ACTIVE TECTONICS, TRANSCURRENT FAULTS AND HIGH MAGNITUDE SEISMICITY ZONES: DURRES (ALBANIA) AND VRANCEA (ROMANIA)

DUMITRU IOANE[1], IRINA STANCIU[2]

[1] *University of Bucharest, Faculty of Geology and Geophysics, Romania, dumitru.ioane@g.unibuc.ro*
[2] *National Institute for Research and Development on Marine Geology and Geo-ecology – GeoEcoMar, Romania, irina.stanciu@geoecomar.ro*

A high magnitude earthquake (Mw = 6.4) occurred on November 26, 2019, at 2:54 AM, close to Durres city, Albania. Ten hours later, in Vrancea seismic zone occurred three seismic events (Mw = 1.7; 3.2; 2.6), with epicenters migrating eastward. During 26 and 27 November, a higher number of earthquakes occurred in Durres seismic zone, when comparing to its average seismicity. Almost simultaneously, significant seismic events have been recorded in Greece (N Peloponnesus ml = 3.8; W Crete ml = 6.0) and Bosnia-Herzegovina (ml = 5.9), on a regional NW–SE lineament. A recent study interpreted a wrench tectonics system across Romania, its southern NE–SW trending transcurrent fault being associated with the intermediate-depth, subcrustal seismicity in the Vrancea seismic zone. When extending south–westward the two transcurrent faults from Romania to Albania, resulted that most earthquake epicenters that occurred during 26 and 27 November 2019 in the Durres seismic area are located between them. A north–westward tectonic lineament, interpreted using seismic events occurred between W Crete and S Bosnia-Herzegovina during the same time interval, crosses the two transcurrent faults within the Durres–Shkoder seismic area, suggesting that the regional NE–SW and NW–SE fault systems have been activated during November 2019.

Key words: active tectonics, wrench tectonics, fault systems, Durres and Vrancea seismic zones, seismotectonic model.

1. INTRODUCTION

This study started during the Durres (Albania) high magnitude earthquakes on November 26, 2019, when real time seismological recordings released on the Internet showed that in Vrancea (Romania) seismic events also started to occur. The main scientific objective of this research was to carry out a detailed seismotectonic model in the Durres seismic area, based on the high quality positioning of the earthquakes that occurred in Albania during November 26 and 27, recorded by the National Institute of Earth's Physics (Romania). The observation that most epicenters of the November 26–27, 2019 Durres earthquakes are located between two transcurrent faults, which are situated in the direct prolongation to Albania of a wrench tectonics system recently interpreted in Romania (Ioane, Stanciu, 2018), offered an unexpected but highly interesting research target. This development of the study, by including regional active tectonics and geodynamics, arises the possibility of better understanding the regional seismotectonic aspects related to the collision between Africa and Eurasia tectonic plates, as well as of local ones, in high seismicity areas from Albania and Romania.

Tectonic, seismological, geophysical (seismic tomography, refraction seismics), geodetic (GPS monitoring) and remote sensing data have been analyzed and interpreted, aiming to evaluate possible connections determined by regional active tectonics between high seismicity zones in Romania (Vrancea) and Albania (Durres). A seismotectonic and geodynamic model for the Durres seismic area was built based on the November 2019 seismicity, the regional wrench tectonics system and the active fault systems in Albania.

2. GEOTECTONIC SETTING

Considering the distance between the two selected areas (Fig. 1) and the significant tectonic and geodynamic differences between the Durres and Vrancea seismic zones, only relevant information for this study objectives has been selected from available scientific publications.

Local tectonics, in both Durres and Vrancea zones, was possible to be surveyed and mapped due to outcropping geological structures in hilly and mountainous areas of the Albanides and the Carpathians. Regional tectonics between the two analyzed seismic zones was more difficult to be completed, due to large areas with concealed relevant tectonic features of the geological structures, such as the Moesian Platform, in Romania and Bulgaria.

One possibility to avoid difficulties in getting a regional tectonic framework (arised from compilation of countries maps or lack of tectonic information in areas devoid of outcropping geological structures), was offered by remote sensing data interpreted as lineaments having geotectonic and neotectonic significance. The map presented in Fig. 2, published by Dachev (1988), illustrates regional and local tectonic lineaments in a large area, including Romania and Albania. The main fault systems having regional development are trending NE–SW and NW–SE, as tectonic consequences of post–subduction collisions in the East Carpathians and at the Adriatic Sea margin.

Of particular interest for this study are the regional NE–SW lineaments interpreted on remote sensing observations between the Black Sea and the Adriatic Sea, slightly different in trend to the transcurrent faults interpreted by Ioane and Stanciu (2018), the latter developed at least between Chişinău (Republic of Moldova) and Durres (Albania).

The fact that the remote sensing interpreted lineaments slightly differ from the transcurrent faults may be understood as follows:

a) the transcurrent faults trend is the correct one, since long sectors of the remote sensing lineaments are represented by interrupted lines, which means lack of continuity in the observed relief features;

b) there are two regional fault systems, slightly differing as trend, results of two compressional stages of Africa and Eurasia plates, accommodating the Adriatic microplate by north-eastward lateral escape tectonic processes.

The coeval high seismicity in Durres and Vrancea seismic zones during 26–27 of November 2019 and the location of the Durres earthquakes between the two transcurrent faults, recently interpreted by Ioane and Stanciu (2018), are illustrated in Fig. 2.

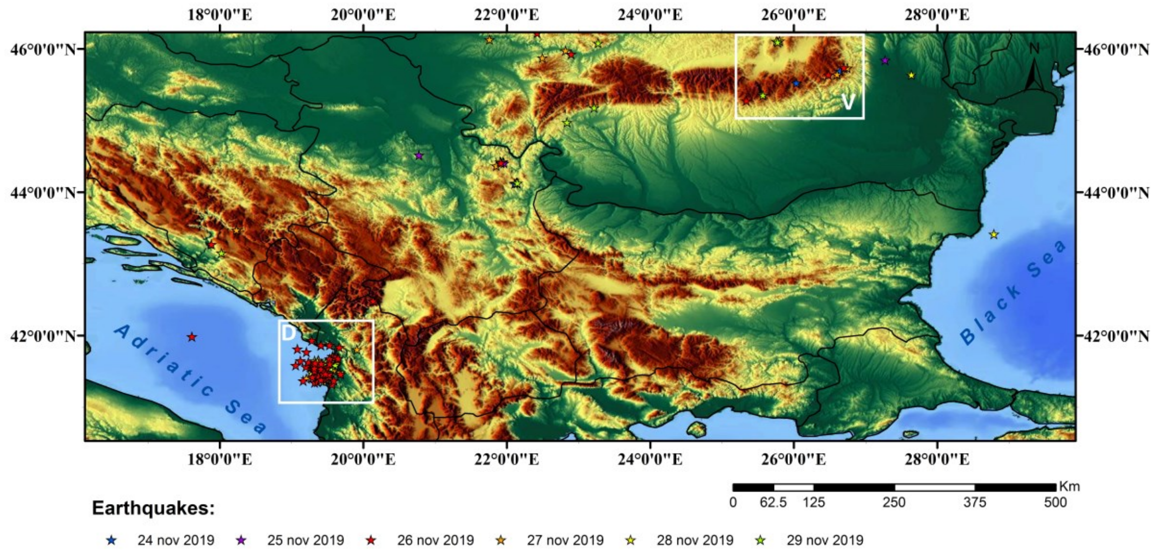

Fig. 1 – Location of Durres (Albania) and Vrancea (Romania) seismic zones.
D = Durres seismic zone (white rectangle at the eastern margin of the Adriatic Sea); V = Vrancea seismic zone (white rectangle at the East Carpathians Bend). Seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020). Relief map: H. Braxmeier (2017), https://maps-for-free.com/ accessed 2020.

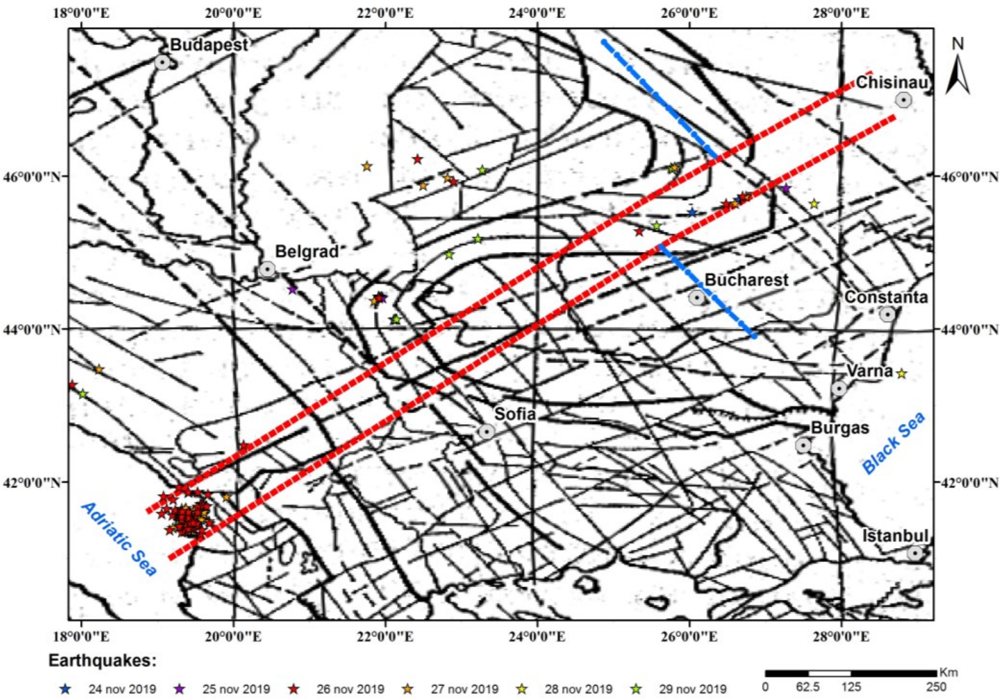

Fig. 2 – Regional tectonic lineaments in the studied area (modified from Dachev, 1988). Black lines represent the faults interpreted on remote sensing data by Dachev (1988); red dashed lines represent the transcurrent faults interpreted by Ioane & Stanciu (2018); blue dashed lines represent displaced western boundary of the East European Platform (Ioane & Stanciu, 2018). Stars = epicenters of seismic events, 24-29 November 2019. Seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020).

Traces of past subductions and signatures of actual post–subduction collisions, situated opposite one another in the studied region between the Carpathians and the Adriatic Sea, are best depicted by a seismic tomography section published by Piromallo and Morelli (1997), trending NE–SW and crossing both the Vrancea and Durres seismic zones (Fig. 3).

The two inclined "blue structures" developed beneath Romania, Bulgaria, Serbia and Albania, and crossing each other at ca 400 km depth, are interpreted as remnants of subducted slabs of oceanic lithosphere, engulfed in the mantle up to 600 km depth during subduction processes.

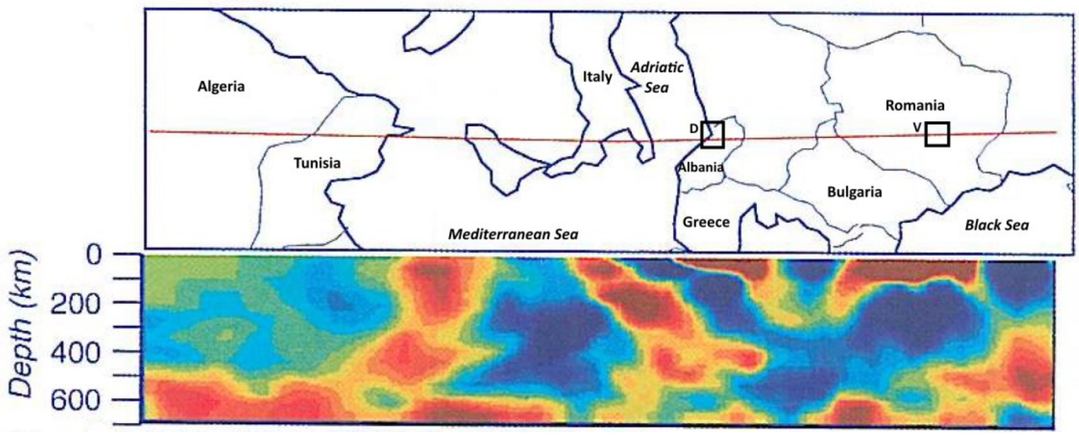

Fig. 3 – Seismic tomography section between Vrancea (V – black rectangle) and Durres (D – black rectangle) seismic zones (modified from Piromallo, Morelli, 1997).

2.1. TECTONIC SETTING OF DURRES (ALBANIA) SEISMIC ZONE

According to Aliaj *et al.* (1974), the geological structures in Albania are separated by the Shkodra–Peja transverse tectonic line into:

a) Northern Albanides, connected with the Dinarides;

b) Southern Albanides, connected with the Hellenides.

The interpretation that the troughs in the Southern Albanides are older (Upper Lias) than those in the Northern Albanides (Upper Dogger) (Aliaj *et al.*, 1974), illustrates the importance of the Shkodra – Peja deep fault, as this fault interrupts the extension of the southern and northern geological structures.

The Shkodra – Peja transverse fault shows left-lateral displacement illustrated by the shifting of the Kruja mountain range; it cuts the Albanides and the younger overlapping depressions and is still currently active (Aliaj *et al.*, 1974).

Five NW–SE trending seismogenic lines have been interpreted in Albania considering the regional seismicity and epicenters areal distribution. The location of strong earthquakes is connected with the crossings situated at the intersection of longitudinal (NW–SE) and transverse (NE–SW) faults (Aliaj *et al.*, 1974).

2.2. TECTONIC SETTING OF VRANCEA (ROMANIA) SEISMIC ZONE

Vrancea seismic zone area, located in the East Carpathians Bend Zone, between the Transylvanian Depression (W) and the Moesian Platform (E), is characterized by crustal and lithospheric seismicity down to about 200 km depth (Oncescu *et al.*, 1999, updated).

The outcropping geology displays Alpine tectonics, the overthrusted nappes being the result of several tectonic phases: Laramian (Late Cretaceous), Early Styrian and Late Styrian (Early Miocene) (Săndulescu, 1984).

The main tectonic models proposed for the Vrancea crustal and lithospheric structures were based on:

a) oceanic slab break-off (*e.g.*, Linzer, 1996);

b) subduction of an oceanic lithospheric slab, ended as continental collision and tectonic blocks docking (*e.g.*, Wortel, Spakman, 2000);

c) lithosphere delamination followed by asthenosphere upwelling (*e.g.*, Knapp *et al.*, 2005).

When interpreting the presence of trans-crustal faults across the East Carpathians Bend, an important tectonic feature in the Vrancea seismic zone may be considered the vertical tectonic contact between Tisza–Dacia continental block and the Moesian Platform, shown by refraction seismic data to develop downward at least 40 km beneath the overthrusted sedimentary nappes and the metamorphic deep structures (Hauser *et al.*, 2007).

3. SEISMICITY OF DURRES AND VRANCEA ZONES IN NOVEMBER 2019

Information on the regional seismicity has been consulted and/or utilized from several seismological data sources: Romanian National Institute of Earth's Physics real-time seismicity – RTM (https://web.infp.ro/#/, 2019, 2020), Romanian National Institute of Earth's Physics ROMPLUS Earthquake Catalogue (Oncescu *et al.*, 1999 updated), EMSC Earthquake Catalogue (http://www.emsc-csem.org, 2020), Aristotle University of Thessaloniki Seismicity Catalogue (http://geophysics.geo.auth.gr/ss/catalogs_en.html, 2020), Bollettino Sismico Italiano INGV (http://terremoti.ingv.it/bsi, 2020), GFZ Helmholtz Centre Potsdam Earthquake Catalogue (https://geofon.gfz-potsdam.de/, 2020), USGS Earthquake Catalogue (https://earthquake.usgs.gov/earthquakes/search/, 2020), as well as Geoscience Australia (https://earthquakes.ga.gov.au/, 2020).

When analysing the consistency of seismological information provided by various catalogues for the Durres November 26, 2019 strong earthquake, a quite large variability in location was observed (Fig. 4). Offering a better accuracy of positioning in GIS, which is a very important key in data interpretation, the regional and local seismological data provided in real time by the National Institute of Earth's (Romania) have been selected and utilized in this study.

At a regional scale, the high seismicity in Durres seismic zone was accompanied during November 26 and 27, 2019 by several large magnitude earthquakes (Fig. 5). Significant seismic events have been recorded in Greece (N Peloponnesus ml = 3.8; W Crete ml = 6.0) and in Bosnia–Herzegovina (ml = 5.9), on two regional NW–SE lineaments: W Crete – N Peloponnesus and Durres – Bosnia–Herzegovina, shifted toward NE in the Durres area, at the regional shape modification of the shoreline.

During 26 and 27 November 2019, a higher number of earthquakes, as compared to the average seismicity, occurred in the Durres and Vrancea seismic zones.

3.1. SEISMICITY OF DURRES ZONE IN NOVEMBER 2019

Several earthquakes have been recorded in November 2019 in the Durres seismic zone, prior to the strong Mw = 6.4 seismic event occurred on November 26. The high magnitude earthquake started at 2:54 AM, close to Durres city (Albania), causing casualties, collapse of buildings and infrastructure destruction. Numerous earthquakes followed during November 26 and 27, having epicenters both onshore and offshore. The seismicity diminished thereafter, till the end of November 2019 (Fig. 6).

During November 26, 2019 more than 40 earthquakes occurred in the Durres seismic zone; besides the few strongest ones, with magnitudes over 5 and 6, more than 10 seismic events have been characterized by M ≥4.

The magnitude of the earthquakes that occurred in the Durres seismic zone on November 26 and 27, 2019, have been interpolated using the kriging method and represented as referenced contour maps (geographic coordinates). The contoured map upon earthquakes magnitude shown in Fig. 7 illustrates that the strongest seismicity on November 26 occurred along the NW–SE direction, the NE–SW direction of active seismicity being characterized by lower magnitudes, below 4.

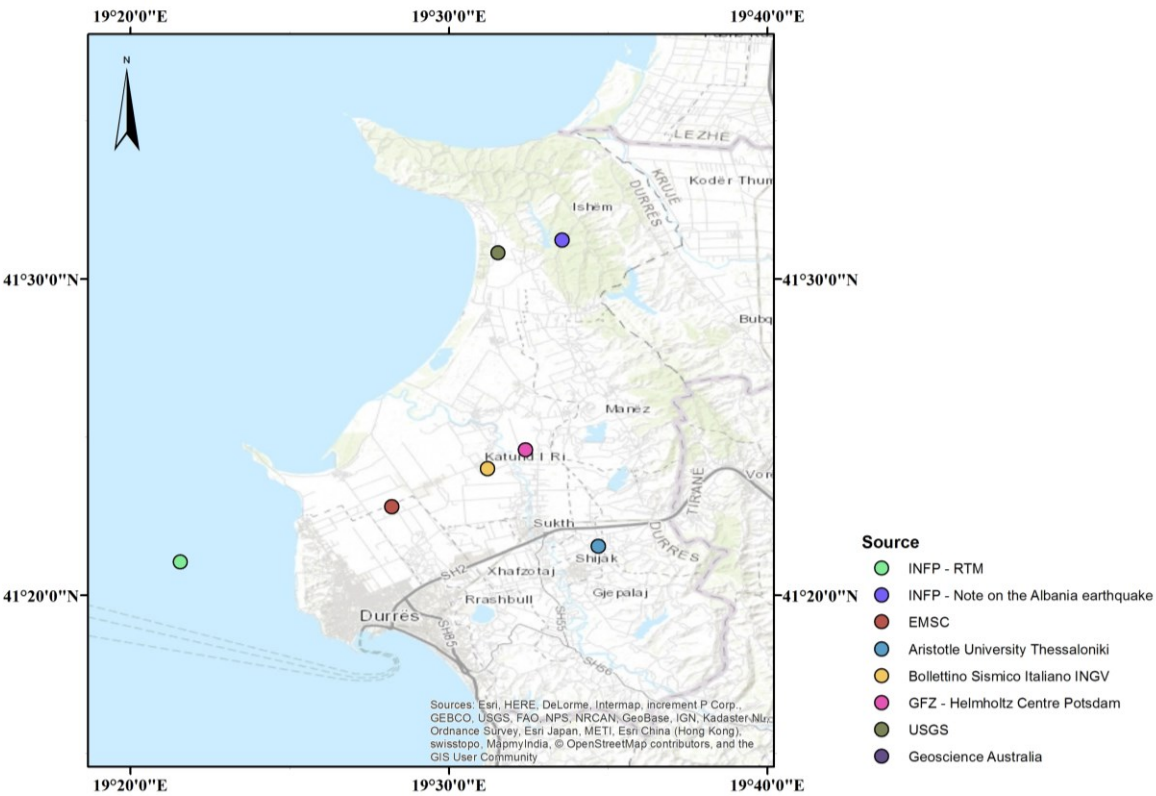

Fig. 4 – Variability in locating the Durres 2019 main seismic event in seismological catalogues (plotted on the background of World Topographic Map, available from ESRI ArcMap online resources).

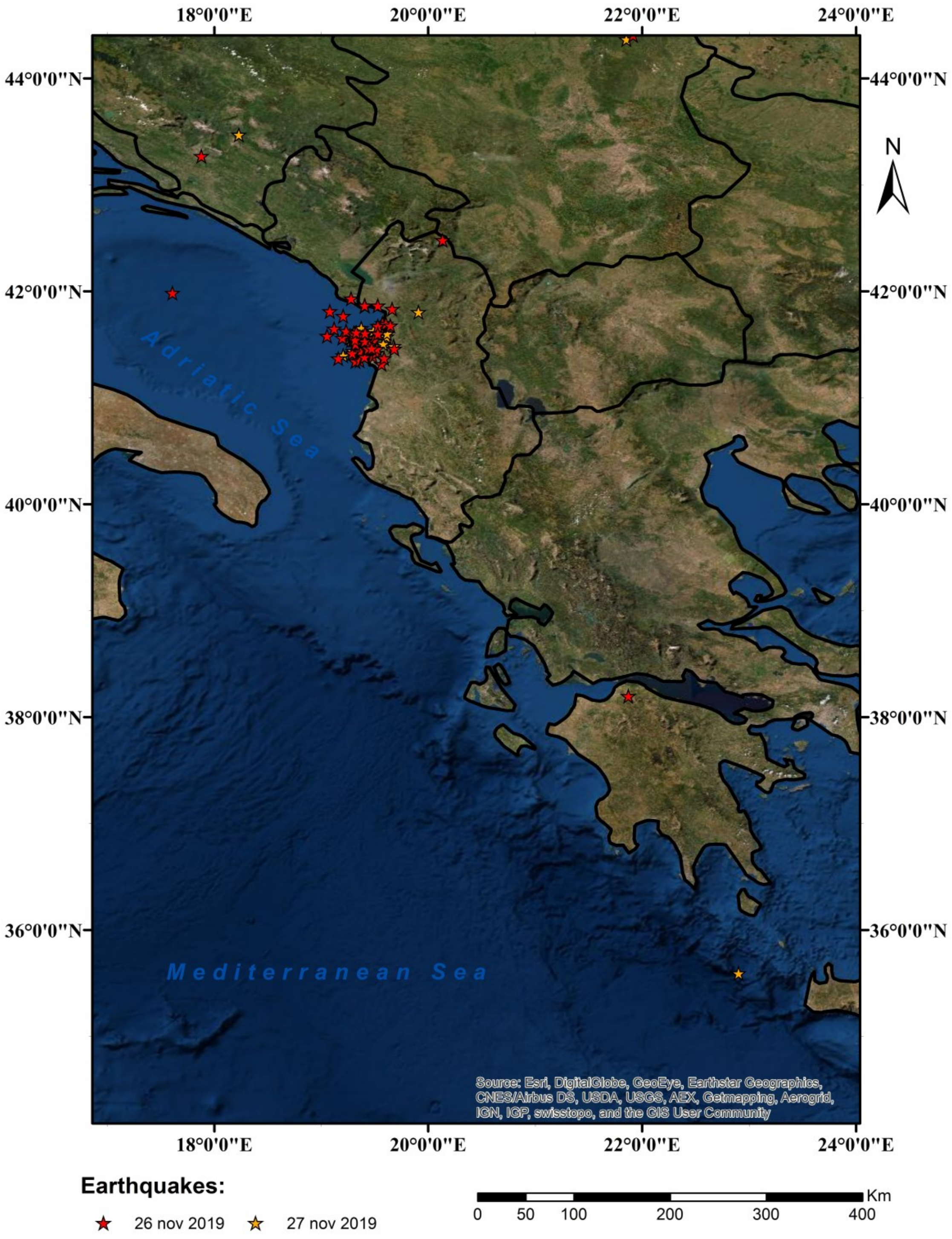

Fig. 5 – Regional seismicity during November 26–27, 2019: Greece, Albania, Bosnia.
Seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020)
(plotted on the background of Word Imagery Map, available from ESRI ArcMap online resources).

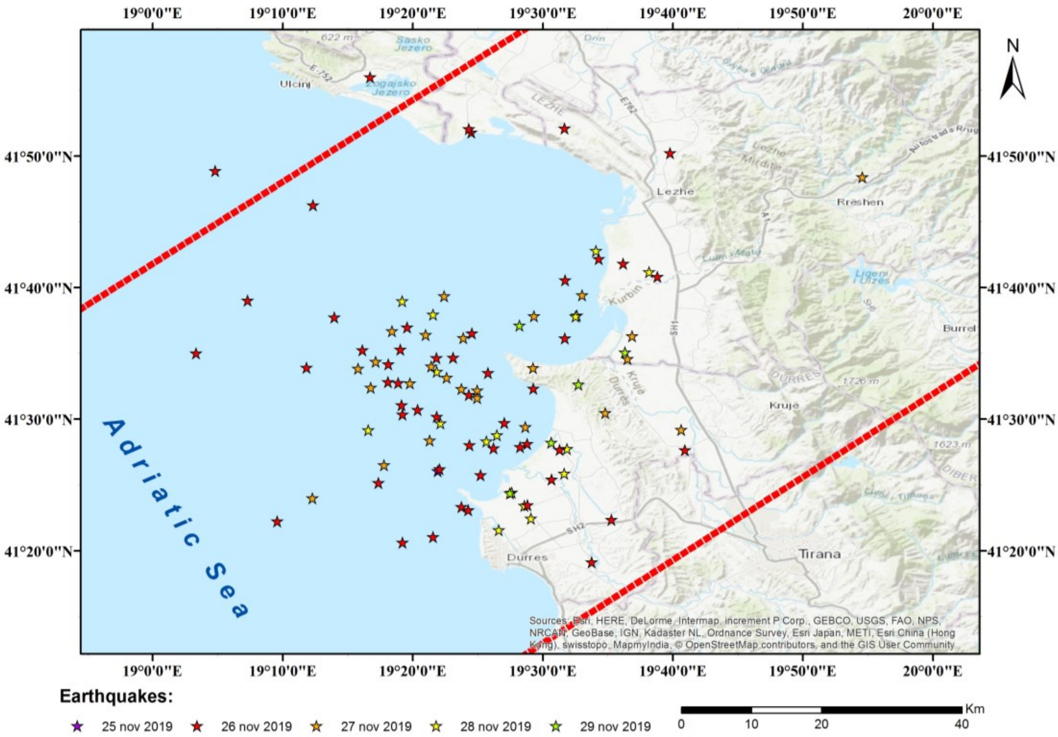

Fig. 6 – High seismicity sequence in Durres seismic zone during November 25–29, 2019. Seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020) (plotted on the background of World Topographic Map, available from ESRI ArcMap online resources).

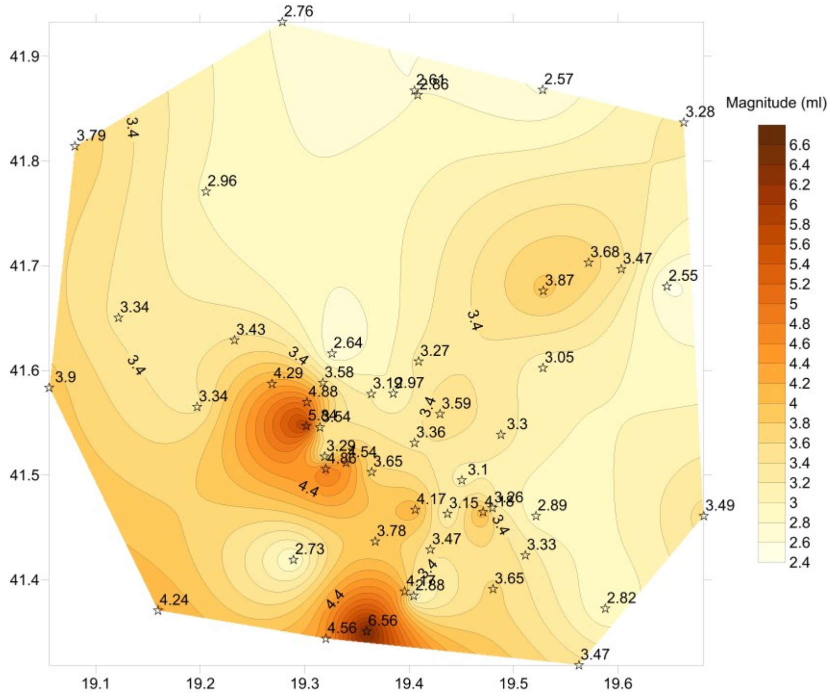

Fig. 7 – Magnitude contour map (kriging interpolation method) of the seismic events occurred in Durres seismic area on November 26, 2019. Seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020).

The high seismic activity continued in the Durres seismic zone during November 27 with more than 20 seismic events, decreasing in both earthquakes number and magnitude. The strongest recorded earthquake had magnitude over 5, most seismic events being characterized by magnitudes between 3 and 4 (Fig. 8).

The location of epicenters and earthquakes magnitude looks different on November 27, as compared to November 26, the seismic activity being slightly displaced north-eastward on the NW–SE active fault system.

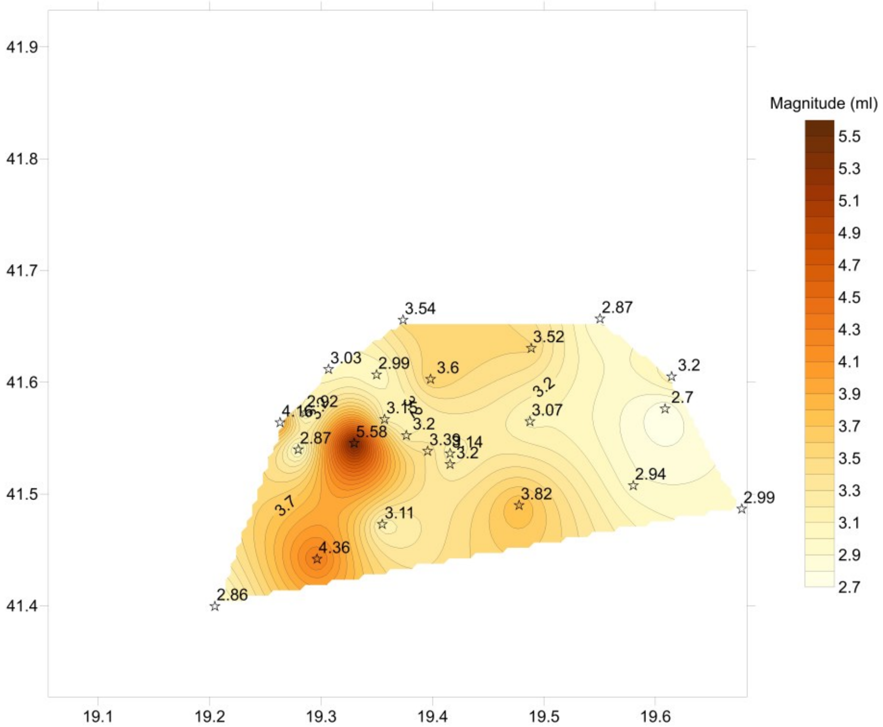

Fig. 8 – Magnitude contour map (kriging interpolation method) of the seismic events occurred in Durres area on 27 November, 2019. Seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020).

3.2. SEISMICITY OF VRANCEA ZONE IN NOVEMBER 2019

Up to 20 seismic events occurred in the Vrancea seismic zone (Romania) and in its immediate vicinity – within the wrench tectonics system or along the southern transcurrent fault – before, during and after the strong earthquake Mw = 6.4 recorded at 2.54 AM in the Durres seismic zone (Albania) on November 26, 2019.

Ten hours after the strong earthquake occurred in the Durres seismic zone on November 26, a seismic sequence started in Vrancea seismic zone, consisting of three events of 1.7, 3.2 and 2.6 Mw, their epicenters migrating eastward. During 26 and 27 of November 2019, a higher number of earthquakes occurred in the Vrancea seismic zone, as compared to its average seismicity, clearly associated to the southern transcurrent fault (Fig. 9).

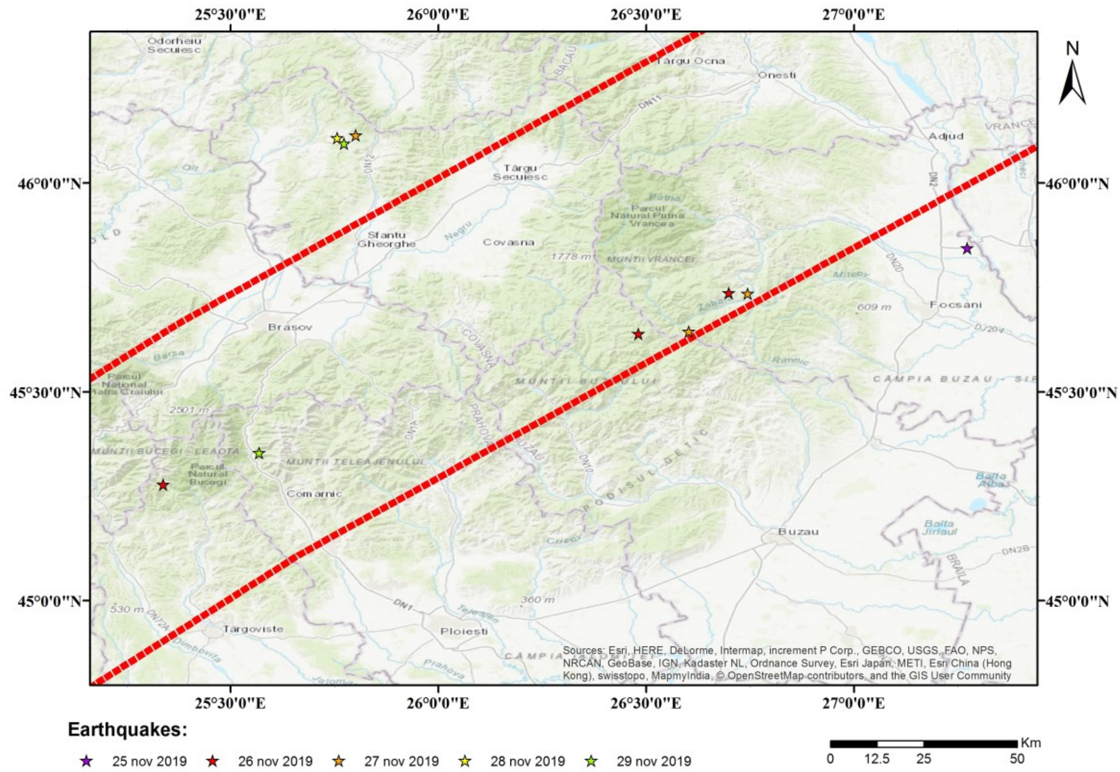

Fig. 9 – Seismic events occurred in Vrancea zone during November 25–29, 2019. Seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020). Plotted on the background of World Topographic Map, available from ESRI ArcMap online resources.

4. WRENCH TECTONICS BETWEEN ROMANIA AND ALBANIA

A wrench tectonics system was recently interpreted in Romania, having as starting dataset the EGG 97 geoidal anomalies along TESZ and in the region of the East and South Carpathians (Ioane, Stanciu, 2018). To better illustrate deep tectonic features, a processing technique usually employed to detect fault systems and tectonic contacts (horizontal gradient of Bouguer gravity anomalies) was applied over the EGG 97 geoidal gridded values. The resulted elongated high anomalies were interpreted as deep tectonic contacts or regional fault lines, with significant vertical displacements of compartments (Ioane, Stanciu, 2018).

The NE–SW trending anomaly, shifting the Trans-European Suture Zone (TESZ) at the East Carpathians Bend area and within the Vrancea seismic zone, was interpreted as being due to two regionally developed parallel transcurrent faults, a wrench tectonics system. Compressional regimes determined by eastward lateral escape displacements towards this region (associated with the collision between Africa and Eurasia), and possibly westward displacements (associated with the opening of the West Black Sea basin), have been possibly accommodated along this wrench tectonics system (Fig. 10) (Ioane, Stanciu, 2018).

In Fig. 10, most important for this study are:

– displacements of geological structures along the two transcurrent faults are taking place at a regional scale;
– the southern transcurrent fault of the wrench tectonics system is involved in the subcrustal seismicity in the Vrancea seismic zone.

The wrench tectonics system interpreted in Romania has been extended up to Albania, in the Durres seismic zone, after the November 2019 high seismicity sequence including the Mw = 6.4 strong earthquake. When prolonging south-westward to Albania the two transcurrent faults from Romania, it was observed that most earthquake epicenters occurred during 26 and 27 November 2019 in the Durres area fall between them (Fig. 2), suggesting that wrench tectonics processes might be here also involved.

Trying to constrain the assumption that the wrench tectonics system interpreted in Romania continues south-westward to Albania on more than 700 km, several GPS based geodynamic maps for this region have been consulted. Figure 11, based on GPS results published by Jouanne *et al.* (2012), shows the trend changes of GPS geodynamic vectors determined by horizontal displacements along the regional wrench tectonics system. North of the northern transcurrent fault, the vectors describing horizontal displacements in southern Italy, Albania, Serbia and Bulgaria are trending NE, while such vectors situated south of the southern transcurrent fault are clearly trending differently: N–S, NNW–SSE or W–E. Even the SSW–NNE trending vector computed for Nis city is in good agreement with the SW–NE direction of displacements determined immediately south of the northern transcurrent fault, considering its strike-slip characteristics.

There might be also a geographical aspect to support the prolongation of the wrench tectonics system from Romania to Albania: the Adriatic Sea shoreline shape is suddenly changed between the two transcurrent faults. Since seismic tomography data show that the litoral change is accompanied by the subducted slab up to 50 km depth (Piromallo, Morelli, 1997), the area north of the northern transcurrent fault was displaced in geological time toward NE, while the area south of the southern transcurrent fault was displaced toward SW. The GPS based geodynamic data presented in Fig. 11 suggest that such displacements are still nowadays taking place between the Albanides and the Carpathians.

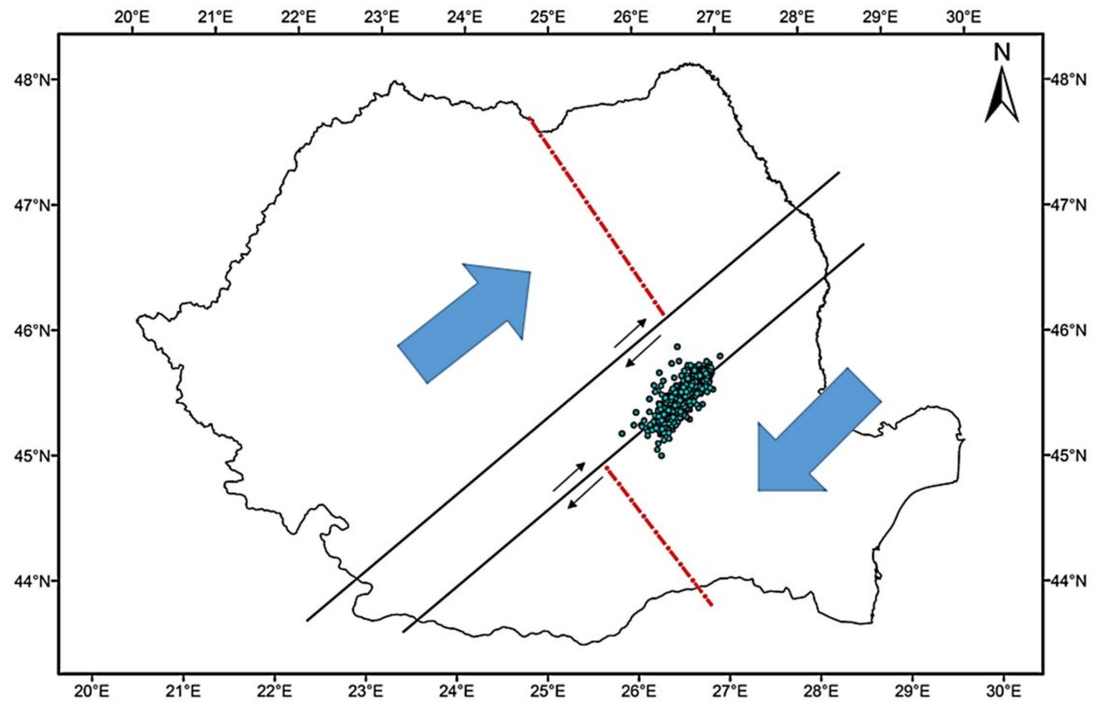

Fig. 10 – Wrench tectonics system interpreted across the Romanian territory (Ioane, Stanciu, 2018). Blue arrows: geodynamic displacements; black arrows: strike-slip faults; black lines: transcurrent faults; red dotted lines: western boundaries of East European Platform; green circles: subcrustal seismicity in Vrancea seismic zone (seismological data from Oncescu *et al.*, 1999, updated).

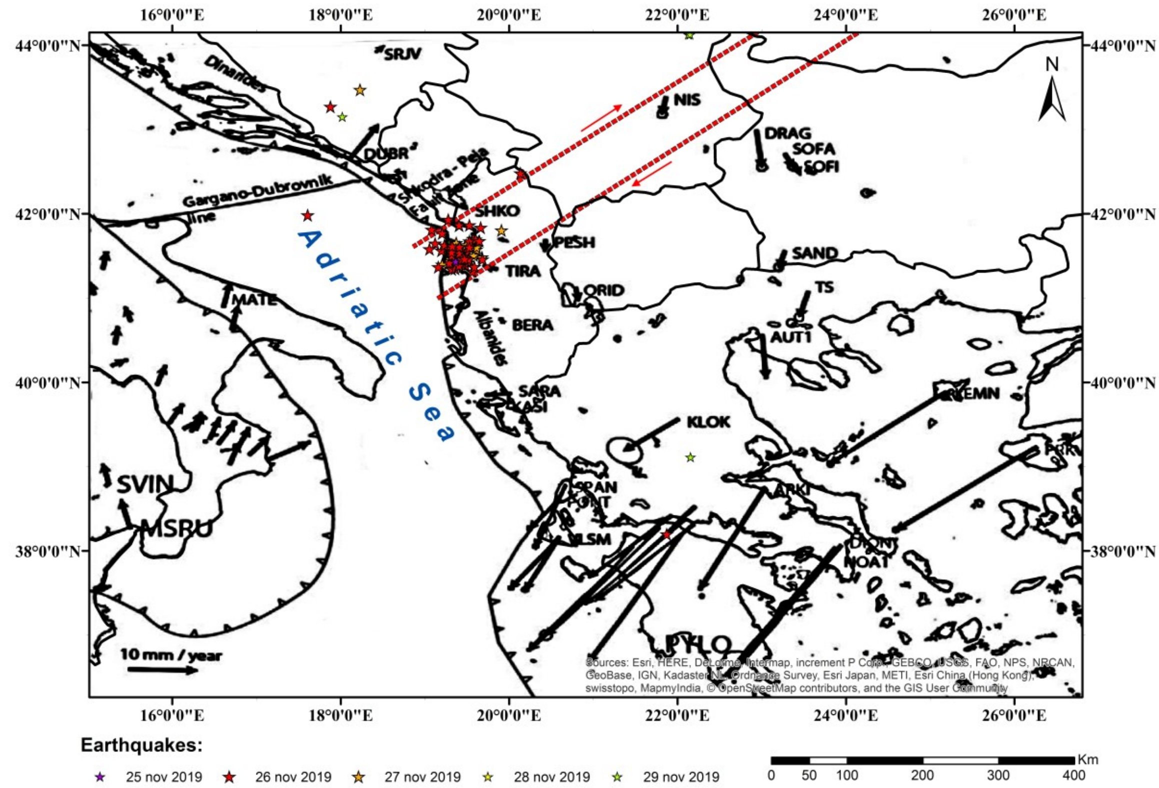

Fig. 11 – Trend changes of GPS geodynamic vectors determined by horizontal displacements along the regional wrench tectonics system. GPS data: Jouanne *et al.*, 2012. Red dotted lines: transcurrent faults from Ioane & Stanciu, 2018; red arrows: regional displacements due to wrench tectonics system. Seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020).

Trying to understand why the wrench tectonics system was initiated between its present time location, a seismic tomography section crossing almost orthogonal the transcurrent faults and the active subduction zone along the Hellenic Arc (Fig. 12 – van der Meer *et al.*, 2018) was analyzed and interpreted. The blue structure situated at 100 – 300 km depth beneath Greece, is interpreted as a cooler and high seismic velocity subducted slab, as compared to warmer and low velocity seismic mantle and asthenospheric matter developed north-westward, their contact being at the Durres area latitude. It is likely that the massive blue brittle structure was more difficult to break and displaced as compared to the more viscous asthenosphere, in the compressional regime determined by lateral escape tectonic processes associated to the collision between Africa and Eurasia plates, in the region of the Adriatic Sea.

5. ACTIVE FAULT SYSTEMS IN DURRES SEISMIC AREA

The main fault system trending NW–SE in Albania is considered as longitudinal, being crossed by the NE–SW transverse system. The NW–SE fault system is mostly developed in the southern part of Albania, while the NE–SW one is mainly developed in its northern part. The NE–SW fault system acting as sinistral strike-slip faults, is obviously younger that the NW–SE one, the neotectonic map illustrating situations where the NW–SE faults are interrupted and horizontally displaced by NE–SW and W–E trending faults (Fig. 13).

Of high tectonic importance for this study and supporting the south-westward prolongation of the wrench tectonics interpreted in Romania is the accurate overlapping of the northern transcurrent fault with the NE–SW transverse fault mapped in northern Albania and crossing the Shkoder city. There is another NE–SW trending fault north of Elbasan, extending north-eastward outside Albania, illustrating this way the importance of this fault system. The fact that the map does not show a fault in Albania associated with the southern transcurrent fault (Fig. 13) may be due to the crossing of a large depressionary area, the overlying sedimentary formations possibly concealing fault traces, as it is the case in the Moesian Platform (Romania and Bulgaria).

The sinistral strike-slip fault character of the southern transcurrent fault is also supported by remote sensing data interpretation, since a regional NW–SE trending fault in the area between Sofia (Bulgaria) and Durres (Albania) is interrupted and displaced laterally (Fig. 2).

The high seismicity depicted in the Durres seismic area in November 2019 between the two transcurrent faults, mostly located offshore, is determined by the activation of the two fault systems described above: NW–SE and NE–SW, especially at their faults junctions.

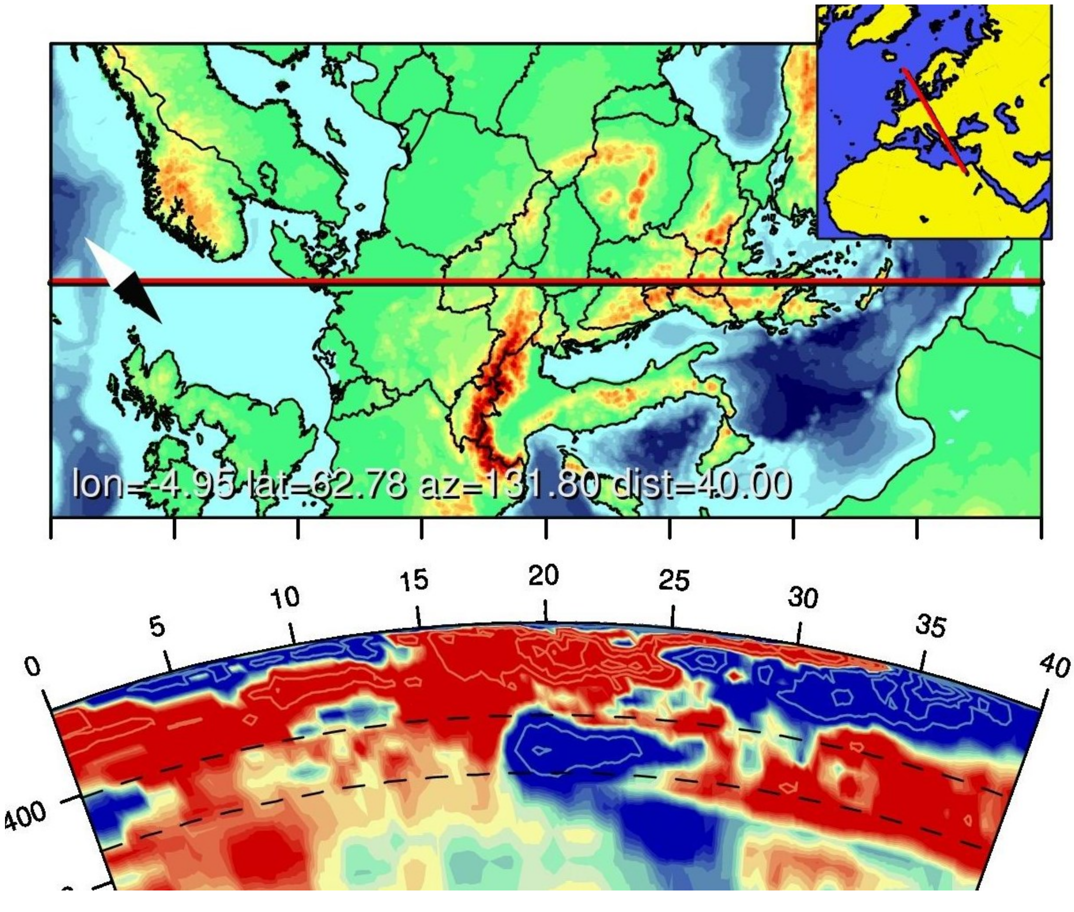

Fig. 12 – Seismic tomography section across the subduction beneath the Hellenic Arc (modified from van der Meer *et al.*, 2018).

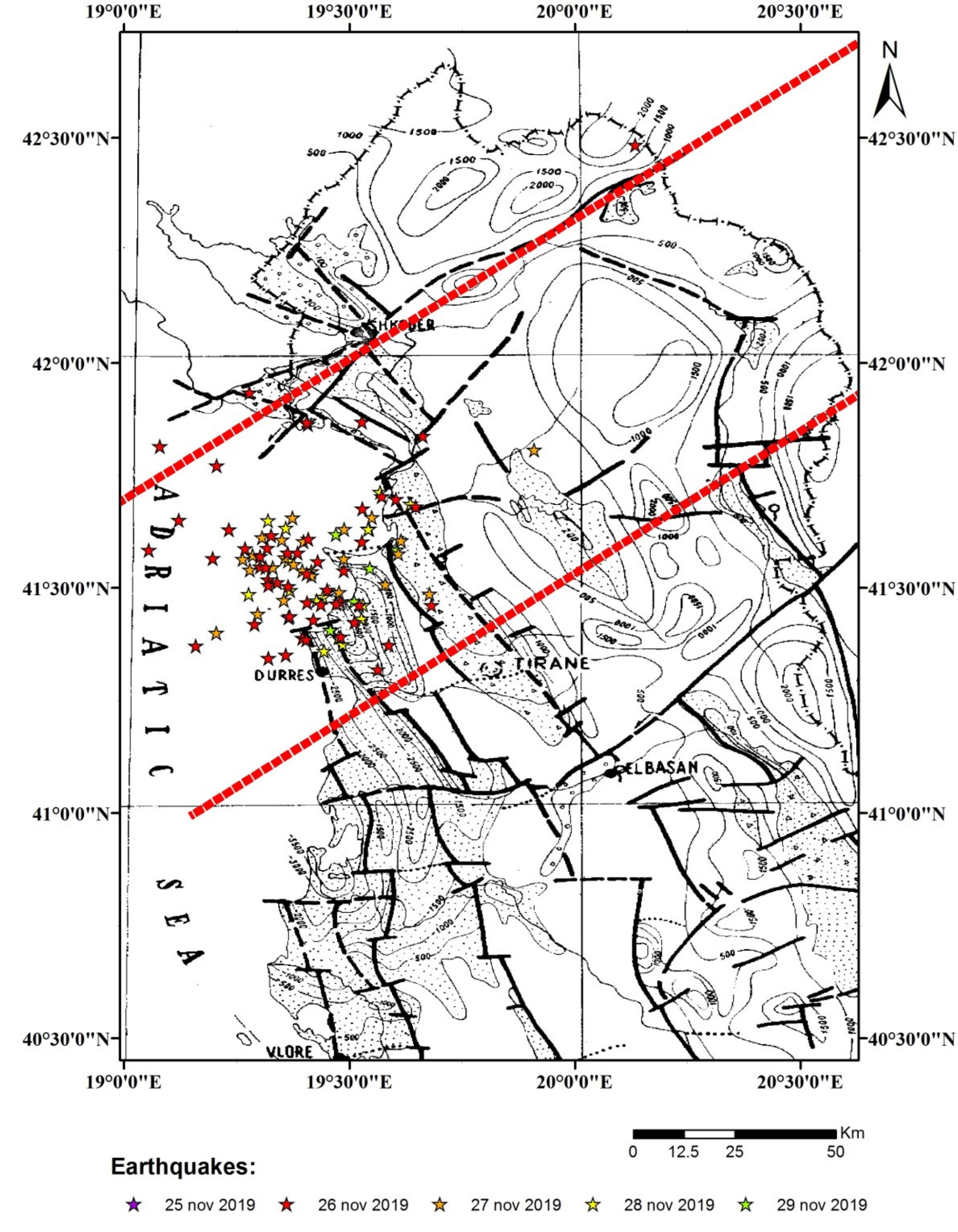

Fig. 13 – Neotectonic fault systems and earthquakes epicenters in the Durres seismic zone during November 25–29, 2019. Black lines: fault lineaments (modified from Aliaj *et al.*, 1974); black dotted lines: transcurrent faults; stars: earthquakes epicenters during November 25–29, 2019; seismological data: Romanian National Institute of Earth's Physics RTM Earthquake Catalogue (2020).

6. DURRES SEISMOTECTONIC MODEL

As mentioned in the introductory part, the most important objective of this study was to build a seismotectonic model for the Durres seismic zone, using regional and detailed information on active tectonics, geodynamics and seismicity.

When considering active tectonics, the regional component is represented by the south-western extremity of the wrench tectonics system, recently interpreted in Romania and extended in this study to the Durres seismic zone.

The NE–SW trending transcurrent faults and their sinistral “satellite” faults are acting as regional or local strike-slip faults, interrupting and displacing older fault systems, such as the NW–SE fault system, largely developed in Albania (Fig. 14). A NW–SE tectonic lineament, interpreted using the seismic events that occurred between W Crete and S Bosnia–Herzegovina during November 26–27, 2019, crosses the transcurrent faults within the Durres seismic area.

Observing that the epicenters of earthquakes occurring on November 26–27, 2019 are located on the NW–SE and NE–SW local fault systems in the Durres seismic zone, it is likely that both NE–SW (Vrancea – Durres) and NW–SE (Crete – Bosnia-Herzegovina) regional fault systems have been activated by regional geodynamics and determined the recorded high seismicity (Fig. 14).

The network of active faults, as illustrated in Figure 14, determines sudden displacements and hence, earthquakes, especially at crossings of the fault systems, as a consequence of regional compressional regime and strike-slip faults activation due to lateral escape tectonic processes.

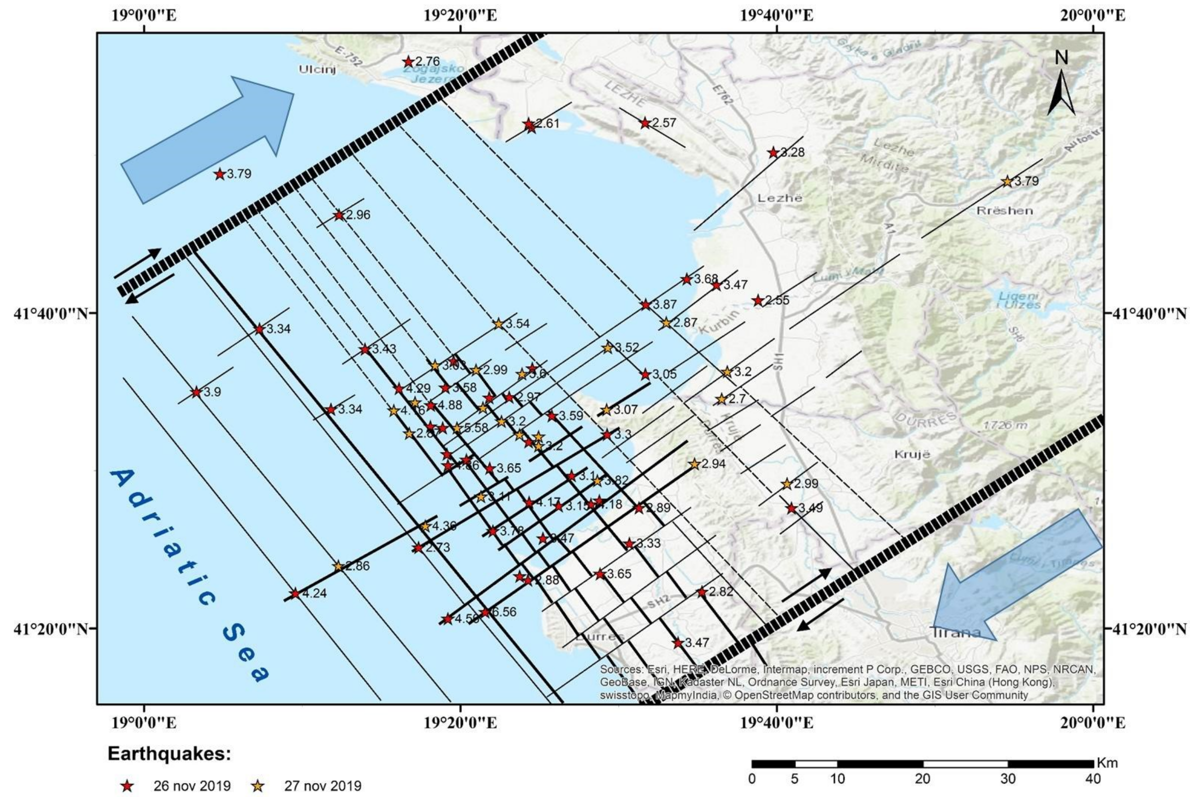

Fig. 14 – Seismotectonic model in the Durres area based on the November 2019 high seismicity.
Blue arrows: geodynamic displacements; black thick dotted lines: transcurrent faults; black lines: faults; black arrows: strike-slip displacements; stars: earthquakes epicenters. Seismological data: Romanian National Institute of Earth’s Physics RTM Earthquake Catalogue (2020). Plotted on the background of World Topographic Map, available from ESRI ArcMap online resources.

7. CONCLUSIONS

The scientific objective of this study was to build a seismotectonic model in the Durres seismic area, based on the high quality of the seismological data recorded by the National Institute of Earth's Physics (Romania) during the high seismicity sequence in Durres seismic zone on November 2019.

Most of the November 2019 epicenters of the seismic events occurred in the Durres area are located between the south-westward prolongation of two transcurrent faults, components of the wrench tectonics system recently interpreted in Romania.

To avoid difficulties in getting a regional geotectonic framework, remote sensing data interpreted as lineaments with geotectonic and neotectonic significance have been analyzed for a large region including Romania and Albania.

The main fault systems showing regional development are trending NE–SW and NW–SE, as a tectonic consequence of post–subduction collisions in the East Carpathians and at the Adriatic Sea margin. The fact that the remote sensing interpreted lineaments slightly differ from the transcurrent faults might be understood as the presence of two NE–SW trending regional fault systems, results of two compressional stages of Africa and Eurasia plates when accommodating the Adriatic microplate by north-eastward lateral escape tectonic processes.

Traces of past subductions and signatures of actual post–subduction collisions, situated opposite one another between the Carpathians and the Adriatic Sea, have been interpreted on seismic tomography section crossing both the Vrancea and Durres seismic zones.

At a regional scale, the high seismicity in the Durres seismic zone was accompanied during November 26–27, 2019 by several earthquakes, which are interpreted here to be located on two regional NW–SE lineaments: W Crete – N Peloponnesus and Durres – Bosnia-Herzegovina, shifted toward NE in the Durres area.

At a local scale, earthquakes have been recorded in November 2019 in the Durres seismic zone (Albania) prior to the strong one, Mw = 6.4, occurred on November 26. Numerous earthquakes followed during November 26 and 27, having epicenters both onshore and offshore. The strongest seismicity on November 26 and 27 occurred along the NW–SE direction, the NE–SW direction of active seismicity being characterized by lower magnitudes.

Earthquakes occurred in the Vrancea seismic zone (Romania) and in its immediate vicinity – within the wrench tectonics system or along the southern transcurrent fault – before, during and after the strong earthquake (Mw = 6.4), recorded in the Durres seismic zone (Albania). On November 26–27, 2019, a higher number of earthquakes occurred in the Vrancea seismic zone, as compared to its average seismicity, clearly associated to the southern transcurrent fault.

To constrain the assumption that the wrench tectonics system interpreted in Romania continues south-westward on more than 700 km till Albania, several GPS based geodynamic studies have been consulted, the vectors describing horizontal displacements showing different trends north and south of the transcurrent faults.

A geographical aspect may also support the prolongation of the wrench tectonics system from Romania to Albania, as between the two transcurrent faults, the shape of the Adriatic shoreline shows a sudden change, its indentation being consistent with the interpreted wrench system displacement arrows.

Of high tectonic importance for this study and supporting the south-westward prolongation of the wrench tectonics interpreted in Romania is the accurate overlapping of the northern transcurrent fault with the NE–SW transverse fault geologically mapped in northern Albania and crossing the Shkoder city.

The high seismicity which occurred in the Durres seismic area during November 2019 between two transcurrent faults, mostly located offshore, was determined by the two active fault systems described above and trending NW–SE and NE–SW, especially at their faults junctions. The NE–SW trending transcurrent faults and their sinistral "satellite" ones act as regional or local strike-slip faults, interrupting and displacing older ones, such as the NW–SE fault system.

The active faults network, as illustrated in the seismotectonic model, determines sudden displacements due to regional geodynamics and hence, earthquakes, especially at crossings of the fault systems, suite of regional compressional regime and strike-slip faults activation due to lateral escape tectonic processes.

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