INSTITUTE OF ROCK STRUCTURE AND MECHANICS
The Czech Academy of Sciences

INSTITUTE OF ROCK STRUCTURE AND MECHANICS OF THE CAS

The Institute of Rock Structure and Mechanics of the Czech Academy of Sciences is an academic institution specialising in the study of the structure and properties of rocks and the rock environment. It is also involved in research into glass, ceramic materials for technical use, composite materials and biomaterials, their properties and application potential, and technological topics relating to the processing of inorganic as well as organic waste. Its research activities are spread across six scientific departments.

The **IRSM** is one of the five institutes belonging to the Earth Sciences section of the CAS. As of 2007, the IRSM is a legally constituted public research institution (abbreviated as v. v. i.).

The main objectives of the research and educational activities of the IRSM include:

- Acquisition, processing and dissemination of scientific knowledge at conferences, their publishing in monographs and scientific journals.
- Cooperation with universities and other scientific and professional institutions and private business companies through joint projects and cooperation agreements
- Teaching and tutoring young researchers at universities
- Management of doctoral and postdoctoral programs
- Contributing to furthering scientific knowledge and to the development of practical applications of research findings
- Involvement in international cooperation
- Management and operation of research infrastructures
- Organizing scientific meetings, conferences and seminars at the national and internationa level.
- Publishing of scientific journals: *Acta Geodynamica et Geomaterialia*, and in cooperation with the University of Chemistry and Technology, Prague, *Ceramics-Silikáty*

HISTORY OF IRSM

- **1927**

  The Institute was founded under the name **"Institute for Scientific Coal Research".** The research was mainly related to the chemistry of coal and chemical processing of solid fuels. Its founder and first director, Dr. Hans Tropsch, was a co-discoverer of the well known **"Fischer-Tropsch synthesis"** of liquid fuels from coal.

- **1947**

  Due to the fact that the research scope of the Institute had been extended, the Institute's name was changed to **"Institute for Scientific Coal and Mineral Research"**.

- **1948**

  The institute was renamed **"Institute for the Research and Use of Fuels"**.

- **1958**

  "Mining Institute of the Czechoslovak Academy of Sciences (CSAS)" was founded in 1958 as a basic research centre for mining sciences. The staff, equipment and research programmes were taken over from previous institutions with thirty years of research tradition already behind them. The Institute helped to develop montane and mining sciences and achieved world excellency in the field of coal and mineral processing.

- **1967**

  The Scientific journal **"Reports of the Mining Institute"** was founded, later (1970) renamed **"Acta Montana".**

- **1970**

  The Mining Institute underwent major reorganisation. Gradually, individual departments were established, aiming at various aspects of research in geomechanics, geotechnics, aerology, groundwater hydraulics and radionuclides, and related areas such as coal and coke refining, chemistry, coal processing, briquetting, etc.

- **1978**

  After a series of mining accidents in Ostrava's coal mines, a branch of the Mining Institute was established in Ostrava. This branch later became today's **"Institute of Geonics of the CAS".**

- **1979**

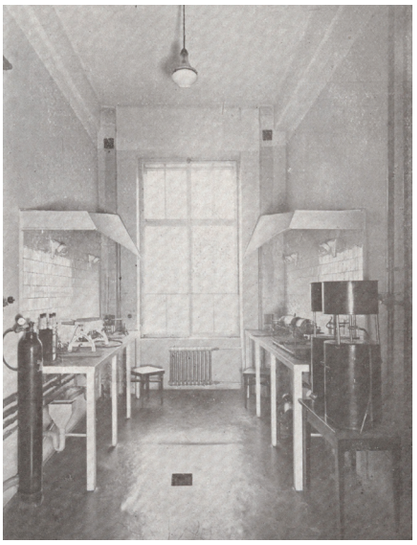
  The Mining Institute and the Geological Institute of the Czechoslovak Academy of Sciences were merged under the new name: **"Institute of Geology and Geotechnics of the CSAS".**

- **1990**

  "Institute of Geology and Geotechnics" was again divided into two independent institutes: **"Institute of Geotechnics"** and **"Geological Institute of the CSAS".**

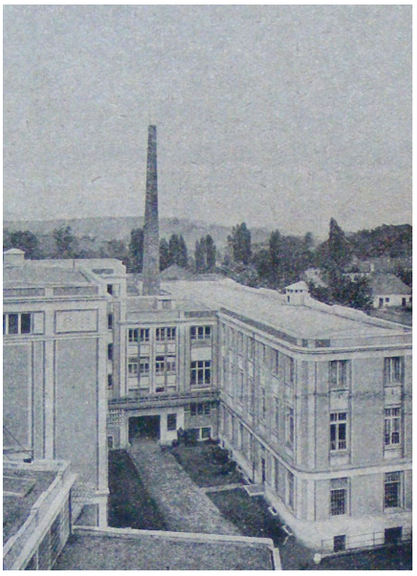
- **1992**

  After the formation of the Academy of Sciences of the Czech Republic, the Institute of Geotechnics changed its name to the current **"Institute of Rock Structure and Mechanics of the CAS".**

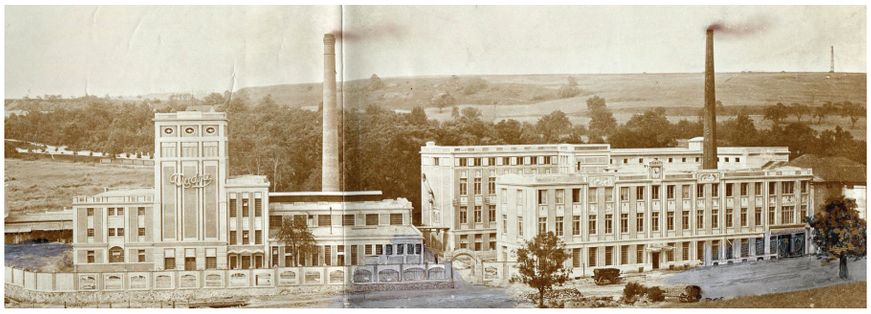


Laboratory of Elementary Analysis. Institute for Scientific Coal Research, 1930.

A view of the Mining Institute in 1966



Intitute for Scientific Coal Research 1930



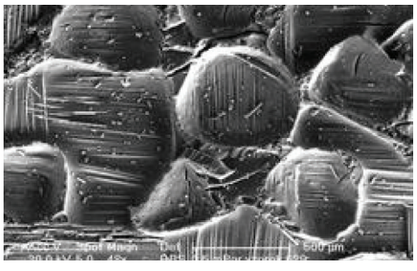
The present large premises of the Institute were redesigned into more or less what we see today at the beginning of the 20th century with the support of the entrepreneur and researcher František Vydra (1869–1921), who had built the seat of his Vydra Consumables Factory here

OUTSTANDING RECENT ACHIEVEMENTS 2005 – 2014

- Preparation of additives and definition of modifications in reaction conditions to reduce emissions of sulphur compounds and toxic elements in the pulverized combustion of brown coal.
- Preparation of glass with new properties, such as resistance to oxidation at high temperatures during pyrolysis.
- Processing of brown coal fly ash for the production of ceramic and building materials.

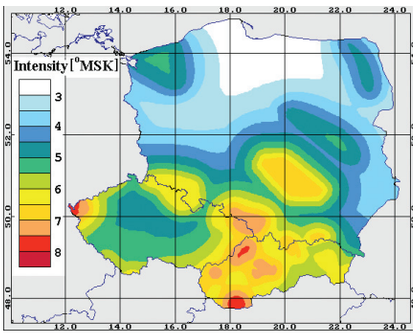
Architectural ornament: a volute made of a geopolymer

- Treatment and recycling of waste polyethylene from municipal dumps with coal.
- Design of composite materials and their preparation for use in orthopaedics as a bone substitute and filling.



Surface of a glass-based composite (pore size 400–600 microns)

- Design and verification of a technology for processing of waste rubber in cooperation with the Sokolovská coal company and ÚVP Běchovice institute.
- Development of new methods for shallow seismic purposes.
- Development of geopolymer compounds applicable as a new sound-proofing material, as a replacement for epoxy resins.
- Earthquake hazard map of the Czech Republic, Poland and Slovakia, showing macroseismic intensities that with 90% probability will not be exceeded in the next 50 years.



Seismic hazard map

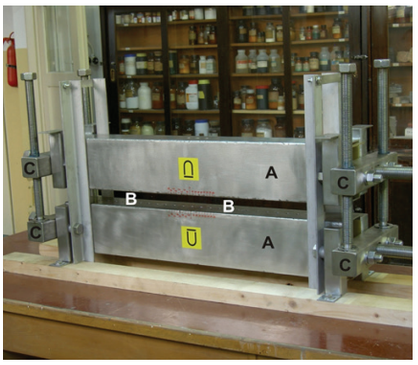
- Industrial filter-cleaning materials designed from neodymium magnets. The magnetic field has a magnetic induction value approximately 3.4 times higher than that of the ferrite magnets used up to now.

Industrial filter

- Development of a new quantitative determination of shear wave velocity for various geological units of the Bohemian Massif.
- Identification of pulses caused by changes in stress in the Earth's crust.
- Analysis of the composition of black layers on building materials in selected parts of Prague Castle as part of the protection of stone monuments. Incomplete combustion of fossil fuels and biomass along with transport emissions were determined as the main source of organic particles and compounds.
- Reconstruction of the formation of brown coal lithotypes from selected Miocene deposits, based on a systematic study of petrographic compositions and biomarkers.
- Calculation and verification of the trajectory and origin of the Chelyabinsk bolide, in cooperation with the Astronomical Institute of the CAS.
- Explanation of the principle of cementation and blackening of Holocene sands by humates from overlying peat.
- Comprehensive biological assessment of composites to serve as a substitute for the bone grafts used in the treatment of degenerative or traumatic disc diseases.

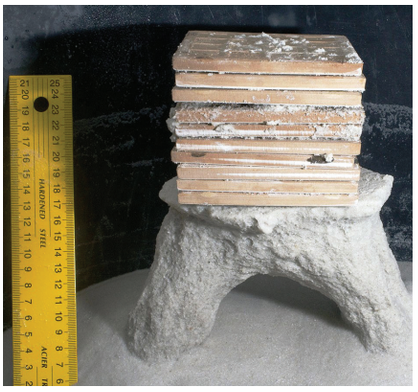
Mosaic of a dust trace from the Chelyabinsk bolide

- The granting of a patent for a device for creating strong magnetic fields using permanent NdFeB magnets.



A – Tubes with sets of magnets
B – Air gap with strong magnetic field
C – Devices to control air gap width
D – Bolts to adjust the magnet sets

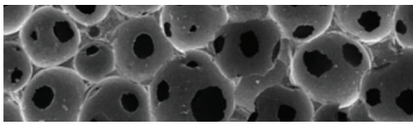
- Clarification of the previously undocumented mechanism of typical sandstone rock relief formation in cooperation with Charles University in Prague and the Geological Institute of the CAS.



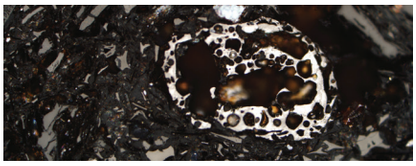
Result of experiments with Střeleč sandstone – a perfect experimental gate, formed by repeatedly flooding a loaded block with a rectangular opening

SELECTED RESULTS SINCE 2015

● Development of advanced ceramic foams based on pyrolyzed polymer precursors. *(Ceram. Int. 41, 6237, 2015; J. Eur. Ceram. Soc. 35, 2015)*

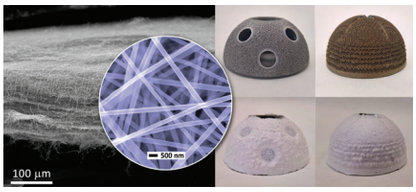


● The influence of uranium mineralisation and spontaneous combustion processes on the physical and chemical properties of coal components was studied at the "Novátor" mine heap in Bečkov. Uranium minerals have caused local radioactive changes in organic compounds. Organic substances located in burned and burnt-out zones pose a potential risk to the environment, in particular to local river basins, soil and vegetation. *(International Journal of Coal Geology 168, 162–178, 2016)*



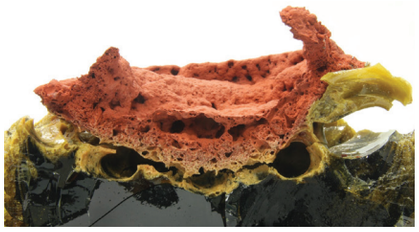
Expelled bitumen in a mineral matrix with coke spherule and detritus in burnt coal wastes, Intrasudetic Basin

● The granting of a European patent for collagen-calcium phosphate nanolayers with the controlled release of antibiotics intended for orthopaedic implants applicable in cases of known inflammation or to prevent its formation. *(European Patent Office EP3311854, Eur. J. Pharm. Biopharm. 140, 50, 2019)*



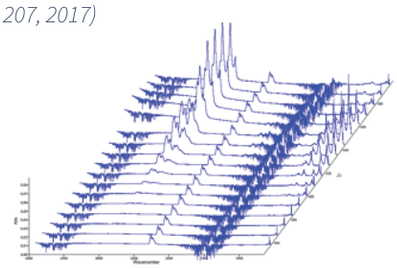
● High-pressure sorption isotherms were measured in Silurian shales from the Barrandian Basin (an area in the Czech Republic) in order to find the main factors of methane and CO_2 sorption. The sorption parameters were used to determine the effect of total organic carbon content, maturation, shale porosity and their clay component on the sorption capacity for both gases. *(Fuel 203, 68–81, 2017; Journal of Natural Gas Science and Engineering 8, 103377, 1–12, 2020)*

● In collaboration with the Pacific Nortwest National Laboratory in the USA, we have provided an innovative explanation of the formation, thermal properties and subsequent interactions in the "cold-cap" – a layer of reacting melter feed that floats on the surface of molten glass during the vitrification of nuclear waste. *(Ceramics International 45, 2019)*



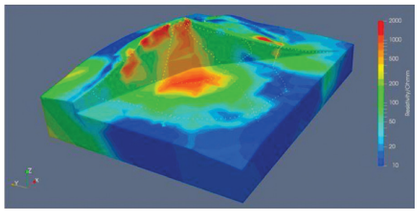
Cold cap – a reacting melter feed that floats on the surface of molten glass

● Heat treatment of three-component mixtures of polyethylene, polypropylene and polystyrene was analysed. The results show that the oils from the waste mixture obtained during pyrolysis can be used as a pure liquid fuel as well as a source of chemicals and solvents. *(Journal of Analytical and Applied Pyrolysis 128, 196–207, 2017)*



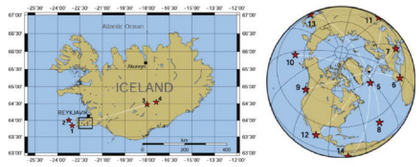
Infrared recording of the increase in key product contents over time

● Geophysical methods were used to describe the origin and development of the Miocene volcanic cone Zebín in the Czech Republic. A model of the internal structure of the volcano was created, its age was found to be 18.38 – 18.52 Ma and the directions of magma flow inside the volcano were determined. *(Geochemistry, Geophysics, Geosystems 19, 3764–3792, 2018)*



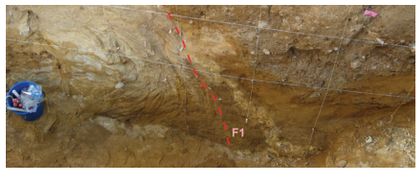
Spatial model of the Zebín volcano derived from geoelectric resistance measurements. The highest values of specific resistances (over 500 Ωm, orange and red) show supply paths filled with unventilated basic lava.

● The seismic structure under the Reykjanes peninsula was refined, using stations from the REYKJANET seismic network. At depths exceeding 20 km, a significant zone of low seismic velocities was found. *(Tectonophysics 753, 1–14, 2019)*



Earthquakes used to calculate the model. To determine the model, 14 earthquakes from 2013 to 2015 were used with different epicentral distances, which were recorded by the REYKJANET seismic network.

● Paleoseismic research in the Cheb basin has revealed repeated Quaternary movements at the Mariánské Lázně fault, accompanied by earthquakes that damaged Earth's surface. Dating has shown that even during the Holocene, there were at least two major earthquakes with M = 6.3 to 6.5, the most recent of which occurred around 1000 A.D. *(Geomorphology 327, 472–488, 2019)*



Photograph from the Kopanina paleoseismic trench in the Cheb basin with several types of tectonic deformation of late Quaternary sediments

● Acceleration of movements at faults preceding local catastrophic earthquakes was discovered by monitoring movements at faults in the central Apennines in Italy. *(Tectonophysics 750, 22–35, 2019)*

● The Global Database of Giant Landslides on Volcanic Islands summarizes statistics and knowledge of giant landslides on volcanic islands that are cubic kilometers in size. Landslides on volcanic islands – volcanic collapses – are among the largest on Earth and are fully comparable in size to the extra-terrestrial landslides observed on Mars. *(Landslides 16, 2045–2052, 2019)*

El Golfo: scarp of a giant landslide – collapse of a volcano. El Hierro, Spain

V Holešovičkách 94/41,
182 09 Praha 8, Czech Republic
www.irsm.cas.cz

Phone: +420 266 009 318
+420 266 009 111
E-mail: irsm@irsm.cas.cz