RR GEO

RESEARCH REPORTS

2020

INSTITUTE OF GEOLOGY
CZECH ACADEMY OF SCIENCES

Cover photo: Silica-alumina speleothem overflown by water.
Gobholo Cave, Eswatini, South Africa. Photo by M. Filippi.

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CONTENTS

1. DIRECTORS INTRODUCTION

You have opened the latest volume of Research Report, a traditional publication of the Institute of Geology of the Czech Academy of Sciences, presenting the most important last-years' news from the Institute.

Year 2020 was a specific one in many respects; allow me to mention two issues which had a considerable bearing on the performance of the Institute.

The first issue is, naturally, the coronavirus epidemic. The virus taught us a lesson in how realistic is the notion that everything we do lies safely within our control. A potential threat by this disease, the illness as such, but also the effort to respect anti-epidemic regulations forced us to step out of our comfort zone: individuals, communities and the society as a whole. All of us had to improvise to a lesser or greater extent.

Despite a certain discomfort and restrictions related to the endeavour of stopping the epidemic, the Institute of Geology of the Czech Academy of Sciences continued its work. Moreover, we may say that our scientific production has not been affected much.

Although the coronavirus epidemic has not been driven to a definite end, our life has partly adapted to the new situation, which can be described as a progressively stabilizing one. It is, however, necessary to learn to accept all the consequences and realities resulting from the current situation.

The second issue is the evaluation of the Institute within the whole-Academy Evaluation in the period of 2015–2019. This was a key event in the life of the Institute as it has a potential to impact (either directly or indirectly) the work and future orientation of the whole institution. Allow me to declare that, despite the multiple postponement and other complications, we went through the evaluation process successfully and the resulting assessment raised no major critical points. To the contrary, the Institute received a high credit, which is something we can be proud of.

I believe that the mitigation of consequences of the coronavirus pandemic as well as the experience of the latest evaluation will make the Institute of Geology yet stronger. I also believe that these stimuli will – in some of their aspects – even result in an enhanced effectiveness of some operations which have perhaps become somewhat ossified over the many past years.

TOMÁŠ PŘIKRYL
DIRECTOR

2. GENERAL INFORMATION

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

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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.) by the change of 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. PUBLISHING ACTIVITY OF THE INSTITUTE OF GEOLOGY

3A GEOLOGICA CARPATHICA

Published: Vol. 70, Nos. 1–6 (February to December), 2020; 35 articles, 557 printed pages; IF 2020 = 1.875 (co-publisher)

3B OTHER JOURNALS AND BOOKS PUBLISHED OR CO-PUBLISHED BY THE INSTITUTE OF GEOLOGY

Dašková, J., Ed. Research Reports 2019. Czech Academy of Sciences, Institute of Geology, Prague. 2019, 1–52.

4. ORGANIZATION UNITS

4A 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

prof. RNDr. Pavel Bosák, DrSc.	Chairman
Mgr. Michal Filippi, Ph.D.	Vice-Chairman

doc. RNDr. Emil Jelínek, CSc. (Faculty of Science, Charles University)
prof. RNDr. Martin Mihaljevič, Ph.D. (Faculty of Science, Charles University)
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)

4B SCIENTIFIC DEPARTMENTS

The staff of the **Department of Analytical Methods** primarily provides analytical service to cover the needs of the other institutional departments. Nevertheless, specific research is also conducted, being largely focused on the application of instrumental methods to Earth and planetary sciences.

Researchers of the Department continue the study of tektites and archaeological glasses and participate in long-term research devoted to low-grade uranium mineralizations of sandstone type. The latter studies involve mineral characteristics of uranium and non-uranium associations, and geochemical modelling of the origin and evolution of uranium deposits. The applied approach aims at new forms of visualization, correlation-based analyses, and mathematical processing of spectral data. Further, an ongoing process of design and improvement of analytical protocols in individual laboratories is continued in an attempt to optimize the use of the instruments.

Members of the **Department of Environmental Geology** and Geochemistry were engaged in studies of globaly relevant topics as well as topics of local importance in the year 2020. Significant and extensive work was also done in the area of science promotion, especially in the form of radio/TV broadcast, popular articles and monographs.

Research continued in the established broad area of environmental geochemistry of toxic elements. Studying mercury threat in the Czech ecosystems responding to global change and entering of Cd, Hg, and U from the pollution hotspots in floodplains to the food web represent two new projects of societal importance, both supported by new grants of the Czech Science Foundation, which started their 3-year period in 2020. First results obtained were already published in journals with IF. Geochemical evidence embedded in the interdisciplinary study helped in the understanding of the history of a Pannonian oak woodland. The potential wildfire effects on mercury remobilization from topsoils and biomass in a polluted semi-arid area is an example of a globally relevant topic, which was studied on the case of a Tsumeb (Namibia) smelter. Geomycology as an interdisciplinary area was especially fruitful, and several important results were published in prestigious journals. Collaborative work in an international team extened the understanding of role of arsenic in the toxicity of hyperaccumulating mushrooms. In the area of environmental geology and speleology, we took part in the description of speleothems in the granite Gobholo Cave in Eswatini. The topic of stress- and hydraulic field-controlled weathering and erosion of granular rocks was studied theoretically using advanced numerical modelling; the results were presented to scientific audience. The study conducted within the Strategy AV21 Programmes / Water for Life Programme of the Czech Academy of Sciences concentrated on innovative monitoring and modelling techniques for hydroecological analysis in a small catchment. We continued our collaboration with the Bohemian Switzerland National Park Administration, Krásná Lípa, monitoring of atmospheric precipitation within the national park limits, as well as with private companies ISATech and Watrad.

Our work for public audience was widely recognized. The book "Granite Landscapes of Central Bohemia" obtained the award of Egon Ervín Kisch in the category of non-fiction literature. Silver Memorial Award of the Senate of Czech Republic for lifelong publishing activity was granted to V. Cílek. The extensive popularisation activity of V. Cílek was further acknowledged by the Award of the Ministry of Education for the documentary film "Landscape of the next century in several scenes" and by the Award of Librarians of Children Literature. An outdoor permanent exhibition of typical rocks of the Rakovník District was established in the Museum of T. G. M. at Rakovník under the auspices of local authorities of Central Bohemia and under the guidance of the Department staff (K. Žák).

The **Department of Geological Processes** utilized a combined approach using a range of methods in petrography, mineralogy, geochemistry and geochronology.

In 2020, the Department also launched a new method of zircon dating using isotope dilution and U and Pb isotope measurement by the present thermal ionization mass spectrometer (TIMS) making use of amplifiers with a resistivity of 10^13 Ohm. In collaboration with the Polish Academy of Sciences, a novel monazite "TS-mon" reference material for the analysis of U-Pb ages by laser ablation ICP-MS was defined after a four-years' effort. L. Polák successfully completed the Fulbright Fellowship at University of South Carolina within his PhD study. The fellowship was focused on Lu-Hf and Fe isotopes in carbonatites. J. Sláma continued his study of rock materials using the Lu-Hf isotope system and U-Pb zircon dating within the "J. E. Purkyně Fellowship for outstanding prospective scientific workers". Staff of the Department were working on 7 grant projects supported by the Czech Science Foundation, related to the study of silicites and carbonate rocks (principal investigator L. Ackerman), study of Sm-Nd composition of foraminiferal tests (co-investigator L. Ackerman), geoarcheological study (co-investigator L. Lisá), study of greisenization and albitization of granites (principal investigator K. Breiter), dating and geochemistry of Archean granites (co-investigator M. Svojtka), dating and petrology of the Uralides (co-investigator M. Svojtka), and a junior grant

FIG. 1 Buildings in Průhonice. Photo by J. Petráček.

project from the Czech Science Foundation, aimed at magma emplacement processes in collapsing orogens (F. Tomek).

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 2020, activities of the Department were largely affected by the global pandemic of coronavirus. Accordingly, many events have been cancelled or postponed. Among others can be listed 15th International Palynological Congress to be held in Prague (J. Bek – Chair of the Organizing committee, J. Dašková – General Secretary) or Annual business meeting of the Devonian subcommission (SDS) to be held in New York State (L. Slavík – coordinator of the meeting). Members of the Department took part in several important results that were published in prestigious geological journals. For example, a proposal of stratotype (International correlation standard, GSSP – Global Stratotype Section and Point) for the Jurassic-Cretaceous boundary, and, completion of conodont biostratigraphy of Early Devonian in the Prague Synform that has a global applicability in stratigraphic correlation. Many results in the field of vertebrate and invertebrate paleontology and palynology were published in journals, e.g., Palaeogeography, Palaeoclimatology, Palaeoecology; Journal of Vertebrate Paleontology, and Review of Palaeobotany and Palynology. L. Slavík started his term as the Chairman of the International Subcommission on Devonian Stratigraphy (SDS/ICS of the IUGS). P. Štorch was confirmed as the Chairman of the International Subcommission on Silurian Stratigraphy (ISSS/ICS of the IUGS) for the next four-year term. L. Laibl accomplished a prestiguous fellowship at the University of Lausanne (Switzerland) and returned back to the Department. M. Aubrechtová obtained DAAD fellowship at the Museum für Naturkunde Berlin. In 2020, three projects of the Czech Science Foundation passed the competition and will start their 3-year periods in 2021.

The research of the **Department of Paleomagnetism** encompasses paleomagnetism, magnetostratigraphy and rock magnetism of a variety of terrestrial and extraterrestrial materials. The results provide means for numerous geoscience applications.
In 2020, the research was mainly focused on two stratigraphic boundaries, the Cretaceous/Paleogene boundary in the Carpathians (Czechia, Slovakia, Poland), and the Jurassic/Cretaceous boundary in the Carpathians (Czechia, Slovakia, Poland), the Vocontian Basin (in France), and localities in England and China (Czech Science Foundation projects). Extensive magnetic research was completed in multi-proxy research of biota (a. o., molluscs, nannoplankton), geochemistry (stable isotopes, mercury concentration), as well as by paleoecological reconstructions. We also studied shock darkening and space-weathering effects on extraterrestrial materials, conducted archeomagnetic research (silicite industries; Czech Science Foundation project), and studied various magnetic fabrics. Karst and cave sediments were studied in the Krkonoše National Park (within the EU project: Environment, Priority axis 4.1), in Slovakia (Agreement of Co-operation) and Slovenia (MOBILITY project) with the multi-proxy approach (petrology, sedimentology,

mineralogy, magnetism, biota, geochemistry). The research in the department was performed in close co-operation with other Institute departments as well as with number of Czech and foreign universities, research institutes and institutions, companies, or NGO bodies. The Air unit upgrade of the MAVACS system was realized in 2020. The intention of the paleomagnetic team to purchase a new system for thermal demagnetization using space-demanding Helmholtz coils and the need for additional space for measuring instruments led to acquiring a new pavilion from the Inst Geophys, Czech Acad Sci (**Fig. 1**). The building is located about 300 m from the current Paleomagnetic laboratory at Průhonice. The acquisition started in 2019, and drawings for a substantial interior reconstruction were finished in 2020. The pavilion is planned to be shared with the Czech Metrology Institute (CMI) that would install their own Helmholtz coil system in one room of the building. This interdisciplinary use of the pavilion should contribute to interesting collaboration in the future.

The **Department of Physical Properties of Rocks** deals with the study of mechanical properties of rocks under uniaxial or triaxial load.

We study acoustic emission monitored during brittle fracturing of rocks. As a fracturing model, the shear-tensile mechanism is used. This model represents the simplest model combining the shear and tensile components. The Laboratory also deals with the study of elastic anisotropy of rocks under high hydrostatic stress. The study is carried out by the ultrasonic sounding of longitudinal and transversal waves through spherical samples. The aim of the study is the determination of the full stiffness tensor and its changes according to the different values of hydrostatic stress. Staff members of the Department were involved in grant project supported by the Czech Science Foundation: Study of petrographic parameters and rock mechanical properties influencing technological-mechanical performance of selected rocks used for crushed stone (continued) – co-investigator – T. Lokajíček. Further, they were involved in an international project studying elastic anisotropy and properties of lithosphere materials using neutron diffraction and ultrasonic sounding and elastic anisotropy of layered rocks. Results of the research conducted by the staff of the Department were published in prestigious geophysical and geological journals in 2019. Most of the published data in these journals were produced by the laboratories of the Department.

4C LABORATORIES

FIG. 2 Clean chemistry laboratory. Photo by M. Svojtka.

Clean Chemistry Laboratory
(Head: P. Le, supervised by L. Ackerman)

Two laboratories (**Fig. 2**) for processing the samples destined for (ultra)trace element and isotopic analyses. Both labs are supplied with HEPA-filtered air. One lab (class-100000 filtered air) is using for sample decomposition and labware cleaning. It contains 1× plastic custom-made fume-hood and working table for the work with strong acids (e.g., HF, HCl and HNO^3), 2× Teflon distillation apparatus for the preparation of ultraclean acids, 1 x analytical weight (precision of 0.1 mg) and 1× device for preparation of clean water (Millipore Elix 3). The other lab (class-10000 filtered air) is using for a clean chemistry (e.g., ion exchange chromatography and special chemical procedures for the extraction of selected elements from the rock and environmental matrix) and final preparation of the samples for mass spectrometry (HR-ICP-MS, MC-ICP-MS, TIMS). It contains 2× custom-made laminar flow work spaces (class-100 filtered air), 1× analytical weight (precision of 0.01 mg), 1 x combined device for preparation of ultraclean water (Millipore Elix 3 + Millipore IQ 7000 + Millipore Q-POD Element) and 1 x centrifuge.

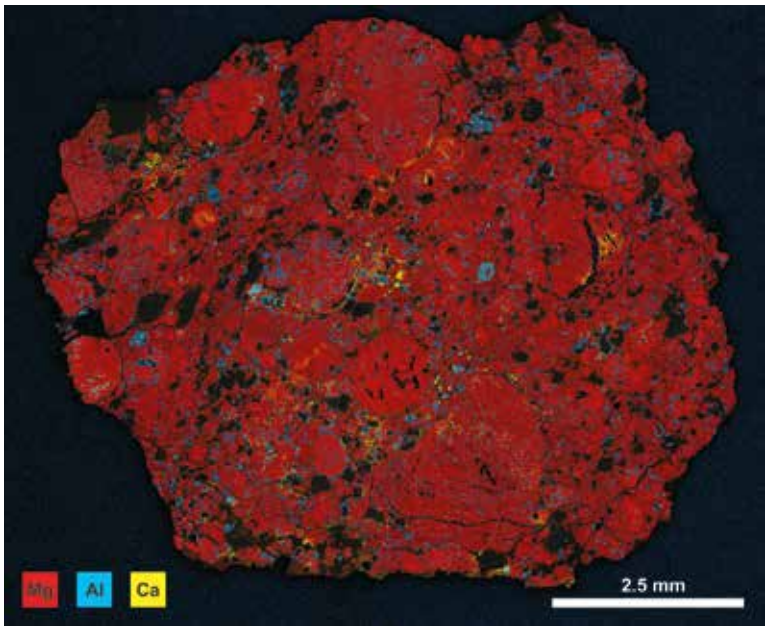

FIG. 3

An example of element distribution maps collected with Large Area Mapping module of the AZTec LIVE software controlling ED spectrometer Oxford Ultim Max 65. Pictured is the mosaic of a polished thin section of enstatite chondrite Asuka 12245 (type EL4, loaned from the NIPR, Tokyo). Note, e.g., the fragment of barred chondrule in the upper left, porphyritic chondrule in about the centre, and the fan-shaped radial chondrule on the bottom right. The time of mosaic collection was about 8 hours at an accelerating voltage of 20 kV. Image by N. Mészárosová.

Laboratory of Electron Microanalysis
(Supervised by R. Skála)

Scanning electron microscope (SEM) TESCAN VEGA-3XMU 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 and back--scatted electrons, low vacuum secondary electron detector (LVSTD), and color cathodoluminescence detector (CL). A recent advancement of the microscope (purchased in 2020) is an energy-dispersive (ED) spectrometer Oxford Ultim Max 65 (**Fig. 4**) teamed with AZtec LIVE control and evaluation software, which is suitable for qualitative and/or semiquantitative standardless chemical analyses and fast elemental mapping. The software has an extension of Large Area Mapping (LAM) for unattended chemical composition mapping of large sample areas (**Fig. 3**).

FIG. 4

Energy-dispersive (ED) spectrometer Oxford Ultim Max 65 attached to the scanning electron microscope (SEM) TESCAN VEGA3XMU. Photo by R. Skála.

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

X-ray diffractometer Bruker D-8 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. Optional focusing primary asymmetric monochromator of Johansson type produces spectrally pure K-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), the beam limited with a collimator and the sample is placed on a special motorized xyz-stage.

Laboratory of Paleomagnetism
(Head: P. Bosák)

The laboratory is situated in Průhonice Park (UNESCO World Heritage site) and is well equipped for rock-magnetic and paleomagnetic research. The laboratory is featuring state-of-the-art instruments such as 2G 755 4K Superconducting Rock Magnetometer: highly sensitive and accurate instrument for measurement of remanent magnetization of rocks and conducting alternating-field (AF) demagnetization; AGICO JR5a and JR-6A Spinner Magnetometers: sensitive automatic magnetometers, MAVACS – Magnetic Vacuum Control System – a unique system to create and maintain virtual magnetic vacuum for thermal demagnetization; MAGNETIC MEASUREMENTS MMTD80 Thermal Demagnetizer: a standard instrument for thermal demagnetization; MAGNETIC MEASUREMENTS MMPM10 Pulse Magnetizer: an instrument for creating isothermal remanent magnetizations

FIG. 5 MAVACS: a new air unit, Paleomagnetic laboratory, Průhonice. Photo by L. Kouklíková.

up to 9T; AGICO MFK1-FA Kappabridge: a highly sensitive apparatus for measuring magnetic susceptibility in variable magnetic fields, frequencies and temperatures, as well as anisotropy; AGICO LDA-5 and PAM-1 Specimen Unit: a multifunctional device for anhysteretic magnetization and AF demagnetization up to 200 mT, which may be used also as a pulse magnetizer in weak fields (1 to 20 mT), and others.

The Air unit upgrade of the MAVACS system in 2020: MAVACS is a unique, highly accurate rock sample thermal demagnetizing system securing a precise compensation of the Earth's magnetic field. Highly accurate variation-free magnetic vacuum is crucial for gradual thermal demagnetization of rock samples for paleomagnetic and petrophysical studies. MAVACS Air unit was completely re-designed by the JIMAZ company (**Fig. 5**). The original two Air units for standard measurement and for calibration process were joined into one new Air unit that shows stable and reliable operation after first months of functioning. The purpose of the Air unit is a distribution, pressure adjustment and stability of the drive air supplied from oil-free compressor to MAVACS sensors.

FIG. 6 Dust-tight jaw crusher BB50 Retsch in the separation lab. Photo by M. Svojtka.

Grinding and Polishing Shop
(Supervised by R. Skála)

Reliable quantitative point chemical analyses and/or acquisition of element distribution maps using EPMA/SEM require planar polished conductive surfaces. Such prerequisites are fulfilled 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 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).

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, 532 and 785 nm. The microscope is designed for sample observation in either reflected or transmitted light. Objective lenses with following magnifications are installed: 4×, 10×, 50×, 50× LWD and 100×. Samples are placed on a computer-controlled motorized stage. Spatial resolution with 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 488 and 532 nm excitation lasers and 60–3,500 cm^{-1} with 785 nm excitation laser.

A Fourier-transform infra-red spectrometer (FTIR) Thermo Scientific Nicolet iS-50 with built-in mid- and far-IR capable diamond attenuated total reflectance (ATR) accessory 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 the ATR mode, the wavenumbers covered are 4,000–100 cm^{-1} depending on used beam-splitter.

Laboratory of rock processing and mineral separation
(Head: M. Šťastný)

Equipment of the lab for mineral and rock separation: laboratory table WILFLEY 13B; vibration processor VT 750; crusher CD 160*90; laboratory mill RETSCH; crusher ŽELBA D 160/3; mill SIEBTECHNIK; muffle oven LAC LMH 11/12; hydraulic slab cutter 4H HYDROTRONK MONTOLIT; magnetic separator FRANTZ, dust-tight jaw crusher BB50 RETSCH (**Fig. 6**), and air compressor GÜDE.

Fission-track Laboratory
(Head: D. Kořínková)

The laboratory (**Fig. 7**) develops fission-track dating analysis for determining the age and time-low temperature evolution (t/T modeling) of minerals and rocks. Analytical system for fisson track analysis: AXIOPLAN ZEISS microscope and Trackscan AUTOSCAN system; ZEISS IMAGER M1m microscope and AUTOSCAN computer-controlled microscope stage, and MTH APX 010 polishing and grinding machine.

FIG. 7 Fission-track counting system. Photo by M. Svojtka.

Laser ablation ICP-MS Laboratory
(Head: J. Ďurišová and Š. Matoušková, supervised by M. Svojtka)

The laboratory (**Fig. 8**) is equipped with the ELEMENT2 (ThermoFisher Scientific) high-resolution magnetic sector field ICP-MS (inductively coupled plasma – mass spectrometer), purchased in 2009. 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 a $mg \cdot l^{-1}$ to sub $pg \cdot l^{-1}$ concentration range, and (2) measuring of isotope ratios. The Element2 ICP-MS is coupled with an ANALYTE EXCITE excimer 193 nm laser ablation system (Cetac/Teledyne) for analysing solid samples and with an Aridus II (Teledyne) desolvating nebulizer.

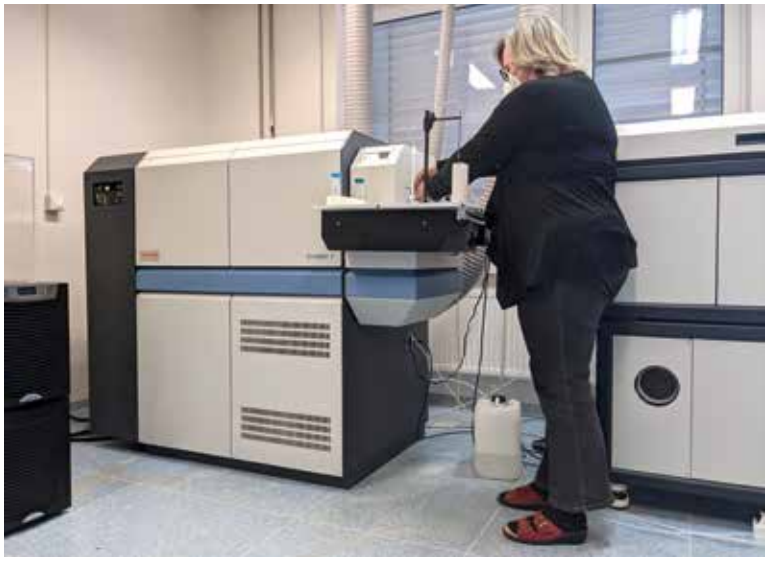

FIG. 8 Laser ablation ICP-MS laboratory with Element2 magnetic sector field ICP-MS and Analyte/Excite excimer 193 nm laser ablation system. Photo by M. Svojtka.

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

The laboratory is equipped with TRITON Plus (ThermoFisher Scientific), a thermal ionization mass spectrometer (TIMS) whose applications are divided into three purposes: (a) Elemental abundance determination with the isotope dilution method; (b) Precise isotopic ratio analysis; (c) Isotopic fractionation

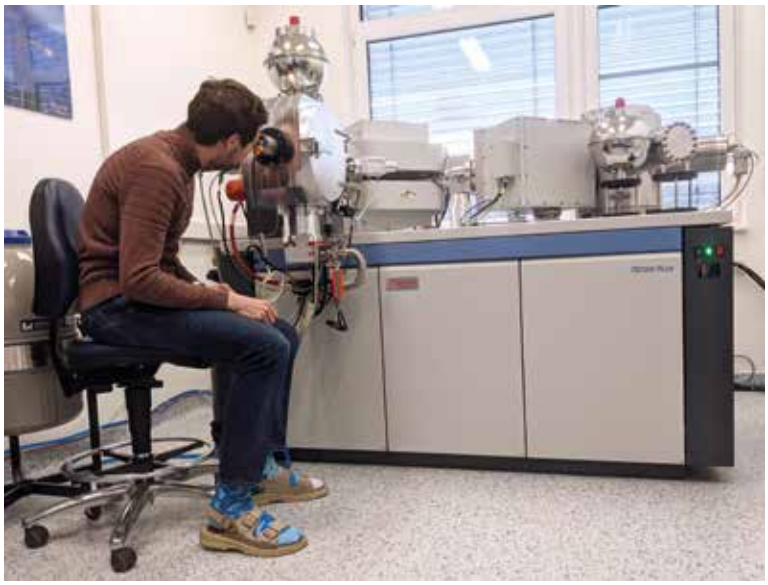

FIG. 9 Triton Plus mass spectrometer (TIMS laboratory). Photo by M. Svojtka.

measurement. TIMS is supplied with five 10^{13} Ω technology amplifiers along with 3.3 pA current calibration board, the central dual-channel detector (SEM/Faraday cup), oxygen bleeding valve and RPQ device (**Fig. 9**). The filament bakeout device (ThermoFisher Scientific) is placed in the TIMS laboratory for the filament degassing and PCR box Airstream (ESCO) for the sample loading.

Geoarchaeology laboratory
(Supervised by L. Lisá)

Laboratory for basic sedimentary sample processing. The laboratory is equipped with a fume-hood designed for the work with strong acids. The lab serves mainly for the processing of sedimentary samples, such as basic sample descriptions, micromorphological sample preparations, pH measurements and particle-size analyses. A dryer and a vacuum chamber are available for micromorphological sample impregnations. Other equipment includes the centrifuge and Cillas 2000 laser particle-size analyser (purchased in 2011) with the range of 0.004–2,500 micrometres, and sets of sieves for different types of grain-size analyses (**Fig. 10**).

FIG. 10 Cillas 2000 laser particle size analyser in the Geoarchaelogy laboratory. Photo by M. Svojtka

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

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

Sedimentary laboratory
(Head: A. Žigová)

The laboratory is equipped with an apparatus for sample preparation and pH measurements: 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.

Laboratory of liquid and solid samples analysis
(Head: Jan Rohovec)

The laboratory is equipped with: Makro analyser of CHNS in organic matrices VarioMacro CUBE Elementar (2020), high pressure microwave digestion owen Preekem (kind loan from HPST s. r. o.), DTA /DSC (2018), Ultrasonic horn Bandelin Sono plus (2016), Gas chromatography system for methylmercury separation DANI (2015), ICP-EOS spectrometer Agilent 5100 (2014), HPLC system (KNAUER 2010): anion analysis in aqueous samples using ion-exchanging column and conductivity detector (2013), Anton Paar High Pressure Asher (2012), Mettler-Toledo (2011): analytical balances, TOC-VCPH Shimadzu (2011): total Carbon Analyser, MARS (2009): microwave digestion unit – with 8 fully equipped PTFE digestion vessels, MILESTONE mls 1200 mega (2009): microwave digestion unit – with 6 fully equipped PTFE digestion vessels, CINTRA 303 (2009): UV-VIS Spectrometer, BALANCE 2000G (1999): analytical balances, B-2A Epi/FL (1996): filtration blocks, SARTORIUS Basic analytical (1992) analytical balances.

Mercury analysis laboratory
(Head: Tomáš Navrátil)

The laboratory is equipped with: Second mercury analyser AMA 254 with an autosampler for solid samples (2019), Speciation oven for RA-915 M Lumex analyser (upgrade 2019), two-zone cylinder furnace Clasic (2018). Total mercury and methylmercury analyser MERX (2017), RA-915M Lumex mercury analyser providing real-time direct detection of mercury vapour analysis in air and gases (2016), Shimadzu DOC/TOC analyser determining dissolved organic carbon content, total organic carbon content, inorganic carbon in aqueous samples (2010), PSA Millennium Merlin providing ultra-low mercury analysis in liquid samples on CV-AFS principle (2009). Extension of this analytical procedure with a single-purpose HPLC enables mercury species separation and analysis. Mercury analyser AMA 254 provides mercury analysis in solid and liquid samples on CV-AAS principle (2008).

5. AWARDS AND RESEARCH FELLOWSHIPS

Bosák P.

Emeritus Scientist of the Czech Academy of Sciences. Awarded by the President, Czech Academy of Sciences (January 8, 2020).

Cílek V.

The award for popularisation, The Commission for Science, Research and Innovations under the auspices of the Prime Minister of the Czech Republic (October 13, 2020).

Cílek V., Rohovec J. and a team of authors

International award of Egon Erwin Kisch in the Non-Fiction category for the book "*The Underground Heritage of Central Bohemia*" (May 15, 2020).

Polák L.

Fulbright-Masaryk Fellowship. Hafnium isotopic systematics of mantle-derived carbonatites. University of South Carolina, 6 months' internship (October, 2019 – April, 2020).

Sláma J.

Fellowship J. E. Purkyně for outstanding creative scientists, Czech Academy of Sciences, Praha (2016 –2020).

6. DEGREES OBTAINED BY THE STAFF OF THE INSTITUTE OF GEOLOGY

Ph.D.

Mikysek P.

Mineralogy and Zr bonding within uranium mineralization at the Břevniště deposit. (Institute of Geological Sciences, Masaryk University in Brno; supervised by M. Slobodník)

7. PROJECTS

7A FOREIGN GRANTS, JOINT PROJECTS AND INTERNATIONAL PROGRAMMES

FINISHED PROJECTS

***Bilateral co-operation between Czech Geological Survey, Praha and Geologische Bundesanstalt Wien, Austria*: Palynology of Gosau Group sediments in Salzkammergut, in particular on maps 3211 – West Wolfgangsee, 3211-Ost Bad Ischl and 3206-West Gmunden (H. Lobitzer, Geologische Bundesanstalt, Vienna, Austria; L. Švábenická, Czech Geological Survey, Prague & M. Svobodová; 2020)**

Biostratigraphy and paleoenvironmental conditions were interpreted based on the study of palynomorphs and calcareous nannofossils in the Nierental Formation of the Zwieselalm Plateau, Upper Austria. Strata of the Höhbühel section demonstrate gradual deepening during Lower Maastrichtian. Grey deposits provided angiosperm pollen of the Normapolles group and rare marine dinocysts with *Palaeostomocystis bakoniensis*, indicating marine environment. The presence of *Classopollis classoides* proves the near presence of mangrove vegetation. The abundance of *Lucianorhabdus* in nannofossil assemblages confirms shallow sea and scarce *Broinsonia parca constricta* and *Reinhardtites levis* UC16-UC18 zone interval, Lower Maastrichtian. The occurrence of *Lithraphidites praequadratus-quadratus*, rare *L. quadratus* and *Corollithion completum* in the overlying brick red rocks indicates UC20a^{TP} zone, lower Upper Maastrichtian. The elevated number of nannofossil specimens proves a deeper sea far from the mainland.

***DAAD Research Grants*: Lituitid cephalopods from the Ordovician erratics ("Geschiebe") of Germany and Poland (*M. Aubrechtová*; 2020)**

Cephalopods are highly diversified and ubiquitous marine carnivorous molluscs, which are famous for their vertebrate-like intelligence and complex behaviours. At present, most cephalopods are soft-bodied but in the past, the majority of them had hard, external conchs that were commonly preserved in rocks as fossils. The abundance of cephalopods in the fossil record in combination with the long evolutionary history of the group makes the cephalopods useful in the reconstructions of ancient ecosystems and the biotic and abiotic events of the past.

However, the application of cephalopods for palaeobiological studies is often limited by the lack of knowledge on some important groups. The above

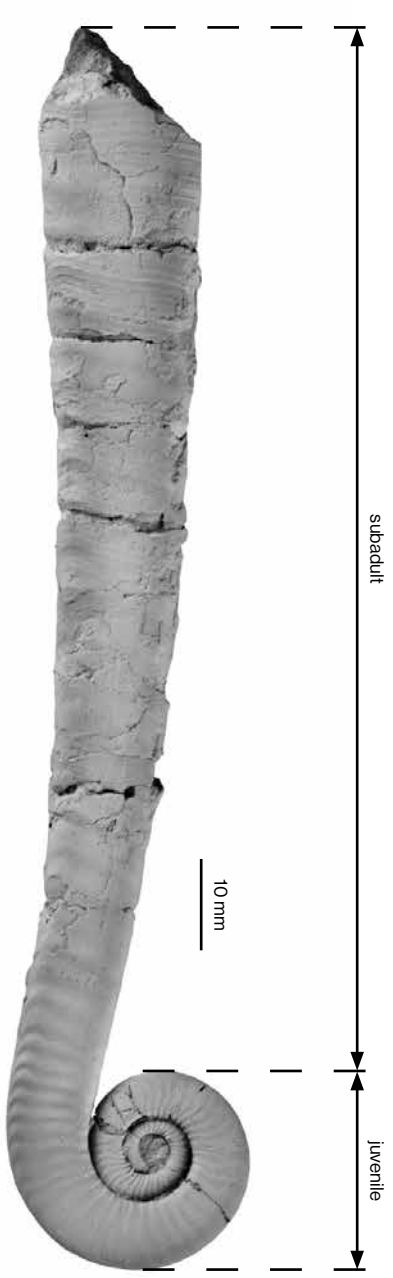

FIG. 11 Fossil cephalopod *Lituites lituus* from the Middle Ordovician erratics of northern Poland (Island of Chrząszczewska, West Pomerania). Neben & Krueger Coll., Museum für Naturkunde Berlin. Photo by M. Aubrechtová and L. Voß (MfN), modified by D. Korn (MfN).

FIG. 12

?*Archaeoconularia isp.* with tunnels after feeding on the sediment. The tunnels probably correspond to the hitherto unknown soft tissues of conulariids. Upper Ordovician, Beroun locality. Photo by J. Bruthansová.

DAAD research grant project was carried out to investigate insufficiently known cephalopods of the order Lituitida (Ordovician time period, ca. 485–444 Myr; **Fig. 11**). The study was based on the collections of the Museum für Naturkunde (MfN) in Berlin (Germany), where dozens of lituitid specimens are stored, including type specimens of several species. The aim was to describe this type material to solve persisting taxonomic problems and to address open questions related to the evolutionary origin of the group. The preservation of juvenile as well as sub-adult parts of the conch in a number of specimens facilitated the investigation of how the lituitid conch grew, how its morphology changed in ontogeny and what the effects of these changes were on the mode of life of the animals. The research results are a part of a comprehensive palaeobiological study and assessment of the role of cephalopods in the Great Ordovician Biodiversification Event.

***International Geoscience Programme (IGCP) of UNESCO & IUGS, Project Code IGCP No. 653*: The onset of the Great Ordovician Biodiversification Event (International Leader: T. Servais, French National Centre for Scientific Research, France; Czech representative: O. Fatka, Faculty of Science, Charles University in Prague; other Czech workers: *R. Mikuláš*; P. Budil, Czech Geological Survey, Prague; 2016–2020).**

Ichnological research joined to the 653 IGCP Project was, during its whole course, focused on the study of mutual interactions of body fossils and trace fossils of in-fauna (**Fig. 12**). Both the study of museum collections and the newly obtained material proved to be useful. The research was focused on the finds from the Bohemian Massif (Barrandian area). Diversity of in-fauna consuming soft tissues of dead shelly animals reached its maximum in the Šárka Formation (early and middle Darriwilian); it is associated with almost all taxonomic groups composing a rich and diversified fossils assemblage of the formation. The preferential distribution of feeding traces in each shell reflects the topology of soft tissues serving as food. The post-Darriwilian sedimentary environments in the Barrandian area were not favourable for the development of such rich benthic assemblages. Nevertheless, finds of rare fossils (e. g., conulariids) with traces of in-fauna brought new insights into the distribution of nutrient-rich soft tissues, i. e., the anatomy of this poorly known animals (**Fig. 13**).

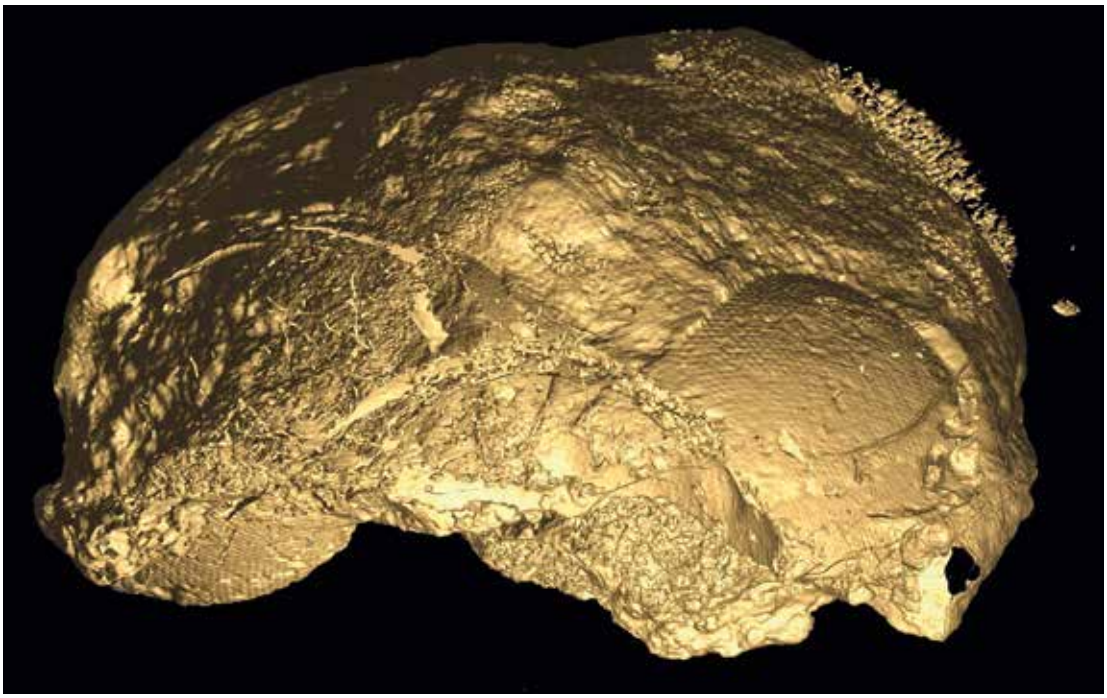

FIG. 13

Ordovician (Darriwilian) trilobite of the genus *Pricyclopyge* damaged with post-mortem burrowing by feeding in-fauna. Computed tomography image, National Museum in Prague. Size ca. 3 cm. Photo by J. Bruthansová.

ONGOING PROJECTS

***BILATERAL MOBILITY Project No. SAZU-19-01*: Cave sediments: multi-proxy interpretation of karst processes (N. Zupan Hajna, A. Mihevc, A. Švara, Karst Research Institute ZRC SAZU, Postojna, Slovenia; *P. Pruner*, *Š. Kdýr*, *P. Bosák*; supported by RVO67985831; 2019–2021)**

The Rhinoceros locality near Lokev village, Classical Karst, was discovered during a railway construction at the "Severni portal predora T1" (The northern portal of tunnel T1). The section, most probably a fill of a shaft along a fault/fissure zone, was composed of yellow, grey and red clays with rhinoceros bones. The relation to other sediments found nearby or above the sampled profiles (breccias with bones of different large mammals) was not clear enough. Paleomagnetic samples were taken using a high-resolution method in the lower, clay-dominated, part of the section in two parts separated by a bed with the remains of a rhinoceros skeleton (**Fig. 14**). All samples were subjected to detailed alternating field demagnetization (AF) in 14 steps. Multi-component analysis was applied to separate the respective remanent magnet ization (RM) components for each sample. Two components were isolated after the AF demagnetization. The *A-component* is undoubtedly of viscous origin and can be demagnetized in the AF (0–5 up to 10 mT). The characteristic *C-HFC* is stable and can be demagnetized or isolated in the AF (ca 10–30 up to 100 mT). The upper part (profile I) was only normal-polarized. Lower part (profile II) contained one reverse?-polarized sample, probably an excursion of the magnetic field. Rock magnetic and anisotropy of magnetic susceptibility (MS) measurements indicated mostly the presence of oblate, low-coercivity magnetic fraction, presumably magnetite. The S-ratio profile for the entrance facies shows values close to 0 in profile I (at a depth of 19 to 33 cm and of 38 cm) as for profile II (at a depth of 35 to 44 cm) followed by almost constant values close to 0. This confirms the presence of hematite and/or goethite in these parts of the profiles. Low-field bulk magnetic susceptibility shows a slight decrease at the same depths above. Remanence parameters, including MS and isothermal remanent magnetization, definitely reveal a change at about a depth of 19 and 44 cm for profiles I and II, supporting the susceptibility pattern. The S-ratio parameter reveals the dominance of a lower-coercivity mineral (likely magnetite) in profile I from the top to a depth of 19 cm and in profile II from the depth of 44 cm to the end.

FIG. 14

A complete view of a sampled site with a rhinoceros skeleton (Lokev, Classical Karst, Slovenia). Upper section in blue, lower section in red (A. Švara in front of the section). Photo by N. Zupan Hajna.

***Bilateral co-operation between Institute of Geology of the Czech Academy of Sciences, v. v. i., and Karst Research Institute, Scientific Research Centre, Slovenian Academy of Sciences and Arts*: Paleomagnetism and magnetostratigraphy of Cenozic cave sediments in Slovenia (N. Zupan Hajna, A. Mihevc, Karst Research Institute ZRC SAZU, Postojna, Slovenia; *P. Pruner*, *P. Bosák*; in co-operation with MOBILITY No. SAZU-19-01; internal code 7273; supported by RVO67985831; since 1997)**

Grofova jama is a partly unroofed relict of a (bathy) phreatic cave situated high above the present leveled surface of the NW Classical Karst. The cave is still partly filled with clays which once completely filled the cave. Yellow-white lower clays are composed of dioctahedral clay mineral from the smectite group, i. e., montmorillonite (**Fig. 15**), with subordinate kaolinite, mica and quartz. Quartz grain morphology indicates the origin of source materials by *in situ* weathering processes. Geochemical characteristics and dating results indicate clay affinity to volcanic rocks of the Smrekovec Volcanic Centre (SVC; NE Slovenia, 28–23 Myr) by the similarity of the REE contents and distribution, LRRE-enrichment manifested in high La_N/Yb_N ratios, and significant negative Eu/Eu* ratio. Negative anomalies in primitive mantle-normalized trace-element patterns for K, Ba, Sr, Ti and Y could be explained by an admixture of volcaniclastic materials from other and/or younger sources. Fission-track analysis of apatite revealed the age of 22±7 Myr and K-Ar dating of montmorillonite obtained a minimum age of 23.4±1.7 Myr. Studied clays have no relation to present allogenic input.

Grofova clays were supported by air-transported volcaniclastics. This fact represents strong evidence of (1) massive subaerial eruptions of the SVC, which was expected only as a submarine edifice, and

(2) intensive northeasterly trade winds during Upper Oligocene and Lower Miocene. Volcanic material was deposited in freshwater environment on levelled karst surface with a relatively low relief. Very rapid and intensive argillization/bentonitization of volcaniclastic material in humid and warm climates of tropical/subtropical types is expected. The transport of weathering products from surface down to the cave was most probably the effect of suffosion through evolving epikarst and vadose zones during initial stages of gradual tectonic uplift. Coarse-grained particles were sieved in the epikarst zone and further in phreatic loops. This model does not necessitate big, long and complicated cave systems with ponors to emplace allogenic input into the cave.

Red to reddish brown clays overlie the lower ones with an erosional surface, local rests of calcite speleothems, and ferruginization effects. They are composed of quartz, chlorite, hematite, mica, calcite, kaolinite and montmorillonite. Quartz grain morphology indicates their source from coluvial and fluvial sediments and terra rossa-type soils. They represent weathered products of flysch rocks possibly still mixed with remains of volcaniclastic material. Surface weathering was induced by warm and periodically dry and wet climate. Red clays were deposited only after the underlying clays had been substantially eroded from the cave, i. e., after a prolonged hiatus with tectonic uplift.

The Grofova jama represents a tiny but extremely important fragment of the ancient Tertiary karst landscape in Slovenia, allowing an insight into already denuded landscapes of the Dinaric Lake System.

FIG. 15 Decantation of montmorillonite clay from the Grofova jama in the yard of the Karst Research Institute ZRC SAZU, Postojna (October 3, 2009). Photo by A. Mihevc.

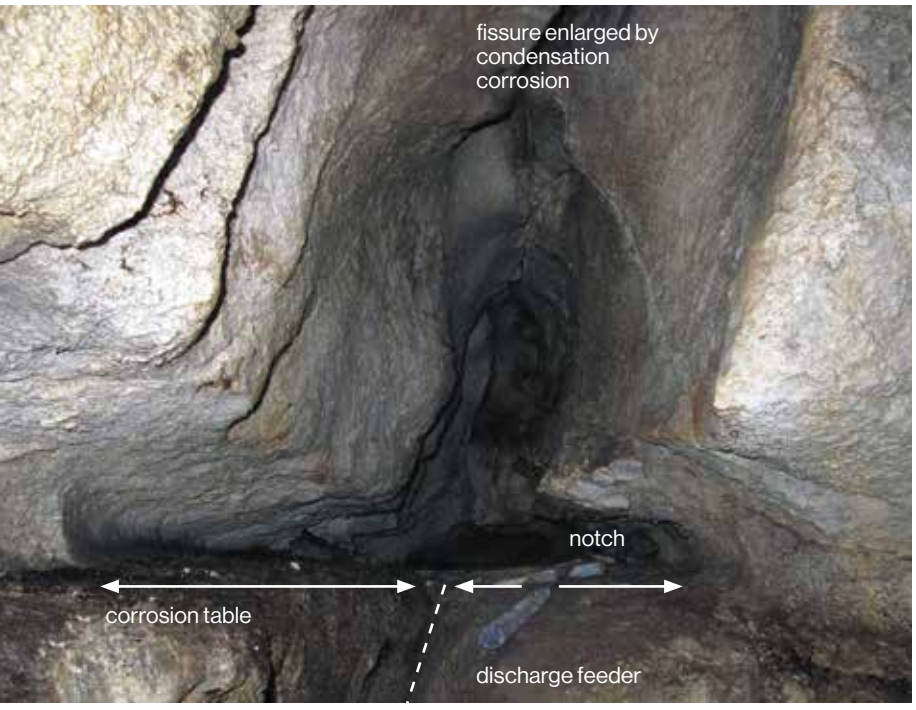

FIG. 16 Typical speleogens for sulphuric acid speleogenesis found in the Plavecká Cave (Malé Karpaty Mountains, Western Slovakia). Photo by P. Bella.

***Bilateral co-operation between Institute of Geology of the Czech Academy of Sciences, v. v. i., and State Nature Conservancy of the Slovak Republic – Slovak Caves Administration, Liptovský Mikuláš*: Paleomagnetism and magnetostratigraphy of Cenozic cave sediments and speleogenesis of selected caves in Slovakia (P. Bella, Slovak Caves Administration, Liptovský Mikuláš and Catholic University in Ružomberok, Slovakia; J. Littva, Slovak Caves Administration, Liptovský Mikuláš; *P. Bosák*, *P. Mikysek*; internal code 7448; supported by RVO67985831; since 1997)**

Caves at Plavecký hradný vrch Hill (431 m asl; Malé Karpaty Mountains, MKM) were formed in Triassic carbonates (Hronic Unit) by deeply circulating fault-related waters ascending along the horst-graben structure at the contact of the MKM and Záhorská nížina Lowland (NE part of the Vienna Basin). Both the Plavecká jaskyňa Cave (PJC), and the above-lying Pec Cave consist of almost horizontal passages and halls/chambers with flat corrosion bedrock floors (corrosion tables), feeding fissures, and wall water-table notches (**Fig. 16**), clear morphological indicators of sulphuric acid (hypogenic) speleogenesis. Flat corrosion bedrock floor in the upper part of the PJC reaches up to 10–12 m in width. Floors truncate fissure discharge feeders, on the edges with wall water-table notches, which represent products of rapid lateral corrosion by sulphuric low-thermal waters. Shallow cupolas, ceiling spherical holes, wall niches, and upward wall channels formed by condensation

corrosion on the overlying walls and ceilings, as well as vadose vents or small hemispherical corrosion depressions deepened into the overhanging walls and resembling replacement pockets are among the predominant speleogens. Subhorizontal cave segments are interconnected by steep/vertical oval feeders.

Phases of sulphuric low-temperature acid speleogenesis are indicated by gypsum and jarosite in rare fine-grained cave sediments, mainly in the upper cave level. The alteration of a thin top zone of the limestone cave wall, recorded in stable isotope composition, resulted from its interaction with hypogene waters. The PJC lowest evolution level is at about the same altitude as the recent springs of slightly warmer groundwater in front of the cave (11.6–13.6 °C). Subaerial calcite popcorn rims were also precipitated due to water evaporation and CO_2 degassing from condensation water at edges of feeders that were still active as thermal vents when the water table had been slowly dropping. Hydrogen sulphide involved in speleogenesis was most probably derived from hydrocarbon reservoirs of the adjacent Vienna Basin.

Four subhorizontal passages of the PCJ (at 212, 214, 220, and 225 m asl) developed along former piezometric surfaces during water table stagnations. They correspond to phases of erosion base level stabilization related to landform evolution when the adjacent part of the Vienna Basin subsided. The Pec Cave consists of three subhorizontal parts (at 283, 287, and 295 m asl) that represent the highest-lying and oldest (probably Early Pleistocene or pre-Quaternary) known cave level segments in the Plavecký hradný vrch.

***Project of Joint Institute for Nuclear Research, No. 04-4-1121-2015/2020*: Investigations of condensed matter by modern neutron scattering methods (T. Ivankina, I. Zel, R. Vasin, Joint Institute for Nuclear Research, Frank Laboratory of Neutron Physics, Dubna, Russia; *T. Lokajíček*, *M. Petružálek*, *T. Svitek*; 2015–2020)**

Subproject 1: Comprehensive analysis of the lithosphere elastic anisotropy and properties of lithosphere materials using neutron diffraction and ultrasonic sounding. The study of meteoritic matterial is of great importance for solving the problem of the origin and evolution of the Solar system. With the help of modern physical methods and instruments it is possible to obtain data on the chemical composition and structural features of various types of meteorites containing matter formed at the earliest stages of the evolution of the Solar system.

Two fragments of the Chelyabinsk meteorite and of the Kunya-Urgench meteorite, subjected to a powerful impact of a thermobaric shock when entering the Earth's atmosphere were studied. High-resolution neutron diffraction and the use of a SKAT diffractometer (JINR, Dubna) make it possible to assess the preferred orientation of the polycrystalline structure of the meteorites. The Chelyabinsk meteorite is classified as a carbonaceous chondrite of the LL chemical group, and the Kunya-Urgench meteorite is an ordinary chondrite, type H5. The crystallographic textures of mineral phases of the Chelyabinsk and the Kunya-Urgench meteorites are pronounced and have fiber orientation. The nature of the preferred orientation allows to assert that texture formation occurred at the time of the meteorite fall at high pressures and strong heating of the space body due to high-temperature plastic deformation.

Subproject 2: Elastic anisotropy of layered rocks: ultrasonic measurements and texture-based theoretical predictions. Volumetric studies of mica spatial distribution inside samples of the Westerly and Czech granites (Mrakotin, Liberec, and Brno syenite) were performed using a neutron tomography method. A significant difference in the neutron attenuation coefficients of mica and other rock-forming minerals of the granites studied yielded a large neutron radiography contrast and, as a result, allowed us to perform a detailed analysis of three-dimensional structural data based on the neutron tomography reconstruction procedure. The morphology and spatial distribution of the mica phase within the studied granites were obtained. Tomography data were compared to the results provided by other experimental methods commonly used in rock mechanics research such as optical and electron microscopy, as well as ultrasonic shear-wave measurements. The benefits and limitations of the application of the neutron tomography method for studies of granitic rocks are discussed.

***UNESCO IGCP project No. 679*: Cretaceous Earth Dynamics and Climate in Asia (G. Li, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China; T. Hasegawa, Department of Earth Sciences, Faculty of Science, Kanazawa University, Kakuma, Japan; D. K. Cheong, Department of Geology, College of Natural Sciences, Kang-won National University, Kangwondoo, Korea; V. Prasad, Birbal Sahni Institute of Palaeobotany, Lucknow, India; *P. Schnabl*, *A. Svobodová*, *P. Pruner*, *J. Adamovič*, *T. Elbra*, *Š. Kdýr*; 2019–2022)**

Cretaceous was the most recent warm period in the Phanerozoic Eon. Compared to nowadays, it comprised elevated atmospheric CO_2 levels and considerably higher global sea level. The project addresses three main topics: (1) Cretaceous geological records of sea and land facies in Asia; (2) climate and environment, and (3) the nature of linkages between major geological events and rapid climate and environmental changes; with an aim to understand biodiversity evolution under greenhouse climate conditions. The information about Cretaceous ‚Greenhouse' oceanic and terrestrial climate, environmental conditions, and their evolution, will lead to an in-depth knowledge of the existing characteristics of rapid climate and environmental changes and global warming. These results can also provide scientific evidence for human response to contemporary global warming trends. The project will play a significant role in promoting geoscience communication among Asian countries, including some countries outside Asia.

7B CZECH SCIENCE FOUNDATION

ONGOING PROJECTS

***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 in Prague; *M. Svojtka*, *J. Sláma*, *J. Rejšek*, *J. Ďurišová*, *D. Kořínková*; 2020–2022)**

The Covid-19 pandemic situation completely changed the original research plan of the first year. The key part of the project was a one-month field expedition to the Urals, where all samples and field data were supposed to be acquired. As it was impossible to get the samples and data, to save as much of the project as possible, the first year concentrated on three issues. First, we compiled an extensive database of geologic maps and published literature on the geologic evolution of the Uralian orogen and adjacent areas as well on the final assembly of Pangea, including geochronologic and paleomagnetic data. Second, for comparison, we compiled a database of geochronologic data from Variscan plutons in the Bohemian Massif and analysed them using the GIS system. The latter pursuit was also included as a part of a theoretical publication on magmatic tempos in orogens (Journal of Geology). Third, we started preparation of analytical methods and instrumentation for the U-Pb laser ablation and ID-TIMS dating.

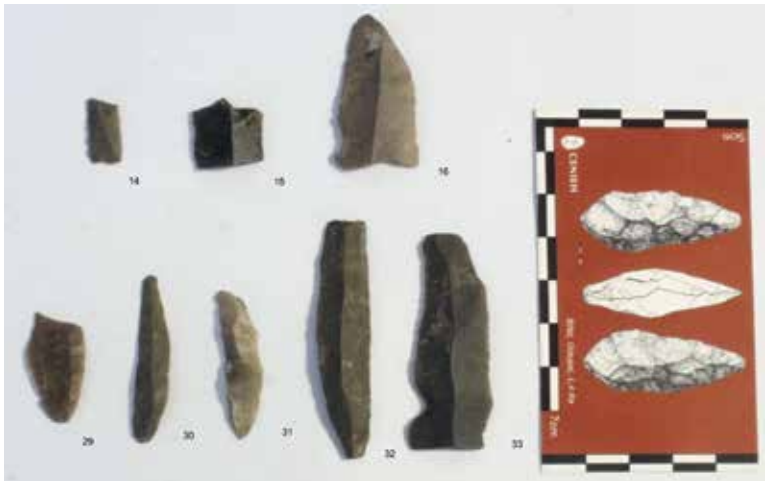

FIG. 17 Examples of studied artefacts. Photo by M. Moník.

***No. GJ19-02177Y*: Magma transfer and emplacement processes in collapsing orogens (*F. Tomek*, *J. Černý*, *J. Rejšek*, *Minh Phuong Le*, *Eva Vosáhlová*; 2019–2021)**

Two papers were published by the team members. Tomek et al. in press (International Geology Review) linked the pyroclastic layers in post- orogenic basins with volcanism of the late Variscan caldera. Here, a multidisciplinary approach using the U/Pb zircon dating, thickness and grain size distribution analysis, and volume calculation suggested that the source volcano was the Altenberg–Teplice Caldera (ATC) located in the NW Bohemian Massif. The paper by Černý et al. 2020 (Journal of Geophysical Research) filled the gap in general knowledge on the anisotropy of magnetic susceptibility, one of the main methods used during the project. To understand the meaning of inverse magnetic fabrics for geological interpretations, a new, more detailed classification of inverse magnetic fabrics types is formulated in this paper.

We finalized field and analytical works, including data analysis and interpretations of rocks from the ATC. From the Sayda dyke swarm, we collected 659 AMS specimens from 41 sampling points and some additional samples for magnetic mineralogy tests. Data interpretation allowed us to describe in great detail the architecture of an ignimbrite caldera feeding system. From the Teplice rhyolite, an intra-caldera ignimbrite fill, we have sampled 74 AMS points (1,486 specimens), 12 specimens for magnetic mineralogy tests and 25 thin sections for petrography. We also continued to sample rocks of the Tharandt Forest Caldera. However, due to travel restrictions related to the pandemic situation, both the field works and the analogue modeling parts of this project were temporarily suspended.

***No. 18-02606S*: Non-destructive determination of heated artifacts in Upper Palaeolithic assemblages (M. Moník, Faculty of Science, Palacký University in Olomouc; Z. Nerudová, Moravian Museum, Brno, Czech Republic; *P. Schnabl*; 2018–2020)**

The aim of this project was to test in a non-destructive way how colour and magnetic susceptibility measurements can distinguish between heated/burnt and unheated siliceous material and, if possible, identify heated artifacts in selected Upper Paleolithic assemblages from Moravia, Czechia. Knapped stone assemblages from the Kůlna Cave, layers 6 and 5, Hranice III – Velká Kobylanka, Loštice I–Kozí vrch, and Brno-Štýřice III were analysed (**Fig. 17**). No heat-treated artefacts were found at any of them suggesting that the heat treatment of flints, known, e. g., from W and SW Europe, was not known in the Late Glacial Magdalenian culture in Moravia. This is despite the fact that surface roughness measurements in experimental samples have shown that easier knappability can be achieved by heat treatment of Baltic flints. A list of methods useful for the identification of heated silica materials is presented together with ideal temperatures of heat treatment. These are critically evaluated, and the method can serve as a guideline in further research. By using mostly macroscopic analysis, the chipped stone assemblage from the Kůlna Cave (Moravian Karst) of Magdalenian age was analysed. It was shown that one radiocarbon date from the site is likely erroneous. No heat-treated artefacts were identified like in the Balcarka Cave, only burned pieces from disturbed hearths. This is

consistent with data from the open-air Magdalenian site of Hranice III–Velká Kobylanka where heat treatment was not identified either. The absence of the Olomučany chert in the assemblage distinguished this site, however, from the many sites of the Moravian Karst and other open-air sites. Two possible migration waves of Magdalenian population from SW Europe 14 kyr ago were indicated, one arriving along the Danube, the other across central Germany. It is probable that the technique of heat treatment was used nowhere in the Late Glacial of Central Europe, either due to imports of high-quality flints from neighbouring regions, which did not require heat treatment, or due to the absence of pressure flaking which is usually linked to the technique.

***No. 18-05935S*: From past to present: fossil vs. recent marine shelled organisms as a substrate for colonization and bioerosion (K. Holcová, Faculty of Science, Charles University in Prague; Z. Heřmanová, National Museum in Prague; M. Vohník, Inst Botany, Czech Acad Sci; *R. Mikuláš*, *L. Slavík*; M. Mergl, University of West Bohemia in Pilsen; 2018–2020; prolonged till June, 2021)**

The combination of SEM images of vacuum casts of microborings with computed tomography images of analogous fossil material proved to be the best presently accessible method of the study. Among the case studies, insect borings found from the lowermost Cretaceous lignite on the Isle of Bornholm (Denmark) were recognized as the work of Scolytidae. The find consists of six thin, roughly parallel, short passages connected with a remnant of a long straight tunnel running along a mechanically induced fissure just below the wood surface. This find is not fully analogous with the presently most common feeding insect borings as the passages are situated in an oblique fissure of the wood sample (instead of the usual position below the bark). Nevertheless, the best modern analogues of the borings found in Bornholm still come from the insect forestry pests such as the Scolytidae (bark beetles). The find shows that ecological predecessors of bark beetles probably first inhabited random mechanic cracks; later, they occupied the most devastating niche at the boundary between the bark and the wood.

***No. 18-08826S* Resistance to brittle damage: use of petrographic/rock mechanical data for the technological-mechanical behaviour and serviceability of crushed stone (R. Přikryl, Faculty of Science, Charles University in Prague; *T. Lokajíček*, *M. Petružálek*, *T. Svitek*; Z. Weishauptova, M. Vorokhta, Inst Rock Struct Mechan, Czech Acad Sci, Prague; 2018–2020)**

Major aims of this research were to experimentally verify mutual relationships between fundamental rock mechanical (RM) properties (deformability, strength) and empirically derived technological-mechanical performance (MTP) properties (mechanical resistance), to find which of the RM parameters contribute to MTP, and to find how these properties are controlled by rock fabric and composition.

Two groups of rocks (volcanic rocks of various age, greywackes) were used, which contribute to more than 50 % of crushed stone aggregates (CSA) in Czechia. Representative samples were subjected to the laboratory RM tests, to the tests on TMP, and to a petrographic/rock fabric study including quantitative petrographic image analysis.

RM tests for uniaxial compressive strength (UCS) allowed for recording stress-strain behaviour and derivation of principal stress/strain domains separated by thresholds. By integrating areas under the respective parts of the stress-strain curve, the recorded data were further utilised for the computation of energetic parameters below the crack initiation threshold (which is the stress level above which new – isolated – microcracks are formed within the tested material) and below the unstable crack growth stress threshold (which is the stress level above which the dense network of newly formed microcracks starts to coalesce in an uncontrolled manner, later resulting in the macroscopic failure of the tested specimen). These parameters are considered to be independent of the test conditions, thus reflecting intrinsic physico-mechanical properties of the tested materials. Along with UCS, indirect tensile strength (TS) tests were also performed to allow for brittleness calculation.

Experimental data proved that the TMP of crushed stone aggregates is controlled by RM properties of the sources rocks, specifically by the amount of mechanical energy which can be absorbed by the material prior to the formation of new microcracks and/or their coalescence. The experiments thus verified the initial assumption that UCS alone does not present a suitable predictor of TMP of crushed stone. Considering genetically/compositionally homogeneous groups of rocks (e. g., basalts s. s., greywackes), the contribution of specific microstructural parameters on TMP is obvious, specifically the influence of grain size on rock-forming constituents (TMP and RM properties improve with a decreasing grain size) and quality of rock microfabric (expressed by the degree of interlocking of rock-forming minerals).

***No. 19-08066S*: 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 in Prague; *M. Svojtka*, *L. Ackerman*, *J. Sláma*, *J. Rejšek*, *J. Ďurišová*, P. Le; 2019–2021)**

The original research plan 2020 was severely affected by the Covid-19 situation and travel restrictions. In particular, we had to completely cancel the planned field work, which is a disaster for a field work-based project. Thus, no additional or new samples nor new field data could have been acquired. Nevertheless, in 2020 we worked on samples and data acquired during the first year of the project (2019). First, the AMS, structural, and microstructural data from the Bienville intrusion were completely processed and a final version of the interpretation was produced in the submitted manuscript. We suggest that the studied Canadian Superior Province has become one of the key terrains to discuss tectonic processes and mechanisms of crustal growth in the Late Archean. We examined the Radisson pluton in northeastern Québec (**Fig. 18**), which intruded the southern, outer edge of the presumed magmatic arc (Bienville domain) along its ~WNW–ESE-trending tectonic boundary with the

FIG. 18 A field photo of a late-stage biotite granite dyke (bright colour) in the Radisson pluton, which was dated at ~2.696 Ga, cutting across micro-granular enclaves, schlieren, and K-feldspar foliation in the host monzogranite (grey color). Photo by M. Svojtka.

proto-cratonic crust (La Grande domain). The pluton, dominated by a porphyritic monzogranite to quartz monzonite suite, was emplaced at around 2,712 Myr and exhibits a complex internal structure resulting from superposed magmatic to solid-state deformation succession in the Canadian Superior Province. Second, we measured and finally processed detrital zircon ages from six samples taken in 2019 from metasedimentary successions of the Opinaca belt, now working on a manuscript on provenance and plate-tectonic implications of these presumably accretionary wedge/forearc deposits. Third, Pb isotopic analyses of the La Grande (11 samples) and Opatica granitic rocks (6 samples) were accomplished as well as *in situ* zircon Hf isotopic analyses of these rocks. Collectively, zircons from both sub-provinces show similar epsHf values between +0.9 and +3.4. The rocks from Opatica are characterized by uniform Hf between ca. 1.6–3.4 with one outlier (Salamandre Suite granite) with a slightly lower value of ca. 0.9. The ages of Opatica magmatic rocks span between ca. 2.73–2.69 Gyr with the exception of diorite from Lac Rodayer Pluton with a much older age of ca. 2.83 Gyr. Magmatic rocks from La Grande River domain are also very homogenous with most types having Hf between ca. 1.4–3.2 and ages between ca. 2.74–2.71 Gyr.

***No: 19-02606S*: Oppidum as an urban landscape: multidisciplinary approach to the study of space organization "intra muros" (P. Goláňová, Faculty of Arts, Masaryk University in Brno; *L. Lisá*; 2019–2021)**

Despite the situation around COVID-19, the 2020 excavation season was successfully conducted at the Bibracte oppidum, in co-operation with the European Archaeological Centre. The excavation works took place during a 5-week period (19 July–22 August 2020), and focused on the areas of Le Porrey and Le Verger, in the inner space of the oppidum. Sampling, in the scope of long section profiles, was performed in six test-pits (1×1 m), where samples were taken for archaeobotanical, palynological, phytological, parasitological, anthracological, and diatomal analyses. Furthermore, micromorphological and pedological samples were taken for analyses. Only minimum human activities (artefacts, features) were detected in these test-pits. Some excavated areas (Le Porrey) showed traces of teracement of the terrain. The plateau around Le Verger has been affected by strong erosion. Two core samples were taken in the not-excavated spring area in the central part of the oppidum, in order to obtain waterlogged environmental data. Coring was done by J. Petřík, with M. Hajnalová, I. Jouffroy-Bapicot, and O. Girardclos (Université Franche-Comté Besançon, France) participating in its evaluation and analysis. Dating of the macroremains (AMS) unfortunately showed a medieval origin of the sediments. Alongside the excavation works, a geophysical survey was conducted in the central part of the oppidum, close to the excavated parts.

During 2020, due to COVID-19, most of the planned conferences and workshops were cancelled and the organizing of a session on the EAA (Empty spaces intra muros) in virtual environment was cancelled for the lack of interest of the participants. The results were thus presented only at the meeting of European Archaeological Centre researchers in March 2020, and in an online research council at Bibracte (October 2020). A part of geoarchaeological results was presented at the international conference CEA (Conference of environmental archaeology) in Prague at the beginning of the year as a lecture and also as a poster at the International workshop "*Microscopy*

Approaches in Archaeobotany" held in Reading (GB). In 2020, an article in the impacted journal PLOS ONE and two preliminary reports of the archaeological and geophysical research from 2019 were published in Rapports Bibracte 2019 (accessible on-line). Two publications on the research were submitted for print in Rapports Bibracte 2020, and another case study of archaeological soils from La Terrasse, oppidum Bibracte" was prepared for submission.

***No. 19-05198S*: 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 in Brno; 2019–2021)**

Greisenization and albitization are chemically complementary post-magmatic metasomatic processes in granitoids, which play an important role in the concentration of rare elements like Li, Sn, Nb, Ta etc. The aim of this project was to distinguish magmatic and hydrothermal (metasomatic) processes (episodes) in typical rare-element enriched magmatic systems and to assess their significance for transport and concentration of metals.

We finished the study of trace element signature of magmatic vs. hydrothermal quartz. About 1,900 laser ablation inductively coupled plasma mass spectrometry analyses of quartz from rare-metal granites and related greisens and quartz veins, performed in our lab were evaluated in order to define the typical trace-element signature of quartz of different origin. The studied dataset comprises typical examples of strongly peraluminous plutons from Czechia, France, England, Portugal, Finland, Russia and Mongolia. Compiled data reveal a high diversity in the contents of trace elements in quartz also among rocks of similar geochemical composition.

We continued chemical, petrological and mineralogical study of the Argemela intrusion in Portugal. The intrusion is texturally much diversified. Diversity of facies and zoned structure of quartz and micas allow to study several episodes of magmatic fractionation and subsequent hydrothermal evolution of the system. Chemical bulk-rock data, TIMA and CL textural data (**Fig. 19**), and EMPA and LA-ICP MS compositions of the main minerals are already available and will be converted into the manuscript at the beginning of 2021.

We started the study of feldspar-rich granite varieties associated with large greisen-type deposits, examples Cínovec and Krásno: Large cupola-shaped greisen-type deposits in the Krušné Hory areas (Cínovec, Krásno) form a conjugate system with deeper-seated voluminous bodies of feldspar-rich granite varieties. Some of the feldspar-rich rocks (feldspathites) have common igneous granitic texture, while other exhibit signs of strong hydrothermal metasomatism. This sub-theme aims to distinguish the two types of feldspathites and to understand their relation to adjacent greisen. In 2020, we realized field work, bulk-rock chemical analyses and a part of the textural studies. This work should be finished in 2021.

***No. 19-06728S*: 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; Milan Libertín, National Museum in Prague; 2019–2021).**

Palaeogeographically, the Czech localities were located in eastern tropical Pangea and the Chinese locality was located in the much smaller North China continent (block), both in equatorial latitudes. Excavation methods and modes of preservation (compressions as well as 3D anatomical preservation) do not differ between the two regions. This allows us to perform principally the same type of investigation and compare these similar ecosystems to a considerable detail in a close co-operation with the team from the Nanjing Institute of Geology and Palaeontology, China. International excavations provided unrivalled insights into the structure and composition of the forests including whole-plant reconstructions, tree

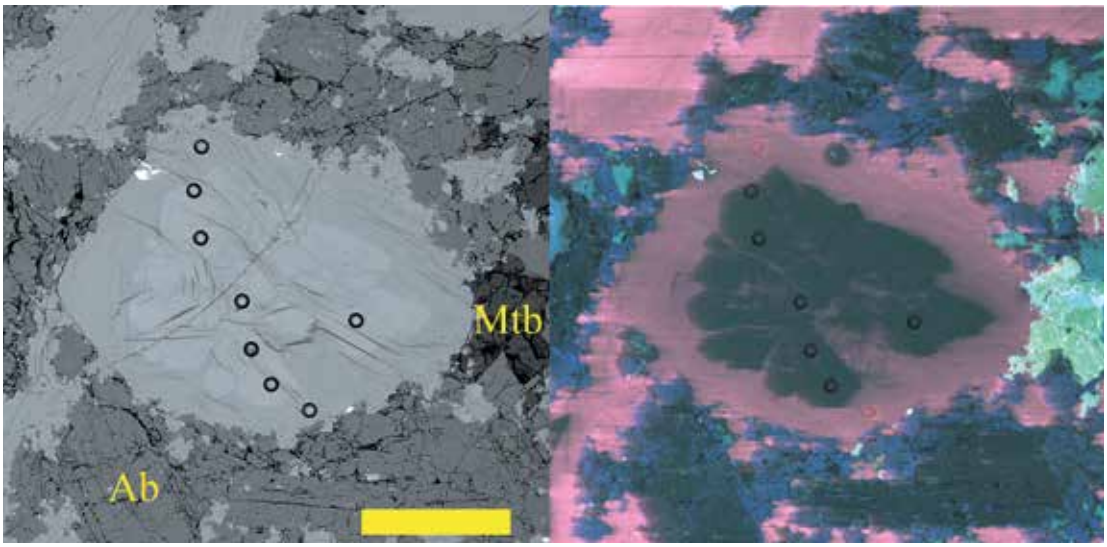

FIG. 19 A crystal of zoned mica from the main facies of Argemela granite in back-scattered electrons (BSE, left) and cathodoluminescence (CL, right). Early magmatic core of mica (black in CL) has the composition of muscovite, while its late magmatic rim, lilac in CL, is lepidolite. Small holes are spots of laser-ablation analyses. Mica is surrounded by an aggregate of albite (Ab) and montebrasite (Mtb). Scale bar is 0.5 mm. Photo by Z. Korbelová.

FIG. 20 Cadmium- and arsenic-hyperaccumulating fungus *Thelephora penicillata* growing in its natural habitat in the Highland, Czech Republic. Photo by J. Borovička.

density and canopy height, spatial heterogeneity and ecological gradients. Documentation of the fossil record uncovered in an area of about 80 m^2 shows 14 morphotaxa representing 11 whole-plant species with a wide variety of growth forms. The uncovered phytocoenosis is interpreted as a forest dominated by cordaites as the tallest trees, the remains of which covered over 50 % of the excavated area. Marattialean tree ferns represent the lower canopy that was not taller than about 3 m. This storey fills gaps between cordaites and covers over 20 % of the area. Although members of the herbaceous layer covered only 7 % of the excavated area, it was the most diverse storey of the peat-forming forest. The mesofossil study and the interaction of plants and animals are represented by the first insight into a plant–insect interaction in the Late Paleozoic of China and demonstrates the existence of 8 insect-feeding types belonging to 5 functional feeding groups.

_No. 19-06759S_: Cadmium hyperaccumulation in macrofungi: from isotopes to proteins and bacterial communities (*J. Borovička*; P. Kotrba, University of Chemistry and Technology in Prague; 2019–2021)

The project combines mycological, biogeochemical, biochemical, molecular biology, and current microbiological/metagenomics approaches to investigate Cd accumulation in macrofungi (mushrooms). We particularly focus on the investigation of (i) Cd isotopic fractionation in mushrooms, (ii) Cd accumulation, sequestration and chemical speciation in fungal tissues, (iii) bacterial communities associated with Cd-hyperaccumulating macrofungi.

A new analytical protocol for high-precision Cd isotopic analyses in biological materials using thermal ionization mass spectrometry (TIMS) with double spike correction was established at the Inst Geol, Czech Acad Sci. Cd isotopic composition of Cd-hyperaccumulating mushroom *Thelephora penicillata* (**Fig. 20**) was investigated and the Cd isotopic fingerprints of the hyperaccumulator were compared to those of mushrooms growing at the same site. The Cd concentrations in *T. penicillata* were in the range of 1,100–1,730 $mg.kg^{-1}$, highly elevated when compared to other ectomycorrhizal mushrooms from that site (0.9–10 $mg.kg^{-1}$). The Cd isotopic composition of *T. penicillata* was rather homogeneous ($\delta^{114/110}$Cd 0.03–0.14) and more or less corresponded to that found in nitric acid extracts from the underlying soil substrate ($\delta^{114/110}$Cd 0.06–0.16). The $\delta^{114/110}$Cd values detected in common mushrooms varied in a rather large range of -0.37 to +0.09 and the vast majority of samples was below 0 which is in contrast to what we observed in *T. penicillata*.

Agaricus bisporus grown on an artificially Cd-enriched substrate was inspected for possible Cd fractionation within different parts of sporocarps (stipe, cap flesh, lamellae) which were highly contrasting in terms of their Cd concentration. However, no Cd fractionation could have been observed in the analysed samples and the measured Cd isotopic fingerprints corresponded to those of the Cd solution amended to the substrate. This was a rather surprising result as Cd fractionation within tissues has repeatedly been reported from Cd-accumulating vascular plants.

In *Amanita muscaria*, a Cd-binding metallothionein "AmMT1" was successfully isolated and characterized in yeast mutants. Furthermore, the abundance of *Agaricus crocodilinus* mycelium in soil samples collected in the field from *A. crocodilinus* natural habitats was assessed by qRT-PCR (samples directly below the sporocarps and controls). NGS sequencing was performed on them and the results are analysed. Bacterial isolates from *A. crocodilinus* sporocarps were sequenced (16S) and one of the isolates is possibly a previously characterized metal-tolerant endophyte (Enterobacterales).

_No. 19-07516S_: Cretaceous-Paleogene boundary in the Carpathians – a multidisciplinary search for local variations in global cataclysm event (*T. Elbra*, *Š. Kdýr*, *T. Kohout*, *P. Pruner*, *P. Schnabl*, *R. Skála*; M. Bubík, Czech Geological Survey, Branch Brno; P. Skupien, VŠB – Technical University in Ostrava; 2019–2021)

The paleomagnetic team (Inst Geol, Czech Acad Sci) mainly concentrated on detailed studies of two Czech sections – Uzgruň and Bukovec. A sampling campaign for detailed magnetic studies, geochem-

FIG. 21 A photomicrograph of iron sulphide framboids in reflected light. Photo by T. Elbra and R. Skála.

istry and mineralogy was carried during the summer. Laboratory analyses indicated that most of the samples are magnetically relatively weak with no distinct change in magnetic properties across the

K/Pg boundary. The presence of a small amount of magnetite was identified as the main contributor to the observed susceptibilities and remanent magnetization. The Uzgruň samples showed also the presence of iron sulphides (**Fig. 21**). Powder diffraction data showed that phase contents, particularly of calcite and feldspar, vary along the Uzgruň section with no systematic variations. Sample to sample changes of the clay mineral proportions were also observed. The geochemical analyses showed a wide range in Hg content and moderately elevated Hg/TOC ratios around the stratigraphic boundary interval. In addition to Czech localities, the team also worked on combining magnetic data from Žilina borehole (Slovakia) with other proxies (a. o., biochronology), as well as collaborated on the study of the Kršteňany (Slovakia) drilled section. A magnetic study was published on Chicxulub ejecta samples from Belize, which gave evidence of electric charging during vapor plume cloud processes of the K/Pg impact event.

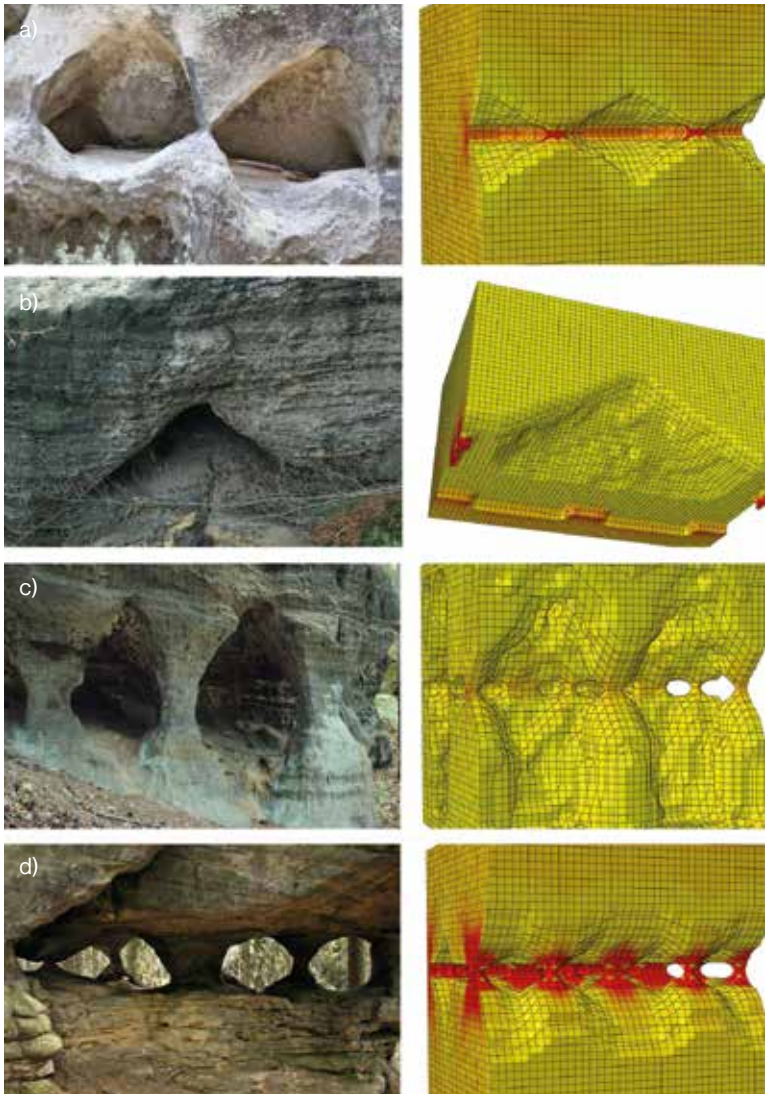

FIG. 22

Examples of various arcade-derived cavities and related rock pillars and their modelled analogues: a) two lenticular arcades with a distinct pillar, Apolena Rock City, CZ; b) a large sole symmetrical rhombic cavity, Kobylka Gorge, Mšeno area, CZ; c) elongated arcades with massive pillars, Kokořínský důl Valley ("2D distribution of cavities"), CZ; d) pillars developed in a weaker layer ("3D distribution of cavities"), Svídnická Tower, Adršpach-Teplice Cliffs monument, CZ. Modified from Safonov et al. (2020).

***No. 19-08614S*: Biogeochemistry of mercury isotopes in anthropogenically affected areas (*M. Vaňková*; J. Trubač, Faculty of Science, Charles University in Prague; 2019–2021)**

The aims of the project included (i) identification and quantification of different anthropogenic sources of Hg pollution affected by smelting and mining activities and coal combustion, followed by (ii) the influence of vegetation cover on Hg isotopic composition of impacted soils and also (iii) Hg isotopic fractionation in soils and its dependence on the stage of soil decomposition.

Despite the postponement of some works due to pandemic restrictions, the aims of this project have been successfully accomplished.

Soil profiles polluted by Hg and Fe mining activities were studied in order to trace the source of pollution using Hg isotope composition. The resulting Hg isotopic signatures of mined HgS displayed negative δ 202, ranging from -1.10 ‰ to -1.06 ‰, which is in good agreement with Hg isotopic composition of HgS reported from similar mining sites.

While topsoil signatures were resembling the HgS signature (-1.15 to -1.03 ‰), the horizon of mineral soil showed elevated δ 202 values of up to -0.8‰. Additionally, a thermo-desorption analysis was used for the determination of Hg species within the soil horizons, and the presence of cinnabar was confirmed in impacted horizons.

The influence of Hg pollution sources (such as cement production, caustic soda production, pig iron and steel factories) on nearby forest soils was proved using the assessment of changes in soil parameters (contents of Hg, organic C, N and S). Published results showed that although some of the study sites exhibited mean Hg mineral and organic pools within the range reported for pristine forest soils, soil characteristics and Hg concentrations in soils proved to be strongly affected by the presence of a chlor-alkali plant at one site and a nearby limestone mine at another site.

Another aim of this project was completed by the publication of results of Hg remobilization from polluted topsoils in Tsumeb, Namibia, as a result of recurring wildfires in this area.

***No. 19-14082S*: Stress- and hydraulic field-controlled weathering and erosion of granular rocks (J. Bruthans, Faculty of Science, Charles University in Prague; *M. Filippi*; J. Schweigstillová, Inst Rock Struct Mechan, Czech Acad Sci, Prague; 2019–2021)**

This project deals with *in situ* documentation and experimental testing of stress- and hydraulic field-controlled weathering and erosion of granular rocks (**Fig. 22**). It combines several non-traditional approaches. The following partial tasks were addressed in 2020. The tests with sandstone and other rock cubes in compression and tension and cores encased in reinforced concrete continued (granite, shale, rhyolite, and various arenites). Disintegration of granite is extremely slow. Frost weathering experiments need a large number of cycles and will continue for most of 2021. SEM study of various rock samples continued. Rock salt and quartzite were studied via uCT. Drilling resistance was measured. The obtained

results indicate that two different classes of stress stabilization can be recognized in the studied samples. Weathering of most of the studied materials is delayed by radial stress. On the other hand, just a small subset of materials is stabilized by uniaxial stress. Laboratory experiments with impure sandstone focused on flaking, and experiments with rock salt were performed. Flaking was observed repeatedly on various materials which are cemented. Now a paper is being prepared based on laboratory and field measurements concerning the origin of vaults in Iranian salt caves. Monitoring of cubic blocks of sandstone in an open-air lab continued. ERT measurement was repeatedly applied on blocks and compared with other methods. Field monitoring continued in Czechia and abroad. Analyses of salt composition from various locations were performed. Attempts to model moisture and salt transport are being made. Erosion affected by stress field was modelled on the example of arcades. The model was capable to replicate real shapes observed in nature.

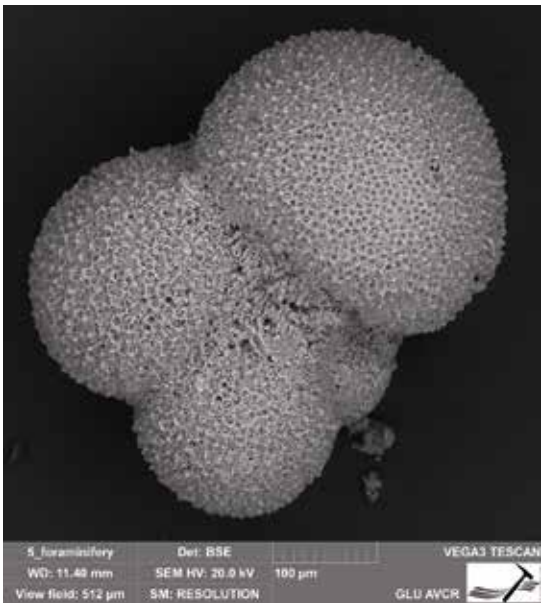

FIG. 23 A detailed SEM image of planktonic foraminifer *Globigerinoides trilobus*; one of the commonly used species for paleoceanographic reconstructions. Photo by N. Mészárosová.

***No. 20-05872S*: The Langhian Mediterranean-Paratethys enigma: hydrography based on Nd isotopes proxy on foraminifera revealing changes in paleoceanography (K. Holcová, F. Scheiner, Faculty of Science, Charles University in Prague & *L. Ackerman*, *J. Rejšek*, *P. Le Minh*; 2020–2022)**

The main goal of the proposed project is to provide a global model of oceanographic interactions within the Mediterranean-Paratethys marine system during the interval characterized by the closure of the Indic-Mediterranean gateway that is related to crucial Neogene climatic changes – the Monterey event. The proposed synthesis of multiproxy data should bring new insights into the evolution of one of the key areas representing a junction between two oceans. We are planning to use an innovative combination of progressive geochemical methods on foraminifera (high-precision, single-test $^{143}Nd/^{144}Nd$ analyses), together with the established ones (Mg/Ca; $\delta^{18}O$; $\delta^{13}C$). These geochemical methods will be used jointly with classical paleoecological and sedimentological approaches to obtain robust datasets for paleoceanographic interpretations. The project should elucidate the origin and evolution of the Mediterranean-Paratethys hydrography in relation to adjacent oceans (Atlantic, Indic) as well as assess the influences of global climatic changes and the role of local source variations.

The first year of the project was largely affected by Covid-19 pandemic which prevented the collection of samples abroad representing the core of the project. Nevertheless, we focused on state-of-art of the Nd isotope method (cleaning, decomposition, Sr-Nd extraction from the matrix, TIMS isotopic analyses using 10^{13} Ω resistors) and different protocols of foraminifera cleaning and their impact on the Nd isotope systematics. Subsequently, due to extensive collaborations with other universities, a large dataset for ~50 samples was obtained in terms of Sr and Nd isotopic compositions as well as paleotemperatures proxy such as Mg/Ca ratios. The samples represent different foraminifera from the Langhian period extracted from several sedimentary successions (e.g, Ukraine, Malta, Slovakia, Czech Republic) as well as modern foraminiferal samples from the Mediterranean. For these samples, several different foraminiferal species (**Fig. 23**) were analysed to test possible $^{143}Nd/^{144}Nd$ variability among them and estimate the overall precision and accuracy of the analytical protocol. The pilot data revealed that a very small sample amount (< 1 ng Nd) provides analytical precision sufficient for detailed paleoceanographic studies.

***No. 20-06134S*: Paleoecology of early angiosperms during mid-Cretaceous, case study of material from Iberian Peninsula and central Europe (J. Kvaček, National Museum in Prague; *J. Dašková*; 2020–2022)**

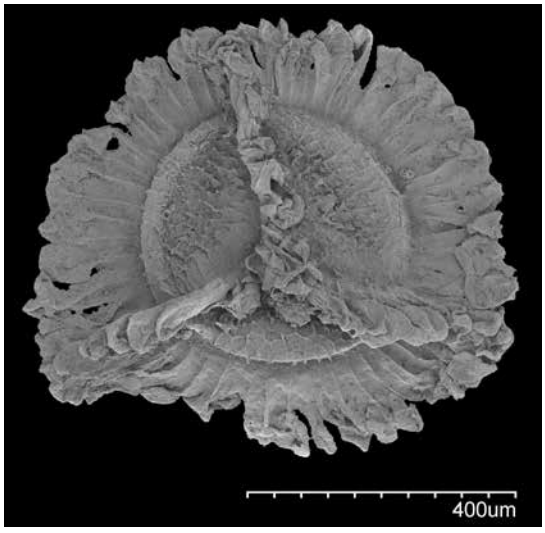

FIG. 24 Cretaceous megaspore of Isoëtales, Pecínov, Cenomanian. Photo by J. Dašková.

The main goal of the project is to determine the paleoecophysiology and paleoecology of early angiosperms and place them in their paleoenvironmental context. The project focuses on palaeofloristic and palynological studies (**Fig. 24**) of Aptian-Cenomanian floras of two areas in Europe with selected localities from each area. Besides standard application of morphological, anatomical and palynological analyses

the project focuses on detailed investigation of key ecophysiological traits which can be derived from plant fossils. δ13C analyses from n-alkenes derived from plant cuticle will be carried out and used for the identification of water or salinity stressed plants. In combination with stomatal conductance and venation density analyses we will be able to predict plant performance. These data will be combined with palaeoclimatological analysis to determine plant assemblages. Our data will thus deliver a broad mechanistic understanding of how the angiosperms functioned during the Aptian-Cenomanian and place their evolutionary expansion in Europe into a paleoenvironmental context.

***No. 20-06728S*: 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*; 2020–2022)**

We succeeded in sampling tree rings of the larch tree at four sites on a transect from Marktredwitz (Germany) to the Skalka Reservoir. Tree cores from these sites indicate a significant historical level of air pollution near the former chemical plant in Marktredwitz. The temporal record was typical with two peaks coinciding with the plant production and changes of industrial processes. Low current air pollution with respect to Hg was checked using passive samplers. Systematic research of Hg contamination of the floodplain near the Skalka reservoir included analyses of air, biomass, shallow groundwater and river water. The main results represent the analysis of floodplain willow leaves and biomass for a contamination with risk elements. The plant pump of willows, woody plant species common in floodplains of temperate regions, can translocate Cd and Zn in soil profiles of uncontaminated and weakly contaminated floodplains. Plant pump of common species growing in floodplains can increase Cd and Zn ratios with respect to lithogenic elements like Al in top strata of floodplains including severely contaminated ones via element-specific uptake by the growing plant. Neither groundwater nor plants show Cd, Zn, and Pb concentrations simply proportional to those in sediments, but they probably reflect groundwater pH, with risk element mobilized by growing acidity typical for floodplain strata. The effect of plants on Pb in floodplains is negligible in comparison to Cd and Zn. Groundwater and plant leaves can definitely contribute to secondary contamination spreading from floodplain pollution hotspots.

***No. 20-10035S*: 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. Kouklíková*, *M. Košťák*, *M. Mazuch*, *L. Vaňková*, Faculty of Science, Charles University in Prague; P. Skupien, P. Doupovcová, Institute of Geological Engineering, Faculty of Mining and Geology, VŠB-Technical University in Ostrava; M. Bubík, L. Švábenická, Czech Geological Survey, Prague/Brno; 2020–2022)**

The project is focused on the boundary between the Jurassic and Cretaceous periods (J/K), the last boundary of stratigraphic periods which has not been defined by the International Commission on Stratigraphy (ICS) yet. Several global sites were compared with the Tre Maroua section in the Vocontian Basin (France), which was proposed for the GSSP. The approval of the GSSP is becoming an increasingly important topic, as the ICS is waiting for further counter proposals.

The principal aim for 2020 was to study and evaluate paleomagnetic, rock magnetic, magnetostratigraphic, biostratigraphic, geochemical and sedimentological methods from various J/K localities. A field campaign to sites in Czechia (Ropice, Karpentná, Kurovice) and Poland (Goleszów; **Fig. 25**) was carried out. Magnetic results helped to produce new magnetostratigraphic columns and revealed magnetic mineralogy for newly studied localities. In addition to the Czech and Polish localities, the Berrias (France) section was subject to magnetic analysis. Moreover, the existing magnetic and biostratigraphic data of several Carpathian sections were compared and combined with first results of gamma-ray spectrometry (GRS) as well as additional magnetic susceptibility data of the Kurovice section and accepted for publication. New GRS logging was completed in the Kurovice, Ropice and Goleszów sections. A combination of field measurements of K, U, Th concentrations in limestones and laboratory measurements was applied.

FIG. 25 An Early Berriasian sedimentary rock sequence in the Goleszów abandoned quarry (Poland). Photo by Š. Kdýr.

The localities were sampled also for mercury (Hg) and calcareous nannofossil (Ca-nanno) analyses. Total Hg concentration was analysed for selected samples from the Berrias and Sněžnica (Slovakia) sections and showed average or slightly elevated Hg contents with a small number of isolated peaks. However, for further interpretation, the data need to be correlated with, e. g., total organic carbon contents. Ca-nanno analysis of samples from the Berrias locality and Theodosia area (Eastern Crimea) were evaluated. Ichnological interpretation was prepared for the Kurovice section. Structures and the bioturbation index were evaluated in the Berrias section. The palynological assemblage of the studied samples from Liaoning (NE China; **Fig. 26**) was dominated by conifers of genera *Classopollis* which were very often found in tetrads documenting no transport of sediments. Results will be compared with upcoming data from the Ropice and Goleszów sections.

FIG. 26 Early Cretaceous sedimentary rocks in Liaoning province (China). Photo by A. Svobodová.

FIG. 27 Chert with a stromatolitic texture from Kokšín Hill, Teplá-Barrandian Unit. Photo by K. Žák.

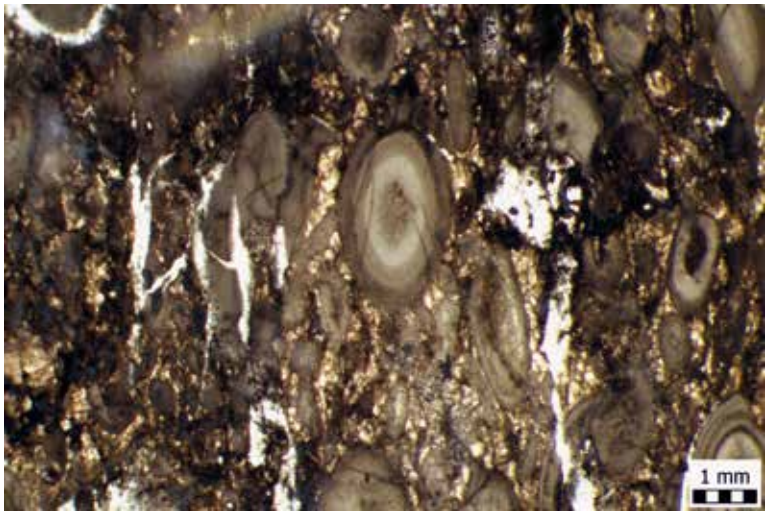

FIG. 28 Well-developed spheroidal texture with strongly zoned ooids, Příbram area, Teplá-Barrandian Unit. Photo by L. Ackerman.

***No. 20-13644S*: 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; J. Žák, J. Hajná, F. Tomek, J. Trubač, Faculty of Science, Charles University in Prague; 2020–2022)**

This project represents a multi-technique study combining tectonic, structural, and stratigraphic observations with elemental and isotopic (Hf-Nd-Mo-Si-C-O) data to reveal the origin and nature of chert and carbonate successions in ancient OPS sections and test whether they can be used as geochemical proxies for the variable processes occurring on oceanic plates. The project will also contribute to our understanding of paleoenvironmental conditions during the late Proterozoic-Cambrian with implications for global events preceding, and synchronous with, the Great Cambrian Explosion of life.

The first year of the project was significantly affected by Covid-19 pandemic. Nevertheless, we performed an extensive sampling campaign in the Teplá-Barrandian unit (TBU) of the Bohemian Massif gathering a large sample set (about 55 samples altogether) of Proterozoic-Cambrian cherts from all different belts. The sampling strategy was to cover all individual types of cherts in terms of texture, colour related to the amounts of SiO2 and FeO, presence of stromatolitic textures (**Fig. 27**) and position within the large bodies of cherts successions. Similarly, carbonates and carbonate-rich lithologies (tuff, graywacke, shales) within the TBU were sampled (**Fig. 28**) to provide an overview on their depositional conditions and especially relationship to the closely associated volcanic rocks (~20 samples altogether). The samples were processed in terms of thin section preparation and whole-rock powder for subsequent

geochemical analyses including major/trace element geochemistry, triple oxygen isotope systematics (chert) and C-O isotope analyses (carbonates).

Within the framework of this project, we also finished a detailed study of strongly silicified, arc-related black shales (so-called Lečice Member) deposited during the late Proterozoic. We demonstrate that they serve as an excellent geochemical archive recording sea-level fluctuations in response to the late Neoproterozoic glaciations.

***No. 20-14292S*: Mercury – overlooked threat in the Czech ecosystems responding to global change (*T. Navrátil*; F. Oulehle, Czech Geological Survey, Prague; 2020–2022)**

All 14 GEOMON catchments were equipped with relevant sets of samplers (precipitation and air) and together with stream water were sampled with a monthly step. The first results indicate relatively low Hg concentrations in the bulk precipitation ranging from 1.1 to 10.7 ng.l^{-1}. Elevated Hg concentrations were typical for the spruce throughfall from 3.0 to 21.0 ng.l^{-1} due to DOC and Hg leaching from the canopy. Sampling of litterfall proceeded at all catchments every 3 months. The large soil dataset from all sites will be statistically evaluated in year 2021. Furthermore, above the planned activities we prepared samples of juvenile spruce needles from all the individual sites, which will enable to link air Hg concentrations at all sites with Hg uptake by the vegetation. We quantified and evaluated the Hg cycling at the Lesni potok catchment with the longest record of Hg monitoring. In the period of 2011 to 2019, mercury (Hg) stores and fluxes were studied in the small forested catchment of Lesní potok (LES) in the central Czechia using the watershed mass balance approach together with internal measurements. Input flux of Hg *via* open bulk deposition, beech and spruce throughfall over the monitored period averaged 3.8, 4.2 and 8.4 µg m^{-2}.yr^{-1}, respectively, considerably lower than the corresponding Hg fluxes reported in the early years of the 21st century from catchments in Germany. But current bulk precipitation inputs from pristine Czech mountainous sites were lower. The largest Hg inputs to the catchment were via litterfall, averaging 22.6 and 17.8 µg m^{-2}.yr^{-1} for beech and spruce stands. The average input Hg flux, based on the sum of mean litterfall and throughfall deposition, was 26.5 µg m^{-2}.yr^{-1}, compared to the estimated Hg output flux in runoff of 0.5 µg m^{-2}.yr^{-1}, which is low with respect to what has been reported elsewhere. Thus, only ~2 % of Hg input are exported in the runoff.

FIG. 29 Minute larval stage (ca. 3 mm long) of an Ordovician arthropod from Morocco. Photo by L. Laibl.

***No. 20-23550Y*: Exploring developmental aspects in fossil arthropods during Cambrian explosion and Ordovician biodiversification (*L. Laibl*; 2020–2022)**

The research project tackles arthropod ontogenetic development during Cambrian and Ordovician periods. In particular, it focuses on the description of tiny larval stages of trilobites and both close and distant relatives of today's crabs or spiders. These arthropod larvae were in many ways similar to their modern equivalents but might have differed in some important aspects (e. g., size, morphology, speed of the development, number of larval stages, etc.). Such research allows us to understand the developmental beginnings of the most diverse group of animals that exist today. It can also tell us how these tiny larval stages of arthropods react to the major ecosystem changes, such as the Ordovician biodiversification. During the first year of the project, author explored the development of a bizarre Ordovician euarthropod with a spiny head, using minute fossils of its early developmental stages (smaller than 4 mm, **Fig. 29**). These stages come from the famous Fezouata Shale locality in Morocco and date to about 480 Ma. They are generally similar to adults, suggesting that the morphological development of this species was rather gradual, without any later metamorphosis. During 2020, author compiled the database of all well-known larval stages of trilobites. Thanks to this database, he discovered that the oldest trilobites have had gradual development without any metamorphosis. He also revealed that subsequently, during the late Cambrian and earliest Ordovician (~497–480 Myr), many trilobite groups independently incorporated metamorphosis in their development. This change in life-history strategy might be related to a change in the ecosystem structure during the Ordovician biodiversification.

***No. 20-23363S*: Biostratigraphy and dynamics of pelagic faunas in the Silurian of the Prague Basin in context of major environmental swings and changes (*P. Štorch*, *L. Slavík* & *Š. Manda*, Czech Geological Survey, Prague; 2020–2022)**

A detailed study concentrated on the Sheinwoodian and Homerian sedimentary succession (*Monograptus belophorus*, *Cyrtograptus rigidus*, *Cyrtograptus*

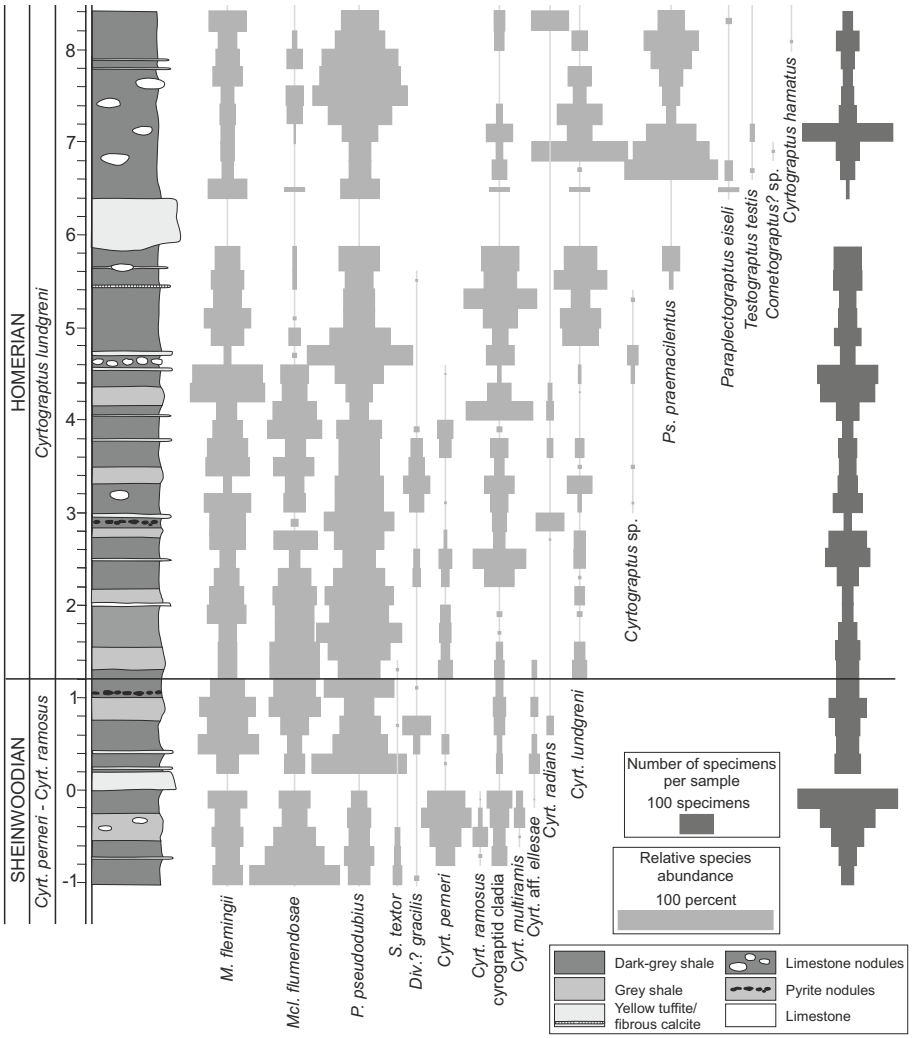

FIG. 30

Stratigraphy, lithology and graptolite dynamics of the Sheinwoodian/Homerian boundary interval of the Kosov section. Abbreviations: *Cyrt.* – *Cyrtograptus*, *Div.* – *Diversograptus*, *M.* – *Monograptus*, *Mcl.* – *Monoclimacis*, *P.* – *Pristiograptus*, *Ps.* – *Psedoplectograptus*, *S.* – *Sokolovograptus*.

ramosus-Cyrtograptus perneri and *Cyrtograptus lundgreni* biozones) exposed on the 5th bench of the Kosov Quarry (**Fig. 30**) and on the Přídolí section on the 1st bench of the quarry (*Neocolonograptus ultimus-Neocolonograptus parultimus* and *Neocolonograptus lochkovensis* biozones). The Kosov section is considered as a potential candidate for the International stratotype (GSSP) of the Homerian Stage. Further data have been collected from the Gorstian succession (*Colonograptus ludensis*, *Neodiversograptus nilssoni*, *Lobograptus progenitor* and *Lobograptus scanicus-Saetograptus chimaera* biozones) between Bykoš and Všeradice villages. All data have been incorporated in a new graptolite biozonal chart and a comprehensive species range chart of the Silurian System which are currently under preparation. A complete database of 346 Silurian graptolite species to date identified in the Prague Synform, excluding doubtful taxa left in open nomenclature, has been completed as an essential prerequisite for subsequent analysis of the faunal dynamics with particular focus on diversity, species richness, origination and extinction events and morphological disparity. The same database is intended as a fundament for a comprehensive review (book) on Silurian graptolites in Czechia. Systematic, biostratigraphic and paleogeographic study carried out in collaboration with Z. Y. Sun, M. J. Melchin and A. Suyarkova dealt with lower Aeronian graptolites of genera *Rastrites* and *Stavrites* throughout the world.

The database of 120 cephalopod species recorded from the Llandovery to lower Ludlow was built including biostratigraphic ranges plotted with graptolite biozones. Cephalopods are grouped upon ecological strategies in order to better understand Silurian cephalopod faunal dynamics.

The Přídolí succession of the Kosov Quarry yielded rich conodont fauna represented, for the most part, by slender coniform elements. Its minor part consists of both fragmented and complete P and S spathognathodontid elements and very rare prioniodinids. The composition of conodont fauna differs largely from fauna from other sections in the Pridoli in spite of its close proximity. This reflects a rather calciturbidite character of sedimentation in the Kosov section where hydrodynamic sorting of particles is responsible for a composition exclusively represented by mostly very small and fragmented grain-sized elements. Most important is the presence of several zonal diagnostic taxa, confirming the recently updated biozonation of the Přídolí. Coniform elements predominated also in the Sheinwoodian/Homerian boundary section of the Kosov Quarry. Among zone-diagnostic taxa were few spathognathodontids including *Ozarkodina sagitta sagitta*. The sample provided combined graptolite-conodont dating of the basal part of the Homerian Stage in the Kosov section.

7C GRANT AGENCY OF THE CHARLES UNIVERSITY

ONGOING PROJECTS

***GAUK No. 192218*: Highly siderophile elements geochemistry and Re-Os isotopic composition of Fen carbonatite complex, Norway (*L. Polák*, *L. Ackerman*, Faculty of Science, Charles University in Prague; 2018–2021)**

Carbonatites form an important part of economic geology and are important to understand its genesis. According to our latest findings, a small part of carbonatites carry information about mantle evolution that can be dated back to almost 2 Gyr. Eclogitized oceanic crust has been subducted into the upper mantle, melted, and the newly created melts metasomatized different regions of the upper mantle. This signature can be observed until today. This research also connected periodic carbonatite occurrences through time and super-continent cycles.

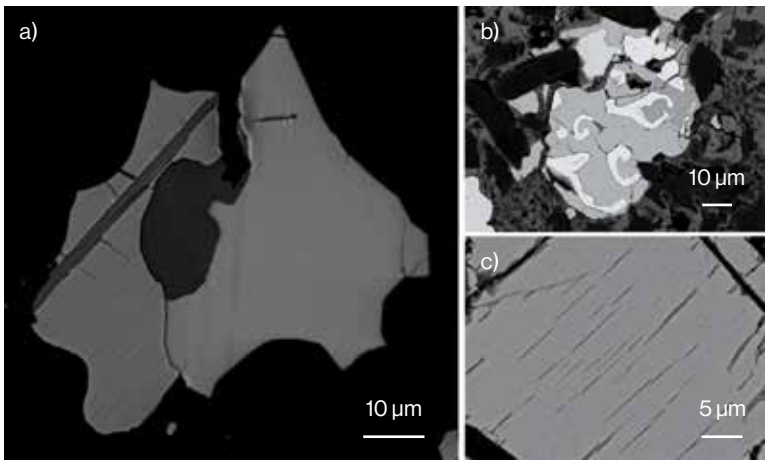

FIG. 31 Back-scattered electron images of sulphides and their assemblages from enstatite chondrites. (a) An assemblage of Fe-rich ZnS phase, troilite (FeS) with daubréelite ($FeCr_2S_4$) lamellae, and alabandite (MnS) from meteorite Eagle (type EL6); (b) association of troilite, daubréelite, kamacite [(Fe,Ni)-alloy], and perryite [$(Ni,Fe)_8(Si,P)_3$] from meteorite Yamato 74370 (type EH4), and (c) grain of troilite with daubréelite lamellae from meteorite Yamato 001621 (type EL5).

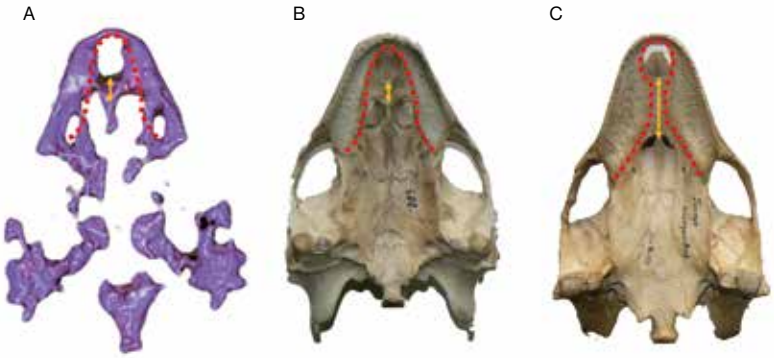

FIG. 32 A comparison of the scanned skull of *Rafetus bohemicus* with the extant specimen of *Rafetus euphracticus*.

***GAUK No. 1090119*: A clue for the origin of enstatite-rich meteorites from Cr-Ti-bearing troilites (*N. Mészárosová*, *R. Skála*, Faculty of Science, Charles University in Prague; 2019–2021)**

As one of the oldest materials in our Solar system, meteorites record processes of solar nebula evolution and processes involved in the formation and alteration of their parent bodies. Among enstatite-rich meteorites are included enstatite chondrite (EH and EL groups), enstatite achondrites (aubrites), and anomalous enstatite-rich meteorites. These meteorites are expected to have formed under highly reducing conditions. The study of their unusual reduced mineralogy is mainly focused on Cr-Ti-bearing troilites and their mineral association (**Fig. 31**). The sample suite was extended to Antarctic meteorites borrowed from the collection of the National Institute of Polar Research (NIPR) in Tokyo, Japan, and meteorites borrowed from the collection of the Natural History Museum Bern, Switzerland. The newly acquired samples cover a wide range of petrologic types and some anomalous samples. Last year, the mineralogical study was mainly focused on a thorough investigation of chemical composition and trace element distribution among sulphides, Fe-metals, and silicates across different enstatite-rich meteorites.

GAUK No. 1094119: A review of Tertiary turtles from the Most Basin (Czech Republic) and their global importance (M. Chroust, M. Mazuch, Faculty of Science, Charles University in Prague; 2019–2021)

Turtles (Testudinata) are a diversified group of reptiles with 365 extant living species. Fossil turtles are very common in sedimentary record because their shells have a high fossilization potential. Fossil material from the Most Basin is amazing and for now contains at least six different genera of fossil turtles. That makes Czechia a "hot spot" of the Cenozoic turtle diversity. This project aims at a revision of historical material and a description of new one using advanced methods. In 2020, the skulls of soft-shell turtles (Trionychidae) were scanned by a high-resolution CT scan housed at Centre of Excellence, Telč (Inst Theor Appl Mechan, Czech Acad Sci). Thanks to this method we are able to describe a new fossil soft-shell turtle *Rafetus bohemicus* (**Fig. 32**). This is the first appearance of this taxon in Europe. In the future, additional discoveries can be expected in turtle diversity in the Most Basin (Czechia).

7D GRANTS OF THE STATE DEPARTMENTS

FINISHED PROJECTS

***Administration of the Krkonoše National Park/Ministry of Environment of the Czech Republic, EU Operation Programme: Environment, Priority axis 4.1 no. CZ.05.4.27/0.0/0.0/15_009/0004533*: Inventarization of the Krkonoše karst areas; subproject: Scientific evaluation of cave sediments (R. Tásler, Speleoalbeřice ZO 5-01 ČSS, Svoboda nad Úpou; *P. Bosák*, *M. Šťastný*, *P. Mikysek*; internal code 7325; 2018–2020)**

FIG. 33

Fine-grained infiltration sediments in the Trucovna Cave with indistinct lamination below the marble block and with brecciated texture above it (probably caused by frost action). Photo by P. Bosák.

Sedimentary fills in the studied caves of the Krkonoše National Park are highly similar in their grain size and somewhat differ in their mineral composition (detected by XRD). Sediments are silty clays to clayey silts, with a low and variable proportion of sand fraction. Particles above 2 mm in size comprised max. 7 % of samples. In mineral composition, quartz (up to 35 %) and micas dominate (illite, muscovite, sometimes polylithionite, up to 57 % in total), clay minerals were less common (kaolinite up to 3 %, chlorite up to 28 %), as well as K-feldspars (up to 7 %) and plagioclases (up to 11 %). Smectite (max. 6 %) or talc (max. 10 %) were subordinate. Goethite (up to 1 %), and amphiboles (up to 1 %) were detected only in individual samples. Gypsum was identified only in 2 samples (2 and 10 %). Heavy minerals in trace quantities were as follows: mostly zircon and rutile; locally apatite; accessory: ephesite (Li-mica), lepidocrocite, chamosite, hematite, goethite, wollastonite, tremolite, amphiboles (incl. edenite). Organic matter was present in all samples in amounts up to 7 %.

The studied cave sediments represent infiltration deposits transported to open spaces (**Fig. 33**) through permeable vadose zone from surface sediments, soils, and weathering profile. Within the caves, the sediments were redistributed by small surface streams fed by dripwater, responsible for internal sediment textures (e. g., various lamination types). The intensity of dripwater reflects the low thickness of marble overburden with often widely opened fissures and cracks, also due to frost action. No traces of allogenic fluvial transport were detected. Detections of gypsum in two samples indicate dry conditions with evapotranspiration of interstitial waters rather than participation of sulphuric acid speleogenesis (due to sulphide oxidation at the contact with crystalline rocks, especially phyllites).

The primary source of the cave sediments was in weathering products on crystalline rocks (phyllites, slates: high content of muscovite and chlorite), often results of contact metamorphism (wollastonite, tremolite). The intensity of rock weathering of source rocks varied from immature (prevailing muscovite) to mature (kaolinite, smectite), i. e., both in cooler (chlorite, illite, muscovite) and warmer (kaolinite, smectite) paleoclimatic conditions mixed in various proportions in caves. Secondary Fe-containing minerals (hematite, goethite, less chamosite) are also weathering-related. The mineral composition in individual caves reflects the petrological composition of rocks surrounding the marbles (calcitic and dolomitic) and supports the infiltration nature of cave sediments with a source in the immediate overburden of the caves. The infiltration nature of cave sediments and the missing allogenic input might indicate that the sediments were transported underground in early phases of relief evolution.

ONGOING PROJECTS

***Ministry of Education, Youth and Sports, "Mobility", Project No. 8J20AT004*: Geological correlation of intra-Alpine crustal fragments with the Bohemian Massif (*M. Svojtka*, *J. Sláma*, *F. Tomek*; J. Žák, K. Verner, J. Hajná, Charles University in Prague; F. Finger, University of Salzburg, Austria; 2020–2021)**

Due to epidemiological situation, only one joint Czech-Austrian mobility exchange was made. The meeting at the University of Salzburg took place before epidemiological restrictions. As a part of this trip, a detailed project preparation was organized, key materials and documents necessary for the project were summarized (geological and topographic maps, unpublished reports from libraries, etc.). During this visit, a number of key geological localities

FIG. 34 Amphibole-biotite granodiorite outcrops near the Eissee Lake (Prägraten in Großvenediger, Austria). Photo by M. Svojtka.

and profiles were visited in the part of the Alps, and especially in the area of the so-called Tauern window. The aim of the excursion was focused on Variscan and pre-Variscan geological units (**Fig. 34**) incorporated into the Alpine orogenic zone, as well as on relics of Variscan igneous rocks in younger sedimentary formations. The visit and the field trip of Austrian colleagues in the Czech Republic could not be carried out in 2020 due to the epidemiological situation.

***Ministry of the Interior of the Czech Republic, "Program bezpečnostního výzkumu České republiky 2015–2022", Identification 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 in Prague; *R. Skála*, *L. Ackerman*, *Š. Matoušková*, *L. Polák*, *N. Mészárosová*, *P. Mikysek*; M. Kotrlý, I. Turková, J. Wolker, Policie ČR Kriminalistický ústav Praha; J. Sejkora, Z. Dolníček, J. Hyršl, J. Ulmanová, National Museum in Prague; 2019–2022)**

Raman spectroscopy has been applied to test its applicability in deciphering the origin of pyrope garnets. Those from the localities in the area of České středohoří Mts. were selected for this purpose. For each sample, Raman spectra with a grating of 1,200 gr.mm^{-1} in the range from 60 to 1,500 cm^{-1} were taken from several different spots. The most intense bands in the Raman spectra lie in positions of approx. 361–365 cm^{-1}, 556–559 cm^{-1} and 915–919 cm^{-1}. Other bands have significantly lower intensities. The laser-induced steady state photoluminescence determined in the overview spectra was subsequently studied in detail using a laser with a wavelength of 532 nm and a grating of 1,200 gr.mm^{-1} in the range from 600 to 820 nm.

Raman spectra provide rather limited information about the type of garnet under scrutiny. The sensitivity of this method is limited by the type of signal it presents. The general structural features of the garnets are identical and therefore the Raman spectra are vastly similar. In addition, due to the nature of the whole group of garnets, where we encounter relatively wide solid solutions, the positions of the belts move substantially smoothly depending on the composition. Photoluminescence spectra, on the other hand, are a sensitive indicator of the presence of chromophore elements and their wavelength and shape are quite characteristic. In addition, the intensity of the spectra compared to the intensity of the Raman signal provides a guide for estimating the content of a given coloring element, in this case chromium.

Further, the inclusions found in the tested garnets were studied by Raman spectrometer and SEM/EDS and EPMA techniques. The inclusions are both mono- and poly-phase. Amphiboles, micas, spinel group minerals, carbonates, quartz, sulphides, rutile, zircon and apatite were found in the inclusions. The size of the inclusions, the frequency of their occurrence and the mineral composition vary according to the rock type in which the host garnets are contained. These parameters thus seem to be usable as further supporting parameters for determining the provenance.

7E INDUSTRIAL GRANTS AND PROJECTS

***Biological Centre of the Czech Academy of Sciences and Charles University, Czech Republic, Project No. 7004*: Platinum-group element concentrations in paleolakes in the Šumava Mts. (*L. Ackerman*, *J. Ďurišová*)**

A joint project with E. Stuchlík dealing with platinum-group element concentrations in paleolake sediments.

***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*)**

The increased bulk precipitation amount of 1017 mm in hydrological year 2019 (11/2018 – 10/2019) resulted in a slightly elevated deposition of the main acidifying anions sulphate ($SO4^{2-}$) and nitrate (NO^{3-}). Bulk deposition of the main cations and risk elements also slightly increased with respect to hydrological year 2018 with 647 mm, only. In spruce throughfall, SO_4^{2-} deposition flux was the lowest at 19.4 kg.ha^{-1} since the beginning of monitoring in year 2002. This indicates that nitrate is becoming the major acidifying compound. Mercury bulk deposition remained low at 2.0 µg m^{-2}.yr^{-1}. The database on atmospheric deposition in the Bohemian Switzerland National Park started in year 2002 includes 189 monthly records up to date.

***Comenius University, Slovakia, Project No. 7004*: Sr-Nd-Pb isotopic compositions of Permian volcanic rocks from the Carpathians (*L. Ackerman*, *P. Le Minh*, *J. Rejšek*)**

A joint project with Comenius University in Bratislava (Slovakia; Prof. Marián Putiš) focused on the evolution of volcanic rocks from the Carpathians.

***Czech Geological Survey, Project No. 7004*: Re-Os isotopic composition of the Erzgebirge (ultra)mafic rocks (*L. Ackerman*, *J. Rejšek*, *J. Ďurišová*)**

A joint project with Czech Geological Survey (Dr. Jana Kotková) dealing with Re-Os isotopic composition of peridotites, pyroxenites and eclogites from the Erzgebirge.

***Czech Geological Survey, Project No. 7012*: Early Jurassic rare metal granitic pluton of the Central Asian Orogenic Belt in north-central Mongolia (*M. Svojtka*, *J. Ďurišová*)**

Joint project with Saint Mary's University (Canada) was focused on the Tukhum granitic pluton, which is a part of the Mesozoic composite Khentei batholith from north-central Mongolia of the Central Asian Orogenic Belt. The shallow seated pluton (~900 km^2) is made up of two distinct biotite granite intrusions that were dated at ~191 and 183 Myr using zircon U-Pb age technique.

***European Space Agency, Contract No. 4000125580/18/NL/GLC: HERA-Asteroid Prospection Explorer* (*T. Kohout*)**

The project was a part of ESA Hera space mission and its APEX (Asteroid Prospection Explorer) CubeSat sub-spacecraft equipped with ASPECT hyperspectral imager. The target of Hera mission is binary asteroid Didymos. ASPECT will hyperspectrally image the asteroid and map its composition at high spatial resolution. Institute of Geology work package focused on the development of AI (artificial intelligence) based software tools to process and interpret ASPECT hyperspectral data.

***Institute of Archaeology of the Czech Academy of Sciences, National Museum in Prague, Charles University in Prague, Project No. 7004*: Strontium and lead isotopic compositions of selected burial grounds (*L. Ackerman*, *J. Rejšek*)**

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

***Institute of Geological Sciences, Polish Academy of Sciences, Cracow, Project No. 7042*: In-situ U-Th-Pb LA-ICP-MS analysis of phosphates (*J. Sláma*)**

A continuation of a joint project aimed at in situ LA-ICP-MS analysis of various phosphate phases, mostly in order to define the absolute age of crystallization or alteration of U-Th-Pb ages due to fluid alteration. A part of the project was dedicated to final characterization of new monazite U-Th-Pb age reference material TS-mon from S Norway. The material was tested for homogeneity and in the final stages of testing the material was used as a primary material for reduction of U-Th-Pb data of other monazites of known age. The TS-mon is a homogeneous isotopic material suitable for routine U-Th-Pb analysis of monazite by LA-ICP-MS and other microbeam techniques and will be distributed to other labs. The second part was aimed at U-Pb analysis of monazite and xenotime altered by fluids under controlled environment of various fluid phases and temperatures. The results will be used for characterization of stable fields under which the studied phases can be used reliably for geochronological studies. Within this project, apatite from a set of eclogites from Norway has been successfully dated

(U-Pb LA ICP-MS) for the first time in the ICP-MS lab of Inst Geol.

***Institute of Rock Structure and Mechanics of the Czech Academy of Sciences, Prague, Project No. 7172*: (U-Th)/He dating of zircons and apatites (*Š. Matoušková*)**

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

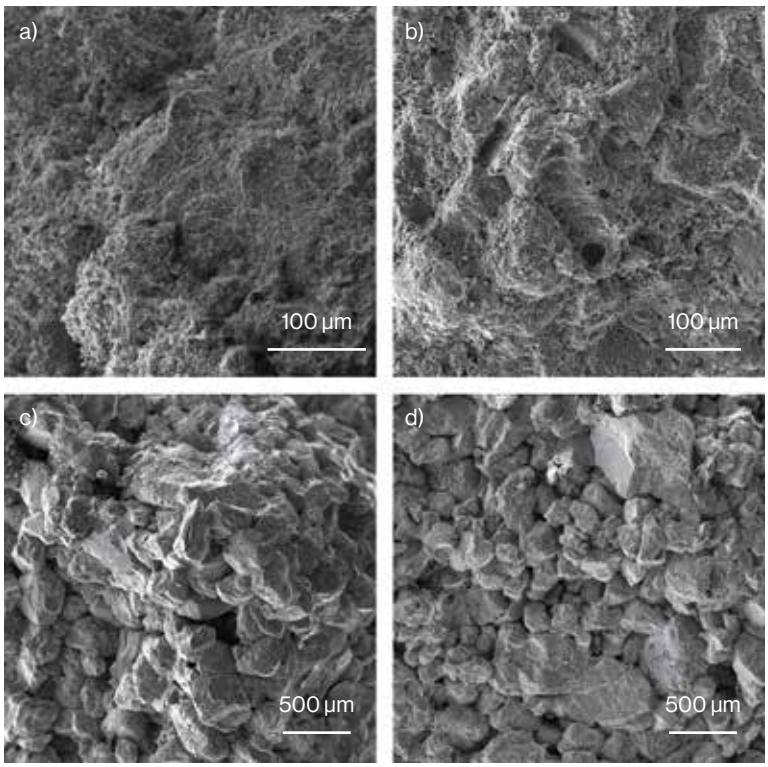

FIG. 35

SEM images of sandstone samples from historical monuments and from quarries. A – Zahořany, side altar of the church, sample Z1, B – Encovany, former quarry, sample 416, with a foraminiferal test in the centre, C – Zahořany, eastern pillar of a garden bridge near the chateau, sample Z15, D – Hřensko, former quarry *Goldnen Ranzen*, sample 51. Samples Z1 and 416 (photos A and B) are fine-grained calcareous sandstones, and the quarry at Encovany was a probable source of stone for the altar. Equally related are quartzose sandstone samples Z15 and 51 (photos C and D). Photos by N. Mészárosová.

***Jan Evangelista Purkyně University in Ústí nad Labem, Philosophical Faculty, Project No. 7464*: Petrographic study for NAKI II Project – Hortus Montium Mediorum. Documentation, research and presentation of cultural heritage of selected sites of northeastern České středohoří Mts., No. DG 18P02OVV066 (*J. Adamovič*)**

Specific tasks of sedimentary petrology in the recognition of building stone provenance at specific objects in the eastern part of the České středohoří Mts. employed a set of methods like optical microscopy, scanning electron microscopy, X-ray diffraction analysis, helium pycnometry and mercury intrusion porosimetry, and magnetic susceptibility measurements. A manuscript was prepared discussing the building stone of two objects at the town of Zahořany: the chateau and the Holy Trinity church. Some building material corresponds with local calcareous sandstones, and a very good fit was found between samples from the side altar of the church and samples of the Jizera Formation (Upper Cretaceous) from Encovany in all methods used. Fine-grained sediments from window sills of the chateau are also similar. Some constructional elements in the chateau (pillars of garden bridge, cellar window sill) show a very good fit with medium-grained sandstones of the Bílá hora Formation from quarries between Děčín and Hřensko, suggesting a probable provenance (**Fig. 35**). The main entrance to the church is represented by Carboniferous subarkose from the Kralupy area, although none of the samples from classical quarries at Olovnice showed a perfect fit. Some other elements used hydrothermally altered sandstones from the Bohemian Cretaceous Basin.

Activities in 2020 concentrated on the Konojedy church, chateau and brewery. As has been revealed by an archival study, most of the dimensioned stone for the chateau was quarried at Úštěk. For this purpose, the quarry area at Úštěk was documented, and samples were taken from three height levels of the quarries, all quartzose sandstones pertaining to the Jizera Formation. A good fit was found with the dimension stone from the chateau and the church. Samples taken from the wall of the chateau garden correspond well with the samples of the Březno Formation subarkose from and old quarry at the Úštěcký Stream near Držovice.

Four dozens of stones with engraved numbers were studied at Vlhošť Hill near Stvolínky, a property of the Litoměřice episcopate at the time these stones were erected (latter half of 17th century, according to sign analysis). The material is fine- to medium-grained quartzose sandstone with an admixture of very coarse grains and a considerable amount of siliceous cement. It was compared with similar material quarried at Vřísek Chateau and a few sites at Vlhošť Hill itself. An undoubted source for the stones was a quarry in the Teplice Formation at the contact with the Vlhošť phonolite body. An archival study is going on with respect to the time the quarry was in use and the purpose of the numbered stones.

***Masaryk University in Brno, Project No. 7004*: Molybdenum isotopic compositions of Ordovician carbonates from southern Sweden (*L. Ackerman*, *L. Polák*)**

A joint project with Masaryk University in Brno and Palacký University in Olomouc (Prof. Ondřej Bábek, Dr. Tomáš Kumpan) focusing on the determination of Mo isotopic composition of carbonates from selected boreholes from southern Sweden.

***Muzeum T. G. M. Rakovník, s. p., Project No. 7454*: Outdoor permanent exhibition of typical rocks of the Rakovník District (*K. Žák*, *J. Adamovič*)**

Alogether 18 typical rocks of the Rakovník District were selected to be shown in this permanent outdoor exhibition. Large blocks of the rocks were picked in the field (mostly in active and abandoned quarries) and petrographic descriptions were prepared based on the study of polished sections. The displayed blocks are up to one cubic metre in size and include sedimentary and volcanic rocks of Neoproterozoic and Cambrian age, magmatic rocks of Cambrian to Devonian age, and Carboniferous and Tertiary sediments. Texts and

FIG. 36

A panoramic view of the northern faces of the Velkolom Čertovy schody – západ in October 2015 with inclined blocks of dark-coloured Kotýz Limestone (Lochkovian). Light-coloured is the Koněprusy Limestone (Pragian), also forming an irregular network of neptunian dykes of different orientations in the Kotýz Limestone. Photo by M. Filippi.

graphic items for the information boards of the exhibition were also prepared. This permanent outdoor exhibition will be used for geological education of museum visitors and students of primary and secondary schools.

***National Centre for Polar and Ocean Research (NCPOR), India, Project No. 7004*: Re-Os isotopic compositions of basaltic rocks from Indian Ocean (*L. Ackerman*, *J. Ďurišová*, *J. Rejšek*).**

A joint project with Dr. Khogenkumar Singh focused on the determination of Re-Os isotopic compositions of ocean-floor basalts.

***University of Helsinki, Finland, Project No. 7004*: Strontium isotopic compositions of Luistari burial grounds (*L. Ackerman*, *J. Rejšek*).**

A joint project with Dr. Laura Arppe dealing with Sr isotopic compositions of enamels and bones from the Luistari burial grounds in western Finland.

***University of Hong Kong, Hong Kong, Project No. 7004*: Highly siderophile element and Re-Os isotopic compositions of dunites from Pilbara and Isua cratons (*L. Ackerman*, *L. Polák*, *J. Ďurišová*, *J. Rejšek*)**

A joint project with Dr. Jiawei Zhuo focused on highly siderophile element systematics of cumulate dunites from Australia and Greenland.

***University of South Carolina, USA, Project No. 7004*: Highly siderophile element and Re-Os isotopic compositions of mantle-derived rocks from Hawaii and Alaska (*L. Ackerman*, *L. Polák*, *J. Ďurišová*, *J. Rejšek*)**

A joint project with Dr. Michael Bizimis focused on highly siderophile element systematics of mantle xenoliths and tectonites from Hawaii and Alaska, respectively.

***University of Vienna, Austria, Project No. 7004*: Highly siderophile element and Re-Os isotopic compositions of volcanic rocks from East African Rift (*L. Ackerman*, *J. Ďurišová*, *J. Rejšek*).**

A joint project with Dr. Andrea Mundl dealing with the nature of sources parental to magmatic rocks within East African Rift System.

***Velkolom Čertovy schody, Inc., Project No. 7302*: Velkolom Čertovy Schody: documentation of progress of quarry walls – reclamation of the Quarry–West (*P. Bosák*)**

The regular documentation of faces in northern and eastern walls of the Velkolom Čertovy schody – západ (West) during 2003 to 2020 had the character of salvage documentation in quarry segments reaching final shapes. Activities enabled to observe, discover, and describe a number of unusual features, new for the area. Slightly inclined blocks of Kotýz Limestone (Lochkovian; **Fig. 36**) do not represent tectonically shifted blocks along the Očkov Thrust, but the primary relief at the Kotýz/Koněprusy (Pragian) limestones contact. Although tectonically later modified and inclined by Variscan Orogeny, primary block morphology was complicated and dissected by vertical open fissure-controlled morphologies with quite high vertical relief (rias rocky coast). The contact plane represents an abrasion surface with prolonged hiatus in deposition and a slight angular disconformity. The hiatus differed at different present plane altitudes – the higher the altitude, the higher the hiatus. At the present quarry bottom, the hiatus was rather short, probably did not appear at all. Local sedimentary breccias (Kotýz clasts up to 1 m in size in Koněprusy matrix) are present in front of the Kotýz cliffs. In addition, limestones of unclear stratigraphic position (alternation of mudstones and grainstones in different proportions) were found in low quarry benches. Before the deposition of the Koněprusy Limestone, Kotýz Limestone rocks were cut and penetrated by dense systems of white veinlets,

often in en *echelon* arrangements, reflecting ancient movements and hydrothermal activity in the Očkov Thrust zone. Veins of that type terminate in basal parts of the Koněprusy Limestone. Neptunian dykes, a characteristic feature of the whole Koněprusy Devonian, are arranged in a clear hierarchy of fills, starting by Koněprusy dykes in the Kotýz Limestone and terminating by youngest black-coloured fills belonging to the Kačák anoxy (Zlíchovian). The vertical extent is the greatest in the latest black fills. Paleokarst porosity partly relates to the evolution of neptunian dykes (blue holes on tension cracks) and partly to oscillations of Lower Devonian sea levels (Pragian to Zlíchovian). Paleokarst porosity is polycyclic and polygenetic, from small vugs to paleocaves metres across. The fill is composed of variegated mudstones, sometimes with sulphides (pyrite, chalcopyrite due to anoxy), often by saccharoidal dolomite, sometimes with spar cements or laminated incrustations of walls. Larger forms are usually tectonically deformed/cut. Hydrothermal karst was often documented – metric to decametric caves with phreatic morphology later modified by cold meteoric waters. Their walls were often covered by thick crusts of banded and varicoloured calcite crystals (rhombohedra, scalenohedra), sometimes with chalcedony coatings. These karst forms are clearly younger than the main phase of the Variscan Orogeny, maybe they are at least related to terminal phases of Variscan hydrothermal activity and partly to younger, Mesozoic – Tertiary, paleovolcanic phases.

7F PROGRAMMES OF STRATEGY AV21 OF THE CZECH ACADEMY OF SCIENCES

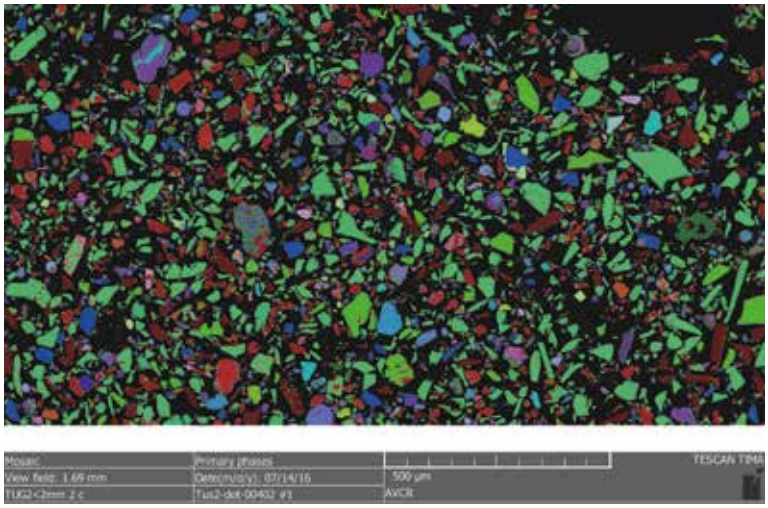

FIG. 37 Automated contaminant particles analysis in topsoils from Namibia. Photo by T. Hrstka.

***Project No. 9221 within the Natural Hazards Programme*: Development of algorithms for automatic detection of components of deposited dust (*T. Hrstka*, *J. Hladil*, *L. Chadimová*)**

This project is focused on a better understanding of individual constituents of the deposited dust and their potential effects related to human health and the environment. Dust as such plays an important role in the Earth climate and in the quality of air we all breathe. Our development of new analytical techniques provides unique tools for understanding the source and characteristics of air contaminants and also related soil pollution. After a successful testing of machine learning methods in Orange software (https://orange.biolab.si/) in cooperation with the University of Ljubljana (Slovenia), selected neural network methods have now been fully implemented in the in-house "DUST" program platform for similarity analysis of dust particle spectra for the purpose of automatic clustering of individual dust components (**Fig. 37**).

***Project No. 9222 within the Natural Hazards Programme*: Causes of rock instabilities in sandstones of the Bohemian Cretaceous Basin 2020 (*J. Adamovič*; F. Hartvich, Inst Rock Struct Mechan, Czech Acad Sci, Prague)**

The year 2020 was the concluding year of filling the database http://rockfall.gli.cas.cz, established in 2016. This is an open internet-based file of rockfalls in sandstone areas in the Bohemian Cretaceous Basin. This final stage concentrated on the Elbe Sandstones Protected Landscape Area and the Bohemian Switzerland National Park (BSNP). All sandstones are quartz-dominated, pertaining to the Bílá hora and Jizera Formations. These protected areas are characterized by very high relief dynamics and locally intensive fracturing connected with 1. the course of faults of the Doubice Fault Field and the zone of the Lusatian Fault, 2. the emplacement of NE–SW-striking basaltic dykes. The high risk of slope failure in these settings combines with the high numbers of tourists and other visitors, which makes the situation worth of public attention. Tens of rockfall cases were documented in collaboration with the NP staff and included in the database. The help of J. Šafránek (BSNP) and Z. Vařilová (Municipal Museum of Ústí nad Labem) was of crucial importance. Dissemination within the public was also realized through a contribution in the popular-science Vesmír journal.

A phenomenon greatly contributing to rockfall risk in the BSNP is undercutting, which occurs at bases of upwards-coarsening cycles. Unlike in other areas, even smaller-scale cycles (on the order of several metres) are developed here, with strong bioturbation and high silt admixture at cycle bases. In the Lusatian Fault zone, such levels are the sites of bedding-parallel slip, which further enhances the tendency to footslope notch formation and undercutting.

Besides, new cases of rockfall were documented in other sandstone areas and entered in the database. The most important of these in terms of wasted rock volume was the one in the Jizera Formation between Svitava and Velenice (near Zákupy, **Fig. 38**).

FIG. 38

The rockfall at Velenice of 11 March 2020 was conditioned by an open joint dipping steeply WNW and by a former construction of an underground canal brining water to a local mirror-polishing factory. Altogether 60 m^3 of rock collapsed onto a path following the Svitavka River. Photo by J. Adamovič.

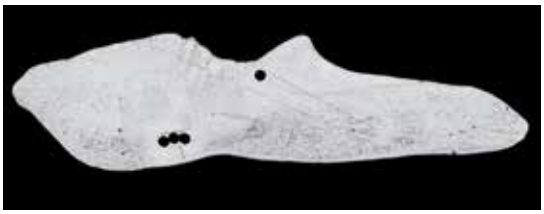

FIG. 39

BSE image of a pikeperch otolith from the Lipno water reservoir showing the grain structure and laser ablation ICP-MS concentration spots (3× in the core and 1× in the rim). Otoliths were ablated at spots 50 µm in diameter, laser was fired at a repetition rate of 10 Hz and the fluence of 3.5 $J{\cdot}cm^{-2}$. Photo by N. Mészárosová.

***Project No. 9223 within the Water for Life Programme*: Innovative monitoring and modelling techniques for hydroecological analysis in a small catchment (*T. Navrátil*; M. Tesař, Inst Hydrodyn, Czech Acad Sci; F. Oulehle, Global Change Res Inst, Czech Acad Sci, Brno; J. Kopáček, Inst Hydrobiol, Biol Centre, Czech Acad Sci, České Budějovice)**

Stream sediments inselected streams contained mercury (Hg) in concentrations varying from 34 to 211 $\mu g.kg^{-1}$. Following analysis of organic carbon content indicated that these results can be indeed misleading because Hg concentrations were determined by those of carbon. This indicates the need to assess the contamination of sediments with respect to normalized concentration, e. g., Hg/C ratio. This normalization indicated that the most contaminated sediments were at Pluhův bor catchment with a ratio of 2.8 $\mu g.mg^{-1}$ while the lowest ratio of 0.9 $\mu g.mg^{-1}$ was at Liz catchment. Furthermore, the continued exposition of passive samplers at 14 sites indicates that the mean air Hg concentration in Czechia was low, at 1.43 $ng.m^{-3}$, ranging from 1.15 to 1.84 $ng.m^{-3}$. Thus, it can be concluded that the contamination of Czech air with atmospheric Hg is near the background values of 1.5–1.6 $ng.m^{-3}$.

***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).**

A new methodology for the preparation of otoliths for measurements on laser ablation ICP-MS technique was tested at the Inst Geol workplace. In cooperation with Biol Centre, representative otoliths from several fish species with their typical habitat were selected. The studied fish specimens migrate within the Lipno water reservoir or are artificially planted as fish stocks. The concentrations (in ppm) of the following elements were measured: Li, B, Mg, Cu, Zn, Rb, Sr, Na, K, Mn, and Fe (**Fig. 39**). Using the concentrations of the above elements, the population dynamics of individual fish species were studied and the environment of occurrence of individual species in relation to the effectiveness of human intervention in water management were specified.

7G PROGRAMMES OF INSTITUTIONAL RESEARCH PLAN

***Project No. 9344*: A comparative study of anorogenic ultramafic lamprophyres (Upper Cretaceous / Paleocene) and alkaline lamprophyres (Oligocene / Miocene) from the Bohemian Massif (*J. Ulrych*, *L. Krmíček*, *S. Krmíčková*, *L. Ackerman*, *J. Adamovič*)**

***Project No. 9346*: Soil development on rocks of the central part of the Bohemian Cretaceous Basin (*A. Žigová*, *P. Mikysek*, *M. Šťastný*)**

***Project No. 9381*: Use of lake sediments as a geochemical archive of the history of mercury pollution (*T. Nováková*, *T. Navrátil*, *M. Roll*, *J. Rohovec*)**

8. PUBLICATION ACTIVITY OF STAFF MEMBERS OF THE INSTITUTE OF GEOLOGY

8A PAPERS PUBLISHED

12.413* Bradák, B., Seto, Y., **Chadima, M.**, Kovács, J., Tanos, P., Újvári, G., Hyodo, M. Magnetic fabric of loess and its significance in Pleistocene environment reconstructions. *Earth-Science Reviews*. 2020, 210, 103385.

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7.991* Chikyu, N., Nakano, T., **Kletetschka, G.**, Inoue, Y. Excellent electromagnetic interference shielding characteristics of a unidirectionally oriented thin multiwalled carbon nanotube/polyethylene film. *Materials and Design*. 2020, 195, 108918.

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4.094* Koštejn, M., Fajgar, R., Dřínek, V., Jandová, V., Kupčík, J., Huber, S., **Mikysek, P.** Ferromagnetic properties of MnSix and MnGex thin layers prepared by pulsed laser ablation. *Materials Chemistry and Physics*. 2020, 251, 123105.

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In thousands of Czech Crowns (CZK)		**2020**
A.	**INCOMES**	
1.	From the annual budget of the Czech Acad Sci	45 568
2.	From the Czech Science Foundation (accepted research projects)	19 233
3.	From the internal research projects of the Czech Acad Sci	3 219
4.	From other public sources	1 510
5.	Applied research	7 314
6.	Investment (instruments)	9 943
7.	Investment (constructions)	6 675
	TOTAL INCOMES	**93 462**

B.	**EXPENSES**	
1.	Scientific staff (wages, insurances)	48 999
2.	Research and scientific activities	10 557
3.	Administration and technical staff (wages, insurances)	10 338
4.	General expenses (service, maintenance of buildings, energies, transport, office supplies, miscellaneous, etc.)	3 149
5.	Library	995
6.	Editorial activities	265
7.	Investment (instruments)	12 263
8.	Investment (constructions)	6 896
	TOTAL EXPENSES	**93 462**

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