TECTONICS AND SEISMICITY OF NORTHWESTERN OLTENIA

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Abstract. The northwestern region of Oltenia is located in the Romanian sector of the Carpatho-Balkan orogenic bend, an area with complex tectonics, related to four fracture systems: NE-SW, NW-SE, N-S and E-W. The most important are the NE-SW Cerna-Jiu and Balta-Baia de Aramă tectonic corridors, which accommodated the bending of the orogen by slips along the structure direction. The Balta-Baia de Aramă tectonic corridor corresponds to a seismic line, but the most earthquakes are registered on the Turnu Severin - Târgu Jiu seismic line, which tectonically corresponds to the Romanian segment of the Timoc Fault. The Târgu Jiu city area, located at the intersection of the Turnu Severin - Târgu Jiu seismic line with the Târgu Jiu - Călimănești seismic line, is the most active seismic epicenter in northwestern Oltenia.

Key words: Oltenia, faults, seismic lines, earthquakes

INTRODUCTION

In general, there is a direct cause-effect relationship between the tectonics and seismicity of a region, especially for major faults and fault intersections. The north-west of Oltenia is an intensely tectonized region, located in the Romanian sector of the Danubian Bend of the Carpatho-Balkan orogen. Formed under the action of predominantly compressive stresses, the orogenic areas of the bend have a more complex geological structure and tectonics than the linear segments of the orogen, where tangential stresses with slip on the direction of the structure are predominant. In the bend areas, the case of the orogen in the north-west of Oltenia, extensional stresses materialized through transverse fractures on the arc of the bend also occur.

We must mention that the data from the geological literature regarding the kinematics of the faults in the north-west of Oltenia are quite contradictory and differ from one author to another, sometimes even among the co-authors of the same work (Berza & Drăgănescu, 1988). That is why we preferred to analyze the tectonic structure in the north-west of Oltenia as depicted on the official geological maps of the region, coherent over large areas and correlated from one map sheet to another.

In addition to the historical earthquakes in the north-west of Oltenia, at the end of the paper we inserted a sub-chapter with the current earthquakes in the north of Oltenia.

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TECTONICS OF NORTHWESTERN OLTENIA: FRACTURE SYSTEMS

Four main fracture systems affect the orogen in the north-west of Oltenia in NE-SW, NW-SE, N-S and E-W directions, figured as such and on the geological maps of Romania at a scale of 1: 200,000, the Baia de Aramă sheet (Codarcea et al., 1968) and at a scale of 1: 50,000, the Tismana (Pop et al., 1975) and Obârsia Cloşani (Bercia et al., 1977) sheets (Fig. 1).

NE-SW system. It is the most important fracture system in the region, its Cenozoic activity making possible the orogen bending by slips along the structure direction. The main fracture in this system is the Cerna Fault (Cerna-Jiu tectonic corridor), a trans-crustal fault of Eocene age, with an average dextral displacement of 35 km (Berza & Drăgănescu, 1988). It was reactivated in an extensional regime during the Oligocene, when the Cerna graben was formed, and compressive in the Early and Middle Miocene, the tectonic activity ceasing in the Late Miocene. Very probably, the Cerna Fault is still active today as a reverse fault in the context of the movement towards the NW of the Moesian Microplate (Airinei, 1977), more precisely of the Wallachian sector of the Moesian Platform (Săndulescu, 1994).

To the east, the Cerna Fault continues with the Jiu Fault, which reaches the Petroşani Basin (filled by Oligocene and Miocene sedimentary deposits) forming together the Cerna-Jiu tectonic corridor. South of the Danube, the tectonic corridor continues along the Porećka River (Săndulescu, 1984), on a parallel alignment with the Timoc Fault, geophysically highlighted (Visarion et al., 1988).

An important fault from the same system is the Balta-Baia de Aramă tectonic corridor, with Cenozoic activity similar to that of the Cerna graben (Berza & Drăgănescu, 1988) and currently seismically active (Atanasiu, 1961). Secondary faults with the same orientation are frequent in the sedimentary cover, especially on the southern slope of the Vâlcan Mountains, in the south of the Tismana granite massif, in the Sohodol-Topeşti area and further east, between the Sohodol and Şuşita valleys.

The NW-SE system. It is a pre-Middle Miocene (intra-Burdigalian) fault system, strongly penetrative in the northwest of the Mehedinţi Mountains, consisting of normal slip faults and sinister strike-slip faults (Bercia et al., 1977; Pop et al. , 1975). It is possible that sinister strike-slip faults appeared during the Eocene as conjugate with dextral-slip faults in the Cerna Fault system.

The faults in the NW-SE tectonic system affect both the Getic Nappe in the Godeanu Mountains (the Godeanu Outlier) and the Mehedinţi Plateau (the Iron Gates Outlier), as well as the Danubian basement in the northeast of the Mehedinţi Mountains, sometimes on coincident alignments. Being post-thrust faults, they must also be penetrative at the level of the Mesozoic cover caught between the Getic Nappe and the Danubian basement, more than what results from the geological maps.

The tectonic regime on the NW-SE fractures varies from extensional, on subvertical normal-slip faults, to transcurrent, on vertical sinister strike-slip faults. Theoretically, the sinister slips on the NW-SE faults could be conjugated with the

dextral slips on the NE-SW faults, which means that the age of the first tectonic movements on these faults could be Eocene.

The N-S system. The fractures in the N-S system accommodate the uplift of the Danubian basement in the Vâlcan Mountains sector in relation to the Mehedinţi Mountains and Plateau sector, where it is covered by its Mesozoic cover, the Severin Nappe and the Getic Nappe. The only major fault in this system is the Motru Fault.

The Motru Fault is a vertical fracture, on the upper course of the Motru Valley, with the eastern compartment raised. In this tectonic compartment the Mesozoic cover of the Tismana granite is largely eroded. The granitic batholith is affected by vertical faults parallel to the Motru Fault, a consequence of the fact that this was the mobile tectonic compartment. To the south, the Motru Fault does not exceed the Balta-Baia de Aramă tectonic corridor. The newest sedimentary formations affected by the fault are of Late Cretaceous (Turonian – 'Senonian') age.

The E-W system. This is the newest tectonic system in the region, represented by parallel vertical fractures, with dextral slip (Codarcea et al., 1968). The most important are the Isverna and Obârşia Cloşani faults that affect the northeastern sector of the Mehedinți Plateau through dextral slips in steps of 2 km, on curved paths, with E-W sectors alternating with ENE-WSW and even NE-SW oriented sectors. To the south, the Isverna Fault disappears into the Danubian sedimentary cover as reverse fault.

To the east, the Isverna Fault affects the Lower Miocene deposits of the Balta-Baia de Aramă tectonic corridor (Năstăseanu et al., 1968), and the Obârşia Cloşani Fault, which only crosses pre-Cenozoic formations, must be approximately of the same age. Very likely, the tectonic movements on both faults were initiated in the Early-Middle Miocene, when compressional tectonic regimes were settling on the Cerna and Balta-Baia de Aramă faults (Berza, Drăgănescu, 1988) due to the northwest movement of the Moesian Platform. In this geotectonic context, the two faults should be active even today, accommodating the bending of the western South Carpathians.

SEISMICITY OF THE NORTH-WEST OLTENIA

Historical earthquakes in the north-west of Oltenia. Atanasiu (1961) records twelve historical earthquakes with outbreaks in the north-west of Oltenia, four in the Târgu-Jiu area (November 13, 1905 – weak); January 6, 1910 – degree III; July 9, 1912 – degree V; February 14, 1913 - degree III), three in the Tismana area (7 December 1895 - degree III; 12 December 1904 - degree III; 9 July 1912 - degree IV), one in the area of Baia de Aramă (11 October 1910 - degree IV), one in the Baia de Aramă area (October 11, 1910 – degree IV), one in the Turnu-Severin area (March 11, 1894 – weak), two in the Drăgoteşti area (December 30, 1894 – degree III; February 13, 1916 – degree IV), and one in the Samarineşti area (May 20, 1893 – degree IV).

Seismic lines and epicenters in the north-west of Oltenia. According to Atanasiu (1961), the seismic lines in the north-west of Oltenia are: Turnu-Severin –

Drăgoteşti – Târgu-Jiu, Topeşti – Tismana – Glogova, Baia de Aramă – Balta – Vârcorova, Târgu-Jiu – Horezu – Călimăneşti and Govora – Râmnicu Vâlcea (Fig. 2). Seismic epicenters are at Târgu-Jiu, the most important, and at Drăgoteşti (Fig. 2), both on the Târgu-Jiu-Drăgoteşti-Turnu Severin seismic line which roughly follows the geophysically highlighted route of the Timoc Fault (Visarion et al., 1988).

Relationship between seismic lines and faults. Three seismic lines in the north-west of Oltenia, Balta-Baia de Aramă, Călimănesti - Târgu-Jiu and Turnu Severin - Târgu-Jiu (Atanasiu, 1961), correspond to geophysically highlighted faults (Visarion et al. 1988), also having tectonic expression on the surface; for the Călimăneşti - Târgu-Jiu Fault we do not have field data. The Turnu Severin - Târgu-Jiu Fault roughly corresponds to the Romanian segment of the Timoc Fault (Visarion et al., 1988). This fault intersects with the Călimăneşti - Târgu-Jiu Fault in the seismic epicenter at Târgu-Jiu. We also note that in this region there are some seismic lines that do not correspond to surface faults, such as the Topeşti-Tismana-Glogova seismic line (Atanasiu, 1961).

CURRENT EARTHQUAKES IN THE NORTH OF OLTENIA

According to the ROMPLUS catalogue, produced by the National Institute of Earth Physics, in the 2021-2023 time span 3725 earthquakes occurred in the north of Oltenia, concentrated in the orogenic zone northwest of Târgu Jiu, between the Sohodol and Bistriţa valleys (Fig. 3). Of these, 75 earthquakes occurred in 2021, with magnitudes (Ml) in the range 0.41-2.84, and in 2022, 56 earthquakes occurred, with magnitudes (Ml) between 0.84 and 4.03. The year 2023 is characterized by intense telluric activity, there were no less than 3594 earthquakes, with magnitudes (Ml) in the range 0.59-5.66.

Referring only to the earthquakes of 2023, they are grouped by magnitude as follows: 3289 earthquakes with Ml<2 and depths of 0-26 km; 264 earthquakes with Ml 2-3 and depths of 2-18 km; 30 earthquakes with Ml of 3-4 and depths of 2-17 km, 9 earthquakes with Ml of 4-5 and depths of 3-14 km; 2 earthquakes with Ml>5 and depths of 6 and 16 km, respectively.

CONCLUSIONS

Given its location in the bend of the Carpathian-Balkan orogen, the region of northwestern Oltenia is affected by several fracture systems, located both along the Carpathian orogen and transverse to it. The most important fault in the region is the Cerna Fault, from the NE-SW tectonic system. With a dextral slip of 35 km, also passing south of the Danube, this directional fault had an important contribution to the bending of the Carpatho-Balkan orogen. Also, the faults in the E-W system, with dextral slips in steps of 2 km, contributed to the bending of the orogen in the area of the Mehedinţi Plateau.

In the geotectonic context of the northwest displacement of the Moesian Platform, the faults in the two tectonic systems should be still active today. We only have data in this regard for the Balta-Baia de Aramă tectonic corridor, which is also a seismic line, with extension to the Tismana area. Parallel to this tectonic corridor, but in the Subcarpathian area, is the Turnu Severin-Târgu-Jiu seismic line, coinciding with the geophysical route of the Timoc Fault.

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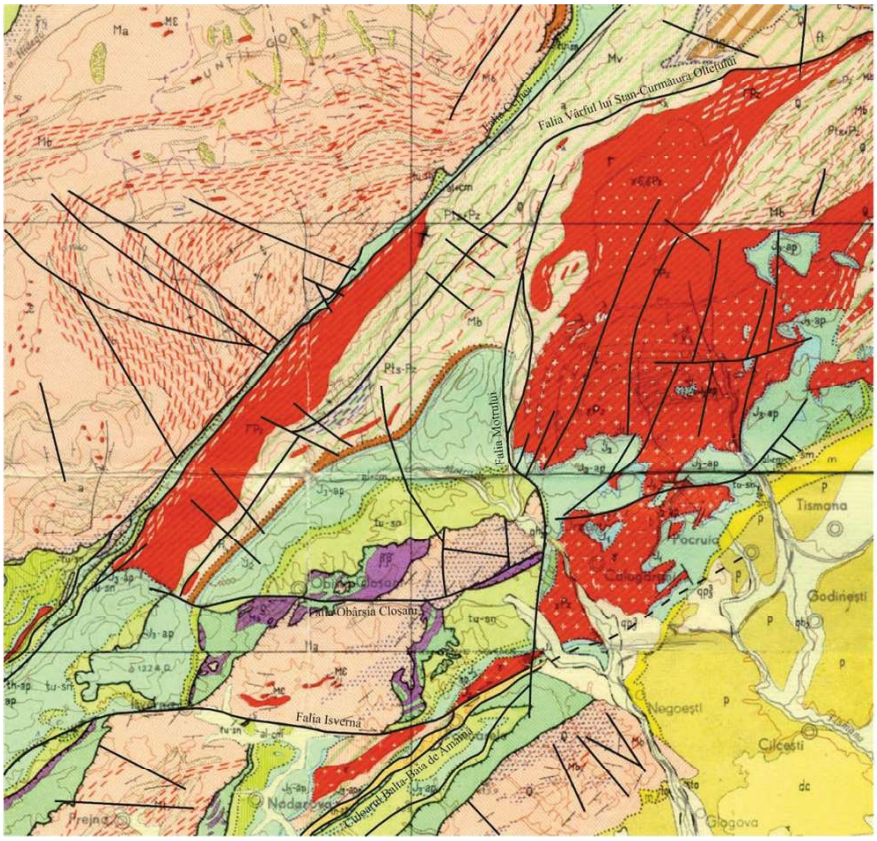

Fig. 1. Geological map of Romania, scale 1:200,000, Baia de Aramă sheet with tectonics completed according to the 1:50,000 geological maps, Tismana and Obârșia Cloșani sheets.

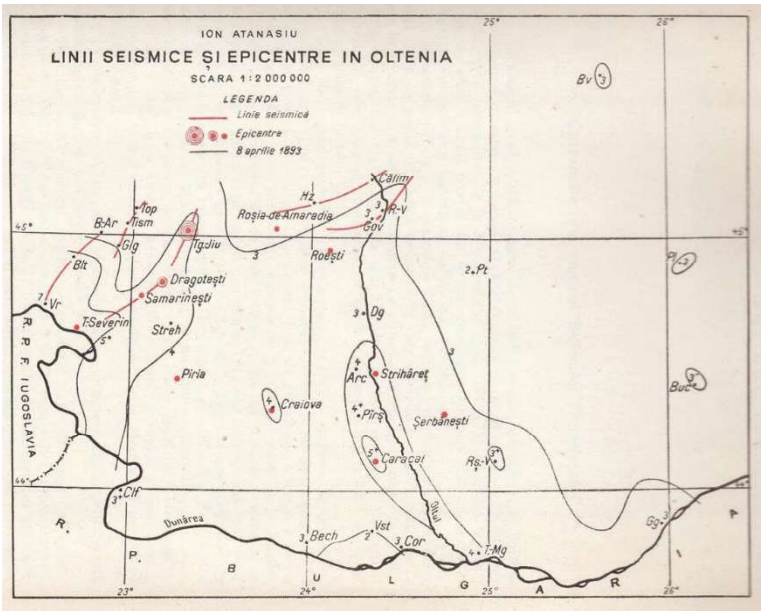

Fig. 2. Map with seismic lines and epicenters in Oltenia (Atanasiu, 1961).

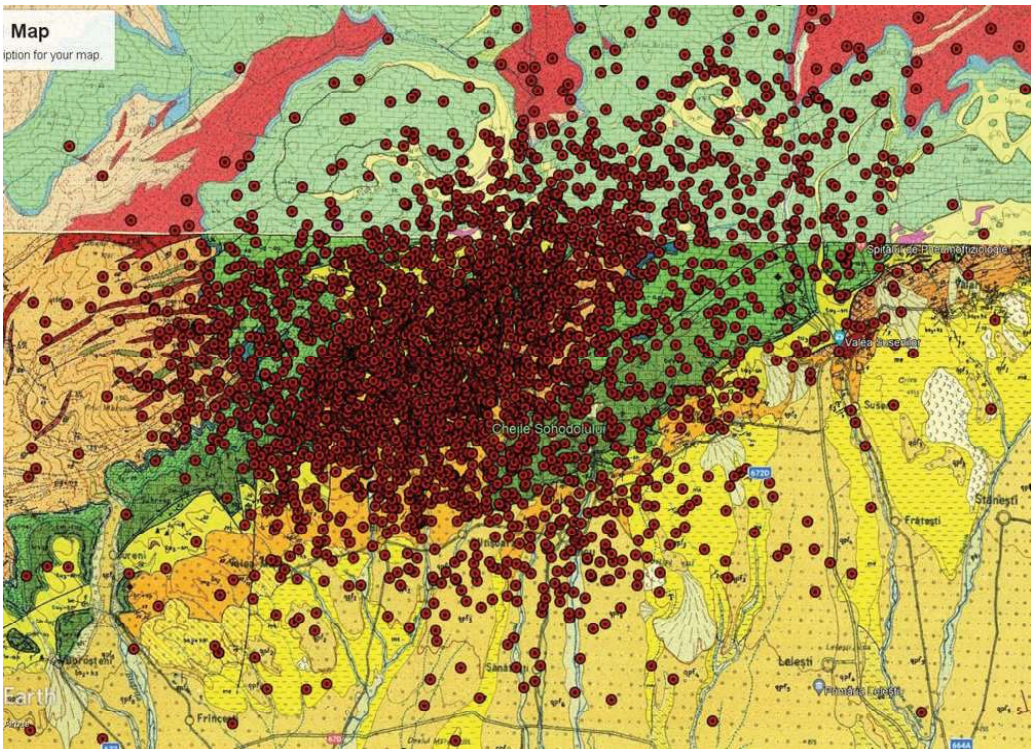

Fig. 3. Earthquqkesin the north of Oltenia during the period 2021-2023 according to ROMPLUS projected on the 1:50,000 geological map (Peștișani and Câmpul lui Neag sheets). Details in text.