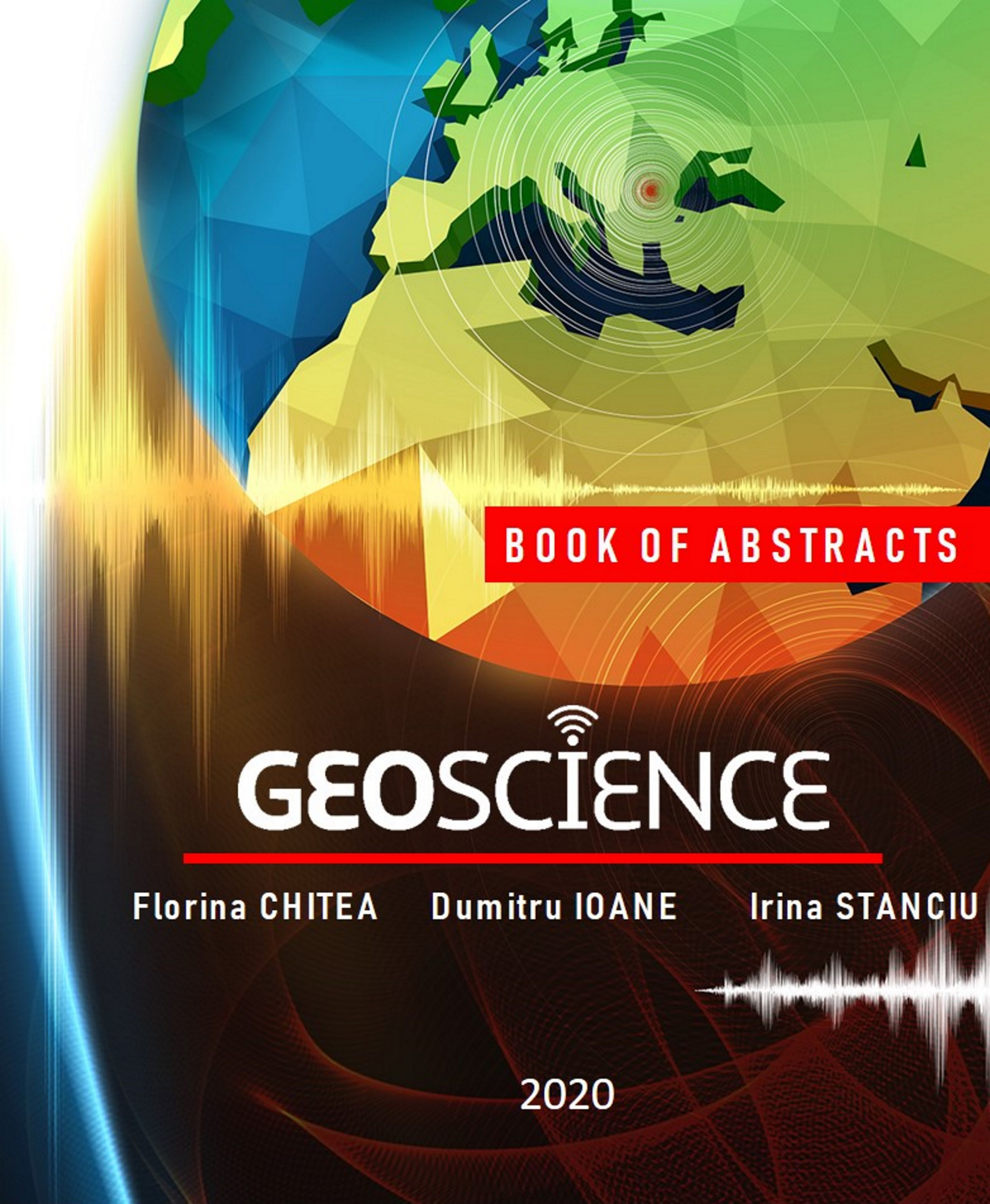
BOOK OF ABSTRACTS
GEOSCIENCE
Florina CHITEA
Dumitru IOANE
Irina STANCIU
2020

FOREWORD

GEOSCIENCE is a yearly symposium held in Bucharest, Romania and organized by the Romanian Society of Applied Geophysics (SGAR). Over the years, the symposium has continued to grow and expand its area of interest, tackling topics ranging from Earth Physics (Geodynamics, Seismology and Geomagnetism), Near Surface Geophysics, Geoscience for Energy, Geoscience for Cave and Karst Areas, Geology, Environmental Studies & Geohazards, to Geoscience For Society, Education And Environment.

This year, the GEOSCIENCE International Symposium had to be held exclusively online. Over the course of two days (20-21 November 2020), we are proud to host the participation of researchers, professors and engineers from the extended field of Earth Sciences, and we salute the strong international presence among the presenters, who came from countries such as U.S.A., Switzerland, Greece, France, Serbia, Russia, UK, Turkey, India, China, joining the Romanian participants. The event offers a wide range of topics and welcomes contributions in various research areas, with the clear intention of providing the geoscientific community and industry with the opportunity to share scientific knowledge and expertise, as well as to discuss the newest trends in the field of applied or theoretical geoscience.

GEOSCIENCE 2020 was organized in collaboration with the National Institute for Research and Development for Earth Physics, the "Sabba Ştefănescu" Institute of Geodynamics of the Romanian Academy, the Faculty of Geology and Geophysics, University of Bucharest, Romania, with the support from the media partner Radio Guerilla and powered by Discovery.

A selection of the works presented during the symposium will also appear as extended papers within a forthcoming book published at the Romanian Academy Publishing House.

Editors of the volume,
Florina Tuluca
President of the Organizing Committee Geoscience 2020
President of the SGAR

Dumitru Ioane
Vice-President of the SGAR

Irina Stanciu
Treasurer of the SGAR

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Andrei Bălă [1], Mircea Radulian [1], Dragoș Toma-Dănilă [1]

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The mechanisms involved in the geodynamic evolution and the links with present day seismicity in and around an active orogenic area such as Vrancea area, located at the bend of the South-Eastern Carpathians in Romania, is of fundamental importance for studies concerning the seismic hazard and attenuation assessment in Romania. The task is attempted through the partitioning of seismic events and corresponding stress at the crustal level in and around the Vrancea zone. We start in this respect with the configuration of seismogenic zones as defined in previous investigations and then we use all the available and reliable earthquake focal mechanisms to study present-day deformation and stress.
The goal of the present paper is to investigate the stress field characteristics in relation with the specific geotectonics and seismogenic zones in Vrancea and neighboring areas. The principal stress components are computed by inverting the fault plane solutions provided by a completed and updated catalogue for the crustal earthquakes recorded since 1952 up to 2012. Our investigation is justified to the extent that the basic hypothesis of properly representing the seismic area partitioning by individual clusters of events is relevant at the scale of each earthquake-prone area and from a statistical point of view (minimum 25 - 30 events/active zone).
The results obtained through inversion procedure shows that the focal mechanisms are kinematically compatible for the selected clusters (earthquake-prone areas) despite an apparent scattering of the fault plane solutions. For example, the specific thrust faulting regime (compression) in the seismogenic zones in the Vrancea area and extensional stress regime as we go away from the Vrancea area. Note also the general lack of strike-slip faulting, except the seismogenic area located along the Peceneaga-Camena Fault, which separates the Scythian Platform to the north-east from the Moesian Platform to the south-west.
All the relevant information obtained in the process of inversion is further used in order to analyze the geodynamic evolution of the seismic active zones around Vrancea area and to try to improve the understanding of some geophysical observations that still does not have a satisfactory explanation in the light of existing models. The assessment of the stress field configuration on the basis of improved and updated focal mechanism data let to a real improvement of the shape of the regional field as computed in the last version of the World Stress Map (WSM 2016).

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

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A high magnitude earthquake (Mw = 6.4) occurred on November 26, 2019, at 2:54 AM, close to Durres city, Albania, causing casualties, buildings collapse and infrastructure destruction. Numerous earthquakes followed, mostly with magnitude ranging between 3.0 and 5.0 Mw, having epicenters both onshore and offshore. Ten hours later started in Vrancea, a zone characterized by strong earthquakes, a seismic sequence consisting of three seismic events of 1.7, 3.2 and 2.6 Mw, their epicenters migrating eastward during six hours along 120 km.

During 26 and 27 November 2019, a higher number of earthquakes occurred both in the Durres (65) and Vrancea (6) seismic zones, as compared to their average seismicity. The two seismic areas are separated by a distance of ca 750 km. Within the same time interval, significant seismic events have been recorded in Greece (N Peloponnesus ml = 3.8, W Crete ml = 6.0) and southern Bosnia-Herzegovina (ml = 5.9) along a regional NW-SE lineament.

Information on the regional seismicity has been consulted and/or utilized from several seismological catalogues: National Institute of Earth's Physics ROMPLUS Earthquake Catalogue, National Institute of Earth's Physics RTM Earthquake Catalogue, EMSC Earthquake Catalogue, Aristotle University of Thessaloniki Seismicity Catalogue, USGS Earthquake Catalogue, GFZ Potsdam Earthquake Catalogue.

Considering a recent study (Ioane & Stanciu, 2018), a wrench tectonics model has been interpreted across Romania, its southern NE-SW trending transcurrent fault being associated in a transtensional tectonic regime with the intermediate, subcrustal seismicity in the Vrancea seismic zone.

When extending south-westward the two transcurrent faults from Romania to Albania, most earthquake epicenters occurred during 26 and 27 November 2019 in the Durres area fall between them, suggesting that wrench tectonics processes might be also involved. The north-westward tectonic lineament, interpreted using the seismic events occurred between W Crete and S Bosnia-Herzegovina during the same time interval, crosses the transcurrent faults within the Durres seismic area, showing that both NE-SW and NW-SE fault systems have been activated in November 2019, causing the distructive seismic event in Albania.

THE INTRAMOESIAN FAULT: EVOLUTION IN TIME AND SPACE

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The name *Intramoesian Fault* was introduced in the scientific literature by M. Săndulescu in 1984. Săndulescu (1984) described the fault as being a sinistral transcrustal fault, after several dextral-sinistral displacement variations during geological time. The fault was located in the central part of the Moesian Platform, displaying NW-SE direction; it was continued south of Danube river up to the Bulgarian Black Sea shelf, and northward underneath the Getic Nappe. Although this is the most accepted model of the Intramoesian Fault, used by many researchers as marker for the Moesian Platform compartments delineation, the Intramoesian Fault proved to be a complex and complicated tectonic target both at local and regional scale (in space), being differently located on maps throughout history (in time).

The geological mapping of the Intramoesian Fault was not possible, as it does not outcrop and has no topographic expression, being concealed beneath a thick Neogene sedimentary cover, traces of regional faulting being totally hidden.

This intriguing tectonic structure, still subject of debate, had a large variety of names and was identified so far as fault, fracture or tectonic contact.

An extended documentation on the Intramoesian Fault and the Moesian Platform was carried out within the PhD Thesis "Intramoesian Fault: geophysical detection and regional active (neo)tectonics and geodynamics", Doctoral School of Geology, Faculty of Geology and Geophysics, University of Bucharest. This PhD study offered the framework for a focused research on geophysical detection of the Intramoesian Fault and its regional tectonic and geodynamic framework, analysing and integrating a large number of geophysical and geodetic data, as well as geomorphological and geological observations.

An updated regional tectonic and geodynamic model was developed within this study, showing the Intramoesian Fault is composed of a number of segments, laterally displaced by several active regional NE-SW, N-S and W-E faults systems. Due to repeated junctions with the younger NE-SW strike-slip faults, and due to a NE-SW transcurrent fault in the Vrancea wrench tectonics system (Ioane & Stanciu, 2018), the Intramoesian Fault is displaced south-westward in the area close to the Carpathians. North of the Danube, a north-eastward displacement of the Intramoesian Fault was interpreted as due to an indentation of an Argeş – Danube Promontory along the Argeş (W-E) and Gabrovo – Veliko Tarnovo (NE-SW) faults.

ROMANIA CONTINUES THE PARTNERSHIP IN THE NEW STAGE OF EPOS-ERIC PROJECT (SUSTAINABILITY PHASE)

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The EPOS Research Infrastructure (EPOS RI) has completed its Implementation Phase (2015-2019), the phase in which INCDFP remained with 23 other European countries, achieving a cornerstone in its lifecycle and it is currently facing the transition from the Implementation to the Operational Phase.
To ensure the long-term sustainability of the EPOS Research Infrastructure, this year a new phase of the project was started, EPOS Sustainability Phase, in which Romania is a partner. The overall objective of the EPOS Sustainability Phase (EPOS SP) project is to provide the long-term sustainability of the operational services (Integrated Core Services and Thematic Core Services). This requires government support and efficient financial mechanisms to support the activities of the service, but also the attractiveness of using these services in scientific research, as well as in their applications for society, in all these activities INCDFP being involved and having significant contributions.
Main objectives of the EPOS SP dissemination and communication for ABD (Adriatic-Balkans-Dinarides) region, where Romania is involved are: 1) to consolidate existing contacts with stakeholders already engaged in EPOS; 2) to engage new stakeholders (users, new scientific communities, the private sector, society) to tackle the sustainability challenge; 3) to foster an effective collaboration framework with solid Earth science community projects and initiatives in Europe and at the global level.

SEISMICITY AND TSUNAMIGENIC POTENTIAL OF THE BLACK SEA AND SURROUNDING AREAS

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ABSTRACT

The main purpose of the paper is to highlight the crustal seismicity of the Black Sea taking into account and the tsunamigenic potential.
The following elements have been taken into account in order to delimit the seismic sources:
- depth of the earthquakes foci, crustal one, less than 40 km deep;
- development of the earthquakes epicenters in zones with active tectonics (active faults);
- establishment of the areas of active faults along which the earthquakes epicenters are aligned.
The studies on active tectonics have clearly shown the position of the seismic sources which are connected to well define active fault.
According to the distribution map of earthquakes epicenters and as well as to the map of the areas with active faults, were established nine seismic sources, such as: Central Dobrogea (S1), Shabla (S2), Istanbul (S3), North Anatolian Fault (S4), Georgia (S5), Novorossjsk (S6), Crimea (S7), West Black Sea Fault (S8) and Mid Black Sea Ridge (S9).
The maximum possible magnitude of the seismic source was determined based on seismotectonic and geological database, concerning international practice and IAEA recommendation or applying empirical formulas of Wells and Coopersmith.
From the seismological point of view the types of faults (earthquakes types) which are responsible for tsunami are the thrust fault (associated with subduction zones), normal/ inverse faults and less strike-slip fault, if the oblique-slip and deep slip components are predominant, magnitude higher than 6.5 and depth, a crustal one, less than 40 km depth.
The major contribution to the total seismic hazard in the western part of the Black Sea is given by the Shabla crustal source that has a maximum epicentral intensity equal with VIII½.

EVALUATION OF UP-TO-DATE GROUND MOTION MODELS FOR INSLAB SEISMIC EVENTS IN ROMANIA

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Romania is exposed to high seismic hazard due to the Vrancea seismogenic region, where ~3 earthquakes with M>7 occur per century at intermediate-depths (60-170 km). The impact of such strong intermediate-depth events transcends the national borders with significant damage being reported in neighboring countries (e.g., observed intensities of VII-VIII at more than 250 km epicentral distances during 1940 event Mw=7.7).

In this study, an exploratory analysis was made to test the efficiency of relevant ground motion models proposed for subduction zones (Sokolov et al., 2008; Skarlatoudis et al., 2013; Vacareanu et al., 2015; Abrahamson et al., 2015). Therefore, efficient tests were performed in order to properly evaluate a set of selected models to predict ground motion parameters (PGA, PGV and SA) in case of Vrancea intermediate-depth events.

The dataset used in this study contains over 4000 geometric means of the horizontal components from 170 Vrancea intermediate depth events with moment magnitude (Mw) within 4 to 7.4. The strong motion data were recorded by 130 seismological stations of the Romanian National Seismic Network, since 1977.

The comparison between the computed and recorded parameters shows that four ground motion models fit relatively well the data within the model's magnitude validity range (Mw>5) and overestimate the values below this one. In line with international practice of selecting GMPEs, the selected models are ranked using two statistical methods: the likelihood (LH, Scherbaum et al., 2004) and log-likelihood (LLH, Scherbaum et al., 2009). All the equations with the exception of Abrahamson et al. (2015) gave the highest capability to predict the PGA and SA at 0.3, 1 and 3 seconds. In the case of PGV, the equation proposed by Skarlatoudis et al. (2013) has high capability to predict while the others have lower grades or even outside of acceptance range.

GEOPHYSICAL BEDROCK DEPTH COMPUTATION FOR THE EXTRA - CARPATHIAN AREA OF ROMANIA

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Local site evaluation is an essential step in understanding the amplification of seismic motion induced by the complex geological structure and their estimation for future strong earthquakes in urban regions. One of the critical parameters on evaluating amplification effects is the depth of the geophysical bedrock, whose interface to soft sediments is responsible for the development of destructive resonance phenomena. The geophysical bedrock represents the interface at which the seismic wave impedance suffers modification. The present study focuses on the estimation and interpretation of the geophysical bedrock depth along the extra - Carpathian area of Romania. The datasets consist of 143 seismic stations from the National Seismic Network of the National Institute for Earth Physics and from two temporary ones set up during the Carpathian Arc Lithosphere X-Tomography (1999) and South Carpathian Projects (2009 - 2011). Each site was investigated through the computation of horizontal-to-vertical (H/V) spectral ratios from three-component single station measurements of ambient vibrations. The geophysical bedrock depth was computed using a two-step inversion scheme, based on the retrieval of the Rayleigh-wave ellipticity peak at each seismic station using a regional generic velocity profile. These velocity profiles (in terms of P and S velocities) were established for the sedimentary part for the specific regions along the study area, based on the available geological information from the BIGSEES database. Finally, the geophysical bedrock depth was retrieved at each seismic station and empirical correlation models were developed between the fundamental frequencies of resonance and the depth. The fundamental frequency of resonance reaches the lowest value in the deepest side (0.07 Hz) and is rising to 13 Hz in the South of the Moesian Platform, where a shallow bedrock is present. The computed bedrock depths (from 30 to ~3100m) show a dipping tendency towards the Southern Carpathians and complex features such as local outcrops and lateral depth variations superpose this gradually dipping trend. In the Carpathian foreland, the bedrock is interpreted as the transition between different sediment layers of Neogene, while outside this area as the Neogene - Cretaceous transition.

EARTHQUAKE CATALOG DECLUSTERING OF DANUBIAN SEISMOGENIC CRUSTAL AREA

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The purpose of this work consists in analyses of declustering catalogue and seismic sequence recorded in Danubian crustal area. The goal of seismicity declustering is to separate earthquakes in the seismicity catalog into independent and dependent earthquakes.
The Danubian area represents the western extremity of the orogenic unit of the Southern Carpathians and it presents two groups of seismicity: Moldova-Noua - Oraviţa - Resita, in the western part of the area and Baile Herculane - Mehadia - Oroşova, in the eastern part of the area.
We remove the aftershocks by replacing each earthquake cluster by an equivalent event using the declustering procedure proposed by Reasenberg. For the declustering analysis, the events from 01 January 1990 to 01 February 2018 in the latitude region of 44.38 N - 45.5 N and 21.7 E - 23 E, with a local magnitude of $0.1<M_L<5.7$, depth, h (0-50) Km, were selected from the Romplus catalog, www.infp.ro. An important contribution to seismic hazard assessment and earthquake models prediction it's represented by the earthquake separation process into independent (mainshocks) and dependent ones (foreshocks, aftershocks).
The triggered and spontaneous earthquakes identification is closely related with the seismicity background. In order to define the three type of shocks (foreshocks, main shocks, aftershocks) we currently analyse parameters with values obtained thru subjective criteria.

VERTICAL DEFORMATIONS AND SEASONALITY ON GNSS STATIONS IN ROMANIA AND BALKAN REGION USING PPP SOLUTIONS

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The last two decades, the Romanian and regional GNSS networks came into existence and expanded in a fast manner. The technological evolution makes it possible to reach high frequencies recordings from 1 to 20 Hz and more, opening new ways not only for slow deformation processes analysis but also for fast geophysical phenomena like crustal earthquakes, landslides or even mining subduction. Nowadays, analyses of GNSS (Global Navigation Satellite System) time series reveal vertical deformation signals among significant seasonal variation. Data from these networks have been used to produce high-precision, UP-component velocity fields covering broad geographic regions as well as position time series that track time-varying crustal deformation.

The purpose of this study is to analyse in terms vertical deformations and seasonal variations, more than 300 GNSS stations from the Romanian and Balkan regional networks since 1995. Daily observations were processed by precise point positioning (PPP) technique from Nevada Geodetic Laboratory (NGL).

We introduced and applied for the first time "GPS (Global Positioning System) Imaging", a new technique for robust estimation of the vertical velocity field of the Earth's surface, to Romania and the Balkan region.

Starting with vertical position time series from GNSS stations, we first estimated vertical velocities using the MIDAS robust trend estimator, which is insensitive to undocumented steps, outliers, seasonality and heteroscedasticity. We then applied a weighted median spatial filter to remove velocity outliers and enhance signals common to multiple stations. Finally, we interpolated the data using weighted median estimation on a grid and applied a bootstrapping statistical method in order to eliminate the outcome artefacts. The resulting velocity field is temporally and spatially robust and edges in the field remain sharp. Results show a smooth and coherent interpolate vertical velocity field and we made further integrations by correlating the punctually seasonality results with the GPS Imaging results and looking ahead for proper geophysical interpretations.

EVALUATION OF THE PREDOMINANT FREQUENCY OF RESONANCE FOR 2014 5.4 Mw VRANCEA CRUSTAL EVENT

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Seismic site effects evaluation has a substantial impact on the evaluation of seismic hazard and risk and it is a crucial step for the mitigation of potentially high seismic risk in densely populated urban regions. The extra - Carpathian region is among the most populated in Romania (including the capital city of Bucharest, ~ 12 million people) and has experienced significant damage during earthquakes from the Vrancea source. In this study, the predominant frequency of resonance was identified and mapped along this area for the November 22, 2014, 5.4 Mw crustal event generated at 40 km depth in the Vrancea seismogenic area. It is the most significant recent crustal earthquake and occurred as a result of the tectonic deformation at the contact between the Peceneaga-Camena Fault and the Moesian and Scythian Platforms. It was felt in almost all the Romanian regions and the recorded maximum seismic intensity was VI MMI. The Horizontal to Vertical spectral ratios (H/V; e.g. Nakamura, 1989) technique was primarily applied in the frequency range of 0.1 - 15 Hz, in order to retrieve the predominant frequency of resonance. This ratio was computed not only on the entire earthquake record but also on the coda waves in order to approximate the response of the near surface geology. The T/V ratio between the Fourier spectra of the transverse component and Fourier spectra of the vertical was computed to approximate the shape of the SH transfer function and to interpret the major peaks observed in the H/V. In this study, 50 seismic stations were used from the National Institute for Earth Physics. All these curves were compared with the H/V obtained previously by Manea et al. (2020) using ambient vibration to see the impact of the ground motion on the seismic wavefield. Two peaks were observed at almost all the stations, one attributed to the fundamental frequency of resonance and a second one that can be interpreted as a mixture of the second higher mode of Rayleigh waves and other types of waves such as SH waves (Manea et al., 2016). In case of the station located in the deep sedimentary basin, the second peak observed using ambient vibration develops and becomes predominant. It matches the fundamental one in the case of the stations located at the extremities of the Moesian sedimentary platform. These new results increase our understanding of ground motion propagation by emphasizing the strong ground motion peculiarities in this area.

A SLOW-SLIP-EVENT IN THE VRANCEA SEISMOLOGICALY ACTIVE REGION OF ROMANIA

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In the last 300 years the window of time for two consecutive large and destructive earthquakes in Vrancea was as small as 36 years and as large as 102 years. An explanation for the larger window of time might be a release of stress produced by a large slow-slip-event (SSE). However, SSE have been discovered about 20 years back only, when reliable GPS stations have been placed above the epicentral areas of earthquakes. And no SSE have been discovered in Vrancea yet. At the present time it is widely accepted that most of the 13 km deep basin of the Focsani depression has been created as a result of the sinking slab with intermediate-depth earthquakes. This slab in the vertical position moved in the last 10 Myr from the level of Persani-Baraolt Mountains towards southeast in the actual position at the bending of the Eastern Carpathians. As a result, both large intermediate-depth earthquakes and SSE are expected to generate a downward movement in the vertical displacements showed of the GPS data. The building-up of stress in the sinking slab, regarded as slightly attached from the Earth's crust, it was expected to be transmitted upwards around faults in crust and recorded based on a magnetotelluric phase splitting effect. A large stress build-up has been suggested around a fault in Covasna in the years 2012-2013 and presented at the 2013 IASPEI Meeting in Gothenburg, Sweden. No large earthquake was recorded so we supposed that a large SSE in the year 2014 released the accumulated stress of 2012-2013. GPS data obtained both in the Focsani depression and in the epicentral region of Vrancea intermediate-depth earthquakes supported our suggestion by showing a clear downward displacement of vertical GPS data obtained for the year 2014.

ANALYSIS AND INTERPRETATION OF SEISMIC LOW MAGNITUDE DATA IN NORTHERN ALGERIA

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The seismicity of Northern Algeria is concentrated in the Tellian Atlas onshore and in the Algerian Basin offshore. It is distributed all along these areas where low, moderate to strong magnitude events occur within the crust. The majority of hypocentres are located in the first 10-15 km, characterizing very well the seismicity of northern Algeria. The seismicity reduces gradually toward the south in the Saharan Atlas, being absent in the High Plateaus region.
The seismicity of Northern Algeria results from the convergence of the African and Eurasian tectonic plates. The recent geological and geodetic observations (Nocquet and Calais, 2004) indicate the rate of shortening between Africa and Europe is presently of 5 mm/year at the longitude of Algiers. The Tellian Atlas mountainous region accommodates 2.7 to 3.9 mm/year of total convergence. The convergence is at the origin of stress accumulation at the edge of the plates inducing ruptures or reactivating old faults. The Tellian Atlas is dominated by a compressive regime of NW-SE direction, changing to transtentional regime in the north-eastern part of Algeria.
The northern part of Algeria is from a geological point of view younger than the Saharan platform, being therefore unstable and mobile. The associated seismicity is occurring on elongated sectors trending NNW-SSE and NW-SE, both onshore and offshore, suggesting that the active faults pass from one domain (e.g. continental) to another (e.g. marine).
The occurrence of low magnitude earthquakes is a special research topic, first of all for the reason of their importance to understanding the active faults and their impact in this region, and secondly, because most studies focused so far only on seismic events having moderate to strong magnitude. Hereby, this study will concentrate on the analysis and interpretation of the low magnitude earthquakes having Mw $\leq$ 4 recorded during 2000 - 2020 in Northern Algeria.

IMPACT OF BACK – ARC ATTENUATION ON SEISMIC WAVEFIELD

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The purpose of this study is to investigate how the seismic wavefield is influenced by the local and regional geological structures of the Carpathians back - arc area. It was observed that the seismic energy released by an earthquake occurring at intermediate-depths in the Vrancea seismic source has strong lateral variation on the wave propagation toward the back - arc area of Carpathians as compared with the propagation toward the fore - arc area. In this study, we analyse the impact of earthquakes produced at different depth ranges (from 2 to ~ 150 km) in Romania on the seismic wavefield recorded in the intra-Carpathian area by applying the Horizontal - to - Vertical Spectral Ratios (H/V) method. In order to identify different features, this ratio was computed not only for five significant earthquakes generated in different seismogenic sources but also for 24h of ambient vibrations recorded by 24 seismic stations that belong to the National Institute for Earth Physics. The seismic events selected for the present study have magnitudes between 3.1 - 5.7 Mw and belong to three earthquake-prone areas in Romania, one at intermediate depths (Vrancea) and other two in the crust (Danubian and Crisana - Maramures zones). The results show slight variations of the predominant peak with respect to the fundamental frequency at the recording sites (identified by means of H/V curves of the noise records) for all the events. The amplitudes of the H/V curves computed for the events occurred outside of the Carpathian arc (including Vrancea source) are strongly reduced by back-arc attenuation, while no significant effects are detected in the recorded wavefield. The seismic wave attenuation is much more reduced in case of the events produced inside the Carpathian arc as compared with the case of events located in the external area of Carpathians. For some of the stations, located on sedimentary basins that present complex geological features as significant lateral variations, a development of higher peaks in the H/V curves is observed. These peaks are interpreted as a mixture of the second higher mode of Rayleigh waves and other types of waves such as SH waves. This study represents a step forward in understanding the effects of back-arc attenuation on ground motion for future microzonation purposes.

EARTHQUAKE MECHANISMS AND STRESS FIELD FOR VRANCEA INTERMEDIATE-DEPTH ZONE

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In general, the focal mechanism data and their analysis allow and facilitate a revisiting of tectonic interpretations of the present-day stress field. The stress patterns obtained from formal stress inversion of focal mechanism solutions can reveal many things in the stress field that were not captured by large-scale numerical models of previous studies.
In the present study, the fault plane solutions (FPS) of 366 seismic events starting with January 2005 and up to the present day were obtained for stress field investigation of the Vrancea region. The dominant style of faulting for Vrancea intermediate-depth earthquakes presents a predominant reverse faulting, with two main earthquakes categories: the first one with the nodal planes oriented NE-SW parallel with the Carpathian Arc and the second one with the nodal planes oriented NW-SE perpendicular on the Carpathian Arc.
The inversion, mainly based on the assumption that (a) the stress field is uniform and invariant in space and time, and (b) slip on a plane occurs in the direction of the maximum resolved shear stress, indicates a predominant compressional stress field.

LATERAL VARIATIONS OF THE ATTENUATION OF SEISMIC WAVES IN THE AREA FROM THE BEND OF THE SOUTHEASTERN CARPATHIANS

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The attenuation of the shear waves in the crust, in the area from the bend of the Southeastern Carpathians, is investigated by a procedure based on the modelling of the high-frequency waveforms. Local records of crustal low-to-moderate magnitude earthquakes from the study region are considered to determine 1-D (depth dependent) models of the quality factor of the medium *Q* along individual travel paths. A non-linear inversion in spectral domain is applied. The maximum frequency considered is 5 Hz.

The area of interest comprises several juxtaposed structural units: the Carpathian Orogen, the sedimentary Focsani Basin (component of the Carpathian Foredeep), the stable Moesian and Scythian platforms.

The *Q*-models determined for paths crossing different crustal provinces emphasize distinctive attenuative properties, that is high attenuation beneath the mountain range and the Focsani Basin, and high *Q*-values in the stable platforms.

Quite similar lateral variations have been pointed out by several earlier studies investigating the seismic wave attenuation along travel paths from undercrustal earthquakes (depths greater than 60 km) occurred in the Vrancea region: low *Q*-values were observed at the stations above and near the intermediate-depth seismogenic zone, and high *Q*-values at the stations located on the platforms of the Extra-Carpathian area. These variations were mainly attributed to the structure and physical properties of the upper mantle beneath the study area.

The present results evidence, however, that the heterogeneities of the crystalline upper crust and layers above have also a significant contribution, which should not be neglected, to the attenuation pattern in the study region.

REAL TIME ANALYSIS FOR VRANCEA INTERMEDIATE-DEPTH EVENTS USING STRONG MOTION DATA

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The seismicity of Romania is significantly affected by earthquakes produced by the Vrancea seismic source with intermediate depth events (3 shocks/century with magnitude Mw greater than 7.0). The seismic activity on the Romanian territory consists of both shallow and intermediate-depth earthquakes. The crustal seismicity is moderate and more scattered in comparison with the intermediate-depth one.

The recent upgrade of the seismic network in Romania with high dynamic range accelerometers (123 real time seismic stations equipped with episensors) allows recording of moderate to large magnitude earthquakes at very close epicentral distances (less than 10-20 km). Strong motion data of high quality are also of help in increasing the effective preparation against seismic disasters, and the response during seismic emergencies. The consequent increased ability of a community to quickly recover from the damages of an earthquake thus contributes to lower the seismic risk, usually measured in terms of casualties and economic losses. During 2016 in this seismic area were recorded two moderate events with 5.7 magnitudes in September respectively December.

The purpose of this work consists mainly in the estimation of moment magnitude Mw using the strong motion network of the National Institute for Research and Development for Earth Physics (NIEP). A stable and automatic method was developed by Gallo et al. (2014), has been implemented in the real time data acquisition and processing system (ANTELOPE) to estimate in real time the seismic moment, the moment magnitude and the corner frequency of events recorded by accelerometers, using Andrews (1986) method applied to S waves. The main goals are the independent estimation of seismic moment and the common characterization for all events recorded by the strong motion network.

NEAR REAL TIME FOCAL MECHANISM DETERMINATION FOR VRANCEA CRUSTAL DEPTH EARTHQUAKES 2010-2020

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One of the main objectives in real-time assessment of seismic hazard is the development of algorithms for rapid estimation of the seismic source parameters (fault planes solutions).
To determine fault planes solutions were implemented the FPFIT code (written by Reasenberg and Oppenheimer (1985), uses polarities to find one or several fps's) in ANTELOPE 5.6, software developed by Kinemetrics. Program FPFIT finds the double-couple fault-plane solution (source model) that best fits a given set of observed first motion polarities for an earthquake.
The objective of this work is to determine the near real-time fault planes solutions for Vrancea crustal depth and study of stress regime based on the inversion of earthquake focal mechanisms has been obtained.
In the present study, the fault plane solutions (FPS) of 98 seismic events starting with January 2010 and up to the present day were obtained of the Vrancea crustal depth region. The retrieved fault plane solutions of the weaker earthquakes show certain variability, the stress field is complex in the study area, showing a transition regime from the extensional regime in the Moesian Platform to the compressional regime in the Vrancea subcrustal zone.

REVISION OF MACROSEISMIC EFFECTS OF THE AUGUST 30, 1986 VRANCEA SUBCRUSTAL EARTHQUAKE

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In the past time the macroseismic intensity was an important parameter for the quantification of seismic activity of a territory, and it will continue to be, especially in areas without a good coverage of seismic networks, proving to be a good substitute for instrumental data.
The present study presents the revision of macroseismic intensities estimated after the Vrancea subcrustal earthquake occurred on August 30, 1986 at 18:28:35.7 local time 21:28:35.7 (GMT).
Parameters of this event were determined by the National Institute for Earth Physics (NIEP), as follows: magnitude Mw = 7.1, epicenter 45.52 N latitude, 26.49 E longitude and 131 kilometers depth.
The earthquake of August 30, 1986 is one of the strongest event which shacked Eastern Europe, being the sixth largest in Romania in the last two centuries or the third in the last century.
The main purpose of the revision was, on the one hand, to eliminate the existing suspicions regarding to the accuracy of macroseismic effects evaluation, and on the other hand, to eliminate some of the uncertainties that have appeared during the process of estimation, processing and interpretation of the macroseismic questionnaires and reports with damage description. Previous studies, together with original macroseismic questionnaires, have been gathered and examined in order to reevaluate macroseismic intensities. In this process, in many cases we found higher values of intensity than those assigned in earlier study. In other words, after the reevaluation an intensity increase in certain zones as compared to the same areas previous analyzed, is suggested. Maximum intensity observed VIII-IX, according to MSK scale, was assessed after the revision of data collected through macroseismic questionnaires.

THE PAST, PRESENT AND FUTURE OF SHAKEMAP IN ROMANIA

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ShakeMaps are map representations portraying the distribution of the ground motion intensity immediately after a significant earthquake. In earthquake-prone countries, like Romania, shakemaps are very important for emergency responders as they provide rapid information on the areas that have been shaken most severely by an earthquake, so that emergency services may be driven and coordinated more rapidly towards targeted areas. With this aim, the National Institute for Earth Physics (NIEP) has implemented since 2007 the USGS ShakeMap v3.5 (Wald et al., 1999) to provide rapid estimates and quantitative description of ground shaking for earthquakes occurring in Romania. The instrumental data recorded by the stations of the Romanian Seismic Network are combined with additional information from empirical ground motion prediction equations (GMPEs) to obtain the maps with the distribution of the ground motion parameters (PGA, PGV, SA). At present, the ShakeMaps are generated within 7-8 minutes after the occurrence of any earthquake (crustal or subcrustal) with Ml $\geq$ 3.0 on the Romanian territory. Taking advantage of recent technological developments made available by the United States Geological Survey (USGS), NIEP has recently started implementing the new version of ShakeMap (v 4.0) distributed freely by the USGS. We used all the intermediate-depth and crustal earthquakes with Mw $\geq$ 5.0, respectively Mw $\geq$ 4.0 occurred in Romania between 1996 and 2020 for testing purposes. We made tests using different GMPEs available in the literature and GMPEs weighting schemes, improved soil condition maps and combined strong motion and intensity (macroseismic and Did You Feel It - DYFI) data with the overall aim of finding the proper configuration that will be further used during the implementation of ShakeMap 4.0 in near-real time. Our results show an overall improvement of the accuracy of the ground motion distributions when using the new configuration as compared to the old one. Finally, we also present the newly developed Web service which will allow the rapid availability of the ShakeMaps on the Internet.

CRUSTAL FIELD DEFORMATION CHARACTERISTICS IN VRANCEA SEISMIC AREA FROM GPS DATA

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The present paper aims to bring an important contribution to the geodynamic researches by carrying out a study of the crustal deformations field in the Vrancea area, known as the most important seismic area in Romania at both crustal and subcrustal level. To meet this goal a network of GPS measurement points centered on the Vrancea active area was considered, the geodetic network being developed within a large scale international project, CRC461. The senzors network have been repeatedly measured every year since 1997, aiming to make it possible to determine the points' movement velocities each year, and drawing some conclusions on the characteristics of the kinematics of the crustal blocks. The measurement network, hereinafter referred to as the "*Vrancea Extended Network*", consisted of more than 50 measuring stations, of which only 26 were considered, as this group overlap very well at surface the maximum seismic activity in Vrancea zone, covering both the subcrustal and crustal domains of earthquakes occurring in the area. As the considered network presents distinct geodynamic behaviors in the two compartments placed to the south and to the north of the Trotuș fault, regarding the vertical displacement velocities of the measurement points, the network was divided into two compartments, *North Vrancea* and *South Vrancea*, the calculations being made on the extended network as well as on several separate subnets. The present paper continues this research, carrying out a calculation of the crustal deformation vectors' field, on the main components, maximum principal strain, ε_1, and the minimum principal strain, ε_2, together with their graphical representation in the form of deformation maps. All calculations were performed through a specialized software, using the finite element method, and graphic representations using specialized GIS software. Some geodynamic interpretation of the maps is performed having all the information about the behavior of the zone during several years.

DEVELOPMENT OF THE FIRST MACROSEISMIC INTENSITY DATASET FOR CRUSTAL ACTIVITY IN ROMANIA

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Even if most up-to-date seismic hazard studies are conducted in terms of different parameters derived from ground motion shaking, the macroseismic observations can provide valuable constraints for reconstructing shaking distributions, especially since in areas such as Romania crustal destructive events did not occur so much in the instrumental period. Macroseismic data quantifies the effects earthquakes have on buildings and people and plays a paramount role for effective earthquake response and risk mitigation. The aim of this study is to present the development of a high-quality dataset of macroseismic intensity values reported online and offline on Romanian territory for significant crustal events since 1926 (questionnaires data)/ 2013 (online data). Up to now, the dataset contains over 5000 intensity data points (IDPs) and more than 4500 answers that have been assigned from macroseismic observations retrieved from Internet reports and questionnaires, and also digitised from previously published isoseismal maps. It includes IDPs from 18 earthquakes with magnitudes in the range of Mw 3.1 to 5.4, at epicentral distances up to 600 km. The development of online tools (like: "Did You Feel It?" - DYFI) that are rapidly computing the macroseismic intensity data based on Internet users' responses immediately following earthquakes brings a lot of challenges in analyzing and harmonizing. As these information are collected and processed by multiple DYFI systems implemented by different organizations, the final intensity values can vary. To harmonize this data, we performed comparative analysis (in terms of maps) between the ones collected by the National Institute for Earth Physics (INFP, Romania), the Euro-Mediterranean Seismological Centre (EMSC) and the published macroseismic map of the events obtained from the macroseismic questionnaires. In the case of the 5.4 Mw crustal Vrancea event on 22 Nov 2014, our analysis shows that the datasets from different sources are in good agreement between them, allowing us to have a more detailed mapping and interpreting of intensity distribution.
This macroseismic intensity dataset is a key input for any further calibration of intensity prediction equations (IPEs) and/or the elaboration of a new probabilistic seismic hazard model for crustal activity in Romania.

APPLICATION OF EARTHQUAKE EARLY WARNING SYSTEM FOR GAS DISTRIBUTION PROTECTION

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The Romanian National Institute of Earth Physics (NIEP) developed a protection of gas distribution against seismic events using its Rapid Earthquake Early Warning System (REEWS). The results were included in a patent application (OSIM RO-BOPI 3/2019) and applied in a technology transfer project (10PTE2020) between a research institute (NIEP) and a private company (Electrovalcea SRL). The implementation of this project uses a local confirmation made by a sensor installed in the protected area at a depth of 40 m. An accelerometer is used in a PVC drill that includes a compass useful for installation, but also for continuous monitoring of the orientation of the sensor. The protection of gas installations is done on the distribution connections to the beneficiary (for example, a block of flats). If NIEP's seismic network detects an event confirmed by the local sensor, the gas supply is blocked to prevent fires in the protected area. The method used is distributed between a general seismic warning system and a local one. The system is redundant, allowing the use of two communication networks, one of which is provided by the Romanian Special Telecommunications Service and the possibility to use only the local sensor if there is no connection with the general REEWS. Between the two systems, we have developed a voting method that allows the ensemble to operate automatically in the most difficult situations. Even if we have foreseen many situations of interruption of the warning service, an operator will supervise the entire operation and will intervene in case of serious errors. The seismic event decision confirmed by the local system is transmitted to the beneficiaries through a private encrypted data connection with acknowledgment of receipt. The terminals installed at the beneficiaries are continuously monitored by a distribution system that indicates the start / stop status. The system also has an information component. Our application refers to the Vrancea seismic area and offers protection in the city of Râmnicu Vâlcea and its surroundings (everything that is west of the local sensor). Beneficiaries can be informed about the seismic events that occurred in Vrancea but were not dangerous for their area (not confirmed by the local sensor). This system has general applications in the field of protection of industrial objectives. The application is not intended to warn the population but only to protect it. NIEP's REEWS is connected to the Romanian authorities involved in emergency situations.

RE-EVALUATION OF THE ROMANIAN SEISMICITY BETWEEN 1900 AND 2005

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The revision of the present catalogue comprising the seismic activity observed in Romania (Romplus catalogue) shows some important shortcomings, such as the lack of significant events (especially for the western part of the country), inadvertencies in magnitude estimation and hypocenter location.
In this study, we aim to re-evaluate the Romanian earthquake catalogue and to compile a primary database as a tool for understanding and characterizing long-term seismicity observed in Romania, and as a reliable data source for the seismic hazard assessment.
The catalogue will include, besides the basic source parameters (origin time, epicenter, focal depth, magnitude, intensity), other available documents relevant for the source and effects information (maps of macroseismic distribution, scientific references), aiming to complete the Romplus catalog for the period from 1900 until the end of 2005.
The documentation and references associated with the significant events, swarms and sequences recorded in Romania is extracted from foreign catalogues, investigations and projects.
The new version of the Romplus catalogue will be decontaminated by anthropogenic events using techniques to discriminatee between man-made events and tectonic earthquakes.

THE LITHOLOGICAL COLUMN OF RAMNICU VALCEA SEISMIC SITE BASED ON DRILL CUTTINGS AND IMPLICATIONS IN SEISMOLOGY

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Station noise levels play a fundamental role in the seismic signals detection. Unlike ground-based seismometers that are affected by high level of seismic noise, the noise level recorded in borehole seismometers is significantly low. The Quaternary sediments bellow Ramnicu Valcea city were recently penetrated by a 12″ drill hole at depth of 40 m. This borehole has been drilled to install a downhole seismometer in order to minimize the seismic noise. During the drilling process, the drill cuttings were sampled at every two meters, labeled and packed up. Drill cuttings were caught as composite samples that reflect the various lithologies drilled over a 3 m interval. In the last 4 m the sample rate increased to 1 sample per meter. The samples were washed and lithological description was performed. The main objective of this paper is to build up a lithological column based on drill cuttings. This lithological column is very useful in site characterization, helping us to understand the geological properties that may influence the propagation of seismic waves. The dynamic ground response is determined by the local soil conditions that are highlighted very well throughout lithological columns. Many earthquakes in the past have shown that local site conditions significantly affect the intensity of the earthquake and so to the damages caused by those earthquakes. A lithological column associated to every seismic site helps us to better understand the local site effects that can play an important role in modifying the intensity of ground shaking.

THE SEISMIC ACTIVITY AROUND QUARRIES IN ROMANIA DURING COVID-19 LOCKDOWNS

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The discrimination between earthquakes and quarry blasts is a sensitive topic studied by numerous scientific researchers. Lacking an implemented procedure in separating the anthropic activity from tectonic seismic activity, the earthquake catalogues are contaminated with seismic events from artificial sources. In Romania, the pandemic lockdown measures applied by the Romanian Government in March 2020 due to the COVID19 outbreak were followed by a decrease of the number of seismic events recorded in areas of 10-km radius around the quarries compared to the previous years (2014-2019).

Our study covers the time period from February to July 2020 with highlights on the period of the state of emergency between March and June 2020 compared with the last 6 years (2014-2019) for the events recorded around the quarries.

Based on these premises, on average, the number of events recorded in 2020 between February and June is 40% smaller than the number of events recorded yearly between 2014 and 2019 for the same time-interval. From July, 2020, the number of events located around the quarries started slowly to increase overall the country.

URBAN AND DISASTER LEGISLATION: EXAMPLES FROM TURKEY AND ALL OVER THE WORLD

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Disasters, deadly events even if for past civilizations, cause major damages complete destruction of urban areas. The casualties and structural damages caused by disasters have forced people to take preventions to protect themselves and their assets. The first written document on disaster legislation in Turkish history is an edict issued by the Sultan at the time for the 1509 Istanbul earthquake, called "little apocalypse", and fires caused by the earthquake. This edict is considered as the first legal prevention that regulating rules on reliefs for those who want to rebuild their houses, the type of buildings, and the building materials to be used. These legal preventions mainly include response to a disaster and improvement attempts during reconstruction activities.

Based on the historical development of the legislation and practices for the prevention and risk reduction related to earthquake, flood, and mass movement, in Turkey, these prominent disasters are divided into, four periods consisting of the period before 1944, 1944-1958 period, 1958-1999 period and the period after 1999. The period before 1944, the 1939 Erzincan, 1942 Niksar-Erbaa, and 1943 Tosya-Ladik earthquakes that occurred consecutively resulted in major causalities and serious damages. Subsequently, the Bolu-Gerede earthquake, the 1949 Karlıova earthquake, and 1948 Eskişehir flood event led to further development of the legislation. Therefore, the 1944-1958 period involves with post-disaster intervention and the development process of recovery-oriented approaches. The 1958-1999 period covering 1966 Varto, 1970 Gediz, 1971 Bingöl, 1983 Erzurum, 1992 Erzincan, 1995 Dinar earthquakes, 1995 Senirkent landslide, 1995 İzmir and 1998 Western Black Sea flood events, which the legislation was improved by intervention and recovery approaches. Between 1990 and 2000, acceptance of the idea that reducing disaster risks will reduce post-disaster losses by the United Nations has led to developing an international strategy in reducing disasters. After the 1999 Kocaeli and 1999 Düzce earthquakes were an essential milestone in the development and regulation of legislation in Turkey. During this period, going beyond the crisis management perspective, pre and post-disaster processes has been handled integrated and systematically, and all processes were focused on preventing disaster risks and reducing losses.

Pre-disaster risk reduction studies were encouraged in consequence of the constitution of the Hyogo framework action plan between 2005 and 2015 in the world. During the 2015-2030 period, Sendai framework for disaster risk reduction plan is aimed to prevent disaster risks, increasing resilience to disasters, and being prepared before the occurrence of disasters.

AN ASSESSMENT OF NOVEMBER 08, 2019 TURKMANCHAY EARTHQUAKE (MW = 5.9) USING INSAR AND AFTERSHOCK DATA (NW IRAN)

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Remote sensing studies have an important role in identifying natural disaster risks and subsequently planning the cities in reliable areas. Prior to field studies, the application of remote sensing observations facilitates the determination of the potential areas where the active fault zones pass by, saves both time and economy. Furthermore, after the occurrence of earthquakes, it provides Significant advantages in understanding the surface deformations and related faulting characteristics.
The arc-shaped Bozgush Mountains is a remarkable morphological feature bounded with active faults in northwest Iran. The southern and northern parts of this mountain belt are limited by South and North Bozgush fault zones, respectively. These active fault zones exhibit right-lateral strike slip characteristics with reverse components and have produced numerous destructive earthquakes both in historical and instrumental periods. November 8, 2019, Turkmanchay earthquake (Mw = 5.9) has occurred on the South Bozgush Fault Zone (SBFZ). As a result of this moderate earthquake, seven people have died, and 529 people were injured. About 2600 buildings in 6 cities and 145 villages were damaged in different amounts, and many farm animals perished.
The absence of surface rupture during the Turkmanchay earthquake has caused discussions about the faulting characteristics which produced the earthquake. This study aims to determine and illustrate co-seismic deformation/displacement areas, which occurred after the Turkmanchay earthquake, as numerical and graphical models, by analyzing both Sentinel-1A Interferometric Synthetic Aperture Radar (InSAR) and earthquake aftershock data. Our InSAR studies have demonstrated that the deformation zone covers an area of 25×20 km^2. Results also reveal that subsidence and uplift amounts changes from -6 cm to +4 cm, respectively. The total LOS displacement between these two maximum deformation areas is about 10 cm. Interferogram fringes and deformation patterns indicate that the direction of the potential fault that caused the earthquake is WNW-ESE. These patterns are consistent with the orientation of the SBFZ. Continuous patterns of obtained interferogram fringes indicate that the surface rupture did not occur during the earthquake. Structural discontinuities derived from the geometry of patterns coincide with the orientation of the SBFZ. Following the main earthquake, a great number of aftershocks have occurred in the region. Observation of aftershocks in Bozgush Mountains along a week after the mainshock indicates that the WNW-ESE orientation of aftershocks is consistent with the orientation of segments which constituting the SBFZ. All findings reveal that November 08, 2019, Turkmanchay earthquake has occurred along the SBFZ.

REGIONAL-SPECIFIC GROUND MOTION MODELS FOR VRANCEA INTERMEDIATE-DEPTH SOURCE

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A newly compiled high-quality ground-shaking dataset of 205 Vrancea (Romania) intermediate-depth earthquakes has been used to develop region-specific empirical predictive equations for various intensity measure types as peak ground acceleration, velocity and 5% - damped pseudo-spectral acceleration up to 10 s. Beside common predictor variables (e.g. moment magnitude, depth, hypocentral distance and EC8 site classes), a couple distance scaling parameters were added to describe fully the specific attenuation pattern observed at the stations located not only on the back- and fore- but also along the Carpathian arc. In this model, we introduce a new proxy measure for the site as the fundamental frequency of resonance (f0) to better characterize the site response at each seismic station. Statistical evaluation of the newly proposed ground motion models indicates a robust performance of the model in respect to observations. It shows significant improvements of the spatial variability description (at different spectral ordinates), particularly for the fore - arc area of the Carpathians where a deep sedimentary basin is settled. The general trend of the ground motion model indicates an agreement with other regional models, within relevant hypocentral distances (i.e. $\leq$ 200 km) at short periods. Furthermore, the model presented herein improves the ground shaking estimates at longer spectral ordinates (> 0.7 s) in trend with the observations. The proposed ground motion model is valid for hypocentral distances less than 400 km, depth over 70 km and within the moment magnitude range 4.0 – 7.4.

THE SCIENTIFIC OPPORTUNITY OF A MAJOR EARTHQUAKE IN ROMANIA

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Earthquakes are one of the perceptible proofs that the Earth is a living planet. Besides seeing them as natural hazards capable of generating considerable damage in a matter of seconds, we need to acknowledge that each major earthquake provides important lessons on the implications of geo-tectonic and local soil influences on seismic hazard and how we should mitigate the risks. But there are still very high uncertainties in nowadays hazard, vulnerability and risk models. Clearly, we missed important chances of understanding more about the phenomenon and behaviour of built structures, but new technologies could bridge the gaps and deliver better insights. In this paper we first investigate what data was recorded during and after major earthquakes in Romania and how it was used - with a focus on contributions to understanding wave propagation and local soil effects, to the re-evaluation of seismic hazard, to building vulnerabilities assessment and seismic design improvement. We mainly relate to damaging or largely felt earthquakes in the Vrancea intermediate-depth source (events in 1908, 1940, 1977, 1986, 1990 and 2004 with moment-magnitude $\geq$ 6) but also to crustal events such as the Banat sequence in 1991 or older earthquakes in Făgăraș-Câmpulung (in 1916) or Shabla (in 1901) sources. Through this investigation we try to identify the lessons learned and missed during these earthquakes, in order to make a comparison with actual capabilities of recording and understanding the earthquakes and their effects on buildings, people and economic activities. It is clear that these capabilities have significantly improved, but are they well enough positioned and operated in order to deliver significant contributions to science and society? For a comparison of the past with the present, our preliminary analysis relates to the actual stations distribution of the Romanian Seismic Network and of the GNSS/GPS Network administrated by INFP, to seismic stations installed in buildings, vulnerability databases for buildings or the evolution of seismic design, layered with maps showing areas with high uncertainties for ground motion estimates or areas with a high seismic risk (using the Ro-Risk project or the Seisdaro results). Each major earthquake changes paradigms in a continuously evolving world. Given that we know that a major earthquake will strike again in Vrancea (and not only), we need to build upon previous experiences and use the nowadays scientific opportunities in order to better understand the phenomenon and the way to build earthquake resistant structures.

THE GEOMAGNETIC DIPOLE EVOLUTION IN THE LAST 400 YEARS. SUB-CENTENNIAL OSCILLATIONS

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The temporal evolution of the geomagnetic field shows the existence of several oscillations at decadal, inter-decadal, and sub-centennial time scales that superimpose on a so-called inter-centennial constituent (Demetrescu and Dobrica, 2014; Dobrica et al., 2018; Stefan et al., 2017). We discuss some issues concerning the geomagnetic field evolution, from the perspective of long time-span main field model *gufm1* (Jackson et al., 2000). In the present paper we focus on the 400-year evolution of the geomagnetic dipole, which is the prominent constituent of the observed geomagnetic field. We include in the analysis the dipole tilt evolution, important for the organization of the terrestrial magnetosphere.

The constructed time series of the dipole coefficients of *gufm1* (http://www.epm.geophys.ethz.ch/~cfinlay/) represent the data base of this study. To distinguish oscillatory characteristics at smaller (decadal) timescales from a trend concerning larger (centennial) timescales variations of a time series we apply a Hodrick and Prescott (1997) (HP) type analysis. The HP filter separates a time series into a trend component and a cyclical component. Further, we decompose the trend in constituents at two timescales (sub-centennial – 60-90 years – and inter-decadal – 20-30 years) by means of a Butterworth (1930) high-pass filtering with appropriate cutoffs. A so-called inter-centennial (≥400 years) constituent is obtained after subtracting the inter-decadal and sub-centennial constituents from the trend. The dipole tilt shows the same kind of variations as *gufm1* and its dipolar coefficients; the decadal one, of the order of 1 minute of arc, is superimposed on the intra-decadal (amplitude of ~2.5 minutes of arc) and the sub-centennial (amplitude of ~12 minutes of arc) variations. The inter-centennial variation constituent shows much larger variations: a period of increase of several degrees is followed, after ~1800, by a rather constant increasing evolution and, after ~1980, by a decreasing regime. However, the constituents at sub-centennial and inter-decadal timescales are present along the entire 400 years timespan of *gufm1*.

OSCILLATIONS AT SUB-CENTENNIAL TIME SCALES IN THE SPACE CLIMATE OF THE LAST 400 YEARS

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The "space climate" and "space weather" concepts, developed in the last decades, get an increasing significance, as the technological development of humanity, that includes new and new space missions, on one hand, and an increasing need for ground technologies to transport the energy, on the other, is increasing. While space weather affects directly humanity on short terms, the space climate, that refers to long-term solar variability and its effects in the heliosphere and upon the Earth, induces subtler consequences.

Our earlier results regarding the long-term evolution of the solar – terrestrial interactions (e.g., Demetrescu and Dobrica, 2008; Demetrescu et al., 2010) showed that signals at the solar magnetic (MC) and solar Gleissberg (GC) timescales can be found in any of the solar, heliosphere, magnetosphere and ionosphere parameters, and they are quite similar in the heliosphere – magnetosphere environment, pointing to a common pacing source, the solar dynamo. The present study is focused on the evolution of the coupled system heliosphere – magnetosphere, for the last 150 years, at the timescales of Hale (22 years) and Gleissberg (60-90 years) solar cycles, with a special regard to the low level of solar activity in the last solar cycle. The aim is to bring the information to the present, by using a different methodology.

The data used in this study concern time series of parameters describing the space climate, that characterize media such as the Sun, the heliosphere and the magnetosphere. We apply a Hodrick and Prescott (1997) (HP) type analysis, which is able to separate oscillatory features at smaller (e.g., decadal) time-scales from trends representing variations at larger (e.g., centennial) time-scales, to each considered time series. The results complete the former ones to the present and characterize the space climate in the last 400 years, at the timescales of the Gleissberg and Hale solar cycles.

ON THE MAGNETOSPHERE STAND-OFF DISTANCE DURING MODERATE AND INTENSE GEOMAGNETIC STORMS OF THE SOLAR CYCLE 24

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The magnetosphere shape and dimensions are a result of the equilibrium between the magnetic pressure of the geomagnetic field and the dynamic pressure of the solar wind in which the Earth and its magnetosphere are embedded. Our previous studies (Dobrica et al, 2012) concerned the long-term evolution (timescale the last ~150 years) of the stand-off distance, i.e. the sub-solar distance to the magnetopause, commeasured in Earth's radii (R_E). In the present paper we tackle the stand-off distance evolution during 26 moderate and intense geomagnetic storms (Dst < -100 nT) occurred in the solar cycle 24. This distance is given by the equation $L = ((AM^2/(2\mu_0 P))^{1/6}$, where M is the Earth's magnetic moment, P is the dynamic pressure of the solar wind, μ_0 is the permeability of the vacuum, and A is a given constant. Though the magnetic moment of the Earth is time-dependent at long-term timescale, it is constant during the short-time span (hours, days) of geomagnetic storms; it was calculated from the dipolar coefficients of available geomagnetic field models. 1-minute data for the dynamic pressure of the solar wind have been retrieved from the site ftp://nssdcftp.gsfc.nasa.gov/aspacecraft_data/omni/. While the long-term evolution of the stand-off distance shows variations between 11.6 and 9.5 R_E, during geomagnetic storms it shows variations of 0.5-1.0 R_E. An attempt is done to use the superposed epoch analysis in comparing various storms. Also, the stand-off distance is discussed in correlation to the parameters of the solar wind.

RECENT INFORMATION ON THE EVOLUTION OF THE GEOMAGNETIC FIELD ON THE ROMANIAN TERRITORY

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The information on the spatial and temporal variability of the geomagnetic field provided by the global network of geomagnetic observatories that permanently record its evolution, is supplemented at country scales by repeat measurements of geomagnetic elements in so-called secular variation networks. In Romania, such annual measurements, that began as long back as 1964, are carried out at present by the Institute of Geodynamics, in a network of 26 repeat stations.

During the years 2019 and 2020, measurements of the horizontal component, total intensity, magnetic declination and magnetic inclination have been performed at the repeat stations, by means of two DI-Flux theodolytes (LEMI 024, Bartington Mag 01H), one proton magnetometer (Geometrics G-856), and two Quartz Horizontal Magnetometers (QHM). In paralel with the absolute measurements, recordings of components X, Y, Z, F have been taken by two recording fluxgate magnetometers (LEMI 018, produced in 2009 and, respectively, 2016).

The determined values were corrected for diurnal variation and translated to the time of the first measurement of the series taken according to the observations protocol, using continuous recordings from the geomagnetic Surlari observatory. These values were then translated to the mid-year (geomagnetic epoch 20XX.5) using annual means published by the observatory. Maps of the geographical distribution of geomagnetic field components, referred to the epoch 2018.5, that represent the main results of the study, will be presented.

SESSION 2
NEAR SURFACE GEOPHYSICS

GEOPHYSICAL AND GEOCHEMICAL SURVEY IN THE AREA OF HOMOROD MUD VOLCANOES

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At the SE border of the Neogene-age Transylvanian Depression, near Homorod village, a remarkable gas seepage is known to exist, extruding at the surface the highest amount of nitrogen ever reported for a mud volcano. This specific location was subject to a geophysical survey consisting in Electrical Resistivity Tomography measurements, performed down to 54m deep. On the resulted sections and constructed 3D geoelectrical model it was noticed a fault lines system, which acts as a conduits for the liquid and deep origin gas discharges.
The trend of the fault lines (one striking SSW-NNE and other one W-E) revealed by ERT data interpretation was confirmed by new evidences provided by chemical analyses on Na-Cl facies groundwater samples recently collected (2020) from Homorod and other outlets. Based on major and minor ionic constituents comparison it was possible to set the regional trend of the SSW-NNE fault line, and to find evidences (sampled water sources from Baile Perşani and Grid) of its extend over at least 28km far from the Homorod Mud Volcano area.

GEOPHYSICS AS A TOOL IN RISK ASSESSMENT DURING ROAD CONSTRUCTION: A CASE STUDY IN A COMPLEX GEOLOGICAL REGIME IN WEST GREECE

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Road monitoring by means of visual inspection has been and will be standard procedure for many years. However, common problems such as sudden cracks and collapses of the pavement have shown that more efficient methodologies are essential. Furthermore most of these problems are related with specific geological formations, hydrological and ground conditions that where not taken under consideration during the construction phase. During road inspection, geophysics can provide valuable insight on the possible underground extent of the observed damage and most importantly identify areas with increased probability of collapse or crack in the future. Even most importantly, near surface geophysics can be a very useful decision-making tool during construction so that these problematic areas can be mapped and future damages can be avoided.

In West Greece near the city of Agrinio, during the construction of a road, a small collapse took place near the edge of the deck of the road. Due to the presence of complex geology with thin plate limestone, karstified limestone, clay, gypsum and intense fractures related to a fault line crossing the area of interest a near surface geophysical investigation was ordered in order to map possible problems along the road.

Ground Penetrating Radar (GPR) was used to scan almost 1 km of the road with many parallel lines and evaluation led to the classification of the parts of the road based on the condition of the soil down to 6 to 7 meters depth. According to this classification the less safe areas were investigated further with the Electrical Resistivity Tomography (ERT) method. The ERT provided 2D and 3D images of the resistivity distribution and based on the combination of GPR and ERT results, areas with possible cavities and/or abrupt changes in the sediments or rocks were identified. The most important finding was a very large karstic cave close to the edge of the road. The last stage was the excavation of suggested areas and verification of the results of the geophysical investigation.

MAGNETIC EXPLORATION APPROACH TO RESEARCH AND RECONSTRUCT THE ARCHAEOLOGICAL SETTLEMENT OF URLAȚI, PRAHOVA COUNTY

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The settlement at Urlați (Prahova county), *La Islaz*, is a complex archaeological site. It is found in the contact area between Câmpia Română and the Subcarpathian hills, at the foot of the Dealul Mare – Istrița massif, in a swampy area south-east of the locality. The archaeological researches were begun in 2004, being interrupted in 2006. They were reopened in 2013. The archaeological layers include settlements of the Neolithic (Starčevo-Criș culture), Aeneolithic (Gumelnița culture), the Bronze Age (Tei Culture), the 2nd – 3rd century AD (Chilia-Militari culture), the 4th – 7th Centuries AD (Ipotești-Cândești culture) and the Middle Ages (17th – 18th centuries AD). In isolated cases some fragments belonging to Boian culture were found.
Several geophysical methods have often been applied successfully for archaeological purposes. Thus, in 2018, we conduced the first geophysical investigations, using the geomagnetic method. We used an equipment of 5 Fluxgate (*Dr. Förster*) magnetometers. We researched a surface of about 5900 m^2. The choice of the researched perimeters was determined by the results of previous archaeological researches, the configuration of the relief, as well by the limits imposed by the on-site presence of an animal farm.
The results we obtained by interpreting the magnetic anomalies indicate the traces of an underanged archaeological complex, with the dimensions of 4,5x7 m (perimeter A). To it a series of archaeological elements of small dimensions are attached, aligned on 21 m (B perimeter), as well as others, of 3x1,5 m, 1,7x2 m, 1,7x1,2 m, 2,2x1,7 m (C perimeter). On the entire surface, as the geomagnetic map shows it through the black and white contrast (the presence of some small anomalies that cumulate negative-positive values - bipolar anomalies) we found objects that contain modern iron, that do not belong to the archaeological context.
The research of *La Islaz*, Urlați settlement demonstrates that magnetometry is capable of providing a rapid overview of the distribution of archaeological artefacts, of the spatial demarcation and extension of archaeological layers without alteration or destruction of any features of the site(s). Applying the geomagnetic method and techniques for prehistoric sites is very useful and efficient to determine the archaeological structures, avoiding large excavations, which consume too much time and money.

THE BRONZ AGE SETTLEMENTS OF ȘOIMEȘTI (CEPTURA, PRAHOVA COUNTY): EXPLORING THE ARCHAEOLOGICAL REMAINS USING GEOPHYSICAL METHODS

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Geomagnetic prospecting is the most widely used method for the investigation of archaeological structures. The geomagnetic data offers a useful picture of the subsurface since the results obtained through this method are not much influenced by the time of day they are collected in, the season, the weather, agriculture or the state of the soil's surface at the moment when the prospection is conducted. The archaeological site of Șoimești is a settlement from the Early Bronze Age, which is found in northern Muntenia, on the *Merez* hill in the Prahova Subcarpathians (447 m). The site was divided into three archaeological areas (A, B, C), all of which were approached through systematic research (450 sq.) since 2014, by a team of researchers from the Prahova Museum of History and Archaeology and the Buzău County Museum. The investigations for archaeomagnetic evaluation were conducted in 2018, focusing on 5 perimeters (1-5) found outside the limits of the archaeological sections, adding up to a total of 6800 m^2. We have used an equipment of 5 Fluxgate (*Dr. Förster*) magnetometers. The objectives of this work were to explore the spatial parameters of the possible archaeological structures, specially the localisation, demarcation and extension, depth, and thickness in the archaeological layers. The paper presents the preliminary results of the investigation. The significant elements were suggested by the presence of anomalies in two of the researched perimeters, 1 and 3. These allowed us to identify a circular fencing of the site previously researched through archaeological diggings. The fencing presents an opening towards the outside, on its southern side. Even if the investigations and the interpretation of results were limited by the microrelief of the researched surface and the mobile phone antenna placed inside it, the geomagnetic technique can be useful in prehistoric archaeological site assessment.

QUARRY BLAST IDENTIFICATION IN THE DEVA (ROMANIA) AREA USING SEISMO-ACOUSTIC RECORDS

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The large number of seismic events recorded in the South-Western part of the Carpathian Bend is related to the enhanced coverage of the region with seismic stations, as well to the intensification of anthropogenic activities such as mining activities.
The data used for this study were recorded between 2016 and 2018 on distances within a radius of 10 km around the quarries in the Deva region and surrounding areas. Statistically, it has been shown that most of the recorded events from the study zone were localized inside a 10 km-radius circle around quarries, typical distance for location errors in case of small and shallow-depth events.
The Romanian Seismic Catalogue (Romplus) has been contaminated over time with anthropic events especially in the areas with active exploitation of quarries. This contamination is affecting the interpreting and modelling of the geodynamic areas. Therefore, a procedure to discriminate between tectonic and anthropic events is required.
Discrimination between earthquakes and quarry blasts in a data based used for seismicity studies, hazard and seismic risk assessment, identification of soil structure and characteristics, is very important, as the use of the two types of events together can lead to misinterpretations.
For this purpose, we applied first statistical criteria according to the hour, day, and depth at which the events occurred. In this study, the events presumed as quarry blasts are validated using the acoustic observations of the Romanian infrasound arrays. A duo of detection-oriented software, recently developed by CEA/DASE and packaged in the extended CTBTO NDC-in-a-box, is used to investigate infrasound signals: DTK-GPMCC and DTK-DIVA. The events identified as quarry blasts by meeting the discrimination criteria and association with infrasonic signals are used as templates in the cross-correlation techniques applied on all events recorded in the study area between 2016 and 2018.
The results of this study will be used to analyse the possible influence that anthropogenic events may have in the occurrence of the seismic events in the area.

ADVANCE AND CHALLENGES OF WAVEFORM-BASED SEISMIC SOURCE LOCATION METHODS THROUGH APPLICATION EXAMPLES

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Estimation of seismic source locations is one of the fundamental problems in seismology that provides input information for many seismological analysis procedures and lays foundation for seismic monitoring at different scale. Recent decades have seen a significant densification in seismic station coverage, providing constantly increasing volumes of data to the seismological observatories and datacenters. Together with the methodological advances and the availability of computational resources this caused an important progress in seismic source location methods. As an alternative to the conventional traveltime-based methods, a new category of fully automatic waveform-based methods adapted from migration or stacking techniques in exploration seismology has emerged. Such methods are estimating a location of seismic source in space in time by exploiting coherence of seismic wavefield or its characteristics across the seismic stations. Waveform-based methods have shown promising results in detection and location of weak seismic events at multiple scales and, in many cases, demonstrated to provide a significant improvement in event detectability increasing the significance of statistical analysis of seismicity rates in space and time.
On an example of a detection and location method BackTrackBB (Poiata et al., 2016), I here discuss the main advantages, performance improvement and challenges of waveform-based seismic source location methods. These issues are addressed through a synthetic test dataset and a series of application examples focused on the problem of seismic source location and monitoring in different tectonic environments by large- and small-scale seismic networks. The examples include: detection and location of weak seismic events corresponding to low-frequency earthquakes along the Nankai subduction zone of southwestern Japan, microseismic monitoring of mining-induces seismic activity, and, detection and location of local earthquake in the post-swarm seismicity in Galati, Romania.

OBJECT DETECTION, CLASSIFICATION AND IDENTIFICATION USING SIDE SCAN SONAR IMAGERY CASE STUDY: SULINA FREE ZONE MARITIME BASIN

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In the year 2015 three wooden shipwrecks (Constantin, 2015) were found inside Sulina Free Zone maritime basin by amateur scuba divers: they recovered a cannon wheel and a cannon ball from one of these shipwrecks. The artefacts recovered were donated to Old Lighthouse – Sulina Museum, while the shipwrecks are assumed to be at least 200 years old.
In the year 2019 a team of researchers from NIRD GeoEcoMar conducted a geophysical survey with the objective to precisely identify the location of these shipwrecks and to identify other possible shipwrecks or artefacts lying on the basin floor. During the survey which took place in May – June 2019 the basin was investigated using side scan sonar, magnetometry and singlebeam bathymetry measurements.
Side scan sonar measurements were carried out using a Klein System 3900 mounted on a speedy boat at a profile spacing of 100 m and a survey speed of 4 – 5 knots to ensure overlapping of the sonar images in order to have complete coverage of the basin floor. The basin was surveyed using a high side scan resolution [445 kHz] followed by very high resolution [900 kHz] that was used to investigate high interest areas and targets.
By analysing side scan sonar imagery it was possible to identify four shipwrecks on the basin floor, accurately confirming the position and providing sonar images of the three shipwrecks found in 2015, while identifying another shipwreck previously unknown (Dimitriu et al., 2019).
The objects detected on the basin floor were analyzed and classified by length, width and height and when possible they were identified. A database containing these targets parameters and description was created and provided to "Simion Gavrilă" Eco-Museum Research Institute, Tulcea for further investigation through other methods.
Many objects and possible artefacts were detected on the basin floor, objects such as pipes, logs, barrels etc. were identified, while others were just analyzed and described without a clear identification.

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SESSION 3
GEOSCIENCE FOR ENERGY

INTEGRATED SEISMIC INVERSION AND ROCK PHYSICS ANALYSIS FOR CO_2 STORAGE

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Eighty percent of the world's energy relies on fossil fuels and under increasingly stricter national and international regulations on greenhouse gas emissions, storage of CO_2 in geologic repositories is a feasible and vital solution for near- and mid-term reduction of carbon emissions in any climate change mitigation strategy. To achieve the 2°C climate goal set by the Paris Agreement at least cost, projections by the International Energy Agency indicate that around 4,000 million tons of CO_2 per year would need to be captured and stored by 2040, growing to around 6,000 million tons per year by 2050. Currently, ~20 large-scale carbon capture and sequestration (CCS) projects are operational around the world with ~30 billion USD investment in comparison to more than 2 trillion USD spent on renewable energy. Therefore, a significant opportunity exists for CCS nationally and globally.

The Southeast Offshore Storage Resource Assessment (SOSRA) research project funded by the U.S. Department of Energy is focused on assessing the Atlantic offshore resources for CO_2 storage. This study focuses on development of offshore prospective storage resource assessment of the Upper and Lower Cretaceous as well as Upper Jurassic sections within the Southeast Georgia Embayment (SGE) with significant potential storage capacity. This work includes a reliable and replicable workflow of model-based inversion that provides the tools to discriminate lithology and predict porosity and permeability. The impedance and porosity relationships show well-founded and reliable correlations. These analyses have included integration of seismic surveys with core samples and geophysical well logs leading to a detailed stratigraphic, structural, petrophysical, and injection simulation model showing the heterogeneity and highly complex tectonic evolution of the target reservoirs of the Eastern North American Margin. The acoustic impedance results show that the Upper Cretaceous strata have two main potential reservoirs that are overlain by a thick impermeable interval, mostly shale which has high seismic impedance, low porosity, and low permeability. The extracted values of porosity, ranging from 15 to 36 %, and permeability, ranging from 1 to 100 mD, are close to the measured values from the well core data at the Upper Cretaceous strata interval.

There are three target reservoirs within the Lower Cretaceous strata based on geophysical and well log analysis. The calculated storage capacity is 746 Gt of CO_2 at P_{50} that could be stored securely in a 4.61*1012 cubic ft volume. The total average thickness of the potential reservoirs is 1425 ft.

CORE-INDEPENDENT RELATIVE PERMEABILITY MODEL FROM NMR DERIVED SINGLE PHASE CAPILLARY CURVE-NEW APPROACH IN CARBONATE

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Relative permeability is one of the most dominating factors behind the effective displacement of reservoir fluids. However, the determination of Capillary pressure (Pc) data and relative permeability information highly dependent on lab studies with cores. On the other hand, in spite of having a bunch of information, till date the use of NMR log is confined for the evaluation of different kind of porosity distributions and permeability. With the development of Fluid Substitution algorithm, core equivalent NMR logs can be generated. In our study we have done the statistical approach of NMR factor analysis and then fluid substituted core equivalent T2 distributions and Pc curves are generated. The Pc corresponding to identical poro facies are used for the modeling of core independent relative permeability. The model of relative permeability helps us in understanding of flow behavior of wetting phase and non-wetting phase in exploratory wells of Indian carbonate. NMR factor analysis study is done, which segregates the carbonate formation in different facies depending on their poro fluid behavior. After that, the NMR fluid substitution is performed to get water substituted T2 distribution response, which can be compared with the core NMR data. Capillary curves are generated corresponding to each poro facies and those are equivalent to MICP equivalent capillary data. Fluid substituted single phase capillary data is used for the modeling of core equivalent relative permeability of wetting and non-wetting phases in MATLAB. Different poro facies are obtained depending upon the pore distribution and fluid. Permeability and water substituted T2 distribution have a better match with the core derived NMR T2 distributions and permeability after using optimized T2 cutoff from factor analysis. Promising correlation has also been observed with the MDT derived permeability data. NMR derived water substituted Pc curves are used for facies wise relative permeability modeling, which explains the flow behaviors of the tested objects in the exploratory wells. Till date Core based relative permeability models has been used for industry, which are expensive both in time and cost, but a core doesn't represent the entire reservoir heterogeneity. In current oil price scenario, to optimize the cost and time with promising accuracy the present model is an extra aid in formation evaluation and reservoir characterization using only NMR data. So far, this is the first such case study from Indian carbonate reservoir.

MULTI-SCALE ANALYSIS OF ALKALINE LACUSTRINE SHALE OIL CHARGING CHANNELS IN FENGCHENG FORMATION, JUNGGAR BASIN, CHINA

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Fengcheng Formation is typical dolomitic shale oil of alkaline lacustrine in Junggar Basin, the high quality source rocks show pervasive distribution, fine-grained sedimentary, micro-nano pore-throat system, tight reservoirs, "integration of reservoir and source" and resource potential is great. Mahu Sag experienced humid-semiarid climate during Fengcheng deposition stage. The lacustrine transgression period occurred from the late stage of the first member of Fengcheng Formation (F1) to the early stage of the second member of Fengcheng Formation (F2), then the lake retreated gradually, and wide distribution high potential source rocks were developed. Under this sedimentary background, the Fengcheng Formation including two types of unconventional oil and gas reservoirs developed the lithological sequence from shale rich in organic matter (F2+F3-The third member of Fengcheng Formation) to tight volcanic rocks (F1). Based on the above analysis, this paper carried out a study on the charging channel of shale oil according to logging scale, core scale and micro pore-throat scale.

According to the study of drilling cores, imaging logs, thin sections, confocal microscopy, fluorescence observation and scanning electron microscopy (SEM), it shows that F3 and F2 develop multiple reservoir space type, such as rock fractures, kerogen networks, stylolites, and micro-nano pore-throat systems. The macro-charging channels identified by drilling core and FMI images in Fengcheng Formation include tectonic fractures, induced fractures, bedding fractures and dissolution expansion fractures. The micro-charging channel types identified by laser confocal microscope, thin section and SEM include kerogen network, micro-fractures + stylolite and micro-nano pore-throat system. Shale oil charging is a complex geological process, and charging and micro-migration rarely occur along a single channel. There are a large number of stylolite structures in the source rocks of the Fengcheng Formation. The reservoir pore types are mainly secondary dissolution pores and intercrystalline pores, and the fractures are mainly tectonic fractures and bedding fractures. Channels with different types of genesis and scales interconnected to form a complex pore-fractures network system.

The research shows that the Fengcheng Formation has two types of source-reservoir channel combination models: tectonic fractures + pores (tectonic fractures-type reservoirs) and stylolites + matrix pores + tectonic micro-fractures (shale oil reservoirs), forming the shale oil preponderant charging channel. The early generated hydrocarbons was charged into the micro-nano pore-throat system, which promoted the change of the wettability of the rock particles from hydrophilic to lipophilic, and the thickness of the oil film was reduced, resulting in an increase in free oil content.

STANDARDIZATION OF NMR T2 CUT OFF AND BETTER ELECTROFACIES MODELING OF LOW RESISTIVITY CARBONATES WITH MULTI POROSITY SYSTEM

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Carbonate reservoirs comprise about 50% of world's oil and gas reserves and more than 60% in their respective production. But the inherent heterogeneity leads to difficulty in the interpretation of carbonate reservoirs due to its petrophysical properties like mineralogy, porosity, their distribution (Macro, Meso and Micro), pore throat tortuosity, permeability, capillary pressure, irreducible water saturation, wettability, pore throat radius and many more. The low resistivity low contrast (LRLC) carbonate reservoirs are most challenging in the domain of petrophysical evaluation and their interpretations. Nuclear Magnetic Resonance (NMR) tool gives very useful information for the characterization of reservoir. It gives the porosity types (whether bound or free fluid), distribution of pore sizes and type of fluids present in the reservoir. Due to the movement of protons (Hydrogen), the T2 distribution is obtained and the T2 cut off is the most critical parameter in the whole processing as this parameter strongly influences the computation of permeability and porosity distributions. Our study area consists of the low resistivity pay (LR) in the Ratnagiri formation, which is aligned along the spurs extending from west of main Mumbai High Field in the NE-SW direction. The water filled micro-porosities & presence of Micrites have been thought to be reason for low resistivity carbonate reservoirs in this area. Due to the unavailability of lab data it is difficult to calibrate the NMR permeability with the intisu permeability of the formation. The free fluid volume (FFV) also plays a typical role in the quality of the prolific zone for further production testing. We have applied two different inversion methods to standardize the T2 cut off value for the low resistivity pay with five wells in the area. Recomputed T2 cut off is used to evaluate free fluid volumes, permeability and effective reservoir thickness (He), which holds better with the production testing results. For the first time so far, we attempted to integrate different inversion methods and correlated them with available core data to standardize the T2 cut off for the low resistivity carbonate. The statistical electrofacies modeling is also done for the computation of improved He with the wire line data, Permeability and FFV over set intervals.

AN INTEGRATED APPROACH FOR IDENTIFYING RESERVOIR FLUIDS AND CONTACTS IN DEEP WATER THINLY LAMINATED SEDIMENTS

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The newest hydrocarbon discovery in the East Coast of India was made based on appraisal wells drilled in the study area to view the geological and geographical continuity of discoveries made earlier. The X field is a crucial chunk of the multi-billion-dollar project undertaken by Stated Owned Oil and Natural Gas Corp (ONGC). The target sands belong to the Post rift tectonic stage of evolution with hydrocarbon occurring in the structurally/ stratigraphically controlled traps deposited under marine condition, making reservoir evaluation challenging. The paper highlights the application of multi-component induction logging, formation pressure testing and sampling for determining hydrocarbon column in a deep-water Pliocene turbidite formation composed of thin sand inter-bedded with shale. In such cases, conventional petro physics using horizontal resistivity and bulk porosity will lead to an underestimation of the reserves or, at times, completely miss a potential hydrocarbon bearing zone. The presence of Synthetic Oil Based Mud and logging in an unconsolidated formation made fluid identification challenging. The shale distribution and porosity are computed form Thomas-Stieber cross-plot, in which volume of shale is plotted on X-axis and total porosity on Y-axis. Formation pressure testing and sampling intervals were successfully identified on the basis of multicomponent induction tool and the intervals were found to be gas bearing. Conventional bulk volume analysis, in contrast, gives a very pessimistic estimate at the pay interval compared to Laminated Sandy Shale Analysis (LSSA). The LSSA petro physical model is an approach of volumetric evaluation using sand-shale-fluid components along with vertical and horizontal resistivity. The vertical and horizontal resistivity derived from multicomponent induction tool along with user defined vertical and horizontal shale resistivity computes laminar sand resistivity (R_{sand}) and laminar shale volume (V_{lam}). Carrying out formation pressure tests and sampling based on these results helped in determining Gas Shale Contact from fluid identification tests and pressure gradient analysis. Clean formation gas samples were collected, thereby successfully meeting the objective in a challenging unconsolidated environment by integrated value added services.

REDUCING GEOLOGICAL UNCERTAINTIES OF NEW DISCOVERED FIELD IN RUSSIA WITH SEISMIC INVERSION

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Research area is located in Russia in the Khanty-Mansiisk Autonomous district of the Tyumen region. It is a Greenfield discovered in 2017. Since the field is new, poorly studied and is in full autonomy, it is necessary to perform the most accurate forecast of the resources and reserves for the construction of optimal surface facility design. A wide-azimuth 3D seismic survey was performed at the field with an explosive source, using a centrally symmetric observing system, with a fold of 144 and a maximum source-receiver distance of 5056 m. Four wells were drilled within the framework of the 3D seismic survey, three of them have sonic scanner and density well-logs in the interval wellbore. The main geological objects are deposits of Cretaceous and Jurassic. Deep-water sea sediments (from the Cretaceous period also known as Achimov reservoirs) represent most of the resources of this licensed area. The traps are most often lithological, or structural-lithological.

The main difficulties are prediction of pay thicknesses and determining the distribution area of the reservoir, without which it is impossible to make an accurate forecast of the resources estimation. Task of the research was to perform attribute analysis and seismic inversion with aim to obtain most accurate properties of the reservoir for further geological and infrastructural activities. In our case, since it is a new field, we had a small number of observations, and as a result, the absence of a representative sample of data for regression analysis. That led to lack of reliable causal relationships between changes in predicted parameters (porosity, permeability etc.) and changes in attributes and explicit multicollinearity of predictors. To solve this ambiguity and select the forecasting methodology for complex reservoirs of reservoirs, petroelastic modeling was performed.

The results of the performed work on seismic inversion allowed us to accomplish:

- Quantitative forecast of pay thicknesses and their distribution over the area for deep-sea sediments (Achimov reservoir) for which previously it was not possible;
- To perform a probabilistic evaluation of reserves and to create an exploration program to decrease residual uncertainties;
- Make the decision on the construction of surface facility and early development drilling;
- Transfer the experience to other fields with the same type of deposits (Achimov resevoirs).

USE OF PASSIVE SEISMIC TO PREVENT ERRORS RELATED TO INCORRECT ESTIMATION OF HYDROCARBON RESERVES

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One of the main problems for the petroleum geology of the contemporary world is a difficulty in hydrocarbon reserves' calculation process. 2D and 3D seismic exploration methods are typically applied for such purposes. However, the information received using them often may be insufficient to plan field development effectively.

Even with the 2D and 3D seismic data available, sometimes it is not possible to identify oil- and gas-bearing structures having good prospects with precision as well as to calculate proved reserves of hydrocarbons.

Among the most complex structures in the geological point of view in the Udmurt Republic is the Karsovaysky field. Each oil- and gas-bearing bed was initially envisaged to have only one oil-water contact. Probable geological recourses of this field were estimated at 994 million barrels and recoverable probable recourses – at 278 million barrels (with a recovery factor value of 0,28).

However, it was demonstrated by drilling a significant number of prospecting and exploration wells that the field consists of three separate oil- and gas-bearing structures. Proved geological reserves accounted for 603 million barrels and proved recoverable reserves – for 169 million barrels.

Initially, 259 of production and injection wells were planned to be drilled in the field. Due to a significant decrease in the petroleum-bearing area, there were drilled only 158 wells.

The use of passive seismic could help to avoid such overestimation of hydrocarbon quantity.

Passive seismic principles are based on using low frequencies as seismic sources. This method is applied to give the correct forecast for the discovery of hydrocarbons accumulated in reservoirs. The 3D seismic data provide the identification of prospective geological structures, and the passive ones only confirm the hydrocarbon existence precisely.

The implementation of passive seismic would allow oil- and gas-saturated zones to be detected accurately and errors contained during the estimation of hydrocarbon quantities in a reservoir to be removed. Furthermore, it will help to reduce the number of prospecting and exploration wells as well as to avoid the drilling of empty wells.

REDUCE UNCERTAINTY IN OIL & GAS BY LEVERAGING THE POWER OF CLOUD COMPUTING

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Digital transformation is on top of the agenda of all E&P organizations in the Oil and Gas industry today. The focus is on automation and collaboration in a resource-constrained market. Furthermore, E&P companies are looking to optimise their organizations and lower the cost per barrel. The need to leverage open platforms and cloud has become very important. The latest cloud native technologies are far more flexible and able to leverage the elastic capabilities to deliver results faster and more accurately by using ML and AI methods. Cloud also brings a new level of collaboration and the freedom to work from a workplace or anywhere else.

Performance and security are of utmost importance as most organizations embark on this journey. At Halliburton, we started this journey many years ago, and have already achieved a performance increase of up to about 70% when using cloud vs on premise solutions. Halliburton's hybrid cloud offers the highest level of security with SOC2 compliance.

Cloud native solutions are designed and developed to exploit cloud capabilities to their full potential – this allows the use of resources on-demand and the ability to scale up or down depending on the process loads. The development of microservices brings many advantages, being detached from the applications and can be run separately on top of other processes.

Landmark® is developing a suite of new integrated cloud native solutions which take advantage of distributed computing infrastructure for both seismic and well data to quickly derisk prospects in the Oil & Gas Upstream sector.

In terms of seismic data computation, Landmark applications take advantage of these distributed systems on a range of activities, which include seismic attributes generation and processing and computation tools. The DecisionSpace® platform provides an extensible framework that enables linking and running several geophysical processes and algorithms.

In regards to well data, the manual lithological interpretation of petrophysical well logs can be a very time-consuming process, and it can lead to inconsistencies. The developments of cloud native solutions can assist the interpreter by offering supervised machine learning capabilities and scalability.

Scalable earth modeling allows you to rapidly build large models and generate multiple scenarios to create accurate, integrated, and reliable 3D subsurface models, while maintaining the fidelity of the original data.

In this presentation, we will demonstrate practically how the new technologies developed by Landmark Halliburton reduce uncertainty, taking advantage of cloud technology.

CHALLENGES IN CARBON STORAGE: A REVIEW OF KEY SOLUTIONS FOR UNDERSTADING CAPACITY, INJECTIVITY AND CONTAINMENT

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With the increasing concern on the negative climate effects of carbon dioxide (CO_2) emissions, governments worldwide need to establish policies to stabilize global warming at 1.5 degrees Celsius above pre-industrial levels by the latter half of this century. Implementing CO_2 sinks are a key factor in achieving this target and include a significant increase in biomass capture (forests and bioenergy crops) and carbon capture and sequestration (CCS). CCS is seen as an essential process necessary to mitigate against an increase in global temperatures.

The CCS workflow has three main components – capture, transport and storage. Each of these requires specialist technologies to safely and effectively capture the CO_2 from source (e.g. power plants. chemical industries, manufacturing industry etc.) and then transport it to the storage site where it will be injected in the reservoir and stored for many 1000s years. The storage component of this workflow has multiple phases, with each one containing distinct operations and stages. The key process for CO_2 storage are prospecting for new storage sites, understanding cap rock integrity, CO_2 injection rates, injection interval pressure and predicting the long-term fate and risks of a storage site in the post operational phase. The nature of CO_2 storage differs in many ways from other subsurface modelling activities carried out by the oil and gas industry. Halliburton has technology and solutions that can help facilitate many of these stages and operations, and has built this expertise based on decades of operations and project management in oil and gas extraction. A key component of this solution is software that is specifically developed to successfully characterize the subsurface and enable suitable site selection for the safe and effective long term storage of CO_2.

PHOTO DATABASE OF RENEWABLE ENERGY

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Aim of the paper is to present entries to the photo database of the COST action TU1401 "Renewable energy and landscape quality" by the author. A preliminary version has been published in Urbanism. Architecture. Constructions as "Contributions to WG4 outcome photographic database and competitions of COST RELY" (https://uac.incd.ro/Rez/v9n4a04.htm) and another presented at the final conference in Clermont-Ferrand and Mende. Afterwards, more historical renewable energy installations have been visited, namely the wind and water mills in the village museums in Bucharest and Sibiu, but also a solar energy entry done on the IBA Emscher Park installation regarding the recent past, or some solar energy retrofits of buildings in the mountains in Sinaia in Romania or at a monastery in Érd, Hungary. The Astra village museum in Sibiu is a museum of crafts, so technical buildings like those related to energy are well represented, including also hand and horse mills. Some mills were included in the national minorities street. The IBA Emscher Park was a large scale retrofit in the 1990s of a former coal mining region and therefore the renewable energy there in the high tech industry buildings enjoys a special connotation. Reference will be done to the coal mining challenge today, including geotextiles to cover the ash for vegetation rehabilitation, considering two sites in Romania. Geotextiles on mountain sites have been also observed in France, including at the COST RELY final conference which presented the UNESCO geoheritage of Chaine du Puys. An overview of the early entries, from which some were prize awarded by the action and of the late entries will be provided. The mills conserved in museums will be compared to the in situ mills for example water mills in Eftimie Murgu village or a wind mill in Nessebar. Also, a connection will be done between the romantics of early renewable energy items and that of turn of the millennium innovative buildings, and common practice. The impact of renewable energy installations on landscape can be also seen in connection with geotourism and geoheritage, since many times they are in areas connected to national parks (for example an entry on the Black Forest mountains and entries on the Iron Gate park). The structure of the entries for the database will be presented and exemplified on selected examples. The renewable energy covered is related to water, wind, solar energy. The photo database of the COST action is further in work.

SESSION 4
GEOSCIENCE FOR CAVE AND KARST AREAS

PALEOENVIRONMENT STUDIES USING CAVE DEPOSITS

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Caves are void spaces, predominantly in carbonate rocks, which tend to fill over time with a variety of autochthonous and allochthonous clastic, chemical, and organic materials, such as sediments, speleothems, ice, guano, etc. These deposits may yield a wealth of paleoenvironmental information since their accumulation in caves is tightly connected with processes acting at surface. Furthermore, we now know they are often preserved for long periods of time (millions of years) because cave environments are protected from surficial weathering and maintain year-round constant temperature and relative humidity.

Fast-paced and rapid advances of analytical facilities, including radiometric dating and stable isotope techniques, opened unprecedented opportunities to karst/cave scientists to advance the understanding of caves as physical, chemical, and biological environments. These led to a surge in exciting new researches that triggered outstanding studies. Among these, speleothems take center stage as they complement ice core and deep-sea sediment records. Speleothems are secondary mineral deposits precipitated from cave seepage water, thus they are sensitive to climate and environmental changes as their growth mechanism is intimately linked to Earth's atmosphere, hydrosphere, and biosphere. For example, δ^2H (in fluid inclusions) and $\delta^{18}O$ values provide critical information on air temperature, source, amount, and composition of meteoric precipitation, whereas $\delta^{13}C$ values yield clues regarding soil biological activity, type of vegetation around the cave, etc. In addition, speleothems allow the development of robust chronologies that are critical to temporally link climatic events at regional scale.

Caves and lava tubes in different parts of the world host perennial ice deposits. Combining the powerful radiocarbon dating method with the isotopic composition of ice (δ^2H and $\delta^{18}O$), show to be a very good approach in reconstructing past climate variability and the dynamics of large-scale atmospheric circulation.

The investigation of past environmental changes in areas where speleothems or ice deposits are scarce, focused on bat guano, which is composed of chitin resulted from the disaggregation of insect fragments. Long-term bat maternity roosts favor the accumulation of significant cave guano deposits. In any given karst area, bats are feeding on insects whose dietary preferences mirror the local vegetation of which distribution is controlled by the local/regional climate and human impact (deforestation, fire). Thus, analyzing the pollen and isotopic composition of hydrogen, carbon, and nitrogen of guano sequences, will ultimately provide high-resolution information on vegetation changes and water availability ($\delta^{13}C$), nitrogen-cycling ($\delta^{15}N$), and hydroclimate (δ^2H).

GROUNDWATER CHEMICAL SIGNATURES – POSSIBLE CLUES FOR THE SEEMINGLY ERRATIC PRODUCTIVITY OF A GEOTHERMAL AQUIFER HOSTED BY A ~1 KM THICK CARBONATE SEQUENCE IN THE MOESIAN PLATFORM (ROMANIA)

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A several hundred meters thick carbonate reservoir located in the Moesian Platform (Romania) has been tapped by deep wells (2000-3000 m) drilled for geothermal exploration. Because of the carbonate reservoir progressive deepening – from its outcrop area, down to more than 3 km – the temperature range of the stored groundwater spans over more than 50°C. Thermal waters discharged by boreholes whose pay-zones occurred within regions of correspondingly contrasting temperatures displayed Ca^{2+} and HCO_3^- concentrations which were reversely correlated with the inflow temperatures. Since calcite ($CaCO_3$) has the distinctive property of becoming increasingly soluble as the aqueous solution cools down ("retrograde solubility"), the noticed reverse correlation could indicate: either calcite dissolution along upflowing plumes of deeply-originating groundwater subject to progressive cooling; or calcite deposition along downflowing plumes of meteoric recharge water that experienced progressive heating. The coexistence of such adjacent, "warm" and "cold" plumes – each of them several kilometres wide – is in accordance with the overall temperature distribution within the aquifer.
That model could explain as well why the geothermal aquifer displayed, over short lateral distances (a few kilometres), productivity variations of more than one order of magnitude. Where reflection seismic records were available, significant lateral variations were also noticed to be displayed by the velocity of the seismic waves which propagated across the thick carbonate stack: such variations appeared to be correlated with the aquifer productivity – namely, increased seismic velocities corresponded to poor productivity, and vice-versa. The low-productivity, compact zones could be ascribed to pore clogging in response to calcite precipitation, as the meteoric water recharge – supplied from the reservoir outcrop area – became progressively heated while descending deep into the aquifer; while the less compact zones could be due to calcite dissolution, ensuing to cooling of the ascending, deeply-originating groundwater.

CHARACTERISTICS OF KARST DEPRESSIONS LOCATED AROUND MANGALIA (ROMANIA)

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In Southern Dobrogea (SE Romania), the occurrence of oolithic-lumashelic Sarmatian limestone, as well as the presence of H_2S-rich mesothermal groundwater created conditions for hypogene karst development, apart from epigene processes. The most pervasive karst form is represented by sinkholes, resulting from both dissolution and collapse.

A handful of very large collapse sinkholes are located around the town of Mangalia, the largest (>1 km in diameter) being the Mangalia Swamp. The town of Mangalia itself is built over such karst features that are known to be geomorphic hazards, posing a threat to infrastructure. Apart from understanding their extent for infrastructure development reasons, the occurrence of these karst landforms raises interesting questions about their genesis, linked to the presence of sulphidic water, but possibly with a contribution of meteoric and salt water intrusions.

We present here an analysis of some of the geomorphological features of this area (both at the surface and submerged by the sea) using modern surveying techniques such as unmanned aerial vehicles and side-scanning sonars. Where sinkholes appear within the residential areas, their extent was measured with a differential GPS or extracted from topographical maps.

As the genesis of sinkholes could be linked to groundwater changes, their sedimentary infill could be used as an archive that could bring more information on the Quaternary environmental history of this region. We undertook geophysical measurements on some of these sinkholes in order to gain more insight into their bedrock morphology and sedimentary infill. We performed several electrical resistivity tomography (ERT) and self-potential (SP) profiles reaching maximum depths of 50 m in and around the Obanul Mare collapse sinkhole, to define the collapse sinkhole limits and to study a nearby dissolution sinkhole. As well, by measuring several ERT profiles on a small area near Limanu Cave, we identified there a collapse sinkhole with a diameter of about 200 m and with a depth greater than 50 m, completely filled with sediment and inconspicuous in the surrounding relief.

THE INFLUENCE OF PEDOGENETIC PROCESSES ON RECONSTRUCTING HOLOCENE CLIMATE DATA IN MEHEDINTI (SW ROMANIA)

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Speleothems, an important part of paleoenvironmental research, are intimately linked to the overlaying soil covers, as their growth depends on organic soil activity and percolating water. This research investigates a sedimentary accumulation above Ascunsă Cave (Mehedinți Mountains, SW Romania) that should be in direct depositional connection with the POM 2 stalagmite, which provided isotopic evidence for hydroclimate changes over the Middle Holocene. Our aim is to study if this sedimentary deposit could be used as an environmental proxy archive in parralell with the stalagmite, knowing that soils behave as open systems and environmental proxies might be reworked.

We excavated a 2.5 m deep soil profile and took contiguous bulk samples every 5 cm. The profile starts with a 5 cm thick organic horizon O, followed by the A horizon down to 40 cm. From 40 to 250 m depth the profile displays the features of colluvium comprising a heterogenous composition. Samples were analyzed for clay mineralogy, grain size, chemical composition, and magnetic susceptibility. Results show the soil deposit is at an intermediate stage of weathering and is still developing. Pedogenic processes affect the behaviour of clay minerals and also induce changes in the chemical composition. Leaching is one of these processes and is responsible for the eluviation of Al, Si, K, and Mg which are translocated and accumulated downwards in the illuviation area.

Observed mineralogical changes such as chlorite replacement by vermiculite or mixed layer structures might also be a consequence of pedogenesis. Chlorite is present in the upper part of the profile with concentrations up to 65% while in the lower part of the sequence chlorite is almost absent being replaced by vermiculite or mixed layer structures.

In the upper 40 cm of the soil sequence, it could be observed that all proxies, including magnetic susceptibiliy, undergo a major change.

At this stage of our research, we can state that only chemical elements seem to be reworked through eluviation. Other proxies such as bulk organic matter $\delta^{13}C$ or bulk C:N need to be analysed in the future, while radiocarbon dating is needed to put these proxies in a chronological context.

COMPRESSED RARITIES: GEO-, PALEO- AND MORPHOLOGICAL PARTICULARITIES WITHIN THE SPELEAN ENVIRONMENT

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Retezatul Mic (Piatra Iorgovanului-Piule Mountains), belonging to Retezat National Park, represent a distinct unit of Southern Carpathian Mountains (Romania), spanning between Jiul de Vest River in the south, and Lăpușnicul Mare River in the north. It represents an alpine karstic plateau (around 2000 m above sea) of Dogger to Aptian limestones (Danubian domain) shaped by ancient rivers and glaciers.
Retezatul Mic stands out for the presence of at least 300 known caves, only a small number of them exceeding a few hundred meters in length. However, some of these caves show remarkable features, like several vertical caves hosting perennial ice, the 114 meters drop from the vertical cave known as Avenul din Stâna Tomii, the almost 5 meters long stalactites and 2 meters wide disk found in Zeicului Cave, or, the calcite-cemented concretions or so-called "trovanți" which can be found in Ursului Cave from Cracul Stâna Tomii.
The Ursului Cave, though 429 meters in length and -63 meters vertical extent, proves to be unique in Romania through the sedimentological perspective, but also showing paleontological and morphological particularities.
In the first two halls of the cave, shortly after the entrance, the presence of skeletal fragments of *Ursus Spelaeus*, can be noticed. Furthermore, of noticeable rarity the abundance of claw marks (grifade) located in the recently discovered halls; the small distance between claws may suggest that a small mammal was involved, possible from Mustelidae family.
The most intriguing feature of this cave is the calcite-cemented concretions found in one of the sedimentary deposits. The concretions, from spheroidal to more complex shapes, have diameters between 1 - 2 to 30 centimeters. The remarkable fact is that they have developed *in-situ* opposite to transported, a fact confirmed by the concretions mineralogy which is identical with the gravelly sand or fine sand layers in which they are formed.
From a morphological point of view the cave is really impressive, it consists of a series of superposed halls, the largest of all having around 33 meters in height, 35 meters in length, and 25 meters wide, punctuated by monumental flowstones and uniquely shaped stalactites.
These halls initially acted as an inflow point for the drained waters from the torrential valley above. Later on, the short and narrow passage which gives access nowadays to the cave was formed.
Retezatul Mic Mountains, through its history of geo- and speleological explorations consistently provided spectacular geological novelties.

SESSION 5
GEOLOGY

PLIOCENE–PLEISTOCENE FOSSIL PRIMATES FROM ROMANIA

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The study of Pliocene–Pleistocene fossil primates is important in the context of habitat sharing with early *Homo* species. In Romania, only a handful of palaeontological sites yielded fossil primate remains. We here present a review of cercopithecine finds from Romania, including both published and unpublished specimens from paleontological collections.
The dominate primate from the Pliocene site of Măluşteni was *Dolichopithecus ruscinensis.* The Middle Pliocene site of Ciuperceni yielded *Dolichopithecus ruscinensis* and *Macaca sylvanus*. The latter was also described from the Early Pleistocene site of Betfia-XIII, while during the same period *Paradolichopithecus arvernensis* was present at Tetoiu. Additional *M. sylvanus* remains were found at the Middle Pleistocene Betfia-IX site.
For this study we employed morphological and morphometrical methods and we compare the results with the recent literature. Apart from the already published materials from Măluşteni that were assigned to *Dolichopithecus*, we studied a molar crown from the same site which, by morphological traits, could belong to *Mesopithecus monspessulanus*.
From Ciuperceni, we present a female *Dolichopithecus rusciniensis* tooth, probably a lower canine, previously published as *Dolichopithecus* sp. We also identify a heavily worn and fragmented *Macaca* molar, as well as a molar fragment that could not be clearly assigned to neither *Dolichopithecus* nor *Macaca*.
The sites from Betfia yielded *Macaca* specimens in different stages of evolution. The juvenile molar crown of *Macaca sylvanus florentina* from Betfia-XIII is obviously larger than the adult molar from Betfia-IX. These results raise interesting questions for the evolution of *M. sylvanus* during the Pleistocene.

INTERPRETATION OF THE MAGMA CHAMBER PROCESSES OF THE ANDESITES FROM KARACADAG VOLCANITES (CENTRAL ANATOLIA) WITH THE HELP OF AMPHIBOLE TRACE ELEMENT DATA

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Amphibole major and trace element compositions from 2 different types of andesites from the Karacadağ Volcanites, southwestern part of Capadoccia Volcanic Province, in Konya (Turkey) have been analyzed by electron microprobe and laser ablation inductively coupled plasma mass spectrometry. From the core to the rim, especially the changes in the contents of REE, Li V, Zr, Cr, Ti, Sc, Nb in the amphiboles give considerably significant information about the replenishment processes of the magma, the formation sequence of the minerals and can be a signature to estimate how many different types of amphibole minerals can be found in the rocks. MORB and Chondrite normalized diagrams of the amphibole cores suggest that there are 3 types of amphiboles in the andesites from the Karacadağ Volcanites (in andesite-1 and andesite-2). Type-1 amphibole (GK-80C3), from core to rim, contains Li = 55-67-86-98-52-58 ppm, V = 596-563-506-533-588-626 ppm, Cr = 70-93-30-12-129-47 ppm, Ba = 97-92-99-130-101-105 ppm, Gd = 5.30-4.1-8-5.5-5.5-4.25 ppm. Type-2 amphibole (GK-35C6), from core to rim, has Li = 53-112-97 ppm, V = 496-520-351 ppm, Cr = 10-69-11 ppm, Ba = 166-144-88 ppm, Gd = 14.30-8.40-35.7 ppm. However Type-3 amphibole (GK-6C5) includes Li = 17-35-50 ppm, V = 475-532-615 ppm, Cr = 137-16-10 ppm, Ba = 131-124-181 ppm, Gd = 5.40-4.74-7.10 ppm. Geothermobarometer calculations of Type-1 amphibole have yielded temperature and pressure estimates 946°C-3.38 kbar, respectively. However for Type-2 and Type-3 amphiboles temperature estimates are 915-1023°C and pressure estimates are 2.17-6.78 kbar, respectively. According to MORB and Chondrite-normalized diagrams, along with the geothermobarometer calculations, the most primitive amphibole is Type-3 amphibole and the last evolved amphibole is Type-2 amphibole. Oscillatory and inverse zonnig of the amphiboles in terms of Li, V, Cr, Ba, Gd, etc. indicate (repeated or not) magma recharging processes. From core to rim, increasing in the Li content of the minerals is the most important evidence for the crustal contamination effect on their formation. Amphibole trace element chemistry data and geothermobarometer calculations indicate that there are 3 different types of amphiboles in the Karacadağ andesites, which crystallized at various depths of the crust from 25 km to 5 km depth, and the rocks were clearly exposed to magma replenishment and crustal contamination processes.

PETROCHEMICAL STRATIGRAPHY OF CUMULATE ENCLAVE BEARING ANDESITES FROM KARAPINAR-KARACADAG VOLCANIC COMPLEX (KONYA, CENTRAL ANATOLIA)

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Amphibole and pyroxene major and trace element compositions from the cumulate enclave bearing andesites from the Karapınar - Karacadag Volcanic Complex, in Konya (Turkey), have been analyzed by electron microprobe and laser ablation inductively coupled plasma mass spectrometry. A petrochemical stratigraphy can be interpreted for the rocks by using major and trace element contents of the minerals and their changes from center to rim. Amphibole (GK-35C1) of the cumulate enclave, from core to rim, contains Li = 107-103-112 ppm, Ti = 7760-6120-772 ppm, V = 410-342-415 ppm, Cr = 149-166-249 ppm, Zr = 79-94-88 ppm, Mn = 1764-1961-1726 ppm. However host rock's amphibole grain (GK-35C6), from core to rim, includes Li = 52-111-97 ppm, Ti = 7760-6120-772 ppm, V = 496-520-351 ppm, Cr = 10-69-11 ppm, Zr = 117-53-50 ppm, Mn = 1790-2723-3300 ppm. Moreover, pyroxene from the host rock has 10.7-8.5-11.6 ppm Li, 1230-658-1933 ppm Ti, 162-114-202 ppm V, 29-7-1420 ppm Cr, 31-16-42 ppm Zr, 4010-3721-2422 ppm Mn. Amphibole thermobarometer calculations have yielded temperature and pressure estimates 993-915°C and 5-2.17 kbar for enclave and host rock, respectively. Also, clinopyroxene geothermobarometer calculations have given 1.34 kbar pressure and 1116°C temperature. Especially the mineral chemistry data of amphiboles and pyroxenes show that the cumulate enclave is more primitive than its host, and enclave were formed at an earlier stage. Geothermobarometer calculations also indicate that the amphiboles in the enclave was formed at a deeper depth than the pyroxenes in the host and the enclave was broken off during convection in the magma chamber and brought to the host. Oscillatory and reverse zonning in terms of Li, Ti, Zr, Hf, Cr, V contents in the minerals indicate magma replenishment. In the host rock, decreasing in Zr and Hf contents from core to rim shows co-magmatic zircons with the amphiboles. Ti negative anomaly in the amphiboles exhibits that they crystallized after Fe-Ti oxide formation. In the light of the mineral chemistry data, Petrochemical stratigraphy (P) should be as in the bottom.

P1) Formation of the amphibole cores in the cumulate enclave, after Fe-Ti oxides formations P2) Recharging of the amphiboles in the enclave, P3) Formation of the host rock's amphibole cores and crystallization of comagmatic zircons P4) Breaking off the cumulate enclaves with convection and settling in the host rock, while the recharging of the host rock amphiboles, P5) Formation of host rock's pyroxene cores, P6) recharging of the pyroxenes P7) crystallization of the plagioclase and quartz minerals in the shallow depths of the upper crust.

A PETROGNETIC MODEL FOR EVIDENCE OF ASTHENOSPHERIC INPUT INTO THE SOURCE OF CENTRAL ANATOLIA QUATERNARY BASALTS (CENTRAL ANATOLIA)

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In this study, we present for the first time a petrogenetic model of the Quaternary aged nepheline normative Karapınar basalts (Karapınar-Karacadağ Volcanic Complex-KKVC) to explain the asthenospheric material involvement into their source. In recent studies, it has been proved that nepheline normative basalts cannot only be derived from peridotite melts, and they can also be originated from pyroxenite melts. Investigated basalts from KKVC show orogenic pattern in MORB-normalized diagram. Although having flat HREE patterns, which is interpreted as originating from garnet-free source in many studies, these basalts may be derived from a garnet bearing source which underwent higher degree partial melting. Their moderate to low Y (< 25 ppm) and low HREE concentrations (Yb < 2 ppm), along with fractionated HREE patterns (Dy/YbN > 1) indicate that garnet was likely to have been involved in the source of the rocks. Furthermore, the most primitive basalts (B1; MgO~10-12 wt%) contain Zn/Fe (*10000) ratio (~16) resembling those of pyroxenite derived melts. Here, we present partial melting and binary mixing models for the Karapınar basalts. The results for modal batch partial melting model of spinel lherzolite and garnet pyroxenite show that mixing between pyroxenitic and peridotitic melts can produce the observed trace element heterogeneities of the most primitive basalts. Although melting model shows that the basalts have plottod into the area between the pyroxenitic and peridotitic sources whose melting degrees are minimum 30% and 5% respectively, the binary mixing model indicates that the rocks were derived from a mixture source of 50% molten pyroxenite and 3% molten peridotite. Furthermore, the mixing model also suggest that the proportion of the pyroxenitic melts in the source should be minimum 45%. According to geochemical data and petrogenetic calculations, we propose a mixing model that nepheline normative basalts were derived from mixing of a peridotitic source with a pyroxenitic source which was brought from the deeper parts of the upper mantle by asthenospheric upwelling.

COUPLING A LANDSCAPE EVOLUTION MODEL WITH A CARBONATE PRODUCTION MODEL TO SHOW SEDIMENT FLUX INFLUENCE ON CARBONATE PLATFORMS

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Terrigenous clastic sediment input has several effects on carbonate production and reef growth. However, carbonate production models often use arbitrary sediment source inputs to capture such interactions. I construct a workflow to model terrigenous clastic sediment pathways penetrating a carbonate platform and analyse the effect of such input on the production and distribution of carbonate deposits. These pathways are generated by a landscape evolution model (LEM) where fluvial, debris flows, and hillslopes processes define channel networks and erode sediments. Consequently, the output sediment flux from LEMs is sensitive to uplift rate, lithology, climate parameters, and the specific parameters of the active processes (e.g. landslide-triggering threshold). In addition to sediment input coordinates and volume, I propose a code to calculate grain size decay as a linear degradation function of distance from the channel heads. The outputted results are inputted in a diffusion-based carbonate production model at every time step, and the sensitivity of carbonate thickness and lithology is analysed in relation to the LEM parameters. The carbonate model is built to account for sediment supply at the boundaries and in-situ carbonate production at the cells. The carbonate production and carbonate lithofacies are controlled by water depth, temperature, turbidity threshold and salinity. In addition, different time-averaged diffusion coefficients are used to account for compaction and wave activity.

Once the incision of drainage basins reaches equilibrium with the uplifting mountains, the sediment flux stabilizes at a constant rate while the average grain size decreases as channels propagate, increasing their length farther into the mountain chain. Also, as the slopes of mountain edges get steeper, both hillslopes and debris flows activate increasing sediment flux. The calculated velocity to steady-state drainage basins and constant sediment fluxes is dependent on the ratio of uplift rate to the erodibility of rocks. The carbonate production rate at the beginning is constant despite the penetration of coarse sediments into the system by early formed river channels. However, once the turbidity threshold is triggered, the production rate decreases exponentially at areas overwhelmed by the sediment input. Also, the deltaic input changes the marine bathymetry, and consequently, varies the carbonate lithofacies. These findings support the potential application of such a workflow to a case study where the behaviour of mountainous denudation is tested for its effect on nearby marine carbonate factories.

SESSION 6
ENVIRONMENTAL STUDIES & GEOHAZARDS

DETERMINATION OF LAND SUBSIDENCE IN GORGAN PLAIN WITH INSAR METHOD (GOLESTAN, NE IRAN)

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Golestan Province is among the areas with high natural disaster risk in Iran, which has been suffered from disasters such as earthquakes, floods, landslides, and land subsidence. In recent years, remote sensing techniques have played a key role in the determination of land subsidence events that produce significant environmental problems in various plain areas around Iran (e.g., Hashtgerd, Qara Bulaq, Damghan, South West Tehran, Golpayegan, South Mahyar, and Gorgan plains). Land subsidence events can be clearly identified by employing remote sensing and geodetic methods such as well-known and frequently used GPS measurements and InSAR studies. Any changes on the ground surface caused by deformation events can be accurately calculated using the InSAR technique. Basically, this method compares pairs of satellite images of a region, which were acquired before and after the deformation event, and detects the possible changes between them.

Application of the InSAR analysis technique on ENVISAT satellite data acquired between 26.01.2007 - 11.12.2009 in Gorgan Plain, located in the western part of Golestan Province, has revealed the occurrence of 4.8 cm and 1.1 cm of land subsidence amounts for the Gorgan and Akkale areas, respectively. InSAR analysis results also suggest that land subsidence has distributed in a relatively east-west direction. This orientation is consistent with the geometry of the Khazar (Caspian) Fault Zone, which affects the Golestan Province and exhibits a curved geometry with ENE-WSW and NE-SW directions. The active Khazar Fault Zone displays reverse/thrust fault characteristics and has produced many significant earthquakes during the instrumental period with magnitudes ranging from 4.0 to 6.2.

Lower amounts of precipitation and consequently sudden decreases in the groundwater level can be an alternative reason for the observed subsidence in the region. However, it is noteworthy that the land subsidence displays a linear distribution rather than a homogeneous propagation in the study area. This condition indicates that the continuous land subsidence events in Gorgan Plain are dominantly related to the ongoing tectonic processes in the region. Also, our observations demonstrate that meteorological processes contribute to the occurrence of land subsidence events.

FRACTURE ANALYSIS OF ÇAYSIMAV SEGMENT AND ITS SURROUNDINGS USING REMOTE SENSING METHODS (WEST ANATOLIA)

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The Çaysimav segment constitutes one of the most important parts of the Sındırgı-Sinanpaşa Fault Zone, as one of the remarkable active fault zones in Western Anatolia. Numerous earthquakes (e.g., 1875-M:6.1; 1928-Ms:6.1; 1944-Ms:6.0; March 28, 1970-Mw:7.2; February 17, 2009-Mw:5.3; May 19, 2011-Mw:5.9; May 3, 2012-Mw:5.8) have occurred along the segment both in historical and instrumental periods. The Çaysimav segment exhibits a distinct lineament between Izzettin and Yeşilköy settlements, which is approximately 67 km long and N65°-85°W striking. The lineaments represent by fault traces and related fractures with various lengths extending between 320 m and 14 km. Remote sensing studies reveal that all lithologies constituting the hanging wall and footwall of the segment, such as bedrocks (metamorphites, granitoids, ophiolitic melange rocks) and cover units (volcano-sedimentary units, clastic sediments, alluvial deposits), have affected by fracturing processes intensively.

Lineament analysis was carried out using 10 m resolution digital elevations model data in Geomatica, ArcGIS, and RockWorks programs throughout the Çaysimav segment and its surrounding areas of lithologies cut by the segment. Several rose diagrams have been prepared from lineaments (5636 number) obtained from each lithology groups. The analysis of the rose diagrams shows that the dominant orientations of the fracture lineaments in Quaternary units are ENE-WSW, E-W, and NNE-SSW orientations. Limited number fractures with WNW-ESE and NE-SW orientations exist as well. The orientation of the fractures measured form Neogene volcano-sedimentary units and bedrocks are dominantly in NW-SE-oriented. These lithologies also have lineaments showing several direction maxima. It is remarkable that some of the fracture orientations obtained from the basement rocks close to the Çaysimav segment can be correlated with orientations taken from Quaternary sediments.

All these data suggest the following conclusions: (1) Rose diagram patterns of fractures in Quaternary units are in a close relationship with the formation and evaluation of the Çaysimav segment and are also represent the fractures associated with faulting. Lineaments with ENE-WSW, E-W, and WNW-ESE orientations correspond to the Çaysimav segment with normal fault zone characteristics. Limited NE-SW orientation is also present. (2) Dominant NW-SE oriented fractures in other units within the study area are associated with the NE-SW direction regional extensional tectonics regime in Western Anatolia.

REMOTE SENSING AND IN-SITU DATA ANALYSIS FOR IDENTIFYING DYNAMIC PATTERNS IN MINING SITES

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Dynamics of mining sites are usually subjected to environmental and anthropogenic changes that translate into erosion on the long term and sudden changes in local topography at local and regional scales due to setup of exploitation roads, dump sites, backfilled or mined out zones. Assessing risks in relation to morphometric characteristics of mining sites is an important step in preventing site degradation or maintaining it under control during mining activities and after decommission. The study area is a former sulphur mine with an area of 4.76 km^2, localized in the Călimani Mountains, Romania. The mine functioned between 1969 and 1997, reaching a peak in activity around 1980.
The current study employs an integrative analysis of in-situ and radar satellite data with the goal of evaluating long-term (1953-2019) three-dimensional geospatial patterns in the morphology of the region associated with the impact of human and natural factors. In addition, the study aims to demonstrate the viability of using a satellite radar interferometry (InSAR) based DTM for monitoring the long-term response of the exploitation site to environmental changes after the mine was closed. In this purpose, a series of morphometric parameters such as hipsometry, geodeclivity, length-slope (LS) factor, slope exposure and terrain fragmentation were derived from three digital terrain models of the study area using GIS techniques.
Overall, the analysis of the topographic and satellite data confirmed changes in elevation in the area of study between 1953 and 2019 associated with human intervention and environmental factors such as erosion and landslides occurring especially in the post-operatory phase. Also, the interferometric-based DTM proves to be a valuable tool for depicting changes in mining landscapes topography at relatively high resolution, showing that for large and remote sites, the current satellite imagery easy accessibility and high availability can represent the most practical and least expensive solution for long-time monitoring.

VLF SIGNALS AS THE REMOTE SENSING TOOL FOR GEOHAZARD MONITORING

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Very Low Frequency (VLF) signals with frequencies in range 3-30 kHz, propagating through Earth-Ionosphere waveguide, are well known diagnostic tool for remote sensing of the Earth lower ionosphere's response to a wide range of phenomena, from their extraterrestrial to terrestrial origin. In recent years, monitoring of VLF signal's day/night terminator shifting related to seismo-ionospheric coupling during earthquake activity, became routine technique for investigation of this type of geohazards. In this paper, the same technique was applied on NWC VLF signal, transmitted on frequency 19.8 kHz, from H. E. Holt (21.8° S, 114.16° E), Australia, towards receiving system located at the Institute of Physics in Belgrade (44.85° N, 20.38° E), Serbia. Surveying was conducted on VLF signal records obtained by the Absolute Phase and Amplitude Logger (AbsPAL) receiving system, developed by the Radio and Space Physics Group at the University of Otago, New Zealand, for 1.5 years time period, from 2005 to 2007. During analysed period, data related to reported seismic activity, for cases of reported earthquakes with a magnitude greater than 6.5 degrees on the Mercalli intensity scale, were taken from archive at official website of Helmholtz-Zentrums Potsdam - Deutsches GeoForschungsZentrum GFZ (https://geofon.gfz-potsdam.de/). Observed area of interest included all active regions on the signal's path from transmitter to receiver, with specially paid attention to NWC signal's modal extrema locations, on one, and reported earthquakes with hypocenters at relatively shallow depths with coordinates near to the position of the NWC signal's first and second modal minima, on the other hand. The possible relationship between monitored NWC signal's characteristics and reported seismic activity was investigated and main results are presented in this paper.

DATABASE AS A METHOD OF NATURAL HAZARD MONITORING AND RISK ANALYSIS

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Among the methods that can be applied for investigation and monitoring of natural hazards, their manifestations in space and time, frequencies of occurrences, and consequences, databases are very relevant and important. The information about previous hazardous natural events collected in a database for a more or less long period can be used for natural risk assessment and prediction of future developments. The main objectives of this study are to present an electronic database of technological and natural-technological accidents occurring in Russia, which was created by the author, and to analyze its methodological features and possibilities provided for natural hazards monitoring and risk assessment. The database was compiled using Microsoft Access. Currently, it contains about 24,000 units of information from 1992 to 2020 and is constantly updating with new data. Almost 12% of all the events listed in the database are of natural-technological character. Natural-technological accidents are considered all those accidents in the technological systems or infrastructure facilities that were triggered by the impacts of various adverse and hazardous natural events or phenomena. The database includes the following information for each entered event: the date of accident; region and location of its occurrence; type of accident; causes and triggers; scale of the emergency situation caused by this accident; the number of deaths and affected people; economic and ecological damage, etc. The statistical analysis of this information allows tracing impacts of natural hazards on technological systems and infrastructures within the country area, assessing the scale of their consequences, and evaluating natural risk. The database also provides possibilities to compare different regions in terms of natural risk and natural hazards manifestations by conducting various thematic search queries and analyzing their results according to the goals and objectives of appropriate researches. To conclude, the database is an effective method to investigate and monitor natural hazards and their consequences in spatial and temporal context.

CHALLENGES FOR NATURE-BASED SOLUTIONS APPLICATION IN URBAN AREAS

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Nature-based solutions are a category of new tools that can help cities increase their resilience and sustainability. They represent those actions inspired, supported or copied from nature, which have a high potential to be energy efficient and to use natural resources, as well as promoting multifunctionality and connectivity between green infrastructure and built-up areas.

Among the benefits associated with nature-based solutions in urban areas we can highlight the improvement of the quality of urban life, the increase of the cities' contribution to the conservation of biodiversity, the amplification of social equity and the development of a new type of business. Nature-based solutions address multiple social (i.e. accentuation of urban mobility, social inclusion of disadvantaged groups and labor market dynamics), economic (i.e. changing the economic profile of cities, implementing the green economy and ensuring the financial sustainability of urban communities), institutional (i.e. improving the decision-making process, promoting the participatory planning of cities and increasing the anticipatory character of the urban management process) and environmental challenges (i.e. reconversion of abandoned lands and buildings, sustainable management of natural resources and expansion of areas occupied by green-blue infrastructure).

PROTECTIVE FUNCTIONS OF "GREEN INFRASTRUCTURE" AGAINST NATURAL HAZARDS

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The concept of "green infrastructure" has been actively working out in spatial planning of many developed countries since the early 1990s. This approach takes a very important place in the strategy of sustainable development. The main components of "green infrastructure" include both natural areas (such as forests, meadows, wetlands), and artificially created green spaces and structures (parks, gardens, fields, green dams, hedges, bioswales, etc.). The so called "blue infrastructures" such as canals, harbors, etc. can be also considered as a part of "green infrastructure". Various components of the "green infrastructure" perform many ecosystem services including providing, regulatory, and cultural services, as well as supporting services that are necessary for the production of all other ecosystem services. The main objective of this study is to analyze the protective functions and services of "green infrastructure" in context of natural hazards impacts on the technosphere and human society. In the terms of this research, the regulatory services are especially relevant. Regulatory services include global and local climate control, climate adaptation, river flow regulation, groundwater retention and accumulation, prevention of soil erosion, purification of air and water, storm water management, protection against floods, tsunamis, strong winds, and other dangerous natural processes, and other functions. It can be concluded that various components of "green and blue infrastructure" play very important role as protection against natural hazards and disasters. They can serve as an important alternative to traditional engineering protection methods and be a part of natural risk management. Scientifically and practically well-performed "green infrastructure" can provide real economic, ecological, and social benefits.

EXAMPLE OF THE BIGGEST FLOOD DISASTER IN IRANIAN HISTORY: GOLESTAN PROVINCE (NE IRAN)

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Golestan province is one of the regions with high natural disaster risk in Iran due to the occurrence of many natural disasters. In the last 30 years, many flood disasters have occurred because of heavy rains, and thus many people lost their lives, animals perished, residential and agricultural areas submerged, and significant structural damages occurred. These flood disasters caused the most loss of life and damage that occurred between 2001 and 2019.

On August 10, 2001, a flood event had resulted in the death of more than 243 people and missing of 190 people. Kalaleh, Galikesh, and Minodasht settlement areas in the Golestan Province were the most affected areas by the flood. Flood disaster caused submersion of forests and farmland in 500.000 hectares of Gorgan river basin, devastated two dams, and destroyed the main road connecting the Golestan and Khorasan provinces. Additionally, the accumulation of human and animal corpses behind the dam caused the spreading of some epidemic diseases. The United Nations has announced this flood event as the deadliest flood event in the world in 2001.

Another significant flood disaster in Golestan Province occurred on March 20, 2019. In this event which at least eight people were dead, and 116 people were reported to be injured, overflow of dams in the region, residential areas, and 240.000 hectares of farmlands were submerged. Also, 287 km of roads, 84 bridges, and 200 meters of railways were destroyed, and landslides have occurred in 31 villages.

Considering major flood disasters of the last decade in the region reveals that the negative impact of human activities on nature and heavy rains that increase due to climate changes cause the occurrence of disasters. Therefore, disaster risk determination, reduction, and preparedness studies must be made in the region immediately. Preparing the precaution plans for settlement areas and infrastructures and superstructures in the region against flood disasters that likely to be repeated is preferential. Improvements in the river or streambeds are among the necessary preferential precautions. The protection of forest areas in the region is also crucial in minimizing flood risks.

APPLIED COMPARISON OF THE EROSION RISK MODELS RUSLE-3D, SP AND USPED

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Soil erosion is a widespread form of soil degradation, and it has a considerable environmental and economic impact on different scales. The determination of soil loss predisposition within a valley is considered a significant theoretical and practical issue, the knowledge of it creating premises for better risk management. Predicting spatial patterns and intensity of soil erosion can be problematic mostly due to few obtainable data. On the other hand, due to GIS platforms, distributed erosion models have evolved and are now commonly used as the georeferenced backbone for the analysis of geomorphological processes. However, the accuracy of their predictions is seriously hampered by the natural complexity and spatial heterogeneity of the processes acting on the landscape itself. Research on soil erosion modelling is required to get more quantitative information needed for predicting potential soil loss and to design and select proper management solutions. Therefore, this paper aimed to use and compare three existing low data demanding approaches in combination with different geo-information techniques for analyzing erosion. Three models were selected (RUSLE-3, SP, and USPED) and applied in the upper and the middle sectors of Prahova River Valley. This area is heavily affected by slope and river processes related to the growing demand of an expanding population leading to an intensification of buildings and road construction. Although it was possible to compute a satisfactory accurate soil erosion distribution, the output maps have shown some differences. This means that similar approaches must not necessarily give similar results.

HOW GLOBAL WARMING HAS AFFECTED AGRICULTURE IN A TRANSYLVANIAN CITY. CASE STUDY: SIGHIȘOARA

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The phenomenon of global warming is by no means new and this is the challenge of the century. It affects the entire planet, from Greenland, where about 11 trillion ice has been lost, according to CNN, to Romania where agricultural crops suffer due to lack of rainfall, according to local media and data provided by the National Institute of Statistics. While areas destined for agriculture suffer, in Romania, in Mures County people discuss how they can remedy this issue. Thus, for Sighisoara, a city in this county, projects that focused on climate change were implemented. But in order to make them work, the people need to know about how the agricultural areas are affected and how much of the production has been lost.
This paper aims to explain how agricultural areas in Sighisoara suffer, analyze the decline in agricultural production and propose viable solutions to combat this phenomenon that Sighișoara farmers are trying.

POTENTIAL TOXIC ELEMENTS IMPACT ON SOIL QUALITY ONCE THE USE CATEGORY IS CHANGE FROM A TRADITIONAL VINEYARD TO RESIDENTIAL AREA (IASI, ROMANIA)

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The vineyard area of Copou (Iaşi) is one of the oldest Romanian vineyard region but due to the rapid urbanization and population grow the parcels closed to the main road became residential areas.
The study purpose was to evaluate the contamination and the health risk of potentially toxic elements in the context of changing the land use category. A total of 36 topsoil samples were collected from the vineyard parcel closed to the new residential buildings and were analyzed by ED-XRF method in order to obtain the content of Cr, Co, Ni, Cu, Zn, Cd, Pb, As. The assessment of soil contamination was accomplished by the mean of the potential ecological risk index (PER) and by the comparison with Romanian legislative values and some published data about their content in the Botanical Garden and the parks (Copou and Expoziţiei) from Copou Boulevard. The health human risk assessment was fulfilled by the hazard index (HI) for children and adults. Values of Cr, Ni, Pb, As exceed the normal values but only Cu exceeds the alert threshold of Romanian legislation. The mean contents of studied soil exceed the mean values of parks only in the case of Ni and Cu (due to the viticultural practices), while the highest content in parks is given by the Pb, due to the input from car traffic. The PER values indicate a low risk for Zn, considerable risk for Cr and high and very high risk for Co, Ni, Pb, Cu, As, Cd but the calculated HI indicates non-carcinogenic risk. The health risk assessment varies with the type of the PTE, the level of contamination and human age, but no significant risk for childrens and adults were identified. The development of a residential area in the former vineyard location from Copou did not involve any risk. Moreover, the long time of agricultural practices is not responsible for high soil contamination. This means that the vineyard soil management was correctly and the environmental consequence is reduced.

SESSION 7
GEOSCIENCE FOR SOCIETY, EDUCATION AND ENVIRONMENT

THE EFFECT OF COVID-19 LOCKDOWN MEASURES ON SEISMIC NOISE RECORDED IN ROMANIA

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Ambient Seismic Noise (ASN) represents small amplitude vibrations of the ground recorded everywhere on the Earth's surface, its sources being both natural (e.g., ocean and coastal waves, wind) and anthropic (e.g., traffic, industrial activity). Usually, seismologists try to reduce the ASN from the data as it may mask weak signals (e.g., small amplitude earthquakes) that are very important for various seismological investigations. However, in the last decades, the ASN data proved to be useful for seismologists as they started to be used for evaluating the performance of seismic stations, urban seismic microzonation, investigation of shallow and deep Earth structure, monitoring of active faults and volcanoes as well as for climate change impact. In a very recent study (Lecocq et al., Science 2020), the ASN data recorded at more than 300 stations distributed worldwide have been used to monitor the population dynamics in different countries affected by the COVID-19 pandemic.
In this work, we investigate the effect of the COVID-19 lockdown measures imposed by the Romanian authorities on the high-frequency ASN data recorded by the Romanian Seismic Network (RSN) stations. Starting with 16th of March 2020, when the Romanian government enforced the state of emergency in the whole country, reduction of ASN was observed at many RSN stations, most of them being located in urban environments. We noticed significant reductions in seismic noise of up to 30% (e.g., in Bucharest) in the 4 - 14 frequency range as well as in the higher frequency range 25 - 40 Hz. We analyze and discuss the results in correlation with the moment of containment measures (before, during and after the lockdowns), location of stations (in buildings, schools, small or large cities, etc.) as well as with the population mobility data available from Google and Apple.

GEOSCIENCE GEOSPATIAL INTELLIGENCE!

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Formally defined as "the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth", Geospatial Intelligence (GEOINT) is a young but already established metadisciplinary field encompassing foundational technical knowledge (GIS, remote sensing, geospatial data management and data visualization) and new, emerging areas such as Data Science, Artificial Intelligence, Machine Learning, Virtual Reality, UAVs/UAS, etc. Foundation GEOINT is the global representation of physical features in the form of maps, charts, and data, being inclusive of other mapping, charting, and geodesy (MC&G) components such as surveying, elevation modeling, and gravity modeling; Global Navigation Satellite System/GPS monitoring and processing; and satellite and aerial imagery, LiDAR, and radar collection. Today, in a fast-changing technology landscape and with the onset of a high-speed digital revolution in which the 'where' and 'when' dimensions are becoming smaller and fundamental to all decision-making, openly sourced and enterprise geospatial have emerged as enablers where new data options such as crowdsourcing, do-it-yourself data collection from drones and other sensors, and machine learning approaches are coming to supplement traditional foundational products with truly on-demand content, further accelerating the geospatial industry's global reach and contribution. This panel will provide a short overview of the history & current state of GEOINT, then discuss the intersection between geosciences and GEOINT by providing real world examples of how to acquire data, create information, and develop geospatially-explicit knowledge to better understand the natural environment through the use of Remote Sensing, Geographic Information Systems, and unmanned systems. The panel will discuss applications of GEOINT to integrative vulnerability approaches to natural hazards and to global monitoring of intersectional and interdisciplinary issues relevant to the geosciences, such as land degradation. Finally, we will highlight successful and ongoing efforts to match higher education & workforce development with industry-led agile learning environments.

ROMANIAN EDUCATIONAL SEISMIC NETWORK (ROEDUSEIS): PAST-PRESENT-FUTURE

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The Romanian Educational Seismic Network (ROEDUSEIS) is the main product of the first educational initiative in Romania in the field of seismology (www.roeduseis.ro) which involved two research institutes (National Institute for Earth Physics (NIEP) as coordinator), one university and one software development private company. The educational seismic network started in 2013 with 11 SEP seismometers installed in schools from different Romanian cities (Brasov, Bucharest, Cluj, Constanta, Focsani, Iasi, Sibiu, Timisoara, Zalau). Every educational seismic station from each participating school contains the educational seismometer, PC desktops with jAmaseis package software installed for data acquisition and analysis, and educational materials and guides. The recorded seismic waveforms were available to the schools that were part of the project and were stored locally. In this configuration remote access to the educational seismic stations was achieved through the TeamViewer application.

In 2015 the educational seismic network was extended with 3 Slinky vertical seismometers installed in 3 schools and completed with data from 10 professional broadband seismic stations from the National Seismic Network of NIEP with the role of completing the database with seismic events and helping students and teachers to locate the earthquakes recorded by the Educational Seismic Network. Inclusion of professional seismometers in the Educational Seismic Network involved the installation of RaspberryPi computers and the use of dedicated programs (*SeisComp* - program that allows the acquisition and processing of data in real time and *seedlink* - communication protocol for real-time data acquisition and exchange). So far, the educational network has been updated and has reached a number of 17 educational seismometers completed with data from 10 professional seismometers. Since 2018 NIEP has been part of the organizing committee of the Science and Technology Summer School held every year in the city of Magurele. On these Summer Schools researchers from NIEP mentored participant students and involved them in hands-on activities related to earth interior, earthquakes, seismometers, sensors or seismic data topics. In 2020, NIEP purchased 8 educational Raspberry Shake seismometers that will be installed in the schools where the students participating in the Summer School come from.

By the end of 2020 we want to standardize data acquisition and processing by introducing *Swarm*, a highly interactive program and very easy to work with for inexperienced users in educational seismological programs. At the same time, the program can integrate data from all types of seismometers in the ROEDUSEIS.

Across Europe scientists and educators have been discovering the power of using earthquakes and seismology as an educational tool to inspire and educate students in a wide range of science and geoscience topics. The standardization of the network will thus make it easier to exchange data with other educational networks in Europe (Greece, Italy, France, U.K.).

EDUCATION FOR GEOSCIENCE - A STEM (ONLINE) SUMMER PROGRAM FOR UNDERGRADUATES

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The global development of the society requires a constant updating of the objectives that education pursues, as well as the ways in which they are achieved. Science education is an area undergoing a process of advanced transformation, both at the level of objectives and methodologies, with a strong social, economic and knowledge impact.
Research-based education is a well-established term especially in the higher education system. More and more studies and key policy documents argue that education has to be based on the cutting edge research, while many universities are claiming to place the approach at the core value they believe in.
Each year a two week summer school for high school pupils complemented with a three month internship program for undergraduate students is proposed and supported by the National Institute for Earth Physic, Romania, alongside with partners, national research institutes and universities. It seek to attract, nurture, and retain students in the science, technology, engineering, and mathematics (STEM) career pipeline. This is accomplished by providing mentoring focused on enhancing student learning, opportunities for students to contribute meaningfully to research, experience with current research practice, and opportunities to create research products.
The fact that, for scientist in general and geoscientist in particular, sharing data and working remotely with distant peers is a common practice, has helped to translate the research experiences for undergraduates in online environment, moving further and innovating education practices even in these difficult times.
After three years of implementation the program factually proved that in order to persist in geoscience majors students must first be attracted to them. This goal can be achieved if we proper communicate career opportunities, demonstrate domain relevance to students' lives by facilitate real-world experiences, succeed to reach out and engage the K12 students and teachers and involve them even from early stages in research experiences.

EDUCATION THROUGH EXTRACURRICULAR ACTIVITIES RELATED TO PETROLEUM ENGINEERING AND GEOPHYSICS

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With the rapid development of science and technology, we have reached a new era in which it is extremely important to connect acquired theoretical and practical knowledge by applying modern communication tools, connecting with teams from different scientific disciplines and all with the goal of improving personal and professional achievements of future generations of professionals. Attending the AGES events in May 2019, students and young professionals from the Technical Faculty "Mihajlo Pupin" in Zrenjanin (Serbia) were given an exceptional opportunity to expand the acquired theoretical knowledge by cooperating with experts from the whole world. In this study, the results of a survey of extracurricular activities provided to students and young professionals who participated in the 1st International Workshop "Pupin meets Nobel", which is a continuation of the activities of the AGES Student Section under the auspices of the Geoscientists Without Borders Project, are presented. Extracurricular activities performed by AGES after accomplishing the project in 2017 are continuation of that approach and they are directed to students and young professionals dealing with geosciences, geophysics and petroleum engineering. We hope that our contribution will be visible soon.

INTEGRATING ENGINEERING AND TECHNOLOGY IN EARTH SCIENCE EDUCATION PRACTICES

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Seismology is a complex science, multidisciplinary and close related to the fast evolution of technology that often may seem rigid and hard to understand by young pupils and students. To overcome this issue in the learning process, a seismic simulator (shake table) was developed in our attempt to bring seismology forward to young students, guiding them for future career possibilities. A software was also developed to control the mechanics of the shake table by converting a seismic wave signal into movement impulses induced to the shake table. By using this instrument, and understanding its functional principles can help in developing educational activities that ease the learning process of the basic concepts of seismology and earthquake engineering. Thus, notions such as: ground motion, peak ground acceleration, fundamental period of an earthquake / building and the soil-structure interaction can be easily explained and experiments can be set for children and students. Moreover, this educational tool can be used to illustrate practical methods of reducing the lateral forces induced in a building subjected to earthquake, by the use of base isolation systems and damping devices. The results of these educational activities can contribute to a better understanding of soil-structure behavior during an earthquake. In addition, it can be underlined how different types of buildings respond to earthquakes, and what means of seismic protection are adequate in the given situation. Using the seismic simulator to demonstrate the physical phenomena that occurs during an earthquake and its effects on buildings, in conjunction with events on seismic risk awareness, can significantly increase the society's resilience to natural disasters.

FROM EARTHQUAKE STORIES TO EFFECTIVE PREPAREDNESS MEASURES

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According to the risk matrix of Ro-Risk Project, earthquakes have the highest damage impact at national level (compared to 10 other types of hazards including floods, landslides, epidemics or nuclear accidents). At least half of Romania is exposed to peak ground acceleration greater than 0.25 g (determined probabilistically, for a mean return period of 1000 years). The main responsible for these high values is the intermediate-depth Vrancea source. Here major earthquakes up to 8.1 Mw can occur roughly once or twice per lifetime, with the most recent destructive earthquake being on 4 March, 1977. As far as we've seen and as other recent perception studies point out, people in Romania are aware of the seismic risk, but their level of preparedness and the high seismic vulnerability of buildings (according to official documents but even more visible to the naked eye) shows that they generally fail to take effective preparedness measures. In this context, is the formal approach of providing contextualised information about earthquakes, to do lists and earthquake drills enough for increasing resilience, or newer technologies and approaches can contribute to a significant difference? In this paper we present our recent experiences in trying to convince people that, besides acknowledging that earthquakes are a serious threat in Romania, they should mitigate the risks. This is of course not an easy task and we still don't have a good traceability of how people implement what they've learned. However, the feedback that we've received during and after events such as "4 March: a day about earthquakes", "Civil Protection Days", "Bucharest and earthquakes" guided tour, "Researcher's night", "OMV-PETROM seismic risk awareness campaign" or the "Different School Week" provided us glimpses on new ways to focus the large public interest in earthquake preparedness. In these events we used formal and non-formal approaches such as hands-on experiments, shake-tables, live-result quizzes, interactive apps or live interaction with researchers, for different target groups (from kindergarten children to grown-ups with different education backgrounds). Our continuously improved Mobile Earthquake Exhibition was the main feature of these events. One question we discuss is where we should go from here, also in the context of COVID-19 pandemic: vlogs, digital or board games, new types of digital content? It is clear that seismology can have an important impact in risk reduction for societies, but it is also becoming increasingly clear that the message must be conveyed in new and adapted ways.

CROSS COUNTRY LANDSCAPE OF DANUBE SWABIANS

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Aim of the paper is to show transnational landscapes of the Danube Swabians. The first transnational landscape is in Sathmar, NW Romania, between Romania, Hungary and Ukraine. The colonists came from Upper Swabia, south of the UNESCO geo-park Schwäbische Alb. In Sathmar they settled north of Valea Ierului, a natural protected area in Romania, also with a tectonic past including the Érmellék seismic sequence 1829 - 1834. Sathmar itself contains a natural protected area of Foieni sand dunes. Both natural areas neighbouring the areas of the colonists, who were active in agriculture (peasants) are connected also to seismic activity. The second transnational landscape is in Banat, between Romania, Hungary and Serbia. In both of them about 300 years ago so-called Danube Swabians were brought from Germany. Banat features an important natural protected area among those on the Danube, the Iron Gate natural park, which is aimed to connect the park in Romania with the one in Serbia to create a similar protected area to the Danube Delta. The landscape of Banat encompasses mountain and field. This landscape is also part of the European Green Belt and of the Iron Curtain trails. Despite these pan-European belonging, investing in cross country landscape projects is made more difficult in these two landscapes by the fact that Romania is not part of the Schengen area and Serbia and Ukraine respectively are not part of the European Union. However, in case of the Sathmar area, some European projects focusing on increasing tourism will be shown. The natural heritage of Valea Ierului is put in value by different festivals (of acacia trees, of storks) which open the way to geoproducts. The natural heritage of Banat will be highlighted in the context of the Danube Transnational Programme for example the DANUrB project, focusing on including in tourism less known areas, in frame of which the author looked to landscapes across the Danube and in which there are several UNESCO geoparks and protected areas for their nature or culture, and recently one park has been added in Serbia. The landscape in Sathmar is instead object of a DOMUS scholarship which aims to see how natural landscape influenced the creation of landscape architecture heritage in the area. The natural landscape with the tectonic setting in all settings (earthquakes occurring in the areas will be analysed) and the resources of natural materials influenced the vernacular architecture heritage in the local (seismic) culture.

WUHAN LINEAR CLOUD

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Observing, between March and August 2020, the 3D image of the globe (Google Earth – internet) and assuming that the cloud formations correspond to the Landsat/Copernicus data in the spectral band centered on the wavelength of 1.38 μm, specific to cirrus clouds, became evident, between Greenland and Antarctica and along the meridian 115º E, a linear pattern consisting of 3 segments: one in the northern hemisphere, about 7500 km, lasting 8 hours, one in the southern hemisphere, lasting 8 hours and another between 20º N and 25º S, devoid of cirrus, but visible by disturbing ordinary weather cloud formations. Two periods of 4 hours separate the appearance of cirrus clouds in the two hemispheres, during which the paths of the corresponding linear clouds disappear entirely, only the central segment between the tropics remaining active, but devoid of cirrus.
Several reasons are discussed why the three segments would have a common path, of an electrical nature due to ultra low frequency electromagnetic fields emitted vertically by two distinct structures of the planet, which reach lateral contact, as in the case of a seismic fault generating linear seismic clouds, or the scattering of clouds.
There are a few coincidences: we cross the deep minimum of solar activity between cycles No. 24 and No. 25; this causes the intensity of cosmic radiation to increase on the Earth's surface; one of the consequences consist in the genetic mutations of viruses and the outbreak of pandemics as given by the coronavirus Covid19, today. But the city of Wuhan in China, where the flu spread in December 2019, is right on the path, at the beginning of the northern segment of the linear cirrus cloud, which we consider to have tectonic causes.

GEOLOGICAL AND HYDROGEOLOGICAL PATRIMONY OF PUCIOASA CITY

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The spa resort of Pucioasa is located in the area of the Sub Carpathians, in the basin of Pucioasa, at a distance of about 100 km from Bucharest and respectively from Brasov (via DN 71). The tourist potential of the area is under the influence of the subsoil resources, respectively of the sulfur that has contributed to the transformation of an anonymous settlement into a spa resort, due to the sulphur enriched mineral waters used for curative purposes. Since 1873, the springs from Pucioasa have been classified on the occasion of the Vienna Exhibition as being superior to the most famous European resorts by the content of sulfuric elements with a percentage of mineral water per liter of 106.6%.
While the hydrogeological heritage of the Pucioasa City is quite renowned and represents the main attraction for visitors, our focus in the next years is to integrate also the geological patrimony of the area in the city tours.
From a geological perspective, the "Pucioasa strata" appear here, consisting in alternations of clays, marls, disodiles, menilites, breccias and marly clay shales below which mineral springs turn up in some places. Valuable natural resources such as sulphur deposit, of bacterial-diagenetic origin, were once mined in the area. At the contact line between Miocene and Pliocene are identified sulfurous-chloride-sodium-sulfated and bicarbonate springs whose origin is related to Miocene formations composed of marls, clays, sandstones with gypsum intercalations as well as dacitic tuffs and bituminous marl-limestones, with sulfur content.
The region is known for the strong dynamism of the relief, this phenomenon being observed in the area of Motaianca and Maluri hills.
There are three watercourses in the area of Pucioasa City and its surroundings, named Ialomița, Bizdidel and Tisa, which allows visitors to have an incursion into geological history. Several outcrops along stream courses reveal a littoral to fluvial past environment and even if you are not passionate about the geology you will be surprised by the shells diversity.
Culturally, Pucioasa keeps the tradition from 1953 through the Aeromodelling club (Dumitru Dorin Prunariu), one of its kind in Europe, due to its impressive collection of aircraft models, and missiles, exhibits made exclusively by children.
Sports tourism is a new segment of great national interest. Pucioasa through the mountain bike routes initiated by the BikeXpert.

GEOLOGICAL OBSERVATIONS ON THE OUTCROPS, LANDSLIDE AFFECTED AREAS AND SOME OTHER EROSION FORMS IN PUCIOASA TOWN AND ITS SURROUNDINGS AS A BASIS FOR GEOTOURISM DEVELOPMENT

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The geological diversity and the visible part of its history revealed by outcrops have been proved to be at the base of the (geo)attractiveness of various spots in the world.
The distribution, types, characteristics, causes of formation and changes of various scenic spots within the Pucioasa City and surrounding villages are analyzed in this paper from a geological perspective, using specific methods and technologies.
Pucioasa town and the adjacent areas presented in this paper are located at the northern border of the central part of the Dacian Basin, where the mollase-type deposits of the Carpathians Foredeep come in contact with the Moldavides nappes stack of the East Carpathians. Pucioasa City touristic activity is triggered by the already famous cold - chloride-sulphurous waters (springs and tapped sources in the northern part of the city), which stood since 1838 at the base of the touristic development of the area. But the geological diversity and the visible part of its history revealed by outcrops tracked in area of Pucioasa City may become a powerful tool for initiating geotourism or enhancing other forms of sustainable tourism developed here.
Therefore, this paper has as a secondary objective the aim to provide geological information and genetic interpretation of the Neogene sedimentary succession observed along the proposed route for geo-observations.

DISCOVERY: POWERING PEOPLE'S PASSIONS ACROSS THE GLOBE, WITH CONTENT THAT INSPIRES, INFORMS AND ENTERTAINS

Discovery Inc.

As the global leader in creating remarkable real-life entertainment, Discovery delivers day by day content that informs and educates, inspiring the passionate fans to explore their world. The distributed content galvanizes an overwhelming desire to know, explore and experience the world, as the company truly believes there are so many great things that haven't been discovered yet and people need to wise up and come across new, untraveled roads. Still, Discovery celebrates curiosity with over 8,000 hours of authentic programming each year, captivating viewers with enthusiasm and adventure, while also meeting their need and desire for expanding and bringing into light their knowledge.

We are committed to sharing extraordinary stories about great discoveries, giving people the chance to feel a special connection with the world surrounding them by witnessing the most fulfilling experiences on screen. The company's focus is sharing the stories that showcase the innermost passions of people across the globe, striving to give voice to the unheard and the undiscovered. With stories of experts and mavericks encouraging viewers to spark their imaginations, Discovery powers people's passions that make them human, such as the passion for discovery, using five main pillars of content: science and nature, turbo, tough jobs, survival and adventure, hidden treasure, available in 220 countries and territories and nearly 50 languages.

Additionally, the TV channels in the portfolio encourage people to touch and cherish the spirit of Discovery in themselves. This is achievable by picturing breathtaking and liberating real-life adventures, with fascinating experts who have really experienced the great stories they share, that ultimately contribute to changing the way audiences see things.

THE BOONE PICKENS SCHOOL OF GEOLOGY (BPSOG) AT OKLAHOMA STATE UNIVERSITY

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The Boone Pickens School of Geology (BPSoG) at Oklahoma State University School is housed in the Noble Research Center, a 35,000 sq. ft research and teaching facility in Stillwater, Oklahoma, United States of America. The BPSoG offers interdisciplinary research and education led by nineteen faculty dedicated to providing the highest quality education in the energy and environmental fields including carbon storage (CCS). Our faculty perform research and instruction in: sedimentology/ (bio)stratigraphy, structural geology and tectonics, geophysics, paleontology, hydrogeology, remote sensing, geochemistry, and geological engineering. Broadly speaking, our main core research areas all into four main categories: (1) Petroleum and Energy Geosciences, (2) Water, Environment, and Climate, (3) Earth Structure and Dynamics, and (4) Computational Geosciences.

The BPSoG undergraduate and graduate programs currently offer a Bachelor of Science (B.S) degree with concentrations in (1) Petroleum Geology, (2) Environmental Geology, (3) Pre-Law, and (4) Secondary Teacher Certification. Our pending proposal for a B.S. degree in Geophysics is in the final stages of approval. We also offer Minors in Geology and Geophysics, an accelerated Master of Science in Geology degree, and a B.S. in Geology/ MBA five-year program. We also grant M.S. and PhD degrees in Geology. In fall of 2020, our program had 60 B.S., 48 M.S, and 25 PhD enrolled students.

We are now in the process of startong a Professional Science Master's degree program with four tracks: Geophysics, Petroleum Geosciences, Hydrogeology, and Carbon Capture and Storage (CCS).

Due to tireless dedication and generosity of our alumni, the BPSoG has many endowed scholarships and is able to grant annually ~ $65,000 to our undergraduate students and ~$180,000 to our graduate (M.S. and PhD) students. While the student enrollments in our school typically ride the wave of the cyclical nature of the industry and compounded by oil and gas's exceptionally long and rocky comeback, our degree offering portfolio is broad and comprehensive to fit many interests in the field of geosciences. Our current graduate students come from 12 different countries and that is very representative to our very diverse faculty. Our graduates are most successful in finding employment opportunities with energy and environmental companies, academia, research institutions, and national labs. Several oil and gas companies recruit our students on a regular basis with campus visits.

The BPSoG owns a 71 year old Geology Field Camp facility in Cañon City, Colorado. This serves as the 6 credit-hour Capstone Course for our undergraduate majors and it hosts students from ~15 other institutions on an annual basis. Out-of-state tuition is waved and it provides 8 new cabins, 6 vintage cabins with drafting room, a central kitchen with professional-grade cooking facilities, cooks, and dining facilities.

Research funding in the BPSoG is strong with projects sponsored by federal agencies such as the Department of Energy or the National Science Foundation, the private sector, and non-profit organizations. We have six student organizations that are very active from organizing conferences, professional workshops, short courses, and panels, bringing nationally renowned speakers, and fostering camaraderie among students. Go Pokes!!!

NATIONAL INSTITUTE FOR RESEARCH AND DEVELOPMENT FOR EARTH PHYSICS

The National Institute for Research and Development for Earth Physics (NIEP), Romania has been carrying out fundamental and oriented research activities in Earth Physics since its establishment. The scientific activity carried out within NIEP is focused on modern experimental and theoretical aspects of Earth Physics in general and seismology in particular, among which we mention: physics of seismic source, seismicity and seismotectonics, structure and dynamics of the Earth's crust, seismic hazard and risk, earthquake engineering and engineering seismology, site effects, earthquake prediction. NIEP's mission aims to broaden the horizons of scientific knowledge, increase, and promote creativity and innovation through fundamental and applied research in the field of Earth Physics and seismology and the implementation and capitalization of research for the benefit of society. Having a team of highly qualified specialists, many of them with recognized international prestige, NIEP plays a key role at national level in the field of Earth Physics research, having a leading role in the South-Eastern Europe. Also, NIEP has permanently made a significant contribution to the programs launched within the Romanian National Strategy for Research-Development-Innovation as well as within the European programs, actively participating in numerous national and international projects and initiatives.
NIEP is the institution responsible for monitoring seismic activity in Romania. For this purpose, NIEP operates one of the largest seismic networks in the South-Eastern Europe consisting of modern instruments capable of recording both small local earthquakes and moderate or strong earthquakes produced in Romania or abroad. Currently, the National Seismic Network consists of 123 digital stations equipped with broadband and short-period sensors, 159 digital seismic stations equipped with acceleration sensors installed in free field, a network of 24 digital stations equipped with acceleration sensors installed in the Bucharest area, an "array" network in Bucovina, 9 observatories for multiple monitoring of Vrâncioaia, Muntele Roșu, Ploștina, Timișoara, Eforie, Bucovina, Deva, Mediaș and Buziaș. Data from all stations are transmitted in real time to the Data Center in Magurele using various communication systems, such as: internet connections, GPRS lines, dedicated satellite lines and dedicated lines provided by the Romanian Special Telecommunications Service (STS). NIEP participates in the global system for verifying compliance with the Comprehensive Nuclear Test-Ban Treaty (CTBT) through the Cheia-Muntele Roșu seismological station included in the auxiliary seismic network of the International Monitoring System (IMS - International Monitoring System).

FACULTY OF GEOLOGY AND GEOPHYSICS, UNIVERSITY OF BUCHAREST

The Faculty of Geology and Geophysics, the only one of its kind in Romania, originates in three faculties with a geology and geophysics profile established through the 1948 educational reform. Today, it continues the traditions of Romanian geology at a high scientific and educational standard, through permanent modernization and updating. The current organization of the faculty dates back to 1990 and it shows a dynamic approach, offering its graduates opportunities for a professional career in the industrial field, as well as in the scientific and academic field.

The Faculty of Geology and Geophysics offers several study programmes, on all levels and means of university education: there are 3 bachelor programmes, 4 master programmes and 1 doctoral programme. All of these are accredited or authorised.

Very intense research activity takes place in numerous research centres: the Centre for Ambient Tectonics and Geology, the LYTHOS Centre, the Geomedia Centre, the Expertise and Consulting Office, the Ambient Geology and Geophysics Research Department, the Research Collective for the Geology of Hydrocarbon Deposits, the Research Centre for Coal Deposit Geology and Environmental Protection and the Mineral Resources and Environmental Management Research Centre. These centres carry out many research agreements with important institutions and organizations, such as UEFISCDI, CNFIS and specialized units such as IGR, PETROM, GEOECOMAR, GEOTEC, the Geodynamics Institute of the Romanian Academy and many others, projects that also involve many undergraduates. Geology, the fundamental field in the large spectrum of Earth sciences, is inseparable from the applied domain of data and sample collection in the field. Therefore, the specialized geological practical courses represent an essential component in the solid training of the undergraduates. Students carry out field practice in areas such as Rucăr-Buzău, Lopătari, Olăneşti, Orşova, Dobrogea, Baia Mare, Hațeg and Leaota.

The Bucharest Student Chapter (BSC) distinguishes itself among the professional student associations. This is a scientific student body affiliated to the Faculty of Geology and Geophysics of the University of Bucharest, with a 12 year history.

The teaching staff and many of the students are part of research programmes carried out in universities and research institutes from USA, Germany, France, the Netherlands, Switzerland, Austria, Greece, the United Kingdom, Italy, Ukraine and Hungary."

THE „SABBA S.ȘTEFĂNESCU" INSTITUTE OF GEODYNAMICS OF THE ROMANIAN ACADEMY

Institute mission: basic research imposed by the Priority Program of the Romanian Academy ***Complex geophysical research in geodynamically active areas, with a special view on the Vrancea seismogenic area***, and particularly:

- Study of spatio-temporal variations of some parameters causally related to the cumulating of earthquake responsible stresses
- Study of natural hazard (tectonic, seismic, landslides, etc.)
- Monitoring of spatio-temporal variations of the gravity, geomagnetic, electromagnetic geoelectric Earth's fields and crustal deformation
- Modelling the structure and thermo-mechanical evolution of lithosphere
- Nonlinear analysis of geodynamic systems
- Study of endogenous processes in connection to Geodynamics
- Study of geomagnetic field in relation to physical processes in heliosphere
- Complex geophysical study in active geodynamic areas caused by anthropogenic activity.

The 2021 projects are:

1. Clinometric and gravimetric recording at observatories of geodynamics
2. Complex research on causal relationship between the internal structure and processes and the seismicity of active geodynamic areas
3. Spatial evolution of the geomagnetic field at global and national scales as well of its variability in relation with heliospheric sources
4. Electromagnetic studies of the geodynamic activity in the Vrancea area, with possible implications in triggering of seismic events
5. The post-collisional Upper Cretaceous (Banatitic) magmatism in Romania; geodynamic constraints and consequences
6. Complex study of the Carpathians Orogene on some peculiarities of the hydrographic network; monitoring crustal deformation.

The Institute edits and coordinates the publication „Revue Roumaine de Géophysique / Romanian Geophysical Journal" under the aegis of the Romanian Academy.

For undertaking measurements in observational national networks, for purchasing equipment and research supplies and participation at international scientific meetings, for supplementing funds for utilities (electricity, heating, water, phone), and current repairs of buildings, additional funds from national and international organizations (e.g., UEFISCDI - Romania, EEA Grants – Norway, etc.) programs are also used.

6 of the researchers have a Hirsch Index above 8.

The Institute of Geodynamics carries out, with the scientific habilitated supervisors a PhD program within the frame of the Romanian Academy School for Advanced Studies.

ABOUT THE MISSION OF THE ROMANIAN SOCIETY OF APPLIED GEOPHYSICS

The Romanian Society of Applied Geophysics (SGAR) was founded in 2012 in Bucharest, Romania, at the Department of Geophysics, within the Faculty of Geology and Geophysics, at University of Bucharest, by academic staff and geophysicists involved in research or exploration activities. SGAR embraced a mission of connecting the scientific community and the geophysical exploration industry, as well as of supporting the professional development of not only its members but also young geoscientists, students and PhD students.

The Romanian Society of Applied Geophysics (SGAR) is an integral part of the international geoscientific community, being an Associated Society and active member of the European Association of Geoscientists and Engineers (EAGE), as well as an active member of the Balkan Geophysical Society.

The Society is headed by Dr. Eng. Florina Tuluca who is currently the President of the Romanian Society of Applied Geophysics (SGAR) and who follows Prof. Dr. Eng. Dumitru Ioane, whose tenure ended in 2020.

Romanian Society of Applied Geophysics
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BALKAN GEOPHYSICAL SOCIETY

In September 2019, the Romanian Society of Applied Geophysics took on the Presidency of the Balkan Geophysical Society (BGS) and will be at the helm of this international society until 2021.

SGAR organizes short courses, scientific workshops and field activities, mostly dedicated to students and young geophysicists, as we appreciate the value of sharing scientific knowledge and experience.

The Romanian Society of Applied Geophysics organizes two main events every year: the GEOSCIENCE International Symposium and the Workshop on Electrical Resistivity Methods.

The GEOSCIENCE International Symposium offers a wide range of topics and welcomes contributions in various research areas, with the intention of providing the geoscientific community and industry with the opportunity to share and discuss research results, as well as to learn about the newest trends in the field of applied or theoretical geoscience.

The Workshop on Electrical Resistivity Methods is an opportunity for young participants to gain new skills or insights, as well as a chance for the experienced members to share their knowledge on a chosen topic.

Through its field activities, the Romanian Society of Applied Geophysics aims to increase awareness about the geoheritage of less famous parts of Romania, by proposing thematic routes and supporting geophysical research activities.

For further information or the opportunity to become a member, please visit us at http://appliedgeophysics.ro/

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