Institute of Rock Structure and Mechanics of the Czech Academy of Sciences

ANNUAL REPORT 2024

Compiled: 20 March 2025

Discussed by the Supervisory Board: 27 May 2025

Approved by the Board of Institute: 24 June 2024

Prague, 24 June 2024

This english translation serves for informative purposes only, legally binding is the Czech version.

TABLE OF CONTENTS

I. Information on the composition of the statutory bodies of the Institute of Rock Structure and Mechanics of the Czech Academy of Sciences (IRSM of the CAS) and the activities there of

Composition of the Institute's statutory bodies

Director:	RNDr. Filip Hartvich, Ph.D.
Board of the Institute:	
Chairman:	RNDr. Josef Stemberk, CSc.
Vice-chairman:	Mgr. Martina Havelcová, Ph.D.
Internal members:	Ing. Olga Bičáková, Ph.D., Mgr. Jan Blahůt, Ph.D., RNDr. Jiří Málek, Ph.D., doc. Ing. Tomáš Suchý, Ph.D. RNDr. Petra Štěpančíková, Ph.D.
External members:	Mgr. Jiří Adamovič, CSc., (Geological Institute of the CAS), Prof. RNDr. Tomáš Fischer, Ph.D. (Charles University Prague, Faculty of Natural Sciences), doc. Ing. Jaroslav Kloužek, CSc. (University of Chemistry and Technology Prague) Ing. Pavel Kriegsman, (KM, s.r.o.),
Secretary to the Board:	doc. RNDr. Pavel Straka, DrSc.
Supervisory Board:	
Chairman:	Ing. Ilona Müllerová, DrSc. (Institute of Scientific Instruments of the CAS)
Vice-chairman:	Mgr. Lucia Fojtíková, Ph.D. (Institute of Rock Structure and Mechanics of the CAS)
Members:	doc. Ing. Jakub Kostelecký, Ph.D. (Faculty of Civil Engineering CTU in Prague) prof. RNDr. Jakub Langhammer, Ph.D. (Charles University Prague, Faculty of Natural Sciences) Ing. Radek Sedláček, Ph.D., (Faculty of Mechanical Engineering CTU in Prague),
Secretary to the Board:	RNDr. Jakub Stemberk, Ph.D.

Activities of the Institute's statutory bodies

Director:

- Director issued a total of 7 organisational communications during 2024. Six meetings were held between the Institute's management and Heads of Department.

- One contract was concluded for a new Czech Science Foundation (GA ČR) project, one GA ČR project was transferred from Institute of Geology of the CAS to the IRSM; three contracts were concluded for new TA ČR (The Technology Agency of the Czech Republic) projects and one contract for a Ministry of Health project.

- In 2024, new projects financed from the OP JAK, TAČR and GAČR programs were launched, focusing on innovative research approaches and developing traditional research topics of the Institute.

- In cooperation with the Road and Motorway Directorate of the Czech Republic, extensive geotechnical work was carried out in the form of an economic contract to assess the stability of newly constructed sections of roads and motorways.

- The publishing activity of scientific workers was evaluated in the form of a competition, and its results were published and financially rewarded.

- On January 1, 2024, a new Department of Applied Rock Mechanics was established. Dr. Jan Blahůt was appointed head of the department. The team was expanded to include new young experts, including foreign ones (Dr. Xuan Xinh Nguyen; Ghazaal Rastjoo, MSc.).

- The Institute actively participated in the Science Fair in Letňany (May 30–June 1, 2024), where it presented the most extensive exhibition of its scientific activities to date.

- Construction project – Photovoltaic power plant (project from 2023): the building permit was issued on February 19, 2024, but the tender announced in 2024 was canceled due to incomplete bids.

- A representative of the Institute was appointed as a member of the permanent expert commission for monitoring the condition of the Prague Castle archaeological site, thereby strengthening the institute's role in the field of heritage preservation and interdisciplinary research.

Board of the Institute:

The Board of the Institute held four regularly-scheduled meetings during 2024:
5 March, 27 May, 25 November and 12 December.

- 5 March - The institute´s financial statements of the 2023 and the budget for 2024 were discussed and approved, the conditions of the new department in Pushkin Square Prague 6 after its reconstruction and possibilities for its improvement were also discussed. The Board took note of changes in laws concerning public research institutions.

- 27 May - The Annual Report of the IRSM for 2023 was discussed. After incorporating all comments and re-checking the technical and economic sections, the Board agreed to submit the audited Annual Report to the Supervisory Board for approval. At the same time, the updated and discussed budget of the institute for 2024 was also submitted to the Supervisory Board for approval. In addition, 35 research project proposals were approved for submission to the Czech Science Foundation (GA ČR), 9 projects for the Mobility Plus program, and other projects. Changes to the ÚSMH Election Rules were discussed and the new wording of the

IRSM Election Rules was approved. The Board also discussed changes to the IRSM Organizational Rules and forwarded them to the Director of the Institute for approval. The Board took note of the Director's directive on the protection of whistleblowers pursuant to Act No. 171/2023 Coll. and the basic provisions on conflicts of interest for the upcoming evaluation of the institute.

- **25 November** - The Board was informed by the Director of the institute that the tender for the implementation of the photovoltaic power plant had been canceled and a new tender would be announced; the new institute´s department at Pushkin Square Prague 6 is operating successfully and is fully staffed, but still has to deal with structural and technical defects. Sixty-eight articles in impacted journals and nine in peer-reviewed journals, as well as five chapters in monographs and one patent, have been submitted to the publication competition. The institute-wide project for the SIGMA program, TAČR, was not accepted due to an obvious error on the part of the evaluator.
The head of the Economic Department, Žaneta Hessová, informed the Board about the institute's ongoing budget expenditure in 2024. The institute must meet its financial obligations by drawing on the Reserve Fund. To this end, the Economic Department will prepare a proposal to be submitted to the Board for approval per rollam.

- **12 December** - The economic activity and the economic outlook of the Institute for 2025 was discuss. It will be necessary to prepare new IRSM wage regulations that will take into account, among other things, the prescribed minimum wage in 2025 and other circumstances. With the arrival of the new year, the wage regulation will be updated, particularly in Article 12 and the annexes. The Board discussed the additional financing of the Asset Reproduction Fund at the request of the head of the ÚSMH Economic Department. After discussion, the Board recommended that the Director of the Institute approve the withdrawal of the necessary amount from the Reserve Fund to supplement the Asset Reproduction Fund, in accordance with Section 17(c) of Act No. 341/2005 Coll. on public research institutions.

Supervisory Board:

In accordance with the Rules of Procedure, the Supervisory Board met twice in 2024, and discussed of 3 total issue per rollam. The Board was provided with the institute's financial activities results, its 2023 Annual Report and the budget for 2024.

The first meeting of the Board, held on June 10, 2024, included the verification and approval of the of the last February meeting, a discussion on the disbursement of the IRSM budget in 2023 and the outlook for 2024, and a discussion on, and the noting of, the financial and auditor’s reports for 2023. Further, the Board discussed and approved the Report on the Activities of the IRSM Supervisory Board for 2023 and The Annual Report of the IRSM for 2023. The activities and results of the IRSM were discussed, The director of the institute, Dr. Hartvich, informed the members of the Board about the scientific activities of the ÚSMH, the progress of preparations for the evaluation of the institute, and other activities of the institute's management (preparation of FVE, support for science and laboratory operations in the form of small institutional projects, etc.). The proposal for the evaluation of the managerial skills of the Director of the ÚSMH was discussed and approved. The results of the per rollam votes 1/2024 and 2/2024 were also verified at the meeting.

At its second meeting, held on December 12, 2024, the Board verified and approved the minutes of meeting 1/2024 and per rollam vote no. 3/2024. The Board also discussed the disbursement of the budget in 2024 and the outlook for 2025. The Board was informed by the Director about the progress and difficulties with the management of the construction of a photovoltaic power plant on the roofs of the institute's buildings, as well as about developments at the Institute.

During 2024, the Board discussed and approved 3 draft resolutions by means of a per rollam vote to:

1) supplementary agreement to the lease agreements between ÚSMH AV ČR, v.v.i. and the tenants of the premises: the Institute of Archaeology of the CAS, Masaryk Institute and Archives of the CAS, INPEK s.r.o., Jan Kanyitura, and Ondřej Kulík.
2) lease agreement for business premises between the IRSM of the CAS and The Institute of Contemporary History of the CAS
3) conclusion of the contract for the ACONTIP, s.r.o company as the financial auditors of the IRSM

II. Information on changes to the Institute's charter

No changes were made to the Institute's charter during the year 2024.

III. Evaluation of the Institute's main activities

1. Results of the Institute's scientific activities

The scientific activities of the Institute were performed in the context of the Long-term Research Organisation Conceptual Development Project, no. RVO 67985891 and concerned both research in selected geoscientific fields and the socially desirable research of materials.

- **Geoscientific research:**

The study of the properties of rocks employing instrumental methods and the research of rocks focusing on the conditions for the emergence of natural and induced geodynamic processes and activities in the upper layer of the earth's crust, namely:
- processes that threaten the stability of the earth's surface and the minimisation of their adverse impacts;
- the monitoring and study of the propagation of seismic waves in various rock environments;
- the monitoring and analysis of slope and tectonic movements;
- the study of the paleo-stress conditions in the Bohemian Massif;
- the study of neo tectonic phenomena in the USA and Turkey
- monitoring and analysis of the physical and mechanical properties of rock massifs depending on rock composition, precipitation, and temperature.

- **Materials research:**

The study of raw materials and organic and inorganic materials focusing on their origin and properties and with regard to their use in the medical, glassmaking, construction and environmental technology sectors, namely:
- the preparation and research of the properties of collagen materials for use in the field of vascular surgery,
- the modelling of melting processes, the development of new melting facilities and the vitrification of radioactive waste;
- the preparation of special glass materials permeable to infrared radiation and the characterisation thereof;
- the development of special composite materials;
- the preparation of new geopolymer composites;
- the development of technologies for the heat treatment of sludges, biomass and plastic waste;
- separation of germanium from brown coal for further use

The Institute achieved a number of significant research results during the year via international cooperation, especially with foreign research institutions, cooperation with

domestic research facilities, universities and other institutes of the Academy of Sciences of the Czech Republic and cooperation with industrial organisations Road and Motorway Directorate of Czech Republic, CEZ Group, Czech Radioactive Waste Repository Authority (SÚRAO), The Vyšehrad National Cultural Monument, a contributory organisation of the City of Prague, etc.).

One outcomes are described below as example of successful international cooperation:

International cooperation and collaboration between academic institutions has achieved significant results in the disposal of radioactive waste through vitrification into glass. Vitrification involves melting radioactive waste into glass, thereby preventing its spread into the surrounding environment.

1) Effect of Alumina Source on the Retention of Rhenium during Low-Activity Waste Feed Conversion to Glass.

Summary:

A method for retaining radioactive technetium in glass has been developed. The volatility of technetium during vitrification is a problem that needs to be addressed, as high technetium retention in glass allows a high proportion of radioactive waste to be dosed into the input mixture. Radioactive technetium can be simulated in experiments with rhenium (Re) and the retention of Re can be monitored for various sources of aluminum oxide (Al2O3) in glass. Mixtures with kyanite (Al2SiO5) and gibbsite (Al(OH)3) were prepared as sources of aluminum oxide, and the retention of Re in the produced glasses was measured. Significantly higher retention of Re was observed in glass produced from a mixture containing gibbsite compared to kyanite. It was found that Re retention is up to 20% higher in glass produced with gibbsite. This can be explained by the formation of nanocrystalline aluminum oxide with a large surface area. Nanocrystalline Al_2O_3 can adsorb molten salt containing the rhenium anion RhO_{-4}, thereby increasing the rate at which Re is incorporated into the alkali-aluminium-borosilicate glass matrix. Technetium will behave in the same way. It has also been demonstrated that replacing kyanite with gibbsite has no adverse effect on the actual processing of the radioactive waste in question by vitrification.

The result was achieved in collaboration with the University of Chemistry and Technology, Prague, the Institute of Macromolecular Chemistry of the Czech Academy of Sciences, Pacific Northwest National Laboratory (USA), and the U.S. Department of Energy.

Publication:

Eret M., Löwy L., Kloužek J., Cincibusová P., Vernerová M., Lhotka M., Kohoutková M., Michalcová A., Brus J., Hrma P., Kruger A., Pokorný R.: Effect of Alumina Source on the Retention of Rhenium during Low-Activity Waste Feed Conversion to Glass. *Ceramics International* 50, 42229 (2024). doi.org/10.1016/j.ceramint.2024.08.067

Illustration:

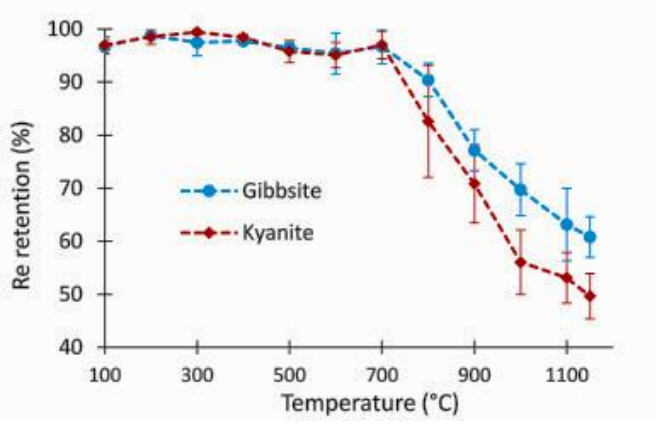

Fig). Retention of rhenium (Re) in a mixture with kyanite (red curve) and gibbsite (blue curve) depending on temperature at a heating rate of the raw material mixture of 10 K/min. Re retention in the presence of gibbsite is significantly higher at processing temperatures above 700 °C.

Another significant result was also achieved in international cooperation with universities in California and Colorado.

2) Characteristic Slow-Slip Events on the Superstition Hills Fault, Southern California.

Summary:

A recent slow slip event was investigated on the Superstition Hills Fault in southern California, where energy is regularly released without ground shaking. From May to July 2023, the fault experienced its largest documented slow slip in 13 years, releasing energy equivalent to a magnitude 4.5 earthquake. The spatial behavior of the slip was similar to previous events in 1999, 2006, and 2010, indicating characteristic slip behavior for the Superstition Hills Fault.

The result was achieved in collaboration with the Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California, San Diego, USA; Department of Geological Sciences, San Diego State University, USA; Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, USA.

Publication:

Vavra E.J., Fialko Y., Rockwell T., Bilham R., Štěpančíková P., Stemberk Jakub, Tábořík P., Stemberk Josef (2024): Characteristic Slow-Slip Events on the Superstition Hills Fault, Southern California. *Geophysical Research Letters* 51, e2023GL107244. doi.org/10.1029/2023GL107244

Illustration:

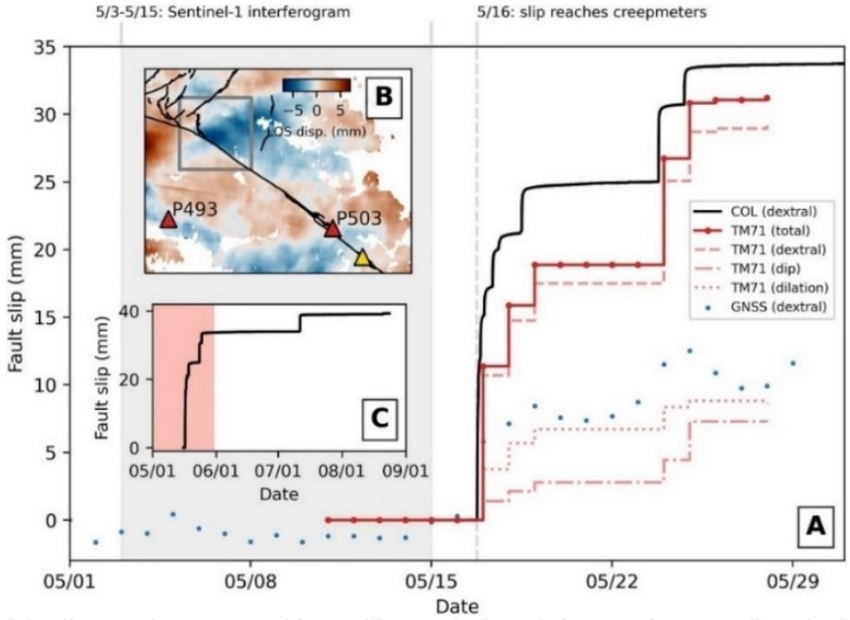

Fig).Slip on the Superstition Hills Fault (SHF) in Southern California in May 2023: The black lines represent dextral slip from the COL creepmeter (a device that monitors slow surface movement of an active geological fault);. Dextral slip measured by COL creepmeter (a device that monitors slow surface movement of an active geological fault); is shown in black lines. Red lines represent various components the slip - show dextral slip (dashed), dip slip (dot-dashed), dilation (dotted), and total fault displacement (solid) from TM71 creepmeter (a device that monitors slope displacement and transmits data remotely). Blue dots show the fault-parallel baseline change between Global Navigation Satellite System stations P503 and P493. Gray shading indicates the epoch of the 3–15 May Sentinel-1 interferogram (recording of distance changes). (B) 3–15 May Sentinel-1 interferogram showing initial slip on the northern Superstition Hills Fault (gray box). (C) Time series of fault slip through August 2023 from COL. Red shading indicates the time span of time series in panel (A).

As an example of **cooperation with universities and institutes of the Czech Academy of Sciences**, we present the following result of clarification of the radiolytic transformation of solid bitumen at the Bytíz deposit.

3) Formation and radiolytic alteration of uraniferous solid bitumen related to hydrothermal base-metal mineralization in the Bytíz deposit.

Summary:
Samples of solid bitumen with a U content of up to 38% by weight from the Bytíz deposit were characterized petrologically, geochemically, and mineralogically. It was found that more than 80% by volume of the solid bitumen from the vein fill was radiolytically altered. Three generations of uraninite were distinguished in connection with solid bitumen, the formation of which is probably related to several stages of inflow of hot hydrothermal fluids with viscous bitumen into the uranium deposit.

The result was achieved in cooperation with the Faculty of Science of Charles University and the University of Chemistry and Technology in Prague.

Publication:
Tatiana Larikova, Ivana Sýkorová, Martin Racek, Martina Havelcová, Vladimír Machovič, Ladislav Lapčák, Formation and radiolytic alteration of uraniferous solid bitumen related to hydrothermal base-metal mineralization in the Bytíz deposit, Příbram district, Czech Republic. *International Journal of Coal Geology* 293, 2024, 104590. Doi.org/10.1016/j.coal.2024.104590

Illustration:

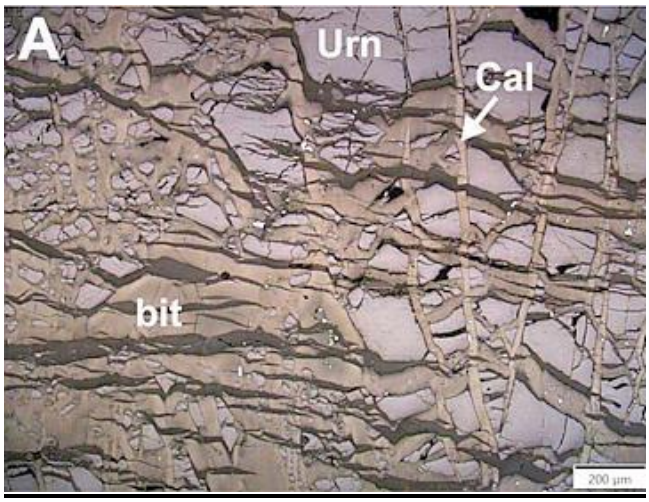

Fig). Microphotograph of a sample from the Bytíz deposit obtained in reflected light. Fragments of uraninite (Urn) with coffinite are intersected by calcite veins (Cal). Bitumen (bit) is visible between the fragments.

=

2. Activities and selected results of the Institute's scientific departments

The Institute conducted its scientific activities during the year via all **seven of its research departments**, **five** of which focused on geoscientific and **two** on materials disciplines:
Geoscientific research was conducted by the **Departments of Engineering Geology**, **Department of Neotectonics** and **Thermochronology**, **Department of Seismotectonics** and **Department of Geochemistry**. A new **Department of Applied Rock Mechanics** was added, which began its activities on **January 1, 2024**.
Materials research was performed by the **Department of Composite and Carbon materials** and the **Department of Material Structure and Properties**.

The institute's scientific departments benefit from the sharing of research facilities with various universities. Laboratory of Sorption and Porosimetric Analyse of institute´s Geochemistry Department is joint laboratory established by the Institute of Rock Structure and Mechanics together with the Faculty of Science, Charles University, Prague. Similarly, the Department of Material Structure and Properties Materials' Inorganic Materials Laboratory is shared with the University of Chemical Technology, Prague.

In 2024, the Institute's scientific departments were involved in the Strategy AV21 research programmes, in 5 international projects, carried out 16 extensive research projects, cooperated with domestic and numerous foreign universities and research centres, and carried out contracts for practice.

The staff of the Institute took part in important international scientific committees, organised three scientific conferences and participated in the popularisation of science and public education. The Institute has been awarded 1 patent.

The staff of the Institute's scientific departments continued to be involved in teaching at various universities in 2024, not only at Czech universities, but also at Oregon State University, Corvallis and University of New York, USA.

=

The Department of Engineering Geology focuses on the analysis and interpretation of geodynamic hazardous phenomena associated with exogenous processes, i.e. slope deformations and weathering. Particular attention was devoted during the year to the development of reliable and accurate monitoring methods for the monitoring of slope phenomena, especially landslides, and the prediction of their future occurrence and development.

The department was involved in international research on slope deformations and tectonic structures via the use of the following **monitoring networks**:

- Name of network: **TecNet**

Monitored issue: Microdisplacements on tectonic faults.
Operator: IRSM + cooperating organisations
RI/OP VVV Programme
Content: Tracking of seismic tectonic movements along faults.

- Name of network: **Geonas**

Monitored issue: GNSS fixed point movements.
Operator: IRSM
RI/OP VVV Programme
Content: Monitoring of tectonic movements.

- Name of network: **SlopeNet**

Monitored issue: Slope processes / landslides, rockfalls.
Operator: IRSM
RENS Programme
Content: Monitoring of slope movements and rockfalls.

Main outcomes:

1) Long-term movement activity and internal structure of deep-seated landslide by using dendrochronology analysis and electric resistivity tomography in flysch rocks, Carpathians.

Summary:
Complex or compound landslides, which combine different types of movements at different depths with varying acceleration frequencies, are very challenging to map in terms of terrain morphology, movement monitoring, and reliable risk assessment.

To describe the surface morphology, underground structures, and movement dynamics of the complex and deeply buried landslide, several techniques were combined, including dendrogeomorphological survey, with the aim of providing reliable data for assessing its risk. Interpretation of the digital terrain model and detailed terrain morphological mapping, together with geological records and interpretation of electrical resistivity tomography profiles, made it possible to describe the characteristics of two distinct forms of relief typically identified in complex or deep-seated landslides in the studied Carpathian region – shallow landslides and landslide blocks.
The dendrogeomorphological survey demonstrated for the first time an acceleration in the movement of landslide blocks, which reactivate approximately twice as often as shallow landslides. It also showed different responses of trees to the movements of these two forms. Trees on shallow landslides responded to the movements of heavily disturbed material primarily by sudden growth suppression (54.4%). In contrast, trees on landslide blocks showed a dominant response to the tilting of landslide blocks made of more cohesive rock material (84.7%). The research has shown that dendrogeomorphological investigations allow for the reliable identification of years with accelerated movements, which corresponds well with instrumental surface monitoring of landslides. At the same time, this method provided a wealth of data on partial reactivations of landslides over several decades in conditions where remote sensing methods are difficult to use (e.g., in dense forests).
To describe the surface morphology, underground structures, and movement dynamics of the complex and deeply buried landslide, several techniques were combined, including dendrogeomorphological survey, with the aim of providing reliable data for assessing its risk. The interpretation of the digital terrain model and detailed terrain morphological mapping, together with geological records and the interpretation of electrical resistivity tomography profiles, made it possible to describe the characteristics of two different forms of relief that are typically identified on complex or deep-seated landslides in the studied area.
Dendrogeomorphological research is therefore well suited for assessing the risks of partial failures of complex or compound landslides. It also provides information on the type of landslide movement (sliding vs. surface tilting) and the nature of the deformed material (highly disturbed vs. more cohesive). The reactivation frequencies determined for shallow landslides and landslide blocks are reliable and represent the long-term movement activity of these partial landslides, which could not be obtained by other methods (58 years for landslides, 118 years for landslide blocks).

Publication:
Klimeš J., Hartvich F., Šilhán K. (2024). Long-term movement activity and internal structure of deep-seated landslide by using dendrochronology analysis and electric resistivity tomography in flysch rocks, Carpathians, Czech Republic. *Landslides.*
doi.org/10.1007/s10346-024-02330-9

Illustration:

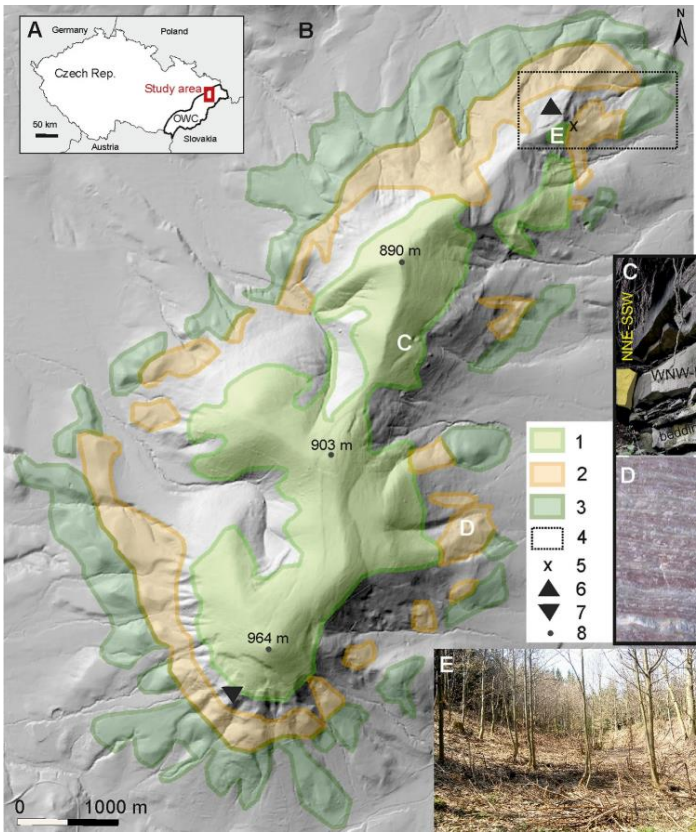

Fig. A), above – studied area. Main map: B) – geological units from a map at a scale of 1:50,000 (Czech Geological Survey) and shaded relief (State Administration of Surveying and Cadastre). C), D) – photographs showing the typical lithology of the studied area with the main geological structures, E) – double ridge.

Further outcomes:

Vavra E. J., Fialko Y., Rockwell T., Bilham R., Štěpančíková P., Stemberk Jakub, Tábořík P., Stemberk Josef (2024). Characteristic Slow-Slip Events on the Superstition Hills Fault, Southern California. *Geophysical Research Letters* 51, e2023GL107244. doi.org/10.1029/2023GL107244

Baroň, I., Jelének, J., Klimeš, J., Dong, J-J., Melichar, R., Šutjak, M., Chen, Y., Yang, C-M., Zhang, E-L., Méndez, J., Tseng, C-H., Hartvich, F., Blahůt, J., Nguyễn, T-T., Kociánová, L., Bárta, F., Dušek, V., Kycl,P. (2024). Source area morphometry and high depletion rate of landslides may indicate their coseismic origin. *Engineering Geology* 330:107424. doi.org/10.1016/j.enggeo.2024.107424

Klimeš, J., Kilnar, K., Kopačková-Strnadová, V., Pánek, T., McColl, S. (2024). Landslides in the glaciated mountains of the Cordillera Blanca, Peru – types, spatial distribution and conditioning factors. *Landslides*. doi.org/10.1007/s10346-024-02387-6

Šilhán K., Fabiánová A., Klimeš J., Tábořík P., Hartvich F., Blahůt J. (2024): The effect of tree growth disturbances inertia on dendrogeomorphic spatio-temporal analysis of landslides: A case study. *Catena* 235, 107678.

Klimeš J., Novotný J., Balek J., Rosario A.M., Torres J.C., Vargas R., López D., Obispo Y., Roldán-Minaya E., Caballero A., Jara H., Villafane H., Melgarejo E. (2024). Landslide hazard

assessment and risk reduction in the rural community of Rampac Grande, Cordillera Negra, Peru. *Environmental Earth Sciences* 83. doi.org/10.1007/s12665-023-11307-1

Klimeš J. (2024). Landslides in the Cordillera Blanca. *In*: Vilímek, V., Mark, B., Emmer, A. (eds) Geoenvironmental Changes in the Cordillera Blanca, Peru. Geoenvironmental Disaster Reduction. Springer, Cham, pp 129–145. doi.org/10.1007/978-3-031-58245-5_8

Novotný J., Klimeš J. (2024). Stability of Moraine and Rock Slopes at Glacial Lakes—Two Case Studies in the Cordillera Blanca. *In*: Vilímek, V., Mark, B., Emmer, A. (eds), Geoenvironmental Changes in the Cordillera Blanca, Peru. Geoenvironmental Disaster Reduction. Springer, Cham, pp 147–168. doi.org/10.1007/978-3-031-58245-5_9

Loche M., Klimeš J., Racek O., Blahůt J. (2024). Preliminary Landslide Risk Assessment: A Glimpse in Hazard Probability in NW Czech Republic. *In*: Schneider J et al. (eds), Conference proceedings INTERPRAEVENT 2024, Vienna, Austria, pp. 643–647. 10.13140/RG.2.2.13330.47041

Klimeš J., Emmer A. (2024). Comments on Landslide Occurrence under Changing Climate in Earthquake-prone Cordillera Blanca, Peru. *Revista de Glaciares y Ecosistemas de Montaña* 9:97–107.

Vargas R., Klimeš J., Torres J.C., Jara H., Rosario A.M., Melgarejo E. (2024). Susceptibility Analysis for Mass Movements, in a Participatory Framework in the Town of Rampac Grande and Hornuyoc, Carhuaz, Ancash. *Revista de Glaciares y Ecosistemas de Montaña* 9:7–24.

=

The Department of Neotectonics and Thermochronology in 2024 continued its research into paleo-stress conditions in the Bohemian Massif and investigated selected fault structures, such as the Krušné Hory, Mariánské Lázně and Lusatian (Lužický) faults. Foreign tectonic and geophysical research was conducted in US in the San Andreas fault zone. In collaboration with Oregon State University, research on active slope deformations on the Pacific coast in the Cascadia subduction zone (Oregon, USA) has begun., Reconnaissance took place also in Turkey to select sites for monitoring fault movements and field research and sampling focused on thermochronological evolution of areas at the lithospheric plate interface. In addition, fieldwork was conducted in the northeastern Himalayas in India. In cooperation with other geoscience institutions, the department participated in research on slope deformations and the structural-tectonic development of sandstone reliefs in the Czech Republic and Poland as well as using geophysical methods in interdisciplinary studies.

The department's staff are involved in expert activities in the field of geology and are involved in international research on slope deformations and tectonic structures via the use of the following monitoring networks:

- Name of network: **SlopeNet**

Monitored issue: The monitoring of slope deformations, landslides and rockfalls.
Operator: IRSM
RENS Programme
Content: The geophysical and geotechnical monitoring of slope deformations, active involvement in international research and the taking over of co-responsibility for monitoring.

- Name of network: **Network EU TecNet**

Monitored issue: Tectonic structures in the EU.
Operator: IRSM
Czech/Geo Programme.
Content: active involvement in the EU network, meter reading and service, and data evaluation.

Main outcomes:

1) Characteristic Slow-Slip Events on the Superstition Hills Fault, Southern California (see page 8).

2) Geomorphological and Geo/Thermo-chronological responses of Indian Plate's deformation during Neogene-Quaternary time along the Eastern Himalayan Syntaxis: Formation of Manabhum Anticline.

Summary:
The uplift rate of the eastern Himalayan syntaxon was calculated using low-temperature thermochronology and optically stimulated luminescence methods for both the Neogene (23.0 to 2.58 million years ago) and Quaternary (2.58 million years ago to the present) periods. It was found that the uplift rate increased during the Quaternary period. The result obtained is important for understanding the process of orogenesis.

Publication:
Goswami (Chakrabarti) C., Gülyüz E., Gülyüz N., Narzary B., Jaiswal M. K., Karaoglan F. (2024). Geomorphological and Geo/Thermo-chronological responses of Indian Plate's deformation during Neogene-Quaternary time along the Eastern Himalayan Syntaxis: Formation of Manabhum Anticline. *Journal of Asian Earth Science* 260, 105967. Doi.org/10.1016/j.jseaes.2023.105967

Illustration:

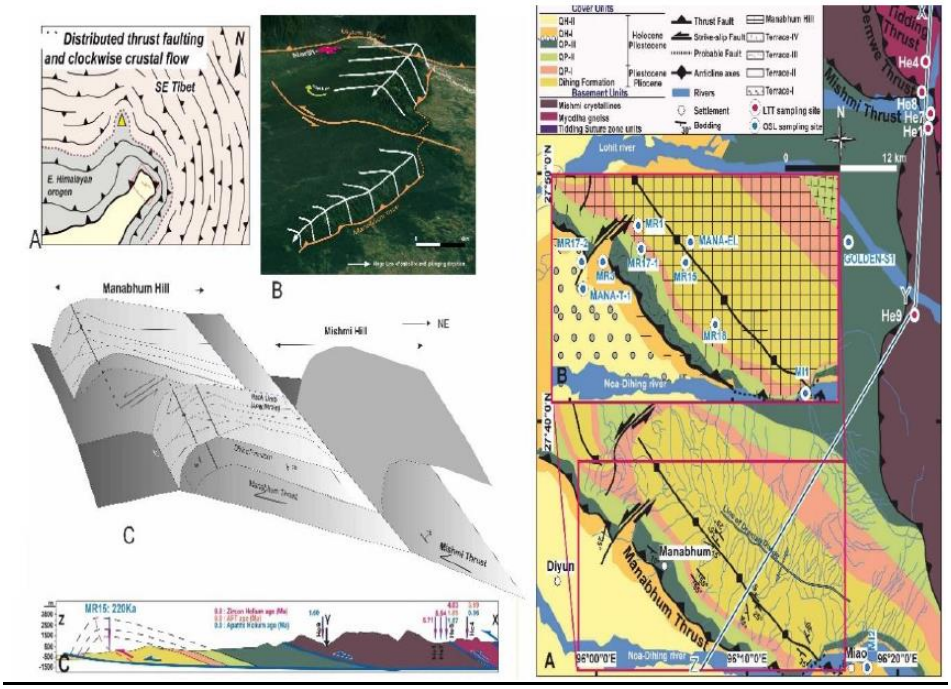

Fig. The figure illustrates an interpretative model showing the uplift of the Indian plate along the eastern Himalayan syntax during the Cenozoic era and the formation of new faults and folds that gave rise to the Quaternary hills. The uplift rate in the Quaternary (~3.2 mm/year) is significant compared to the uplift rate in the Neogene (~2.3 mm/year).

3) Application of (U-Th)/He hematite geochronology to the Çaldağ lateritic Ni-Co deposit, Western Anatolia: Implications for multi-stage weathering events during interglacial periods/segments

Summary:
Ni-Co laterite deposits are formed by the weathering of ultramafic rocks in the tropics and reveal paleoclimatic processes. The study uses hematite (U-Th)/He dating at the Çaldağ deposit in Turkey, with ages of 502, 206, 178, and 63 thousand years, associated with interglacials.

Publication:
Gülyüz N., Kuşcu İ., Danišík M. (2024). Application of (U-Th)/He hematite geochronology to the Çaldağ lateritic Ni-Co deposit, Western Anatolia: Implications for multi-stage weathering events during interglacial periods/segments. *Ore Geology Reviews* 172, 106203. Doi.org/10.1016/j.oregeorev.2024.106203

Illustration:

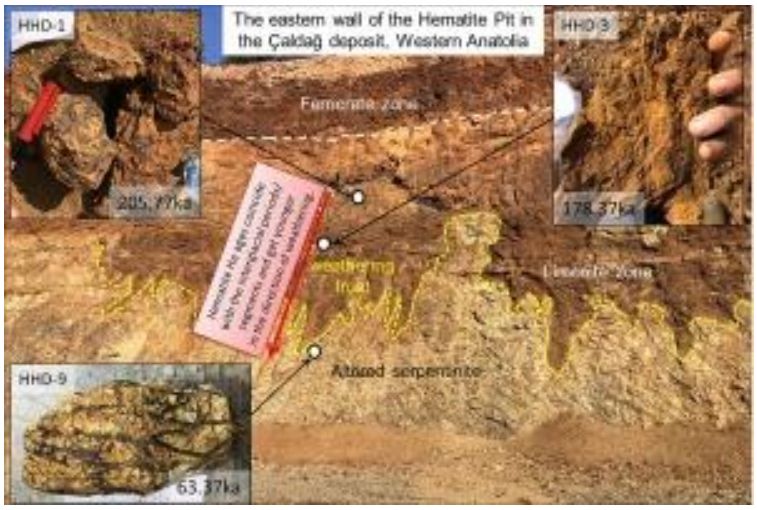

Fig. Locations and ages of hematite samples using the (U-Th)/He method in the Çaldağ Ni-Co laterite deposit, western Anatolia. The age of hematite obtained from the Çaldağ laterite deposit decreases towards the deeper parts of the laterite profile and in the direction of weathering, corresponding to interglacial periods.

Further outcomes:
Šilhán K., Fabiánová A., Klimeš J., Tábořík P., Hartvich F., Blahůt J. (2024). The effect of tree growth disturbances inertia on dendrogeomorphic spatio-temporal analysis of landslides: A case study. *Catena* 235, 107678. Doi.org/10.1016/j.catena.2023.107678

Gülyüz N., Gülyüz E., Karaoğlan F., Kuşcu İ. (2024). Low temperature thermochronology reveals tilting of crystalline bodies, Halilaga porphyry Cu-Au deposit, NW Anatolia: Implications for exploration of porphyry copper deposits and interpretation of low-temperature thermochronology data for regional tectonics. *Ore Geology Reviews* 166, 105958. Doi.org/10.1016/j.oregeorev.2024.105958

Gildir S., Karaoğlan F., Gülyüz E. (2024). Low-Temperature Thermochronology Records the Convergence between the Anatolide–Tauride Block and the Arabian Platform along the Southeast Anatolian Orogenic Belt. *Minerals* 14(6), 614. Doi.org/10.3390/min14060614

Shivsager V., Basumatary D., Goswami Chakrabarti C., Rawat M., Singh S., Jaiswal M. K. (2024): An assessment of oxbow lakes and their potential in reconstructing past river discharge: Implication to reconstruct past climate in Southern West Bengal. *Geochronometria* 51(1). Doi.org/10.20858/geochr/192455

Gülyüz N. (2024): Preliminary study of scandium enrichment in Çaldağ-Manisa lateritic Ni-Co deposit, Western Anatolia. YERBİLİMLERİ/Bulletin for Earth Sciences.
Doi.org/10.17824/yerbilimleri.149128

=

The Department of Seismotectonics addressed the study of natural seismic phenomena associated with the dynamics and tectonic development of structures in the Earth's crust (especially in the upper part of the crust). The department continues to develop new applications for the evaluation of geophysical measurements, and the development of new monitoring devices and methodologies for seismic activity research purposes. Department also participates in seismic experiments focused on the study of significant seismic areas (the Vrancea area in Romania, the Reykjanes Peninsula in Iceland, and the East African Rift in Ethiopia). Seismic phenomena on Mars were investigated. The possibilities of using geothermal energy were also explored. Special attention was paid to its assessment of seismic hazards in the Czech Republic, with an emphasis on the locations of existing and planned nuclear power plants.

The department was involved in international research on seismic phenomena via monitoring networks. Monitoring systems were operated in several countries and were connected to the following international seismic networks:

- Name of network: **REYKJANET**

Monitored issue: Earthquakes in Iceland
Operators: Institute of Geophysics and Institute of Rock Structure and Mechanics of the CAS
Czech/Geo Programme
Content: The detailed long-term international research of the seismic activity in Iceland.

- Name of network: **MKNET**

Monitored issue: Earthquakes in the Lesser Carpathians.
Operators: IRSM; Institute of Geophysics, Earth Science Institute of the Slovak Academy of Sciences and Progseis s.r.o.
Czech/Geo Programme
Content: Detailed research of this seismically active area; continuous recording and evaluation of the data.

- Name of network: **Czech Regional Seismic Network**.

Monitored issue: Earthquakes in the Czech Republic and worldwide.
Operators: Czech Academy of Sciences (CAS): Institute of Geophysics, IRSM, Institute of Geonics; Institute of Physics of the Earth of Masaryk university; Institute of Geodesy, Topography and Cartography Zdiby, Faculty of Mathematics and Physics Charles University Prague, Observatory Úpice, Military Geographic and Hydrometeorologic Office (VGHMÚ) Dobruška, German Research Center for Geosciences - GEOFON Potsdam, Zentralanstalt für Meteorologie und Geodynamik (ZAMG) Viena,Technical university of Ostrava
Czech/Geo Programme
Content: Basic scientific infrastructure for the research of earthquakes, especially concerning long-term seismicity research in Europe and worldwide.

Main outcomes:

1) **Seasonal energy extraction and storage by deep coaxial borehole heat exchangers in a layered ground**

Summary:
Geothermal energy extracted and stored using boreholes has attracted considerable attention for its potential use in district heating and electricity generation by geothermal power plants. Given the limitations of standard models based on cumbersome numerical approaches, we have proposed an analytical solution that is both fast and accurate. The extraction and storage of geothermal energy through coaxial boreholes are linear systems as long as the water flow remains constant. The temperature in the flowing water can be determined realistically, provided that the operating mode is periodic over time. This approach has been applied to operating periods of up to one year for heat exchanger depths of up to 1 km. Temperature variations of several kelvins in the flowing water are associated with storage and extraction power amplitudes of several kilowatts.

Publication:
Matyska C., Zábranová E. (2024). Seasonal energy extraction and storage by deep coaxial borehole heat exchangers in a layered ground. *Renewable Energy* 237, 121530.
Doi: 10.1016/j.renene.2024.121530

Illustration:

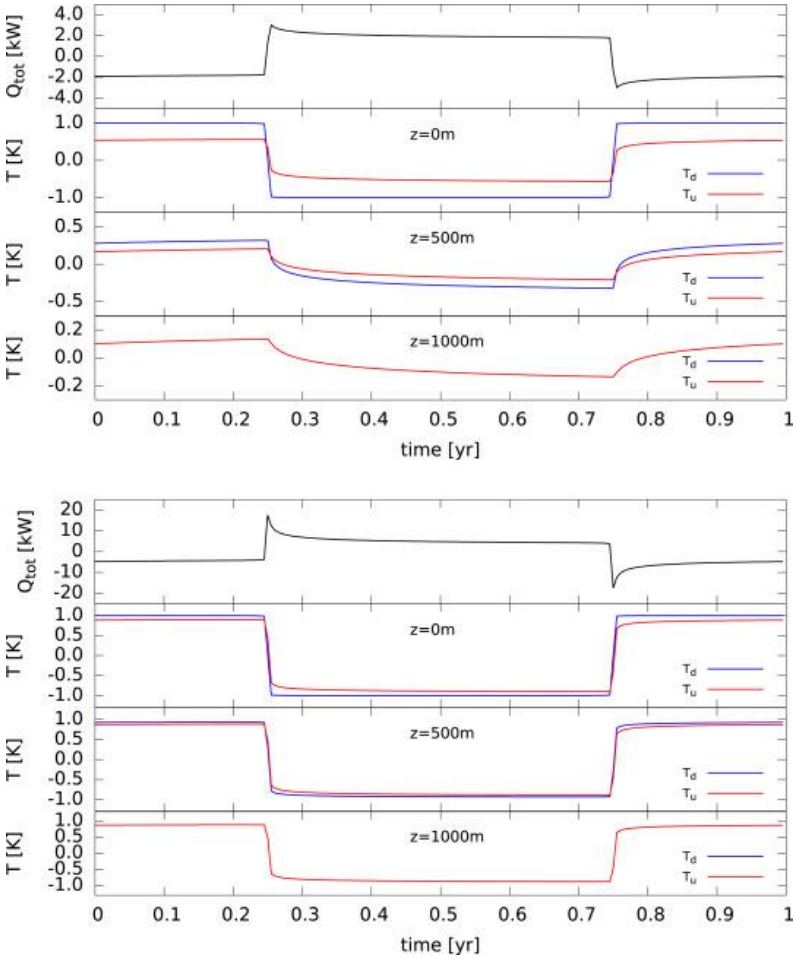

Fig. Time-dependent differences of the total heat extraction Qtot (black curves), the temperature at the bottom of the borehole Td (blue curves), and the temperature at the surface of the borehole Tu (red curves) from a background state are shown for a step-like input surface temperature. The temperature profiles are presented at three depths: 0 m, 500 m, and 1 km (from top to bottom). The upper panel corresponds to a water flow rate of 1 kg/s, while the lower panel corresponds to a water flow rate of 10 kg/s. The results are based on simulations of a 1 km deep borehole with a radius of 0.2 m.

2) Rotaphone-D, A New Model of Six-Degree-of-Freedom Seismic Sensor: Description and Performance.

Summary:
The original new model of the Rotaphone-D short-period seismic sensor with six degrees of freedom is designed for simultaneous and collocated measurement of the rotational and translational components of ground surface motion.

Publication:

Brokešová J., Málek J. **(**2024). Rotaphone-D, A New Model of Six-Degree-of-Freedom Seismic Sensor: Description and Performance. *Seismological Research Letters* 96 (2A): 968–979. doi: 10.1785/0220240258

Illustration:

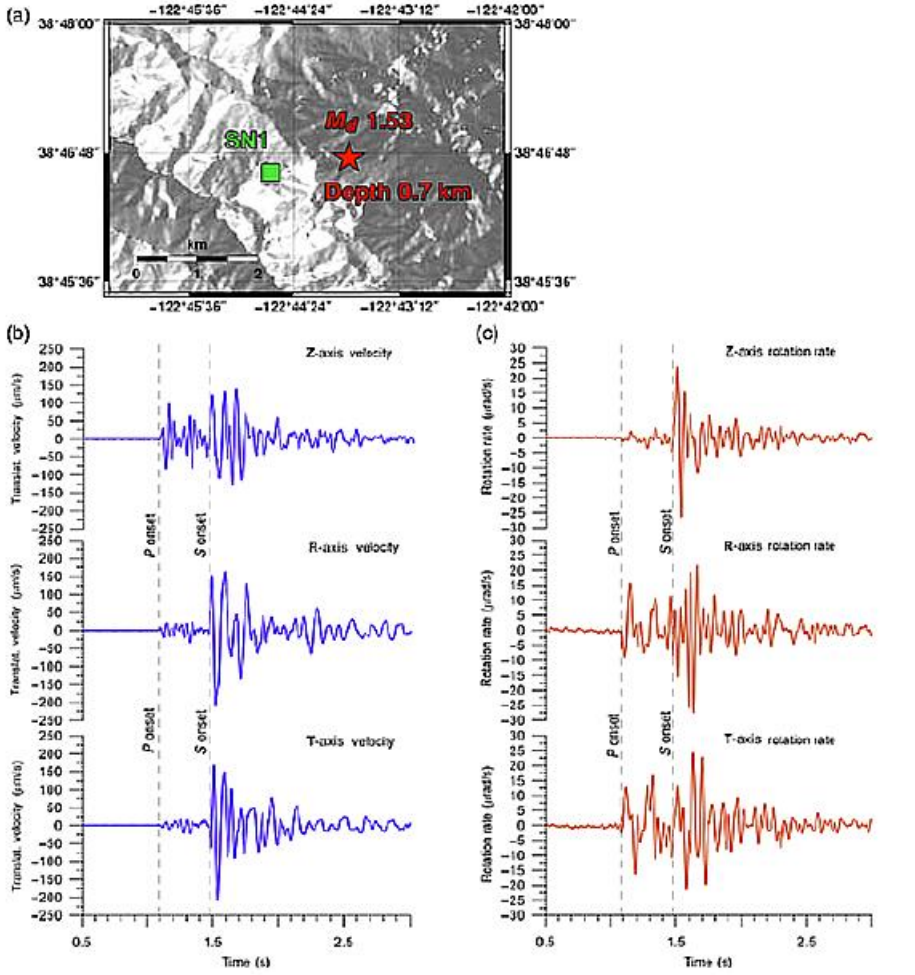

Fig. Recording of an earthquake with a magnitude of 1.56 in The Geysers (California) at a hypocentral distance of 2 km, recorded with Rotaphon D: (a) topographic map of the terrain, (b) translational components, (c) rotational components.

3) Determination of the VS profile at a “noisy” industrial site via active and passive data: The critical role of Love waves and the opportunities of multicomponent group velocity analysis.

Summary:

A methodology was developed for defining a subsurface seismic wave propagation model using active and passive seismic data in an environment with significant industrial noise. Both active and passive seismic data were used, including Rayleigh and Love wave dispersion curves and horizontal and vertical spectral ratios. Three approaches to data combination were tested. The results emphasise the importance of modelling effective curves for passive data and the key role of Love waves in refining S-wave velocity profiles. Hybrid acquisition with minimal equipment proved to be an effective solution.

Publication:

Dal Moro G., Mazanec M. (2024). Determination of the VS profile at a “noisy” industrial site via active and passive data: The critical role of Love waves and the opportunities of multicomponent group velocity analysis. *Geophysics* 89: B209-B227. doi: 10.1190/geo2022-0540.1

Further outcomes:

Malytskyy D., Křížová D., Lognonne P., Kawamura T., Perrin C., Plasman M., Xu Z., Maguire R. (2024). High- and low-frequency waveform analysis the Marsquake of Sol 1222: Focal mechanism, centroid moment tensor inversion, and source time function. *Earth and Space Science* 11, e2023EA003272. doi: 10.1029/ 2023EA003272

Halauwet Y., Afnimar, Triyoso W., Vackář J., Daryono D., Supendi P., Daniarsyad G., Simanjuntak A.V.H., Pranata B., Narwadan H.A.A.M., Hakim M. L. (2024). A new automated procedure to obtain reliable moment tensor solutions of small to moderate earthquakes (3.0 ≤ M ≤ 5.5) in the Bayesian framework. *Geophysical Journal International* 239, 1000–1020. doi:10.1093/gji/ggae309

Mazanec M., Valenta J., Málek J. (2024). Does VS30 reflect seismic amplification? Observations from the West Bohemia Seismic Network. *Natural Hazards* 120, 12181–12202. doi: 10.1007/s11069-024-06679-x

Lukešová R., Málek J. (2024). Seismic Beacon – A New Instrument for Detection of Changes in Rock Massif. *Sensors* 24, 234. doi: 10.3390/s24010234

Pertoldová J., Verner K., Buriánek D., Valenta J., Dudíková B., Skácelová Z., Jelének J., Jelínek J., Johnson K., Petiniak O., Hejtmánková P. (2024). Geology, U-Pb dating and 3D visualisation of late-orogenic Klenov Pluton (Pelhřimov Core Complex, Central European Variscides). *Journal of maps*, 20 (1), 2317144. doi: 10.1080/17445647.2024.2317144

Malytskyy D., Fojtíková L., Málek J., Gnyp A., Astashkina O., Nikulins V., Pak R. (2024). Seismic moment tensor and focal mechanism of the October 9, 2023 earthquake in Eastern Slovakia. *Geodynamics* 1(36), 5–11. doi: 10.23939/jgd2024.01.005

=

The Department of Geochemistry focused on the study of organically rich materials, in which systematic characterization of fossil samples, identification of biological resources, reconstruction of accumulation conditions, charring, maturation and weathering in sedimentary environments. Geochemical approaches are also used in the study of non-geological problems, for example in the long-term study of the relationship between resins of modern and fossil conifers. Furthermore, the properties of waste materials as sorbents and the properties of natural and synthesized carbonaceous materials as filters and contaminants associated with coal mining were investigated. Following to research in previous years, granitic rocks, tektites, foams and uranium ores and the interaction of uranium minerals with organic matter.

Main outcomes:

1) **Formation and radiolytic alteration of uraniferous solid bitumen related to hydrothermal base-metal mineralization in the Bytíz deposit, Příbram district, Czech Republic** (for details, see page 9).

Further outcomes:

Vršanský P., Sendi H., Kotulová J., Szwedo J., Havelcová M., Palková H., Vršanská L., Sakala J., Puškelová Ľ., Golej M., Biroň A., Peyrot D., Quicke D., Néraudeau D., Uher P., Maksoud S., Azar D. (2024). Jurassic Park approached: a coccid from kimmeridgian cheirolepidiacean Aintourine Lebanese amber. National Science Review, nwae200. Doi.org/10.1093/nsr/nwae200

J. Mizera, V. Strunga (2024). Proximal ejecta of the putative parent impact crater for Australasian tektites at the Bolaven Plateau. Proceedings of the National Academy of Sciences 121, e2400122121. Doi.org/10.1073/pnas.2400122121

Řimnáčová D., Bičáková O., Moško J., Straka P., Čimová N. (2024). The effect of carbonization temperature on textural properties of sewage sludge-derived biochars as potential adsorbents. Journal of Environmental Management 359, 120947. Doi.org/10.1016/j.jenvman.2024.120947

V. Suchý, I. Sýkorová, J. Zachariáš, K. Brabcová Pachnerová, P. Dobeš, M. Havelcová, I. Rozkošný, Q. Luo, W. Cao, J. Wu, P. Mácová, A. Viani, I. Světlík, D. Maxa (2024). Solid bitumen as an indicator of petroleum migration, thermal maturity, and contact metamorphism: a case study in the Barrandian Basin (Silurian - Devonian), Czech Republic. International Journal of Coal Geology 286, 104493. Doi.org/10.1016/j.coal.2024.104493

T. Larikova, I. Sýkorová, M. Racek, M. Havelcová, V. Machovič, L. Lapčák (2024). Formation and radiolytic alteration of uraniferous solid bitumen related to hydrothermal base-metal mineralizationin the Bytíz deposit, Příbram district, Czech Republic. International Journal of Coal Geology 286, 104590. Doi.org/10.1016/j.coal.2024.104590

M. Švábová, M. Šváb, M. Vorokhta (2024). Comparison of microwave and thermal reactivation of spent activated carbons: A pilot scale demonstration. Journal of Water Process Engineering 67, 106189. Doi.org/10.1016/j.jwpe.2024.106189

Perná I., Novotná M., Hanzlíček T., Šupová M., Řimnáčová D. (2024). Metakaolin-based geopolymer formation and properties: The influence of the maturation period and environment (air, demineralized and sea water). Journal of Industrial and Engineering Chemistry 134, 415–424. Doi.org/10.1016/j.jiec.2024.01.005

K. Holcová, F. Scheiner, M. Havelcová, P. Kraft, L. Ackerman, A. Tichá, K. Česáková, R. Milovský (2024). Quaternary floodings in the Zanzibar Channel (NW Indian Ocean, Tanzania) – Identifying palaeoceanographic patterns and palaeoenvironment using a multiproxy study. Marine Geology 476, 107366. Doi.org/10.1016/j.margeo.2024.107366

Karoui O., Andrejkovičová S., Pato P., Patinha C., Řimnáčová D., Perná I., Hajjaji W., Rocha F., Mlayah A. (2024). Foamed phosphate by-product based geopolymers and dye adsorption efficiency. Applied Clay Science 257, 107446. Doi.org/10.1016/j.clay.2024.107446

N. Kostkova, Maryna Vorokhta, M. Kormunda, R. Pilar, G. Sadovska, P. Honcova, E. Mikyskova, J. Moravkova, P. Sazama (2024). Controlling the structure of nitrogen-doped zeolite-templated carbon for CO2 capture based on the synthesis conditions. Microporous and Mesoporous Materials 379, 113286. Doi.org/10.1016/j.micromeso.2024.113286

D. Řimnáčová, A. Malhocká, M. Havelcová, J. Hendrych, Z. Weishauptová (2024). Physicochemical characteristics of natural and anthropogenic inorganic and organic solid porous materials: Comprehensive view. Materialia 33, 101973. Doi.org/10.1016/j.mtla.2023.101973

M. Košťák, J. Schlögl, D. Fuchs, M. Havrila, T. Kolar-Jurkovšek, A. Vörös, M. Havelcová, J. Šurka, J. Havrila, K. Holcová (2024). Rare Middle Triassic coleoids from the Alpine-Carpathian system: new records from Slovakia and their significance. Swiss Journal of Palaeontology 143, 19. Doi.org/10.1186/s13358-024-00316-7

Bednář D., Geršlová E., Otáhal P., Vöröš D. (2024). Effects of mine water discharge on river sediments: metal fate and behaviour, Upper Silesian Coal Basin. Environ Earth Sciences 83, 71. Doi.org/10.1007/s12665-023-11356-6

Košek F., Dudák J., Tymlová V., Žemlička J., Daniela Řimnáčová, Jehlička J. (2024). Evaluation of pore-fracture microstructure of gypsum rock fragments using micro-CT. Micron 181, 103633. Doi.org/10.1016/j.micron.2024.103633

M. Krejčí Kotlánová Michaela, Z. Dolníček, M. René, W. Prochaska, J. Ulmanová, J. Kapusta, V. Mašek, K. Kropáč (2024). Fluid Evolution of Greisens from Krupka Sn-W Ore District, Bohemian Massif (Czech Republic). Minerals 14, 86. Doi.org/10.3390/min14010086

Perná I., Havelcová M., Šupová M., Žaloudková M., Bičáková O. (2024). The Synthesis and Characterization of Geopolymers Based on Metakaolin and on Automotive GlassWaste. Applied Science 14, 3439. Doi.org/10.3390/app14083439

M. Rasiņa, M. Racek, J. Přikrylová, Daniela Řimnáčová, D. Pumpuriņš, R. Přikryl (2024). Natural Stones Used in the Cultural Heritage of Latvia: Historical Context, Stone Selection Criteria, Durability, and Conservation. Geoheritage 16(4), 128. Doi.org/10.1007/s12371-024-01029-6

Perná I., Havelcová M., Šupová M., Žaloudková M., Bičáková O. (2024). The Synthesis and Characterization of Geopolymers Based on Metakaolin and on Automotive GlassWaste. In: Applied Science – Special Issue Reprint: Development, Characterization, Application and Recycling of Novel Construction Materials. Edited by Mouhamadou Amar and Nor Edine Abriak, pp.5-23. Doi.org/10.3390/books978-3-7258-2145-7

A. Malhocká, M. Švábová, M. Havelcová (2024). The monoterpenes as a characteristic marker for pine species distinction: a chemotaxonomic study from the Czech Republic. Journal of Essential Oil Bearing Plants 27, 870–886. Doi.org/10.1080/0972060X.2024.2335532

L. Vavro, M. Vavro, K. Souček, D. Řimnáčová (2024). Relation between crack geometrical parameters, fracture toughness and rock microstructure investigated using X-ray computed tomography. In: New Challenges in Rock Mechanics and Rock Engineering, 1st ed., 1409–1415. Doi.org/10.1201/9781003429234

E. Geršlová, D. Vöröš (2024). Hydrocarbon-based parameters for the identification of oil contamination in an area with brown coal mining: Emphasis on pyrogenic index and alkylated PAHs. Environmental Advances 15, 100484. Doi.org/10.1016/j.envadv.2024.100484

=

The Department of Composite and Carbon Materials in 2024 finished a research project investigating the impact of the primary structural elements of human aortas on their delamination properties. This materials research focused on the physicochemical and mechanical properties of biological tissues and issues related to the propagation of cracks in arteries and their rupture — conditions that occur clinically in arterial dissection and rupture.

The study's key findings, particularly the description of differences in enzymatic and non-enzymatic collagen cross-linking in aortic tissue and its impact on delamination strength, were published in the esteemed journal *Acta Biomaterialia*. The development of a biomimetic vascular replacement that enables physiological pulse wave transmission was initiated as part of a Health Research Agency project (No. NW24-02-00206). This replacement comprises a sandwich composite of extruded collagen and a polyester knitted scaffold that respects the structure of the native vessel. The research focused on isolating collagen from fish skin (African catfish), characterising it in detail, and setting conditions for collagen cross-linking using a mono-energetic beam of accelerated electrons. As part of the GAČR 21-07851S project, which studied the effect of various ionising radiation parameters on the physicochemical properties of collagen gels with different concentrations, the department further investigated the effect of this type of physical cross-linking.

Other activities focused on developing technology to coat magnesium wires and degradable polymers used for surgical sutures, and on optimising their degradation time. The usability of the coated materials was tested in a simulated body environment, with the results being correlated with those of in vivo experiments. These results, which were obtained as part of the TAČR GAMA 2 TP01010055 4GEO project, were published in the prestigious Journal of Magnesium and Alloys in 2024.
Another area of research involved verifying collagen dispersion processing technology for impregnating the porous surfaces of implant anchoring parts. This issue will be addressed further in the Antibacterial Barrier in Human Joint Replacements project (CZ.01.01.01/01/22_002/0000934, OP TAK), which is being conducted as part of a contract with ProSpon s.r.o.

Other activities in the field of biopolymers focused on using collagen in additive technologies, the potential for dehydrothermal cross-linking of collagen, how artificially induced osteoporosis affects the physicochemical properties of collagen and investigating the mechanical and structural properties of nanofibre threads experimentally.

In the field of special composite materials, the main focus was on the climate resistance and fire safety of composites with a partially pyrolysed polysiloxane matrix reinforced with basalt fibres. Building on the TAČR GAMA 2 TP01010055 4GEO project, we used testing equipment and methodologies to evaluate changes in mechanical properties during long-term cyclic freezing. The study also involved verifying the flammability and fire resistance of the developing composites.

Main outcomes:

1) **Age-related changes in the biochemical composition of the human aorta and their correlation with the delamination strength**.

Summary:
A detailed biochemical and histological analysis of human aortic samples (ascending thoracic, descending thoracic, and abdominal aorta) taken from 34 cadavers was performed. The contribution of the study lies in a detailed biochemical comparison of enzymatic and non-enzymatic cross-links formed by glycosylation of vascular tissues and their effect on the delamination strength of the human aorta. To our knowledge, no such comprehensive study exists in the literature.

Publication:
Suchý T., Horný L., Šupová M., Adámek T., Blanková A., Žaloudková M., Grajciarová M., Yakushko Y., Blassová T., Braun M. (2024). Age-related changes in the biochemical composition of the human aorta and their correlation with the delamination strength. *Acta Biomaterialia* 190, 344–361. Doi.org/10.1016/j.actbio.2024.11.002

Illustration:

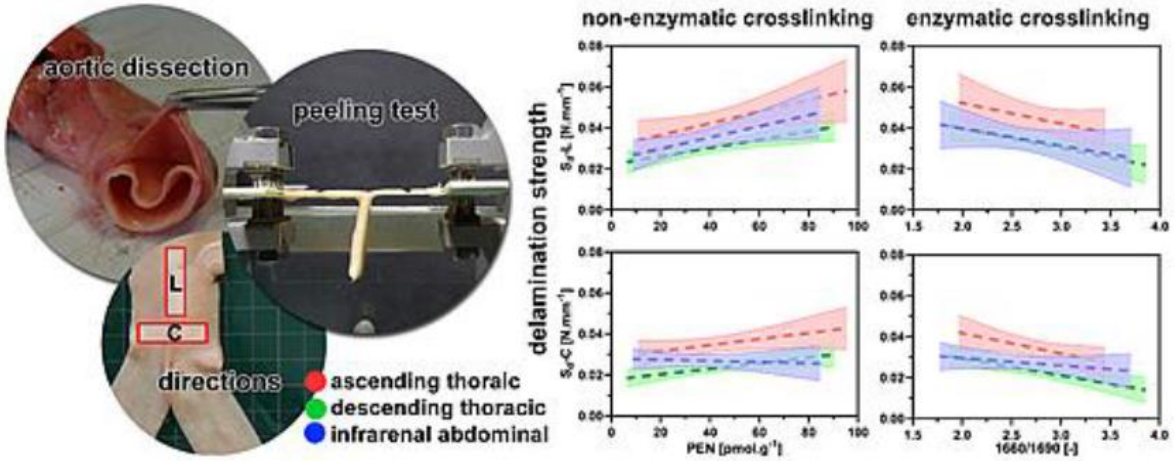

Fig. The different effects of various methods of cross-linking on the delamination strength of the human aorta. The peeling test can be used to test the delamination strength of the human aorta and simulate conditions during aortic dissection. It appears that delamination strength varies depending on the different methods of collagen cross-linking, i.e., one of the main components of aortic tissue. Enzymatic cross-linking, which is related to the natural maturation of tissue, tends to reduce delamination strength. Non-enzymatic cross-linking associated with glycosylation of vascular tissue paradoxically increases it.

2) In vivo and in vitro study of resorbable magnesium wires for medical implants: Mg purity, surface quality, Zn alloying and polymer coating.

Summary:
Magnesium is an excellent material in terms of biocompatibility and its corrosion products can serve as an active source for new bone formation. However, localized corrosion and H_2 generation limit the potential of Mg-based implants. Utilizing low-alloyed Mg-Zn wires can strongly reduce problems with large H_2 bubbles and improve the mechanical properties considerably while maintaining excellent long-term biocompatibility. Acidic pickling and a polymer coating can be effectively used to lower the rate of *in vivo* degradation. In this work, microstructural, mechanical, and *in vitro* characterization of 250 µm and 300 µm extruded wires made from ultra-pure Mg, commercially pure Mg, Mg-0.15Zn, Mg-0.4Zn and Mg-1Zn was performed. Additionally, Mg-0.4Zn wires together with a variant coated with a copolymer of l-lactide and ε-caprolactone were tested *in vivo* on artificially damaged Wistar rat femurs. Based on the observed Mg-induced osteogenesis, polymer-coated Mg wires with a small addition of Zn are a perspective material for bone-support applications, such as cerclage and fixation wires.

Publication:
Tesař K., Luňáčková J., Jex M., Žaloudková M., Vrbová R., Bartoš M., Klein P., Vištejnová L., Dušková J., Filová E., Sucharda Z., Steinerová M., Habr S., Balík K., Singh A. (2024). In vivo and in vitro study of resorbable magnesium wires for medical implants: Mg purity, surface quality, Zn alloying and polymer coating. *Journal of Magnesium and Alloys* 12, 2472–2488. Doi.org/10.1016/j.jma.2024.06.003

Illustration:

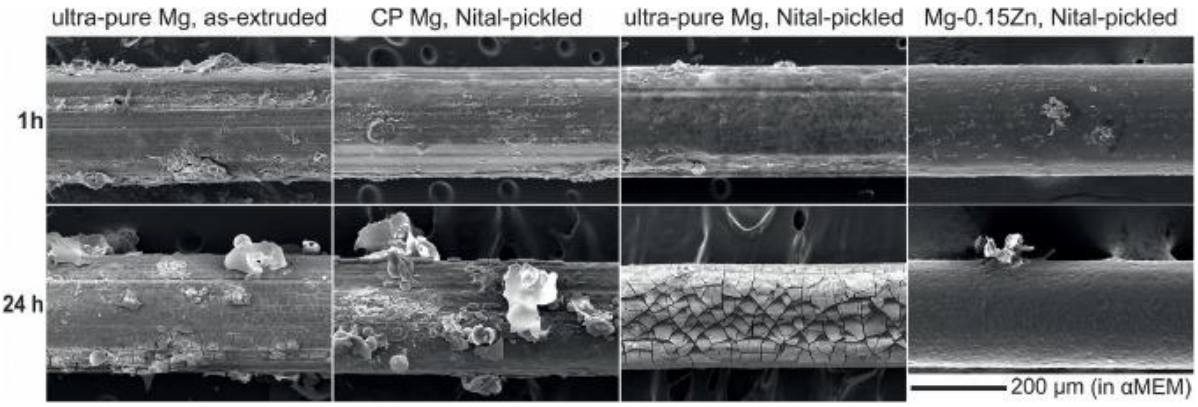

Fig. Typical SEM micrographs of the degradation morphology of uncoated thin Mg and Mg-Zn wires in αMEM+FBS after 1 and 24 h. Based on the bone formation observed in our study, magnesium wires with a small addition of zinc and coated with polymer appear to be a promising material for applications in the form of bone supports, such as cerclages or fixation wires. The figure shows SEM images of wires prepared from ultra-pure magnesium (Mg), commercial Mg (CP), and Mg with 0.15% Zn added, pickled in Nital solution (Nital-pickled) after 1 and 24 hours of exposure in a cell culture medium simulating the body environment.

3) The comparison of eight different common in vitro and ex vivo environments with in vivo conditions applying model collagen samples: Correlation possibilities and their limits.

Summary:

The study confirmed the existence of numerous statistically significant differences in the mechanical and structural properties of collagen scaffolds resulting from exposure to eight different in vitro environments. The results emphasise the limitations of predicting and correlating laboratory simulations with in vivo conditions. One benefit of the research is its contribution to the search for in vitro alternatives to in vivo animal experiments, in line with the '3Rs' concept (reduction, refinement and replacement). The scientific applicability of the results, and the main contribution of this research, lie in developing knowledge of the behaviour of model porous scaffolds prepared from type I collagen when exposed to eight different in vitro environments. This is especially significant given that no such extensive study has yet been conducted on this type of material.

Publication:

Suchý T., Vištejnová L., Sedláček R., Vopálková M., Šupová M., Simha Martynková G., Staňo J., Klein P., Denk F., Kužma J., Bartoš M. (2024). The comparison of eight different common in vitro and ex vivo environments with in vivo conditions applying model collagen samples: Correlation possibilities and their limits. *Polymer Testing* 140, 108621. Doi.org/10.1016/j.polymertesting.2024.108621

Illustration:

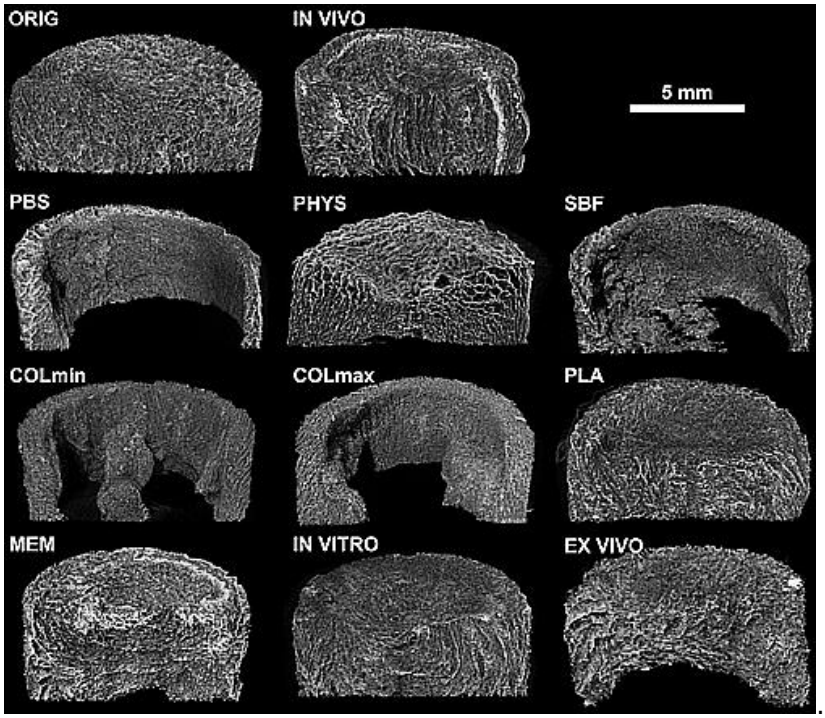

Fig. Micro-CT visualization of collagen scaffolds exposed to various simulated body environments for 21 days. Micro-CT visualization illustrates the different effects of simulated body environments to which collagen scaffolds were exposed for three weeks. Commonly used conditions, such as phosphate buffer (PBS), physiological saline (PHYS), simulated body fluid (SBF), physiological saline with varying concentrations of collagenase enzyme (COLmin, COLmax), human blood plasma (PLA), cell culture medium without (MEM) or with fibroblasts (IN VITRO), and fresh porcine cortical bone blocks (EX VIVO) have a significantly different effect on collagen scaffolds (ORIG) than the actual body environment (IN VIVO) they are designed to mimic. The observed changes were quantified in the study by characterizing mechanical and structural properties.

Further outcomes:

Trávníčková, M.; Filová, E.; Slepička, P.; Slepičková Kasalková, N.; Kocourek, T.; Žaloudková, M.; Suchý, T.; Bačáková, M. (2024). Titanium-doped Diamond-like Carbon Layers as a Promising Coating for Joint Replacements Supporting Osteogenic Differentiation of Mesenchymal Stem Cells, *International Journal of Molecular Sciences* 25(5), 2837. Doi.org/10.3390/ijms25052837

Perná I., Zárybnická L., Mácová P., Šupová M., Ševčík R. (2024). Physico-mechanical properties of geopolymers after thermal exposure: Influence of filler, temperature and dwell time. *Construction and Building Materials* 451, 138893. Doi.org/10.1016/j.conbuildmat.2024.138893

Perná I., Novotná M., Hanzlíček T., Šupová M., Řimnáčová D. (2024). Metakaolin-based geopolymer formation and properties: The influence of the maturation period and environment (air, demineralized and sea water). *Journal of Industrial and Engineering Chemistry* 134, 415–424. Doi.org/10.1016/j.jiec.2024.01.005

Kužma J., Suchý T., Horný L., Šupová M., Sucharda Z. (2024). Comparative Study of the Dehydrothermal Crosslinking of Electrospun Collagen Nanofibers: The Effects of Vacuum

Conditions and Subsequent Chemical Crosslinking. *Polymers* 16(17), 2453. Doi.org/10.3390/polym16172453S
Matějková J., Kanoková D., Šupová M., Matějka R. (2024). A New Method for the Production of High-Concentration Collagen Bioinks with Semiautonomic Preparation. *Gels* 10, 66. Doi.org/10.3390/gels10010066

Kanoková D., Matějka R., Žaloudková M., Zigmond J., Šupová M., Matějková J. (2024). Active Media Perfusion in Bioprinted Highly Concentrated Collagen Bioink Enhances the Viability of Cell Culture and Substrate Remodeling. *Gels* 10, 316. Doi.org/10.3390/gels10050316

Černý M., Chlup Z., Kužma J., Růžička M., Ševčík L., Kácha P., Schweigstillová J., Svítilová J., Strachota A. (2024). Fire Safety and Impact and Frost Resistance of Basalt Fiber-Reinforced Polysiloxane Matrix Composite Processed under Partial Pyrolysis Conditions. *Journal of Composites Science* 8 (10), 405 (23pp). Doi.org/10.3390/jcs8100405

Šupová M. (2024). Calcium Orthophosphate–Clay Composites—Preparation, Characterisation, and Applications: A Review. *Minerals* 14, 169. Doi.org/10.3390/min14020169

Perná I., Havelcová M., Šupová M., Žaloudková M., Bičáková O. (2024). The Synthesis and Characterization of Geopolymers Based on Metakaolin and on Automotive GlassWaste. *Applied Science* 14, 3439. Doi.org/10.3390/app14083439

Perná I., Havelcová M., Šupová M., Žaloudková M., Bičáková O. (2024). The Synthesis and Characterization of Geopolymers Based on Metakaolin and on Automotive GlassWaste. *In*: Applied Science – Special Issue Reprint: Development, Characterization, Application and Recycling of Novel Construction Materials. Edited by Mouhamadou Amar and Nor Edine Abriak, pp.5-23. Doi.org/10.3390/books978-3-7258-2145-7

=

The Department of the Structure and Properties of Materials continued the research of (i) Technological issues of glass production, the preparation of infrared-permeable glasses; the vitrification of radioactive waste for technical applications; (ii) Monitoring the rheological properties of fresh composites; determining the influence of the environment and curing time on their properties; evaluating the physical properties of materials after thermal exposure in a wide temperature range; using waste vehicle glass as an alternative aggregate in the preparation of geopolymer composites; (iii) Textural properties of biochar from sewage sludge and its use as a potential adsorbent.

Main outcomes

1) Effect of Alumina Source on the Retention of Rhenium during Low-Activity Waste Feed Conversion to Glass. (see page 7)

2) Metakaolin-based geopolymer formation and properties: the influence of the maturation period and environment (air, demineralized and sea water).

Summary:

The influence of the surrounding environment (air, demineralized and seawater) and the curing time on the properties of geopolymer materials was monitored, in particular on their mechanical properties, the formation of geopolymer chemical bonds, and porosity. It was found that immersing the geopolymer composite in an aquatic environment, even in seawater, just two

days after preparation had no adverse effects on the formation of geopolymer bonds or on mechanical properties. The determination of textural properties showed that neither the curing time nor the surrounding environment have a significant effect on the pore morphology of geopolymer materials.

Publication:

Perná I., Novotná M., Hanzlíček T., Šupová M., Řimnáčová D. (2024). Metakaolin-based geopolymer formation and properties: the influence of the maturation period and environment (air, demineralized and sea water). *Journal of Industrial and Engineering Chemistry* 134, 415–424. doi: 10.1016/j.jiec.2024.01.005

Illustration:

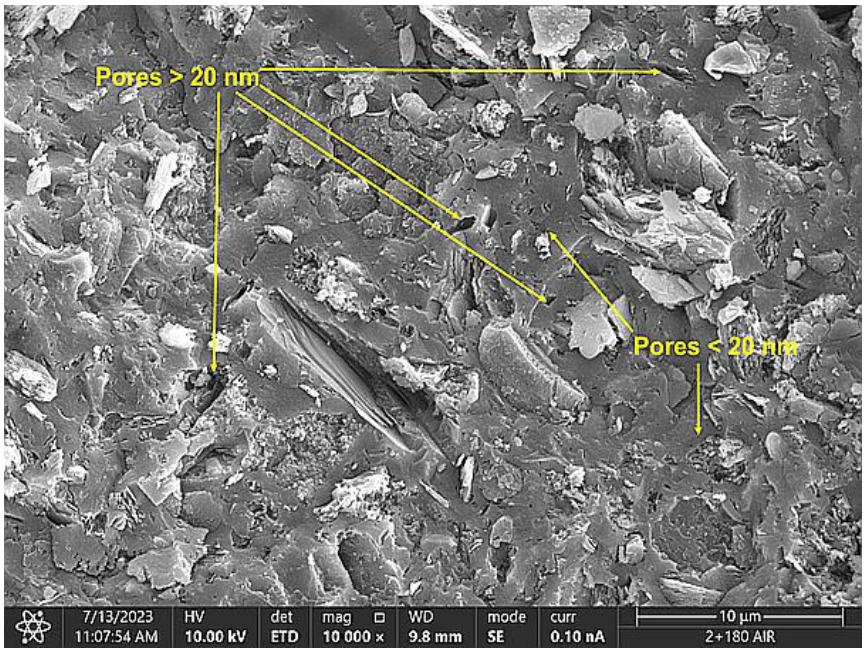

Fig. Description of pore morphology obtained by STEM microscope with 10000x magnification. The analysis showed that neither the curing time nor the surrounding environment have a significant effect on the pore morphology of geopolymer materials.

3) The effect of carbonization temperature on textural properties of sewage sludge-derived biochars as potential adsorbents.

Summary:

Anaerobically digested and dried sewage sludge were were processed by carbonization at various temperatures in the range of 400–900 °C. The resulting products, biochars, are investigated in terms of yield, surface properties and Raman spectra analysis. The sorption capacity of biochars differs depending on the carbonization temperature. Additionally, there is a strong positive dependence of the adsorption capacity on the micropore volume. Higher carbonization temperatures support the powerful formation of micropores and improve their sorption capacity.

Publication:

Řimnáčová D., Bičáková O., Moško J., Straka P., Čimová N. (2024). The effect of carbonization temperature on textural properties of sewage sludge-derived biochars as potential adsorbents. *Journal of Environmental Management* 359, 120947. doi:10.1016/j.jenvman.2024.120947

Illustration:

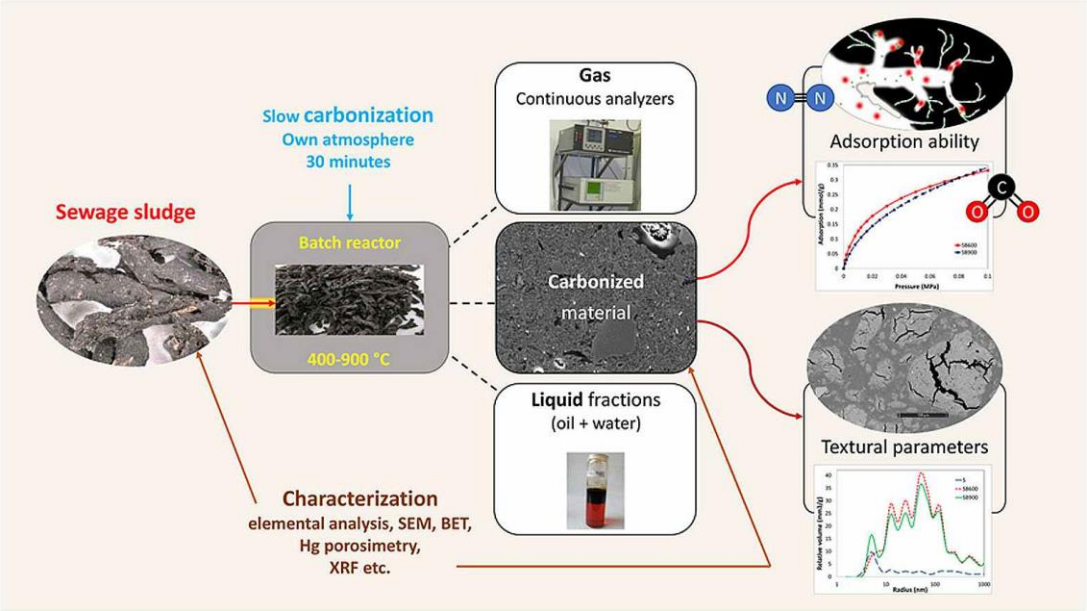

Fig. Preparation and characterization of biochar from sewage sludge: sewage sludge is carbonized by slow carbonization into carbonized material, which is characterized by sorption properties (adsorption ability, textural parameters).

Further outcomes:

Perná I., Zárybnická L., Mácová P., Šupová M., Ševčík R. (2024). Physico-mechanical properties of geopolymers after thermal exposure: Influence of filler, temperature and dwell time. *Construction and Building Materials* 451, 138893. doi.org/10.1016/j.conbuildmat.2024.138893

Karoui O., Andrejkovičová S., Pato P., Patinha C., Řimnáčová D., Perná I., Hajjaji W., Rocha F., Mlayah A. (2024). Foamed phosphate by-product based geopolymers and dye adsorption efficiency. *Applied Clay Science* 257, 107446. doi.org/10.1016/j.clay.2024.107446

Santos A., Andrejkovičová S., Perná I., Almeida F.., Rocha F. (2024). Mechanical and thermal properties of geopolymers derived from metakaolin with iron mine waste. Applied Clay Science 258, 107452. doi.org/10.1016/j.clay.2024.107452

Karoui O., Andrejkovičová S., Pato P., Patinha C., Perná I., Řimnáčová D., Hajjaji W., Ascenão G., Rocha F., Mlayah A. (2024). Alkali-activated geopolymers based on calcined phosphate sludges and metakaolin. Environmental Science and Pollution Research 31, 45138–45161. doi.org/10.1007/s11356-024-34025-y

Kostka P., Jílková K., Bošák O., Kubliha M., Michalcová A., Kudrnová M., Bártová K., Dománková M., Kolářová M., Havlík Míka M. (2024). Electrical properties of PbO–Bi2O3–Ga2O3 glasses with addition of Ag2O and Sb2O3. *Ceramics International* 50, 10098–10107. doi.org/10.1016/j.ceramint.2023.12.319

Cihlář J., Tkachenko S., Bednaříková V., Cihlář J. Jr., Částková K., Trunec M., Celko L. (2024). Study of the Synthesis of Multi-Cationic Sm-Co-O, Sm-Ni-O, Al-Co-O, Al-Ni-O, and Al-Co-Ni-O Aerogels and Their Catalytic Activity in the Dry Reforming of Methane. *Gels* 10, 328. doi.org/10.3390/gels10050328

Vernerová M., Šůsová K., Kohoutková M., Kloužek J., Cincibusová P., Ferkl P., Marcial J., Hrma P., Kruger A.A., Pokorný R. (2024). Effect of glass forming additives on low-activity waste feed conversion to glass. *Journal of Nuclear Materials* 593, 155003. doi.org/10.1016/j.jnucmat.2024.155003

Jebavá M., Cincibusová P., Tonarová V., Němec L. (2024). Influence of energy distribution, melting temperature, kinetics and space geometry on glass melting efficiency. *Journal of Non-Crystalline Solids* 646, 123227. doi.org/10.1016/j.jnoncrysol.2024.123227

Hrma P., Ferkl P., Pokorný R., Kruger A. (2024). Effect of cold-cap-bottom shear stress on primary foam stability. *Journal of Non-Crystalline Solids* 646, 123262. doi.org/10.1016/j.jnoncrysol.2024.123262

Perná I., Havelcová M., Šupová M., Žaloudková M., Bičáková O. (2024). The Synthesis and Characterization of Geopolymers Based on Metakaolin and on Automotive GlassWaste. *Applied Science* 14, 3439. doi.org/10.3390/app14083439

Kunc J., Kloužek J., Vernerová M., Cincibusová P., Ferkl P., George J.K., Hrma P., Kruger A.A., Pokorný R. (2024). Viscosity of transient glass-forming melt and its relation to foaming during batch-to-glass conversion. *Materials Letters* 363, 136284. doi.org/10.1016/j.matlet.2024.136284

Guillen D.P., Ferkl P., Pokorny R., Hall M., Hrma P., Kruger A.A. (2024). Numerical modeling of Joule heated ceramic melter. *Materials Letters* 362, 136201. doi.org/10.1016/j.matlet.2024.136201

Verger L., Coudray S., Bertrand E., Lebullenger R., Rocherullé J., Bosak O., Kubliha M., Labas V., Kostka P., Chenu S., Le Coq D. (2024). Preparation and characterizations of glasses in the TeO2–Ga2O3–M2O (M═Li, Na, K) systems. International *Journal of Applied Glass Science* 15 (3), 203–211. doi.org/10.1111/ijag.16661

Perná I., Havelcová M., Šupová M., Žaloudková M., Bičáková O. (2024). The Synthesis and Characterization of Geopolymers Based on Metakaolin and on Automotive GlassWaste. Applied Science – Special Issue Reprint: Development, Characterization, Application and Recycling of Novel Construction Materials. Edited by Mouhamadou Amar and Nor Edine Abriak, pp.5–23. available at: www.mdpi.com/journal/applsci/special issues/4UKS4SN5D2); doi.org/10.3390/books978-3-7258-2145-7

Patent:
Straka P., Bičáková O. (2024). Method for producing industrial oil, technical paraffin, and energy gas by low-temperature cracking of waste cross-linked polyethylene by defined heating in the presence of a catalyst. Industrial Property Office of the Czech Republic, patent owner: Institute of Rock Structure and Mechanics of the Czech Academy of Sciences, Prague, Patent number: CZ 310 024.

═

The Department of Applied Rock Mechanics was established on January 1, 2024, as the seventh scientific department at the Institute of Structural and Mechanical Engineering of Rocks. The core of the department is the rock mechanics laboratory at Puškinovo náměstí 9 in Prague-Bubeneč. The laboratory was transferred from the Geological Institute of the Czech Academy of Sciences to the Institute of Rock Structure and Mechanics of the Czech Academy of Sciences. Dr. Jan Blahůt became the new head of the department and Dr. Marco Loche his deputy. During 2024, there was a change in personnel and rejuvenation of the scientific team,

so that by the end of the year, three researchers, two postdoctoral fellows, and two doctoral students were working in the department, together with three technicians (representing a total of five nationalities). The scientific focus of the department is primarily on research into the physical and mechanical properties of rock and their short-term and long-term changes depending on endogenous and exogenous factors. This mainly involves monitoring and analyzing rock masses depending on rock composition and properties, precipitation, and temperature. Special attention is paid to the influence of climate change or high temperatures (e.g., during fires) on rock properties and to the development of non-destructive methods for monitoring rock properties. Another research topic that the department has historically focused on is the study of rock anisotropy using acoustic emission. The department is equipped with a fully equipped rock mechanics laboratory and a network of rock mass monitoring sites in Czechia, Italy, the USA, and Svalbard. Funding for research topics was secured through grants from TAČR – Environment for Life (SS07010216: The impact of fires and high temperatures on the stability of rock massifs) and the bilateral Mobility Plus project with Turkey (TÜBITAK-24-01: Changes in the properties of rock massifs after forest fires). Department staff are also participating in the OP JAK project (CZ.02.01.01/00/22_008/0004605: Natural and Anthropogenic Geohazards) and another TAČR – Environment for Life project (SS02030023: Rock Environment and Mineral Resources). From 2025, department staff will be working on the GAČR project (25-17664S: Patterns and trends of rock slope instability explained by thermal influences in a temperate climate).

Fig: Loading a cylindrical rock sample using the uniaxial compression strength measurement method while simultaneously detecting failure using acoustic emission.

Fig. Sampling of sandstones affected by fire in the Bohemian Switzerland National Park.

Further outcomes:

Alvioli M., Loche M., Jacobs L., Grohmann C.H., Abraham M.T. et al. (2024). A benchmark dataset and workflow for landslide susceptibility zonation. *Earth-Science Reviews* 258. doi.org/10.1016/j.earscirev.2024.104927

Baroň I., Jelének J., Klimeš J., Dong J-J., Melichar R., Šutjak M., Chen Y., Yang C-M., Zhang E-L., Méndez J., Tseng C-H., Hartvich F., Blahůt J., Nguyễn T-T., Kociánová L., Bárta F., Dušek V., Kycl P. (2024). Source area morphometry and high depletion rate of landslides may indicate their coseismic origin. *Engineering Geology* 330:107424. doi.org/10.1016/j.enggeo.2024.107424

Šilhán K., Fabiánová A., Klimeš J., Tábořík P., Hartvich F., Blahůt J. (2024). The effect of tree growth disturbances inertia on dendrogeomorphic spatio-temporal analysis of landslides: A case study. *Catena* 235, 107678. doi.org/10.1016/j.catena.2023.107678

Loche M, Racek O, Petružálek M, Scaringi G, Blahůt J (2024). Infrared thermography reveals weathering hotspots at the Požáry field laboratory. Online. *Scientific Reports* 14(1). doi.org/10.1038/s41598-024-65527-x

Bruthansová J, Bruthans J, Schweigstillová J, Van Iten H (2024). Underwater drunken forest – changes in growth direction and ornamentation in Conularia fragilis Barrande, (Lower Devonian, CzechRepublic). *Palaeontologia electronica* 1867. doi.org/10.26879/1414

Starý J, Bruthans J, Schweigstillová J, Mareš J, Procházka M (2024). Origin of Fracture-Controlled Conduits in Calcite-Rich Highly Productive Aquifers Impregnated with Diagenetic Silica. *Water* 16 (5), 687 (18pp). doi.org/10.3390/w16050687

Černý M, Chlup Z, Kužma J, Růžička M, Ševčík L, Kácha P, Schweigstillová J, Svítilová J, Strachota A (2024). Fire Safety and Impact and Frost Resistance of Basalt Fiber-Reinforced Polysiloxane Matrix Composite Processed under Partial Pyrolysis Conditions. *Journal of Composites Science* 8 (10), 405 (23pp). doi.org/10.3390/jcs8100405

Loche M, Klimeš J, Racek O, Blahůt J (2024). Preliminary landslide risk assessment: a glimpse in Hazard probability in nw czech republic. *In*: Schneider J. et al. (eds), Conference proceedings INTERPRAEVENT 2024, Vienna, Austria, pp.643–647.

=

All scientific departments popularised the results of their activities, either in exhibitions, in the framework of the Week of Science of the CAS, Science Fair or in field panels or presentations to the public (see section 7).

=

3. Research projects conducted by the Institute's scientific departments in 2024

Projects funded by the Czech Science Foundation (GACR) and Technology Agency of the Czech Republic (TAČR)

- Landslides in a changing climate: temperature controls over landslide susceptibility and hazard in temperate climate, Period: 2024 - 2026
- Fossil seagrass meadows - a neglected Phanerozoic ecosystem: its contribution to shelf biodiversity and identification in the fossil record, Period: 2023 - 2026
- Tree-ring microscopic anatomy as a chronological data source for optimization of landslide hazard assessment, Period: 2022 – 2024
- Coseismic landslides in the mountains of active and stabilized accretion wedges, Period: 2022 - 2024
- The role of rock anisotropy in hydraulic fracturing through acoustic emission, Period: 2022 - 2024
- Natural and anthropogenic georisks, Period 2024 - 2028
- Mapping of seismic amplification in the Czech Republic, Period: 2024 - 2027
- Biomimetic vascular replacement for low flow allowing physiological pulse wave transmission, Period: 2024 – 2027
- Influence of wildfires and high temperatures on the rock slope stabilty, Period 2024–2026
- Long-term and reliable production of drinking water using activated carbon considering the circular economy approach, Period 2024–2026
- Changes in rock mass properties after wildfires, Period 2024–2026
- Natural seismicity as a prospecting and monitoring tool for geothermal energy extraction, Period: 2021 - 2024
- Rock Environment and Natural Resources, Period: 2020 - 2026

Projects Strategy AV21:

- Preparation of new materials using geopolymer technology for conservation and restoration. Research Programme: City as a Laboratory of Change: Historical Heritage and Place for Safe and Quality Life, Period: 2020 – 2024
- Dynamic Planet Earth. Research Programme: Top research in the public interest, Period: 2023 – 2027

- Circular economy for the energy industry. Research Programme: Sustainable Energy, Period: 2022-2026

Projects financed by the Ministry of Education, Youth and Sports and the Ministry of Health:

- Experimental and mathematical analysis of primary glass-forming melt properties, gas evolution, and their relation with primary foam production. Research Programme: Inter-Excellence II USA ID: LUAUS23062, Period: 2023–2026.

Projects with foreign participation:

- Representation of the Czech Republic in the management of INQUA (International Union for Quaternary Research).
- The six-component continuous monitoring of seismic swarms and other earthquakes in the Long Valley Caldera area, California.

International projects:

- see section VI. International cooperation, p. 37.

=

4. Cooperation with universities

With respect to university teaching activities during the year, the staff of the IRSM provided in the summer semester 236 hours in bachelor's and 283 hours in master's study programmes; in the winter semester 84 hours in bachelor's, 287 hours in master's study programmes. The institute trained 14 doctoral students, 4 of them from abroad. The staff of the Institute worked as teachers and taught several courses and number of study programmes in various fields during the year, especially at the Charles University (Faculty of Science, Faculty of Mathematics and Physics and the Faculty of Medicine in Pilsen), the Czech Technical University in Prague (Faculty of Mechanical Engineering and the Faculty of Nuclear Sciences and Physical Engineering), the University of Chemical Technology (Faculty of Chemical Technology and Faculty of Environmental Technology), the Masaryk University in Brno (Faculty of Natural Sciences), the Mendel University in Brno, the University of Ostrava (Faculty of Natural Sciences) and the University of South Bohemia in České Budějovice (Faculty of Education), as well as at the Oregon State University, Corvallis, and University of New York, USA.

The Institute has two joint workplaces with universities, namely with the Faculty of Science of Charles University and the University of Chemical Technology in Prague.

The Institute's staff participated during the year in 5 doctoral study boards, namely at the University of Chemical Technology in Prague, the Technical University of Ostrava and Charles University in Prague (Faculty of Science).

The implementation continues of the “Agreement on Mutual Cooperation concerning the Implementation of the Physics of the Earth and Planets doctoral study programme” concluded with the Faculty of Mathematics and Physics of Charles University involving both full-time and combined forms of study.

=

5. Contractual services

Contracts:

1) Commissioned by: The Road and Motorway Directorate (ŘSD ČR)
Contract: Analysis of planned sections of motorways and class I roads and their potential risk of slope deformation 2024. Phase II.: Geophysical research of selected slope deformations.

Summary: As part of stage 2/2024, a geophysical study of selected slope deformations was carried out. A 37-page research report was prepared for the client, commenting on the potential threat posed by these deformations to the planned constructions.
Application: Roads and motorways construction

2) Commissioned by: The Czech Radioactive Waste Repository Authority (SÚRAO)
Contract: Monitoring of seismic phenomena at the radioactive waste repository at the Richard mine near Litoměřice.

Summary: As part of the long-term, continuous seismic monitoring programme, seismic phenomena were monitored throughout the year at the Richard repository. The results were summarised in three reports for the client.
Application: Ensuring the seismic safety of radioactive waste repositories.

3) Commissioned by: Vyšehrad National Cultural Monument management
Contract: Stability monitoring of selected objects in the Vyšehrad National Cultural Monument.

Summary: The stability of the selected objects of the Vyšehrad National Monument for the needs of its administration has been monitored and evaluated.
Application: Preservation of Monuments

4) Commissioned by: UJP Praha a.s.; Group ČEZ
Contract: Characteristics of the surface layer texture of Zr alloys.

Summary: The porous texture of the surface layers of zirconium alloys intended for use in nuclear reactors was measured using high-pressure mercury porosimetry.
Application: Nuclear power.

5) Commissioned by: Group ČEZ
Contract: Monitoring seismic activity at the Tušimice power plant.

Summary: In preparation for the possible installation of a small modular nuclear power plant in the building, a special seismic station was installed at the power plant site to monitor local seismic phenomena in conditions of increased noise. The results of the monitoring were summarised in a report for the client.
Application: Small Modular Reactor (SMR) installation.

Expertise:

1) Commissioned by: The Road and Motorway Directorate (ŘSD ČR)
Expertise: A geophysical survey of selected sites within the planned road and motorway construction sections was carried out from March to May 2024, based on mapping and inventory work from the first stage of the survey in 2023. This research focused on sites that pose a potential threat to the planned linear structures in terms of slope stability. The extent of slope deformations was confirmed, and information on the depth of shear surfaces, total

landslide thickness, and moisture distribution was collected. This information formed the basis for a detailed assessment of the threat posed to the planned linear structures by slope processes.

2) Zadavatel: Group ČEZ
Expertise: Consultation on the selection of a contractor to complete the Dukovany nuclear power plant. Bids submitted by participants in the tender were evaluated in terms of seismic risk.

Authorization to perform expert activities pursuant to Act No. 254/2019 Coll.
The Institute is registered in the list of experts for the field of GEOLOGY (36/1967 Coll.)

=

6. International cooperation

The Institute participated during the year in 5 international projects, in 13 bilateral scientific cooperation agreements with foreign partners and cooperated with an International Advisory Board. The Institute's staff participated in 8 international scientific organizations, in two cases in official management positions.

International projects:

- Mathematical Modeling and Experimental Evaluation of Melter Cold Cap for Nuclear Waste Vitrification. Battelle Energy Alliance, LLC, Idaho, USA, Contract No. 166789, 2016–2026.

- International project GACR/MOST TW 22-24206J Earthquake-triggered landslides in recently-active and stabilized accretionary wedges, 2022–2024.

- Radiolytical alteration of the organic matter in coal and rocks enriched in radioactive minerals. International Committee for Coal and Organic Petrology, 2024.

- Natural Seismicity as a Prospecting and Monitoring Tool for Geothermal Energy Extraction. Iceland, Liechtenstein and Norway grants (the EEA Grants) and the Technology Agency of the Czech Republic, 2021–2024.

- European initiative Adria array: Understanding Active Deformation of the Adriatic Plate and its Margins, 2024.

Official positions in the membership of international organisations:

1) Ass. Prof. Jaroslav Kloužek.: International Commission on Glass, Technical Committee No. 18 – Glass melting. Vice president, term of office: 2019 – 2025.

2) Dr. Petra Štěpančíková: International Union for Quaternary Research, Commission on Terrestrial Processes, Deposits, and History. Vice president, term of office: 2023 – 2027.

Bilateral cooperation with foreign partners:

1) Instituto Geofísico del Peru
Theme: The monitoring and assessment of landslide hazards in selected locations in Peru.

2) Instituto Nacional de Investigación en Glaciares y Ecosistemas de las Montaña (Peru)
Theme: The evaluation of the danger of slope movements around the village of Rampac Grande, Cordillera Negra, Peru.

3) Instytut Geofizyki Polskiej Akademii Nauk
Theme: The research of tectonic movements and slope deformations in the Svalbard archipelago.

4) Uniwersytet Wroclawski
Theme: The research of the structural-geological conditions and construction of the Broumov/ Góry Stolowe table mountains; arctic and permafrost research.

5) Naturhistorisches Museum Wien
Theme: The research of active tectonics in caves in the Eastern Alps.

6) Johannes-Guttenberg Universität Mainz
Theme: The radiometric dating of active tectonics in karst caves.

7) University of Memphis
Theme: The research of local seismicity.

8) Uniwersytet Wroclawski – Wydzial Nauk o Ziemi i Ksztaltowania Srodowiska
Agreement of co-operation: Joint research projects concerning research fields stated in the agreement; Exchange of academic staff and students; Joint publications and exchange of scientific and didactic materials; Organisation of joint scientific conferences and workshops.

9) Polish Geological Survey
Theme: Monitoring of tectonic movements in Niedzwiedz Cave.

10) INGEMMET – Instituto Geológico, Minero y Metalúrgico
Theme: The monitoring and assessment of landslide hazards in selected locations in Peru

11) Chelungpu Fault Park (Zhushan), NCU (Tayouan), Taiwan
Theme: 3D measurements of micro kinematics at Chelungpu seismic fault.

12) Agency of Rural Development and Soil and Water Conservation, MOA – m ARDSWC (Nantou), Taiwan
Theme: Monitoring of deep landslides triggered by extreme rainfall.

13) Université Savoie Mont Blanc, ISTerre (Le Bourget du Lac).
Theme: Monitoring of deep alpine structurally conditioned potentially catastrophic landslides in the Chamonix area.

International Advisory Board of the IRSM (IAB)

In 2024, the members of the International Advisory Board were informed about the research activities of each departments.The members of the Board provided recommendations for further improvements activities of the IRSM.

Chairman
- **Dr. Rouwen Lehné**
Hessisches Landesamt für Umwelt und Geologie (HLNUG)
Dezernat G1 – Geologische Grundlagen, Rheingaustr. 186, 65203 Wiesbaden, Germany

Members:
- **Prof. Vladimir Yudin**
Institute of Macromolecular Compounds RAS
199004 Saint-Petersburg, Bolshoy pr. 31, Russia
- **Prof. Dr. Manfred Joswig**

Stuttgart University, Institut für Geophysik
Goethestr. 25, D-40237 Düsseldorf, Germany

- **Dr. Yann Klinger**
Institut de Physique du Globe – CNRS
Université de Paris 1, rue Jussieu 75238 Paris cedex 05, France

- **Prof. Dr. Kimon Christanis**
University of Patras, Department of Geology
University Campus, GR-265.04 Rio-Patras, Greece

=

7. Popularisation and public education activities

1). Presentation of the Environmental Technology Laboratory: use of organic and inorganic waste materials, examples of various types of organic and inorganic waste materials with an explanation of their properties, demonstration of gas analysis and determination of the dynamic viscosity of oils.The Week of the Czech Academy of Sciences and Open Houses of the Institutes, November 6 - 8, 2024

2). Excursion and presentation of research of the Geochemistry laboratory (illustration of pores and adsorption mechanisms on a macro scale, microscope window, colour experiments, rocks and sorption materials, demonstration of the transformation "from plant to coal"), Laboratory of Environmental Technologies and Laboratory of Geopolymers and Thermal processes (possibility of processing/utilizing inorganic and organic waste), composite materials laboratory (demonstration of polymer nanofiber preparation using electrostatic spinning), presentation of the work of seismologists and their research on earthquakes around the world and in the Czech Republic, including a demonstration of a seismograph. The Week of the Czech Academy of Sciences and Open Houses of the Institutes, November 4 - 10, 2024

3). Presentation of activities, scientific results, and new achievements of the Department of Seismotectonics, Department of Geochemistry, and Department of Materials Structure and Properties, Science Fair at the PVA Expo Prague, May 29 – June 1, 2024

4). Interview for Radio Prague International Machu Picchu, a pre-Columbian Inca cult city in the Peruvian Andes, has been protected by Czech technology for twenty years. Two scientists have now received international awards. January 18, 2024

5). Interview for Czech Radio Plus (Český rozhlas Plus, Odpolední Plus - Věda Plus) Dr. Ivana Perná from the Department of Materials Structure and Properties - geopolymer technology used in the repair of the pavement of the Pilgrimage church of St. John of Nepomuk on Zelená hora, April 16, 2024

6). Workshop "Restoration of the Church of St. John of Nepomuk on Zelená Hora in Žďár nad Sázavou" - This series of lectures focuses on the complete reconstruction of the pilgrimage church of St. John of Nepomuk. The lecturers were ÚSMH employees specialising in wall painting restoration, plaster and stone restoration, and silicate material technology. The reconstruction of the original paving was documented in a pictorial publication. May 13 and June 1, 2024

7). Excursion of the department's thermochemical facilities and consultation on fiberglass heat treatment solutions with Ing. Václav Marek, Ph.D., from the University of West Bohemia in Pilsen and representatives of cooperating companies.

8). Seminar Biomaterials and Their Surfaces: basic issues of biomaterials and the current state of research and development and production of prosthetics or artificial replacements in the Czech Republic. Department of Composite and Carbon Materials, Herbertov Southern Bohemia, September 17 – 20, 2024.

=

8. Network monitoring

Monitoring 1
Monitoring network: SlopeNet:
Monitoring of slope deformations, landslides and rock falls.
Operator: IRSM, RENS Programme.
Activities: The geophysical and geotechnical monitoring of slope deformations with co-responsibility for monitoring.

Monitoring 2
Monitoring network: Network EU TecNet:
The 3D monitoring of tectonic structures in the EU.
Operator: IRSM, Czech/Geo Programme.
Activities: Device readings, service and data evaluation.

Monitoring 3
Monitoring network: Czech Regional Seismic Network:
Earthquake monitoring in Europe and worldwide.
Operators: Institute of Geophysics AS CR, IRSM, Institute of Geonics AS CR, Institute of Earth Physics, Masaryk university and the Charles University Faculty of Mathematics and Physics, Czech/Geo Programme.
Activities: Basic scientific earthquake research infrastructure, especially concerning long-term seismicity research in Europe and worldwide.

Monitoring 4
Monitoring network: MKNET:
Earthquake monitoring in the Lesser Carpathians.
Operators: IRSM, the Earth Science Institute of the Slovak Academy of Sciences, Progseis Ltd., Czech/Geo Programme.
Activities: the continuous recording and evaluation of detailed research data on selected seismically active areas.

Monitoring 5
Monitoring network: REYKJANET:
The monitoring of earthquakes in Iceland.
Operators: Institute of Geophysics AS CR and IRSM, Czech/Geo programme
Activities: Detailed long-term international research in a seismically active area of Iceland.

Monitoring 6
Monitoring network: Landslides, rockfalls and ground currents as recorded in the media since 2011:
The emergence and reactivation of slope deformations in the Czech Republic.
Operator: IRSM, NASA Programme.
Activities: Determination of the location and the time of occurrence of landslides, and the damage they cause.

Monitoring 7
Monitoring network: TecNet:
The monitoring of slow movements along tectonic faults.

Operator: IRSM, Czech/Geo Programme.
Activities: The tracking of seismic tectonic movements along faults.

Monitoring 8
Name of network: WEBNET
Monitored issue: Earthquake in western Bohemia.
Operators: Institute of Geophysics and Institute of Rock Structure and Mechanics of the CAS, Czech/Geo Programme
Activities: Detailed long-term study of seismically active area in western Bohemia

=

9. Published periodicals

1) Acta Geodynamica et Geomaterialia, Vol. 21, Nos. 1 - 4, 2024, ISSN 0862-5468 (Print); ISSN 1804-5847 (On-line), is an international multidisciplinary journal focusing on research, applied science, and education in geophysics, geodynamics, geology, geodesy, petrography of geomaterials, materials engineering and mineral raw materials processing. Impact-factor journal published on a quarterly basis. Database monitoring: Science Citation Index Expanded; Journal Citation Reports/Science Edition.

2) Ceramics-Silicates, Vol. 68, Nos. 1–4, 2024, ISSN 0862-5468 (Print); ISSN 1804-5847 (On-line). Impact-factor journal published on a quarterly basis. Database monitoring: Science Citation Index; Materials Science Citation Index; the Engineering Index (Published by Engineering Information Inc.).

IV. Evaluation of other activities

The Institute has no other activities. For the evaluation of other activities, see Section III, point 5.

V. Information on measures to remedy management deficiencies and the report on how the said measures imposed in the previous year have been implemented

The IRSM had no management deficiencies in 2024 or in the previous year.

VI. Financial information on items that are significant in terms of the assessment of the economic situation of the Institute that may affect its future development

See the financial statement - Profit and loss statement 2024.

VII. Envisaged development of the Institute's activities

The scientific activities of the IRSM will continue to develop in accordance with global research trends, with an emphasis on publishing and teaching and popularisation activities. With respect to scientific research and the enhancement thereof, the Institute will continue to recruit from the doctoral study programmes mentioned previously in this report. The certification of the Institute's researchers will continue aimed at enhancing the quality of their work. The performance of researchers will be rewarded by increases in remuneration and the adjustment of working hours. The Institute's equipment will be expanded, updated and developed on a continuous basis and the staff will be provided with the appropriate training.

VIII. Environmental protection activities

In response to the needs of society as a whole, the assessment of alternative fuels will continue and the Institute will continue to be involved in developing plastic and municipal waste treatment methods, the treatment and transformation of sludge from wastewater treatment plants into fertilisers and the advancement of radioactive waste disposal technologies. A further significant contribution comprises the development of a municipal waste processing method in cooperation with two industrial companies. Conditions are in place for IRSM employees to recycle their waste and hazardous waste is disposed of ecologically by authorised companies. Pest control is performed on a yearly basis.

IX. Further sections of the Annual Report: Profit and loss statement 2024

Institute of Rock Structure and Mechanics of the CAS, V Holešovičkách 94/41, 182 09 Prague 8, Czech republic

Profit and loss statement

ID number 67985891	**Balance as at 31. 12. 2024** (in Czech Crowns, the comma separates two decimal places)	According to Decree No. 504/2002 Coll.

Item		Row	Activities		
Number	Designation		Main activity	Supplementary activy	Total
A	***A. Expenses***				
A.I	**I. Consumed purchases and purchased services**	**002**	**20 644**	**1 539 000**	**22 183**
A.I.1	1.Consumption of material, energy and other non-inventory items	003	7 832	456	8 288
A.I.3	3. Repairs and maintenance	005	1 590	11	1 600
A.I.4	4. Travel expenses	006	1 926	434	2 361
A.I.5	5. Representation costs	007	25	1	26
A.I.6	6. Other services	008	9 271	637	9 908
A.III	**III. Total personnel expenses**	**013**	**70 646**	**1 815**	**72 462**
A.III.10	10. Wages and salaries	014	52 166	1 350	53 517
A.III.11	11. Statutory social insurance	015	17 321	452	17 773
A.III.13	13. Statutory social expenses	017	1 159	13	1 172
A.IV	**IV. Total taxes and fees**	**019**	**229**	**-**	**229**
A.IV.15	**15. Taxes and fees**	**020**	**229**	**-**	**229**
A.V	**V. Total other expenses**	**021**	**4 256**	**1 241**	**5 497**
A.V.19	19. Exchange rate losses	025	50	-	50
A.V.22	22. Other expenses	028	4 206	1 241	5 447
A.VI	**VI. Total depreciation expenses, sold assets, addition and utilization to reserves and adjustments**	**029**	**17 011**	**-**	**17 011**
A.VI.23	23. Depreciation expenses of fixed assets	030	17 011	-	17 011
A.VIII	**VIII. Total income tax**	**037**	**248**	-	**248**
A.VIII.29	29. Income tax	038	248	-	248
	Total expenses	**039**	**113 035**	**4 595**	**117 630**
B	***B. Revenues***				
B.I	**I. Total operating grants**	**041**	**91 159**		**91 159**
B.I.1	1. Operating grants	042	91 159		91 159
B.III	**III. Revenues of own services and merchandise**	**047**	**574**	**5 268**	**2 842**
B.IV	**IV. Total other revenues**	**048**	**22 569**		**22 569**
B.IV.7	7. Interest income	051	406		406
B.IV.8	8. Exchange rate gains	052	37		37
B.IV.9	9. Settlement of funds	053	1 497		1 497
B.IV.10	10. Other revenues	054	20 629		20 629
	Total revenues	**061**	**114 302,00**	**5 268,00**	**119 570,00**
C	**C. Profit / Loss before tax**	**062**	**1 516,00**	**673,00**	**2 188,00**
D	**D. Profit / Loss after tax**	**063**	**1 267,00**	**673,00**	**1 940,00**

Institute of Rock Structure and Mechanics
of the Czech Academy of Sciences
V Holešovičkách 94/41
182 09, Prague 8
Czech Republic

Phone No.: +420 266 009 318
E-mail: irsm@irsm.cas.cz
VAT: CZ67985891
www.irsm.cas.cz