EARTH SCIENCE INSTITUTE OF THE SLOVAK ACADEMY OF SCIENCES

QUESTIONNAIRE

Summary report
January 1, 2016 – December 31, 2021

Bratislava, June 30, 2022 RNDr. Ján MADARÁS, PhD.

Questionnaire
Summary of the main activities of a research institute of the Slovak Academy of Sciences

Period: January 1, 2016 - December 31, 2021

1. Basic information on the institute:

1.1. Legal name and address

Earth Science Institute Slovak Academy of Sciences
Dúbravská cesta 5805/9, P.O.Box 106, 840 05 Bratislava

1.2. URL of the institute web site
http://www.geo.sav.sk

Bratislava – Geological Division

Bratislava - Geophysics Division

Banská Bystrica

Stará Lesná

Skalnaté pleso

Hurbanovo

1.3. Executive body of the institute and its composition

Directoriat	Name	Year of birth	Years in the position, from - to
Director	RNDr. Ján Madarás, PhD. RNDr. Igor Broska, DrSc.	1967 1955	2018- 2010-2018
Deputy director	RNDr. Pavol Nejedlík, CSc. RNDr. Ladislav Brimich, CSc.	1957 1950	2018- 2015-2018
Scientific secretary	Mgr. Milan Onderka, PhD. Mgr. Adam Tomašových, DrSc.	1979 1978	2021- 2015-2021
Head of organizational unit:			
Geological Division	Dr. Radovan Kyška-Pipík, PhD. RNDr. Ján Madarás, PhD.	1970 1967	2018- 2015-2018
Geophysics Division	RNDr. Pavol Nejedlík, CSc. RNDr. Ladislav Brimich, CSc.	1957 1950	2017- 2015-2017

1.4. Head of the Scientific Board

Mgr. Adam Tomašových, DrSc. 2020-
RNDr. Marián Janák, DrSc. 2015-2020

1.4.1 Composition of the International Advisory Board

Prof. Götz Bokelmann (Department of Meteorology and Geophysics, Vienna University, Austria)

Prof. Josef Eitzinger (Institute of Meteorology, BOKU Vienna, Austria)

Prof. Nikolaus Froitzheim (Steinmann-Institut, Universität Bonn, Germany)

Prof. Reto Gieré (Department of Earth and Environmental Sciences, University of Pennsylvania, Philadelphia, USA)

Prof. József Pálfy (Department of Geology, ELTE Budapest, Hungary)

Prof. Jan Veizer (Department of Earth Sciences, University of Ottawa, Canada)

Dr. Zoltán Vörös (Austrian Academy of Sciences, Space Research Institute, Vienna, Austria)

Prof. Hermann-Josef Zeyen (Département des Sciences de la Terre, Université de Paris-Sud)

1.5. Basic information on the research personnel

1.5.1. Fulltime equivalent work capacity of all employees (FTE all), FTE of employees with university degrees engaged in research projects (FTE researchers)

2016		2017		2018		2019		2020		2021		2016-2021	
FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	average FTE all per year	average FTE researchers per year
81,73	46,16	78,14	43,67	81,52	42,92	80,26	43,22	78,17	42,78	78,97	42,90	**79,80**	**43,61**

1.5.2. If applicable, add also a short information on the merger of the institute in the evaluation period. You can also add rows in the above table corresponding to the founding institutes

1.6. Basic information on the funding of the institute

1.6.1. Institutional salary budget, other salary budget[1], non-salary budget[2]

Salary budget	2016	2017	2018	2019	2020	2021	average
Institutional salary budget *[millions of EUR]*	1,386	1,410	1,494	1,722	1,900	1,852	**1,627**
Other salary budget *[millions of EUR]*	0,038	0,025	0,056	0,048	0,045	0,047	**0,043**
Total salary budget *[millions of EUR]*	1,423	1,435	1,550	1,770	1,945	1,899	**1,671**
Non-salary budget *[millions of EUR]*	0,301	0,302	0,296	0,300	0,423	0,383	**0,334**

[1] Salary budget originating outside the regular budgetary resources of the organization, e.g. from the project funding.
[2] Includes Goods and Services and PhD fellowships

1.7. Mission Statement of the Institute as presented in the Foundation Charter indicating the years when it was adopted and revised

Geological Division

a. carries out and develops basic research on mineralogy, petrology, geochemistry, geochronology, tectonics, palaeoclimatology, palaeogeography, palaeontology, sedimentology, sequence stratigraphy, evolutionary biology, environmental geochemistry and raw materials. Scientific activity is oriented towards comprehensive research on geological structures, their material composition, geodynamic evolution and dynamic of ecosystems of the Earth. The research is bound not only to the territory of the Slovak Republic.

b. organizes research in the framework of the national funding sources and international cooperation. It is interdisciplinary research on the edge of fields of geology, chemistry, physics, biology and climatology.

c. develops geoscience disciplines by solving research grants and tasks. It takes part in international scientific projects and collaborates with Earth science institutions abroad. It participates in the transfer of scientific information into practice. By scientific popularizing and educational activities, it contributes to the growth of knowledge and cultural level of Slovakia's population.

d. provides PhD study within the framework of valid Slovak legislation.

e. directly engages stakeholders in practical efforts to improve the environment, energy security and industrial sustainability.

f. publishes international scientific periodical journal Geologica Carpathica indexed also in the Web of Science.

Geophysics Division

a. carries out research in the Earth and the Environmental Sciences. It focuses on basic research in geophysical fields and the solid Earth with particular focus on the Western Carpathians, on the development of interpretation methods, on investigation of energy balance and radiation processes in the atmosphere, as well as atmospheric pollution.

b. Original theoretical work regarding the properties of geophysical fields in inhomogeneous environments, and mathematical modelling of meteorological processes in rugged terrain are part of the research activities.

c. is the only worksite in Slovakia, which systematically observes and continuously analyses seismic phenomena, spatial and temporal changes of the geomagnetic field, and slow deformations of earth's crust. It performs also various non-standard meteorological investigations. Data from observatories are processed and assessed. They serve as databases for research tasks and expert opinions on the Slovak territory. The data are also provided to international data centres, where they meet the needs of global research.

d. is in charge of PhD studies, too, in accordance with general statutes

e. publish international scientific periodical journal Contributions to Geophysics and Geodesy indexed also in the SCOPUS.

Until 31.12.2021

State contributory organization established by Resolution P SAS No. 1130, dated July 22, 2008, Charter issued by P SAS No. j. 477 / G / 12/2008 of 28 July 2008, amended by Appendix No. 2 of 1 July 2015 (on the change of name after the merger). Appendix No. 1 dated 3 November 2011 (amended asset management), Appendix No. 3 dated March 1, 2018 changed the organizational structure forming Geological Division and Geophysics Division.

From 1.1.2022

On the basis of the Founding Document No. 6161/2021 of 15.11.2021, and the Founding document in the full wording with Appendix No. 1 under No. 00390/2022 of 11.2.2022, with effect from 1.1.2022, issued by the Slovak Academy of Sciences, Štefánikova 49, Bratislava, the legal form is being changed to a public research institution (v.v.i.).

1.8. Summary of R&D activity pursued by the institute during the evaluation period in both national and international contexts. Describe the scientific importance and societal impact of each important result/discovery. Explain on general level – the information should be understandable for a non-specialist (recommended 5 pages, max. 10 pages for larger institutes with more than 50 average FTE researchers per year as per Table 1.5.1.)

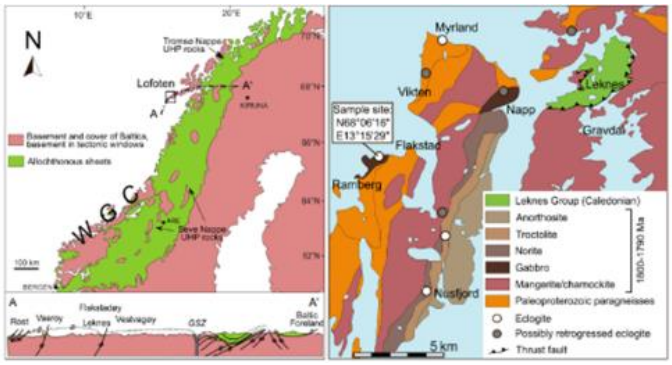
The R&D activities at the Earth Science Institute SAS were in accordance of the Institute Action Plan communicated by the International Advisory Board and prepared shortly after the international assessment in 2016 (see chapter 4.1). During the time interval 2016-2021, the research within Geological Division were focused on the three main topical fields, including (1) petrology and mineralogy (2) deep-time and Holocene/Anthropocene palaeobiology, stratigraphy, and sedimentology and (3) metallogeny and environmental geochemistry. The research in ppetrology and mineralogy was focused on granitic and volcanic rocks and metamorphic processes - mainly high-pressure and ultrahigh-pressure metamorphism. The research in palaeobiology, stratigraphy and sedimentology was oriented on Mesozoic and Cenozoic biotic events, on macroevolution and biogeography of Cenozoic ecosystems, and taphonomy and conservation palaeobiology of Anthropocene ecosystems, and on Holocene paleoclimatic and limnological inferences based on lake deposits and speleothems. The studies in metallogeny, environmental geochemistry and geomaterial studies were oriented mainly towards modelling heat flow and fluid migration in sedimentary basins, metallogenetic investigation of world-class deposits of critical metals, environmental impacts of ancient mining sites, tailings and dumps, and mineralogical research on historical objects and artworks.

Research outcomes of the Geophysics Division covered the fields of (1) seismology (2) gravimetry and geodynamics (3) geomagnetism and (4) atmospheric physics and hydrology. The seismological research mainly covered numerical modelling of seismic motion and seismic wave propagation, seismic hazard analyses, analysis of earthquakes and explosions. The researchers in gravimetry and geodynamics were focused on geophysical investigation of the earth crust/lithosphere, geothermics, gravimetric methodology, and near surface applied geophysics. The research in geomagnetism also incororated studies of the deep Earth's interior, magnetotelluric and paleomagnetic research, and monitoring of ^{222}Rn, and observations of the geomagnetic field and studying the geomagnetic activity. Finally, the research in the atmospheric physics, hydrology and climate-vegetation interactions was focused on atmospheric deposition and air quality in High Tatra Mts., climate change impacts and adaptations to climate change, and monitoring of atmospheric properties.

The main achievements are listed below and **are further documented in the list of main publications in 2.1.2 and in the chapter 2.3.1**, demonstrating the international position of Institute, with intense and efficient collaborations. Most of the research outcomes show a broad and diverse international dimension as they were carried out in collaboration with colleagues mainly from the European Union, Norway, Ukraine, Canada, USA, New Zealand, Egypt and China.

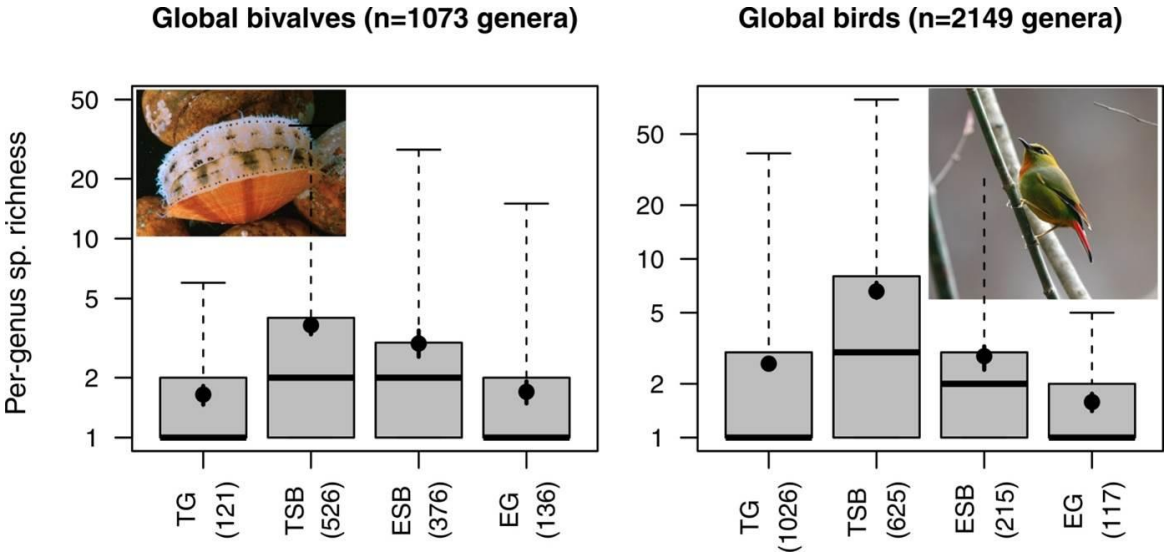
Devonian subduction and syncollisional exhumation of continental crust

The research was realised in collaboration with foreign partners from Norway (University Tromsø), Germany (University Bonn) and Sweden (Uppsala University), and comprised the determination of pressure – temperature conditions and age of metamorphism of Lofoten eclogites, Norwegian Caledonides (Froitzheim et al. 2016, Geology). The P-T conditions of eclogite metamorphism were calculated as T = 650-670 °C, P = 2.5-2.7 GPa. The age was determined by Lu-Hf method applied to eclogite garnets. The results demonstrate that the Lofoten basement was subducted to depths more than 90 km, 400 Ma ago (the Devonian period) and resulted from global continental collision by Baltica subduction below Laurencia. This resolved a critical controversy on the age of eclogite metamorphismand and its correlation with other tectonic units of northatlantic Caledonides.



The role of species diversification origin of latitudinal gradients in diversity

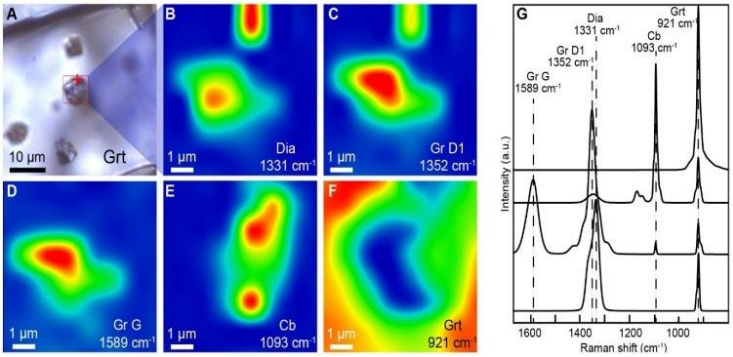
Many marine and terrestrial clades show similar latitudinal gradients in species richness, both peaking in the tropics. However, on land, endemic species occur in the tropics, whereas in the sea, endemic species occur at higher latitudes. Comparing terrestrial birds and marine bivalves at global scales, Tomašových et al. (2016) found that (1) gradients in endemicity are similar at genus level and (2) genus endemicity positively correlates with per-genus species richness, suggesting that within-genus species diversification promotes genus expansion to novel latitudes. On the basis of international cooperation with colleagues from the University of Chicago and supported by the Slovak Scientific Grant Agency, the results by Tomašových et al. (2016) demonstrate that birds and bivalves share similar latitudinal dynamics in net species diversification that peaks in the tropics.



Subduction of continental crust in the Scandinavian Caledonides

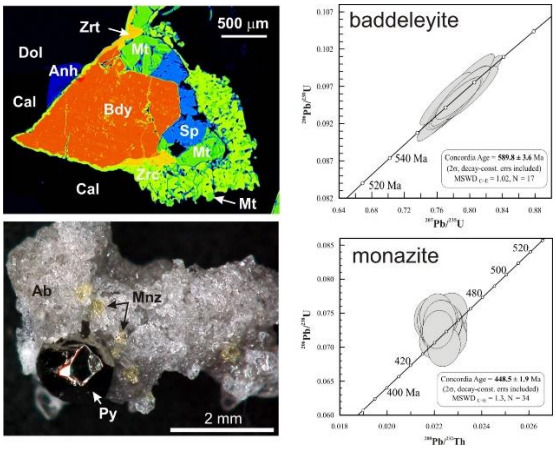
New finds of diamond in the Scandinavian Caledonides, in metasedimentary crustal rocks of the Seve Nappe Complex in Sweden (Jämtland, Vesterbotten) were reported by Klonowska et al. (2017) in Journal of Metamorphic Geology. Diamond was identified by Raman spectroscopy. Occurence of diamond is evidence of ultrahigh-pressure (4.2 GPa, 150 km) metamorphism due to deep subduction of Baltica continent in Ordovician (ca. 460-450 Ma) time. Timing of UHPM was recorded by Th-U-Pb dating of monazite (Klonowska et al. 2017), Lu-Hf dating of garnet and U-Pb

dating of zircon (Fassmer et al. 2017). Possible geodynamic setting was collision of Baltica with an Island arc during closure of the Iapetus ocean.



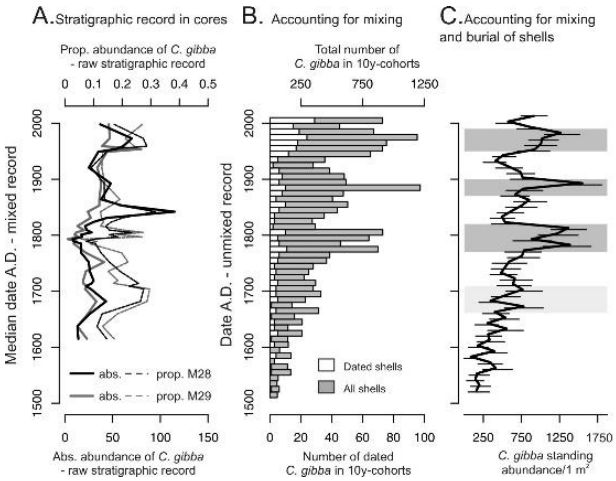
The origin of the Evate apatite-iron oxide-carbonate deposit in Mozambique

The Evate deposit in Mozambique represents the largest accumulation of apatite ores in southeast Africa bound to magnetite horizons in carbonates. Origin of the deposit remains poorly elucidated. The research by Hurai et al. (2017) confirmed that magnetite-apatite ores formed within the time interval between 590 and 450 Ma. The high-temperature stage (>800 °C) represented by zircon, baddeleyite and molybdenite is coeval with mafic and alkalic rocks, which intruded the metamorphic complex during peak temperature conditions of granulite-facies metamorphism. Hydrothermal stage represented by sulfides, anhydrite, monazite and zeolites precipitated from sulfate brines at temperatures <300 °C along the Cambrian-Ordovician reactivation.



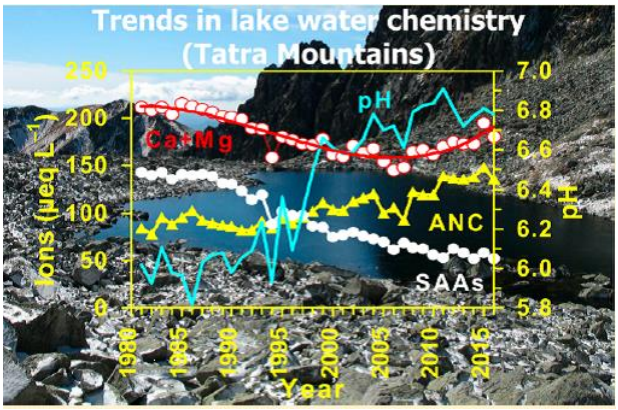
Responses of marine benthic ecosystems to anthropogenic impacts on the California and Adriatic shelves

Climatic and ecological history of marine environments archived in sediment cores can be traced on the basis of stratigraphic analyses. However, such analyses are compromised by bioturbational mixing. Bioturbation frequently mixes dead shells of different age into the same stratigraphic increments. On the basis of extensive radiometric dating of molluscan and brachiopod shells, we have developed methods that allowed us to unmix the effects of bioturbation on stratigraphic distributions of dead shells. We have applied these methods to marine ecosystems in the northern Adriatic Sea (Tomašových et al. 2017 in Geology) and on the southern California shelf (Tomašových and Kidwell 2017 in Proceedings Royal Society B). We have found that outbreaks of hypoxia-tolerant bivalves represent long-term phenomena in the northern Adriatic Sea rather than novel states characteristic of the 20th century eutrophication. These outbreaks positively correlate with fluctuations in sea-surface temperature, suggesting that the hypoxia events were coupled with water-column stratification. We have also found that benthic ecosystems dominated by epifaunal suspension-feeders on the southern California shelf effectively collapsed at the end of the 19th century, and were replaced by deposit- and detritus-feeding infaunal benthic species.



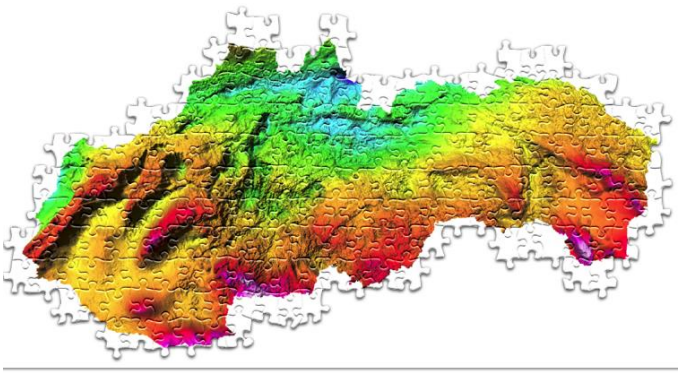
Climate-induced calcium and magnesium leaching from granitic Alpine catchments

Climate change can increase calcium and magnesium [Ca+Mg] leaching from granitic alpines catchment in the High Tatra Mts. In these catchments, reverse trend of the average [Ca+Mg] concentration over the period of recovery from acidification was found. It is in contrary with unchanged trends of strong acid anions concentration (SAAs), pH and acid neutralising capacity (ANC) since the early 1990s. It is assumed that increasing [Ca+Mg] leaching is associated with elevated terrestrial export of [Ca+Mg] resulted from extensive weathering and accelerated physical erosion of rocks due to climate-related mechanical forces. This assumption is supported by the fact that frequency of days with high precipitation amounts and air temperatures around 0 °C increased during the last 2−3 decades (Kopáček et al. 2017).



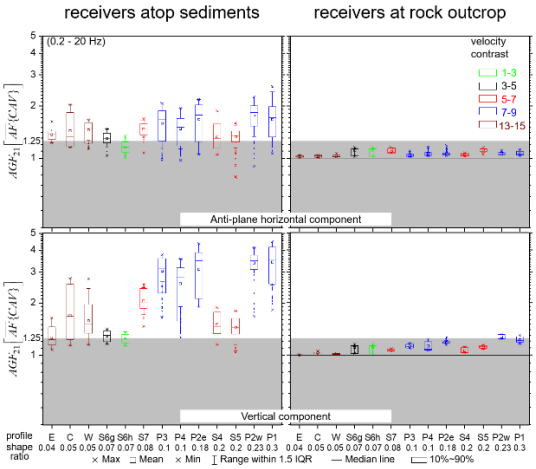
Understanding the Bouguer anomaly

The current Bouguer anomaly map of Slovakia is compiled from approx. 320 000 observation points collected during more than 50 years which represent a very heterogeneous dataset. Quality control process and complete recalculation of the Bouguer anomalies was presented by Zahorec et al. (2017, chapter 7). Primary focus was on a proper recalculation of the terrain corrections. The new software Toposk was developed for this purpose (Zahorec et al. 2017, chapter 5). The most important attribute of the new software is the correct calculation for arbitrary point location with regard to the real Earth surface. The use of the program is worldwide, not limited to the territory of Slovakia.



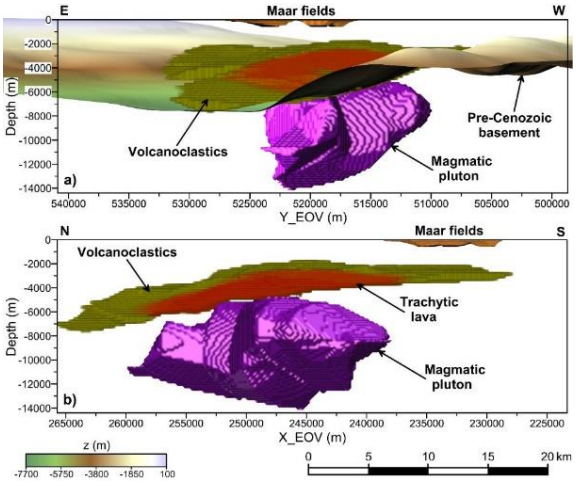
Earthquake ground motion in sedimentary structures

Alluvial valleys generate strong effects on earthquake ground motion (EGM). These effects are rarely accounted for even in site-specific studies because of (a) the cost of the required geophysical surveys to constrain the site model, (b) lack of data for empirical prediction, and (c) poor knowledge of the key controlling parameters. We performed 3D, 2D and 1D simulations for six typical sedimentary valleys of various width and depth, and for a variety of modifications of these 6 “nominal models” to investigate sensitivity of EGM characteristics to impedance contrast, attenuation, velocity gradient and geometry. We calculated amplification factors, and 2D/1D and 3D/2D aggravation factors for 10 EGM characteristics, using a representative set of recorded accelerograms to account for input motion variability. For all investigated sites, there is always an area in the valley for which 1D estimates are not sufficient. 2D estimates are insufficient at several sites. The identified key structural parameters are the shape ratio and overall geometry of the sediment-bedrock interface, impedance contrast at the sediment-bedrock interface, and attenuation in sediments. We showed that the amplification factors may largely exceed the values that are usually considered in GMPEs between soft soils and rock sites (Kristek et al. 2018, Moczo et al. 2018).



Intraplate volcanism in the Danube basin of NW Hungary: 3D geophysical modelling

For the 3-D geophysical modelling of the early Late Miocene Pásztori volcano (~11-10 Ma) in the volcanic field of the Lower Hungarian Plain, belonging to the Danube basin, gravitational and magnetic data, seismic reflection sections and drilling data in combination with the latest geological knowledge were used by Pánisová et al. (2018). Petrological analysis of rock samples from the cores of six exploration boreholes has found that volcanic rocks are built by alkaline trachytic and trachyandesitic volcanoclastic and effusive rocks. The measured magnetic susceptibilities of these samples showed that they are generally characterized by very low magnetization, indicating their deeper magnetic source.



The 3-D model of the Danube basin correlates very well with the observed high magnetic anomalies ΔZ above the volcano until the complete Bouguer anomaly correlates better with the crystalline basement depth. The model of the volcano consists of three magnetic sources. The nearest source to the surface is built by volcanoclastic and its thickness is 0.3-1.8 km. The second

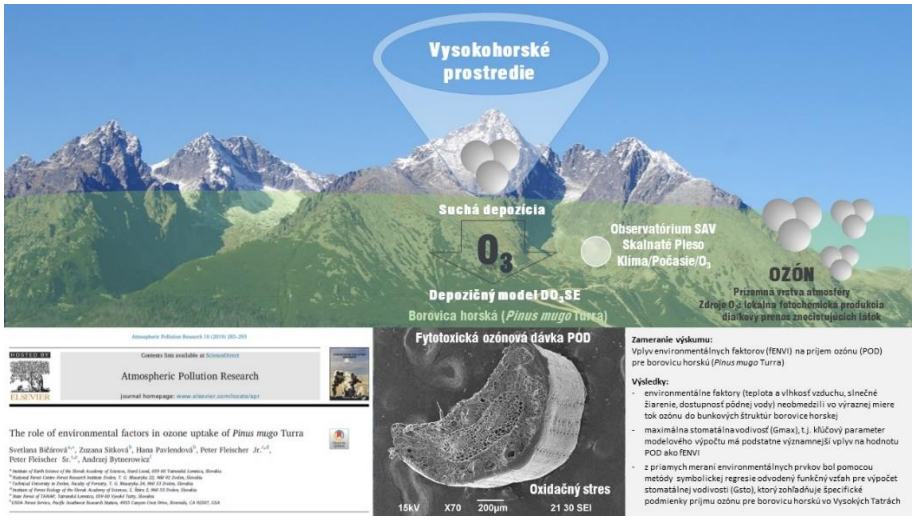
one is composed of trachytic-trachyandesitic and volcanoclastic rocks with a maximum thickness of 2 km and their minimum deposition is at a depth of 2.3 km. The deepest source is represented by a deep magmatic pluton located at a depth of 5-15 km. The results significantly contributed to the expansion of the knowledge on crustal structure and the evolution of the Danube basin, which was accompanied by alkaline intraplate volcanism.

Raman spectroscopic study of polysulfanes in natural fluid inclusions

Sulfur-bearing methane inclusions with up to 74 wt. % H_2S in Proterozoic quartzite from Bastar Craton (India) exhibit common n1 vibration modes of H_2S and CH_4 at 2609 cm-1 and 2919 cm-1, respectively, associated with unknown Raman bands at 2488-2574 cm-1. Quantum chemistry modeling based on the density functional theory confirmed that the unknown vibrations correspond to polysulphane-sulphur complexes. The H_2S-CH_4 gas phase was transformed into H_2S-CH_4 mixture with negligible H_2S concentration after short irradiation of the associated sulphur with 532 nm photons emitted by a 25mW Nd-YAG laser. However, no H_2S splitting occurred in the inclusions devoid of sulphur. We infer that photolytic breakdown of the sulphur-bound polysulphanes provided accelerated H· radicals capable of breaking the strong S-H bond in the molecular H_2S at room temperature. The polysulphane-supported photolysis combines benefits of toxic H_2S deactivation with hydrogen recovery, and as such it could be utilized for the environment-friendly processing and hydrogen recovery from super-soar natural gas (Hurai et al. 2019).

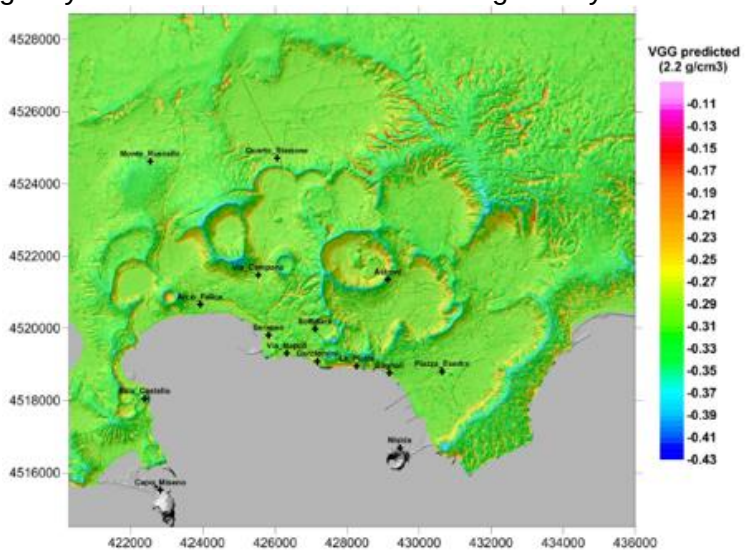
The role of environmental factors in ozone uptake of Pinus mugo

Montane forests in the High Tatra Mountains are exposed to high ambient ozone (O3) concentrations that may adversely affect the physiological processes and health of plants. The harmful influence of ozone on forest trees can be indicated by the model-based value of the phytotoxic ozone dose (POD). Bičárová et al. (2019) analyzed the effect of environmental factors (fENVI) on the POD obtained by the deposition model DO3SE for dwarf mountain pine (Pinus mugo Turra). We determined a moderate limitation of O3 uptake due to environmental factors (fENVI) such as air temperature and´humidity, solar radiation, and soil water availability in the temperate mountain forest. In addition, maximal stomatal conductance (Gmax) derived from gasometric field measurement in local conditions was included in the model. It appears that Gmax is more relevant for annual POD than fENVI. We developed a site-specific stomata response function for dwarf mountain pine using the symbolic regression approach that confirmed the robust performance of the DO3SE model for stomatal conductance (Gsto).



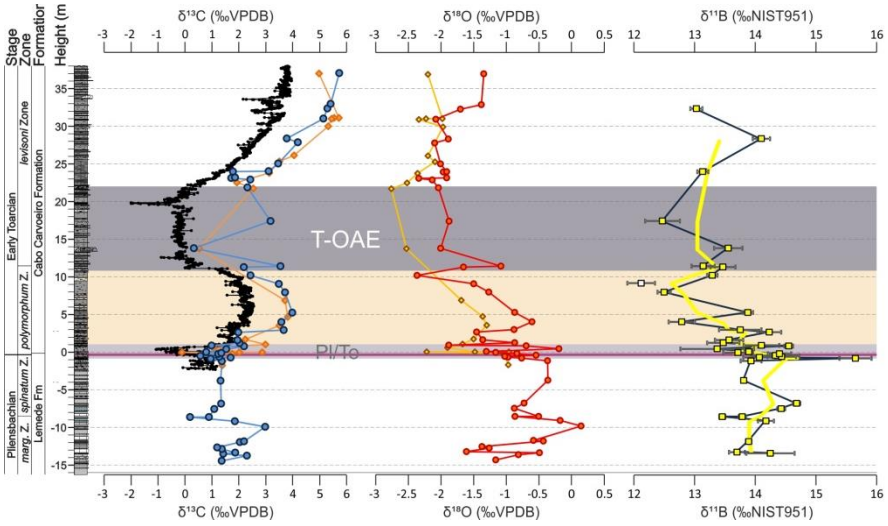
The significance and implications of topographic effects in gravimetry

Vajda et al. (2020a, b) presented a comprehensive review of the origin, significance and implications of topographic effects in Earth Sciences in the field of gravimetry (Campi Flegrei, Italy). The authors illustrate the sizes and shapes (spatial properties) of these effects, discuss their relevance and impacts in the areas of geodesy, geophysical structural studies (exploration and prospection), and in geodynamics with a focus on volcano geodesy.



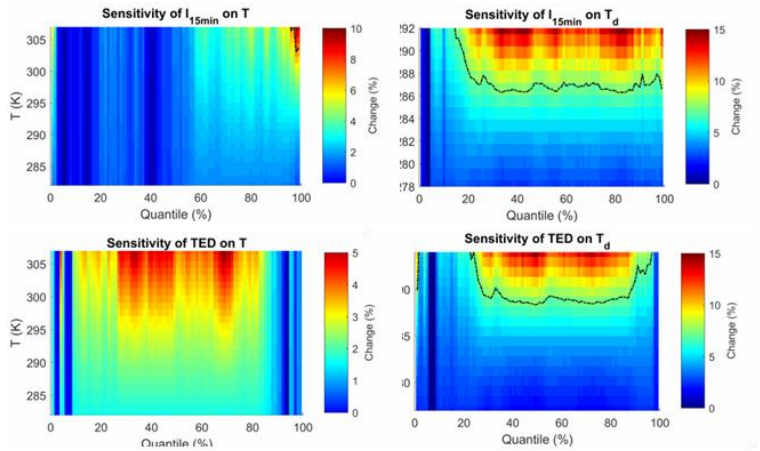
Ocean acidification during the Early Jurassic

Extensive volcanic activity from the Karoo-Ferrar large igneous province affected marine and terrestrial environments during the latest Early Jurassic The release of CO_2 to the atmosphere led to abrupt warming of seawater and left two major negative $\delta^{13}C$ anomalies in the stratigraphic record. These two (late-Pliensbachian and early Toarcian) events were associated with a significant decline in carbonate production, with a collapse in the development of coral reefs, with extensive anoxia, and extinction of organisms. One of the hypotheses that explain this extinction is seawater acidification. However, this hypothesis has never been directly tested. In the article of Muller et al. (2020) published in Geology (developed in the framework of the ITN Baseline-Earth project in collaboration with colleagues from Portugal, France and Germany), we have calibrated pH of seawater its potential saturation with respect to calcite and aragonite on the basis of $\delta^{11}B$ measured in brachiopod shells from the Lusitanian Basin. The stratigraphic record indeed shows a decline in $\delta^{11}B$ in beds corresponding to the late-Pliensbachian and early Toarcian events, and thus supports the acidification hypothesis.



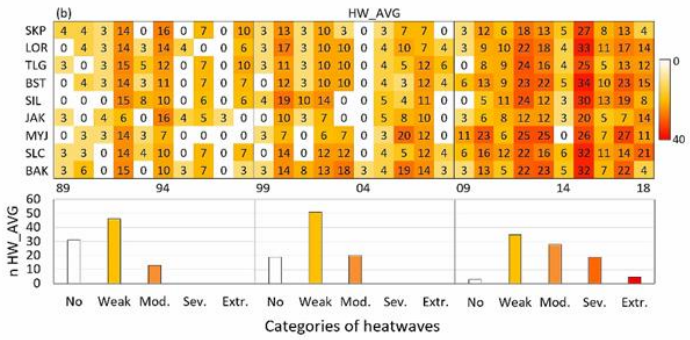
Sensitivity of selected summertime rainfall characteristics to pre-event atmospheric and near-surface conditions

We quantified the relationships between selected summertime rainfall characteristics (depth, intensity, duration and intermittency) on air temperature, dew-point temperature and selected thermodynamic indices reflecting the instability conditions of the lower atmosphere prior to precipitation events. The performed analyses revealed that the total rainfall kinetic energy and 15-minute intensities are particularly sensitive to dew-point temperature. Super-CC (7 – 14 % per Kelvin) was observed at dew-point temperatures above 288 K. Dew-point temperature appears to be physically more consistent predictor of intense rainfall than air temperature alone. These findings may have implications for more accurate predictions of extreme rainfall in the context of changing climate (Onderka and Pecho 2021).



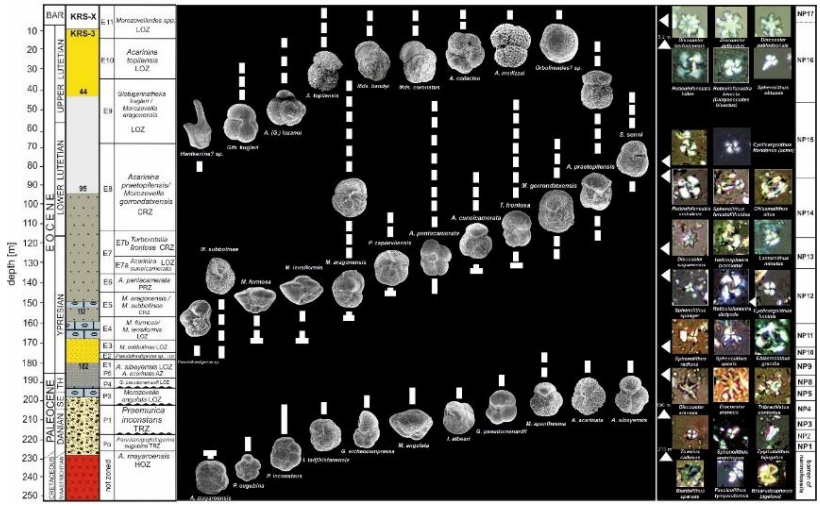
Regional and altitudinal aspects in summer heatwave intensification in the Western Carpathians

In Lukasová et al. (2021), we analysed the progress of the main type of temperature-extreme weather events—heatwaves (HWs). We focused on the area of the Western Carpathians (Central Europe) since the Carpathian Mountains are widely recognised as an important biodiversity hot-spot, particularly for mountain species in Europe. In particular, endemics, as autochthonic components of ecosystems, are more sensitive to environmental changes, especially climate change, which can lead to the extinction of the living conditions they need. The HWs were identified for a range of elevations from low to high altitudes including a high mountain station. We used the percentile threshold-based calculation of HW, which in comparison to those using absolute thresholds allows for revealing the possible threats of climate warming extremes at the range of altitudes. The trend of the heatwave characteristics was significantly positive ($p < 0.05$) at most of the stations throughout the region of Western Carpathians. The majority of the strongest HWs occurring across Europe over the last three decades hit the area of the Western Carpathians. The area experienced the regional HWs, severity of which was comparable to those of exceptionally strong HWs. Our results point to the increased risk of the effects of climate change on biodiversity in the Western Carpathians, mainly due to the coincidence of abnormally high maximum and average daily temperatures, when organisms are not able to recover.



End-Cretaceous to middle Eocene events from the Alpine Tethys

Soták et al. (2021) documented over 30 Ma record of boundary events and proxies of global environmental changes derived from the end-Cretaceous to middle Eocene formations of the Western Carpathians. This critical period after the Earth's collision with an asteroid before 66 Ma., is indicated in more distant Tethyan realms, such as the Western Carpathians, by unconformities of sedimentary record, storm erosion, reduction of marine plankton, periods of extreme warming (55 Ma) and a gradual stabilization of climatic and biotic conditions (42 Ma). This study introduced a first comprehensive evaluation of K / Pg boundary in the Western Carpathians, which was exactly documented by the extinction and recovery of new taxa, changes in magnetic polarity, isotope excursions, anomalous Hg concentrations, intensification of weathering evidenced by clay minerals, etc. These findings allow to present a models of changes in marine bioproductivity, climate regimes, hydrological cycles and circulation systems in the oceanic basins of the Alpine Tethys and the European epiplatform areas.



Development: According to the Action Plan development, the Earth Science Institute SAS was oriented on the improvement of preparation and laboratory facilities in Bratislava workplace where the old building was abandoned and new modern workplaces were established in main SAS campus at Patronka. Several new devices in total price ca 105,000 EUR were acquired (sawmill, modern ventilation system, and other equipment for polished and thin sections). During the evaluation period, the seismological laboratory as well as the magnetic laboratory at Hurbanovo historical workplace were also modernized. The Institute also hired several young scientists such as dr. Martin Števko (who was awarded by the SAS price for a discovery of new mineral, mineralogist), dr. Milan Onderka (Scientific secretary, climatologist, meteorologist), dr. Ján Vozár (Saspro fellowship, geomagnetist), Ing. Veronika Lukasová (Stefan Schwarz fellowship, bioclimatologist) and the Ukrainian researcher dr. Sergyi Kurylo who improved and further developed our utilisation of the electron microprobe.

2. Partial indicators of main activities:

2.1. Research output

2.1.1. Principal types of research output of the institute: basic research/applied research, international/regional (in percentage)

Geological Division:

basic/applied research in percentages: 80/20
international/regional in percentages: 100/0

Geophysics Division:

The estimation of the ratio of basic to applied research output of the institute: 80/20 percent.
The estimation of the ratio of international to regional research output of the institute: 95/5 percent.

Comments: The research at the Earth Science Institute SAS is defined clearly as basic and international, even in the cases when the studied samples have been taken from localities from the territory of Slovakia. By virtue our main object of research is the Earth's crust and our research publications show always some international significance and implications.

2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications should not exceed the number of average FTE researchers per year. The principal research outputs (max. 10% of the total number of selected publications, including Digital Object Identifier – DOI if available) should be underlined. Authors from the evaluated organizations should be underlined.

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2.1.3 List of monographs/books published abroad

1. NEMČOK M. – RYBÁR S. – SINHA S.T. –HERMESTON S.A. –LEDVÉNYIOVÁ L.: Transform Margins : Development, Controls and Petroleum Systems. 1. vyd. London: ***Geological Society, Special Publications,*** 2016. 385 s. 431. ISBN 978-1-86239-744-6. https://doi.org/10.1144/SP431.15
2. VRŠANSKÝ P.: Cockroaches from Jurassic sediments of the Bakhar Formation in Mongolia. 1. Edition. Cham : ***Springer*****,** 2020. 98 p. ISBN 978-3-030-59406-0 https://link.springer.com/content/pdf/10.1007/978-3-030-59407-7.pdf
3. NEJEDLÍK P., DALEZIOS N.R.: Hazards information management and services. In Environmental hazards methodologiest for risk assesment and management. - ***London : Iwa Publishing,*** p. 504-528. ISBN 1780407122, 9781780407128.

   https://doi.org/10.2166/9781780407135_0503

2.1.4. List of monographs/books published in Slovakia

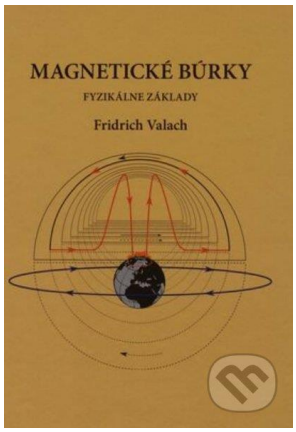
1. BOCHNÍČEK O. - BORSÁNYI P. - ČEPČEKOVÁ E. - FAŠKO P. - CHMELÍK M. - JANČOVIČOVÁ Ľ. - KAPOLKOVÁ H. - LABUDOVÁ L. - MIKULOVÁ POĽČOVÁ K. - MIŠAGA O. – NEJEDLÍK P. - PRIBULLOVÁ A. - SNOPKOVÁ Z. - ŠŤASTNÝ P. - ŠVEC M. - TURŇA M.: ***Klimatický Atlas Slovenska = Climate atlas of Slovakia***. Banská Štiavnica: Slovenský hydrometeorologický ústav, 2015. 132 s. + CD-ROM. ISBN 978-80-88907-91-6.
2. VALACH F., Magnetické búrky: fyzikálne základy, SÚH Hurbanovo, KASICO, 2020. 240 s., ISBN 978-80-89998-11-1.

2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items for institute with less than 50 average FTE researchers per year, 20 for institutes with 50 – 100 average FTE researchers per year and so on

1. Book on the physical foundations of the magnetic storms in Slovak language

VALACH V., Magnetické búrky: fyzikálne základy [in Slovak, ***Magnetic Storms: Physical Foundations***], SÚH Hurbanovo, KASICO, 2020. p. 240, ISBN 978-80-89998-11-1.
The lack of quality candidates, graduates of relevant university studies, for doctoral studies is one of the most pressing problems in natural sciences, the effects of which are also felt by our institute. In an effort to make the study of geomagnetism more attractive in the graduate and postgraduate (PhD) studies, a monograph/textbook on the physical foundations of magnetic storms was published. The book is written in the Slovak language and is intended as a study material for students of general physics, geophysics and applied geophysics. The publication intends to help

attract talented students to study space physics and earth sciences at universities. In addition to an accessible but rigorous interpretation of the study material, the publication also presents some of the latest results of the author's research work and brings the reader to some current, open and unresolved issues. The main issue on which the book focuses is the mechanism of extreme magnetic storms.

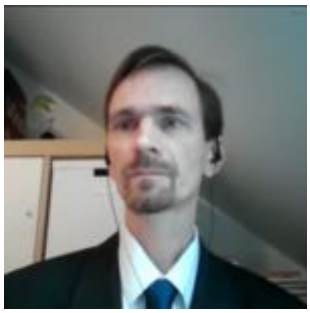


2. DrSc. dissertations

To ensure doctoral studies at our institute, it is important to prove the high quality of leading scientific personalities. In our academic environment, obtaining an advanced doctorate DrSc. (Doctor of Science) is such proof of exceptional quality. During the period under review, the advanced doctorate was awarded to two relatively young researchers. This was done on the basis of the defense of the following two dissertations, in which excellent scientific results were published:

Tomašových Adam: Detection of ecosystem shifts in the fossil record: time averaging and mismatches between living and subfossil assemblages (dissertation on the basis of which a higher doctorate was awarded, 2020)

Kristek Jozef: ***An efficient finite-difference numerical modelling of seismic waves and earthquake ground motion*** **(dissertation on the basis of which a higher doctorate was awarded, 2021)**



3. Using BTS signal for multi-frequency passive monitoring for rainfall detection

Department of atmospheric physics performed some experiments on possible use of base transceiver station (BTS) signal for rainfall detection. BTS signal is attached to the frequencies from hundreds of MHz to 3 GHz. Any rain detection by using the electromagnetic signal is so far based on the attenuation of the signal. It works for the frequencies over 10 GHz (the International Telecommunication Union stated: rain attenuation for frequencies below 6 GHz can be neglected (ITU-RP.838-3)). These frequencies do not sufficiently cover the territory with the signal. Further to that it is necessary to know the technical parameters of the broadcaster in order to calculate the signal attenuation. BTS signal covers the populated territory in sufficient way (more than 30000 BTS stations in Slovakia of less than 50000 km^2. ESI SAS in collaboration with University of Žilina developed a method of possible rain detection from the BTS signal. The methodology was put in experimental check and proved its validity. It does not need any signal parameters and does not decode the signal. It is fully passive. No similar methods were found in the literature check so far. ESI SAS is further collaborating on the development of the method for its possible practical use.

4. International cooperation on the research and monitoring of the volcano Etna

Etna volcano is one of the most active volcanoes on Earth and threatens the health and lives of people, especially tourists. The research of the volcano therefore rightly attracts the attention of geoscientists. The monitoring of this volcano is mainly done by Italian geophysicists from INGV (Istituto Nazionale di Geofisica e Vulcanologia, Catania, Italy). Since 2018, the Department of Gravimetry and Geodynamics of ESI SAS, namely Peter Vajda, Pavol Zahorec and Jaroslava Pánisová, has also been cooperating with colleagues from INGV. In 2018, we focused on the prediction and verification of the so-called vertical gravity gradients (VGG) at the monitoring points of the gravimetric network on Mount Etna. VGG values are an important parameter in the processing of gravity monitoring measurements. Cooperation continued in 2020–2021 thanks to a Trans-National Access project titled Gravimetric investigation of the structure of the Etna summit craters system (acronym G-ET-SUMMIT, principal investigator Peter Vajda, ESI SAS, contact person Filippo Greco, INGV Catania) granted under the EUROVOLC project that received funding from EU Horizon 2020 research and innovation actions under grant agreement No 731070. As part of the project, we carried out a measurement campaign in 2021 at the top of Mount Etna. The aim of the project is a 3D model of the central structures of the volcano, which we are still working on.

2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad

None

2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia

Registered trade-mark: **GEOLOGICA CARPATHICA**
Registry authority: Úrad priemyselného vlastníctva SR
Date of the registration: 13.05.2003
Owner: 100 % intellectual property of Earth Science Institute, Slovak Academy of Sciences
See web page: https://wbr.indprop.gov.sk/WebRegistre/OchrannaZnamka/Detail/3429-2001

GEOLOGICA CARPATHICA
International Geological Journal

2.1.8. Narrative on the most important research outputs of the institute – especially focused on their importance for society (3-5 pages)

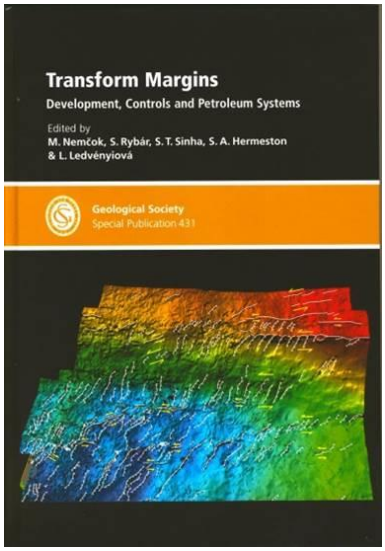
Several outputs with implications for society and education are also presented in Chapters 1.8, 2.3.1 and 2.3.5

Climate atlas of Slovakia
The Climate Atlas of Slovakia edited by Collective of authors (P.Nejedlik c-o author), (2015) represents a unique book as it is coming as a second work of this kind after more than 55 years. 172 maps and more than 200 graphs and tables show the evolution of climate in Slovakia over last 50 years in its geographic and historic frame.

Hazards information management and services
Natural risk management is one of the biggest challenges for society. This fact is also emphasized by the ongoing climate change, which in many places brings increased weather extremes both in their frequency and magnitude. Concerns about environmental risks are growing due to the growing damage caused by natural disasters in recent decades. Effective risk management starts with a well-prepared system that includes risk identification, monitoring and a warning system. Based on timely information, response and rescue activities can be organized. The availability of relevant information is crucial for the deployment of any relevant activities. For these reasons, the processing and management of natural risk information is the basis of any effective natural risk management system (Nejedlík and Dalezios 2017).

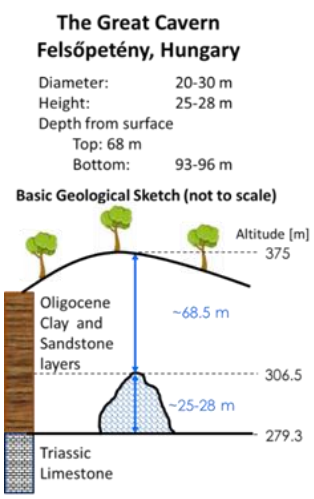
Transform Margins : Development, Controls and Petroleum Systems

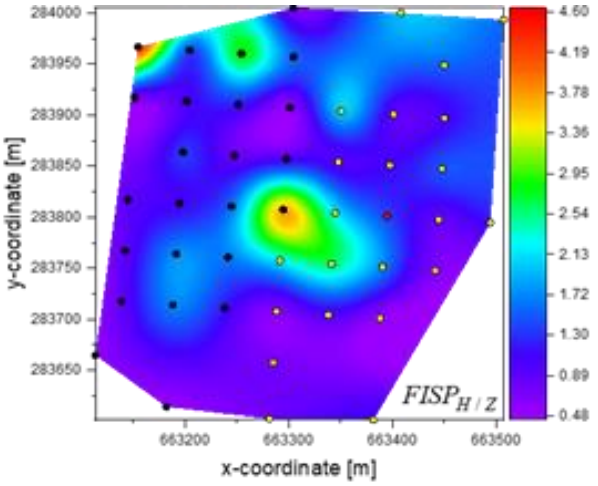
The Geological Society of London Special Publications monograph by Nemčok et al. (2016) provides an overview of the existing knowledege of transform margins of litospheric plates including their dynamic development, structural architecture and thermal regime. The monography can be used for describing predictive models of various petroleum systems. Monography was written by many experts from abroad.



The Finite-interval Spectral Power method for detecting underground cavities using seismic ambient noise

Kristeková et al. (2020) focused on identification of underground cavities using seismic noise analysis. In addition to reducing geotechnical risk, the identification of underground cavities is also important for monitoring nuclear test ban violations (underground nuclear explosions). We have developed a non-invasive method for locating cavities using seismic ambient noise measurements. As a minimum, it is sufficient to use two mobile seismic stations, one at the reference point and the other measuring seismic noise in the network of points. The method is based on the calculation of the FISP (finite-interval spectral power) characteristic with the help of statistical processing of power spectral densities of noise recordings in a properly selected frequency interval. The horizontal position of the cavity can be identified by analysis of spatial anomalies of this characteristic.


The Great Cavern
Felsőpetény, Hungary
Diameter: 20-30 m
Height: 25-28 m
Depth from surface
Top: 68 m
Bottom: 93-96 m
Basic Geological Sketch (not to scale)
Altitude [m]
375
Oligocene
Clay and
Sandstone
layers
~68.5 m
306.5
~25-28 m
279.3
Triassic
Limestone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FISP H / Z
4.60
4.19
3.78
3.36
2.95
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2.13
1.72
1.30
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0.48

2.1.9. Table of research outputs

Papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. /1 million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	0	0,000	0,000	1	0,021	0,697	0	0,000	0,000	0	0,000	0,000	1	0,022	0,514	0	0,000	0,000	**2**	**0,333**	**0,007**	**0,200**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*	1	0,019	0,702	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	1	0,021	0,526	**2**	**0,333**	**0,007**	**0,200**
Chapters in scientific monographs published abroad *(ABC)*	1	0,019	0,702	5	0,104	3,485	**0**	0,000	0,000	1	0,021	0,565	0	0,000	0,000	1	0,021	0,526	**8**	**1,333**	**0,028**	**0,798**
Chapters in scientific monographs published in Slovakia *(ABD)*	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	**0**	**0,000**	**0,000**	**0,000**
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	38	0,719	26,695	48	0,998	33,451	54	1,127	34,833	59	1,234	33,329	50	1,076	25,704	62	1,311	32,642	**311**	**51,833**	**1,071**	**31,027**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above *(ADMA, ADMB, ADNA, ADNB)*	29	0,549	20,372	24	0,499	16,726	22	0,459	14,191	30	0,628	16,947	19	0,409	9,768	26	0,550	13,689	**150**	**25,000**	**0,516**	**14,965**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	0	0,000	0,000	1	0,021	0,697	2	0,042	1,290	2	0,042	1,130	1	0,022	0,514	1	0,021	0,526	**7**	**1,167**	**0,024**	**0,698**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	1	0,019	0,702	6	0,125	4,181	3	0,063	1,935	4	0,084	2,260	4	0,086	2,056	4	0,085	2,106	**22**	**3,667**	**0,076**	**2,195**
Scientific papers published in foreign peer-reviewed proceedings *(AECA)*	0	0,000	0,000	0	0,000	0,000	1	0,021	0,645	0	0,000	0,000	1	0,022	0,514	0	0,000	0,000	**2**	**0,333**	**0,007**	**0,200**
Scientific papers published in domestic peer-reviewed proceedings *(AEDA)*	1	0,019	0,702	2	0,042	1,394	0	0,000	0,000	1	0,021	0,565	0	0,000	0,000	0	0,000	0,000	**4**	**0,667**	**0,014**	**0,399**
Published papers (full text) from foreign scientific conferences *(AFA, AFC)*	2	0,038	1,405	3	0,062	2,091	9	0,188	5,806	2	0,042	1,130	0	0,000	0,000	1	0,021	0,526	**17**	**2,833**	**0,059**	**1,696**
Published papers (full text) from domestic scientific conferences *(AFB, AFD)*	18	0,341	12,645	30	0,624	20,907	17	0,355	10,966	46	0,962	25,986	7	0,151	3,599	7	0	4	**125**	**21**	**0**	**12**

2.2. Measures of research outputs (citations, etc.)

2.2.1. Table with citations per annum (without self-citations)

Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) are listed separately

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	805	15,23	1 080	22,46	1 048	21,87	1 268	26,53	1 366	29,39	1 519	32,11	**7 086**	**1 181,00**	**24,40**
Citations in SCOPUS (1.2, 2.2) if not listed above	114	2,16	89	1,85	95	1,98	120	2,51	165	3,55	144	3,04	**727**	**121,17**	**2,50**
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	0	0,00	0	0,00	0	0,00	1	0,02	1	0,02	0	0,00	**2**	**0,33**	**0,01**
Other citations (not listed above) (3.1, 4.1)	52	0,98	46	0,96	56	1,17	50	1,05	45	0,97	69	1,46	**318**	**53,00**	**1,09**
Reviews (5,6)	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	**0**	**0,00**	**0,00**

2.2.2. List of 10 most-cited publications published any time with the address of the institute, with number of citations in the assessment period (2015 – 2020)

1. BONNEFOY C. - CORNOU C. - BARD P. Y. - COTTON F.A - MOCZO P. - KRISTEK J.. H/V ratio: A tool for site effects evaluation. Results from 1-D noise simulations. In *Geophysical Journal International*, 2006, vol. 67, no. 2, p. 827-837. (2005: 1.826 - IF, Q2 - JCR, 2.177 - SJR, Q1 - SJR). ISSN 0956-540X. Available on: https://doi.org/10.1111/j.1365-246X.2006.03154.x
   (166 citations)

2. ALROY J. - ABERHAN M. - BOTTJER D.J. - FOOTE M. - FÜRSICH F. T. - HARRIES P.J. - HENDY A. J. W. - HOLLAND S. M. - IVANY L. C. - KIESSLING W. - KOSNIK M.A. - MARSHALL Ch. R. - MCGOWAN A.J. - MILLER A.I. - OLSZEWSKI T. D. - PATZKOWSKY M.E. - PETERS S. E. - VILIER L. - WAGNER P. J. - BONUSO N. - BORKOW P.S. - BRENNEIS B. – CLAPHAM M.E. - FALL L.M. - FERGUSON Ch. A. - HANSON V. L. - KRUG A. Z. - LAYOU K. M. - LECKEY E. H. - NÜRNBERG S. - POWERS C. M. - SESSA J. A. - SIMPSON C. - TOMAŠOVÝCH A. - VISSAGI Ch.C. Phanerozoic trends in the global diversity of marine invertebrates. In *Science*, 2008, vol. 321, p. 97-100. (2007: 26.372 - IF, Q1 - JCR, 10.072 - SJR, Q1 - SJR). ISSN 0036-8075. Available on: https://doi.org/10.1126/science.1156963
   (152 citations)

3. MOCZO P. - KRISTEK J. - VAVRYČUK V. - ARCHULETA R. J. - HALADA L. 3D heterogeneous staggered-grid finite-difference modeling of seismic motion with volume harmonic and arithmetic averaging of elastic moduli and densities. In *Bulletin of the Seismological Society of Amerika*, 2002, vol. 92, no. 8, s. 3042-3066. ISSN 0037-1106. Available on: https://doi.org/10.2478/s11600-014-0235-4
   (139 citations)

4. MOCZO P. - KRISTEK J. - GÁLIS M. *The finite-difference modelling of earthquake motions: waves and ruptures*. Cambridge : Cambridge University Press, 2014. 365 p. Available on: https://doi.org/10.1017/CBO9781139236911. ISBN 978-1-107-02881-4
   (102 citations)

5. PÉCSKAY Z. - LEXA J. - SZAKACS A. - SEGHEDI I. - BALOGH K. - KONEČNÝ V. - ZELENKA T. - KOVACS M. - PÓKA T. - FÜLÖP A. - MÁRTON E. - PANAIOTU C. - CVETKOVIĆ V. Geochronology of Neogene magmatism in the Carpathian arc and intra-Carpathian area. In *Geologica Carpathica*, 2006, vol. 57, no. 6, p. 511-530. (2005: 0.449 - IF, Q4 - JCR, 0.379 - SJR, Q2 - SJR, Current Contents - CCC). (2006 - Current Contents). ISSN 1335-0552.
   (89 citations)

6. MOCZO P.- KRISTEK J. - HALADA L. 3D fourth-order staggered-grid finite-difference schemes: Stability and grid dispersion. In *Bulletin of the Seismological Society of America*, 2000, vol. 90, no. 3, p. 587-603. (2000 - Current Contents). 2/5131/99
   (88 citations)

7. CSONTOS L. - NAGYMAROSY A. - HORVÁTH F. - KOVÁČ M. Tertiary evolution of the Intra-Carpathian area: a model. In *Tectonophysics*, 1992, vol. 208, no. 1-3, p. 221-241. (1992 - Current Contents). ISSN 0040-1951.
   (84 citations)

8. KRISTEKOVÁ M.- KRISTEK J.- MOCZO P. Time-frequency misfit and goodness-of-fit criteria for quantitative comparison of time signals. In *Geophysical Journal International*, 2009, vol. 178, issue 2, p. 813-825. (2008: 2.219 - IF, Q1 - JCR, 2.243 - SJR, Q1 - SJR, karentované - CCC). (2009 - Current Contents). ISSN 0956-540X. Available on: https://doi.org/10.1111/j.1365-246X.2009.04177.x
   (68 citations)

9. KRISTEK J. - MOCZO P. Seismic-wave propagation in viscoelastic media with material discontinuities - a 3D 4th- order staggered-grid finite-difference modeling. In *Bulletin of the Seismological Society of America*, 2003, vol. 93, no. 5, p. 2273-2280. (2002: 1.256 - IF, karentované - CCC). (2003 - Current Contents). ISSN 0037-1106.
(66 citations)

10. MOCZO P. - KRISTEK J. - GÁLIS M. - PAŽÁK, Peter. The finite-difference and finite-element modeling of seismic wave propagation and earthquake motion. In *Acta Physica Slovaca : journal for experimental and theoretical physics*, 2007, vol. 57, issue 2, p. 177-406. (2006: 0.647 - IF, Q3 - JCR, 0.188 - SJR, Q4 - SJR). (2007 - SCOPUS). ISSN 0323-0465.
(63 citations)

2.2.3. List of 10 most-cited publications published any time with the address of the institute, with number of citations obtained until 2020

1. ALROY J. - ABERHAN M. - BOTTJER D.J. - FOOTE M. - FÜRSICH F. T. - HARRIES P.J. - HENDY A. J. W. - HOLLAND S. M. - IVANY L. C. - KIESSLING W. - KOSNIK M.A. - MARSHALL Ch. R. - MCGOWAN A.J. - MILLER A.I. - OLSZEWSKI T. D. - PATZKOWSKY M.E. - PETERS S. E. - VILIER L. - WAGNER P. J. - BONUSO N. - BORKOW P.S. - BRENNEIS B. – CLAPHAM M.E. - FALL L.M. - FERGUSON Ch. A. - HANSON V. L. - KRUG A. Z. - LAYOU K. M. - LECKEY E. H. - NÜRNBERG S. - POWERS C. M. - SESSA J. A. - SIMPSON C. - TOMAŠOVÝCH A. - VISSAGI Ch.C. Phanerozoic trends in the global diversity of marine invertebrates. In *Science*, 2008, vol. 321, p. 97-100. (2007: 26.372 - IF, Q1 - JCR, 10.072 - SJR, Q1 - SJR). ISSN 0036-8075. Available on: https://doi.org/10.1126/science.1156963
(324 citations)

2. MOCZO P. - KRISTEK J. - VAVRYČUK V. - ARCHULETA R. J. – HALADA. L. 3D heterogeneous staggered-grid finite-difference modeling of seismic motion with volume harmonic and arithmetic averaging of elastic moduli and densities. In *Bulletin of the Seismological Society of Amerika*, 2002, vol. 92, no. 8, s. 3042-3066. ISSN 0037-1106. Available on: https://doi.org/10.2478/s11600-014-0235-4
(323 citations)

3. BONNEFOY C. - CORNOU C. - BARD P. Y.- COTTON F.A - MOCZO P. – KRISTEK J. H/V ratio: A tool for site effects evaluation. Results from 1-D noise simulations. In *Geophysical Journal International*, 2006, vol. 67, no. 2, p. 827-837. (2005: 1.826 - IF, Q2 - JCR, 2.177 - SJR, Q1 - SJR). ISSN 0956-540X. Available on: https://doi.org/10.1111/j.1365-246X.2006.03154.x
(269 citations)

4. CSONTOS L. – NAGYMAROSY A. - HORVÁTH F. - KOVÁČ M. Tertiary evolution of the Intra-Carpathian area: a model. In *Tectonophysics*, 1992, vol. 208, no. 1-3, p. 221-241. (1992 - Current Contents). ISSN 0040-1951.
(211 citations)

5. MOCZO P. - KRISTEK J.- HALADA L. 3D fourth-order staggered-grid finite-difference schemes: Stability and grid dispersion. In *Bulletin of the Seismological Society of America*, 2000, vol. 90, no. 3, p. 587-603. (2000 - Current Contents). 2/5131/99
(181 citations)

6. MOCZO P. - BYSTRICKÝ E. - KRISTEK J. - CARCIONE J. M. - BOUCHON M. Hybrid modeling of P-SV seismic motion at inhomogeneous viscoelastic topographic structures. In *Bulletin of the Seismological Society of America*, 1997, vol. 87, no. 5, p. 1305-1323. (1997 - Current Contents). ISSN 0037-1106.
(160 citations)

7. POHÁNKA V. Optimum expression for computation of the gravity field a homogeneous polyhedral body. In *Geophysical Prospecting*, 1988, vol. 36, no. 7, p. 733-751. (1988 - Current Contents). ISSN 0016-8025. II-3-3/03
(128 citations)

8. PLAŠIENKA D. - GRECULA P. - PUTIŠ M. - HOVORKA D. - KOVÁČ M. Evolution and structure of the Western Carpathians: an overview. In *Geological evolution of the Western Carpathians*. - Bratislava : Geocomplex, 1997, p. 1-24. ISBN 80-967018-7-8.
(123 citations)

9. MOCZO P. – KRISTEK J. - GÁLIS M. - PAŽÁK P. The finite-difference and finite-element modeling of seismic wave propagation and earthquake motion. In *Acta Physica Slovaca : journal for experimental and theoretical physics*, 2007, vol. 57, issue 2, p. 177-406. (2006: 0.647 - IF, Q3 - JCR, 0.188 - SJR, Q4 - SJR). (2007 - SCOPUS). ISSN 0323-0465.
(122 citations)

10. MOCZO P. Finite-difference technique for SH-waves in 2-D media using irregular grid: Application to seismic response problem. In *Geophysical Journal International*, 1989, vol. 99, no. 2, p. 321-330. ISSN 0956-540X.
(115 citations)

11. PÉCSKAY Z. - LEXA J. - SZAKACS, A. - SEGHEDI, I. - BALOGH K. - KONEČNÝ V. - ZELENKA T. - KOVACS M. - PÓKA T. - FÜLÖP A. - MÁRTON E. - PANAIOTU C. - CVETKOVIĆ V. Geochronology of Neogene magmatism in the Carpathian arc and intra-Carpathian area. In *Geologica Carpathica*, 2006, vol. 57, no. 6, p. 511-530. (2005: 0.449 - IF, Q4 - JCR, 0.379 - SJR, Q2 - SJR, Current Contents - CCC). (2006 - Current Contents). ISSN 1335-0552.
(115 citations)

2.2.4. List of 10 most-cited publications published during the evaluation period (2016-2021) with the address of the Institute, with number of citations obtained until 2021

1. MEZEI P. - JAKUŠ R. - PENNERSTORFER J. - POTTERF M. - ŠKVARENINA J. - FERENČÍK J. - SLIVINSKÝ J. - BIČÁROVÁ S. - BILČÍK D. - BLAŽENEC M. - NETHERER S. Storms, temperature maxima and the Eurasian spruce bark beetle Ips typographus—An infernal trio in Norway spruce forests of the Central European High Tatra Mountains. In *Agricultural and Forest Meteorology*, 2017, vol. 242, p. 85-95. (2016: 3.887 - IF, Q1 - JCR, 2.047 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0168-1923. Available on: https://doi.org/10.1016/j.agrformet.2017.04.004
(57 citations)

2. KOVÁČ M. - PLAŠIENKA D. - SOTÁK J. - VOJTKO R. - OSZCZYPKO N. - LESS G. - ĆOSOVIĆ V. - FÜGENSCHUH B. - KRÁLIKOVÁ S. Paleogene palaeogeography and basin evolution of the Western Carpathians, Northern Pannonian domain and adjoining areas. In *Global and planetary change*, 2016, vol. 140, p. 9-27. (2015: 3.548 - IF, Q1 - JCR, 1.832 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 0921-8181. Available on: https://doi.org/10.1016/j.gloplacha.2016.03.007
(44 citations)

3. TRNKA M. - BALEK J. - ŠTĚPÁNEK P. - ZAHRADNÍČEK P. - MOŽNÝ M. - EITZINGER J. - ŽALUD Z. - FORMAYER H. - TURŇA M. - NEJEDLÍK P. - SEMERÁDOVÁ D. - HLAVINKA P.- BRÁZDIL R. Drought trends over part of Central Europe between 1961 and 2014. In *Climate Research*, 2016, vol. 70, no. 2-3, p. 143-160. (2015: 1.690 - IF, Q3 - JCR, 1.105 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 0936-577X. Available on: https://doi.org/10.3354/cr01420
(31 citations)

4. VRŠANSKÝ P. - ORUŽINSKÝ R. - ARISTOV D.- WEI DD - VIDLIČKA Ľ. - REN D. Temporary deleterious mass mutations relate to originations of cockroach families. In *Biologia*, 2017, vol. 72, no. 8, p. 886-912. (2016: 0.759 - IF, Q4 - JCR, 0.313 - SJR, Q3 -

SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0006-3088. Available on: https://doi.org/10.1515/biolog-2017-0096
(28 citations)

5. GOBIN A. - KERSEBAUM K. K. - EITZINGER J. - TRNKA M. - HLAVINKA P. - TAKÁČ J. - KROES J. - VENTRELLA D. - DALLA M., DEELSTRA J. - LALIĆ B. - NEJEDLÍK P. - ORLANDINI S. - PELTONEN-SAINIO P. - RAJALA A. - SAUE T. - ŞAYLAN L. - STRIČEVIC R. - VUČETIČ V. - ZOUMIDES Ch. Variability in the water footprint of arable crop production across european regions. In *WATER*, 2017, vol. 9, no. 2, art. no. 93. (2016: 1.832 - IF, Q2 - JCR, 0.576 - SJR, Q2 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 2073-4441. Available on: https://doi.org/10.3390/w9020093
(25 citations)

6. KLONOWSKA I. - JANÁK M. - MAJKA J. - PETRÍK I. – FROITZHEIM N. - GEE D. G. - SASINKOVÁ V. Microdiamond on Åreskutan confirms regional UHP metamorphism in the Seve Nappe Complex of the Scandinavian Caledonides. In *Journal of Metamorphic Geology*, 2017, vol. 35, no. 5, p. 541-564. (2016: 3.594 - IF, Q1 - JCR, 2.419 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0263-4929. Available on: https://doi.org/10.1111/jmg.12244
(21 citations)

7. ALBANO P. G. - FILIPPOVA N.A. - STEGER J. - KAUFMAN, D. S. - TOMAŠOVÝCH A. - STACHOWITSCH M. - ZUSCHIN M. Oil platforms in the Persian (Arabian) Gulf: Living and death assemblages reveal no effects. In *Continental Shelf Research*, 2016, vol. 121, p. 21-34. (2015: 2.011 - IF, Q2 - JCR, 0.986 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 0278-4343. Available on: https://doi.org/10.1016/j.csr.2015.12.007
(20 citations)

8. TOMAŠOVÝCH A. - KENNEDY J. D. – BETZNER T. J. - BITLER KUEHNLE N. - EDIE S. - KIM S. - SUPRIYA K. - WHITE A. E. - RAHBEK C. - HUANG S. - PRICE T.D. - JABLONSKI D. Unifying latitudinal gradients in range size and richness across marine and terrestrial systems. In *Proceedings of the Royal Society : B - Biological Sciences*, 2016, vol. 283, no. 1830, art. no. 20153027. (2015: 4.823 - IF, Q1 - JCR, 3.693 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 0962-8452. Available on: https://doi.org/10.1098/rspb.2015.3027
(19 citations)

9. PÁNISOVÁ J. - MURÍN I. - PAŠTEKA R. - HALIČKOVÁ J. - BRUNČÁK P. - POHÁNKA V. - PAPČO J. - MILO P. Geophysical fingerprints of shallow cultural structures from microgravity and GPR measurements in the Church of St. George, Svaty Jur, Slovakia. In *Journal of Applied Geophysics*, 2016, vol. 127, p. 102-111. (2015: 1.355 - IF, Q2 - JCR, 0.837 - SJR, Q2 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 0926-9851. Available on: https://doi.org/10.1016/j.jappgeo.2016.02.009
(17 citations)

10. ARNEITZ P. - LEONHARDT R. - SCHNEPP E. - HEILIG B. - MAYRHOFER F. - KOVACS P. - VALACH F. - VADASZ G. - HAMMERL Ch. - EGLI R. - FABIAN K. The HISTMAG database: combining historical, archaeomagnetic and volcanic data. In *Geophysical Journal International*, 2017, vol. 210, issue 3, p. 1347-1359. (2016: 2.414 - IF, Q2 - JCR, 1.749 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0956-540X. Available on: https://doi.org/10.1093/gji/ggx245
(17 citations)

2.2.5. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations in the assessment period (2015– 2020). The cited papers must bear the address of the institute

1. Kristek Jozef – Number of citations: 1007
2. Tomašových Adam – Number of citations: 906
3. Moczo Peter – Number of citations: 904

4. Broska Igor – Number of citations: 547
5. Janák Marian – Number of citations: 517

2.2.6. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2020. The cited papers must bear the address of the Institute

1. Moczo Peter – Number of citations: 2233
2. Kristek Jozef – Number of citations: 1890
3. Tomašových Adam – Number of citations: 1372
4. Broska Igor – Number of citations: 1092
5. Michalík Jozef – Number of citations: 881

2.2.7. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2021 of their papers published during the evaluation period (2016– 2021). The cited papers must bear the address of the Institute

1. Tomašových Adam – Number of citations: 268
2. Vršanský Peter – Number of citations: 165
3. Janák Marian – Number of citations: 137
4. Bičárová Svetlana – Number of citations: 108
5. Soták Ján – Number of citations: 106

2.3. Research status of the institute in international and national context

The research at the Earth Science Institute SAS is international because outreach is oriented on presentation of current research data for international geoscience community. National context lays only in popularisation of obtained data and in explanation of geological events and risk for public (exhibitions, open days, TV, radio). International character follows from the results published in a number of papers in mostly high ranked international journals. The reputation our researchers documents invitations by institutions and organiser of diferent conferences for call talks. The researcher from instate are involved by top review processes to the review processes in high impact journals, international projects. Moreover the international editorial board of our journals Geologica Carpathica and Contributions to Geophysics and Geodesy consisting of experts from European countries is also the result of a good position of our institution within Europe.

- **International/European position of the institute**

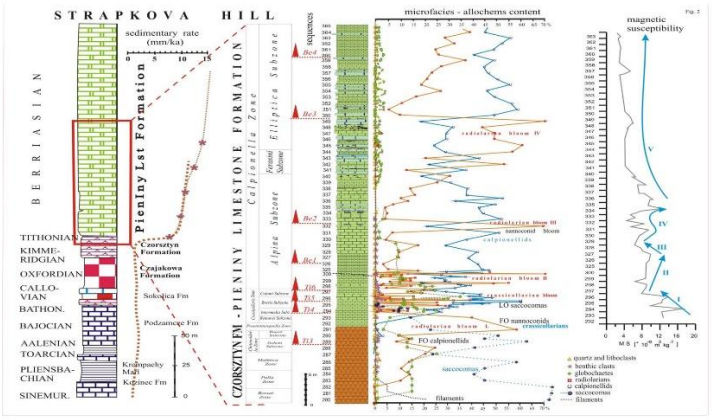
2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items for institute with less than 50 average FTE researchers per year, max. 20 for institutes with 50 – 100 average FTE researchers per year and so on

The key research activities and outputs belong to outcomes of petrological, mineralogical, geochemical, paleontological and stratigraphic research at the Geological Division and to seismologic, gravimetric, geomagnetic, climatic and hydrological research at the Geophysics Division. The main activities, ultimately published in peer-reviewed journals (WOS core collections

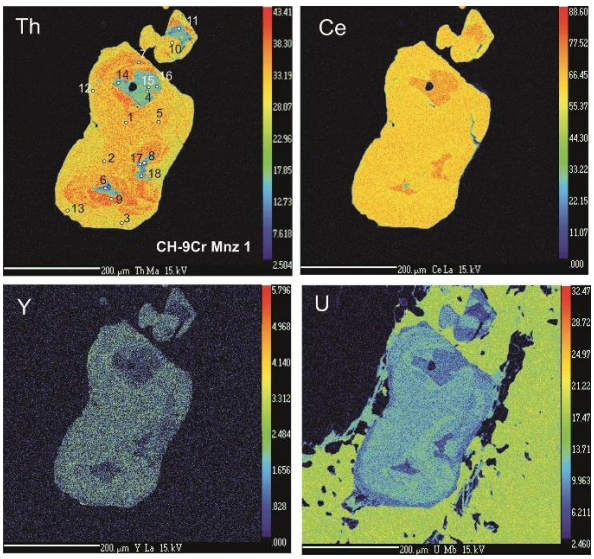
and monographs published by international publishers) summarize these activities and are listed below. They accompany the main outputs listed in the chapter 1.8.

2016

Environmental changes during the Jurassic/Cretaceous transition and Early Cretaceous
Multidisciplinary studies (in collaboration with colleagues from Austria, Poland, Czech R. and Italy) of the Upper Jurassic and Lower Cretaceous formations of the Western Carpathians (Michalík et al. 2016) and Southern Alps (Lukeneder, Soták et al. 2016, PPP) serve as the basis for selection of boundary stratotypes in the international stratigraphic scale and for analysis of global paleooceanographic changes. Important changes in microorganisms, stabile isotopes and organic carbon indicate colder period, disturbed by warmer latest Jurassic episode, and followed by explosive development of planktonic biota in earliest Cretaceous due to warm water influx, salinity increase and intensification of oceanic currents. The study of Jurassic-Cretaceous boundary forms a part of the work of the International Commision on stratigraphy (ICS). The analysis of early Cretaceous events at the Puez section provided an evidence of diversification in planktonic foraminifera since Hauterivian (Faraoni event), indications of global oceanic anoxic events in Albian (OAE 1b a OAB1d), and long-term increasing trend in paleotemperatures culminated in most distinct warming of the Earth in supergreenhause period during the mid-Cretaceous time. By a long-ranging stratigraphic record and comprehensive elaboration, the Puez section became an important stratotype in the Tethyan realm.

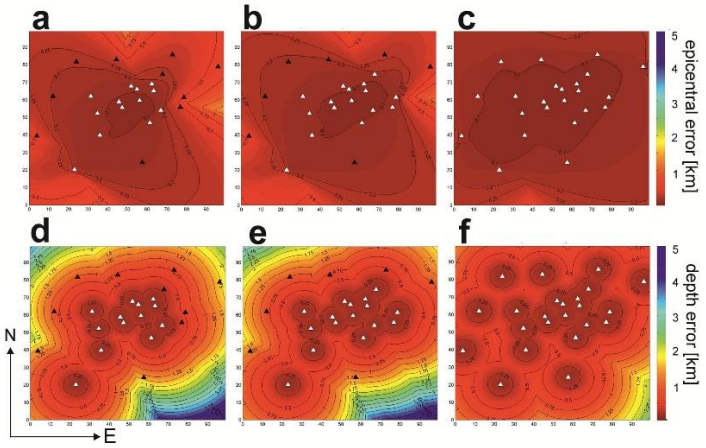


Triassic to Early Jurassic UHP metamorphism in the Central Rhodopes
The work of our international team (with colleagues from Germany, Japan, Bulgaria) published in Journal of Metamorphic Geology by Petrík et al. (2016) discovered and identified a new occurrence of diamonds in the Bulgarian Rhodopes, dated the age of metamorphism and determined pressure – temperature conditions of ultrahigh-pressure (UHP) metamorphism responsible for the diamond formation (Petrík et al 2016). The age of metamorphism (200 Ma) was determined by monazite dating and its pressure (3.5-4.5 GPa), temperature (700-800° C) were calculated by thermodynamic modelling. Besides the older UHP phase the dated mineral monazite has preserved also a younger phase of granulite metamorphism 160 Ma ago. New results change older views on UHP metamorphism in the Rhodopes, which is older than previously thought. The deep subduction occurred when the Paleotethys Ocean has closed, the younger phase indicates already the beginning of a new cycle.



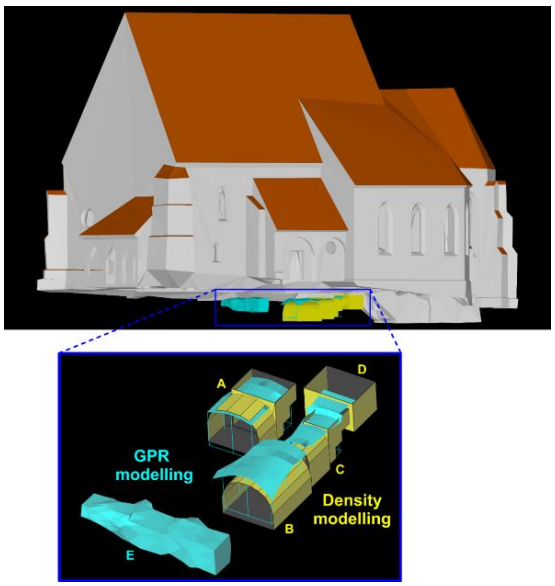
Quantifying capability of a local seismic network

Fojtíková et al. (2016) in Journal of Seismology suggested the combination of suitable methods (including the new one) for quantification of accuracy of earthquake location and determination of focal mechanisms for a given area and seismic station configuration. The authors also developed the free software. Our analysis was applied to the Malé Karpaty local seismic network (Slovakia). This network enables seismic monitoring of the source zone in the vicinity of a nuclear power plant, important from the point of seismic hazard. Obtained results clearly demonstrate that suggested network extension remarkably decreases the errors of earthquake location and focal mechanism determination and improves seismic monitoring of the area. The results can also serve as a basis for decision making process when considering financial support of the network extension.



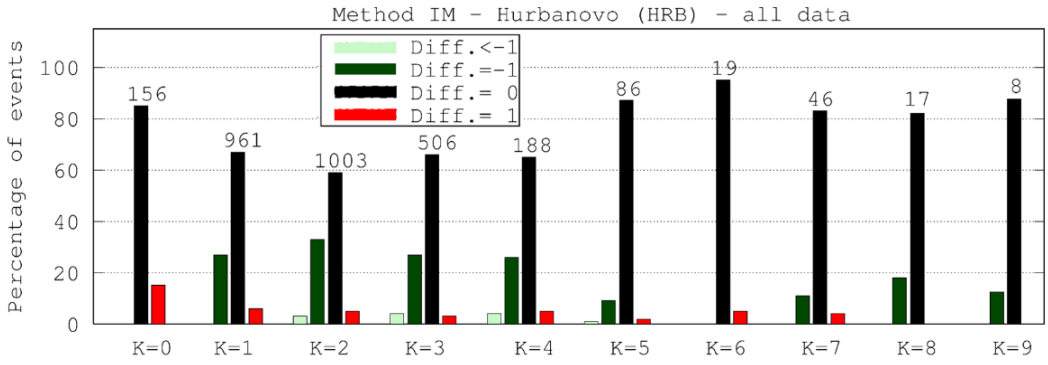
Geophysical fingerprints of shallow cultural structures from microgravity and GPR measurements

Four medieval crypts and west wall foundations of the former Romanesque construction were successfully delineated in the nave of the Church of St. George in Svätý Jur using microgravity and GPR methods. The results from harmonic inversion combined with GPR and density modelling helped to construct a spatial model of these cultural features, which is now added into the visualisation of the visible parts of the church. Pánisová et al. (2016) in Journal of Applied Geophysics have shown that 2D geophysical images or quantitative interpretations in form of 3D models can be easily incorporated into virtual databases of built heritage.



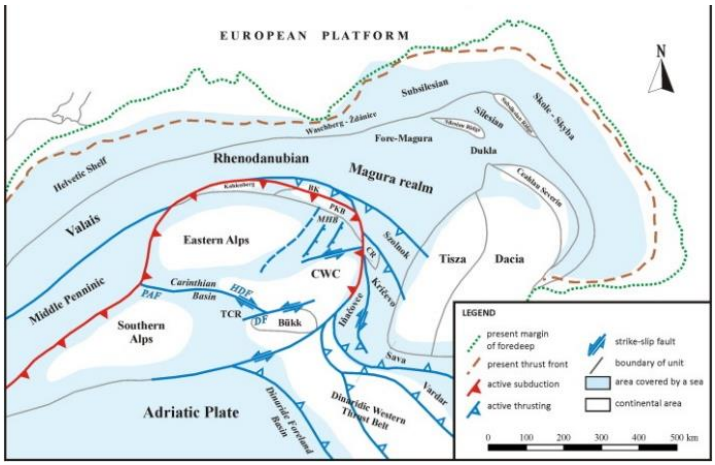
An interactive computer method (IM) for producing K indices

An interactive computer method (IM) for producing K indices on the base of digital magnetograms was developed by Valach et al. (2016) in two papers published in Journal of Atmospheric and Solar-Terrestrial Physics. For high level of the geomagnetic activity (K index at least 5) the IM method performs better than the up-to-date codes FMI and AS.



Paleogene palaeogeography and basin evolution of the Western Carpathians

Using new geological, sedimentological, biostratigraphical, and structural data from the Outer and Central Western Carpathians and North Pannonian Domain, the Paleogene basin evolution, palaeogeography, and geodynamics of the Western Carpathian and Northern Pannonian Basin is newly interpreted in a comprehensive study by Kováč et al (2016), supported by a series of palinspastic and palaeotopographic maps.



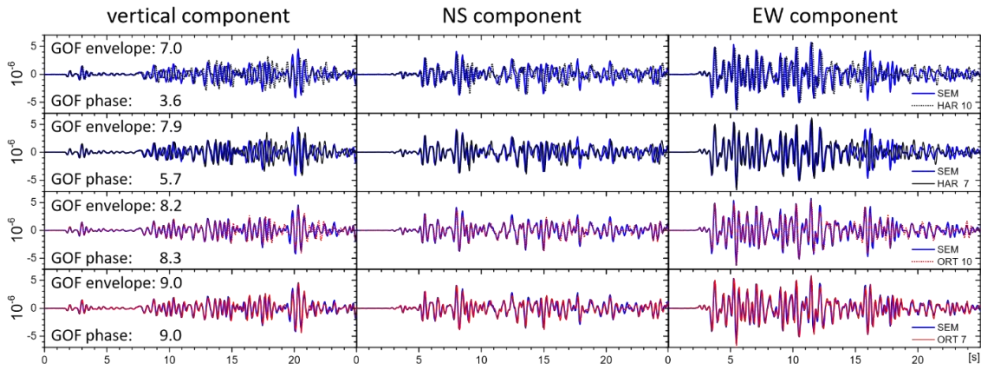
2017

Deep-seated Carbonatite Intrusion and Metasomatism in the Scandinavian Caledonides

Carbonatites (sensu stricto) are igneous rocks typically associated with continental rifts, being emplaced at relatively shallow crustal levels or as extrusive rocks. Some carbonatites are, however, related to subduction and lithospheric collision zones, but so far no carbonatite has been reported from ultrahigh-pressure metamorphic terrains. In the study by Ravna et al. (2017, Journal of Petrology), we present detailed petrological and geochemical data on carbonatites from the Nappe – an ultrahigh-pressure metamorphic terrain in the Scandinavian Caledonides. We suggest that the primary carbonatite magma resulted from partial melting of a carbonated eclogite at ultrahigh pressure, in a deeply subducted continental slab. Microdiamonds found in gneisses (Janák et al. ,2013) intruded by carbonatite are often associated with carbonates, hence formation of diamond by crystallization from carbonatite melt was likely.

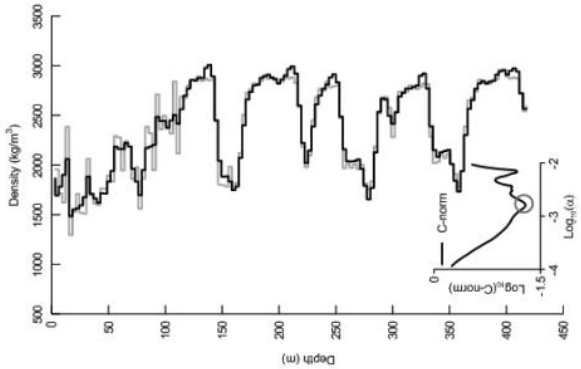
An orthorhombic representation of a heterogeneous medium for the finite-difference modelling of seismic wave propagation

The possibility of applying one explicit finite-difference scheme to all interior grid points (points not lying on a grid border) no matter what their positions are with respect to the material interface is one of the key factors of the computational efficiency of the finite-difference modelling. Smooth or discontinuous heterogeneity of the medium is accounted for only by values of the effective grid moduli and densities. Accuracy of modelling thus very much depends on how these effective grid parameters are evaluated. Kristek et al. (2017) have developed a new orthorhombic representation of a heterogeneous medium for the finite-difference modelling, and numerically demonstrated its superior accuracy. Compared to the harmonic-averaging representation the orthorhombic representation is more accurate mainly in the case of strong surface waves that are especially important in local surface sedimentary basins. The orthorhombic representation is applicable to modelling seismic wave propagation and earthquake motion in isotropic models with material interfaces and smooth heterogeneities using velocity-stress, displacement-stress and displacement FD schemes on staggered, partly-staggered, Lebedev and collocated grids.



Density function evaluation from borehole gravity meter data – regularized spectral domain deconvolution approach

A new method of transforming borehole gravity meter data into vertical density logs was developed by Karcol and Pašteka (2017) based on the regularized spectral domain deconvolution of density functions. It is a novel alternative to the “classical” approach, which is very sensitive to noise, especially for high-definition surveys with relatively small sampling steps.



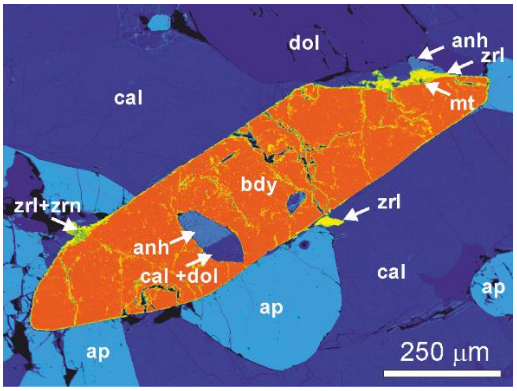
Interpretation of gravity and magnetic data with geological constraints for 3D structure of the Thuringian Basin, Germany

A novel method was applied by Prutkin et al. (2017) for the separation of potential field sources and their 3D inversion at the regional study area of Thuringian Basin in central Germany. The gravity and magnetic data are separated into long, medium and short wavelengths and then inverted separately. The authors studied uniqueness of the solution and its stability in all numerical steps of the interpretation process and to demonstrate, how geological constraints can diminish the degree of non-uniqueness by the interpretation of the gravity and magnetic anomalies. The numerical experiments with medium wavelengths revealed that if we explain negative anomalies with the topography of near-surface layers, the obtained solution is not supported by borehole data. These negative anomalies are thus explained by restricted bodies (granitic intrusions) at the depths from 4 down to 10 km. These bodies are located above a density interface with topography at the depth of approximately 10 km. By means of the 3D inversion of magnetic data (at short wavelengths) two uplifts in the depths between 2.0 and 0.7 km were found. By using the residual negative anomalies the salt tectonics was studied, and it was shown that the geometry of a salt pillow with a thickness of approximately 200 m closely agrees with borehole data.

2018

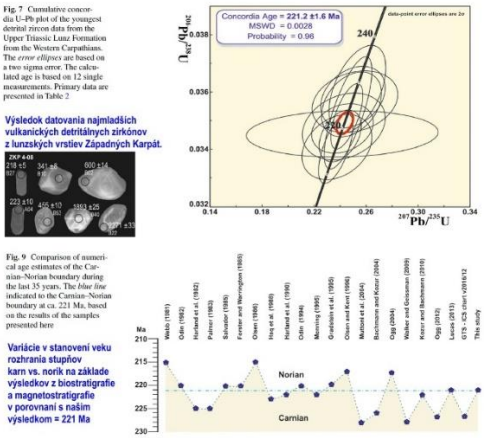
Compositional variations of zirconolite: an indicator of magmatic-hydrothermal conditions during post-orogenic collapse of Gondwana

Hitherto unknown REE- and U-Th-rich zirconolite types have been described in the Evate apatite-magnetite-carbonate deposit in eastern Mozambique by Hurai et al. (2018). Both zirconolite types contain locally increased Nb and Ta concentrations (up to 6 wt% Nb2O5+Ta2O5). Fe3+ predominates over Fe2+ in all zirconolite types, thus enabling the high REE content (28 wt. % REE2O3 in Nb-poor zirconolites to be stored in locally dominant REEZrTiFe3+O7 component known so far only as a synthetic analogue of natural zirconolite. Other zirconolite types are dominated by the common CaZrTi2O7 end member, but the “synthetic” REEZrTiFe3+O7 and another “synthetic” (U,Th)ZrFe3+2O7 component are also abundant. U-Pb-Th age of early U,Th-zirconolite corresponds to 485±9 Ma. Substitutional trends of the REE-zirconolite overlap magmatic deposits associated with carbonatites and syenites, whereas the U,Th-zirconolite is compositionally similar to that from hydrothermal-metasomatic deposits. The predominance of Fe3+ in zirconolite reflects oxidizing fluids percolated during Ordovician-Cambrian rifting of Gondwana.



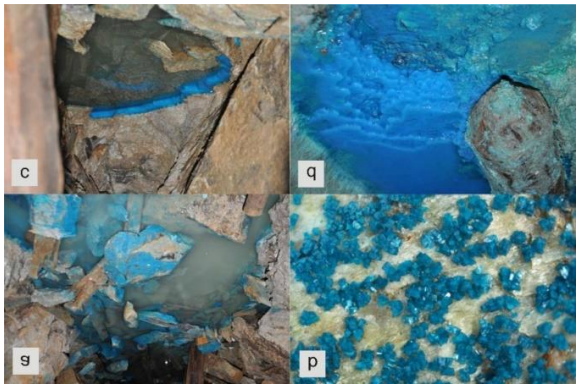
Tracking the Carnian Crisis in the Western Carpathians

Kohút et al. (2018) studied detrital zircons and their dating with the help of LA ICP-MS from the Lunz Formation of the Western Carpathians. The work was realized in the framework of the scientific collaboration with the Senckenberg Naturhistorische Sammlungen, Museum for Mineralogy and Geology, Geochemistry Section, Königsbrücker Landstrasse, Dresden, Germany (Prof. Ulf Linnemann and Dr. Mandy Hofmann). We found with German colleagues, that these clastic sediments were derived from several sources, especially: a) from the recycled Variscan orogen; b) from the remote East European Platform; and c) from the contemporaneous Triassic volcanic sources so called Pietra Verde. The Lunz Formation – marine delta sediments represents a typical product of the "Carnian Crisis"—a major climate change and biotic turnover that occurred during the Carnian stage in the Tethys Ocean within the carbonate shelf and intrashelf basins in the Northern Calcareous Alps and the Western Carpathians. The current age of the Carnian–Norian boundary is listed on the International Chronostratigraphic Chart (International Commission on Stratigraphy 2017 Edition) at ca. 227 Ma. However, our the Pietra Verde vulcanite zircon age determination (221.2 ± 1.6 Ma) separated from the synchronous Lunz Formation of the Western Carpathians, shifts the age of the Carnian–Norian boundary ca. 6 Million years earlier at ca. 221 Ma ago. The importance of the paper is because this is the first time used of a detrital zircon dating for real stratigraphic determination in the entire Alpine-Carpathian realm.



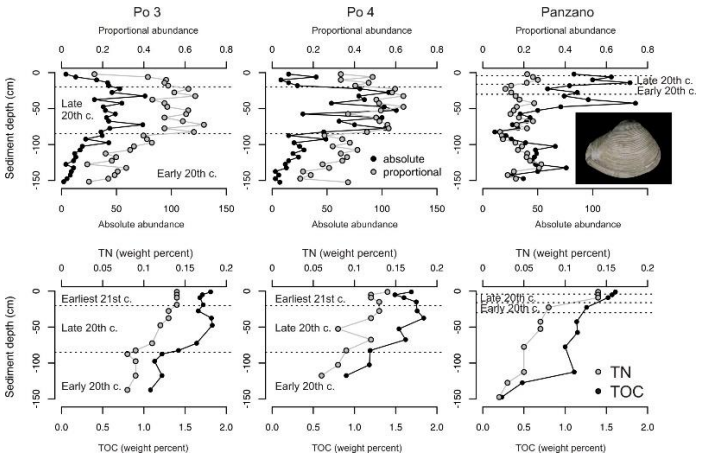
Mineralogy and geochemistry of the copper-dominated neutral mine drainage

The neutral mine drainage system at Ľubietová is dominated by copper and sulfate. It is generated by oxidative dissolution of chalcopyrite, as confirmed by sulfur isotopes. Its neutral nature is maintained by buffering via the primary carbonates. The oxidation zone, composed of Cu phosphates and carbonates (libethenite, pseudomalachite, malachite) plays minor role in the mine drainage generation. The water is discharged through the lowermost adits in the ore field; inside the adit, blue gel covers the stream and converts slowly to crystalline copper sulfate - langite. Outside the adits, redox cycling of Cu was observed. Nanocrystals of native copper crystalize on rock-forming minerals. Cu content is reduced by factor of 100 when mine drainage after 1 km reaches the river. Sulfur isotopes document that no copper sulfides are precipitating; but sulfates or carbonates. The natural attenuation could be responsible for the enrichment of sediments with copper (about few metric tons in size) (Majzlan et al. 2018).



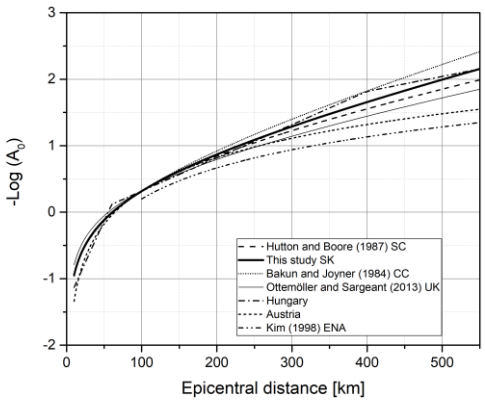
The effects of eutrophication on molluscan communities in the Adriatic Sea

Estimating the effects and timing of anthropogenic impacts on the composition of macrobenthic communities is challenging because the 19th and the early 20th-century biological surveys are sparse and the corresponding intervals in sedimentary sequences are mixed by bioturbation. To assess the effects of eutrophication and hypoxia on macrobenthic communities in the northern Adriatic Sea, Tomašových et al. (2018) analyzed sizes and abundances of molluscan assemblages in sediment cores collected at 10-20 m water depths. We showed that, first, pervasively bioturbated muds typical of highstand conditions deposited in the early twentieth century were replaced by muds with relicts of flood layers and high content of total organic carbon deposited in the late twentieth century. Second, dating of the bivalve Corbula gibba shells shows that the shift from the early to the late twentieth century is characterized by a decrease in stratigraphic disorder and by an increase in temporal resolution of assemblages from ~25–50 years to ~10–20 years. This shift reflects a decline in the depth of the fully mixed layer from more than 20 cm to a few centimeters. Third, the increase in shell size and abundance of the opportunistic species Corbula gibba and the extinction of hypoxia-sensitive species coincided with the decline in bioturbation and higher frequency of seasonal hypoxia in both regions.



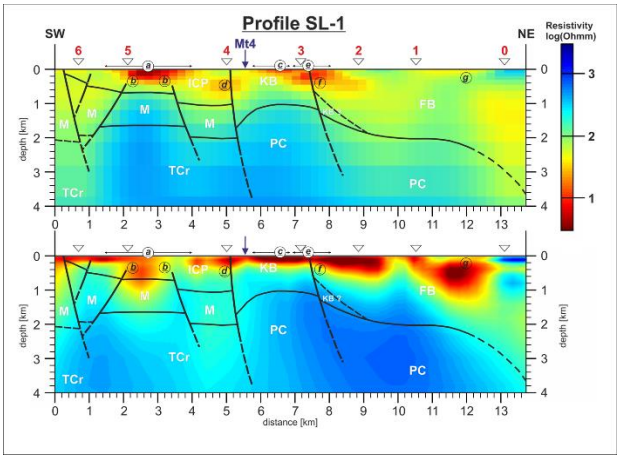
A local magnitude scale for Slovakia

Each country or region should have its own formula for estimating a local magnitude of local earthquakes which consistently reflects the seismic attenuation behavior of the region. Until now, the Hutton and Boore (1987) scale derived for Southern California was used for local magnitude estimation in Slovakia because of similar attenuation properties of the regions. Chovanová and Kristek (2018) have determined the distance correction term and the attenuation term of the local magnitude scale from collected trace amplitudes of earthquakes recorded by the National Network of Seismic Stations (NNSS) from 2005 to 2016 using linear regression analysis. Additionally the station corrections for the nine seismic stations of NNSS have been estimated for the first time. Using the newly determined scale reduces error by up to 58% compared to the formula previously used. Since both local magnitude formula and ground motion prediction equation (GMPE) are attenuation relationships, their similarity can be used in seismic hazard analysis.



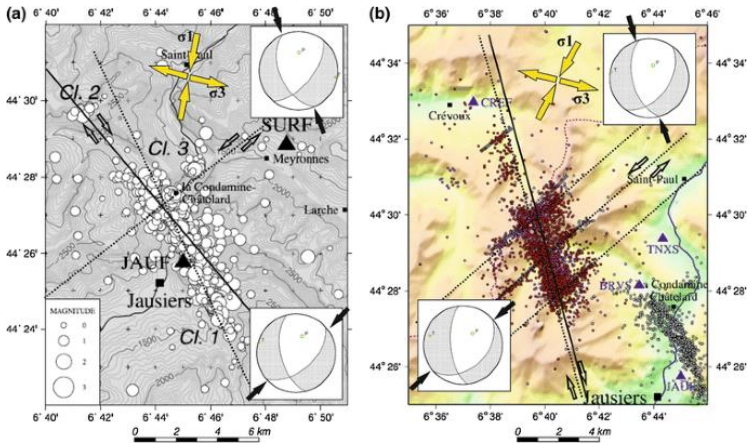
Klippen Belt, Flysch Belt and Inner Western Carpathian Paleogene Basin Relations in the Northern Slovakia by Magnetotelluric Imaging

The structural model of the space relations of the Klippen Belt with the Inner Carpathian Paleogene and also with Outer Flysch Belt units was constructed by Majcin et al. (2018) on the base of the magnetotelluric measurements interpretation in the region near Stará Ľubovňa. The research includes also hydrogeological structures of the studied region and the relations to the Ružbachy horst structures. The results have direct application at appraisal of the geothermal energy source parameters within the studied region. We used the innovative approach for interpretation of the MT measurements from independent 2D and 3D models of the electric conductivity distribution models in upper parts of the Earth crust and another geological and geophysical knowledge (Majcin et al. 2017).



Tectonic stress regime in the 2003–2004 and 2012–2015 earthquake swarms in Ubaye Valley

Fojtiková and Vavryčuk (2018) studied two earthquake swarms that occurred in the Ubaye Valley, French Alps within the past decade: the 2003–2004 earthquake swarm with the strongest shock of magnitude ML = 2.7, and the 2012–2015 earthquake swarm with the strongest shock of magnitude ML = 4.8. We applied the iterative joint inversion for stress and fault orientations developed by Vavryčuk (2014) to focal mechanisms. The retrieved stress regime is consistent for both seismic activities. The σ3 principal axis is nearly horizontal with azimuth of ~ 103°. The σ1 and σ2 principal axes are inclined and their stress magnitudes are similar. The active faults are optimally oriented for shear faulting with respect to tectonic stress and differ from major fault systems known from geological mapping in the region. The estimated low value of friction coefficient at the faults 0.2–0.3 supports an idea of seismic activity triggered or strongly affected by presence of fluids.



Accessory minerals and evolution of tin-bearing S-type granites

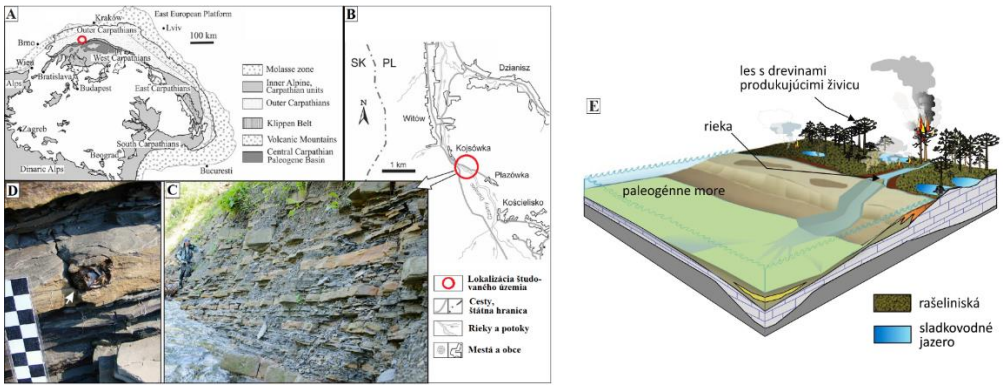
The S-type accessory mineral assemblage of zircon, monazite-(Ce), fluorapatite and tourmaline in the cupolas of Permian granites of the Gemeric Unit underwent compositional changes and increased variability and volume due to intensive volatile flux. Broska and Kubiš (2018) decribed rare-metal granite in the Western Carpathians which evolved in granite cupolas in the Permian Gemeric Unit. The formation of rare-metal granite apexes caused intrusion of fluid-rich magmas

which derived from deeper seated porphyritic magma by second boiling during emplacemen. Rare-metal granites in apexes and porphyritic bioitite granite form now composite granites.

2019

Amber and organic matter from the late Oligocene deep-water deposits of the Western Carpathians

The recent unique finding of amber in the Central Carpathian Paleogene sediments near the Slovak-Polish border represented an ideal opportunity to obtain valuable information about the origin and fate of this fossilized more than 20 million years old resin, as well as the nature of the environment, from which the amber came. The research by Kotulová and Starek (2019) suggests that amber is a fossilized resin that had originally been exuded from a conifer tree of the Araucariaceae family. At present, this plant species is no longer naturally present in the Northern Hemisphere. Resin-producing forests grew in the humid subtropical zone on the coast of the Paleogene Sea, and extensive peatlands spread out around the mouth of the river. Forest and peatlands were affected from time to time by wildfires and floods. Peats and surface vegetation fires could reach temperatures between 370-750 °C. Even the amber itself was briefly exposed to a fire-temperature of about 250 °C. Analysis of char particles indicated recurring high-severity wildfires that could reach temperatures well above 980 °C. Such high temperatures are typical of intense forest fires that spread in the treetops. During the flood, the altered amber was flushed into the river and transported along with the sediments to the deep-sea environment. As a result of the rapid burial under that sediments, amber remained relatively well preserved to the present day.



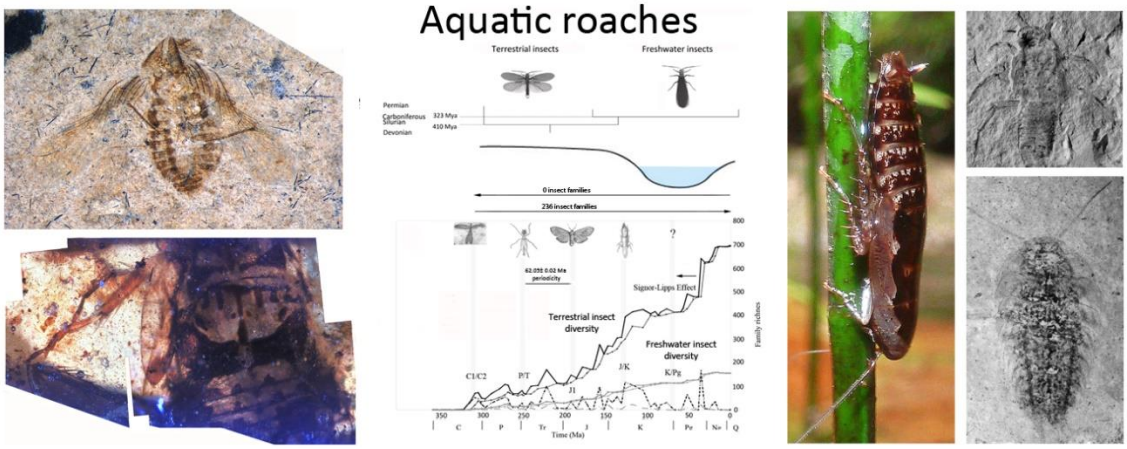
A decline in carbonate production driven by the loss of vegetated habitats in the Gulf of Trieste

Seasonal hypoxic conditions leading to mass mortalities and the collapse of shallow-water seagrass communities characterized the history of marine communities in the northern Adriatic Sea in the late 20th century. These changes can be detected and quantified in stratigraphic sections visible in sediment cores. We quantified paleoecological trends in the composition and diversity of molluscan communities in two sediment cores collected in the southern Gulf of Trieste at locations with very slow sedimentation rates. Time averaging of 5-10 cm-thick core increments attains 1,000-2,000 years and stratigraphic decline in diversity and in population density of molluscs that occurred over the past 200 years are obscured by bioturbation. However, with stratigraphic unmixing based on radiometric dating, we were able to show that a strong decline in abundance of species associated with seagrasses occurred at the 19th-20th century transition (Tomašových et al. 2019).

Ancient roaches further exemplify 'no land return' in aquatic insects

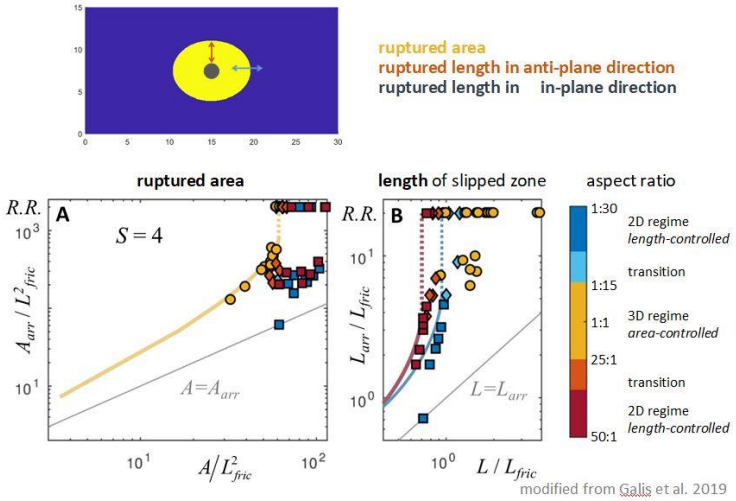
International consortium guided by P. Vršanský contributed to knowledge on evolutionary dynamics of aquatic insects. Comparative material was calibrated at 300, 270, 220, 151, 127, 115 and 98 Ma. For study of living equivalents, two expedition to primeval rainforests were conducted (UNESCO BR SUMACO, Equador). Discovery resulted in global analysis of all aquatic animals (Vršanský et al. 2019). 6.000 records of evolution of aquatic insects from the Mississippian to the present reveal that insect are incapable of returning to land once adapted to aquatic lifestyle. Originally, the partition of aquatic groups was small, and this ratio stabilized during the Triassic and is for nearly 250 million years constant. Majority aquatic lineages still survive, which is contrary to

terrestrial lineages. In insect history 236 invasions to water occurred, but reversal is absent at all (0). This contrast with vertebrates, which frequently return to land. Thus it is doubtful that the first insect was aquatic. Living aquatic cockroaches in Ecuador swim extremely rapidly (1 ms-1) and though they are without a single macroscopic adaptation, adaptations are disclosed in nanosurfaces. They belong to the most progressive lineages.



Initiation and arrest of earthquake ruptures due to elongated overstressed regions

Natural and induced earthquakes are nucleated in areas where shear stress is close to fault strength. In many situations, these asperities are very elongated; for example, in the case of a fault intersecting a reservoir subject to fluid-injection, or the stress concentration along the bottom of a seismogenic zone induced by deep fault creep. Theoretical estimates of the minimum asperity size leading to runaway rupture and of the final size of self-arrested ruptures are only available for 2D problems and for 3D problems with an asperity aspect ratio close to 1. We studied how the nucleation of ruptures on elongated asperities, and their ensuing arrest, depends on the size and aspect ratio of the asperity and on the background stress. We found that if the shortest asperity side is smaller than the 2D critical length, the problem reduces to a 2D problem, in which the shortest length of the asperity controls rupture evolution. Otherwise, rupture is controlled by the asperity area, as in a 3D problem. In the context of induced seismicity, our model provides insights into the conditions leading favourable or challenging conditions for traffic light systems (Gális et al. 2019).



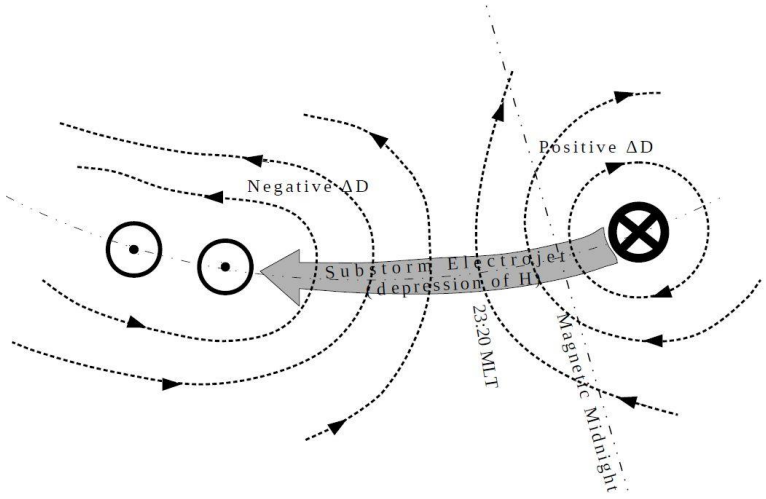
A discrete representation of a heterogeneous viscoelastic medium for the finite-difference modelling of seismic wave propagation

The accuracy and efficiency of numerical simulations of seismic wave propagation and earthquake ground motion in realistic models strongly depend on discrete grid representation of the material heterogeneity and attenuation. We have developed a new orthorhombic representation of a heterogeneous viscoelastic medium with interfaces. Heterogeneity of the medium in a finite-difference cell is represented by an averaged medium with an orthorhombic anisotropy. Effective material grid parameters are evaluated numerically as volume orthorhombic averages in the grid

cells centred at the grid positions of the corresponding stress components. The representation is applicable to the velocity–stress, displacement–stress and displacement FD schemes on staggered, partly staggered, Lebedev and collocated grids. We also found an optimal procedure for a joint determination of the anelastic coefficients and relaxation frequencies for an arbitrary Q(ω) law (Kristek et al. 2019).

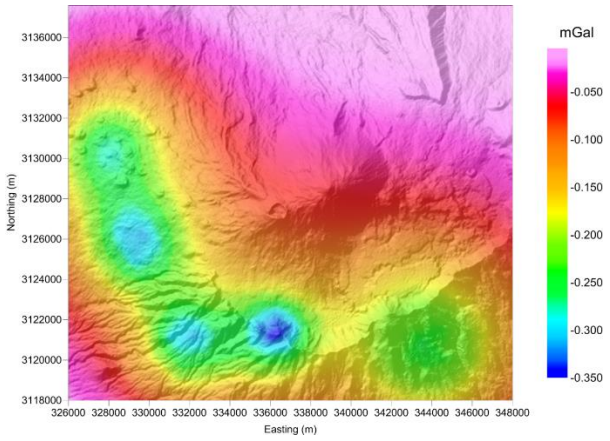
Two intense magnetic storms recorded by old mid-latitude observatories Clementinum and Greenwich

We analyzed two extremely intensive magnetic storms. The event of 17.11.1848, which has been unknown to the scientific community, was observed in Prague by means of Gauss's type bifilar magnetometer. The storm of 4.2.1872, however, is known to be the most intense storm in the modern history, as regards the extent of accompanying auroras. Both events were characterized by swift depression of the horizontal intensity (>400 nT and >500 nT) and the auroral oval appeared at low latitudes. We interpreted the storm of 1848 to be due to the substorm electrojet and attributed the unusual course of the 1872 event to a combination of a ring-current storm with the eastward electrojet. Contrary to the theory accepted so far, the studied events demonstrate that the violent events which are well known in high magnetic latitudes, may appear at lower latitudes too and present dangerous phenomena for the environment there (Valach et al. 2019).



Deformation-induced topographic effects in interpretation of spatiotemporal gravity changes (review)

Vajda et al. (2019) have improved the methodology of compiling and interpreting residual spatiotemporal gravity changes in volcanic areas (Tenerife, Canary Islands) by deriving an accurate expression for the deformation-induced topographic effect used as a correction in residual gravity changes evaluation. This improved methodology may improve the gravimetric assessment of volcanic hazard associated with magma rejuvenation and migration.



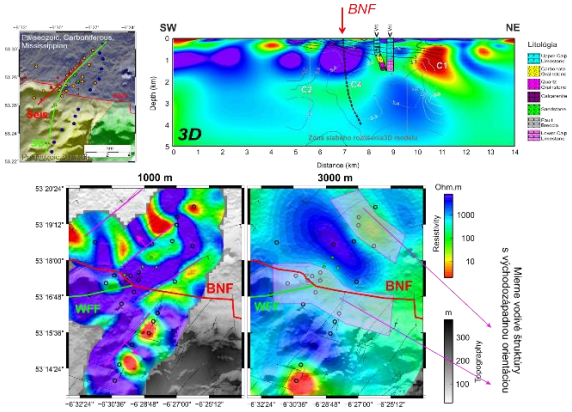
Reproductive phases of Miocene algae from central Paratethys

Coralline algae that were widely distributed and diverse in shallow-water habitats during the Miocene in the central Paratethys are useful in paleoenvironmental and paleoclimatic studies. However, these inferences rely on accurate and robust species-level taxonomic identifications. Taxonomy of fossil coralline algae was traditionally based on morphology of bi/tetrasporophytes whereas taxonomy of extant coralline algae at species level is supported by characters that can be observed in the remaining life cycle phases. Therefore, Hrabovský (2019, Acta Palaeontologica Polonica) investigated morphology of reproductive phases in subfamilies Hydrolithoideae and Mastophoroideae from the middle Miocene of the central Paratethys. In addition, we also used coralline algae in the overall detection of ecostratigraphic events during the Middle Miocene (Holcová et al. 2019).

2020

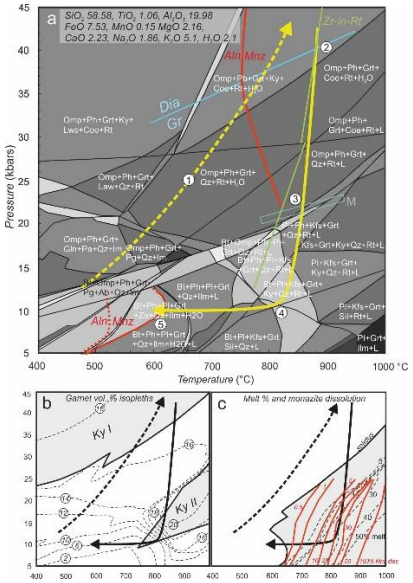
A geothermal aquifer in the dilation zones on the southern margin of the Dublin Basin

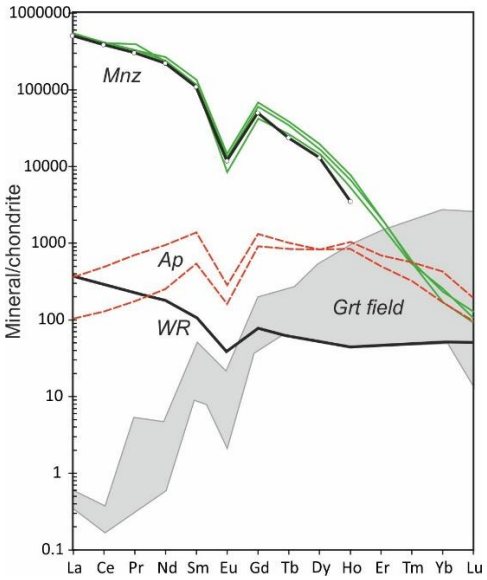
The geoelectric images of subsurface conductivity were derived based on magnetotelluric (MT) data from the Newcastle area near Dublin in Ireland for geothermal potential estimation. The conductivity models and their interpretation with existing seismic profiles and borehole information in the area reveals that the Blackrock–Newcastle Fault (BNF) zone is visible in the models as a conductive feature down to depths of 4 km. The investigated area below Newcastle can be divided into two domains in different depths, formed as depth zones. The first zone, from the surface down to 1–2 km, is dominated by NE–SW oriented conductors connected with shallow faults or folds probably filled with less saline waters. The conductors are also crossing the surface trace of the BNF. The second depth domain can be identified for depths of 2–4 km, where structures are oriented along the BNF and the observed conductivity is lower. The deeper conductive layers are interpreted as geothermal-fluid-bearing rocks. Porosity and permeability estimations from the lithological borehole logs indicate the geothermal potential of the bedrock, to deliver warm water to the surface. The rock permeability for fluids estimation, based on Archie's law for porous structures and synthetic studies of fractured zones, suggests a permeability in the range, which is prospective for geothermal energy exploitation (Vozár et al. 2020).



Monazite behaviour during metamorphic evolution of a diamond-bearing gneiss

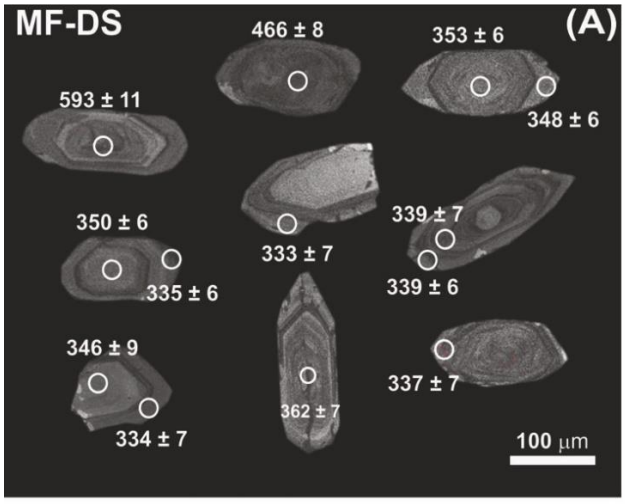
Monazite is an important mineral for dating of metamorphic processes - ultrahigh pressure (UHP) metamorphism. During metamorphic evolution monazite adapts its composition to the changing mineral assemblage especially by its heavy rare earth element contents. We studied this process in diamond-bearing gneiss containing monazite, from Saxnäs in the Seve Nappe Complex of the Scandinavian Caledonides which attained metamorphic conditions of 4.2 GPa and 830 - 840°C (Petrík et al. 2019). Monazite was formed from allanite during deep subduction (ca.150 km) of continental crust and during exhumation monazite was partialy dissolved in melt. Monazite composition shows negative Eu anomalies, which we interpret to be inherited from the source rock, not reflecting the coexistence with plagioclase which is unstable at UHP conditions. Our results suggest that the effect of whole-rock composition may be more important than that of coexisting phases.

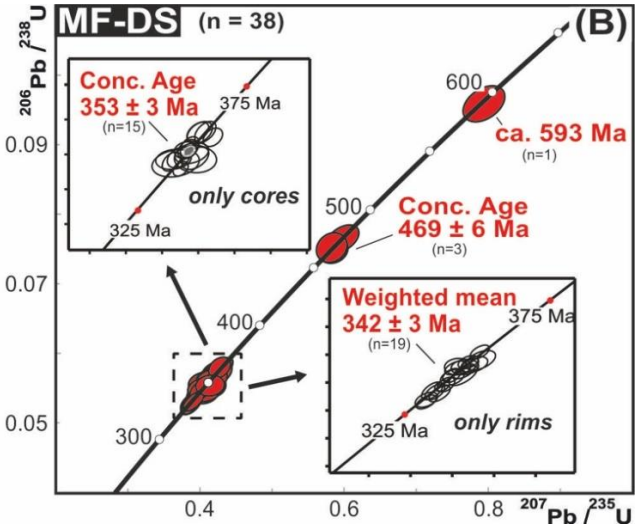




Early Carboniferous successive I/S granite magmatism recorded in the Malá Fatra Mountains by LA-ICP-MS zircon dating

Granite dating, carried out on the basis of cooperation with the Geological Institute of the Czech Academy of Sciences, shows multistage formation of the Malá Fatra granites in the range of 11 million years (from 353 mil. to 342 million years). The intrusion of a hot granite body into the Earth upper crust 342 million years ago thermally affected older granites as illustrate the origin of their newly-formed zircon rims on older cores (Broska and Svojtka 2020).

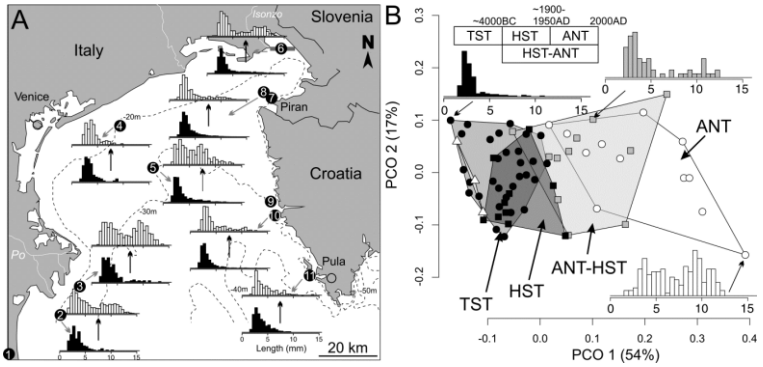




Ecological regime shift preserved in the Anthropocene stratigraphic record

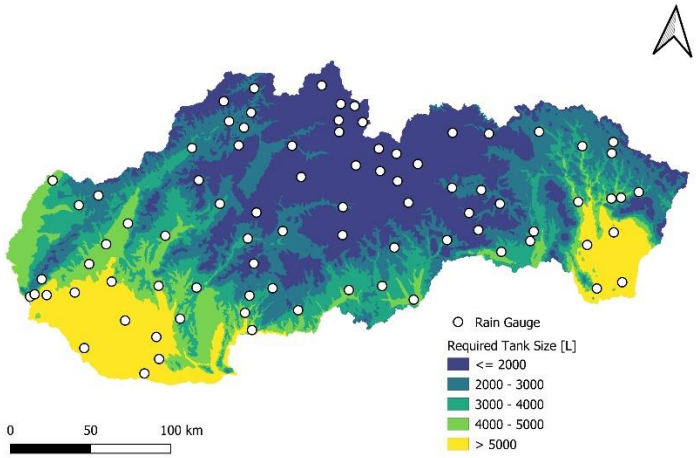
It is assumed that the stratigraphic record of continental shelves is too coarse (with centennial-millennial resolution) and incomplete to detect ecological processes taking place at yearly or decadal scales. However, on the basis of collaboration with colleagues from the University of Florida University of Vienna, and University of Bologna and supported by the APVV17-0555, Tomašových et al. (2020) found that the youngest (Anthropocene) stratigraphic record on the northern Adriatic continental shelf provides a relatively high, decadal-scale stratigraphic resolution that accurately documents an abrupt ecological change affecting benthic communities on this shelf during the twentieth century. They showed that the magnitude and the duration of the twentieth century shift in body size of the bivalve *Corbula gibba* is unprecedented given that regional populations of this species were dominated by small-size classes throughout the Holocene. Larger size and higher abundance of bivalves coincide with an increase in the frequency of seasonal hypoxia during the late 20th century. Importantly, the higher frequency of hypoxic events is coupled with a decline in the depth of intense sediment mixing by burrowing benthic organisms from

several decimetres to less than 20 cm, significantly improving the stratigraphic resolution of the Anthropocene fossil record. In the absence of this decline in the depth of bioturbation, the stratigraphic resolution would be poor even at sites with high sedimentation rates.



The effects of rainfall characteristics on the sizing of rain barrels in Slovakia

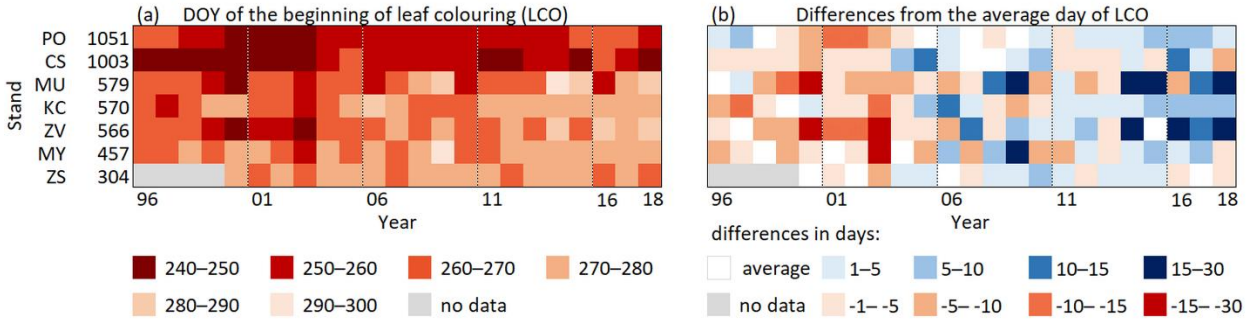
The article by Onderka et al. (2020) analyzes spatial variability of atmospheric precipitation and its impliocations for the design of small-scale water harvesting projects. Torrential rains and periods of prolonged drought are becoming more intense and frequent phenomena in Slovakia. Rainwater harvesting measures reduce and slow down the runoff of water from paved surfaces such as roofs and parking lots, and at the same time positively affect the microclimate in cities during hot summer days. In our recent study (https://doi.org/10.1016/j.ejrh.2020.100747) we analyzed rainfall data in order to provide location-specific design parameters for rainwater tanks. With the help the published statistics of rain episodes, every homeowner in Slovakia can now estimate the optimal volume of the rainwater tank for a desired location, rooftop catchment area and the water consumption rate.



Autumn phenological response of european beech to summer drought and heat

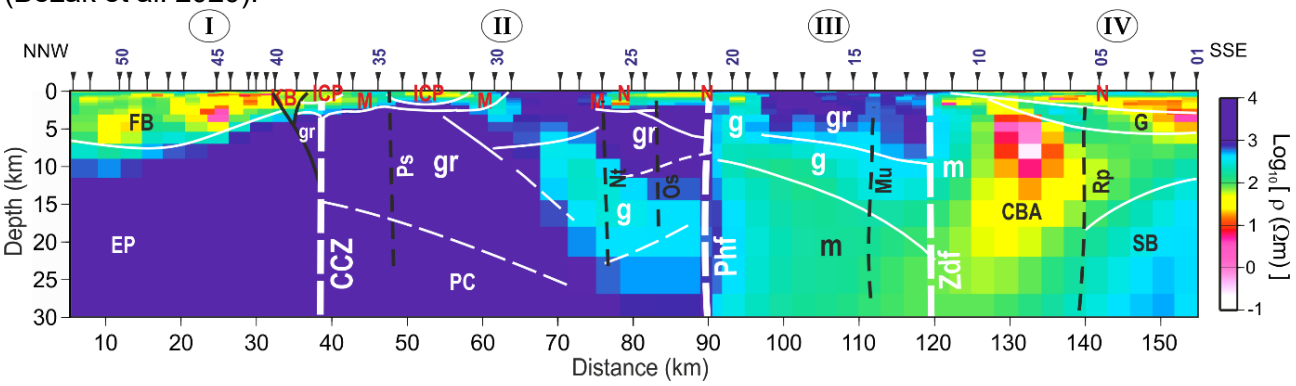
The changes in precipitation and temperature regimes brought on by the current climate change have influenced ecosystems globally. Using phenological and meteorological data from 1996–2018, we analysed changes of the onset of leaf colouring in European beech (Fagus sylvatica, L.) as an important native tree species growing throughout Europe. While at the beginning of the studied period the earliest onset of leaf colouring of European beech was observed at low altitudes, over the last decade it was observed to start at the middle altitudes concurrently with the low altitudes or even later. At present, the increase in precipitation and rising temperatures are advantageous for beech at most stands at middle to high altitudes. There the trend of delayed onset of leaf colouring is significant. However, at the low altitudes, we discovered a significant negative effect of drought prior to the leaf colouring leading to an earlier onset. This indicates that the meteorological drought conditioned by lower precipitation total and higher evapotranspirative demands in the warmer climate advances the leaf senescence and the growing season ends earlier. Furthermore, we revealed the first signs of the commencing negative effect of drought at mid-altitudes at stands with lower (below 700 mm) annual precipitation total. The ongoing warming

trend of summer months suggests a continual increase of evapotranspiration in the next decades and thus further intensification of droughts, which will limit the growing season duration of beech at the low as well as middle altitudes (Lukasová et al. 2020).



Geoelectrically distinct zones in the crust of the Western Carpathians: A consequence of Neogene strike-slip tectonics.

Based on magnetotelluric modelling and other geophysical methods (seismic, gravimetric, partly geothermic), significant interfaces in the crust of the Western Carpathians were identified. These are steeply inclined tectonic interfaces, where the crustal blocks with different physical properties and thus different geological composition meet. Interfaces represent mostly Neogene transform shear zones, although some of them may have been older origin. These tectonic zones separate the European platform with the overthrusted outer flysch units from the inner Western Carpathians and the sub-blocks within the Western Carpathians (northern granitized block, the middle formed mainly by metamorphites and the southern altered by young volcanic and hydrothermal processes) (Bezák et al. 2020).



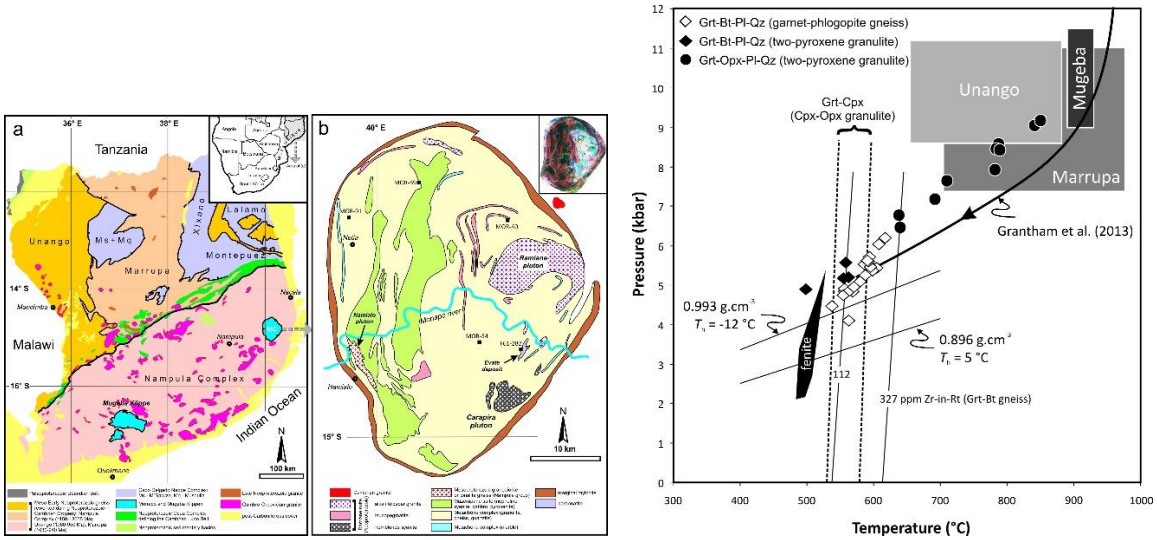
Fluorapophyllite-(NH4)-a new member of the apophyllite group

Fluorapophyllite-(NH4), ideally NH4Ca4(Si8O20)F·8H2O is a new member of the apophyllite group and one of a few natural minerals containing NH4 groups. It was found at the Vechec andesite quarry located near Vechec village, Vranov nad Topľou Co., Prešov Region, Slovak Republic. Fluorapophyllite-(NH4) occurs in cavities of quartz-illite-saponite-tobelite xenolith embedded in pyroxene andesite. It is a hydrothermal mineral, which was formed at the late stage of an (auto)-hydrothermal alteration of the xenoliths together with calcite and zeolites. The crystal structure of fluorapophyllite-(NH4), refined to R1 = 0.0299 for 743 unique (I > 3□I) observed reflections, confirmed that the atomic arrangement is very similar to that of the other members of the apophyllite group (Števko et al. 2020).

2021

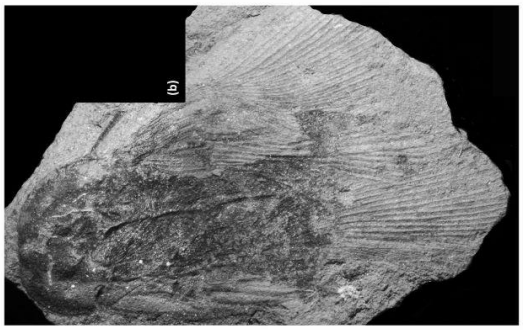
Thermobarometric and geochronologic constraints on the emplacement of the Neoproterozoic Evate carbonatite during exhumation of the Monapo granulite complex

The Evate carbonatite deposit in the Monapo granulite complex (Mozambique) is the resource of apatite for planned production of superphosphate fertilizer. Apart from this, the deposit is also the potential resource of graphite, molybdenite, actinoids and lanthanoids. Pressure-temperature trajectory of the granulite complex and the metasomatic fenite from the carbonatite margin were deciphered from the combination of thermobarometric methods based on mineral equilibria and fluid inclusions. The multi-proxy thermobarometric analysis and the U-Pb-Th dating of monazite revealed that peak metamorphic conditions in the Monapo nappe complex corresponded to a hot orogen (850 °C, 9 kbar). Alkalic metasomatism triggered by the carbonatite intrusion took place during retrograde metamorphic phase at temperatures between 530 and 480 °C and a 5.4-2.1 kbar pressure within the time interval between 590 and 573 Ma. Maximum depth of burial attained ~20 km and this datum represents the first exact information about the formation depth of an orogenic carbonatite (Hurai et al. 2021).



Cockroaches from Jurassic sediments of the Bakhar Formation in Mongolia

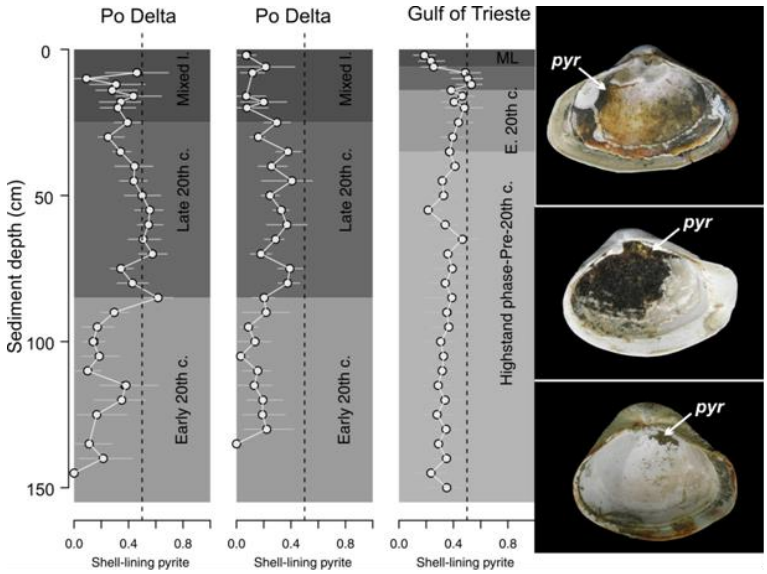
A first monograph on fossil cockroaches by Vršanský (2021) compares all Jurassic assemblages and investigates key locality Bakhar in Mongolia, revealing extreme diversity of insects. The monograph is based on more than a thousand samples, and contains descriptions of 32 new species (among just 300 Jurassic species known worldwide). It contains first data on variability of any (Middle) Jurassic organism and focuses on optimal climatic conditions as a reference point to the most important selectively studied Daohugou in China. The book is also important from the point of view of applied sciences due to the mining (the layers with cockroaches contain strategic coal and uranium).



Pyrite-lined shells as indicators of bioirrigation in the Anthropocene stratigraphic record

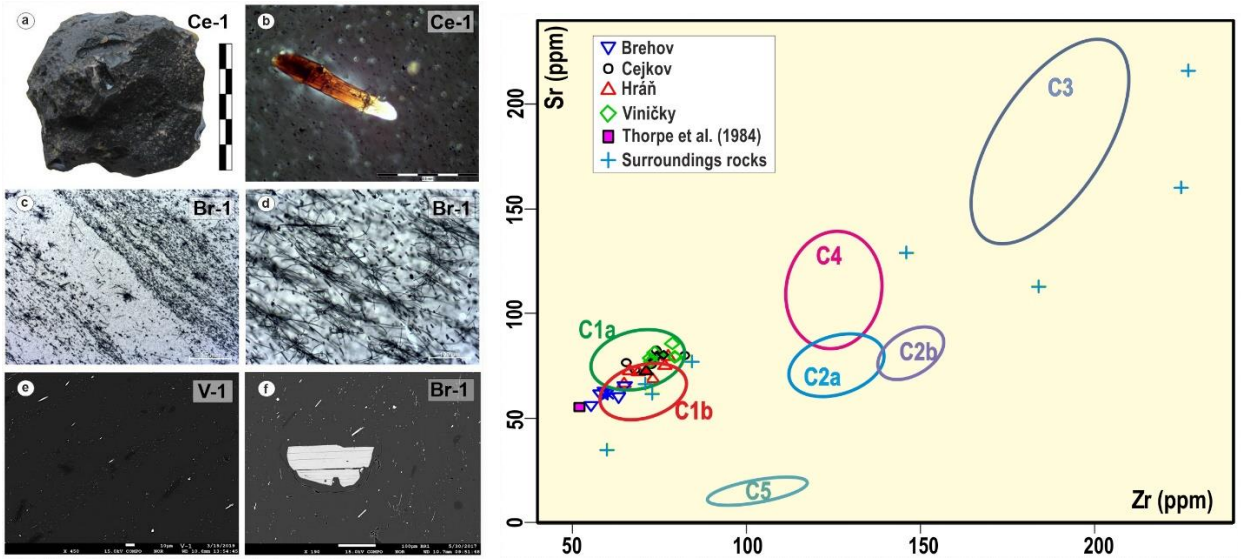
On the basis of preservation and geochronological dating of molluscan shells in sedimentary cores collected in the northern Adriatic Sea, we have found that during the 20th century, the frequency of dead shells coated by framboidal pyrite (up to 40-50% of the total molluscan assemblage in individual sedimentary increments). Pyrite-lined shells are rare (less than 10-20%) in sediments

that were deposited prior to the 20th century. The geochronological dating of shells demonstrates also that framboidal pyrite that lines shells was formed under reducing conditions during the decomposition of organic matter very rapidly within shells – after a few years - after the death of molluscs. Our hypothesis is that these changes in shell preservation and in the frequency of pyrite-lined shells reflect a decline in the depth of the oxycline in sediments. This change coincides with the eutrophication that occurred in the northern Adriatic during the second half of the 20th century (Tomašových et al. 2021).



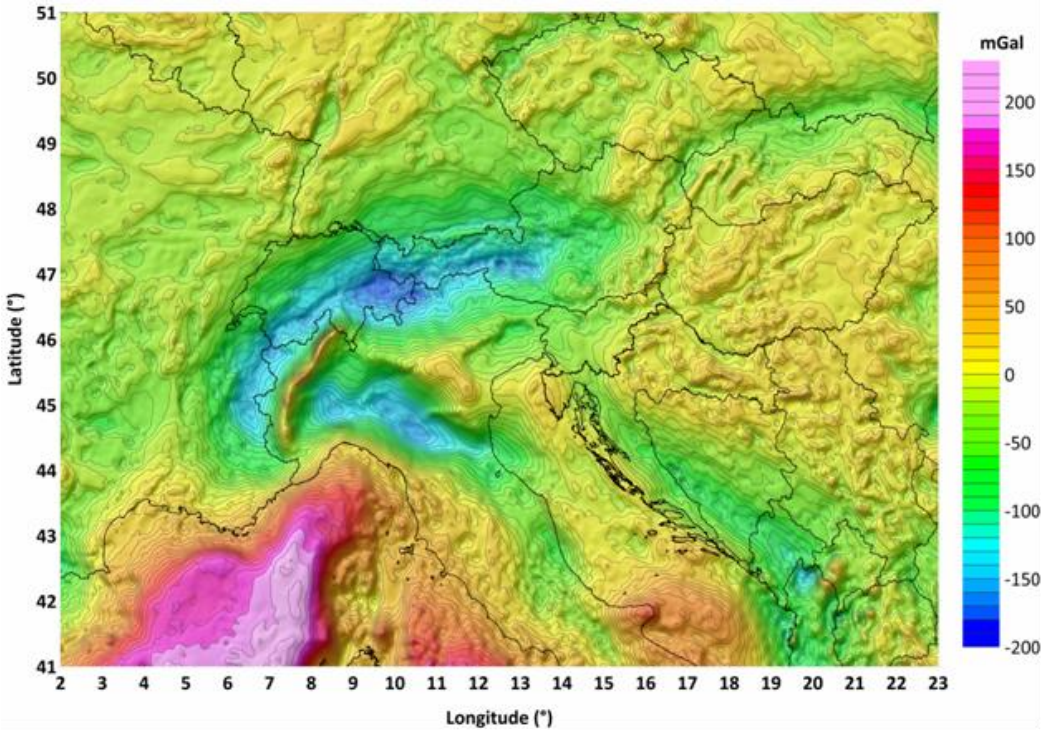
Fission-track dating and provenance of the Carpathian obsidians

The Carpathian obsidian samples from the Slovakian part of the Zemplín – Tokaj area have been studied by means of fission-track dating (FT) and geochemistry to better understand the provenance of the archaeological obsidians from the Central Europe realm (Kohút et al. 2021). New FT obsidian ages obtained by the isothermal plateau method (ITPFT) are in a narrow time interval between 12.45 ± 0.45 and 11.62 ± 0.25 Ma, and indicate a short-time monogenic volcanic evolution rather than a long-lasting volcanism over the 16–10 Ma period, as was previously thought. Chemical composition of the Carpathian obsidians clearly exhibits a common similarity among all examined localities (Brehov, Cejkov, Hraň, and Viničky). The presented results by Kohút et al. (2021) disprove the established opinion about two different sources of Carpathian obsidians in Slovakia (*C1a* - Viničky and *C1b* - Cejkov). A comprehensive provenance study, including physical properties of the obsidians, confirms a general congruence within the studied obsidians and the use of common provenance labelling, such as *Carpathian-1* (*C1*) for the Slovakian – Zemplín area obsidians, is recommended.



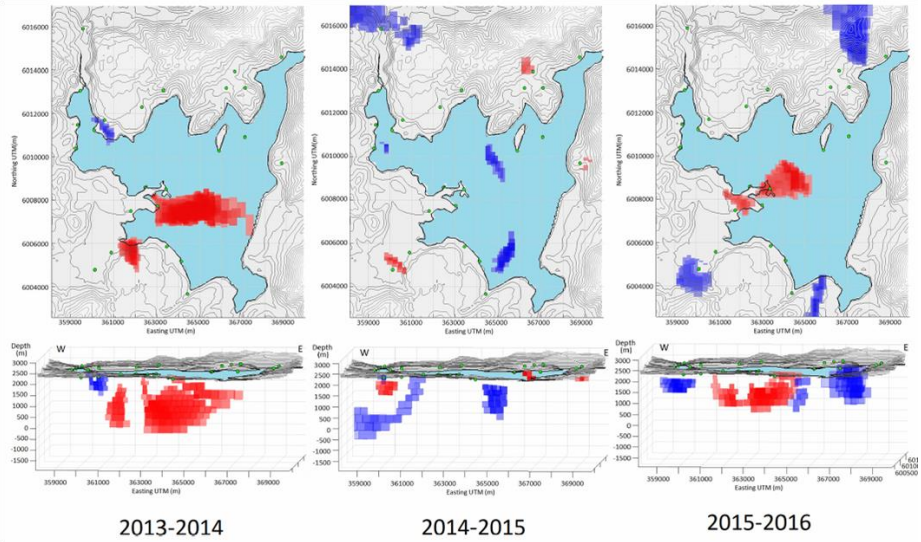
The first pan-Alpine surface-gravity database

The European AlpArray initiative, launched in 2015, improved our understanding of the geological development of the Alps and the seismic risk in the Alps-Apennines-Carpathians-Dinarides mountain system. The initiative integrated current Earth research with high-resolution geophysical imaging of 3D structures and the physical properties of the lithosphere and upper mantle, focusing on top seismological measurements. As part of this project, the AlpArray Gravity Research Group (AAGRG) was established, the aim of which was to compile a homogeneous gravity data set in the wider Alpine region. This database will be used to create a basic Bouguer anomaly map and to subsequent interpretations of the geological structure of the whole area. The primary output of the project was published in the world-leading journal Earth System Science Data (https://www.earth-system-science-data.net/). The article "The first pan-Alpine surface-gravity database, a modern compilation that crosses frontiers" was the result of several years of intensive cooperation between European gravimetrists and geodesists. Slovak researchers Dr. Zahorec, Dr. Papčo, Prof. Pašteka and Prof. Bielik (and their PhD. students, e.g. Mgr. Nogová) built a natural authority in this group through their own activity and work, which led them to play a leading scientific role in the creation of the first pan-Alpine surface gravity database. The published map of complete Bouguer anomalies of the wider Alpine region is homogeneous for the first time and compiled according to state-of-the-art criteria in terms of input data sets, applied methods and all corrections of the measured gravity acceleration (topography, bathymetry, atmosphere, special emphasis was placed on the gravitational effect of large mountain lakes, which are located in the studied area). The first interpretations of the new gravity map show that the resolution of gravity anomalies is appropriate and fully sufficient for integrated modelling of local, regional to continental geological structure of the European lithosphere, as well as for its joint inversion with other, especially seismic data sets. The data is published through GFZ Data Services (Zahorec et al. 2021).



Novel treatment of the deformation–induced topographic effect for interpretation of spatiotemporal gravity changes

Two methodically related results from one field of study were evaluated. The spatio-temporal changes observed in the Laguna del Maule volcanic region in the southern Andes (Chile) during three one-year intervals are the result of the migration of hydrothermal solutions released by the intrusion of fresh magma. We interpreted the changes using a modern inverse methodology based on the Growth approach. We corrected the measured changes in gravity by the gravitational effect of spatio-temporal surface deformation using a new method developed by us. Research on subsurface migration of hydrothermal solutions, as one of the main indicators of active volcanism, is of particular importance in predicting volcanic activity (Vajda et al. 2021, Camacho et al. 2021).

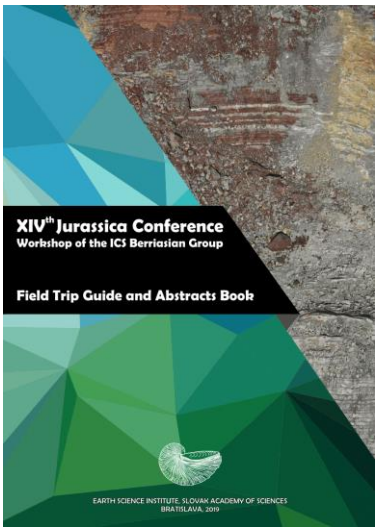


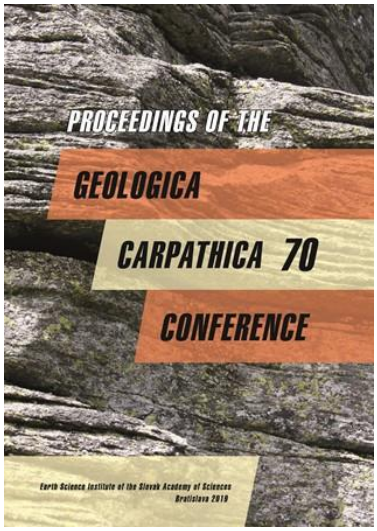
2.3.2. List of international conferences (co)organised by the institute

1. Snow measurements field campaign international workshop, Slovakia, Chopok, 20 participants, 14.02.-16.02.2016
2. 12th Jurassica Conference and Workshop of the ICS Berriasian Working Group meeting, Slovakia, Smolenice, 50 participants, 20.04.-22.04.2016
3. 3D MT III - Magnetotelluric 3D Inversion Workshop III, Italy, Bari, 30 participants, 16.05.-18.05.2016
4. Czech-Slovak seismologic days, Slovakia, Stará Lesná, 11.-14.10.2016
5. IWAF-10 - 10th International Workshop on Agglutinated Foraminifera, Slovakia, Smolenice, 45 participants, 19.04.-23.04.2017
6. Petros 2017, Slovakia, Bratislava, 25.05.-26.05.2017
7. 18th Czech-Slovak-Polish Paleontological Conference, Slovakia, Stará Lesná, 140 participants, 15.06.-16.06.2017
8. Open Geological Congress, Slovakia, High Tatras, Stará Lesná, 140 participants, 14.06.-17.06.2017
9. 13th Jurassica Conference and Workshop of the ICS Berriasian Working Group meeting, Poland, Krakow, 50 participants, 19.-23.06.2017

10. 2nd Conference on Natural Dynamos, Czech Republic, Valtice, 54 participants, 25.06.-01.07.2017
11. IEC – 12th International Eclogite Conference, Sweden, Are, 130 participants, 26.08.-29.08.2017
12. CAM2017 - Conference on Accessory Minerals, Austria, Vienna, Austria and Bratislava, Slovakia, 80 participants, 13.09.-19.09.2017
13. The SNOW - an Ecological Phenomenon Conference, Slovakia, Smolenice, 92 participants, 18.09.-21.09.2017
14. XXXIX. Radiation Protection Days, Slovakia, Stará Lesná, 215 participants, 06.11.-10.11.2017
15. 5th Central European Mineralogical Conference and 7th Conference of Mineral Sciences in the Carpathians, Slovakia, Banská Štiavnica, 94 participants, 26.06.-30.06.2018
16. 14th Jurassica International Conference and Beriasian Working Group meeting, Slovakia, Comenius University Science Park, Bratislava, 90 participants, 10.06.-14.06.2019
17. NMEM 2019 – Workshop on Numerical Modeling of Earthquake Motions: Waves and Ruptures, Slovakia, Smolenice, 82 participants, 30.06.-04.07.2019
18. Open Congress of the Czech Geological Society and the Slovak Geological Society, Czech Republic, Beroun, 100 participants, 03.09.-06.09.2019
19. Geologica Carpathica 70 Conference, Slovakia, Smolenice, 90 participants, 09.10.-12.10.2019
20. Transform Margins Workshop 2, Slovakia, Smolenice, 87 participants, 14.12.-16.12.2020
21. CETEG 2021 - 18th Meeting of Central European Tectonic Groups and 25th Meeting of the Czech Tectonic Group, Slovakia, Terchová - Vrátna, 120 participants, 22.09.-25.09.2021
22. XLII. Radiation Protection Days, online, 159 participants, 08.11.-12.11.2021

2.3.3. List of edited proceedings from international scientific conferences





1. XIIth Jurassica Conference : Workshop of the ICS Berriasian Group and IGCP 632, Slovakia, Smolenice, 20.04-22.04.2016 : Field Trip Guide and Abstracts Book. Editor: Jozef Michalík, Kamil Fekete. Bratislava : Earth Science Institute, Slovak Academy of Sciences, 2016. 131 p. ISBN 978-80-85754-36-0
2. Microfauna and biostratigraphy of the Mesozoic and Cenozoic formations of the Western Carpathians : Guidebook of the IWAF-10 field trip to Middle Valley and Malé Karpaty Mts. Editor Ján Soták, Natália Hudáčková, Jozef Michalík, Kamil Fekete, Štefan Józsa, Dušan Plašienka, Andrej Ruman, Samuel Rybár ; reviewer Daniela Reháková, Katarína Holcová. Bratislava : Earth Science Institute, Slovak Academy of Sciences, 2017. 173 p. ISBN 978-80-224-1574-3 (IWAF-10 - 10th International Workshop on Agglutinated Foraminifera, Slovakia, Smolenice, 19.04.-23.04.2017)
3. 18th Czech-Slovak-Polish Paleontological Conference and Open Geological Congress of the

Slovak Geological Society and the Czech Geological Society, Slovak Republic, Stará Lesná, 15.06.-16.06.2017. Abstracts Book and Field Trip Guide. Editor: Ladislav Šimon, Marianna Kováčová, Silvia Ozdínová, Jozef Michalík, Daniel Pivko, Viktor Goliáš, Pavel Bokr, Pavla Tomanová Petrová, Helena Gilíková ; reviewer Peter Reichwalder, Michal Elečko. Bratislava : Slovak Geological Society, 2017. 158 p. ISBN 978-80-972667-7-6. ISSN 2453-9732

4. Special Issue: Recent Developments in Natural Dynamos Introduction. In Geophysical and Astrophysical Fluid Dynamics, 2019, Vol. 113, No. 1-2, pp. 1-255. Editors: Ján Šimkanin, Juraj Kyselica, Jozef Brestenský, Peter Guba. ISSN 0309-1929 (II. Conference on Natural Dynamos, Czech Republic, Valtice, 25.06.-01.07.2017)
5. Special Issue "High- and ultrahigh-pressure rocks - keys to lithosphere dynamics". Journal of Metamorphic Geology, 2018, Vol. 36, No. 5, pp. 511-666. Guest editors: Charlotte Möller, Jaroslaw Majka, Marian Janák and Herman van Roermund. (IEC – 12th International Eclogite Conference, Sweden, Are, 26.08.-29.08.2017)
6. Special Issue: Recent progress in the study of accessoric minerals. Mineralogy and Petrology, 2017, Vol. 111, No. 4., pp. 431-658. Editors: Lutz Nasdala, Igor Broska, Daniel E. Harlov, Ray Macdonald. (CAM2017 - Conference - accessory minerals, Austria, Vienna, 13.09.-19.09.2017)
7. The SNOW - an Ecological Phenomenon Conference, Slovakia, Smolenice,18.09.-21.09.2017. Book of Abstracts. Editors: Bernard Šiška, Pavol Nejedlík, Mariana Eliášová. Bratislava : Czech Bioclimatologic Society : Earth Science Institute, Slovak Academy of Sciences: COST, 2017. 86 p. ISBN 9788085754407
8. XXXIX. Radiation protection days, Stará Lesná, 06.-10.11.2017. Book of abstracts. Editors: Iveta Smetanová, Helena Cabáneková. Bratislava : Slovak Medical University in Bratislava : Society of Public Health, 2017. 118 p. ISBN 978-80-89702-40-4
9. XIVth Jurassica Conference & Workshop of the ICS Berriasian Group : Field Trip Guide and Abstracts Book. Editors: Kamil Fekete, Jozef Michalík, Daniela Reháková. Bratislava : Earth Science Institute, Slovak Academy of Sciences : Faculty of Natural Sciences, Comenius University, 2019. 192 p. available online: http://geo.sav.sk/files/2019/Jurassica2019_guide-web.pdf. ISBN 978-80-85754-41-4 (XIVth Jurassica Conference, Bratislava, 10.06.-14.06.2019)
10. Workshop on numerical modeling of earthquake motions: waves and ruptures - NMEM 2019 : Proceedings of the workshop - Abstract Book, 30.06-04.07. 2019 : Smolenice Castle near Bratislava, Slovakia. Editors: Peter Moczo, Jozef Kristek, Martin Galis, Eric M. Dunham. Bratislava : Faculty of Mathematics, Physics Comenius University in Bratislava : Earth Science Institute, Slovak Academy of Sciences, 2019. 87 p. ISBN 978-80-8147-0905.
11. Proceedings of the Geologica Carpathica 70 Conference. Editors: Igor Broska, Milan Kohút, Adam Tomašových ; reviewers: Peter Bačík, Vladimír Bezák, Miroslav Bielik, Igor Broska, František Hrouda, Stanislav Jeleň, Peter Koděra, Milan Kohút, Júlia Kotulová, Lukáš Krmíček, Sergiy Kurylo, Ján Madarás, Jozef Madzin, Štefan Méres, Jozef Michalík, Martin Ondrejka, Igor Petrík, Marián Putiš, Adam Tomašových, Pavel Uher, Ján Vozár. Bratislava : Earth Science Institute of the Slovak Academy of Sciences, 2019. 190 p. ISBN 978-80-85754-42-1 (Geologica Carpathica 70 Conference, Slovakia, Smolenice, 09.10.-12.10.2019)
12. Nemčok, M., Doran, H., Doré, A. G., Ledvényiová, L. and Rybár, S. (Eds.), 2021. Tectonic development, thermal regimes and hydrocarbon habitat of transform margins, and their differences from rifted margins. Geological Society of London Special Publication No 524, DOI: https://doi.org/10.1144/SP524-2021, in press. (Transform Margins Workshop 2, Slovakia, Smolenice, 14.12.-16.12.2020)

2.3.4. List of journals edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

GEOLOGICA CARPATHICA

Geological Institute is publisher of international geological journal ***Geologica Carpathica***, which is an official journal of Carpathian-Balkan Geological Association established in 1923.

2016 - vol. 67, No. 1-6, IF=1,358 WOS

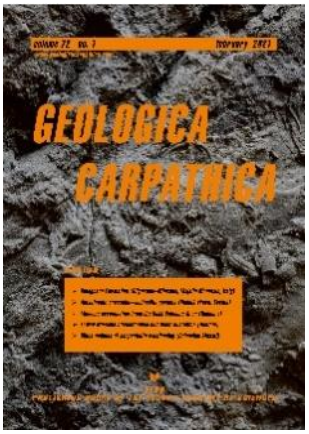
2017 - vol. 68, No. 1-6, IF=1,169 WOS

2018 - vol. 68, No. 1-6, IF=1,699 WOS

2019 - vol. 70, No. 1-6, IF=1,535 WOS,

+ PROCEEDINGS OF THE GEOLOGICA CARPATHICA 70 CONFERENCE 2020 - vol. 71, No. 1-6, IF=1,875 WOS

2021 - vol. 72, No. 1-6, IF=1,415 WOS



CONTRIBUTIONS TO GEOPHYSICS AND GEODESY

CGG publishes original research papers, short and rapid communications and review articles covering a wide spectrum of earth science disciplines including deep structural geophysics, geodynamics, tectonics, near surface geophysics, applied and environmental geophysics, geomagnetism, seismology, paleomagnetism, space weather, geodesy and geomatics, surveying engineering, hydrology, hydro-geology, atmospheric science, climatology.

2016 - vol. 46, No. 1-4, CiteScore SCOPUS=0,6

2017 - vol. 47, No. 1-4, CiteScore SCOPUS =0,7

2018 - vol. 48, No. 1-4, CiteScore SCOPUS =0,7

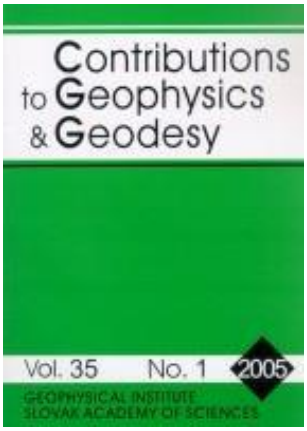
2019 - vol. 49, No. 1-4, CiteScore SCOPUS =0,70

2020 - vol. 50, No. 1-4, CiteScore SCOPUS =1,0

2021 - vol. 51, No. 1-4, CiteScore SCOPUS = 1,4

Quartile (SJR) = Q3 (2021), Q3 (2020), Q4 (2019), Q3 (2018), Q4 (2017), Q4 (2016)

Abstracting and Indexing: SCOPUS, WOS Core Collection (ESCI), DOAJ, Index Copernicus Int., EBSCO, SCImago (SJR), Genamics Journal Seek, and others.



- **National position of the institute**

The researchers are involved to the research of the Slovak territory to understand geological history and evolution of area. Institute provides the most modern geosciences laboratories in the Slovakia for geological organisations and customers from geoscience community. The national position of the institute is specially highlighted by the National Network of Seismic Stations (NNSS), which is the most important Slovak infrastructure for monitoring of seismic activity. The seismic database comprises data on earthquakes with epicentres on the territory of Slovakia as well as earthquakes epicentres outside Slovakia having macroseismic effect on the territory of Slovakia.The Geomagnetic observatory at Hurbanovo is one of the oldest observatories in Europe that has observed the data of the geomagnetic field at the same place since 1900. The observatory is certified by the Slovak Office of Standards, Metrology and Testing as a reference center for magnetic declination, which is important for the calibration of navigation systems.

2.3.5. List of selected activities of national importance

2021

ONDERKA, Milan - PECHO, J. Sensitivity of selected summertime rainfall characteristics to pre-event atmospheric and near-surface conditions. In Atmospheric Research, 2021, vol. 259, article number 105671. (2020: 5.369 - IF, Q1 - JCR, 1.488 - SJR, Q1 - SJR, CCC). (2021 - Current Contents). ISSN 0169-8095. 10.1016/j.atmosres.2021.105671
The objective of this study was to determine the sensitivity of selected rainfall characteristics on pre-event near-surface temperature, dew point temperature and pre-event thermodynamic conditions. We observed a strong responsiveness of rainfall kinetic energy and 15-minute peak rainfall intensities to dew point temperature with a super–CC scaling (7 – 14 $\%K^{-1}$) when near-surface dew point temperature exceeds ~ 288 K. Dew-point temperature seems to be a physically more consistent driver of intensive precipitation than dry-bulb temperature. These findings may be useful for projections of intensive rains under the ongoing climate change.

LUKASOVÁ, Veronika - ŠKVARENINOVÁ, Jana - BIČÁROVÁ, Svetlana - SITÁROVÁ, Z. - HLAVATÁ, Helena - BORSÁNYI, Peter - ŠKVARENINA, Jaroslav. Regional and altitudinal aspects in summer heatwave intensification in the Western Carpathians. In Theoretical and Applied Climatology, 2021, vol. 146, no. 3-4, p. 1111-1125. (2020: 3.179 - IF, Q2 - JCR, 0.935 - SJR, Q2 - SJR, CCC).
In our study, we observed the heatwaves (HWs) occurrence in the Western Carpathians during 1989-2018. The Carpathian Mountains are widely recognized as an important biodiversity hot-spot particularly for mountain species in Europe. Especially the endemics as autochthonous components of ecosystems are more susceptible to environmental changes, in particular climate change, which may induce the disappearance of the existing niche, they occupy. Relative threshold-based calculation of HW allowed for revealing the potential threats of this temperature extreme at the range of altitudes, including the high mountains. The trend of the heatwaves is significantly increasing in the Western Carpathians with the greatest intensification of HWs recorded in the last decade. Over the studied 30 years, the majority of the strongest heatwaves occurring across Europe hit the Western Carpathians´ region. More importantly, the area experienced the regional HWs, severity of which was comparable to those of exceptionally strong HWs, although these regional HWs were less important from the large-scale aspect. Following the coincidence between abnormally high maximum and average daily temperatures that minimize opportunities for organisms to recover, the risk of climate change–associated impacts of extreme weather on biodiversity is worsening in the Western Carpathians.

KOHÚT, Milan - WESTGATE, John A. - PEARCE, J. G. - BAČO, Pavel. The Carpathian obsidians - Contribution to their FT dating and provenance (Zemplin, Slovakia). In Journal of Archaeological Science: Reports, 2021, vol. 37, art. no. 102861. (2020: 3.216 - IF, Q1 - JCR, 1.572 - SJR, Q1 - SJR, CCC). (2021 - Current Contents). ISSN 0305-4403.
The Carpathian obsidian samples from the Slovakian part of the Zemplín – Tokaj area have been studied by means of fission-track dating (FT) and geochemistry to better understand the provenance of the archaeological obsidians from the Central Europe realm. New FT obsidian ages

are in a narrow time interval between 12.45 ±0.45 and 11.62 ±0.25 Ma, and indicate a short-time monogenic volcanic evolution rather than a long-lasting volcanism over the 16–10 Ma period, as was previously thought. Chemical composition of the Carpathian obsidians clearly exhibits a common similarity among all examined localities (Brehov, Cejkov, Hraň, and Viničky). A comprehensive provenance study, including physical properties of the obsidians, confirms a general congruence within the studied obsidians what excludes different provenance (e.g. **C1a** – Viničky vs. **C1b** – Cejkov), and the use of common provenance labelling, such as Carpathian-1 (**C1**) for the Slovakian – Zemplín area obsidians, is recommended.

2020

ONDERKA, Milan - PECHO, Jozef - NEJEDLÍK, Pavol. On how rainfall characteristics affect the sizing of rain barrels in Slovakia. In ***Journal of Hydrology***: Regional Studies, 2020, vol. 32, article number 100747. (2019: 3.645 – IF).

The article analyzes spatial variability of atmospheric precipitation and its impliocations for the design of small-scale water harvesting projects. Torrential rains and periods of prolonged drought are becoming more intense and frequent phenomena in Slovakia. Rainwater harvesting measures reduce and slow down the runoff of water from paved surfaces such as roofs and parking lots, and at the same time positively affect the microclimate in cities during hot summer days. In our recent study (https://doi.org/10.1016/j.ejrh.2020.100747) we analyzed rainfall data in order to provide location-specific design parameters for rainwater tanks. With the help the published statistics of rain episodes, every homeowner in Slovakia can now estimate the optimal volume of the rainwater tank for a desired location, rooftop catchment area and the water consumption rate.

LUKASOVÁ, Veronika - VIDO, Jaroslav - ŠKVARENINOVÁ, Jana - BIČÁROVÁ, Svetlana - HLAVATÁ, Helena - BORSÁNYI, Peter - ŠKVARENINA, Jaroslav**. Autumn phenological response of european beech to summer drought and heat. In ***Water***, 2020, vol. 12, no. 9, article number 2610. (2019: 2.544 – IF).

The changes in precipitation and temperature regimes brought on by the current climate change have influenced ecosystems globally. Using phenological and meteorological data from 1996–2018, we analysed changes of the onset of leaf colouring in European beech (Fagus sylvatica, L.) as an important native tree species growing throughout Europe. While at the beginning of the studied period the earliest onset of leaf colouring of European beech was observed at low altitudes, over the last decade it was observed to start at the middle altitudes concurrently with the low altitudes or even later. At present, the increase in precipitation and rising temperatures are advantageous for beech at most stands at middle to high altitudes. There the trend of delayed onset of leaf colouring is significant. However, at the low altitudes, we discovered a significant negative effect of drought prior to the leaf colouring leading to an earlier onset. This indicates that the meteorological drought conditioned by lower precipitation total and higher evapotranspirative demands in the warmer climate advances the leaf senescence and the growing season ends earlier. Furthermore, we revealed the first signs of the commencing negative effect of drought at mid-altitudes at stands with lower (below 700 mm) annual precipitation total. The ongoing warming trend of summer months suggests a continual increase of evapotranspiration in the next decades and thus further intensification of droughts, which will limit the growing season duration of beech at the low as well as middle altitudes.

BEZÁK, Vladimír - PEK, Josef - VOZÁR, Ján - MAJCIN, Dušan - BIELIK, Miroslav - TOMEK, Čestmír. Geoelectrically distinct zones in the crust of the Western Carpathians: A consequence of Neogene strike-slip tectonics. In Geologica Carpathica, 2020, vol. 71, no. 1, p. 14-23. (2019: 1.535 – IF).

Based on magnetotelluric modelling and other geophysical methods (seismic, gravimetric, partly geothermic), significant interfaces in the crust of the Western Carpathians were identified. These are steeply inclined tectonic interfaces, where the crustal blocks with different physical properties and thus different geological composition meet. Interfaces represent mostly Neogene transform shear zones, although some of them may have been older origin. These tectonic zones separate the European platform with the overthrusted outer flysch units from the inner Western Carpathians and the sub-blocks within the Western Carpathians (northern granitized block, the middle formed mainly by metamorphites and the southern altered by young volcanic and hydrothermal processes).

2019

BIČÁROVÁ, Svetlana - SITKOVÁ, Zuzana - PAVLENDOVÁ, Hana - FLEISCHER, Peter jr. - FLEISCHER, Peter - BYTNEROWICZ, Andrzej. The role of environmental factors in ozone uptake of Pinus mugo Turra. In *Atmospheric pollution research*, 2019, vol. 10, no. 1, p. 283-293. (2018: 2.918 - IF, Q2 - JCR, 0.818 - SJR, Q1 - SJR,CCC). (2019 - Current Contents). ISSN 1309-1042.
Montane forests in the High Tatra Mountains are exposed to high ambient ozone (O3) concentrations that may adversely affect the physiological processes and health of plants. The harmful influence of ozone on forest trees can be indicated by the model-based value of the phytotoxic ozone dose (POD). In this work, we analyzed the effect of environmental factors (fENVI) on the POD obtained by the deposition model DO3SE for dwarf mountain pine (Pinus mugo Turra). We determined a moderate limitation of O3 uptake due to environmental factors (fENVI) such as air temperature and´humidity, solar radiation, and soil water availability in the temperate mountain forest. In addition, maximal stomatal conductance (Gmax) derived from gasometric field measurement in local conditions was included in the model. It appears that Gmax is more relevant for annual POD than fENVI. We developed a site-specific stomata response function for dwarf mountain pine using the symbolic regression approach that confirmed the robust performance of the DO3SE model for stomatal conductance (Gsto).

VAJDA, Peter - ZAHOREC, Pavol - BILČÍK, Dušan - PAPČO, Juraj. Deformation-induced topographic effects in interpretation of spatiotemporal gravity changes: Review of approaches and new insights. In *Surveys in Geophysics*, 2019, vol. 40, no. 5, p. 1095-1127. (2018: 5.226 - IF, Q1 - JCR, 2.294 - SJR, Q1 - SJR, CCC). (2019 - Current Contents). ISSN 0169-3298.
We have improved the methodology of compiling and interpreting residual spatiotemporal gravity changes in volcanic areas by deriving an accurate expression for the deformation-induced topographic effect used as a correction in residual gravity changes evaluation. This improved methodology may improve the gravimetric assessment of volcanic hazard associated with magma rejuvenation and migration.

2018

CHOVANOVÁ, Zuzana - KRISTEK, Jozef. A local magnitude scale for Slovakia, Central Europe. In Bulletin of the Seismological Society of America, 2018, vol. 108, no. 5A, p. 2756-2763. (2.343 - IF2017). (2018 - Current Contents). ISSN 0037-1106.
Each country or region should have its own formula for estimating a local magnitude of local earthquakes which consistently reflects the seismic attenuation behavior of the region. Until now, the Hutton and Boore (1987) scale derived for Southern California was used for local magnitude estimation in Slovakia because of similar attenuation properties of the regions. We have determined the distance correction term and the attenuation term of the local magnitude scale from collected trace amplitudes of earthquakes recorded by the National Network of Seismic Stations (NNSS) from 2005 to 2016 using linear regression analysis. Additionally the station corrections for the nine seismic stations of NNSS have been estimated for the first time. Using the newly determined scale reduces error by up to 58% compared to the formula previously used. Since both local magnitude formula and ground motion prediction equation (GMPE) are attenuation relationships, their similarity can be used in seismic hazard analysis.

MAJCIN, Dušan - BEZÁK, Vladimír - KLANICA, Radek - VOZÁR, Ján - PEK, Josef - BILČÍK, Dušan - TELECKÝ, Josef. Klippen Belt, Flysch Belt and Inner Western Carpathian Paleogene Basin Relations in the Northern Slovakia by Magnetotelluric Imaging. In Pure and Applied Geophysics, 2018, vol. 175, p. 3555-3568. (1.652 - IF2017). (2018 - Current Contents). ISSN 0033-4553.
The structural model of the space relations of the Klippen Belt with the Inner Carpathian Paleogene and also with Outer Flysch Belt units was constructed on the base of the magnetotelluric measurements interpretation in the region near Stará Ľubovňa. The research includes also hydrogeological structures of the studied region and the relations to the Ružbachy horst structures. The results have direct application at appraisal of the geothermal energy source parameters within the studied region. We used the innovative approach for interpretation of the MT measurements from independent 2D and 3D models of the electric conductivity distribution models in upper parts of the Earth crust and another geological and geophysical knowledge.

MAJZLAN, Juraj - ŠTEVKO, Martin - CHOVAN, Martin - LUPTÁKOVÁ, Jarmila - MILOVSKÁ, Stanislava - MILOVSKÝ, Rastislav - JELEŇ, Stanislav - SÝKOROVÁ, Martina - POLLOK, Kilian - GÖTTLICHER, Jörg - KUPKA, Daniel. Mineralogy and geochemistry of the copper-dominated neutral mine drainage at the Cu deposit Ľubietová-Podlipa (Slovakia). In Applied Geochemistry, 2018, vol. 92, p. 59-70. (3.088 - IF2017). (2018 - Current Contents). ISSN 0883-2927.
The neutral mine drainage system at Ľubietová is dominated by copper and sulfate. It is generated by oxidative dissolution of chalcopyrite, as confirmed by sulfur isotopes. Its neutral nature is maintained by buffering via the primary carbonates. The oxidation zone, composed of Cu phosphates and carbonates (libethenite, pseudomalachite, malachite) plays minor role in the mine drainage generation. The water is discharged through the lowermost adits in the ore field; inside the adit, blue gel covers the stream and converts slowly to crystalline copper sulfate - langite. Outside the adits, redox cycling of Cu was observed. Nanocrystals of native copper crystalize on rock-forming minerals. Cu content is reduced by factor of 100 when mine drainage after 1 km reaches the river. Sulfur isotopes document that no copper sulfides are precipitating; but sulfates or carbonates. The natural attenuation could be responsible for the enrichment of sediments with copper (about few metric tons in size).

2017

HURAI Vratislav, PAQUETTE J.L., HURAIOVÁ Monika, SLOBODNÍK Marek, HVOŽĎARA Pavel, SIEGFRIED P., GAJDOŠOVÁ M., MILOVSKÁ Stanislava. New insights into the origin of the Evate apatite-iron oxide-carbonate deposit, Northeastern Mozambique, constrained by mineralogy, textures, thermochronometry, and fluid inclusions. In Ore Geology Reviews, 2017, vol. 80, p. 1072-1091. (3.095 - IF2016). (2017 - Current Contents). ISSN 0169-1368.
The Evate deposit in Mozambique represents the largest accumulation of apatite ores in southeast Africa bound to magnetite horizons in carbonates. Origin of the deposit remains poorly elucidated. Our research confirmed that magnetite-apatite ores formed within the time interval between 590 and 450 Ma. The high-temperature stage (>800 °C) represented by zircon, baddeleyite and molybdenite is coeval with mafic and alkalic rocks, which intruded the metamorphic complex during peak temperature conditions of granulite-facies metamorphism. Hydrothermal stage represented by sulfides, anhydrite, monazite and zeolites precipitated from sulfate brines at temperatures <300 °C along the Cambrian-Ordovician reactivation.

KARCOL Roland, PAŠTEKA Roman. Density function evaluation from borehole gravity meter data – regularized spectral domain deconvolution approach. In Geophysical Prospecting, 2017, vol. 65, no. 1., p.365-378. (1.846 - IF2016). (2017 - Current Contents). ISSN 0016-8025.
A new method of transforming borehole gravity meter data into vertical density logs was developed based on the regularized spectral domain deconvolution of density functions. It is a novel alternative to the “classical” approach, which is very sensitive to noise, especially for high-definition surveys with relatively small sampling steps.

ZAHOREC Pavol, MARUŠIAK I., MIKUŠKA J., PAŠTEKA Roman, PAPČO Juraj. Numerical calculation of terrain correction within the bourguer anomaly evaluation (Program Toposl). Chapter 5. In PAŠTEKA, Roman - MIKUŠKA, Ján - MEURERS, Bruno. Understanding the bouguer anomaly. A gravimetry puzzle. - Amsterdam: Elsevier Science Publishing, p. 79-92. ISBN 978-012-812913-5.

ZAHOREC P., PAŠTEKA R., MIKUŠKA J., SZALAIOVÁ V., PAPČO J., KUŠNIRÁK D., PÁNISOVÁ J., KRAJŇÁK M., VAJDA P., BIELIK M., MARUŠIAK I. National gravimetric database of the Slovak Republic. Chapter 7. In PAŠTEKA, Roman - MIKUŠKA, Ján - MEURERS, Bruno. Understanding the bouguer anomaly. A gravimetry puzzle. - Amsterdam: Elsevier Science Publishing, p. 113-125. ISBN 978-012-812913-5.
The current Bouguer anomaly map of Slovakia is compiled from approx. 320 000 observation points collected during more than 50 years which represent a very heterogeneous dataset. Quality control process and complete recalculation of the Bouguer anomalies is presented in Chapter 7 of the monograph. Primary focus was on a proper recalculation of the terrain corrections. The new software Toposk was developed for this purpose (Chapter 5). The most important attribute of the new software is the correct calculation for arbitrary point location with regard to the real Earth surface. The use of the program is worldwide, not limited to the territory of Slovakia.

2016

FOJTÍKOVÁ L. - KRISTEKOVÁ M. - MÁLEK J. - SOKOS E. - CSICSAY K. - ZAHRADNÍK J. Quantifying capability of a local seismic network in terms of locations and focal mechanism solutions of weak earthquakes. In Journal of Seismology, 2016, vol. 20, no. 1, p. 93-106. (1.550 - IF2015). (2016 - CurrentContents). ISSN 1383-4649.
We suggested the combination of suitable methods (including the new one) for quantification of accuracy of earthquake location and determination of focal mechanisms for a given area and seismic station configuration. We also developed the free software. Our analysis was applied to the Malé Karpaty local seismic network (Slovakia). This network enables seismic monitoring of the source zone in the vicinity of a nuclear power plant, important from the point of seismic hazard. Obtained results clearly demonstrate that suggested network extension remarkably decreases the errors of earthquake location and focal mechanism determination and improves seismic monitoring of the area. The results can also serve as a basis for decision making process when considering financial support of the network extension.

PÁNISOVÁ J. - MURÍN I. - PAŠTEKA R. - HALIČKOVÁ J. - BRUNČÁK P. - POHÁNKA V. - PAPČO J. - MILO P. Geophysical fingerprints of shallow cultural structures from microgravity and GPR measurements in the Church of St. George, Svaty Jur, Slovakia. In Journal of Applied Geophysics, 2016, vol. 127, p. 102-111. (1.355 - IF2015). (2016 - Current Contents). ISSN 0926-9851.
Four medieval crypts and west wall foundations of the former Romanesque construction were successfully delineated in the nave of the Church of St. George in Svätý Jur using microgravity and GPR methods. The results from harmonic inversion combined with GPR and density modelling helped to construct a spatial model of these cultural features, which is now added into the visualisation of the visible parts of the church. We have shown that 2D geophysical images or quantitative interpretations in form of 3D models can be easily incorporated into virtual databases of built heritage.

2.3.6. List of journals (published only in the Slovak language) edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

none

- **Position of individual researchers in the international context**

Membership and functions in international scientific societies, unions and national committees of the Slovak Republic

Antolíková S.
- Slovak IGCP Commission at UNESCO (position: Secretary)

Aubrecht R.:
- International Association of Sedimentologists (IAS) (position: National Correspondent)
  International Subcommission on Jurassic Stratigraphy (position: National Coordinator)

Bačík P.:
- Mineralogical Society of America (position: member)
- Mineralogical Society of Canada (position: member)

Bezák V:.
- American Geophysical Union (position: member)

Bielik M.:
- American Geophysical Union (position: member)
- Carpathian-Balkan Geological Association (position: member)
- Slovak National Committee for Geodesy and Geophysics (position: member)

Biroň A.:
- Clay Mineral Society (position: member)

- European Clay Groups Association (position: member)

Brimich L.:
- International Association of Geodesy IAG (position: member)
- International Association of Mathematical Geosciences IAMG (position: member)
- Slovak National Committee for Geodesy and Geophysics (position: member)

Broska I.:
- European mineralogical union (position: national correspondent)

Cipciar A.:
- European Mediterranean Seismological Centre EMSC/CSEM (position: Representative for the Geophysical Department of the ÚVZ)

Fojtíková L.:
- American Geophysical Union (position: member)

Janák M.:
- Carpathian-Balkan Geological Association (position: member)
- Deutsche Mineralogische Gesellschaft (position: member)
- European Union of Geosciences (position: member)
- IEC17 (funkcia: representativ of SR)

Jeleň S.:
- IAGOD- International Association of Geology of ore Deposits (position: member)

Kristek J.:
- American Geophysical Union (position: member)
- European Geophysical Union (EGU) (position: member)
- Seismological Society of America (position: member)
- IUGG Slovak National Committee for Geodesy and Geophysics (position: chairman)

Kristeková M.:
- EPOS (position: representative of the Slovak Republic in the General Assembly)
- Seismological Society of America (position: member)
- IUGG Slovak National Committee for Geodesy and Geophysics (position: member)
- European Geophysical Union (EGU) (position: member)

Labák P.:
- European Geosciences Union (EGU) (position: member)

Lexa J.:
- Carpathian-Balkan Geological Association (position: member)
- IAGOD- International Association of Geology of ore Deposits (position: member)
- National Geological Committee of the Slovak Republic (position: member)

Michalík J.:
- National Commission for UNESCO Programs of the Ministry of Foreign Affairs of the Slovak Republic (position: chairman for geoscience program until 2018)
- Polske Towarzysztwo geologiczne (post: honorary member)
- Slovak Geological Survey of the IGCP (function: chairman of the IYPE committee)
- IUGS Stratigraphic Subcommittee on Triassic (post: corresponding member)

Moczo P.:
- American Geophysical Union (position: member)
- EPOS (position: representative of the Slovak Republic in negotiations and on the performance of relevant work)
- European Geophysical Union (EGU) (position: member)
- European Seismological Commission (position: titular member)
- IASPEI (function: national correspondent)
- Seismological Society of America (position: member)
- Society of Exploration Geophysicists (position: associate member)

Nejedlík P.:
- International Society of Biometeorology (position: member)
- IUGG National Committee for Geodesy and Geophysics (position: member)

Nemčok M.:
- American Association of Petroleum Geologists (position: member)
- American Geophysical Union (position: member)
- European Geosciences Union (EGU) (position: member)
- Utah Geological Association (position: member)

Pánisová J.:
- European Association of Geoscientists & Engineers (EAGE) (position: member)
- International Society for Archaeological Prospection (ISAP) (position: member)

Petrík I.:
- Mineralogical Society of America (position: member)
- National Geological Committee of the International Union of Geological Sciences (position: Secretary)

Podhorský D.:
- EIAELPS (position: member)

Revallo M.:
- National Space Research Committee (COSPAR) (function: Scientific Secretary)
- National Committee of the Slovak Republic for the Physics of Solar-Earth Relations (SCOSTEP) (position: chairman and national representative)
- Steering Committee for the International Space Weather Initiative (ISWI) (position: member)

Soták J.:
- Central-European Tectonic Group - CETEG (position: member)
- Climate & Biota Early Paleogene Group - CBEP (position: member)
- Foraminiferal Research Consortium - FRESCO (position: member)
- International Association of Sedimentologists (position: member)
- The Micropaleontological Society TMS & Grzybowski Foundation (position: member)

Števko M.:
- International Mineralogical Association (position: National Representative of the Slovak Republic in the Commission on New Minerals, Nomenclature and Classification)

Tomašových A.:
- Paläontologische Gesellschaft (position: member)
- Paleontological Society (position: member)
- Society for Sedimentary Geology (position: member)
- European Geoscience Union (position: member)

Vajda P.:
- American Geophysical Union (AGU) (position: member)
- European Geosciences Union (EGU) (position: member)
- IAG study group IC-SG 28 (position: member))
- Inter-Commission Committee on Theory (ICCT) of the IAG, Joint Study Group (JSG) T.30: Dynamic modeling of deformation, rotation and gravity field variations (position: member)
- International Association for Mathematical Geosciences (IAMG) (position: member)
- International Association of Volcanology and Chemistry of the Earth Interior (IAVCEI) (position: member)
- International Union of Geodesy and Geophysics (IUGG) (Function: Member of the IUGG Council, National Delegate of the IUGG GA)
- Slovak National Committee for Geodesy and Geophysics (position: Secretary)
- Society of Exploration Geophysicists (SEG) (position: member)

Valach F.:
- National Committee of the Slovak Republic for the Physics of Solar-Earth Relations (SCOSTEP) (position: member)
- Steering Committee of the International Space Weather Initiative (position: member)

Vozár Ján:
- AGU – American Geohysical Union (position: member)
- EGU – European Geophysical Union (position: member)

Vozár Jozef:
- Carpathian-Balkan Geological Association - KBGA (position: V
- ice President)
- OGG - Geological Soc. of Austria (position: honorary member) SGS - Serbian Geological Society (position: honorary member)

Vršanský P.:
- Czechoslovak Biological Society (position: member)

Mgr. Pavol Zahorec, PhD.
- European Association of Geoscientists & Engineers (EAGE) (position: member)
- European Geosciences Union (EGU) (position: member)

Membership in editorial boards of journals

Antolíková S.:
- Geologica Carpathica (position: editor)
- Mente et maleo (position: editor)

Aubrecht R.:
- Bulletin of Geosciences (position: associated editor)
- Geological research in Moravia and Silesia (position: member of the editorial board)
- Geology, Geophysics & Environment, Kraków (position: member of the editorial board)
- Volumina Jurassica, Warsaw (position: member of the editorial board)

Bačík P.:
- Acta Geologica Slovaca (position: member)
- Geologica Carpathica (position: member)

Bičárová S.:
- Folia Oecologica (position: member)

Bielik M.:
- Acta Geodaetica et Geophysica Hungarica (position: member)
- AGEOS Acta Geologica Slovaca (position: Chief editor)
- Contributions to Geophysics and Geodesy (position: member)
- Geologica Carpathica (position: member)

Bilčík D.:
- Contribution to Geophysics and Geodesy (function: Content Management System Administrator)

Brimich L.:
- Contributions to Geophysics and Geodesy (position: Editor-in-Chief)

Broska I.:
- Geologica Carpathica (position: Chief editor)
- Journal of Geosciences (position: member of external advisory board)
- Mineralia Slovaca (position: member)
- Mineralogical journal (position: member)
- Mineralogy (position: member of the editorial board)

Csicsay K.:
- Contributions of Geophysics and Geodesy (position: editor)

Guba P.:
- Contributions to Geophysics and Geodesy (position: member)

Hurai V.:
- Minerals (position: member)

Janák M.:
- Geologica Carpathica (position: member)

Kohút I.:
- Contributions to Geophysics and Geodesy (position: executive editor)

Kohút M.:
- Journal of Geosciences (position: executive editor, member)

Kotulová J.:
- Geologica Carpathica (position: associate editor)

Kyška-Pipík R.:
- Geologica Carpathica (position: Handling editor)
- Geological Bulletin of Turkey (post: Member of the Editorial Board)
- Open Geosciences (former Central European Journal of Geosciences) (position: editor)

Lexa J.:
- Geologica Carpathica (position: member)
- Ore Geology Reviews (position: associate editor)

Lukasová V.:
- Folia Oecologica (position: Member of the Editorial Board)

Luptáková J.:
- Mente et Malleo - Rapporteur of the Slovak Geological Society (position: editor for Banská Bystrica)

Madarás J.:
- Geologica Carpathica (position: member)
- Mente et Malleo (MeM) (position: editor-in-chief)

Majcin P.:
- Contributions to Geophysics and Geodesy (position: member)
- Geoinformatika (position: member)

Michalík J.:
- Bulletin of Geosciences (position: member)
- Geologica Carpathica (position: scientific editor)
- Geological Quaterly (position: member)
- Geoscience e-journals (position: member)
- Iranian Journal of Geosciences (position: member)
- Mineralia Slovaca (position: member)
- Open Paleontology Journal (position: member of the Editorial Advisory Board)

Nejedlík P.:
- Advances in Science and Research (Vydavateľ Copernicus) (position: Handling editor to special issue Contributions in applied Meteorology and Climatology)
- Italian Journal for Agrometeorology (position: Member of the Editorial Board)
- Meteorologický časopis (position: Member of the Editorial Board)

Petrík I.:
- Geologica Carpathica (position: electronic version editor)

Siman P.:
- Geologické práce - Správy (position: member)
- Editorial Board of Encyclopedia Beliana (position: member)

Soták J.:
- Geologica Carpathica (position: member)
- Geological Quarterly (position: member of the Consulting Editor´s Board)
- Global Ecology and Biogeography (position: Editorial Board Member until 2010)
- Mineralia Slovaca (position: member)
- Paleontology Journal (position: member of the editorial board until 2010)

Števko M.:
- Bulletin Mineralogie Petrologie (position: member)
- Esemestník (position: member)
- Journal of Geosciences (position: member)
- Mineral (position: member)

Tomašových A.:
- Ameghiniana (position: Editorial Board do 2010)
- European Geoscience Union (position: member)
- Geologica carpathica (position: Associate Editor)
- Global Ecology and Biogeography (position: Editorial Board Member)
- Palaios (position: Associate Editor)
- Paleobiologhy (position: Editorial Board)
- Paleontological Society (position: member)
- Revista Espanola de Paleontologia (position: Editorial Board Member)

Vajda P.:
- Contributions to Geophysics and Geodesy (position: member)

Vozár Ján.:
- Contributions to Geophysics and Geodesy (position: member of the editorial board)

Vozár Jozef:
- Annales Geologiques de la Péninsule Balkanique (position: member)
- Geologica Carpathica (position: member)
- Polish Geological Institute Papers (position: member)

2.3.7. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter

Invited lectures at international scientific events

1. Bielik M. et al.: Integrated geophysical modelling of the lithosphere in the Carpathian–Pannonian region: A review. Geologica Carpathica 70, Smolenice, October 9–11, 2019
2. Bielik M. et al. 2019: Study of the Lithosphere in the Carpathian-Pannonian Region: based on integrated interpretation of gravity field. Eötvös Loránd, a Földtudós-Roland Eötvös the Earth Scientist. Földtudományok Osztálya, A geofizikai tudományos bizottság, A geodéziai és geoinformatikai tudományos bizottság, Tudományos ülése 2019. May 15., 10:00-16:00. Az MTA Székház Felolvasótermében
3. Bielik M. et al.: Study of the Lithosphere in the Carpathian-Pannonian Region: based on integrated interpretation of gravity field. 100th anniversary of Roland Eotvos. Venue Culture House, Gbely, Slovakia, 17th October, 2019.
4. Bielik M.: Geophysical study of the Carpathian-pannonian lithosphere.
5. Broska I., Petrík I., Uher P: "Accessory minerals and Variscan granite types in the Western Carpathians". 9th assembly of Petrology and Geochemistry (Maďarsko, Salgotarjan; 7.09.2018).
6. Guba P.: Stability of a density-change flow in the solidification of a ternary alloy. 70th Annual Meeting, American Physical Society Division of Fluid Dynamics, Denver, CO, USA, 19. 11. 2017
7. Janák, M. et al.: „Recent progress in recognition of UHP metamorphism in allochthons of the Scandinavian Caledonides (Seve Nappe Complex and Tromso Nappe)“, Europen Geoscience Union General Assembly 2017 TS7.5 session „The Caledonian orogen of the North Atlantic region: understanding tectonic processes in collisional belts“. Viedeň 28.4.2017
8. Janák, M.: “The Tatra Mountains: small but beautiful heritage of Variscan and Alpine orogeny”. Otvorený geologický kongres Slovenskej geologickej spoločnosti a České geologické společnosti, Vysoké Tatry, 14.-17.6. 2017.
9. Kristek J., Kristekova M., Moczo P., Galis M.: „Numerical Modeling of Seismic Wavefields at the Felsopeteny Site". Pozvaná prednáška na „Expert Meeting on Resonance Seismometry for OSI“ v CTBTO TeST Centre v Seibersdorf, Rakúsko, 27.11.-29.11.2019
10. Kristekova M., Kristek J., Moczo P.: „Analysis of measured and numerically simulated seismic wavefields at the Felsopeteny site“. Pozvaná prednáška na „Expert Meeting on Resonance Seismometry for OSI“ v CTBTO TeST Centre v Seibersdorf, Rakúsko, 27.11.-29.11.2019
11. Kyška-Pipík, R., Milovský R., Starek, D., Šurka J., Uhlík P., Bitušík, P., Hamerlík, L., 2017: Koniec ľadovca v Tatrách. Otvorený geologický kongres SGS a ČGS, Vysoké Tatry 2017, 54-55.
12. Kyška-Pipík R.: Long lived lakes of the Central Paratethys – hot spots of Miocene biodiversity. The Micropalaeontological Society Annual Conference, Praha, 18.-19.11.2021
13. Michalík J.: 10th ESSEWECA Conference, December 1-2nd, 2016, Bratislava. Slovakia
14. Moczo P.: The 6th IASPEI / IAEE International Symposium: Effects of Surface Geology on Seismic Motion
15. Moczo P., Kristek J., Gabriel A. A., Chaljub E., Ampuero J.-P., Sánchez-Sesma F.-J., Galis M., Gregor D. and Kristekova M.: Numerical Wave Propagation Simulation
16. Nejedlík P., Bartošová L., Labudová L., Turňa M. : Drought monitoring in Slovakia. Climate, Agriculture and Food Security: a look into the Future, Florence, Italy, 24. October, 2016
17. Nejedlík P., Labudová L.: “Introducing drought monitoring system in Slovakia”, Commission on Agricultural Meteorology, World Meteorological Organization. Technical Conference on Future Challenges and Opportunities in Agricultural Meteorology. (Južná Kórea, Incheon, 16.-17. 4. 2018.)
18. Nemčok M.: Invited keynote speaker: International Symposium on Deep Seismic Profiling of the Continents and Their Margins, (Poľsko, Krakov, 17.-22. 6. 2018).
19. Revallo M.: Space weather forecast and the solar wind – magnetosphere interaction.

20. Soták, J.: End-Cretaceous extinction, recovery and radiation of the Paleocene–Eocene Foraminifera: Multiproxy data from the Western Carpathians (Keynote talk). TMS Annual General Meeting, 19. 11. 2021, London – Praque. Dokumentácia vyžiadanej prednášky: Keynote programme of conference: TMS 2021 Annual Conference Prague (cuni.cz)
21. Tomašových A.: "Testing the efficiency of isotherm tracking by marine bivalves and brachiopods". Sympozium Macroecology and the Fossil Record. 5th International Paleontological Congress. (Francúzsko, Paríž, 9.-13. 7. 2018).
22. Tomášovych A., Testing the effects of time averaging and bioturbation on the defection of extinction and turnover events. Erdwissenschaftliches Kolloquium (ÖGG), Universitat Wien, 12.11.2020,
23. Vojtko R., Lexa J., Broska I.: "Magmatic evolution of the Miocene Štiavnica stratovolcano", Přírodovědecká fakulta, ÚPSG Praha, Česká republika, 06.11.2020

Invited lectures at important scientific institutions

1. Bielik M.: "Study of the lithosphere in the Carpathian-Pannonian region: based on an integrated interpretation of gravity field." University of Ottawa, (Canada, Ottava, 30. 5. 2018).
2. Bielik M., Marko F., Madarás J., Mojzeš A., Fekete K., Papčo J., Siman P.: Lithosphere in the Carpathian-Pannonian Region. Tribhuvan University, (Kathmandu, Nepal, 11.4. 2019)
3. Broska I.: Earth science Institute of the Slovak Academy of Sciences: mission and infrastructure. Semenenkov ústav geochémie, mineralógie a rudotvorby Národnej ukrajinskej akadémie vied, (Ukraine, Kijev, 14.11. 2017).
4. Broska I.: Typology and evolution of the West-Carpathian granites during Variscan tectonic events. Taras Schevchenko University, Fakulty of Natural Science, (Ukraine, Kijev, 15.1. 2017).
5. Broska I.: "Accessory minerals and granite typology of the Western Carpathians". (Korea, Ochang; 15.11.2018).
6. Guba P.: Convective instabilities during solidification of binary and ternary alloys. National Institute of Standards and Technology, Gaithersburg, MD, USA, 15. 11. 2017
7. Guba P.: "Pattern selection in mushy layer convection" Department of Mathematical Sciences, University of Nottingham (invited seminar talk), (Great Britain, Nottingham, 10. 3. 2018)
8. Guba P.: "Pattern selection in mushy layer convection", Department of Applied Mathematics and Theoretical Physics, Cambridge University (invited seminar talk), (Great Britain, Cambridge, 11. 12. 2018).
9. Janák M.: Ultravysokotlaková metramorfóza alochtónnych jednotiek škandinávskych kaledoníd. Karlova Univerzita, Ústav petrologie a strukturní geologie, (Czech Republic, Praha, 9.3.2016).
10. Janák M.: "UHP metamorphism in the Scandinavian Caledonides – recent progress". Chinese Academy of Geological Sciences (China, Peking, 31.5.2018).
11. Kristek J., Kristeková M., Moczo P., Gális M.: "Simulácie seizmického vlnového poľa v prostrediach pozmenených podzemnou jadrovou explóziou pre rezonančnú seizmometriu". Katedra geofyziky Matematicko-fyzikální fakulty, Univerzita Karlova. (Czech Republic, Praha, 27. 4. 2018).
12. Lexa J., Pécskay Z.: Ryolitové vulkány stredného Slovenska, Geofyzikální ústav Akademie věd České republiky (Czech Republic, Praha, 10. 03. 2016)
13. Tomašových A.: "Diverzifikácia, stabilita a degradácia morských ekosystémov počas treťohôr a v súčasnosti". Centrum pro teoretická studia, Spoločné pracovište Univerzity Karlovy a AVČR. http://www.cts.cuni.cz/ (Czech Republic, Praha, 26.4. 2018). Online ako video: http://www.cts.cuni.cz/ctvrtecni-seminare.
14. Tomašových A: Inferring paleoecological dynamics of marine benthic communities on the basis of time-averaged fossil record. Institute for Chemistry and Biology of the Marine Environment Carl-von-Ossietzky University Oldenburg, 19.1.2021.

15. Vajda P.: "Issues to be treated carefully in interpretation of spatiotemporal gravity changes". Seminar of Institute of Geophysics and Tectonics, School of Earth and Environment, University of Leeds, (invited IGT seminar talk). (Great Britain, Leeds, 19. 11. 2018).

2.3.8. List of researchers who served as members of the organising and/or programme committees

1. Snow measurements field campaign international workshop, Slovakia, Chopok, 14.02.-16.02.2016, Pavol Nejedlík
2. 12th Jurassica Conference and Workshop of the ICS Berriasian Working Group meeting, Slovakia, Smolenice, 20.04.-22.04.2016, Jozef Michalík, Ľubica Puškelová, Kamil Fekete, Tomáš Fuksi, Roman Aubrecht, Ján Soták, Vladimír Šimo, Adam Tomašovych
3. 3D MT III - Magnetotelluric 3D Inversion Workshop III, Italy, Bari, 16.05.-18.05.2016, Ján Vozár
4. 17th Czech-Slovak-Polish Paleontological Conference, Poland, Krakow, 20.08.-21.08.2016, Ján Soták
5. Czech-Slovak seismologic days, Slovakia, Stará Lesná, 11.-14.10.2016, Lucia Fojtíková, Kristian Csicsay, Andrej Cipciar, Zuzana Margočová, Miriam Kristeková, Jozef Kristek, Peter Moczo, Róbert Kysel
6. IWAF-10 - 10th International Workshop on Agglutinated Foraminifera, Slovakia, Smolenice, 19.04.-23.04.2017, Ján Soták, Kamil Fekete, Zuzana Pulišová, Ľubica Puškelová, Silvia Ozdínová, Marek Vďačný, Jozef Michalík
7. Petros 2017, Slovakia, Bratislava, 25.05.-26.05.2017, Igor Broska, Marián Janák, Igor Petrík
8. 18th Czech-Slovak-Polish Paleontological Conference, Slovakia, Stará Lesná, 15.06.-16.06.2017, Silvia Ozdínová, Jozef Michalík, Ján Soták
9. Open Geological Congress, Slovakia, High Tatras, Stará Lesná, 14.06.-17.06.2017, Igor Broska, Silvia Ozdínová, Roman Aubrecht, Ján Madarás
10. 13th Jurassica Conference and Workshop of the ICS Berriasian Working Group meeting, Poland, Krakow, 19.-23.06.2017, Jozef Michalík, Vladimír Šimo
11. 2nd Conference on Natural Dynamos, Czech Republic, Valtice, 25.06.-01.07.2017, Peter Guba, Tomáš Šoltýs
12. IEC – 12th International Eclogite Conference, Sweden, Are, 26.08.-29.08.2017, Marián Janák
13. CAM2017 - Conference on Accessory Minerals, Austria, Vienna and Slovakia, Bratislava, 13.09.-19.09.2017, Igor Broska
14. The SNOW - an Ecological Phenomenon Conference, Slovakia, Smolenice, 18.09.-21.09.2017, Pavol Nejedlík
15. XXXIX. Radiation Protection Days, Slovakia, Stará Lesná, 06.11.-10.11.2017, Iveta Smetanová
16. 5th Central European Mineralogical Conference and 7th Conference of Mineral Sciences in the Carpathians, Slovakia, Banská Štiavnica, 26.06.-30.06.2018, Igor Broska, Tomáš Mikuš
17. 14th Jurassica International Conference and Berias Working Group meeting, Slovakia, Comenius University Science Park, Bratislava, 10.06-14.06.2019, Kamil Fekete, Jozef Michalík, Adam Tomašových
18. NMEM 2019 – Workshop on Numerical Modeling of Earthquake Motions: Waves and Ruptures, Slovakia, Smolenice, 30.06.-04.07.2019, Peter Moczo, Jozef Kristek, Martin Galis, Miriam Kristeková, Lucia Fojtíková, Andrej Cipciar, Kristián Csicsay, Róbert Kysel
19. Open Congress of the Czech Geological Society and the Slovak Geological Society, Czech Republic, Beroun, 03.06-06.09.2019, Silvia (Ozdínová) Antolíková
20. Geologica Carpathica 70 Conference, Slovakia, Smolenice, 09.10-12.10.2019, Ján Madarás, Igor Broska, Milan Kohút, Ľubica Puškelová, Silvia (Ozdínová) Antolíková, Nataša Halašiová, Kamil Fekete, Monika Szabóová, Jaroslav Lexa, Jozef Michalík, Igor Petrík, Ján Soták, Adam Tomašových

21. Transform Margins Workshop 2, Slovakia, Smolenice, 87 participants, 14.12-16.12.2020, Michal Nemčok
22. CETEG 2021 - 18th Meeting of Central European Tectonic Groups and 25th Meeting of the Czech Tectonic Group, Slovakia, Terchová - Vrátna, 22.09.-25.09.2021, Jozef Madzin
23. XLII. Radiation Protection Days, online, 08.11.-12.11.2021, Iveta Smetanová
24.

2.3.9. List of researchers who received an international scientific award

J. Lexa

J. Michalík

1. Bielik M. **-** Record in the 3rd edition of the encyclopedia „Encyclopedia of personalities of the Czech and Slovak Republics“ Awarded by: Oxford Encyclopedia Publication, 2016
2. Broska I.:Outstanding reviewer of Chemical Geology, Awarded by: Elsevier , 2016
3. Janák M.: Outstanding reviewer of Chemical Geology, Awarded by: Elsevier, 2016
4. Kristek J.: Outstanding reviewer of Geophysical Journal International. Awarded by: Geophysical Journal International , 2016
5. Moczo P.: Outstanding reviewer of Geophysical Journal International. Awarded by: Geophysical Journal International, 2016
6. Lexa J.: For an invaluable contribution to the Capital City of San Salvador. Awarded by: San Salvador Mayor's Council (COAMSS) and San Salvador Capital Planning Office (OPAMSS), 2018
7. Michalík J.: František Pošepný's medal, Awarded by: Akademie věd České republiky, 2018
8. Brimich L.: Eötvös 100 Honorary Board Member, Awarded by: Hungarian Academy of Sciences, 2019

- **Position of individual researchers in the national context**

Antolíková S.
- Slovak Geological Society (SGS) (position: scientific secretary)

Aubrecht R.:
- Slovak Geological Society (SGS) (position: member of the extended committee)

Bačík P.
- Slovak Mineralogical Society (position: chairman)

Bezák V.
- Association of Slovak Geologists (position: chairman)
- Slovak Geological Council (Advisory Board of the Ministry of the Environment of the Slovak Republic) (position: member)

Bičárová S.
- Slovak Bioclimatological Society at the SAS (position: scientific secretary)
- Assembly of the Slovak Academy of Sciences (position: member)

Bielik M.
- Slovak Geological Society (position: member)
- SAS Scientific Commision for Earth and Space Sciences (position: member)

- Slovak Commision for Scientific Degrees (position: member)
- Slovak Geological Council (Advisory Board of the Ministry of the Environment of the Slovak Republic) (position: member)

Biroň A.
- Slovak Geological Society (position: member)
- Slovak Clay Society (position: Committee Member)
- Slovak Mineralogical Society (position: member)

Brimich L.
- Slovak Mining Company (position: committee member)
- SAS Scientific Commision for Earth and Space Sciences (position: member)
- SAS Commision for the Environment and Climate Change (position: member)
- VEGA: Commision No.2 for Earth and Space Sciences, Environmental sciences (including Earth Resources) (position: member)

Broska I.
- Slovak Geological Society (position: member)
- Slovak Mineralogical Society (position: committee member)
- Slovak Research and Development Agency - Commission natural sciences (position: member)
- Slovak Commission for Scientific Degrees (position: member)
- SAS Scientific Commision for Earth and Space Sciences (position: member)
- Assembly of the Slovak Academy of Sciences (position: member)
- SAS Editorial Board (position: member)
- SAS Commission for Economic Issues (position: member)
- National technological platform for research, development and innovation of raw materials (position: member)

Dérerová J.
- Slovak Mining Company (position: committee member)

Janák M.
- Slovak Geological Society (position: member)

Jeleň S.
- Slovak Association of Deposit Geologists (position: member)
- Slovak Geological Society (position: member)
- Advisory Board of the State Nature Protection of the Slovak Republic for the protection pf anorganic nature (position: member)

Kristek J.
- IUGG Slovak National Committee for Geodesy and Geophysics (position: chairman)
- Expert group for resonance seismometry, Comprehensive Test Ben Treaty organisation (CTBTO) (position: member)

Kristeková M.
- Slovak National Committee for Geodesy and Geophysics (IUGG) (position: member)
- Expert group for resonance seismometry, Comprehensive Test Ben Treaty organisation (CTBTO) (position: member)

Kysel R.
- Union of Slovak Mathematicians and Physicists (position: member)
- Slovak Physical Society (position

Kyška-Pipík R.
- Slovak Geological Society (position: member)
- Slovak Limnological Society (position: member)

Lexa J.
- Slovak Geological Society (position: honorary member)

Luptáková J.
- Slovak Association of Deposit Geologists (position: member)
- Slovak Geological Society (position: Chairman of the Regional Branch since 2013)
- Slovak Mineralogical Society (position: member)

Madarás J.
- Slovak Geological Society (position: member)
- Expert assessor of Slovak Accreditation Agency for Higher Education of the Slovak Republic (position: member)

- SAS Commision for the Environment and Climate Change (position: member)
- VEGA: Commision No.2 for Earth and Space Sciences, Environmental sciences (including Earth Resources) (position: member)
- Slovak Geological Council (Advisory Board of the Ministry of the Environment of the Slovak Republic) (position: member)
- National technological platform for research, development and innovation of raw materials (position: member)

Majcin D.
- Slovak Geological Society (position: member)

Michalík J.
- Slovak Geological Society (position: Chairman of the Paleontological Expert Group)
- SAS Scientific Commision for Earth and Space Sciences (position: member)
- SAS Editorial Board (position: member)
- The Learned Society of Slovakia (position: emeritus fellow)

Mikuš T.
- Slovak Mineralogical Society (position: committee member)

Milovská S.
- Slovak Geological Society (position: member)
- Slovak Mineralogical Society (position: member)

Milovský R .
- Slovak Geological Society (position: member)

Moczo P.
- Slovak Academic Society (position: member)
- Slovak National Committee for Geodesy and Geophysics (position: member)
- The Learned Society of Slovakia (position: president – 2018-2021, member)

Nejedlík P.
- Slovak Bioclimatic Society at SAS (position: vice-chairman)
- Slovak Meteorological Society (position: member)
- SAS Commision for the Environment and Climate Change (position: member)

Nemčok M.
- Slovak Geological Society (position: member)

Onderka M.
- Slovak Meteorological Society (position: member)

Petrík I.
- Slovak Geological Society (position: member)
- Slovak Geological Council (Advisory Board of the Ministry of the Environment of the Slovak Republic) (position: member)
- National Geological Committee of the Slovak Republic (position: member)

Puškelová Ľ.
- Slovak Geological Society (position: member)

Siman P.
- Slovak Geological Society (position: member)
- Slovak Mineralogical Society (position: committee member)
- Expert assessor of Slovak Accreditation Agency for Higher Education of the Slovak Republic (position: member)
- Section for scientific and professional literature and computer programs, Literary Fund (position: member)
- SAS Commision for the Environment and Climate Change (position: member)
- Partnership Council (Bratislava region, Trnava region) (position: member)
- Interdepartmental working group of the Ministry of the Environment of the Slovak Republic for the prevention and mitigation of the consequences of drought (position: member)
- Interdepartmental working group of the Ministry of the Environment of the Slovak Republic for adaptation to the adverse consequences of climate change (position: member)
- Working group for the creation of the Water Policy Concept for the years 2021-2030 with a view to 2050 - established by the Minister of the Environment of the Slovak Republic (position: member, expert)

- Regional Council of Partnership for the Environment BSK (position: member)
- Member, expert of the Sectoral Council for Raw Materials and Geology for NSP Sector-driven innovations to an effective labor market in Slovakia
- Working group of the Council of Government for export and investment support of the Ministry of Foreign and European Affairs of the Slovak Republic (position: member)
- Working group for material research and development, and nanotechnology, for the areas of specialization RIS3, Ministry of Education, Science, Research and Sport of the Slovak Republic (position: member)
- Working group to update the Intelligent Specialization of the Slovak Republic (RIS3 SK) - domain - Healthy food and environment (position: member)

Smetanová I.
- Slovak Nuclear Society (position: member)

Soták J.
- Slovak Geological Society (position: member)

Starek D.
- Slovak Geological Society (position: member)
- VEGA: Commision No.2 for Earth and Space Sciences, Environmental sciences (including Earth Resources) (position: member)

Sýkorová M.
- Slovak Geological Society (position: member)

Šimo V.
- Slovak Geological Society (position: member)

Števko M.
- Slovak Mineralogical Society (position: member)
- SAS Commission for Cooperation with Scientific Societes

Tomašových A.
- Slovak Geological Society (position: committee member)
- VEGA: Commision No.2 for Earth and Space Sciences, Environmental sciences (including Earth Resources) (position: member)

Vajda P.
- Slovak National Committee for Geodesy and Geophysics (SNKGG) (position: Secretary, National Delegate of the General Meeting of IUGG 2019)

Vozár Ján
- VEGA: Commision No.2 for Earth and Space Sciences, Environmental sciences (including Earth Resources) (position: member)

Vozár Jozef
- Slovak Geological Society (position: member)

Vršanský P.
- Slovak Entomological Society (position: member)
- Slovak Geological Society (position: member)

Zahorec P.
- Assembly of the Slovak Academy of Sciences (position: member)

2.3.10. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter

1. Broska I., Kubiš M.: Evolúcia granitového systému v oblasti Podsúľová – Betliar – Čučma. Predvianočný seminár Slovenskej geologickej spoločnosti, Bratislava, 8.12.2017
2. Kyška-Pipík R., Milovský R., Milovská S., Biroň A., Luptáková J., Šurka J., Mikuš T.: Laboratóriá Ústavu vied o Zemi SAV pre výskum anorganickej zložky životného prostredia. Štrbské Pleso, Odborný seminár: Environmentálne záťaže. 21.-22. marec 2016
3. Nejedlík P.: Agrometeorology activities at the European COST level. 23. Posterový deň s medzinárodnou účasťou a Deň otvorených dverí na ÚH SAV, Bratislava, 10. novembra 2016

4. Nejedlík P.: Projekty COST – brána k ďalšej medzinárodnej spolupráci a tvorbe konzorcií. Informačný deň CVTI, Bratislava, 5.12.2017
5. Kristek J., Moczo P.: Efektívne konečno-diferenčné numerické modelovanie seizmických vĺn a zemetrasného pohybu

2.3.11. List of researchers who served as members of organising and programme committees of national conferences

2.3.12. List of researchers who received a national scientific award

M. Števko

P. Vajda

A. Tomašových

J. Lexa

Jozef Vozár

J. Michalík

V. Bezák

I. Broska

1. Bezák: Gold Medal of the State Geological Institute of Dionýz Štúr, Awarded by: The State Geological Institute of Dionýz Štúr, 2018
2. Bielik M.: Awards on the occasion of November 17, Students' Day, Awarded by: Rector of Comenius University, 2018
3. Bielik M.: Personality of the year 2020 - handed over in 2021, Awarded by: The Presidium of SAS
4. Bielik M.: Bohuslav Cambel Medal, Awarded by: Institute of Earth Sciences SAS, 2020
5. Bielik M.: Dimitrij Andrusov Medal, Awarded by: Faculty of Science, Comenius University Bratislava, 2020
6. Bielik M.: Member of top scientific teams from Slovak universities, Awarded by: Accreditation Commission, 2016

7. Brimich L.: Thank-you letter for the development of the Departments of Applied and Environmental Geophysics of Faculty of Science, Comenius University, Awarded by: Departments of Applied and Environmental Geophysics Faculty of Science, Comenius University in Bratislava, 2019
8. Broska I.: The SAS Award for popularization, Awarded by: The Slovak Academy of Sciences, 2017
9. Broska I.: Silver medal of the State Geological Institute of Dionýz Štúr, Awarded by: The State Geological Institute of Dionýz Štúr, 2017
10. Broska I.: Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2016
11. Guba P.: Thank-you letter for the development of the Departments of Applied and Environmental Geophysics of Faculty of Science, Comenius University, Awarded by: Departments of Applied and Environmental Geophysics Faculty of Science, Comenius University in Bratislava, 2019
12. Hurai V.: For the best geological monograph for the years 2014-2015, Awarded by: Slovak Geological Society, 2016
13. Jeleň S.: Honorable mention for long-term contribution in the field of geology, Awarded by: Ministry of the Environment of the Slovak Republic The Deputy Prime Minister, and Minister for the Environment László Sólymos,2019
14. Janák M.: SAS Prize in the field of international scientific and technological cooperation, Awarded by: The Slovak Academy of Sciences, 2016
15. Janák M Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2016
16. Michalík J.: Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2016
17. Michalík J.: Silver medal of the Comenius University in Bratislava, Awarded by: Rector of Comenius University in Bratislava, 2016
18. Moczo P.: Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2016
19. Jeleň S.: St. Clements Award, Awarded by: CO LIBETHA, Mining and Metallurgical Association Ľubietová, 2019
20. Kohút M.: Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2020
21. Kotulová J.: Honorable mention of the Minister for the Environment, Awarded by: Minister for the Environment SR, 2021
22. Kristek J.: Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2017
23. Kristek J.: Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2016
24. Lexa J.: Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2020
25. Lexa J.: Dionýz Štúr Award, Awarded by: The State Geological Institute of Dionýz Štúr, 2019
26. Lukasová V.: Honorable mention L´Oréal - UNESCO for women in Science, Awarded by: L´Oréal – UNESCO, 2020
27. Madarás J.: Honorable mention of the Minister for the Environment, Awarded by: Ministry for the Environment SR, 2016
28. Madarás J.: The best geological publication for the years 2014 - 2015; VII. category of popularization publications, Awarded by: Slovak Geological Society, 2016
29. Michalík J.: Gold medal of the State Geological Institute of Dionýz Štúr, Awarded by: The State Geological Institute of Dionýz Štúr, 2018

30. Michalík J.: Significant personality of SAS 2016, Awarded by: The Slovak Academy of Sciences, 2016
31. Moczo P Thank-you letter for the development of the Departments of Applied and Environmental Geophysics of Faculty of Science, Comenius University, Awarded by: Departments of Applied and Environmental Geophysics Faculty of Science, Comenius University in Bratislava, 2019
32. Moczo P.: Science and Technology Awards for 2018 in category Personality of Science and Technology, Awarded by: Minister of Education, Science, Research and Sport of the Slovak Republic, 2018
33. Moczo P.: Gold medal of Comenius University Bratislava, Awarded by: Comenius University Bratislava, 2018
34. Müller T.: Top journal publication, Awarded by: The Slovak Academy of Sciences, 2019
35. Petrík I.: Honorable mention for long-term contribution in the field of geology, Awarded by: Ministry of the Environment of the Slovak Republic The Deputy Prime Minister, and Ministry for the Environment, 2018
36. Rigová J.: Stanislav Gazda Award, Awarded by: Slovak Association of Geochemists Bratislava, 2017
37. Soták J.: Commemorative medal on the occasion of the 80th anniversary of the founding of the State Geological Institute of Dionýz Štúr, Awarded by: The State Geological Institute of Dionýz Štúr, 2021
38. Soták J.: Bronze medal of the State Geological Institute of Dionýz Štúr, Awarded by: The State Geological Institute of Dionýz Štúr, Bratislava, 2016
39. Števko M.: SAS Award for the results of scientific research work for young workers, Awarded by: President of the SAS, 2021
40. Tomašových A.: SAS award in the Nature Index category, Awarded by: The Slovak Academy of Sciences, 2021
41. Tomašových A.: The Ludmila Sedlárová-Rabanová Prize, Awarded by: Fund of the Dr. Ludmila Sedlárová-Rabanováand the civic association Natura in cooperation with Faculty of Science, Comenius University in Bratislava, 2019
42. Tomašových A.: Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2016
43. Vajda PSAS Award for top scientific publication (first percentile) in 2020, Awarded by: SAS Presidency, 2021
44. Vajda P.: Thank-you letter for the development of the Departments of Applied and Environmental Geophysics of Faculty of Science, Comenius University, Awarded by: Departments of Applied and Environmental Geophysics Faculty of Science, Comenius University in Bratislava, 2018
45. Vozár Jozef (emmeritus): Dionýz Štúr Award, Awarded by: The State Geological Institute of Dionýz Štúr, 2018
46. Vozár Jozef (emmeritus): Ján Pettko Award, Awarded by: The National Geological Committee of the Slovak Republic, 2018
47. Zahorec P.: Thank-you letter for the development of the Departments of Applied and Environmental Geophysics of Faculty of Science, Comenius University, Awarded by: Departments of Applied and Environmental Geophysics Faculty of Science, Comenius University in Bratislava, 2018

2.4. Research grants and other funding resources

(List type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator "C", work package leader "W", investigator "I". Add information on the projects which are interdisciplinary, and also on the joint projects with several participating SAS institutes)

- **International projects**

2.4.1. List of major projects of Framework Programmes of the EU (which pilar), NATO, COST, etc.

COST:

CA20108 **FAIR Network of micrometeorological measurements** - NEJEDLÍK (14.10.2021-13.10.2025) - C, 0,-€

CA20136 **Opportunistic precipitation sensing network** – ONDERKA (13.10.2021-12.10.2025) – W/I, 0,-€

OC-2019-1-23948 **Working group on larger foraminifera: stratigraphy, palaeoecology, palaeoenvironment,** - SOTÁK, (1.1.2019 / 31.12.2023), W

ES1401 - **Time Dependent Seismology** – MOCZO, (3.11.2014 / 2.11.2018), project manager, 0,-€ C

COSTES1404 **A European network for a harmonized monitoring of snow for the benefit of climate change scenarios, hydrology and numerical weather prediction**, - NEJEDLÍK, (10.11.2014 / 9.11.2018), project manager, 0,-€ (MVTS 4725 € /2017) C

ESF (European Science Foundation):

Continental Lithosphere: a Broadscale Investigation - BIELIK (1.1.2021 / 31.12.2021), 0,-€ C

UNESCO:

IGCP 710 **Western Tethys meets Eastern Tethys -** SOTÁK (1.1.2020 / 31.12.2024) – 0,-€ C

IGCP 609 **Climate-environmental deteriorations during Greenhouse phases: Causes and consequences of short-term Cretaceous sea-level changes** – MICHALÍK, (25.4.2014 / 31.12.2019), project manager, 0,-€ C

IGCP No. 632 **Continental crises of the Jurassic: Major Extinction events and Environmental Changes within Lacustrine Ecosystems,** - MICHALÍK, (1.1.2014 / 31.12.2018), C, 0,-€

NA **Global evolutionary patterns and envoronmental change indicated by the fossil record of cockroaches, termites and mantises (AMBA framework),** - VRŠANSKÝ, (1.1.2009 / 31.12.2018), C, 0,-€

Climate-environmental deteriorations during greenhouse phases: Causes and consequences of short-term Cretaceous sea-level changes – Michalík, (1.1.2013 / 31.12.2017), C, 0,-€

NA **Global evolutionary patterns and envoronmental change indicated by the fossil record of cockroaches, termites and mantises (AMBA framework)** – VRŠANSKÝ, (1.1.2009 / 31.12.2018), C, 0,-€

IVF (International Visegrad Found):

Importance of raw materials in the economy of V4 countries – BROSKA (1.10.2020 / 31.1.2022) – project manager, 0,-€ W

Visegrad Grant No. 21930053 - **CAPABLE** *(CAPABLE – CArpathian PAnnonian Basin Lithosphere Enquiry)*- FOJTÍKOVÁ (1.1.2020 / 31.12.2021) – project manager, 0,-€ W

HORIZONT 2020:

Gravimetric investigation of the structure of the Etna summit craters system – VAJDA, (1.3.2020 / 30.11.2021), - project manager, 0,-€ C

55 **Deposit-to-Regional Scale Exploration,** - VOZÁR, (1.12.2020 / 30.11.2023), project manager, 0,-€ C

H2020-MSCA-ITN-2014; REA Grant Agreement No. 643084 **Brachiopods As SEnsitive tracers of gLobal mariNe Environment: Insights from alkaline, alkaline Earth metal, and metalloid trace element ratios and isotope systems,** - TOMAŠOVÝCH, (1.10.2015 /

31.12.2018), project manager, Funding: 42281 € (2018 GEOMAR), 4480 € (MVTS); 57669 € (2017 GEOMAR); 3150 € (MVTS); 55992 € (2016 GEOMAR); 3500 € (MVTS); 4000 € (MVTS); 14000 € (Geomar Germany) C

Project MAD:

Application of a new SpaceMap program for calculation of 3D complex crustal model in the Carpathian-Pannonian Basin region – BIELIK (1.4.2020 / 31.3.2022) – C, 0,-€

SAV-18-05 **Correlation of Jurassic-Cretaceous boundary sequences in the Tethyan Mediterranean Belt and adjacent regions based on geodynamics (lithostratigraphy, sequence analysis, paleogeography), micro- and nannofossil record and global climate and sea-level change** – MICHALÍK, (1.1.2018 / 31.12.2021), C, 0,-€

Geophysical events and their bioindication using microorganisms – NEJEDLÍK, (1.4.2020 / 31.3.2022), -C, 0,-€

Regional conductivity anomalies role in tectonic development of the Carpathians – VOZÁR, (11.2.2019 / 30.12.2021), - C, 0,-€

SAV-18-06 **Correlation of magmatic and metamorphic evolution of the Rodopes and Western Carpathians** –BROSKA, (1.1.2018 / 31.12.2020), BROSKA, -C, 0,-€

Application of a new automated software system (GMT-Auto) for interpretation of the Carpathian-Pannonian Basin lithosphere, - BIELIK, (6.4.2017 / 5.4.2019), C, 0,-€

Accessory minerals as indicators of geological processes of Precambrian granitoids formation and their metalogenetic potential (Ukrainian Shield) - BROSKA, (1.1.2017 / 31.12.2019), C, 0,-€

Low-frequency fluctuations of the geomagnetic field and their bioresponse effects in case of water characteristics, luminescent bacteria and yeast granules – VACZYOVÁ, (6.4.2017 / 31.12.2019), - C, 0,-€

MAD 15-13, SAV-AV ČR 15-13 **Electrical conductivity and geological structure in the West Carpathians and its transition to the Bohemian Massif** – BEZÁK, (1.1.2015 / 31.12.2017), C, (2017 - 1003€)

Distribution patterns of diatoms and ostracods in the Slovakian and Bulgarian Neogene lake systems – KYŠKA-PIPÍK, (1.1.2015 / 31.12.2018), C, 0,-€

Integrated 3D geophysical interpretation of the lithosphere in the junction of the Carpathians and European platform, - BIELIK, (1.1.2014 / 31.12.2016), C, 0,-€

Assessment of the peak ground horizontal acceleration generated by paleo-earthquakes from failure tensile stress of speleotherms. Study of seismicity of the remote past with the use of engineering seismology – BRIMICH, **(**1.10.2011 / 31.12.2016), C, 0,-€

Revealing of genetic and age relations between magmatism and epithermal ore formation in volcanic structures of eastern-Slovakian and Western-Ukrainian regions of the neogene volcanism - JELEŇ, (25.9.2014 / 31.12.2016), C, 0,-€

ASSESSMENT OF EUROPEAN AGRICULTURE WATER USE AND TRADE UNDER CLIMATE CHANGE – NEJEDLÍK, (18.4.2012 / 17.4.2016), project manager, 0,-€

Investigation of the influence of the geological inhomogeneities on the microseismical measurements - BRIMICH, (1.10.2007 / 31.12.2015), C, 0,-€

Revealing of genetic and age relations between magmatism and epithermal ore formation in volcanic structures of eastern-Slovakian and Western-Ukrainian regions of the neogene volcanism – JELEŇ, (25.9.2014 / 31.12.2016), C, 0,-€

The constitutional agreement:

19-07516S **Cretaceous – Paleogene boundary in Carpathians – multidisciplinary research** – SOTÁK, (1.9.2018 / 31.12.2021), - project manager, 0,-€ C

Bi-lateral project:

Magura Piggy-back Basin at the font of the PKB: lito and biostratigraphy, provenance analysis and paleogeographic interpretations (Western Outer Carpathians, Poland and Slovakia – SOTÁK, (1.1.2015 / 31.12.2018), - project manager, 0,-€ C

Multilatetal projects:

Deposit-to-Regional Scale Exploration – VOZÁR, **(**1.12.2020 / 30.11.2023), - project manager, 0,- €

Importance of raw materials in the economy of V4 countries, BROSKA, (1.10.2020 / 31.1.2022), - project manager, 0,-€

AlpArray, - CSICSAY, (1.1.2013 / 31.1.2020), - project manager, 0,-€

AlpArray Gravity Research Group, - ZAHOREC, (25.5.2018 / 25.5.2020), project manager, 0,-€

LS-2288 **Fossil subcellular structures in giant sperm cells of Miocene ostracods: expanding the record to specimens preserved in amber***,* - KYŠKA-PIPÍK, project manager, 0,-€

International Real-time Magnetic Observatory Network – VACZYOVÁ, (6.9.1998 / 31.12.2020), project manager, 0,-€

MOBILITY

SAV-AV ČR-21-07 **Comparison of geophysical and geological structures of the Western Carpathian lithosphere with other orogenic areas in Europe (mainly Bohemian Massif and Norwegian Caledonides)** – BEZÁK, (1.1.2021 / 31.12.2022), - C, 1500,-€

BAS-SAS-21-06 **Correlation and comparisom of the products of the late Permian and early to mid Triassic magmatic activity in the Balkanides (median and external zones) and Western Carpathians** – BROSKA, (1.1.2021 / 31.12.2022), - C, 2000,-€

SAV-AV ČR-21-02 **Adria Array in Slovakia** – CSICSAY, (1.1.2021 / 31.12.2022), 1500,-€

SK-KR-18-0008 – **U-Th-Pb zircon dating of Varisca granitic and Alpine subvulvanic intrusive rocks of the Western Carpathians: implications to orogenic and metallogenetic processes,** - BROSKA, (1.9.2018-31.9.2019), project manager, 7800€

Other projects:

De-risking Ireland's Geothermal Energy Potential – VOZÁR, (11.2.2020 / 30.12.2022), - project manager, 0,-

UMR CNRS 6112 LPG **Foraminiferal research consortium,** - SOTÁK, (1.1.2015 / 31.12.2018), C, 0,-€

- **National projects, incl. international projects with only national funding**

2.4.2. List of ERA-NET projects funded from SAS budget

None

2.4.3. List of projects of the Slovak Research and Development Agency, APVV

Coordinator:

APVV-0436-12 **Evolutionary patterns as indicated by panarthropods** – VRŠANSKÝ, (1.10.2013 / 30.9.2017), 2016 – 8500€, 2017 – 6302€

APVV-14-0278 **Stability of accessory minerals and the mobility of rare lithophile elements and C in the rocks of collisional orogenic zones: prograde and retrograde transformations** – PETRÍK, (1.7.2015 / 30.6.2019), 2016 – 39085€, 2017 – 39598€, 2018 – 39010€, 2019 - 15506€

APVV-14-0118 **Regional stratotypes for genetic, earthtime and paleoenvironmental properties of the Western Carpathian sedimentary basins** – SOTÁK, (1.7.2015 /

30.6.2019), 2016 – 26124€, 2017 – 40249€, 2018 - 25749€ , 2019 – 17281€,

APVV-15-0292 **Deglaciation and postglacial climatic evolution recorded in the lake deposits of the High Tatra Mountains** – KYŠKA-PIPÍK, (1.7.2016 / 30.6.2020), 2016 – 18637€, 2017 – 36187€, 2018 – 34962€, 2019 – 35775€, 2020 - 10337€

APVV 16-0482 **Geophysical multi parametric modelling of the Earth´s crust and upper mantle in Slovakia** – VOZÁR (1.7.2017 / 30.6.2021), 2017 – 36989€, 2018 – 57308€, 2019 – 40796€, 2020 – 32421€, 2021 - 12486€

APVV 17-0555 **Evaluating preservation potential of benthic responses to hypoxic and anoxic events in the fossil record** - TOMAŠOVÝCH, (1.11.2018 / 30.6.2022), 2018 – 13901€, 2019 – 45275€, 2020 – 42569€, 2021 - 24808€

APVV-18-0107 **Ultrahigh-pressure metamorphic rocks and granitoids of colisional orogens: P-T-X conditions, formation of microdiamonds, stability of accessory minerals nd geodynamic evolution** - JANÁK, (1.7.2019 / 30.6.2023), 2019 – 15798€, 2020 – 46345€, 2021 - 43463€

SK-KR-18-0008 **U-Th-Pb zircon dating of Variscan granitic and Alpine subvolcanic intrusive rocks of Western Carpathians: implications to orogenic and metallogenetic processes** – BROSKA (1.9.2018 / 31.12.2019). Project costs in EURO: 2018 – 3900€, 2019 - 3900€

APVV-20-0079 **Chronostratigraphic standards and sedimentary archives of global changes of biota and paleoenvironments of the Western Carpathians** – SOTÁK, (1.8.2021 / 30.6.2025), 2021 - 9190€

APVV-20-0358 **Reading in natural archives: thousands of years of environmental history and climate change recorded in alpine lakes of the Ukrainian Carpathians** – KYŠKA-PIPÍK, (1.7.2021 / 30.6.2025), 2021 - 6077€

Project manager:

APVV-0212-12 **Tectonic and sedimentary mass transfer within the prograding Western Carpathian orogenic wedge** – BUČOVÁ (1.10.2013 / 30.9.2017), 2016- 10648€, 2017 - 6955€

APVV-0339-12 **Perlite genesis and inovative approaches to its exploitation and processing** – LEXA, (1.10.2013 / 30.9.2017), 2016 – 6539€, 2017 – 2621€,

APVV-0429-12 **Mappying of phytotoxic ozone doses in the forest environment of the High Tatras** – BIČÁROVÁ, (1.10.2013 / 31.3.2017), 2016- 16611 € , 2017 - 2148€

APVV-0662-12 **Signatures of the solar activity in the time-spatial variations of the geomagnetic field** – VALACH, (1.10.2013 / 30.9.2017), 2016 – 18000€, 2017 – 14476€,

SK-HU-2013-0027 **Comparative study of Miocene rhyolite volcanic formations in Slovakia and Hungary** – LEXA, (1.1.2015 / 31.12.2016), 2016 – 1480€

APVV 15-0050 **Interaction models of crustal and mantle rocks with fluids in accretionary wedges of the Western Carpathians, eastern Alps and northern Turkey; correlation of P-T-X-t parameters** – SIMAN, (1.7.2016 / 31.12.2019), 2016 – 10513€, 2017 – 12254€, 2018 – 11759€, 2019 – 7048€,

APVV 15-0083 **Complex model of base and precious metal mineralisation at the Rozália mine in Hodruša – Hámre –** LEXA, (1.7.2016 / 31.12.2020), 2016-7078€, 2017 – 27174€, 2018 – 21444€, 2019 – 18057€, 2020 - 4500€

APVV 15-0560 **Identification and characterization of a potencial of site effects using robust numerical modelling of equarthquake ground motion** – KRISTEKOVÁ, (1.7.2016 / 30.6.2020), 2016 – 6449€, 2017 – 12149€, 2018 – 8649€, 2019 – 11773€, 2020 – 4762€,

APVV 16-0146 **Multidisciplinary research of geophysical and structural parameters, and environmental impacts of faults of the Western Carpathians –** MADARÁS, (1.7.2017 / 30.6.2021), 2017 – 4302€, 2018 – 25746€, 2019 – 19305€, 2020 – 16252€, 2021 - 5626€

APVV 17-0170 **Early Alpidic tectonic evolution and palaeogeography of the Western Carpathians** – MADZIN, (1.8.2018 / 31.7.2022), 2018 – 9000€, 2019 – 18000€, 2020 – 18000€, 2021 - 18000€

APVV-18-0251 **Linking the evolution of Mesozoic vertebrates to climate in Eastern Laurasia: High-resolution analysis of unique fossil tissues from Chine** – MILOVSKÝ, (1.7.2019 / 30.6.2022), 2019 – 2306€, 2020 – 4945€, 2021 - 5286€

SK-PT-18-0015 **Radon in caves and mines – Portugese and Slovak case studies –** SMETANOVÁ, (1.1.2019 / 31.12.2022), 2019 – 2693€, 2020 – 2693€,

APVV-19-0150 **New Bouguer anomaly map of the Alpine-Carpathian area: a tool for gravity and tectonic applications** - ZÁHOREC, (1.7.2020 / 30.6.2024), 2020 – 6290€, 2021 - 13810€

APVV-20-0175 **Bentonite: Slovak strategic raw material - Innovative assessment of bentonite quality and origin for its efficient use** – BIROŇ, (1.7.2021 / 30.6.2025), 2021 - 7591€

2.4.4. List of projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education, VEGA (for funding specify only total sum obtained from all VEGA grants in particular year)

Coordinator:

2/0012/14 **Cockroaches in amber** – VRŠANSKÝ, (1.1.2014 / 31.12.2017), 2016-7222€, 2017-6295€,

2/0030/14 **Transient and secular variations of the geomagnetic field on the territory of Slovakia** – VALACH, (1.1.2014 / 31.12.2016), 2016-6468€

2/0053/14 **Atmospheric processes and tropospheric ozone in the mountain environment** - BIČÁROVÁ, (1.1.2014 / 31.12.2017), 2016-5405€, 2017-4987€

2/0094/14 **Biostratigraphic and palaeoenvironmental analysis of the Lower to Middle Jurrasic sequences of the selected localities of the Western Carpathian –** OZDÍNOVÁ, (1.1.2014 / 31.12.2016), 2016-2011€,

2/0017/15 **Integrated sedimentological study of the Paleogene formations of the Central Western Carpathians: a reconstruction of the depositional paleoenvironments in relation to tectogenetic processes, subsidence history of the basin and changing climate regimes** – STAREK, (1.1.2015 / 31.12.2017), 2016-3736€, 2017-4399€

2/0042/15 **Implementation of recent innovations in potential fields interpretation methodology** – VAJDA, (1.1.2015 / 31.12.2018), 2016-13724€, 2017-11624€, 2018-11133€

2/0056/15 **Multiproxy analysis of limnic profundal deposits: cyclicity and variability of the environment in Late Miocene of the Central Paratethys** – KYŠKA-PIPÍK, (1.1.2015 / 31.12.2017), 2016-5390€, 2017-5501€

2/0067/15 - **Numerical solution of the kinematic problem for geomagnetic secular variations** – MARSENIČ, (1.1.2015 / 31.12.2017), 2016-1725€, 2017-1760€

2/0083/15 **Statistical analysis of long-term radon time series from Slovakia** – SMETANOVÁ, (1.1.2015 / 31.12.2017), 2016-2156€, 2017-2200€,

2/0091/15 **Crustal tectonic structures in Eastern Slovakia – interepretation based on magnetotelluric and others geophysical data** - BEZÁK, (1.1.2015 / 31.12.2018), 2016-3952€, 2017-3538€, 2018-3374€

2/0136/15 **Tracing changes in seawater temperature during the end-Triassic mass extinction and during the Early Jurassic in the western Tethys (Western Carpathians and Eastern Alps)** – TOMAŠOVÝCH, (1.1.2015 / 31.12.2018), 2016-7186€, 2017-6234€, 2018-4871€

2/0138/15 **Evolution of monogentic rhyolite volcanoes** – LEXA, (1.1.2015 / 31.12.2018), 2016-2479€, 2017-4731€, 2018-2586€

2/0188/15 **Seismic regime in the Malé Karpaty focal zone** - FOJTÍKOVÁ, (1.1.2015 / 31.12.2018), 2016-12935€, 2017-12432€, 2018-13494€

2/0193/15 **Timing, extent and depth of Late Pleistocene epizodic thawing of permafrost inferred from cave paleoclimatic records of Slovakia**. – MILOVSKÝ, (1.1.2015 / 31.12.2017), 2016-5388€, 2017-5499€,

2/0034/16 **Global event stratigraphic correlations and paleoenvironments of the Cretaceous and Paleogene formations of the Western Carpathians: biotic, sedimentary and**

geochemical proxies – SOTÁK, (1.1.2016 / 31.12.2019), 2016-12933€, 2017-15401€, 2018-16492€, 2019-13630€

2/0057/16 **Mesozoic changes of climate, sedimentation, palaeooceanologic proxies, environments and communities of marine organisms –** MICHALÍK, (1.1.2016 / 31.12.2018), 2016-6823€, 2017-7299€, 2018-5620€

2/0060/16 **High-pressure metamorphism in the crystalline complexes of the Western Carpathians** – JANÁK, (1.1.2016 / 31.12.2019), 2016-4307€, 2017-4948€, 2018-6743€, 2019-5448€

2/0067/16 **Stability and retrograde alterations of accessory minerals from the rocks of collisional orogenic zones** – PETRÍK, (1.1.2016 / 31.12.2018), 2016-3988€, 2017-3445 €, 2018-3745€,

2/0115/16 **Convective dynamics of phase transition in the Earth's core** – GUBA, (1.1.2016 / 31.12.2018), 2016-2874€, 2017-2933€, 2018-2998€

2/0118/16 **Origin of the Evate phosphate deposit, Mozambique** – HURAI, (1.1.2016 / 31.12.2018), 2016-3334€, 2017-2523€, 2018-2279€

2/0002/17 **Geomagnetic field in Slovakia round the 2018.5 epoch** – VALACH, (1.1.2017 / 31.12.2019), 2017-5281€, 2018-5398€, 2019-7479€

2/0023/17 **Oxidation of the resistant tungsten minerals in the specific conditions of the Ochtiná deposit** – MIKUŠ, (1.1.2017 / 31.12.2019), 2017-2200€, 2018-2699€, 2019-4674€

2/0028/17 **Magnetic fabric, sedimentologic and provenance study of clastic formations of the Western Carpathians –** MADZIN, (1.1.2017 / 31.12.2020), 2017-4415€, 2018-6686€, 2019-5607€, 2020-4322€

2/0084/17 **Correlation of Permian S-type granites from Gemeric unit of the Western Carpathians with the Permian granites in the southern Europe and Anatolia** – BROSKA, (1.1.2017 / 31.12.2019), 2017-4031€, 2018-4120€, 2019-6619€

2/0186/17 **Biostratigraphy and paleoecology of jurassic and lower cretaceous "fleckenmergel" facies in Western Carpathians** – ANTOLÍKOVÁ, (1.1.2017 / 31.12.2019), 2017-2053€, 2018-2098€, 2019-2492€

2/0014/18 **Sedimentary paleoenvironments and transport-depositional mechanisms in the Paleogene formations of the Central Western Carpathians** – STAREK, (1.1.2018 / 31.12.2021), 2018-3597€, 2019-3737€, 2020-2470€, 2021- 1493€

2/0015/18 **Meso- and micro-meteorological exploration of the occurrence of hydrometeors in boundary layer of the troposphere based on pasive evaluation of changes of electromagnetic radiation from anthropogenic sources** – NEJEDLÍK, (1.1.2018 / 31.12.2020), 2018-5809€, 2019-6037€, 2020-5982€

2/0042/18 **Cockroaches from amber II –** VRŠANSKÝ, (1.1.2018 / 31.12.2021), 2018-4579€, 2019-5220€, 2020-5385€, 2021-6110€

2/0083/18 **Temporal and spatial variations of radon activity concentration and CO2 in the environment** – SMETANOVÁ, (1.1.2018 / 31.12.2020), 2018- 1800€, 2019-2150€, 2020-2316€

2/0122/18 **Temporal and spatial changes in the composition of benthic algal-dominated assemblages of the Vienna Basin and Carpathian Foredeep during the Middle Miocene** – HRABOVSKÝ, (1.1.2018 / 31.12.2021), 2018-2998€, 2019-3115€, 2020-3087€, 2021-1793€

2/0006/19 **Integration of latest findings and approaches of gravimetry, geothermics and deep seismics for determining lithospheric structure and tectonics focusing on Western Carpathians** – VAJDA, (1.1.2019 / 31.12.2022), 2019-20449€, 2020-15516€, 2021-11653€

2/0008/19 **Rock-forming and accessory minerals during retrogression of high-grade metamorphic and metamagmatic rocks from orogenic belts** – PETRÍK, (1.1.2019 / 31.12.2021), 2019-2490€, 2020- 2777€, 2021-2687€

2/0067/19 **Quaternary climate changes in isotope archives of Slovak caves** – MILOVSKÝ, (1.1.2019 / 31.12.2021), 2019-4672€, 2020-5249€, 2021-2807€

2/0090/19 **Composition, sources, transport and paleogeographic conditions of deposition of siliciclastic material in Triassic/Jurassic boundary formation of units of the Tatra Mts** – VĎAČNÝ, (1.1.2019 / 31.12.2022), 2019-1635€, 2020-1852€, 2021-2465€

2/0144/19 **Recent and historical seismic activity in the Little Carpathians Mts. source zone** – CSICSAY, (1.1.2019 / 31.12.2022), 2019-9346€, 2020-9217€, 2021-8065€

2/0169/19 **Preservation potential and effects of hypoxic events on benthic communities in the fossil record** – TOMAŠOVÝCH, (1.1.2019 / 31.12.2022), 2019-6621€, 2020-5790€, 2021-6724€

2/0013/20 **Chronology of global events in Tethyan and Parathethyan basins of the Western Carpathians infered from evolution and life environments of fossil planktonic organisms.** – SOTÁK, (1.1.2020 / 31.12.2023), 2020-11577€, 2021- 10828€

2/0028/20 **Mineralogy and genesis of precious metal epithermal Au-Ag mineralization in the SW part of the Štiavnica stratovolcano (Rudno-Pukanec area)** MIKUŠ, (1.1.2020 / 31.12.2022), 2020-7487€, 2021-8740€

2/0046/20. **An analysis of robustness of selected structural parameters in relation to earthquake ground motion in local near-surface structures with stochastic perturbations of material parameters** – GÁLIS, (1.1.2020 / 31.12.2023), 2020-3647€, 2021-5770€

2/0047/20 **Magnetotelluric modeling of deep tectonic structures at the European pltform and Carpathian block interface** – BEZÁK, (1.1.2020 / 31.12.2023), 2020-6561€, 2021-7469€

2/0056/20 **Metamorphic processes in collisional orogenic zones** – JANÁK, (1.1.2020 / 31.12.2023), 2020-6558€, 2021-6346€

2/0075/20 **Genesis and evolutionary stages of the granite massif in the Tatric part of the Nízke Tatry Mts.** – BROSKA, (1.1.2020 / 31.12.2023), 2020-7640€, 2021-7243€

2/0100/20 **Density analysis of the rock environment based on surface and underground gravity measurements** – ZAHOREC, (1.1.2020 / 31.12.2023), 2020-3474€, 2021-5042€

2/0003/21 **Complex analysis of the effects of rising air temperature on rainfall extremes in Slovakia** – ONDERKA, (1.1.2021-31.12.2023), 2021-5042€

2/0085/21 **Variability of geomagnetic field in various time scales from the point of view of physical causes** – REVALLO, (1.1.2021 / 31.12.2023), 2021-5378€

2/0013/21 **Extensometric measurements and interpretation of the periodical and non periodical deformation of the Earth´s crust in the Western Carpathian region** – DÉREROVÁ, (1.1.2021 / 31.12.2024), 2021-2241€

2/0015/21 **Radon activity concentration in selected show caves in Slovakia** – SMETANOVÁ, (1.1.2021 / 31.12.2024), 2021-2090€

2/0093/21 **Response of Mountain pine to stress factors in mountain areas of the Western Carpathians** – LUKASOVÁ, (1.1.2021 / 31.12.2024), 2021-5049€

2/0163/21 **Fine laminated deposits - a tool for chronology of the latest Pleistocene climatic events in the Tatra Mts.** – KYŠKA-PIPÍK, (1.1.2021 / 31.12.2023), 2021-11577€

Project manager:

2/0089/14 **Flow deposition of acidifying components and ozone in the selected submontain and mountain areas of Slovakia** – BIČÁROVÁ, (1.1.2014 / 31.12.2017), 2016-0€, 2017-0€

1/0141/15 **Geophysical model of the lithosphere of the Western Carpathians** – VAJDA, (1.1.2015 / 31.12.2018), 2016-6746€, 2017-6140€, 2018-6401€,

1/0538/15 **Comparison of country remediation possibilities in surrounding of selected European Cu-deposits** – MILOVSKÁ/LUPTÁKOVÁ, (1.1.2015 / 31.12.2017), 2016-1858€, 2017-872€

1/0560/15 **Mineralogy and genesis of economically important types of gold mineralization in the Central Slovakia Volcanic Field** – LEXA, (1.1.2015 / 31.12.2018), 2016-1893€, 2017-1919€, 2018-2276€

1/0650/15 **Geochemistry and geochronology of the dyke rocks from the Western**

Carpathians – SIMAN, (1.1.2015 / 31.12.2018), 2016-1756€, 2017-733€, 2018-0€

1/0664/15 **A 250 years history of human impacts on a landscape of the Banská Štiavnica mining territory: palaeolimnological reconstruction using biotic and abiotic indicators from lake sediments** – KYŠKA-PIPÍK, **(**1.1.2015 / 31.12.2017), 2016-0€, 2017-0€

1/0119/16 vôd **The influence of landscape annd regulations on the freshwater benthic macroinvertebrates communities** – MILOVSKÝ, (1.1.2016 / 31.12.2019), 2016-0, 2017-0, 2018-0, 2019-650€

1/0462/16 **Solution of actual problems in geophysical and geodetic detection of underground cavities in environmental and archaeological applications** – ZAHOREC, (1.1.2016 / 31.12.2019), 2016 - 3786€, 2017- 3140€, 2018 - 3201€, 2019 - 2886€

1/0143/18 **Mineralogy, petrogenesis and metallogenetic potential of the Pliocene intra-plate magmatism of Western Carpathians** – HURAI, (1.1.2018 / 31.12.2021), 2018 -1067€, 2019-1110€, 2020-2234€, 2021-2141€

1/0237/18 **Rodingites in Western Carpathians, specialized rock type** – SIMAN, (1.1.2018 / 31.12.2020), 2018-0€, 2019-2220€, 2020-2234€

1/0260/19 **Novel approach to analysis of geological and environmental samples by laser spectroscopy techniques** – MILOVSKÝ, (1.1.2019 /), 2019-0,

1/0291/19 **Immobilization of potentially toxic elements in contaminated soils at important Cu-deposits of Europe** – LUPTÁKOVÁ/MILOVSKÁ, (1.1.2019 / 31.12.2022), 2019- 1183€, 2020-1190€, 2021-1141€

1/0526/21 **Rifting and subsidence history of back-arc basins across the Western Carpathians** – KOTULOVÁ, (1.1.2021 / 31.12.2024), 2021-1071€

Table of total sums (€) obtained from all VEGA grants in particular years

	2016	**2017**	**2018**	**2019**	**2020**	**2021**
Coordinator	114036	123729	113119	111421	110907	126612
Proj.Manager	16039	12804	12945	8049	5658	4353
Sumarized	**130075**	**136533**	**126064**	**119470**	**116565**	**130965**

2.4.5. List of projects supported by EU Structural Funds

The projects were completed by 2015, but monitoring of the projects continued until 2020/2021

ITMS 26210120013 **Completion of technical infrastructure for research of geodynamical processes and global changes in Earth‘s history –** BIROŇ, (23.10.2012 / 30.4.2015), C,

ITMS 26220120064 **Centre of excelence for integrated research of the Earth's geosphere** – SOTÁK, (1.9.2010 / 28.2.2015), C,

ITMS 26250120034, **Centers of education of Slovak Academy of Sciences in Banská Bystrica and Smolenice** – KYŠKA-PIPÍK, (1.6.2010 / 1.1.2015), C,

2.4.6. List of other projects funded from national resources

SASPRO 1497/03/01/ CRITHON3D **Multi-dimensional integrated geophysical-petrological modelling of the crust, and uppermost mantle for central Europe region by structural joint inversion** - VOZÁR, (1.3.2016 / 31.12.2018), C, 2016-0€, 2017 – 59039€, 2018 - 52195€

2.4.7. List of projects funded from private funds

More in Chapter 2.6.3.

2.4.8. List of projects funded from other competitive funds

2.5. PhD studies and educational activities

2.5.1. List of accredited programmes of doctoral studies, period of validity, source of funding

Faculty of Science, Comenius University - Framework agreement:

4.1.33	Tectonics	2015-2016
4.1.29	Mineralogy	2020 -
4.1.30	Applied Geophysics	2015 –
4.1.31	Paleontology	2020 -
4.1.32	Petrology	2005 –
4.1.33	Sedimentology	2017-

2.5.2. Summary table on doctoral studies (number of internal/external PhD students at the end of the year; number of foreign PhD students, number of students who successfully completed their theses during the year, number of PhD students who quit the programme during the year)

PhD study	2016			2017			2018			2019			2020			2021		
Number of potential PhD supervisors																		
PhD students	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	unumber, end of yea	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted
Internal total	9	4	1	8		4	8	3	1	7	2	1	9		1	8	1	4
from which foreign citizens	1			2		1	3			3	1		4			1		3
External	3			2	1		1			2	1		3			6		
Other supervised by the research employees of the institute	26			24			20			17			24			29		

The students who completed PhD scholarship according to years:

- standard length of study (I/E):
  1. Barna Peter 13.12.2016
  2. Porubčanová Barbora 23.8.2016
  3. Kubišová Lenka 23.8.2016
  4. Fuksi Tomáš 22.8.2018
  5. Žecová Katarína (E) 18.12.2017
- above-standard length of study (I/E)
  1. Sýkorová Martina 14.1.2016
  2. Fekete Kamil 22.8.2018
  3. Pulišová Zuzana 1.6.2018
  4. Kovacs Erika 27.8.2019
  5. Chovanová Zuzana 17.7.2019
  6. Luhová (Mareková) Ľubica 14.6.2021
  7. Seko Michal (EI) 27.8.2019

8. Müller Tamás (ITN Horizon 2020, with Kiel University, Germany) 25.11.2021

PhD student from abroad

1. Kovacs Erika (Hungary, starting in 2013 – ending in 2017)
2. Müller Tamás (Hungary, starting in 2015, ending in 2019)
3. Vidhya Marina (India, starting in 2017)
4. Ramachandran Dhavamani (India, starting in 2017)
5. Maraszewska Maria (Poland, starting in 2018)
6. Campos Bruno (Brazil, starting in 2020 – ending in 2021)

The number of potential PhD supervisors for programmes that were accredited as of 31.12.2021:

1. **Applied geophysics: 15** - Broska I., Brimich L., Bezák V., Bielik M., Kristek J., Kristeková M., Madarás J., Moczo P., Onderka M., Revallo M., Smetanová I., Vajda P., Valach F., Vozár J., Zahorec P.
2. **Mineralogy: 3** - Biroň A., Mikuš T., Števko M.
3. **Paleontology: 5 -** Kyška-Pipík R., Michalík J., Soták J., Šimo V., Vršanský P.
4. **Petrology: 12** - Janák M., Petrík I., Milovský R., Biroň A., Broska I., Hurai V., Soták J., Siman P., Mikuš T., Kotulová J., Lexa J., Števko M.
5. **Sedimentology: 9** - Soták J., Tomášových A., Starek D., Biroň A., Kyška-Pipík R., Michalík J., Kotulová J., Milovský R., Vršanský P.
6. **Tectonics: 2** - Michalík J., Milovský R.

2.5.3. PhD carrier path – Information on the next career steps of the PhD graduates who received their degree from the institute

2.5.4. Summary table on educational activities

Teaching	2016	2017	2018	2019	2020	2021
Lectures (hours/year)*	271	545	292	179	119	68
Practicum courses (hours/year)*	136	363	205	72	280	49
Supervised diploma and bachelor thesis (in total)	16	12	15	11	12	12
Members in PhD committees (in total)	14	14	13	14	15	14
Members in DrSc. committees (in total)	2	2	1	1	2	3
Members in university/faculty councils (in total)	8	7	7	6	5	5
Members in habilitation/inauguration committees (in total)	5	1	5	3	3	5

2.5.5. List of published university textbooks

Hurai V., Huraiová M. (2016) Izotopová geológia I. Stabilné izotopy. Univerzita Komenského, Bratislava, 78 p. ISBN 978-80-223-3722-9

2.5.6. Number of published academic course books

The institute published one academic course book

2.5.7. List of joint research laboratories/facilities with universities

1. **Laboratory of Thermomechanics of Materials** - Institute of Anorganic Chemistry SAS from 2019 in Banská Bystrica
2. **Energy geoscience laboratory (EGL)** Joint laboratory of Energy and Geoscience Institute of University Utah and Geological Insttute of the Slovak Academy of Sciences was established in 2007. Prospespection and studying ef energetic resources is the objective of common activities funded by worldwide oil companies (leader: M. Nemčok)
3. **Institute of Botany and Geology at Geological Institute of the SAS** is a training workplace for the students of botany and geosciences from the Natural Faculty of Matej Bell University. Recently new treaty is just in preparation (new name, contents and partners - e.g. mathematics, informatics, etc.).
4. **Joint researd laboratory of the study of mixed-layered silicates.** Laboratory was established in 1994 upon the agreement between GI SAS and FNS Comenius University Bratislava.
5. **Joint research laboratory** with Faculty of Mathematics, Physics and Informatics, Comenius University). Main common research:
    - seismic stations
    - paleomagnetic and archeomagnetic laboratory
    - station of the radon emanation

2.5.8. Supplementary information and/or comments on doctoral studies and educational activities – focused on what changes have occurred since the last evaluation in 2016

The course "Analytical Methods in Geology" at the SAS Education Center in Banská Bystrica has been running since 2016. The course is intended for master's and doctoral students in geology, geography, biology, and chemistry, and is conducted for students from AGH University of Science and Technology in Krakow, Matej Bel University in Banská Bystrica and Comenius University in Bratislava.

During the week, the students learn the analytical and field methods that are implemented in the workplace in Banská Bystrica.

2.6. Societal impact

2.6.1. The most important case studies of the research with direct societal impact, max. 4 for institute with up to 50 average FTE researchers per year, 8 for institutes with 50 – 100 average FTE researchers per year and so on. Structure: Summary of the impact; Underpinning research; References to the research; Details of the impact; Sources to corroborate the impact. One page per one case study

The hydrocarbon potential

In this chapter, we present the research carried out for a private company, which has the potential to become a benefit from the point of view of societal importance as well. In 2016, the Earth Science Institute of the Slovak Academy of Sciences (ESI SAS) realized a research study for the company NAFTA a.s. which is the most important player in Slovakia's oil and gas exploration sector. Within the research, EISAS evaluated the perspective of the Trnava Exploration Area from the point of view of the occurrence of hydrocarbon deposits, mainly natural gas.

Summary of the impact; Exploration for oil and gas deposits is a long-time process involving a number of partners, performing partial surveys and analyses. In 2016, a team of researchers from EISAS worked on the unification of the individual data obtained and on the final recommendations. The direct benefit of our research is the main knowledge of the hydrocarbon system in the studied area, on the basis of which NAFTA a.s. locates future gas production wells. Another benefit for the company as well as for the whole society will be when the company really drill gas deposits and extract them.
In the overall complex process of gas exploration within the Trnava Exploration Area, the contribution of **ESI SAS** research is very important. From the overall aspect of energy security, our contribution to society as a whole is also very clear. Especially nowadays, when there is a lack of energy due to the geopolitical and energy crisis, and when every new and especially domestic energy source that can help overcome energy dependence is welcome.

Underpinning research; 20 thousand EUR

References to the research; The name of the final research report: *Research on the hydrocarbon potential of the Blatnianska depression - based on new as well as existing geochemical and geological knowledge. Authors: Kotulová, J., Rybár, S., Pramuková, Š., Ozdínová, S., Lexa, J., Rigová, J., Halašiová, N., Manuscript: NAFTA a.s., p 113.*
Details of the impact; In the case of drilling positive structures, the share of domestic gas could increase from 1% to 10%

Sources to corroborate the impact. At the present time (April-June 2022), there have been several mentions on TV, radio and daily press broadcast that the drilling of new natural gas wells in the Trnava region must be carried out as soon as possible and bureaucratic procedures must be accelerated so that the gas extraction can be started within 2-3 years.

The preservation of cultural heritage

The infrastructure acquired within the scope of the Centre of Excellence for Integrated Research on the Earth´s Geosphere and the project ITMS-26220120064 funded by the European Regional Development Fund has been systematically engaged in the preservation of cultural heritage mainly in collaboration with the Monuments Board of the Slovak Republic, Bratislava, National Technical Museum, Praha, Artworks, Limited Liability Company, Praznovce, and Department of Anthropology, Comenius University, Bratislava, Municipal Institute of Monumets Preservation, Bratislava. The employed methods involved Raman and infrared spectroscopy, X-ray fluorescence, isotope ratio mass spectrometry, and energy-dispersive electron microanalysis applied to investigation of plasters, pigments in artworks and other cultural and sacral objects. Within the evaluation period of 2016-2021, the following objects have been studied:

- Pigments in wall-paintings in Dolná Krupá, Fintice, Krásna Hôrka castles, Calvaries near Nitra and Rožňava, churches in Stará Ľubovňa, Hradište, Belá, Stredné Turovce, Sokolce, Trstín, Lipovník, Žíp, Nedožery – Brezany, Malé Kostihy, and Hanušovce.
- Pigments of baroque statues (Ján Nepomucký in Belá, St. Florian in Hladovka), and gothic altar of St. James Church in Levoča
- Determination of oxidation state of a historical seal from the Bratislava Castle
- Mummified hand from the collection of the Museum in Spišská Nová Ves
- Mineralogical composition of teeth infilling from the skeleton of industrialist Anthony Wels, great grandfather of actress Audrey Hepburn
- Mineralogy and isotope composition of mineralised mummy of Zofia Seredy from the crypt of the church in Krásnohorské Podhradie village
- Pigments in paintings of Joseph Theodor Mousson, impressionist of 19th Century.

The research on Gothic Altar in St. James Church in Levoča has been published:

ŽELINSKÁ J, KOPECKÁ I, SVOBODOVÁ E, MILOVSKÁ S, HURAI V, 2018. Stratigraphic EM-EDS, XRF, Raman and FT-IR analysis of multilayer paintings from the Main Altar of the St. James Church in Levoča (Slovakia). JOURNAL OF CULTURAL HERITAGE 33, 90–99 (2017: 1.706 - IF, Q3 - JCR, 0.562 - SJR, Q1 - SJR)

and received following citations:

FU P, TERI G-L, LI J, LI J-X, LI, Y-H, YANG H, 2020. Investigation of ancient architectural painting from the Taidong Tomb in the Western Qing Tombs, Hebei, China. COATINGS 10, 7.

MANZANO E, BLANC R, DANIEL MARTIN-RAMOS J, CHIARI G, SARRAZIN P, LUIS VILCHEZ J, 2021. A combination of invasive and non-invasive techniques for the study of the palette and painting structure of a copy of Raphael's Transfiguration of Christ. HERITAGE SCIENCE 9, 1.

VANHOOF C, BACON JR, ELLIS AT, FITTSCHEN UEA, VINCZE L, 2019. Atomic spectrometry update a review of advances in X-ray fluorescence spectrometry and its special applications. JOURNAL OF ANALYTICAL ATOMIC SPECTROMETRY 34, 9, 1750-1767.

CAKMAK Y, KARADAG R, KAYAMAN APOHAN N, ARAL ÖY, CAKMAKCI E, 2021. Characterization of the alphabet reform painting. JOURNAL OF THE TURKISH CHEMICAL SOCIETY, SECTION A: CHEMISTRY 8, 1, 249-262.

GLIOZZO E, IONESCU C, 2022. Pigments – Lead-based whites, reds, yellows and oranges and their alteration phases. ARCHAEOLOGICAL AND ANTHROPOLOGICAL SCIENCES 14, 1, 17.

ZOU W, YEO S-Y, 2022. Investigation on the painting materials and profile structures used in ancient Chinese folk architectural paintings by multiple analytical methods. COATINGS 12, 3, 320.

The Photolysis

The cutting-edge research conducted in collaboration among the Earth Science Institute in Bratislava, Department of Physical and Theoretical Chemistry, Comenius University in Bratislava, and Department of Geology, Rashtrasant Tukadoji Maharaj University in Nagpur, India, within the scope of the European Regional Development Funded Research & Development Operation Programs CGreen-I 26240120001, CGreen-II 26240120025, the Slovak Infrastructure for High-Performance Computing (ITMS 26230120002, 26210120002), and the Centre of Excellence for Integrated Research on the Earth´s Geosphere (ITMS 26220120064) resulted in the discovery of the low-temperature splitting of molecular H_2S to hydrogen and sulphur under 532 nm photons emitted by a 25mW Nd-YAG laser. The laser-induced H_2S photolysis was accidentally observed during the investigation of small inclusions of super-soar natural gas dominated by hydrogen sulphide and methane trapped in quartzite from the Archaean Bastar Craton of south-central India. The H_2S photolysis in inclusions with sulphur daughter phases was revealed thanks unusual Raman vibrations with lifetimes only several seconds. The time-dependent density functional theory calculations confirmed the low-energy H_2S splitting triggered by the photolysis of $H_2S_n...S_8$ and $H_2S_n...S_8...H_2S_n$ (n=1–2) bonds in the photo-activated sulphur. The discovered low-energy H_2S-to-hydrogen conversion in the super-soar natural gas may represent an emission-free, environment friendly and economically viable alternative to recent methods of super-soar natural gas processing and cleaning based on the H_2S oxidation, combustion and recombination, which

result in the conversion of H_2S-bound hydrogen into waste water, instead of the hydrogen extraction and utilization as an emission-free fuel or feedstock for the production of industrial commodities.

The research was published in two Q1-ranked SCI journals:

HURAI V – ČERNUŠÁK I – RANDIVE K (2019) Raman spectroscopic study of polysulfanes (H_2S_n) in natural fluid inclusions. CHEMICAL GEOLOGY 508, 15-29.

HURAI V – ČERNUŠÁK I – RANDIVE K (2019) Hydrogen recovery from H_2S-CH_4 inclusions trapped in quartz triggered by green laser-induced photolysis of polysulphane-sulphur bonds. APPLIED GEOCHEMISTRY 106, 75-81.

The two papers received the following citations:

HUANG W, NI P, ZHOU J, FAN M, YANG Y (2022) Fluid inclusion and titanite U-Pb age constraints on the Yuanjiang ruby mienralization in the Ailao Shan-Red River metamorphic belt, southeast China. CANADIAN MINERALOGIST 60, 1, 3–28

HU, M., CHOU I-M., WANG R, SHANG L, CHEN C (2022) High solubility of gold in H_2S-H_2O±NaCl fluids at 100-200 MPa and 600-800 °C: A synthetic fluid inclusion study. GEOCHIMICA ET COSMOCHIMICA ACTA (in press)

HUANG W, NI P, ZHOU J, CAI Y, FAN M (2021) Discovery of disulfane (H2S2) in fluid inclusions in rubies from Yuanjiang, China, and its implications. CRYSTALS 11, 11, 1305

YU Y, HU W, CHOU I-M, XIN Y, WANG X (2021) Species of sulfur in sour gas reservoir: Insights from in situ Raman spectroscopy of S-H_2S-CH_4-H_2O systems and its subsystems from 20 to 250 °C. GEOFLUIDS 6658711

OLADIPO H, YUSUF A, AL JITAN S, PALMISANO G (2021) Overview and challenges of the photolytic and photocatalytic splitting of H_2S. CATALYSIS TODAY 380, 125–137

ZHAO X, HE Y, LIU Z, ZHANG W, TONG L (2020) Method for extracting Raman spectra characteristic variables of biological sample based on Hilbert-Huang transform. JOURNAL OF RAMAN SPECTROSCOPY 51, 6, 1019–1028

How rainfall characteristics affect the sizing of rain barrels in Slovakia – contributing to blue-green infrastructure

Rainwater can reduce vulnerability of different areas to climate change by storing water for rainless periods and by reducing surface runoff. It was used thousands years ago but it has many applications also in the modern society. Rainwater harvesting (RWH) can contribute to a reduction of the amount of water abstracted from public mains, which makes RWH attractive particularly for economic and environmental reasons. Particular attention is paid to the RWH in urban areas where they can strongly contribute to water management issues and generally to the blue-green infrastructure. The efficiency and reliability of water harvesting systems contributing to green infrastructure in local conditions depends on the local climate. The average annual rainfall varies in Slovakia from less than 500 mm to approximately 2000 mm in high mountains. Lowest annual totals are observed in the lowlands in south part of the country but relatively low precipitation occure also in rain shadows. The work focused on analyzing event-based statistical properties of rainfall at a total of 84 locations in geographicaly distinct regions in Slovakia. Analysing rainfall characteristics is therefore essential for a proper sizing of any rainwater collecting project. Records from climatologically distinct regions of Slovakia were separated into statistically independent episodes to derive event-based statistical characteristics. A considerable spatial and seasonal variability has been observed in over the respective teritorry. It appeared that inter-event rainfall times reflect the local climate and are site-specific even within a relatively small investigated region. Inter-event times decrease with elevation, whereas event volume and annual incidence of rainfall events increase with elevation. The applicability of the derived rainfall statistics was illustrated by simulations for a typical residential house using the analytical probabilistic approach. Empirical relationships between tank size and site elevation have

been developed to estimate tank sizes for un-gauged locations. The simulations show that rain barrels in the southern parts of Slovakia, naturally, require larger storage capacities than those located in the mountainous regions. Required tank sizes which were estimated for selected locality in lowland areas were suggested based on annual statistics of relevant rain parameters, seasonal statistics of IET and mean event depth derived on data from: (b) the spring season (M-A-M); (c) the summer season (J-J-A); and (d) the fall season (A- S-O). The results clearly showed the water needs in different regions of Slovakia and gives the opportunities to deal with in water managemenent practice. The results are freely available for the communities in interest.

ONDERKA M. – PECHO J. - NEJEDLÍK P.: On how rainfall characteristics affect the sizing of rain barrels in Slovakia. *Journal of Hydrology*: Regional Studies, 2020, vol. 32, article number 100747. (2019: 3.645 – IF). (2020 - Current Contents).

Microgravity methods applied in archaeological prospection

Microgravity methods were used by ESI SAS workers in a number of studies with applications in archaeological investigations or geohazards, aiming at detection of shallow cavities such as crypts, hidden rooms and bunkers at historical or cultural sites, or abandoned mine-workings at urban sites. One of the studies was done by comparing electromagnetic properties of the soil with density changes in a depth of upper few meters beneath the floor in the interior of the Church of St. George in Svätý Jur. Four medieval crypts mentioned in historical archives were successfully delineated in the nave using microgravity and GPR methods. The discovery of the west wall foundations of the former Romanesque construction approx. in one third of the nave, oriented northwards perpendicularly to the main entry, is the most significant result of the geophysical survey. The results from harmonic inversion combined with GPR and density modelling helped to construct a spatial model of these cultural features, which is now added into the visualisation of the visible parts of the church.
In further case studies, we focused on the so-called building correction that plays an important role in the processing of acquired gravimetrical data into a Bouguer anomaly, because the gravitational effect of building masses can produce false, usually negative anomalies. The building correction is calculated using an in-house program Polygrav that utilizes 3D polyhedral models reconstructed from photographs in special photogrammetric software. Successful case studies of microgravity detection of crypts in various churches from the Middle Ages and period of Modern History, were surveyed during recent decades in Slovakia and Czechia. With state-of-the-art gravity meters it is usually possible to detect subsurface cavities with volumes of several cubic metres, when the upper edge of the target is not very deep, i.e. in the upper few metres. Several of the detected cavities, mostly crypts, have been verified by video-inspections and/or excavation. Some of the archeological artefacts detected by above described methods are planned to be open to public in the future.

References:

J. Chromčák, M. Grinč, J. Pánisová, P. Vajda, A. Kubová: Validation of sensitivity and reliability of GPR and microgravity detection of underground cavities in complex urban settings: Test case of a cellar. *Contributions to Geophysics and Geodesy* 46(1), p. 13-32, ISSN 1335-2806 (2016).

J. Pánisová, I. Murín, R. Pašteka, J. Haličková, P. Brunčák, V. Pohánka, J. Papčo, P. Milo: Geophysical fingerprints of shallow cultural structures from microgravity and GPR measurements in the Church of St. George, Svätý Jur, Slovakia *Journal of Applied Geophysics* 127, p. 102-111, ISSN 0926-9851 (2016).

R. Pašteka, J. Pánisová, P. Zahorec, J. Papčo, J. Mrlina, M. Fraštia, G. Vargemezis, D. Kušnirák, I. Zvara: Microgravity method in archaeological prospection: methodical comments on selected case studies from crypt and tomb detection
Archaeological Prospection 27(4), p. 415-431, ISSN 1099-0763 (2020).

More informations about activities of the research with direct societal impact are in Chapters 2.1.5., 2.3.1., 2.3.5., 2.6.2. and 2.6.3.

2.6.2. List of the most important studies and/or other activities commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes (title, name of institution, contract value, purpose (max 20 words)

1. Cipciar A., Csicsay K. 2016: Expert opinion on blasting. District Mining Authority, Banská Bystrica In May 2016, an expert report was prepared for the District Mining Authority in Banská Bystrica concerning the size of the control blasting and other industrial blasting in the Ružomberok III quarry. PK Doprastav, a.s.
2. Fojtíková L. 2019: 3. Control of seismic monitoring of the EBO site and operation of stations of the local EBO seismic network; inspection no. 214/2019. UJD SR, Inspection checked the equipment and functionality of seismic stations, data quality, methods of data collection, data analysis and archiving of seismic records, as well as cooperation with the national network of seismic stations in the localization of events and their interpretation.
3. Hurai V. 2018, 2019: Mineralogical analysis of pigment. Natural monument office of the Slovak Republic, Bratislava - non-destructive analysis of mineral pigments on works of art from the 20th century using Raman spectroscopy. 2019 - Identification of inorganic mineral pigments in the image of J.T. Mousson – "In the village yard" by using Raman spectrometry.
4. Jeleň S. 2021: Cooperation in the working group for the creation of the environmental strategy of the Banská Bystrica self-governing region (assistance in creating and commenting on the section "Rational use of the rock environment and minerals). BBSK, Strategy and Analysis Department.
5. Kristeková M. 2016: Evaluation of seismic activity in the Bratislava area. Technical and Testing Institute of Civil Engineering, n. o., Bratislava. Expert evaluation and provision of an opinion on the possibility of seismic activity in February 2009 that could cause damage to the building structure in the Bratislava
6. Madarás J. 2017: Expert report for reconstruction of the National Cultural Monument Artillery Caverns from the First World War over the Dúbravka district of Bratislava - geological characteristics of rocks and assessment of stability conditions in underground tunnels, expert excursion for the public at the opening of the DK3 cavern in September 2017 - cooperation with Citizen society OZ Bunkre Bratislava.
7. Madarás J. 2017: Expert consulting activities in the preparation of reconstruction and new exhibition in the underground spaces on the citadel of Devín Castle - National Cultural Monument - cooperation with the Museum of Bratislava City of - branch Devín; ceremonial opening of a new archeological and geological - paleontological exposition 5.5. 2017. Bratislava City Museum.
8. Smetanová I. 2019: 10. Commission for assesment the ability to act as a radiation protection expert. Public Health Office of the Slovak Republic. The Commission assesses compliance with the requirements for recognition of the competence of a natural person and a legal person to act as a radiation protection expert and a member of the commission since 6.12.2018.
9. Soták J. 2016: Assessment of state research contract and review of the manuscript of the monographic work: Paleocene Reef Complex of the Western Carpathians (authors: S. Buček & E. Köhler), State Geological Institute D. Štúra Bratislava.
10. Soták J. 2016: Final report on the solution of the project: Geological map of the Biela Orava region at a scale of 1: 50,000 - elaboration of an opinion of the final report submitted in the form of a monographic work. State Geological Institute of D. Štúr Bratislava - assessment of the geological contract and proceedings at the Ministry of the Environment of the Slovak Republic.
11. Siman P. 2018: Expertise on the development of the Hydrogen Strategy of the Slovak Republic

12. Soták J. 2019: Assessment on the geological contract of the State Geological Institute of D. Štúr Bratislava. Elaboration of the opponent's report on the project Geological map of the Biele Karpaty Mts. - north region at a scale of 1: 50,000.
13. Soták J. 2020: Expertise for Ministry of the Environment of Slovak Republic – evaluation of final report on the geological task "Biele Karpaty Mts. - geological map of north region at scale of 1: 50,000.
14. Soták, J. 2020: Opponent's report on the geological contract of the Ministry of the Environment of the Slovak Republic – assessing of the final report of the task "Research of geological structure and compilation of geological maps in problematic areas of the Slovak Republic".
15. Soták J. 2021: Expertise to stratigraphic elaboration of the HGŽ-3 borehole intended for project "Geological map of the Danubian Lowland – southeastern part – M &. 50 000. D. Štúr State Geological Institute Bratislava.

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues (study title, name of institution, contract value, country of partner, purpose (max 20 words))

1.Study title: Magnetic declination measurements for the Air Force (2016-2021)
Name of institution: Ministry of Defence of the Slovak Republic. Air Force Commandership of the Forces the Slovak Republic. **Contract value:** 3000 € per year. **Country of partner:** Slovak Republic **Purpose:** A service for the military airports Sliač, Kuchyňa and Prešov, within which the homogeneity of the geomagnetic field on the magnetic compensation circles and on other selected areas in the airport area is checked. Measurements of magnetic declination, which determine the declination values for individual airports in a given epoch, are also carried out.

2.Study title: Provision of data for the needs of the Partial Monitoring System Geological factors of the environment (2016-2021)
Name of institution: State Geological Institute of the Dionýz Štúr **Contract value:** 6 000 € per year. **Country of partner:** Slovak Republic **Purpose:** Monitoring of seismic activity in Slovakia. Analysis of seismic data.

3.Study title: Research of the hydrocarbon potential of the Blatnianska Depression based on new as well as existing geochemical and geological knowledge (2016)
Name of institution: NAFTA, a.s. Bratislava. **Contract value:** 20 000 €. **Country of partner:** Slovakia
Purpose: Exploration of gas deposits within the Trnava Exploration Area

4. Study title: A survey to quantify the stomatal ozone fluxes on several forest tree species studied in the Department of Alpes-Maritimes for the year 2017
Name of institution: Services Communication Sciences, designated under the term "SCSciences", association law 1901- registered office at 234 avenue de la Lanterne, Les Belles Terres, A3, 06200 Nice **Contract value**: 5 000 € **Country of partner:** France
Purpose: Modeling of stomatal ozone fluxes (Phytotoxic Ozone Dose, POD) by DO3SE model to estimate ozone uptake in selected forest trees.

5.Study title: Realization of geophysical works - gravimetry within the task "Expressway R2 Rožňava - Jablonov nad Turňou" (2016 – 2017)
Name of institution: DPP Žilina. **Contract value:** 30 000 €. **Country of partner:** Slovakia

6.Study title: Geochemical characterization of stable isotopes of hydrocarbon gases in monitored reservoirs and exploratory wells in the Slovak part of the Vienna Basin and East Slovak basin (2017)
Name of institution: NAFTA, a.s. Bratislava. **Contract value:** 9 500 €. **Country of partner:** Slovakia

Purpose: Systematic analysis of gases including isotopic composition. The institute participates in solving the problem of monitoring gas reservoirs, the genesis of gases and their zonality in the Vienna and East Slovakia basins.

7. Study title: A survey to quantify the stomatal ozone fluxes on several forest tree species studied in the Principality of Monaco for the year 2018
Name of institution: Services Communication Sciences, designated under the term "SCSciences", association law 1901- registered office at 234 avenue de la Lanterne, Les Belles Terres, A3, 06200 Nice **Contract value**: 2 000 € **Country of partner:** France
Purpose: Modeling of stomatal ozone fluxes (Phytotoxic Ozone Dose, POD) by DO3SE model to estimate ozone uptake in selected forest trees.

8. Study title: Highway D1 Turany – Hubová. Detailed engineering geological and hydrogeological survey (2018 - 2019)
Name of institution: DPP Žilina **Contract value**: 6 000 € **Country of partner:** Slovak Republic
Purpose: Isotopic study of the waters from the rock massive influenced by landslides on the D1 highway

9. Study title: Research of the sedimentary filling of the Halčiansky tajch pond (2019)
Name of institution: Slovenský vodohospodársky podnik, š.p. Banská Štiavnica **Contract value**: 5 000 € **Country of partner:** Slovak Republic
Purpose: Research of thickness, grain size and chemical composition of the bottom sediment for the purpose of reservoir cleaning.

10.Study title: Organic – geochemical analysis of samples from the Špačince-4 well (2018 – 2019)
Name of institution: NAFTA, a.s. Bratislava. **Contract value:** 1 800 €. **Country of partner:** Slovakia
Purpose: Analytical works for the customer. The results of the analyses help the evaluation of the exploration area in terms of oil and gas potential and the business intentions of the customer.

11.Study Title: Acoustic inspection and coring of the deposits in Galovanská zátoka bay.
Name of institution: Envigeo, a.s. **Contract value:** 9 300 €. **Country of partner:** Slovak Republic
Purpose: Research of spatial distribution, thickness, grain size and chemical composition of the bottom sediment for cleaning of the dump bottom after an ecological disaster.

12.Study Title: Expertise of interior frescoes pigmets (composed of several small projects).
Name of institution: Artus, a.s. **Contract value:** 1 000 €. **Country of partner:** Slovak Republic
Purpose: Determination of the mineral composition of pigments used on the frescoes of medieval sacral monuments in Slovakia

13.Study Title: Micro-CT measurements and detection of the voids (several small projects – 2016-2021).
Name of institution: Semikron, s. r. o. **Contract value:** 6 000 €. **Country of partner:** Slovak Republic
Purpose: MicroCT inspection of the industrial products for detection of the porosity, voids, and comparison of the planed and measured data.

14.Study Title: Micro-CT measurements and detection of the voids (several small projects – 2016 - 2021).
Name of institution: Semikron, s. r. o. **Contract value:** 6 000 €. **Country of partner:** Slovak Republic
Purpose: Mineral composition

15.Study Title: Mineralogical evaluation of primary ore and flotation waste (Ag, Pb, Cu, Zn) of the Banská Hodruša deposit
Name of institution: Slovenská banská, s. r. o. **Contract value:** 1 100 €. **Country of partner:** Slovak Republic

Purpose: Comparison of the elemental and mineralogical composition of the primary ore and the product after floating process.

16.Study Title: Mineralogical study of technogenic material (2017 – 2019)
Name of institution: Rudné bane, š.p. **Contract value:** 8 400 €. **Country of partner:** Slovak Republic
Purpose: Mineral composition of metallurgical slag from the landfill with the aim of further industrial use.

17.Study Title: Petrographic analysis and stratigraphic evaluation of samples (2017 – 2019)
Name of institution: DPP Žilina, s.r.o. **Contract value:** 20 000 €. **Country of partner:** Slovak Republic
Purpose: Microscopic study, complex petrographic and stratigraphic analysis was carried out as part of the highway construction.

18.Study title: Numerical processing of gravimetric data using new methods in the survey area Vienna Basin-North **(**2021)
Name of institution: NAFTA, a.s. Bratislava. **Contract value:** 16 200 €. **Country of partner:** Slovakia

19.Study title: Computational determination of seismic hazard to critical infrastructure sites of EBO and EMO (2020 – 2022)
Name of institution: Nuclear Regulatory Authority of the Slovak Republic. **Contract value:** 72 000
€ **Country of partner:** Slovak Republic
Purpose: The seismic hazard assessment of the critical infrastructure sites of the Jaslovské Bohunice (EBO) and Mochovce (EMO) nuclear power plants.

2.6.4.1 List of intangible fixed assets (internally registered IP (confidential know-how), patent applications, patents granted, trademarks registered) denoting background IPR

2.6.4.2 List of licences sold abroad and in Slovakia, incl. revenues (background IPR identification, name of institution, contract value, country of partner, purpose (max 20 words))

2.6.5. Summary of relevant activities, max. 300 words (describe the pipeline of valorization in terms of Number of disclosure, Number of registered IP internally, number of CCR/LIC contracts and their respective summary values, the support you are receiving in specific points internally at the institute, at SAS, externally – also the limitations and drawbacks.

2.7. Popularisation of Science (outreach activities)

2.7.1. List of the most important popularisation activities, max. 20 items

1. Discussion of volcanoes and volcanic activity and products. Elementary school at the Children's University Hospital with a polyclinic, Nám. L. Svobodu 4, Banská Bystrica, 19.9.2016, S. Jeleň.
2. Broadcast Night Pyramid - Slovak Radio, 19.9.2016, J.Kotulová, 2020, J. Madarás 2020 (https://www.rtvs.sk/ra dio/archiv/11436/1268 342)
3. “The hidden beauty of the underground” - Exhibition of photographs from the environment of old mining works as part of the Science and Technology Week in Slovakia, “Veda na dosah”, http://vedanadosah.cvtisr. sk/albert-russ-skrytakrasa-podzemia, J. Madarás, 22.10.2016
4. “Geology under Everest”, “Veda na dosah”, http://vedanadosah.cvtisr. sk/geologia-podeverestom, J. Madarás, 31.5.2016
5. How Dinosaurs Extinct - The Winding Fates of Living on a Living Planet, science cafe SAVinci v Malom kongresovom centre vydavateľstva Veda, doc. RNDr. J. Michalík, 30.11.2016
6. “Čertová skala” - Reportage about a remarkable rock formation and its risks, TV Markíza, 17.4.2016, J. Soták
7. “Let's meet the planet we live on”, book promotion, http://www.ucn.sk/knihy/ spoznajme-planetu-naktorej-zijeme, S. Ozdínová, 4.3.2016
8. Exhibition: Weekend with SAS, Primatial square, Bratislava, 7.9.2018, 21.6.2019
9. European Researchers' Night - Science Festival –in Bratislava and Banská Bystrica, 2016, 2017, 2018, 2019
10. “Petržalka super school” - a series of lectures for primary school students, coordinator
11. P. Vršanský, 2017 /2018
12. "Tresky Plesky" - animated fairy tales - professional assistance in creating a series of animated fairy tales for children. Each deals with one selected natural disaster (tsunami, holes in the ground, volcano eruption, earthquake, lightning, forest fire ...), Z. Chovanová, 2018
13. Exhibition: Geoparks SR - protection of lifeless nature and promotion of tourism. Area of SAS, Bratislava Patrónka. 2019, 2020, 2021
14. Exhibition: TRITRI – Tatry Mts. through the eyes of geologists, SNM - Natural History Museum, Bratislava, 6.12.2019 - 6.7.2020.
15. RTVS – TV magazin Experiment - Volcanoes (Risks of eruptions in Europe, supervolcanoes and their monitoring), P. Zahorec, J. Madarás, J. Lexa 12.10.2021
16. Journal Quark – Dobšináit and new minerals, M. Števko, 12.4.2021
17. Journal Quark - Earthquake physics, https://www.quark.sk/f yzika-zemetraseni 4.4.2021
18. P. Moczo, P. Labák, R. Kysel, J. Kristek
19. Journal Quark - Earth as a big magnet - article for the 120th anniversary of the Geomagnetic Observatory in Hurbanovo, M. Revallo, J. Vozár, F. Valach, M. Váczyová, P. Guba, 4.11.2020
20. Excursion with expert lectures at the Skalnaté pleso observatory UVZ SAV Skalnaté pleso, V. Lukasová, L. Holko, 16.9.2020

21. Cockroach species found to live like ants with workers and a queen New Scientist, https://www.newscient ist.com/article/225606 7-cockroach-species-found-to-live-like-antswith-workers-and-a-qu een/, P. Vršanský, M. Marshall
22. The extinct mountains of northern Europe: the paleorelief of the country and the "genius loci" of Scotland. Presentation, Faculty of Education, Catholic University, Ružomberok, doc. J. Soták, D. Plašienka, D., Soták, J., Michalík, 7.11.2019
23. Gates to the lost world. Museum of Croats in Slovakia, Devínska Nová Ves, R. Aubrecht, 15.2.2018
24. Studying volcanoes and predicting eruption hazards – a detective work of a geophysicist v rámci programu ERASMUS+ KA2 Strategické partnerstvá (Strategic partnership), projekt: European Investigation T, UVZ, P. Vajda, 25.10.2018
25. If dinosaurs lived, people would climb trees. Article, Journal Denník N., J. Michalík, 16. 2018, J. Michalík

2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2016	2017	2018	2019	2020	2021	total
Articles in press media/internet popularising results of science, in particular those achieved by the Organization	18	26	36	10	36	33	159
Appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	23	24	15	4	17	16	99
Public popularisation lectures	37	28	60	15	7	6	153

2.8. Background and management. Infrastructure and human resources, incl. support and incentives for young researchers

2.8.1. Summary table of personnel

2.8.1.1. Professional qualification structure (as of 31 December 2021)

	Degree/rank				Research position		
	DrSc./DSc	CSc./PhD.	professor	docent/ assoc. prof.	I.	II.a.	II.b.
Male	11	37	3	7	10	21	16
Female	0	13	0	0	0	4	8

I. – director of research with a degree of doctor of science/DrSc.

II.a – Senior researcher

II.b – PhD holder/Postdoc

2.8.1.2. Age and gender structure of researchers (as of 31 December 2021)

Age structure of researchers	< 31		31-35		36-40		41-45		46-50		51-55		56-60		61-65		> 65	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Male	0,0	0,0	1,0	1,0	8,0	6,8	4,0	3,7	10,0	7,8	5,0	3,5	2,0	1,5	8,0	6,8	7,0	5,0
Female	1,0	0,5	1,0	0,2	0,0	0,0	4,0	3,5	2,0	2,0	2,0	2,0	2,0	2,0	0,0	0,0	0,0	0,0

A – number

B – FTE

2.8.2. Postdoctoral fellowships (list of positions with holder name, starting date, duration. Add brief information about each fellow's career path before and after receiving PhD degree, etc.)

2.8.2.1. MoRePro and SASPRO fellowships

1. Vozár Ján – SASPRO 1497/03/01/CRITHON 3D - 01.03.2016 -31.12.2018 – Marie Curie fellowship

2.8.2.2. Stefan Schwarz fellowships

1. Vďačný Marek – 01.05.2015 -30.4.2019
2. Hrabovský Juraj – 1.6.2018 – 31.6.2021
3. Lukasová Veronika - 1.6.2020 – 31.5.2023

2.8.2.3. Postdoctoral positions from other resources (specify)

1. Fekete Kamil - 1.1.2019 – 1.10.2019 - Compensatory allowance - early termination of employment

2.8.2.4. Postdoctoral research position provided by ESI SAS

1. Enrico Filippi - Italy (1.2. 2020-1.5.2020)

2.8.3. Important research infrastructure introduced during the evaluation period with the information about the sources of funding *(max. 2 pages)*

The infrastructure of the Geological division of the ESI SAS includes essential technical equipment necessary in geological, mineralogical, petrological and palaeontological research. Computer and technological infrastructure of the former Geological Institute branch in Banská Bystrica has been significantly improved by implementation of the Structural Funds of EU during the period 2010-2015. These new devices are placed in a new building built in 2014. The new building in Banská Bystrica offers 2000 m^2 of laboratories, lecture rooms, and a modern depository for geological samples. In addition, it also includes rooms with sanitary facilities, including kitchens, for accommodation of 20 students. Therefore, this building is now the most comfortable education centre of the Slovak Academy of Sciences.

Benefitting from the European Regional Development Fund, the Institute established the excellent analytic centre, in which operate (1) Laboratory of compute tomography with tomograph **micro-CT v|tome|x L 240**; (2) Laboratory of isotope and organic geochemistry dedicated to analysis of light stable isotopes with Isotope ratio mass spectroscopy **Finnigan MAT 253** (ThermoFisher Scientific); (3) Laboratory of electron microanalysis with field emission **Electron Probe Microanalyser (EPMA) JEOL JXA 8530F**; (4) Laboratory of vibrational spectroscopy with the **Raman**; (5) Infrared micro spectroscopy laboratory equipped with **LabRam HR 800** from fy Horiba Jobin-Yvon; (6) X-ray diffraction laboratory with diffractometer **D8 Advance SolXE** fy Bruker; (7) Laboratory of electron microscopy with the scanning electron microscope **JEOL JSM-6390LV** purchased in 2007 upgraded with an energy dispersive spectrometer from OXFORD Instruments Ltd., Inca X-Act cathodoluminescence spectral imaging system CLue (Horiba Jobin-Yvon) and with new sputter coaters for carbon and gold coating samples; (8) Laboratory for geofluids and microthermometry; (9) Laboratory for palaeolimnology equipped with a floating platform, chirp sonar, and corresponding air-conditioned repository; (10) Laboratory of X-ray fluorescence spectrometry equipped with **M4 TORNADO;** (11) Laboratory of X-ray powder diffraction analysis with diffractometer **Bruker D8 ADVANCE**; (12) other computational and communication technologies.

The preparation laboratory at the workplace in Bratislava was modernized in 2021. The purchase of advanced cutting machine **Geocut 302**, sectioning instrument **Geoform 102**, thin section preparation system **Forcipol TS** coupled with **Forcimat-TS**. The laboratory covers special requirements of the geologists and palaeontologists in the whole domain of trimming, lapping and polishing of geological materials, preparation of polished and covered thin sections. Moreover the mobile laboratory unit from the Banská Bystrica branch also includes the **Raman spectroscopy** fy Horiba.

The infrastructure of the Geological division of the ESI SAS offers the services of 12 fully organized laboratories. The Banská Bystrica branch offers the space to organize the workshops and meetings on the basis of video conferences. The high technological analytical devices and optical microscopes placed in laboratories in Banská Bystrica provide the opportunity to organize courses for graduate and postgraduate students in specific analytical geological methods. The first course for 40 students happened in October 2016 on the basis of cooperation between our institute and AGH University in Krakow (Poland) and it was annually organized up to the Corona-crisis in 2020.

The infrastructure is presented on the institutional web page http://www.geo.sav.sk/en/structure-of-the-institute/laboratories/ and offered for a broad academic community. The laboratories (1), (2), and (3) mentioned above attract the majority of users. The attractiveness of the laboratories is best evidenced by the students and scientists from more than 20 countries of the world who visited the workplace in Banská Bystrica in the years 2016-2021. The results of this co-operation is evidenced by higher publication activity. The interest of the commercial sphere in laboratories, which use the analytical possibilities of our infrastructure to improve the quality of their production, is significant. We then use the obtained funds for the maintenance and service of equipment.

2.9. Supplementary information and/or comments on all items 2.1 – 2.8 (max. 2 pages in total for the whole section)

2016 – 2017
Organizing a study trip (a field methods course in geology) in the Western Carpathians for students from University of Texas at Austin (USA) accompanied by Ass. Prof. Brent Elliot and Ass. Prof. Elizabeth Catlos. This project for training of students in an orogenic belt was attended by 7 undergraduate students and 1 phD student. The Slovak field programme was prepared by I. Broska and Milan Kohút.
A paper prepared by a student Villassenor represents the main outcome of this effort: VILLASEñOR, Gabriel - CATLOS, Elizabeth J.** - BROSKA, Igor - KOHÚT, Milan - HRAŠKO, Ľubomír - AGUILERA, Kimberly - ETZEL, Thomas M. - KYLE, Richard J. - STOCKLI, Daniel. Evidence for widespread mid-Permian magmatic activity related to rifting following the Variscan orogeny (Western Carpathians). In Lithos, 2021, vol. 390, art. no. 106083. (2020: 4.004 - IF, Q1 - JCR, 1.899 - SJR, Q1 - SJR, karentované - CCC). (2021 - Current Contents). ISSN 0024-4937. Dostupné na: https://doi.org/10.1016/j.lithos.2021.106083

2016 – 2020
Courses in isotope geology and Raman spectroscopy were held at the workplace in Banská Bystrica
for students from Charles University (Prague, Czech Republic, AGH University of Science and Technology, Krakow (Poland) and Eötvos Lorand University (Budapest, Hungary).

2016 – 2020
Analythical Methods in Geology for students. AGH University of Science and Technology, Krakow (Poland)

3. Implementation of the recommendations from the previous evaluation period

The two divisions that stem from two independent institutes were evaluated separately during the former accreditation. This chapter thus consists of comments and implementations as we respond separately to the two accreditation reviews, even when some implementations are naturally shared or interfinger, including the scientific evaluation of researchers that was implemented at the scale of the whole ESI SAS (motivating researchers to publish in journals with higher-impact factors), the overlap between research topics or activities related to the supervision of PhD students. **The original comments from the commission are in bold**, our implementations are in normal font.

The assessment of Geology Division (former Geological Institute ranked C) contains following comments and recommendations on the past performance

1. **Funding on European level for projects is almost inexistent**
2. **Publications - the number of highly cited authors is limited, too many articles are published in the house journal (Geology)**
3. **PhD program - the environment could be more supportive (see examples within SAS)**
4. **Research is solid, in few cases innovative -interaction within the institute was limited**
5. **Women are underrepresented**
6. **There are few international researchers, PhD students in the institute or affiliated with the institute**
7. **The institute succeeded in bringing back excellent researchers to SAS, after long stays abroad.**

3.1 Activities on the implementation of comments and recommendation from international assessment in 2016 for further development of Geology Division (former Geological Institute)

1. Funding on European level for projects is almost inexistent

The research at the Geology Division was funded by the Horizon 2020 project for a PhD student within the network of the **Innovative Training Network** project *BASE-LiNE Earth* **(Marie Skłodowska-Curie Actions** in **Horizon 2020 'European Union Funding Programme for Research and Innovation'** (H2020-MSCA-ITN-2014; REA Grant Agreement No. 643084) - the project finished at the end of **2018, and the PhD student Tamas Muller defended his thesis devoted to the early-Toarcian ocean anoxic event and brachiopod geochemistry in 2021, in collaboration with the Kiel University. The researchers of the Geology Division also participate in projects of the** International Visegrad Fund (Importance of raw materials in the economy of V4 countries) and in several IGCP projects. Concerning the topic of critical elements at the Geology division, we were also involved in a collaborative project with mineralogists from the France, Czech Republic, Bulgaria and Romania on Li pegmatite. This project successfully passed the review process in 2021 in the framework of the scheme ERA MIN network (project is currently in progress). Although several proposals submitted to the ERC (e.g., collaborative COST proposals) were not funded in the past, we note that the vast majority of researchers at this Division directly cooperate with researchers from other European countries through bilateral agreements.

2a. Publications - the number of highly cited authors is limited, and too many articles are published in the house journal (Geology)

Since 2016, the Geology Division (and the whole ESI SAS) implemented a 5-year-window evaluation of international publications and citations (updated every year), with the top 20% of researchers (about ten out of fifty researchers) receiving additional salary benefit. This evaluation is simple and takes into account the impact factor (exclusively based on SCI), a simple weight that gives a benefit for first authors but does not strongly penalize co-authors, and the citation rate weight.

The increasing frequency of higher-impact publications observed in 2020-2021 represents fruits of this change. This evaluation also shows that significant number of researchers does not necessarily produce many outputs because they took management, editorial, or administration positions, and thus cannot fully participate in the scientific process. In spite of this constraint, the researchers from the Geology Division (about 24 ETE researchers in total) published 74 papers in the Q1 (JCR) category during the assessment period (31% of JCR papers).

In total, the number of papers published in journals indexed in JCR per year (with the number of researchers remaining constant) increased from 26-29 in 2012-2015 to 41-51 in 2019-2021. Comparing the average number of publications published per year between the 2012-2015 and 2016-2021 evaluation periods within the Geology Division, the per-yearly number of publications increased from 8 in to 12 in the first JCR quartile (Q1) and from six to ten in the second quartile (Q2). The mean number of publications increased from six to 13 in the Q3 journals, without any increase in the Q4 journals, demonstrating that the increase in the number of publications occurred in all higher quartiles, and not in the lowest quartile. The total number of citations per year has significantly increased as well.

The researchers at the Geology Division published many manuscripts in the top Q1 journals and in chapters of renowned monographic series such as the Geology society London, Special publications. We think that manuscripts led by our authors published in journals such as Geology (4x), Journal of Metamorphic Geology, Journal of Petrology, Terra Nova, Proceedings of the Royal Society B (3x), Sedimentology, Biogeosciences, Global Ecology and Biogeography, Chemical Geology, Lithos, Ore Geology Reviews, or Palaeogeography, Palaeoclimatology, Palaeoecology speak for themselves.

For example, a series of petrological publications with a common subject based on international cooperation - the association of coexisting diamond and monazite, the first indicating ultrahigh-pressure experienced by hosting rocks, the second recording their age, were published with an international team of geologists working in the Caledonides, Alps and Carpathians (Slovakia,

Poland, Czechia, Germany, Japan). Here, the geochronological interpretation critically depends on deciphering of petrological evolution based on mineralogy which finally enabled age determination of the peak metamorphic conditions, indicating the burial of protoliths to the depths of 150 km in the Caledonides (diamond-bearing) and ca 90 km in the Carpathians (diamond-free) during Caledonian and Variscan subductions:

Klonowska, I., Janák, M., Majka J., Petrík, I., Froitzheim, N., Gee, D.G., Sasinková, V., 2017: Microdiamond on Åreskutan confirms regional UHP metamorphism in the Seve Nappe Complex of the Scandinavian Caledonides. Journal of Metamorphic Geology, Q1, doi: 10.1111/jmg.12244

Petrík, I., Janák, M., Klonowska, I., Majka, J., Froitzheim, N., Yoshida, K., Sasinková, V., Vaculovič, T., 2019: Monazite behaviour during metamorphic evolution of a diamond-bearing gneiss: a case study from the Seve Nappe Complex, Scandinavian Caledonides. Journal of Petrology, 60, Q1, 1773-1796.

Trapp, S., Janák, M., Fassmer, K., Froitzheim, N., Munker, C., Neven, G., 2021: Variscan ultra-high-pressure eclogite in the Upper Allochthon of the Rhodope Metamorphic Complex (Bulgaria) Terra Nova, 33, 2, 174-183.

2b. Publications - too many articles are published in the house journal (Geology)

Although the major incentive is to publish in journals with high-impact factors, the proportion of articles published by researchers from the Geology Division in Geologica Carpathica in 2016-2021 is 31 (out of 237 WOS-SCI articles), and thus 13% only. However, we also actively support publications in Geologica Carpathica (with green open access), not because it is our house journal, but because its strategy is not confounded with questionable behaviour of commercial for-profit publishers that outsource management and editing process to low-income countries. The international editorial board guarantees the quality of Geologica Carpathica, e.g., ca 45% of submitted papers are rejected annually, and the proportion of corresponding authors from the ESI SAS also does not exceed 10% of published papers. It is obvious that the excessively high publication fees (beyond reasonable profit) and rushing review process damages present-day scientific progress and the journal Geologica Carpathica sides with journals that protect critical-thinking style of review process. Moreover, we support the strategy that incentives that researchers publish in society journals (such as the Carpathian Balkan Geological Society established in 1921).

3. PhD program - the environment could be more supportive (see examples within SAS)

Response: The support for PhD students and the overall environment significantly improved and expanded during the assessment period since 2016. During the assessment period, 21 PhD students (10 women and 11 men) were enrolled (including two students from India, two students from Hungary, one student from Poland and one student from Brasil), and eight PhD students defended their thesis successfully. First, the institute working place at Banska Bystrica have now excellent facilities and conditions for students and we would argue that they do not have any equivalent in geological studies in Slovakia – the students have a direct access to SEM, XRF, electron microprobe, Raman spectroscopy, CT, organic geochemistry, and all laboratory spaces. The Institute in Banská Bystrica directly provides long-term accommodation to all PhD students (and accommodates also short-term stays of students). Second, all PhD students must be now directly supported from funding projects of their supervisors and other advisors. With opening of the PhD funding in the framework of the SAS in 2021, students are also obliged to apply for their own independent funding (so that they also learn how to write projects and apply for funding). Third, several our students spend some subsets of their PhD abroad (e.g. some examples include the PhD student Maria Maraszewska who dated her samples at the Korea Basic Science Institute in Ochang in 2019, the PhD student Tamas Muller who measured boron isotopes in brachiopod shells n GEOMAR in Kiel, or the PhD student Tomáš Fuksi who analyzed Holocene bivalves at the University of Vienna, or the PhD student Maria Vidhya, who harmonized her taxonomical determinations of diatoms in Centre for Ecological Research in Budapest). In general, the students are matriculated and enrolled at the Comenius University, and thus also take advantage of classes and other interactions with students not only from the Slovak Academy of Sciences but also from other institutions. Fourth, PhD students are required to present their results and progress every year, and their progress is tracked. For example, the PhD project of Tamas Muller, supervised at

the ESI SAS by Adam Tomašových, led to the publication of analyses of brachiopod boron isotopes in Geology in 2020, gaining more than 20 WOS citations since then. Examples:

FUKSI, Tomáš- TOMAŠOVÝCH, Adam - GALLMETZER, Ivo - HASELMAIR, Alexandra - ZUSCHIN, Martin. 20th century increase in body size of a hypoxia-tolerant bivalve documented by sediment cores from the northern Adriatic Sea (Gulf of Trieste). In Marine Pollution Bulletin, 2018, vol. 135, p. 361-375. (2017: 3.241 - IF, Q1 - JCR, 1.147 - SJR, Q1 - SJR, CCC).

MÜLLER, Tamás - JURÍKOVÁ, Hana - GUTJAHR, M. - TOMAŠOVÝCH, Adam - SCHLŐGL, Ján - LIEBETRAU, V. - DUARTE, L. V. - MILOVSKÝ, Rastislav - SUAN, G. - MATTIOLI, Emanuela - PITTET, B. Ocean acidification during the early Toarcian extinction event: Evidence from boron isotopes in brachiopods. In Geology, 2020, vol. 48, no. 12, p. 1184-1188. (2019: 4.768 - IF, Q1 - JCR, 2.754 - SJR, Q1 - SJR, CCC).

Research is solid, in few cases innovative - interaction within the institute was limited

Response: As we have mentioned the implementation of the performance evaluation that also highlights the impact factors and citations (that should, even when imperfectly, correlate with research innovations), the degree of innovativeness is now pushed by the evaluation criteria that we enforced since 2016 so that researchers must also attempt to publish in journals that require innovative manuscripts. A significant factor in the increase of publishing activity is also the full operation of analytical laboratories implemented in the years 2010 to 2014. The interactions among departments within the Geology Division significantly improved and were at high level over the past years – this is directly evidenced by (1) the diversity of co-authorship teams of peer-reviewed publications, with coauthors from different departments and across divisions within the ESI SAS, including collaborations between geochemists, mineralogists, stratigraphers and paleontologists, and by (2) explicit collaborations on projects supported by grant agencies that are shared by researchers from different institutes outside of the ESI SAS and from abroad. The ESI institute also runs regular scientific seminars where all researchers can interact, with online webinars during the Covid period, and now in the hybrid form. Most researchers actively interact and collaborate with researchers at the Comenius University and universities in Austria, Germany, Poland, Hungary, Bulgaria, Ukraine and Czechia, and most research interactions are also determined by external collaborations (with researchers from other countries from the Western Europe and USA) as recommended by our Scientific Board. The efficiency of these international collaborations is also visible in the publication record of researchers from the Geology Division during years of 2017-2021.

The examples of diverse international collaboration published and in publications with Q1:

FROITZHEIM N. – MILADINOVA I. - JANÁK M. - KULLERUD K. - RAVNA E.J. K. - MAJKA J. - FRONSECA R.O.C. - MÜNKER C. - NAGEL T.: Devonian subduction and syncollisional exhumation of continental crust in Lofoten, Norway. ***Geology***, 2016, vol. 44, no. 3, p. 223-226. (4.548 - IF2015). (2016 - Current Contents). ISSN 0091-7613.

PETRÍK, Igor - JANÁK, Marian - KLONOWSKA, I. - MAJKA, Jarosław - FROITZHEIM, Nikolaus - YOSHIDA, Kenji - SASINKOVÁ, Vlasta - KONEČNÝ, Patrik - VACULOVIČ, T. Monazite behaviour during metamorphic evolution of a diamond-bearing gneiss: a case study from the Seve Nappe Complex, Scandinavian Caledonides. ***Journal of Petrology***, 2019, vol. 60, no. 9, p. 1773-1796. (2018: 3.380 - IF).

HURAI V., PAQUETTE J.L., HURAIOVÁ M., SLOBODNÍK M., HVOŽĎARA P., SIEGFRIED P., GAJDOŠOVÁ M., MILOVSKÁ S. 2017: New insights into the origin of the Evate apatite-iron oxide-carbonate deposit, Northeastern Mozambique, constrained by mineralogy, textures, thermochronometry, and fluid inclusions. In **Ore Geology Reviews**, 2017, vol. 80, p. 1072-1091. (3.095 - IF2016).

BROSKA I., BAČÍK P., KUMAR, S., JANÁK M., KURYLLO S., FILIP J., BAZARNIK J., MIKUŠ T. 2019: . Myrmekitic intergrowth of tourmaline and quartz in eclogite-hosting gneisses of the Tso Morari ultrahigh-pressure metamorphic terrane (Eastern Ladakh, India): A possible record of high-pressure conditions. In **Geological Society Special Publications**, 2019, vol. 481, no. 1, p. 175-194. (2018: 0.791 - SJR, Q1 - SJR). ISSN 0305-8719.

KOHÚT, Milan - WESTGATE, John A. - PEARCE, J. G. - BAČO, Pavel. The Carpathian obsidians - Contribution to their FT dating and provenance (Zemplin, Slovakia). In **Journal of Archaeological Science: Reports**, 2021, vol. 37, art. no. 102861. (2020: 3.216 - IF, Q1 – JCR)

SOTÁK, Ján - ELBRA, Tiiu - PRUNER, Petr - ANTOLÍKOVÁ, Silvia - SCHNABL, Petr - BIROŇ, Adrián - KDÝR, Šimon - MILOVSKÝ, Rastislav. End-Cretaceous to middle Eocene events from the Alpine Tethys: Multi-proxy data from a reference section at Kršteňany (Western Carpathians). ***Palaeogeography, Palaeoclimatology, Palaeoecology***, 2021, vol. 579, art. no. 110571. doi.org/10.1016/j.palaeo.2021.110571 (IF - 3.318, JCR - Q1).

TOMAŠOVÝCH, Adam - ALBANO, Paolo G. - FUKSI, Tomáš - GALLMETZER, Ivo - HASELMAIR, Alexandra - KOWALEWSKI, Michał - NAWROT, Rafał - NERLOVIĆ, Vedrana - SCARPONI, Daniele - ZUSCHIN, Martin. Ecological regime shift preserved in the Anthropocene stratigraphic record. In **Proceedings of the Royal Society : B - Biological Sciences**, 2020, vol. 287, no. 1929, art. no. 20200695. (2019: 4.637 – IF).

Women are underrepresented

Response: We closely follow the strategy of equal opportunities and treatment of all demographic groups, irrespective of their gender, and all assessments are merit-based (taking into account and consideration that the career development is affected by age, health and maternity leaves). However, we have improved gender balance by incorporating female PhD students (Diana Ölveczká, Maria Maraszewska, Marina Vidhya, Lucia Žatková) and hiring one young researcher (Ivana Koubová). Generally, the proportion of women remains constant through time, with 25% women out of 29 academic positions in the Geology Division. This proportion is still low but rather reflects a systemic issue at the higher levels (conditions for maternity leave in Slovakia and economic conditions), as our number of women researchers exceeds the proportions at most other institutes in the Slovak Academy of Sciences. We note that one of the main barriers and causes of under-representation of women in academic institutions lies at the level of Slovak legislation and maternity-leave conditions - the lack of any support for childcare for children < 2 years (unless private kindergarten is used) and their very low financial support.

The institute succeeded in bringing back excellent researchers to SAS, after long stays abroad

Response: The Geology Division attracted two additional young researchers from abroad during the assessment period (Juraj Hrabovský and Martin Ševko). The Earth Science Institute in Bratislava faces an immense barrier in its overall development that is caused by the lack of appropriate building and infrastructural facilities (that cannot be achieved from external funding). The ESI SAS and the Geology Division in Bratislava resides in a small building built in 1950s, with insufficient space for offices and extremely limited spaces for laboratories and sample repositories. This situation makes the hiring process of young and competitive candidates difficult and challenging, on the other hand, the young researchers profit from infrastructure in Banská Bystrica. For example, the research by Martin Ševko was also awarded by the Slovak Academy of Sciences in 2021 for the study:

ŠTEVKO, Martin - SEJKORA, J. - PLÁŠIL, Jakub - DOLNÍČEK, Z. - ŠKODA, Radek. Fluorapophyllite-(NH4), NH4Ca4(Si8O20)F center dot 8H(2)O, a new member of the apophyllite group from the Vechec quarry, eastern Slovakia. In Mineralogical Magazine, 2020, vol. 84, no. 4, p. 533-539. (2019: 1.738 - IF, Q2 – JCR

Comments and recommendations for further improvement of the institute:

In addition to general comments that apply to all institutes to a varying extent, the following specific recommendations and comments are made:

The new institute of Earth Sciences will offer new opportunities for integrated research within the institute and, most important, across institute boundaries. One of the future research themes is an SAS overarching theme in the field of "water, landscape evolution and future climate change and its impact on society", should be done in collaboration with Geography, and Hydrology and others (Ecology). Hydrology, with its subsurface Hydrology branch, is very close to hydrogeology; and Geography, with its river studies, is closely related to fluvial sedimentology, if looked from an international perspective. Collaboration potential is high. We recommend interaction with joint seminars, with joint projects, with joint PhD's. This collaboration will provide the baseline for development of international projects (EU).

The integration of formerly independent divisions within the ESI over the past years progressed towards high levels of collaboration between the Geology and Geophysics Division. The Earth Science Institute (Geophysics Division) hired new young researchers (Milan Onderka, Veronika Lukasová) who are active in the field on the intersection between climate, biology and geology. The integration was further improved at the scale of whole Earth Science Institute by hiring new young researchers who work with coralline algae and by supervising a graduate student. We note that several proposals for large-scale funding (from the structural funds of the European Union) on the topics surrounding the overarching theme of "Water" were not supported by the funding agencies. The main research strategies of the Geology Division and its main successful research topics cover petrological, mineralogical, paleobiologic and stratigraphic themes (including the stratigraphic expression of anthropogenic signals in the Holocene rock record) and themes devoted to metallogenesis (agenda of critical raw materials). The research strategy devoted to investigation of several critical elements like e.g. Sb, Si or Mg (to further assess the economic potential of these resources in Slovakia). For example, the International Visegrad Fund supported the project that included Czech Republic, Poland and Hungary, titled "Importance of raw material in the economy of V4 countries" (2019-2020).

Funding on European Level for projects should increase. Research in several clusters needs to become more innovative. This will be possible through stronger interaction with international science. Existing opportunities should be taken to invite guest lecturers, to send students to international summer schools. Existing programs have been poorly used (e.g. in Geology). The institute should search for stronger interaction with institutes outside Slovakia.

We comment on the issue of the European-level funding at the beginning of the section 3. The participation of researchers in international teams and their active collaboration with colleagues from Europe and USA strongly improved during the assessment period, as attested by many papers published in multi-author and international co-authorship. The efficiency of these collaborations propagated into the Web of Science publications with high impact factors/in the Q1 category clearly since 2016, and researchers from the Geology Division now interact and more collaborate with institutes of the other countries more than ever – we note that these countries cover most of the European countries so we do not list them explicitly. Examples include:

Interaction and joint projects between Paleobiology and Stratigraphy may strengthen the institute in a field which is of high visibility (Co-evolution of life and physical environment through geological time)

These departments were interacting since 2016, in fact they share most projects and overlap in membership, including projects devoted to the Early Toarcian oceanic anoxic event, the Jurassic/Cretaceous boundary, the Cretaceous/Paleogene boundary and several other events in the Eocene, Oligocene and Miocene. These interactions became visible in the outputs from the Western Carpathians but also from other regions:

SOTÁK, Ján - ELBRA, Tiiu - PRUNER, Petr - ANTOLÍKOVÁ, Silvia - SCHNABL, Petr - BIROŇ, Adrián - KDÝR, Šimon - MILOVSKÝ, Rastislav. End-Cretaceous to middle Eocene events from the Alpine Tethys: Multi-proxy data from a reference section at Kršteňany (Western Carpathians). In Palaeogeography, Palaeoclimatology, Palaeoecology, 2021, vol. 579, art. no. 110571. doi.org/10.1016/j.palaeo.2021.110571 (IF - 3.318, JCR - Q1).

STAREK, Dušan - ŠIMO, Vladimír - ANTOLÍKOVÁ, Silvia - FUKSI, Tomáš. Turbidite sedimentology, biostratigraphy and paleoecology: A case study from the Oligocene Zuberec Fm. (Liptov Basin, Central Western Carpathians). In Geologica Carpathica, 2019, vol. 70, no. 4, p. 279-297. (2018: 1.699 - IF, Q3 - JCR

MÜLLER, Tamás - KARANCZ, Szabina - MATTIOLI, Emanuela - MILOVSKÝ, Rastislav - PÁLFY, József - SCHLŐGL, Ján - SEGIT, T. - ŠIMO, Vladimír - TOMAŠOVÝCH, Adam. Assessing anoxia, recovery and carbonate production setback in a hemipelagic Tethyan basin during the Toarcian Oceanic Anoxic Event (Western Carpathians). In Global and planetary change, 2020, vol. 195, art. no. 103366. (2019: 4.448 - IF, Q1 – JCR

TOMAŠOVÝCH, Adam - SCHLÖGL, Ján - BIROŇ, Adrián - HUDÁČKOVÁ, Natália - MIKUŠ, Tomáš. Taphonomic clock and bathymetric dependence of cephalopod preservation in bathyal, sediment-starved environments. In Palaios, 2017, vol. 32, no. 3, p. 135-152. (2016: 1.983 - IF, Q1 – JCR

TOMAŠOVÝCH, Adam - SCHLÖGL, Ján - MICHALÍK, Jozef - DONOVALOVÁ, Lenka. Non-condensed shell beds in hiatal successions: instantaneous cementation associated with nutrient-rich bottom currents and high bivalve production. In Italian Journal of Geosciences, 2020, vol. 139, no. 1, p. 76-97. (2019: 1.625 - IF, Q3 – JCR

Publications - more authors should publish in international highly ranked journals, today only few top researchers are working at the institute.

The main strategy to improve the quality of publications was to implement the evaluation and bonus driven by impact factors of publications at the Geology Division (and in the whole ESI SAS), and we think that this strategy led to visible and successful results - the per-year number of papers published in journals indexed in WOS JCR (with the number of researchers unchanging) changed from 26-29 in 2012-2015 to 28-39 in 2016-2018 and to 41-51 in 2019-2021. Out of 20 researchers at the Geology Division, five researchers (Vratislav Hurai, Marián Janák, Adam Tomašových, Peter Vršanský, Martin Ševko) have on average more than 3 SCI papers (indexed in JCR) per year over the assessment period (2016-2021), including one young researcher (Martin Ševko) hired during the assessment period. Additional three researchers from Banská Bystrica (Stanislava Milovská, Rastislav Milovský, Tomáš Mikuš) significantly improved their per-year publication rate to 5 SCI papers in 2019-2021, and four researchers publish in journals with high impact factors (Igor Broska, Ján Soták, Igor Petrík, Jozef Michalík). Four researchers are tied to top management positions (two directors and managers of the Division, and a member of the Presidium of the SAS). Most other researchers publish on average one-two SCI papers per year.

3.2 Activities on the implementation of comments and recommendation from international assessment in 2016 for further development of Division of Geophysics (former Geophysical Institute)

The institute has an international focus; however, some research clusters are internationally better established than others. This is reflected in citations, which are best in Seismology with many articles in high-standing international journals and with international collaboration. The small atmosphere-climate group does very important work (e.g. draught predictions, climate change research). International funding was not sufficient, the institute is embedded into international themes, more European funding can be expected.
Environment of young researchers was not highly supportive; few PhD students are active.
The female to male ratio among researchers is too low.
Comments and recommendations for further improvement of the institute:
In addition to general comments that apply to all institutes to a varying extent, the following specific recommendations and comments are made:

-Team-building within the new Institute and across disciplíne boundaries (transdisciplinary) will be of importance. Broad collaboration will provide opportunities to get better national and international funding. Partners are in hydrology and geography for climate research, and with hydrology (and others) in investigation of the deep geological underground.

The new Earth Science Institute offers opportunities in two research domains:

- Water, landscape evolution and future climate change and its impacton society" will be important for atmospheric science and geology

-The investigation of the "deep geologicalunderground" will be of relevance for geophysics and geology. Such new overarching SAS Research themes will provide opportunities for establishing stronger interdisciplinary (and transdisciplinary) research teams. These teams may have better chances to get European funding and to even take a leading role in some European projects.

-Improve gender balance - women are dramatically underrepresented (1:12. assistant profs)

-PhD's - a better collaboration with university is recommended - structural/legal problems between the SAS and the universities seem to complicate collaboration in some

disciplines. Collaboration with researchers abroad as part of PhD study is strongly recommended. Learning by good practice in other SAS Institutes.

-Public outreach - Activities should be intensified in the fields where society is involved. The new Earth Science Institute will offer chances for an integrative public outreach. Geology was more active, and may bring additional expertise in public outreach

Improvements following the previous accreditation comments and recommendations

(1) "The institute has an international focus; however, some research clusters are internationally better established than others"

The "gravimetry cluster", the Dept. of gravimetry and geodynamics, has significantly improved its performance since the latest accreditation. The number of high impact publications and citations has increased. We have published two works in the top impact geophysical journals. One was a review paper in Earth-Science Reviews:

Vajda Peter, I. Foroughi, P. Vaníček, R. Kingdon, M. Santos, M. Sheng, M. Goli (2020) Topographic gravimetric effects in earth sciences: Review of origin, significance and implications. ***Earth-Science Reviews***, vol 211 (Dec 2020), 103428, doi.org/10.1016/j.earscirev.2020.103428 (CCC/WOS-SCI, Q1, SJR = 3.750, IF = 9.724, IF(5yr) = 10.973, CiteScore = 15.0, Elsevier, ISSN: 0012-8252)

which was awarded (in 2021) the price of the Slovak Acad. Sci. for excellence in publishing (top first percentile). This work was lead by our research scientist (Peter Vajda) and resulted from a cooperation with the geodesy and geomatics UNB Canada research group. Another top impact paper was published in Earth System Science Data:

Zahorec, P., Papčo, J., Pašteka, R., Bielik, M., Bonvalot, S., Braitenberg, C., Ebbing, J., Gabriel, G., Gosar, A., Grand, A., Götze, H.-J., Hetényi, G., Holzrichter, N., Kissling, E., Marti, U., Meurers, B., Mrlina, J., Nogová, E., Pastorutti, A., Scarponi, M., Sebera, J., Seoane, L., Skiba, P., Szűcs, E., and Varga, M. (2021) The first pan-Alpine surface-gravity database, a modern compilation that crosses frontiers, ***Earth Syst. Sci. Data***, 13, 2165–2209, https://doi.org/10.5194/essd-13-2165-2021 (CCC/WOS-SCI, Q1, SJR = 4.066, IF_{2020} = 11.333, eISSN 1866-3516)

This work was conducted under a large international initiative of several European countries under the project AlpArray. Our research scientist (Pavol Zahorec) played a leading role in managing the data processing and the preparation of the unified complete Bouguer anomaly dataset and map of the region. This work was awarded a price of the Slovak Geological Society.

We have completed a review paper evaluating the past and current practices in correcting the observed spatiotemporal gravity changes for the gravitational effect of surface deformation and have proposed a new approach by introducing the so called deformation-induced topographic effect (DITE) giving a numerical recipe for its computation:

Vajda Peter, Pavol Zahorec, Dušan Bilčík, Juraj Papčo (2019) Deformation–induced topographic effects in interpretation of spatiotemporal gravity changes: Review of approaches and new insights.

Surveys in Geophysics, 40:1095–1127, https://doi.org/10.1007/s10712-019-09547-7 (CCC/WOS-SCI, Q1, IF = 5.23)

We have cooperated with the GNS Science New Zealand (Craig Miller) and the Carnegie Institution for Science, Earth and Planets Laboratory, Washington D.C., USA (Helene Le Mevel) on the methodology of processing observed spatiotemporal gravity changes and applying the DITE in inversion and interpretation of gravity changes in volcanic areas. We have re-interpreted the gravimetric picture of the volcanic unrest at Laguna del Maule in southern Andes (Chile):

Vajda Peter, P. Zahorec, C.A. Miller, H. Le Mével, J. Papčo, A.G. Camacho (2021)
Novel treatment of the deformation–induced topographic effect for interpretation of spatiotemporal gravity changes: Laguna del Maule (Chile) ***Journal of Volcanology and Geothermal Research*** 414, 107230 (June 2021) doi 10.1016/j.jvolgeores.2021.107230 invited research paper, (CCC/WOS-SCI, Q1, IF = 2.827, Elsevier)

We have started intense cooperation with the Institute of Geosciences (IGEO), CSIC-UCM, Madrid, Spain (Antonio Camacho and Jose Fernández) devoted to the advancement of the gravimetric inverse approach based on free-geometry model exploration and growing source bodies as applied to sparse scattered 4D micro-gravity data of low signal-to-noise ratio, given on the topographic surface:
Camacho Antonio G., Peter Vajda, Craig A. Miller, José Fernández (2021)
A free-geometry geodynamic modelling of surface gravity changes using Growth-dg software
Scientific Reports 11, 23442 (6 Dec 2021) doi 10.1038/s41598-021-02769-z
(CCC/WOS-SCI, Q1, IF(2yr) = 4.379, IF(5yr) = 5.133, Nature Publishing Group, Nature Research)

This work has attracted a student from the Comenius University, who cooperated on this topic in terms of his master thesis, which was successfully defended. Now he is employed at our institute part time and will continue in this research as a PhD student.
We have cooperated with researchers from the INGV Napoli, Osservatorio Vesuvio, Italy in interpreting the spatiotemporal gravity changes of the 2017 destructive earthquake on the Ischia island. This work resulted in a joint published paper. Under a collaboration with the IGN, Spain, namely Observatorio Geofísico Central, IGN in Madrid, and Centro Geofísico de Canarias, IGN, Tenerife (Canary Islands) we have conducted a gravimetric field campaign on Tenerife in summer of 2016. These measurements resulted in several publications. Under collaboration with INGV Catania, Osservatorio Etneo, we have carried out field measurements on Etna in summer of 2018, and in the summit area of Etna in 2021. These measurements have served for gravimetric studies of the plumbing system of Etna. This cooperation resulted in joint papers and some are still under preparation. We also collaborated with colleagues from the Institute of Earth Sciences, Jena University, Jena, Germany on the geophysical inverse modelling and interpretation of the Thuringian Basin in Germany.

Researchers from our gravimetry department have significantly contributed (by co-authoring many chapters) to the monograph:
Pašteka Roman, Ján Mikuška and Bruno Meurers (eds.): Understanding the Bouguer Anomaly: A Gravimetry Puzzle, 2017, Elsevier, ISBN 978-0-12-812913-5, doi 10.1016/B978-0-12-812913-5.00006-3

A substantial proportion of our research work is devoted to a deep structure and composition of the Carpathian-Pannonian lithosphere and the dynamic processes that take place in it. To achieve this goal, we use and apply modern, world-renowned 2D and 3D integrated geophysical modelling (e.g., LitMod3D|. The results were obtained in very close and fruitful international cooperation. The results relate to a deep geophysical interpretation of the lithosphere in the wider Carpathian-Pannonian region and have been published in several prestigious international journals such as: Earth System Science Data, Global and Planetary Change, Tectonics, International Journal of Earth Sciences, Tectonophysics and so on.

We have been very active in disseminating our research results at international conferences worldwide, including events held on Fiji, Hawaii, Singapore, Canary Islands, Reunion, Stromboli, Santorini, as well as on the large annual or general assemblies of the EGU, AGU, EAGE and IUGG. The head of the gravimetry department (Peter Vajda) is the Slovak national delegate to IUGG and secretary general of the IUGG-Slovakia (Slovak National Committee). He is also the editor-in-chief of the journal Contributions to Geophysics and Geodesy. The journal has reformed its Editorial Board to become more internationally renowned with the aim to gradually keep improving the quality and impact of the journal.

With respect to the “geomagnetism cluster”, In an effort to improve the international reputation, the Dept. of geomagnetism implemented the following actions: (1) maintain the well-functioning international cooperation with the proven international teams with which we have worked so far, and at the same time (2) expand the international cooperation. The following outputs are examples of the first action:
Márton, E., Madzin, J., Plašienka, D., Grabowski, J., Bučová, J., Aubrecht, R. & Putiš, M. (2020): New paleomagnetic constraints for the large-scale displacement of the Hronic nappe system of the Central Western Carpathians. ***Journal of Geodynamics*** 141-142, 101796. (CC/WOS-SCI, Q1, IF = 2.345, Elsevier)

This paper is the main result of a long-term cooperation with Mining and Geological Survey of Hungary, Paleomagnetic Laboratory, Budapest, Hungary. It provides paleomagnetic analysis of many sampling sites involving mainly the base of the Hronic nappe system of the Western Carpathians, with paleotectonic an paleogeographic interpretations.

VALACH, Fridrich - HEJDA, Pavel - REVALLO, Miloš - BOCHNÍČEK, Josef. Possible role of auroral oval-related currents in two intense magnetic storms recorded by old mid-latitude observatories Clementinum and Greenwich. ***Journal of Space Weather and Space Climate***, 2019, vol. 9, p. A11.

HEJDA, Pavel - VALACH, Fridrich - REVALLO, Miloš. The geomagnetic data of the Clementinum observatory in Prague since 1839. ***Annales Geophysicae***, 2021, vol. 39, no. 3, p. 439-454.

HEJDA, Pavel; REVALLO, Miloš; VALACH, Fridrich (2021): Magnetic storm and term-day observations at the Prague observatory Clementinum in the mid-19th century. ***Geoscience Data Journal***, https://doi.org/10.1002/gdj3.141 (Early View).

HEJDA, Pavel; REVALLO, Miloš; VALACH, Fridrich (2021): Data of magnetic storms and term-day observations from the Prague-Clementinum observatory (1839-1849). ***PANGAEA***, https://doi.org/10.1594/PANGAEA.936921

These publications originated from bilateral cooperation with the Institute of Geophysics, Academy of Sciences of the Czech Republic. The work presents the results of the ongoing research of unique records of historical geomagnetic observations at the old Clementinum observatory in Prague with particular focus on strong geomagnetic disturbances. We followed the technique of observations and measurements, which was used in the 19th century (in Prague since 1839); the key was to learn the methodology of working with the bifilar device that was designed to observe the horizontal intensity of the geomagnetic field. We have re-processed continuous time series of horizontal intensity and declination since 1839. We have processed and interpreted observations of several geomagnetic storms, in some cases extremely intense, from the first half of the 19th century. The study of 19th century events is of great importance for understanding the mechanisms of extreme magnetic storms because the events of that time were much more intense than the recent and present events. This kind of effort may stimulate future collaborative research in the collection and analysis of hitherto unknown historical geomagnetic data from worldwide observatories.

We have also involved a new doctoral student (a PhD-student in external form) in the research of extreme historical storms. The student is currently researching the extreme geomagnetic storm of May 1921 recorded in Hurbanovo (then called Stará Ďala), which is probably the most intense event since the events that occurred in the 19th century.

Part of the international activities of our institute is also participation in the global INTERMAGNET program, of which the Hurbanovo geomagnetic observatory has been a full member (with the IMO status) since 1998. Within this program, we contribute daily with processed magnetograms (one-minute values) to the GIN data node in Paris.

The result of the second action is documented, for example, by the following works:
We have started cooperation with researchers from Poland (Laboratory of Radiometric Expertise, Institute of NuclearPhysics PAN, Krakow) and Hungary (Social Organisation for Radioecological Cleanliness, Veszprem) and Czech Republic (RADON, v.o.s., Prague) on radon monitoring in the kindergartens and homes. It resulted in several joint publications:

Műllerová, Monika - Kozak, Krzysztof - Kovács, Tibor - Smetanová, Iveta - Csordás, Anita - Grzadziel, Dominik - Holý, Karol - Mazur, Jadwiga - Moravcsík, Attila - Neznal, Matěj - Neznal, Martin, 2016: Indoor radon survey in Visegrad countries. ***Applied Radiation and Isotopes*** 110, 124–128 (1.136 - IF2015)

Műllerová, Monika - Mazur, Jadwiga - Csordás, Anita - Grzadziel, Dominik - Holý Karol - Kovács, Tibor - Kozak, Krzysztof - Kureková, Patrícia - Nagy, Erika - Neznal, Matej - Smetanová, Iveta, 2017: Preliminary Results of Radon Survey in the Kindergartens of V4 Countries. ***Radiation Protection Dosimetry*** 177 (1-2), 95-98. (0.917 - IF2016)

Műllerová, Monika - Mazur, Jadwiga - Csordás, Anita - Holý Karol - Grzadziel, Dominik - Kovács, Tibor - Kozak, Krzysztof - Smetanová, Iveta - Danyłec, Karolina - Kureková, Patrícia - Nagy, Erika - Neznal, Matej, 2019: Radon survey in the kindergartens of three Visegrad countries (Hungary, Poland and Slovakia). ***Journal of Radioanalytical and Nuclear Chemistry*** 319,1045–1050. (1.186 - IF2018)

We have started cooperation with researchers from Israel (Geological Survey of Israel, Jerusalem) on radon monitoring in the boreholes:
Smetanová, Iveta - Steinitz, Gideon - Holý - Karol, 2017: Multi-year monitoring of radon in boreholes at the Modra Geophysical Observatoty, Slovakia. ***Radiation Protection Dosimetry*** 177 (1-2), 134-139. (0.917 - IF2016)

Cooperation with the USA was initiated in a joint study of a model for convective transport of heat and solutes in ternary mushy layers, conducted by our researcher Peter Guba and Daniel M. Anderson (Department of Mathematical Sciences, George Mason University, USA and National Institute of Standards and Technology, USA).
P. Guba and D. M. Anderson, Pattern selection in ternary mushy layers, ***Journal of Fluid Mechanics***, vol. 825, p. 853-886, 2017.

The dynamics of supercooled solidification of a pure material in a finite domain subject to isothermal boundary conditions was studied by Peter Guba in collaboration with Juraj Kyselica (Institute of Geophysics, Czech Academy of Sciences) and Martin Chudjak (PhD student, Department of Applied Mathematics and Statistics, Comenius University)
J. Kyselica, P. Guba and M. Chudjak, ***International Journal of Heat and Mass Transfer*** 159, 120048, 2020.

We entered a broad international cooperation, which aimed to create an extensive database of geomagnetic data, HISTMAG: instrumental historical observations on the one hand, and field estimates based on the magnetization acquired by rocks, sediments and archaeological artefacts on the other hand. The HISTMAG data base combines available global historical data compilations covering the last ca 500 years as well as archaeomagnetic and volcanic data collections from the last 50,000 years. Furthermore, new historical and archaeomagnetic records, mainly from central Europe, have been acquired. In total, ca 200,000 records are currently available in the HISTMAG database, whereby the majority is related to historical declination measurements. The HISTMAG database supports thorough reliability and uncertainty assessments of the widely different data sets, which are an essential basis for geomagnetic field reconstructions. A database analysis revealed systematic offset for declination records derived from compass roses on historical geographical maps through comparison with other historical records, while maps created for mining activities represent a reliable source. The research was led by Austrian colleagues P. Arneitz a R. Leonhardt. The response to this publication is 24 WOS citations (according to the journals's website).
ARNEITZ, Patrick - LEONHARDT, Roman - SCHNEPP, Elisabeth - HEILIG, Balázs - MAYRHOFER, Franziska - KOVACS, Peter - VALACH, Fridrich - VADASZ, Gergely - HAMMERL, Christa - EGLI, Ramon - FABIAN, Karl. The HISTMAG database: combining historical, archaeomagnetic and volcanic data. ***Geophysical Journal International***, 2017, vol. 210, issue 3, p. 1347-1359.

(2) "International funding was not sufficient"

Thanks to our cooperation with INGV Catania, Osservatorio Etneo, and our field work on Etna, we were successful in applying for a Trans National Access project (acronym G-ET-SUMMIT) granted under EUROVOLC project that received funding from EU Horizon 2020 research and innovation actions under grant agreement No 731070 (03/2020–11/2021). We also participate as a partner in an ERA.Net ERA-MIN-2 project (acronym D-Rex).
In 2021, the international collaboration of the Dept. of Atmopsheric Physics was enhanced by getting involved with two COST projects, namely the CA20108 FAIR project "Network of micrometeorological measurements – Dr. Nejedlík (Grand holder), and the CA20136 OPENSENSE project "Opportunistic precipitation sensing network" – Dr. Milan Onderka (MC member). We anticipate that active involvement in these two COST actions will lead, through networking, to a higher recognition of the department's activities in the European space with possible opportunities of international collaboration and funding.
We were successful in applying for Bilateral Mobility Project for joint projects supporting cooperation between organisations in the Slovak Republic and the Republic of Portugal: Radon in caves and mines - Portuguese and Slovak case studies (acronym RADCAMIN). Project received funding from Slovak Research and Development Agency No SK-PT-18-0015 (1/2019-12/2022).

The project leader was Iveta Smetanová, in this project one PhD. student (Ľubica Mareková Luhová) and one young researcher under age 35 (Marek Vďačný) was included.

A well-established team of geomagnetists from the Earth Science Institute SAS, which specializes in magnetotellurics, has been involved in several multilateral and bilateral projects:

D-REX project – the ERA.MIN programme of ERA.Net - global, innovative and flexible pan-European network of research funding organisations, supported by EU Horizon 2020 The consortium of D-Rex project consist of institutions from Sweden (Lulea University of Technology), Finland (Geological Survey of Finland), Czech Republic (Institute of Geophysics of the Czech Academy of Sciences) and Slovakia (Earth Science institute of the SAS) and several industrial partners. The first objective of D-Rex is to build onto this new paradigm with geophysical data from three prospective areas in Sweden, Norwayand Finland. Therefore, the second objective of D-Rex is the integration of multi-facetted geophysical data acquired at those prospective areas. The third objective is the unification, optimum integration and visualization of geological and geophysical data on the basis of the Common Earth Modelling (CEM) concept.

De-risking Ireland's Geothermal Energy Potential (implementation: 2020–2022, a co-investigating institution from **Ireland**).
Regional conductivity anomalies role in tectonic development of the Carpathians (implementation: 2019–2021, a co-investigating institution from **Poland**).
Comparison of geophysical and geological structures of the Western Carpathian litosphere with other orogenic areas in Europe: mainly Bohemian Massif and Norwegian Caledonides (implementation: 2021– 2022, a co-investigating institution from Czech Republic).
Another example of bilateral cooperation is the following interdisciplinary project:
Low-frequency fluctuations of the geomagnetic field and their bioresponse effects in case of water characteristics, luminescent bacteria and yeast granules (implementation: 2017–2019, a co-investigating institution from Ukraine).

(3) "Environment of young researchers was not highly supportive; few PhD students are active"

This has improved. We have 3 new internal PhD students (Dominika Godová, Ema Nogová, Lenka Ondrášová) and another one will start in September (Jozef Bódi). We have two new external PhD students (Michal Hoffman and Eduard Koči). A new young researcher (post-doc) was employed who received the Schwarz fund (Veronika Lukasová).

In an effort to make the study of geomagnetism more attractive in the graduate and postgraduate (PhD) studies, a monograph/textbook on the physical foundations of magnetic storms was written ("Magnetické búrky: fyzikálne základy [Magnetic storms: physical foundations]" by Fridrich Valach, published in 2020). The book is written in the Slovak language and is intended as a study material for students of general physics, geophysics and applied geophysics. The book intends to help attract talented students to study space physics and earth sciences at universities. We note that the lack of university students in science is currently one of the most pressing problems in our society. We aim to mitigate this problem with this publication.

With the aim to attract students, we also carried out teaching activities at the Faculty of Informatics and Information Technologies, Slovak University of Technology: semester exercises in Physics, teachers: Alexandra Marsenić, Iveta Smetanová

(4) "The female to male ratio among researchers is too low"

We have improved gender balance: +3 female PhDs (Dominika Godová, Ema Nogová, Lenka Ondrášová), +1 female young researcher (Veronika Lukasová).

Selection of the applicants for PhD. study at the Earth Science Institute, SAS is done solely on the basis of applicants skills and not according to their gender. The institute has no record of decision between two applicants of different genders, when gender would play a decisive role in the success of the applicant.

(5) "Public outreach"

We have improved the public outreach in the Geophysics Division:

We have repeatedly participated in the European Researchers' Night (all-day presentation), the Weekend with the Slovak Academy of Sciences (two day event), the FEBIOFEST festival, and the AMAVET festival. We organize repeatedly Open Door events at our observatories and laboratories for high school students or general public. Our researchers visit schools to give popular lectures. We are also active in refuting hoaxes such as flat Earth, etc.

We have organized also dedicated outreach activities, such as that of the Dept. of Geomagnetism aimed at commemorating the 120th anniversary of the establishment of the Geomagnetic Observatory (GMO) in Hurbanovo. A popularization article has been prepared presenting the GMO's past and recent activities as well as summarizing the current geomagnetic research in Slovakia.

During the period 2016–2021 the Geophysics Division has extensively participated in popularization activities including (but not limited to) many radio interviews, TV interviews, including the national TV broadcast Experiment, popularizing public lectures, press conferences. We have written and published several popular research articles for science branches of national newspapers, such as HN Science.

Dept. of Seismology continually provides to the media, to relevant institutions and to general public information on current earthquakes (particularly the macro-seismically observed ones) on the territory of Slovakia and worldwide, using the web site www.seismology.sk. Live online seismograms from the National Network of Seismic Stations are available, too. Integral part of the web is the interactive macro-seismic questionnaire and instructions how to behave and what to do during an earthquake.

4. *Research strategy and future development of the institute for the nextfive years* (Recommended 3 pages, max. 5 pages)

Research strategy of the institute in the national and international contexts, objectives, and methods (including the information on when the strategy was adopted)

4.1 Application of action plan as strategic document for future development of institute

The mission and key focus of the Institute of Earth Sciences SAS (ESI SAS) is to deepen the knowledge of geological and geophysical processes, to apply robust field and laboratory methods and approaches to main geoscience research problems, and to contribute with consequential findings to the development of cutting-edge geoscience research topics with a global (international) impact. The research at this Institute should increase understanding, explaining and predicting the outcomes geological and geophysical processes, including those processes that directly affect the society globally or with regional impacts or represent some threat to the health of group of citizens (geological risk). The principal mission of the Institute is the transfer of

1. scientific results to geoscience community through publications and expert lecture presentations;
2. scientific knowledge to the commercial sphere;
3. geoscience knowledge to the students and in generally to the society by educational tools and by popularization of geoscience research results and thus to foster a scientific way of thinking.

ESI SAS provides services of a state-of-the-art geological (geochemical, mineralogical, and paleontological) and geophysical (gravimetric, geomagnetic, seismological and meteorologic) laboratory base in the Slovakia. The Institute carries out permanent monitoring of seismic activity, the measurements of magnetic field and deformation of the Earth crust of Slovak surface, and meteorological monitoring. The main target of Institute is to perform innovative geoscience research and distribute the knowledge to students and society so that it represents an internationally-recognized and reputable geoscience institution.

The Action Plan developed by the ESI SAS in 2016 was oriented to achieve the following goals:

1. to direct the research towards key internationally visible and themes and topics;
2. to operate and develop geological and geophysical laboratories designed to perform modern geoscience research;
3. to create the conditions for interdisciplinary projects operating across geological and geophysical fields;
4. to intensify international cooperation and improve the quality and international aspect of graduate (PhD) studies (including training courses for students from abroad);
5. to reduce administration duties of researchers and to enhance communication among departments and among divisions by removal of administration barriers
6. to produce well-recognised and reputable international scientific journals; (task is in accordance with the state law of the Slovak Academy of Sciences (SAV) – § 4 (point No 2) letter „g“: SAV performs publishing of periodic and non-periodic publications“. We think that Geologica Carpathica with the JCR IF=1.875 currently excellently fulfills this goal.
7. to develop the scientific evaluation of scientists on the basis of their publication and citation output, evaluating the quality and not the quantity of research outputs. This goal was immediately and successfully established since 2016 and is regularly updated on the yearly basis.

In order to achieve the objectives of the Action Plan, it is necessary:

1. to stabilise prospective researchers and increase the number of young scientists in order to maintain an appropriate demographic and gender structure; - this plan is continuously refined

2. to integrate workplaces in Bratislava into a single unit - continuously in plan, but inhibited by the lack of laboratory and office spaces and by the lack of building facilities
3. to relocate laboratories from the former detached workplace Valašská street in Bratislava to the main venue-campus of the Slovak Academy of Sciences at Dúbravská cesta in Bratislava – this goal has been realised.
4. to create departments as dynamic and flexible units that are able to change their focus according to current requirements in the time; - continuously in programme
5. to maintain the material and personnel at the largest and the most modern geoscience workplace located in Banská Bystrica by material and human resources; - continuously in programme
6. to modernize devices and equipment in other all workplaces (Bratislava, Hurbanovo, Stará Lesná and Skalnaté Pleso. – the investment in 2021 to the new equipment achieved 67 000 €

4.2. Future research activities at Geology Division

4.2.1 Magmatic and metamorphic processes and geodynamic evolution of lithosphere mainly in Variscan and Alpine orogeny

Research activities in the coming years will be now more focused on research of magmatic and metamorphic complexes in the Western Carpathians and adjacent areas in order to understand and decipher main Variscan and pre-Variscan sequences, character of emplacement, and degrees of metamorphism. Determination of metamorphic character of the host rocks is crucial for deciphering main tectonic consequences. The magmatic suites will be evaluated within metallogenetic framework, especially in order to resolve the origin of the critical metals necessary for modern technologies. These investigations will be joined with suggestions of utilization of critical metals towards their economic potential. We shall focus on metamorphic processes in collisional orogenic zones and geodynamic evolution of Earth´s lithosphere in selected terrains including the Western Carpathians, Eastern Alps, Scandinavian Caledonides and Rhodopes. Major objectives include phase relations of mineral assemblages and thermodynamic (P-T-X) conditions of metamorphism. A special attention will be paid to identification of ultrahigh- pressure phases including coesite and microdiamond. Formation of melt will be studied based on field and microtextural observations (nanogranites). Detailed study of accessory minerals (monazite, zircon, rutile) will be focused on their stability in metamorphic processes with implications for geochronological dating, thermometry (Zr in rutile) and reconstruction of the P-T-t paths.

4.2.2 Biodiversity dynamics and evolutionary changes during the Mesozoic and Cenozoic biotic crises

The future research continuously builds on the former and running projects, focusing on paleoecological and evolutionary inferences of causes and factors that led to major biotic (regime) shifts and mass extinctions at the Triassic/Jurassic boundary, during the early Toarcian anoxic event, during the Cretaceous anoxic events, at the Cretaceous/Paleogene boundary, during the Cenozoic climatic events (Paleocene-Eocene Thermal Maximum and Middle Miocene Climatic Optimum), and during the Holocene-Anthropocene transition. However, new approaches addressing quantitative changes in diversity, body size, morphology and biomineralization at high stratigraphic resolution will be now pursued. We will target the stratigraphic record not only in the Western Carpathians, but also in the Eastern Alps, Lusitanian Basin, Adriatic Sea and in other regions. This research incorporates various taxonomic groups (calcareous nannoplankton, foraminifers, molluscs, brachiopods, coralline algae, vertebrate bones, and insects) that serve not only for assessment of phylogenetic relationships and evolutionary changes in their diversity, abundance and biomineralization strategies, but also represent proxies for analyses of seawater chemistry and climatic conditions, using geochemical methods (used in 4.2.3).

4.2.3 Tracking paleoenvironmental and basin evolution on the basis of proxies preserved in the sedimentary archives.

The development and testing of temperature, productivity, seawater chemistry, redox conditions and other environmental proxies archived in Mesozoic and Cenozoic marine and terrestrial sediments (in carbonate shells and tests and in organic matter), focusing on unique events (e.g., Mesozoic oceanic anoxic events and Cenozoic events associated with major climatic oscillations) and including the Pleistocene speleothems and Holocene lake and continental shelf sediments deposited since the Last Glacial Maximum. This research will use traditional bio- and sequence-stratigraphic and sedimentological tools (provenance analyses) coupled with sclerochronological, limnological and paleogeographic analyses, and will use biomarkers and other geochemical applications (stable isotopes in carbonates, elemental ratios). The research team will need to be expanded to include experts in organic geochemistry and in geochronology.

4.2.4 Metallogeny, geomaterials, environmental impact of old mining activities

Emphasis will be given to metallogenetic investigation of critical elements (REE, Nb, Li, V) in ore deposits localised in China, Iran, Ecuador, and Mozambique. Research on secondary minerals of dumps and tailings from abandoned ore deposits in Western Carpathians will be made with the aim of elucidating their potential role in the environmental pollution by As, Sb, and Hg during weathering. The research on geomaterials will be focused on the mineralogical analysis of ancient plasters and pigments using non-destructive spectrometric methods (Raman, Infra-Red, Laser-Induced Breakdown Spectroscopy). The investigation of archaeological pottery, medieval paintings and artworks will have to be supported by acquisitions of portable handheld Raman, X-ray fluorescence and LIBS instruments.

4.3 Future research activities at Geophysics Division

4.3.1. Activities in seismology will be focused on an international cooperation and projects with installation of temporary seismic stations that are very helpful to understand the seismic regime of active source zones and to estimate focal mechanisms of earthquakes with epicenter on the territory of Slovakia. A potential of anomalously large earthquake ground motion (site effects) in local surface structures will be investigated using numerical simulations including development and improvement of numerical methods for simulation of seismic motion in complex 3D realistic structures and development of methods for full waveform inversion in local sedimentary structures. Further, a detailed analysis of historical seismic events that belongs to the most important inputs into the calculation of seismic hazard assessment of critical infrastructures like nuclear power plants will be applied.

4.3.2. Research in geomagnetism will continue to focus on issues related mainly to the planetary magnetic field and the solar-terrestrial processes. Integrated modeling of deep tectonic structures using magnetotellurica nd other geophysical methods, be performed in order to understand the processes associated with geological and tectonic evolution of structures and with strategic energy and mineral resources. Space weather modeling will be continued with the aim of improving the forecasts of strong geomagnetic disturbances in mid-latitude regions. Scientific research will in gravimetry be focused on application of modern approaches and methods of gravimetric inversion and structural density and integrated modelling for studying lithospheric structure, geodynamic processes and tectonics in selected regions of interest. Dynamic crustal processes in selected areas with focus on magma movement and volcanic unrest will be studied. New gravity and magnetotelluric (MT) data in the Carpathian-Pannonian region will be acquired, processed and interpreted. Interpretation of the periodical and non periodical deformations of the Earth's crust in the Western Carpathian region will be carried out.

4.3.3. Climate change and environmental impacts, climate-biosphere interaction

Research will be focused on supporting the planning adaptations to climate change impacts on the biosphere both in wild nature and human bioclimatology and on changes in the interaction of climate parameters under changing conditions. These activities will be applied also at

micrometeorological level by applying alternative remote sensing methods of monitoring with possible practical applications. Furthermore, environmental research will be performed by monitoring the volume activity of radon in various components of the natural environment and in living spaces.

4.3.4. Research in gravimetry and geodynamics will continue to target the studies of the structure, tectonic evolution, and properties of the earth crust and lithosphere. Methods of integrated geophysical modelling and up-to-date modelling tools will be used to prepare updated structural models. We will focus also on development and advancement of modern approaches and methods of gravimetric inversion and their application to complete Bouguer anomalies in structural density determination, to spatiotemporal gravity changes in volcanological and hydrological studies, and to microgravity data in near surface and archeological studies Extensometric observations at tidal station Vyhne will continue in the context of interpretation of the periodic and aperiodic deformations of the Earth's crust in the Western Carpathians region.

4.4. Social potential of the Institute resulting from the Action Plan

The societal impact of the institute dwells on the following points:

1. Production of high and top impact deliverables and publications in the field of Earth sciences that will represent Slovakia in the context of the worldwide research scene.
2. Monitoring and analysis of earthquakes on the territory of Slovakia and analysis of seismic hazards.
3. Observation of magnetic declination for air traffic (aviation).
4. Integrated research of the geosphere (Centre of Excellence at Banská Bystrica).
5. Expertise for infrastructure and investment civil engineering (railways, highways, tunnels).
6. Expertise for prospection and exploration of raw materials, sources of renewable energy, sequestration, nuclear waste deposition.
7. Expertise for protection of the environment threatened by contamination from industrial activities, mining, and old disposal sites (waste dumps).
8. Teaching activities that includes the supervision of undergraduate and graduate (PhD) students and lecturing at universities
9. Identification of minerals, rocks and fossils for museums and other institutions
10. Near surface and archeomagnetic geophysical investigations for cultural heritage
11. Popularization and dissemination of geoscientific knowledge to general public

4.5 Career development of PhD students

The support PhD students and their scientific progress for is the priority for our Institute. To improve the quality of PhD students, the ESI SAS sets clear conditions on the basis of which new PhD topics are announced and how supervision of PhD students should take place.

1. PhD topics announced by supervisors are assessed by the members of the Scientific Board, in cooperation with respective universities.
2. All PhD students must be supported through scientific projects of their supervisors at the national or at the international level. All PhD students and/or postdocs are expected (and recommended) to be active in their international contacts and to spend some portions of their contracts at other international institutions.
3. All PhD students are required to present their progress reports annually on regular institutional seminars.
4. We plan to introduce new PhD programmes based on extended cooperations of our Institute with the Faculty of Mathematics, Physics and Informatics of the Comenius University (e.g. meteorology). Other broader cooperation is planned with The Matej Bell University in Banská Bystrica and with the Mining University in Košice. Common programmes are planned also with faculties abroad, e.g. with the Charles University in Czech Republic, AGH University of Science and Technology in Poland.

4.6. Career development of PhD students and postdocs

The ESI SAS strives to create conditions that will attract young and talented scholars. To improve the hiring process of postdocs and the quality of their career development, the ESI SAS sets clear criteria and conditions on the basis of which new young researchers (postdocs) can be appointed.

1. All candidates must go through an interview process that will contain a scientific presentation. They need to have their own vision about their research directions and strategies.
2. Pre-conditions for hiring young researchers at postdoc level include a recommendation letter, they need to show several peer-reviewed publications (WOS core collection) on their CV, and need to be competitive for the Stefan Schwarz scholarship awarded by the Slovak Academy of Sciences. All postdocs need to have also a good research track record so that they will be competitive to apply for grant from the Slovak Scientific Grant Agency, and need to submit their.
3. The candidates that studied or spent significant amount of their study or research time abroad or have experiences from institutes or universities abroad can be preferred. New postdoc applicants need to be approved by members of the Scientific Board of the ESI SAS.
4. Research strategy and career development of young researchers, including whether their publication trajectory rises or whether they stagnate, will be supervised by a senior independent research from a given department at the Geology or Geophysics Division.
5. The regular yearly or five-year evaluation of all researchers at the ESI SAS can be disadvantageous for young researchers, Therefore, the evaluation of young researchers thus takes into account the amount of time since their PhD and their temporal trajectory rather than absolute number of research outputs or citations, i.e., they should be awarded when they exhibit significant progress even when their citation rates do not achieve the levels typical of senior researchers.

4.7. Increasing participation in international research programmes and funding opportunities

The ESI SAS actively supports the participation of researchers in international collaborations (this is directly visible in the co-authorship of our researchers) and informs all researchers about ongoing calls from international funding schemes. The researchers who apply for the ERC grants and similar schemes within the EU calls can apply for national-level support when preparing proposal and will be supported from the administration point of view (also from the sources of the Slovak Academy of Sciences). Such researchers also benefit during the regular performance evaluations. The ESI SAS was and is supported by the funding from the Horizon 2020 calls (with the successful support for the ITN Baseline Earth project, EUROVOLC and ERA.Net ERA-MIN-2 projects), by two new COST projects (in one case, the ESI SAS is the principal coordinator) and one NATO project (all starting in 2021).