INTRODUCTION

to the **Institute of Geology** of the CAS, v. v. i.

Institute of Geology CAS, v.v.i.

First edition 2015

Published by the Institute of Geology of the Czech Academy of Sciences, v. v. i.

Purpose and structure of the text

Who we are…

Where we work…

What we offer…

What we do…

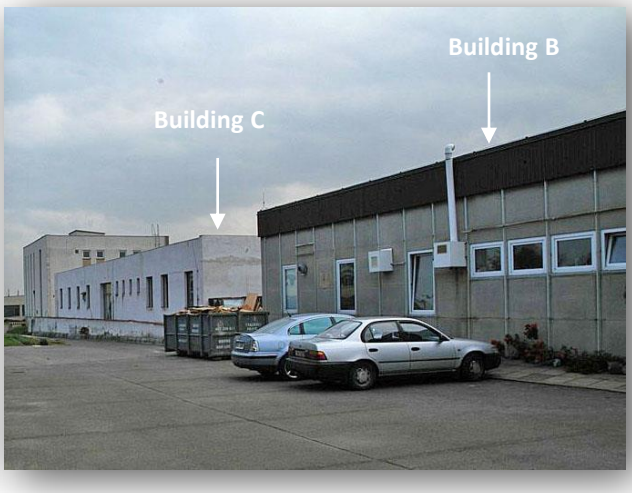
The Geological Institute of the Czechoslovak Academy of Sciences (ČSAV) was founded on July 1, 1960. Nevertheless its structure had developed in the period of 1957 to 1961. During this period, several independent laboratories were constituted: Laboratory of Paleontology, Laboratory of Engineering Geology, 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 CAS, v. v. i., and the evaluation of its results lie within the responsibility of the Executive Board and Supervisory Board which include both the internal and external members. Plans of the Institutional Financing are evaluated by the special Committee at the CAS. 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.



Photos of the three old buildings of the Institute of Geology. Building A was used in period 1969 – 2009; building B in period 1976 – to this day (reconstructed in 2009 – 2010); building C in period 1983 – 2007.

The Institute of Geology (IG) of the Czech Academy of Science (CAS), v. v. i., is a public research institute of modest size: it employs 90 to 100 staff members (i.e. 67 to 69 recalculated full-time job workers) including 43 to 49 scientists (in 2015). The Institute is a permanently stabilized, relatively homogeneous and internally integrated modern scientific institution, which covers a significant portion of the set of geological sciences. After 55 years of provisional arrangement, it is housed in a new, well technically equipped building (since 2009).

The IG is an institution with a multi-disciplinary focus, with historically delineated, i.e. "traditional", research themes, and with the ability of scientists to respond to topical needs and problems. The Institute collaborates with other geoscientific institutions in the Czech Republic and abroad (research institutes, universities/technical universities) in disciplines which are not personally covered at the Institute. In addition, the international co-operation gives the opportunity to use scientific equipment not operated at the IG. Despite the overall fragmentation and specialization of all sciences, the Institute represents a relatively homogeneous scientific body, tied together by a number of running projects, irrespective of its organizational chart (see more in section Scientific ability). Although the number of grant projects slightly decreases in last years (which is however a general trend after the dissolution of one of the grant agencies in the Czech Republic – Grant Agency of the Academy of Sciences CR), the incoming financial support has not changed much. Many of the Institute employees lecture at universities, spread scientific knowledge among the public and participate in scientific activities such as peer reviews, work in university boards and editorial boards of journals.

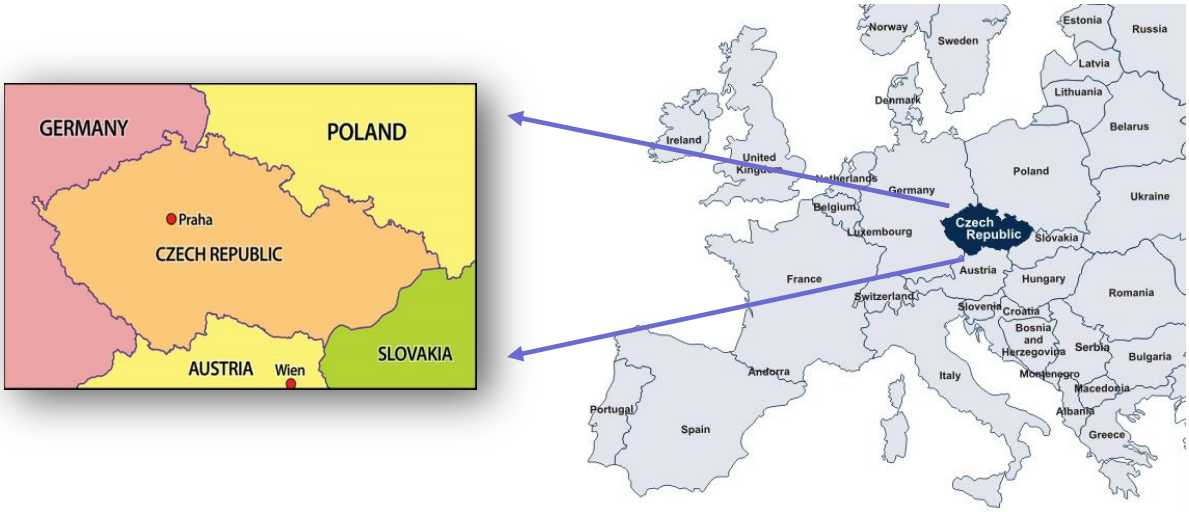
The principal research areas pursued by the Institute are often unique in national or even international scale but – which is the most important – they are firmly settled in the Institute research portfolio. We perceive it as an advantage and our prime asset that the Institute combines top research in selected directions in geology with the tradition of a wide-scope geoscientific institution with rich international co-operation. At the same time, we reflect modern trends in research in the given areas. Although the sites in the Bohemian Massif and neighbouring European areas continue to lie in the main focus of our activities, a positive trend in recent times is the orientation (with project support) to the study of significant localities worldwide connected with interpretations in global scale. Such approach allows to present the results in prestigious international journals.

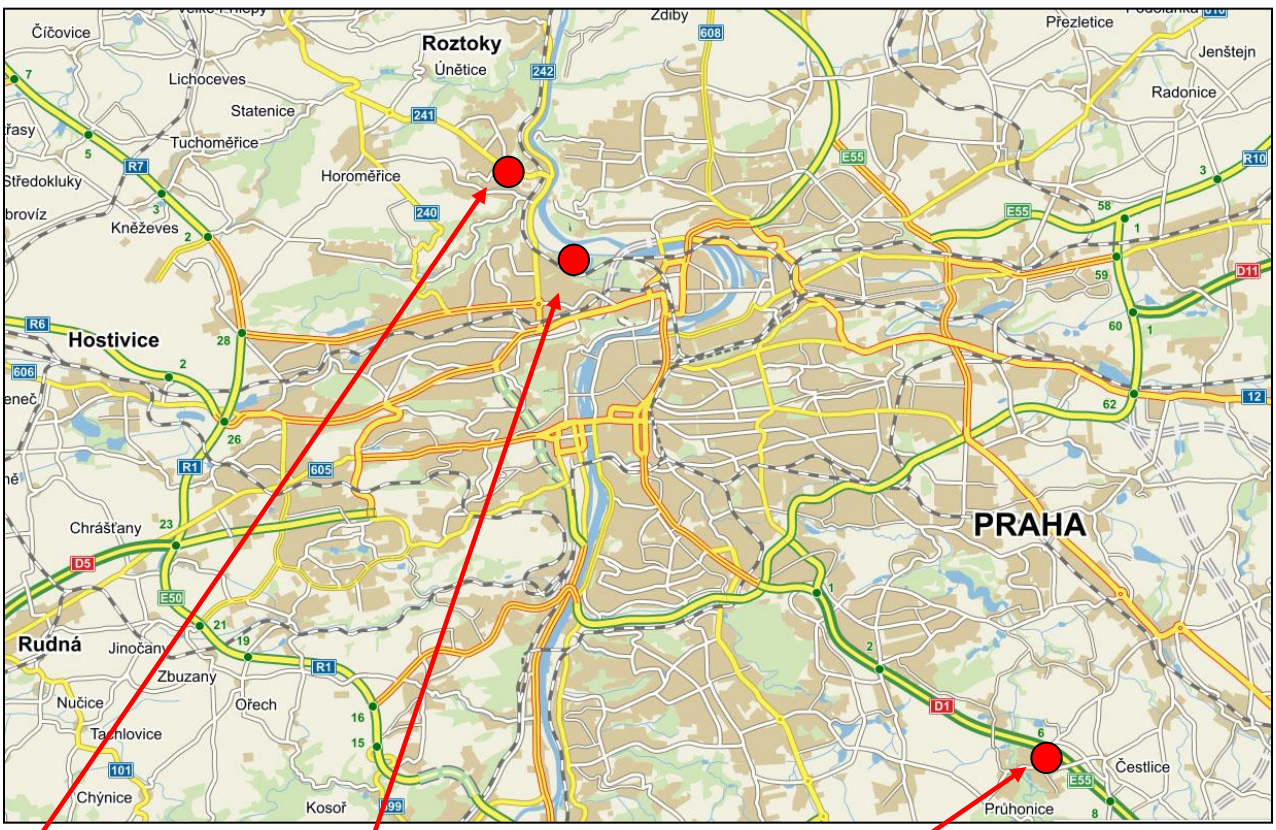
The Institute offers data acquisition and interpretation, together with a share in applied outputs. This provides the greatest financial profit to the Institute.

Demolition of old buildings.

Construction of a new building.

Positions of Research Centres of the Geological Institute





Address:
Main Research Centre

Rozvojová 269
165 00 Praha 6 – Lysolaje
Czech Republic

Address:
Research Centre at Puškinovo náměstí

Puškinovo náměstí 447/9
160 00 Praha 6 – Bubeneč
Czech Republic

Address:
Research Centre at Průhonice

252 43 Průhonice
Czech Republic

Main Research Centre at Lysolaje

Address: Rozvojová 269, 165 00 Praha 6 – Lysolaje, Czech Republic

Director: Pavel Bosák (phone: +420 233087 206, e-mail: bosak@gli.cas.cz)
Deputy director: Michal Filippi (phone: +420 233087 254, e-mail: filippi@gli.cas.cz)
Scientific secretary: Tomáš Přikryl (phone: +420 233087 287, e-mail: prikryl@gli.cas.cz)
Main economist: Bohumil Pick (phone: +420 233087 207, e-mail: pick@gli.cas.cz)

Department of Analytical Methods

Head: Roman Skála (phone: +420 233087 249, e-mail: skala@gli.cas.cz)
Deputy: Zuzana Korbelová (phone: +420 233087 214, e-mail: korbelova@gli.cas.cz)

Department of Environmental Geology and Geochemistry

Head: Tomáš Navrátil (phone: +420 233087 222, e-mail: navratilt@gli.cas.cz)
Deputy: Jan Rohovec (phone: +420 233087 258, e-mail: rohovec@gli.cas.cz)

Department of Geological Processes

Head: Martin Svojtka (phone: +420 233087 242, e-mail: svojtka@gli.cas.cz)
Deputy: Lukáš Ackerman (phone: +420 233087240, e-mail: ackerman@gli.cas.cz)

Department of Paleobiology and Paleoecology

Head: Ladislav Slavík (phone: +420 233087 247, e-mail: slavik@gli.cas.cz)
Deputy: Marcela Svobodová (phone: +420 233087218, e-mail: msvobodova@gli.cas.cz)

Information Centre and Library

Head: Sabina Bielská (phone: +420 233087 272, e-mail: bielska@gli.cas.cz)
Deputy: Václava Škvorová (phone: +420 233087 273, e-mail: skvorova@gli.cas.cz)

Research Centre at Průhonice

Address: 252 43 Průhonice, Czech Republic

Department of Paleomagnetism

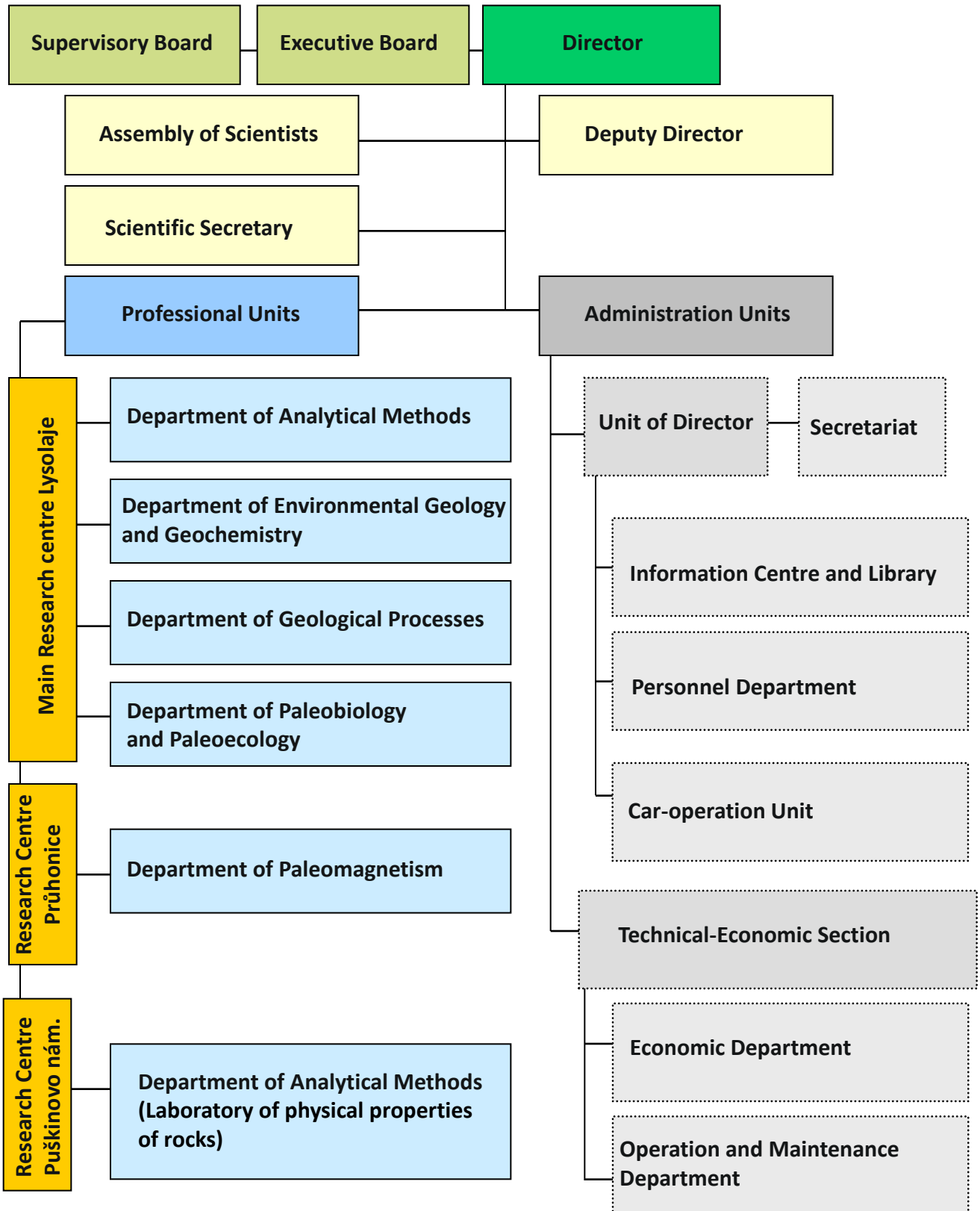
Contacts: Petr Šnábl (phone: 272 690 115, e-mail: schnabl@gli.cas.cz);
Petr Pruner (phone: 272 690 115, e-mail: pruner@gli.cas.cz)

Research Centre at Puškinovo náměstí

Address: Puškinovo náměstí 447/9, 160 00 Praha 6 – Bubeneč, Czech Republic

Department of Analytical Methods – Laboratory of physical properties of rocks

Head: Roman Skála (phone: +420 233087249, e-mail: skala@gli.cas.cz)
Contact: Tomáš Lokajíček, Matěj Petružálek (phone: +420 224 313 520, e-mails: lokajicek@gli.cas.cz; petruzalek@gli.cas.cz)


Supervisory Board
Executive Board
Director
Assembly of Scientists
Deputy Director
Scientific Secretary
Professional Units
Administration Units
Main Research centre Lysolaje
Department of Analytical Methods
Department of Environmental Geology and Geochemistry
Department of Geological Processes
Department of Paleobiology and Paleoecology
Research Centre Průhonice
Department of Paleomagnetism
Research Centre Puškinovo nám.
Department of Analytical Methods (Laboratory of physical properties of rocks)
Unit of Director
Secretariat
Information Centre and Library
Personnel Department
Car-operation Unit
Technical-Economic Section
Economic Department
Operation and Maintenance Department

Library of the Institute of Geology CAS, v. v. i., is a public library with a specialized library fund.
Its main purpose is to collect, process, store and provide scientific information contained in the library fund. It provides its readers with literature focused on Earth sciences, especially from the fields of geology, paleontology, petrology or mineralogy.
The library fund counts some 8,000 books and over 450 journal titles, besides various qualification theses, research reports or maps.

The library serves not only to the Institute employees but also to the wide public. It mediates the following services to its customers:

- **Mediation of documents from its own library fund (within-building and out-of-building loans).**
- Rendering interlibrary loans or reprographic services, among others using the Virtual Polytechnical Library (VPK).
- Making access to specialized bibliographic and full-text information sources (both freely available and licensed).
- Providing information of bibliographic and factographic character.
- Reprographic services.

Another significant task of the Library is keeping files related to publication activities of the Institute of Geology staff using the ASEP (automated system of evidence of publications). The ASEP is designed to collect, proces, store and spread information on publications and other information outputs of basic research in the Czech Academy of Sciences.

Useful links

Official website: https://www.gli.cas.cz/cs/skupina/knihovna

Online catalogue: http://aleph20.lib.cas.cz/F/AQAAD4YK35EUHQ4XHJVFIETCDKLSYXCGA3APRN8DIN7P9LJJUQ-04092?func=file&amp=&amp=&file_name=find-b&local_base=GLU&pds_handle=GUEST

ASEP database: http://www.library.sk/i2/i2.entry.cls?ictx=cav&language=2&op=esearch

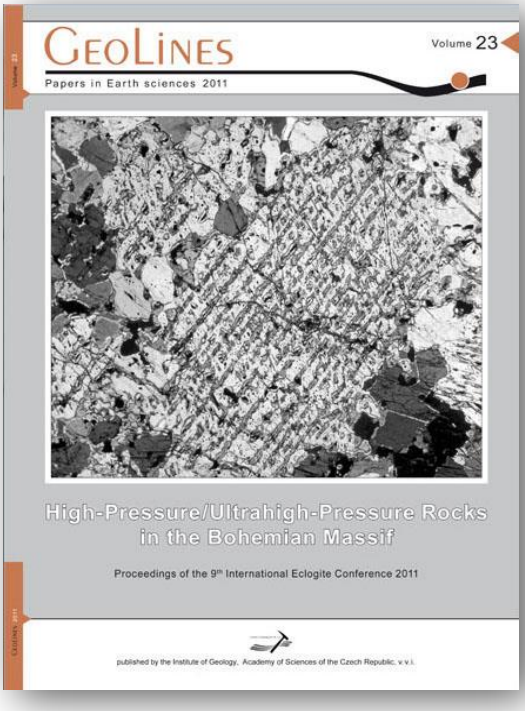
Contacts

Address:	Rozvojová 269, 165 00
	Praha 6 – Lysolaje
	(library is located v přízemí budovy)
E-mail:	library@gli.cas.cz
Phone:	+420 226 800 272
	+420 226 800 273

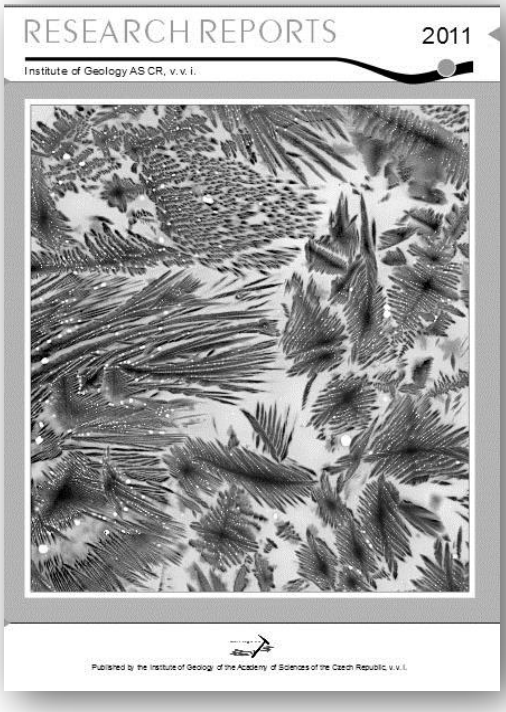
Opening hours:

Monday	08:00 – 12:00
Tuesday	08:00 – 15:00
Wednesday	closed
Thursday	08:00 – 15:00
Friday	08:00 – 12:00

Access beyond the opening hours is subject to advance notification.



The **Research Reports** journal summarizes in detail all news and the whole production of the institute for each year. It is published in English. *GLI is the publisher.*



The Geolines Journal is a series of papers and monothematic volumes of conference abstracts. GeoLines publishes articles in English on primary research in many field of geology (geochemistry, geochronology, geophysics, petrology, stratigraphy, palaeontology, environmental geochemistry, etc.). *GLI is the publisher.*

International journal **Bulletin of Geosciences** is focused on paleoenvironmental geology, including palaeontology, sedimentology, stratigraphy and related fields.
Impact factor 2013: 1,495.
GLI is the co-publisher, together with the Czech Geological Survey in Prague, the West Bohemia Museum in Pilsen and the Palacký University Olomouc.

Geologica Carpathica is the official journal of the Carpathian-Balkan Geological Association. The journal publishes contributions to petrology, mineralogy, geochemistry, applied geophysics, stratigraphy, paleontology, sedimentology, tectonics, etc.
Impact factor 2013: 0.835
GLI is the co-publisher, together with Geological Institute of the Slovak Academy of Sciences and Polish Geological Institute.

Acta Carsologica publishes original research papers and reviews, letters, etc. covering topics related to the specifics of karst areas. These comprise, but are not limited to, karst geology, geomorphology, speleology, hydrogeology, biospeleology, etc.
Impact factor 2013: 0.710
GLI supported financially the whole 2012 issue.

Current analytical equipment is in good condition, expired equipment has been refurbished. The new instruments enable the introduction of new methods. Laboratories of the IG are frequently used by partners from other institutes of the CAS, universities, museums and from the private sector. Laboratory of Physical Properties of Rocks provides the best technical equipment in the CR for all basic tests in rock mechanics, including the world-unique apparatus for the determination of high-pressure rock elastic anisotropy using P- and S-waves in spherical samples.

In the coming years, our instrumental equipment will be modernized. Along with the introduction of new methods, modernization will result in maintaining scientific competitiveness and strengthening the position of the Institute of Geology as a solid research partner for the Czech as well as foreign research institutions. Some of the most important innovation of the instrumental facilities are:

Upgrade of the CAMECA SX-100 microprobe including an installation of a new energy-dispersive spectrometer and complete control and analytical software upgrade. The CAMECA SX-100 is an essential instrument supporting research of teams across the Institute and also providing external projects.

Upgrade of equipment in the grinding shop (polishing, grinding and lapping machines) should be either refurbished or replaced in several consecutive steps.

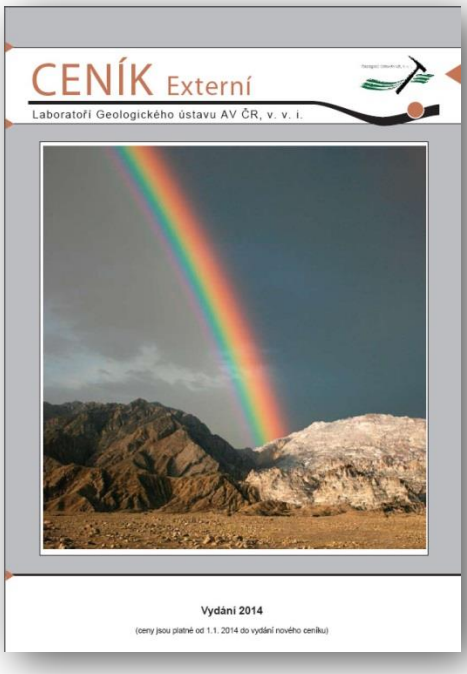
Purchase of a Raman micro-spectrometer allowing 3D confocal spectral mapping with micron-scale spatial resolution; equipped with two lasers to cover visible and near-infrared excitation wavelengths, and a CCD detector to record Raman spectra. The system should provide a quick and detailed tool to identify minerals.

The acquisition of a new excimer laser for laser ablation for the Element 2 high-resolution mass spectrometer coupled with a 213-nm NdYAG UP-213 laser ablation system. The proposed acquisition and implementation of the latest innovations in the laser ablation field (e.g., CA-chemical abrasion of zircon, small spot-size due to the laser efficiency, new calculation routines) should guarantee the best performance of the U-Pb technique with high accuracy and precision comparable to, e.g., double-focusing magnetic sector SIMS.

The Department of Paleomagnetism plans to modernize its essential equipment via purchasing motor and valve assembly of SRM (2017) for the 2G Enterprises Superconducting Rock Magnetometer, which is used to determine the intensity and direction of remanent magnetization of magnetically weak samples. Also, the compressor adsorber unit has to be replaced. To start hydrostatic pressure experiments on various magnetic properties, a new non-magnetic pressure cell is planned to be designed and built. Other paleomagnetic and rock-magnetic instruments (e.g., MFK-1 – new holder for magnetic anisotropy) as well as tools for preparation of samples should also be partly refurnished.

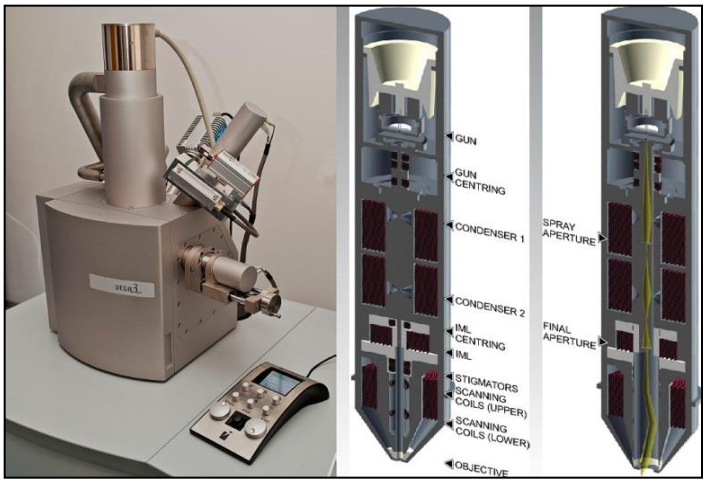
On the next pages you find a list of the most important instruments, laboratory equipment and other facilities with brief explanations and comments. For other relevant information see the price list of the Institute.

Price list for services of the Institute.



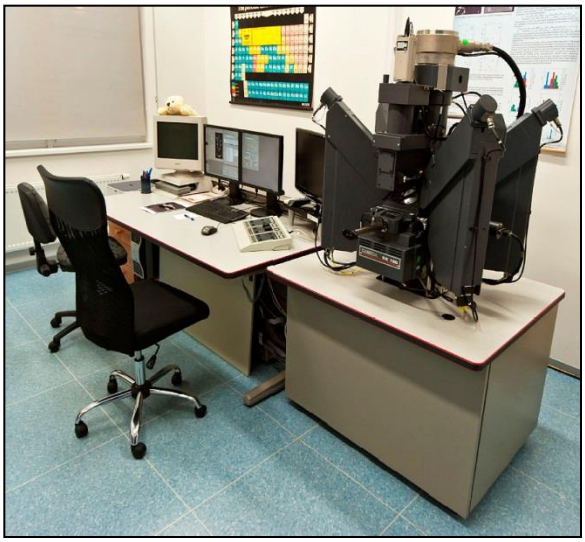
Most of facilities of Department of Analytical Methods are situated in the main research center. The staff here provides a service for the needs of the other professional units, however, they also pursue their own high-quality research focused especially on the application of instrumental methods to geological sciences.

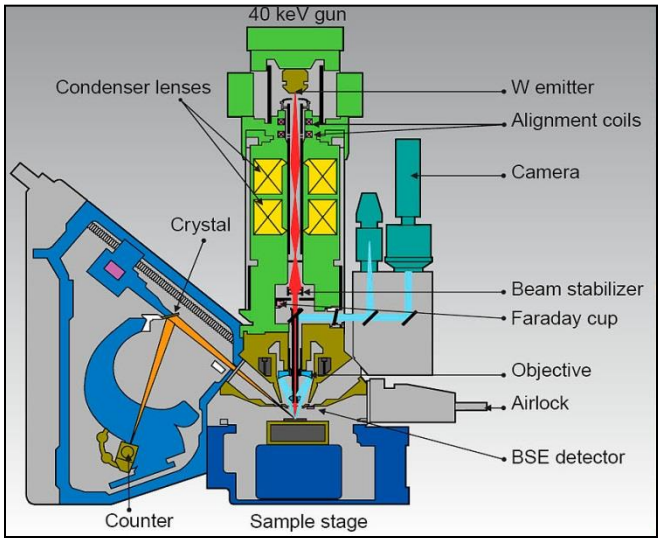
Reliable quantitative local chemical analysis and/or acquisition of element distribution maps using electron microprobe analyses and scanning electron microscopy (EPMA/SEM) require planar polished conductive surfaces. Such prerequisites are fulfilled when bulky solid samples are sectioned, polished and coated. For that purpose a suite of **cutting**, **grinding**, **lapping** and **polishing machines** to prepare polished sections or thin sections is available at this laboratory. 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 also all necessary instruments to **carbon-coat** or **gold-sputter** the specimens.



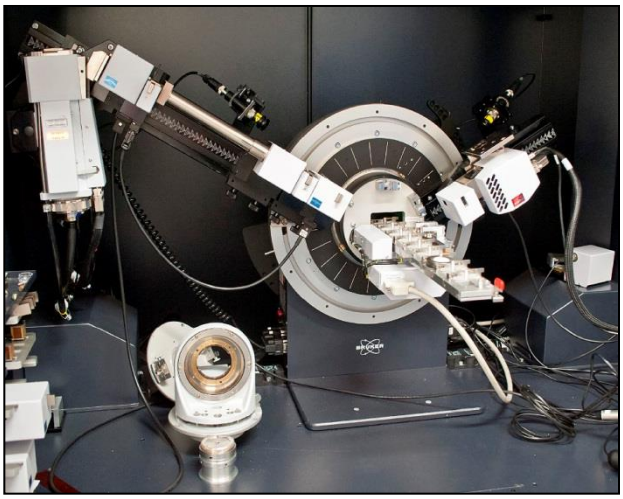
TESCAN VEGA3XMU scanning electron microscope (SEM) is an SEM of a variable pressure construction and allows observation and analysis of not only carbon-coated or gold-sputtered materials but also of uncoated specimens including biological materials. It is equipped with detectors of secondary and back-scatted electrons as well as energy-dispersive spectrometer (EDS) **Bruker QUANTAX 200**, which collects the entire spectrum allowing data acquisition typically within a minute. The spot which the analytical data are collected from may be on the order of 1 um in diameter. Element contents reliably measured with the device are as low as 0.X-X wt.%. Also available are low vacuum secondary electron (LVSTD) and color **cathodoluminescence** (CL) (detection range 350-850 nm) detectors. The source of electrons is a tungsten heated cathode. Under the optimum conditions the magnification of the SEM may reach up to 150,000× which translates to a resolution of 10 nm. The minimum magnification is 1.5× that means that objects as large as 127 mm across can be observed at once. 3D surface metrology is also possible.

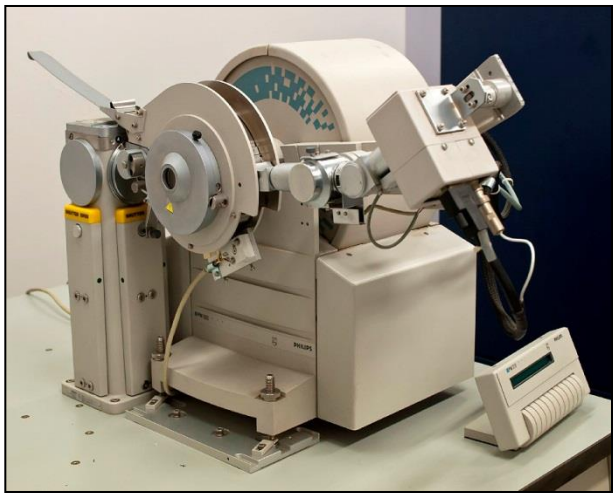
Typical application of the SEM instruments are: observation and imaging of surface characteristics of both coated and uncoated 3D specimens (various objects in paleontology, mineralogy, material science, etc.); observation and imaging of samples (polished (thin)sections) by BSE detector to reveal compositional differences; mapping of element distribution; local standard-less or standard-based chemical analyses.





CAMECA SX-100 electron probe microanalyzer (EPMA) 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. The method is strictly standard-based, i.e., solid-state standards of known composition for all elements to be analyzed must be provided. A selection of correction procedures applied to calculate element concentrations include ϕρZ, PAP, and Merlet. Element contents can be reliably measured down to tens ppm. Chemical composition can be measured exclusively from planar polished surfaces. All the measurements and imaging are carried out in high vacuum. Though the probe is used usually for local chemical analysis, it occasionally serves also for imaging or collection of element distribution maps.





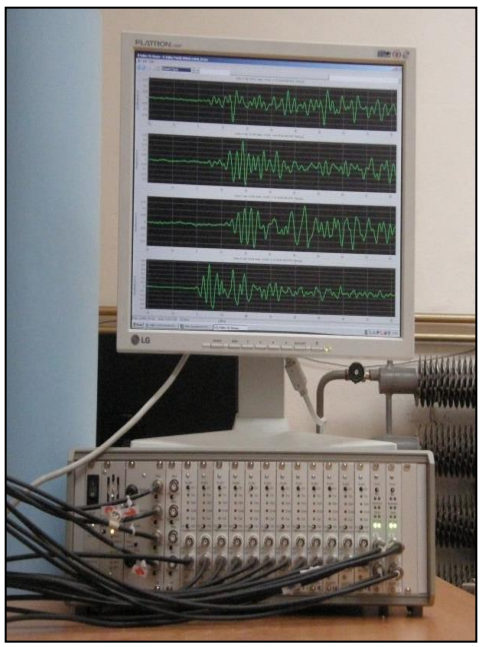
Bruker D-8 DISCOVER X-ray powder diffractometer is a multi-purpose powder X-ray diffraction instrument with a variable measuring radius designed to study powder samples or solid polycrystalline blocks (polished (thin)sections, rock chips etc.). Diffractometer is of the design θ-2θ and allows studying materials in both reflection and transmission (either foil or capillary) geometry. Optional focusing primary asymmetric monochromator of Johansson type produces spectrally pure K 1 radiation. Diffracted radiation is collected with a position-sensitive 1D silicon strip detector LynxEye. In the microdiffraction setup used for bulk samples, the primary monochromator is replaced by polycapillary optics and beam limited with a collimator and a sample is placed on a special motorized xyz-stage.

Philips X'Pert X-ray powder diffractometer is a compact powder X-ray diffraction unit for routine analytical work. Typical applications of this instrument are: phase identification and (semi)quantitative phase analysis; extraction of information on unit-cell size, peak intensities and peak shape parameters; crystal structure refinement, etc.

Department of Analytical Methods (Reseacrh Centre at Puškinovo náměstí)

This workplace focuses on research of the physical properties of rocks. The staff there is mainly focused to basic research of rock physical properties, nevertheless unique measuring systems are used to supply experimental data to the other professional units and to private sphere.

Uniaxial load frame MTS is a computer-controlled servo-hydraulic loading system specifically adjusted for long-term testing. This system allows testing of rocks in regime of controlled force or controlled deformation. Together with triaxial cell, this equipment allows simulation of pressure-temperature conditions and permeability measurements.



High pressure chamber - a unique device developed to study elastic anisotropy of rocks under high hydrostatic pressure on spherical samples. We are able to simulate pressures acting in 15 – 20 km depth. Because of spherical shape of studied samples we can describe properties of rock in 3D what is unique in the world. From the experiment we can tell reliable information about orientation of basic rock structures as microcrack systems or alignment of mineral grains. Measuring of shear waves gives us the ability to determine a complete set of elastic parameters and better describe qualities of rock under examination. Experiments done at several pressure levels provide information about process of closing of microcrack systems.

Vallen System AMSY-5 is a sixteen-channel transient recorder which allows us to monitor process of cracking during the uniaxial loading of rock sample. A net of 16 sensors detects every single crack in rock above the limit set. Recorded data are used to localize each crack and map the process of their propagation in time. This helps us to understand better the behavior of the rock failure process.

This department flexibly conforms to the needs of study of natural changes of the Earth system, especially the understanding of climatic oscillations and paleoenvironmental changes in the youngest geological history, and influence of the human impacts on the environment. Multi-disciplinary orientation of the staff, necessary for the solution of environmental problems, is comparable to those of foreign teams. Research activities of the staff of the laboratory cover such scientific fields as mineralogy, geochemistry, sedimentology, pedology, climatology, geomorphology, ecology, etc. Significant activities of the laboratory have been focused on the biogeodynamics of chemical elements in the environment. Changes and long-term trends in element budgets caused by human activities and climatic oscillations have been monitored in experimental areas for the last 20 years.

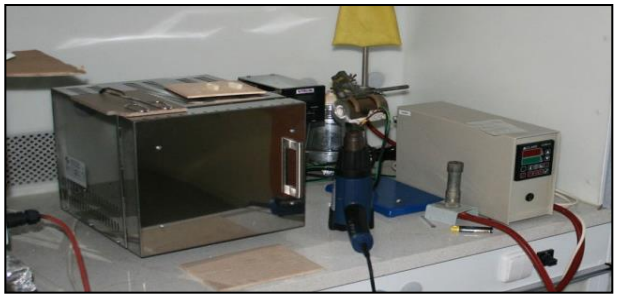
Collection of an environmental sample: **Pasive collector** for collection of rain water.

A set of **iceboxes** is used for storage of environmental samples.

We operate with several preparatory laboratories that serve for prime preparation of samples for the following analyses.

Before analysis, majority of solid samples are prepared by decomposition in acids. In the **HPA-S Anton Paar high pressure asher**, samples are dissolved at temperatures up to 300 °C and pressures up to 100 atm.

Microwave oven is not only useful in a house kitchen, but with a special teflon PTFE pressure bombs it is useful for decomposition of samples as well. Of course, the microwave power inserted on sample is far more higher than in the kitchen models.



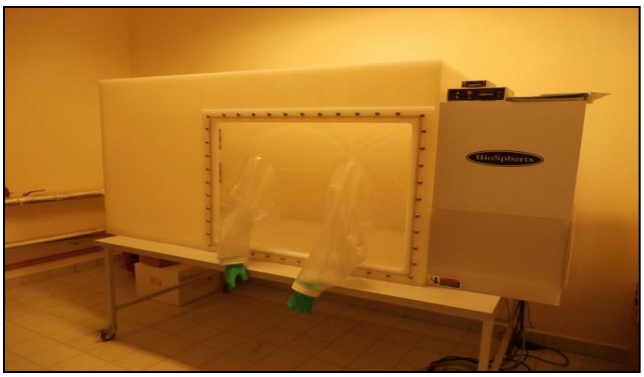
Another approach to decomposition of minerals is based on melting in resistance oven upon regulated temperature up to 1,300 °C in platinum, silver or quartz crucibles.

SPECIAL EQUIPMENT AND TECHNIQUES FOR WORKUP, PREPARATION AND STUDY SAMPLES

Some samples collected in geochemical study sites are air sensitive, prone to decomposition, lost of target analytes or sensitive to contamination. For these samples, special workup procedures are required.

The freeze-drying apparatus is frequently used in biochemical and biological applications for careful drying of sensitive samples. Samples are frozen before drying *in vacuo*, water is removed from the sample by sublimation.

Diluted liquid samples can be preconcentrated before analysis on the **vacuum rotatory evaporator**. Samples are delivered in the plastic bottles, transferred into an evaporation flask and evaporated *in vacuo*. Concentrated sample resulting is present in a small flask connected to the apparatus.



Glove-box where inside the closed space, argon atmosphere is maintained to protect the sample from air influence and contamination from atmospheric dust. Samples are inserted by the port to the right site and handled by gloves connected to long plastic sleeves.

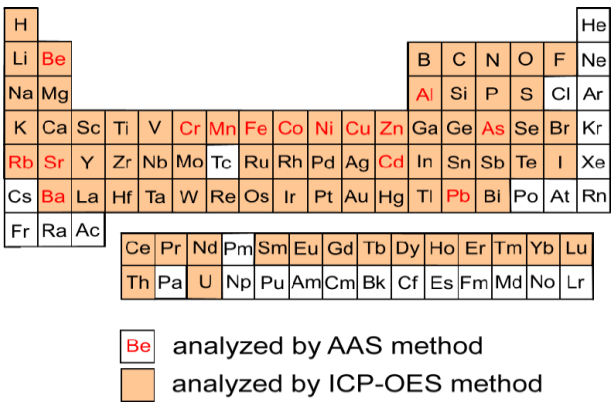
Quantification of inorganic carbon (carbonate) and organic carbon in natural liquid or solid samples is performed on **TOC analyser equipped with autosampler** for liquid samples introduction.

The presence and amount of nitrates, chlorides, sulfates and other anionic component is analysed on the **HPLC liquid analyser** by chromatography on anion exchanging chromatography with conductivity detection.

Majority of chemical elements can be analysed in the Geochemical labs by ICP techniques.

Samples of various origin are studied. Besides minerals and rocks which are the main materials of interest of geology and geochemistry, the soils, rain, precipitation, water and fog are study subjects of geochemistry. Biogeochemistry concerns on various biomaterials (wood, leaves, pines, organic soil horizons etc.).

Chemical composition of samples is studied on universal multielement spectrometers in an argon plasma discharge (**ICP EOS instrument**). At temperatures about 10,000 K, chemical elements present in the sample emit visible or UV radiation, which is collected and processed. As a result, certain element is identified together with its content in the sample.



Geochemical laboratory is also equipped with other standard instruments: **AAS analysers**, **microwave** and **UV digestion instruments**, **UV spectrometer** equipped with **CV-AFS** and **CV-AAS analysers**, **UV digestion** and of coarse **ICP-MS ELEMENT 2** with a laser ablation system shared with the Laboratory of *Geological Processes*.

SPECIALITY OF RESEARCH IN GEOCHEMICAL DEPARTMENT OF GEOCHEMISTRY: UTLTRA-TRACE MERCURY ANALYSIS

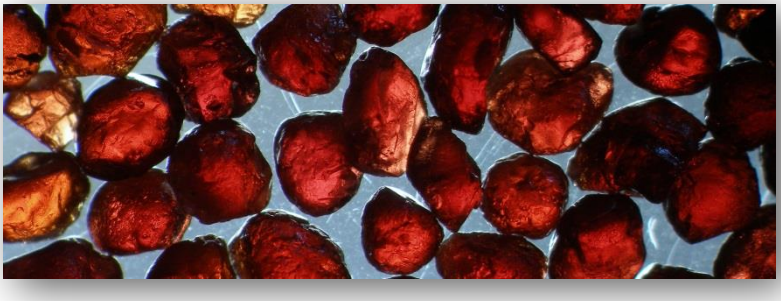
Mercury is a highly toxic element, dangerous for the environment and humans even in minute amounts. The analysis of mercury in ultra-trace amounts, especially in environmentally related samples, is demanding task and extraordinary sensitive machines are needed. In the mercury lab at GLI we are working on two such instruments. Detection limits up to 0.1 ng/l of mercury can be reached.

Advanced mercury analyser used for analysis of mercury content in solid samples. Extraordinary sensitivity (up to fractions of nanogram Hg) is reached.

The instrument is designed for mercury analyzes in liquid samples and for speciation studies.

OLYMPUS SZX 16 Optical binocular microscope with the **CANON digital photocamera** and specialized **QuickPHOTO Micro software** and a **Deep Focus module** is used for the documentation of samples, separation of sub-samples for other methods and, of coarse, for imaging of samples and details for publications.

OLYMPUS BX50 Optical polarizing microscope with the **digital camera DP 70** and specialized **QuickPHOTO software** and a **Deep Focus module** is used for a detailed study of thin (for transmitted light) and polished (for reflected light) sections. Software enables documentation, image preparation and image analysis. The microscope is equipped also with a fluorescent source of different wavelengths.



Examples of photos from the above characterized microscopes.

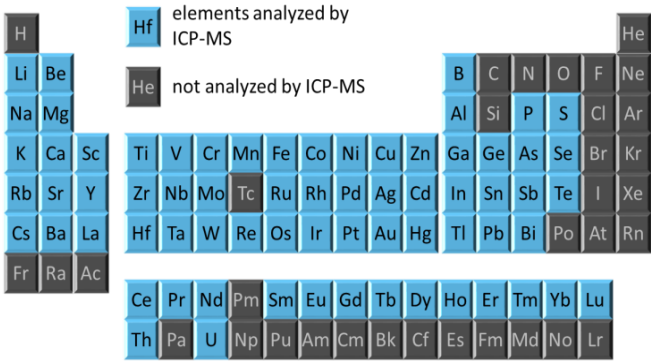
The Department of Geological Processes conducts a complex research in the field of processes, past and present, acting within the lithosphere – the Earth crust and the upper part of the Earth mantle. The analysis of material, physical and biological record preserved in the available rocks permits us to describe the dynamics of large lithospheric blocks in the past, to reconstruct temperature and pressure histories of large rock complexes including the evolution of sedimentary basins from the Early Paleozoic to the present. Good knowledge of these processes in the geological history of Central Europe together with extensive research activities at a global scale enable us to present results of general validity and universal use in the realm of Earth sciences.

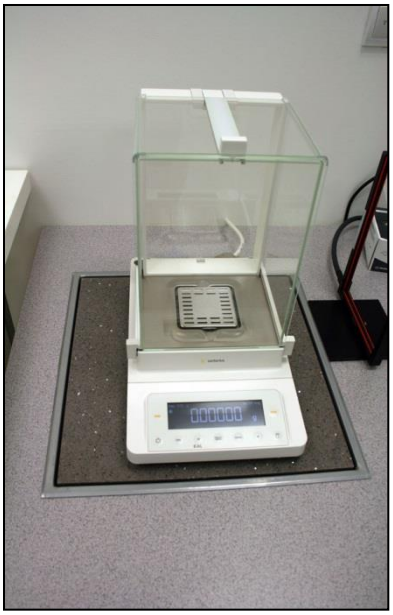
Element 2 (Thermo Fisher) inductively coupled plasma mass spectrometer (ICP-MS) is used for trace and ultra-trace element analysis (down to a sub-ppm level) and for the determination of isotope ratios (with a precision of up to 0.1% relative standard deviation). Both solution and solid-state analyses are available. The instrument is equipped with a double focusing magnetic sector field mass analyzer based on a reverse Nier-Johnson geometry, which allows high-speed multielement analysis. A high mass resolution mode of operation enables the elimination of polyatomic interferences. Typical applications include multi-element analysis of digested inorganic and organic materials, ultra-trace analysis of natural waters, determination of $^{206}Pb/^{207}Pb$ and $^{208}Pb/^{206}Pb$ isotope ratios in environmetal samples. Preparation of samples is carried out in a specialized clean laboratory (see next page).

The ICP-MS is equipped with optional sample introduction systems:

- **Aridus II** desolvating nebulizer for the elimination of oxide interferences in solution analyses. It can be also used for simultaneous aspiration of a tracer solution during laser ablation analyses.
- **Hydride generator** provides sub-ppb detection limits for hydride-forming elements such as As, Se, Sb.

Laser ablation unit (New Wave Research, UP213) in connection with the ICP-MS is used for sampling of solid-state materials. It employs a Nd:YAG medium to produce laser light at 213 nm. The main applications are space-resolved quantitative analysis of trace and elements in mineral grains in silicates (pyroxenes, quartz, etc.) or sulphides (molybdenite, chalcopyrites, etc), such as elemental profiling and mapping, and U-Pb dating of zircons. The spatial resolution of the laser beam is in the range of tens micrometers. Planar polished surface and compact structure of a sample is necessary for any analysis using LA-ICP-MS.



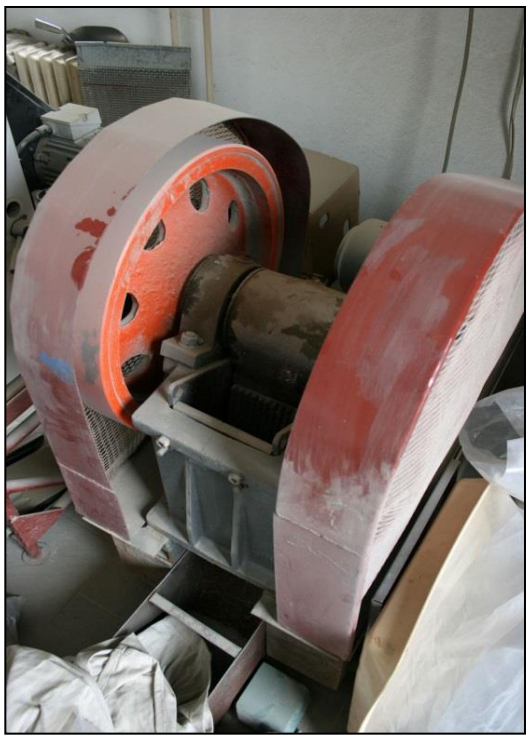


Lab digital analytical balance scale is used for precise sample weighing.

Clean laboratory of the Institute consists of two independent labs with different degree of air quality. The **first lab** (picture upper left) with a HEPA-filtered air of class D is using for sample decomposition in acid-resistant fume hood and acid purification (HNO_3, HCl, HF using Savillex Distillation Unit). The **second lab** (upper right and bottom pictures) with HEPA-filtered air of class C is devoted to low-blank chemistry, which includes sample decomposition and separation of the elements (e.g., Os, Re, Pb, Lu, Hf) from the matrix for subsequent isotopic analyses. This room is equipped with 2 custom-designed laminar flow hoods with HEPA-filtered air of class A, system for preparation of ultraclean Milli-Q water Millipore Element and high precision weighting device Sartorius Cubis.

Currently, the clean lab is mainly used for research projects dealing with highly siderophile element, Re-Os and Lu-Hf isotopic analyses and molybdenite Re-Os geochronology.

A certain kind of mineral concentrate is needed for the study of minerals and their properties. This is obtained by separation of minerals from the rocks. First, the rock is crushed in **jaw crusher** into smaller fragments, then in **crusher roller mills** to obtain small grains. Sieving of samples to various fractions is a following procedure needed for the other process. Using a **floating table** and **magnetic separator** the grains are divided into light/heavy weight fraction and on the magnetic and non-magnetic minerals. Finally, the mineral grains are separated in heavy liquids based on their density.



Jaw rock crusher

Crusher roller mill

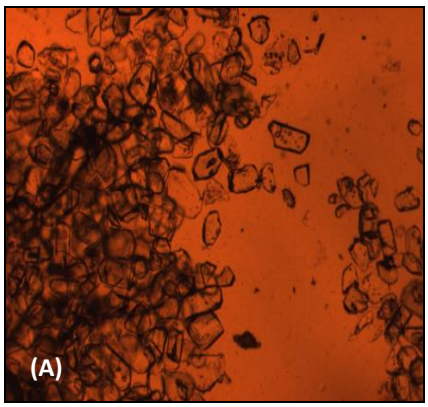
Magnetic separator

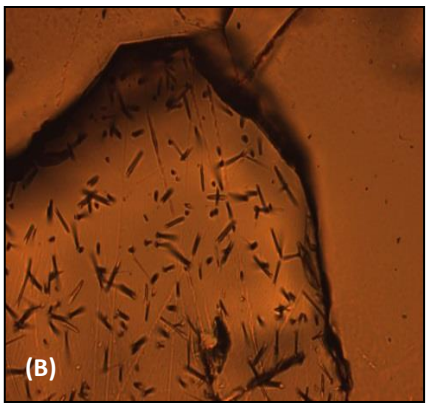
Floating table

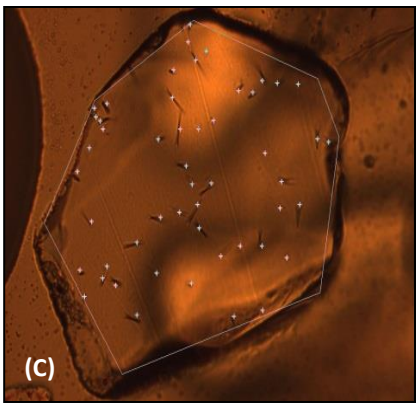
Laboratory of heavy liquid separation

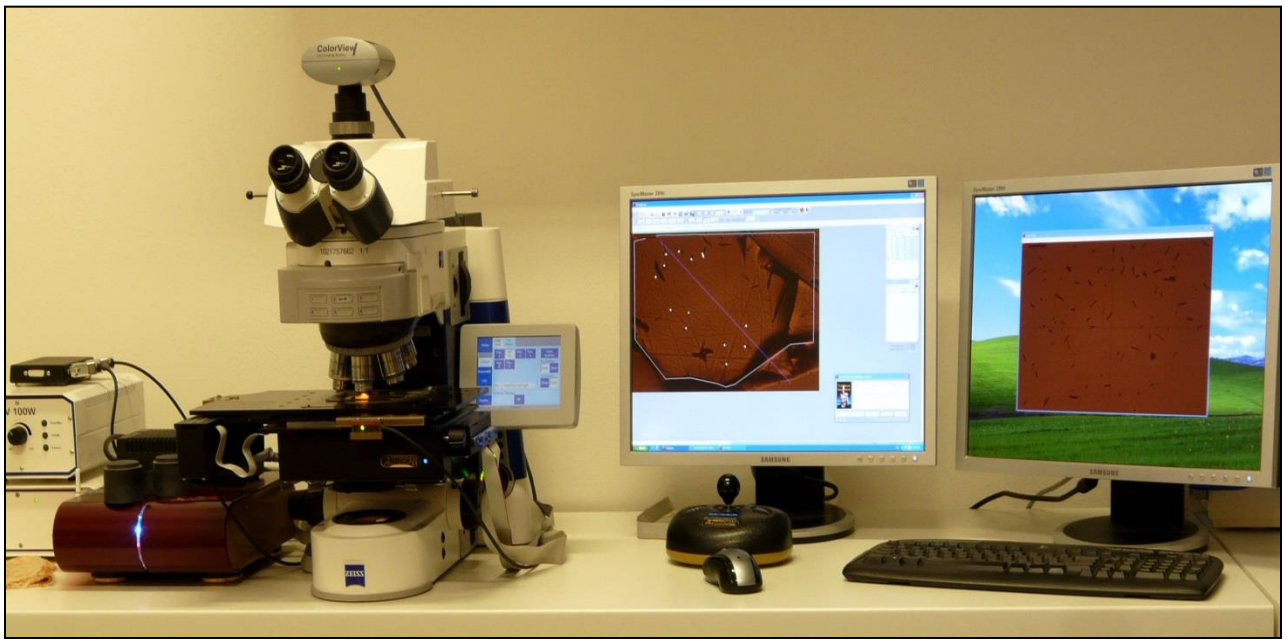
Fission track analysis is a radiometric dating method based on the analysis of radiation damage trails ("fission tracks") within U-bearing minerals (such as apatite, zircon, titanite,…). This method allows to determine simultaneously time and temperature evolution of rocks by counting fission tracks in individual grains and length-measuring of the confined tracks. This results in time-temperature curves for each sample and reconstruction of the uplift/burial history in areas such as tectonic active fault zones, sedimentary basins and their source areas.

A simplified procedure for FTA using the ZEISS Imager M1m microscope: apatite grains in a sample at a magnification of 5x (A); part of the selected grain with fission tracks at a magnification of 50x (B); apatite grain with defined area and counted fission tracks for age determination (C); confined track for thermal-condition determination.









ZEISS Imager. M1m Microscope connected to two monitors of a computer for a fission track analysis (FTA).
The Microscope is equipped with an AUTOSCAN table moving in directions x, y, z. controlled by a computer and manual joystick; two light sources using reflected and transmitted light. Another part of the microscope is a digitizing equipment for measuring lengths of specific tracks parallel to the surface of the mineral grain (i.e. confined tracks).

RS-230 instrument is a portable radiation detector (Georadis Ltd., Brno, Czech Republic) with Bismuth Germanate detector (103 cm^3) with a high sensitivity (approximately 3 x higher in comparison to the same size NaI detector). Counts per seconds (cps) in selected energy windows are directly converted to the concentrations of potassium, K (%), uranium, U (ppm), thorium, Th (ppm) and total dose (nGy/h). The instrument offers an assay mode (provides sample concentrations of K, U and Th in selectable time intervals), scan mode (numeric display on front panel scanned to memory and audio response) and survey mode (cps at 1/sec rate display on front panel). It has bluetooth and USB data connections.

Gamma-ray spectrometry (GRS) can be used for direct detection of the concentrations of K, U and Th in geological mapping by detecting and delineating the lateral distribution of these elements in surface rocks and soils. Field GRS is very effective method – low-cost, fast, non-destructive and large data sets can be acquired. GRS in sediments is used as a principal tool for correlations in palaeoenvironmental studies and high-resolution stratigraphy. It can reveal information on the quality of impurities trapped in the sediments where Th and K concentrations usually reflect the presence of some minerals.

GR-320 Envispec Portable Gamma-ray Spectrometer (Exploranium, Canada and Geroadis, Czech Republic) is another portable gamma-ray spectrometer which can be used in the field. It has external detector, and the system utilizes 256/512 channel and a high-sensitivity 76x76 mm (3" x 3") Sodium-Iodide detector. Counts per seconds (cps) in selected energy windows are directly converted to the concentrations of potassium, K (%), uranium, U (ppm), thorium, Th (ppm) and total exposure or dose rate (nGy/h). It can be used for the same purposes as the RS-230 device.

Vacuum chamber connected with an air-pump is used for preparation of non-solid samples for thin sectioning in the geoarcheological laboratory. When the samples are cured enough, they are processed in thin sectioning lab (samples in dimension 3 x 4 cm).

The **CILAS 1190 LD laser granulometer** is used to provide a measurement of the grain size distribution in range from 0.04 to 2,500 µm. The measurement is based on a small amount of material and might be easily repeated. Using the different types of dispersion allows to get the picture about the primary or secondary given grain size distribution. Data can be reported in different fractions set by the user.

The aim of this department is focused on:

- reconstruction of biological evolution in selected fossil groups
- reflection of major changes and turnovers in biota - study of causations of important (often catastrophic) events in the Earth history
- high-resolution stratigraphy; precise dating and correlation of sedimentary strata
- paleogeographic reconstructions
- intersections with sedimentology, geochronology, ecology, archaeology, and other scientific disciplines
- popular science and education

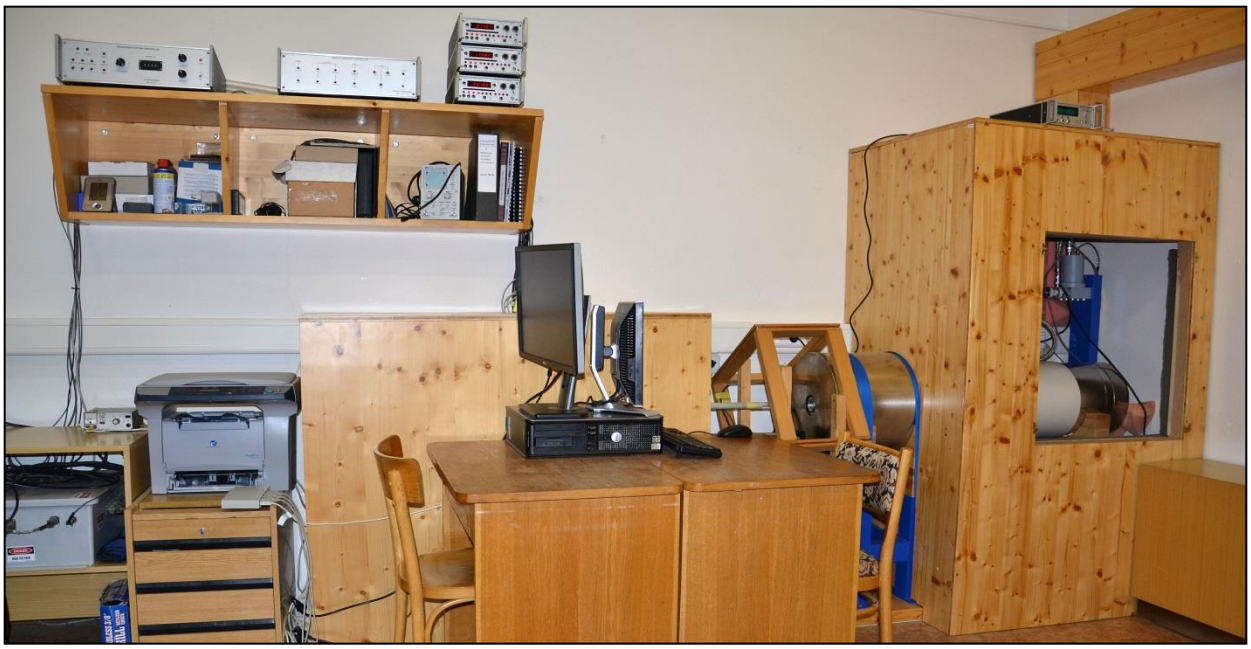
Research concentrates to the four principal directions: 1. the study of living conditions and biostratigraphy of invertebrate fossil groups (especially conodonts, graptolites, brachiopods, poriferans and echinoderms); 2. evolution of vertebrate groups (fishes, amphibians and mammals); 3. palynology of Carboniferous, Cretaceous and Cenozoic sediments; and 4; paleoichnology in a broad stratigraphic range from the Cambrian to the Recent.

The department has **rooms for maceration and processing of micropaleontological samples** equipped with levigation facility and fume hoods.

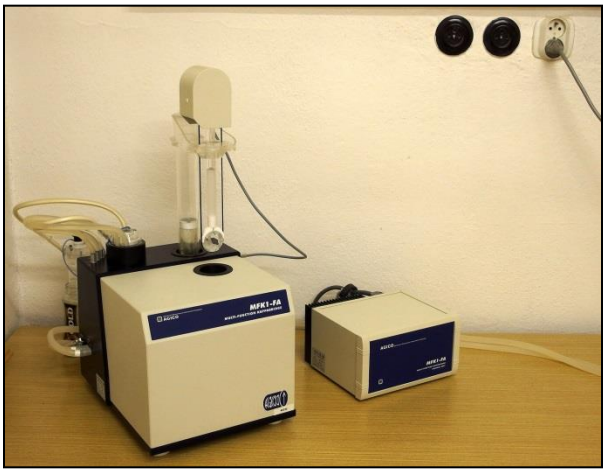
The MicroScribe® MX desktop 3D digitizer combined with the Skiron Kreon laser scanner serves for scanning of three-dimensional objects and uneven surfaces. The gained spatial data clouds are subsequently processed into graphic outputs by using 3D **Rhinoceros® NURBS** program with the rendering **Flamingo®** module. It is also possible to create a 3D animation with the help of the **BongoTM** module. 3D digitization offers the possibility of precise measurement, making of any non-destructive cross-sections or rotating visualizations for presentations or electronic publication supplements. Another option is measuring of the relative spatial relationships of the markers on the object. Scanning is particularly suitable for paleontological, ichnologic, and sedimentologic objects or surfaces.

The laboratory is situated in the magnetically quiet environment of the Průhonice Park. It was built using non-magnetic materials to guarantee strict requirements of paleomagnetic research. The team consists of highly experienced scientists with interests in paleomagnetism, magnetostratigraphy, rock and mineral magnetism, geology and planetology. The team is supported by mathematicians and programmers in order to develop new laboratory techniques. The scientific team members are involved in numerous national and international co-operations. The laboratory is equipped with modern instruments for paleomagnetic and rock magnetic studies, the most important are listed below.

Magnetic Vacuum Control System MAVACS with triaxial **Helmholz Induction Coil System HELICOS**, **Rotating Coil Magnetometer ROCOMA** and **Induction Coil Control Unit ICCON** is a self-contained automatic system creating a limited non-magnetic space (magnetic vacuum < ± 2nT; typical offset of the magnetic field sensor < ± 0.1nT) for paleomagnetic investigations, i.e. for thermal demagnetization of the remanent magnetization is conducted in the oven situated in the center of the MAVACS system. The operation of MAVACS is based on the feedback loop principle where the Earth's magnetic field is compensated by HELICOS and continually monitored by ROCOMA. The output of the ROCOMA controls the ICCON, which supplies the HELICOS generating the compensating magnetic field.



2G 755 4K Superconducting Rock Magnetometer (SRM) with a **2G800 Automatic Sample Handler System** and **Applied Physics Systems 581 DC SQUID System** is a very sensitive (magnetic moment < 10E-12 Am^2), liquid helium-free measurement system for determining the intensity and direction of natural remanent magnetization and for conducting alternating field demagnetization of the remanent magnetization. The SRM measures current induced in 3 sets of superconducting pickup coils placed at the center of the rock measurement region. The system permits remanent magnetization measurement in three axes and is designed to process discrete samples with a volume of up to 10 cm^3. Data are collected and displayed using the **2G Acquisition** software.



AGICO JR-6A Spinner Magnetometer is a sensitive (2.4 μA/m) laboratory instrument used for measurements of remanent magnetization. JR-6A is equipped with automatic specimen holders which enable automatic measuring of all components of the remanence vector. The magnetometer offers two rotation speeds, the higher (87.7 r,p,s) enabling the maximum sensitivity and the lower (16.7 r,p,s) to measure fragile specimens, soft specimens placed in perspex container and specimens with considerable deviations in size and shape. The JR-6A is fully controlled by an external computer and data are processed with REMA6W software.

AGICO MFK1-FA Kappabridge is the most sensitive (< 2x10-8 SI) laboratory instrument for measuring of 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). The measurements are controlled by the SAFYR4W (magnetic susceptibility, anisotropy) and SUFYTE5W (temperature dependence) softwares.

Magnetic Measurements Pulse Magnetiser MMPM10 is a high field instrument for creating isothermal remnant magnetizations. The MMPM10 is equipped with 2 coils to generate accurate, short-duration (7 ms) high magnetic field pulse: the largest coil (max. field 3T) accommodates standard paleomagnetic samples in any orientation for IRM anisotropy studies. The smaller coil is 1.25 cm in diameter and generates pulsed field up to 9T. The magnetic field pulse is generated by discharging a bank of capacitors through the coil.

Magnetic Measurement Thermal Demagnetizer MMTD80A with **Eurotherm 3204 temperature controller** is a programmable thermal demagnetizer for up to 80 paleomagnetic samples up to 750 °C. The 4-layer closed Mu-metal shield guarantees a constant field <10nT during heating and cooling.

As we believe, geology will maintain its – to a certain degree – attractive position as one of the essential scientific disciplines in the coming decades. This can be expected especially due to the need of settling the growing environmental, climatic and mineral-resource problems on the Earth. Even in space science, the study of geological samples and geological processes is the first-hand experience. We are convinced that, within a period not longer than a decade, basic research in geology will have to adapt to new themes of increasing significance: carbon dioxide sequestration, understanding of the geological structure of the upper mantle with the aim of large-scale geothermal energy utilization, or a search for rock environments suitable for long-term repositories of nuclear waste. Research directed at a detailed study of climatic oscillations in the young geological past will be probably also growing as it will be necessary to understand the present climate changes on the Earth and to take appropriate measures. These are the reasons why such predictable trends will be reflected and further developed in the wide range of themes now pursued at the Institute of Geology – perhaps the most universal geoscientific institution of the Academy of Sciences of the Czech Republic.

The Institute conducts research in many scientific areas provided by particular departments. This entails intensive collaboration on a variety of research topics with scientific institutions from the Czech Republic and abroad. Below we list and shortly comment/justify major scientific research areas grouped into broader thematically related and/or complementary fields on which we focus our effort. We believe they are of a high scientific importance and topicality.

- **Basic Geological Research** (Evolution of sandstone landscapes; Late Cretaceous and Cenozoic volcanism in the Bohemian Massif; Paleomagnetic and rock magnetic investigation, magnetostratigraphy; New mineral descriptions, and other research areas) guarantee the continuation in traditionally solved topics in the Institute. The results contribute to the general knowledge in geosciences and more universal and versatile research at the Institute.
- **Determination of the Chemical Composition and Evolution of the Earth's Mantle and Earth's Crust** will help to refine our knowledge of the Earth history and also to understand the composition, age and development of extraterrestrial materials/bodies.
- **Studies of Sedimentary Environments, Geomorphology and Quaternary Processes** aim at the understanding of past sedimentary events, evaluation and prediction of formation and destruction of landscapes, which has a direct connection to various natural threats including landslides, rockfalls etc.
- **Paleontological and Paleoenvironmental (Paleoclimatic) Studies** provide knowledge for palaeoecological interpretations. A profound understanding of the evolution and extinctions of plant and animal communities and knowledge of paleoclimate history are critical in the context of studies focused on present climatic changes and related responses of present live organisms. Important data on climatic events are also recorded and extracted from cave sediments of various origin and location. Furthermore, paleontological evidence is the only actual proof of evolutionary processes that allow to verify hypotheses produced by various modern (often indirect or theoretical) methods.
- **Cycling and Behaviour of Hazardous Elements in Particular Spheres of the Environment** is an update topic including the whole set of geological and chemical methods. Release and migration of hazardous elements may endanger soil, sources of drinking water and consequently also sources of human food.
- **Atmospheric Transport of Solid Materials** is a relatively new scientific direction pursued at the Institute. It has, however, high impact to several areas of public sphere. Prediction of the amount, direction of transport and related consequences of atmospheric dust during natural disasters are key knowledge for the air transport safety.
- Participation of our Institute in the evaluation of the **Repository of Radioactive Waste Materials** and nuclear safety is a new direction of our applied research. This is a highly topical field of increasing importance since a large number of nuclear power plants in Europe will need a large background for the deposition of nuclear waste in a relatively near future.
- **Experimental and Theoretical Studies of Rock Properties and Deformations** provide critical data for applied research, especially for engineering geology. This direction of research provides appreciable financial income to the Institute.
- **Analytical service for research and for commercial projects** is an important source of financial income. Moreover, it provides an opportunity to extend scientific collaboration.

Our scientific ability is demonstrated via „Selected Research Topics" presented on the following pages.

Geological research of salt kart in south-western Iran *Information: M. Filippi, P. Bosák*

Complex geological research held with the Charles University Prague and the Shiraz University is aimed to describe unique salt karst phenomena and explain the influence of different factors on evolution of exo- and endokarst forms.

Peculiarities: The world's longest salt cave was discovered and documented during the research and the National geopark was established in the area. The BBC asked the research team for a cooperation on the documentary series „How the Earth Made Us" with prof. Iain Stewart.

Selected outputs: **Filippi M**, Bruthans J, Palatinus L, Zare M, Asadi N. (2011) Secondary halite deposits in the Iranian salt karst: general description and origin. **International Journal of Speleology**. 40, 2: 141-162.

Bruthans J, **Filippi M**, Zare M, Churáčková Z, Asadi N, Fuchs M, **Adamovič J.** (2010): Evolution of salt diapir and karst morphology during the last glacial cycle: effects of sea-level oscillation, diapir and regional uplift, and erosion (Persian Gulf, Iran). **Geomorphology**. 121: 291-304.

Cryogenic cave carbonates *Information: K. Žák*

Cryogenic cave carbonates can be identified in caves based on their characteristic mode of occurrence, typical shape, unique carbon and oxygen stable isotope compositions. These specific carbonates were revealed as a new tool for estimation of the Last Glacial minimum permafrost depth in Central Europe

Peculiarity: Karel Žák of the GLI is a famous expert and pioneer in the cryogenic cave calcite issue.

Selected output: **Žák K**, Richter DK, **Filippi M**, **Živor R**, Deininger M, Mangini A, Scholz D. (2012). Coarsely crystalline cryogenic cave carbonate – a new archive to estimate the Last Glacial minimum permafrost depth in Central Europe. **Climate of the Past**. 8: 1821-1837.

Geomycology and hyperaccumulation of metals in mushrooms *Information: J. Borovička*

A detailed research connects the geological and biological approaches in order to study interactions of macrofungi and the geological bedrock, particularly the phenomenon of metal (hyper-)accumulation in mushrooms and ectomycorrhizae.

Peculiarity: *Amanita* species like *A. strobiliformis* (bottom picture) can hyperaccumulate silver with concentrations up to 1,200 mg/kg in dry mass. We currently test the possibility of using Pb isotopes to track the soil origin of the accumulated metal.

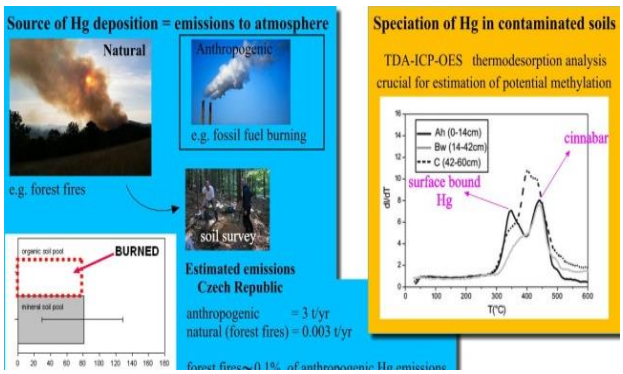
Selected outputs: **Borovička J**, Mihaljevič M, Gryndler M, Kubrová J, **Žigová A**, Hršelová H, Řanda Z. (2014): Lead isotopic signatures of saprotrophic macrofungi of various origins: Tracing for lead sources and possible applications in geomycology. **Applied Geochemistry.** 43: 114-120.

Kubrová J, **Žigová A**, Řanda Z, **Rohovec J**, Gryndler M, Krausová I, Dunn CE, Kotrba P, **Borovička J.** (2014): On the possible role of macrofungi in the biogeochemical fate of uranium in polluted forest soils. **Journal of Hazardous Materials.** 280: 79-88.

Geochemistry of mercury in contaminated areas

Information: T. Navrátil, J. Rohovec, M. Hojdová

A complex geochemical research extending knowledge about the behaviour of mercury in contaminated soils, waters and plants.



Peculiarity: Soils affected by a large forest fire in 2006 in the Bohemian Switzerland National Park were studied to estimate the Hg enrichment.

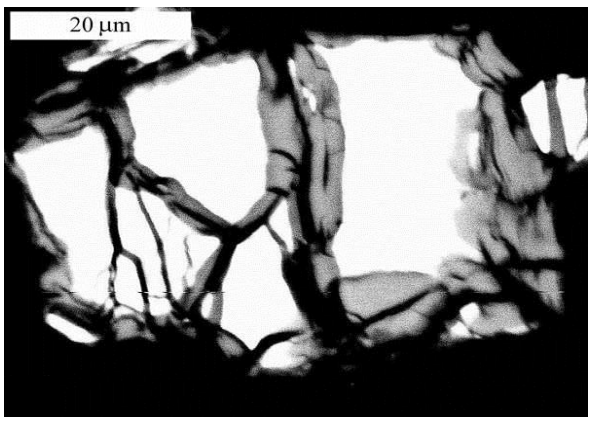
Selected outputs: **Navrátil T**, **Hojdová M**, **Rohovec J**, Penížek V, **Vařilová Z.** (2009): Effect of Fire on Pools of Mercury in Forest Soil, Central Europe. **Bulletin of Environmental Contamination and Toxicology,** 83, p. 269-274.

Hojdová M, **Navrátil T**, **Rohovec J**, Penížek V., Grygar T. (2009): Mercury Distribution and Speciation in Soils Affected by Historic Mercury Mining. **Water Air and Soil Pollution,** 200 (1):89-99.

Geochemistry of arsenic in contaminated areas

Information: M. Filippi

A complex mineralogical research is focused on arsenic mineralogical binding in contaminated soils and mine waste dumps. Description and understanding of factors and conditions of transformation of the primary arsenic minerals and origin of the newly precipitating secondary minerals is the main goal of this research.



Peculiarity: Start of the research at one of the studied extremely contaminated locality in an old mining area caused remediation of the site by the local authority.

Selected outputs: Majzlan J, Drahota P, **Filippi M.** (2014) Parageneses and Crystal Chemistry of Arsenic Minerals. In: Bowell R., Alpers C.N., Jamieson H.E., Nordstrom D.K., Majzlan J. (eds.) Arsenic: Environmental geochemistry, mineralogy, and microbiology. **Reviews in Mineralogy & Geochemistry,** 79: 17-184

Filippi M, Machovič V, Drahota P, **Böhmová V.** (2009): Raman microspectroscopy as a valuable additional method to X-ray diffraction and electron microscope/microprobe analysis in the study of iron arsenates in environmental samples. **Applied Spectroscopy,** 63, 6: 621-626

The origin, development and degradation of sandstone landscapes and landforms

Information: J. Adamovič, R. Mikuláš, V. Cílek, M. Filippi

Detailed long-term research of sandstone landforms (rock cities, towers, shelters, balanced rocks, honeycomb and tafone forms, etc.) includes a wide variety of complementary methods with the purpose to explain the origin and evolution of these landforms.

Peculiarity: Results concerning with the origin of the sandstone landforms (arches, alcoves, etc.) were reported in more than 150 media across the world.

Selected outputs: Bruthans J, Soukup J, Vaculikova J, **Filippi M**, Schweigstillova J, Mayo AL, Masin D, **Kletetschka G**, Rihosek J. (2014). Sandstone landforms shaped by negative feedback between stress and erosion. **NATURE Geoscience,** 7: 597-601

Adamovič J, **Mikuláš R**, Schweigstillová J, **Böhmová V.** (2011): Porosity changes induced by salt weathering of sandstones, Bohemian Creaceous Basin, Czech Republic. **Acta Geodynamica et Geomaterialia,** 8, 1, 21-45.

Mineral dust: fluxes, processes, background events

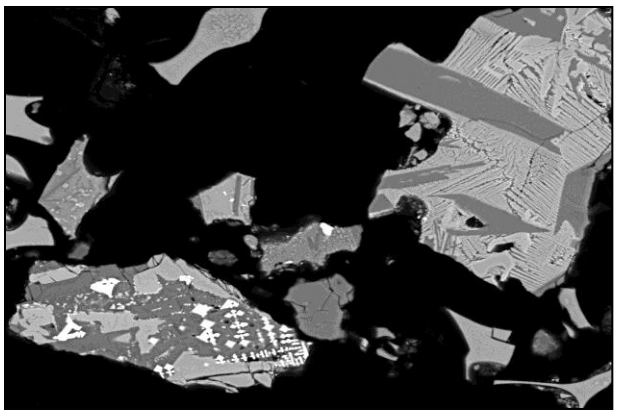
Information: J. Hladil, L. Chadimová. T. Navrátil

Recent studies proved the necessity to correct the amount of coarse particles transported over long distances in the atmosphere. Mixing of sources (natural vs. anthropogenic) is an important feature of the settled dust. A database of reference samples was established.

Peculiarity: The team is working both on modern events, e.g., dust delivery from Icelandic Eyjafjallajökull volcano (2010), Alaskan Mt. Redoubt volcano (2009), etc. and also analogues from the geological history (Palaeozoic Era, mostly Devonian limestone where aeolian-transported particles are being identified).

Selected outputs: **Navrátil T**, **Hladil J**, Strnad L, **Koptíková L, Skála R.** (2013) Volcanic ash particulate matter from the 2010 Eyjafjallajökull eruption in dust deposition at Prague, central Europe. **Aeolian Research**. 9: 191-202.

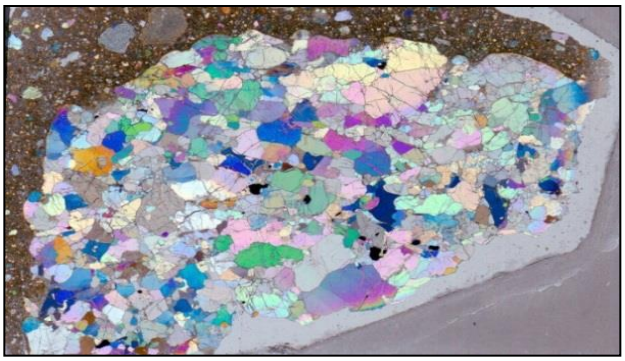
Hladil J, Strnad L, Šálek M, Jankovská V, Šimandl P, Schwarz J, Smolík J, **Lisá L**, **Koptíková L**, **Rohovec J**, **Böhmová V**, **Langrová A**, Kociánová M, Melichar R, **Adamovič J.** (2008): An anomalous atmospheric dust deposition event over Central Europe, 24 March 2007, and fingerprinting of the SE Ukrainian source. **Bulletin of Geosciences**. 83, 2: 175-206.



Composition, age and evolution of mantle lithosphere

Information: L. Ackerman

Complex study of petrology, geochemistry and mineralogy of mantle-derived rocks including platinum-group element geochemistry and mineralogy.



Peculiarity: This research includes an insight into the architecture of Earth`s mantle and its modification during the formation and evolution of the continents.

Selected outputs: **Ackerman L**, Špaček P, Magna T**, Ulrych J**, **Svojtka M**, Hegner E. (2013): Alkaline and carbonate-rich melt metasomatism and melting of subcontinental lithospheric mantle: Evidence from mantle xenoliths, NE Bavaria, Bohemian Massif. **Journal of Petrology**, 54, 2597-2633.

Ackerman L, Pitcher L, Strnad L, Puchtel IS, Jelínek E, Walker RJ. (2013): Highly siderophile element (HSE) geochemistry of peridotites and pyroxenites from Horní Bory: implications for HSE behaviour in subduction-related upper mantle, **Geochimica et Cosmochimica Acta**, 100, 158-175.

Re-Os geochronology of molybdenites

Information: L. Ackerman, E. Haluzová

Determination of molybdenite ages from various tectonic setting using high-precision Re-Os method.

Peculiarity: The geochronological results provide age constraints on the ore mineralization processes as well as granite-related magmatic and hydrothermal events.

Selected outputs: **Žák K, Svojtka M, Breiter K, Ackerman L**, Zachariáš J, Pašava J, Veselovský F, Litochleb J, **Ďurišová J, Haluzová E.** (2014): Padrť Stock (Teplá-Barrandian Unit, Bohemian Massif): Petrology, geochemistry, granodiorite U-Pb zircon dating, and Re-Os age and origin of related molybdenite mineralization, **Journal of Geosciences**, 59: 351-366.

Kohút M, **Trubač J**, Novotný L, **Ackerman L**, Demko R, Bartalský B, Erban V. (2013) Geology and Re-Os molybdenite geochronology of the Kuriskova U-Mo deposit (Western Carpathians, Slovakia). **Journal of Geosciences**, 58: 275-286.

The age, evolution and records in rocks from polar regions

Information: M. Svojtka, L. Krmíček

Thermochronology method was used to understand evolution of the sedimentary basin at the James Ross and Seymour islands in Antarctica. Polar regions also represent a unique environment for the study of geochemical cycling. The studied Hg contents in volcanic rocks of Antarctica and Greenland show that the input of Hg of geological origin into the polar ecosystem is significantly lower than expected.

Peculiarity: Research in Antarctica was conducted close to the Czech Polar Mendel base. Sampling in Greenland was carried out in the vicinity of the Qeqertarsuaq Arctic Station operated by the University of Copenhagen.

Selected outputs: Coufalík P, Zvěřina O, **Krmíček L**, Pokorný R, Komárek J. (2014) Ultra-trace analysis of Hg in alkaline lavas and regolith from James Ross Island. **Antarctic Science** 27, 3: 281-290.

Svojtka M, Nývlt D, Murakami M, **Vávrová J**, **Filip J,** Mixa P. (2009).Provenance and post-depositional low-temperature evolution of the James Ross Basin sedimentary rocks (Antarctic Peninsula) based on fission track analysis. **Antarctic Science** 21, 593-607.

Materials of the ancient Egyptian pyramids

Information: V. Cílek

A detailed research of stone materials, mortars, mud bricks and other materials used during the construction of the Abusir pyramid field was conducted to prove the great variety of local rocks together with the long-distance transport from other parts of Egypt.

Peculiarity: Surprising construction materials were found, such as sand-gypsum bricks or “flexible” mortars.

Selected output: **Cílek V**, **Novák J**, Krejčí J, **Hladil J**, **Lang M.** (2012) Rocks and building materials of the Abusir area. In Krejčí J. ed. “The Royal Necropolis in Abusir“ XVIII, 162-178. Český egyptologický ústav FF UK, Praha. ISBN 9788073083465 .

Geoarcheology

Information: L. Lisá, V. Cílek

The complex evaluation of sedimentary and pedological record using methods of geoarchaeology (including the micromorphology in archaeological context) may provide a key information on human environment, past climates, but also for example on maintenance practices used in history and prehistory.

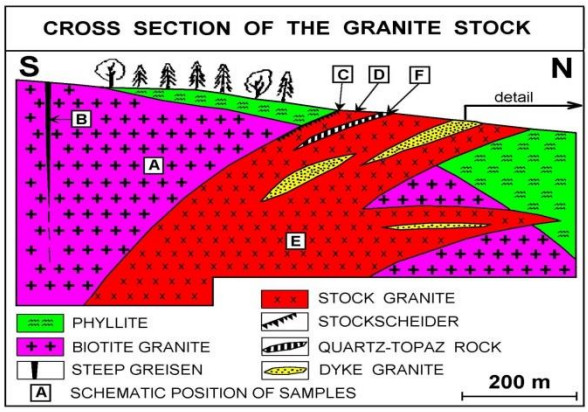
Peculiarity: Geoarchaeological research of uniquely preserved Medieval bailey in Veselí nad Moravou provided information about the maintenance processes used for horse stabling, but also about vegetation history, use of landscape or horse feeding.

Selected outputs: Dejmal M, **Lisá L**, Nývltová Fišáková M, Bajer A, Petr L, Kočár P, Kočárová R, Nejman L, Rybníček M, Suvová Z, Culp R, Vavrčík H. (2014) Medieval horse stable; The Results of Multi Proxy Interdisciplinary Research. **Plos One** 9(3): e89273.

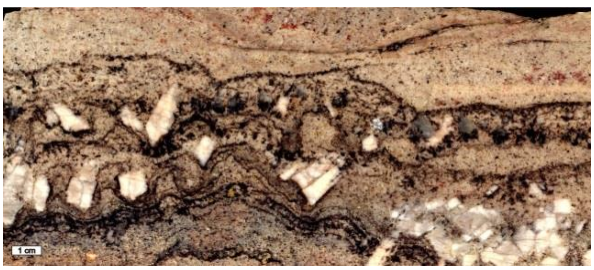
Lisá L, Hošek J, Bajer A, Matys Grygar T, Vandenberghe D. (2015) Geoarchaeology of Upper Palaeolithic loess sites located within a transect through Moravian valleys, Czech Republic. **Quaternary International** 351: 25–37.

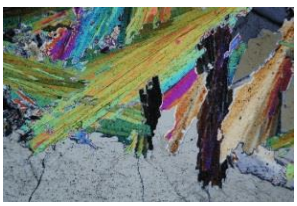
Granites as potential source of critical raw materials *Information: Karel Breiter*

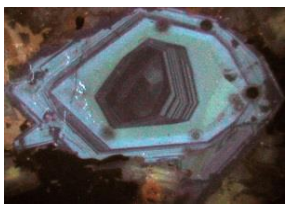
Based on combination of economic importance versus supply rick, the European Union identified altogether 20 „critical raw materials“ (CRM), in 2013 among others Be, Ga, Ge, In, Nb, REE and W. The Krušné hory/Erzgebirge Mts. is one of the historically most important and geologically best studied mining districts in Europe. In order to assess the metallogenic perspective of individual granite plutons, systematic investigation of petrological and geochemical aspects of the evolution of granitic melt and greisen deposits is going on.



Peculiaritiy: Layred granite: the ore-bearing granites (rare metal granites) usually intruded close to the earth surface. Here, in conditions of strong pressure and temperatute gradients, the silicate melt undercooled, forming layered textures with disseminated Sn and Nb+Ta-minerals.







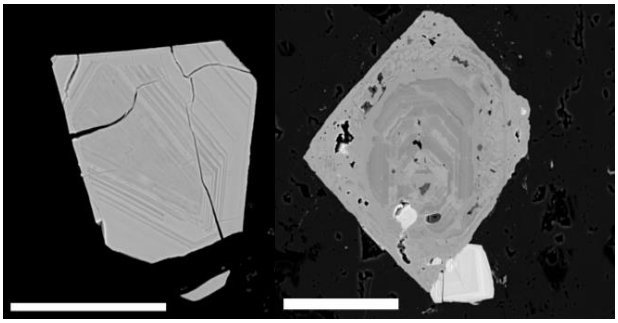
Selected outputs: **Breiter K**, Gardenová N, Vaculovič T, Kanický V. (2013) Topaz as an important host for Ge in granites and greisens. **Mineralogical Magazine**, 77, 403-417.

Breiter K. (2012) Nearly contemporaneous evolution of the A- and S-type fractionated granites in the Krušné hory/Erzgebirge Mts., Central Europe. **Lithos** 151, 105-121.

Chemical composition of zircon – a useful tool for petrogenetic interpretations

Information: Karel Breiter

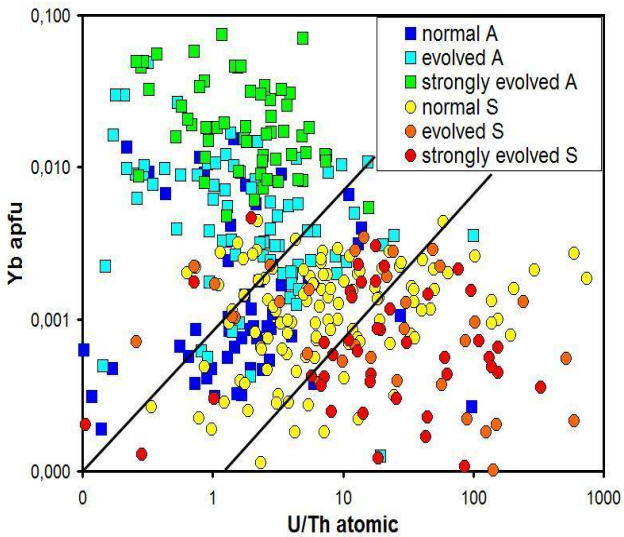
Zircon is almost ubiquitous and relatively stable accessory mineral in granitoids, often used for genetic considerations and geochronology. In spite of apparently simple chemical composition (Zr,Hf)SiO4 zircon is able to accept in their crystal lattice substantial amounts of a number of other minor and trace elements. Its crystals not affected by intense metamictization provide information about the chemical composition of the melt from which the granite crystallized.



Peculiarity: To clarify differences in chemical composition of zircons from different granites, we analyzed more than 1000 zircon grains from Bohemia, Germany, France, England, Finland, and Brazil.

Selected outputs: **Breiter K**, Lamarao CN, Borges RMK, Dall´Agnol R. (2014) Chemical characteristic of zircon from A-type granites and comparison to zircon of S-type granites. **Lithos**, 192-195, 208-225.

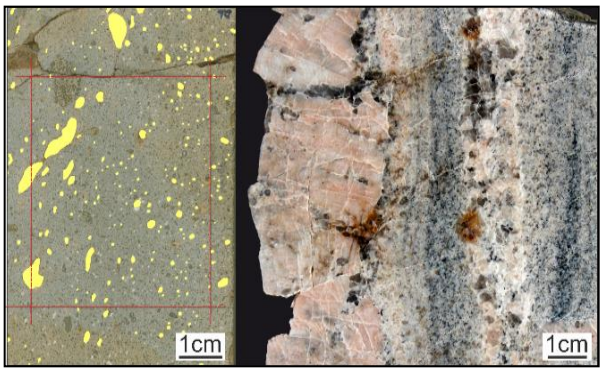
Breiter K, Čopjaková R, Škoda R. (2009) The involvement of F CO2-, and As in the alteration of Zr-Th-REE-bearing accessory minerals in the Hora Svaté Kateřiny A-type granite, Czech Republic. **Canadian Mineralogist**, 47, 1375-1398.



Evolution of volcano-plutonic systems

Information: J. Trubač, F. Tomek

A complex research focuses on processes during emplacement of volcanic and plutonic rocks in the Bohemian Massif and Western Carpathians. Anisotropy of magnetic susceptibility technique is applied to study internal relations and fabrics in magmatic rocks, including inverse strain estimations. Apart from classic geological techniques, we are developing a new approach using image analysis of magmatic textures (Matlab based PolyLX toolbox, and ImageJ program).



Peculiarities: Textural analysis of a bubble-bearing subvolcanic dike (left), layered aplite texture (right).

Selected outputs: **Tomek F**, Žák J**, Chadima M.** (2014) Magma flow paths and strain patterns in magma chambers growing by floor subsidence: a model based on magnetic fabric study of shallow-level plutons in the Štiavnica volcano–plutonic complex, Western Carpathians. **Bulletin of Volcanology** 76: Article No. 873.

Trubač J, Žák J, Chlupáčová M, Janoušek V. (2014) Magnetic fabric and modeled strain distribution in the head of a nested granite diapir, the Melechov pluton, Bohemian Massif. **Journal of Structural Geology** 66: 271–283.

The origin and evolution of Cenozoic rift-related magmatism of the Bohemian Massif

Information: J. Ulrych, J. Adamovič, L. Ackerman L. Krmíček

Long-term research of rift-related magmatism presenting and discussing new ideas concerning igneous rocks, their petrogenesis and the acting paleostress.

Peculiarity: Study of extensional-related volcanism, both modern and ancient, can contribute to understanding of mantle and crustal processes and interactions between them.

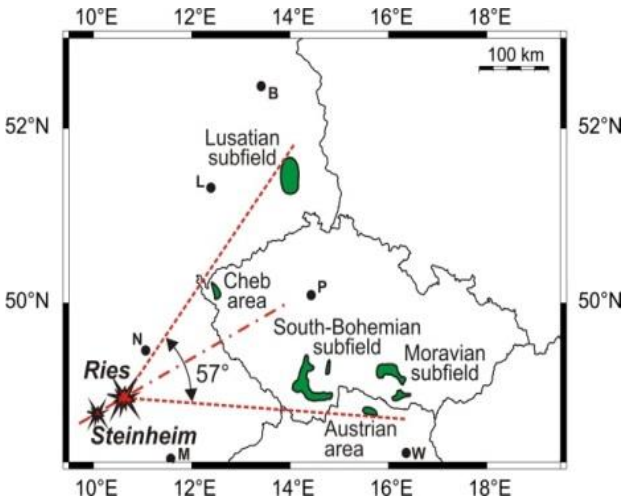
Selected outputs: **Ulrych J,** Dostal J, **Adamovič J,** Jelínek E, Špaček P, Hegner E, Balogh K. (2011): Recurrent Cenozoic volcanic activity in the Bohemian Massif (Czech Republic). **Lithos** 123, 133-144.

Ulrych J, Ackerman L, Balogh K, Hegner E, Jelínek E, Pécskay Z, Přichystal A, Upton BGJ, Zimák J, Foltýnová R. (2013): Plio-Pleistocene basanitic and melilititic series of the Bohemian Massif: K-Ar ages, major/trace element and Sr–Nd isotopic data. **Chemie der Erde – Geochemistry** 73, 4, 429-450.

Moldavites – central European tectites

Information: R. Skála, K. Žák

The study of moldavites provides a new insight into a complex behavior of elements at extreme conditions as well as better constrains on their formation process and source materials.



Peculiarities: Moldavites are a well-known variety of tectites (i.e., natural glasses formed by meteorite impacts). Analyses of isotopic composition of carbon contained in the moldavites suggest that terrestrial organic matter represented a substantial carbon source during the moldavite formation.

Selected outputs: **Skála R**, Strnad L, McCammon C, Čada M. (2009) Moldavites from the Cheb Basin, Czech Republic. **Geochimica et Cosmochimica Acta** 73: 1145-1179.

Žák K, **Skála R**, Řanda Z, Mizera J. (2012) A review of volatile compounds in tektites, and carbon content and isotopic composition of moldavite glass. **Meteoritics and Planetary Science** 47: 1010-1028.

Hi-res correlation and dating of Mid-Paleozoic sedimentary sequences of Peri-Gondwana

Information: L. Slavík. J. Hladil

The complex method based on application of integrated biostratigraphy and chemo-physical data was developed in order to increase the precision of relative dating of marine sedimentary strata.

Peculiarity: The integration of multiple correlation methods into refined biostratigraphic frameworks results in an increased precision in the correlation of marine carbonates in peri-Gondwana – i.e. up to 20 ky (= single carbonate bed).

Selected outputs: **Slavík L**, Carls P, **Hladil J**, **Koptíková L.** (2012) Subdivision of the Lochkovian Stage based on conodont faunas from the stratotype area (Prague Synform, Czech Republic). – **Geological Journal** 47, 616-631.

Valenzuela-Ríos JI, **Slavík L**, Liao J-C, Calvo H, **Hušková A, Chadimová L.** The middle and upper Lochkovian (Lower Devonian) conodont successions in peri-Gondwana key localities (Spanish Central Pyrenees and Prague Synform) and their relevance for global correlations. (Accepted) **Terra Nova**.

Reconstruction of Carboniferous tropical forest

Information: J. Bek

Reconstruction of Carboniferous tropical forest based on palaeobotanical and palynological research in the Radnice Basin was included among the ten greatest achievements of scientific research in the Czech Republic. It is based on international collaboration of Czech, Chinese and American palaeobotanists and palynologists called “Carboniferous Pompeii“.

Peculiarity: The Review of Palaeobotany and Palynology journal dedicated a whole special issue to the work of Czech Carboniferous palynologists and paleobotanists.

Selected output: **Bek J**, Kerp H. (2009) Late Palaeozoic palaeobotany and palynology in Central Europe: New contributions from the Czech Republic. **Review Palaeobotany and Palynology**. 155, 99-308.

Reconstructions of Carboniferous and Permian palaeoenvironment and palaeoclimate changes on the basis of vertebrate palaeontology and taphonomy

Information: J. Zajíc

Many lakes successively emerged and disappeared in the area of the Bohemian Massif during 20 Myr. They were fully alive with aquatic vertebrates. Both animals and lakes responded to climatic changes that were the most distinct near the Carboniferous/Permian boundary. Food webs and relationships between organisms and environment are reconstructed for particular stratigraphic levels.

Peculiarity: School of Permian acanthodians *Acanthodes gracilis* were swimming also in the tropical lakes of the Krkonoše Piedmont Basin and Boskovice Graben. One of the last species of the extinct group of fish preyed on microscopic organisms.

Selected outputs: Opluštil S, Šimůnek Z, **Zajíc J,** Mencl V. (2013) Climatic and biotic changes around the Carboniferous/Permian boundary recorded in the continental basins of the Czech Republic. - **International Journal of Coal Geology.** 119, 114-151

Lojka R, Drábková J, **Zajíc J**, Sýkorová I, Franců J, Bláhová A, Grygar T. (2009) Climate variability in the Stephanian B based on environmental record of the Mšec Lake deposits (Kladno–Rakovník Basin, Czech Republic). **Palaeogeography, Palaeoclimatology, Palaeoecology.** 280, 1-2, 78–93.

The study of trace fossils *Information: R. Mikuláš*

A useful research helping to asses whether the Holocene floods affected healthy or dead forests and also to investigate the occurrence of dinosaurs in the Middle Triassic of the Bohemian Massif.


Peculiarity: During the research, a dinosaur trace and a fossil bird nest were found in the Czech Republic. Both topics are very popular among the journalists, so many interviews and public presentations have been made.

Selected outputs: **Mikuláš R**. (2008) Xylic substrates at the fossilisation barrier: oak trunks (Quercus sp.) in the Holocene sediments of the Labe River, Czech Republic. – In: Wisshak M. & Tapanila L. (Eds.): **Current developments in bioerosion**: 415–429. Springer. Berlin, Heidelberg.

Past global geological events, climate changes and biotic crises *Information: P. Štorch, L. Slavík*

Complex geological research of changes and extinctions of biota during the geological past is trying to find causal connections and subsequent response of ecosystems.

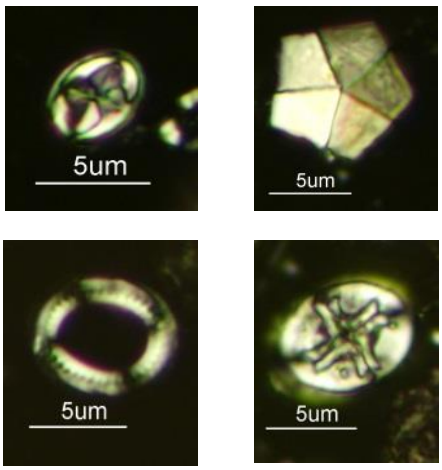
Peculiarity: Reconstructions of past biotic extinction events help to presume impacts and reactions of modern ecosystems under actual catastrophic conditions (e.g., climate change).

Selected outputs: Manda Š, **Štorch P, Slavík L**, Frýda J, Kříž J, Tasáryová Z. (2012) The graptolite, conodont and sedimentary record through the late Ludlow kozlowskii Event (Silurian) in the shale-dominated succession of Bohemia. **Geological Magazine**. 149, 3: 507-531.

Slavík L, Carls P. (2012) Post-Lau Event (late Ludfordian, Silurian) recovery of conodont faunas of Bohemia. **Bulletin of Geosciences**. 87, 4: 815-832.

Fossil marine nannoplankton – an important tool for dating sedimentary rocks *Information: A. Svobodová*

Calcareous microscopic remnants of marine algae provide useful biostratigraphic and palaeoecologic data for the Mesozoic and Cenozoic.

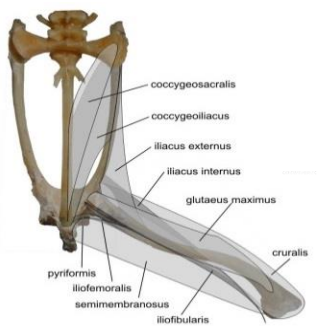


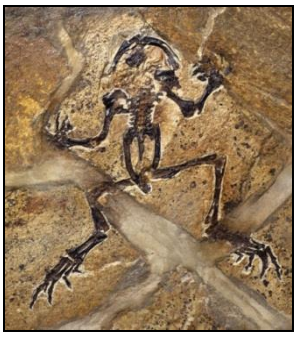
Peculiarity: Calcareous nannofossils research is applied in multiproxy studies in combination with other geoscience disciplines such as magnetostratigraphy etc.

Selected output: **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.

Origin and evolution of the anuran locomotion *Information: T. Přikryl, Z. Roček*

Origin and evolution of jumping (and other types of locomotion) in frogs based on comparative anatomy of modern groups and morphology of fossil bones.





Peculiarity: This research helps to understand anatomical adaptations to newly inhabited environments.

Selected output: **Přikryl T,** Aerts P, Havelková P, Herrel A, **Roček Z.** (2009) Pelvic and thigh musculature in frogs (Anura) and origin of anuran jumping locomotion. **Journal od Anatomy**. 214, 1: 100-139.

Larval development in fossil frogs *Information: Z. Roček*

Fossil tadpoles may be preserved both as skeletal and soft-tissue parts, incl. nerves and eye pigments.

Peculiarity: Development of fossil larvae helps to clarify mechanisms of evolutionary processes.

Selected outputs: **Roček Z**, Böttcher R, Wassersug R. (2006) Gigantism in tadpoles of the Neogene frog Palaeobatrachus. **Paleobiology** 32(4): 666–675.

Roček Z, Van Dijk E. (2006) Patterns of larval development in Mesozoic pipid frogs. – **Acta Palaeontologica Polonica** 51(1): 111–126.

Fossil Mammals – witnesses of the environmental changes during the Late Cenozoic *Information: S. Čermák, J. Wagner*

New excavations in Central and Eastern Europe provide an important platform for a better understanding of mammalian evolution and its correlation with palaeoenvironmental events in the continental scale.

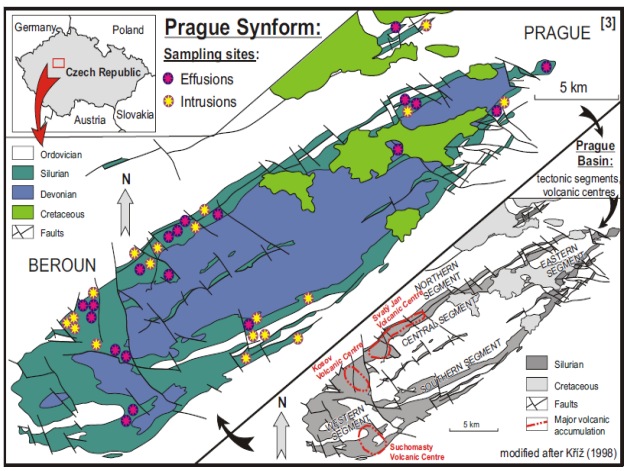
Peculiarity: Some of analyzed taxa were recognized as important biotic markers useful for large-scale stratigraphic and palaeoecologic correlations (see, *e.g.*, "Leporid datum"). Their taxonomy was refined and several new species were described.

Selected outputs: Flynn LJ, Winkler AJ, Erbajeva M, Alexeeva N, Anders U, Angelone C, **Čermák S**, Fladerer FA, Kraatz B, Ruedas LA, Ruf I, Tomida Y, Veitschegger K, Zhang Z. (2014) The Leporid Datum: a late Miocene biotic marker. **Mammal Review**. 44, 3-4: 164–176.

Wagner J, Čermák S. (2012) Revision of the early Middle Pleistocene bears (Ursidae, Mammalia) of Central Europe, with special respect to possible co-occurrence of spelaeoid and arctoid lineages. **Bulletin of Geosciences**. 87, 3: 461–496.

Silurian geotectonic paleosettings of the Prague Basin *Information: P. Pruner, T. Elbra, P. Schnabl, K. Čížková*

The Prague Basin, Bohemian Massif, East European Plate, has been a tectonically stable block since the Early Permian according to palaeomagnetic results. It was formed as a part of the emerging Pangea supercontinent. Paleomagnetic and paleogeographic investigations support the notion that the Prague Basin was a continental rift basin, situated on the presumed Perunica microplate in the Silurian.



Peculiarity: Many localities indicate that the Perunica microplate drifted at southern subtropical palaeolatitudes of 24° in Late Silurian time and experienced either 170° counter clockwise or 190° clockwise rotation during the Variscan orogeny. Some, however, prove quite strong remagnetization in the late Carboniferous – early Permian with no significant rotation.

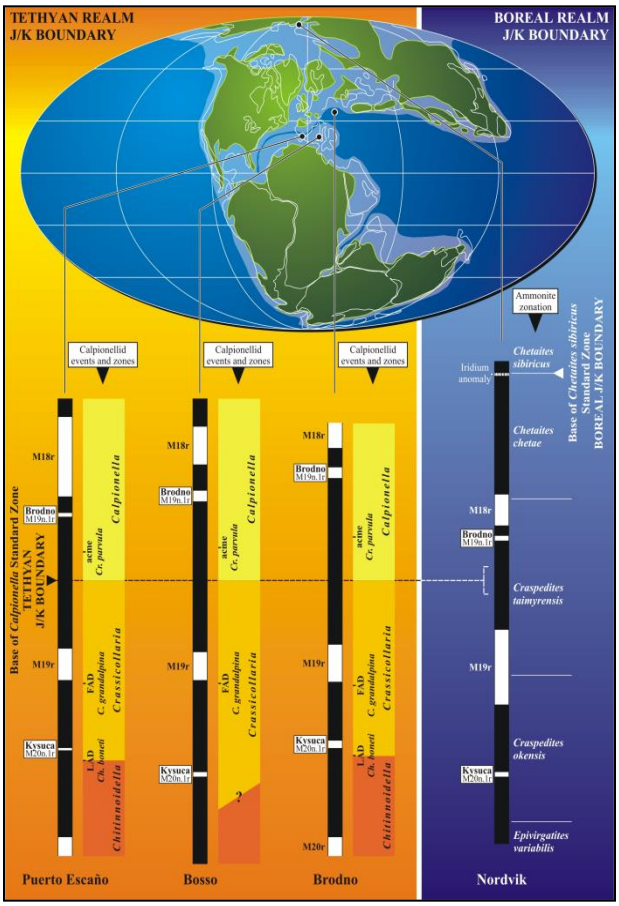
Selected outputs: Tasaryova Z, **Schnabl P**, **Čížková K**, **Pruner P**, Janoušek V, Rapprich V, **Štorch P**, Manda Š, Frýda J, **Trubač J.** (2014) Gorstian palaeoposition and geotectonic setting of Suchomasty Volcanic Centre (Prague Basin, Tepla-Barrandian Unit, Bohemian Massif). – **GFF**, 136(1): 262–265.

Elbra T, **Schnabl P**, Tasáryová Z, **Čížková K, Pruner P.** (2015) New results for Paleozoic volcanic phases in Prague Basin –magnetic and geochemical studies of Lištice, Czech Republic. **Estonian Journal of Earth Sciences**, 64(1): 31–35.

Integrated stratigraphy of the Jurassic/Cretaceous boundary strata in the Tethyan and Boreal Realms

Information: P. Pruner, P. Schnabl

The Boreal and the Tethyan Jurassic/Cretaceous (J/K) boundary strata were successfully correlated for the first time using high resolution magnetostratigraphic investigations. Magnetostratigraphy is the only method that enables global correlation. The team of the Laboratory of Paleomagnetism is incorporated within the Berriasian Working Group of International Commission on Stratigraphy (Subcommission on Cretaceous) which recently submitted new proposal of fixing J/K boundary.



Peculiarity: One of the markers for definition of the J/K will be a transition between two magnetozones.

Selected outputs: **Houša V**, **Pruner P**, Zakharov VA, Kostak M, **Chadima M**, Rogov MA, **Šlechta S**, Mazuch M (2007) Boreal-Tethyan correlation of the Jurassic/Cretaceous boundary interval by magneto- and biostratigraphy. **Stratigraphy and Geological Correlation** 15, 3: 297–309.

Wimbledon WAP, Rehakova D, Pszczolkowski A, Casellato CE, Halasova E, Frau C, Bulot LG, Grabowski J, Sobien K, **Pruner P**, **Schnabl P**, **Cizkova K**. (2013) An account of the bio- and magnetostratigraphy of the Upper Tithonian-Lower Berriasian interval at Le Chouet, Drome (SE France). **Geologica Carphathica** 64, 6: 437–460.

Laboratory investigations and simulations of extraterrestrial materials

Information: T. Kohout, G. Kletetschka

The research focuses on several topics, such as magnetic and optical properties of meteoritic materials; space weathering, shock darkening in ordinary chondrites; and magnetic minerals and anomalies in Mars.

Peculiarity: Asteroid 1986 RF3 was named "14351 Tomaskohout" in recognition of Tomas Kohout's research work.

Selected outputs: **Kohout T,** Gritsevich M, Grokhovsky VI, Yakovlev G A, Haloda J, Halodova P, Michallik RM, Penttilä A, Muinonen K. (2014) Mineralogy, reflectance spectra, and physical properties of the Chelyabinsk LL5 chondrite – insight into shock induced changes in asteroid regoliths. **Icarus** 228: 78–85.

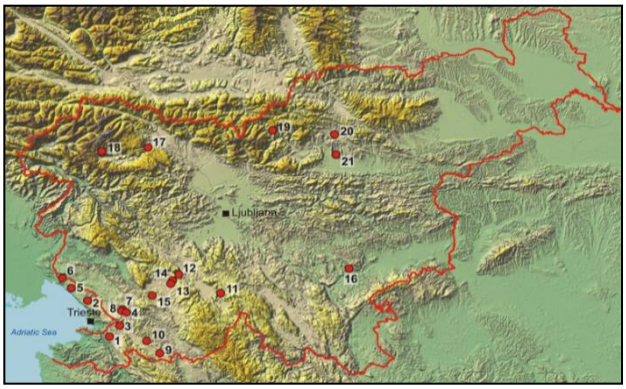
Leer K, Goetz W, Chan MA, Gorevan S, Hansen MF, Jensen CHJ, **Kletetschka G,** Kusack A, Madsen, MB. (2011) RAT magnet experiment on the Mars Exploration Rovers: Spirit and Opportunity beyond sol 500. **Journal of Geophysical Research** 116, E00F18: 1–8.

Paleomagnetic and magnetostratigraphic research of karst sediments in Slovenia

Information: P. Bosák, P. Pruner

For the first time in Slovenia, biostratigraphic data contributed to the correlation of magnetostratigraphy logs with the GPTS and to allocate the ages of cave fill more precisely to pre-Quaternary times. The period contains three distinct phases of massive deposition in caves with still preserved sediments dated to about 5.4–4.1 Ma (Miocene–Pliocene), 3.6–1.8 Ma (Pliocene) and Quaternary, following the Miocene sedimentation gap in Slovenian part of the Pannonian Basin, and the last, but principal, change of the tectonic regime at about 6 Ma.

Peculiarity: Paleomagnetic investigation brought important data for modification of the model of karstogenesis and geomorphic evolution of the Classical Karst in Slovenia.



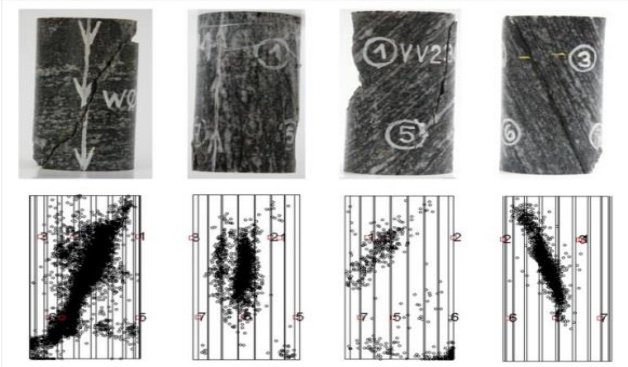
Selected outputs: Zupan Hajna N, Mihevc A, **Pruner P, Bosák P.** (2008) Palaeomagnetism and Magnetostratigraphy of Karst Sediments in Slovenia. **Acta Carsologica** 8: 1-266.

Pruner P, Zupan Hajna N, Mihevc A, **Bosák P, Man O, Schnabl P, Venhodová D.** (2010) Magnetostratigraphy and fold tests from Račiška Pečina and Pečina v Borštu Caves.(Classical Karst, Slovenia). **Studia Geophysica et Geodaetica** 54: 27–48.

Acoustic emission monitoring of fracturing process

Information: M. Petružálek, T. Lokajíček

Acoustic emission, a non-destructive tool, is used for monitoring of fracturing process in rock. This phenomenon is used for the detection of material microfracturing, localization of individual microcraks and mechanism of fracturing.



Peculiarity: During the experiment every little crack stronger than the set limit is registered. We deal approximately with 1 000 000 of AE events. From this amount roughly 100 000 are used for the determination of the main fracture.

Selected outputs: **Petružálek M, Vilhelm J, Rudajev V, Lokajíček T, Svitek T.** (2013). Determination of the anisotropy of elastic waves monitored by a sparse sensor network, **International Journal of Rock Mechanics and Mining Sciences**, 60, 208–216

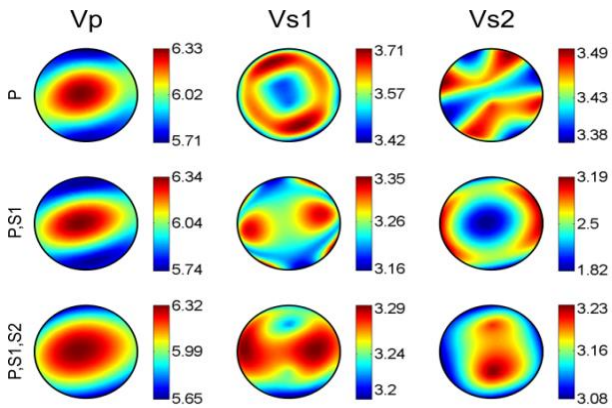
Lokajíček T, Goel RK, **Rudajev V,** Dwivedi RD. (2013). Assessment of velocity anisotropy in rocks. **International Journal of Rock Mechanics and Mining Sciences**, 57, 142–152

High pressure study of elastic anisotropy under high hydrostatic pressure by ultrasonic sounding

Information: T. Lokajíček, T. Svitek

Elastic properties of rocks can be studied by means of ultrasonic testing of spherical rock samples under acting hydrostatic pressure. Based on testing in a large number of independent directions the three dimensional distribution of longitudinal P and transversal (S1-fast, S2-slow) wave velocities can be calculated based on non-linear inversion of Christoffel equation. Velocity scale is in km/s.

Peculiarity: Our research has revealed that for obtaining the most accurate material properties it is necessary to incorporate velocities of P, S1 and S2 waves into the calculation process. Calculations based only on P-wave velocities are not sufficient.



Selected outputs: **Lokajíček T**, Kern H, **Svitek T,** Ivankina TI. (2014) 3D velocity distribution of P- and S-waves in a biotite gneiss, measured in oil as the pressure medium: Comparison with velocity measurements in a multi-anvil pressure apparatus and with texture-based calculated data, **Physics of the Earth and Planetary Interiors (PEPI)**. 241, 1–15.

Svitek T, Vavryčuk V, **Lokajíček T, Petružálek M.** (2014). Determination of elastic anisotropy of rocks from P- and S-wave velocities: Numerical modeling and lab measurements. **Geophysical Journal International**, 199(3): 1682–1697.

Determination of migration parametres of rocks with fracture permeability using fluorescent solutions

Information: J. Rohovec

Applied research realized together with private companies and other academic institutions (ISATECH, CVUT) is focused on the transport of tracing colorants in granites. In laboratory model we use a well defined fracture packed with inert filling, through which a yellowish tracer Fluorescein is passed.

Thank you for your interest

Institute of Geology CAS, v.v.i.

The Czech Academy of Sciences

Issued by Institute of Geology of the Czech Academy of Sciences, v. v. i., First edition, 2015

The material was compiled by M. Filippi.
The English was revised by J. Adamovič.
WEB page of the Institute:
https://www.gli.cas.cz/en

Notes

Notes

Notes

Notes