Published papers with abstracts
Lucrări publicate, cu rezumate in Engleza

2021

1. **Shimojo, K., Enescu, B., Yagi, Y. and Takeda, T. (2021). Nucleation process of the 2011 northern Nagano earthquake from nearby seismic observations. Scientific Reports, 11, 8143 (2021). https://doi.org/10.1038/s41598-021-86837-4.**

Published/Publicat: 16 April 2021

Abstract/Rezumat: The 2011 magnitude (M) 9.0 Tohoku-Oki earthquake was followed by seismicity activation in inland areas throughout Japan. An outstanding case is the M6.2 Northern Nagano earthquake, central Japan, occurred 13-h after the megathrust event, approximately 400 km away from its epicenter. The physical processes relating the occurrence of megathrust earthquakes and subsequent activation of relatively large inland earthquakes are not well understood. Here we use waveform data of a dense local seismic network to reveal with an unprecedented resolution the complex mechanisms leading to the occurrence of the M6.2 earthquake. We show that previously undetected small earthquakes initiated along the Nagano earthquake source fault at relatively short times after the Tohoku-Oki megathrust earthquake, and the local seismicity continued intermittently until the occurrence of the M6.2 event, being likely 'modulated' by the arrival of surface waves from large, remote aftershocks off-shore Tohoku. About 1-h before the Nagano earthquake, there was an acceleration of micro-seismicity migrating towards its hypocenter. Migration speeds indicate potential localized slow-slip, culminating with the occurrence of the large inland earthquake, with fluids playing a seismicity-activation role at a regional scale.

2. **Placinta, A.O., Borleanu, F., Popescu, E., Radulian, M., Munteanu, I. (2021). Earthquake source properties of a lower crust sequence and associated seismicity perturbation in the SE Carpathians, Romania, Collisional Setting. *Acoustics*, 3, 270–296 (Editor: C. W. Lim), https://doi.org/10.3390/acoustics3020019.**

Published/Publicat: 19 April 2021

Abstract/Rezumat: Romanian seismicity is mainly confined to the Eastern Carpathians Arc bend (ECAB), where strong subcrustal earthquakes (magnitude up to 7.9) are generated in a narrow lithospheric body descending into the mantle. The seismic activity in the overlying crust is spread over a larger area, located mostly toward the outer side of the ECAB. It is significantly smaller than subcrustal seismicity, raising controversies about possible upper mantle-crust coupling. A

significant earthquake sequence took place in the foreland of the ECAB triggered on 22 November 2014 by a mainshock of magnitude 5.7 (the greatest instrumentally recorded earthquake in this region) located in the lower crust. The mainshock triggered a significant increase in the number of small-magnitude events spread over an unusually large area in the ECAB. The paper's goal is to compute the source parameters of the earthquakes that occurred during the aforementioned sequence, by empirical application of Green's function and spectral ratio techniques. Fault plane solutions are determined using multiple methods and seismicity evolution at regional scale is investigated. Our results highlight a still active deformation regime at the edge of the EE Craton, while the source parameters reveal a complex fracture of the mainshock and a very high-stress drop.

3. **Toader, V-E; Mihai A.; Moldovan, I-A; Ionescu, C.; Marmureanu, A.; Lingvay, I. (2021). Implementation of a Radon Monitoring Network in a Seismic Area. *Atmosphere*, 12(8) 1041, Academic Editor: Cucos (Dinu) Alexandra, doi: 10.3390/atmos12081041.**

Published/Publicat: 13 August 2021

Abstract/Rezumat: Large-scale radon monitoring is carried out due to the fact that it is directly responsible for public health. European Directive 2013/59/EURATOM has been transposed into the legislation of several countries and provides for the need for long-term monitoring of radon in homes and workplaces by setting the average annual reference level at 300 Bq/m^3. At the same time, radon is a precursor factor, its emission being correlated with seismic and volcanic activity. In this case, the protection of the population is ensured by a forecast similar to a meteorological one. The NIEP (National Institute for Earth Physics) is developing a multidisciplinary real-time monitoring network in the most dangerous seismic area in Romania, Vrancea. This is located at the bend of the Carpathian Mountains and is characterized by deep earthquakes (over 80 km), with destructive effects over large distances. Implementing a multidisciplinary monitoring network that includes radon, involves finding the locations and equipment that will give the best results. There is no generic solution for achieving this, because the geological structure depends on the monitoring area, and in most cases the equipment does not offer the ability to transmit data in real time. The positioning of the monitoring stations was based on fault maps of the Vrancea area. Depending on the results, some of the locations were changed in pursuit of a correlation with zonal seismicity. Through repeated tests, we established the optimal sampling rate for minimizing errors, maintaining measurement accuracy, and ensuring the detection of anomalies in real time. The radon ^{222}Rn was determined by the number of counts and ROI1 (region of interest) values, depending on the particularities of the equipment. Finally, we managed to establish a real-time radon monitoring network which transmits data to geophysical platforms and makes correlations with the seismicity in the Vrancea area. The equipment, designed to store data for long periods of time then manually download it with manufacturers' applications, now works in real time, after we implemented software designed specifically for this purpose.

4. **Zheng, Y., Enescu, B., Zhuang, J.C., and Yu, C. (2021). Data replenishment of five moderate earthquake sequences in Japan, with semi-automatic cluster selection, *Earthquake Science*, 34, doi:10.29382/eqs-2021-0030.**

Published/Publicat: 7 October2021

Abstract/Rezumat: Missing early aftershocks following relatively large or moderate earthquakes can cause significant bias in the analysis of seismic catalogs. In this paper, we systematically address the aftershock missing problem for five earthquake sequences associated with moderate-size events that occurred inland Japan, by using a stochastic replenishing method. The method is based on the notion that if a point process (e.g., earthquake sequence) with time-independent marks (e.g., magnitudes) is completely observed, it can be transformed into a homogeneous Poisson process by a bi-scale empirical transformation. We use the Japan Meteorological Agency (JMA) earthquake catalog to select the aftershock data and replenish the missing early events using the later complete part of each aftershock sequence. The time windows for each sequence span from 6 months before the mainshock to three months after. The semi-automatic spatial selection uses a clustering method for the epicentral selection of earthquakes. The results obtained for the original JMA catalog and replenished datasets are compared to get insight into the biases that the missing early aftershocks may cause on the Omori-Utsu law parameters' estimation, characterizing the aftershock decay with time from the mainshock. We have also compared the Omori-Utsu law parameter estimates for two datasets following the same mainshock; the first dataset is the replenished sequence, while the second dataset has been obtained by waveform-based analysis to detect early aftershocks that are not recorded in the JMA catalog. Our results demonstrate that the Omori-Utsu law parameters estimated for the replenished datasets are robust with respect to the threshold magnitude used for the analyzed datasets. Even when using aftershock time windows as short as three days, the replenished datasets provide stable Omori-Utsu law parameter estimations. The *p*-values for all the analyzed sequences are about 1.1 and *c*-values are significantly smaller compared to those of original datasets. Our findings prove that the replenishment method is a fast, reliable approach to address the missing aftershock problem.

5. **Dinescu R., Ghica D., Popa M., Munteanu I., Radulian M., Discrimination between tectonic and anthropic events in Targu-Jiu quarry region (Romania), Proceedings Conference: *11th Congress of the Balkan Geophysical Society*, DOI: 10.3997/2214-4609.202149BGS86, 2021.**

Published/Publicat: 10 October 2021

Abstract/Rezumat: The Romanian Seismic Catalogue has been contaminated in the last period with events from anthropic sources, especially in the regions with active quarry activities.
In this paper, we chose as the study area the Targu-Jiu zone, located in Southern Carpathians, where the National Seismic Network (RSN) recorded both crustal events and quarry blasts.

For discrimination purposes, the events recorded in a 10-km radius circle around each quarry will be analysed through several methods, to properly identify the quarry blasts. Thus, statistical methods are used, as well as the cross-correlation technique for the recordings of Gura Zlata (GZR) seismic station. In the first stage, a statistical analysis of the events recorded in the quarries area is performed, based on depth intervals, magnitude, working hours and days of the week. The spectrogram analyses are investigated with the DTK-GPMCC and DTK-DIVA extended CTBTO NDC-in-a-box packages developed by the CEA-DASE.
The events identified on the seismic recordings are used as templates for the cross-correlation method applied to the events recorded by the GZR for the 2010–2020 time interval.

6. **Placinta, A.O., Borleanu, F., Popescu, E., Radulian, M. (2021). Source parameters, clustering and scaling properties for the Vrancea (Romania) subcrustal earthquakes recorded between 2016 and 2018, *XXIth International Multidisciplinary Scientific GeoConference Surveying, Geology and Mining, Ecology and Management* – SGEM 2021**

Published/Publicat: April 2022
Abstract/Rezumat: The Vrancea zone, located in Romania, at the sharp bend of the Southeastern Carpathians, is a well-defined seismic region in a continental convergence area with unique properties and generating the most destructive subcrustal earthquakes in Europe. The seismicity is concentrated in a confined, high-velocity, focal volume at 60–200 km depth range. The increasing number and quality of waveforms digitally recorded in the last time by the National Institute for Earth Physics (NIEP) provide the opportunity to better constrain individual source properties and to systematically investigate collective scaling properties. These are fundamental elements to understand the overall seismogenic process in this particular geotectonic area. The purpose of the present paper is to investigate the source parameters and clustering properties for the moderate subcrustal earthquakes recorded between 2016 and 2018 using the Empirical Green's function and spectral ratios techniques and to see how the results comply with the scaling laws characterizing the Vrancea subcrustal activity. In order to apply the relative deconvolution techniques, we selected a set of Green's events, recorded between 2016 and 2018, in association with the main events, the largest earthquakes occurred in 2018 in the Vrancea intermediate-depth source: March 14, 2018 (Mw=4.2), April 25, 2018 (Mw=4.1) and October 28, 2018 (Mw=5.5). The application of relative deconvolution techniques shows relatively simple source time function and source spectrum, compatible with a circular source model with homogeneous rupture process. The scaling of seismic moment with source dimension resulted from our analysis on a set of 30 small and moderate earthquakes reproduces well (within inherent errors) the scaling obtained on larger data sets and the theoretical scaling generally adopted for simple source models.

7. **Ghita C., Raicu R., Constantinescu E. G., Moldovan I. A., (2021) Estimating the magnitude of completeness and spatial variation of seismic b value for Vrancea area**

(Romania), crustal earthquakes for the last three decades, XXIth International Multidisciplinary Scientific GeoConference Surveying, Geology and Mining, Ecology and Management – SGEM 2021

Published/Publicat: April 2022

Abstract/Rezumat: The purpose of this study consists in the evaluation of completeness magnitude (Mc), b value spatial variation and seismic energy release in Vrancea crustal seismogenic area, during the period between 1990 and 2021. This parameters are essential for a correct interpretation of seismicity analysis. For the analyses, we have selected from the Romplus seismic catalog (www.infp.ro) the crustal events with depth 0<h<52 Km, and magnitudes 0.1 <Mw <5.4, recorded from 01 January 1990 to 01 March 2021, in the area bordered by 44.5 N - 46.5 N latitude and 26.0 E - 27.5 E longitude. The method we used to calculate Mc is based on the Goodnes of Fit test (GFT).The Mc completeness magnitude parameter is essential in seismology studies and represents the minimum value of the magnitude for which all events in a given region are correctly detected. The b value parameter is calculated taking into account the magnitude of completeness Mc and the average value of the magnitudes of events above the threshold value Mc The seismic energy release in Vrancea zone was calculated in the period 1990-2020 only for crustal depth earthquakes using Mw resulted from the seismic moment (Mo), parameter that measures the overall deformation in the source.

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2022

8. **Placinta A.O., Borleanu F, Moldovan I.A., Coman, A., (2022). Correlation between changes in seismic propagation velocities and the occurrence of moderate earthquakes from Vrancea (Romania),** ***Acoustics*****, 4(4), 934-947; https://doi.org/10.3390/acoustics4040057**

Published/Publicat: 25 October2022

Abstract/Rezumat: Seismic velocity is the geophysical property that has a key role in characterizing dynamic processes and the state of the stress around the faults, providing valuable information regarding the change in the tectonic regime. The stress in the crust is an important indicator of the possible occurrence of a major earthquake, and the variation of seismic velocities, in time, can provide a clearer picture on the tectonic processes taking place in the region. In the crust, velocities change before, during, and after earthquakes through several mechanisms related to fault deformations, pore pressure, stress changes, and recovery processes. In this study, we investigate the possible correlation between the changes of seismic velocities (Vp/Vs) in time and the occurrence of moderate size crustal and intermediate depth earthquakes from the Vrancea region. Our findings show that there are no significant variations in Vp/Vs for the intermediate depth earthquakes, while crustal events have decreased seismic activity prior to the main earthquake and no high Vp/Vs anomalies. Our results indicate key aspects, and such analyses

should be carried out in real-time to continuously explore any unusual pattern pointed out by the seismic velocity changes. Vp/Vs and their standard errors can also be used to describe seismic activity patterns that shape the tectonic evolution of the area.

9. **Ghita C., Tuta L., Moldovan I.A., Ionescu C., Nicolaescu M. (2022). FastICA Algorithm Applied on Black Sea Water-Level Ultrasound Measurements, A*tmosphere*, 13, 1973; https://doi.org/10.3390/ atmos13121973.**

Published/Publicat: 25 November 2022

Abstract/Rezumat: The parameters influencing the sea level measured with ultrasonic devices that are ana- lyzed in this paper are the air temperature, atmospheric pressure and wind speed. As these varia- tions are independent to each other and to the sea level, they can be removed from the measured sea level by applying a filtering algorithm based on independent component analysis (FastICA), adapted and improved for this application. The sound speed increases with temperature, so an in- ternal temperature sensor is required to compensate for the sound-speed variation. Though this may improve the measurement accuracy, it is not enough to achieve the best results because there is a discrepancy between the internal sensor and the actual environment temperature. For high ac- curacy measurements, an external temperature sensor is required. In our case, we imported temper- ature datasets from a weather station, along with other datasets regarding atmospheric pressure and wind speed. The use of these external datasets, along with an algorithm based on principal component analysis (PCA) for error removal and the filtering algorithm based on FastICA for envi- ronmental phenomena extraction, allows us to achieve more accurate values for the Black Sea level in Constanta (2017–2020), independent of external influences

2023

10. **Moldovan I.A., Popescu E., Radulian, Enescu B, Placinta A.O., Ghita C., Constantin A.P. (2023). Fractal properties of the spatial distribution of crustal and subcrustal Vrancea earthquakes, Romanian Journal of Physics, 68 (802).**

Published/Publicat: January 2023

Abstract/Rezumat: Seismicity clustering characterizes the seismic process. We compute the fractal dimension for the Vrancea earthquakes recorded between 1995 and 2008, both in the crust and in the mantle. The fractal dimension shows a visible decreasing anomaly preceding the largest Mw = 6.0 earthquake in the dataset occurred on 27th of October 2004.

11. **Borleanu, F., Petrescu, L., Seghedi, I., Thomas, C., De Siena, L. (2023). The seismic attenuation signature of collisional orogens and sedimentary basins within the**

Carpathian Orogen, Global and Planetary Change, 223, 104093, doi: 10.1016/j.gloplacha.2023.104093.

Published/Publicat: March 2023

Abstract/Rezumat: Sedimentary basins in collisional settings result from interactions within and between lithospheric plates and sublithospheric mantle. Imaging their structure brings fundamental constraints to both the extraction of hydrocarbon or geothermal resources and seismic hazard analyses, especially in seismogenic areas affected by fluid percolation. Seismic attenuation is highly sensitive to stress, fluid saturation, and fluid-rock interaction and can often constrain small changes in the Earth's matrix better than seismic velocity. Here, we separate different attenuation mechanisms (scattering and absorption) at multiple frequencies and map them in space to constrain the properties of the Carpathian Orogen and the surrounding basins. The separation is achieved by determining S-wave peak delay times and late-time coda quality factors based on first-order Tikhonov inversion and analytical sensitivity kernels. We analysed 366 small-to-moderate crustal local earthquakes ($0.7 < ML < 5.8$) recorded by permanent and temporary stations operated by the Romanian Seismic Network between 2008 and 2021. Scattering and absorption appear to be frequency-dependent and highly heterogeneous throughout the region. High scattering and absorption characterise the Vrancea Seismic Zone, located in the Eastern Carpathian bend region, at all frequencies, likely due to high-stress rate and fluid inclusions. The seismically-active bend of the collisional orogen also shows high absorption and high scattering, particularly at low frequencies (~3 Hz). Low scattering and high absorption features are observed across the Danubian section of the South Carpathians, marking the contact with the Pannonian Basin, which sits on top of a thin and highly-extended lithosphere. A transition from high to low-scattering regimes with increasing frequencies could mark small-scale heterogeneous structures in the Transylvanian Basin, an elevated sedimentary unit surrounded by high topography, comprising Cretaceous Neogene sediments deposited on top of oceanic ophiolites.

12. **Yagi, Y., Okuwaki, R., Enescu, B. and Lu, J. (2023). Irregular rupture process of the 2022 Taitung, Taiwan, earthquake sequence. Sci Rep 13, 1107, doi: 10.1038/s41598-023-27384-y**

Published/Publicat: 20 January 2023

Abstract/Rezumat: In September 2022, two destructive earthquakes of moment magnitude (Mw) 6.6 (foreshock) and 7.1 (mainshock) occurred in Taitung County, south-eastern Taiwan. To understand their complex rupture processes, we analysed these earthquakes using the Potency Density Tensor Inversion method, which can stably estimate the rupture propagation process, including fault geometry, without overfitting the data. The analyses revealed that the major rupture of the foreshock propagated towards shallow depth, in a south–southwest direction, following an initial rupture that propagated towards the deeper part of the fault. The mainshock, with its

epicentre on the north–northeast side of that of the foreshock, consists of two distinct episodes. During the first episode (0–10 s), the initial rupture propagated north–northeast, through a deep path, followed by the main rupture that propagated bilaterally in a north–northeast and south–southwest direction. The second rupture episode (10–16 s) started near the hypocentre of the mainshock, and the rupture propagated towards the shallow side of the fault. The results suggest that the stress concentration from both the foreshock and mainshock's first rupture episode may have caused the second rupture episode in the high fracture surface energy area between the foreshock and the first rupture episode of the mainshock. The irregular rupture process of the foreshock and mainshock may reflect the heterogeneity of stress and structure in the source region.

13. **Armeanu, I., Borleanu, F., Varzaru, L., Ghica D., Popa M. (2023). A reanalysis of the seismic activity at the western edge of the Eastern European Platform, accepted for publication in the Romanian Journal of Physics.**

Published/Publicat:

Abstract/Rezumat: Over the previous decades, seismic activity has sporadically increased along the western edge of the European Platform. Although the Romanian Seismic Network has been continuously enlarged, the growth in the number of events in the Romanian earthquake catalogue, ROMPLUS in this area does not always follow the number of newly installed stations. To shed more light on the patterns of seismic activity in this region, we performed a statistical analysis of events recorded between 2005 and 2021 in the ROMPLUS catalogue and used correlation analysis to investigate the similarity degree and nature of these events. The poorly located events were relocated after the seismic phases were manually examined. We show that a large number of events are clustered around fault systems distributed near several quarries.

14. **A. P. Constantin A.P., Manea, M., Diaconescu, M., and I. A. Moldovan, I.A. (2023). Intensity and macroseismic maps of the latest moderate sized Vrancea earthquakes, accepted for publication in the Romanian Reports in Physics.**

Published/Publicat:

Abstract/Rezumat: Vrancea is the major region with the highest seismic hazard in Romania. We investigate macroseismic data and analyze also the influence of local geological structure on earthquake intensities in many areas affected by these earthquakes. It's known that the soft sediments existing in many areas of the territory have also a strong influence on seismic ground motion. The topographic effects can be also responsible for this apparent amplification of the ground motion. In this paper we determined intensities according to MSK Macroseismic Scale for seven small to moderate earthquakes (Mw > 4.5) occurred between 2013 and 2020 in Vrancea seismogenic region. Following the shaking, many people submitted reports to NIEP via the online questionnaire in which recorded their experience, while others reported macroseismic observations in the classic questionnaires requested by NIEP experts to the local authorities. The intensity data points resulted after analysis of the collected macroseismic data showed that a maximum intensity of V-VI was experienced for many localities for four of the seven earthquakes, also

isolated/sporadic a few IDPs of degree VI were assigned. The shaking with intensity of V was experienced with a majority in the case of all the earthquakes studied here. Surprisingly, strong shaking of this intensity (V) was also experienced at great distances, about hundreds of km from the epicenter.

15. Mihai A, Toader V-E, Moldovan I-A, Radulian M. (2023). Exploring the Relationship between Geomagnetic Variations and Seismic Energy Release in Proximity to the Vrancea Seismic Zone. Atmosphere. 14(6):1005, doi: 10.3390/atmos14061005.

Understanding the seismo–ionospheric coupling mechanism requires a quiet geomagnetic condition, as this represents an ideal situation to detect abnormal variations in the geomagnetic field. In reality, continuous interactions between solar wind and Earth's magnetosphere create many fluctuations in the geomagnetic field that are more related to sun–magnetosphere interactions than to seismotectonic causes. A triaxial magnetometer was installed at the Muntele Rosu Observatory near the Vrancea seismic zone in 1996 to measure the local magnetic field. Since 2002, the data have become more consistent, allowing for the representation of long time series. Since then, variations have been observed on the eastern component (B_y) of the magnetic field, which sometimes overlaps with significant earthquakes. Previous studies have shown that high decreases in amplitude recorded on the B_y component of the magnetic field measured at Muntele Rosu have been accompanied by higher seismicity, while small decreases have been accompanied by lower seismic energy release. This research analyzes the geomagnetic data collected between September 2002 and May 2008 from two geomagnetic observatories, one located in the proximity of the Vrancea seismic zone and another one situated 120 km away. For each geomagnetic anomaly identified, the daily seismic energy released was plotted logarithmically, along with seismicity and Kp indices. Additionally, the daily seismic energy released was also plotted logarithmically for all earthquakes with Mw ≥3. To identify variations in the B_y component, datasets recorded at Muntele Rosu (MLR) were compared with those recorded at Surlari National Geomagnetic Observatory (SUA), to discriminate between global magnetic variations associated with solar activity and possible seismo–electromagnetic variations. The standard deviation (SD_{By}) was calculated for each anomaly recorded on the B_y component of the magnetic field and compared with the cumulative seismic energy release. To determine if this type of variation was present in other components of the magnetic field, the following ratios were calculated for all data recorded at Muntele Rosu: B_z/B_x, B_z/B_y, and B_z/B_H. The size of the anomalies resulting from the standard deviation measured on the B_y component (SD_{By}) partially validates the relationship between the size of the anomalies and the seismic energy release during the anomaly. The relationship between the released seismic energy and the anomaly magnitude is vaguely respected, but these variations seem to follow two patterns. One pattern is described by smooth decreases, and the other pattern involves decreases where the B_y component varies significantly over short periods, generating decreases/increases in steps. It was noticed that seismic activity is greater for the second pattern. Additionally, using standard deviation measured on the

magnetic field represents a great tool to discriminate external magnetic field variations from local, possibly seismo–magnetic variations.

16. **Toader, V.E., Ionescu, C., Moldovan, I.-A., Marmureanu, A., Brisan, N.-S., Lıngvay, I., Mihai, A. (2023). The Results and Developments of the Radon Monitoring Network in Seismic Areas. Atmosphere, 14(7), 1061, doi: 10.3390/atmos14071061.**

The analysis of the relationship between radon and seismicity was previously carried out in the seismic zone of Vrancea (Romania), positioning the measuring stations on tectonic faults. This article analyzed the evolution of radon under conditions of deep and surface seismicity and the presence of mud volcanoes, as well as fires caused by gasses emanating from the ground. The monitoring area was extended to the Black Sea and the area of the Făgăras-Câmpulung fault, where a special radon detection system was established and proposed for patenting. The case study was the impact of the earthquakes in Turkey (7.8 R and 7.5 R on 6 February 2023) on the seismically active areas in Romania in terms of gas emissions (radon, CO_2). The main analysis methods for radon (we also included CO_2) were applied to integrated time series and the use of anomaly detection algorithms. Data analysis showed that the effects of global warming led to variations in seasonal gas emissions compared to previous years. This made it difficult to analyze the data and correlate it with seismicity. Several of the cases presented require more in-depth analysis to determine the cause of the unusually high radon levels. The primary purpose of establishing the monitoring network is to use the gas emissions as seismic precursors, but the measurements are affected by the conditions under which the monitoring is conducted. In some cases, we are dealing with the effects of pollution, and in other cases, more extensive studies are required. One solution we plan to use is to expand the measurement points to locate the source of the anomalies and use weather data to determine the impact of global warming on the measurements. The main conclusions related to the development of a radon monitoring network and, in general, to the emission of gasses in earthquake-prone areas relate to the importance of the choice of equipment, monitoring location, and installation method.

17. **Enescu, B., Ghita, C., Moldovan, I.-A., Radulian, M. (2023). Revisiting Vrancea (Romania) Intermediate-Depth Seismicity: Some Statistical Characteristics and Seismic Quiescence Testing. Geosciences, 13(7), 219, doi: 10.3390/geosciences13070219.**

Background: The intermediate-depth seismicity in the Vrancea region (Romania) is characterized by localized and persistent earthquake activity that culminates about two or three times in a century with the occurrence of a large event ($M \geq 6.5$). Here we have revisited some important seismicity characteristics, using earthquake catalog data spanning two different time periods: 1960–1999 and 2005–2013. Methods: we have determined the *b*-value of the frequency-magnitude distribution of earthquakes, using a maximum likelihood procedure, and estimated the parameter β to quantify anomalous seismicity rate decreases and increases. Results: by using data from the first period, we have confirmed the existence of a decreased *b*-value in the deepest part of the seismogenic zone; by using data from the second period, we have statistically confirmed the seismic quiescence that preceded the occurrence of the 1977 M7.4 Vrancea earthquake. Conclusions: the decreased *b*-

value has been interpreted either in terms of an increased lithostatic stress with depth or as an indicator of the depth range where the next major Vrancea earthquake may occur. The time variation of the seismicity parameter β may reveal anomalous seismic quiescence and increased earthquake rates that may precede the occurrence of large earthquakes.

Chapters in the book/Lucrari in cartea: Proceedings of the 3rd European Conference on Earthquake Seismology and Engineering, Bucharest, Romania, September 4-9, 2022.

1. **Borleanu F., Petrescu L., Seghedi I., Thomas C., De Siena L., (2022). Crustal structure of the East European Craton beneath the Carpathian Orogen revealed by attenuation tomography*, Proceedings of the 3rd European Conference on Earthquake Seismology and Engineering, Bucharest, Romania, September 4-9, 2022,* 4671 - 4677.**

Abstract/Rezumat: The seismic activity in Romania is primarily confined to the bending of the Eastern Carpathians, where strong subcrustal earthquakes occur, causing significant damage over extended areas. Crustal earthquakes spread over a larger area, mostly occur to the outer side of the Eastern Carpathians bend. These earthquakes are significantly smaller than the intermediate-depth earthquakes, raising controversies about the processes that generate seismicity. The current study analyses seismograms from low to moderate (ML<5.8) crustal earthquakes that occurred between 2008 and 2021 in the Carpathian orogen and surrounding areas in order to map attenuation features and distinguish between the main mechanisms affecting seismic wave propagation, namely scattering and absorption. We used an absorption tomography technique based on the regionalisation of S-wave peak delay times (as a measure of scattering) and the inversion of late-time coda quality factors (indicating anelastic absorption). The lateral variation and dimensions of the attenuation structures outline the structural complexity of the study region. Absorption is prevalent southwest of Vrancea, while the Carpathian orogen and its foreland are dominated by both strong absorption and high scattering structures, which fade away towards the Eastern European Craton.

2. **Constantin A. P., Manea L., Moldovan I. A., Ionescu C., (2022). Analysis of recent macroseismic data collected through online and classic questionnaires: uncertainties, discrepancies and limitations, *Proceedings of the 3rd European Conference on Earthquake Seismology and Engineering, Bucharest, Romania, September 4-9, 2022,* 4992 - 4998.**

Abstract/Rezumat: The extent of the internet has greatly expanded the abilities to obtain more macroseismic data in parallel and/or compared with the classical methods used to investigate the effects of moderate and strong earthquakes. The collection of macroseismic observations after the earthquakes occurrence was more efficient due to the implementation in the institute of the online system to complete the macroseismic questionnaires (MQ). The online system for collecting of macroseismic observations, of automatic evaluation of intensities and of elaboration of intensity

maps for Romanian earthquakes has been constantly improved since the year of implementation. The present study discusses the differences between modern web-based and classical macroseismic data acquisition methods, assesses the importance and limitations in the use of both methods, and analyzes the effectiveness of the online system (interactive questionnaires and rapid feedback) accessible at the NIEP website and developed for Romanian earthquakes. For this analysis, the macroseismic data collected for seven earthquakes (Mw> 4.5) occurred between 2013 and 2020 in Vrancea region were used. Other issues related to these methods were also discussed, such as: highlighting errors resulting from data collection, differences in the content of the questions from the macroseismic questionnaires and the ambiguities induced by filling in the answers.

3. **Enescu B., Moldovan I., Radulian M., Ghita C., Borleanu F., Placinta A.O., and Poiata N., (2022). Seismicity analysis for Vrancea region (Romania) using a z-value statistical approach*, Proceedings of the 3rd European Conference on Earthquake Seismology and Engineering, Bucharest, Romania, September 4-9, 2022*, 4300 - 4305.**

Abstract/Rezumat: We analyse the intermediate-depth (depth between 60 – 220 km) seismicity in the Vrancea region (Romania) using the ROMPLUS seismic catalog and a z-value statistical analysis. The method detects an increase of seismicity rate around 2004, which is likely due to an increase of earthquakes with magnitudes Mw > 5.5, produced in the years 2004-2005. The most significant anomaly is a decrease of seismicity, after the year 2014, at depths of 150 – 160 km. We show that the decreased seismicity rates after 2014 are caused by a change in the location algorithms, including the velocity model. Currently we are working to produce a uniform earthquake catalog.

4. **Ghita C., Diaconescu M., Constantinescu E.G., Moldovan I.A., (2022). Analysis of seismicity in north eastern part of Romania for the last three decades, *Proceedings of the 3rd European Conference on Earthquake Seismology and Engineering, Bucharest, Romania, September 4-9, 2022*, 4362 - 4367.**

Abstract/Rezumat: The purpose of this study is to analyses the use of statistical techniques that evaluate seismicity such as the frequency distribution of magnitude (FMD), completeness magnitude (Mc). These parameters are considered effective approaches for understanding local seismotectonic activities. The crustal seismic activity manifested in the Northern and central areas of the Moldavian platform and the part of the Eastern Carpathians has magnitudes no greater than 5.3 Mw for the 31.01.1900 earthquake located East of Bacau and West of Vaslui. The maximum depth of a hypocenter recorded in the studied area was 59 km and was calculated for the 30.05.1970 earthquake of magnitude 2.4 Mw located East-South-East of Onesti. A seismic cluster made of 35 seismic events was observed in 2020, North-West of Vaslui and South-East of Roman. This cluster occupied an area of approximate 23.33 sq. km, and took place during the entire year. The range of

magnitudes calculated for the cluster was between 1.8 – 3.3 Mw. The most significant earthquake of the cluster was recorded on 29.10.2020 and had a magnitude of 3.3 Mw.

5. **Opris A., Ariyoshi K., Hatano T., and Hori T., (2022), Imaging the changes in the clustering properties of deep low-frequency earthquakes caused by the occurrence of the 2010 long-term slow slip event in Western Shikoku, Japan*, Proceedings of the 3rd European Conference on Earthquake Seismology and Engineering, Bucharest, Romania, September 4-9, 2022*, 4276-4283.**

Abstract/Rezumat: By using the space-time cross-correlation integral as a statistical method to perform a self-consistent analysis, we aim to reveal the changes in space-time patterns of deep low frequency activity across the western part of the Nankai subduction region. We present an imaging method derived from the gradient of the cross-correlation integral in respect to space-time domain which captures the characteristic clustering pattern of ETS episodes. This allows us to evaluate the influence of the 2010 long-term slow slip episode on the space-time patters in the segment directly affected by the long-term slip, as well as the neighboring segment. Both segments show significant change in the spatiotemporal clustering during the L-SSE event, as well as small changes in the before and after clustering patterns.

6. **Szakacs A., Kovacs I.J., and Radulian M., (2022). Precursor-based earthquake prediction: wishful thinking or real possibility?*, Proceedings of the 3rd European Conference on Earthquake Seismology and Engineering, Bucharest, Romania, September 4-9, 2022*, 3580-3583**

Abstract/Rezumat: Earthquake prediction-related research gained a new impetus during the last two decades after a period of prevailing pessimistic attitude of the science community. Encouraging results were obtained using new and various approaches and innovative techniques mostly focused around the idea of the lithosphere-atmosphere- ionosphere- magnetosphere coupling. However, skepticism still persists due to 1) ambitious individual or restrained team efforts aiming at discovering the 'holy Grail' of earthquake prediction by developing self-conceived methodologies, hence obstructing large-scale synergic multidisciplinary approaches, and 2) the lack of a conceptually well-supported long-term research strategy. To counteract this drawback, a paradigm shifting long-term research strategy was recently proposed based on the newly introduced concept of 'precursory fingerprint' targeting individual seismogenic zones. Because its well-known structure and centuries-long record and behaviour, Romania's Vrancea seismic zone appears to be an ideal natural laboratory for experimenting the new concept-based earthquake prediction research strategy.

7. **Toader V.E., Moldovan I.A., and Mihai A., (2022). Analysis of the relationship between geochemical data and seismicity parameters for the development of a**

procedure for OEF, ***Proceedings of the 3rd European Conference on Earthquake Seismology and Engineering, Bucharest, Romania, September 4-9, 2022*****, 4338-4345.**

Abstract/Rezumat: In TURNKEY H2020 project, NIEP was involved in making a comprehensive state of the art on reliability of geophysical, geochemical and geodetic fields as earthquakes precursors, and has started to develop an OEF (Operational Earthquake Forecasting) procedure at national and international level, by including the existing non-seismic measurements into the seismic hazard. The project proposed to develop an OEF procedure that consider short-term changes in the seismic hazard and precursors factors evidenced by geophysical and geochemical parameters. The studies were continued in national projects. In this paper are presented the results obtained by INFP in the field of OEF, especially by analyzing the relationship between non-seismic (geochemical) and seismic parameters (a and b from Gutenberg Richter law and the released seismic energy).