RESEARCH REPORTS 2016

Institute of Geology of the Czech Academy of Sciences

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Praha, June 2018

Cover photo: Fossil tree fern from the tropical forest of the Lower Permian, which was buried by volcanic ash. Wuda locality, Inner Mongolia, China. Photo by J. Frojdová

2016

Research Reports

The contents and scientific quality of the contributions of individual authors lie within the responsibility thereof.

The report was compiled by P. Bosák and English was revised by J. Adamovič.

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Contents

Introduction

In the perspective of past time, year 2016 can be evaluated as successful, lucky, and full of good news. The Institute personnel succeeded in a tender for grant projects in the Czech Science Foundation (GAČR), obtaining funding for 6 projects (2017–2019). Scientists from the *Department of Geological Processes* succeeded in the Academic tender for high-cost scientific equipment for 2016: the excimer laser (193 nm, Cetac/Teledyne company) was successfully introduced in the LA-ICP-MS laboratory in a combination with the previously acquired ICP-MS (Element2) mass spectrometer, now in full operation. They were also successful in the Academic tender for high-cost scientific equipment for 2017 and 2018: the thermal ionization mass spectrometer (TIMS) will be purchased in 2017. The TIMS is a device used for high-precision determination of isotope ratios. Its acquisition will allow to develop the most advanced analytical methods used in geology. The year 2016 marked the onset of contractual co-operation with the Institute of Rock Structure and Mechanics in the development of U-Th/He method; a part of the analytical works will be conducted in the laboratories of the Department. This method will extend low-temperature dating and modelling of rocks using fission-track analysis, now routinely conducted at the Department. The other analytical procedures successfully implemented in 2016 include dating of crustal sulphides by the Re-Os isotope system, and the method of platinum-group element analyses in carbonate-rich rock materials. The U-series ICP-MS dating of Pleistocene carbonates (developed with the Institute of Geological Sciences of the Polish Academy of Sciences, Warsaw) started to fully operate also on the market level.

Dr. Jiří Sláma started his 5-years scholarship for outstanding prospective scientific workers previously working abroad – the J. E. Purkyně Fellowship of the Czech Academy of Sciences. Dr. Tomáš Přikryl obtained a prestigious Premium of Otto Wichterle for young researchers. Dr. Filip Tomek started the Prospective Human Resources Support Programme (PPLZ) – Salary Support for PhD students at the CAS institutions. Dr. Petr Štorch has been appointed a chairman of the International Subcommission on Silurian Stratigraphy ICS, IUGS. Dr. Ladislav Slavík has been appointed a secretary of the International Subcommission on Devonian Stratigraphy ICS, IUGS. Both have started their term for the next four years (2016–2020) after the Meeeting of the International Commission on Stratigraphy that was held at the 35th International Geological Congress in Cape Town, South Africa, in August 2016.

The slight increase in institutional financing for 2016 enabled to increase salaries by 5 % on average. The most positive news appeared after the meeting of the Academy Assembly on December 2016 – the institutional financing of the Institute was supported by additional 13 %! This increase resulted from successful Institute evaluation in the period of 2011–2015.

International cooperation in research and development of new methods continued successfully and intensively. Popular science, especially in the frame of complex Academic project Strategy 21, has been developing explosively, again.

Pavel Bosák

2. General Information

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http://www.gli.cas.cz
The Institute of Geology is a public research institute belonging to the Czech Academy of Sciences. It concentrates on the 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 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. The major research areas covered by the Institute are:
- 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
- Petromagnetism
- Physical parameters of rocks

The Geological Institute of the Czechoslovak Academy of Sciences (ČSAV) was founded on July 1, 1960. Nevertheless, its structure had developed in the period of 1957 to 1961. During this period, several independent laboratories were constituted: Laboratory of Paleontology, Laboratory of Engineering Geology, Laboratory for Pedology and Laboratory of Geochemistry; Collegium for Geology and Geography of the ČSAV represented the cover organization. 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 into 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 into the Geological Institute.

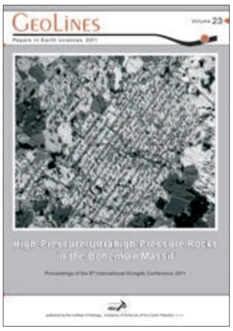
On March 1, 1979, the Geological Institute was united with the Mining Institute of the ČSAV under the Institute of Geology and Geotechnics of the ČSAV, and finally split from the latter on March 1, 1990 again.

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 CAS. The Institute belongs to the Ist 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 Supervisory Board which include both internal and external members. Plans of the Institutional Financing are evaluated by the 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.

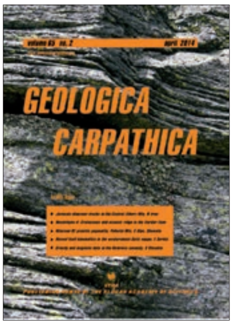
3. Items published by of the Institute of Geology

3a. Journals



The Institute of Geology of the Czech Academy of Sciences is the publisher of **GeoLines**. GeoLines (www.geolines.gli.cas.cz) is a series of papers and monothematic volumes of conference abstracts. GeoLines publishes articles in English on primary research in many fields of geology (geochemistry, geochronology, geophysics, petrology, stratigraphy, paleontology, environmental geochemistry). Each issue of the GeoLines journal is thematically consistent, containing several papers to a common topic. The journal accepts papers within their respective sectors of science without national limitations or preferences. However, in the case of extended abstracts, the conferences and workshops organized and/or co-organized by the Institute of Geology are preferred. The papers are subject to reviews. Details on journal scope, Editorial and Advisory boards are available on journal web page.

No volume of GeoLines was published in the year 2016.



Since 2000, the Institute of Geology of the Czech Academy of Sciences has been a co-producer of the international journal **Geologica Carpathica** (www.geologicacarpathica.sk), registered by Thomson Reuters WoS database. The Institute is represented by one journal co-editor (usually Institute Director) and several members of the Executive Committee (at present *P. BOSÁK*, *J. HLADIL* and *L. LISÁ*).

Geologica Carpathica publishes contributions to: experimental petrology, petrology and mineralogy, geochemistry and isotope geology, applied geophysics, stratigraphy and paleontology, sedimentology, tectonics and structural geology, geology of deposits, etc. Geologica Carpathica is published six times a year. The distribution of the journal is rendered by the Geological Institute, Slovak Academy of Sciences. Online publishing is also possible through Versita on MetaPress platform with rich reference linking. Online ISSN 1336-8052 / Print ISSN 1335-0552. Details concerning the journal are on journal web page.

In 2016, six issues (1 to 6) of Volume 67 were published with 36 scientific papers and short communications. Impact factor for 2016 has been set at 1.358. For the full version see www.geologicacarpathica.sk.

Address of the editorial office: Earth Science Institute, Slovak Academy of Sciences, Dúbravská cesta 9, P. O. BOX 106, 840 05 Bratislava 45, Slovak Republic, Phone: +421 2 3229 3209, Fax: +421 2 5477 7097, www.geol.sav.sk
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Electronic version: De Gruyter Open, www.degruyter.com
Co-publishers: Polish Geological Institute, Warszawa, Poland, and the Institute of Geology of the Czech Academy of Sciences in Praha, Czech Republic.

Since 2014, the Institute of Geology of the Czech Academy of Sciences, has become a co-publisher of the international journal Bulletin of Geosciences (http://www.geology.cz/bulletin/scope; bulletin@geology.cz), registered by the Thomson Reuters WoS database. The Institute is represented by several journal co-editors (*J. HLADIL*, *L. SLAVÍK*, *P. ŠTORCH*, *J. WAGNER* and *J. ZAJÍC*).

The Bulletin of Geosciences is an international journal publishing original research papers, review articles, and short contributions concerning paleoenvironmental geology, including paleontology, stratigraphy, sedimentology, paleogeography, paleoecology, paleoclimatology, geochemistry, mineralogy, geophysics, and related fields. All papers are subject to international peer review, and acceptance is based on quality alone.

The Bulletin is an open access journal and it is published as a non-profit making journal and the vast majority of people (including members of the editorial board) receive no payment for their work. The budget covers costs for type-setting and printing. Online ISSN 1802-8555 / Print ISSN 1214-1119. Details concerning the journal are on the journal web page.

In 2016, four issues (1 to 4) of Volume 91 were published with 36 scientific papers and short communications. For the full version see http://www.geology.cz/bulletin. The impact factor for 2016 is 1.175.
Address of the editorial office: Bulletin of Geosciences, Czech Geological Survey, Klárov 3/131, 118 21 Praha 1, Czech Republic
Co-publisher: West Bohemia Museum in Plzeň, Palacký University Olomouc, and Institute of Geology of the Czech Academy of Sciences in Praha.

3b. Monographs, proceedings, etc.

PŘIKRYL T., BOSÁK P. (Eds; 2016): *Research Reports 2014.* – Institute of Geology of the Czech Academy of Sciences, v. v. i.: 1–80. Praha. ISBN 978-80-87443-12-5.

SVITEK T., BOSÁK P. (Eds.; 2016): *Research Reports 2015.* – Institute of Geology of the Czech Academy of Sciences, v. v. i.: 1–80. Praha. ISBN 978-80-87443-13-2.

4. Research Reports

4a. Foreign Grants, Joint Projects and International Programmes

Finished projects

International Geoscience Programme (IGCP) of UNESCO & IUGS, Project Code IGCP No. 591: **Early to Middle Paleozoic Revolution** (International leader: B. D. Cramer, USA, international co-leaders: T. R. A. Vanderbroucke, France; Renbin Zhan, China; M. J. Melchin, Canada; Z. Zigaite, Lithuania; K. Histon, Italy; G. L. Albanesi, Argentina & M. Calner, Sweden; Czech participants: *L. Slavík, P. Štorch*, J. Frýda, Š. Manda, Czech Geological Survey, Praha; 2011–2015)

P. Štorch participated in a long-term research on graptolite faunal dynamics before, during and after the Late Ordovician global mass extinction. An international team led by H.D. Sheets, C. E. Mitchell and M. J. Melchin focused on various aspects of major disruptions of ecological communities affected by mass extinction (Sheets et al. 2016). As large numbers of species go extinct, complex interrelated communities are replaced by simpler communities comprising mainly generalist and opportunist species. Although climate changes clearly are a source of stress in ecological communities, few paleobiological studies have systematically addressed the impact of global climate changes on the fine details of community structure with a view to understanding how community structure changes presage, or even cause, the dramatic losses in biodiversity in mass extinctions. Structural changes within graptolite communities exhibit significant decreases in community complexity and evenness as a consequence of the preferential decline in abundance of deep-water specialist species. Changes in community complexity and evenness commenced well before the dramatic loss in species diversity and population depletions that mark the tipping point of the extinction event. Environmental isotope and biomarker data suggest that changes in the sea surface temperature and nutrient cycling in the paleotropical oceans changed abruptly during the latest Katian time, with consequent changes in the extent of the oxygen minimum zone and phytoplankton community composition. Most deep-water species became rare as populations were depleted in step with this habitat loss and extinction risks rose correspondingly. Although many of the affected species persisted in ephemeral populations for hundreds of thousands of years, the cumulative toll of the enhanced extinction risk depleted the diversity of paleotropical (diplograptine) graptolite species during the latest Katian and early Hirnantian. These results indicate that the effects of long-term climate change on habitats can degrade populations in ways that cascade through communities, with effects that persist for geologically significant intervals of time and culminate in mass extinction.

L. Slavík worked on the integration of newly obtained and revised conodont data into the stratigraphic scales. The major results include the stratigraphic correlation of the Ludfordian in the Prague Synform that was summarized using refined biostratigraphic data from updated conodont and graptolite faunal records. Seven graptolite and seven conodont biozones and faunal intervals were correlated. The biozonations were integrated with the generalized eustatic and carbon isotope curves. The proposed correlation chart is a basis for further high-resolution correlation of that region. The regional zonation of the Wenlock/Ludlow boundary was established for the Prague Synform using refined data from updated conodont records. The following conodont zones have been recognized in the Prague Synform: the *Ozarkodina sagitta sagitta* Zone, the *Ozarkodina bohemica* Interval Zone, the *Kockelella crassa* Zone, the *Kockelella variabilis variabilis* Interval Zone and the *Ancoradella ploeckensis* Zone. The Bohemian conodont zonation was correlated with the recently proposed standardized zonation. The established conodont zones are tentatively correlated with global graptolite zonation and matched against generalized eustatic and carbon isotope curves.

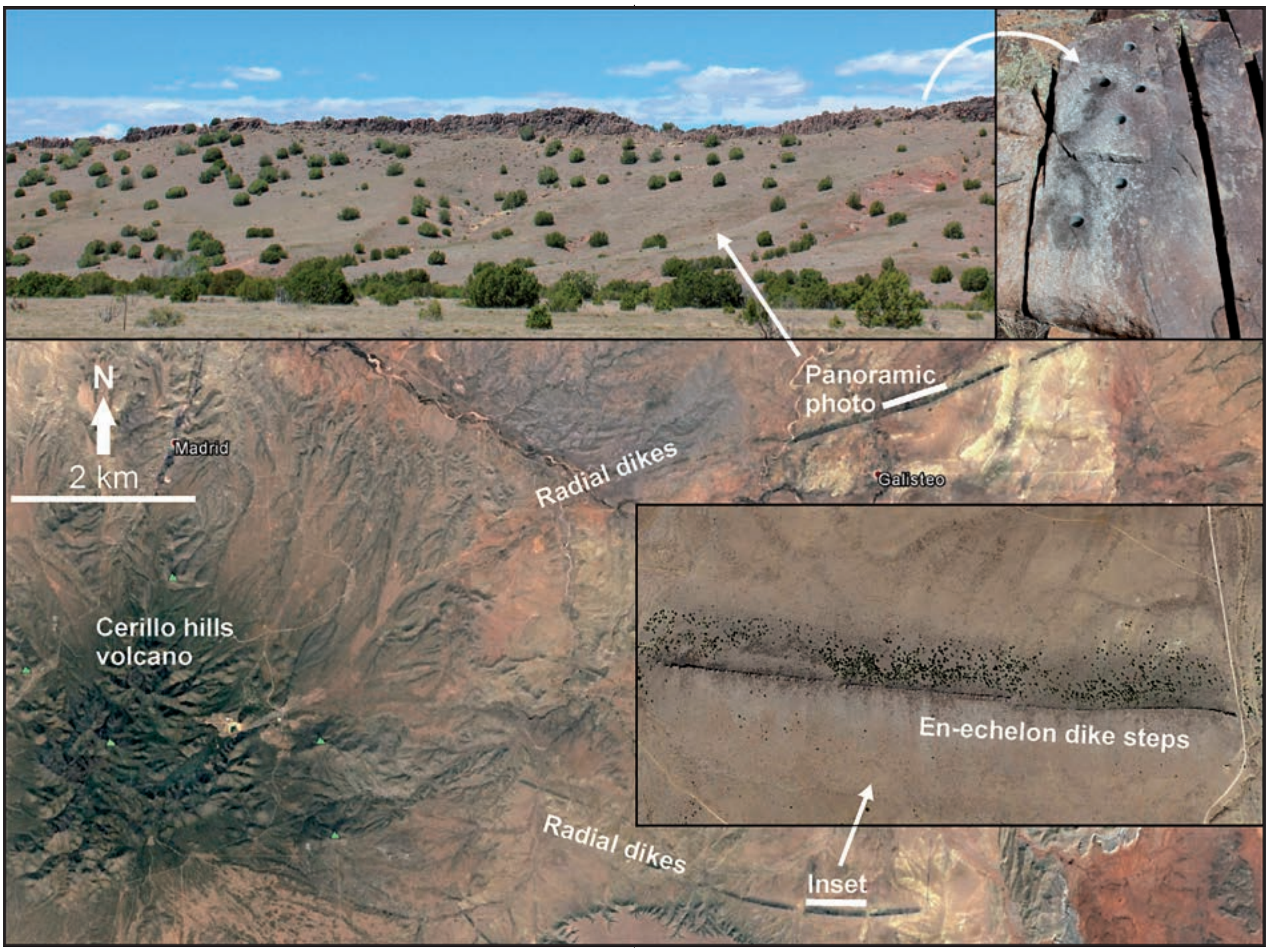
SHEETS H.D., MITCHELL C.E., MELCHIN M.J., LOXTON J., *ŠTORCH P.*, CARLUCCI K. L. & HAWKINS A.D. (2016). Graptolite community responses to global climate change and the Late Ordovician mass extinction. – *Proceedings of National Academy of Sciences*, 113, 30: 8380–8385.

Bilateral co-operation between Czech Geological Survey, Praha and Geologische Bundesanstalt Wien, Austria: **Palynology of Gosau Group sediments on the geological maps (GK 50) St. Wolfgang and 97 Bad Mitterndorf** (H. Lobitzer, Geologische Bundesanstalt, Wien, Austria; L. Švábenická, Czech Geological Survey, Praha & *M. Svobodová*; 2016)

Grey siltstones of the Laimer 1 locality (Oberalmer Formation, near Bad Ischl, Northern Calcareous Alps, Austria) from the abandoned railway tunnel near Kalvarienberg in the vicinity of Bad Ischl contain very rare plant microfossils. Inaperturate gymnosperm pollen grains prevail (*Classopollis torosus*, *Inaperturopollenites* sp., *Cycadopites* sp.). Agglutinated planispiral microforaminiferal linings, acritarchs and dinoflagellate cysts reflect shallow marine environment. The appearance of dinocyst species *Nannoceratopsis spiculata* Stover 1966 is important for the biostratigraphy and evidences the Jurassic age. This occurrence is important because no other microfossils, i.e., calcareous nannofossils, were found. The presence of pyrite crystals as well as agglutinated microforaminiferal linings documents the environment with lower oxygen content.

Continued projects

Czech Academy of Sciences grant promoting development of international cooperation for early-career scientists: **Rock-mag-**



■ **Fig. 1.** Photos and a satellite image of the Cerillo Hills radial dikes complex, New Mexico (Satellite images from Google Earth, Image Landsat / Copernicus; photos by F. Tomek).

netic and paleomagnetic studies of volcano plumbing systems: implications for magma flow dynamics beneath composite volcanoes (*F. Tomek*; October 2016–December 2017)

The project deals with a complex architecture of volcano plumbing systems in order to decipher magma flow and ascent beneath calderas and stratovolcanoes. Anisotropy of magnetic susceptibility (AMS) and rock-magnetism were used to track magnetic fabric record in dykes, sills and plutons. To complete the magmatic history of selected volcano-plutonic complexes, radiometric dating will reveal magma crystallization ages. Three volcano-plutonic examples were selected for field studies – the Altenberg–Teplice Caldera (Bohemian Massif), the Platoro Caldera and the Cerillo Hills radial dyke complex (Fig. 1; Colorado and New Mexico, USA). Main part of the project is the 6-month fellowship at the New Mexico Highlands University, USA, planned for April–September 2017. In 2016, field work was also conducted in the Altenberg–Teplice caldera (see Chapter 7h).

MOBILITY SAZU/CAS SAZU-16-03: **Analyses of karst sediments for dating of morphogenetic and environmental changes in karst areas of Slovenia** (N. Zupan Hajna, A. Mihevc, Karst Research Institute, ZRC SAZU, Postojna, Slovenia; *P. Pruner* & *P. Bosák*; internal code 7448; supported by RVO67985831; 2016–2018)

The territory of Slovenian Dinarides (Dinaric Karst) is mainly built of Mesozoic carbonates and Paleogene flysch deposits. There is no evidence of younger marine and/or continental deposits in the SW part of Slovenia. Due to the missing direct record, i.e., correlate sediments, it is very difficult to define tectonic, paleoclimatic and other processes for the last 30 My. All younger sediments are represented only by surface soils or karst sediments with almost no floral and faunal remains. Their age has been a subject of long-lasting speculations. Karst sediments, especially cave sediments, are allochthonous, mostly fluvial clastic sediments or autochthonous sediments such as speleothems. They provide a valuable source of recorded data. Owing to chemical denudation rate from 20–50 $m \cdot My^{-1}$, many older caves and cave sediments already no longer exist, but their residues are present on the surface as unroofed caves or bigger accumulation of clastic sediments. These sediments were once interpreted as remains of rivers deposits, deposited on karst surface during the so-called “pre-karst” phase.

Karst is a unique source of paleoclimate information, the most important carriers of which are karst sediments present on the karst surface and in numerous caves. Lately, these have become a very interesting research topic. Caves act as sediment traps, accumulating various detrital, chemical and organic sediments. The knowledge of karst sediments informs us of global climatic changes in the past, giving us the keys to what we can expect in the future. A novel view on sedimentation in Slovenian caves was expressed based on the application of palaeomagnetic and magnetostratigraphy studies combined with numerical dating methods and mineralogical, petrological, geochemical, paleontological and geomorphological analyses. Their results indicate that sedimentations in presently unroofed caves and in still active caves started a million years ago in many cases. Therefore, the cave deposits inform us mostly only about the last infilling episodes, only indirectly indicating the age of the speleogenesis. Nevertheless, they also conserve a broad variety of past environmental data in archives missing in the respective correlative surface deposits due to the destruction by erosion/denudation processes. Sedimentary structures and textures as well as mineralogical and geochemical compositions and faunal contents of the deposits allow to reconstruct the character of outer environment before and during the deposition. Some post-sedimentary (diagenetic) changes can be also recorded indirectly by the records of environmental changes.

The systematic study of cave sediments in Slovenian caves in the last 20 years using different dating methods showed that the sediments are much older than was originally assumed: the identified ages cover not only the entire period of the Pleistocene but also the Pliocene and even reach below the Pliocene/Miocene boundary. However, since the processes of sedimentation in the caves are very complex and strongly influenced by local factors, sediment thicknesses in the sections usually reach only a few metres, occasionally interrupted by unconformities. Accordingly, the interpretation of cave sediments and the resulting data on surface and subsurface processes is very complex. Calibrated data contributed to the reconstruction of speleogenesis, deposition in caves, and indirectly to the evolution of karst surfaces and succession of tectonic displacements.

The majority of datings of karst sediments was carried out in SW Slovenia (i.e., in the northwestern part of the Dinaric Karst), and at some sites of the Alpine Karst. More than 3,500 samples were taken from 42 different sections in caves (both relict and active caves) and on the karst surface. Magnetostratigraphy data and the arrangement of obtained magnetozones often indicated ages of sediment fill older than 1.77 Ma and even older than 5 Ma. Distinct phases of massive deposition in caves with still preserved sediments were dated to about 5.4–4.1 Ma (Miocene–Pliocene), 3.6–1.8 Ma (Pliocene/Pleistocene) and Pleistocene, following the cessation of Miocene deposition in the Paratethys and Pannonian Basin in the central, eastern and southeastern Slovenia and post-Messinian evolution in the southwestern and western Slovenia. These sedimentation phases in the underground suggest climatic changes on the surface with possible flood events and/or changes in tectonic regimes during the Cenozoic.

The evolution of caves in Slovenian karst took place within a single karstification period, which began with the regression of Eocene sea. Then, limestones became exposed on the surface within a complicated imbricated (overthrust) structure formed principally during the Oligocene and early Miocene (Zupan Hajna et al. 2016). Although certain cave sediments are several millions of years old, they cannot be described as true paleokarst sediments as they belong to a single ongoing karstification period without any interruption by marine transgression and/or massive terrestrial deposition. Caves and cave levels with old sediments are not fully detached from the present hydrological karst system but originated and filled under different climatic and geomorphic conditions – they represent a classical example of a relic karst (*sensu* Bosák et al. 1989).

Future research should concentrate also on detrital sediments of karst poljes of South Slovenia. The bottoms of karst poljes (intermontane basins in External Dinarides) in southern Slovenia are dominated by Pleistocene lake sediments, except for the Kanižarica Polje (with Pliocene brown coal) and Kočevje Polje (with Miocene and Pliocene brown coal). Newly exposed lake deposits were sampled on the bottom of the Cerkniško Polje in 2016.

BOSÁK P., FORD D.C. & GŁAZEK J. (1989): Terminology. – In: *BOSÁK P*., FORD D.C., GŁAZEK J. & HORÁČEK I. (Eds.): *Paleokarst. A Systematic and Regional Review*: 25-32. Elsevier–Academia. Amsterdam–Praha.

ZUPAN HAJNA N., MIHEVC A., *PRUNER P*. & *BOSÁK P*. (2016): Several million old cave sediments as a part of ongoing karstification period. – *24th International Karstological School "Classical Karst": Paleokarst. Abstracts & Guide Book (Eds.: B. OTONIČAR, P. GOSTINČAR)*: 35. Karst Research Institute, Scientific Research Centre of the Slovenian Academy of Sciences and Arts, Založba ZRC. Postojna–Ljubljana.

Bilateral co-operation between Institute of Geology of the Czech Academy of Sciences and Karst Research Institute, Scientific Research Centre, Slovenian Academy of Sciences and Arts: **Paleomagnetism and magnetostratigraphy of Cenozoic cave sediments in Slovenia; sub-project: palygorskite in cave sediments** (N. Zupan Hajna, Karst Research Institute, ZRC SAZU, Postojna, Slovenia; *R. Skála*, *M. Šťastný* & *P. Bosák*; internal code 7448; supported by RVO67985831; since 1997)

Following the expeditions of the Karst Research Institute ZRC SAZU to United Arab Emirates, we studied unusual cave fills from the Wadi Haqil in the foothills of the Musandam Mountains (part of the Oman Mountains; Ras Al-Khaimah Emirate) with surprising results (Zupan Hajna et al. 2016). We also prepared a review of palygorskite occurrences in caves around the World.

Palygorskite is a fibrous mineral representing a transitional phase between chain silicates and layer silicates with a modulated phyllosilicate structure. Although often found in carbonate environments, it forms a quite uncommon constituent of cave fills. Palygorskite occurs in cave fills in two forms: (1) allogenic palygorskite in arid and semiarid conditions can represent a substantial portion of cave fills, often associated with smectite, gypsum, calcite and halite; it is wind-blown or transported by surface run-off to caves from desert soils and paleosoils, calcretes, dolocretes and related deposits; (2) autogenic palygorskite occurs as *in situ* precipitate in cave fills from percolating solutions and/or transformation of smectite and kaolinite in cave fills in dry evaporative conditions and suitable geochemical composition of solutions. In carbonate host-rocks, palygorskite fills fissures and faults and is often found in cave walls. It commonly occurs in

Samples	Sm	Pa	Ch	K	I	Q	Plg	K fe	Gy	Ge
UAE 1/1a	16	32	tr	6	0	43	nd	0	3	nd
UAE 1/1b	9	19	4	9	0	42	5	0	12	0
UAE 1/2a	19	24	4	9	0	42	nd	0	2	nd
UAE 1/2b	7	13	3	9	0	55	2	3	8	0
UAE 1/3a	11	20	0	8	0	52	nd	0	9	nd
UAE 1/3b	11	16	4	11	8	40	2	4	4	0
UAE 1/4a	10	15	0	34	0	29	nd	0	11	nd
UAE 1/4b	3	12	0	23	0	44	0	0	7	11
UAE 1/5a	14	31	0	8	0	37	nd	6	4	nd
UAE 1/5b	6	21	2	5	0	50	11	0	5	0
UAE 1/6a	22	6	0	14	4	47	nd	0	7	nd
UAE 1/6b	14	5	1	16	0	52	0	0	4	8

■ **Tab. 1.** Contents of minerals (%) in bulk samples (marked a) and in clay fraction (under 4 µm) of the insoluble residue (a semiquantitative estimation; samples marked b; modified from Bosák et al. 2014). Explanations: Sm – smectite, Pa – palygorskite, Ch – chlorite, K – kaolinite, I – illite, Q – quartz, Plg – plagioclase, K fe – potassium feldspar, Gy – gypsum, Ge –goethite, tr – traces, nd – not determined in bulk samples.

the form of "mountain leather" as a result of hydrothermal and/or weathering processes or represents a product of *in situ* chemical precipitation from percolating meteoric solutions with suitable pH, redox conditions and chemical composition.

The identification of clay minerals in clay fraction from the Wadi Haqil separated from the samples of cave sediments confirmed the presence of palygorskite in all samples except one (5 to 32 %; Tab. 1). Besides palygorskite, other clay minerals are present in variable amounts in the samples: smectite, kaolinite, and illite. Analyses of oriented, glycolated and heated specimens appear to be consistent also with the presence of chlorite. Based on data obtained after heating, it appears that chlorite represents a Fe-dominant species. The mutual proportions of minerals in clay fraction are highly variable among the samples. Smectite and kaolinite are omnipresent in substantial amounts in all samples. Scanning electron microscope images show the complex microstructure of sediments. They contain, in agreement with X-ray diffraction data, considerable amounts of gypsum, calcite and quartz. A direct determination of clay minerals is not possible from the SEM images even with the help of chemical analyses. Palygorskite and smectite often occur in desert types of soils or in sediments connected with arid and semi-arid depositional settings (saline deposits, playa lakes, etc. at low latitudes) with alkaline environment enriched in Si and Mg. Palygorskite can be also produced by alteration of Mg silicates. High kaolinite content and negligible feldspar content may indicate (1) a high degree of weathering of the original source rocks, and/or (2) a redeposition of older weathering crusts, coming at least partly from ultrabasic (mafic) magmatites. Most of the studied cave sediments represent redeposited palygorskite-bearing weathering products and desert soils originated from different Mg-bearing sources (e.g., ophiolites, rocks of the Hawasina Nappe, dolomites), or eroded from Cenozoic palygorskite-bearing deposits, which occur in the complicated structure of the Musandam Mountains. They were transported into the interior of the 3-D cave maze of hypogene origin, uplifted and in vadose conditions, re-worked by slope processes, wind and/or surface runoff. The *in situ* palygorskite neomorphism is unlikely. A mixture with other clay minerals, quartz, feldspars, etc. supports this interpretation. Fine-grained quartz fraction is probably wind-blown (eolian). The cave sediments are represented by quartz, palygorskite, other clay minerals and other minor minerals. Gypsum and calcite are the precipitates (crusts and/or cements), although gypsum can also be redeposited from the widespread gypsum-cemented surface sediments.

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4b. Czech Science Foundation

Finished projects

No. 13-15390S: **Re-Os geochronology of ore mineralizations from the Bohemian Massif with possible metallogenic implications** (*L. Ackerman*, *K. Žák*, *M. Svojtka*, *J. Ďurišová*, J. Pašava, F. Veselovský & V. Erban Czech Geological Survey, Praha; 2013–2016)

Re-Os geochronology of Sn-W mineralizations related to Krušné hory/Erzgebirge metallogenic province. Re-Os geochronology of the molybdenites from Cínovec, Sadisdorf, Krupka, Krásno and Jáchymov was accomplished in spite of its very demanding task due to extremely low Re contents (typically <1 ppm). The obtained data indicate the predominance of one and/or multiple short-time mineralization events taking place between ~319 and 323 Ma, with the exception of the Krupka deposit associated with the Altenberg–Teplice caldera where the data may suggest prolonged activity until ~315 Ma. The results have been published in a complex paper dealing with the Re-Os molybdenites from the Bohemian Massif (Ackerman et al. 2017). Furthermore, to get additional data from Sn-W-associated base metal sulphides, more than 10 arsenopyrite and pyrite separates have been analysed for their Re contents. Unfortunately, all of them yielded very low Re contents in the range of 0.1 and 1.1 ppb and therefore, there are not suitable for Re-Os geochronology.

Re-Os geochronology of Au mineralizations from the Bohemian Massif. The age of the Au mineralization at Mokrsko-Čelina was established through Re-Os geochronology of the molybdenite yielding an age of 342–343 Ma (Ackerman et al. 2017). Unfortunately, molybdenite fractions from the rest of Au mineralizations were too small for the analyses but the age of the Jílové and Kašperské Hory Au deposits was constrained through the arsenopyrite Re-Os geochronology, yet with higher errors due to their extremely Os radiogenic nature (confirming predominant crustal source of the fluids). The Jílové Au deposit yielded a 6-point Re-Os isochron with the age of 325 ± 29 Ma while the Kašperské Hory yielded the age of 326 ± 54 Ma (5-point isochron). The age of the latter deposit is better established through Os model ages with values of 333 ± 1 Ma and 340 ± 2 Ma as almost all Os at this locality is radiogenic (^{187}Os). Nevertheless, the obtained ages argue for Carboniferous age of all studied Au deposits.

Re-Os geochronology and characteristics of selected base-metal mineralizations from the Bohemian Massif. Sampling has been performed at several selected base-metal mineralizations (e.g., Zlaté Hory Pb–Zn–Au deposit). Intensive field, mineralogical, geochemical, geochronological (Re-Os), C-S isotopic and fluid inclusion studies of the Obří důl polymetallic skarn deposit (Fig. 2) were performed. Data indicate complex mineralogy of the Fe-Cu-As ores, three types of ore-forming fluids and C-S isotopic systematics suggesting close connection with skarns of the Krkonoše-Jizera Plutonic Complex, whose age was confirmed by arsenopyrite Re-Os isochron at 307.5 ± 5.6 Ma (6-points). Some preliminary data were published in Pašava et al. (2016b).

Mineralogical, geochemical, geochronological (Re-Os and U-Pb) and fluid inclusion studies were performed at the previously poorly described Padrť Stock intrusion and related Fe-As-Mo mineralization located near the SE margin of the Teplá–Barrandian Unit, Bohemian Massif (Žák et al. 2014). The Ni-arsenides from Jáchymov U-Ag-Bi-Co-Ni have been tested for their Re contents yielding high contents in the range of 3.1 and 3.5 ppb. Subsequent analyses of two arsenide separates produce a preliminary 2-point Re-Os isochron with an age of ~138 Ma. However, analyses of additional arsenide separates will be needed to confirm this age.

Geochronology and characteristics of Ni-Cu-(PGE) mineralizations of the Bohemian Massif. The age of the Ran-

■ **Fig. 2.** Sampling molybdenites from the Žulová pluton, Černá Voda quarry (photo by M. Svojtka).

■ **Fig. 3.** Sampling at the Fe-Cu-As Obří důl deposit for mineralogy, fluid inclusion studies and Re-Os geochronology (photo by M. Svojtka).

sko gabbro-peridotite massif hosting important Ni-Cu-(PGE) mineralization was successfully established through a Re–Os isotopic system yielding a regression of 341.5±7.9 Ma (Ackerman et al. 2013). This suggests its close association with the late-stage evolution of the nearby Kutná Hora Crystalline Complex. A complex study dealing with the Ni-Cu-PGE mineralization in the Rožany–Kunratice area in northern Bohemia was accomplished. The obtained results include U-Pb geochronology of zircon from the host rocks (the age of mineralization), highly siderophile and Os isotopic composition determination for ore samples and identification of PGE principal carriers (Haluzová et al. 2015).

Re-Os geochronology and characteristics of molybdenite mineralizations. Molybdenite is a common mineral in several granitic plutons throughout the Bohemian Massif (e.g., Žulová pluton), see Fig. 3. Eighteen separates of molybdenites from disseminated Mo mineralization in Cadomian and Variscan granitoids and/or related to quartz veins/pegmatites were analysed. They provide Re-Os ages that predominantly overlap with the previously published geochronological data for the host rocks, suggesting coeval evolution. However, molybdenite samples from the Sázava suite granites of the Central Bohemian Plutonic Complex (CBPC) have resolvable younger ages than their host granites but similar to the age of spatially related Au mineralization, which is associated with the latest evolution of the CBPC. The results have been published in a complex paper dealing with Re-Os molybdenites from the Bohemian Massif (Ackerman et al. 2017).

Trace element geochemistry of molybdenite, its use for mineralization fingerprint and implications for Re-Os geochronology. Trace element geochemistry of molybdenite from several types of mineralization was studied in detail *in situ* using LA-ICP-MS. In combination with the identification of micro-nano inclusions within individual molybdenite grains, it has been shown that this coupled tool can be used for the identification of different mineralization types (Pašava et al. 2016a). A detailed study of the Vítkov molybdenite–tungstenite mineralization was accomplished (Pašava et al. 2015). A mineral paragenesis was identified along with the identification of the tungstenite formation. LA-ICP-MS analyses revealed extreme W enrichment in molybdenite and the presence of transitional Mo-W and W-Mo disulphides.

Re-Os and U-Pb geochronology, trace element and Mo-Fe isotopic study of metal-rich black shales from the Teplá–Barrandian Unit. More than 20 pyrite separates from several volcanosedimentary base metal mineralizations hosted in black shales (e.g., Liblín, Hromnice) were analysed for their Re contents. All of them show sufficient Re contents (6–90 ppb) and attest their suitability for Re-Os dating. At present, preliminary results at Liblín yielded a Re-Os isochron age of 505 ± 21 Ma (8-point). Trace element concentrations of these pyrites were studied *in situ* by LA-ICP-MS showing a wide range in ppm contents and could be divided into several groups depending on their As, Ni, V, Cu and Sb contents.

Establishing Re-Os analytical protocols in the joint lab of Institute of Geology of the Czech Academy of Sciences

and Czech Geological Survey. During the course of the project, three different Re-Os geochronological protocols have been established in the joint lab of the Institute of Geology of the Czech Academy of Sciences and Czech Geological Survey especially due to extensive collaboration and visits of the team members (Ackerman, Haluzová, Erban) in the Re-Os geochronology lab of Dr. Robert A. Creaser of University of Alberta: (a) Re-Os molybdenite geochronology – ^{185}Re spike-Os normal and Os double spike method; (b) Re-Os arsenopyrite and pyrite geochronology; (c) Re-Os black shale geochronology. These include methods for the decomposition of molybdenites, sulphides and black shales and Re-Os separations at the Institute of Geology of the Czech Academy of Sciences and N-TIMS analyses of Re and Os at the Czech Geological Survey. Establishing of these analytical protocols definitely represent a milestone of geochronological methods available in central Europe as a whole as only a few laboratories worldwide are capable of such type of analyses. This can be recognized from increasing demand coming from scientists from the Czech Republic and successful applications of the new research proposals of both investigators (Ackerman and Pašava) such as the Czech Science Foundation project (2017–2019) or the ARC project (2017–2019).

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No. 14-16124S: **Refinement of lower Silurian chronostratigraphy: proposal of new GSSPs of the Aeronian and Homerian stages** (*P. Štorch*, *L. Slavík*, *L. Chadimová* & Š. Manda, J. Frýda, Z. Tasáryová, Czech Geological Survey, Praha; 2014–2016)

The major objective of the project was a thorough, multidisciplinary characterization of (1) the Hlásná Třebaň section chosen to be formally proposed as a new international (global) boundary stratotype of the Aeronian Stage and (2) the Kosov section which is an appropriate – and to date the only – candidate for the GSSP of the Homerian Stage. Biostratigraphic markers selected for the definition of the base of each of the two stages of the Silurian System are well developed in both sections; the complete fossil records and chemostratigraphic tools of correlation were also investigated. Sedimentary logs of the two sections were studied in relevant detail to characterize depositional settings and to identify potential gaps in sedimentation.

Standard biostratigraphic description and correlation of the sections is based on graptolites. Conodont record obtained from several levels of the Homerian Kosov section was used to enhance correlation with coeval limestone-dominated successions. Apart from biostratigraphic markers, geochemical markers were studied in the two sections. Trends in carbon and nitrogen isotopic composition were traced in correlation with TOC. Changes in organic productivity, redox conditions and/or subtle changes in the rate of black-shale sedimentation, which can be used as proxies of global environmental changes, were examined using selected geochemical proxies and rock magnetic susceptibility.

The Aeronian GSSP. With respect to combined results of our multi-proxy biostratigraphic, chemostratigraphic (Frýda & Štorch 2014; Pašava et al. 2017) and lithological studies we propose (Štorch et al., in print) that the Hlásná Třebaň section should be considered a new GSSP for the base of the Aeronian – the second stage of the Silurian System – marked by the first occurrence of *Demirastrites triangulatus*, which defines the base of the *Dem. triangulatus* graptolite Biozone. Data from Bohemia, together with an overview of published records worldwide, showed that *Dem. triangulatus* is a widely applicable and potentially well recognizable tool for stratigraphic correlation and that its FAD at the proposed GSSP is closely bracketed by the first and last occurrences of several other taxa, some of which are widely geographically distributed. The FAD of *Dem. triangulatus* lies 1.38 m above the base of Silurian black shale succession of the Želkovice Formation, just below a minor positive shift in $\delta^{13}C_{org}$ values recorded in the lower part of the *triangulatus* Biozone, which also appears to be recognizable in several different parts of the world. The lower *triangulatus* Biozone clearly exhibits a rapid graptolite diversification event with closely spaced appearances of several new lineages: monograptids with isolated and hooked thecae (genera *Demirastrites*, *Rastrites* and *Campograptus*) as well as the species of *Petalolithus* with ancorate biserial rhabdosome, tabular in cross section.

Combined redox element proxies [Ce/Ce*, V(V+Ni), V/Cr, Th/U] suggest that the Rhuddanian black shales and silty micaceous laminites of the Hlásná Třebaň section were deposited under anoxic to euxinic bottom conditions. High TOC values (ca. 6 wt. %), recorded in the middle and upper Rhuddanian strata (upper *vesiculosus* and *cyphus* biozones), may be indicative of high palaeoproductivity despite apparently condensed sedimentation. A subsequent stepwise decrease in the TOC to about 4 wt. % started from the lowermost Aeronian lower *triangulatus* Biozone. In the same interval, a minor but significant $\delta^{13}C_{org}$ positive excursion is recorded, along with slightly weakened anoxia suggested by a gradual shift in redox-sensitive element ratios. The lithology of the lower Aeronian black shales changed gradually toward more siliceous lithotypes, including alternation of siliceous shale and silty silicite in the uppermost *pectinatus* and *simulans* biozones. The changing lithology is also reflected in rock magnetic susceptibility record, which results from an increasing proportion of diamagnetic quartz cement. The lithology, detrital input and redox element proxies indicate gradual and relatively minor environmental and depositional changes in the late Rhuddanian and early Aeronian. In addition, the $\delta^{15}N_{bulk}$ record supports the interpretation that the succession was deposited under primarily anoxic bottom-water conditions and also that there was no significant change in the community of primary producers throughout the studied time interval. Other Bohemian sections that span the Rhuddanian–Aeronian boundary interval (sites: Karlík, Vočkov near Karlštejn, Zadní Třebaň, Černošice and Nové Butovice) archive sedimentary and graptolite records that are fully consistent with that described from the proposed stratotype.

The graptolite succession of Hlásná Třebaň and other sections of the Prague Synform can be readily correlated with sections in the Welsh Basin, where the current GSSP occurs, although the current GSSP itself contains a poor and ambigious biostratigraphic record through the boundary interval. The graptolite record across the boundary is more complete in Bohemia, enabling high resolution and nearly world-wide correlation based on both biostratigraphic and, potentially, chemostratigraphic data.

Particularly well-preserved graptolites of the Rhuddanian–Aeronian boundary interval (upper *vesiculosus* to lower *triangulatus* zones), collected from bleached loose stones and subcrops at Všeradice have been described by Štorch (2015) in order to facilitate correct determinations of some less well-preserved taxa in the Hlásná Třebaň section. Specimens from Všeradice are flattened but their fine apertural details, spines, ancoras and membranous structures as well as pressed-through internal structures are visible in remarkable detail. Thirty-six graptolite species have been identified, including some tiny taxa, barely recognizable in black shales of the Hlásná Třebaň section.

A systematic revision of the genus *Demirastrites* comprising current and prospective lower Aeronian zonal index taxa was carried out in collaboration with M. J. Melchin. Specimens were grouped according to their precise stratigraphic position in the section, and biometric data were evaluated using a number of plot diagrams and statistics (Excel graphs and PAST software package). As a result, intraspecific variability and phylogeny of the so-called "monograptids with triangulate thecae" were elucidated. *Demirastrites triangulatus* (Harkness), *Dem. brevis* (Sudbury), *Dem. pectinatus* (Richter), *Dem. major* (Elles and Wood) and *Dem. mandai* sp. n. were described whereas *Demirastrites fimbriatus* (Nicholson), *Dem. raitzhainensis* (Eisel) and *Dem. separatus* (Sudbury) are placed in their synonymy lists.

The Homerian GSSP. Since the critical Sheinwoodian–Homerian boundary interval became poorly accessible in the Kosov section, and a removal of dump material by mechanical excavator promised by the quarry keeper did not materialize, we paid major attention to the upper part of the Homerian succession exposed on the 4th level of the Kosov Quarry. A full spectrum of research works were carried out in the section running through an important interval of global mass extinction (*lundgreni* of Mulde Event) at the base of the upper Homerian. Obtained data revealed the anatomy of the mid-Homerian mass faunal extinction, survival, and subsequent recovery along with chemostratigraphic record of dramatic environmental fluctuation. In the section studied, significant changes in graptolite community structure and species dominance pre-dated major species extinctions and changes in benthic communities. First victims of the changing environment were large and specialized cyrtograptids, plectograptines and some monograptids. Latest survivors *Monograptus flemingii* and *Pristiograptus dubius* belong among ubiquitous, ecologically tolerant, long-ranging taxa. The post-extinction interval is represented by shale rich in pyrite, slumped limestone lenses, tuffite, clayey limestone with specific shell fauna and grey-blue heavily bioturbated shale. The interval witnessed a period of survival, in which the planktic graptoloids were close to extinctions. Minute rhabdosomes of the only monograptid survivor *Pristiograptus parvus* may serve as a text-book example of Lilliput effect. Dwarf *P. parvus* was soon accompanied by the plectograptid *Gothograptus nassa*. Abundant shell fauna of the *Decoroproetus–Ravozetina* Community accounts for enhanced ventilation in the *parvus* Biozone. Appearance of the trilobite and brachiopod benthic fauna of the *Decoroproetus–Ravozetina* Community and appearance of slumped limestone lenses indicate a shallowing documented across the globe in this interval. Some limestone lenses were quite rich in platform conodont elements including zonal indexes: *Ozarkodina bohemica, Ozarkodina bohemica longa* and *Kockelella ortus absidata*. The latter two listed are index taxa of the respective subzones within the late Homerian *Oz. bohemica* Interval Zone (Slavík 2014). The *Decoroproetus–Ravozetina* Community recorded at the same level in several other sections in the Prague Synform reflected environmental stress conditions responsible for graptolite mass extinction. The overlying *Pristiograptus frequens* Biozone witnessed incipient recovery of the graptolite fauna heralded by immigration of standard-sized *P. frequens*, still accompanied by *G. nassa*. Subsequent *Colonograptus praedeubeli–Colonograptus deubeli* Biozone brought evolution novelty in the shape of sicula which gave birth to early colonograptids. Recurrent occurrences of the low-diversified small shelly fauna and trilobites of *Decoroproetus–Ravozetina* Community continued until the lower part of *Colonograptus ludensis–Colonograptus gerhardi* Biozone. Graptolite diversity increased and species dominance decreased in the uppermost part of the section studied at the level which, according to absence of *C. gerhardi* and some other species, belongs to the lower–middle part of the *ludensis-gerhardi* Biozone.

A correlation with the Nesvačily section (Štorch et al. 2016) suggests that well-balanced environment and post-extinction adaptive radiation among graptolites developed as late as in the middle *ludensis-gerhardi* Biozone.

The Homerian/Gorstian (i.e., Wenlock/Ludlow) boundary section excavated near Nesvačily exhibits a shale-dominated offshore succession, 8 m in thickness, comprising upper *Colonograptus ludensis* and lower and middle *Neodiversograptus nilssoni* biozones. This interval is notorious for its rather low diversity of the graptolite fauna. Despite this precaution, we identified 16 species along with subordinate shell fauna. Some graptolite taxa are new, unknown or little known from the Prague Basin. The limestone bed just above the base of the Ludlow Series yielded some conodonts consistent with *Ozarkodina bohemica* and *Kockelella crassa* conodont biozones. The whole succession was sampled also for C_{org} isotopes. Published results (Štorch et al. 2016) qualified the Nesvačily section for one of the most important reference sections worldwide in the ongoing search for new GSSP of the Ludlow Series (and Gorstian Stage).

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No. 13-22351S: **Combined use of novel and traditional stable isotope systems in identifying source components and processes of moldavite formation** (T. Magna, V. Erban, J. Farkaš, Z. Rodovská, Czech Geological Survey, Praha; *K. Žák, R. Skála, L. Ackerman, Š. Jonášová, J. Ďurišová*; Z. Řanda, J. Mizera, J. Kučera & J. Kameník, Inst Nuclear Phys, Czech Acad Sci, Praha; 2013–2016)

The project was focused on materials formed during hypervelocity impacts of large extraterrestrial bodies on the Earth surface. The major focus was on the tektites, cm-sized glassy objects, which represent high-speed distant ejecta of an early phase of the impact process. Majority of the analytical work was done on moldavites, tektites of the Central European Strewn Field, genetically related to the Ries Impact Structure in Germany. Analytical work also focused on other types of impact glasses from the close surroundings of the crater, and on sediments of this area. The other studied objects were various types of impact glasses and target rocks of the Zhamanshin Impact Structure in Kazakhstan and tektites of the Australasian Strewn Field (AAT). The applied analytical methods included chemical analyses (conventional bulk silicate analysis, EMPA, ICP-MS and LA-ICP-MS, INAA, IPAA in laboratories of all three project participants) and traditional and novel isotope systems (triple oxygen isotopes, isotopes of Mg, Ca, Si, Zn, Cu, Cr, Pb and other). Simultaneously, the distribution of highly siderophile elements (HSE) and Os isotope chemistry were studied in tektites and other types of impact glasses. Therefore, the scope of the study was very wide, both with respect to analytical methods and the number the studied objects. Of the three institutions participating on the project, the role of the Institute of Geology, Czech Academy of Sciences, centered around precise element analyses of the samples selected based on previous INAA/IPAA data performed in the Institute of Nuclear Physics. We also performed a crucial part of interpretation of chemical data, selection and preparation of the samples for isotope analyses (analyses itself were made or arranged by the Czech Geological Survey, CGS) and a participation in the interpretation of isotope data. Also the HSE analyses and their interpretation were performed at our institute, and Os isotope analyses in cooperation with the Czech Geological Survey. Each of the major topics studied within the project usually resulted in a paper published in an international journal, or in a submitted manuscript.

The key phase for further work was to select and characterize a large set of tektites (moldavites) and major sedimentary lithologies in the vicinity of the Ries crater, which are considered suitable precursors of moldavites. The chemical composition of the selected set of moldavite samples was characterized (including micro-analytical data) in a greater detail than ever before (55 elements analysed). Furthermore, this extensive work served to derive a suite of samples suitable for further isotope analyses which could provide further insight into tektite genesis. This resulted in a large set of chemical data which was statistically evaluated and compared with published data to (i) characterize the behaviour of elements during hypervelocity impacts, (ii) provide a new model for the formation of moldavites, and (iii) verify the theory of significant component of ashes from local Ries vegetation in the moldavite melts (Žák et al. 2016).

In collaboration with Tomasz Brachaniec (University of Silesia, Sosnowiec, Poland), a moldavite find from a newly discovered tektite sub-strewn field in Poland has been characterized in detail for major and trace element concentrations by EMPA and LA-ICP-MS techniques (Skála et al. 2016b). This sub-strewn field is located at the outer limit of moldavite ejecta spread from Ries and, therefore, it probably represents an important physical limit of their distribution consistent with theoretical modeling. The analytical results were compared with a large data set for other moldavites from the other sub-strewn fields (Skála et al. 2016a).

Major and trace element concentrations were determined for a suite of impact-related glasses from the Zhamanshin Crater, Kazakhstan, in order to improve the understanding of tektite-like forms of this impact structure, and to constrain the type of impactor for this young impact site. This work also incorporated sediment and rock samples from the area, in a collaborative effort with prof. Alexander Deutsch (Universität Münster, Germany). A detailed investigation of microstructures of selected impact glasses, paralleled by a detailed high-resolution chemical mapping (EMPA, LA-ICP-MS), offered important clues to the formation process of these peculiar glasses. Data on HSE contents and Os isotope data together with detailed evaluation of the contents of Ni, Co and Cr enabled the determination of a Ni-rich carbonaceous chondrite as the probable impactor (Jonášová et al. 2016a, b; this topic is also a part of the PhD study of Š. Jonášová).

A new large data set of Li abundance and isotope compositions for selected moldavites and a range of sediments from Ries were collected to provide further clues on the likely source materials of moldavites. Moldavites show progressive homogenization of Li contents and isotope compositions despite a large range of these parameters reported for their source sediments. Several sedimentary sources were refused to provide any important contribution to moldavite melts (Rodovská et al. 2016; this is a part of the PhD study of Z. Rodovská at the Czech Geological Survey).

Stable isotope systematics of Cu and Zn was investigated in selected moldavites and sediments from Ries, in a collaborative effort with Prof. Frederic Moynier and his team (IPGP Paris, France). This has been compared with scant literature data for tektites while no data for associated parental materials were published before. This allowed to compare the behavior of Cu and Zn isotopes under the same conditions of a single impact. It was shown that Zn behaves much more refractory than Cu despite its reverse general geochemical behaviour. The observed Cu isotope ratio values are the highest ever observed in terrestrial materials (Rodovská et al., 2017; this is also a part of the PhD study of Z. Rodovská).

The new data set for triple oxygen isotopes and Cr isotope composition of moldavites and impact glasses from Zhamanshin was acquired, in a collaborative effort with Prof. Andreas Pack (Universität Göttingen, Germany). This collaboration enabled to obtain high-precision triple-oxygen isotope data in parallel to conventional $\delta^{18}O$ analyses originally planned in the project proposal. Triple-oxygen isotope data can help to estimate the mixing of terrestrial and meteorite matter, and they can aid in the impactor type determination. The triple-oxygen isotope data were paralleled by high-precision Cr isotope measurements for selected samples of moldavites and impact glasses.

■ **Fig. 4.** Z. Řanda, R. Skála and J. Mizera during the study of impactites in the Aumühle Quarry in the Ries area, Germany. Typical reddish impact breccia (Bunte Breccia) is present in the lower part of the section, and is sharply overlain by grey suevite with fragments of impact glass (photo by K. Žák).

This enabled to qualify the impactor type for Zhamanshin as a rare CI chondrite using Cr isotope data and, for the first time, suggested a possibility of partial exchange with ambient air during the impact using O isotope data. This finding was compared with data on moldavites with no O-Cr isotope anomalies, indicating no O-Cr trace of impactor for the Ries event in the moldavites (Magna et al. 2017).

HSE and Os isotope data were collected for a suite of moldavites and sediments from Ries in an attempt to seek for an elusive impactor component in the Ries event. While new data do not constrain the impactor type for the Ries event, they improved the knowledge on HSE behaviour at high temperatures, such as preferential Os loss due to its volatility in oxide form and its exchange with Os derived from the impactor. This material exchange/mixing prevented a more precise characterization of the impactor for Ries (Ackerman et al. 2017).

Some topics could not be completed in the form a paper within the project duration and are pending. A systematic survey of Sr-Nd-Pb isotope compositions in moldavites and sediments from Ries is being finalized, in collaboration with Dr. Ladislav Strnad (Faculty of Science, Charles University in Praha, Czech Republic). This effort should provide constraints on the sources of moldavites with a more refined approach. Experiments were made with the high-vacuum-crushing apparatus developed within the project to detect chemical and isotopic compositions of gases entrapped in large bubbles enclosed in tektites. We found that crushing in high vacuum is very efficient and that most bubbles were opened. However, the concentrations of gases were extremely low which impeded the reliable isotope measurements of carbon in the gases. The analyses will warrant further investigations using the Muong Nong-type tektites which have higher gas contents in enclosed bubbles. Moreover, selected moldavite specimens with large bubbles will also be prepared. In 2016, chemical analyses of materials produced in a controlled plasma experiment were finished. In a follow-up study, a systematic survey of selected stable isotope systems will be performed to test the role of volatilization in creating measurable isotope differences relative to starting parental sediment. Measurements of remanent magnetization of tektites were initiated in collaboration with Dr. Petr Schnabl (GLI CAS). These analyses could provide new constraints on the form of Fe in tektites. As indicated by preliminary data, a part of Fe is distributed in the form of nanoparticles. This could have consequences for detailed modelling of the impact process and chemical modifications, with a possible relationship to redox change of Fe. As a part of the PhD study of Š. Jonášová, which was the integral part of this project, a suite of Muong Nong type tektites from the AAT Strewn field was thin-sectioned and characterized for major and trace element contents. Also, concentrations of highly siderophile elements (HSE) and $^{187}Os/^{188}Os$ isotopic ratios were determined for selected samples of AAT tektites with significantly elevated Ni contents. This topic will be continued in a follow-up project No. 17-27099S.

ACKERMAN L., MAGNA T., *ŽÁK K.*, *SKÁLA R.*, *JONÁŠOVÁ S.*, MIZERA J. & ŘANDA Z. (2017): The behavior of osmium and other siderophile elements during impacts: Insights from the Ries impact structure and central European tektites. – *Geochimica et Cosmochimica Acta*, 210: 59–70.

JONÁŠOVÁ Š., *ACKERMAN L.*, *ŽÁK K.*, *SKÁLA R.*, *DURIŠOVÁ J.*, DEUTSCH A. & MAGNA T. (2016a): Geochemistry of impact glasses and target rocks from the Zhamanshin impact structure, Kazakhstan: Implications for mixing of target and impactor matter. – *Geochimica et Cosmochimica Acta*, 190: 239–264.

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MAGNA T., *ŽÁK K.*, PACK A., MOYNIER F., MOUGEL B., PETERS S., *SKÁLA R.*, *JONÁŠOVÁ Š.*, MIZERA J. & ŘANDA Z. (2017): Zhamanshin astrobleme provides evidence for carbonaceous chondrite and post-impact exchange between ejecta and Earth's atmosphere. – *Nature Communications*, 8, 1, article No. 227: 1–8.

RODOVSKÁ Z., MAGNA T., *ŽÁK K.*, KATO C., SAVAGE P.S., MOYNIER F., *SKÁLA R.* & JEŽEK J. (2017): Implications for behavior of volatile elements during impacts – Zinc and copper systematics in sediments from the Ries impact structure and central European tektites. – *Meteoritics and Planetary Science*, 52, 10: 2178–2192.

RODOVSKÁ Z., MAGNA T., *ŽÁK K.*, *SKÁLA R.*, BRACHANIEC T. & VISSCHER C. (2016): The fate of moderately volatile elements in impact events – Lithium connection between the Ries sediments and central European tektites. – *Meteoritics and Planetary Science*, 51, 12: 2403–2415.

SKÁLA R., *JONÁŠOVÁ Š.*, *ŽÁK K.*, *ĎURIŠOVÁ J.*, BRACHANIEC T. & MAGNA T. (2016a): A new constraints on the Polish moldavite finds: a separate sub-strewn field of the central European tektite field or re-deposited materials? – *Journal of Geosciences*, 61: 171–191.

SKÁLA R., *JONÁŠOVÁ Š.*, *ŽÁK K.*, *ĎURIŠOVÁ J.*, BRACHANIEC T. & MAGNA T. (2016b): A new moldavite sub-strewn field in Lower Silesia, Poland. – *79th Annual Meeting of The Meteoritical Society, Berlin 7–12 August 2016. Abstracts*: 6406.

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No. 14-18183S: **Sequence stratigraphy of Devonian bioevents – sea-level changes at the transition from greenhouse to icehouse world** (O. Bábek, D. Šimíček, Faculty of Science, Palacký University in Olomouc; *J. Hladil*, *H. Weinerová*, *L. Slavík*, *L. Chadimová* & J. Kalvoda, T. Weiner, Faculty of Science, Masaryk University in Brno; 2014–2016)

The project of three years' duration focused on the investigation of several tens of field sections using a broad and modern multifaceted suite of methods and solutions. The intense works resulted in voluminous sedimentological, petrological (diagenetic), biotic (environmental and biostratigraphic), magnetic, gamma-ray and geochemical (isotope) data sets which were acquired with a remarkably high resolution along these sections. The above mentioned data set originated, on one side, from the Lower and Middle Devonian of the Barrandian part of the Teplá-Barrandian Unit (deformed and reconstructed basins) and, on the other side, from the Middle and Upper Devonian of south-eastern Moravian part of the Moravo-Silesian Zone (equally deformed structures with basins).

In many disciplines used by this complex-designed project, the findings and solutions had an immediate impact on the assessment of the palaeoenvironment and time correlation in various parts of the World or even globally. Nine publications published within the project in impacted journals at the end of 2016 illustrate well this sort of impact (Da Silva et al. 2016; Slavík et al. 2016; Weiner & Kalvoda 2016; Poukarová & Weiner 2016; Bábek et al. 2016; Fačevicová et al. 2016; Valenzuela-Ríos et al. 2015; Mikuláš & Hladil 2015; Baranov et al. 2014). In addition, the large volume of data supports also at least the same number of publications, which are in stages of submission and/or preparation.

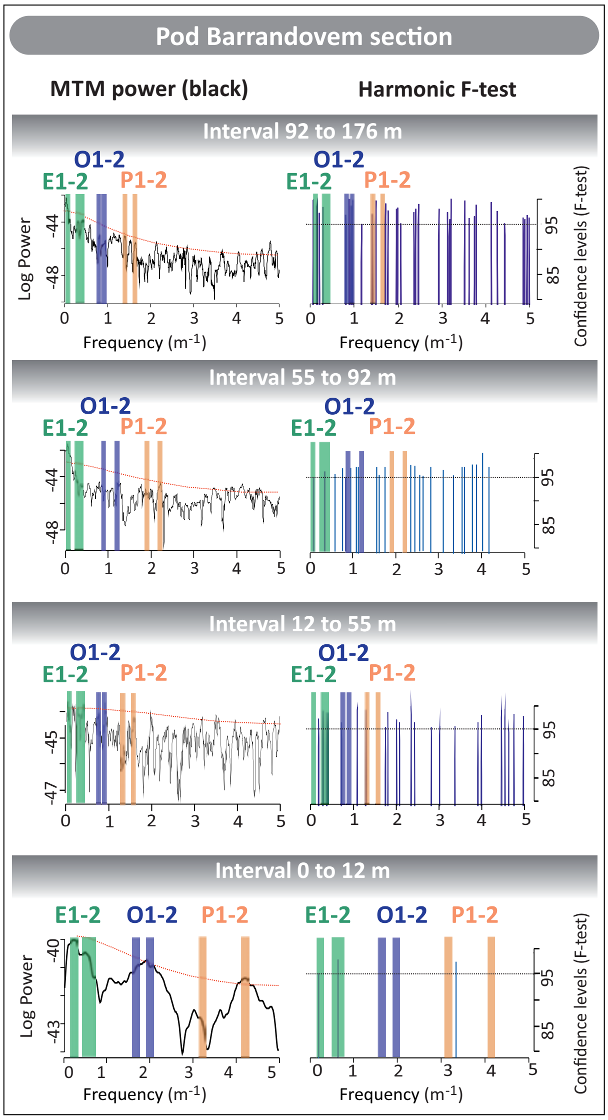
Although all three teams worked in the Barrandian and Moravian areas, the team of the Czech Academy of Sciences was particularly engaged in the former of these two areas. Here, at least several aspects of our studies require a detailed description:

Magnetic susceptibility data and understanding of the duration of stages and sequence units. Based on a detailed magnetic susceptibility (and partly gamma ray spectrometric) data series, the structure of Milankovitch cyclicity record was computed using the latest achievements of Meyers's Astrochron Program Package. The reliability of the analysis of multiple spectral features was further enhanced using the techniques of Continuous Wavelet Transform, Evolutive Harmonic Analysis, Multi-taper Method and Average Spectral Misfit, all with the effort to make the study more secure against phenomena of gapped and/or significantly varying nature of the records, and to reach an optimum astronomical interpretation. This is due to the fact that the stratigraphical records are usually much more complex than ordinarily assumed to be. This was proved even by the early steps of the computation as exemplified here by the effect of the basic (large-scale) fluctuations of sedimentary accumulation rate (SAR) on the arrangement and preservation of the cyclicity-related signal (Fig. 5)

The age model, obtained after all these all procedures, resulted in the durations as follows: 7.7 ± 2.8 My for the Lochkovian Stage (7.7 ± 2.6 My for the Lochkov Formation in the stratotype area), and 1.7 ± 0.7 My for the Pragian Stage that is trimmed due to extremely low current position of the GSSP base of the Emsian stage (5.7 ± 0.6 My for the Praha Fm. which continues into Lower Emsian where overlain by the basal Zlíchovian rocks).

Besides the 18 ka and other, relatively short-period cycles (often with heterodyne-features), the 100 and 405 ky eccentricity signals seem to be considerably strong, and even 1 and ~2.0–2.5 My long-period cycles are well manifested. This implies a revision of the chronostratigraphic stage durations, reducing also the uncertainty in the related part of the Time Scale (Da Silva et al. 2016).

Contribution of spectral gamma-ray logs to unveiling the facies and sequence stratigraphic architecture. Spectral



■ **Fig. 5.** Magnetic susceptibility (χ_{in}) multitaper method results (MTM and F-test) for the Pod Barrandovem section intervals of different stratal patterns and basic sediment accumulation rates (SARs). The computed/interpreted positions of the eccentricity (E1: 405 ka and E2: 91 to 126 ka), obliquity (O1: 38 ka and O2: 31 ka) and precession (P1: 20 ka and P2: 17 ka) cycles are involved. MTM: red dotted line = 95% significance; harmonic F-test: dark dotted line = 95% confidence (original).

gamma-ray data proved to be an extremely useful tool for stratigraphic correlation in the Prague Basin. In particular, high U/Th ratios are typical for the Lochkov, Zlíchov and Choteč Formations whereas low U/Th values are characteristic for the Praha and Daleje-Třebotov Formations. Consequently, the U/Th logs show distinct reversals near the Lochkov/Praha; Praha/Zlíchov, Zlíchov/Daleje-Třebotov and Daleje-Třebotov/Choteč formation boundaries; and these adjusted levels served for the purpose of enhanced stratigraphic correlation. Using the combination of gamma-ray and sedimentological/petrological features, we established a facies classification of the Devonian Prague Basin encompassing twelve facies types which occur within the ranges of the sediments as follows: (1) mixed carbonate-siliciclastic ramp sediments partly deposited under the partial influence of, or initiated by, storm sedimentation upslope; (2) carbonate gravity-flow deposits (debris-flow breccias, proximal and distal turbidites); and (3) siliciclastic, mainly gravity-flow deposits of the Srbsko Formation.

Gravity-flow deposits are typical for the Lochkov, Zlíchov and Choteč Formations, suggesting the presence of carbonate paleo-slope, in contrast to the Praha and Daleje-Třebotov Formations, where the inferred depth and complexness of the slope relief must have had a rather reduced form. Although the depths of sedimentation must have reached "several hundreds of meters, not more" (using the catch-phrase ascribed to Zdeněk Kukal) even in the latter two formations, the sediments in the Praha–Zlíchov Formation time span lack the typical gravity-flow facies deposited from low-density currents. On the other hand, they often show the deposition from slowly moving, gradually thickened slurry sheets that are indicative of deposits of giant homoclinal ramps (without a shelf break in the relief). The relevant "sheet bodies of bed dimensions" are usually several centimetres thick but several kilometres large. The length and the type of sedimentary starvation between the event-deposition of such sheets, including the cases of submarine stiffgrounds and hardgrounds, were characterized by distinct trace-fossil assemblages together with successions of earliest diagenetic changes (Mikuláš & Hladil 2015).

There are distinct trends of increasing computed ("clay") gamma-ray (CGR) values along the proximal-to-distal ramp facies gradient, reflecting the dilution of siliciclastic mineral components by marine calcium carbonate. Consequently, the CGR values provide a quantitative proxy of the distality of a mixed carbonate-siliciclastic ramp that is instrumental in sequence-stratigraphic analysis. However, it must be pointed out that, according to low SARs values (in metres and first tens of metres per million years) and mineral/geochemical composition of non-carbonate material, the use of the term "mixed carbonate-siliciclastic system" is specific in the fact that the non-carbonate material is primarily of aeolian origin. Papers summarizing these features and their complex sea-level, aquafacies and climate controls are also in the stage of preparation (i.e., to the date – beginning of February 2017).

Presence of ocean red-bed facies. The lithostratigraphic units of the Devonian Prague Basin differ in their elemental geochemical composition; in particular, the Lochkov, Zlíchov and Choteč Formations show compositions typically enriched in organic productivity proxies, Si, P, S, Zn, Ni, Cu and TOC compared to the Praha and Daleje-Třebotov Formations. The increased organic productivity in the former formations has also manifestation in allochem composition (higher proportion of prasinophytes, dasyclad algae and peloids) and higher U/Th ratios (suggesting poor bottom oxygenation due to water eutrophization). The Praha and Daleje-Třebotov Formations contain ocean red-bed facies, which reflect very good bottom oxygenation and which coincide with the Pragian/earliest Emsian and late Emsian intervals of global cooling interludes within the Lower Devonian greenhouse climate, as indicated by global conodont apatite $\delta^{18}O$ data. Analyses of sediment accumulation rates (SARs) using the whole complex of methods allow us to suggest the event and facies controls of red beds. A significant result is that the former is much stronger than the latter. The apparent differences in the shape and thickness of the red-bed bodies are often due to SARs fluctuation and hiatuses in the sequence architecture. The fact that the oxygenation on the sea floor and surprisingly also in the first centimetres of the sediment has a primary role for the precipitation and preservation of hematite in rocks is documented, for example, by the almost identical element compositions at the contacts of the Dvorce-Prokop and Řeporyje facies types, and principally the equal amounts of iron in these rocks.

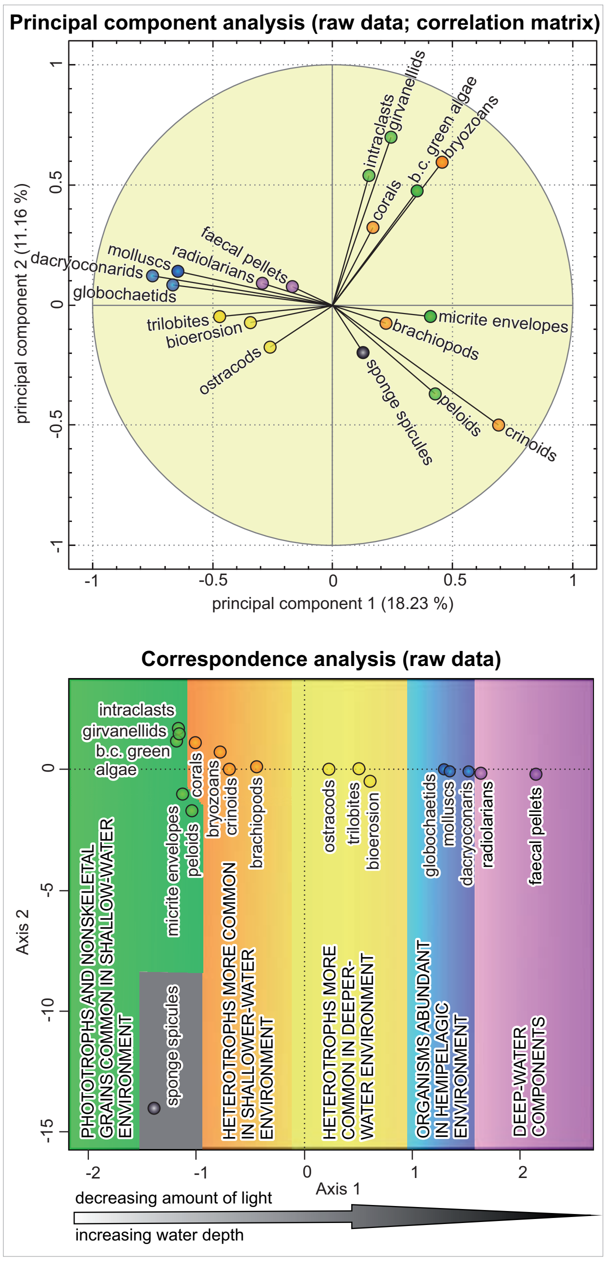
Quantitative microfacies analysis – an example of results at the Lochkovian/Pragian boundary. Multivariate statistical approach was applied to variations in allochem composition to reveal changes across this stage boundary. Raw quantitative data of determinable allochems (da) were obtained from 148 samples from 3 stratigraphic sections. The content of individual groups of allochems in thin sections was acquired by point-counting method. These data were subjected to correspondence, principal component (PCA) and cluster analyses. The latter two were also applied to data transformed by the centred log-ratio (clr) methodology that reduces biased patterns of closed data.

Upper parts of the Lochkov Formation (Lochkovian) consist of grey, well-bedded, locally slightly nodular calcisiltites/fine-grained calcarenites. Shale intercalations and cherts were recorded in the Na Chlumu Quarry section. The microfacies is represented by crinoid-dominated (≤93 % da) grainstones to wacke/packstones with peloids, trilobites, ostracodes, brachiopods, bryozoans and rare dacryoconarids.

Basal parts of the Praha Formation (Pragian) are composed of grey/pink, thick-bedded/massive, fine- to coarse-grained calcarenites with stromatactis and locally developed trough cross-bedding. These grainstones/packstones contain crinoids (≤96 % da) accompanied by bryozoans (≤13 % da), brachiopods, trilobites and ostracodes. Microfacies in the Čertovy schody Quarry section show lower contents of crinoids (≤75 % da), higher contents of bryozoans (≤75 % da) and local presence of tabulate corals (≤26 % da) and green algae (≤42 % da).

In the Na Chlumu and Na Branžovech Quarry sections, these facies gradually pass upward into a succession of calcisiltites/fine-grained calcarenites (Praha Formation, Pragian–Emsian): greyish-greenish-pink slightly nodular limestones, red nodular limestones and grey bedded nodular limestones (with shale intercalations in the Na Branžovech Quarry section). These dacryoconarid-dominated (≤83 % da) wacke/packstones contain globochaetids, molluscs, trilobites, ostracodes, brachiopods, bryozoans and common traces of sponge bioerosion. Lower parts of the Zlíchov Formation (Na Branžovech Quarry section; Emsian) and the Suchomasty Member (Čertovy schody Quarry section; Emsian) were also analysed.

The correspondence analysis reveals several allochem categories following the environmental gradient from shallow photic to deep aphotic zones. The following assemblages illustrate the gradient: phototrophs and nonskeletal grains common in shallow-water environment (benthic green algae, intraclasts, girvanellids, micrite envelopes, peloids); heterotrophs with possible autotrophic symbionts (corals); heterotrophs common in



■ **Fig. 6.** Results of multivariate statistics applied to Lower Devonian allochem assemblages from the Barrandian area. The 'principal component 1' shows relation to water depth and light conditions. This conclusion is in accordance with the results of the correspondence analysis, as well as environmental interpretation obtained by means of other methods and techniques. Note that an equivocal environmental significance of sponge spicules is suggested by extraordinarily negative coordinate along 'axis 2' in the lower diagram (grey field; original).

shallower-water environment (bryozoans, crinoids, brachiopods); heterotrophs common in deeper-water environment (ostracodes, trilobites, bioerosion by sponges); organisms abundant in pelagic and/or hemipelagic environments (globochaetids, molluscs, dacryoconarids); and radiolarians and faecal pellets.

This classification is in accord with the PCA results and looks very similar even for the Lower Devonian data altogether (Fig. 6).

Microfacies were classified into groups by a cluster analysis (Q-mode) based separately on raw and log-ratio transformed data. The relative water depth of environments represented by these microfacies groups was inferred according to the proportion of allochem categories revealed by the correspondence analysis. The inferred curves of facies shifts show very similar results for the raw and log-ratio transformed data.

Stratigraphic distribution of the microfacies groups indicates a lowstand boundary setting just below and around the Lochkovian/Pragian boundary, which changes into a secondary transgressive- to highstand-succession of the entire Praha Formation. The sequence boundary, therefore, lies close to the Lochkovian/Pragian stage boundary. The content of phototrophs and non-skeletal grains (8–48 % da) is relatively low even in the microfacies, which represent the shallowest environments among the investigated stratigraphic sections (e.g., in the Koněprusy area, in the tectonically separated belt and klippen relict at the southwestern tip of the Devonian carbonates). The dominance of heterotroph associations is in accord with ramp topography interpretations, supported by regional-scale facies architecture.

Major events. The Lochkov/Praha boundary event is an expression of global sea-level fall, which is associated with progradation to retrogradation trends that have a lot of evidence in the project data on facies, basin-wide correlation of gamma-ray logs, allochem composition and element geochemistry. The Daleje event has a clear transgressive character, as evidenced by facies and basin-wide correlation of gamma-ray logs. It is possible to put these two events in a sequence-stratigraphic framework and identify their keystone surfaces (late Lochkovian basal surface of forced regression, correlative conformity at the Lochkovian/Pragian boundary, maximum regressive surface in the early Pragian, maximum regressive surface at the base of the Dalejan and maximum flooding surface within the Dalejan).

Biostratigraphy. An extensive set of biostratigraphic (particularly conodont) data was produced, which facilitated correlation of the Prague Basin with many areas of the world, as exemplified by studies related to distant areas of Spanish Pyrenees and northeastern Asia (Baranov et al. 2014; Valenzuela-Ríos et al. 2015; Slavík et al. 2016).

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No. 14-13600S: **Rock textures and mineral zoning: Insights into open system processes in granitoids** (*K. Breiter*, *J. Ďurišová*, *Z. Korbelová*; V. Kanický, M. Vašinová Galiová, T. Vaculovič & J. Leichmann, Faculty of Science, Masaryk University in Brno, 2014–2016)

This project examined several magmatic systems that have undergone episodic opening (in the viewpoint of physical chemistry) and document a transition from magmatic to hydrothermal crystallization stages. The most extensive work was done with the evaluation of the Cínovec granite pluton and adjacent Li-Sn-W mineral deposit in the eastern Krušné hory Mts. While Li and W belong to commodities of strategic importance in the European Union and Czech Republic, we paid a special attention to this locality. We also studied vertical evolution of volcanic rocks within the Teplice caldera (eastern Krušné hory Mts.) and quantitative changes during the transformation of granite to vein greisen in the Horní Blatná granite body (western Krušné hory Mts.).

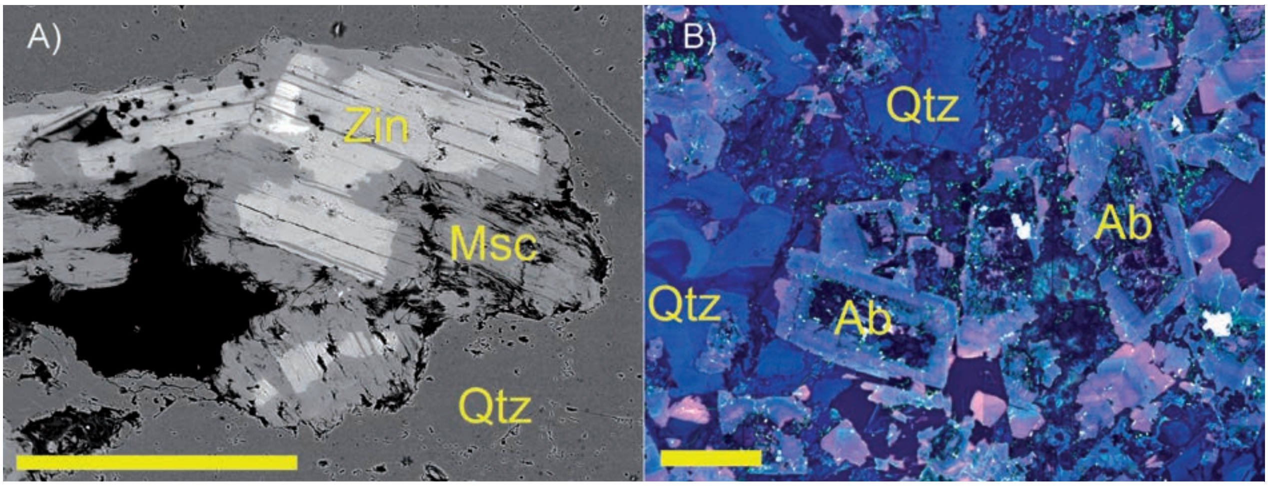
Main results achieved during the project should be summarized in the following paragraphs.

Evolutionary model of the Cínovec deposit. The most detailed investigation was realized at the Cínovec granite cupola, eastern Krušné hory Mts. Borehole CS-1 offers outstanding material for the study of vertical evolution of complicated magmato-hydrothermal system to the depth of 1,596 m. We used a complex of imaging and analytical methods to explain crystallization history of individual mineral species and consequently of the whole system. Li-bearing micas (Fig. 7A) were studied in detail using electron microprobe and LA-ICP-MS for contents of Li and rare-metals Sn, W, Nb, and Ta. Quartz was studied by panchromatic cathodoluminescence to visually distinguish its magmatic and hydrothermal zones/populations and consequently analysed using LA-ICP-MS. The structure of feldspars was visualized by colour cathodoluminescence to distinguish magmatic and metasomatic zoning (Fig. 7B) and analysed by electron microprobe. Feldspar thermometry was applied to perthitic K-feldspars.

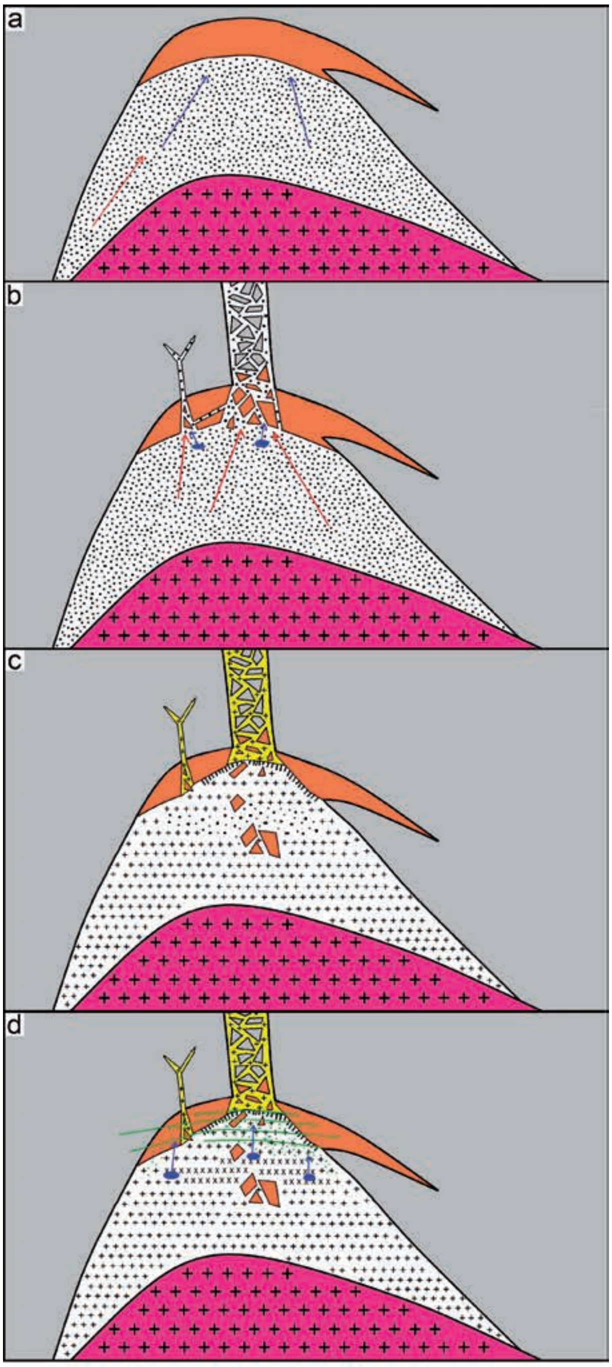
Zircon and oxide minerals of Sn, W, Nb, Ta and Ti were analysed along the whole vertical section of the pluton and through the greisen deposit using a microprobe (Breiter et al. 2016b).

Finally, the model of the origin of the Cínovec granite pluton and greisen deposit has been formulated (Breiter 2016b; Fig. 8A–D):

The first portion of granitic magma intruded into the volcanic pile of the Teplice caldera and crystallized in several facies



■ **Fig. 7.** Visualization of secondary processes in minerals in granite in the uppermost part of the Cínovec granite cupola (scale bars 0.5 mm): A. hydrothermal muscovitization (Msc) of primary magmatic zinnwaldite (Zin) in back-scattered electron (BSE) image (photo by Z. Korbelová); B. hydrothermal overgrowth of late albite (violet) on cores of magmatic feldspars (black) in colour cathodoluminescence (photo by M. Dosbaba).



■ **Fig. 8.** A model of the origin of the Cínovec Li-Sn-W deposit (original). For details see explanation in the text.

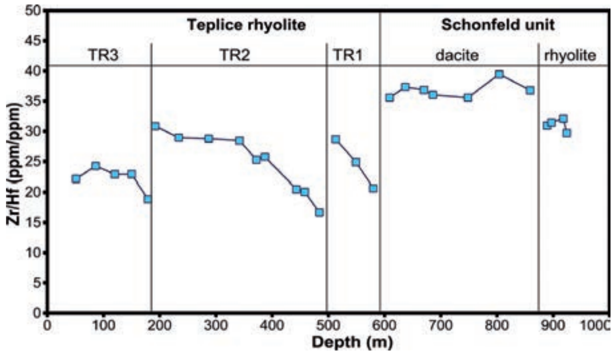
of biotite granite differing in their texture but very similar in their chemical composition. This magma was already slightly enriched in Sn, W, Nb and Ta, but due to low contents of water and other fluxing agents, it was unable to fractionate and/or segregate ore elements into the fluid. Somewhat later, the second, more fractionated and Li, Sn, W, Nb, Ta-enriched portion of magma intruded along the western contact of biotite granite and reached subvolcanic position. This magma started to crystallize from the upper contact downwards as zinnwaldite microgranite (Fig. 8A).

The magma under the impermeable carapace was enriched in water. Subsequently, separation of oversaturated fluid from the melt caused explosive degassing, partial destruction of the carapace of zinnwaldite microgranite and the origin of breccia pipes (Fig. 8B).

The breccia pipes were cemented with medium-grained zinnwaldite granite, volatiles in the magma migrated upward, and stockscheider crystallized along the upper contact of the intrusion. Individual solid blocks of zinnwaldite microgranite plunged into relatively low-viscosity magma. This magma evolved through *in situ* magmatic fractionation: water and fluxes migrated upwards, contents of lithophile elements such as Li and Rb increased upwards, and Zr and other compatible elements slightly decreased. Fine-grained columbite and cassiterite disseminated in granites crystallized from a residual interstitial melt mainly during this process (Fig. 8C).

Water and volatiles became concentrated in the residual melt up to saturation and following a sudden segregation ("second boiling"). Rare metals, F and Li partitioned to fluid, and the water-poor residuum of melt crystallized as mica-free granite. The segregated fluid escaped upwards, causing hydrofracturing and greisenization. Alkalis liberated from destroyed feldspars partly escaped the system and partly caused "albitization" (i.e., crystallization of thin coatings of pure albite on primary albite feldspar crystals; Fig. 7B). The main episodes of Sn and W transfer and cassiterite and wolframite crystallization are contemporaneous with, or slightly younger than, the greisenization. Later, a portion of fluid poor in Li and F caused pervasive sericitization of the granite in the canopy and local muscovitization of the zinnwaldite in greisen and veins (Fig. 7A). Local scheelitization of wolframite and the replacement of columbite by pyrochlore can be also assigned to this stage. Crystallization of the sulphide assemblage with native Bi required a temperature of less than 270 °C (Fig. 8D).

Magmatic evolution of the Teplice caldera documented by the Zr/Hf value in the whole rock and in zircon. We used samples of volcanic rocks (rhyolite and dacite) from borehole Mi-4 at Mikulov and samples of plutonic rocks (biotite and zinnwaldite granite, greisen) from borehole CS-1 at Cínovec, both geologically located within the Teplice caldera, to document and interpret the evolution of silica-rich magma in volcanic and plutonic conditions. The Zr and Hf contents (together with contents of other major and trace elements) in rock samples were analysed in commercial laboratories, while the Zr/Hf values in zircons were analysed using a microprobe at the Institute of Geology of the Czech Academy of Sciences. New whole-rock data confirmed the existence of five chemically distinct eruptive stages within the caldera fill: two oldest stages (basal rhyolite



■ **Fig. 9.** The Zr/Hf value in whole-rock samples of volcanic rocks from borehole Mi-4 documents a complicated evolution of the caldera fill and reversal zoning of the TR1–TR3 units (original).

and dacite) form calc-alkaline Schönfeld unit, while the three younger units (TR1→TR3) with A-type chemical composition belong to the Teplice rhyolite. All TR1→TR3 units show a reversed vertical zoning with generally upwards decreasing concentrations of Rb and other incompatible elements, and upwards increasing concentrations of compatible elements and the Zr/Hf values (Fig. 9). In the case of the Cínovec granite cupola, a strong fractionation, i.e., a decrease in the Zr/Hf value upwards was found. The Zr/Hf ratios in zircons are in good accordance to the Zr/Hf values in their host rocks. Moreover, our investigation indicated that the Zr/Hf value in zircon was altered neither during hydrothermal alteration of granites, nor after metamictization. This value seems to be an excellent indicator of magmatic fractionation also in plutons which underwent strong post-magmatic changes.

The study of chemical changes during greisenization in peraluminous granites in the western Krušné hory Mts. Textures and chemical compositions of quartz and micas from greisens and their parent peraluminous granites were studied in the area of Podlesí and Horní Blatná. Aluminum, Li, and Ti are the most abundant trace elements in quartz. The content of Al in phenocysts of magmatic quartz is approximately 400 ppm (range 300–500 ppm), whereas only 115–270 ppm were found in the greisen quartz. The contents of Ti in magmatic quartz vary between 40 and 100 ppm, with rare values up to 200 ppm near margins of some crystals, approximately 20 ppm Ti were found in greisens. The contents of Li in magmatic quartz range between 30–50 ppm. Those in quartz from greisen are somewhat lower, approximately 10–30 ppm. The contents of Li and Al are generally positively correlated. Our preliminary research revealed that quartz produced during metasomatic greisenization differs from the primary magmatic quartz in lower intensity of cathodoluminescence and significantly lower concentrations of trace elements Al, Ti, and Li (Breiter et al. 2017a).

Distribution of lithium in granites was studied on the example of selected plutons of different geotectonic positions through the whole Bohemian Massif. Processes of lithium concentration in small late Variscan intrusions in the Krušné hory Mts. were described in detail (Breiter et al. 2017b).

Long-term study of chemical composition of **accessory minerals as indicators of magmatic fractionation** was finished. Zircon and monazite were found to be the major hosts of U, Th, and Y in all studied peraluminous granitoids in the Bohemian Massif (Breiter 2016a).

International cooperation. Granite/greisen system at Dlhá Dolina, Slovakia was studied for comparison with greisen localities in the Krušné hory Mts. in cooperation with geologists from the Komenský University and Slovak Academy of Sciences, Bratislava, Slovakia (Breiter et al. 2015). Evolution of the chemical composition of zircon from granites in Cornwall, SW England, and its comparison with zircon from granites in the Bohemian Massif was studied in cooperation with geologists from the Camborne School of Mines, Penrin, United Kingdom (Breiter et al. 2016b).

Organization of workshops for students (see Chapters 6 of this Report and Report for 2015).

BREITER K. (2016a): Monazite and zircon as major carriers of Th, U, and Y in peraluminous granites: examples from the Bohemian Massif. – *Mineralogy and Petrology*, 110, 6: 767–785.

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BREITER K., BROSKA I. & UHER P. (2015): Intensive low-temperature tectono-hydrothermal overprint of peraluminous rare-metal granite: a case study from the Dlhá dolina valley (Gemericum, Slovakia). – *Geologica Carpathica*, 66, 1: 19–36.

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BREITER K., *ĎURIŠOVÁ J.* & DOSBABA M. (2017a): Změny chemického složení křemene během greisenizace, předběžné výsledky ze západních Krušných hor. – *Zprávy o geologických výzkumech*, 50: 25–31.

BREITER K., VAŇKOVÁ M., VAŠINOVÁ GALIOVÁ M., *KORBELOVÁ Z.* & KANICKÝ V. (2017b): Lithium and trace element concentrations in trioctahedral micas from granites of different geochemical types meassured via laser ablation ICP-MS. – *Mineralogical Magazine*, 81, 1: 15–33.

Continued projects

No. 13-13967S: **Experimental study of crack initiation and crack damage stress thresholds as critical parameters influencing the durability of natural porous stone** (R. Přikryl, A. Šťastná, Faculty of Science, Charles University in Praha; Z. Weishauptová, I. Sýkorová, M. Švábová, Inst Rock Struct Mech, Czech Acad Sci, Praha; *T. Lokajíček* & L. Zamrazilová, Academy of Fine Arts, Praha; 2013–2017)

During the fourth year of the project (2016), the sampling of remaining types of rocks suitable for preparation of experimental specimens was completed. The whole set of examined materials thus covers: (1) siliciclastic sedimentary rocks (quartz sandstones with various types of matrix/cement, arkosic sandstones and arkoses, greywackes), (2) porous carbonate rocks (detrital limestones), (3) chemogenic rocks (calcareous silica-rich chemogenic rocks locally known as opuka stone), (4) volcanic/volcanosedimentary rocks (tuffites, porous volcanic rocks), and (5) porous/altered magmatic rocks (greisens). Most of the sampled material comes from the territory of the Czech Republic, some materials were taken from quarries in Poland and Hungary. During the whole year, test specimens (specifically cylindrical specimens, but also other shapes such as cubic and/or prismatic specimens) were prepared for experimental study focused on the determination of stress-strain behaviour and on artificial weathering tests. Basic physical properties (index characteristics) were determined using non-destructive tests. The sampled rock types were examined by a combination of microscopic techniques (optical, cathodoluminescence, electron microscopy with energy dispersive microanalysis plus X-ray elemental mapping) for mineralogical composition and rock fabric description, and by complementary analytical methods (XRD, silicate analyses). The decayed materials were studied by the same methods with special emphasis on fractographic study (analysis of newly formed cracks generated from various types of loading or from decay processes). The observed microfracture patterns were interpreted based on the knowledge of material composition and on the decay processes that affected them. The results of this research topic were presented at an international congress (poster 1 presented by R. Přikryl at EGU 2016 under title *"Phenomenological observation of brittle damage from physical weathering processes and proposal for adequate estimation of durability from experimentally derived rock mechanical data"* and oral presentation given by R. Přikryl at EGU 2016 under title *"Indoor damage of aged porous natural stone due to thermohygric stress: a case study of opoka stone altar from the St. Vitus Cathedral, Praha"*). The presented study highlights the importance of detailed and exact knowledge of the damage processes which allows for the formulation of adequate testing procedure leading to the reliable estimate of natural stone durability. Together with the above mentioned techniques, a detailed quantitative study of pore space textural characteristics by means of mercury porosimetry was applied at the co-operating IRSM team (Z. Weishauptová as joint-investigator). Durability indices were computed by using porosimetry data. These data were correlated with stress/strain behaviour of studied rocks. The observed relationships were discussed at an international congress (poster 2 presented by R. Přikryl at EGU 2016 under title *"Pore space characteristics vs. stress strain markers: two contrasting approaches on how to predict durability of porous natural stone"*). The results of this study show that despite the importance of porosimetry data as indirect indicator of natural stone susceptibility to decay, only stress-strain behaviour and computed energetic parameters can be used as a reliable indicator of natural stone resistance to decay processes.

During the fourth year of study, the laboratory rock mechanical testing program (performance of tensile and uniaxial compressive tests of intact specimens, and monitoring of acoustic emission) continued. Evaluation of data focused on a precise determination of 'microcrack initiation stress/strain threshold', which appeared to be a fundamental parameter necessary for a correct correlation between rock mechanical parameters and stone durability. In contrast to 'microcrack damage stress/strain threshold', which can be easily located on the deflection of volumetric curve, the precise location of 'microcrack initiation stress/strain threshold' requires more sophisticated stress-strain data analysis supported with advanced processing of acoustic emission data.

The newly included test procedure of artificial weathering by using climatic box allowing simulation of atmospheric conditions (in our case, a combination of sulphur dioxide and wetting/drying or freezing/thawing) appeared to be highly effective in the simulation of weathering processes and in the development of decay patterns similar to those observed *in situ*. Importance of the phenomenological study of real weathering patterns in the formulation of decay simulations were partly discussed at an international congress (poster 1 presented by R. Přikryl at EGU 2016).

During the fourth year of study, an alternative approach in freezing/thawing and wetting/drying artificial weathering of cubic/prismatic test specimens in special steel frames was started to be tested. Despite promising preliminary results, further experiments are necessary for finding the effects of specimen geometry and test conditions (specifically the effect of testing of partially and fully saturated material) on observed decay phenomena. Regarding the 3D characterization of materials by ultrasonic sounding the spherical rock samples for simultaneous measurement by P-wave ultrasonic sounding and deformation were prepared. Calibration measurements of deformation on homogeneous and isotropic samples such as technical plastic, glass, and/or aluminium with known elastic/deformational parameters were performed up to 400 MPa confining pressure. Additionally, several anisotropic low-porosity rocks such peridotite, biotite gneiss, and serpentinite were measured as well. Based on the measured data, microcrack preferred orientation and their 3D distribution were determined. Regarding the research task connected with the application of conservation agents (L. Zamrazilová as joint investigator of the recent project), the FTIR (Fourier transform infrared spectroscopy) study continued in order to determine the depth of penetration of conservation agents.

No. 16-00800S: **Reference climate curve for the beginning of the Miocene Climatic Optimum in Central Europe** (T. Matys Grygar, M. Fáměra, M. Hošek, Inst Inorg Chem, Czech Acad Sci, Praha; *P. Schnabl, P. Pruner, T. Elbra* & *K. Čížková*; 2016–2018)

Magnetostratigraphy of the drill core in Miocene sediments at Háj u Duchcova was compared with that of two older cores from the Sokolov Basin of comparable age. Magnetostratigraphic investigation was conducted on the newly excavated HD-50 core and previously retrieved DP-333-09 and JP-585-10 cores. The new HD-50 core was sampled at the old Prvního Máje Coal Mine near Háj u Duchcova in the Most Basin, while the DP-333-09 and JP-585-10 cores come from the benches of opencast coal mines of Družba and Jiří in the Sokolov Basin. Both basins fall within a segment of the European Cenozoic Rift System. Sediments in both basins are of Burdigalian age (lower Miocene). Their lithology mainly comprises fossil-free clays/silts above the main coal seam, with two phosphatic horizons with mineral crandallite in the Most Basin and several greigite layers in the Sokolov Basin.

The anisotropy of magnetic susceptibility (AMS), alternate field demagnetization and remanent magnetization were measured in all sediment samples. Unusually behaving samples with extremely high magnetic susceptibility (siderite), prolate anisotropy of magnetic susceptibility AMS and samples with the angle of the main AMS axis exceeding 20° were excluded from further evaluation.

The sedimentation rate was computed by multivariate spectral analysis on data acquired by X-ray fluorescence. The spectral analysis was performed with our original software solution for the identification of typical frequencies and their assignment to the Milanković cycles. The sedimentation rate (after compaction) was around 15 $cm \cdot ka^{-1}$ for the DP-333-09 core and around 30 $cm \cdot ka^{-1}$ for the JP-585-10 core.

The sediment succession above the coal seam in the DP-333-09 core starts with 20 m, in which the magnetic polarity could not be solved (70–50 m), then there is a top part of reverse (R) zone (50–49 m) and a short normal (N) subzone above (49–48 m). Higher up, there is the second R zone (45–44 m). Two additional magnetozones above that could be found only in the HD-50 core from the Most Basin. The JP-585-10 core begins with a disturbed zone 14 m thick (94–80 m), followed by ca. 12 m of N polarity (69–80 m). Above that, after a small gap of magnetically disturbed sediments, there are sediments 60 m thick with R polarity (62–2 m) with a short N excursion in the upper half (24–17 m).

According to the detailed analysis of the HK591 core (Matys Grygar et al. 2014), we suppose that the succession begins in C5En (only JP-585-10), then C5Dr.2r (in DP-333-09 and HD-50 cores could be found only the upper part of this subzone), and after C5Dr.1n continue up to the C5Dr.1r. The zone C5Cr could be found only in the HD-50 core. Additional investigation should be done.

New age model (Matys Grygar et al. 2017a) was based on magnetic polarity analysis (5 reversals) and later refined at the metre scale using cyclostratigraphy. The onset of the basin was interpreted as a wide lacustrine phase in the Most Basin due to enhanced input of fluvial clastic sediment to the former peat swamps during the high-eccentricity period at 17.7–17.55 Ma, i.e., immediately after the initial decay of the East Antarctic ice sheet according to Levy et al. (2016). The most important environmental change recorded by the lacustrine interval in the Most Basin occurred during the eccentricity maximum at 16.44 Ma and is nearly coeval with further shrinkage of the East Antarctic ice sheet. The second stage of monotonous lacustrine deposition, which exhibited enhanced precession-controlled compositional variability in 16.1–16.0 Ma witnessed the onset of the MCO.

Additional measurements show that a local lake was present in the Bílina area from the end of palaeomagnetic chron C5Er through chron C5En (18.524–18.056 Ma) to the beginning of the C5Dr chrons. This finding extends the previous age models for the Most Formation by more than 0.5 Ma (18.6 to 17.9 Ma; Matys Grygar et al. 2017b).

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MATYS GRYGAR T., MACH K., HOŠEK M., *SCHNABL P.*, MARTINEZ M. & KOUBOVÁ M. (2017b): Early stages of clastic deposition in the Most Basin (the Ohře Rift, the Czech Republic, early Miocene): timing and possible control. – *Bulletin of Geosciences*, 92, 3: 337–355.

No. I6-03950S: **Solid body fracturing mode by shear-tensile source model: acoustic emission laboratory study** (*T. Lokajíček, M. Petružálek, T. Svitek*; J. Šílený, Z. Jechumtálová, P. Kolář & P. Adamová, Inst Geophys, Czech Acad Sci, Praha; 2016–2018)

The following points cover the laboratory work progress reached during the first year of the project.

Directional sensitivity of the acoustic emission (AE) sensors. The amplitude registered by the AE sensor depends on the incidence angle between the sensor surface and the ray path of incoming seismic wave. Due to this problem, the measured amplitudes have to be corrected on the directional sensitivity of AE sensors. These sensor corrections were established by means of laser interferometer and measurement on glass half spheres.

Improvement of contact conditions between AE sensors and tested specimen. The registered amplitude is proportional to the contact area between the specimen surface and the AE sensor. To improve the measurement conditions, the specimens of octagonal prism shape (full sensor surface contact) were used instead of the cylindrical ones (linear contact). A device for grinding cylindrical samples to prepare octagonal ones was developed.

The development of the MATLAB code for data processing. A MATLAB code was developed to process the acoustic emission and ultrasonic sounding waveforms. It is fully automatic and it enables: first arrival picking by the automatic picker based on the Akaike information criterion, picking of first arrival amplitude, determination of stress-strain dependent anisotropic velocity model from ultrasonic sounding, localization of AE events in the anisotropic velocity field, determination of source types of AE events based on the average first arrival amplitude.

Realization of uniaxial compression loading experiments with the AE monitoring. Five uniaxial compression tests were carried on the 5 types of granitic rocks with different grain size in the range of 0.5 mm–2 cm. The specimens were of octagonal prism shape (100 mm in height and 50 mm in diameter). A 16 channel AE monitoring was used during these experiments. The same channels were used for periodical ultrasonic sounding. The registration device (Vallen AMSY 5) was used to record full AE and ultrasonic sounding (US) waveforms. The extensometers measured the axial and the radial strains.

The processing and interpretation of measured experimental data. Experimental data of the 5 tests, mainly the AE and US waveforms, were processed to determine the AE activity, stress/strain-dependent velocity model, localization of AE events, source types of AE events and first-arrival amplitude of AE events. The elastic constants were determined from the measured axial and radial strains. Crack initiation and crack damage thresholds were determined from the strains and AE activity. All the mentioned outputs were used to evaluate the fracturing process of tested specimens. The stress-strain dependent velocity model, locations of AE hypocenters and first arrival amplitude of AE events served as input parameters for determination source mechanisms using moment tensor and shear-tensile-implosion models.

The role of the IG CAS team in the project is the development of the methodology of the AE data processing towards determining the mode of fracturing within the foci of the AE events, corresponding data processing and interpretation. Because of the preferential application of the shear-tensile crack (STC) source model has been suggested already in the Project proposal thanks to its robustness revealed in the previous experiments, we concentrated on simultaneous testing of the performance of the STC and the traditional moment tensor (MT) source model in various seismological setups. The proceedings in the first year of the project are the following:

1. Simultaneous performance of the MT, STC and a pure shear-slip model (double-couple, DC) was tested in 3D configuration of the monitoring. Because of the complexity of the acoustic waveforms measured in the laboratory, which we are not able to fully understand yet (e.g., the issue of direct *vs.* reflected phases, near-field *vs.* far-field zone, wave conversion within the piezoelectric transducer and the related free-surface conversion correction), we tested the features of the inversion using local seismological data first, where the waveforms are simpler. Thus, the set-up of seismological monitoring of the underground natural gas storage at Háje Village (Czech Rep.) was applied. The 3D extension of the surface local network is acquired by adding two borehole sensors. For assessment of reliability of the retrieved mechanisms, confidence zones constructed for a priori specified probability levels were compared for the three source models employed. In this way, the confidence zones were compared separately for the orientation of the retrieved source and for its decomposition into the DC and non-DC parts, i.e., for the assessment of the uncertainty of the possible non-shear feature of the particular event. We found that in the configuration investigated the orientation of the mechanism is determined always well, regardless of the particular source model. This is, however, not the case of the decomposition: the results unambiguously prefer the STC against the MT. The former source model yields the answer even if the latter one fails.
2. The validity of construction of confidence zones for the particular solution of the inverse task of seismic source retrieval was demonstrated in the case study of mechanisms of the earthquake swarm in West Bohemia in 1997. In several previous studies the classification into two basic types of the mechanism – shear and non-shear – was substantiated, the confidence of this distinction has, however, never been evaluated. We performed this in a special study taking advantage of the robustness of the STC inversion and the methodology developed to construct the confidence zones. The result is the confirmation of the significance of the distinction into the two types mentioned, in other words the confirmation of the existence of tensile events within the West Bohemia earthquake swarm 1997. For the purpose of the Project just reported, the result is important as the proof of the performance of the STC inversion including its capacity to assess the credibility of the solution obtained. In addition, the paper explores the chance to extend the STC search for the mechanism by estimating the Poisson ratio. The answer is, however, negative, unfortunately: for the configuration of the WB monitoring in 1997 the confidence of the Poisson ratio determination is too low to yield a reasonable estimate of the quantity. For the application in the laboratory set-up the study extends the pessimism from the field, as the gaps in the focal sphere coverage are similarly large regardless the 3D sensor distribution in the lab. We may expect the success in the extended inversion for events close to the centre of the rock sample only, where the observation is theoretically available from the directions all around.
3. A preliminary study of inversion of P-amplitudes of a set of about 40 AE events generated within a loading experiment in the lab was performed to check the effect of the various features of the experiment: velocity within the rock sample, attenuation, sensors on the free surface of the sample. The goal was to understand the influence of the particular factor and quantify the importance of the individual corrections. The amplitudes were inverted into the MT mechanism. Generally, subsequent employing the individual corrections decreases the data *vs.* synthetics misfit apart from the attenuation, obviously the available values of the parameters (a causal model was used) need to be made more accurate. Results are however largely dependent of the individual events themselves, which is the consequence of the variable quality of the geometry of monitoring to a large extent. Therefore, the dataset was limited to exclude the events situated close to the surface of the sample. The benefit of this limit was two-fold: (a) to improve the monitoring geometry and (b) to make the picking of the P-onset more confident thanks to achieving a bigger delay of the reflected/converted phases. In this way, the dataset was limited to 19 events. An important achievement was the implementation of the station calibration according to Davi & Vavryčuk (2012), which enabled to identify two sensors with an irregular response; there were excluded from the processing subsequently. As the next step, the STC model was employed in the inversion task, the non-linearity introduced was tackled by applying the Matlab library routine

lsqnonlin. The STC inversion logically yields slightly worse data *versus* synthetics fit, and provides similar orientations of the mechanism (in accordance with ad 1). The interpretation of the shear *versus* non-shear decomposition is, however, not straightforward yet. Also a test with determination of the Poisson ratio related to application of the STC source model was performed, the scatter within the dataset investigated is, however, large and some of the values are disputable. This is in agreement with the pessimism concerning the estimation of this parameter invoked by the study ad 2).

4. A synthetic study on the possibility to obtain an estimate of the direction and speed of the rupture propagation within the STC source model was initiated. In fact, it means – in a simplistic way – to combine the point-source approximation with features of a finite-extent source. The STC model is convenient for such a purpose, thanks to its definition in terms of physics and not phenomenology like the moment tensor, and to saving up one parameter against the MT. The extension is important from the viewpoint of practice: a reliable determination of the rupture direction would remove the inherent ambiguity of the nodal planes, in other words it could identify the fault from the couple of fault plane solutions. The results are encouraging provided a good station distribution around the current focus is available, which is more feasible in laboratory setups than in earthquake seismology, in fact.

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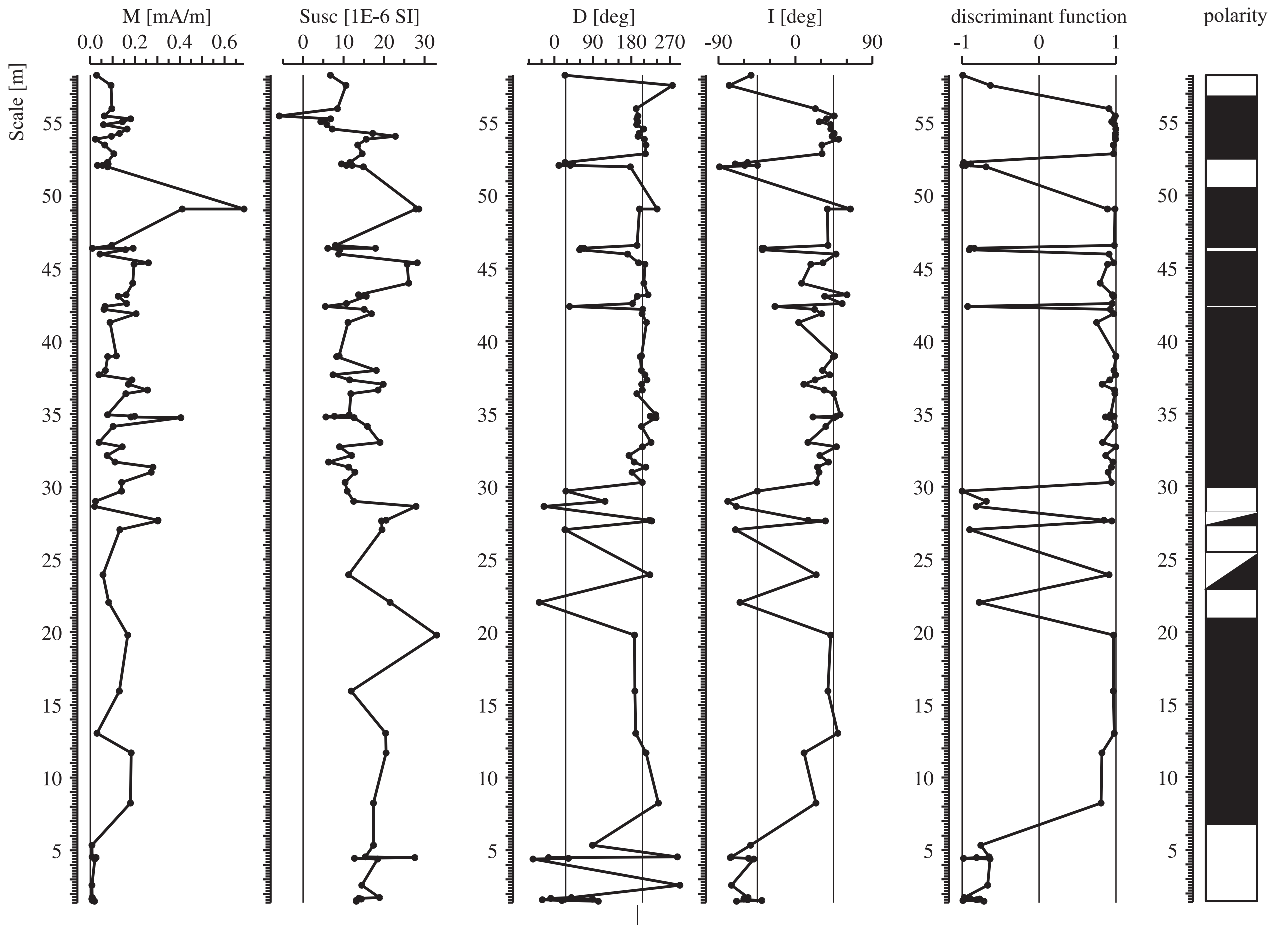
No. 16-09979S: **Integrated multi-proxy study of the Jurassic–Cretaceous boundary in marine sequences: contribution to global boundary definition** (*P. Pruner*, *P. Schnabl*, *T. Elbra*, *K. Čížková*, *J. Hladil*, *A. Svobodová*; M. Košťák, M. Mazuch, Faculty of Science, Charles University in Praha; P. Skupien, Institute of Geological Engineering, Faculty of Mining and Geology, Mining-Technical University in Ostrava; M. Bubík & L. Švábenická, Czech Geological Survey, Praha; 2016–2018)

Rock magnetic, magnetostratigraphic, biostratigraphic and sedimentological investigations in 2016: Several field campaigns to Czech (Kurovice, Štramberk), French (e.g., St Bertrand) and Ukrainian (Veliky Kamenets) localities were carried out. Additionally, two new possible localities of Vigantice (Czech R.) and Tre Maroua (France) were scouted. The main focus of the Paleomagnetic Department (GLI CAS) team was on rock-magnetic and paleomagnetic measurements, such as progressive thermal



■ **Fig. 10.** Magnetostratigraphy of the Kurovice section. M – remanent magnetization in the natural state; Susc – value of volume magnetic susceptibility in natural state; D – declination; I – inclination of palaeomagnetic directions. Polarity zones (black is normal and white is reverse; original drawing).

■ **Fig. 11.** Jurassic/Cretaceous boundary (approx. 145 Ma) limestones of the Vocontian Basin (France) were drilled for paleomagnetic investigations (photo by Š. Kdýr).

and alternating field demagnetization, frequency and temperature dependence of magnetic susceptibility, and saturation magnetization on samples from Kurovice and St Bertrand localities. The first results of these measurements helped to produce new preliminary magnetostratigraphic columns. The magnetostratigraphy of St Bertrand indicates three normal/reversed polarity sequences, possibly representing ages between the upper Tithonian (M19r) and middle Berriasian (M17n). The results of St Bertrand were combined in a publication (Elbra et al., 2018). The preliminary magnetostratigraphy of Kurovice indicates the presence of four normal and five reversed polarity (sub)zones, which might correspond to age from Tithonian (M20r) to early Berriasian (M18n). The results could be used for the correlation of chronostratigraphic units among diverse faunal realms, since the polarity changes of the main geomagnetic dipole field are geologically rapid events recorded simultaneously around the World (Fig. 10). In recent studies of the Berriasian Working Group, the scientists focus their attention on an integrated approach to the issue of defining a Jurassic–Cretaceous (J–K) boundary. This approach in Tethys involves mainly high-resolution magnetostratigraphy, calpionellids, ammonites and calcareous nannofossils. The results of current work-group on magnetic proxies, in combination with stratigraphy and plankton communities in the Pieniny Klippen Belt, were published in Michalík et al. (2016).

The rock-magnetic and paleomagnetic results were presented at two international conferences – XIIth Jurassic Conference together with Workshop of the ICS Berriasian Group, Slovakia and 15th Castle Meeting: New Trends on Paleo, Rock and Environmental Magnetism, Belgium. Additionally, as public outreach, two information tables were placed in the Kurovice Quarry to inform the public on the J–K boundary and the current research project.

The team of the VŠB-Technical University in Ostrava focused on field work at the Kurovice and Štramberk localities in the first year of the project. Two sections (each with a thickness of 20 m) in the Kotouč Quarry near Štramberk were documented in detail. Collected ammonites were determined as of Lower Berriasian age. Ammonites of Tithonian to Lower Berriasian age were systematically elaborated in publication (Vašíček & Skupien 2016). In cooperation with Prof. D. Reháková (Bratislava), an attempt was made to correlate the age of some Štramberk ammonites deposited in the museums with those recently collected in the Kotouč Quarry by studying the microfossil content in thin sections of rocks that surround and fill the ammonites. Laboratory work comprised palynological maceration of 20 samples of marlstones from the Kurovice Quarry. Preliminary results show small content of organic matter and determinable pollen, spores and non-calcareous dinoflagellate cysts.

The team of the Faculty of Science, Charles University in Praha acquired more than 550 samples of carbonates (Kurovice and Štramberk sections) for the stable isotope analysis ($\delta^{18}O$ a $\delta^{13}C$), thin sections and for dissolving in acid. More than 50 belemnite rostra from the J–K boundary interval were collected for $^{87}Sr/^{86}Sr$ analysis. About 150 carbonate samples were used for establishing $\delta^{18}O$ and $\delta^{13}C$ isotopes, representing the complete section of the Kurovice Quarry. Samples from Kurovice are currently analysed using bulk analyses (SiO_2, TiO_2, Al_2O_3, Fe_2O_3(tot), MnO, MgO, CaO, Na_2O, K_2O, P_2O_5) for the determination of terrestrial input (a method successfully used in the J/K boundary interval in the Puerto Escaño section, Spain (Svobodová & Košťák 2016). Moreover, the PhD study (Svobodová 2016) of planktonic ecosystems of the Upper Jurassic and Cretaceous was completed.

The Czech Geological Survey team documented the J–K section at the Kurovice Quarry in bed-by-bed detail (78 m in thickness, 160 numbered beds). 32 samples were selected for the study of nannofossils, radiolarians and foraminifers. The samples were processed in laboratories for thin sections, nannofossil slides, acetolysis and washing of foraminifers, and were partly studied.

ELBRA T., SCHNABL P., ČÍŽKOVÁ K., PRUNER P., KDÝR Š., GRABOWSKI J., REHAKOVÁ D., SVOBODOVÁ A. & WIMBLEDON W.A.P. (2018): Palaeo- and rock magnetic investigations across Jurassic-Cretaceous boundary at St Bertrand's Spring, Drome, France – Applications to magnetostratigraphy. – *Studia Geophysica et Geodaetica*, 62, 2: 323–338.

MICHALÍK J., REHÁKOVÁ D., GRABOWSKI J., LINTNEROVÁ O., *SVOBODOVÁ A*., SCHLÖGL J., SOBIEN K. & *SCHNABL P*. (2016): Stratigraphy, plankton communities, and magnetic proxies at the Jurassic/Cretaceous boundary in the Pieniny Klippen Belt (Western Carpathians, Slovakia). – *Geologica Carpathica*, 67, 4: 303–328.

SVOBODOVÁ A. (2016): *Planktonic ecosystems of the Upper Jurassic and Cretaceous (calcareous nannoplankton, calpionellids)*. – PhD. Thesis. Charles University in Praha: 1–49. Praha.

SVOBODOVÁ A. & KOŠŤÁK M. (2016): Calcareous nannofossils of the Jurassic/Cretaceous boundary strata in the Puerto Escaño section (southern Spain) - biostratigraphy and palaeoecology. – *Geologica Carpathica*, 67, 3: 223–238.

VAŠÍČEK Z. & SKUPIEN P. (2016): Tithonian–early Berriasian perisphinctoid ammonites from the Štramberk Limestone at Kotouč Quarry near Štramberk, Outer Western Carpathians (Czech Republic). – *Cretaceous Research*, 64: 12–29.

No. 16-14762S: **Mercury and methylmercury in surface waters and soils at two sites with contrasting deposition histories** (*T. Navrátil*, *J. Rohovec*, *Š. Matoušková*, *I. Dobešová*, *S. Hubičková*, *M. Šimeček*, *T. Nováková* & *M. Roll*; 2016–2018)

Up to date the Hg concentrations in the bulk precipitation solutes were 2.9 and 3.5 ng.l^{-1} at Plešné jezero (PLE) and Červík catchment (CER), respectively. In contrast, the reference site of Lesní potok (LES) with the longest time span of monitoring averaged at 5.4 ng.l^{-1} Hg during the same period. Higher Hg concentrations in bulk precipitation in Central Bohemia (LES) relative to those in more remote and mountainous sites of PLE and CER result from lower precipitation amounts and from a higher number of near emission sources.

Nevertheless, the main input pathway of Hg into the forest ecosystems is the litterfall, which usually represents more than 80 % of the total deposition flux. Samples representing year 2015 were analysed and the results indicate that Hg deposition at bark beetle infested sites did not decrease to zero. The highest Hg concentrations in the litterfall material of infested site PL were found in lichens with an average concentration of 205 μg.kg^{-1}, bark with average concentration of 123 μg.kg^{-1} and a mixture of unidentifiable organic debris including the bark beetle excrements with 159 μg.kg^{-1}. Relatively similar concentrations of Hg 240, 167 and 172 μg.kg^{-1} in litterfall compartments occurred at the site of CT, which has not been infested by the bark beetle yet. We plan to analyse the archived litterfall samples and reveal the development of the changes in Hg litterfall flux during the bark beetle infestation back to year 2003 (Fig. 12).

Furthermore, we studied the current and archived soil samples to assess Hg distribution and pools at the sites of CER and PLE. Soils may serve as a geochemical archive and an indicator of current and past deposition load to the ecosystem. The up-to-date results indicate Hg concentrations of 311, 501 and 145 μg.kg^{-1} in O, A and mineral soil horizons, respectively, at the PLE catchment. The soils at CER catchment averaged at 337, 85 and 51 μg.kg^{-1} for the O, B and C soil horizons, respectively. Concentrations of Hg in soils result from the distribution of organic carbon (C_{org}) within the soil profiles (Navrátil et al. 2016), therefore the highest concentrations of Hg at both sites occurred in organic-rich soil horizons O and A. The slight difference in the topmost O horizon between sites PLE and CER indicates a possible small difference in current Hg deposition, which occurs mostly through litterfall. We further investigated the relationships between Hg concentrations and concentrations of C_{org}, N and S in individual soil samples at the studied sites. Negative statistical relationships of Hg and C_{org} concentrations were found for organic (litter) horizons but a positive correlation of Hg with C_{org} was found in mineral soil. The findings on soil Hg pools and concentrations in context of the Načetín site were summarized in the paper of Navrátil et al. (2016).

To assess the output of Hg from the studied forest ecosystems, we sampled and analysed stream water at PLE, CER and LES sites and lake water of the Bohemian and Bavarian Forest lakes with special attention to the PLE and Čertovo Lake (CT). The Hg and DOC concentrations at CER were relatively low, averaging at 4.2 ng.l^{-1} and 4.9 mg.l^{-1}. High Hg and DOC mean concentrations occurred at inlet to PLE-1, in particular 16.5 ng.l^{-1} and 21.2 ng.l^{-1} but the stream PLE-4, lowest in Hg and DOC, averaged at 2.0 ng.l^{-1} and 2.1 mg.l^{-1} only. The inlet streams of the lake at PLE thus showed a very wide range in Hg and DOC concentrations. With respect to the same lithology and forestation it is possible to conclude that these differences originate in hydrology. Soil solutions from the lower parts of the soil profile are low in Hg and DOC, therefore we suggest that lake inlets with low Hg and DOC are fed primarily by these sources. On the other hand, high Hg and DOC inlets are mostly fed by solutions from the surface soil horizons which are rich in Hg and DOC. This indicates a high importance of local hydrology for the Hg and DOC export from the forest ecosystems.

Similar to the stream water, the Hg concentrations in the lake water from all studied lakes were low, lying in range of 3.6–10.8 ng.l^{-1}. Again, much like for the stream water, Hg concentrations in the suboxic parts of the water column are tightly

■ **Fig. 12.** The Plešné Lake surrounded by the dead forests from bark beetle infestation in year 2004 (photo by T. Navrátil).

related to the DOC concentrations. The highest Hg concentrations in lake water were found at the PLE site (10.8 $ng.l^{-1}$) and the lowest at the CT site (3.6 $ng.l^{-1}$). Where possible, the depth zonation of DOC and Hg concentrations was studied at selected lakes. Water samples from lake bottoms were typical with increased Hg concentrations, which were not in line with appropriate DOC concentrations. These surplus Hg concentrations were released from the bottom sediment during anoxia and dissolution of iron oxides. The anoxia situations occurred primarily during the stratification of the lake water column, i.e., summer–autumn.

According to the results of methylated Hg analysis (MeHg), the concentrations of MeHg in stream and lake waters at the studied sites ranged from 0.01 to 0.72 $ng.l^{-1}$. These concentrations represented 0.2 to 9.7 % of the total Hg concentration. Under anoxic conditions at lake bottoms, the MeHg concentrations represent a much greater proportion of the total Hg, i.e. 12–93 %.

NAVRÁTIL T., SHANLEY J.B., *ROHOVEC J*., OULEHLE F., ŠIMEČEK M., HOUŠKA J. & CUDLÍN P. (2016): Soil mercury distribution in adjacent coniferous and deciduous stands highly impacted by acid rain in the ore mountains, Czech Republic. – *Applied Geochemistry*, 75: 63–75.

No. 16-15065S: **Factors affecting heavy metal accumulation in macrofungi** (P. Kotrba, T. Leonhardt, J. Sácký, V. Beneš, University of Chemistry and Technology in Praha; *J. Borovička* & *A. Žigová*; 2016–2018)

During the first year of the study, progress conforming to the proposed schedule for 2016 was achieved in isolation and functional characterization of cDNAs coding for two putative P1B-1 ATPases of *Amanita strobiliformis*; the construction of complete set of vectors for agrotransformation of *Hebeloma mesophaeum* and *A. strobiliformis*; metal tolerance assays in two distinct *H. mesophaeum* ecotypes; the analyses of Zn, Zn-to-phylogeny relations and RaZBP-like peptides in *Russula* spp.; analyses of Cd/Zn contents in *Cystoderma* species and the analysis of Cd speciation in the sporocarps of *C. carcharias*; as well as in detailed field studies involving metal and Pb isotopic analyses of *A. strobiliformis*; soil sampling and investigation of metal mobility and soil Pb isotopic composition at selected sites; and collection of a reasonable set of macrofungi for Zn/Cd speciation analyses. Substantial progress was achieved in the construction and characterization of *H. mesophaeum* expressing the *Russula atropurpurea* RaZBP1 as transgene. We originally expected that the confirmed transformants and data obtained from metal tolerance and speciation analyses in 2016 should be available in early 2017.

Progress consists in: (1) on-site soil characteristics and spatial distribution of the mycelium of *A. strobiliformis*; (2) a case study of the genus *Cystoderma*, and finally (3) the accumulation of trace elements in the genus *Phaeocollybia*. A more detailed description of these partial results is given here:

1. the first step was a thorough soil survey of the area aimed at the selection of representative profiles. With respect to the

size of the territory of Jinonice and Klíčov, soil descriptions were performed at 5 sites in each area. The samples were taken using a single gouge auger. Then, the basic characteristics were established, such as diagnostic horizons and their thicknesses. In the second step, characteristic plots were chosen. Soil profiles were excavated down to the parent material. A detailed soil description was made, including the determination of individual diagnostic horizons, their colour, structure, texture, consistency, the presence of carbonates, biological conditions and the contents of rock fragments. In the study area, the soil cover is represented by Calcaric Leptosols – soils developed on carbonate-silicate rocks. Jinonice: stratigraphy of soil profile Ok-Ahk-AhkCrk-Crk, thickness of soil without Ok horizon 76 cm, thickness of Ok horizon 4 cm. Klíčov: stratigraphy of soil profile Ahk-AhkCk1-Ck1-Ck2, thickness of soil 90 cm. The BCR sequential extraction was performed in 3 replicates on all soil horizons. Concentrations of Ag, Cu, Cd, Pb, and Zn in soil extracts were measured by ICP-SF-MS and Pb isotopic composition was determined. Furthermore, 1M nitric acid extracts were performed on all horizons and also in a detailed division (6 cm subhorizons to 40 cm depth). The results indicate higher content and mobility of Ag at Klíčov, which possibly contributes to higher Ag accumulation in *A. strobiliformis* at the Klíčov site. Total levels of of Ag, Cu, Cd, Pb, and Zn were also determined in 28 sporocarps of *A. strobiliformis* from both areas. Lead isotopic composition (^{206}Pb/^{207}Pb ratio) of the fruit-bodies varied in a rather narrow range of 1.169–1.172 and corresponded to the topsoil soil horizons (Ahk at Klíčov and Ok/Ahk at Jinonice).

2. Twenty-one sporocarps of *Cystoderma carcharias* were harvested from a fairy ring and analysed for metal content. On average, Cd concentration in sporocarps was 348 mg kg^{-1} and the individual sporocarps took up 15.5–215 µg Cd (*C. carcharias* specimens were dispatched to UCT Prague for metal speciation analyses). In sporocarps, concentrations of Cd were highly significantly positively correlated with those of Zn. No significant correlation was seen between sporocarp weight and Cd concentration, but the total Cd content positively correlated with sporocarp weight. In order to compare polluted and pristine sites, we harvested 7 additional collections of *C. carcharias* from unpolluted habitats, which are yet to be analysed.
3. We have been able to collect 5 of the 6 *Phaeocollybia* species known from Europe/Czech Republic species (the most common were *P. lugubris, P. christinae*, and *P. jennyae*). Only one collection of *P. cidaris* was found and *P. arduennensis* was not collected (the latter species is extremely rare). DNA sequencing was performed to obtain ITS rDNA, LSU and EF1-α sequences from both fresh and older herbarium specimens. Preliminary soil screening at Malonty site revealed contrasting Pb isotopic ratios of extractable Pb in particular soil horizons. This observation is promising as we aim to use Pb isotopes to trace its origin in *Phaeocollybia* mushrooms.

No. 16-19459S: **Effect of gravity-induced stress on sandstone erosion: physical and numerical modelling** (J. Bruthans, Faculty of Science, Charles University in Praha, *M. Filippi* & J. Schweigstillová, Inst Rock Struct Mech, Czech Acad Sci, Praha; 2016–2018)

The project is focused on several related topics: (1) physical and numerical modelling of 3D sandstone landforms; experimental salt and frost weathering of sandstone; (2) role of gravity loading stress in the evolution of open fracture porosity, and (3) material mechanical modelling of locked sand disintegration. To fulfill these tasks the following tasks were gradually solved in 2016.

Various small-scale landforms were experimentally created in the Střeleč Quarry. These landforms were artificially eroded by splashing water. The erosion process was documented by a camera and also by a 3D photogrammetry method. Some of the created arches fully replicated the real shapes of the spectacular natural rock arches on the Colorado Plateau (Fig. 13). Currently, two papers are being prepared based on the analysis of erosional progress of modelled arches and arcades. A dry wall from small sandstone masonry was prepared in our “natural laboratory” established in the Střeleč Quarry. Erosion of this stone/ashlar wall was documented in a similar way as models of natural landforms. It was clearly demonstrated that even erosion of dry stone wall is affected by stress. Loaded contacts between the ashlars were eroded at a slower rate than the unloaded portions. Modelling in the Střeleč Quarry was complemented by the documentation of erosion progress on a 160 years old sandstone masonry wall in the Česká Lípa area, where clear traces of stress-affected weathering producing arcade- and arch-like forms were observed and documented. Gravity-induced stress in the 3D space was modelled using PLAXIS 3D software, based on 3D shapes of experimental landforms and on photogrammetry models.

For salt (by concentrated Na_2SO_4) and frost weathering lab experiments, sandstone samples from several sites in the Czech Republic, Jordan and USA were used. Salt weathering was performed on 4 cm cube samples. For each kind of the sandstone, the unloaded cube and 6 levels of compressed cubes were used. The unloaded cubes show fastest weathering rate. In addition, cubes loaded by higher loads show generally slower weathering rate than cubes with lower applied loads. Besides the weathering tests at various levels of compression, pilot tests of frost weathering in tension were performed on two types of sandstone: quartzose sandstone with very minor fines and sandstone rich in fine material. Tension of 0–8 kPa was applied to sandstone cores by lead loads. This relatively minor tension strongly affected the frost weathering rate. The experiments showed that even minor tension increases considerably the weathering rate.

The role of gravity loading stress in the evolution of open fracture porosity was studied and photographically documented in the Střeleč Quarry. Fracture zone geometry was compared with well-developed fractures feeding springs in Zion National Park, USA. Cores acquired from several localities were studied. Small cores 3 cm in diameter and 3–4 cm in length were taken levelled and leached in HCl acid to remove carbonate and to observe the degree of disintegration after the carbonate removal. The study was completed by a SEM and microprobe determinations. The extent of fracture zones was calculated based on the flow rate of springs, transmissivity of the aquifers and hydraulic gradient.

A numerical model was developed in 2D using Tochnog Professional finite element software, whose annual licence was supported by the research grant. First of all, a modification was

■ **Fig. 13.** The Double O Arch and other sandstone landforms in the Arches National Park, Utah, USA (photo by M. Filippi).

included in the core of the finite element code in cooperation between the research grant team member D. Mašín and Tochnog software developer D. Roddeman. The modification allows us to define user-defined material law controlling the elimination of individual finite elements from the finite element mesh depending on stress and time. Subsequently, a law for the element elimination representing erosion of Střeleč Locked Sand has been implemented into Tochnog as a user-defined material property. Very good agreement was found between the artificially created sandstone arch and results of finite element analyses.

No. 16-21523S: **Changes of the Paratethys fish fauna during Oligocene to Lower Miocene – evidence on selected groups from sites in Moravia (Czech Republic)** (*T. Přikryl*; 2016–2018)

The Oligocene (Rupelian; regional stage Kiscellian) ichthyofauna from the Moravia region (Czech Republic) was described from several sites, such as Nikolčice, Mouchnice, Litenčice, Kelč, Špičky u Hranic na Moravě, Rožnov pod Radhoštěm etc. The assemblage is composed of abundant sharks (e.g., cetorhinids, odontaspids, lamnids, mitsukurinids, squalids, alopiids; Gregorová 2011, 2014) and teleosts (e.g., clupeids, argentinids, gonostomatids, phosichthyids, sternoptychids, mycthophids, centriscids, syngnathids, trachichthyids, merlucciids, zeids, brotulids, echeneids, trichiurids, scophthalmids, trachinids; e.g., Gregorová 1988, 2011, 2014; Přikryl 2009, 2013). On the other hand, the fauna from localities representing time interval close to the transition of Chattian to Aquitanian (regional stage Egerian) is far less diversified, being represented by only one group of sharks (carcharhinids, Brzobohatý et al. 1975) and eleven groups of teleosts (clupeids, phosichthyids, ?myctophids, syngnathids, echeneids, merlucciids, caproids, leiognathids, ophidiids, trichiurids, gobioids; Jaroš 1936; Kalabis 1966; Brzobohatý et al. 1985; Gregorová 2014). Even though these taxa lists are based on data from several localities (and therefore local discrepancies should be limited) from different (but related) litho-stratigraphic units, relative disproportion of diversity is recognizable even among individual sites. The transition from the Oligocene to the Miocene is associated with a short-lived cold episode at about 23.7 Ma (Zachos et al. 2001) and, of course, also changes of paleogeography play its role (see e.g., Popov et al. 2009). Nevertheless, these are probably not the only causes for such a prominent change. Furthermore, in a few cases, the representatives of one family survive from one period to another, but the species (or even genera) are different. Remarkable fact is that the supposed paleoecological demands of such taxa are often practically the same, and reasons of such change are not known. The project deals with related questions, identification of fish taxa in the key strata and the comparison of the assemblages at different time levels.

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4c. Technology Agency of the Czech Republic

Finished projects

No. TA03021289: **Measurement of migratory properties of rocks with fracture permeability using fluorescent solutions** (*J. Rohovec*; V. Lachman, R. Kovářová, P. Bílý, P. Novák, ISATech, s. r. o., Praha; R. Vašíček, Czech Technical University in Praha; J. Bajer, M. Černý, M. Milický & O. Zeman, ProGEO s. r. o., Praha; 2013–2016)

The project was focused on finding appropriate fluorescent tracers for hydrogeological studies and evaluation of migration parameters of tracers in real environment in rocks with fracture permeability. The call for fluorescent traces arises from serious disadvantages of other classes of hydrological tracers.

First, literature search concerning availability and properties of various groups of fluorescent dyes was performed. Among others, parameters like low toxicity, reasonable price, commercial accessibility, performance at previous hydrological studies were considered. Based on the search result, several types of fluorescent dyes (xanthene, triphenylmethane, pyrene, stilbene-derived) were selected for the following laboratory testing.

Laboratory tests represented highly important stage of project solution. In the course of lab test, sorption properties, stability in natural water and detection limit (related to fluorescence yield) for selected fluorescent dyes was measured. Laboratory tests were performed either in the batch or column setup. Batch tests were performed in order to quantify sorption parameter on various granites and similar rocks, as well as on typical fracture fillings, generally in semi-micro scale. The most successful fluorescent dyes, in respect to low or medium sorption, accompanied with high fluorescence yields and ease of detection, were Fluorescein disodium salt, Rhodamine WT and Fluorescein sulfonate. Other fluorescent, like Stilbene disulfonate (Tinopal), Fast Green FCF, Fast Blue FCF dyes gave less favourable results, mainly due to unacceptable degree of sorption on clay minerals. As a result of this project stage, a set of sorption parameters and geochemical conditions limiting the application of the tracer was obtained.

The shift from small-scale batch or column tests to a more realistic scale was done in the Underground Research Centre – Josef Adit (Regional Underground Research Centre in Smilovice 93, Chotilsko, operated by the Center of Experimental Geotechnics of the Czech Technical University in Praha). In this facility, tests on model granite units were performed. The model unit was constructed mounting two planparallel granite blocks 40 × 60 × 15 cm in size, onto a distance shim. This way, model fracture with well-defined opening was artificially created. Optionally, it was filled with inert filling of glass micropearls of chosen diameter (100 μm, 500 μm). Solutions of Fluorescein disodium and Rhodamine WT in natural water sampled in the Josef Adit were applied as a fluorescent tracer. The instrumentation routinely used in HPLC was adapted in order to ensure steady continuous flow through the unit and injection of fluorescent tracer of exactly known volume into the system. The optimal flow rate was 5 ml per minute. The evolution of the fluorescent tracer concentration profile was followed by custom-designed probes, mounted into one of the granite block. This way, time dependences of tracer concentrations in various positions in the block were obtained. The amount of fluorescent tracer eluted from the system was totalized using an UV VIS spectrometer equipped with a flow cell inserted into the outlet channel from the block. As a result, a set of experimental functions c (x, y, t) was obtained, in which c stands for the concentration of the tracer, x and y for the spatial position of the observation point and t for the time.

The effects of fracture opening and glass beds diameter on tracer migration parameters were among the variables studied. An increase in bed diameter, as well as fracture aperture, led to an increase of the time needed for tracer passage through the system, but did not change the parameter of tracer sorption loss in the material. Generally, recovery R was higher than 90 % in all experiments employing Fluorescein as a tracer, while 80–90% recovery was obtained with Rhodamine WT. Further, the sorption ability of glass beads was augmented by a surface modification technique, introducing quaternary ammonium groups on the surface of the beads. This way, a dramatic increase of sorption coefficient of fluorescent tracers was reached. At the same time, all other parameters of material, especially geometric and grain-size ones, were preserved. The same data set as previously was collected on block unit with fracture filling with the modified glass beads. A comparison of the data ob-

■ **Fig. 14.** View of the Josef gallery, JP47 site, in the course of a tracing test. Tracer solutions, present in the blue tanks, are pumped into the fracture through a steel tubing. The tested fracture system is located in the right corner above the floor (photo by J. Rohovec).

tained allowed separation of sorption effects in mathematical models from other parameters governing the artificial fracture.

The final stage of the project solution was focused on *in situ* study of fractures found in the Josef Adit, Figure 14. Two experimental sites, namely JP47 a SP17, were chosen. The aim of this stage was testing of the mathematical models derived as well as valuation of model parameters. At experimental site JP47, the fracture system was already identified and described. Appropriate natural fracture was carefully selected in the massif, equipped with packers and other gear for hydrological tracing, and pilot tracing experiments using Fluorescein and Rhodamine WT were used as tracers with low and moderate sorption ability, respectively. The concentration of the tracer in the solution on inlet and outlet sites (i. e. functions $c_{in}(t)$, $c_{out}(t)$) were subjected to mathematical modelling procedures and acceptably described by current optimized parameter sets introduced to models.

Using two different modelling software codes (MODFLOW, FEFLOW) *in situ* tracing experiments results were successfully described and model parameters were further optimized. The parameters measured in blocks experiments and in the lab tests were input into the model in a very early numerical modelling stage. The introduced parameters were optimized and calibrated in the course of the modelling procedure in order to minimize the difference of calculated and *in situ* measured data. As a result of mathematical simulations, the hydraulic and transport characteristics of rock environment and tracer were more precisely specified. The final calibrated model was validated using data sets obtained in the *in situ* tests at site SP17. The fracture at SP17 represented a completely unknown environment. The advantage of the methodology developed and applied is the possibility of controlled setting of input parameters of the tracing test (flow, pressure, tracer concentration on input, time of tracer introduction) and the possibility of keeping these parameters constant through the whole tracing test.

Based on experiences with *in situ* test performance, methodology named *"Evaluation of migration parameters of tracers in real environment in rocks with fracture permeability using fluorescent tracers"* was elaborated. This document was treated and certified by the Department of Geology of the Ministry of Environment of the Czech Republic, No. of certification 84404/ENV/16, 2079/660/16.

4d. University Grant Agencies

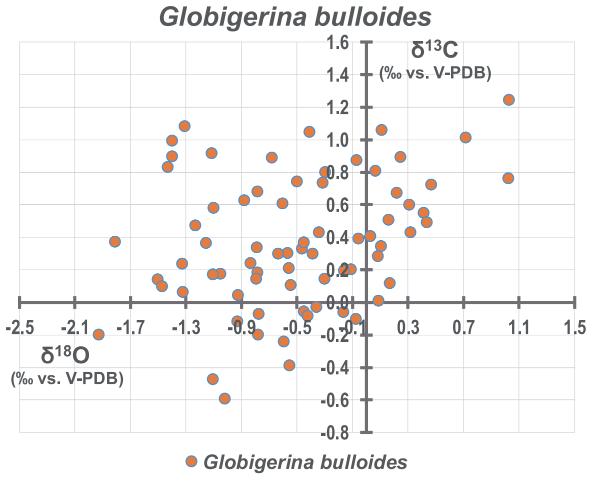
Finished projects

GAUK No. 222214: **Geochemical proxies from Foraminifera as a key to the paleoenvironmental interpretation in an epeiric sea** (*F. Scheiner* & K. Holcová, Faculty of Science, Charles University in Praha; 2014–2016).

The (Lomnice) LOM-1 borehole records a nutrient-rich, low-energy environment of the outer shelf to upper bathyal in the Moravian (sub-stage of the Badenian; Langhian) of the Carpathian Foredeep. The studied section can be correlated with the interval from 14.6 Ma (the FO of *Orbulina* spp.) to 13.42 Ma (the LO of *Sphenolithus heteromorphus*) which agrees with the beginning of the "Middle Miocene Climate Transition".

Foraminifers for the carbon and oxygen stable isotope analysis as well as for the Mg/Ca ratio analysis were picked from the size fraction of 0.063–2 mm. The suitability for the stable isotope analysis and Mg/Ca ratio analysis was carefully evaluated based on the inner wall preservation. The isotopic analysis was done for fifteen samples with a total of 373 analysed tests. Each analysis was performed from exactly a single foraminiferal test. The following foraminiferal genera were used to document the isotopic signal for the superficial, bottom and sediment water: *Globigerina bulloides*, *Globigerinoides trilobus*, *Cibicidoides* spp. and *Melonis pompilioides*. This approach allows limiting errors caused by inhomogeneous diagenetic alteration of foraminiferal calcite, which is a common feature in fossil environments. Unique methodology of the carbon and oxygen stable isotopic analysis revealed a notable interspecies isotopic variability (Fig. 15).

The Mg/Ca ratio was analysed from all of the fifteen samples. A total of 43 Mg/Ca ratio samples were analysed. For the Mg/Ca ratio analysis, we used the same foraminiferal species. Mg/Ca ratio proved to be a reliable paleotemperature proxy in the studied fossil environment. This project presents the first detailed application of this method in the Central Paratethys. The calculated temperature curves are in good agreement with calcification depths of different used species and with the paleobathymetry estimation based on otoliths and foraminifers for the studied site from Holcová et al. (2015). The main limitation of this method is mainly based on the preservation of the analysed material, which can be directly affected. Commonly used paleotemperature equations, based on oxygen isotopes (e. g., Epstein et al. 1953) and a modification by Shackleton & Opdyke (1973), operate with an arbitrarily estimated $\delta^{18}O_{sw}$ constant in its mathematical formula, when used for the Central Paratethys area. Based on a comparison with the temperature calculations



■ **Fig. 15.** The captured interspecies isotopic variability of *Globigerina bulloides* (all δ values are reported vs. V-PDB standard; original).

from Mg/Ca ratio, this project shows that using an arbitrary estimated constant for δ^{18}Osw (+1; 0; −1) is not appropriate for the Central Paratethys.

This project assessed several detailed characteristics of the paleoenvironment based on a combination of geochemical results. The Lomnice borehole represents a dynamic environment with rapid changes of various parameters such as temperature, nutrient flux, circulation regimes etc. throughout the entire water column. Nutrition aspect played the pivotal role in the distribution of foraminifers at the studied locality. In addition, general factors affecting the environment as a whole present notably a cyclical pattern belonging apparently to orbital cycles.

EPSTEIN S., BUCHSBAUM R., LOWENSTAM H.A. & UREY H.C. (1953): Revised carbonate-water isotopic temperature scale. – *Geological Society of America Bulletin*, 64: 1315–1325.

HOLCOVÁ K., BRZOBOHATÝ R., KOPECKÁ J. & NEHYBA S. (2015): Reconstruction of the unusual Middle Miocene (Badenian) palaeoenvironment of the Carpathian Foredeep (Lomnice/Tišnov denudational relict, Czech Republic). – *Geological Quarterly*, 59, 4: 654–678.

SHACKLETON N.J. & OPDYKE N.D. (1973): Oxygen isotope and paleomagnetic stratigraphy of equatorial Pacific core V28–238: oxygen isotope temperatures and ice volumes on a 105 and 106 year scale. – *Quaternary Research*, 3: 39–55.

Continued projects

GAUK No. 704216: **The revision of some sphenopterid types of ferns from Carboniferous coal basins of the Bohemian Massif, Czech Republic** (*J. Frojdová* & J. Pšenička; Faculty of Science, Charles University in Praha; 2016–2017)

This project deals with true “sphenopterid” ferns which come from the Czech Carboniferous basins. This group of ferns comprises tens of genera. Unfortunately, the “sphenopterid” ferns were lying on the edge of interest of paleobotanists in the last twenty years, although ferns could play an important role in the whole forest ecosystem. The importance of herbaceous ferns is mainly in context of forest regeneration, especially for undergrowth of forest. A clear classification of fossil species of ferns also allows to define phylogenetic lines in geological time. The fossil species of ferns of Pennsylvanian age have not been studied during the last several decades in the Czech Republic; the last integrated work was published in 1930s. Due to the fact that the research methods had been developed, we applied a new method for the description of fossil species. This means that we used “sporangial” analysis, which contains a description and function of individual types of sporangial cells. Different sporangial cells lead to a different type of strategy for dispersion of spores and consecutive colonization of land. This strategy is closely related with the environment and it should be possible to establish the function of ferns in the original phytocenosis, and also in vegetation. We prefer a holistic approach of research of fossil ferns. In the case of good preservation (permineralization specimens), anatomy of individual species was studied, allowing for a systematic inclusion of fossils ferns. The main component of the project is the description of *in situ* spores which were known from the dispersion and are described *in situ* for the first time.

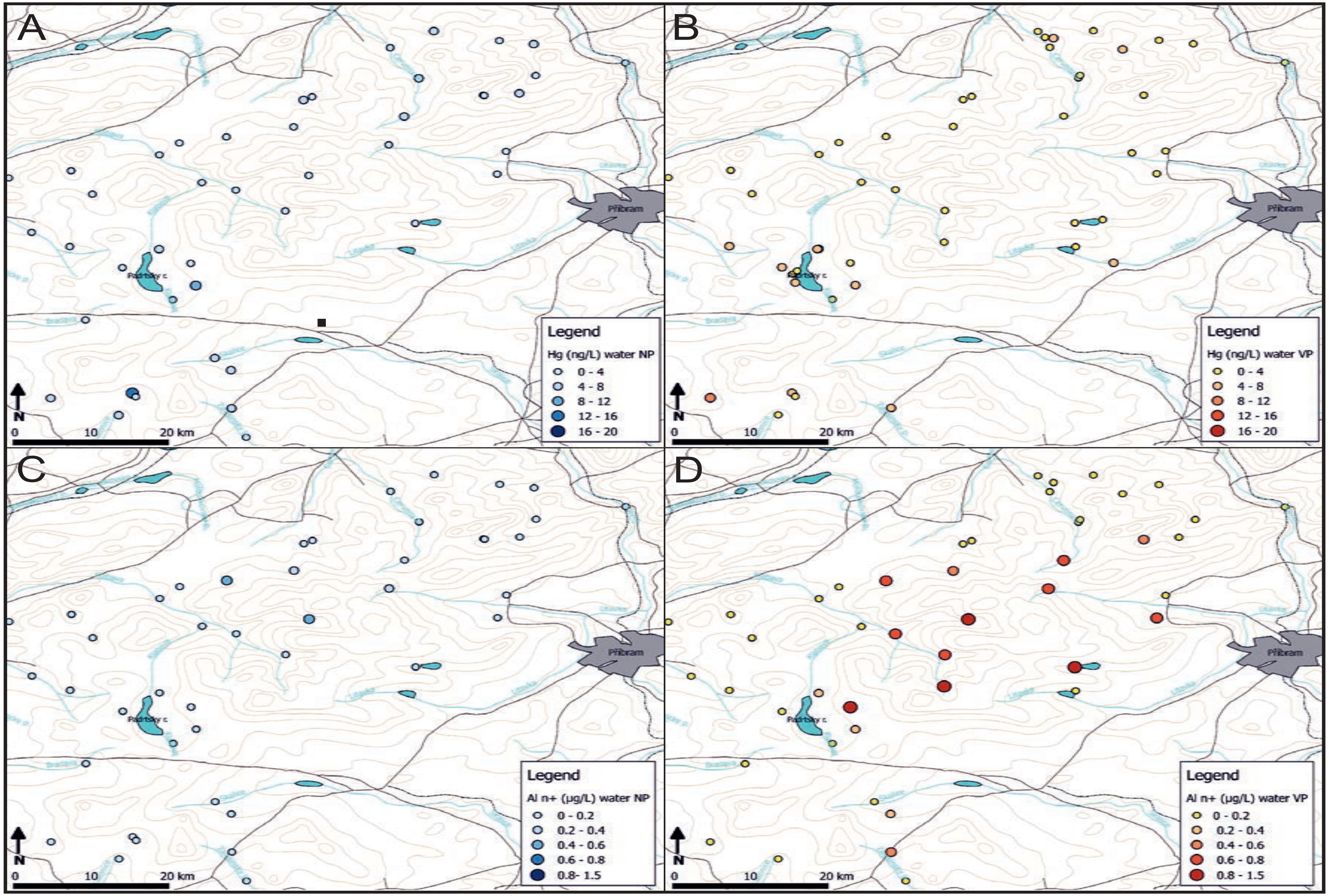
4e. Grants of the State Departments

Finished projects

Nature Conservation Agency of the Czech Republic: **Contamination of forest and aquatic ecosystems within the Brdy Protected Landscape Area with mercury and speciation of aluminum in the surface waters** (*T. Navrátil*, *T. Nováková*, *K. Žák*, *J. Rohovec*, *M. Roll*, *Š. Matoušková*, *S. Hubičková* & *I. Dobešová*; internal code 7465; 2016)

The issues connected with environmental contamination of protected landscapes with toxic elements such as mercury (Hg) are elevated in areas impacted directly or indirectly by ore mining and processing activities. The Brdy Protected Landscape Area (BPLA) established in 2016 is a typical example of such area. Therefore, this study focused onto mapping of the contamination and mobility of Hg within the forest and aquatic ecosystems of the BPLA. Furthermore, this study yielded new knowledge on the occurrence of ionic aluminum in the surface waters.

All the studied components of the forest ecosystems indicate a significant effect of geological setting in vicinity of the former mining area at Jedová hora (Poison Mount) and somewhat surprisingly around the Padrť ponds. The overall mean Hg concentration in the sediments of the BPLA was 512 $\mu g \cdot kg^{-1}$, which was not very far from the country-wide average Hg concentration for forest O-horizons of 676 $\mu g \cdot kg^{-1}$ from 1995. But the anomalies of elevated Hg concentrations were noticed around Jedová hora in O-horizon soils (up to 1,408 $\mu g \cdot kg^{-1}$), stream water (up to 19.7 $ng \cdot l^{-1}$), sediments (up to 8,366 $\mu g \cdot kg^{-1}$) and bedrock substrates (up to 120,000 $\mu g \cdot kg^{-1}$). The Jedová hora anomaly is very significant due to the occurrence of cinnabarite (HgS) as an admixture in the oolitic Ordovician iron ores. The less evident anomaly around the Padrť ponds is very likely connected with the occurrence of bedrock with elevated Hg concen-



■ **Fig. 16.** Graphic presentation of the areal distribution of Hg and Al^{n+} concentrations in the surface water of the BPLA. GIS maps were generated using QGIS open source software. Figure denotes an increase in Hg concentrations from low discharge (panel A) to high discharge (panel B). Areal spread of high Al^{n+} concentrations due to temporal acidification, i.e., pH decrease, during a high-flow period can be spotted by comparison of panel C (low flow) and panel D (high flow; original by T. Nováková).

trations such as Neoproterozoic shales and wackes, Cambrian or Ordovician conglomerates, Carboniferous arkoses and bone coal, or Variscan iron mineralization.

The mobilization of Hg in surface water becomes dominant during high-flow periods (Fig. 16). Export of Hg from forest ecosystems is closely related to the export of dissolved organic carbon (DOC). Concentrations of DOC increase in the surface waters with increasing episodic discharge due to penetration of soil solutions on the way to the stream through the topmost soil O-horizons rich in organic material (humus). With respect to low-flow periods with mean concentration of 3.6 $ng \cdot l^{-1}$, high-flow Hg concentrations (overall mean 5.4 $ng \cdot l^{-1}$) on the surface increased virtually at all sites due to increases in DOC from 5.7 to 9.7 $mg \cdot l^{-1}$. As a result, the Hg/DOC ratio appeared as a good tool to observe differences between the contamination of exported dissolved organic material. Areas with elevated Hg concentrations in surface waters were significantly larger during the high flow but the central hotspots remained noticeable even during the low flows. A similarly toxic form of aluminum ionic Al^{n+} occurrence during high-flow periods spread from 2 sites in central high elevation area to more than 14 sites due to temporal acidification, i.e., a decrease in pH (Fig. 16). The highest Hg concentrations coincided with areas of high Hg/DOC and copied the results of O-horizon contamination around Jedová hora and the Padrť ponds. Finally, very similar trends and results were observed in stream sediments, which averaged at 400 $\mu g \cdot kg^{-1}$ of Hg. The spread of high contamination of toxic elements such as Hg and Al can be critical for management strategies and conservation plans concerning the sensitive aquatic life.

Nature Conservation Agency of the Czech Republic (AOPK): **Evaluation of requests for speleological research in the Bohemian Karst Protected Landscape Area; Preparation of a database of former mining activities in the Křivoklátsko Protected Landscape Area** (*K. Žák* & *P. Bosák*; internal code 7454; 2016)

Two contracts financed by the Central Bohemian Regional Office of the Nature Conservation Agency of the Czech Republic were focused on speleological activity in the Bohemian Karst (Žák et al. 2016) and on the former mining sites in the Křivoklátsko Protected Landscape Area (PLA; Žák 2016). Within the first contract, individual requests to perform speleological cave prospection and research in the caves of the Bohemian Karst, submitted by individual caving clubs, were evaluated from the scientific point of view. Our expert opinions were used in the process of issuing the permission for these activities by the nature protection authorities. The second contract, which was financed by the same ordering institution, was focused on preparation of a database of former mining sites in the Křivoklátsko PLA.

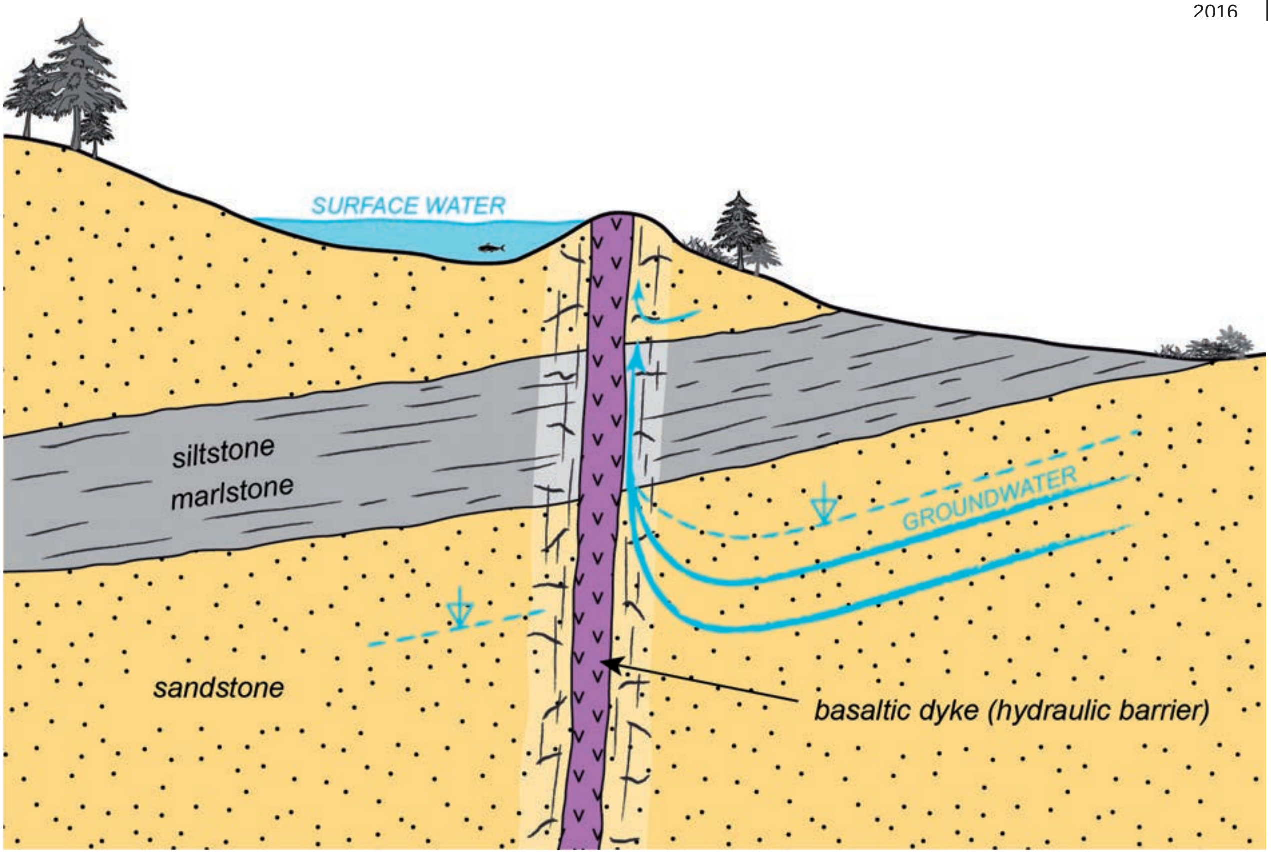
ŽÁK K. (2016): *Přehled lokalit těžby nerostných surovin v CHKO Křivoklátsko*. – Czech Acad Sci, Inst. Geol., Praha for Agency of Nature Protection and Conservation of the Czech Republic: 1–19 + 1 – 88 (appendices). Praha.

ŽÁK K., *BOSÁK P.*, *FILIPPI M.* & *WAGNER J.* (2016): *Odborné stanovisko Geologického ústavu AV ČR, v. v. i., k žádosti Základní organizace České speleologické společnosti 1-05 Geospeleos ze dne 7. ledna 2016 o udělení výjimky ke speleologické činnosti v celkem 8 jeskyních (resp. jesk. systémech), nacházejících se v k. ú. Bubovice, Budňany, Korno, Kozolupy, a Svatý Jan pod Skalou*. – Czech Acad Sci, Inst Geol., Praha for Adminstration of the Bohemian Karst Landscape Protected Area: 1–12. Praha.

Continued projects

Nature Conservation Agency of the Czech Republic: **Specification of geological setting along basaltic dykes functioning as barriers for groundwater and surface water in the Kokořínsko–Máchův kraj PLA** (*J. Adamovič*; internal code 7464; 2016–2017)

The area of the Kokořínsko–Máchův kraj Protected Landscape Area (KMPLA) is formed by sedimentary rocks of the Bohemian Cretaceous Basin (BCB) including thick sandstone bodies, locally exceeding 250 m in thickness. These function as aquifers and accommodate considerable groundwater reserves. The aquifers are split into compartments by vertical semi-permeable or impermeable barriers, represented by major shear faults and, most notably, by basaltic dykes. Basaltic magma penetrated the BCB sedimentary fill in the latest Cretaceous and in the Tertiary, forming dykes reaching a thickness of max. 10 m and an alongstrike length of max. 10 km. When emplaced into permeable sandstone, the dyke rocks were immediately altered – partly or completely – by circulating hydrothermal fluids, and turned into a mixture of iron oxyhydroxides and clay minerals. Such dykes act as perfect barriers for near-horizontal groundwater flow. Piezometric groundwater levels in blocks lying upstream from the dykes are therefore naturally elevated by a few metres or tens of metres compared to the blocks downstream of the dykes. Under favourable conditions, springs occur on valley bottoms in blocks with such elevated groundwater levels (Fig. 17). Hydrothermal alteration along a basaltic dyke includes secondary cementation of host sandstone by ferruginous or siliceous cement. Not only does the cemented sandstone further reduce the permeability but it also results in the formation of topographic highs (hills or ridges) on land surface. Typically, low-relief altered basaltic dykes are lined by high-relief sandstone ridges on both sides. Such topography is favourable for the storage of surface water in front of the barrier in the form of peat bogs, marshlands or lakes. In the KMPLA, not always have such bodies of standing water been identified as resulting from dyke-related hydraulic/topographic barriers. The present study provided a revision of bodies of standing water (including ponds past and present) and spring issues in the territory of the KMPLA from the viewpoint of their geological controls. The presence and the geometry of basaltic bodies (dykes, stocks) were determined using field documentation and surface geomagnetic survey. The composition of fresh basaltic rocks and their alteration products was characterized by means of thin section study and XRD analysis. Water from twenty spring issues was sampled and submitted for chemical analyses. A good example of the hydraulic effect of basaltic dykes in sandstone environment is the dam of the Máchovo jezero Reservoir near the town of Doksy. A basaltic dyke has been previously reported from the axial part of the dam, which has the character of a ca. 10 m high ridge elongated NNE–SSW. Excavations conducted during the reconstruction of the outflow device in 2015



■ **Fig. 17.** A scheme of the barrier effect exerted by a basaltic dyke on groundwater flow in a sandstone aquifer. Topographic effect induced by sandstone cementation is important for the formation of bodies of standing water in front of the dykes (original drawing).

■ **Fig. 18.** Reconstruction of the outflow sluice in the dam of the Máchovo jezero Reservoir in January 2015. The newly discovered basaltic dyke, totally argillized, is highlighted in yellow (photo by J. Adamovič).

provided a good insight in the dyke geometry and revealed an another dyke 20 m to the east (Fig. 18). Both these dykes, 1 and 0.6 m thick, consist of a mixture of low-permeability goethite and kaolinite. The geomagnetic survey revealed the presence of two additional dykes and indicated sites where the barrier effect may be reduced due to tectonic dyke offsets. The whole dyke swarm has a total length of 3.3 km and its barrier and topographic effects were probably responsible for the formation of a lake which preceded the foundation of the present reservoir in Medieval times. The study will be finished in early 2017.

4f. Industrial Grants and Projects

University of Wrocław, Project No. 7001: **External analyses using ICP-MS** (*J. Ďurišová*)

External commercial project of the University of Wrocław (Dr. M. Matusiak-Małek) deals with geochemical characteristics of xenoliths. We provided data on rare earth elements measured by the LA-ICP-MS. External commercial project of the University of Wrocław (Dr. E. Słodczyk) deals with geochemical characteristics of zircons from the German Basin. We analysed concentrations of rare earth elements using LA-ICP-MS. External project with the Department of Power Engineering, UCT (Dr. L. Jelínek) is focused on enrichment of lithium isotopes using ion exchange resins. We analysed $^{7}Li/^{6}Li$ isotopic ratios in experimental solutions by ICP-MS Element2.

Czech Geological Survey, Praha, Project No. 7004: **Re-Os and highly siderophile element systematics of carbonatites** (*L. Ackerman*)

This project is focused on the determination of highly siderophile elements and $^{187}Os/^{188}Os$ compositions of selected carbonatites from southern India, eastern/southern Africa and USA. It represents the external project connected with the project of Czech Science Foundation held in Czech Geological Survey (Dr. Magna).

Karadeniz Technical University, Trabzon, Turkey, Project No.7004: **Re-Os and highly siderophile element analyses of chromitites and associated peridotites from Anatolia, Turkey** (*L. Ackerman, E. Haluzová* & *J. Ďurišová*)

Joint project with the Karadeniz University is focused on the determination of highly siderophile elements and $^{187}Os/^{188}Os$ compositions of selected peridotites and chromitite separates from ophiolites in Anatolia, Turkey.

Energoprůzkum Praha, spol. s r. o., Project No. 7006: **Paleomagnetic investigation of rocks in the vicinity of the Dukovany Nuclear Power Plant** (*P. Schnabl*, *P. Pruner*, *K. Čížková*, *J. Petráček* & *Š. Kdýr*)

Paleomagnetic measurements of clay-dominated sediments in the vicinity of the Dukovany Nuclear Power Plant proved that the specimens from drill core have reverse polarity. This means that magnetization must be older than the Brunhes/Matuyama boundary (more than 781 ka). The position of virtual geomagnetic poles shows the age might be in range of tens of millions of years. From paleomagnetic perspective the sediments uncovered by a trench contain a secondary component that is older than 1–2 Ma. The paleomagnetic results are not in contradiction with the Miocene age assumed by finds of tektites close to the sampling area. The connection between the sites was not proved (Schnabl et al. 2016).

SCHNABL P., *PRUNER P.*, *ČÍŽKOVÁ K.* & *KDÝR Š.* (2016): *Paleomagnetický výzkum horninového podloží v okolí jaderné elektrárny Dukovany: zpráva za rok 2016.* – Czech Acad Sci, Inst. Geol., Praha for Energoprůzkum, spol. s r. o.: 1–76. Praha.

Czech Geological Survey, Praha; Project No. 7012: **The age of the basement from the Hovd Domain in western Mongolia using U-Pb laser ablation ICP-MS dating** (*M. Svojtka*)

The studied magmatic complex in western Mongolia is formed by variably deformed gabbros to diorites and granodiorites to orthogneisses emplaced into a high-grade volcanosedimentary sequence. New laser ablation U-Pb data of magmatic zircons from two orthogneisses yielded concordia ages of 476 ± 2 and 467 ± 1 Ma respectively, whereas the single diorite gave a concordia age of 430 ± 1 Ma. These results indicate that the studied rock assemblage mainly consists of mid-Ordovician magmatic arc-related rocks.

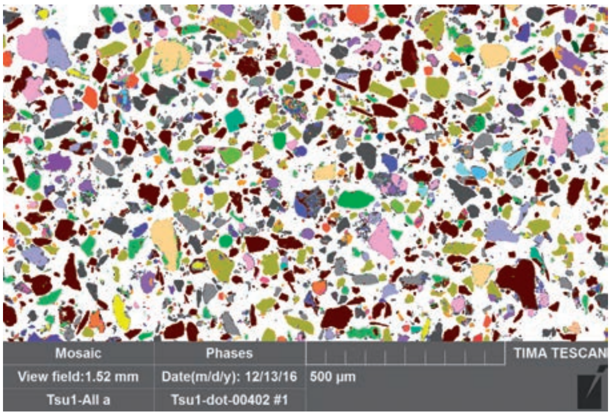
Czech Acad Sci, Inst Archaeol Brno, Project No. 7020: **Processing of micromorphological samples from the Kylešovice site** (*L. Lisá*)

The principal aim of the presented research was geoarcheological (including micromorphological) evaluation of archaeological deposits of a Medieval tell in Kylešovice village near Opava. It appeared that the tell was built in a quite different type of landscape than the recent one, i.e., in a swampy alluvial landscape. The construction of the tell took place in more than one phase, and positions with the floor deposits and accumulations of organic matter show how the surface was used during the construction (Lisá 2016). These results change the archaeological suggestion on this type of constructions.

LISÁ L. (2016): *Mikromorfologický posudek vzorků z lokality Kylešovice.* – Czech Acad Sci, Inst. Geol., Praha for the Institute of Archaeology of the CAS in Brno, v. v. i.: 1–21. Praha.

Czech Acad Sci, Inst. Geol., Project No. 7041: **Successful continuation of a project of testing laboratory for automated and applied mineralogy** (*T. Hrstka*)

The TIMA GMH Mineralogical analyser, a highly automated scanning electron microscope (SEM), hosted at the Institute of Geology, was successfully used to continue to test its applications in geoscience in collaboration with the TESCAN ORSAY HOLDING, a. s. This instrument as the first installation of its type in the Czech Republic proved essential in a fast acquisition of sta-



■ **Fig. 19.** The TESCAN Integrated Mineral Analyzer (TIMA) map providing false color image for phases from the heavy fraction of the soil profile samples. Modal and textural data were collected with the newly introduced „Dot mapping mode. Scale bar is 500 µm (photo by T. Hrstka).

tistically robust modal and textural data (Fig. 19). A newly developed "DOT mapping" analysis mode designed in collaboration with the TESCAN for the TESCAN Integrated Mineral Analyser (TIMA) was tested to collect modal, textural and compositional data on different types of geological samples. This new method provides an excellent compromise between high resolution x-ray mapping and the point spectrometry to speed up the analysis of both mounted particle sections and thin sections without compromising spatial resolution. Among other projects the instrument helped in understanding the elemental deportment in the contaminated semiarid areas linked to mine-tailing disposal sites in Tsumeb (northern Namibia), where copper, lead, zinc and to lesser extent silver and germanium were historically mined. Automated mineralogy approach has been also successfully tested on deposited dust to provide information on modal distribution of phases, as well as information on their potential source and forms of transport. Apart from the research into application of automated mineralogy and petrology in geosciences the laboratory collaborates on further development of software for TIMA Mineralogical analyser. This initiative helped with the release of new generation of the TIMA-X instrumentation. The new generation of the instrument should become available in the coming year.

Institute of Geological Sciences, Polish Academy of Sciences; Oil and Gas Institute – National Research Institute, Kraków, Poland, Project No. 7042: **U-Pb detrital zircon provenance of Neoproterozoic and Paleozoic rocks in a global sedimentary cycle** (*J. Sláma*)

Joint project with the Institute of Geological Sciences, Polish Academy of Sciences (Bartosz Budzyn, Mariusz Paszkowski, Katarzyna Koltonik and Agnieszka Pisarzowska) and the Oil and Gas Institute – National Research Institute, Kraków (Urszula Jonkis Zagorska) focused on diverse problems of provenance ranging from Neoproterozoic strata of eastern Europe (Sláma 2016) to Carboniferous sediments of Variscan foreland. Samples from Bielarus provided data showing changing sedimentary flux with possible sources in Cadomian blocks of Gondwana periphery in the south and Baltica paleo-continent in the north. The samples of Carboniferous sediments from Poland provide accurate estimate of the first appearance of Variscan detritus in the orogen foreland (U. Jonkis Zagorska). Zircon U-Pb data from Devonian sediments from the Rhenish Massif are used to discuss possible source terrains of this part of Variscan belt.

SLÁMA J. (2016): Rare late Neoproterozoic detritus in SW Scandinavia as a response to distant tectonic processes. – *Terra Nova*, 28, 6: 394–401.

GEOtest, a. s. Brno, Project No. 7045/1: **Laboratorní zkoušky popílko-cementové směsi pro akci tunel Ejpovice. Závěrečná zpráva** (*M. Petružálek* & *L. Svoboda*)

The report summarizes the results of laboratory tests on the fly ash – cement mixture from the Ejpovice Tunnel, namely the descriptive properties, uniaxial and triaxial strengths together with the parameters of Mohr Coulomb failure envelope.

PETRUŽÁLEK M. (2016): *Laboratorní zkoušky popílko–cementové směsi pro akci tunel Ejpovice, závěrečná zpráva.* – Czech Acad Sci, Inst. Geol., Praha for GEOtest, a. s.: 1–9. Praha.

Energoprůzkum Praha, spol. s r. o Project No. 7045/2: **Laboratorní zkoušky hornin na vzorcích z lokality NJZ EDU 6 JO+CHV (Dukovany)** (*M. Petružálek, T. Svitek, L. Svoboda* & *Vlastimil Filler*)

The report summarizes the results of laboratory tests measured on rock specimens from the vicinity of the Dukovany Nuclear Power Plant. Namely: descriptive properties; uniaxial, triaxial and indirect tension strengths; P and S wave ultrasonic velocities; static and dynamic elastic moduli.

PETRUŽÁLEK M. (2016): *Laboratorní zkoušky hornin na vzorcích z lokality NJZ EDU 6 JO+CHV (Dukovany), závěrečná zpráva*. – Czech Acad Sci, Inst. Geol., Praha for Energoprůzkum Praha, spol. s r. o.: 1–53. Praha.

GEOtest, a. s. Brno, Project No. 7045/3: **Stanovení parametrů Hoek-Brownovy obálky smykové pevnosti. Závěrečná zpráva** (*M. Petružálek, L. Svoboda* & *V. Filler*)

The report summarizes the results of geomechanical testing of three rock types (greywacks) from the vicinity of planned water dam in Nove Heřmínovy. The Hoek–Brown failure envelopes, for three tested rock types, were determined from measured strengths (uniaxial, triaxial and indirect tension strengths).

PETRUŽÁLEK M. (2016): *Stanovení parametrů Hoek Brownovy obálky smykové pevnosti, závěrečná zpráva.* – Czech Acad Sci, Inst Geol., Praha for GEOtest, a. s.: 1–25. Praha

Stress Measurement Company Oy, Project No 7046: **Measurements of physical and elastic properties on drilled cylindrical rock samples** (*T. Svitek, M. Petružálek, V. Filler* & *L. Svoboda*)

A set of basic descriptive physical properties such as density, porosity and water content were required together with the measurements of ultrasonic velocities and triaxial tests. Specimens of approximate size 50 mm in diameter to 100.0 mm in height were prepared from supplied drill cores of 74.5 mm in diameter. Triaxial tests were performed at a confining pressure of 5 MPa. All tests and calculations were realized according to the client's specification (Svitek 2016).

SVITEK T. (2016): *Measurements of physical and elastic properties on drilled cylindrical rock samples, Final report.* – Czech Acad Sci, Inst. Geol., Praha for Stress Measurement Company Oy: 1–11. Praha.

Czech Geological Survey, Praha, Project No. 7130: **Mineralogical and geochemical investigation of samples from the Cínovec Li-Sn-W deposit** (*K. Breiter*)

This report describes petrographic, mineralogical and geochemical characteristics of the samples preserved from the period of exploration of the "Cínovec-south" Sn-W deposit in 1970–1990. New data on the distribution of rare metals and ore minerals through the greisen deposit will serve for the formulation of a new evolutionary model of the deposit and assessment of its economic potential (Breiter 2016).

BREITER K. (2016): *Korelační vyhodnocení geochemických a petrograficko-mineralogických vlastností dochovaných vzorků ložiska Cínovec-jih s typovým profilem vrtu CS-1*. – Czech Acad Sci, Inst Geol., Praha for Czech Geological Survey, Praha: 1–41. Praha.

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 monitoring of atmospheric deposition at Kuní vrch site in the territory of the Bohemian Switzerland National Park continues since 2008. According to the bulk precipitation, the hydrological year 2015 can be assessed as below-average not only in the Bohemian Switzerland National Park but in the whole Czech Republic. The bulk precipitation at Kuní vrch locality reached 683 mm and at the spruce throughfall locality 507 mm.

The precipitation pH at an open place ranged between 4.13 and 5.66, which was comparable with the pH values in previous hydrological years. The spruce throughfall pH values at KV-thsf locality ranged from 3.81 to 6.00. High variation in pH of both precipitation types results from buffering of the acid precipitation by various organic and inorganic materials such as pollen, dust, tree debris etc. The bulk deposition fluxes of the most important acidificants SO_4^{2-} and NO_3^- further decreased with respect to hydrological years in period 2011–2014 to reach 8.9 and 11.5 $kg \cdot ha^{-1} \cdot yr^{-1}$. The spruce throughfall fluxes of SO_4^{2-} and NO_3^- amounted at 24.9 and 31.8 $kg \cdot ha^{-1} \cdot yr^{-1}$ and remained similar to those in hydrological year 2014.

NAVRÁTIL T., DOBEŠOVÁ I., ROHOVEC J. & HUBIČKOVÁ S. (2016): *Monitoring srážkových vod na území NPČŠ. Zpráva za rok 2015*. – Czech Acad Sci, Inst Geol., Praha for Administration of National Park Bohemian Switzerland: 1–20. Praha.

The Vysočina Region Branch of the Czech Society for Ornithology, Project No. 7463: **Natural diversity of the Vysočina region, Part III – Molluscs** (*J. Hlaváč*)

Molluscs belong to invertebrates and are one of the most frequently used model groups of invertebrates, which can yield overview on development of the natural environment. It is due to their limited mobility, often small size and especially in case of terrestric species their tight relation to vegetation and substrate. This project was aimed at the inventory and catalogization of molluscs found in the Vysočina region, Czech Republic.

In 2015 to 2016, 114 species of terrestric molluscs were identified on the basis of published or unpublished records, which represents over 66 % of the known species from the Czech Republic. Additionally, 19 species of aquatic molluscs were identified. Over 46 species in total are listed on the red list of endangered species, which represents over 40 % of the total. The malacofauna of the Vysočina region can be considered rich in species which cover a very broad range of ecological groups. Besides the dominant forest species, xerothermic, steppe, euryvalent, hydrophilic and heliophilic species were identified. The most significant terrestric species found were *Vertigo geyeri*, *Bulgarica cana*, *Cochlodina orthostoma* and *Vertigo lilljeborgi*. The most significant mountaineous species were *Clausilia cruciata*, *Discus ruderatus*, *Semilimax kotulae*, *Causa holosericea*, *Vitrea subrimata*, *Nesovitrea petronella*, *Vertigo substriata* and *Bielzia coerulans*. Finally, the rare species among the xerothermic ones were *Cepaea vindobonensis*, *Chondrula tridens*, *Pupilla sterri* and *Pupilla triplicata*. From the nation-wide point of view, the most valuable records are related to species of *Vestia turgida*, *Macrogastra tumida*, *Laciniaria plicata*, *Clausilia rugosa*, *Balea perversa*, *Daudebardia rufa*, *Discus perspectivus*, *Deroceras praecox*, *Deroceras turcicum* and *Helix thessalica*. The most important areas of rare species occurrence concentrate to low-elevation nature protected areas of the Vysočina region.

HLAVÁČ J. (2016): *Přírodní rozmanitost Vysočiny, Část III. – Měkkýši, závěrečná zpráva 2015-2016*. – Czech Acad Sci, Inst. Geol., Praha for The Czech Ornithological Society, branch Vysočina: 1–75. Praha.

Czech Acad Sci, Inst Geoph, Praha, Project No. 7516: **Palynology of selected samples from the Běchary borehole (Bch-1)** (*M. Svobodová*)

The project is focused on the determination of non-marine sporomorph assemblage from the Běchary borehole. Biostratigraphically important angiosperm pollen from the Normapolles Group evidenced the uppermost part of Late Turonian and Coniacian. The composition of sporomorphs is comparable to that found in hemipelagic deposits of the Úpohlavy Quarry (Svobodová 2016). Marine part of the palynospectra was studied by Dr. K. Olde (Kingston University, London, UK). It represents the external project connected with the project of Czech Science Foundation held at the Institute of Geophysics, Czech Academy of Sciences, v. v. i. (Dr. D. Uličný).

SVOBODOVÁ M. (2016): *Palynologie vybraných vzorků z vrtu Běchary (Bch -1)*. – Czech Acad Sci, Inst Geol., Praha for Czech Acad Sci, Inst. Geophys., Praha, Project NS085200 Sediments: 1–14. Praha.

Czech Geological Survey, Praha, Project No. 7516: **Palynology of samples from slected boreholes from the Bohemian Cretaceous Basin and Třeboň Basin** (*M. Svobodová*)

Palynological analyses of selected samples from the geological and hydrogeological cores from the Bohemian Cretaceous Basin and Třeboň Basin were carried out within the project of "*Review of groundwater resources*" of the Czech Geological Survey. Samples from the Bohemian Cretaceous Basin were deposited in the continental to shallow marine environments and correspond to Cenomanian age. Samples from the Třeboň Basin were deposited in non-marine environment and correspond to the Senonian and Tertiary age (Svobodová 2016).

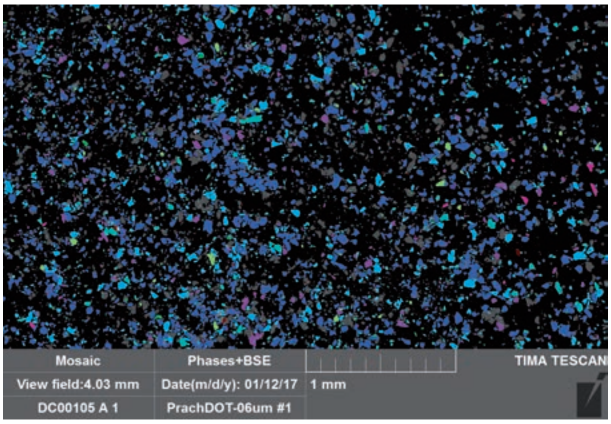
SVOBODOVÁ M. (2016): *Palynologické vyhodnocení vzorků z vybraných vrtů české křídové pánve a třeboňské pánve.* – Czech Acad Sci, Inst. Geol., Praha for Czech Geological Survey: 1–15. Praha.

4g. Strategy AV21 Programme – Natural Hazards and Programmes of Institutional Research Plan

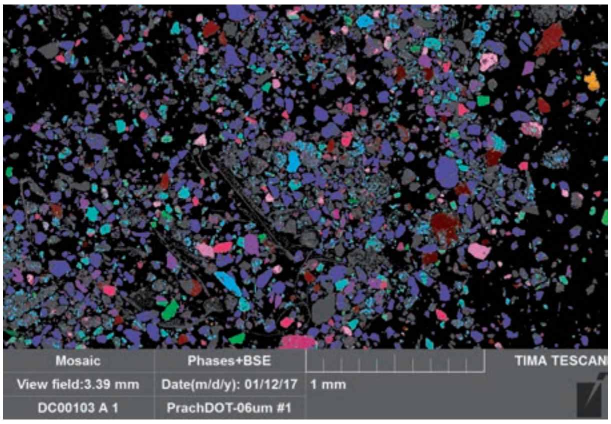
Strategy AV21 programme – Natural Hazards

Project No. 9221: **Automatic analysis of dust particles by electron microscopy, and creation of a "Dust particle atlas"** (*T. Hrstka, J. Hladil & L. Chadimová*)

This project deals with the use of automated mineralogy in the study of deposited dust and creation of a Dust Particles Atlas for research and environmental monitoring. The transport of dust particles (both natural and artificial) is more important than previously thought. It possesses numerous potential risks for both human health and the environment. In the global perspective, the deposited dust is around 8 g·m^{-2}·y^{-1} for a worldwide average and about half that is preserved, buried into sediment or infiltrated into soils and rocks. It is represented by a mixture of organic and inorganic particles of a complex nature. At present, there is very little evidence about the individual sources and transport patterns of a large proportion of this material. In our research, we aimed to develop a simple sampling, sample preparation and automated analysis procedure to create a basic workflow for easy routine evaluation of deposited dust material primarily from the geological perspective. Numerous preparation techniques were tested. The most appropriate for the majority of the materials proved to be the combination of polished sections/blocks doped with ultrafine (P80 = 75 µm) epoxide particles (for reducing the problem of agglomerate formation) and carbon tape imprints (where a small part of a sample is dispersed on a sticky carbon tape). A newly developed "DOT mapping" analysis mode designed in collaboration with TESCAN for the TESCAN Integrated Mineral Analyser (TIMA) was tested to collect modal, textural and compositional data on large populations of deposited dust particles on carbon tape and in polished sections (Figs. 20 & 21). This could help us to fingerprint the source and origin of the constituents of deposited dust. As a part of the research a free online database of dust particles and micromarkers – a "Dust particle atlas" is being made available to the public and the research community.



■ **Fig. 20.** The TESCAN Integrated Mineral Analyzer (TIMA) map providing a false color image for phases of Sahara dust as sampled from a car windshield in the Czech Republic on February 19, 2014. Sahara fine sand grains mixed with other dust constituents. Scale bar is 1,000 µm (photo by T. Hrstka).

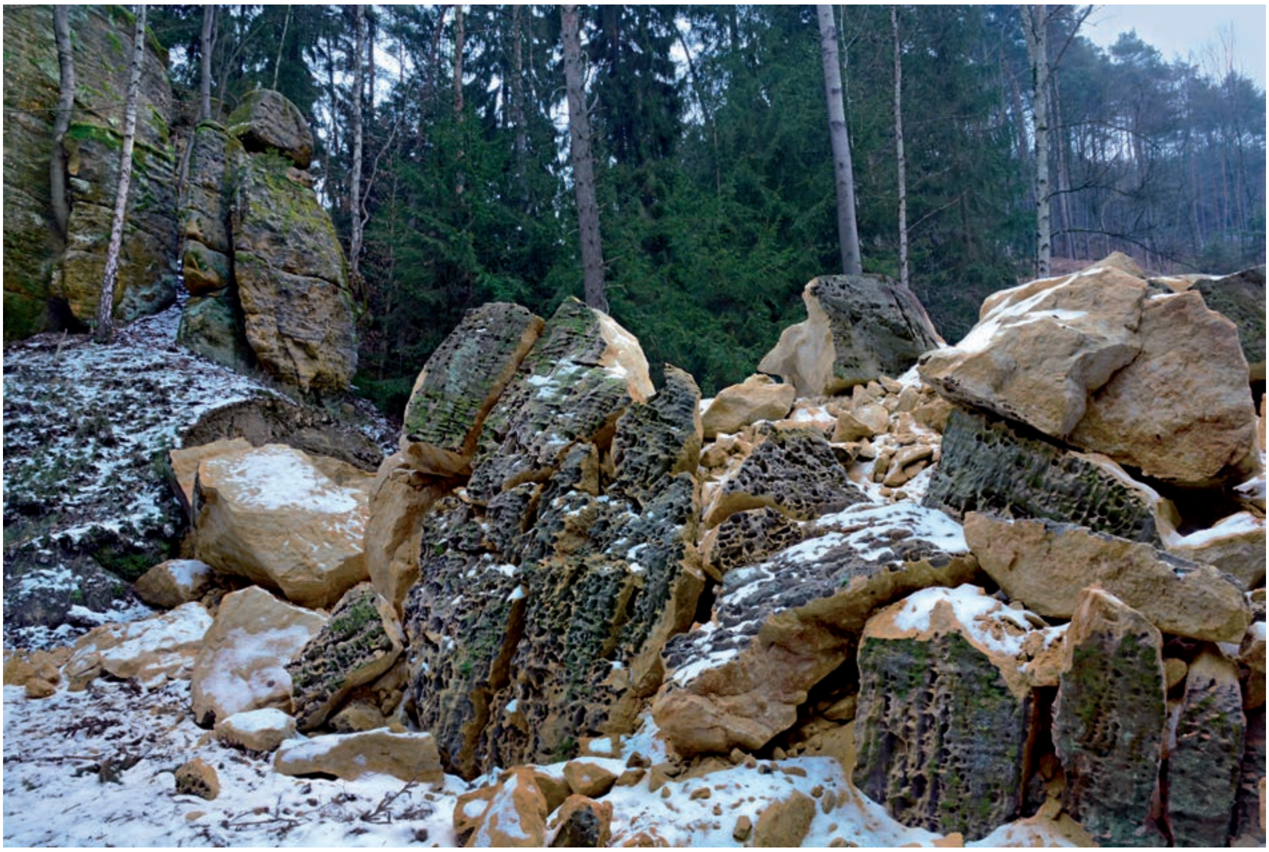


■ **Fig. 21.** The TESCAN Integrated Mineral Analyzer (TIMA) map providing false color image for phases of volcanic dust as sampled close to an active volcano in Iceland. Fine tephra (blue) mixed with other dust constituents. Scale bar is 1,000 µm (photo by T. Hrstka).

Project No. 9222: **File and classification of rockfall phenomena in the Kokořínsko area** (*J. Adamovič*)

The generally higher incidence of climatically extreme situations in the last decades accelerated rock weathering and disintegration. Rockfall is a phenomenon showing an increasing incidence, especially in sandstone areas. This can be explained by the high pore space (28–32 %) in sandstone, which is extremely sensitive to sudden changes in water saturation, drying or freezing. As yet, no file of the instances of rockfall in the Czech sandstone areas has been kept. This gap was being filled with the current project, which was designed to gather and to share evidence of rockfall phenomena in the Kokořínsko area (north-central Bohemia). Every year, a rockfall with a volume in excess of 100 occurs in this area but the volumes of wasted rock reach as much as 400 m^3 in some recent cases (Fig. 22).

All rockfall phenomena were described in detail including their geological and geomorphic settings, sandstone lithology and tectonic deformation, situation in the detachment area and in the accumulation area. Triggering mechanisms of specific rockfalls were suggested. The rockfalls were dated with the maximum possible precision based on direct and indirect evidence. The established rockfall database for the Kokořínsko



■ **Fig. 22.** Sandstone pillar called Jestřebická perla in the Truskavenský důl Valley, Kokořínsko area, collapsed in January 2014. The site is now fully remediated (photo by J. Adamovič).

area was made accessible to the public via an internet application hosted by webpage http://rockfall.gli.cas.cz. It is fully open to contributions from experts and from the wide public, after a simple registration with the webpage supervisor. The rockfall phenomena are sorted by areas and subareas, as well as by the approximate age of the event (recent, historic and fossil rockfalls, and potentially instable objects). The following types of information are provided for each rockfall: location incl. GPS coordinates, description, volume, age, remediation and future prospect. Each rockfall is accompanied with photos from different times after the event and from the time before the event, where available. These photos should illustrate the hazardous settings, the rockfall mechanisms, and also the natural succession of wasted material. This database is the first of its kind in the Czech Republic. Besides experts in engineering geology and the public, it is also aimed at local authorities who asses potential natural hazards and at authorities in nature conservation.

Project No. 9223: **25 years of research in the Lesní potok model catchment – information brochure** (*T. Navrátil*, *P. Skřivan* & *J. Rohovec*)

Output of this project is a publication (Navrátil et al. 2016) which introduces a small experimental catchment and research executed thereon. It outlines the techniques used to practically implement biogeochemical monitoring and describes and explains some of the most important results.

Biogeochemical data gathered within the small catchment of Lesní potok were basic input data for mathematical models which describe the behaviour of forest ecosystems under stress caused by the acidification and predict their future fate. This represents a very important result for scientists and for public, who are worried by questions such as: Why is the forest dying? or What can we do to make the forest grow better? Further studies and consequent lessons learned from the mechanisms of fixation and mobilization of toxic metals answer the questions of risks for the environment, life and human.

The monitoring of this small forest catchment is a very demanding activity as concerns time, finances and work. Anyway, the acquired information is worth of supporting this research activity.

NAVRÁTIL T., *ROHOVEC J.* & *SKŘIVAN P.* (2016): Lesní potok – čtvrtstoletí monitoringu modelového povodí. – *Edice Strategie AV21, Rozmanitost života a zdraví ekosystémů*: 1–42. Středisko společných činností AV ČR, v. v. i. Praha pro Kancelář Akademie věd ČR.

Programmes of Institutional Research Plan

Project No. 9308: **A new leporid from the Plio-Pleistocene of Sardinia** (*S. Čermák*)

Sardinian Neogene vertebrate assemblages are rare and usually bear scanty remains, and their age attribution is often a matter of debate. Thus a discovery of the Monte Tuttavista karst complex (NE Sardinia, Italy) is extremely important for the paleobiological history of Sardinia. The project was focused on the systematic revision of a unique leporid found in several Monte Tuttavista fissure fillings, correlated with the Capo Figari/Orosei 1 stage of the Nesogoral faunal complex and the Orosei 2 stege of the *Microtus* (*Tyrrhenicola*) faunal complex, i.e., the Late Pliocene–Early Pleistocene (MN16b–MN17). The Sardinian leporid shows some peculiar characters – mainly the discrepancy in premolar (p3/P2) evolutionary stage. Such combination is not compatible with any known genus and justifies the ascription of the Sardinian leporid to a new fossil species and genus. Given the impossibility to relate the studied taxon to any known European leporid, a detailed review of the European leporid record and potential mammalian migration waves to Sardinia was performed.

Project No. 9323: **Palynology of the Lom Member** (*J. Dašková*)

The goal of the project is palynological research of Tertiary sediments from the Lom Member of the Most Basin. Macroflora is well known and also geochemical data from this site have been already published. Palynomorphs have never been studied and the paleoecological interpretation of the environment based on coexistential approach (using the nearest living relatives) is planned to be done. Samples were taken from core OS16 (10 samples). Maceration was done in the laboratory of the Czech Geological Survey, and slides were examined. Because of the lack of palynomorphs, 5 samples were taken again and processed again in the laboratory with the same result. The rest of intended samples (20 samples in total) from this core were not prepared because macroscopically all samples appear almost identical. However, fresh samples were taken during the field campaign and coring at the end of the year and will be investigated in 2017.

Project No. 9324: **Highly siderophile element geochemistry of mafic layers, Horoman massif, Japan** (*L. Ackerman, M. Svojtka, E. Haluzová* & *Š. Jonášová*)

Within the project, fifteen selected samples of mafic layers of different composition were analysed as for their highly siderophile element contents and Re-Os isotopic compositions. These analyses were paralleled by the identification of principal sulphide phases in these samples using an electron microprobe. The results confirmed that two predominant types of mafic layers (Type I–II) from Horoman pose different compositions. *Type I* showed low I-PGE (Os-Ir-Ru) contents, but yielded radiogenic Os isotopic composition ($^{187}Os/^{188}Os$ from 0.2465 to 0.7786) due to high Re/Os ratios. In contrast, *Type II* typically contained higher I-PGE paralleled by sometimes very high Pd and Pt (e.g., Pd up to 74 ppb), but their $^{187}Os/^{188}Os$ ratios were found to be much lower (0.1349 to 0.1395). The major sulphides phases identified in both types of layers are represented by monosulphide solid solution (MSS), pentlandite, pyrrhotite and chalcopyrite.

Project 9325: ***In situ* spores and pollen of reproductive organs of Early Permian lycophytes and ferns from the Wuda Coalfield, Inner Mongolia, China** (*J. Bek*)

The aim of the project is a discovery of new fertile and sterile specimens of Early Permian plants and a correlation with their spores and pollen. The most important specimen is the oldest cycadalean plant (298 Ma) in the World. *In situ* spores were isolated from reproductive organs of lycophytes (*Spencerites*), sphenophytes (*Palaeostachya*, *Sphenophyllum*), a noeggerathialean (*Paratingia*) and ferns (*Chansitheca, Etapteris, Oligocarpia*). The reconstruction of the tropical forest buried by volcanic ash (“Permian Pompeii”) will be made based on excavations across the area of 2,500 m^2.

Project No. 9331: ***In situ* transition from granitic to pegmatitic style of crystallization at Megiliggar Rock, Cornwall, United Kingdom** (*K. Breiter, T. Hrstka* & *Z. Korbelová*)

The genetic relation between granitic pegmatites and their parent granites is a topic of long-term discussions. Despite of intensive search, localities enabling to study a direct transition from a granite pluton to rare-element pegmatite dykes intruded outside the pluton are scarce. One of them is the Megiliggar Rock at the southeastern contact of the Tregonning granite pluton in Cornwall. Spectacular outcrops in the coastal cliff show a transition from the granite pluton through dyke leucogranites to aplites and pegmatites. Although the site has been known for a long time, modern petrological data and interpretation are still missing. The aims of our research was to describe the entire range of granitic rocks at Megiliggar (granites, aplites, pegmatites), their chemical and mineral compositions, and to find out the relationships between the different types of dyke rocks and their parent granite.

Macroscopically, the rocks should be classified into three principal groups: (i) granites, i.e., fine- to medium-grained homogeneous rocks (Tregonning granite, dyke leucogranite), (ii) Li-mica-dominated complex dykes, and (iii) muscovite-tourmaline-dominated aplites/pegmatites. The complex structure of Megiliggar dykes generally originated from a combination of symmetrical zoning, rhythmic layering, and repeated injection of melt. Major leucogranite sheets are composed of prevailing fine-to medium-grained granite combined with flat-oriented laminae/nests of pegmatitic or complex pegmatitic/aplitic texture. Thicker “pegmatite” dykes and bodies are composed of irregular changing, mixing and interpenetration of domains (layers, nests, dykes) of <1 mm-sized (aplitic), 1–2 cm-sized (granitic) and coarser (pegmatitic) matter. Contacts are either sharp or gradational. Undoubtedly, *in situ* fractionation is combined here with repeated injection of similar magma. Thinner pegmatite dykes (usually <20 cm) are usually composed of pegmatitic rims (crystals of K-feldspar and quartz growing perpendicular to the contact plane) and a fine-grained (aplitic) core. In some dykes, the zone of comb crystals may be evolved also in the inner part of the aplitic rock. The most conspicuous mineralogical difference was encountered between the lepidolite- and muscovite-bearing rock groups. Li-mica bearing rocks, i.e., granites and some complex dykes, contain relatively higher P in both feldspars, higher Rb in K-feldspar, higher Li and higher Fe/Mg values in tourmaline, and higher Mn/Fe values in columbite; all these criteria are compatible with the classification of “evolved” or “highly fractionated” rock, fully comparable with peraluminous tin granites of the Krušné Hory or France. In contrast, the aplite/pegmatites bearing Li, F-poor muscovite, common schorl and Fe-dominant columbite are chemically and mineralogically rather primitive.

Taken together, the composition of the lepidolite-bearing dyke leucogranite and complex dykes is compatible with the presumed origin *via* fractionation of a residual Tregonning granite melt, while chemical and mineral compositions of tourmaline-rich aplite/pegmatite dykes seems to be somewhat strange in this context. Whole-rock chemical indicators and mineral compositions of aplite/pegmatites are comparatively remarkably primitive.

Project No. 9332: **Early Miocene inversion of dynamics of the Bohemian Massif – from compression to extension** (*M. Coubal*, *M. Šťastný*, *J. Adamovič* & P. Zelenka, Czech Geological Survey, Praha)

In 2016, our team progressed in the reconstruction of the character of tectonic phases affecting the northern part of the Bohemian Massif during the Tertiary (specifically, in the Late Eocene to Early Miocene). A special attention was given to a more precise determination of their timing, which is only imperfectly known in other regions of the Alpine foreland. Paleostress analysis of fault slip data was the essential method to interpret kinematic and dynamic characteristics of the tectonic phases. In our case, the study was focused on volcanic bodies from the Eger Rift whose age had been previously determined by geochronological dating. The bodies were selected according to their age to provide a time succession (e. g., Říp Hill ca. 26 Ma; Střekov ca. 23 Ma; Slapany ca. 21 Ma; Milá Hill ca. 20 Ma). Such selection allows to continuously compare the character of tectonic deformation identified in bodies of different ages. As revealed by this study, the northern margin of the Bohemian Massif was affected by a group of compressive stress fields emitted probably with almost no change from the area of the Alpine Orogen. These paleostress fields have been designated as paleostress pattern group α in previous papers. From ca 33 Ma onwards, a markedly altered stress came into effect in the Bohemian Massif. It had the character of dilation: a WNW–ESE extension, induced by the NNE–SSW compression. These paleostress fields have been designated as paleostress pattern αβ3 in previous papers. This phase including the characteristic reactivated structures has been reported from the area of the Alpine Orogen (e. g., Eastern Alps) as well as from the Alpine foreland (e.g., the Rhine Graben). Later on, the area became governed by pure extension with a variable (generally SSW–SSE) direction. It was probably endemic to the Bohemian Massif and controlled the formation of the Eger Graben structure. These paleostress fields have been designated as paleostress pattern group β in previous papers. The ages of bodies deformed still by the preceding tectonic phase αβ3 indicate that the onset of phase β can be dated to the Early Miocene (ages less than 20 Ma), i.e., later than has been as yet speculated. The Lusatian Fault was the typical structure activated in this period in the northern part of the Bohemian Massif. Alteration of plagioclase was identified in granitoids disintegrated in the fault core and in the adjacent portions of the rock massif. In weakly acidic conditions, transformation of feldspars to newly formed illite (1Md polytype) at potassium influx occurs at presumed temperatures of 60–170 °C.

Project No. 9332: **U-Pb age data of metasediments from the Varied Unit (Moldanubian Zone, southern Bohemia)** (*J. Fiala*, *M. Svojtka*, *J. Sláma* & *L. Ackerman*)

Detrital zircon U–Pb age data from the Varied Unit in the Moldanubian Zone (southern Bohemian Massif) obtained by laser ablation inductively coupled plasma mass spectrometry show variations in age of the studied metasediments. Biotite paragneisses with preserved Paleoproterozoic to Archean inherited component yielded a U/Pb zircon age of ca 2.1–3.0 Ga (Eburian orogenic event). The age of these rocks is equivalent to Precambrian crystalline rocks from West African Craton and Arabian-Nubian Shield. A distinct zircon U-Pb component of about ~565 Ma is associated with the Cadomian orogeny at the end of the Ediacaran amalgamation of Gondwana. The youngest Lower Carboniferous zircons (~330–360 Ma) from the metasediments are interpreted as being of metamorphic origin.

Project No 9340: **Interpretation and presentation of new ichnological data from the Culm Facies (Lower Carboniferous) in Moravia and Silesia** (*R. Mikuláš*)

An exceptional find of a chiton preserved at the end of its locomotion trace comes from the Culm Facies, i.e., turbidity-controlled dark shales, greywackes and sandstones. The chiton trace is a smooth, bilobate ridge (convex epirelief), forming an incompletely preserved loop. At its end, a completely articulated chiton *Proleptochiton* sp. is preserved, orientated congruently with the trace. The neighbouring strata provide relatively frequent ichnofossils, e.g., *Chondrites* isp., *Planolites* isp., *Dictyodora liebeana* and *Diplocraterion* isp. The chiton trace fossil corresponds to ichnotaxa that have historically been compared to modern gastropod trails; it has been determined as *Aulichnites* isp. The gastropods are well-known for two different monotaxic locomotion techniques, one for hard substrates such as glass, and another for soft substrates, where the animals move through muscular waves of much higher amplitude than observed on glass. Thereby, adhesion useable for the movement on a hard surface is functionally replaced by friction. Loosening of the sediment by rapid moves of foot muscles is the cause of the structure's convexity, i.e., increasing volume. A similar behaviour has been documented in chitons. The studied specimen is the first locomotion trace fossil attributed to polyplacophorans.

Project No. 9344: **Contrasting genetic positions of basic glasses (tachylytes) in Cenozoic basaltic lavas from the Czech Republic and Iceland** (*J. Ulrych*, *L. Krmíček* & *R. Skála*)

Tachylytes in alkaline rift-related volcanic rocks were studied from three geological positions: (i) irregular veinlets and fillings of cavities in host lava flows of the Kozákov volcano, Czech Republic, (ii) (sub)angular xenoliths in lava of the feeding channel of the Bukovec volcano, Czech Republic, and (iii) surface of a lava flow from Svínafellsjökull, Iceland. The tachylyte from Kozákov displays foidite to phonotephrite composition, whereas the tachylyte from Bukovec exhibits phonotephrite to tephriphonolite geochemistry. Host rocks are of basanite and olivine nephelinite composition, respectively. Both glass and host rock from Svínafellsjökull is of basalt to basaltic andesite composition. The tachylyte from Kozákov, compared with the host rock, revealed a substantial enrichment in major elements such as SiO_2, Al_2O_3, Na_2O, K_2O and H_2O, associated with depletion in MgO and FeO_{tot}. The contents of incompatible elements such as Rb, Sr, Ba, Nb, Zr, REE, Th and U in the tachylyte are higher than those in the host rocks. The tachylyte from Bukovec displays the same trend in major element contents but contrasting trends in the incompatible element contents. Very similar trends in chemical composition of the Svínafellsjökull tachylyte and parent lava are characteristic for this geological type of tachylyte occurrence. The tachylyte from Kozákov is a product of an additional late-magmatic portion of fluids penetrating through an irregular fissure system of basaltic lava flows of the Kozákov volcano. The Bukovec tachylyte is represented by xenoliths entrained by ascending lava in a feeding channel, whereas the Svínafellsjökull tachylyte is a product of a rapid cooling/solidification of the surface of a subaerial basalt flow. Tachylytes show irregular alteration, which becomes prominent in veinlets and is manifested in higher H_2O contents and low alkali contents. Rare skeletal clinopyroxene crystals successively transformed to clinopyroxene microphenocrysts are commonly present in the tachylyte from Kozákov, rarely also in that from Bukovec (Fig. 23). The tachylyte from Svínafellsjökull is rich in clinopyroxene and plagioclase skeletal crystals and rare plagioclase (micro)phenocrysts (Fig. 24). Chemical composition of tachylyte depends on the genesis reflected in its geological position in a volcanic edifice and the geochemical character of the parent/host magma.

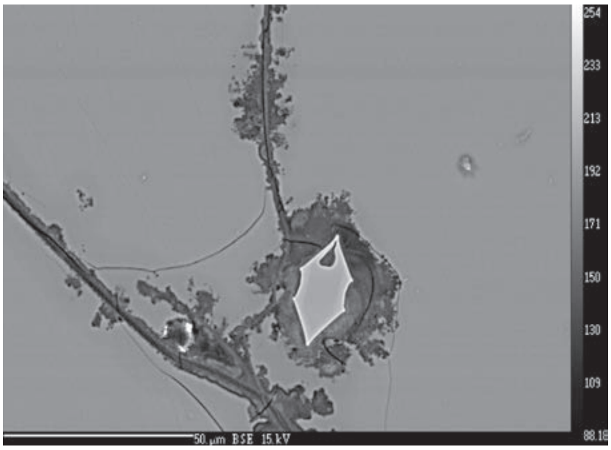


Fig. 23. A BSE image of a zoned veinlet of altered glass with a rhomb-like and skeletal crystal of clinopyroxene, Kozákov (photo by Š. Jonášová).

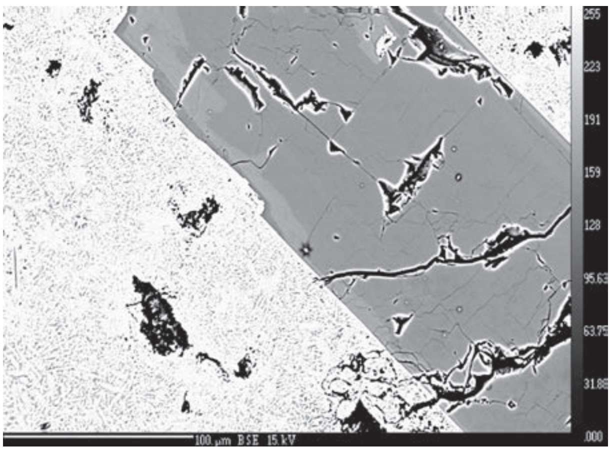


Fig. 24. A BSE image of glass filled with skeletal aggregates of clinopyroxene and plagioclase with (micro)phenocrysts of labradorite, Hafrafell (photo by Š. Jonášová).

Project No. 9346: **Soil development in the area of the Buchava Formation of the Skryje-Týřovice Basin** (*A. Žigová* & *M. Šťastný*)

Soils formed on loess are commonly found in different regions. This study is focused on determining the effects of underlying rocks on pedogenesis of these soils in the area of the Skryje–Týřovice Basin.

The study was performed in the Křivoklátsko Protected Landscape Area. A representative soil sequence was sampled in the Podmokly area. The soil profile was classified as Albic Luvisol (Fig. 25). Petrographic character of the rocks was determined. Quantification of pedogenesis was evaluated based on morphological analysis, particle size distribution, chemical properties, soil organic matter and mineral composition of clay fraction.

Soil development is primarily connected with the process of pedogenic clay differentiation and formation of the Bt horizon. This fact is documented by the particle size distribution, and the values of pH and cation exchange capacity. The thickness of the Ah horizon, the presence of the E horizon and the distribution of organic matter are characteristic for Albic Luvisol. Clay fraction of the studied soil sequence has a polymineral composition with the occurrence of clay minerals, quartz and feldspars. The most common clay minerals are chlorite, illite and smectite. Corrensite was detected in the Ah horizon. This is a relatively rare mixed structure (R=1) of chlorite–smectite, which was first identified in soils in the Czech Republic. The influence of volcanic rocks in soil development is characterized by the presence of chlorite and smectite. Illite and kaolinite indicate the influence of loess.

Fig. 25. Albic Luvisol developed on loess, Podmokly (photo by A. Žigová).

Project 9348: **Anatomy and morphology of Lower Permian ferns from the Wuda Coal Basin, China** (*J. Frojdová*)

The project is focused on ferns from the Wuda Coal Basin (Inner Mongolia, China) of Lower Permian age. The aim of the project is to review and probably describe new species/genera which were found and selected from fossils of Lower Permian ferns. This type of ferns is ranked into artificial groups of plants with a "sphenopterid" type of leaves. Systematic classification of fossil ferns allows to define phylogenetic lines in individual groups of plants in geological history. *Chansitheca wudaensis* was observed in fifteen times macerated samples but the samples were negative for *in situ* spores for today. Samples of *Botryopteris* type of ferns were also observed in detail and will be established as new genera with annulate sporangia and *Granulatisporites-Ahrensisporites* types of *in situ* spores.

Project No. 9351: **Preliminary magnetic study of Uzgruň section, Czech Republic** (*T. Elbra*)

The Cretaceous/Paleogene boundary (K/Pg) marks the limit between the Cretaceous and Paleogene periods and coincides with one of the five mass extinctions in Earth's history, which extinguished at least 75 % of species (e.g., dinosaurs). In the Czech Republic, the K/Pg boundary is known from flysch sediments of the Uzgruň section. The section has been studied by methods of biostratigraphy, sedimentology and geochemistry, but no record has been reported on magnetic properties. Pilot sampling and paleomagnetic and rock magnetic investigations were carried out in 2016 to provide the first outline of magnetic properties of this K/Pg section. The results indicate that the samples are mainly paramagnetic, with only occasional higher values due to low concentrations of magnetic fraction (mainly magnetite). Alternating-field demagnetization shows, despite low natural remanence, easily distinguished and stable remanence components, revealing possible 90° clockwise rotation of the massif.

Project No. 9353: **Preparation of standards for the quantification of boron in boron-containing minerals and glasses using electron microanalysis** (*Š. Jonášová*)

The standards (22 samples in total) intended to be used for analysis by an electron probe microanalyzer (EPMA) were supplied by three institutions: Smithsonian Institution, Washington, USA; Research Institute of glass, Hradec Králové; and Institute of Chemical Technology, Prague. For each standard, wave-dispersive X-ray spectra were measured and chemical composition was determined by EPMA. Besides these data, trace element contents were determined by LA-ICP-MS. The results were compared with data provided with the supplied standards. Five samples containing boron that were found inhomogeneous or rapidly changed their chemical compositions under the beam (BK 110; B 30; B 60; Al – B 30; Al – B 60) are not suitable for use as standards. Only three glasses with boron (Glass, IR-V; Glass, IR-W; Lak 9) were found to be suitable as standards for EPMA. These standards were used in the creation of the analytical protocol for measuring boron in glasses and tourmalines.

Project No. 9354: **Sources and distribution of Li in orogenic mantle** (*L. Krmíček*)

Orogenic mantle-derived melts suggest that subduction may effectively introduce Li from the crust back into the mantle. This project was focused on whole-rock and isotopical compositions of lithium in a set of late Variscan to post-Variscan mantle-derived magmatic rocks exposed along the orogenic wedge of Variscan Europe in the Bohemian Massif. The compositional field encompassed by mantle-derived magmatic rocks in terms of δ^{7}Li and Li content is bracketed by the extreme values of (i) altered oceanic crust and (ii) orogenic mafic eclogites, and (iii) largely overlaps with values for the Saxo-Thuringian crust, which broadly reflects the composition of Gondwana-derived material subducted beneath the Bohemian Massif.

Project No. 9355: **Magnetic properties of microspherules at the beginning of Younger Dryas** (*L. Nábělek* & *G. Kletetschka*)

The goal was to investigate magnetic properties of microspherules that are part of lake sediments. Measurements indicated that the microspherules have magnetic signatures consistent with exposure to atmospheric electric discharge. Electric discharge could be associated with volcanic eruption. Since the occurrence of microspherules was associated with evidence of tephra particles, we concluded that microspherules originated in a tephra cloud from a volcanic eruption. Research funds were used mostly for geochemical analyses. The detailed analysis of the tephra particles identified the Laacher See volcanic eruption. Data from this project were incorporated in the publication (Kletetschka et al., submitted).

Project No. 9356: **U-Pb zircon dating of Teplice porphyritic microgranite using laser ablation ICP-MS: implications for post-caldera magma flow and ascent** (*F. Tomek* & *M. Svojtka*)

Three samples from a caldera ring dike (Fig. 26) of the Altenberg–Teplice volcanic complex (NW Bohemian Massif) were selected for U-Pb dating. The zircon specimens were measured

Fig. 26. Outcrop photo of the Altenberg–Teplice porphyritic microgranite (looking north). The white line marks a trace of magmatic foliation defined by K-feldspar megacrysts. Sampling site FT153, small abandoned quarry, ~1.3 km northeast of Frauenstein, Germany; Gerber pocket knife for scale (10 cm; photo by F. Tomek).

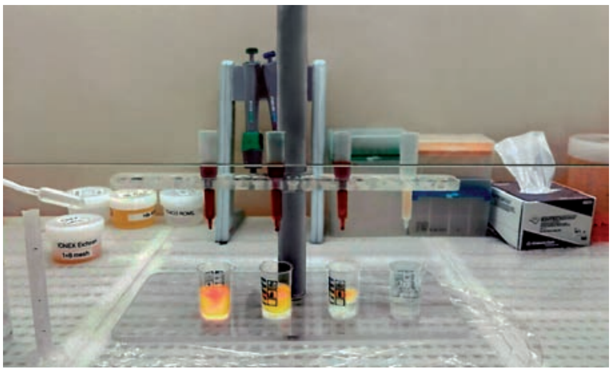
using laser ablation ICP-MS. Zircon populations from all three samples consist mainly of clear euhedral fragments or prismatic grains with a length of ~150–300 μm. Cathodoluminescence images showed mostly euhedral oscillatory magmatic growth zoning with rare featureless unzoned cores. The individual data yielded a relatively wide scatter in concordant or near-concordant ages between ~320 and ~305 Ma that constitute single concordia crystallization ages of 312 ± 3 and 312 ± 4 Ma (2 sigma). No inherited zircon core ages significantly differ from magmatic growth zoning ages. These new data thus also provide a lower limit of explosive and effusive volcanism in the Altenberg–Teplice caldera.

Project No. 9365: **Microcrinoids of the Bohemian-Saxonian Cretaceous Basin** (*J. Žítt*)

The project is based on the study of unique roveacrinid materials collected by O. Nekvasilová (Předboj, CZ) and Ch. Löser (Hoher Stein, Sachsen, D). Taxonomy of cups and study of numerous isolated brachial elements represented the principal aims of roveacrinid investigations. The distribution in sections and comparisons of cup and brachial occurrences contributed to their conspecifications and skeletal reconstructions. Details on sedimentary environment, type of the accompanying macrofauna and composition of foraminiferal and nannoplankton assemblages enabled precise paleoenvironmental, paleoecologic and stratigraphic interpretations.

Project No. 9369: **Improvement of new analytical methods: dating anoxic shales using Re-Os isotopic system at the Czech Academy of Sciences, Institute of Geology** (*E. Haluzová, L. Ackerman* & *M. Svojtka*)

The aim of this project was to improve the Re-Os isotopic analytical methods on the black shales and separated pyrite fractions. Ten samples were selected, representing black shales (including in-house standard, USGS standard and blanks). Then, ~1 g of whole-rock black shale powder was sealed with appropriate amounts of ^{185}Re-^{190}Os spike and digested in Carius tubes using a CrO_3–H_2SO_4 mixture. Decomposition of pyrites in the Carius Tubes was accomplished using a HNO_3-HCl mixture in the presence of ^{185}Re-^{190}Os spikes. Osmium was extracted from the remaining solutions into $CHCl_3$ and then back-extracted into HBr followed by three cycles of high-precision microdistillation. Rhenium was separated by anion exchange chromatography using Eichrom AG 1 × 8 resin (Fig. 27), and the fraction was purified by a single bead anion extraction. These steps were successfully performed and the final fraction is fine. The remaining Re and Os isotope compositions are now ready to be measured by negative thermal ionization mass spectrometry (N-TIMS) using Finnigan MAT 262 housed at the Czech Geological Survey.



■ **Fig. 27.** Separation of Re by anion exchange chromatography (photo by E. Haluzová).

Project No. 9371: **Development of cooperation with the Institute of Karst Geology in Guilin: Survey and research of karst areas in Shaanxi Province, Central China** (*M. Filippi*; *Z.* Motyčka, R. Šebela, L. Matuška & J. Sirotek, Czech Speleological Society)

Several remarkable and still unknown karts areas were found using a Google Earth Application in Honzhong area, Shaanxi Province in central China. Significant karst phenomena recognized in these areas promis discoveries of world significance. The purpose of this project was to: (i) visit these areas and evaluate their exploration and scientific potential, and (ii) to start cooperation with the proper Chinese institution(s) to create a base for future joint exploration and scientific work. As expected, several large caves and sinkholes were found and partly documented in karst areas close to Hanzhong City. During this

■ **Fig. 28.** The entrance to the newly discovered Sky Star Cave, Shaanxi Province China (photo by M. Filippi).

first expedition, several dolines and caves were localized in the field and shortly visited and documented (Fig. 28).

Joint cooperation between the Inst. Geol. of the Czech Acad. Sci. and the Institute of Karst Geology in Guilin and the Chinese Geological Survey in Xi´ was successfully established. Results of this project were reported by various media including the National Geographic Society (http://news.nationalgeographic.com/2016 / 11/49-sinkholes-discovered-in-china-worlds-largest-geology/).

Project No. 9372: **Paleomagnetism of Lunar rocks and interpretation of magnetic anomalies on the Moon** (*G. Kletetschka*)

The goal was to investigate the origin of magnetic remanence associated with Lunar rocks. Investigation of magnetic properties indicated a possible presence of inverse magnetic thermoremanence (ITRM) due to transfer of the Lunar material into the terrestrial conditions (larger external magnetic field and warming up from space temperature to terrestrial ambient temperatures of ~20 °C). The ITRM was subsequently identified in chondrules for the Allende meteorite. Funds were mostly used for chemical analyses of Lunar rocks and Allende chondrules.

Project No. 9373: **Detection of carbon presence in apatite structure and verification of existence of the tetrahedron CO_3F in apatite structure by Raman spectroscopy** (*N. Mészárosová*)

The principal goal of the project was to test Raman spectroscopy as an identification tool for carbon presence in apatite structure. Several natural samples of apatite were chosen for this study. These samples showed a significant departure from stoichiometry commonly determined by electron probe microanalysis (EPMA). These departures can be attributed to the presence of species which are not routinely analysed by EPMA. Amounts of fluorine above the nominal value require incorporation of fluorine by bonding to other functional group because the structural position of fluorine in apatite structure is already fully occupied. The existence of a tetrahedron of CO_3F was considered to explain the fluorine excess.

The symmetric stretching vibration mode (ν_1 CO_3) active in Raman spectra overlaps the asymmetric stretching mode of tetrahedron PO_4 (ν_3 PO_4). The numerical decomposition of spectra is required to separate the peak of ν_1 CO_3. Infrared spectroscopy was used as a complementary method. The position of out-of-plane vibration mode (ν_2 CO_3) of $[CO_3]^{2-}$ is used as a marker indicating the presence of the CO_3F tetrahedron in apatite structure. Consequently, other techniques should be applied to completely confirm the existence of the CO_3F tetrahedron, particularly solid-state ^{13}C and ^{19}F magic-angle spinning nuclear magnetic resonance (MAS NMR) spectroscopy.

Project No. 9374: **Detrital zircon provenance of "Cadomian" blocks of the eastern margin of Bohemian Massif – implications for paleogeography of the lower Palaeozoic** (*J. Sláma*)

Crustal blocks of uncertain origin located E of the the Bohemian Massif in Czech Republic and Poland (Brunovistulian, Małopolska and Łysogory) were studied for sedimentary provenance (Fig. 29). The samples were obtained from storages of drill cores of oil companies and from outcrops in the Holy Cross Mountains (Poland). Zircons were separated in the labs and mounted samples were imaged using cathodoluminescence and subsequently analysed by LA-ICP-MS in the labs of the Inst. Geol. of the Czech Acad. Sci. Preliminary data show affinity of the Brunovistulian Block to Avalonian terranes but further analyses are needed. Zircons from samples from Małopolska and Łysogory were prepared but not analysed yet. The results will be used for paleogeographic reconstruction of the micro-blocks in the Early Paleozoic. The area is crucial for the understanding of the evolution of the suture between Gondwana and Baltica (Laurussia) in the Paleozoic, especially with respect to the assembly of peri-Gondwana blocks and their accretion to Baltica during the Caledonian and Variscan orogenic cycles.

■ **Fig. 29.** Middle Cambrian (Series 3) sandstone from the core Lopiennik, core storage of the Polish Geological Archive in Piaseczno (photo by J. Sláma).

Project No. 9375: **Study of ceramic technology from Loštice** (*M. Šťastný*)

Brown-coloured cups (Fig. 30) with a blistered surface were manufactured at Loštice village from the early 15th century to mid-16th century. The same material was used for the manufacture of pots, pot lids and other products. A swing in the taste in mid-16th century brought about a decline of the characteristic pottery production at Loštice. As revealed by field observations and archaeological research, potters specialized in blistered ceramics were seated in the Loštice area. The present study focused on the identification of starting materials for the blistered ceramics. Loams rich in kaolinite and illite, with very low contents of other clay minerals, seem to be the most appropriate material. Ceramic shards of the Loštice cups are composed of quartz, mullite, cristobalite and feldspars. This composition suggests high firing temperatures of around 1,200 °C. Shards from experimental firing are of similar composition, being dominated by mullite, cordierite, quartz, cristobalite and anorthite. Ceramic material for experimental firing was complemented with pyrite and, for comparison, with garnet to prove or disprove the theory on the origin of blisters on the surface of the cups. Yellow loam from Újezd village, also containing organic matter and pyrite, proved to be the most appropriate material: addition of no other materials (garnet) was needed.

■ **Fig. 30.** The original Loštice cup (photo by M. Šťastný).

Project No. 9376: **Study of calcimicrobes, microproblematics and microbialites from the Frasnian/Famennian boundary interval in the southern part of the Moravian Karst – significance for the environmental change interpretation in the context of the end-Frasnian extinction** (*T. Weiner* & *H. Weinerová*)

The end-Frasnian Kellwasser Crisis represents one of the most severe mass extinctions in the Phanerozoic. This crisis is connected with worldwide decline of coral-stromatoporoid skeletal reefs and expansion of microbial structures which became common reef builders in the uppermost Frasnian and lower Famennian. This project is focused on the rich association of algae, calcimicrobes, microproblematics and microbialites at the Šumbera section near Brno. This section exposes intraclastic floatstones/rudstones, intraclastic and peloidal grainstones/packstones and microbial boundstones deposited in carbonate ramp environment in the time span of *rhenana* to *crepida* conodont zones. Frasnian part of the section contains common girvanellids and some intervals are enriched in udoteacean algae (*Litanaia*). Solenoporids, *Keega* and paleoberesellids sparsely occur. The cortexes of oncoids are composed of micritic matter, girvanellids and *Rothpletzella*. The interval around the Frasnian/Famennian boundary is dominated by renalcids. The cortexes of oncoids are composed of micritic matter, girvanellids, *Rothpletzella* and *Wetheredella*/*Allonema*. Some oncoids contain also microconchid shells and stromatoporoids. Famennian part of the section contains intervals with common girvanellids as well as those enriched in renalcids. *Rectangulina*, solenoporids and umbellids also occur in lower part of this interval. The cortexes of oncoids are composed of micritic matter and girvanellids. *Rothphetzella* and *Wetheredella*/*Allonema* also occur in oncoids from the lower part of this interval.

Project No. 9523: **The use of ICP-MS for U-series dating of cave carbonates** (*Š. Matoušková*, *J. Rohovec* & H. Hercman, Institute of Geological Sciences of the PAN, Warszawa, Poland)

This continued methodological project is based on a dating method, which is frequently used to determine the age of cave carbonates. This method makes use of the radioactive disequilibrium of some members of decay series. It is realized by the measurement of activity ratios of different uranium and thorium isotopes using alpha spectrometry. Some disadvantages are associated with the alpha spectrometry, such as the high sample weight, overlap of emitted energy of key isotopes, time question, or troubles with the detection of low-concentration samples. The TIMS is also used, but this method is arduous, the preparation of samples is very difficult and time-consuming and the measurement is quite expensive. These are the reasons why we decided to find a new possibility of the measurement of activity ratios – the Sector Field Mass Spectrometer with Inductive Coupled Plasma, Element II Thermo Scientific. The ICP-MS measurement was optimized on artificial (from standards prepared) samples in 2013, and the method was verified on natural samples prepared extra for the ICP-MS during 2014. Data from ICP-MS were compared with data from the same parts of cave carbonate formerly measured using alpha spectrometry.

■ **Fig. 31.** A stalagmite collected from Pekelný Dóm in the Demänovská Cave of Liberty (Low Tatra Mts., Slovakia). The U-series dating allows to estimate stalagmite growth between 238 and 106 ka. A detailed study was conducted as a part of the PhD thesis by M. Błaszczyk (Institute of Geological Sciences, PAS) within the PAN-17-22 bilateral collaboration (mobility) project (photo by J. Pawlak).

We started to analyse real natural samples from many different localities and ages (Fig. 31) in 2015. This year, we continued with real samples and search for the method for the preparation of organic archeological/paleontological samples (teeth, bones). Sample preparation is performed at the co-operative institution in Warsaw, Poland (H. Hercman).

5. Publication Activity of Staff Members of the Institute of Geology

5a. Papers Published

* journals/monographs included in the ISI Web of Science (journal IF value according to a list from 2016)

9.661* SHEETS H. D., MELCHIN M. J., LOXTON J., *ŠTORCH P.*, CARLUCCI K. L. & HAWKINS A. D. (2016): Graptolite community responses to global climate change and the late Ordovician mass extinction. – *Proceedings of the National Academy of Sciences of the United States of America*, 113, 30: 8380–8385. DOI: 10.1073/pnas.1602102113

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6.959* CARMICHAEL A., WATERS J.A., BATCHELOR C.J., COLEMAN D.M., SUTTNER T.J., KIDO E., MOORE L.M. & *CHADIMOVÁ L.* (2016): Climate instability and tipping points in the Late Devonian: Detection of the Hangenberg Event in an open oceanic island arc in the Central Asian Orogenic Belt. – *Gondwana Research*, 32: 213–231. DOI: 10.1016/j.gr.2015.02.009

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6.198* VANĚK A., GRÖSSLOVÁ Z., MIHALJEVIČ M., *TRUBAČ J.*, ETTLER V., TEPER L., CABALA J., *ROHOVEC J.*, ZÁDOROVÁ T., PENÍŽEK V., PAVLŮ L., HOLUBÍK O., NĚMEČEK K., HOUŠKA J., DRÁBEK O. & ASH C. (2016): Isotopic Tracing of Thallium Contamination in Soils Affected by Emissions from Coal-Fired Power Plants. – *Environmental Science & Technology Letters*, 50, 18: 9864–9871. DOI: 10.1021/acs.est.6b01751

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4.900* DRAHOTA P., KNAPPOVÁ M., KINDLOVÁ H., CULKA A., MAJZLAN J., MIHALJEVIČ M., *ROHOVEC J.*, VESELOVSKÝ F., FRIDRICHOVÁ M. & JEHLIČKA J. (2016): Mobility and attenuation of arsenic in sulfide-rich mining wastes from the Czech Republic. – *Science of the Total Environment*, 557/558: 192–203. DOI: 10.1016/j.scitotenv.2016.03.079

4.900* *FILIPPI M.*, DRAHOTA P., MACHOVIČ V., *BÖHMOVÁ V.* & MIHALJEVIČ M. (2016): Corrigendum to "Arsenic mineralogy and mobility in the arsenic-rich historical mine waste dump" [Sci. Total Environ. 536 (2015) 713-728]. – *Science of the Total Environment*, 541: 1639. DOI: 10.1016/j.scitotenv.2015.10.023

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Islands: Restricted effects of alteration by basaltic lava flows. – *International Journal of Coal Geology*, 165: 157–172. DOI: 10.1016/j.coal.2016.08.009

4.609* *JONÁŠOVÁ Š*., *ACKERMAN L*., *ŽÁK K*., *SKÁLA R*., *ĎURIŠOVÁ J*., DEUTSCH A. & MAGNA T. (2016): Geochemistry of impact glasses and target rocks from the Zhamanshin impact structure, Kazakhstan: Implications for mixing of target and impactor matter. – *Geochimica et Cosmochimica Acta*, 190: 239–264. DOI: 10.1016/j.gca.2016.06.031

4.609* *ŽÁK K*., *SKÁLA R*., ŘANDA Z., MIZERA J., HEISSIG K., *ACKERMAN L*., *ĎURIŠOVÁ J*., *JONÁŠOVÁ Š*., KAMENÍK J. & MAGNA T. (2016): Chemistry of Tertiary sediments in the surroundings of the Ries impact structure and moldavite formation revisited. – *Geochimica et Cosmochimica Acta*, 179: 287–311. DOI: 10.1016/j.gca.2016.01.025

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CÍLEK V.: Proměna současného světa. *Lecture, Preciosa, firemní vzdělávání, June 27, 2016*. Liberec.

CÍLEK V.: Voda a krajina. *Lecture, Agrární komora, Hotel TOP, November 22, 2016*. Praha.

HRSTKA T.: Od zrnek zlata po měsíční prach. Příběh automatizace elektronové mikroskopie. *Lecture, Týden vědy a techniky AV ČR, November 11, 2016*. Praha.

KLETETSCHKA G.: Dynamo v asteroidech? *Lecture, Seminář pro Geologickou službu, October, 21, 2016*. Praha.

KLETETSCHKA G.: Holocenní událost (impakt?) na začátku mladšího dryasu ve světě a ve střední Evropě. *Lecture, Seminář pro Přírodovědný klub Barrande, October 20, 2016*. Praha.

MARTINEK J., VRTIŠKA O., SEPTHONOVÁ D., *MIKULÁŠ R.*: Upadá v Česku zájem o vědu? *Discussion, The week of Science and Technique, Czech Academy of Sciences, November 9, 2016*. Praha.

MIKULÁŠ R.: Beseda o pískovcových skalních městech ČR a SR (nad knihou, jejíž spoluautory jsou Jiří Adamovič a Václav Cílek). *Lecture, Café Barrande, May 16, 2016*. Praha.

MIKULÁŠ R.: Co všechno je ve sbírkách Gymnázia v Třeboni. Komentovaná prohlídka gymnaziálních geologických sbírek. *Lecture and excursion, Spring Excursions to the World of Science, June 13, 2016.* Třeboň.

MIKULÁŠ R.: Do minulosti Prahy: co vyprávějí pražské skály, kopce a údolí? *Lecture, Skautský institut, September 7, 2016*. Praha.

MIKULÁŠ R.: Geobotanické putování údolími Džbánu. *Lecture and excursion, Spring Excursions to the World of Science, May 21, 2016*. Třebíz.

MIKULÁŠ R.: Geologie Prahy. *Lecture, XXXVII. otvírání studánek, MČ Praha-Kunratice a Sokol Praha – Kunratice, April 16, 2016*. Praha–Kunratice.

MIKULÁŠ R.: Naleziště zkamenělin na Lounsku s návštěvou muzea Zkamenělý les. *Lecture and excursion, Spring Excursions to the World of Science, June 24, 2016*. Primary School in Libochovice.

MIKULÁŠ R.: Pestrost ledového království. *Lecture, Science Café Nové Strašecí, December 6, 2016*. Nové Strašecí.

MIKULÁŠ R.: Příbramsko-jinecká pánev. *Lecture and excursion, Spring Excursions to the World of Science, 19th June, 2016*. Jince.

MIKULÁŠ R.: Stromatolity. *Lecture, Café Nobel, October 25, 2016*. Ústí nad Labem.

MIKULÁŠ R.: Stromatolity na Kokšíně z konce starohor. *Lecture and excursion, Spring Excursions to the World of Science, June 11, 2016*. Mítov.

MIKULÁŠ R.: Výprava za jineckými trilobity. *Lecture and excursion, Spring Excursions to the World of Science, May 30, 2016*. Jince.

MIKULÁŠ R.: Země – živá nebo neživá planeta? *Lecture, The week of Science and Technique, Czech Academy of Sciences & Czech Acad Sci, Inst Geonics, November 1, 2016*. Ostrava.

SCHNABL P. (2016): Fyzika Země s nadšením. *Lectures, Conference of Physics Lecturers organized by the Faculty of Mathematics and Physics of the Charles University in Praha in Náchod, October 3 and 4, 2016*. – *in*: KOUDELKOVÁ V. (Ed.): *Dílny Heuréky 2015, Náchod, October 2–4, 2016*, *Sborník konference projektu Heuréka Praha*: 172–176. Matematicko-fyzikální fakulta, Univerzita Karlova v Praze.

ŠŤASTNÝ M. & COUBAL M.: Tektonické jíly a jílové minerály. *Lecture, Czech National Clay Group, November 24, 2016*. Praha.

ŠŤASTNÝ M. & DUDEK J.: Jsou už loštické poháry zbaveny tajemství. *Lecture, Café Barrande, March 31, 2016*. Praha.

ŠŤASTNÝ M. & DUDEK J.: Jsou už loštické poháry zbaveny tajemství. *Lecture, Czech National Clay Group, November 24, 2016*. Praha.

SVOBODOVÁ A.: Vápnitý nanoplankton: mikroskopický, ale významný obyvatel moří od paleozoika po recent. *Lecture, Faculty of Science, Charles University in Praha, October 26, 2016*. Praha.

TOMEK F.: Sopečné erupce: jaká rizika představují pro lidskou populaci? *Lecture, Seminář Kamenožrout, Faculty of Science, Charles University in Praha, May 11, 2016.* Praha.

WAGNER V., GABRIEL J. & *MIKULÁŠ R.:* Třicet let po Černobylu a pět let po Fukušimě: jak se po těchto událostech změnila jaderná energetika? *Lecture and discussion, Rada pro popularizaci vědy AV ČR, Akademická kavárna, September 21, 2016*. Praha.

5g. Unpublished Reports

Deposited in the Library of the Institute of Geology of the Czech Academy of Sciences

BOROVIČKA J. (2016): *Mykologický průzkum PP Hadce u Hrnčíř, závěrečná zpráva.* – Czech Acad Sci, Inst Geol, Praha for Czech Society of Nature Protection in Vlašim: 1–10. Praha.

BOSÁK P. (2016): *Postup těžebních stěn Velkolomu Čertovy schody–západ. Akce sanace a rekultivace severní stěny. Posudek. Období: leden až prosinec 2014*. – Czech Acad Sci, Inst Geol, Praha for Velkolom Čertovy schody, a. s.: 1–20 + 1–79. Praha.

BREITER K. (2016): *Korelační vyhodnocení geochemických a petrograficko-mineralogických vlastností dochovaných vzorků ložiska Cínovec-jih s typovým profilem vrtu CS-1.* – Czech Acad Sci, Inst Geol, Praha for Czech Geological Survey, Praha: 1–41. Praha.

HLAVÁČ J. (2016): *Přírodní rozmanitost Vysočiny, Část III. – Měkkýši, závěrečná zpráva 2015-2016.* – Czech Acad Sci, Inst Geol, Praha for The Czech Ornitological Socuiety, branch Vysočina: 1–75. Praha.

JONÁŠOVÁ Š. (2016): *Ověření přítomnosti kovů na kamenném artefaktu "Mikulovice 1992/001".* – Czech Acad Sci, Inst Geol, Praha for Czech Acad Sci, Inst Archeology Praha, v. v. i.: 1–40. Praha.

LISÁ L. (2016): *Mikromorfologický posudek vzorků z lokality Kylešovice.* – Czech Acad Sci, Inst Geol, Praha for Institute of Czech Acad Sci, Inst Archeology Brno, v. v. i.: 1–21. Praha.

NAVRÁTIL T., DOBEŠOVÁ I., ROHOVEC J. & *HUBIČKOVÁ S.* (2016): *Monitoring srážkových vod na území NPČŠ. Zpráva za rok 2015.* – Czech Acad Sci, Inst Geol, Praha for Administration of National Park Bohemian Switzerland: 1–20. Praha.

PETRUŽÁLEK M. (2016): *Laboratorní zkoušky hornin na vzorcích z lokality NJZ EDU 6 JO+CHV (Dukovany), závěrečná zpráva.* – Czech Acad Sci, Inst Geol, Praha for Energoprůzkum Praha, spol. s r. o.: 1–53. Praha.

PETRUŽÁLEK M. (2016): *Laboratorní zkoušky popílko–cementové směsi pro akci tunel Ejpovice, závěrečná zpráva.* – Czech Acad Sci, Inst Geol, Praha for GEOtest, a. s.: 1 – 9. Praha.

PETRUŽÁLEK M. (2016): *Stanovení parametrů Hoek Brownovy obálky smykové pevnosti, závěrečná zpráva.* – Czech Acad Sci, Inst Geol, Praha for GEOtest, a. s.: 1 – 25. Praha.

PETRUŽÁLEK M., SVITEK T., SVOBODA L. & *FILLER V.* (2016): *Laboratorní zkoušky hornin na vzorcích z lokality NJZ EDU 6 JO+CHV (Dukovany).* – Czech Acad Sci, Inst Geol, Praha for Energoprůzkum Praha, spol. s r. o.: 1–55. Praha.

SCHNABL P., PRUNER P., ČÍŽKOVÁ K. & KDÝR Š. (2016): *Paleomagnetický výzkum horninového podloží v okolí jaderné elektrárny Dukovany : zpráva za rok 2016.* – Czech Acad Sci, Inst Geol, Praha for Energoprůzkum, spol. s r. o.: 1–76. Praha.

SKÁLA R. (2016): *Ověření obsahu azbestu v serpentinitu z lokality Castellaccio (Itálie). Závěrečná zpráva.* – Czech Acad Sci, Inst Geol, Praha for VÝVRATY, a. s., Bratislava: 1–65. Praha.

SVITEK T. (2016): *Measurements of physical and elastic properties on drilled cylindrical rock samples, Final report.* – Czech Acad Sci, Inst Geol, Praha for Stress Measurement Company Oy: 1–11. Praha.

SVOBODOVÁ M. (2016): *Palynologické vyhodnocení vzorků z vybraných vrtů české křídové pánve a třeboňské pánve.* – Czech Acad Sci, Inst Geol, Praha for Czech Geological Survey: 1–15. Praha.

SVOBODOVÁ M. (2016): *Palynologie vybraných vzorků z lokality Kurovice.* – Czech Acad Sci, Inst Geol, Praha for GAČR Project, Internal No. 3005: 1–7. Praha.

SVOBODOVÁ M. (2016): *Palynologie vybraných vzorků z vrtu Běchary (Bch -1).* – Czech Acad Sci, Inst Geol, Praha for Institute of Geophysics of the CAS, v. v. i., Project NS085200 Sediments: 1–14. Praha.

ŽÁK K. (2016): *Přehled lokalit těžby nerostných surovin v CHKO Křivoklátsko.* – Czech Acad Sci, Inst Geol, Praha for Agency of Nature Protection and Conservation of the Czech Republic: 1–19, 88 pages of appendices. Praha.

ŽÁK K., BOSÁK P., FILIPPI M. & *WAGNER J.* (2016): *Odborné stanovisko Geologického ústavu AV ČR, v. v. i., k žádosti Základní organizace České speleologické společnosti 1-05 Geospeleos ze dne 7. ledna 2016 o udělení výjimky ke speleologické činnosti v celkem 8 jeskyních (resp. jesk. systémech), nacházejících se v k. ú. Bubovice, Budňany, Korno, Kozolupy, a Svatý Jan pod Skalou.* – Czech Acad Sci, Inst Geol, Praha for Administration of Landscape Protected Area Český kras: 1–12. Praha.

6. Organization of Conferences and Scientific Meetings

International workshop: **WASM 2016 (International Workshop on Archaeological Soil Micromorphology) – Brno 2016, May 26–28, 2016.** Organized by the Institute of Geology of the Czech Academy of Sciences, Praha, Masaryk University in Brno, Mendel University and Czech Geological Society, Brno, Czech Republic. Organizing committee: *L. LISÁ* & A. BAJER (Mendel University in Brno).

The goal of WASM was to bring together a wide variety of international researchers, practitioners and students in this diverse and interdisciplinary field in order to facilitate discussion, stimulate research, and promote international scholarship in geoarchaeology. Participants were invited to bring thin sections related to current research which will be used as starting points for discussion and collaborative problem solving during two days of microscope sessions followed by one-day fieldtrip. The main key note was given by Hans Huismann, whose presentation "From Ashes to ashes" was subjected to the micromorphological features resulting from the presence of firing activities in archaeological deposits. Workshop brought participants to the Moravian Karst where we visited sites like the Kůlna Cave, Pod hradem Cave and Výpustek Cave, because participants had previously a chance to see thin sections from these sites during the two days of microscopic sessions. The fieldtrip ended in the Býčí skála Cave and the nearby Josefov Hutě, where we joined another workshop of experimental archaeology "Slavs in Stara Huť near Josefov" organized by the Technical Museum in Brno.

Workshop: **Potential of lithium mining in the Czech Republic and its use in advanced technologies, Praha, October 17, 2016.** Organized by the Institute of Geology of the Czech Academy of Sciences, Praha and the Office of the Czech Academy of Sciences, Praha for the Chamber of Deputies of the Parliament of the Czech Republic.

This workshop was held within the cooperation between the Czech Academy of Science and the Chamber of Deputies of the Parliament of the Czech Republic. The scientific scope of the workshop was organized by the GLI CAS (*K. BREITER*). Five lectures given by specialist from the Academy of Sciences, universities, Czech Geological Survey and mining companies covered the topics from geological exploration, through mining and processing to potential use of lithium for energy storage.

International workshop: **Imaging and analytical methods for geologists, Brno, November 25, 2016.** Organized by the Institute of Geology of the Czech Academy of Sciences, Praha in co-operation with Faculty of Science, Masaryk University in Brno within the Czech Science Foundation project No. GA14-13600S. Organized by *K. BREITER* & V. KANICKÝ (Faculty of Science, Masaryk University in Brno).

Members of the project team and representatives of companies producing analytical devices presented new methods of analytical chemistry and SEM-based mineralogical devices. Altogether nine lectures covered the methods from laser-ablation ICP-MS local analyses and elemental mapping, through cathodoluminescence and automated mineralogy to electron microprobe analyses of glasses and Raman spectroscopy (9 lectures, 22 participants).

7. Undergraduate and Graduate Education

7a. Undergraduate and Graduate Courses at Universities Given by Staff Members of the Institute of Geology

ACKERMAN L.: *Geochemistry of endogenic processes* (MG431P02). Undergraduate (obligatory) Course, Faculty of Science, Charles University in Praha.

BREITER K., LEICHMANN J., NOVÁK M.: *Advanced igneous and metamorphic petrology* (G9801). Undergraduate Course, Faculty of Science, Masaryk University in Brno.

ČERNÝ J.: *Recognition of fossils and structures* (G3131). Undergraduate Course, Faculty of Science, Masaryk University in Brno.

ČERNÝ J.: *Structural geology and geotectonics* (G4101). Undergraduate Course, Faculty of Science, Masaryk University in Brno.

CÍLEK V.: *Czech Landscape*. Graduate Course, summer semester, Academy of Fine Arts (AVU). Praha.

CÍLEK V.: *Towns and their Environment – Praha, Vienna, Budapest, Bratislava*. 5 day excursion and obligatory course, USAC (International Program of Faculty of Liberal Arts, Charles University in Praha).

CÍLEK V.: *Landscape and Cultural Memory*. Summer school of Simon Fraser University in Vancouver (International program of Faculty of Liberal Arts, Charles University in Praha).

DRESLEROVÁ D., *LISÁ L.*, KOČÁR P., RENÉ P. & ŠEFRNA L.: *Environmental archaeology (lecture on Quaternary geology and geoarchaeology)* (KAR_ENV). Undergraduate (optional) Course, Faculty of Philosophy, University of West Bohemia, Plzeň

KLETETSCHKA G.: *Geotechnology in Global Changes* (MG451P10). Undergraduate / Graduate (required) Course, Faculty of Science, Charles University. Praha.

KLETETSCHKA G.: *Physics of the Earth* (MG452P04G). Undergraduate / Graduate (required) Course, Faculty of Science, Charles University. Praha.

KRMÍČEK L.: *Geology* (BF001). Undergraduate Course, Faculty of Civil Engineering, Brno University of Technology, Brno.

KRMÍČEK L.: *Principles of regional geology of the Czech Republic for civil engineers* (BF92). Undergraduate (optional) Course, Faculty of Civil Engineering, Brno University of Technology, Brno.

LISÁ L.: *Geoarchaeology* (KAR_GEOA). Graduate (optional) Course, Faculty of Philosophy, University of West Bohemia, Plzeň.

LISÁ L.: *Geoarchaeology* (AEB_133) Graduate (optional) Course, Faculty of Philosophy, Masaryk University in Brno.

LISÁ L.: *Geoarchaeology for geologists* (G_5131) Graduate (optional) Course, Faculty of Natural Sciences, Masaryk University in Brno.

MAZUCH M. & *PŘIKRYL T.*: *Paleontology of fossil vertebrates (MG422P36)*. Undergraduate (optional) Course, Faculty of Science, Charles University in Praha.

MIKULÁŠ R. in SAKALA J. et al.: *Principles of paleobiology I* (MG422P02). Undergraduate (optional) Course, Faculty of Science, Charles University in Praha.

MIKULÁŠ R. in KOŠŤÁK M. et al.: *Paleoecology* (MG422P51). Undergraduate (optional) Course, Faculty of Science, Charles University in Praha.

MIKULÁŠ R.: Trace fossils and ichnofabric of sedimentary rocks (MG421P40). Undergraduate (optional) Course, Faculty of Science, Charles University in Praha.

MIKULÁŠ R. & *VAVRDOVÁ M.* in *PŘIKRYL T.* et al.: *Paleontological seminar* (MG422S42). Undergraduate (optional) Course, Faculty of Science, Charles University in Praha.

MIKULÁŠ R. in CHLEBOUNOVÁ I. et al.: *The Second Reading of Biology* (MB180C26) Undergraduate and Graduate Course (optional), Faculty of Science, Charles Universityin Praha.

NAVRÁTIL T. & *HOJDOVÁ M.*: *Heavy metals in the environment* (MG431P92). Undergraduate (optional) Course, Faculty of Science, Charles University in Praha.

PŘIKRYL T.: *Comparative anatomy of vertebrates (MB170P47)*. Undergraduate (optional) Course and Practical Study, Faculty of Science, Charles University in Praha.

PŘIKRYL T.: *Paleontological seminars (MG422S42)*. Undergraduate (optional) Course, Faculty of Science, Charles University, Praha.

PŘIKRYL T. in HOLCOVÁ K. et al.: *Principles of paleobiology I (MG422P02)*. Undergraduate (optional) Course, Faculty of Science, Charles University in Praha.

PŘIKRYL T. in KOŠŤÁK M. et al.: *Paleoecology (MG422P51)*. Undergraduate (optional) Course, Faculty of Science, Charles University in Praha.

SKÁLA R.: *Meteorites, their origin and composition* (MG431P40). Under/graduate (optional) course, Faculty of Science, Charles University in Praha.

SKÁLA R.: *Mineralogy* (MG431P52). Undergraduate course, Faculty of Science, Charles University in Praha.

SKÁLA R.: *Impact cratering and shock metamorphism* (MG431P39). Under/graduate (optional) course, Faculty of Science, Charles University in Praha.

SKÁLA R. & PLÁŠIL J.: Minerals: Their origin, occurrence and structure (MG431P48). Under/graduate (optional) course, Faculty of Science, Charles University in Praha.

SKÁLA R. & PLÁŠIL J.: Methods of structure analysis of solids in geoscience (MG431P70). Under/graduate (optional) course, Faculty of Science, Charles University in Praha.

TOMEK F.: *Laboratory course in physical geology I* (MG421C21A). Undergraduate (obligatory) Course, Faculty of Science, Charles University in Praha.

TOMEK F.: Laboratory course in physical geology II (MG421C21B). Undergraduate (obligatory) Course, Faculty of Science, Charles University in Praha.

7b. Supervision in Undergraduate Studies

Bc. Theses

ADAMEKOVÁ K., Faculty of Science, Masaryk University. Brno (*co-supervisor L. Lisá, defended in 2016*)

HAKALOVÁ P., Faculty of Science, Charles University in Praha (*supervisor T. Přikryl, since 2016*)

HRUBÝ J., Faculty of Science, Masaryk University in Brno (*supervisor L. Krmíček, defended 2016*)

KAMENÍKOVÁ T., Faculty of Science, Charles University in Praha (advisor G. Kletetschka, since 2014)

KOTEK J., Faculty of Science, Charles University in Praha (*co-supervisor P. Štorch, since 2014 terminated without defense*)

KRÖGER A., Faculty of Science, University of Helsinki. Finland (*supervisor T. Kohout, since 2015, terminated without defense*)

KUBOUŠKOVÁ S., Faculty of Science, Masaryk University in Brno (*co-supervisor L. Krmíček, defended 2016)*

OLŠANSKÁ I., Faculty of Science, Charles University in Praha (*supervisor G. Kletetschka, defended 2016*)

PÖNTINEN M., Faculty of Science, University of Helsinki. Finland (*supervisor T. Kohout, since 2015*)

SOINI A.J., Department of Physics, University of Helsinki (*advisor T. Kohout, since 2016*)

CHMELOVÁ K., Faculty of Science, Charles University, Praha (*supervisor T. Přikryl, since 2013, interrupted in 2016*)

ČVIRÍK R., Faculty of Science, Charles University, Praha (*supervisor K. Holcová, co-supervisor R. Mikuláš, since 2015)*

GRACIA de C., Faculty of Science, Charles University, Praha (*supervisor T. Přikryl, since 2015*)

HUŠKOVÁ A., Faculty of Science, Charles University. Praha (*supervisor L. Slavík, since 2015*)

JIANG ZUO Qigao, Vertebrate Paleontology and Paleoanthropology of the Chinese Academy of Sciences. Peking (*external research supervisor J. Wagner, defended 2016*)

LEBEDOVÁ K., Faculty of Science, Charles University, Praha (*co-supervisor S. Čermák, since 2016*)

NÁBĚLEK L., Faculty of Science, Charles University. Praha (*supervisor G. Kletetschka, since 2014 terminated without defense*)

NEPOMUCKÁ Z., Faculty of Science, Charles University, Praha (*supervisor T. Navrátil, defended in 2016*)

ONYSKO R., Faculty of Science, Charles University. Praha (*supervisor J. Rott, co-supervisor M. Petružálek, since 2016*)

PLICHTA A., Faculty of Science, Masaryk University. Brno (*co-supervisor J. Wagner, since 2016*)

POLÁK L., Faculty of Science, Charles University, Praha (*supervisor L. Ackerman, since 2015*)

ŠMEJKAL R., Faculty of Science, Charles University, Praha (*supervisor S. Čermák, since 2015*)

ŠNELLEROVÁ Z., Faculty of Science, Charles University. Praha (*supervisor R. Skála, since 2012, terminated without defense*)

MSc. Theses

ADAMEKOVÁ K., Faculty of Science, Masaryk University. Brno (*co-supervisor L. Lisá, since 2016*)

7c. Supervision in Graduate Studies

PhD. Theses

DZIKOVÁ L., Faculty of Science, Masaryk University in Brno (*supervisor R. Skála, since 2007, temporarily suspended in 2013*)

HALUZOVÁ E., Faculty of Science, Charles University in Praha (*supervisor L. Ackerman, co-supervisor M. Svojtka, since 2014*)

HOŠEK J., Faculty of Science, Charles University in Praha *(supervisor L. Lisá, since 2010)*

HRUBÁ J., Faculty of Science, Charles University in Praha (*supercisor G. Kletetschka, since 2013*)

JIANG ZUO Q., Vertebrate Paleontology and Paleoanthropology of the Chinese Academy of Sciences. Peking (*external research supervisor J. Wagner, since 2016*)

JONÁŠOVÁ Š., Faculty of Science, Charles University in Praha (*supervisor R. Skála, since 2014*)

KALLISTOVÁ A., Faculty of Science, Charles University in Praha (*supervisor R. Skála, since 2010*)

KOCHERGINA Y.V., Faculty of Science, Charles University in Praha (*co-supervisor L. Ackerman, since 2014*)

KOŘÍNKOVÁ D., Faculty of Science, Charles University in Praha (*supervisor J. Adamovič, co-supervisor, M. Svojtka, since 2015*)

KUBROVÁ J., Department of Geochemistry, Mineralogy and Mineral Resources, Faculty of Science, Charles University in Praha (*supervisor J. Borovička, defended in 2016*)

MARKLEY M., Faculty of Science, Charles University in Praha (*supervisor G. Kletetschka, since 2016*)

MÉSZÁROSOVÁ N., Faculty of Science, Charles University in Praha (*supervisor R. Skála, since 2016*)

MOREAU J.G., Department of Physics, University of Helsinki (*supervisor T. Kohout, since 2016*)

ŠAMÁNEK J., Faculty of Science, Masaryk University in Brno (*supervisor N. Doláková, co-supervisor/advisor R. Mikuláš, since 2016).*

ŠIMEČEK M., Faculty of Science, Charles University in Praha (*supervisor T. Navrátil, since 2015*)

SOUMAR J., Faculty of Science, Charles University in Praha (*supervisor R. Skála, since 2011*)

TEJNECKÁ-ENGLMAIEROVÁ M., Faculty of Science, Charles University in Praha (*supervisor M. Petružálek, co-supervisor/ advisor R. Přikryl, since 2016, temporarily suspended in 2016*)
VAŠINKA M., Faculty of Science, Masaryk University in Brno (*supervisor L. Krmíček, since 2016*)
VAŠKANINOVÁ V., Faculty of Science, Charles University in Praha (*co-supervisor J. Zajíc, since 2010*)
VEJROSTOVÁ L., Faculty of Science, Charles University in Praha *(supervisor L. Lisá, since 2013)*

7d. Membership in Scientific and Academic Boards

BOROVIČKA J.
Member, Presidium, Scientific Secretary, Czech Mycological Society, Praha.

BOSÁK P.
Member, Permanent Commission for defense of Doctor of Sciences (DrSc.) degree in geology (010501–010502) and geochemistry (010533) at the Ministry of Education, Science, Research and Sports of the Slovak Republic (since April 1, 2016).
Chairman, Committee for degree of Doctor of Sciences (DSc.) in geological sciences at the Czech Academy of Sciences, Praha.
Member of the Executive Board of Institute of Geology of the Czech Academy of Sciences, Praha.
Member, Academic Assembly of the Czech Academy of Sciences, Praha.
Member, Board of Graduate Studies in Geology (4 years), Faculty of Science, Charles University, Praha.
Member, Committee for Interdisciplinary study of Quaternary at the Board of Graduate Studies in Geology, Faculty of Science, Masaryk University, Brno.
Supervisor for PhD. studies, Faculty of Science, Masaryk University in Brno.
Member, Committee for State Doctoral Examinations for Interdisciplinary study of Quaternary at the Board of Graduate Studies in Geology, Faculty of Science, Masaryk University, Brno.
Member, Committee for State Doctoral Examinations, PhD. Study Program of Applied Geology, Faculty of Science, Charles University, Praha.
Member, Committee for Defenses of Dissertations, PhD. Study Program of Applied Geology, Faculty of Science, Charles University, Praha.
Member, Committee for Defenses of Dissertations, PhD. Study Program of Physical Geography and Geoecology, Faculty of Science, Charles University, Praha.
Member, Committee for State Doctoral Examinations, PhD. Study Program of Physical Geography and Geoecology, Faculty of Science, Charles University, Praha.
Member, Committee for State Rigorosum Examinations in Geology (general geology), Faculty of Science, Charles University, Praha.

CHADIMOVÁ L.
Committee Member, International Geoscience Programme of the UNESCO and IUGS – Czech National Committee for IGCP.
Corresponding Member, Subcommission on Devonian Stratigraphy of the ICS and IUGS.

FILIPPI M.
Vice-Chairman, Executive Board of the Institute of Geology of the Czech Academy of Sciences, Praha.

HLADIL J.
Member, Committee for degree of Doctor of Sciences (DSc.) in geological sciences at Academy of Sciences of the Czech Republic. Praha.
Member, Board of Graduate Studies in Geology, Faculty of Science, Charles University in Praha.
Member, Board of Graduate Studies in Geology, Faculty of Science, Masaryk University in Brno.
Member, Executive Board of the Institute of Geology of the Czech Academy of Sciences, Praha.

KLETETSCHKA G.
Member, Advisor board Scientific activities, Ministry of Tranport of the Czech Republic, Praha
Member, Advisor board Cosmic activities, Ministry of Tranport of the Czech Republic, Praha.
Member of Review Board, National Aeronautics and Space Administration, USA.

LOKAJÍČEK T.
Member, Board of Graduate Studies in Applied Geology, Faculty of Science, Charles University in Praha.

MIKULÁŠ R.
Vice-Chairman, Advisory Board of the Institute of Geology of the Czech Academy of Sciences, Praha.
Alternating Member of the Doctoral Examination Committee in Geology, Faculty of Science, Charles University, Praha
Member, Editorial Board of the Czech Academy of Sciences, Praha
Member, Advisory Board of the Czech Academy of Sciences for Science Communication, Praha
Member, Academy of Sciences – Chamber of Deputies, Parliament of the Czech Republic Co-operation Committee, Praha
Chair, IGCP-UNESCO National Committee, Praha

NAVRÁTIL T.
Member of the Committee for Finals of Doctoral Students in Applied Geology, Faculty of Sciences, Charles University in Praha.
Member of the Committee for Doctoral Thesis Defense in Applied Geology, Faculty of Sciences, Charles University in Praha.
Member, Earth Science Panel (geophysics, geochemistry, geology mineralogy and hydrogeology) of Czech Science Foundation. Praha.

PRUNER P.
Member of the Board of the Graduate Studies in Geophysics, Faculty of Science, Charles University in Praha
Member of the Commitee for degree of Doctor of Sciences (DSc.) in geological sciences at Academy of Sciences of the Czech Republic, Praha

Member of the Permanent Working Group of Geosciences Accreditation Commission, Czech Republic
Member of the Executive Board of the Institute of Geology of the CAS, Praha.

SKÁLA R.
Chairman, Committee for Finals of Undergraduate Students in Geology, specialization Mineralogy and Crystallography, Faculty of Sciences, Charles University in Praha
Member, Committee for Finals of Undergraduate Students in Geology, specialization Geochemistry, Faculty of Sciences, Charles University in Praha

SLAVÍK L.
Member, Executive Board of Institute of Geology of the CAS, Praha.
Alternating Member, Doctoral Examination Committee in Geology, Faculty of Sciences, Charles University in Praha.
Member, Undergraduate (MSc.) and Doctoral Committee in Geology-specialization Geobiology, Faculty of Sciences, Charles University in Praha.

ŠTORCH P.
Alternating Member, Committee for Degree of Doctor of Sciences in Geological Sciences, Academy of Sciences of the Czech Republic, Praha
Member of the Expert panel 06 (Earth Sciences) for Evaluation of Results of Research and Development. Office of the Government of the Czech Republic, Research, Development and Innovation Council, Praha.

SVOJTKA M.
Member, Committee for Finals of Undergraduate and Doctoral Students in Geology, Faculty of Sciences, Charles University in Praha.
Member, Committee for Finals of Doctoral Thesis Defense in Geology, Faculty of Sciences, Charles University in Praha.

ULRYCH J.
Member, Committee for degree of Doctor of Sciences (DrSc.) in geological sciences at Slovak Academy of Sciences, Bratislava.
Member, Committee for degree of Doctor of Sciences (DSc.) in geological sciences at the Czech Academy of Sciences, Praha.
Member, Board of Graduate Studies in Geology, Faculty of Science, Charles University in Praha.
Member, Committee for Finals of Undergraduate Students in Geochemistry, Faculty of Science, Charles University in Praha.
Member, Committee for Finals of Undergraduate Students in Mineralogy, Faculty of Science, Charles University in Praha.
Member, Examination Committee for Degree of Doctor of Natural Sciences (RNDr.) in Geochemistry and Mineralogy, Faculty of Science, Charles University in Praha.

ZAJÍC J.
Alternating Member, Committee for the PhD. Examination and Defence of Theses in Geology, Faculty of Science, Charles University in Praha.
Alternating Member, Committee for the Master's and RNDr. Doctoral Examination in Paleontology, Faculty of Science, Charles University in Praha.

ŽIGOVÁ A.
Member, Committee of Soil Science and Soil Conservation of Scientific Council of Research Institute for Soil and Water Conservation, v. v. i. Praha.
Member, Committee of the Czech Society of Soil Science, Praha.
Member, Board of the Committee of Soil Science of the Czech Academy of Agricultural Science. Praha.
Member, Board of the Doctoral Examination Committee in Physical Geography and Geoecology, Faculty of Science, Charles University in Praha.

7e. Membership in Foreign Academies

BOSÁK P.
Foreign Member, Polish Academy of Arts and Sciences (election approved by the Polish President in 2007).
Corresponding Member, Slovenian Academy of Sciences and Arts (elected 2005).

LOŽEK V.
Foreign Member, Polish Academy of Arts and Sciences (election approved by the Polish President).

7f. Degrees Obtained by the Staff of the Institute of Geology

Habilitation

KRMÍČEK L.
Effect of the presence of compositionally distinct enclaves on physico-mechanical properties of rocks from granite and syenite massifs: a pilot study from the Czech Republic. Brno University of Technology: 1–116. Brno. (defended on February 24, 2016).

The habilitation thesis shows a possible research trend in the geotechnical engineering discipline of rock mechanics. The effect of the presence of compositionally distinct enclaves on the physico-mechanical properties of host rocks, both from a quartz-rich granitic massif (two-component system enclave–granitoid) and from a quartz-poor syenitic massif (two-component system enclave–syenitoid), is comprehensively tested in this work. The habilitation thesis presents new correlation curves and empirical

■ **Fig. 32.** Setting the core sample for testing its uniaxial compressive strength (photo by V. Černý).

equations based on the Schmidt hammer and Shore scleroscope hardness, uniaxial compressive strength and rock tensile strength of rock bodies containing compositionally (petrographically, mineralogically, geochemically) distinct enclaves (Fig. 32).

PhD.

PETRÁČEK P.

Geometric linear and nonlinear problems of function spaces – PhD. Thesis, Department of Mathematical Analysis, Faculty of Mathematics and Physics, Charles University in Praha: 1–53. Praha (defended on June 23, 2016).

The work focuses on two main topics: the theory of preduals and the search for linear structures in sets of functions and measures with counter-intuitive properties. In the part devoted to the theory of preduals, an existing characterization is extended from the complex setting and a counter example is found to a question posed some thirty years ago. In the part focused on the search for large linear structures, a dense linear space of measures that change their sign on every opened set is found and, furthermore, an algebra of real functions simultaneously continuous with respect to several topologies that achieve every value on a dense set is constructed.

SVOBODOVÁ A.

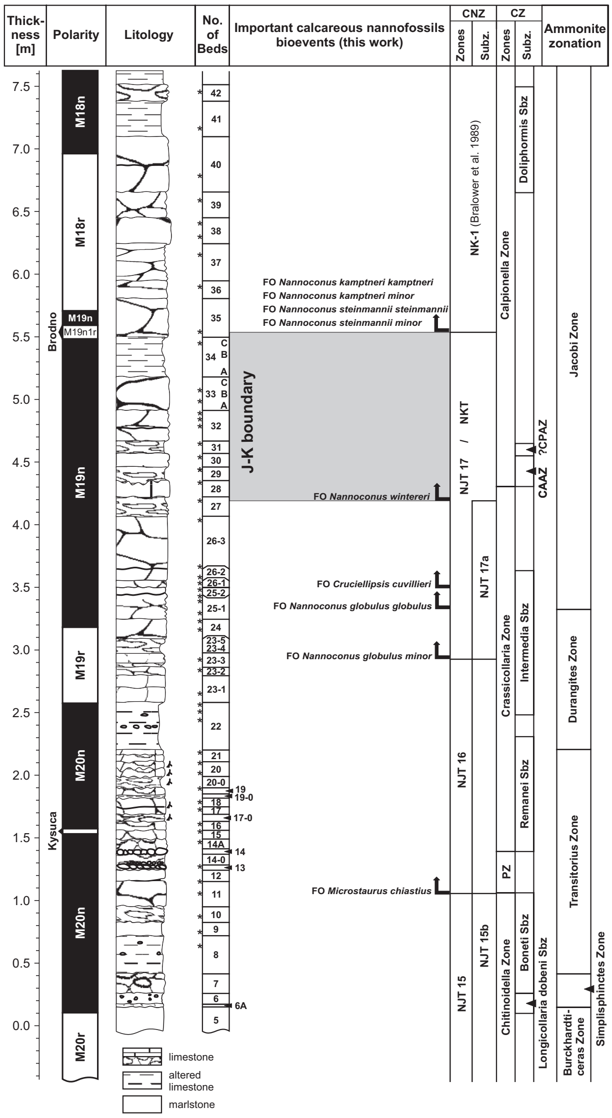
Planktonic ecosystems of the Upper Jurassic and Cretaceous (calcareous nannoplankton, calpionellids). – PhD. Thesis: 1–49. Department of Geology and Palaeontology, Faculty of Science, Charles University in Praha (defended on November 1, 2016).

Despite their small size, calcarous nannofossils and calpionellids deserve a great attention because both of these groups represent a significant component of marine planktonic ecosystems in the geological history. Calcareous nannoplankton fossil record is continuous from the Upper Triassic to the present and it is perhaps the richest and stratigraphically most complete of all fossil groups. Calpionellids represent one of the most important components of the tropical calcareous microplankton in the Tethyan pelagic carbonates from the Upper Jurassic to the Lower Cretaceous. They are excellent biostratigraphic markers and play a key role in the correlation of the Jurassic/Cretaceous (J/K) boundary interval sediments in the Tethyan area. These facts were the main reason for starting this research.

The aim of the PhD Thesis is (1) to expand the stratigraphic research in the Bohemian Cretaceous Basin with calcareous nannofossils data; (2) to contribute to the ongoing research on the J/K boundary interval using calcareous nannofossil and calpionellid analyses within suitable localities in the Tethyan area, where both of these groups are represented. An integral part of the research is the correlation of the results with other applied disciplines, such as magnetostratigraphy biostratigraphy using other fossil groups (ammonites, belemnites, calcareous dinoflagellates) etc. (Fig. 33).

The studied material includes (1) Upper Jurassic and Lower Cretaceous carbonate rocks of the Tethyan area, namely Puerto Escaño section (Spain) and Strapkova section (Slovakia); (2) selected localities in the Bohemian Cretaceous Basin of Upper Turonian and Upper Coniacian ages.

Calcareous nannofossils were studied in smear slides, under the light microscope using an immersion objective with a total magnification of 1,000×. This is commonly used in standard biostratigraphic analysis. The smear slides were prepared using the decanting method (e. g., Bown & Young 1998; Švábenická 2001, 2012), i.e., separating the liquid and the solid substances by a careful decanting of liquid, while the solid substance settlings remain at the bottom. Calpionellids were studied in standard thin sections 20–30 µm in thickness. The light microscope was also used for the standard biostratigraphic analysis.



■ **Fig. 33.** Lithology, magnetostratigraphy, biostratigraphy (calpionellid, ammonite and calcareous nannofossil zonation) and vertical distribution of nannofossil species of the Puerto Escaño section (Svobodová & Košťák 2016). Open circles indicate uncertain species identification. Biozonal (ammonite, calpionellid) and magnetozone data after Pruner et al. 2010 (modified). Nannofossil zones follow Casellato (2010). Expected J/K boundary interval is marked in grey. CNZ – calcareous nannofossil zonation; CZ – calpionellid zonation; CAAZ – *Calpionella alpina* "acme Zone"; ?CPAZ – *Crassicollaria parvula* "acme Zone"; PZ – *Praetintinnopsella* Zone.

From the geological point of view, the dissertation can be divided into two main parts. The first part deals with the J/K boundary interval in the Tethyan area. This time interval is currently one of the most intensively studied periods because the J/K boundary is the last boundary between two stratigraphic systems which has not yet been conclusively defined by the International Commission on Stratigraphy. The study of the J/K boundary includes several geoscience disciplines (e. g., magnetostratigraphy, sequence stratigraphy, biostratigraphy based on macrofossils [ammonites], geochemical analysis, etc.). It should be added that biostratigraphic analysis based on calcareous nannofossils and calpionellids within the above mentioned time interval forms an essential part of this multidisciplinary research.

Rapid global radiation of calcareous microplankton in the mentioned time period was apparently caused by a relative surplus of $CaCO_3$ in the surface oceanic waters. Moreover, the fact that seawater in this time period was aragonite-rich (i.e., not calcite-rich as in the recent oceans) may have also played a role (Ries 2006). A remarkable radiation of the most important groups of the planktonic assemblages (nannoconids, calpionellids) significantly increases their biostratigraphic value and rock-forming potential. From the biostratigraphic point of view, the most important for the base of the Cretaceous is for the calpionellids the beginning of the Alpina Subzone. This is associated with a marked morphological change of loricas of *Calpionella alpina* Lorenz from bigger to small, spherical forms and a replacement of the diversified Upper Jurassic calpionellid assemblage with a monoassociation of this species (Reháková 1995, 2002; Reháková & Michalík 1997). This bioevent is prominent within the calpionellid fossil record and is considered to be the most important stratigraphic marker for the Tithonian/Berriasian boundary. However, calcareous nannofossils also have to be taken into account. For the J/K boundary interval, six most significant and reliable bioevents were defined – the first occurrences (FO) of species *Nannoconus wintereri*, *N. erbae*, *N. steinmannii minor*, *N. steinmannii steinmannii*, *N. kamptneri minor* and *N. kamptneri kamptneri*. In addition, three minor bioevents are known – FO *Hexalithus strictu*, *N. puer* and *N. infans.* Finally, it was emphasized that the most robust and globally recognized bioevent is FO *N. steinmannii minor*, which largely correlates with the basal portion of magnetozone M18r (Casellato & Erba 2016). However, recognizing a suitable profile for the stratotype location is still the subject of research and discussions.

The second part of the dissertation deals with the Bohemian Cretaceous Basin and its diversified and often well-preserved calcareous nannofossil assemblages with biostratigraphic and palaeoecological potential. In recent years, the most important research subject appeared to be the Turonian/Coniacian boundary and then the Cenomanian–Turonian and Coniacian–Santonian boundary intervals.

The analysis of calcareous nannofossils allows also a regressive determination of the stratigraphic position of museum specimens, which was documented in this dissertation (Svobodová et al. 2014). This form of research is of a great importance especially for macrofossils with unspecific locality designation. It should be noted that the importance of calcareous nannofossils in the sediments of the Bohemian Cretaceous Basin is also palaeogeographical, based on the rare occurrences of redeposited specimens of older (Jurassic or Lower Cretaceous) rocks (e.g., *Nannoconus* sp., *Stephanolithion* sp. – Švábenická 2010). From the palaeogeographic point of view, the question on the origin of these redepositions has not been satisfactorily answered yet and provides opportunities for further studies.

BOWN P.R. & YOUNG J.R. (1998): Techniques. – *in*: BOWN P.R. (Ed.): *Calcareous nannofossil biostratigraphy*: 16–28. Cambridge University Press.

CASELLATO C.E. (2010): Calcareous nannofossil biostratigraphy of Upper Callovian-Lower Berriasian successions from the Southern Alps, North Italy. – *Rivista italiana di Paleontologia e Stratigrafia*, 16, 3: 357–404.

CASELLATO C.E. & ERBA E. (2016): Synthesis of calcareous nannofossil events across the Jurassic/Cretaceous boundary: implications for the definition of the Berriasian base. – *in*: MICHALÍK J. & FEKETE K. (Eds.): *XII^th Jurassica Conference: field trip guide and abstracts book*: 119–120. Earth Science Institute of the Slovak Academy of Science. Bratislava.

PRUNER P., *HOUŠA V.*, OLÓRIZ F., KOŠŤÁK M., *KRS M.*, *MAN O.*, *SCHNABL P.*, *VENHODOVÁ D.*, TAVERA J.M. & MAZUCH M. (2010): High-resolution magnetostratigraphy and biostratigraphic zonation of the Jurassic/Cretaceous boundary strata in the Puerto Escaño section (southern Spain). – *Cretaceous Research*: 31: 192–206.

REHÁKOVÁ D. (1995): Nové poznatky o distribúcii kalpionelíd vo vrchnojurských a spodnokriedových súvrstviach Západných Karpát. – *Mineralia Slovaca*, 27: 308–318.

REHÁKOVÁ D. (2002): *Vrchnojurské a spodnokriedové asociácie kalpionelíd a vápnitých dinoflagelát, ich význam pre stratigrafiu a paleoceánografické rekonštrukcie*. – Habilitačná práca: 1–167. Prírodovedecká fakulta Univerzity Komenského v Bratislave.

REHÁKOVÁ D. & MICHALÍK J. (1997): Evolution and distribution of calpionellids – the most characteristic constituents of Lower Cretaceous Tethyan microplankton. – *Cretaceous Research*, 18: 493–504.

RIES J. B. (2006): Aragonitic algae in calcite seas: Effect of seawater Mg/Ca ratio on algal sediment production. – *Journal of Sedimentary Research*, 76: 515–523.

SVOBODOVÁ A. & KOŠŤÁK M. (2016): Calcareous nannofossils of the Jurassic/Cretaceous boundary strata in the Puerto Escaño section (southern Spain) – biostratigraphy and palaeoecology. – *Geologica Carpathica*, 67, 3: 223–238.

SVOBODOVÁ A., KOŠŤÁK M., ČECH S. & ŠVÁBENICKÁ L. (2014): New biostratigraphic evidence (texanitid ammonites, inoceramids and calcareous nannofossils) for the Upper and the uppermost Coniacian in the Bohemian Cretaceous Basin. – *Zeitschrift der Deutschen Gesellschaft für Geowissenschaften*, 165, 4: 577–589.

ŠVÁBENICKÁ L. (2001): Late Campanian/late Maastrichtian penetration of high-latitude calcareous nannoflora to the Outer Western Carpathian depositional area. – *Geologica Carpathica*, 52: 23–40.

ŠVÁBENICKÁ L. (2010): Svrchní turon a hranice turon-coniak na základě studia vápnitých nanofosilií v jizerském vývoji české křídové pánve. – *Geoscience Research Report for 2009*: 58–64.

ŠVÁBENICKÁ L. (2012): Nannofossil record across the Cenomanian-Coniacian interval in the Bohemian Cretaceous Basin and Tethyan foreland basins (Outer Western Carpathians), Czech Republic. – *Geologica Carpathica*, 63: 201–217.

7g. Awards

BOSÁK P.

Honorary member, 50th Speleological Symposium of the Speleological Section of the Polish Society of Naturalists of Copernikus (Oct. 20–23, 2016, Kielce – Chęciny, Poland).

State Decoration of Polish Minister of Environment: Honorable Decoration for Merits in Protection of Environment and Water, No. 2861 from September 6, 2016 given by Deputy Minister of Environment on Sept. 24, 2016 in Stronie Slaskie (celebration of 50th Anniversary of discovery of the Bear Cave in Kletno).

Medal for Merits for the Bear Cave in Kletno by Mayor of Stronie Slaskie City given by Mayor of the City on Sept. 24, 2016 in Stronie Slaskie (celebration of 50th Anniversary of discovery of the Bear Cave in Kletno).

CÍLEK V.

The Award of M. Ivanov for an important non-fiction book "Střední Brdy – hory uprostřed Čech/ Central Brdy Mts. – mountains in the middle of Bohemia" (together with P. Mudra and Z. Sůvová). Prague Book Fair (May 2016).

The award in the category "Most beautiful book of the year 2016" for "Podzemní Čechy/Underground Bohemia" (together with M. Korba and M. Majer), Memorial of the National Literature, Hvězda Chateau (April 2016).

KALLISTOVÁ A.

Enamel 9 Award for Early Career Researchers, Faculty of Science, Charles University in Praha (30th October 30 –November 3, 2016).

PŘIKRYL T.

Otto Wichterle Award, the Czech Academy of Sciences (May 30, 2016).

ŽIGOVÁ A.

Honorary Decree in recognition of contribution to the progress in science and research and for the achieved results applicable to the area of agriculture, Czech Academy of Agricultural Sciences, Praha (May 5, 2016).

7h. Institute Staff on Fellowships and Scholarships

ACKERMAN L.: **Fulbright Research Fellowship, Scripps Institution of Oceanography, University of California, USA**. September 2 to December 4, 2016.

This fellowship resulted in two important aspects. First, a new analytical method for the determination of highly siderophile elements was set up in the laboratories of the Institute of Geology of the CAS. Secondly, an extensive dataset was obtained for the two suites of volcanic rocks representing the core of research project accepted by the Fulbright commission. The results indicate a different evolutionary patterns of these two suites reflecting their origin and evolution (differentiation of melts in a closed *vs.* open system), which can be powerfully traced using highly siderophile element systematics and osmium isotopic composition. These results represent the commenced collaboration between the two teams (Scripps Institution of Oceanography, UCSD & Czech Acad. Sci., Inst. Geol.). This co-operation is planned to be extended through the collaboration in several projects dealing with highly siderophile element geochemistry of mantle-derived carbonatites in the next few years. Two seminars undertaken at two different U.S. universities (Michigan State University & University of South Carolina) allowed to see different U.S. scientific centres, and fruitful discussion with (under)graduate students and colleagues there were strongly inspiring not in terms of science, but also in the understanding of the U.S. system of university education. During these visits, ongoing collaborations with U.S. colleagues have been significantly strengthened, some new data for projects have been obtained (University of South Carolina) and new possibilities of future collaboration have been discussed (Michigan State University).

KLETETSCHKA G.: **Invitation for Research Professor, University of Alaska Fairbanks, USA**. August 16–September 7, 2016.

Invitation to the Geophysical Institute at University of Fairbanks, Alaska, resulted in the formulation of cooperation plans in the area of lake sediment record and in working on journal publication.

KLETETSCHKA G.: **Invitation for Visiting Professor, University of Diderott, Paris, France**. April 1–31, 2016.

Invitation to the University of Diderott in April 2016 allowed a formulation of the work plan in the area of magnetic anomalies and their sources. Together we created a draft for publications about the Moon and about the theory of remanent magnetism.

SLÁMA J.: Fellowship J. E. Purkyně for outstanding creative scientists, Institute of Geology of the Czech Academy of **Sciences, Praha**. 2016–2020.

In connection with the FJEP fellowship, the new excimer laser Excite Teledyne Cetac was purchased to the labs of the Institute of Geology. After a successful installation in autumn 2016 the laser was tested and used for routine analyses of geological samples. During the first 3 months the new laser was already running for hundreds of instrument hours. Analytical techniques were developed for accurate and precise U-Pb dating of zircon and successfully employed in a number of scientific projects. The U-Pb method was further optimized, especially the sample throughput that allowed ca. 50 individual analyses per hour as compared to ca. 30 analyses with the old laser. To correct for the non-linear behaviour of the detector of Element ICP-MS machine (counting *vs.* analogue mode) the new macro-based calculation was coded and used for zircon U-Pb analysis. A great effort was put into the improvement of the mineral separation – especially for the retrieval of heavy mineral fraction from zircon-poor samples where contamination is the greatest threat. The main changes are represented by the introduction of non-toxic separation heavy liquids (LST), the use of clean technique for separation, the use of compressed air, avoiding the big crushers and Wilfley tables, the use of clean consumables, a new type of an adhesive tape, resin with better adhesion, the use of SiC and glass for polishing etc. In the clean labs the new Lu and Hf spikes were prepared for further development of ultra-precise Lu-Hf analysis. In connection with Lu-Hf, the column chromatographic separation was introduced and calibrated. The calibration consists of a separation on the first column (Biorad AG50W-X8, 200–400 mesh) of HFSE and REE from the major part of matrix elements present in rocks/minerals. On the second column (Eichrom Ln resin, 50–100 mesh) the Hf is further purified from Ti, Zr, W and Ta and Lu from Yb and other REEs. A number of collaborations were established during 2016 (other institutes in Czech, UK, Norway, South Africa Republic, Poland). The most important publications are listed below.

ACKERMAN L., BIZIMIS M., *HALUZOVÁ E.*, *SLÁMA J.*, *SVOJTKA M.*, HIRAJIMA T. & ERBAN V. (2016): Re-Os and Lu-Hf isotopic constraints on the formation and age of mantle pyroxenites from the Bohemian Massif. – *Lithos*, 256/257: 197–210.

FARYAD S. W., KACHLÍK V., *SLÁMA J.* & JEDLIČKA R. (2016): Coincidence of gabbro and granulite formation and their implication for Variscan HT metamorphism in the Moldanubian Zone (Bohemian Massif), example from the Kutná Hora Complex. – *Lithos*, 264: 56–69.

GROSCH E. G. & *SLAMA J.* (2017): Evidence for 3.3 billion-year-old oceanic crust in the Barberton Greenstone Belt, South Africa. – *Geology*, 45, 8: 695–698.

KLAUSEN T.G., MÜLLER R., *SLAMA J.* & HELLAND-HANSEN W. (2017): Evidence for Late Triassic provenance areas and Early Jurassic sediment supply turnover in the Barents Sea Basin of northern Pangea. – *Lithosphere*, 9, 1: 14–28.

KONOPÁSEK J., HOFFMANN K.-H., *SLÁMA J.* & KOŠLER J. (2017): The onset of flysch sedimentation in the Kaoko Belt (NW Namibia) – implications for the pre-collisional evolution of the Kaoko-Dom Feliciano-Gariep orogen. – *Precambrian Research*, 298: 220–234.

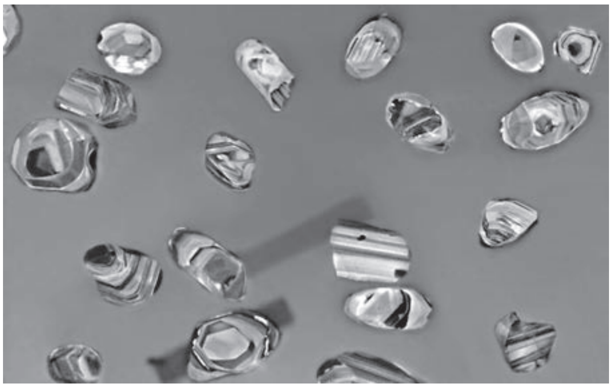
KONOPÁSEK J., *SLÁMA J.* & KOŠLER J. (2016): Linking the basement geology along the Africa-South America coasts in the South Atlantic. – *Precambrian Research*, 280: 221–230.

SOEJONO I., JANOUŠEK V., ŽÁČKOVÁ E., *SLÁMA J.*, KONOPÁSEK J., MACHEK M. & HANŽL P. (2017): Long-lasting Cadomian magmatic activity along an active northern Gondwana margin: U–Pb zircon and Sr–Nd isotopic evidence from the Brunovistulian Domain, eastern Bohemian Massif. – *International Journal of Earth Sciences*, 106, 6: 2109–2129.

SLÁMA J. (2016): Rare late Neoproterozoic detritus in SW Scandinavia as a response to distant tectonic processes. – *Terra Nova*, 28, 6: 394–401.

TOMEK F., ŽÁK J., VERNER V., HOLUB F. V., *SLÁMA J.*, PATERSON S. R. & MEMETI V. (2017): Mineral fabrics in high-level intrusions recording crustal strain and volcano-tectonic interactions: the Shellenbarger pluton, Sierra Nevada, California. – *Journal of the Geological Society of London*, 174, 3: 193–208.

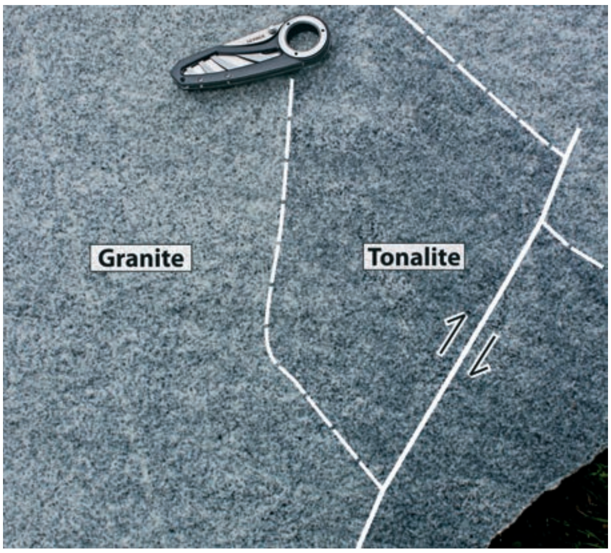
ŽÁK J., *SLÁMA J.* & BURJAK M. (2017): Rapid extensional unroofing of a granite–migmatite dome with relics of high-pressure rocks, the Podolsko complex, Bohemian Massif. – *Geological Magazine*, 154, 2: 354–380.



■ **Fig. 34.** A CL image showing the variability of detrital zircons found in shales of Lower Allochthon of Norwegian Caledonides. The zircon population is formed by local detritus (Mesoproterozoic age) as well as far-travelled detritus from the NE margin of Baltica (Neoptoterozoic, Paleoproterozoic, Archaean; photo by J. Sláma).

TOMEK F.: **Czech Academy of Sciences grant promoting development of international cooperation for early-career scientists**. October 2016–June 2018.

The postdoctoral fellowship focuses on structural inventory of volcanic-plutonic complexes in order to explore the magma ascent, emplacement and eruption processes (see Chapter 4a). In 2016, field mapping and sampling for the anisotropy of magnetic susceptibility (AMS) was conducted in the Altenberg–Teplice ring dyke system (northwestern Bohemian Massif) and the Sternstein Pluton in the NW–SE-trending branch of the Moldanubian Batholith (Fig. 35; southern Bohemian Massif). In addition, analyses of rock magnetism, petrology, whole-rock geochemistry and geochronology were employed to infer full intrusive history of the magmatic rocks.



■ **Fig. 35.** A photo of a syn-plutonic fault crosscutting an enclave of tonalite in granite, Sternstein Pluton, Moldanubian Batholith. WGS84 coordinates: N48.631050°; E14.245510° (photo by F. Tomek; a pocket knife for scale).

TOMEK F.: **Short-term research fellowship AKTION Czech Republic–Austria, Salzburg University, Austria**. October 3 to December 3, 2016.

The project aims to extend an international cooperation with the team of Prof. Fritz Finger (University of Salzburg). The principal goal of the project is to link the geochronology and geochemical signature of the late Variscan Moldanubian Batholith (southwestern Bohemian Massif) with a complex fabric pattern in order to precisely decipher time-pressure-temperature-deformation patterns during the orogenic collapse.

8. Positions in Editorial Boards and International Organizations

8a. Editorial Boards

ADAMOVIČ J.

Příroda, Member of Editorial Board, Nature Conservation Agency of the Czech Republic, Praha, Czech Republic (since 2007).

BOSÁK P.

Acta Carsologica, Member of Executive Board (since 2007), International journal, published by Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia (Member of Advisory Committee 2004–2007).

Aragonit; Member of Editorial Board, published by the Administration of Slovak Caves, Liptovský Mikuláš, Slovakia (since 2008).

Geologica Carpathica, (Co-editor 2001–2005 and since 2012; Member of the Executive Committee 2005–2012), Official journal of the Carpathian-Balkan Geological Association, Earth Science Institute of the Slovak Academy of Sciences,Bratislava, Slovak Republic.

Geologos, Member of Editorial Board, Scientific journal published by Faculty of Geology, Adam Mickiewicz University, Poznań, Poland (since 2000).

International Journal of Speleology, Member of Advisory Board (1994–2005), Member of International Editorial Board (since 2003), Official international journal of the Union Internationale de Spéléologie, published by Societá Speleologica Italiana, Bologna, Italy (until 2005)/University of South Florida Libraries, Tampa (since 2005).

Theoretical and Applied Karstology, Member of editorial board, Scientific journal published by Speleological Institute „Emil Rakoviţa", Bucuresti – Cluj, Romania (since 2000).

Český kras, Co-editor (since 1998; Member of the Editorial Board in 1976 to 1998), Regional journal published by the Museum of the Czech Karst in Beroun, Czech Republic.

Research Reports of the Institute of Geology, Co-editor, Czech Academy of Sciences, Praha, Czech Republic (since 2007).

Slovenský kras/Acta Carsologica Slovaca, Member of the Editorial Board, published by the Slovak Museum of Nature Protection and Speleology and Slovak Caves Administration, Liptovský Mikuláš, Slovakia (since 2014).

Speleo (Praha), Member of Editorial Board, bulletin of the Czech Speleological Society, Praha, Czech Republic (since 1990).

Speleofórum, Co-editor, published by the Czech Speleological Society, Praha, Czech Republic (since 2000).

Editorial Board of the Czech Speleological Society, Member (since 1990).

BREITER K.

Journal of Geochemical Exploration (Elsevier), Associate editor (since 2015).

Zprávy o geologických výzkumech (Geoscience Research Reports), Member of Editorial Board, Czech Geological Survey, Praha, Czech Republic (since 2014).

CÍLEK V.

Slovenský kras/Acta Carsologica Slovaca, Member of Editorial Board, published by the Slovak Museum of Nature Protection and Speleology and Slovak Caves Administration, Liptovský Mikuláš, Slovakia (since 2006).

DAŠKOVÁ J.

Fossil Imprint (formerly Acta Musei Nationalis Pragae, Series B, Historia Naturalis), Member of Editorial Board, Natural History Museum (National Museum), Praha, Czech Republic (since 2016).

HLADIL J.

Bulletin of Geosciences, Co-editor, Czech Geological Survey, Praha, Czech Republic (since 2006).

Geologica Carpathica, Member of Editorial Board, Earth Science Institute of the Slovak Academy of Sciences, Bratislava, Slovakia (since 2001).

Geological Quarterly, Consulting Editor, Polish Geological Institute – National Research Institute, Warsaw, Poland (since 2004).

KRMÍČEK L.

Acta Musei Moraviae – Scientiae geologicae, Member of Editorial Board, Moravian Museum, Brno (since 2013).

LISÁ L.

Geologica Carpatica, Member of Editorial Board, Earth Science Institute of the Slovak Academy of Sciences, Bratislava, Slovakia (since 2013).

MIKULÁŠ R.

Geolines, Member of Editorial Board, Czech Acad Sci, Inst Geol, Praha (since 1998).

Fossil Imprint (formerly Acta Musei Nationalis Pragae, Series B, Historia Naturalis), Member of Editorial Board, Natural History Museum (National Museum), Praha, Czech Republic (since 2008).

PRUNER P.

Geolines, Member of Editorial Board, Czech Acad Sci, Inst Geol, Praha, Czech Republic (since 1997).

Research Journal of Earth Sciences, Member of Editorial Board, IDOSI Publications, Dubai, UAE (since 2009).

Journal of Hydrocarbons Mines and Environmental Research, Member of Editorial Advisory Board, Rennes, France (since 2010).

SKÁLA R.

Journal of Geosciences, Member of the Editorial Board, Czech Geological Society, Praha, Czech Republic (since 2006).

SLAVÍK L.

Bulletin of Geosciences, Member of Editorial Board, Czech Geological Survey, Praha, Czech Republic (since 2013).

Fossil Imprint (formerly Acta Musei Nationalis Pragae, Series B, Historia Naturalis), Associated Editor, Natural History Museum (National Museum), Praha, Czech Republic (since 2016).

ŠŤASTNÝ M.

Acta geodynamica et geomateralia, Member of Editorial Board, Czech Acad Sci, Inst Rock Struct & Mech, Praha (since 1998).

Informátor, Editor, Česká společnost pro výzkum a využití jílů [Czech Society for Study and Utilization of Clays], Praha, Czech Republic (since 1995).

ŠTORCH P.

Bulletin of Geosciences, Co-editor, Czech Geological Survey, Praha, Czech Republic (since 2011).

Paleontological Contributions, Member of Editorial Board, Electronic Journal, University of Kansas, Lawrence, USA (since 2008).

Northwestern Geology, Member of Editorial Board, Xi`an Centre of Geological Survey, China Geological Survey, Xian (since 2012).

SVOJTKA M.

Geolines, Research Reports, Editor-in-chief, Czech Acad Sci, Inst Geol, Praha, Czech Republic (since 1996).

WAGNER J.

Bulletin of Geosciences, Member of Editorial Board, Czech Geological Survey, Praha, Czech Republic (since 2011).

ZAJÍC J.

Bulletin of Geosciences, Member of Editorial Board, Czech Geological Survey, Praha, Czech Republic (since 2001).

ŽÁK K.

Český kras, Member of the Editorial Board (since 2007), Co-editor (since 2008), regional journal published by the Museum of the Czech Karst, Beroun, Czech Republic.

8b. Positions in International Organizations

BOSÁK P.

Honorary Member, the UIS Bureau, the International Union of Speleology (UIS, affiliated to the IUGS; elected in 2009).

Member, Advisory Committee, the International Union of Speleology (UIS, affiliated to the IUGS; elected in 2009, re-elected 2013, 2017).

DAŠKOVÁ J.

Councillor, the Organization of Czech and Slovak palynologists (affiliated to the IFPS; elected in 2008).

HLADIL J.

Committee Member and Web Site Administrator, International Geoscience Programme of the UNESCO and IUGS – Czech National Committee for IGCP (since 1994).

Corresponding Member, Subcommission on Devonian Stratigraphy of the ICS and IUGS (renewed, since 2013).

KLETETSCHKA G.

NASA panels for NASA proposal evaluation.

SLAVÍK L.

Secretary & Titular Member, Subcommission on Devonian Stratigraphy of the ICS/IUGS (appointed in 2016).

Corresponding Member, Subcommission on Silurian Stratigraphy of the ICS/IUGS (since 2011).

ŠTORCH P.

Chairman, Subcommission on Silurian Stratigraphy of the ICS/IUGS (since 2016).

SVOBODOVÁ A.

Secretary and Member of the Czech IGCP National Committee; joined as Co-Opted Member in December 2014.

ZAJÍC J.

Committee Member, International Geoscience Programme of the UNESCO and IUGS – Czech National Committee for IGCP (since 2003).

9. Institute Structure and Staff

9a. Organization Units

The research potential of the Institute is divided into 6 research units:

1. *Department of Geological Processes* extends the knowledge of temperature, pressure and time conditions of different stages of magmatic process in crustal and upper mantle settings as well as of the set of hydrothermal, low- and high-grade metamorphic processes. The evolution of sedimentary basins is studied with special reference to processes affecting the character of sedimentation and diagenesis, and to tectonic deformation of basin fills. Besides the employment of a classical set of geological, petrographic and geochemical methods, new, progressive laboratory approaches have been developed.
2. *Department of Paleobiology and Paleoecology* develops in four principal directions. These comprise the study of living conditions and biostratigraphy of invertebrate fossil groups (conodonts, corals, brachiopods, echinoderms and graptolites), evolution of vertebrate groups (fishes, amphibians and mammals), palynology of Carboniferous and Cretaceous/Cenozoic sediments, and paleoichnology in a broad stratigraphic range from the Ordovician to the Recent.
3. *Department of Environmental Geochemistry and Geology* integrates the studies of chemical elements dynamics in the environment with the geological processes, as they are recorded in sediments and soils formed during the Tertiary and Quaternary. Basic attention is given to the study of complicated interactions between biotic and abiotic components of the nature, climatic oscillations and environmental changes in the past, and anthropogenic impact on the present natural processes.
4. *Department of Paleomagnetism* deals with paleomagnetism, magnetostratigraphy, mineral magnetism, geological interpretation of obtained data, and development of new laboratory techniques. Research is focused on the determination of basic magnetic and paleomagnetic characteristics of Phanerozoic terrestrial and extraterrestrial materials including high-resolu-

tion magnetostratigraphy, and environmental magnetism. Data interpretations encompass geotectonic, stratigraphic and paleogeographic synthesis including paleoclimatic and human-impact reconstructions.
5. *Department of Physical Properties of Rocks* concentrates on the study of strain response of ultrabasic rocks to a dual regime of loading and the analysis of changes of acoustic emission and ultrasound permeability during sample loading. Ultrasonic sounding of rocks and changes in their elastic anisotropy under high pressure are also investigated.
6. *Department of Physical Methods* represents a service analytical unit.

Specialized laboratories

Laboratories of the Institute are not independent units. They are incorporated within the structure of scientific and service departments. The following specialized laboratories have been set up:

1. Paleomagnetic laboratory (Head: Mgr. Petr Schnabl, PhD.)
2. Micropaleontological laboratory (Heads: RNDr. Ladislav Slavík, CSc. & Pavel Lisý)
3. 3D scanner (Head: RNDr. Jaroslav Zajíc, CSc.)
4. X-ray powder diffraction laboratory (Head: RNDr. Roman Skála, PhD.)
5. Scanning electron microscope and electron microprobe laboratory (Supervised by RNDr. Roman Skála, PhD.)
6. Laboratory of molecular spectroscopy (Head: RNDr. Roman Skála, PhD.)
7. Laboratory of rock processing and mineral separation (Head: RNDr. Martin Šťastný, CSc.)
8. Laboratory for thin and polished sections (Head: RNDr. Roman Skála, PhD.)
9. Laboratory of microscopy (Head: Mgr. Michal Filippi, PhD.)
10. Sedimentary laboratory (Head: RNDr. Anna Žigová, CSc.)
11. Fission track laboratory (Head: Mgr. Dagmar Kořínková)
12. Laboratory of liquid and solid samples (Head: RNDr. Jan Rohovec, PhD.)
13. Mercury analysis laboratory (Head: Assoc. Prof. RNDr. Tomáš Navrátil, PhD.)
14. LA-ICP-MS Laboratory (Supervised by Ing. Jana Ďurišová, PhD. & Mgr. Šárka Matoušková, PhD.)
15. Clean Chemistry Laboratory (Supervised by Assoc. Prof. Mgr. Lukáš Ackerman, PhD.)
16. Laboratory of rock behaviour under high pressure (Head: Ing. Tomáš Lokajíček, CSc.)
17. Laboratory of rock elastic anisotropy (Head: Ing. Tomáš Lokajíček, CSc.)

The scientific concept of the Institute and the evaluation of its results lie within the responsibility of the Executive Board that includes both the internal and external members. Besides research, staff members of the Institute are involved in lecturing at universities and in the postgraduate education system. Special attention is also given to the presentation of the most important scientific results in the public media.

9b. Contact Information

Information on the Institute of Geology of the Czech Academy of Sciences and its personnel is available on:

http://www.gli.cas.cz

Institute management	inst@gli.cas.cz
Geolines Editorial Board	geolines@gli.cas.cz
Library	knih@gli.cas.cz

9c. Staff (as of December 31, 2016)

Advisory Board

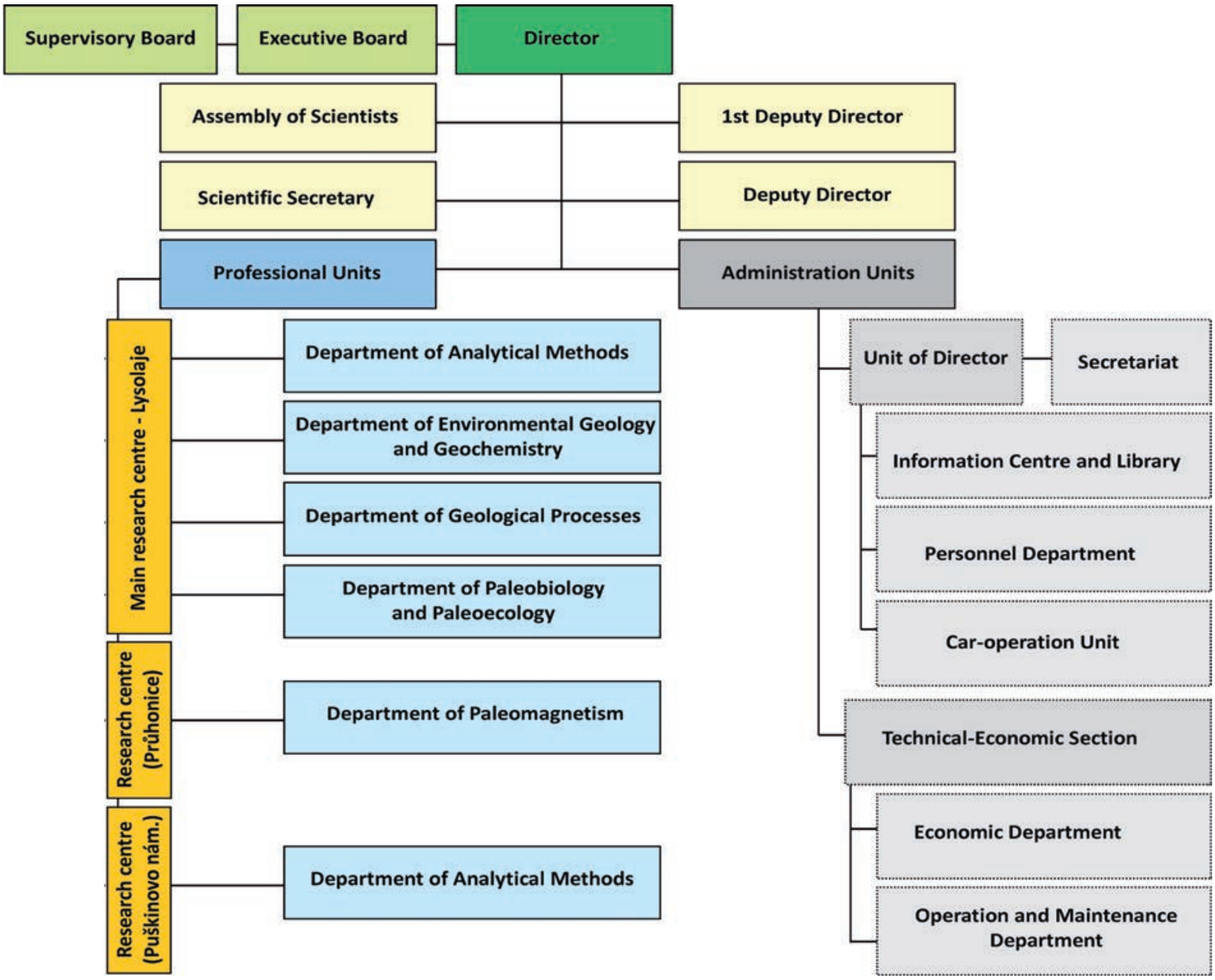
prof. Jiří Chýla, CSc. (Czech Acad Sci, Head Office) . . . . Chairman
RNDr. Radek Mikuláš, CSc., DSc. . . . . Vice-Chairman
prof. Ing. Jiří Čtyroký, DrSc. (Czech Acad Sci, Sci Counc, Praha) . . . . Member
prof. Jiří Pešek, DrSc. (Faculty of Science, Charles University, Praha) . . . . Member
doc. Ing. Richard Šňupárek, CSc. (Czech Acad Sci, Inst Geonics, Ostrava) . . . . Member

Executive Board

RNDr. Petr Štorch, DrSc. . . . . Chairman
Mgr. Michal Filippi, PhD. . . . . Vice-Chairman
prof. RNDr. Pavel Bosák, DrSc. . . . . Member
doc. RNDr. Jindřich Hladil, DrSc. . . . . Member
Ing. Petr Pruner, DrSc. . . . . Member
RNDr. Ladislav Slavík, CSc. . . . . Member
doc. RNDr. Emil Jelínek, CSc. (Charles University, Praha) . . . . Member
doc. RNDr. Stanislav Opluštil, PhD. (Charles University, Praha) . . . . Member
RNDr. Jan Pašava, CSc. (Czech Geological Survey, Praha) . . . . Member

Management

prof. RNDr. Pavel Bosák, DrSc.. . . . . Director of the Institute (CEO)
Mgr. Michal Filippi, PhD. . . . . 1st Deputy Director



Administration units

Unit of Director

Secretariat
Michaela Uldrychová (assistant to the Director)

Information Centre and Library
Bc. Sabina Bielská – Head (librarian)
Mgr. Václava Škvorová – Deputy Head (librarian)
Bc. Jana Popelková (librarian)

Personnel Department
Veronika Šťastná (human resources)

Car Operation Unit
Jaroslav Kratochvíl (garage attendant, driver, storeman, janitor; until Dec. 5)
Karel Jeřábek (driver)

Technical-Economic Section
Ing. Bohumil Pick – Head

Economic Department
Iveta Höschlová (accountant)
Alena Kocová (phone operator, mail service)
Ing. Irina Kosevanova (janitor)
Eva Petráčková (accountant)
Bc. Michal Molhanec (IT specialist)
Renata Müllerová (accountant)
Oksana Seniv (janitor)

Operation and Maintenance Department
Jaroslav Kratochvíl (technical service; until Dec. 5)

Scientific departments

Department of Geological Processes

Scientific Staff:
Mgr. Martin Svojtka, PhD. – Head (petrology of deep crustal rocks, geochronology, geochemistry)
doc. Mgr. Lukáš Ackerman, PhD. – Deputy Head (geochemistry, mantle petrology)
Mgr. Jiří Adamovič, CSc. (basin analysis, tectonics)
RNDr. Karel Breiter, PhD., DSc. (petrology, mineralogy)
Mgr. Jan Černý (structural geology)
RNDr. Miroslav Coubal, CSc. (structural geology, tectonics)
Ing. Jiří Fiala, CSc. (petrology, structure of lithosphere)*
doc. RNDr. Jindřich Hladil, DrSc. (Devonian environments, experimental sedimentology, dust deposition)*

Mgr. Tomáš Hrstka, PhD. (microanalysis using scanning electron microscopy)
RNDr. Leona Koptíková–Chadimová, PhD. (sedimentary petrology, metasediments, magnetic susceptibility)
doc. RNDr. Lukáš Krmíček, PhD. (geochemistry, igneous petrology)
Mgr. Lenka Lisá, PhD. (Quaternary sedimentology)
Mgr. Jiří Sláma, PhD. (geochronology, isotope geochemistry)
Mgr. Filip Tomek (magmatic petrology, structure geology)
Mgr. Jakub Trubač (magmatic petrology, geochemistry)
doc. RNDr. Jaromír Ulrych, DrSc. (igneous petrology, geochemistry)*
Mgr. Hedvika Weinerová (sedimentary petrology, metasediments, magnetic susceptibility)

Technical Staff:
Ing. Jana Ďurišová, PhD. (mass spectrometry analyst)
Mgr. Jiří Filip, CSc. (fission track dating)
Mgr. Eva Haluzová PhD. (clean laboratory analyst)
Mgr. Dagmar Kořínková (fission track methods)
Mgr. Šárka Matoušková, PhD. (mass spectrometry analyst)
Jana Rajlichová (graphics)
RNDr. Martin Štastný, CSc. (mineral separation)

Department of Paleobiology and Paleoecology

Scientific Staff:
RNDr. Ladislav Slavík, CSc. – Head (Silurian–Devonian stratigraphy, conodont biostratigraphy, sedimentary sequences, paleogeography)
Mgr. Andrea Svobodová, PhD. – Deputy Head (Cretaceous palynology)
RNDr. Jiří Bek, CSc., DSc. (Devonian and Carboniferous spores)
RNDr. Stanislav Čermák, PhD. (Cenozoic vertebrate paleontology, small mammals)
Mgr. Jiřina Dašková, PhD. (Carboniferous and Cenozoic palynology)
Mgr. Jana Frojdová (Carboniferous and Permian ferns)
RNDr. Radek Mikuláš, CSc., DSc. (ichnofossils)
RNDr. Tomáš Přikryl, PhD. (vertebrate paleontology, fishes)
Prof. RNDr. Zbyněk Roček, DrSc. (origin and evolution of the Amphibia, Tertiary Anura and Sauria)*
Mgr. Filip Scheiner (Tertiary foraminifers and paleoecology)
RNDr. Petr Štorch, DrSc. (graptolite stratigraphy, stratigraphy in general, sedimentary sequences, paleogeography)
RNDr. Marcela Svobodová, CSc. (Cretaceous palynology)**
Mgr. Radek Vodrážka, PhD. (Cretaceous macrofauna and paleoecology)
Mgr. Jan Wagner, PhD. (Cenozoic vertebrate paleontology, large mammals)
Mgr. Tomáš Weiner (Late Devonian conodonts and bioevents)
RNDr. Jaroslav Zajíc, CSc. (Carboniferous and Permian vertebrates and stratigraphy, acanthodians)
RNDr. Jiří Žítt, CSc. (Cretaceous and Tertiary paleoecology and sedimentology, echinoids and crinoids)**

Technical Staff:
Pavel Lisý (technician)

Department of Environmental Geology and Geochemistry

Scientific Staff:
doc. RNDr. Tomáš Navrátil, PhD. – Head (aquatic and environmental geochemistry)
RNDr. Jan Rohovec, PhD. – Deputy Head (analytical chemistry, ICP analyses)
RNDr. Jan Borovička, PhD. (biogeochemistry)
prof. RNDr. Pavel Bosák, DrSc. (karstology, geomorphology, sedimentology)
RNDr. Václav Cílek, CSc. (Quaternary and environmental geology)
Mgr. Michal Filippi, PhD. (mineralogy, environmental geochemistry)
Mgr. Jaroslav Hlaváč, PhD. (Quaternary geology, malacozoology)
RNDr. Tereza Nováková, PhD. (geochemistry of sedimentary rocks, geomorphology)
RNDr. Maria Vaňková (environmental geochemistry)
RNDr. Karel Žák, CSc. (Quaternary geology, environmental geochemistry)
RNDr. Anna Žigová, CSc. (pedology, paleopedology)

Technical Staff:
Ing. Irena Dobešová (environmental monitoring)
Světlana Hubičková (technician)
Bc. Michal Roll (technician, economic geology)
Michaela Uldrychová (secretary)

Department of Paleomagnetism

Scientific Staff:
Mgr. Petr Schnabl, PhD. – Head (geophysics, paleomagnetism)
Ing. Petr Pruner, DrSc. – Deputy Head (geophysics)*
Dr. Tiiu Elbra, PhD. (paleomagnetism, geophysics)
Mgr. Martin Chadima, PhD. (geophysics, paleomagnetism)
RNDr. Günter Kletetschka, PhD. (paleomagnetism, geophysics)
Mgr. Tomáš Kohout, PhD. (physical properties of meteorites)

Technical Staff:
Mgr. Kristýna Čížková (geophysics)
Bc. Šimon Kdýr (technician)
Bc. Ladislav Nábělek (geophysics)
Mgr. Petr Petráček, PhD. (programming)
Jiří Petráček (technician)

Department of Physical Properties of Rocks

Scientific Staff:
Ing. Tomáš Lokajíček, CSc. – Head (rock elastic anisotropy)
Mgr. Tomáš Svitek – Deputy Head (geophysics, elastic anisotropy analysis)
Mgr. Matěj Petružálek (geophysics, acoustic emission analysis)

Technical Staff:
Lucie Holomčíková (technician, administrative)
Vlastimil Filler (technician, electrician)
Vlastimil Nemejovský (mechanic, technician, rock cutter)
Ing. Libor Svoboda (technician, machinery design, rock grinding)
Martina Tejnecká-Engelmaierová (technician)

Department of Analytical Methods

Scientific Staff:

RNDr. Roman Skála, PhD. – Head (X-ray powder diffraction)

Technical Staff:

RNDr. Zuzana Korbelová – Deputy Head (microprobe and scanning microscope)
Jaroslava Jabůrková (technician, grinding, preparation of thin/polished sections)
Ing. Šárka Jonášová (microprobe and scanning microscope analyst/Raman spectroscopy)
Mgr. Anna Kallistová (X-ray powder diffraction)
Mgr. Noemi Mészárosová (microprobe and scanning microscope/Raman spectroscopy)

Emeritus employees

Fiala Jiří *	fiala@gli.cas.cz
Forman Josef **	forman@gli.cas.cz
Hladil Jindřich*	hladil@gli.cas.cz
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Žítt Jiří **	zitt@gli.cas.cz

** emeritus employee – academical*
*** emeritus employee – institutional*

Note: Czech scientific and pedagogical degrees are equivalents of:

Czech degree	Equivalent
Bc.	BSc, BA
prom. geol., prom. fyz., Mgr.	MSc, MA
RNDr., PhDr.	no equiv.
CSc.	PhD.
DrSc.	DSc.
doc.	Assoc. Prof.
Ing.	Dipl.-Ing.

Staff News

Left the Institute:

Filip Jiří	December 31
Hlaváč Jaroslav	December 31
Kratochvíl Jaroslav	December 5
Mocová Vlasta	August 31
Nábělek Ladislav	December 31
Šimeček Martin	July 31
Štěrbová Věra	May 31

Joined the Institute:

Dašková Jiřina	February 1
Kdýr Šimon	February 1
Nováková Tereza	October 24
Roll Michal	November 1
Scheiner Filip	February 1
Sláma Jiří	January 1
Weiner Tomáš	February 1
Weinerová Hedvika	February 1

9d. Laboratories

The chapter summarizes the list of the most important laboratory equipment.

Paleomagnetic laboratory (Head: Mgr. Petr Schnabl, PhD.)

The *Magnetic Vacuum Control System (MAVACS)* (1984) is a self-contained automatic system creating a limited space with the magnetic field eliminated, i. e. a non-magnetic environment or magnetic vacuum. The operation of MAVACS is based on the feedback loop principle. The Earth's magnetic field is compensated for by the triaxial Helmholz Induction Coil System HELICOS. The resulting field difference is continually measured in each of its three axes by the Rotating Coil Magnetometer ROCOMA, which has its sensors installed inside the HELICOS. The output of the ROCOMA controls the Iduction Coil Control Unit ICCON, which supplies the HELICOS generating the compensating magnetic field. In this way the feedback loop is closed in all the three axes, thus securing a variation-free magnetic vacuum. The above mentioned factors formed the basis for the development of a system which creates a magnetic vacuum in a space of about 5 litres below a value of ± 2nT, the typical offset of the magnetic field sensor being smaller than ± 0.1nT. Multi-component analysis of the structure of the remanent magnetization and reproduction of the paleomagnetic directions even in rocks whose magnitude of secondary magnetization represents 97 to 99 % of the magnitude of natural remanent magnetization, can be achieved accurately with this system.

The *JR-6A* and two *JR-5A Spinner Magnetometers* (2002, 1997, 2003) – the most sensitive and accurate instruments for measurement of remanent magnetization of rocks. All functions are microprocessor-controlled.

The *KLY-4S Kappabridge*, *CS-23* and *CS-L Furnance Apparatus* (2000) – sensitive, commercially available laboratory instrument for measuring anisotropy of magnetic susceptibility (AMS) as well as bulk susceptibility and for measuring the temperature variation of susceptibility (from −190 to 700 °C).

AGICO MFK1-FA Kappabridge is the most sensitive laboratory instrument for measuring magnetic susceptibility and its anisotropy. In conjunction with a CS4/CSL temperature control unit it is further used for measuring temperature dependence of magnetic susceptibility over a temperature range of

−192 °C to 700 °C. MFK1-FA represents a fully automatic inductivity bridge, which allows high precision measurements at three different frequencies (976 Hz, 3904 Hz, 15616 Hz) and in wide field range (2-700 A/m). MFK1-FA Kappabridge with 3D-Rotator allows rapid measurements with full auto-ranging and enables to determine 640 directional susceptibilities during a single anisotropy measurement. The measurements are controlled by the SAFYR4W (magnetic susceptibility, anisotropy) and SUFYTE5W (temperature dependence) software (2016).

Two *LDA -3 AF Demagnetizer* (2000, 2002) – the process is microprocessor-controlled and automated.

The *MMPM 10 PULSE MAGNETISER* (2006) and the magnetizing coil serves for the induction of the isothermal remanent magnetization.

The *AMU-1A Anhysteretic Magnetizer* (2003) is an option to the LDA-3 AF demagnetizer. This equipment permits the deliberate, controlled anhysteretic magnetization of a specimen.

The *KLF-4 magnetic susceptibility meter* (2004) is designed for rapid and precise laboratory measurement of magnetic susceptibility of rocks, soils, and materials investigated in environmental studies in weak magnetic fields ranging in their intensity from 5 A/m to 300 A/m.

755 SRM for Discrete Samples with Automatic Sample Handler and AF Degausser (2007).

Liquid helium-free Superconducting Rock Magnetometer (SRM), type 755 4K SRM (2007) – the set includes a measurement system, alternating field demagnetizer, three-layer permalloy degauss shield, automatic sample holder, electronic unit and software. Sensitivity of the dipole moment is lower than 1×10^{-12} Am^2 RMS for aperture size (sample size) of 4.2 cm. A system is including an automatic sample holder, permitting remanent magnetization measurement in three axes. Possibility of remanent magnetization measurement is without sample rotation.

Micropaleontological laboratory (Heads: RNDr. Ladislav Slavík, CSc. & Pavel Lisý)

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

3D scanner (Head: RNDr. Jaroslav Zajíc, CSc.)

Two devices (2012) enable to collect and evaluate 3D data (as spatial data clouds) of the real geologic or paleontological objects. The utility software allows many ways of measurements. With the help of the additional software solution, it is subsequently possible to model virtual surfaces, virtual closed objects and any cross-sections. All virtual objects can be visualised and rotated with the help of 3D modelling programs.

The *MicroScribe® MX* is a portable measurements system with metrology-level accuracy in six degrees of freedom. This system enables the 3D data collection efficiency of coordinate measurement systems at an affordable price. The counter-balanced and intuitive articulation of the arm allows to quickly position the stylus into even tight spaces. The arm can reach up to 63 cm and the work sphere diameter is 1.27 m. The device works with a precision of up to 0.0508 mm and its weight is 5.4 kg.

MicroScribe Utility Software (MUS) allows data acquisition for some applications that do not provide native support.

The *Kreon Skiron* is a very compact, light and ergonomic 3D laser scanner. Fully integrated on the MicroScribe® desktop digitizer (MX series), this laser scanner dramatically reduces digitizing time. Laser of the class II can scan at speed up to 45 000 points/second with accuracy of 50 µm. Maximum laser line is 75 mm, the measuring field is 65 mm, and stand-off distance is 50 mm. The line resolution is 83 µm and vertical resolution (sub-pixel) is 16 µm. Dimensions of the device are 112 × 61 × 76 mm and its weight is only 260 g.

Scantools 3D software gives access to the functionalities of the Skiron scanner. This easy to use software allows data collection in a very short time as well as processing them. The data processing is solved with help of the *3D NURBS modeling software Rhinoceros®*. Two plug-ins are applied with the Rhinoceros: the *Flamingo* to raytrace rendering and the *Bongo* to animation creation.

X-ray powder diffraction laboratory (Head: RNDr. Roman Skála, PhD.)

The *Bruker D-8 DISCOVER X-ray powder diffractometer* (2011) is a multi-purpose 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.). The 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 Kα1 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., Kα1,2 radiation is used), the beam is limited with a collimator and the sample is placed on a special motorized xyz-stage.

For routine analytical work, also the compact *Philips X'Pert X-ray powder diffractometer* (consisting of PW 1830 generator, PW 3710 MPD control unit, PW 3020 goniometer, PW 1752 secondary graphite monochromator, and PW 3719 display unit; 1997) can be used.

Scanning electron microscope and electron microprobe laboratory (Head: RNDr. Roman Skála, PhD.)

The *TESCAN VEGA3XMU scanning electron microscope (SEM)* is an SEM of a variable pressure construction and 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 as well as energy-dispersive (ED) spectrometer Bruker QUANTAX 200 with Bruker X-Flash 5010 detector (129 eV resolution on MnKα line). Also available is a low vacuum secondary electron detector (LVSTD). The source of electrons is a tungsten-heated cathode. The system has been acquired in 2010.

In 2012, color cathodoluminescence (CL; detection range 350–850 nm) detector has been added to the system.

The *CAMECA SX-100 electron probe microanalyser (EPMA)* (2002) is used mainly for non-destructive quantitative analysis of solid-state materials on the micrometer scale from selected spots down to a few microns across. The instrument is equipped with four wave-dispersive crystal spectrometers. Two of them carry 4 individual standard crystals each (LIF; PET; TAP; PC0 and PC1, respectively), two other house two so-called large crystals each (i.e. crystals with lower detection limits; LLIF; LTAP; LPET; LPC2). Instrument allows analysis of specimens for elements from B to U. To image studied samples, the back-scattered-electron (BSE) and secondary-electron (SE) detectors are used. The ED spectrometer Bruker X-Flash 5010 (2015).

To make the specimens conductive for EPMA/SEM chemical analyses, a coating by carbon is used. For imaging of rough surfaces using secondary electrons in high vacuum, samples are sputtered with gold to prevent their charging. The laboratory owns necessary instruments to carbon-coat or gold-sputter the specimens including

VEB HOCHVAKUUM DRESDEN B 30.2 with R HVG 32 glass recipient (1976): carbon-coater

CARL ZEISS JENA HBA 1 (1968): metal-stutterr

QUORUM Q150T ES (2014): coater – it allows controlled deposition of conducting media on samples to be investigated.

Laboratory of molecular spectroscopy (Head: RNDr. Roman Skála, PhD.)

The *Spectroscopy & Imaging GmbH (S&I) MonoVista CRS+ Raman micro-spectrometer* (2015) is based on the Olympus BX-51 WI upright microscope, Princeton Instruments SpectraPro SP2750 spectrometer (750 mm focal length and aperture ratio f/9.7) and a CCD detector ANDOR iDus 416 with 2,000 × 256 pixels (pixel size 15 µm). Excitation lasers have wavelengths of 488, 532, and 785 nm. Microscope is designed for sample observation in either reflected or transmitted light; an option of (cross-)polarization is available. Objective lenses with following magnifications are installed on microscope turret: 10×, 50×, 50× LWD and 100×. Samples are placed on computer controlled motorized stage. Spatial resolution with 100× objective is 1 µm laterally and 2 µm axially. System allows collection of spectra within the range of 60–9,300 cm^{-1} with 532 nm excitation laser and 60–3,500 cm^{-1} with 785 nm excitation laser. Spectral resolution is better than 1.0 cm^{-1} for 1,800 $gr.mm^{-1}$ grating and 532 nm excitation laser and 0.65 cm^{-1} for 1,200 $gr.mm^{-1}$ grating and 785 nm excitation laser.

Laboratory of rock processing and mineral separation (Head: RNDr. Martin Šťastný, CSc.)

WILFLEY 13 B (1990): laboratory table

VT 750 (1992): vibration processor

*CD 160*90* (1991): crusher

RETSCH (1970): laboratory mill

ŽELBA D 160/3 (1999): crusher

SIEBTECHNIK (1995): mill

LAC LMH 11/12 (2011): muffle oven

4H HYDROTRONK MONTOLIT (2011): hydraulic slab cutter

FRANTZ (2016): electromagnetic separator

GÜDE (2016): compressor

Laboratory for thin and polished sections (Head: RNDr. Roman Skála, PhD.)

To prepare the samples for optical microscopic, SEM and/or EPMA studies a suite *of cutting, grinding, lapping and polishing machines* to manufacture polished sections or thin sections is available.

MONTASUPAL (2 pcs, 1977): grinding machine with diamond platen wheels

Custom-made grinding machines with wheels for loose abrasive powder (2 pcs, 1986 and 1898)

Custom-made saw (1988)

STRUERS DISCOPLAN TS (ROK): cutting and grinding machine (2005)

STRUERS PLANOPOL-3 (1989): polishing machine

KENT MARK II (2 pcs, 1970): polishing machine

MTH APX-010 with *MTH KOMPAKT-1031* (2005): polishing machine

Laboratory of microscopy (Head: Mgr. Michal Filippi, PhD.)

Laboratory of microscopy is used for the first identification of the studied samples and for a detailed preparation for other more sophisticated methods. The equipment of the laboratory enables a photographic documentation of samples and also basic image analyses (for example in case of the thin sections).

The *OLYMPUS BX51* polarization microscope with the *OLYMPUS DP70* digital camera and *U-RFL-T fluorescence light source* equipped with X-ray fluorescence with wavelength filters;

QuickPHOTO MICRO 2.2 software (2006) and *Deep Focus* module

The *OLYMPUS SZX16* Binocular microscope with digital camera *CANON EOS 1200*

Deep Focus 3.0 (2007): software

OLYMPUS SZ51 (2007): binocular microscope

Sedimentary laboratory (Head: RNDr. Anna Žigová, CSc.).

The laboratory is equipped with apparatus for samples preparation and pH measurements:

Analytical balance *SETRA EL–2000S* (1999)

WST 5010 (1991): laboratory dryer

FRITSCH (1986): planetary mill

pHmeter pH 330 / SET (2000)

TESLA (1985): ultrasonic cleaner

Fisson track laboratory (Head: Mgr. Dagmar Kořínková)

The laboratory develops fission-track dating analysis for determining the age and time-temperature evolution of minerals and rocks.

Analytical system for fisson track analysis:

– *AXIOPLAN ZEISS* microscope and Trackscan *452110 AUTOSCAN* system (1999)

– *ZEISS IMAGER M1m* microscope and *AUTOSCAN* computer-controlled microscope stage (2008)

Polishing and grinding machine *MTH APX 010* (2003)

Laboratory of liquid and solid samples (Head: RNDr. Jan Rohovec, PhD.)

Ultrasonic horn Bandelin Sono plus (2016)
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 weights*
TOC-VCPH Shimadzu (2011): total Carbon Analyser
MARS (2009): microwave digestion unit – with 8 fully equipped PTFE digestion vessels.
*MILESTONE mls 1200 meg*a (2009): microwave digestion unit – with 6 fully equipped PTFE digestion vessels.
CINTRA 303 (2009): UV-VIS Spectrometer
BALANCE 2000G (1999): analytical weights
B-2A Epi/FL (1996): filtration blocks
SARTORIUS Basic analytical (1992): analytical weights

Mercury analysis laboratory (Head: doc. RNDr. Tomáš Navrátil, PhD.)

AMA 254 mercury analyser (2008): mercury analysis in solid and liquid samples on CV-AAS principle.
PSA Millennium Merlin (2009): ultra-low mercury analysis in liquid samples on CV-AFS principle. Extension of this analytical procedure with a single-purpose HPLC enables mercury species separation and analysis.
Shimadzu DOC/TOC analyser (2010): Dissolved organic carbon content, total organic carbon content, inorganic carbon in aqueous samples.
RA-915M mercury analyser (2016): real time direct detection of mercury vapor analysis in air and gases.

LA ICP-MS Laboratory (Supervised by Ing. Jana Ďurišová, PhD. & RNDr. Šárka Matoušková, PhD.)

The laboratory is equipped with a high-resolution magnetic sector field ICP-MS (inductively coupled plasma – mass spectrometer) *ELEMENT 2* (ThermoFisher Scientific; 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 Element 2 ICP-MS is coupled with an *ANALYTE EXCITE EXCIMER* 193 nm laser ablation system (Teledyne; 2016) for analysing solid samples and with an Aridus II desolvating nebulizer (Teledyne; 2009).

Clean Chemistry Laboratory (Supervised by doc. Mgr. Lukáš Ackerman, PhD.)

Laboratories for processing of samples destined for (ultra)trace 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 × fume-hood designed for the work with strong acids. The other lab (class-10000 filtered air) is using for a clean chemistry (e.g., ion exchange chromatography separation, special chemical procedures for separation of certain elements) and final preparation of the samples for mass spectrometry (HR-ICP-MS, MC-ICP-MS, TIMS). It contains 2 × originally designed laminar flow hoods (class-100 filtered air), 1 × open laminar flow work space (class-100 filtered air), 2 × analytical weight (0.0000X g), 1 × device for the preparation of clean water (Millipore Elix 3 + Millipore Milli-Q Element), 1 × teflon destillation aparatus (Savillex) for the preparation of ultraclean acids and 1 × centrifuge (2009).

Laboratory of rock behaviour under high pressure and Laboratory of rock elastic anisotropy (Head: Ing. Tomáš Lokajíček, CSc.)

The research of the laboratory was focused on grant projects solving, on projects of international cooperation, training of undergraduate and graduate students and solving of special practical problems in terms of the industrial projects in 2009.

The new methods are developed for assessment of stability mechanically loaded rocks, for multichannel monitoring of seismoacoustic signals occurring during various loading regime. The special software programs are created for automatic pre-processing of acoustic signals and for processing of acoustic series. Processing of acoustic series is based on the correlation and fractal analysis.

Special unique apparatus for investigation of elastic anisotropy enables to measure in 132 independent directions. Obtained results are processed by form of isolines of P-wave velocities in the dependence on confining stress.

MTS 815 (2004): PC controlled servo-hydraulic rock-testing system with high stiffness for compressive loading up to 4,500 kN.
High pressure chamber for elastic anisotropy measurement under hydrostatic pressure up to 700 MPa (2000).
PG-HY-700-1270 (700 MPa; 2007): electronically controlled high pressure generator.
Hydraulic press for uniaxial compressive loading up to 3,000 kN (1958) with conventional triaxial cell for confining pressure up to 150 MPa (1990).
Hydraulic press for uniaxial compressive loading up to 300 kN (1960).
Hydraulic press for uniaxial compressive loading up to 100 kN (1965).
Rheological weight press for uniaxial compressive loading up to 500 kN (1974).
Rheological mechanical presses for uniaxial compressive loading up to 80 kN (1969).
Rheological weight presses for tensile loading up to 3 kN (1974).
Vallen AMSY-5 (2003): multichannel acoustic emission system.
Hottinger (Centipede-100, UPM-40, UPM-60; 2003): digital strain meters.
Permeability apparatus for measurement of permeable and low permeable materials under constant hydraulic incline (2006).
Piezo-ceramics sensors for monitoring P and S waves in the wide frequency band.

Equipment for sample preparation (stone saw machines, drilling machines, grinding and milling machines) allows preparation of test samples (specimens) of various shapes (cubic, prismatic, cylindrical, spherical).

10. Financial Report

in thousands of Czech Crowns (CZK)

A. INCOMES		
1.	From the annual budget of the CAS	35 405
2.	From the Grant Agency CR (accepted research projects)	7 588
3.	From theTechnological Agency CR (accepted research projects)	687
4.	From the internal research projects of the CAS	1 953
4.	From other public sources	1 078
5.	Applied research	4 393
6.	Investment (instruments)	14 108
7.	Investment (constructions)	0
TOTAL INCOMES		**65 212**

B. EXPENSES		
1.	Scientific staff (wages, insurances)	30 947
2.	Research and scientific activities	11 627
3.	Administration and technical staff (wages, insurances)	5 706
4.	General expenses (service, maintenance of buildings, energies, transport, office supplies, miscellaneous, etc.)	1 842
5.	Library	831
6.	Editorial activities	151
7.	Investment (instruments)	14 108
8.	Investment (constructions)	0
TOTAL EXPENSES		**65 212**

Notes

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