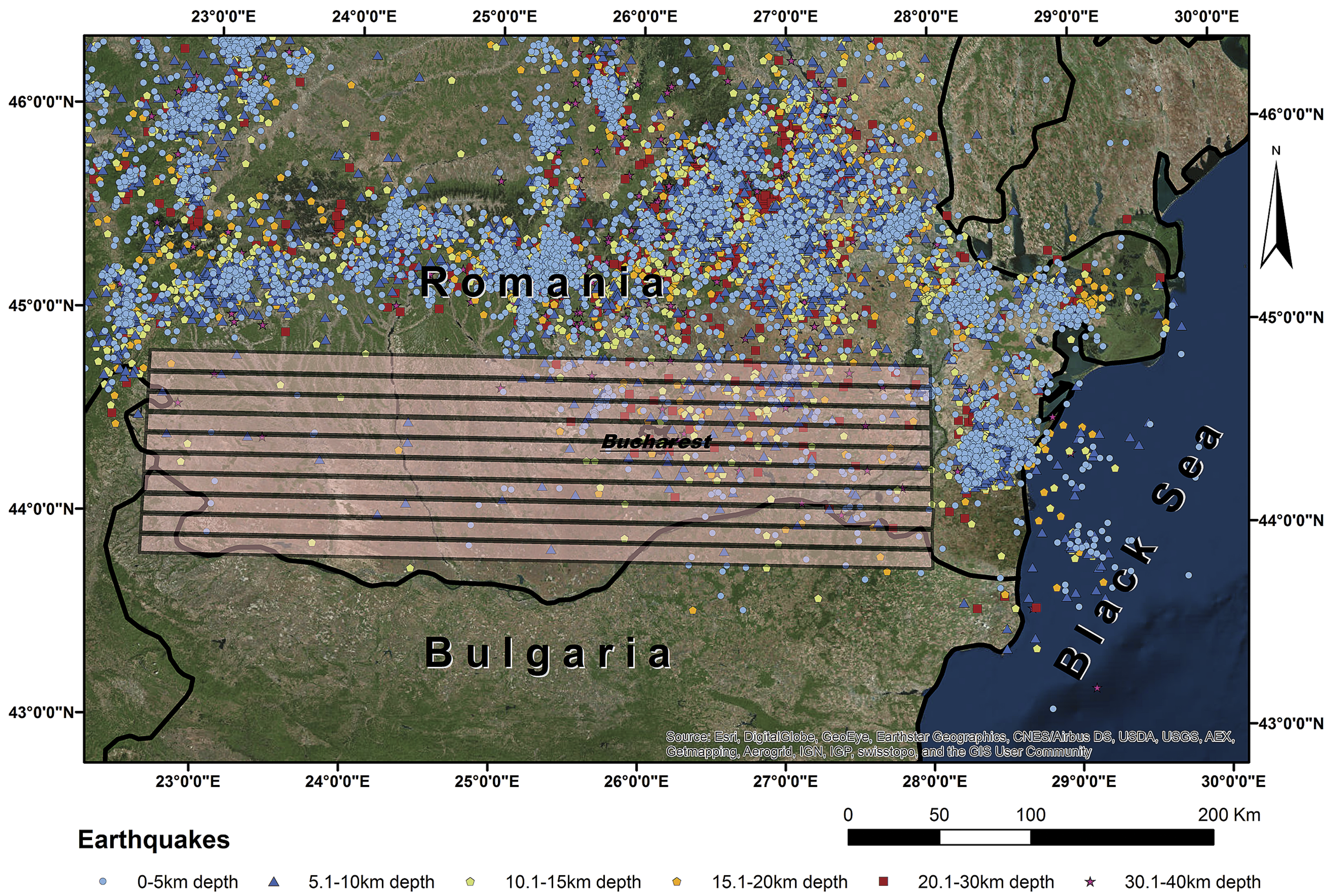

Fig. 3. Location of the analyzed W-E seismicity sections, built on 0.1 degree of latitude wide sections. Seismicity data: 984 – August 2017, ROMPLUS Earthquake Catalogue (Oncescu *et al.*, 1999 updated)

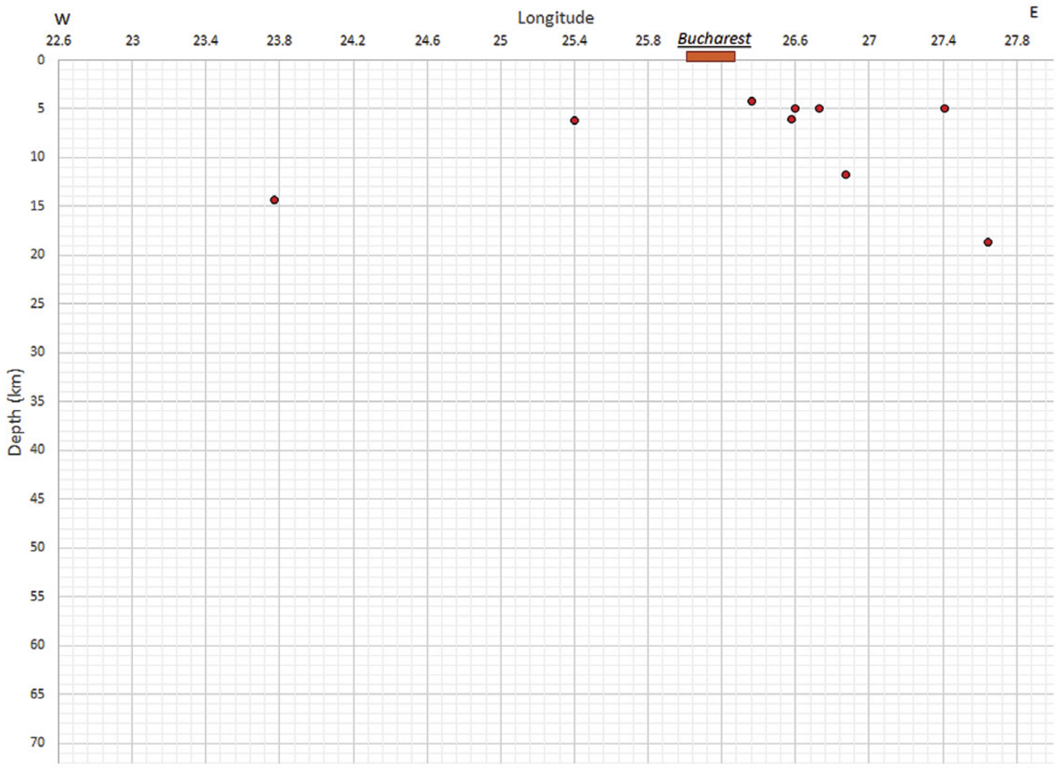

Fig. 4. W-E regional distribution of crustal seismicity along 43.8 N – 43.9 N wide latitude sector, built on 984 – August 2017 ROMPLUS Earthquake Catalogue data (Oncescu *et al.*, 1999 updated)

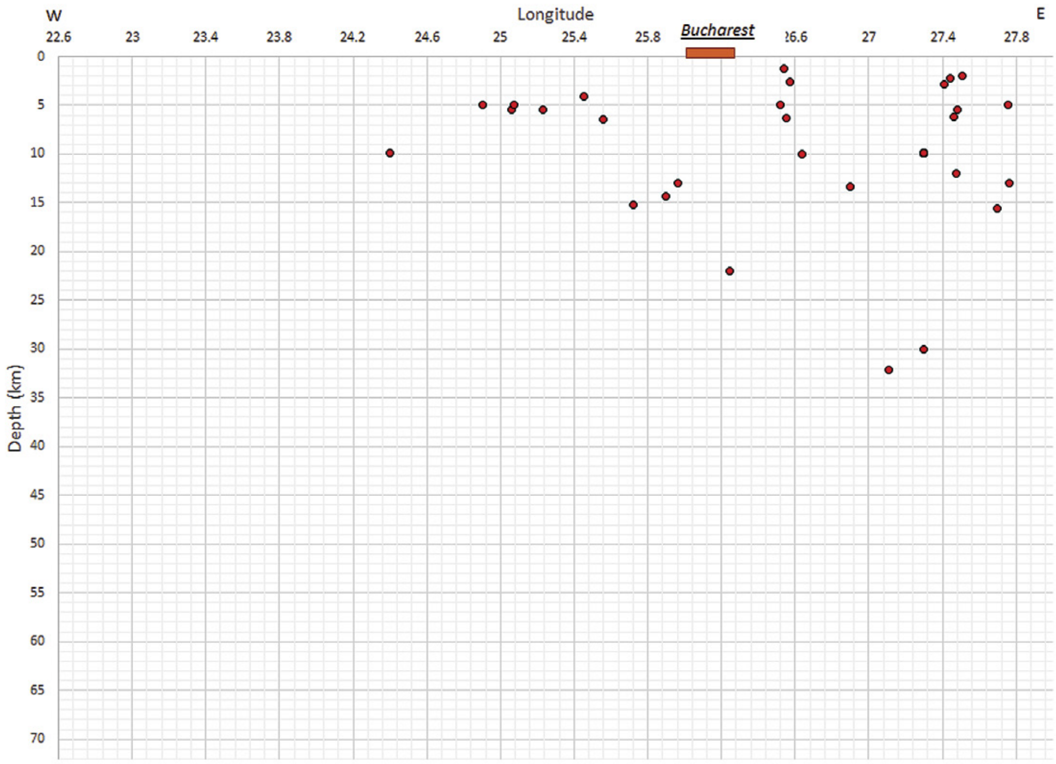

Fig. 5. W- E regional distribution of crustal seismicity along 44.1 N – 44.2 N wide latitude sector, built on 984 – August 2017 ROMPLUS Earthquake Catalogue data (Oncescu *et al.*, 1999 updated)

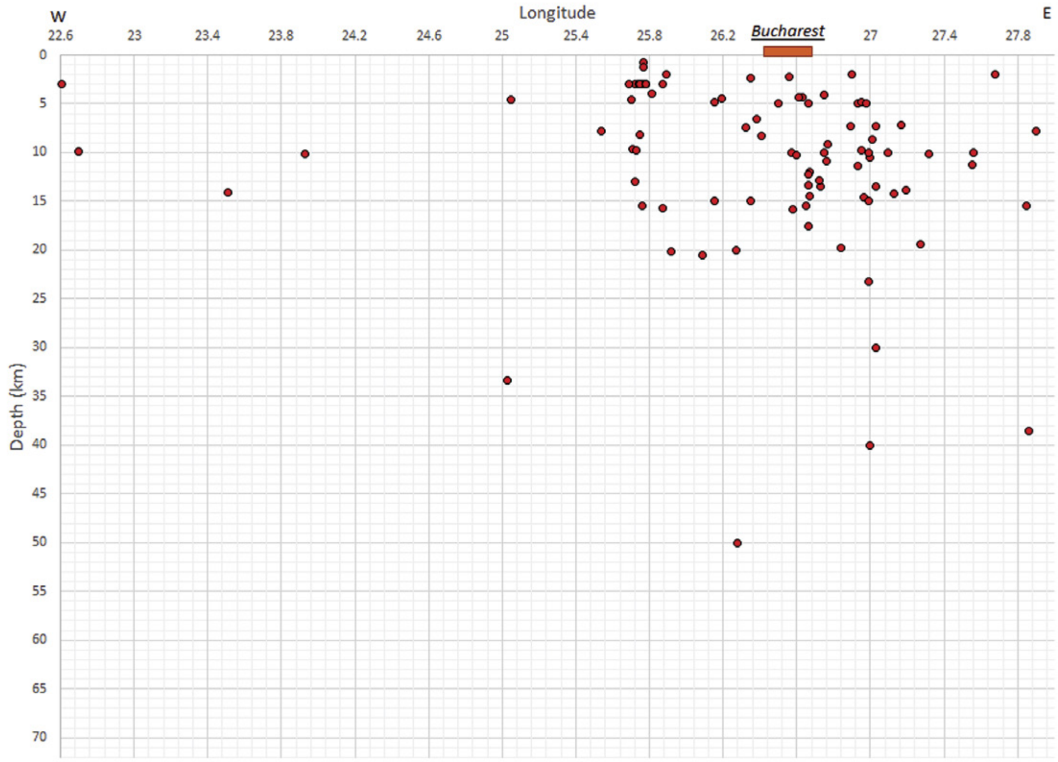

Fig. 6. W-E regional distribution of crustal seismicity along 44.6 N – 44.7 N wide latitude sector, built on 984 – August 2017 ROMPLUS Earthquake Catalogue data (Oncescu *et al.*, 1999 updated)

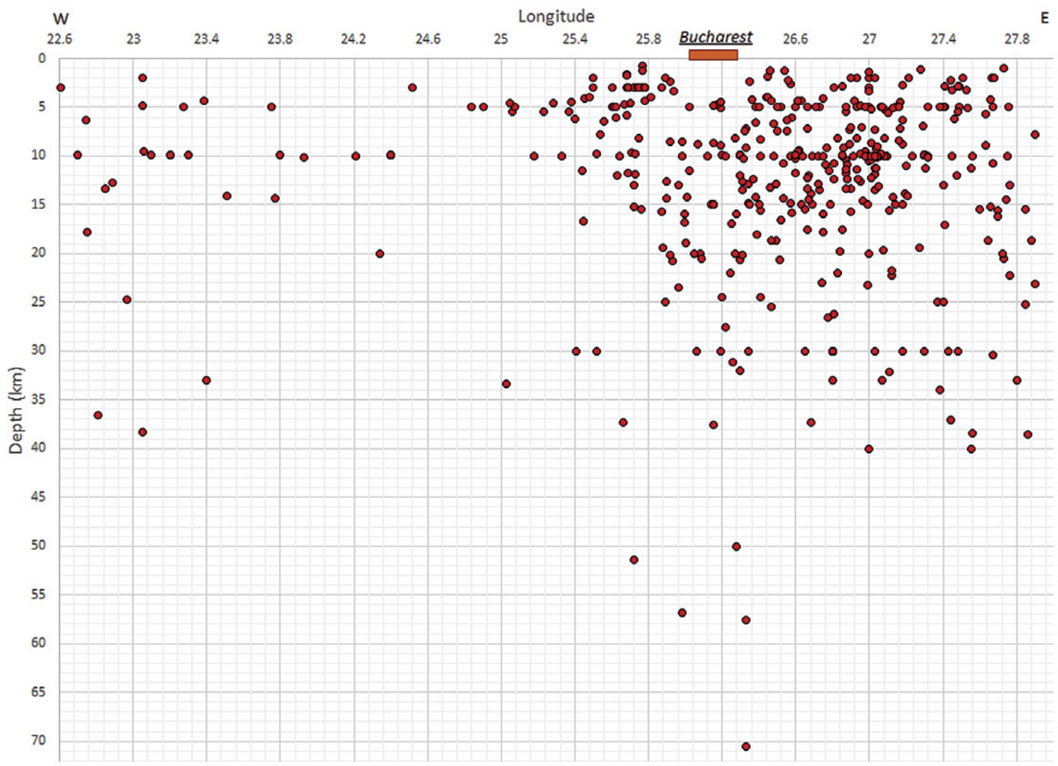

Fig. 7. W-E regional distribution of crustal seismicity along 43.8 N – 44.8 N wide latitude sector, built on 984 – August 2017 ROMPLUS Earthquake Catalogue data (Oncescu *et al.*, 1999 updated)

the Moesian Platform is inclined, the western compartment being overlapped by the eastern one within the "transition zone" (Stanciu and Ioane, 2017); c) most crustal seismicity of the platform seems to be determined along the fault systems trending NW-SE and NE-SW; d) the deepest faults, as depicted in Figure 7 by seismic events up to 70 km depth, are interpreted to represent transcrustal faults assigned to the N – S fault system.

CONCLUSIONS

The Intramoesian crustal fault was represented on numerous geological and tectonic maps, although it was not geologically mapped or geophysically clearly detected. The distribution of seismicity in the Moesian Platfom confirms the presence of two compartments, their NW-SE trending contact being easily illustrated by regional seismicity: the eastern part is characterized by higher seismicity as compared to the western one.

The tectonic model involving two compartments of the Moesian Platform separated by the Intramoesian Fault, as it is shown on tectonic maps, cannot be correlated with the regional seismicity. The "transition zone" displaying high seismicity, noticed between the Intramoesian Fault and the NW-SE lineament on Argeș river, is interpreted here as the area where at crustal levels the western compartment overlaps the eastern one.

The interpretation of W–E crustal seismicity sections crossing the Moesian Platform, between 43.8 N and 44.8 N latitude, suggest that either the contact between the platform compartments is inclined (especially close to Danube River) or shows a stepwise geometry (closer to the Carpathians), in both cases the western compartment advancing eastward at lower crustal depths.

When analysing the seismicity sections, the crustal seismicity of the Moesian Platform up to 40 km deep is considered to be mainly determined by the NW-SE and NE-SW fault systems; the N–S fault system seems to determine the deeper seismic events, up to 70 km.

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