

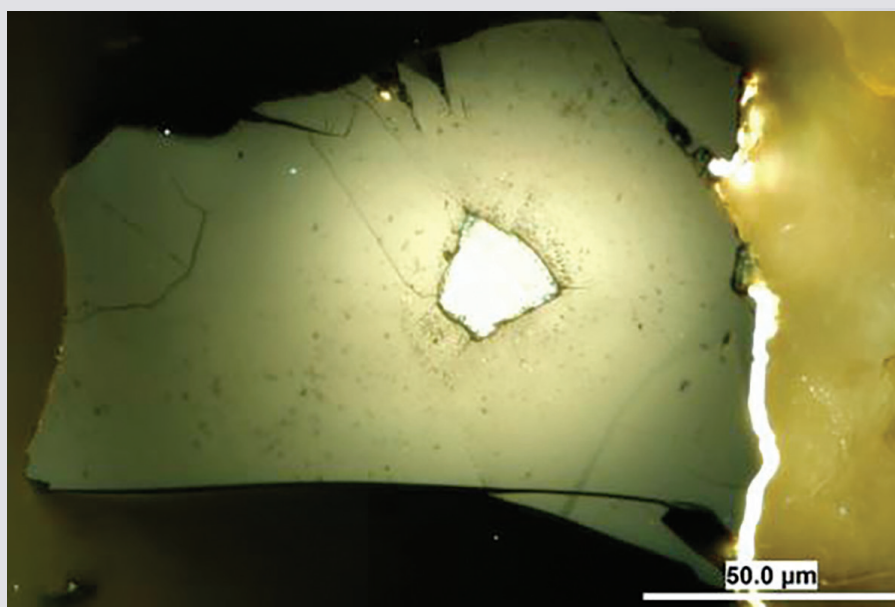


INSTITUTE OF ROCK STRUCTURE AND MECHANICS
The Czech Academy of Sciences

DEPARTMENT OF GEOCHEMISTRY

THEMATIC RESEARCH FOCUS

- COAL AND ORGANIC PETROLOGY
- MINERALOGY AND
PETROGRAPHY AND TEXTURAL
ANALYSIS OF ROCKS
- ORGANIC AND INORGANIC
CHEMISTRY OF GEOMATERIALS
- SORPTION AND COMPLEX
TEXTURAL ANALYSES



Large grain of uraninite with a simple unlimited high reflective halo in weakly altered bitumen from Vrchlabí

JOINT RESEARCH CENTER

The joint Laboratory of Sorption and Porosimetric Analyses was established by the Institute of Rock Structure and Mechanics together with the Faculty of Science, Charles University. Joint research is focused on the porous texture of rock materials and their changes due to environmental conditions and technological processes.

MAIN SCOPE OF RESEARCH

- Coalification, maturation and composition of fossil organic matter and their relationship to paleoenvironmental and paleoclimatic conditions in sedimentary basins
- Characterization of changes in organic and mineral matter in rocks caused by radioactive and thermal alteration and weathering
- Investigation on the carbon dioxide, hydrogen and methane sorption capacity of porous natural materials in dependence on their properties
- Innovative carbon materials with tailored porosity and surface chemistry for efficient CO₂ capture and H₂ storage
- Micropollutant capture on activated carbon and the efficiency of activated carbon reactivation
- Investigation of the textural properties and capturing capacity of raw and altered rocks
- Cycling of trace metals in the geological formations
- Investigation of the properties of the corrosion layer on cladding pipes of nuclear fuel
- Chemotaxonomic research on conifers based on the observation of variability in terpene content and composition depending on the season and environmental conditions.
- Development of verification methods for the detection of adulteration of beeswax with paraffin.

KEY RESEARCH EQUIPMENT

- OLYMPUS BX51 transmitted light optical microscope with photographic unit.
- Olympus BX51 optical microscope with a Carl Zeiss MK3 Photomultiplier under both reflected light and fluorescence regimes
- Carl Zeiss Axio Imager M2m optical microscope with a spectrometer
- DuraScan - 20 microhardness tester (Struers)
- Trace gas chromatograph – DSQ II single quadrupole mass spectrometer (ThermoElectron)
- Trace 1310 gas chromatograph – ISQ single quadrupole mass spectrometer (ThermoElectron)

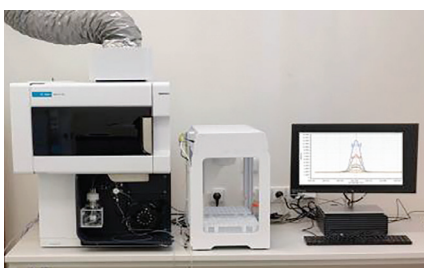


Hidden IGA-100 Intelligent Gravimetric Analyser, Hidden Isochema.



PASCAL 140 + PASCAL 440 EVO mercury porosimeters, Thermo Scientific.

- CDS 5000 Pyroprobe Unit
- ASE extractor (Dionex)
- PASCAL 140 + PASCAL 440 EVO porosimeters (Thermo Scientific)
- IGA-100 and IGA 002 – Intelligent Gravimetric Analyser (Hidden Isochema)
- SURFER volumetric sorption analyzer (Thermo Scientific)
- High-pressure sorption apparatus up to 15 MPa (equipment designed and produced in-house)
- Pycnomatic ATC helium pycnometer (Thermo Scientific)
- ICP-OES Agilent 5900 SVDV (Agilent)



Inductively Coupled Plasma Optical Emission Spectrometry - Agilent 5900 SVDV, Agilent.

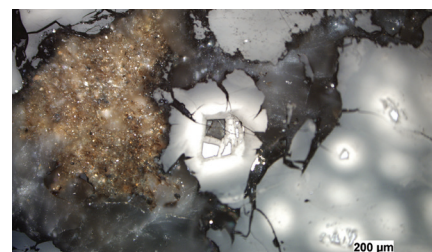


Gas Chromatograph Trace 1310 with DSQ II Mass Spectrometer, Thermo Scientific.

ACHIEVEMENTS

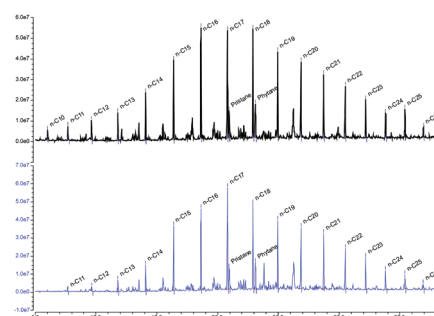
● PETROLOGY, GEOCHEMISTRY AND THERMAL MATURITY, AND PALEOENVIRONMENTAL HISTORY OF MIRES AND SEDIMENTS

Havelcová M., Sýkorová I., René M., Mizera J., Coubal M., Machovič V., Strunga V., Goliáš V., 2022. Geology and Petrography of Uraniferous Bitumens in Permo-Carboniferous Sediments (Vrchlabí, Czech Republic). MINERALS 12, 544.



Petrographical components of black shales and uraniferous bitumens.

Holcová K., Scheiner F., Havelcová M., Kraft P., Ackerman L., Tichá A., Česáková K., Milovský R., 2024. Quaternary floodings in the Zanzibar Channel (NW Indian Ocean, Tanzania) – Identifying palaeoceanographic patterns and palaeoenvironment using a multiproxy study. MARINE GEOLOGY 476, 107366.



Distributions of n-alkanes in fossil samples from the Zanzibar Channel.

Košták M., Schlögl J., Fuchs D., Havrila M., Kolar-Jurkovšek T., Vörös A., Havelcová M., Šurka J., Havrila J., Holcová K., 2024. Rare Middle Triassic coleoids from the Alpine-Carpathian system: new records from Slovakia and their significance. SWISS JOURNAL OF PALAEONTOLOGY 143, 19.

Larikova T., Sýkorová I., Racek M., Havelcová M., Machovič V., Lapčák L., 2024. 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 286, 104590.

Machovič V., Havelcová M., Lapčák L., Mizera J., Sýkorová I., 2022. Chemical character

structure of uraniferous bitumens (Vrchlabí, Czech Republic). INTERNATIONAL JOURNAL OF COAL GEOLOGY 264, 104137.



A photo of a sample of black shales with black uraniferous bitumen

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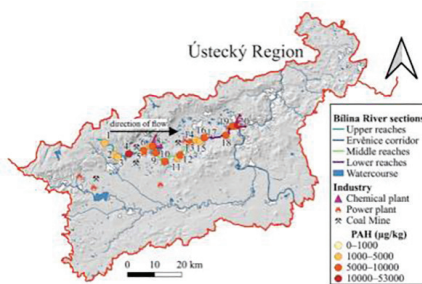
Suchý V., Sýkorová I., Zachariáš J., Brabcová-Pachnerová K., Dobeš P., Havelcová M., Rozkošný I., Luo Q., Cao W., Wu J., Mácová P., Viani A., Světlík I., Maxa D., 2024. Solid bitumen as an indicator of petroleum migration, thermal maturity, and contact metamorphism: a case study in the Barrandian Basin (Silurian - Devonian), Czech Republic. INTERNATIONAL JOURNAL OF COAL GEOLOGY 286, 104493.

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

Vršanský P., Sendi H., Kotulová J., Szwedo J., Havelcová M., Palková H., Vršanská L., Sakala J., Puškelová L., 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.

● MOBILITY AND TRANSFORMATION OF POLLUTANTS

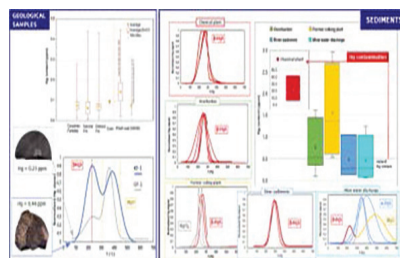
Geršlová E., Vöröš D., 2024. Hydrocarbon-based parameters for the identification of oil contamination in an area with brown coal mining: Emphasis on pyrogenic index and alkylated PAHs. ENVIRONMENTAL ADVANCES 15, 100484.



The geochemical map showing the sum of 16 EPA PAH monitored in the Bělina river profile.

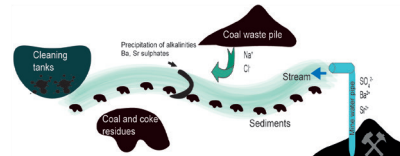
Kříbek B., Bičáková O., Sýkorová I., Havelcová M., Veselovský F., Knésl I., Mészárosová N., 2021. Experimental pyrolysis of metalliferous coal: A contribution to the understanding of pyrometamorphism of organic matter and sulfides during coal waste heaps fires. INTERNATIONAL JOURNAL OF COAL GEOLOGY 245, 103817.

Vöröš D., Baizán P. D., Slaviček K., Díaz-Somoano M., Geršlová E., 2023. Mercury Occurrence and Speciation in Sediments from Hard Coal Mining in Czechia. JOURNAL OF HAZARDOUS MATERIALS 459, 132204.



The example of mercury distribution and speciation in the contaminated sediments compared to the geological background.

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The drainage system of Lazy coal mine site in the Upper Silesian Coal Basin (Czech Republic).

● TEXTURAL AND SORPTION PROPERTIES OF POROUS MATERIALS

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.

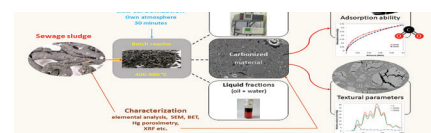
Kostkova N., Vorokhta M., Kormunda M., Pilar R., Sadovska G., Honcova P., Mikyskova E., Moravkova J., Sazama P., 2024. Controlling the structure of nitrogen-doped zeolite-templated carbon for CO₂ capture based on the synthesis conditions. MICROPOROUS AND MESOPOROUS MATERIALS 379, 113286.

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.

Purikova O., Tkachenko I., Šmíd B., Veltruská K., Dinhová T. N., Vorokhta M., Kopecký Jr. V., Hanyková L., Ju X., 2022. Free-Blockage Mesoporous Silica Nanoparticles Loaded with Cerium Oxide as ROS-Responsive and ROS-Scavenging Nanomedicine. ADVANCED FUNCTIONAL MATERIALS 46, 2208316.

Rasina M., Lusens M., Racek M., Přikrylová J., Weishauptová Z., Řimnáčová D., Přikryl R., 2022. Distinction between consecutive construction phases by combined microscopic study and quantitative pore space analysis: Case study of Horn's Bastion, Riga Castle (Latvia). JOURNAL OF CULTURAL HERITAGE 57, 88-96.

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Synthesis and characterization of activated carbon from sewage sludge.

Řimnáčová D., Malhocká A., Havelcová M., Hendrych J., Weishauptová Z., 2024. Physicochemical characteristics of natural and anthropogenic inorganic and organic solid porous materials: Comprehensive view. MATERIALIA 33, 101973.

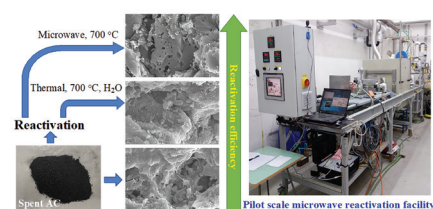


Characterization of various adsorption materials.

Sádovská G., Honcová P., Morávková J., Jirka I., Vorokhta M., Pilař R., Rathouský J., Kaucký D., Mikysková E., Sazama P., 2023. The thermal stability of carbon materials in the air: Quantitative structural investigation of thermal stability of carbon materials in air. CARBON 206, 211-225.

Švábová M., Bičáková O., Vorokhta M., 2023. Biochar as an effective material for acetone sorption and the effect of surface area on the mechanism of sorption. JOURNAL OF ENVIRONMENTAL MANAGEMENT 348, 119205.

Švábová M., Šváb M., Vorokhta M., 2024. Comparison of microwave and thermal reactivation of spent activated carbons: A pilot scale demonstration. JOURNAL OF WATER PROCESS ENGINEERING 67, 106189.



Pilot scale reactivation facility and comparison of SEM images of structures of spent and reactivated carbons.

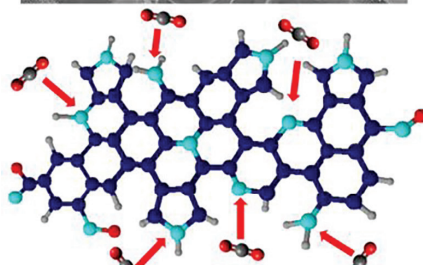
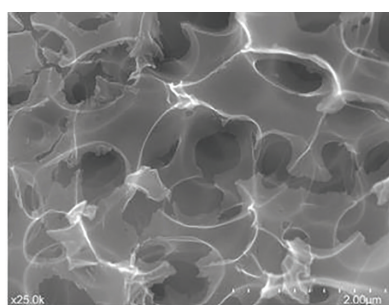
Švábová M., Vorokhta M., 2022. Water sorption and transport in Silurian shales. JOURNAL OF PETROLEUM SCIENCE AND ENGINEERING 210, 109980.

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Vorokhta M., Kusdhany M. I. M., Vöröš D., Nishihara M., Sasaki K., Lyth S. M., 2023. Microporous carbon foams: the effect of nitrogen-doping on CO₂ capture and separation via pressure swing adsorption. CHEMICAL ENGINEERING JOURNAL 471, 144524.

Vorokhta M., Morávková J., Dopita M., Zhigunov A., Šlouf M., Pilař R., Sazama P., 2021. Effect of micropores on CO₂ capture in ordered mesoporous CMK-3 carbon at atmospheric pressure. ADSORPTION 27, 1221-1236.

Vorokhta M., Nováková J., Dopita M., Khalakhan I., Kopecký, Jr. V., Švábová M., 2023. Activated three-dimensionally ordered micromesoporous carbons for CO₂ capture. MATERIALS TODAY SUSTAINABILITY 24, 100509.



SEM image of the graphene carbon foam, and schematic of expected nitrogen species in the graphene carbon foam structure (navy atoms are carbon, silver atoms are hydrogen, red atoms are oxygen, and cyan atoms are nitrogen).

● CHEMOTAXONOMIC RESEARCH

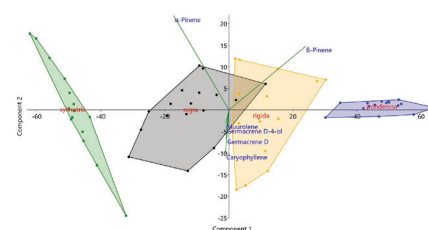
Malhocká A., Švábová M., 2023. A chemotaxonomic analysis of terpenes variation in Metasequoia glyptostroboides and Sequoiadendron giganteum resins. JOURNAL OF ESSENTIAL OIL BEARING PLANTS 26, 1245-1255.



Cone exudate

Malhocká A., Švábová M., Havelcová M., 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.

Špaldoňová A., Havelcová M., Lapčák L., Machovič V., Titěra D., 2021. Analysis of beeswax adulteration with paraffin using GC/MS, FTIR-ATR and Raman spectroscopy. JOURNAL OF APICULTURAL RESEARCH 60, 73-83.



A comparison of individual pine species according to the terpene composition of resins from the needles, using PCA. The points in the graph indicate individual samplings in years 2016-2021, always in the colour of the given species (*P. sylvestris* – empty triangle, *P. nigra* – full dot, *P. rigida* – empty square, *P. ponderosa* – full triangle).

MAIN COLLABORATING PARTNERS

- Brno University of Technology (Brno, CZ)
- Czech University of Life Sciences Prague (Praha, CZ)
- Czech Geological Survey (Praha, CZ)
- ČEZ Energetické produkty (a subsidiary of ČEZ, a. s.) (Hostivice, CZ)
- Dekonta (Dřetovice, CZ)
- Charles University (Praha, CZ)
- Institute of Macromolecular Chemistry of the CAS (Praha, CZ)
- Institute of Geonics of the CAS (Ostrava, CZ)
- J. Heyrovsky Institute of Physical Chemistry of the CAS (Praha, CZ)
- Kyushu University (Fukuoka, Japan)
- Masaryk University (Brno, CZ)
- National Museum (Prague, CZ)
- Nuclear Physics Institute of the CAS (Řež, CZ)
- North Bohemia Coal Mines (Severočeské doly a.s.) (Bílina, CZ)
- Sokolovská uhelná a.s. (Sokolov, CZ)
- Technical University – VŠB (Ostrava, CZ)
- UJP Praha a.s. (Praha, CZ)
- University of Aveiro (Aveiro, Portugal)
- University of Salzburg (Salzburg, Austria)
- University of Strathclyde (Glasgow, UK)



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