RR GEO

RESEARCH REPORTS

2022

INSTITUTE OF GEOLOGY
CZECH ACADEMY
OF SCIENCES

Cover photo: Tomáš Přikryl

PUBLISHED BY THE INSTITUTE
OF GEOLOGY OF THE CZECH
ACADEMY OF SCIENCES
2023

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1. DIRECTOR'S INTRODUCTION

In our retrospect of 2022, we must admit that the year was notably controversial. Compared to previous years, the lives of all of us were becoming progressively stabilized, especially with respect to COVID 19 infection, and the whole society managed to enjoy a step-wise release from the grip of the numerous restrictions. In the latter part of the year, the Czech Republic was holding an important presidential position within the European Union. Despite these facts, in addition to many other positive events, the year 2022 was associated primarily with the Russian invasion to Ukraine, which started on 24 February 2022.

It is difficult to fully empathize with the complicated situation of the local population – a situation which has not been brought to any solution yet. A situation in which many people lost their homes, their relatives, and in which many people attempted – not always successfully – to merely save their bare lives.

In the most general aspect and strictly theoretically, these circumstances provide an opportunity to observe common as well as less common situations in a completely new light. As a society or as individuals, we often learn more about ourselves than about specific problems and their solution. Both kinder and darker sides of our personalities come to the surface including tendencies the real existence of which was expected by neither our surroundings nor ourselves.

Many issues have been affected by the mentioned war conflict, directly or indirectly. The costs of energies became one of them. Due to the complicated situation on the energy market and the subsequent decline of the contracted energy supplier, the Institute of Geology was also facing a problematic situation. This situation was most urgently perceived, literally on our own skin, towards the end of the year. The mood of the society as a whole was further aggravated by the enormous level of inflation. Despite these complications, the relative safety and comfort available in our country, compared with Ukraine and some other countries, should be appreciated.

Nevertheless, allow me to proudly address a single issue related to the Institute of Geology and year 2022: the successfully completed reconstruction of Institute facilities at Puškinovo náměstí Square. The reconstruction will provide not only for improved working conditions but also for an adequate development of the respective department.

TOMÁŠ PŘIKRYL
DIRECTOR

2. GENERAL INFORMATION

Up-to-date information on the Institute is available on the Internet:
http://www.gli.cas.cz.

Institute of Geology of the Czech Academy of Sciences, v. v. i.
Rozvojová 269
165 00 Praha 6 – Lysolaje
Czech Republic

+420-233 087 208 (Secretary)
+420-233 087 206 (Director)
+420-220 922 392
e-mail: inst@gli.cas.cz

Institute of Geology of the Czech Academy of Sciences, v. v. i.
Department of Paleomagnetism
U Geofyzikálního ústavu 769
252 43 Průhonice
Czech Republic

+420-272 690 115
inst@gli.cas.cz

Institute of Geology of the Czech Academy of Sciences, v. v. i.
Department of Physical Properties of Rocks
Puškinovo náměstí 9
160 00 Praha 6 – Dejvice
Czech Republic

+420-224 313 520
inst@gli.cas.cz

The Institute of Geology is a public research institute organized within the Czech Academy of Sciences. It concentrates on scientific study of the structure, composition and history of the Earth's lithosphere and the evolution of its biosphere. Although the Institute does not have the opportunity to cover all geological disciplines (in the widest possible sense) or regionally balanced geological studies, its activities span a relatively broad range of problems in geology, geochemistry, paleontology, paleomagnetism and rock mechanics. The Institute takes part in the understanding of general rules governing evolutionary processes of the lithosphere and biosphere at regional as well as global scales; for this purpose, the Institute mostly employs acquisition and interpretation of relevant facts coming from the territory of the Czech Republic.

The Institute of Geology of the Czech Academy of Sciences is a broad-scope scientific institute performing geological, paleontological, petrological, mineralogical and other disciplines, lately accentuating environmental geology and geochemistry. Major research areas covered by the Institute include: petrology and geochemistry of igneous and metamorphic rocks; lithostratigraphy of crystalline complexes; volcanology and volcanostratigraphy; structural geology and tectonics; paleogeography; terrane identification; taxonomy and phylogeny of fossil organisms; paleobiogeography of Variscan Europe; paleoecology (incl. population dynamics, bioevents); paleoclimatology as evidenced by fossil organisms and communities; biostratigraphy and high-resolution stratigraphy; basin analysis and sequence stratigraphy; exogenous geochemistry; exogenous geology, geomorphology; Quaternary geology and landscape evolution; karstology and paleokarstology; paleomagnetism, magnetostratigraphy and petromagnetism, and physical parameters of rocks.

As concerns the history of the Institute, its predecessor, Geological Institute of the Czechoslovak Academy of Sciences (ČSAV), was founded on July 1, 1960. Nevertheless, its structure had developed in the period of 1953 to 1961. During this period, several independent laboratories were constituted: Laboratory of Paleontology, Laboratory of Engineering Geology, Laboratory of Pedology and Laboratory of Geochemistry; Collegium for Geology and Geography of the ČSAV represented the cover organization since 1957. On July 1, 1960, also the Institute of Geochemistry and Raw Materials of the ČSAV was established. This Institute covered technical and organization affairs of adjoined geological workplaces until their unification within the Geological Institute of the ČSAV in July 1960.

On August 1, 1964 the Institute of Geochemistry and Raw Materials of the ČSAV was integrated within the Geological Institute. On July 1, 1969 the Institute of Experimental Mineralogy and Geochemistry of the ČSAV was founded; a successor of the Institute of Geochemistry and Raw Materials was newly established. A part of the staff of the Geological Institute joined the new institute. On January 1, 1979 the Institute of Experimental Mineralogy and Geochemistry was integrated within the Geological Institute.

On March 1, 1979, the Geological Institute merged with the Mining Institute of the ČSAV under the Institute of Geology and Geotechnics of the ČSAV, and finally split from the latter on March 1, 1990 again.

On January 1, 1993, the Academy of Sciences of the Czech Republic was established by a transformation from the ČSAV, and the Geological Institute became a part of the Academy. The Institute belongs to the 1st Department of Mathematics, Physics and Earth Sciences and to the 3rd Section of Earth Sciences. On January 1, 2007 the Institute became a public research institute (v. v. i.) based on a change in legislation on research and development.

The economic and scientific concept of the Institute of Geology of the Czech Academy of Sciences and the evaluation of its results lie within the responsibility of the Executive Board and the Supervisory Board, which

include both internal and external members. Plans of Institutional Financing are evaluated by a special Committee at the Czech Academy of Sciences. Besides research, staff members of the Institute are involved in lecturing at universities and in the graduate/postgraduate education system. Special attention is also given to the spread of the most important scientific results in the public media.

3. ORGANIZATION UNITS

3A MANAGEMENT, EXECUTIVE BOARD, SUPERVISORY BOARD

Management

RNDr. Tomáš Přikryl, Ph.D. Director of the Institute
Mgr. Michal Filippi, Ph.D. 1st Deputy Director

Executive Board

before January 3, 2022:
prof. RNDr. Pavel Bosák, DrSc. Chairman
Mgr. Michal Filippi, Ph.D. Vice-Chairman
doc. RNDr. Emil Jelínek, CSc. (Faculty of Science, Charles University, Prague)
prof. RNDr. Martin Mihaljevič, Ph.D. (Faculty of Science, Charles University, Prague)
Ing. Petr Pruner, DrSc.
RNDr. Tomáš Přikryl, Ph.D.
RNDr. Ladislav Slavík, CSc.
Mgr. Martin Svojtka, Ph.D.
Ing. Petr Uldrych (Ministry of the Environment of the Czech Republic, Prague)

after January 4, 2022:
prof. RNDr. Pavel Bosák, DrSc. Chairman
Mgr. Michal Filippi, Ph.D. Vice-Chairman
doc. RNDr. Jiří Kvaček, CSc. (National Museum, Prague)
RNDr. Tomáš Přikryl, Ph.D.
RNDr. Roman Skála, Ph.D.
RNDr. Ladislav Slavík, CSc.
Mgr. Martin Svojtka, Ph.D.
Ing. Petr Uldrych (Ministry of the Environment of the Czech Republic, Prague)
prof. RNDr. Jiří Žák, Ph.D. (Faculty of Science, Charles University, Prague)

Supervisory Board

before April 30, 2022:
prof. Jan Řídký, DrSc. (Inst Phys, Czech Acad Sci, Prague) Chairman
RNDr. Radek Mikuláš, DSc. Vice-Chairman
RNDr. Pavel Hejda, CSc. (Geophys Inst, Czech Acad Sci, Prague)
doc. RNDr. Václav Kachlík, CSc. (Faculty of Science, Charles University, Prague)
prof. RNDr. Stanislav Opluštil, Ph.D. (Faculty of Science, Charles University, Prague)

after May 1, 2022:
prof. Jan Řídký, DrSc. (Inst Phys, Czech Acad Sci, Prague) Chairman
Mgr. Jiří Adamovič, CSc. Vice-Chairman
RNDr. Pavel Hejda, CSc. (Geophys Inst, Czech Acad Sci, Prague)
doc. RNDr. Václav Kachlík, CSc. (Faculty of Science, Charles University, Prague)
prof. RNDr. Stanislav Opluštil, Ph.D. (Faculty of Science, Charles University, Prague)

3B SCIENTIFIC DEPARTMENTS

The Department of Analytical Methods continued to provide scientific services to other institutional departments and non-institutional academic bodies. Diverse data were obtained by the instruments hosted by the department. Scanning electron microscopy provided both imaging- and composition-related data. Quantitative chemical analyses were acquired by electron microanalyzer. Information on the phase composition of materials was determined based on X-ray diffraction analysis. Phase and structural information were extracted from vibrational molecular spectral method.

Besides services provided to others, proper research activities of the Department's scientists continued. A new cooperation was established with the Centre for Innovation in the Field of Nanomaterials and Nanotechnologies, which is under the auspices of the J. Heyrovský Institute of Physical Chemistry. Within this cooperation, the Department was analytically involved in the characterization of new photocatalytic nanomaterials. The obtained structural data play an important role in the development of nanomaterials that enable a gentle yet effective removal of pollutants and thus enhance environmental protection (P. Mikysek).

Chemical and structural study of enstatite meteorite minerals continued from previous years. Collaboration with the Department of Physics of Materials at the Faculty of Mathematics and Physics of Charles University in Prague and Departments of Material Analysis and Structure Analysis of the Institute of Physics of the Czech Academy of Sciences in Prague provided access to a suite of (HR)TEM microscopes allowing comprehensive characterization of sulfides in the system FeS–MnS–MgS (N. Mészárosová).

In 2022, a project of the Czech Science Foundation (to R. Skála) started with a focus on the Muong Nong-type-like moldavites of the Central European Tektite strewn field. The concerted SEM and EPMA studies required for initial compositional and textural variability characterization were carried out in the laboratory.

In the 2022, research effort of the **Department of Environmental Geology and Geochemistry** was aimed at obtaining a broad body of knowledge in both named areas. In the area of environmental geology, studies focused on sandstone weathering were continued. In the field of environmental geochemistry, new research areas were opened in the distribution of toxic elements in various components of biomass in forest ecosystems. New projects were prepared, directed at understanding of differences between coniferous tree species with respect to the formation and utilization of tree rings as archives of atmospheric Hg. The extreme ability of fruit-bodies of *Thelephora penicillata* to accumulate high concentrations of Cd and As was investigated, and biological importance of metal(loid) hyperaccumulation in mushrooms was discussed. Research project GAČR 20-14292S (Overlooked mercury threat in ecosystems of the Czech Republic reacting on global change, principal investigator T. Navrátil) was successfully finished, while projects GAČR 20-06728S and GAČR 19-06759S were extended. The long-term project focused on monitoring of fluxes and deposition within the Bohemian Switzerland National Park (NPCS) as well as the long-term monitoring project based on the Lesní potok experimental catchment in the Voděradské bučiny National Nature Reserve continued within the GEOMON network. Owing to the long-established cooperation with the NPCS, a unique set of research samples was collected from the area impacted by extensive wildfire in the NPCS. Department members were teaching at the Faculty of Science, Charles University, Prague, delivering courses "*Heavy metals in environment*" and "*Environmental changes dating*". Team members K. Žák and V. Cílek received awards for the publication of the book "*Srdce Českého krasu*". The science-promotion effort and education of the public was also reflected in a number of outputs. The work of T. Navrátil has attracted public attention also abroad: he was interviewed by the German Frankenpost newspaper, based on common publication with M. Schütze (University of Braunschweig, Germany) regarding mercury decontamination in the town of Marktredwitz, Germany.

In 2022, the **Department of Geological Processes** implemented the method of of Rb and Sr determination using isotope dilution and TIMS mass spectrometer measurement. In result, this will provide for Rb-Sr dating and also simultaneous determination of Sr concentrations and $^{87}Sr/^{86}Sr$ values applicable to, e.g., archaeological samples. Besides, collaboration with several archaeological and anthropological teams within the Czech Republic (e.g., Inst Archaeol, Czech Acad Sci, Prague, National Museum, Prague) and Europe (e.g., University of Helsinki) was significantly intensified. It was related to analyses of Sr isotope composition and especially to the possible use of the Os isotope system ($^{187}Os/^{188}Os$) in provenance studies of metallic artefacts and slags. Members of the Department participated in 8 grant projects supported by the Czech Science Foundation (CSF) as principal investigators or co-investigators; some of these projects were extended due to the Covid situation. These projects were aimed at the study of archaeological soils (L. Lisá), greisenization and albitization processes in granites (K. Breiter), dating and geochemistry of Archean granites (M. Svojtka), dating and petrology of the Uralides (M. Svojtka), geochemistry of silicites and carbonate rocks (L. Ackerman), Sm-Nd composition of foraminiferal tests (L. Ackerman), and stable isotope geochemistry of redox-sensitive elements of continental red beds (L. Ackerman). A CSF-supported junior project was aimed at processes of magma emplacement in collapsing orogens (F. Tomek). Geological correlation of intra-Alpine crustal units with the Bohemian Massif was the subject of an extended Mobility project (supported by the Ministry of Education, Youth and Sports CR, M. Svojtka). A project focused on the concentration of indicative elements in fish otoliths (M. Svojtka) was run within the Strategy AV 21 programme and Water for Life activity.

The Department of Paleobiology and Paleoecology is involved in paleontological and paleoenvironmental interpretations, concentrating on four major areas: Paleozoic stratigraphy and paleoenvironment, Paleozoic to Cenozoic palynology, vertebrate paleontology and Cretaceous research – that can be further subdivided into various sub-topics. The studies of the department contribute to the understanding of the evolution and extinctions of fossil communities, to knowledge of climate changes in the past and to the refinement of Geological Time Scale.

In 2022, activities of the **Department of Paleobiology and Paleoecology** went back to normal. Department members thus took part in on-site international

scientific events again. L. Slavík organized and conducted Annual Business meeting of the Subcommission on Devonian Stratigraphy (SDS/ICS of the IUGS) in conjunction with the 6th International Palaeontological Congress. T. Přikryl started a new scientific bilateral cooperation with colleagues from Academica Sinica in Taiwan. Members of the department contributed to important results that were published in high-ranked geological journals, e.g., Geochemistry, Geophysics, Geosystems; Frontiers in Ecology and Evolution; Journal of Mammalian Evolution and Scientific Reports. L. Laibl was awarded the reputable Otto Wichterle prize by the Czech Academy of Sciences. M. Chroust finished his PhD study at Faculty of Science of Charles University in Prague. He received a prominent grant project Polonez Bis and started a postdoc stay at the Institute of Paleobiology of the Polish Academy of Sciences in Warsaw in 2023. M. Aubrechtová completed a four-month research stay funded by the internal grant of the Museum für Naturkunde Berlin. In 2022, six projects of the Czech Science Foundation continued. T. Přikryl started a new term as elected director of the Institute of Geology of the Czech Academy of Sciences. L. Vaňková became a new deputy head of the Department of Paleobiology and Paleoecology.

Research in the **Department of Paleomagnetism** was mainly focused on magnetostratigraphy, magnetomineralogy, paleomagnetism and rock magnetism. Resulting studies provide data of magnetic field recorded in rocks or archaeological materials, and contribute with valuable information to other geoscience disciplines.

In 2022, a significant part of the research in the Department of Paleomagnetism was devoted to the Czech Science Foundation project dealing with the boundary of Jurassic and Cretaceous periods. High-resolution magnetostratigraphy was applied to profiles in the Czech Republic, Poland, Slovakia, Austria, France and Serbia. Objectives of the project were based on interdisciplinary cooperation with other departments of the Inst Geol, Czech Acad Sci, as well as with other Czech and foreign institutions. Results of magnetic methods were thus complemented by litho- and biostratigraphy, e.g., analyses of calcium nannofossils, ichnological and palynological studies, geochemical analyses including mercury variations and other methods. A considerable part of the research was also focused on geotectonic, stratigraphic and paleogeographical syntheses including paleoenvironmental reconstructions of karst sediments in the Czech Republic, Slovakia and Slovenia. Paleomagnetic research correlated with other methods enabled to reconstruct speleogenetic development in the Plavecký Karst (Slovakia) and in the Ochtinská Aragonite Cave (Slovakia), which yielded significant information about the geotectonic and geomorphological development of broader areas. Other results included a study from the Outer Western Carpathians near Bystřice nad Olší, which focused on the paleoenvironmental reconstruction of the profile covering the sedimentary record of the Late Cretaceous and Mid Paleocene. Furthermore, a study of methods for determining secular variations of the geomagnetic field preserved in burnt archaeological objects (e.g., fireplaces and furnaces) was carried out. The secular variation of the Earth's magnetic field makes it possible to determine the age of the last heating of the studied objects. The department was also involved in the project of the European Space Agency "Advanced compression noise reduction for hyperspectral imagers data" that deals with the algorithm development for on-board denoising and compression of *hyperspectral* images obtained by spacecrafts in order to reduce the volume of data transferred to the ground. The outcomes of the project will be applied to Earth observation and planetary exploration missions.

Reconstruction of a new pavilion close to the existing laboratory was finished in 2022. New premises will facilitate laboratory operation and are planned to be shared with the Czech Metrology Institute (CMI). This interdisciplinary use of the pavilion should contribute to an interesting collaboration in the future.

The **Department of Physical Properties of Rock** focuses on laboratory research linking the rock structure and its mechanical properties.

There were 5 scientists (2 full time, 3 part time) and four technicians (3 full time, 1 part time) employed at the Department in year 2022. The reconstruction of laboratory building was finished in 2022. It significantly improved the working conditions, considering both the experimental and office work. This is supposed to reduce the operation costs of the Department as well.

Staff members of the Department were involved in two grant projects supported by the Czech Science Foundation (GAČR): (1) *The role of rock anisotropy in hydraulic fracturing through acoustic emission* (investigator: T. Lokajíček), and (2) *Study of petrographic parameters and rock mechanical properties influencing technological-mechanical performance of selected rocks used for crushed stone* (co-investigator: T. Lokajíček). In March 2022, the ongoing international project with JINR Dubna (Russia) was terminated following the decision of Czech Republic government. Significant results achieved in 2022 include: (1) determination of the causes of elastic anisotropy of rocks from testing sites for nuclear waste repository (Bukov, Czech Republic; Grimsel, Switzerland); (ii) development of the algorithm for identification, localization and determination of source mechanisms of acoustic emissions based on the neural network approach, and (3) observation of the fracturing process based on acoustic emission monitoring. The mentioned research was carried out in cooperation with international and Czech research institutions. The results were published in highly cited geophysical and geotechnical journals. The mentioned research was carried out in cooperation with international and Czech research institutions. Most of the published data in these papers were produced by the laboratory of the Department. Besides scientific papers, the Department produced several unpublished reports presenting experimentally estimated mechanical properties of rocks mainly for the purpose of planning engineering projects by private companies.

3C LABORATORIES

FIG. 1 Analytical sample preparation in a laminar box in the Clean chemistry lab. Photo by M. Svojtka.

Clean Chemistry Laboratory
(Head: V. Renčiuková; supervised by L. Ackerman)

Two laboratories for processing the samples destined for (ultra)trace element and isotopic analyses. Both are supplied with HEPA-filtered air. One lab (class-100000 filtered air) is used for sample decomposition and labware cleaning. It contains a plastic custom-made fume-hood and working table for the work with strong acids (e.g., HF, and HCl), two Teflon distillation apparatuses for the preparation of ultraclean acids (Savillex), analytical weight (precision of 0.1 mg) and device for preparation of clean water (Millipore Elix 3). The other lab (class-10000 filtered air) is used for clean chemistry (e.g., ion-exchange chromatography and extraction of selected elements) and for the final preparation of the samples for mass spectrometry (ICP-MS, TIMS). It contains two custom-made laminar flow workspaces (class-100 filtered air), a Teflon-coated hotplate (Savillex), analytical weight (precision of 0.01 mg), a combined device for preparation of ultraclean water (Elix 3 + IQ 7000 + Q-POD Element by Millipore), and centrifuge (**Fig. 1**).

FIG. 2 Automated Zeiss microscope counting system in the Fission-track lab. Photo by M. Svojtka.

Fission-track Laboratory
(Head: D. Kořínková)

The laboratory provides low-temperature dating and thermal-history modeling of rocks using apatite fission-track (AFT) data (spontaneous densities, relative U concentration, confined track lengths, and annealing kinetic parameters). The analytical system for fission-track analysis includes an IMAGER M1m microscope (Zeiss, **Fig. 2**) with a computer-controlled microscope stage (Autoscan) running on the software Fission Track Studio (with TrackWorks and FastTracks modules). The integral part of the laboratory is an APX 010 polishing machine (MTH), a binocular microscope (Nikon), and a flow box for the etching of the samples. Relative uranium concentrations are measured with laser ablation ICP-MS mass spectrometer housed at the department and are finally used for T/t modeling and AFT age determination.

FIG. 3 Sample preparation on the Cillas 1190 laser particle size analyser in the Geoarchaeology lab. Photo by M. Svojtka.

Geoarchaeology Laboratory

(Head: L. Lisá)

The geoarchaeological laboratory serves mainly for the processing of sedimentary samples such as basic sample descriptions, micromorphological sample preparations, pH measurements, and particle size analyses. One of the most important methods in geoarchaeology is the study of micromorphological samples. The lab serves for resampling before the drying and impregnation in Pollylite resin. After the impregnation, the samples are slowly cured in a fume-hood designed for work with strong acids. There is a drier and a vacuum chamber available for sample impregnation. Grain-size analyses are processed in the Cillas 1190 laser particle size analyzer (**Fig. 3**) with the range of 0.004–2,500 micrometers, and sets of sieves for the different types of grain-size analyses. A centrifuge is used in some steps of the grain-size sample processing.

FIG. 4 The Buehler PetroThin is a precise thin section cutting machine for re-sectioning and thinning of rock, mineral, and other solid-state samples. Photo by R. Skála.

Grinding and Polishing Shop

(Supervised by R. Skála)

Reliable quantitative local chemical analyses and/or acquisition of element distribution maps using EPMA/SEM require planar polished conductive surfaces. Such conditions are met when bulky solid samples are sectioned and polished. For that purpose, a suite of cutting, grinding, lapping and polishing machines to prepare polished sections or thin sections is available: cutting and grinding machines Buehler PetroThin (**Fig. 4**) and Struers Discoplan TS, grinding machines with diamond platen wheel Montasupal, custom-made grinding machines with wheels for loose abrasive powder, custom-made saw, polishing machines Struers Planopol-3, Kent Mark II (2 pcs) and MTH APX-010 with MTH KOMPAKT-1031.

FIG. 5 Sample introduction system, which is a part of high-resolution Element 2 magnetic sector field ICP-MS (left) connected with a Analyte/Excite excimer 193 nm laser ablation system (right) in the ICP-MS lab. Photo by M. Svojtka.

ICP-MS Laboratory

(Heads: J. Ďurišová and Š. Matoušková; supervised by M. Svojtka)

The laboratory is equipped with the ELEMENT2 (ThermoFisher Scientific) high-resolution magnetic sector field ICP-MS (inductively coupled plasma–mass spectrometer), purchased in 2009 (**Fig. 5**). The instrument is equipped with a high mass resolution to access spectrally interfered isotopes and is used for: (1) multi-element trace analysis across the periodic table covering an $mg \cdot l^{-1}$ to sub $pg \cdot l^{-1}$ concentration range and (2) measuring of isotope ratios. A typical application of isotope ratios measuring is an analysis of solutions (bulk sample solution analysis). In solid samples (in-situ isotopic analysis), we routinely provided U-Pb dating of zircons, monazites, or other minerals or trace element analysis of silicates and sulfides. For these purposes is Element2 ICP-MS coupled with an ANALYTE EXCITE excimer 193 nm laser ablation system (Cetac/Teledyne) for analyzing solid samples (sampler holder is designed for thin sections 27 mm in width or for round resin block 25 mm in diameter) and with an Aridus II (Teledyne) desolvating nebulizer.

FIG. 6 Inserting the sample to the TESCAN VEGA3XMU scanning electron microscope chamber.

Laboratory of Electron Microanalysis
(Supervised by R. Skála)

Scanning electron microscope (SEM) TESCAN VEGA3XMU (**Fig. 6**) allows observation and analysis of not only carbon-coated or gold-sputtered materials but also of uncoated specimens including biological materials. It is equipped with detectors of secondary (SE) and back-scatted electrons (BSE) as well as a detector of secondary electrons at low vacuum (LVSTD). Chemical analyses and fast elemental mapping are possible through an energy-dispersive (ED) X-ray spectrometer Oxford Ultim Max 65.

Electron probe microanalyzer (EPMA) JEOL JXA-8230 is used mainly for non-destructive quantitative analysis of solid-state materials on the micrometer scale. The instrument is equipped with five wave-dispersive crystal spectrometers hosting 14 analytical crystals in total. The instrument allows analysis for elements from B to U. To image the studied samples, the BSE, SE and panchromatic CL detectors are used. For fast compositional screening, the EPMA is equipped with an ED X-ray spectrometer.

The laboratory also possesses necessary instruments to carbon-coat or gold-sputter the specimens including VEB Hochvakuum Dresden B 30.2, Carl Zeiss Jena HBA 1, and Quorum Q150T ES.

FIG. 7 Laboratory of Liquid and Solid Samples Analysis. Liquid samples workup. Photo by P. Lisý.

Laboratory of Liquid and Solid Samples Analysis
(Head: J. Rohovec)

The general-purpose laboratory for preparation, workup, decomposition and various analyses of liquid and solid samples of environmental, geochemical and geological interest (**Fig. 7**). It is equipped with a C, H, N, S analyzer VarioMacro CUBE Elementar (2020), DTA /DSC (2018), Ultrasonic horn Bandelin Sono plus (2016), gas chromatograph for MeHg DANI (2015), ICP-EOS spectrometer Agilent 5100 (2014), HPLC system (KNAUER 2010), anion analyzer with ion-exchanging column and conductivity detector (2013), Mettler-Toledo (2011), analytical balances, TOC-VCPH Shimadzu (2011), total Carbon Analyzer, CINTRA 303 (2009), UV-VIS Spectrometer, BALANCE 2000G (1999), analytical balances, and SARTORIUS Basic (1992). In the year 2022, we acquired the HP microwave digestion oven Preekem, formerly loaned for long-term testing by HPST, s. r. o. We have improved our milling capabilities acquiring the ball mill MM 500 vario (Retsch). It can homogenise minerals as well as biomass, at room temperature in steel or zirconium oxide vessels, with extended possibility of work in microscale or at cryo-milling conditions. Provided with this equipment we are able to perform all basic analyses without the need of outsourcing.

FIG. 8 Laboratory of Optical Microscopy. Photo by M. Filippi.

Laboratory of Optical Microscopy
(Head: M. Filippi)

OLYMPUS SZX 16 Optical binocular microscope with the CANON digital photocamera and specialized QuickPHOTO Micro software and a Deep Focus module are used for the documentation of samples, separation of sub-samples for other methods and, of course, for imaging of samples and details for publications. OLYMPUS BX50 Optical polarizing microscope with the DP 70 digital camera and specialized QuickPHOTO software and a Deep Focus module is used for a detailed study of thin (for transmitted light) and polished (for reflected light) sections. Software enables documentation, image preparation and image analysis. The microscope is equipped also with a fluorescent source of different wavelengths. A new 3D microscope Keyence VHX-7000 was purchased at the end of 2022 (**Fig. 8**). The Keyence VHX-7000 is an excellent instrument for 3D analyses of various geological objects; however, study of thin sections in polarized light is also possible.

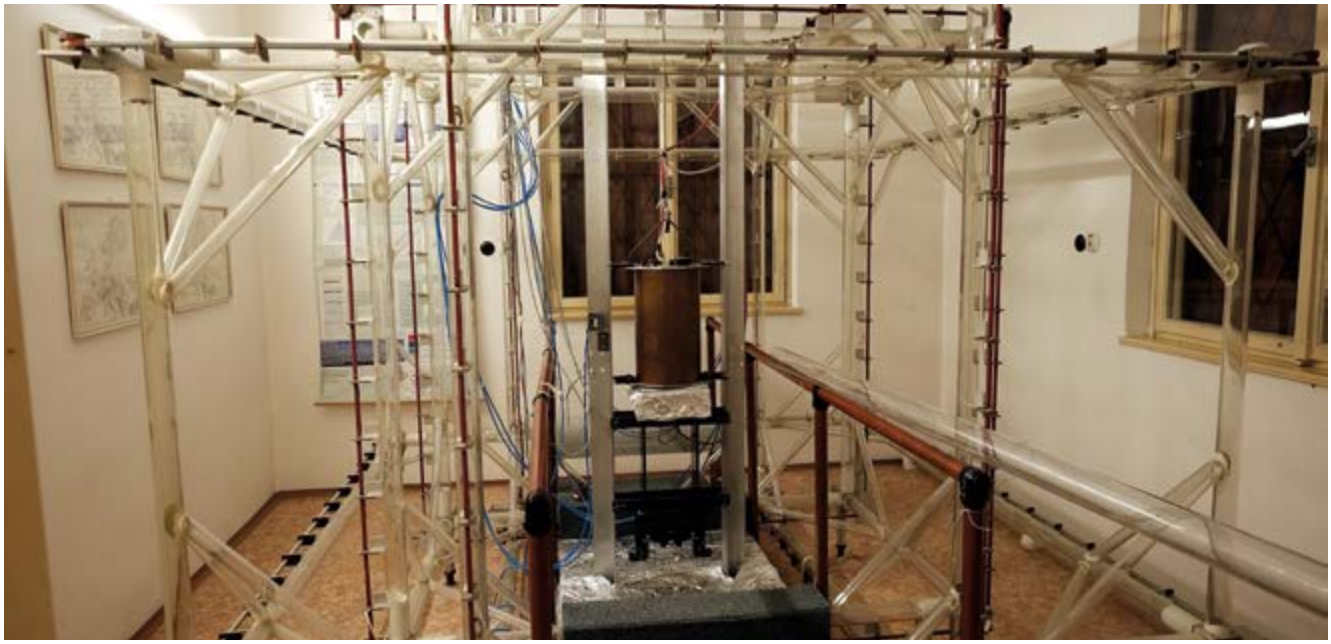

FIG. 9 2G 755 4K Superconducting Rock Magnetometer. Photo by J. Petráček.

Laboratory of Paleomagnetism
(Supervised by L. Kouklíková)

The Laboratory of Paleomagnetism is mainly focused on processing of rock samples to obtain precise paleomagnetic and rock magnetic analyses. It is equipped with the following state-of-the art instruments: 2G 755 4K Superconducting Rock Magnetometer – a highly sensitive and accurate instrument for remanent magnetization and alternating field (AF) demagnetization measurements, sensitive AGICO JR5A and JR-6A Spinner Magnetometers; Magnetic Measurements MMTD80 Thermal Demagnetizer – a standard instrument for thermal demagnetization; Magnetic Measurements MMPM10 Pulse Magnetizer for creating isothermal remanent magnetization up to 9T; AGICO MFK1-FA highly sensitive kappabridge for measuring anisotropy of magnetic susceptibility as well as susceptibility in variable magnetic fields, frequencies and temperatures; AGICO LDA-5 and PAM-1 Specimen Unit for anhysteretic magnetization and AF demagnetization up to 200 mT; MAVACS – Magnetic Vacuum Control System – a unique highly accurate system for creating and maintaining variation-free magnetic vacuum for thermal demagnetization of rock samples (**Fig. 9**). The laboratory is equipped with other instruments for laboratory and field measurements and sample collection.

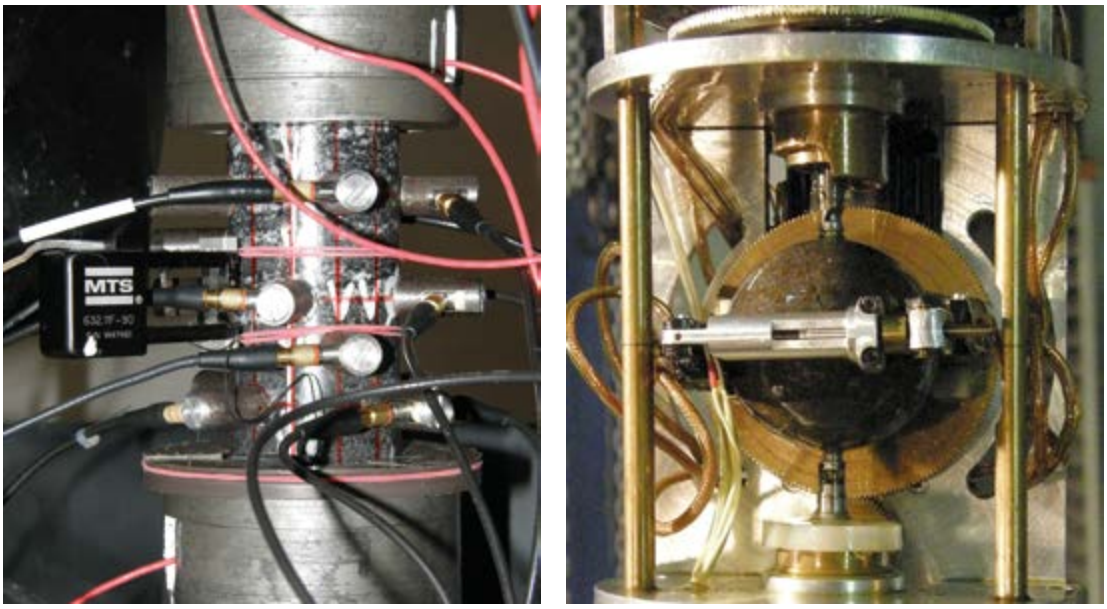

FIG. 10 Hydrostatic pressure vessel for measurement of detail, P and S wave, velocity anisotropy. Photo by V. Filler.

Laboratory of Physical Properties of Rocks
(Supervised by M. Petružálek)

The laboratory (**Fig. 10**) has two main research directions: (i) study of mutual relations between spatial arrangement of structural elements of rocks (minerals, cracks) and directional dependence (anisotropy) of their physical properties (elasticity, magnetic susceptibility), (ii) detailed research of brittle failure process of rocks studied through acoustic emission monitoring and ultrasonic sounding. The laboratory equipment consists of servo-hydraulic loading frame (MTS 815), where can be implemented the triaxial cell Ergotech (100 MPa, 200 °C, 16 channel AE monitoring) or hydraulic fracturing unit Strozatech (biaxial loading, 15 cm cube, 18 channel AE monitoring). To generate and control the loading pressure, pressure intensifier (MTS 286) of hydraulic pump (EMDC 400-250, GL Test Systems) are used. Permeameter (Quizix Q5000) is used to measure the permeability or to control pore pressure. The Vallen AMSY 6 serves for AE monitoring and ultrasonic sounding. The self-designed pressure vessel (up to 400 MPa) is used to measure detailed anisotropy of P and S wave velocity on spherical samples in 132 independent directions.

FIG. 11 Acquisition of a Raman spectrum with the microspectrometer Spectroscopy & Imaging Monovista CRS+. Photo by D. Kořínková.

Laboratory of Raman and Infrared Spectroscopy
(Supervised by R. Skála)

Raman dispersive micro-spectrometer S & I MonoVista CRS+ is based on Olympus BX-51 WI upright microscope, Princeton Instruments SpectraPro SP2750 spectrometer and a CCD detector ANDOR iDus 416. Excitation lasers have wavelengths of 488 nm, 532 nm and 785 nm. The microscope is designed for sample observation in either reflected or transmitted light. Objective lenses with the following magnifications are installed: 4×, 10×, 50×, 50× LWD, 100× and 100× LWD. The samples are placed on a computer-controlled motorized stage. Spatial resolution with the 100× objective is 1 μm laterally and 2 μm axially. The system allows collection of spectra within the range of 60–9,300 cm^{-1} with the 488 nm and 532 nm excitation lasers and 60–3,500 cm^{-1} with the 785 nm excitation laser.

A Fourier-transform infrared spectrometer (FTIR) Thermo Scientific Nicolet iS-50 with built-in mid- and far-IR capable diamond attenuated total reflectance (ATR) accessory (**Fig. 11**) is equipped with a ceramic infrared radiation source and a DLaTGS detector with KBr window. In transmission arrangement, the spectrometer covers the wavenumber range of 7,800–350 cm^{-1}. In ATR mode, the wavenumbers covered are 4,000–100 cm^{-1} depending on the used beam-splitter.

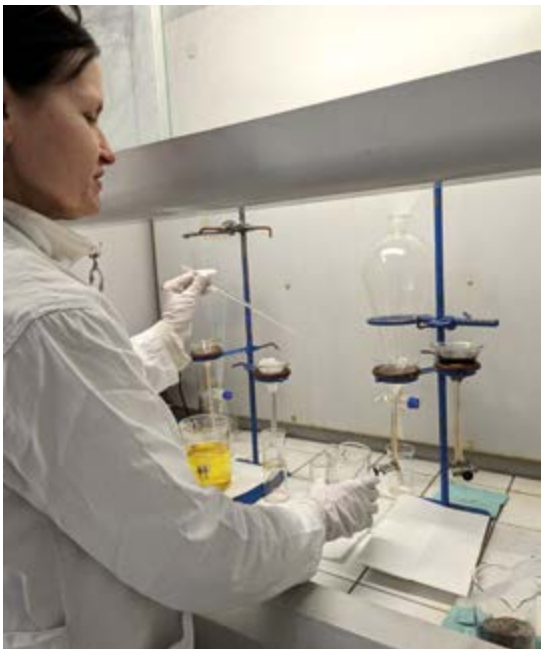

FIG. 12 A new disk mill Pullverisette 13 (Fritsch) was acquired in the Mineral Separation Lab. Photo by M. Svojtka.

Laboratory of Rock Processing and Mineral Separation
(Head: L. Mrázková)

This laboratory is used to separate minerals and paleontological objects from rock materials before subsequent processing in other laboratories (clean chemistry, fission-track laboratory, ICP-MS, and TIMS). The most common minerals that are processed include zircons, apatites, garnets, biotites, pyroxenes, and also sulfides (e.g., pyrites, chalcopyrites). In addition, clay minerals are separated by the sedimentation method for their next determination (**Fig. 12**). For the needs of paleontologists, objects such as conodonts (or others) are separated. The following equipment is routinely used: Anti Pollution System – JET CLEAN DF (Coral), jaw crusher Pulverize 1 (Fritsch), and disk mill Pullverisette 13 (Fritsch), dust-tight jaw Crusher BB 50 (Retsch), and Wilfey floating table. Necessary additional equipment includes ultrasonic sieve cleaner I-17 (Fritsch), vibratory Sieve – Shaker analysis 3 (Fritsch), and ring agate mill (Siebtechnik) for samples sensitive to contamination. The separation of magnetic fraction employs the Frantz® magnetic barrier laboratory separator – model LB-1 (SG Frantz).

FIG. 13 Placing the corundum calibration standard to the sample holder of the X-ray powder diffractometer Bruker D-8 Discover. Photo by R. Skála.

Laboratory of X-ray Powder Diffraction
(Supervised by R. Skála)

X-ray powder diffractometer Bruker D8 DISCOVER is a multipurpose powder X-ray diffraction instrument with a variable measuring radius designed to study powder samples or solid polycrystalline blocks (polished (thin) sections, rock chips etc.). Diffractometer is of the θ-2θ design and allows studying materials in both reflection and transmission (either foil or capillary) geometry (**Fig. 13**). Optional focusing primary asymmetric monochromator of Johansson type produces spectrally pure $K\alpha_1$ radiation. Diffracted radiation is collected with a position sensitive 1D silicon strip detector LynxEye. In the microdiffraction setup used for bulk samples, the primary monochromator is replaced by polycapillary optics (i.e., $K\alpha_{1,2}$ radiation is used) and beam limited with a collimator and a sample is placed on a special motorized xyz-stage.

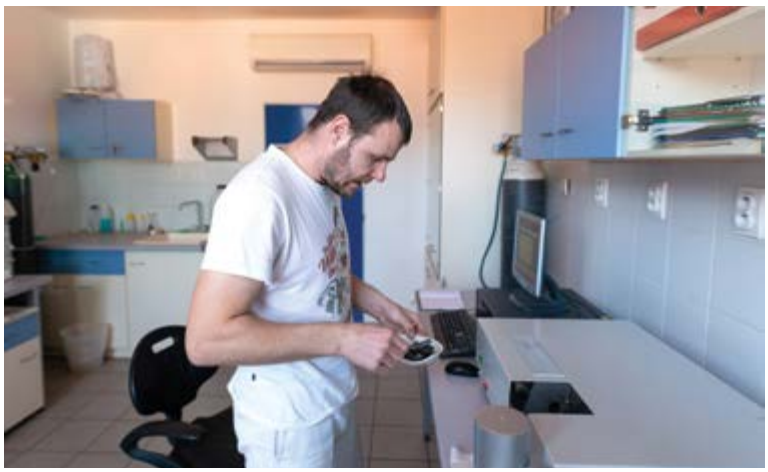

FIG. 14 A pair of cold vapor atomic absorption spectrometers AMA-254 by Altec, Prague with autosamplers and power backup station. Photo by T. Navrátil.

Mercury Analysis Laboratory
(Head: T. Navrátil)

This unique laboratory (**Fig. 14**) is designed for ultra-trace analysis of mercury (Hg) in all types of environmentally relevant samples. The laboratory is equipped with: a set of two mercury analyzers AMA 254 with an autosampler for solid and liquid samples (2019, 2008) working on CV AAS principle, a speciation oven for RA-915 M Lumex analyzer: upgrade (2019), two zone cylinder furnace Clasic (2018). Total mercury and methylmercury analyzer of BrooksRand system MERX (2017), RA-915M Lumex mercury analyzer: real time direct detection of mercury vapor analysis in air and gases (2016). Shimadzu DOC/TOC analyzer: dissolved organic carbon content, total organic carbon content, inorganic carbon in aqueous samples (2010), PSA Millennium Merlin: ultra-low mercury analysis in liquid samples on CV-AFS principle. Extension of this analytical procedure with a single-purpose HPLC enables mercury species separation and analysis (2009).

FIG. 15 Micropaleontological Laboratory. Photo by P. Lisý.

Micropaleontological Laboratory
(Supervised by P. Lisý & L. Slavík)

The laboratory of micropaleontology (**Fig. 15**) disposes of a room for sample preparation with standard equipment and chemicals and a laboratory of sample processing with hoods and levigation sinks.

FIG. 16 Sedimentary Laboratory. Photo by P. Lisý.

Sedimentary Laboratory
(Head: A. Žigová)

The laboratory (**Fig. 16**) is equipped with an apparatus for sediments and soil sample preparation and study: Analytical balance SETRA EL–2000S (1999), WST 5010 (1991), laboratory dryer, FRITSCH (1986), planetary mill, pH-meter pH 330 / SET (2000), TESLA (1985), ultrasonic cleaner.

FIG. 17 The exchange of the sample turret in the ion source housing of the Triton Plus instrument in the TIMS lab. Photo by M. Svojtka.

TIMS Laboratory
(Head: J. Rejšek, supervised by L. Ackerman)

The laboratory is equipped with TRITON Plus (ThermoFisher Scientific; **Fig. 17**), a thermal ionization mass spectrometer (TIMS) whose applications are divided into three purposes: (1) Elemental abundance determination with the isotope dilution method; (2) Precise isotopic ratio analysis, and (3) Isotopic fractionation measurement. TIMS is routinely used for the analysis of Sr, Rb, Nd, Sm, Pb, U, Os, and Cd in geological (e.g., basalts, carbonatites), paleontological (foraminifera), archaeological (e.g., bones, enamels) as well as in environmental (e.g., mushrooms, leaves) samples. TIMS is supplied with five 10^{13} Ω technology amplifiers along with a 3.3 pA current calibration board, the central dual-channel detector (SEM/Faraday cup), oxygen bleeding valve, and RPQ device. The filament bakeout device is placed in the TIMS laboratory for the filament degassing and PCR box Airstream for sample loading.

3D LIBRARY

Information Centre and Library
Bc. Jana Popelková – head librarian
Bc. Sabina Janíčková – librarian

The Library of the Institute is a public library with a specialized library fund. Its main purpose is to collect, process, store and provide scientific information contained in the library fund. It provides its readers with literature focused on Earth sciences, especially from the fields of geology, paleontology, petrology and mineralogy. The fund includes approximately 9,000 books, 480 journals and 300 maps. Some of the latest acquisitions in 2022 are, for example, *Solnhofen: Ein Fenster in die Jurazeit* or *Historické dolování drahých kovů na Českomoravské vrchovině*. Many acquisitions are represented by works of Institute staff, i.e., publications created by the employees.

Another significant task of the Library is to collect, process, store and spread information on publications and other information outputs of the Institute's basic research. These records are stored in the ASEP database, which is designed for the Czech Academy of Sciences specifically for this purpose.

4. AWARDS AND FELLOWSHIPS

FIG. 18 Bosák awarded the František Pošepný Honorary Medal for Merit in Geological Sciences on June 13, 2022. From left: Zdeněk Havlas, Eva Zažímalová, Pavel Bosák, Pavel Baran. Photo by J. Landergott.

Bosák P.
František Pošepný Honorary Medal for Merit in Geological Sciences, awarded by the President, Czech Academy of Sciences, Prague (**Fig. 18**)

Kdýr Š.
Certificate of Excellence award for an excellent student presentation at the 17th Castle Meeting – New Trends on Paleo-, Rock- and Environmental Magnetism, awarded by the Ruđer Bošković Institute, Trakošćan, Croatia.

Krmíčková S.
Dean's award for the best students in the doctoral study program (**Fig. 19**), Faculty of Science, Masaryk University in Brno.

Laibl L.
Otto Wichterle Award for exceptionally outstanding, promising young scientists at the Czech Academy of Sciences, and for their remarkable contribution to the advancement of scientific knowledge in a given area of science, Czech Academy of Sciences, Prague.

FIG. 19 Dean's award for the best students in the doctoral study program, Faculty of Science, Masaryk University, Brno. Photo by R. Miča.

Scheiner F.
Dean's award to the best junior scientific worker – Geology, Faculty of Science, Charles University, Prague.

Soták J., **Elbra T., Pruner P.**, Antolíková S., **Schnabl P.,** Biroň A., **Kdýr Š.,** Milovský R.
Award for the best geological publication in 2018–2021, in category "*Scientific work by authors without age restrictions*", awarded by the Slovak Geological Society, Bratislava.

Žák K., Cílek V.
Miroslav Ivanov non-fiction literature award, Main award, awarded by the Club of Non-fiction Literature Writers at Book Fair, Prague.

5. DEGREES OBTAINED

FIG. 20 L. Krmíček with the professor's appointment decree. Photo by S. Krmíčková.

prof.:

Krmíček L.
Development and prospects of geotechnical discipline "*Rock mechanics*" at Brno University of Technology – inaugural lecture (Faculty of Civil Engineering, Constructions and traffic structures, Brno University of Technology, Brno; **Fig. 20**).

Ph.D.:

Chroust M.
Development of the climate during the Miocene based on the study of reptilian associations in northwest Bohemia (Institute of Geology and Palaeontology, Faculty of Science, Charles University, Prague; supervised by M. Mazuch).

Weinerová H.
Sequence stratigraphy of Devonian biotic events: microfacies and compositional analysis of carbonates of the Barrandian area (Faculty of Science, Masaryk University, Brno; supervised by O. Bábek).

6. PROJECTS

6A FOREIGN GRANTS, JOINT PROJECTS AND INTERNATIONAL PROGRAMMES

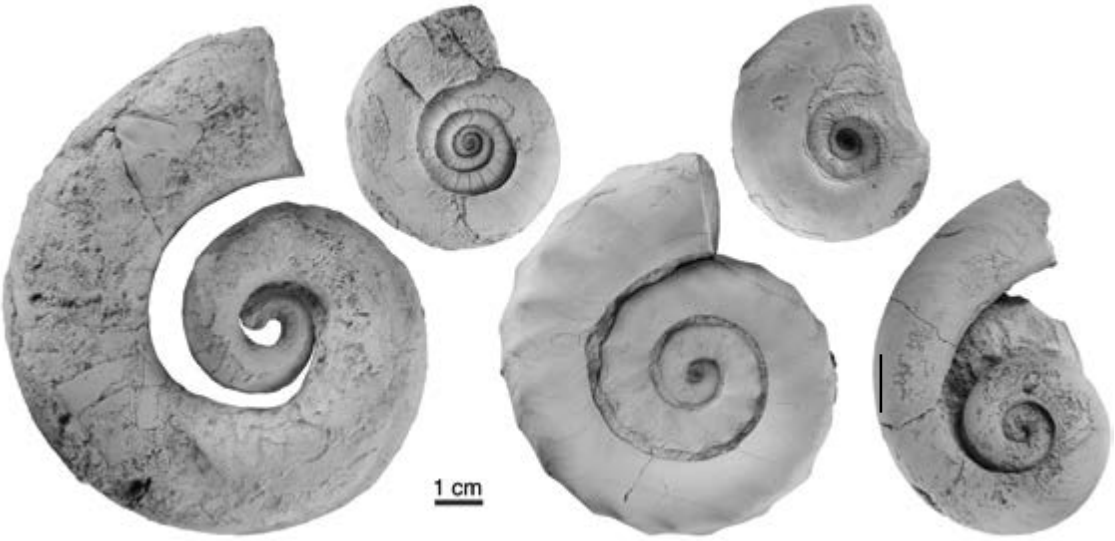

FIG. 21 Variation in conch shapes, sizes, and surface ornament in cephalopods of the order Tarphyceratida from the Ordovician of Baltoscandia and Germany. Photos by O. Werb and D. Korn.

FINISHED PROJECTS

***Bilateral co-operation between Czech Geological Survey, Prague and Geologische Bundesanstalt Wien, Austria*: Palynology of Gosau Group sediments in Salzkammergut, in particular on map sheets 3211 – West Wolfgangsee, 3206 – West Gmunden (H. Lobitzer, Geologische Bundesanstalt, Wien, Austria; L. Švábenická, Czech Geological Survey, Prague; *M. Svobodová*; 2022)**

Samples studied from the Ischlfluss locality contain a rich assemblage of biostratigraphically important angiosperm pollen from the Normapolles group which correspond to the Coniacian age, i.e., pollen of *Semioculopollis, Pseudoculopollis*. Dinoflagellate cysts are comparable to those described from the Upper Cretaceous of Bavaria. Prevailing phytoclasts of non-marine origin as well as the presence of agglutinated foraminifers and dinoflagellate types can characterize a shallow marine environment. Samples from St. Gilgen contain a well-preserved palynomorph assemblage with prevailing dinoflagellate cysts and foraminifers. Both dinocyst and sporomorphs correspond to the Turonian age. Gymnosperm pollen redeposited from the Lower Cretaceous are also present.

***Innovation Fund of the Museum für Naturkunde Berlin*: The evolution of coiling in early Paleozoic cephalopods (Dieter Korn, Museum für Naturkunde, Berlin, Germany; *M. Aubrechtová*; 2022)**

Coiling of the conch was one of the most important steps in the evolution of Cephalopoda. It led to a great success of the ammonoids during the late Paleozoic and especially Mesozoic eras. But first coiled cephalopods appeared and flourished long before that, already in the Ordovician Period, and they were representatives of three (partly) unrelated lineages (Tarphyceratida, Lituitida, "*Barrandeoceratida*"). Thus, coiling in cephalopods originated independently multiple times. Previous research suggests that coiling was a response to increased competition and predatory pressure because the coiled conch is stronger, more compact, and more stable during swimming. By contrast, the diversity of cephalopods with fully coiled conchs decreased in the absence of such selection pressures.

In ammonoid cephalopods, this is rather well investigated but in coiled non-ammonoid cephalopods, including the Ordovician ones, the knowledge is far from sufficient. In the above named project, we extended our previous work focused on selected members of Lituitida by investigating another group with coiled conchs, the Tarphyceratida. The group is well-known from the Ordovician limestones of Baltoscandia as well as glacial erratics embedded in Pleistocene glacio-fluvial sediments in

Germany and Poland. At the Museum für Naturkunde in Berlin, one of the largest collections of these cephalopods is deposited. At the beginning of the project, the taxonomic revision was performed. This was needed because until now, Ordovician coiled cephalopods were usually described using traditional, non-quantitative methods; also, some of the taxa have not been revised for many decades and their use for any modern study would thus be difficult. We have applied the standard coiling parameters and ratios to quantify ontogenetic changes and morphological variation (**Fig. 21**). Based on observed ontogenetic trajectories and changes in shell ornament, we will now be able to analyze and discuss paleoecology of the studied cephalopods. The research is a part of an ongoing effort of the author(s) to investigate the early evolution of coiling in cephalopods and test the hypotheses explaining potential triggers of their appearance.

ONGOING PROJECTS

***Bilateral co-operation between Inst Geol, Czech Acad Sci and Karst Research Institute, Scientific Research Centre, Slovenian Academy of Sciences and Arts (signed agreement)*: Paleomagnetism and magnetostratigraphy of Cenozoic cave sediments in Slovenia (N. Zupan Hajna, A. Mihevc, A. Švara, Karst Research Institute ZRC SAZU, Postojna, Slovenia; *P. Pruner, P. Bosák, Š. Kdýr*; in co-operation with MOBILITY No. SAZU-19-01 and MOBILITY PLUS No. SAZU-22-08; since 1997)**

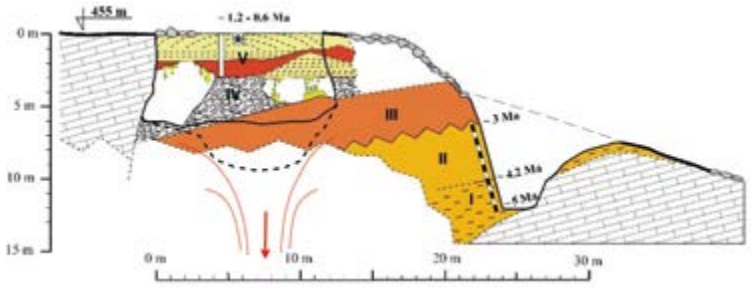

FIG. 22 An example of a composite sedimentary record (in the Risnik Industrial Zone at Divača Village, Classical Karst, Slovenia) reflecting principal changes in cave depositional architecture and external geomorphic changes in catchments during time. I to V) sedimentary sequences: I) deposited in epiphreatic zone (rhythmic lutites), II to V) deposited in vadose zone (II from cave fluvial cycles, III by amalgamated debris flows, IV coarse-boulder conglomerate, single flood result, V set of two flowstone complexes – domes – intercalated by red terra rossa-derived clays). Red arrow points to suffosion effects after or during the deposition of flowstone complex (probably due to the oscillation of dropped groundwater level). The section is cut by the denudation level at ~455 m a. s. l. Original by N. Zupan Hajna and A. Mihevc.

Protected in caves, cave deposits are well-preserved with an exceptionally good multi-proxy record of surface environmental conditions at the time of their deposition. They preserve the evolution of the surrounding landscape, changes of the tectonic regimes, morphology and climatic changes in catchment areas and surface above the caves. Cave sediments, in most cases, represent the only useful source to study past environments and processes in karst landscapes where correlative deposits are usually missing. Nevertheless, owing to the type of special depositional environment, their interpretation can be difficult. Major sources of sediments in caves are allogenic sinking streams, transporting sediments into the underground from eroded non-karst rocks in catchment areas of sinking streams. Allogenic cave sediments are particularly important for the understanding of the environment of their origin before transport and deposition in the cave. They are also integrators of extensive river catchments (**Fig. 22**) and have vast chronological potential for understanding past events as well as offer the insight to the evolution of karst landscapes under the influence of allogenic input during the last ~20 Myr. Studies also focused on the importance of respective facies of cave fills providing indirect evidence of landscape evolution above and in front of the caves, particularly in catchments – especially climatic changes associated with Cenozoic flood events in tectonically active karst regions. The role of sediments transported through vadose zone cannot be forgotten. Nevertheless, such sediments are usually redeposited within caves especially by cave streams, and are only rarely preserved in in situ positions. Systematic studies of cave sediments at 30 sites in the northwestern Dinarides and the Southern Alps in Slovenia were focused primarily on the research of allogenic sediments in relict and unroofed caves. Where possible, paleomagnetic results were calibrated by numerical dating methods (U-Th, radiocarbon, cosmogenic isotopes) and correlated ones (paleontological, geomorphological). Calibrated data allowed the construction of a robust regional chronology in spatially and temporally highly discontinuously preserved sedimentary record. The results indicate that sampled sediments in relict and unroofed caves started to be deposited at ~5 Ma, only rarely sooner (most of such fills have been already denuded). Our data did not confirm the traditional concept of Pleistocene age of most cave sediments in the region related to young climatic changes. Calibrated data additionally contributed to the interpretation of speleogenesis, deposition in caves, and indirectly to the evolution of karst surfaces and the succession of evolving tectonic regimes.

***Bilateral co-operation between Inst Geol, Czech Acad Sci and State Nature Conservancy of the Slovak Republic – Slovak Caves Administration, Liptovský Mikuláš, Slovakia (signed agreement)*: Paleomagnetism and magnetostratigraphy of Cenozoic cave sediments and speleogenesis of selected caves in Slovakia (P. Bella, State Nature Conservancy of the Slovak – Republic Slovak Caves Administration, Liptovský Mikuláš and Catholic University in Ružomberok, Slovakia; J. Littva, State Nature Conservancy of the Slovak – Slovak Caves Administration, Liptovský Mikuláš, Slovakia; P. Bosák, P. Pruner, P. Mikysek, Š. Kdýr; since 1997)**

Sulfuric acid speleogenesis was confirmed, for the first time in Slovakia, in the Plavecký Karst. Hypogene caves in the Plavecký hradný vrch Hill (Western Slovakia, Central Europe) were formed by waters ascending along deep-rooted faults in fractured Triassic carbonates related to the horst-graben structure at the contact of the Malé Karpaty Mountains and the NE part of the Vienna Basin. The Plavecká jaskyňa and Pec caves contain mostly horizontal passages and chambers with flat corrosion bedrock floors, fissure discharge feeders, wall water-table notches, replacement pockets and some other speleogens associated with sulfuric acid speleogenesis. The sulfuric low-temperature

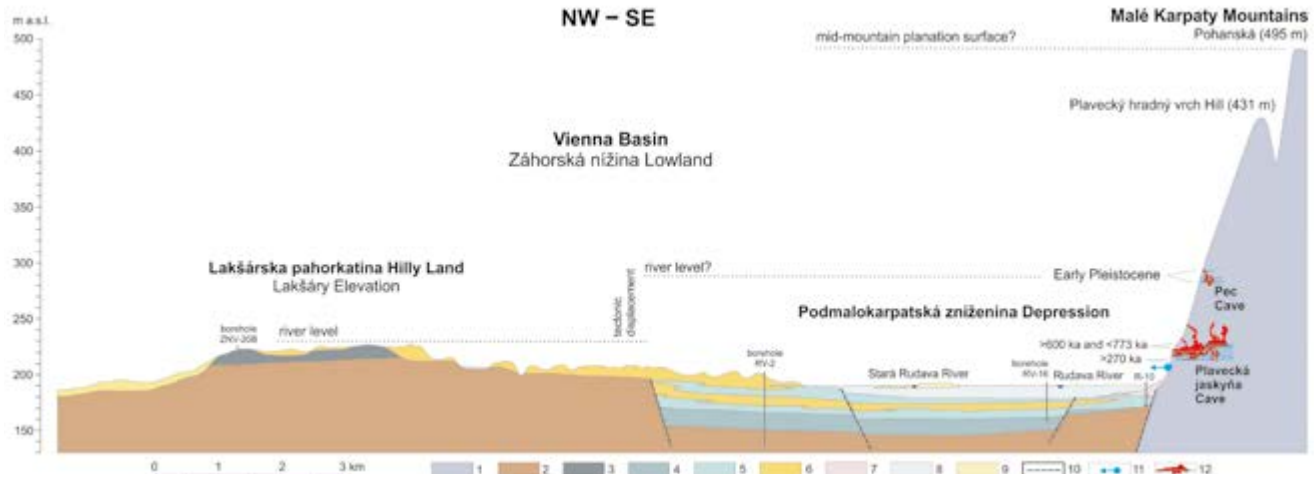

FIG. 23 Recent geomorphic cross-section (simplified geological sketch) from the Vienna Basin (in the NW) to the Malé Karpaty Mountains (in the SE; unpublished original by P. Bella): 1) Triassic; 2) Miocene; 3) Early Pleistocene; 4) early Mid Pleistocene; 5) late Mid Pleistocene; 6–7) Late Pleistocene; 8) Late Pleistocene–Holocene; 9) Holocene; 10) fault; 11) spring; 12) cave (with evolution levels: dotted blue lines). Original drawing by P. Bella.

acid development phases of the Plavecká jaskyňa are also indicated by the presence of sulfate minerals (i.e., gypsum and jarosite). Subaerial calcite popcorn rims were precipitated from condensation water at the edges of feeding fissures that were still active as thermal vents when the water table dropped. Hydrogen sulfide involved in the sulfuric acid speleogenesis was probably derived from anhydrites and/or hydrocarbon reservoirs with sulfate-saline connate waters in the fill of the adjacent Vienna Basin. It ascended to the surface along deep-rooted sub-vertical fault zones at the contact of the Vienna Basin with neighboring mountains. Three cave levels at 295 to 283 m a. s. l. in the Pec Cave, and five levels at 225 to 214 m a. s. l. in the Plavecká jaskyňa Cave were found to correspond to phases of stable local erosional base levels in the bordering part of the Vienna Basin, most likely during periods of strongly decelerated and/or interrupted subsidence. Cave levels separated by vertical differences of only a few meters may be also related to the Pleistocene climatic cycles. Subhorizontal parts of the Pec Cave are probably of late Early Pleistocene age (>0.99–1.07 Myr?). Two highest levels of the Plavecká jaskyňa developed during early Mid Pleistocene (>600 kyr). Fine-grained sediments in the passage at 225 m a. s. l. with the normal magnetic polarity contain jarosite. The middle level of the Plavecká jaskyňa Cave at 220 m a. s. l. was formed in mid Mid Pleistocene, lower and lowermost levels in late Mid Pleistocene (>270 kyr; **Fig. 23**). The water table in the lowermost cave level probably dropped after the tectonic reactivation of the Podmalokarpatská zníženina Depression just in the front of a marginal horst structure of the Malé Karpaty Mountains.

FIG. 24 Upper part of the sedimentary profile in Šimčev spodmol (Classical Karst, Slovenia). Photo by Astrid Švara.

***Bilateral Mobility Project No. SAZU-19-01:* Cave sediments: multi-proxy for interpretation of karst processes (N. Zupan Hajna, A. Švara, B. Otoničar, Karst Research Institute ZRC SAZU, Postojna, Slovenia; *P. Pruner, Š. Kdýr, P. Bosák*; 2019–2022)**

The Šimčev spodmol (Cave) in brezno (Shaft) is a small cave in the corrosional plain of Slavinski ravnik (Classical Karst, Slovenia) and represents an invasion channel from the unroofed Loza Cave down. We studied its sedimentary record and sampled allogenic sediments with flowstone cover and stalagmites in a side passage of the Šimčev brezno, and a flowstone dome in partly unroofed Šimčev spodmol. Mineralogical and paleomagnetic properties, and paleontology were studied in allogenic deposits, while flowstones were sampled for paleomagnetic and U-Th dating (**Fig. 24**). Most of the allogenic sediment consists of quartz and illite with chlorites and plagioclase, the amount of the latter slowly decreases with the depth. Mineral composition corresponds to a weathered source from flysch of the Postojna Basin. Preliminary paleomagnetic results reveal normal and reverse polarities and show greater eastward counterclockwise rotation than in the Markov spodmol Cave, located at the northern border of the Slavinski ravnik in lower altitudes. The preliminary results from the Šimčev spodmol in brezno indicate simultaneous phases of deposition in different hydrological regimes: allogenic sedimentation

FIG. 25 Lipiška jama, sampling of allogenic sediments (Classical Karst, Slovenia). Photo by N. Zupan Hajna.

in the epiphreatic zone, which was confirmed by fauna remains, and sedimentation of the flowstone crust and speleothems in the vadose zone. This shows that the entrance to the Šimčev spodmol functioned in vadose regime at the same time when the 25 m lower inner part (Šimčev brezno) was still frequently flooded. New results compared with our previous research indicate that (1) the formation of the unroofed Loza Cave is the oldest and (2) the sedimentation in the Šimčev spodmol in brezno is older than the allogenic sedimentation in the Markov spodmol, which provides new insights into the speleogenesis of the Slavinski ravnik.

***Bilateral Mobility Plus Project No. SAZU-22-08*: Deeper insight into the deposition of cave sediments (N. Zupan Hajna, A. Švara, B. Otoničar, Karst Research Institute ZRC SAZU, Postojna, Slovenia; *P. Pruner, Š. Kdýr, P. Bosák*; 2022–2023)**

The Lipiška jama Cave at the southern edge of the Kras Plateau (SW Slovenia) is a 1,400 m long cave with a recent epiphreatic and vadose regimes. Three allogenic sedimentary sections, 2 to 3 m thick each, in distinctly developed cave levels were sampled (**Fig. 25**). Except for the bottom level section, disturbed with slides and slumps, other sections were sampled with a high-resolution method. Rock magnetic methods, such as the acquisition of isothermal remanent magnetization, S-ratio, anisotropy of magnetic susceptibility (AMS), etc., were implemented for magnetomineralogy characterization. Magnetic susceptibility shows a wide variation of values in all profiles. A low coercivity mineral (e.g., magnetite) is identified as the main carrier of magnetization. The AMS shows a dominantly oblate fabric, which corresponds to fine-grain sediments. Alternating field demagnetization was applied to determine characteristic remanent magnetization (CRM). Primary magnetization, and the presence of both normal (N) and reverse (R) polarity samples, were determined. The section in the bottom cave level, extensively influenced by post-depositional features, displays a chaotic distribution of CRM components. The section in the middle cave level revealed R and N polarity zones within allogenic sediment with the antipodal position of their mean directions, as well as basal flowstone with R polarity. The highest positioned section revealed mainly R polarity and occasionally N polarity samples. Although the homogeneous non-laminated clay forms this sedimentary sequence, AMS parameters revealed some samples with suspected influence of slumps. The presence of R polarity zones within two studied sections in the Lipiška jama Cave suggests an age at least within the Matuyama Chron.

***International Geoscience Programme (IGCP) of UNESCO & IUGS, Project Code IGCP No. 735:* Rocks and the Rise of Ordovician Life (Rocks n' ROL). Global change theme (International Leader: Bertrand Lefebvre, University of Lyon, France; Czech representatives: O. Fatka, Faculty of Science, Charles University, Prague; other Czech workers: *R. Mikuláš;* P. Budil, Czech Geological Survey, Prague; 2021–2026).**

Strata with echinoderms preserved in situ at distances corresponding to the presumed life position were found in the upper part of the Letná Formation at the Loděnice–Blýskava locality (Ordovician, Barrandian area). This exceptional find thus falls into the category of so-called lagerstätten, i.e., intervals that allow an exceptionally detailed insight

into the fossil environment. In this context, it is also important to characterize the ichnological component of the fossil community. The lower part of the examined section has a relatively high ichnofabric index (ii), i.e., ii=3–5. Fossils occur in fragments. In contrast, higher-positioned strata at the site, which represent the lagerstätte themselves, have a low ichnofabric index (usually ii=2). The absence of fauna living inside the bottom explains the possibility of the perfect preservation of echinoderms (no scavengers available). It cannot be ruled out that the sea bottom at Blýskava emerged at low tide; in the Upper Ordovician, there were no aerial predators. Therefore, organisms adapted to short-term emergence were better protected from predation.

***International Geoscience Programme (IGCP) of UNESCO & IUGS, Project Code IGCP No. 751*: Four Continents Connected through Playful Geoeducation (International Leading Team: M. Pásková, University of Hradec Králové; *R. Mikuláš*; J. Mwankunda, Tanzania; M. A. R. Núñez, Nicaragua; A.C. Cabana, Peru; J. Ganub, Philippines; 2022–2027).**

FIG. 26 Outcrop of the Tachi site (Kueichulin Formation, Mio-Pliocene, North Taiwan). Photo by T. Přikryl.

The project focuses on educational and 'fun' aspects of geoconservation, and its first year experienced exchange of information (the conference in Příbram) between the geoparks of Central and Eastern Europe, Asia, South America and Africa. The following are particularly worthy of further elaboration and future efforts: (1) the offer by the geoparks to award local institutions and businesses the "GEO" certificate if they contribute to fun geological education; (2) special excursions through historic towns to look at the origin of the building stones and changes in their use over time; (3) targeted cooperation on a personal and project level with the most famous museums in each country, and (4) permission for visitors to collect rock samples that would otherwise be lost to natural processes.

***International Geoscience Programme (IGCP) of UNESCO, Project Code IGCP No. 679*: Cretaceous Earth Dynamics and Climate in Asia (G. Li, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, China; T. Hasegawa, Department of Earth Sciences, Faculty of Science, Kanazawa University, Kakuma, Japan; D. K. Cheong, Department of Geology, College of Natural Sciences, Kangwon National University, Republic of Korea; V. Prasad, Birbal Sahni Institute of Palaeobotany, India; *P. Schnabl, A. Svobodová, J. Adamovič, T. Elbra, Š. Kdýr, P. Pruner, R. Mikuláš*; 2019–2023)**

The project deals with the Cretaceous, which was the last warmest period in the Phanerozoic Eon and comprised more elevated atmospheric CO_2 levels and significantly higher global sea level than nowadays. To understand biodiversity evolution under these greenhouse climate conditions, three main topics were addressed within this project: Cretaceous geological records of various facies in Asia, climate and environment, and the link between major geological events, rapid climate and environmental changes. Moreover, our biostratigraphic, sedimentary and magnetic research from the Subsilesian Unit of the Outer Western Carpathians provided data to this project. Results of the current project are promoting geoscience communication among Asian countries and selected countries outside Asia, and can equally provide evidence of human response to present-day global warming trends.

***Project Mobility Plus No. AS-22-01 between Czech Academy of Sciences and Academia Sinica, Taipei, Taiwan:* Cenozoic fossil fishes from Taiwan and the Czech Republic – the once thrived ichthyofaunas (Ch.-H. Lin, D. Mediodia, Biodiversity Research Center, Academia Sinica; *T. Přikryl, M. Chroust;* 2022–2023)**

Fossil fish remains are an essential document of fish evolution preserved in sedimentary archives and often represent the only preserved macro-biota in Cenozoic marine deposits. The fish fossils thus serve as the only available indicator of the paleoenvironment and evidence of the morphological evolutionary history of the respective group. A well-known hypothesis in the record of fish diversity is a shift from the Paleogene-Neogene Europe and Mediterranean (western Tethys) hotspot to the modern Indo-Pacific region. However, the establishment of the modern fish fauna in the Indo-Pacific is not fully understood in terms of its spatio-temporal dynamics. Our knowledge of marine fossil records, particularly the fish record, in the tropical-subtropical West Pacific is largely lagging the modern systematics and phylogenetic hypothesis.

The project thus focuses on several formally undescribed teleost fossil specimens of Cenozoic age of Taiwan (Miocene to Pleistocene), especially from the Tachi site (Kueichulin Formation, Mio-Pliocene, North Taiwan). During late 2022, the site was visited and geological and taphonomic settings were observed and documented personally. A detailed in-person study of fossil fish specimens from the Tachi site was carried out (**Fig. 26**). For the moment, we are able to recognize the presence of tetraodontid puffer fishes and representative of the Acropomatiformes order (research on these specimens is ongoing).

Furthermore, we paid attention to several Oligocene and Miocene taxa from European localities (especially *"Glossanodon" musceli* and *"Serranus" budensis*) with an attempt to clarify their affinity, anatomy, and ecological assignment. These activities were manageable due to access to rich comparative material. With regard to this point, it is necessary to mention that more than 90 comparative specimens of modern fish species were collected during the study trip and are now available for future studies in the collection of the Czech principal investigator.

Last but not least, access to specialized regional literature was mediated, and numerous professional and personal contacts with potential future collaborators were established.

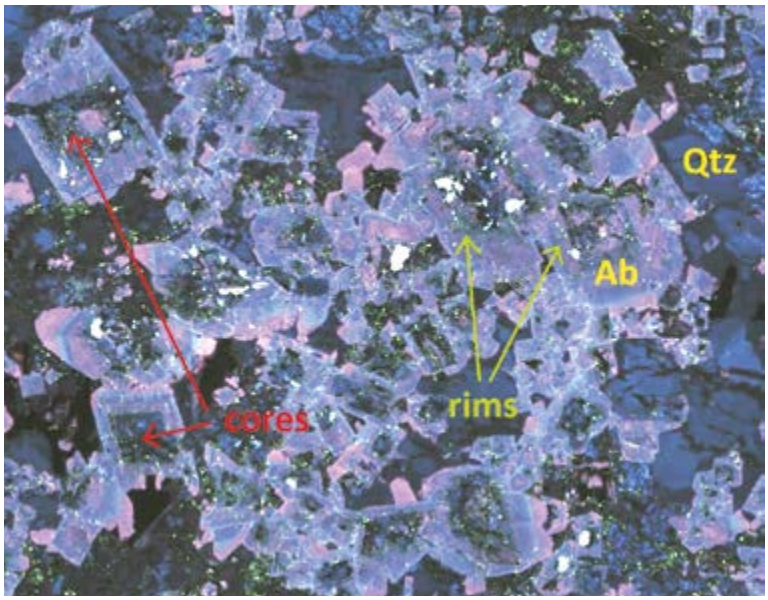

FIG. 27 Late (metasomatic?) albite rims (bright pinkish, <0.05 wt.% CaO) around altered magmatic albite cores (patchy dark blue to black, 0.1–0.4 wt.% CaO) in the uppermost part of the Cínovec granite cupola are well visible using cathodoluminescent (CL) detector on the TESCAN microscope. Ab – albite, Qtz – quartz (dark blue in CL). The width of the image is ca 2.5 mm.

FINISHED PROJECTS

No. GA19-05198S: **Greisenization and albitization – geological processes potentially concentrating some critical raw materials for modern technologies (*K. Breiter, J. Ďurišová, Z. Korbelová; M. Novák*, Faculty of Science, Masaryk University, Brno; 2019–2022)**

Highly fractionated granites and LCT-pegmatites are worldwide important sources of rare metals Sn, W, Nb, Ta, and alkalis Li, Rb, Cs. Gradual concentrations of these elements in magmatic rocks up to economically exploitable sources are closely related to transition from magmatic to hydrothermal stage of their evolution. Greisenization and albitization (**Fig. 27**) – two chemically complementary metasomatic processes play in the concentration of rare elements the most important role. Aim of this project was to identify hydrothermal (metasomatic) processes in typical rare-element enriched magmatic systems and to assess their significance for transport and concentration of metals. The main methodical contribution of the project was the combination of imaging techniques (back-scattered electrons imaging, cathodoluminescence, TIMA) and high-precision spot analyses (EMPA, LA-ICP-MS). The work resulted in models of greisen/feldspatite origin at their typical localities including the transport and precipitation of rare elements. Among our activities, the following topics can be highlighted as generally interesting: Orlovka, eastern Transbaikalia, Russia is the type locality where the term "albitization" was, at ca 1960, used for the first time. The aim of our study was to evaluate the degree of magmatic metasomatic processes on formation of disseminated Ta mineralization. Our results indicate the existence of two comagmatic intrusions: (1) deeper-seated biotite granites, and (2) upper Li-mica granites, forming a cupola and representing residual melt after biotite granite crystallization. The upward transfer of Li and rare metals was supported by fluid unmixed in the middle level of the cupola. Layered pegmatite/aplite bodies represent the latest stage of crystallization from undercooled magma. In Portugal we studied two conjugate, but contrasting granite systems. The strongly peraluminous P, F, Li-rich granitic stock Argemela, is an ideal object for the study of relations between chemical composition of granite, rock-forming minerals, rock and mineral textures, with only very limited postmagmatic alteration. In contrast, the nearby hidden Panasqueira granite pluton is famous for its vein-type wolframite mineralization. While the Panasqueira pluton is chemically well comparable with typical Sn-W-bearing plutons in the western Krušné hory Mts. including postmagmatic pervasive greisenization, the Argemela stock represents one of the unique examples of extremely fractionated (K/Rb =10–20, Zr/Hf=2–6, Nb/Ta=0.7–1.0) leucogranite magma with albite+Li-mica enrichment in the latest but still fully magmatic evolutionary stage. The conspicuous difference in the behavior of Sn and W in the Panasqueira and Argemela magmatic systems, only 15 km apart, cannot be explained by different source lithologies; the cause of this difference should be searched in the process of fractionation as an interesting topic for further research.

No. GA19-06728S: **How precisely can we reconstruct Carboniferous tropical forests? Examples from the Czech Republic and China (S. Opluštil, Faculty of Science, Charles University in Prague; *J. Bek, J. Votočková Frojdová*; J. Pšenička, West Bohemian Museum in Pilsen; M. Libertín, National Museum, Prague; 2019–2022)**

Superb localities in the Czech Republic and north China that preserve Pennsylvanian – early Permian wetland tropical ecosystems buried in situ by volcanic ash consisted the core of the project research. The localities provided (1) exceptionally-well preserved and sometimes even complete specimens as well as (2) structure of the wetland forests conserved by volcanic ash fall. The research significantly extended our current understanding of the whole plant reconstructions and taxonomical relationships of selected species, as well as autecology and synecological characteristics of plants within the Carboniferous to early Permian tropical forest. New detailed reconstructions of the early Permian (298 Myr) forest from north China is accompanied by detailed studies of living strategies of plants, including the oldest evidence of dual-climbing phenomenon known from modern tropical and subtropical forests. One of the most spectacular discoveries made within the project is a finding of nearly complete oldest cycadalean plants in north China. In addition, studied were also changes in diversity of vegetation cover (in macrofloral and miospore records) within about 10 Myr long interval of the Krkonoše-piedmont Basin. Indicated changes are interpreted as consequence of climatic oscillations between humid and seasonal types of climate. Major changes are related to intervals of temporarily increased aridification recorded as red beds. These climatic oscillations resulted either in reorganization of dominancy patterns of particular plant

FIG. 28 *Amanita muscaria*, a well-known mushroom species with remarkable role in human cultural history, frequently contains elevated concentrations of Cd, especially at polluted sites. Photo by J. Borovička.

groups within the wetland biome and since the Late Pennsylvanian also by alternating dominancy of wetland (dominated by free-sporing plants with medullosalean pteridosperms) and "dryland" (gymnosperms, mostly cordaitalen, walchian conifers and peltaspermalean pteridosperms) biomes in the fossil record. More than 35 papers were published during three years of the project.

***No. GA19-06759S:* Cadmium hyperaccumulation in macrofungi: from isotopes to proteins and bacterial communities (*J. Borovička; P. Kotrba*, University of Chemistry and Technology, Prague; 2019–2022)**

The project combined mycological, biogeochemical, biochemical, molecular biological, and current microbiological/metagenomics approaches to investigate Cd accumulation in macrofungi (mushrooms). We particularly focused on the investigation of (1) Cd isotopic fractionation in mushrooms; (2) Cd accumulation, sequestration, and chemical speciation in fungal tissues, and (3) bacterial communities associated with Cd-hyperaccumulating macrofungi.

We developed a method for determining the isotopic composition of Cd in environmental matrices using thermal ionization mass spectrometry (TIMS) with double spike correction; we also demonstrated its use on biogenic certified reference materials. We further applied this method to determine the isotopic composition of Cd in fruiting bodies of mycorrhizal mushrooms. Strikingly different Cd isotopic composition of mushroom fruiting bodies collected at the same place suggests mushroom species-dependent Cd isotopic fractionation (a biologically driven process). This phenomenon may be of environmental significance in Cd isotope cycling in forest soils.

A new mushroom hyperaccumulator *Thelephora penicillata* was discovered. In this basidiomycete mushroom, two elements (Cd and As) are co-hyperaccumulated which is a phenomenon never reported in mushrooms before. By using phylogenetic analysis, we predicted accumulations of these and other elements (S, Se) in other *Thelephora* species and also discovered a new entity of *T. penicillata* which may result in a description of a new biological species. The striking ability of *T. penicillata* to accumulate simultaneously Cd, As, Cu, and Zn has no parallel in the Fungal Kingdom and raises the question of a biological importance of metal(loid) hyperaccumulation in mushrooms.

Intracellular forms of Cd were studied in two Cd accumulating mushrooms: *Cystoderma carcharias* and *Amanita muscaria* (**Fig. 28**). The results indicate that *C. carcharias* has one metallothionein CcMT1 as the ligand for the storage of Cd (and Cu). In *A. muscaria*, the metallothionein AmMT1 gene responds weakly to Cd and Zn, likely serving basal metal homeostasis, not detoxification, function.

Bacterial communities were studied in soils at three sites of *Agaricus crocodilinus* in the Czech Republic. Despite the fact that the data has not yet been published, it was made publicly available via the National Center for Biotechnology Information database (PRJNA910070, Influence of fungus on bacterial diversity in soil). Additional data obtained during this project (such as intracellular Cd speciation and Cd isotopic composition in *A. crocodilinus*) will be published later or will become the basis of a new project proposal when formulating aims and hypotheses.

***No. GA19-08066S:* Late Archean granites: markers of modern-style plate tectonics? (J. Žák, V. Kachlík, J. Ježek, J. Hajná, F. Tomek, J. Trubač, K. Verner, F. Vacek, Faculty of Science, Charles University, Prague; *M. Svojtka, L. Ackerman, J. Sláma, J. Rejšek, J. Ďurišová, P. Le*; 2019–2022)**

Two international trips were organized in 2022: (1) presentation of the project results at an international conference (European Geoscience Union, EGU) in Vienna in May (talk of J. Žák on a session devoted to rock magnetism), and (2) field campaign in Canada in June, which targeted the western part of the Canadian Superior Province (CSP) in Manitoba (**Fig. 29**). During this last field campaign, a number of geochemical, geochronologic, and rock magnetic samples were taken together with structural data, the samples were successfully transported to the Czech Republic and are now being processed and analyzed. Two papers have been already published and four others are submitted or in preparation. The first one, published in the Precambrian Research journal is focused on the CSP that is one of the key test pieces to discuss tectonic processes and mechanisms of crustal growth in the Late Archean. A part of the CSP, the Radisson Pluton, intruded the boundary between the Bienville and La Grande domains of the Superior Province at around 2,712 Myr. The pluton preserves a margin-parallel magmatic foliation that contains a steep lineation, recognized by the AMS, interpreted as recording vertical stretching and horizontal flattening of highly crystallized magma due to emplacement or pure shear-dominated transpression. In summary, these inferences suggest a two-stage evolution of the northeastern CSP during the Late Archean. The NNE-directed terrane convergence and attachment to the cratonic nucleus occurred in a 'hot' regime with voluminous syn-collisional plutonism and was followed by more localized dextral shearing, perhaps caused by an anticlockwise rotation of plate convergence vector, a tectonic style that is observed in modern accretionary orogens. The second paper was also published in the Precambrian Research journal, and tests various models of

FIG. 29 A close-up of Paleoproterozoic layered gabbroic–anorthositic intrusions called "*leopard rocks*" with common presence of plagioclase megacrysts that occur along the margin of the Canadian Superior Province (Pipestone Lake, Manitoba). Photo by M. Svojtka.

crustal growth and evaluates tectonic regimes during the late Archean. Four distinct plutonic suites were newly defined in the northeastern Superior Province: tonalite–diorite, tonalite–granodiorite–diorite, monzogranite to monzodiorite, and granodiorite–granite–monzogranite. The plutonic suites are interpreted as recording a temporal evolution from melting of a mafic lower continental crust through melting of subducted oceanic slab at decreasing depths to remelting of older crustal units of the CSP. The ~2,730–2,700 Myr subduction-related plutonism is the most voluminous addition of the juvenile arc material and thus represents the most significant crustal growth event in the northeastern CSP. The late Archean plutonism in the northeastern Superior Province formed during a transitional regime from plume-dominated to modern-style plate tectonics at ~2,730–2,700 Myr, and this transition was likely diachronous across the Province. Comparison with other Archean cratons suggests a protracted transitional period in the Archean defined by frequent mechanical-thermal interactions of mantle plumes and subducting oceanic plates.

No. GA19-08614S: Biogeochemistry of mercury isotopes in anthropogenically affected areas (*M. Vaňková*; J. Trubač, Faculty of Science, Charles University, Prague; 2019–2022)

The project has been extended for six months. In the final half year, the data obtained were processed into PhD theses, which were defended at the Faculty of Sciences, Charles University. A systematic evaluation of the data showed that soil contamination is mainly caused by the deposition of dust particles by the enrichment of soils in lighter Hg isotopes. In this respect, the study of Hg isotopes proved to be a useful research technique in the field of environmental toxic metal contamination.

***No. GA19-14082S:* Stress- and hydraulic field-controlled weathering and erosion of granular rocks (J. Bruthans, Faculty of Science, Charles University, Prague; *M. Filippi;* J. Schweigstillová, Inst Rock Struct Mechan, Czech Acad Sci, Prague; 2019–2022)**

The project was based on in situ field documentation and measurements, field and laboratory experiments and numerical modelling. Results of the project showed that the strongest effect of stress is in poorly cemented quartz sandstones, while no effect of stress was observed in clay-rich and calcite-rich lithologies. The results also showed that the suppressed dilatation in granular rocks is an important factor for the weathering rate decrease. Especially the laboratory experiments showed that weathering tests are irreplaceable and that the fact that material is stress-controlled by weathering/erosion process of low magnitude does not necessarily mean that a more destructive process will be also affected by stress. There are thus no general criteria that can be formulated for the identification of materials prone to stress-controlled weathering.

A very common phenomenon called flaking was also studied and was found to occur in materials which keep cohesion even after serious weathering, unlike granular disintegration. As considerable dilatation is connected with weathering, this often means some clay content (e.g., clay-bonded sandstones). Arched vaults and scaling originate from repeated dilatation and contraction of material in a few cm thick subsurface zone, and this process is also controlled by the stress.

A new micro-destructive method was developed to measure the depth of the boundary where water evaporates in rocks and salts precipitate from rock moisture. This was a critical achievement in understanding hydraulic-field controlled weathering. The capillary front was visualized in field and lab, which together with 1D evaporation measurement in various lithologies enabled to calculate the actual evaporation rate and – with knowledge of the pore water composition – the salt deposition rate, and to determine the zone of maximum weathering.

An advanced 3D numerical model of stress-controlled erosion was developed and applied to granular material to simulate the erosion/origin of delicate stress-controlled shapes such as arcades and rock pillars. Currently, very complex landform shapes can be successfully reproduced by numerical modelling of stress-controlled erosion. The project thus significantly contributed to the understanding of landscape evolution and landform formation in the environment of granular rocks like sandstones, arkoses, strongly weathered granites or various types of volcanic tuffs (**Fig. 30**).

In addition to the above mentioned topics, the project also achieved a progress in the understanding of chemogenic fills (speleothems) in the underground spaces of the studied rocks. Compared to carbonate rocks, these studied speleothems are much more complex and difficult to study. Eleven publications in impacted journals were produced, two Ph.D. theses were defended and a patent was applied for within the solution of this project.

***No. GA20-06728S*: Enter of Cd, Hg, and U from the pollution hotspots in floodplains to food web (T. Matys Grygar, Inst Inorg Chem, Czech Acad Sci, Řež; *T. Navrátil;* F. Oulehle, Czech Geological Survey, Prague; 2020–2022)**

This project described in detail Cd, Mn, and Zn uptake by willow trees and other plants common in contaminated floodplains in the Czech Republic. The uptake of excess

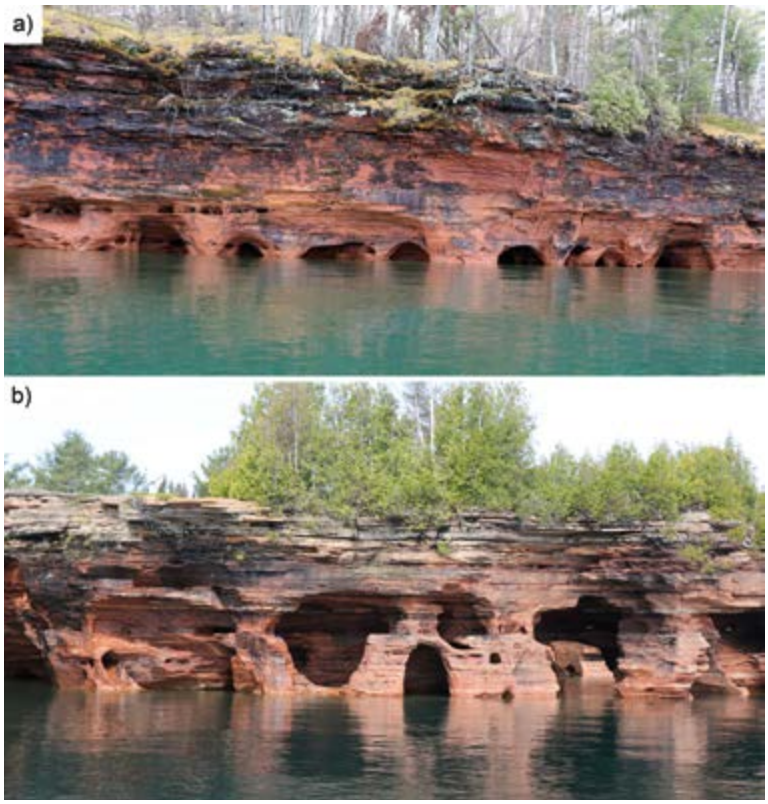

FIG. 30 Examples of two sites with unique stress-controlled weathering forms (sea caves) at the Apostle Islands National Lakeshore, Lake Superior, Wisconsin, USA: a) cliffs of the Lakeshore Trail; b) cliffs of the Devils Islands coast. Photo by M. Filippi.

amounts of Cd, Mn, and Zn by common tree species is a mechanism relevant for anthropogenically impacted environments: trees can mobilize the historical contamination and alter elemental ratios in litter with respect to local soils and sediments.

Furthermore, this research project developed the study of tree rings as an archive of atmospheric Hg levels and successfully applied this method to reconstruct a history of Hg emissions from the Chemical Factory Marktredwitz in Bavaria, Germany.

The project outcomes provided a detailed description of Hg contamination history from the Chemical Factory Marktredwitz with particular focus on timing contamination climax in fine particulates (fluvially suspended matter deposited in the Skalka Reservoir; **Fig. 31**) and current re-mobilisation of historical contamination in the river system.

FIG. 31 The Skalka water reservoir near Cheb accumulating sediments with high mercury concentrations. Mercury pollution originates from the former Chemical Factory in Marktredwitz, Germany. Photo by T. Navrátil.

The field observations demonstrated that (1) fluvial contamination climax post-dated factory closure and revitalization, and (2) current rivers system downstream of the former factory are – and will be – endangered by termination of engineering measures to stabilize the riverbanks – "renaturation". We documented the insufficiency of the current approach to renaturation of historically contaminated river systems at national and European levels. We demonstrated the necessity to study and manage anthropogenically impacted fluvial systems with a holistic approach.

***No. GC20-05011J:* The Urals: a unique natural laboratory of crustal growth and supercontinent assembly (J. Žák, V. Kachlík, M. Košťák, K. Holcová, J. Hajná, F. Tomek, F. Vacek, M. Mazuch, O. Fatka, Faculty of Science, Charles University, Prague; *M. Svojtka, J. Sláma, J. Rejšek, J. Ďurišová, D. Kořínková*; 2020–2022)**

Despite of the prospect of being an exciting research on the poorly understood Uralide orogen, this project was extremely unlucky from the very beginning (Covid-19 pandemic in 2020, Vrbětice case in 2021), culminating in the Russian invasion to Ukraine in early 2022, which totally discouraged us from any collaboration with the Russian side, leading to our request for early termination of the project. Given that the research was based on extensive field campaigns and sampling in the Urals, the original plan of the project had to be altered. Before the Russian invasion, we only completed analyses and U-Pb dating of detrital zircon samples from the Urals, the data are now in a final form and were planned to form a basis of a joint major publication with the Russian team. However, the present-day situation stopped these efforts. We also collaborated on early Carboniferous volcano-plutonic complexes, resulting in a joint publication. In search of possible alternative and closest topic (amalgamation of Pangea), we started informal collaboration with University in Sofia and explored poorly documented Variscan Balkanides, which share a number of features with the Urals. We initially dated 4 detrital zircon samples taken in various late Neoproterozoic and Early Paleozoic units in the Variscides of Bulgaria and Serbia and tested a statistical method of their provenance analysis, resulting a new model for pre-Variscan terrane provenance (published in the International Geology Review). We also took samples for detrital U-Pb zircon geochronology from various Paleozoic units that will allow broader correlations between Bohemian Massif, southern Variscan belt, and the Urals. We focused on synthesis of intra-Pangea plutonism (published in Journal of Geology) and post-orogenic basins in the Bohemian Massif in order to decipher post-orogenic processes and reactivations (as planned in the original proposal). In the latter, a number of detrital samples were collected and yielded zircon and apatite Fission Track (AFT) ages documenting unexpected burial during the mid Triassic and Jurassic. Processing of these data was finalized and we are now preparing a publication together with a review of relevant paleontological and sedimentological data to be submitted in 2023. In summary, despite the very bad luck caused by superior power, we put every effort into saving the project as much as possible. In addition to the papers published, we are now working on other publications (request to postpone evaluation).

***No. GJ19-02177Y:* Magma transfer and emplacement processes in collapsing orogens (*F. Tomek, J. Černý, J. Rejšek, P. Vitouš*; 2019–2022)**

Four research papers were published by the team members. Two of them were focused on pyroclastic rocks of the late Variscan Altenberg-Teplice Caldera (International Geology Review; Bulletin of Volcanology). Two other methodological papers deal with the understanding of the significance of inverse magnetic fabrics and the evolution of magnetite oxidation (Journal of Geophysical Research; Journal of Volcanology and Geothermal Research). These new results shed new light on the applicability of anisotropy of magnetic susceptibility of volcanic and sedimentary rocks. Analog modeling on centrifuge apparatus aimed at deciphering 3D anatomy of granite migmatite core complexes. In cooperation with the Hans Ramberg Tectonic Laboratory, Uppsala University (Sweden), we finalized a general model based on field data from the Pelhřimov complex of the Moldanubian batholith.

ONGOING PROJECTS

***No. GA18-05935S:* From past to present: fossil vs recent marine shelled organisms as a substrate for colonization and bioerosion (K. Holcová, Faculty of Science, Charles University, Prague; Z. Heřmanová, National Museum, Prague; M. Vohník, Inst Botany, Czech Acad Sci, Prague; *R. Mikuláš, L. Slavík*; M. Mergl, University of West Bohemia, Plzeň; 2018–2023)**

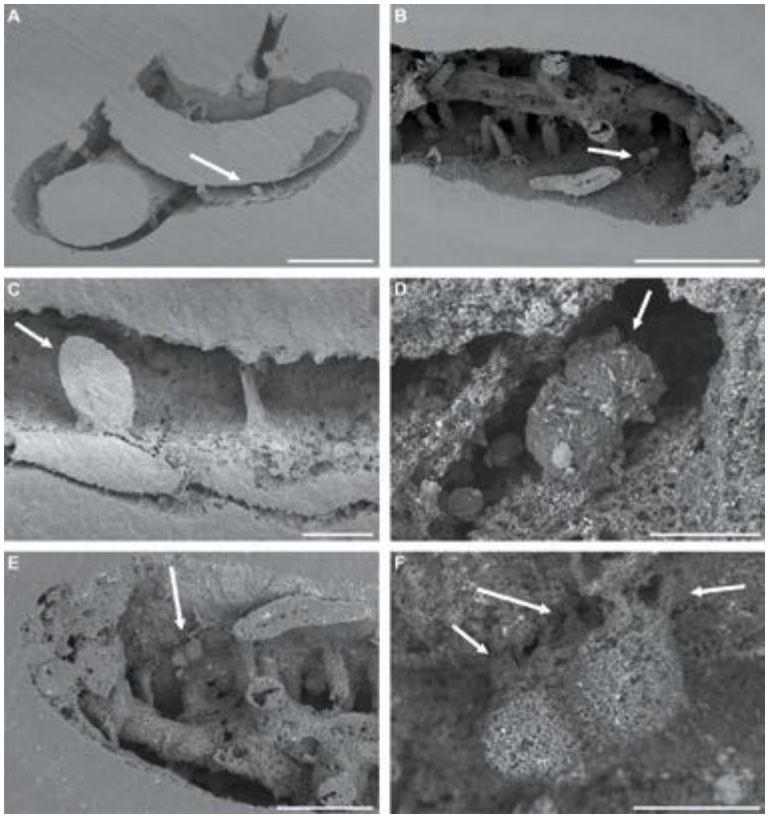

FIG. 32 *Entobia* isp. A, C) A single-chamber specimen of *Entobia isp.* (arrow), from which a thin fiber protrudes from the bottom right and a short shaft at the bottom in the middle. The substrate is *Cementula sp.*; Velim locality (Bohemian Cretaceous Basin), Czechia. B, D–F) *Pyrgopolon sp., Trypanites, Maeandropolydora* and two bi-camerate specimens of Ento*bia isp.* (arrow). Note the very short and thin threads only on the one side of the chambers; NM O 8728; *Kaňk "Na Vrších"* locality, Bohemian Cretaceous Basin, Czechia. Photos by L. Váchová a M. Kočová.

Calcareous tubes inhabited by some polychaetes (Serpulidae and the sabellid *Glomerula*), which are adapted to live sticking in soft ground starting from the Permian, represent widespread but widely neglected and understudied substrates for domichnial bioerosion, i.e., for creation of living chambers and tunnels. Serpulids can be considered small macrofauna. However, due to the thinness of serpulid tubes, borings in them are on the order of 0.01–0.9 mm in diameter and are thus rather considered micropaleontological objects. Extensive and methodologically broad search (vacuum castings studied at SEM; micro computed tomography) and study of borings in these specific substrates were performed on material from the Cenomanian of the Le Mans area (France) and the Cenomanian and Turonian of the Bohemian Cretaceous Basin (Czechia). It shows that the bioerosive traces can be assigned to the existing ichnogenera *Rogerella, Trypanites, Entobia, Maeandropolydora* and *Iramena*. Somewhat surprising is the frequency and disparity of dwelling borings. Several clues, especially in the more abundant ichnogenera *Rogerella*, *Trypanites*, and *Entobia* (**Fig. 32**), support the hypothesis that the tracemakers of these borings adapted to the small size of their substrates by necessarily staying very small by themselves but nevertheless living to adulthood.

***No. GA20-05872S*: The Langhian Mediterranean-Parathetys enigma: hydrography based on Nd isotopes proxy on foraminifera revealing changes in paleoceanography (K. Holcová, F. Scheiner, Faculty of Science, Charles University, Prague; *L. Ackerman, J. Rejšek, V. Renčiuková;* 2020–2023)**

In 2022, the main effort on the project was to collect Sr–Nd isotopic as well as elemental ratios data for the remaining samples (foraminifera, moluscs) and contribute to scientific outputs. Notably, the Inst Geol, Czech Acad Sci team largely contributed to the methodologically oriented paper dealing with the analyses of $^{143}Nd/^{144}Nd$ ratios of small foraminifera fractions (300–500 µg; ca 300 pg to 1 ng Nd loaded) using a novel state-of-art technique that includes preparation of samples using special cleaning protocols, selective ion chromatography, special loading techniques, TIMS measurements using various configurations and testing of the overall veracity on real sample sets from the Mediterranean-Paratethys area. The Nd measurements were paralleled by $^{87}Sr/^{86}Sr$ measurements on extremely small samples (single foraminiferal tests), which were further used as base data for strontium isotope stratigraphy applications. Beside this work, the Inst Geol, Czech Acad Sci contributed to 4 other papers in IF that were already published or are under review that represent application of Sr-Nd techniques on selected samples from the central European area (Croatia, Carpathian Foredeep) and from the Crimea area (Eastern Paratethys). During the fall of 2022, a fieldtrip was realized in Maltese Islands in order to collect Langhian-Serravallian rocks that host different foraminifera species in the world-famous sections of Ras-Il-Pelegrin (Malta) and Marsalforn (Gozo). The sampling was focused namely on Globigerina limestones and Bluy Clay Formation marls (**Fig. 33**). Due to the Covid-19 pandemic, that largely affected the first 2 years, the project was extended to the half of 2023.

***No. GA20-06134S*: Paleoecology of early angiosperms during mid-Cretaceous, case study of material from Iberian Peninsula and central Europe (J. Kvaček, National Museum, Prague; *J. Dašková*; 2020–2023)**

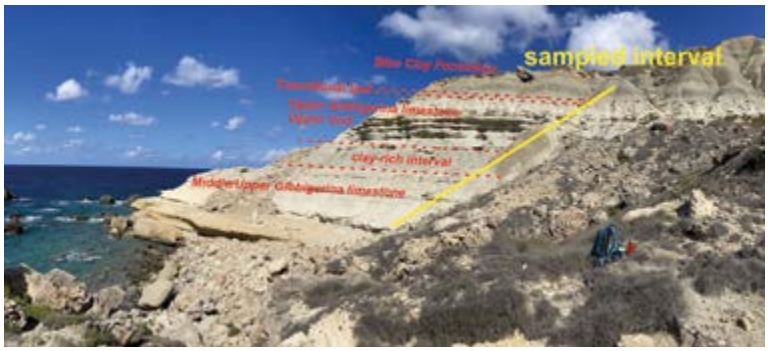

FIG. 33 Ras-Il-Pelegrin rock section of Langhian–Serravallian age on Maltese Islands, Mona Complex, Wales. Photo by L. Ackerman.

In 2022 we continued in addressing major questions of the project. We tried to catch up with the field works in Czechia and Portugal delayed by the pandemic, treated the quantity of material gained from our field trip to Portugal. Many conifer and angiosperm remains were pre-selected from bulk macerated material. They were further sorted and prepared for observation and description. Additional Portugese material was brought by Mario M. Mendes who visited Prague this summer. Based on this material new conifers were described. The Czech fossil material was gained from the localities of Pecínov and Dobrá Voda. We focused on angiosperms and their environment. Material from Czech and Portuguese localities was sampled for stable carbon isotopes. However, the pandemic delayed the field trips and subsequent works. It caused delays that prevented finalization of the project in time. Therefore, we asked the Czech Science Foundation for a prolongation of the project to the year 2023; **Fig. 34**).

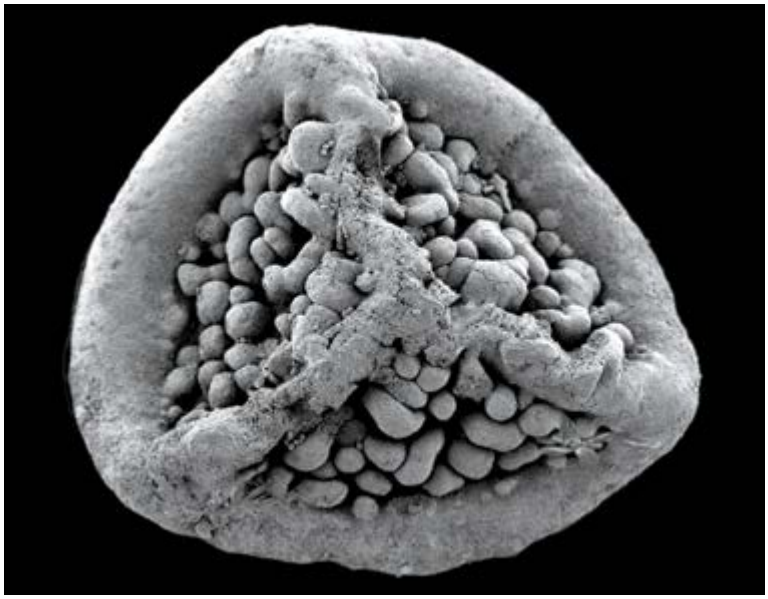

FIG. 34 Megaspore of an aquatic plant from the Březinka locality, 340 µm in diameter. Photo by J. Dašková.

No. GA20-10035S: Leading edge instrumental methods in high resolution global Jurassic–Cretaceous boundary correlations (*P. Pruner, P. Schnabl, T. Elbra, P. Bosák, T. Navrátil, L. Chadimová, R. Mikuláš, M. Svobodová, M. Roll, A. Svobodová, Š. Kdýr, L. Koukliková*; M. Košťák, M. Mazuch, L. Vaňková, Faculty of Science, Charles University, Prague; P. Skupien, P. Doupovcová, Faculty of Mining and Geology, VSB – Technical University in Ostrava; M. Bubík, L. Švábenická, Czech Geological Survey, Prague; 2020–2023)

Stratigraphy in a widely defined Tethys is supported by lithostratigraphy, biostratigraphy, magnetostratigraphy, geochemistry and sequence stratigraphy. Stratigraphic data were mutually and globally correlated. The Jurassic–Cretaceous boundary (J/K) is the last one to be resolved within the Global Stratotype Section and Point (GSSP). Magnetostratigraphy plays a pivotal role in establishing global correlations and represents a key part in understanding the J/K boundary interval due to its independence of facies, geography and biotic provincialism (all of which represent enormous obstacles to correlation in this interval). Detailed magnetic studies of localities from Silesian Unit (Jahodná, Karpentná, Ropice in Czechia, and Goleszów in Poland) and Austria (Rettenbacher) were finalized. New samples from the Golubac section in Serbia (**Fig. 35**) were subjected to paleomagnetic measurements. All results were combined with previous data to verify magnetozone boundaries. Paleomagnetic studies also helped to construct a new magnetostratigraphy for the Berrias section (France). Results of field magnetic susceptibility and gamma-ray spectrometry in Tre Maroua section (France) and comparison with Tethyan records were published. The palynology of Goleszów and Golubac samples were studied and suggested their Berriasian age. The project is a part of Ph.D. studies of J. Geist and Š. Kdýr. Another Ph.D. student H. Ucar was involved in measurements for magnetostratigraphic applications. The research will be coordinated with the International Subcommission on Cretaceous Stratigraphy, and results will contribute to establish the J/K boundary. Presentations and discussions of the results were realized at the 11th International Symposium on the Cretaceous System in Poland and 17th Castle Meeting on Paleo, Rock and Environmental Magnetism in Croatia. In addition, measurements to control magnetically weak samples were performed at the paleomagnetic laboratory in Hungary. The following foreign researchers provided valuable consulting support and interpretation of relevant results: D. Reháková (Slovakia) – evaluation of cuttings, preparation of publications. J. Michalík – collaboration on Sněžnica profile in Slovakia. J. Golonka, J. Kowal-Kasprzyk, A. Waśkowska – collaboration on profiles in Poland and publication activity. J. Grabowski (Poland) – collaboration and correlation of magneto-susceptibility data (Tre Maroua section). D. Rabrenović (Geological Survey of Serbia), V. Radulović and B. Radulović (Belgrade University, Serbia) – collaboration on Serbian profiles and publication activity. V. Bakhmutov (Ukraine) – cooperation on the profile of Veliky Kamenets. W. A. P. Wimbledon (UK) – collaboration on the Berrias section and within micropaleontological teams. C. Frau (France) – collaboration on profiles in France and ammonite interpretation in the Vocontian Basin.

No. GA20-13644S: Cherts and carbonates as geochemical proxies of paleoenvironmental conditions and Ocean Plate Stratigraphy (*L. Ackerman, M. Svojtka, K. Žák, J. Rejšek, J. Ďurišová, J. Sláma, L. Polák*; J. Pašava, F. Veselovský, J. Hora, O. Pour, Czech Geological Survey, Prague, Czech Republic; J. Žák, J. Hajná, F. Tomek, J. Trubač, Faculty of Science, Charles University, Prague; 2020–2023)

The third year of the project was devoted mainly to the completion of necessary fieldwork including that finally realized on Mona Complex, Wales, and to extensive publication activity. Due to the Covid-19 pandemic that largely affected the first 2 years, the project was extended to the half of 2023. In summary, the activities within the project in 2022 resulted in 2 papers that were published

FIG. 35 Sampling Berriasian/Tithonian sedimentary rock sequence in Golubac (Serbia). Photo by L. Kouklíková.

and 2 papers that are currently under review, all in high-ranked journals. Furthermore, the project outcomes were presented at 3 international conferences (3 poster presentations).

(1) A complex study that included a detailed analysis of field relations, petrography and geochemistry of Neoproterozoic–Cambrian cherts from the Teplá-Barrandian Unit was accomplished and the results were published in high-impacted journal Geoscience Frontiers; (2) analyses of silicon isotope compositions of the Neoproterozoic–Cambrian cherts from the Teplá-Barrandian Unit were accomplished. More than 30 samples were analyzed showing that significant Si isotope fractionation occur during Si adsorption onto microbial mats serving as an important sink for Si during the Precambrian. The results have been summarized in a paper being currently under review in journal Chemical Geology; (3) a number of samples of different chert bodies (**Fig. 36**) as well as accompanying limestones and basalts were sampled in the Mona Complex, Wales. Furthermore, rock lithologies of adjacent New Harbour Group were sampled to elucidate the position of this unit. The samples were already characterized in terms of major/trace element compositions and U-Pb geochronology was applied to selected amples; (4) the activity Davle volcanic complex (DVC) played an important role in the circulation of silica-rich hydrothermal fluids and thus in affecting the environment of chert deposition, yet its petrogenesis is a matter of debate. We took a detailed study focused on low-pressure intra-arc oceanic granitoids exemplified on plagiogranites from the DVC; (5) the chert-graywacke Belt I of the Blovice accretionary complex hosts intriguing quartz veins penetrating local silicified, chert-like black shales with uncertain genetic relationship to cherts. We pursued a detailed study on these quartz veins that revealed that they host Au mineralization that might be related to late-stage heat input and silica remobilization in the study area; (6) geochemical analyses of stromatolitic cherts within the Teplá-Barrandian Unit was accomplished. The work includes in situ trace element analyses as well as Si isotope systematics of individual stromatolitic bands in order to reveal the processes responsible for the origin of stromatolitic textures, and (7) a number of analog experiments were performed, simulating subduction of seamounts with various geometries and their disintegration within accretionary wedges. The main pursuit is now to improve the computer-based analysis of the obtained images and to implement the particle image velocimetry.

No. GA20-14292S: **Mercury – overlooked threat in the Czech ecosystems responding to global change *(T. Navrátil;* F. Oulehle, Czech Geological Survey, Prague; 2020–2023)**

After completing the two hydrological years 2021 and 2022, we can conclude that annual wet Hg deposition fluxes to all the GEOMON catchments were low, ranging from 1.1 to 2.3 $\mu g \cdot m^{-2}$ and throughfall 2.7 to 8.1 $\mu g \cdot m^{-2}$. The lowest annual wet Hg deposition flux occurred in catchment ANE, Vysočina Region, and the highest at UDL in the Orlické hory Mountains. In case of throughfall Hg flux, the lowest one was in LES, Central Bohemian Region and the highest was in UHL, in the Jizerské hory Mountains. Overall low values result from significant decline in Hg emissions in Czechia and in Europe over the past two decades. Nevertheless, the highest both annual wet and throughfall Hg deposition fluxes were at the mountainous sites in the border areas with Poland, while the lowest ones in the central part of Czechia with relatively low precipitation amounts.

Much more variable were the annual stream outputs from the GEOMON catchments ranging from 0.2 $\mu g \cdot m^{-2}$ at ANE to 6.9 $\mu g \cdot m^{-2}$ at PLB. Stream water Hg outputs from the forest ecosystems are mostly determined by the DOC outputs. Thus the highest output was at PLB catchment with the highest stream water DOC concentration. DOC concentrations increase during episodic hydrological situations, thus elevated Hg outputs from catchments occur during the years with high precipitation totals.

However, the most significant input to the forest ecosystems was the litterfall. Compartments of the coniferous trees deposited to the soil surface were rich in Hg the mean concentrations of Hg in litterfall mix ranged from 54.6 to 98.9 $\mu g \cdot kg^{-1}$. Using the mean deposition of biomass of 553 $g \cdot m^{-2}$ at the monitored coniferous plots, the mean annual deposition comes at 54.7 $\mu g \cdot m^{-2}$. Thus litterfall was by an order of magnitude greater input flux when compared to the mean wet and throughfall Hg deposition. The extent of the litterfall Hg deposition depends on the biomass production at a site and gaseous elemental mercury (GEM) concentration in the air.

Plants assimilate GEM from the air during the photosynthetic processes and Hg remains fixed in the assimilatory organs and all the other plant compartments. Thus another task was to the determination of GEM levels at the individual sites. The measurements using the passive sampler techniques indicated that GEM concentrations in air of the Czech forest ecosystems are low, ranging from the lowest 1.25 $ng \cdot m^{-3}$ at ANE to the highest 1.66 $ng \cdot m^{-3}$ at

FIG. 36 Alternation of chert (jasper, violet) and claystone beds, Mona Complex, Wales. Photo by L. Ackerman.

JEZ. These results demonstrated that at all the catchments GEM concentrations in the air are lower than the global background value 1.5–1.6 ng·m^{-3}. The only elevated values were noticed at sites JEZ and NAC in the Krušné hory Mountains (**Fig. 37**) along the northwestern border of the Czech Republic and Germany. Here, elevated GEM originated from the Hg emissions by the coal power plants burning lignite mined in the North Bohemian Coal Basin.

Majority of the deposited Hg remains stored in soils of forest ecosystems. Within the soils, Hg is bound to soil organic material and its future fate will be determined by its stability.

No. GA20-23363S: **Biostratigraphy and faunal dynamics of the Silurian pelagic biota of the Prague Basin in the context of major environmental changes and perturbations (*P. Štorch, L. Slavík, Z. Strossová;* Š. Manda, Czech Geological Survey, Prague; 2020–2023)**

Range charts of 386 graptolite species recorded in situ in the Silurian succession of the Prague Basin served as a fundament of our comprehensive paper on Silurian graptolite biostratigraphy and faunal dynamics, published in the Bulletin of Geosciences. Bed-by-bed sampling of 46 localities and sections, supplemented by published graptolite records from another 42 localities, allowed for recognition, definition, and description of 46 graptolite biozones and 7 subzones; **Fig. 38**). The durations of these biozones, deduced from correlation with the Geological Time Scale 2020 age model and the global standard graptolite biozonation, range between ca 0.1 and 1.74 Myr. The Petalolithus folium Biozone is introduced as a replacement of the nearly equivalent Pribylograptus leptotheca Biozone because the latter is a less common and less easily identified index taxon. The range charts provided a solid data source for subsequent study of regional graptolite faunal dynamics, traced by means of species richness per biozone, mean standing diversity, time-normalized Van Valen's metrics, and FADs/LADs score per biozone. Construction works on new metro line D in Praha-Pankrác offered a unique opportunity to study middle Telychian part of the Litohlavy Formation (griestoniensis, tullbergi and lower spiralis biozones) which is barely accessible in any surface exposures. Some data acquired with new subsurface samples have already been incorporated in this paper.

A graptolite-rich section near Estana in Spanish Pyrenees was used as a primary reference in our search for precise stratigraphical delimitation of the early–mid Rhuddanian and Ordovician/Silurian boundary gaps of sequence stratigraphic significance in the Prague Synform. All short-ranging graptolite assemblages recognized in various partial sections of Rhuddanian age across the peri-Gondwanan Europe were found in a successive order in the Estana section. Particular attention was given to the upper acuminatus and lower vesiculosus biozones, which is a crucial but little known interval of early monograptid radiation, entirely missing in the Prague Synform due to a basin-wide gap in sedimentation.

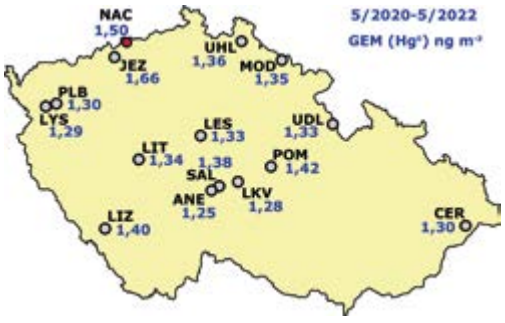

FIG. 37 A map of mean gaseous elemental mercury (GEM) concentrations at monitored catchments of the GEOMON network and experimental site Načetín (NAC). Illustration by T. Navrátil.

Chronostratigraphic division of the Přídolí Series is proposed in the paper published in Newsletters on Stratigraphy. Correlation markers applicable in the division of the Series into two stages are discussed based on data from relevant sections in the Prague Synform. Graptolite *Wolynograptus bouceki* is suggested as the most promising marker for a definition of the base of the upper, Radotinian stage of the Přídolí. Conodont *Delotaxis detorta* enters close to the base of the *bouceki* Biozone as did also pelagic cephalopod *Kopaninoceras fluminese*. Negative to slightly positive $\delta^{13}C_{carb}$ values coincide with the base of the *bouceki* Biozone. The *Hvížďalka* section with uninterrupted sedimentation and integrated graptolite and conodont biostratigraphy and geochemical records is proposed as a potential GSSP of the Radotinian Stage.

FIG. 38 Gorstian (upper Silurian) subzonal index graptolite *Saetograptus fritschi* (Perner) from the Řeporyje section. Photo by P. Štorch.

***No. GA21-10799S:* Environmental control on the rise and fall of the earliest land plant assemblages of Silurian volcanic islands of the Prague Basin (Czech Republic) (*J. Bek*; J. Pšenička, West Bohemian Museum, Pilsen; J. Frýda, Czech University of Life Sciences, Prague; J. Kvaček, National Museum, Prague; 2020–2023)**

The aim of the project is the reconstruction of diversity of earliest land plants occuring in marine sediments of Silurian volcanic islands of the Prague Basin. Macrofossils and spores of land plants are recorded together with precisely dated marine faunas. It enables determining of the time of existence of emerged volcanos and subsequently also the development of terrestrial environment in context of global and local environmental changes. Terrestrial Silurian sediments are almost absent in this area and therefore it is possible to reconstruct the environment of earliest land plants based only on dispersed spores and sedimentary records of marine strata, i.e., mineralogical and geochemical composition of detrital components. The research of sediments includes the character of terrestrial weathered "soils", the type and speed of weathering and intensity of volcanic activities. The significantly multidisciplinary project is focused on the characterization of the environment and occurrence of the earliest land plants, and includes paleobotanical, palynological, sedimentological and geochemical methods. One of the most significant outputs is the occurrence of the globally oldest monolete spores (432 Myr).

***No. GA21-21829S:* Proposal for the GSSP of the Basal Emsian Boundary in the Prague Synform (*L. Slavík, J. Hladil, H. Weinerová, T. Weiner*; 2021–2023)**

In 2022, the team invested most time again to field work in the "home area" – working on sections, measurement, evaluation, sampling; and to laboratory works – processing of biostratigraphic samples, samples for geochemistry, magnetic susceptibility (MS) sample measurements and gamma-ray spectrometry measurements evaluation. The Pragian–Emsian sections in the Prague Synform were studied in order to complete large biostratigraphical and chemo-physical datasets. After evaluation of biostratigraphic data obtained from the previous intense sampling of 2021, the main focus was on two most promising sections with potential of GSSP candidate with presence of the Bohemian Graptolite Event (BGE): Pod Barrandovem and Mramorka Quarry. The team concentrated on dense conodont sampling of short specific intervals in both sections in order to approximate the FADs of critical conodont taxa. The stratigraphically most important taxa obtained from the Mramorka section are: *Caudicriodus curvicauda, Caudicriodus celtibericus, Criteriognathus steinhornensis miae* and *Latericriodus bilatericrescens gracilis*. All these taxa were recorded close and within the BGE. In the Pod Barrandovem section, taxa *C. curvicauda, C. celtibericus* and *L. b. gracilis* were obtained from a lower level in the section than previously recorded. These taxa indicate the early Emsian conodont zone gracilis/exc. – *gronbergi*. New conodont material obtained from stratigraphically older strata enabled a more precise recognition of the steinachensis beta – *brunsvicensis, brunsvicensis – celtibericus* and *celtibericus – gracilis*/exc. Zones. While the microfacies study of the Mramorka section showed an increased dolomitization in studied interval of the uppermost part of the Prague Formation, the corresponding beds of the Pod Barrandovem section are heavily silicified. Bulk carbonate $\delta^{18}O$ and $\delta^{13}C$ records, GRS measurements, MS measurements and data from INAA geochemical analyses across the BGE interval from the Mramorka, Požáry-3 and pod Barrandovem sections have been already evaluated and correlated with the new biostratigraphic framework.

***No. GA21-26542S:* Influence of postgenetic alterations of granites on their resistance to weathering processes in cultural heritage structures (R. Přikryl, Faculty of Science, Charles University, Prague; *T. Lokajíček, M. Petružálek, A. Aminzadeh*; Z. Weishauptová, D. Řimnáčová, Inst Rock Struct Mechan, Czech Acad Sci, Prague; 2021–2023)**

Postgenetic alteration processes (e.g., hydrothermal alteration) accompanied with brittle damage and secondary mineral fillings are common in granites used in construction. These alterations are manifested by discrete phenomena in rock-forming minerals and rock microfabric (e.g., alteration of more basic cores of plagioclases, recrystallization of quartz aggregates and formation of discrete microcracks filled with clay minerals). The question of the influence of these discrete mineralogical and microstructural changes on mechanical properties and on behavior during weathering processes has been neglected in previous studies. This might be influenced by the fact that the above mentioned discrete changes in original rock magmatic fabric have a negligible impact on the examined strength characteristics but can significantly influence stress-strain behavior which is still scarcely examined on materials from cultural heritage structures. Similarly, the influence of the type of mineral filling on deformational characteristics and on durability has not been studied yet.

FIG. 39 Excavation site of the Late Pliocene locality Camp dels Ninots (Caldes de Malavella, Catalonia, Spain). Photo by T. Přikryl.

***No. GA21-33751S:* The Late Pliocene lower vertebrates (fishes and frogs) from the konservat-lagerstätte Camp dels Ninots (north-eastern Spain) (*T. Přikryl*; 2021–2023)**

The project evaluates lower vertebrates (fish and frogs) of the Camp dels Ninots locality in the Catalonia from the systematic and paleoecological viewpoints (**Fig. 39**). Unfortunately, difficult nomenclatoric history of some taxa, unclear systematic position of the earlier described relatives, together with high endemism of the Iberian Peninsula fish and persisted complications related to epidemiological restrictions and ongoing COVID-19 pandemic all induced numerous complications altering the schedule and causing delays in the preparation of final results.

The Leuciscinae fish from CdN belongs to genus *Squalius* rather than *Leuciscus*. Preliminary results were presented during the 8e RIF conference in Paris (oral presentation titled "*New data on leuciscine fish from the Pliocene of the Camp dels Ninots site (Girona, Spain)*"). The *Barbinae* specimens from CdN should be classified within genus *Luciobarbus*. Ongoing results were presented within IPC6 as a poster entitled "*New data on Barbinae fish from the Pliocene of the Camp dels Ninots site (Girona, Spain)*". During the TAPHOS meeting (Alcala, Madrid) a possibility of using cyprinid pharyngeal teeth from CdN as a taphonomic indicator was presented (poster titled "*Pliocene cyprinid pharyngeal teeth at the Camp dels Ninots Konservat-Lagerstätte (Caldes de Malavella, NE Spain) – comments to preservation*").

Specimens of frogs from earlier CdN excavation campaigns were documented graphically (10 articulated specimens) and interpreted taphonomically. Some 59 additional articulated fossil frog specimens from the Miocene locality of Libros (Teruel, Spain), crucial for correct interpretation of CdN frogs, were studied and documented from different Spanish Natural History Museums. These frogs have never been formally studied from an osteological point of view, besides a first preliminary description in the unpublished doctoral thesis of Borja Sanchiz (1977). Osteological characterization of Pelophylax meriani (Miocene of Germany) is expected during 2023 (because of possible synonymies between P. meriani, P. quellembergi and/or P. pueyoi).

***No. GA22-00580S:* The role of rock anisotropy in hydraulic fracturing through acoustic emission (*T. Lokajíček, M. Petružálek, A. Aminzadeh, T. Svitek*; J. Šílený, P. Kolář, Z. Jechumtálová, Geophys Inst, Czech Acad Sci, Prague; 2022–2024)**

Recently, a large variety of different aspects/features of the set-up of the hydraulic fracturing (HF) has been investigated. Texture anisotropy and/or crack anisotropy have a great influence over the effective mechanical properties of rocks and the way of their fracturing and failure. We believe that the influence of texture and/or crack anisotropy, as a characteristic property of most of the rocks, deserves to be studied in greater detail. The proposed project is a joint study concerning laboratory HF experiments and application of advanced seismological methods to registered acoustic emission. The HF will be performed on the rock analogue of anisotropic mica schist from the research geothermal center at the Litoměřice site, Czechia. Stress conditions will simulate the actual test site at the depth of 1 km. Advanced seismological methods will be implemented to anisotropic conditions and applied to detail analysis of registered acoustic emission. This research will lead to a better understanding of the role of the rock texture/crack anisotropy on the HF.

***No: GA22-02149S:* Reconstruction of medieval castle kitchen operation in relation to waste management on Rokštejn Castle example (J. Mazáčková, Faculty of Arts, Masaryk University, Brno; *L. Lisá;* 2021–2023)**

Castle kitchens represent specific features of fortified residences, along with their operation. The project focuses on interdisciplinary research of reconstructing such operation, based on facts from archaeological layers. The case study is represented by the Rokštejn Castle, excavated since 1981. New excavations allowed us to determine the term of kitchen waste in castle environment. Detection of different environmental proxies allowed us the first interpretations of the evolution of the castle kitchens, not only in relation to time, but also to the dynamic rebuilding of the castle with the changes in castle ownership. Several sections studied in 2022 brought interesting data related to the redistribution of kitchen waste and its implementation to the cultural layers inside and outside the main corridors.

***No. GA22-15405S*: Early diagenetic cycling of redox-sensitive geochemical proxies and palaeoclimatologic significance of continental red beds (O. Bábek, D. Šimíček, J. Kapusta, O. Šráček, T. Pluháček, Faculty of Science, Palacký University, Olomouc; *L. Ackerman, H. Weinerová, J. Rejšek, J. Ďurišová, N. Mészárosová, V. Renčiuková;* 2022–2024).**

First year of the project was predominantly focused on sampling. In this respect, we performed detailed sampling of Quaternary Pleistocene glacifluvial and glaciolacustrine sand deposits in northern Bohemia (e.g., Grabštejn, Dubnice). Here, a special attention was given to red and black layers that consist of Fe-Mn (hydro)xides that hold a key to redox element cycling. In autumn, we performed fieldwork in the southwestern Wales logging and sampling three different stratigraphic intervals of red beds in Lower Old Red Sandstone Formation (Pembrokeshire; **Fig. 40**). During

FIG. 40 Vertically rotated Old Red Sandstone Formation, Pembrokeshire, Wales. Photo by L. Ackerman.

these two fieldtrips, hundreds of samples were collected for basic XRF geochemistry whereas about 30 samples were selected to perform detailed geochemical analyses including Mo-Fe isotopic analyses. The analytical works at the Inst Geol, Czech Acad Sci comprise especially development and adjustment of methods for the needs of the project. First of all, elemental LA-ICP-MS mapping of small-scale structures was tested in order to visualize the mobility of redox-sensitive elements (e.g., Fe, Mo, U, V) between different Mn-Fe (oxy)hydroxide phases. In terms of isotopic geochemistry, after a long delay, uranium double-spike ($^{233}U/^{236}U$) was finally delivered and this permit starting to setup uranium isotopic protocol at the Inst Geol, Czech Acad Sci. In this respect, ion exchange protocol for U separation was tested and adjusted for bigger sample weights, and TIMS procedures were optimized.

FIG. 41 Recently identified 211 g Muong Nong-type moldavite from the locality of Byňov near Nové Hrady in South Bohemia. Photos by M. Trnka.

***No. GA22-28249S:* Muong Nong-type-like moldavites in understanding the strewn field geometry and tektite origin (*R. Skála, N. Mészárosová, Š. Matoušková*; 2022–2024)**

Nine samples from localities of Byňov/Jakule, Slavče near Trhové Sviny, Krasejovka, Dříteň, Truskovice, Besednice/Stoh, Vrábče, and Záblatí/Radomilice were newly acquired to supplement the existing collection comprising highly heterogeneous layered moldavites. The principal contribution of the new sample set covers northerly-situated parts of the South Bohemian partial strewn field; so far, this particular type of moldavites is known from only the southernmost localities in the strewn field. Optical observations of polished thin sections revealed what is called a "shimmering structure" in the literature as one of the characteristic features observed in Muong Nong-type tektites of the Australasian strewn field.

Next, the thin sections were imaged with an SEM to select areas with the largest compositional differences as pictured by BSE contrast. These spots were then analyzed with an EPMA. Typically, twenty to 40 chemical analyses were collected from each thin section. This number of analytical points is believed to provide robust enough information on chemical variability within each sample. Also, chemical variability among individual samples will be described satisfactorily with such a number of analytical points within each sample. The most intriguing observation is a depletion in calcium and magnesium in all Muong Nong-type-like moldavites in comparison to splashform moldavites sampled at the same localities. In this context, it should be noted that comparable chemistry is observed in Moravian moldavites; actually, South Bohemian moldavites are even more depleted in Ca and Mg than Moravian moldavites. Next to major element compositions, minor and trace element contents were measured by a LA-ICP-MS technique. REE patterns are close to the UCC reservoir attesting to a similar source material pool as other moldavites.

By the end of the year, a unique sample of moldavite was identified from the locality Byňov near Nové Hrady. Its appearance is similar to the typical blocky tektites of the Muong Nong type of the Australasian strewn field. It is an irregular flat fragment of 90 × 59 × 33 mm in size (**Fig. 41**). The weight of the fragment is 211.8 g. It represents the heaviest South Bohemian moldavite as yet discovered. Its chemical composition was measured by an SEM/EDS under low-vacuum conditions. Because of its uniqueness, the sample cannot be either sampled destructively or carbon-coated to obtain reliable compositional data. Nevertheless, the chemical data measured are consistent with other similar layered moldavites from this region. Preliminary results will be published in the proceedings of the Lunar and Planetary Science Conference as the abstract.

No. GJ20-23550Y: **Exploring developmental aspects in fossil arthropods during Cambrian explosion and Ordovician biodiversification (*L. Laibl*; 2020–2023)**

The project is focused on the evolution of arthropod development between two major events in Earth's history – the Cambrian explosion and Ordovician biodiversification. In particular, the project describes minute larval stages of long-extinct trilobites and relatives of today's crabs or spiders. During the third year of the project, L. Laibl explored temporal changes in the distribution of benthic and planktic trilobite early developmental stages. Trilobites ancestrally (originally) possessed exclusively benthic stages and these forms dominated Cambrian ecosystems. The planktonic larval stages evolved during the end of the Cambrian and the beginning of the Ordovician. Consequently, Ordovician ecosystems comprised a significant number of trilobites with planktonic larvae and these were an important part of the marine trophic web. Another research was related to the description of the early developmental trilobite stages from the Fezouata Shale (Morocco). Stages of nine trilobite species were described from this Early Ordovician Lagerstätte, some of which show remains of soft tissues (e.g., appendages, gut). The extraordinarily large size of some of these early post-embryonic stages suggests that these trilobites might have hatched from yolk-rich eggs and might be explained by low temperatures and seasonal or low productivity in the high-latitude margin of Gondwana. Finally, the research on the new site within Fezouata Shale – Taichoute – was published. This site shows a low-diversity pelagic arthropod community.

6C GRANT AGENCIES OF UNIVERSITIES

FINISHED PROJECTS

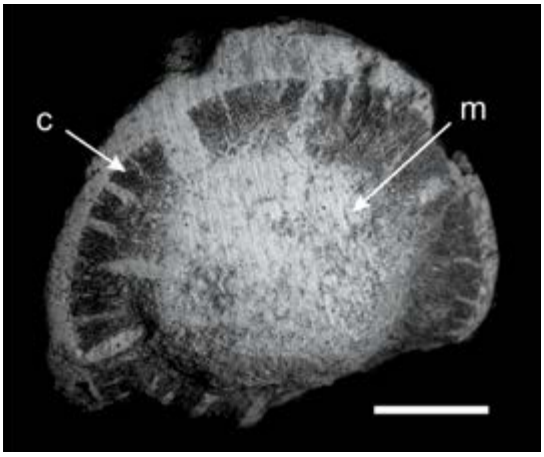

FIG. 42 SEM image of *Pachytheca Hooker* fossil preserved in cross-section. The central part (m), medulla, represents a cluster of omnidirectionally arranged tubules. The contrast section (c), cortex, is composed of radially arranged tubules. The outer part is not preserved. Scale bar 1 mm. Photo by M. Uhlířová.

GAUK No. 243-251220: **Review of Tertiary turtles from the Most Basin (Czech Republic) and their global importance (*M. Chroust*; 2019–2022)**

Turtles (Testudinata) are a diversified group of reptiles of 365 extant living species and belong to the longest living terrestrial animals. Turtles are common in sediments because their typical shells are resistant to biodegradation, and lot of turtles live in aquatic or semi-aquatic environment with high potential for fossilization. Tertiary deposits from the Czech Republic yielded many important finds of fossil turtles. Four genera have been described from the Most Basin: Chelydropsis, *Ptychogaster, Testudo* and *Trionyx*. Most of the material has never been revised after its description, and most of the taxa are invalid. Since the beginning of the last century, the peak of turtle paleontology, new material has been found, waiting for a scientific investigation. This project has the aim to revise the historical material and describe new material using new methods.)

ONGOING PROJECTS

GAUK No. 354821: **Caldera volcanism of the European Variscan belt: insights from structure and rock-magnetism (*P. Vitouš*; 2021–2023)**

Felsic collapse calderas and their eruptive products are present in different geotectonic environments of the European Variscan orogenic belt. The evolution of these calderas is often obscured by erosion but can be studied through various methods on remaining volcanic deposits, such as voluminous ignimbrites (the deposits of pyroclastic density currents) that are often associated with large caldera-forming eruptions. Permocarboniferous Gréixer rhyolite complex, a relic of intracaldera ignimbrites situated in the Paleozoic to Mesozoic Castellar de n'Hug Basin in the Catalan Pyrenees, is an example of these post-Variscan calderas. In this project, a complex structural, petrographic, rock-magnetic, and paleomagnetic investigation was conducted to unravel the depositional history of the ignimbrite body, as well as to locate the source area or even characterize the collapse style of the caldera. The field works in Catalonia were performed along with Spanish colleagues from the Consejo Superior de Investigaciones Científicas (CSIC) in Barcelona.

Some of the preliminary results were presented at an international conference, describing among others the source of magnetic signal being carried dominantly by magnetites or well-preserved Paleozoic magnetic remanence. The conclusive work will be submitted in the form of a scientific paper in an international journal by the end of the year 2023.

***START No. SCI/139*: Cuticles from the Lower Paleozoic of the Barrandian area (*Z. Strossová, M. Uhlířová;* V. Kovář, O. Fatka, Faculty of Science, Charles University; 2021–2023)**

Palynological residues obtained by dissolving rock samples often contain abundant microscopic structures derived from former macroscopic organisms. These structures often comprise cuticular fragments of metazoan and plant origin. However, the classification of these isolated objects is usually problematic.

This project is focused on the study of cuticles and other structures of macrofossils, of both plant and metazoan affinities, e.g., to apply palynological method separately to individual parts of macrofossil remains. It means, to extract parts of bodies of various compositions (mainly carbonaceous and phosphatic in composition) from macrofossils utilizing acid maceration methods. This will allow a direct comparison of micro- to mesoscopic elements with the given part of the macroscopic organism and allow a direct correlation of microscopic and macroscopic remains. Ultimately, this can result in a much better understanding of both the macroscopic and microscopic fossil record of the studied taxa.

Samples collected from several localities of the Lower Paleozoic of the Barrandian area (Czechia) and deposited in the public collections will be used for this study. To test the applicability of the maceration technique, fossils from several stratigraphic levels of the Cambrian through Silurian of the Barrandian area will be studied. The stratigraphic levels were chosen based on the preservation and abundance of suitable macrofossils (of both plant and metazoan affinity); these include the Cambrian Paseky Shale of the Příbram-Jince Basin; several levels in the Ordovician, and selected sites of the Silurian and Devonian, all in the Prague Basin. Each of the units contains specific fossils and is characterized by a suitable lithological development; therefore, the methodology will be developed and tested on various samples. Maceration techniques to obtain residues consist of the application of inorganic acids (hydrochloric and hydrofluoric). The concentration of acids and time of exposure depend on the composition of the fossils and lithology of the samples. Observation of the obtained objects is carried out using optical microscopy or scanning electron microscopy. Preliminary results of the project include detailed descriptions of the cuticles of phyllocarid crustaceans, tentaculites, and new insights into the ultrastructure of the enigmatic genus *Pachytheca Hooker* (**Fig. 42**).

6D GRANTS OF THE STATE DEPARTMENTS

FINISHED PROJECTS

Ministry of the Interior of the Czech Republic, "Program bezpečnostního výzkumu České republiky 2015–2022", Project No. VI20192022148: Complex instrumental protocol for the characterization of selected mineral phases with a link to specific geographic origin (D. Matějka, M. Racek, L. Strnad, J. Zachariáš, Faculty of Science, Charles University, Prague; *R. Skála, L. Ackerman, Š. Matoušková, L. Polák, N. Mészárosová, P. Mikysek*; M. Kotrlý, I. Turková, J. Wolker, Institute of Criminalistics, Police of the Czech Republic, Prague; J. Sejkora, Z. Dolníček, J. Hyršl, J. Ulmanová, National Museum, Prague; 2019–2022)

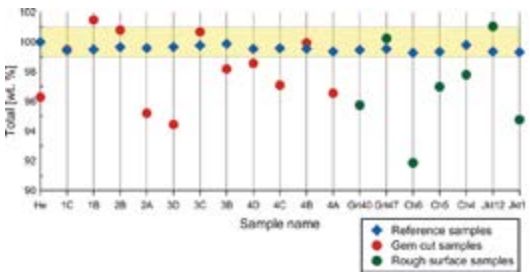

FIG. 43 A plot of analytical totals for EPMA analyses of rough grains and gemstone cuts of garnets compared to the data measured for the same materials prepared as polished sections. The yellow-highlighted band shows ± 1 wt.% range which is generally accepted to indicate reliable analysis. Original by N. Mészárosová.

Optical microscopy methods were used to document a total of 1,000 garnet grains from the following locations and drill cores: Tr-1, Linhorka, T-7, T-31, Chrášťany, Měrunice, Vestřev, Rokytka, Granátový potok in the Český středohoří Mts. and further from diamond mining areas in Yakutia (Russia), Arizona (USA), from the mine near Umba (Tanzania), and from Bobrovka (Russia). A total of 430 individual samples of these grains were characterized by electron microscopy methods, and approx. 5,000 EPMA and approx. 900 SEM-EDS analyses of garnets were taken. At the same time, mineral inclusions of rutile, zircon, apatite, quartz, minerals from the amphibole group, spinel group minerals, pyroxenes, feldspars, carbonates and others were studied in most of the characterized samples (~300 garnets). By observing the distribution of these inclusions, it was found that in many cases their distribution was uneven. Single-phase inclusions of olivine, monazite and pyroxenes were rarely identified. In some cases, high-pressure minerals were also found, such as kyanite or polymorphic modifications of feldspars (kumdykolite and kokchetavite). In total, 1,200 inclusions were studied by SEM and 700 of them by EMPA. In addition, Raman and photoluminescence spectra were taken for a significant part of the chemically characterized garnets and the inclusions they contain. Measured data as well as achieved results were incorporated into the SW application that was developed as one of the results of the project.

Analytical procedures tested in the last year of the project pointed out the risks of using EPMA and LA-ICP-MS methods when the samples are inadequately prepared. It was confirmed that EPMA is susceptible to provide incorrect results with even a slight deviation of the analyzed area from the required orientation. This is illustrated in **Fig. 43**, which compares analytical totals for raw and polished samples. The data collection procedures need to be further developed, optimized and tested. However, for the most part, the outputs from the analyses were used to insert into the developed SW application. Analytical approach to the characterization of inclusions significantly expanded their knowledge because a mere optical study does not allow determining the nature of especially polyphase inclusions. In addition, the results of measurements of major and trace elements and the contribution of Raman and photoluminescence spectroscopy were critically evaluated in the last year.

6E INDUSTRIAL GRANTS AND PROJECTS

Bohemian Switzerland National Park Administration, Krásná Lípa, Project No. 7407: Monitoring of Atmospheric Precipitation in the Bohemian Switzerland National Park (T. Navrátil, I. Dobešová, J. Rohovec, Š. Matoušková)

Monitoring of geochemical parameters at the site of Kuní vrch follows the more or less stable development of the current trends in deposition without significant changes. Even despite the above-average precipitation in the hydrological year 2021, the deposition of sulfate (SO_4^{2-}) and nitrate (NO_3^-) decreased in the spruce stands. The wet deposition of SO_4^{2-} and NO_3^- did not change significantly and the average pH of the both types of precipitation remained > 5. 0. After 5 completed hydrological years we can conclude that wet deposition of Hg in the Bohemian Switzerland National Park (BSNP) was low and comparable to the background sites in Europe and North America.

The database on atmospheric deposition in the BSNP with a monthly step at the KV site, which continued without any stops since May 2008 until June 2022, includes 170 records containing the data on chemical composition of bulk and throughfall precipitations.

Charles University, Prague, Project No. 7004: Strontium isotopic composition of Cretaceous belemnites (L. Ackerman, J. Rejšek)

A joint project with M. Košťák dealing with Sr isotopic compositions of belemnites from the Czech Republic.

Charles University, Prague, Project No. 7012: Dissolution and reprecipitation of garnet during eclogite-facies metamorphism (M. Svojtka, J. Ďurišová)

A joint project with the Czech Geological Survey focused on the determination of three different tectono-metamorphic stages of the early Paleozoic volcano-sedimentary evolution of the Khovd and Gobi-Altai zones of the Mongol-Altai Domain on the basis of U-Pb dating and petrographic investigations.

Several evolutionary stages were identified: (1) Cambrian–mid Ordovician basaltic and rhyodacitic volcanism and sedimentation; (2) late Ordovician flysch-type sedimentation accompanied by a volcanic gap coinciding with Barrovian metamorphism, and (3) Silurian–Devonian within-plate bimodal volcanism followed by mature siliciclastic deposition interpreted as transformation of the former fore-arc region into a back-arc domain associated with HT metamorphism.

Comenius University, Bratislava, Slovakia, Project No. 7004: Sr-Nd-Pb isotopic compositions of Permian volcanic and plutonic rocks from the Carpathians (L. Ackerman, V. Renčiuková, J. Rejšek)

A joint project with Faculty of Science, Comenius University (M. Putiš) focused on the petrogenesis of volcanic and plutonic rocks from the Carpathians.

Goa University, India, Project No. 7004: Highly siderophile element and Re-Os isotopic compositions of volcanic rocks from India (L. Ackerman, J. Ďurišová, J. Rejšek)

A joint project with Goa University (S. Ganguly) dealing with the nature of sources of Indian MORB-basalts.

Inst Archaeol, Czech Acad Sci, Prague, National Museum, Prague, Charles University, Prague, Muzeum Vysočiny, Jihlava, Ústav památkové péče, Brno, Project No. 7004: Strontium isotopic compositions of selected burial grounds (L. Ackerman, V. Renčiuková, J. Rejšek)

A joint project dealing with Sr isotopic compositions of enamels, bones and artefacts from selected burial grounds in the Czech Republic.

Inst Rock Struct Mechan, Czech Acad Sci, Prague No. 7172: (U-Th)/He dating of zircons and apatites (Š. Matoušková)

Thermochronological project with the Institute of Rock Structure and Mechanics of the Czech Acad Sci focused on dating of geological samples from upper crust. The Inst Rock Struct Mechan, Czech Acad Sci provides He measurements and sample preparation for the Inst Geol, Czech Acad Sci isotope analyses of U, Th and Sm.

Prague City Museum, Prague Inst Archaeol, Czech Acad Sci, Prague, Project No. 7004: Re-Os isotopic compositions of artefacts, slags and ores (L. Ackerman, V. Renčiuková, J. Rejšek)

FIG. 44 Sandstone quarries (A, C) and historical monuments they produced material for (B, D) in the Děčín area: A) Ruhr Quarry, Pod stěnami area near Tisá; B) Tyrš Bridge in Děčín: ashlars of the durable lowermost segments of the bridge probably come from the Pod stěnami area; C) Lohmgrund II Quarry near Cotta, Saxony; D) a statue in the portal of the St. Anthony of Padua Church at Milešov, very probably carved from the Cotta sandstone. Photos by J. Adamovič.

A joint project with D. Bursák dealing with Re-Os isotopic compositions of artefacts from selected burial grounds as well as slags and ores in Czechia.

Municipal Museum of Ústí nad Labem and Faculty of Arts, Jan Evangelista Purkyně University in Ústí nad Labem, Project No. 7464: **Petrographic study for project Database of old quarries and mine workings in the territories of the Bohemian Switzerland National Park and the Elbe Sandstones Protected Area, Technological Agency of the Czech Republic ÉTA Programme, No. TL05000407 (*J. Adamovič*)**

Within the project reviewing old quarries and mine workings in the Děčín area (**Fig. 44**), one of the tasks was to determine the specific usage for dimension stone extracted in hundreds of sandstone quarries in this area since Medieval times. Twelve historical monuments built from local sandstone were selected and their possible source localities were tested using a set of standard methods, like optical microscopy, X-ray diffraction analyses, scanning electron microscopy and microanalysis, and mercury porosimetry. All analyzed sandstone samples come from the Bílá hora nd Jizera formations of the Bohemian Cretaceous Basin. The chapel and the tomb at Děčín-Podmokly were confirmed to exploit sandstone from the near Schinderwand Quarry, the church at Terezín probably utilized stone from the Goldnen Ranzen mining area south of Hřensko, the gate at Terezín best fits the Jizera Formation sandstone from Děčín (e.g., Pastýřský vrch), the Tyrš Bridge in Děčín utilized multiple sources including the Goldnen Ranzen area near Hřensko and Pod stěnami area near Tisá. A silicified variety of sandstone from the latter area was used for the manufacture of millstones now kept at the Dolský Mill. A rather weakly silicified varieties of sandstone from Tiské Stěny and from Děčínský Sněžník Hill were probably used for the construction of a fort at Tisá and the lookout tower atop Děčínský Sněžník Hill, respectively. Sculptures from the church at Milešov were confirmed to have been made from the sandstone traditionally extracted at Cotta, Saxony (Cottaer Sandstein). A larger set of sandstone analyses from the Goldnen Ranzen mining area south of Hřensko permitted to define a set of common characteristics for this area, that will allow a reliable identification of this source among building stone used on historical monuments.

Beijing University, University of Hong Kong, China, Project No. 7004: **Highly siderophile element and Re-Os isotopic compositions of selected peridotites and mafic rocks from China (*L. Ackerman, V. Renčiuková, J. Ďurišová, J. Rejšek*)**

A joint project with Beijing and Hong Kong universities (S. Song, Ch. Wang) dealing with the nature of sources parental to, e.g., Tethyan ophiolites in China.

Beijing University, University of Hong Kong, China, Yuzuncu Yil University, Istanbul University, Turkey, Project No. 7042: **Lu-Hf isotopic signature of Archean to Modern volcanic rocks (*J. Sláma*)**

The facilities of the Clean lab were used for preparation of 6 different sets of volcanic rocks within various bilateral agreements. The sample sets cover very young (Recent) to very old (Paleorchean of ca 3.5 Gyr) volcanic rocks and cumulates (OIB basalts, ferropicrites, ophiolites, lherzolites, etc) from a number of geologic units worldwide. Those include the the Late Cretaceous to recent volcanics of Antarctic Peninsula Archipelago (NW Antarctica), Cenozoic basaltic volcanics of Eastern Turkey, basaltic volcanism on the Arabian plate, Paleoarchean of the North China Craton or ophiolites of the Paleo-Tethys. The precise Lu-Hf data obtained by ^{176}Lu-^{180}Hf tracer spiking are used to decipher the tectonic setting and origin of these various magmatic rocks and ultimately to understand the principal processes in broad spectra of geological environments during the evolution of the Earth.

Within the range of Lu-Hf technique employed in the labs of Inst Geol, Czech Acad Sci, analyses have been performed on the samples of orthogneises from the Western Carpathians to find the age of their metamorphism. The garnet-wr isochron technique revealed these rocks have been reworked intensively mostly during the Late Cretaceous. A number of in situ U-Pb and TE LA-ICPMS analyses were run in the ICM-MS lab of the Inst Geol, Czech Acad Sci within additional ca 15 projects with partners from all over the globe. For further development of the in situ dating techniques, a new reference materials of baddeleyite (Phalaborwa) and allanite (SWN208) were acquired.

St. Mary's University, Canada, Project No. 7004: **Sr-Nd isotopic compositions of selected volcanic and granitic rocks from Canada (*L. Ackerman, V. Renčiuková, J. Rejšek*)**

A joint project with St. Mary's University (J. Dostal) dealing with the Sr-Nd isotopic composition of Cenozoic and Precambrian volcanic/plutonic rocks from Canada.

Universidade Federal do Rio Grande do Sul, Brazil, Project No. 7004: **Sr-Nd isotopic compositions of selected granitic rocks from Brazil (*L. Ackerman, V. Renčiuková, J. Rejšek*)**

A joint project with Universidade Federal do Rio Grande do Sul in Brazil (M. F. Bitencourt, M. Battisti) dealing with the Sr-Nd isotopic composition of Precambrian plutonic rocks from Brazil.

University of Helsinki, Finland, Project No. 7004: **Strontium isotopic compositions of environmental samples from western Finland (*L. Ackerman, V. Renčiuková, J. Rejšek*)**

A joint project with University of Helsinki (K. Mannermanna) dealing with Sr isotopic compositions of environmental samples (stream and lake water, fish meat etc.) from western Finland.

University of Hong Kong, China, Project No. 7004: **Lead isotopic compositions of selected ophiolitic rocks from China (*L. Ackerman, V. Renčiuková, J. Rejšek*)**

A joint project with Hong Kong University (Ch. Wang) dealing with the Pb isotopic composition of Tethyan ophiolites in China.

University of Wrocław, Project No. 7001: **Evolution of ophiolitic rocks from Albania based on LA-ICP-MS analysis (*J. Ďurišová*)**

A joint project with J. Mikrut, dealing with trace element analysis of ultramafic and mafic rocks from ophiolitic massifs from Albania is used to reconstruct the history of the massifs and the nature of the magmatism that took place within them.

Yıl Üniversitesi, Turkey, Project No. 7004: **Highly siderophile element and Re-Os isotopic compositions of basaltic lavas from Turkey (*L. Ackerman, J. Ďurišová, J. Rejšek*)**

A joint project with Munzur University (O. Cimen) dealing with the nature of sources of Cenozoic basaltic rocks from eastern Turkey.

Vysoké učení technické v Brně, Fakulta informačních technologií **(*as the Contractor of the European Space Agency "ESA"*), *Project No. 7804:*** **Advanced compression noise reduction for hyperspectal imagers data (*T. Kohout, K. Chrbolková*)**

The project deals with the algorithm development for on-board denoising and compression of hyperspectral images obtained by spacecrafts in order to reduce volume of data transferred to the ground. The outcomes of the project will be applied to Earth observation and planetary exploration missions.

***Department of Survey and Geology, Severočeské doly, a. s., Bílina, Project No.7006*: Magnetostratigraphy of sediments in the Most Basin in the SD mining area (*P. Schnabl, Š. Kdýr*)**

The project was focused on rock samples taken from boreholes DO574, DO575 and AL507A, lithostratigraphically from Holešice and Duchcov formations. Collected samples were subjected to paleomagnetic and magnetomineralogical analyses in order to obtain information about the polarity of the Earth's magnetic field at the time of rock formation.

6F PROGRAMMES OF STRATEGY AV21 OF THE CZECH ACADEMY OF SCIENCES

Project No. 9223 within the VP20 **– Water for Life Programme: Water regime of the soil and watershed, precision water and mass balance of the mid-size watershed in the headwater area of the Bohemian forest (M. Tesař, Inst Hydrodyn, Czech Acad Sci, Prague; F. Oulehle, Global Change Res Inst, Czech Acad Sci, Brno; *T. Navrátil*)**

The passive samplers collected in years 2021 and 2022 to evaluate gaseous elemental mercury (GEM) concentrations indicate that mean GEM concentration at Poledník was 1.36±0.12 ng·m^{-3}. With respect to measurements at other remote forest sites, this represents low air Hg level. The concentration of Hg in the bulk precipitation at Poledník was 3 ng·l^{-1} representing an annual bulk Hg wet deposition of 3.7 µg·m^{-2}. The data suggest that mountainous ecosystems at the Bohemian Forest National Park are currently at low risk in connection with contamination by a global pollutant Hg.

Project No. 9229 within the VP20 **– Water for Life Programme: The interconnection between research and water management practice (*M. Svojtka, J. Ďurišová;* J. Kubečka, Biol Centre, Czech Acad Sci, České Budějovice)**

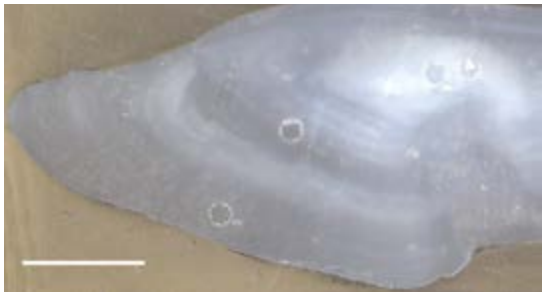

FIG. 45 A close-up of a pikeperch otolith from the Lipno Reservoir showing the growth zonation and four laser ablation ICP-MS concentration spots. The image was taken with a digital microscope Keyence VHX-700 at 400× magnification. Scale bar is 0.2 mm. Photo by T. Weiner and M. Svojtka.

Another set of otoliths for measurements on laser ablation ICP-MS technique was carried out at the Inst Geol, Czech Acad Sci. In cooperation with Biol Centre, Czech Acad Sci, it has been shown that the micro elemental composition of pikeperch otoliths is a very accurate tool to assess the natal origin of fishes, even in areas subjected to multiple stocking sources. The aim of the

recent study is to assess the prevalence of stocked individuals in the adult population in a system with a complex stocking enhancement program (multiple sources). Towards this end the microelemental composition of sagitta otoliths of pikeperch (Stizostedion lucioperca; **Fig. 45**), wild and stocked individuals were investigated. Four chemical elements (rubidium, strontium, potassium and magnesium) were found to differ between stocked and wild pikeperch. The machine learning classification algorithm was trained with data from fish of known origin to classify the origin of fish of unknown origin captured in the lake. The model had an overall accuracy of 91.5 %, with the accuracy for wild fish being 98.4 %, whereas for stocked fish from different rearing facilities ranging from 60 to 85.7 %. The model identified that the fish of unknown origin were predominantly autochthonous (88.6 %), with the contribution of stocked fish being minor (11.4 %). Due to the relatively small contribution of stocked fish into the pikeperch stock, the efficacy of the stocking program should further scrutinize in order to avoid the pursuing of management strategies that are neither efficient nor healthy for the fish stock.

6G PROGRAMMES OF INSTITUTIONAL RESEARCH PLAN

FIG. 46 Star quartz – a world unique form of quartz from Strážník Hill near Jilemnice, Czech Republic. Partricular star-like aggrerates up to 2 cm in diameter. Photo by M. Filippi.

Project No. 9346: **Variability of pedogenic processes on loess and loess loam in the northern part of the Bohemian Massif (*A. Žigová, P. Mikysek, M. Šťastný*)**

Project No. 9354: *Origin and compositional characteristics of amphibole of basalt–trachyte rock association with a transitional alkaline to calc-alkaline composition* (*L. Krmíček, J. Ulrych*)

***Project No. 9359: Study of fungal community and its chemical composition on serpentinite sites in the Czech Republic* (*J. Borovička*)**

***Project No. 9371: Star quartz – 200 years known mineralogical uniqueness, which has never been professionally studied* (*M. Filippi, K. Breiter;* Fig. 46)**

***Project No. 9375: Variability of nodules on the Loštice pottery* (*M. Šťastný*)**

***Project No. 9391: Isotopic Lu–Hf composition of the volcanic rocks from the Davle Volcanic Complex* (*V. Santolík, L. Ackerman, J. Sláma*)**

7. PUBLICATION ACTIVITY

7A PAPERS

12.1* Pisarzowska, A., Paszkowski, M., Kołtonik, K., Budzyń, B., Szczerba, M., Rakociński, M., ***Sláma, J.***, Zagórska, A., Łaptaś, A. Geotectonic settings of Variscan explosive volcanism in the light of Famennian tuffites provenance from southern Poland. *Earth-Science Reviews.* 2022, 234, 104218.

11.1* Ettler, V., Mihaljevič, M., Strnad, L., ***Hrstka, T.***, Kamona, F., Mapani, B. Gallium and germanium extraction and potential recovery from metallurgical slags. *Journal of Cleaner Production.* 2022, 379, 134677.

9.8* ***Borovička, J.***, Braeuer, S., Walenta, M., Hršelová, H., Leonhardt, T., Sácký, J., Kaňa, A., Goessler, W. A new mushroom hyperaccumulator: Cadmium and arsenic in the ectomycorrhizal basidiomycete *Thelephora penicillata*. *Science of the Total Environment*. 2022, 826, 154227.

8.9* ***Nováková, T.***, ***Navrátil, T.***, Schütze, M., ***Rohovec, J.***, ***Matoušková, Š.***, Hošek, M., Matys Grygar, T. Reconstructing atmospheric Hg levels near the oldest chemical factory in central Europe using a tree ring archive. *Environmental Pollution.* 2022, 304, 119215.

8.9* Venhauerová, P., Drahota, P., Strnad, L., ***Matoušková, Š.*** Effects of a point source of phosphorus on the arsenic mobility and transport in a small fluvial system. *Environmental Pollution.* 2022, 315, 120477.

7.2* ***Aminzadeh, A.***, ***Petružálek, M.***, ***Vavryčuk, V.***, Ivankina, T. I., ***Svitek, T.***, Petrlíková, A., Staš, L., ***Lokajíček, T.*** Identification of higher symmetry in triclinic stiffness tensor: Application to high pressure dependence of elastic anisotropy in deep underground structures. *International Journal of Rock Mechanics and Mining Sciences.* 2022, 158, 105168.

6.5* ***Chrbolková, K.***, Halodová, P., ***Kohout, T.***, Ďurech, J., Mizohata, K., Malý, P., Dědič, V., Penttilä, A., Trojánek, F., Jarugula, R. Sub-surface alteration and related change in reflectance spectra of space-weathered materials. *Astronomy & Astrophysics.* 2022, 665, A14.

6.2* ***Lisá, L.***, Mohammadi, S., Goláňová, P., Hajnalová, M., Bajer, A., Moska, P., ***Rohovec, J.***, Král, P., Kysela, J., Kočárová, R. Detection of occupational surface remnants at a heavily eroded site, case study of archaeological soils from La Terrasse, Bibracte oppidum. *Catena.* 2022, 210, 105911.

5.6* ***Bek, J.***, Opluštil, S., Drábková, J. Palynology of Late Pennsylvanian – Asselian strata of the Krkonoše Piedmont Basin, Czech Republic. *International Journal of Coal Geology.* 2022, 263, 104118.

5.6* Gotvaldová, K., ***Borovička, J.***, Hájková, K., Cihlářová, P., Rockefeller, A., Kuchař, M. Extensive collection of psychotropic mushrooms with determination of their tryptamine alkaloids. *International Journal of Molecular Sciences.* 2022, 23(22), 14068.

5.6* Suchý, V., Zachariáš, J., Sýkorová, I., ***Kořínková, D.***, Pešek, J., Pachnerová Brabcová, K., Luo, Q. -Y., ***Filip, J.***, Světlík, I. Palaeo-thermal history of the Blanice Graben (the Bohemian Massif, Czech Republic): The origin of anthracite in a late-Variscan strike-slip basin. *International Journal of Coal Geology.* 2022, 263, 104129.

5.4* Křenek, T., Stich, T., Docheva, D., ***Mikysek, P.***, Koštejn, M., Jandová, V., Fajgar, R., Pola, M., Kovářík, T., Moskal, D., Forejtová, M., Pola, J. Revisiting bioactivity of calcium titanate and titanium dioxide: Hydrolysis and complexation effects in osteogenic medium. *Surface and Coatings Technology.* 2022, 447, 128820.

5.4* Pohle, A., Kröger, B., Warnock, R. C. M., King, A. H., Evans, D. H., ***Aubrechtová, M.***, Cichowolski, M., Fang, X., Klug, C. Early cephalopod evolution clarified through Bayesian phylogenetic inference. *BMC BIOLOGY.* 2022, 20, 88.

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7C UNPUBLISHED REPORTS

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8. SCIENCE PROMOTION

8A MAGAZINES, NEWSPAPERS AND BOOKS

Adamovič, J. Stabilita Pravčické brány v souvislosti s požárem. [Stability of the Pravčice Arch in relation to fire]. *Blesk*, 27. 7. 2022, front page. (In Czech)

Borovička, J. A regular column on various topics related to science (7 times per year) called "Orientation" (Orientace) in Saturday issue of national newspaper *Lidové noviny*.

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8B TELEVISION AND RADIO BROADCASTING

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Borovička J. Houba místo plastu. Oblíbená reishi funguje v čipech a bateriích. Rozhovor: účinkující. *Český Rozhlas Plus.* [Mushroom instead of plastic. Popular reishi works in chips and batteries. Interview: performer. *Czech Radio Broadcast Plus*]. 10. 12. 2022, Praha. (In Czech)

Borovička J. Ranní interview Radiožurnálu. Rozhovor: účinkující. *Český Rozhlas 1 Radiožurnál.* [Morning interview. Interview: performer. *Czech Radio Broadcast Radiožurnál]*. 16. 10. 2022, Praha. (In Czech)

Cílek V. Jak upravit akropoli keltského oppida na Závisti? Komentář. *Česká televize, Přidej se, komentář.* [How to restore the Acropolis of Celtic oppidum in Závist? Commentary], *Czech television*]. 5. 4. 2022, Praha. (In Czech)

Cílek V. O památné hoře Blaníku. Spoluautor a účinkující. *ČR2-Leonardo.* [On memorable mountain of Blaník. Co-author and performer. *Czech State radio ČR2-Leonardo*]. 6. 9. 2022, Praha. (In Czech)

Cílek V. Jak vznikla Vltava. Rozhovor: účinkující. *Jihočeský rozhlas České Budějovice* [How evolved Vltava River. Interview: performer. *South Bohemian Radio České Budějovice*]. 16. 9. 2022, České Budějovice. (In Czech)

Cílek V., ***Adamovič J.*** Vlhošť. *ČRo Plus*, [Vlhošť Hill. *Czech Radio Broadcast Plus*]. 12. 6. 2022, Praha. (In Czech)

Mikuláš R. Oheň a pískovce Českého Švýcarska [Fire and sandstones of the Bohemian Switzerland]. *Czech Radio (ČRo) North,* October 20, 2022 (In Czech).

8C LECTURES FOR POPULAR AUDIENCE

Adamovič J. Vlhošť. [Vlhošť Hill] *Imesta s.r.o. Dubá–Dřevčice*. 7. 10. 2022, Dřevčice. (In Czech)

Adamovič J., ***Cílek V.*** Vlhošť a jeho pískovcová krajina. *Město Dubá, Dny evropského dědictví.* [Vlhošť Hill and its sandstone landscape. *Town of Dubá and Days of European Heritage].* 10. 9. 2022, Dubá. (In Czech)

Adamovič J., ***Cílek V.***, Podroužek, K. Vlhošť – hora v labyrintu skal. *Městská knihovna Česká Lípa.* [Vlhošť Hill – a mountain in a rock labyrinth. *Municipal Library at Česká Lípa].* 25. 10. 2022, Česká Lípa. (In Czech)

Adamovič J., Piller J. Kokořínsko – jak mluví skály. Pivovar Lobeč. [Kokořín area – speech of the cliffs. *Lobeč Brewery*]. 6. 5. 2022, Lobeč. (In Czech)

Cílek V. Water harvesting since prehistory to presence. IN/HABIT. A cross-disciplinary art/science/philosophy symposium, exploring ways of re-imagining our relationship with our mental and physical environment, born of the pressing need to change our habits to protect our habitat. Academy of Arts, Architecture and Design in Prague (Umprum). 1. 12. 2022, Praha. (In English)

Cílek V. Antropocén a velké zrychlení. *Přírodovědecká fakulta Univerzity Karlovy.* [Anthropocene and Great Accelaration. *Faculty of Natural Sciences, Charles University*]. 20. 1. 2022, Praha. (In Czech)

Cílek V. Antropocén a současnost. *Arcibiskupské gymnázium.* [Anthropocene and the Presence, *Archbishop Gymnasium*]. 28. 2. 2022, Praha. (In Czech)

Cílek V. Jak vznikla a vyvíjela se Vltava. Institut plánování a rozvoje hlavního města Prahy. [What was the origin and evolution of Vltava River? Institute for Prague Town Planning (IPR)]. 30. 3. 2022, Praha. (In Czech)

Cílek V. Klimatická minulost a budoucnost. Gymnázium TGM. [Climate Past and Future. Gymnasium TGM]. 31. 3. 2022. Zlín. (In Czech)

Cílek V. Voda v krajině. SPŠ-Stavební. [Water in Landscape. Secondary School of Civil Engineering, Praha]. 9. 6. 2022, Praha. (In Czech)

Cílek V. Klima a budoucnost našich lesů. *Česká lesnická společnost.* [Climate and the future of our forests, *Czech Forest Association]* 14. 6. 2022, Hradec Králové. (In Czech)

Cílek V. a Hynek B. Energetická bezpečnost. *Městská knihovna Liberec.* [Energy and safety. *Town Library, Liberec]*. 14. 9. 2022, Liberec. (In Czech)

Cílek V. Zadržování vody v krajině. In: Voda, moře oceány. *Hluboká nad Vltavou.* [Water harvesting in a landscape. In: Water, Sea and Oceans. *Hluboká nad Vltavou]*. 16. 9. 2022, Hluboká nad Vltavou. (In Czech)

Cílek V. Budoucnost našich lesů. *Střední lesnické školy a VOŠL v Písku.* [The future of our forest. *Forestry Middle School, Písek]*. 22. 9. 2022, Písek. (In Czech)

Cílek V. Energetika jako sociální síla. *Arcdata.* [Energy as social agent. *Arcdata].* 1. 11. 2022, Praha. (In Czech)

Cílek V. Klima a zadržování vody v krajině. *Agrární komora.* [Climate and water harvesting in a landscape. *Czech Agrarian Association]*. 9. 11. 2022, Praha. (In Czech)

Laibl L. Příběhy 480 miliónů let starých zkamenělin z marocké pouště. *Paleontologická sekce Společnosti Národního muzea.* [Stories of the 480 million years old fossils from the Moroccan desert. *Palaeontological*

section of the National Museum Society]. 11. 4. 2022, Praha. (In Czech)

Santolík V. Exkurze po kamenech pražského metra. Přírodovědci.cz [Excursion on the rocks of Prague metro, *Prirodoveci.cz]*. 13. 12. 2022, Praha. (In Czech)

Černý J. Lektor geologie v letní škole Mezinárodní olympiády věd o Zemi [Lector of geology in summer school for Czech students attending the International Earth Science Olympiad] – IESO 1.–5. 7. 2022, Kladno.

8D OTHER ACTIVITIES

Kočová Veselská, M., Kočí, T. Paleontologická exkurze na lokalitu Kaňk – Na Vrších. *Společnost Národního muzea, z.s., paleontologická sekce.* [Geo-paleontological excursion to Kaňk – Na Vrších. *Society of the National Museum, Paleontological Section].* 2. 4. 2022. Kutná Hora.

Filippi M., Věda fotogenická. Pořádá AV ČR. *Účastník fotografické soutěže* [Photogenic Science. Participant of the competition]. Praha.

Filippi M., Weinerová H., Weiner T., Roll M., Nováková T. Geologický ústav AV ČR. *Stánek na Veletrhu vědy a techniky: autoři a účinkující* [Inst Geol, Czech Acad Sci. A stand at the Science and Technology Fair: authors and performers; ***Fig. 47***]. 2.–4. 6. 2022. Praha.

FIG. 47 A stand of the Institute of Geology at the Science and Technology Fair. Photo by T. Weiner.

9. PUBLICATIONS ISSUED

Dašková, J., Ed. Research Reports 2012. Czech Academy of Sciences, Institute of Geology, Prague. 2021, 1–52.

Geologica Carpathica
published: Vol. 73, Nos. 1–6, 2022; 33 articles, 616 printed pages; IF 2022 = 1.3

10. ORGANIZATION OF CONFERENCES AND SCIENTIFIC MEETINGS

International conference: Annual Meeting 4GEON: Global geo-get-together. Příbram, September, 6–8, 2022.

Organized by Příbram-Orlov, o. p. s.; Inst Geol, Czech Acad Sci.

Organizing committee: Pásková M., Zelenka J., ***Mikuláš R.***, Zejda D., Gardoň jr. L., Staňková P., Gardoň L.

The IGCP project No. 751 focuses on educational and 'fun' aspects of geoconservation, and its first year experienced the exchange of information between the geoparks of Central and Eastern Europe, Asia, South America and Africa. The following are particularly worthy of further elaboration and future efforts: (1) the offer by the geoparks to award local institutions and businesses the "GEO" certificate if they contribute to fun geological education; (2) special excursions through historic towns to look at the origin of the building stones and changes in their use over time; (3) targeted cooperation on a personal and project level with the most famous museums in each country, and (4) permission for visitors to collect rock samples that would otherwise be lost to natural processes. For more detailed information and a full list of participants, see the article in Geoconservation Research.

International Conference: 2nd Central European ISTRO Conference (CESTRO) and 8th International Conference of the Czech ISTRO branch: Trends and challenges in soil-crop management, Brno, September, 6–8. 2022.

Organized by the Czech, Croatian and Hungarian branches of ISTRO under the auspices of the International Soil and Tillage Research Organization, Ministry of Agriculture of the Czech Republic, and in cooperation with Faculty of AgriSciences of the Mendel University in Brno, Faculty of Agrobiotechnical Sciences, Josip Juraj Strossmayer University of Osijek, Czech Academy of Agricultural Sciences, Research Institute for Fodder Crops, Ltd. Troubsko, Research Institute for Soil and Water Conservation, Crop Research Institute, Prague, Czech Society of Soil Science, Soil Serbian Tillage Research Organization.

Organizing committee: Badalíková B., Birkás M., Dryšlová T., Elbl J., Elzner P., Houšť M., Jandák J., Jug D., Kroulík M., Kubíková Z., Křen J., Lukas V., Neudert L., Porčová L., Pospíšilová L., Prudil J., Rábek M., Smutná P., Smutný V., ***Žigová A***.

Scientific board: Badalíková B., Barančíková G., Birkás M., Brozović B., Deubel A., Đurđević B., Roger-Estrade J., Jug D., Jug I., Kroulík M., Křen J., Lukas V., Madaras M., McKenzie B., Nedělník J., Pospíšilová L., Rosner J., M., Smutný V., Smutná P., Šarapatka B., Šeremešić S., Šimkovic I., Tyburski J., Vácha R., Zsembeli J., ***Žigová A***.

The conference was attended by 86 participants from 14 countries. Its scientific program consisted 28 lectures and 30 posters. The presentations were divided into sections: Soil health assessment, Soil management, Sustainable crop production adapted to climate change and Precision agriculture.

International Training School: 3rd COST Action SAGA Training School 'Magnetic laboratory methods in support of archaeo-geophysical research, Prague, March 28–31, 2022

Organized by the Geophys Inst, Czech Acad Sci, Prague and co-organized by the Inst Geol, Czech Acad Sci.

Organizing committee: Grison H., ***Schnabl P***.

The aim of the International Training School was to improve participant's ability to obtain, analyze and interpret magnetic data with relevance to archaeo-geophysical research methods. The main topics were devoted to introduction to magnetic property characterization focusing on soil and archaeological material (magnetic susceptibility, remanence and hysteresis characterization), data analysis and interpretation of a variety of soils from 'natural' to archaeological ones, applications of archaeomagnetic dating techniques with reference to archaeology case studies, demonstration of archaeomagnetic measurements and determining paleo-firing temperatures incl. sampling and data processing.

11. FINANCIAL REPORT

In thousands of Czech Crowns (CZK)		**2022**
A.	**INCOMES**	
1.	From the annual budget of the Czech Acad Sci	52602
2.	From the Czech Science Foundation (accepted research projects)	20489
3.	From the internal research projects of the Czech Acad Sci	758
4.	From other public sources	1473
5.	Applied research	6635
6.	Investment (instruments)	6983
7.	Investment (constructions)	1300
	TOTAL INCOMES	**90240**

B.	**EXPENSES**	
1.	Scientific staff (wages, insurances)	48710
2.	Research and scientific activities	17915
3.	Administration and technical staff (wages, insurances)	9334
4.	General expenses (service, maintenance of buildings, energies, transport, office supplies, miscellaneous, etc.)	5221
5.	Library	628
6.	Editorial activities	150
7.	Investment (instruments)	5930
8.	Investment (constructions)	2352
	TOTAL EXPENSES	**90240**

KATALOGIZACE V KNIZE – NÁRODNÍ KNIHOVNA ČR

Geologický ústav (Akademie věd ČR)
Research reports 2022 / Institute of Geology, Czech Academy of Sciences. – Praha : published by the Institute of Geology of the Czech Academy of Sciences, 2023. – 52 stran
Název z obálky. – Obsahuje bibliografie

ISBN 978-80-87443-20-0 (brožováno)

* 55:005.71 * 55 * 001-026.12 * 808.1/.2 * (437.311) * (047.1)
– Geologický ústav (Akademie věd ČR)
– geologické ústavy – Česko
– geologie
– vědecká činnost – Česko – 2021–2030
– publikační činnost – Česko – 2021–2030
– Praha (Česko)
– výroční zprávy

55 – Vědy o Zemi. Geologické vědy [7]

RESEARCH REPORTS 2022
INSTITUTE OF GEOLOGY OF THE CZECH ACADEMY OF SCEINCES

The contents and scientific quality of the contributions of individual authors lie within the responibility thereof.
The report was compiled by J. Dašková and English was revised by J. Adamovič.

Layout by Ondřej Zámiš and Vojtěch Liebl / Printed by Chapiteau, s.r.o.

ISBN 978-80-87443-20-0

80 copies

2022