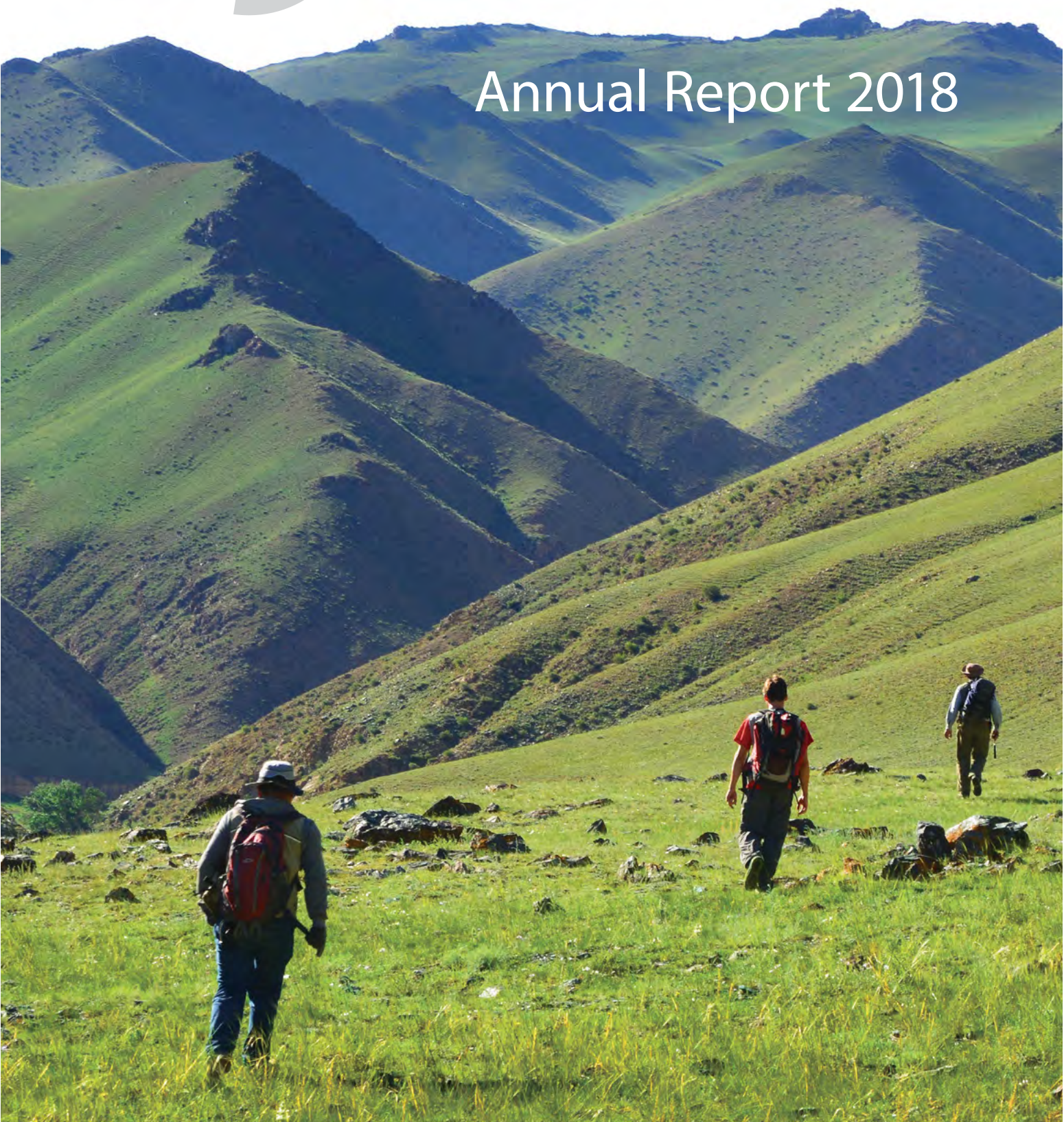


100 YEARS



# Annual Report 2018





# Content

Director's Introduction	1
History of the Czech Geological Survey	2
(SPV) Geological and thematic maps	9
(SPV) Regional geological research	13
(SPV) Research on biodiversity and global changes in the past	17
(SPV) Mineral resources	21
(SPV) Groundwater research and evaluation	27
(SPV) Geoenergy research	31
(SPV) Geosphere-biosphere-atmosphere interaction	35
(SPV) Geohazard research	39
Regional Geological Administration	43
State geological survey agendas of the Geofond Division	47
Mine workings and mining waste	53
Geological Information System	57
Remote sensing	63
International activities and cooperation	67
(SPV) Laboratories	77
Library and collections	83
Geological documentation	87
CGS Publishing House and promotional activities	91
Selected publications issued by the CGS	98
Selected scientific papers	100
Financial review for 2018	106
Human resources	108
Website of the Czech Geological Survey	110
Principal events in 2018	112
Projects	120

## Strategic research plan 2016–2020

- |  |  |
|--|--|
| (SPV) Research on the structure and evolution of the Earth's crust | (SPV) Research on geosphere-biosphere-atmosphere interaction               |
| (SPV) Research on the biodiversity and global changes in the past  | (SPV) Research on geohazards   |
| (SPV) Research on and use of natural resources                     | (SPV) Research on and development of geochemical and mineralogical methods |



# Organizational Structure

Situation as of 31 December, 2018

Advisory bodies	Directorate			Advisory bodies
Scientific Board Review Board Editorial Board CGS Map Approval Committee	Management Project Management Management and Administration of the Brno Branch	Zdeněk Venera Director zdenek.venera@geology.cz	Human Resources Section Internal Audit	Editorial Board of the Bulletin of Geosciences CGS Portal Board CGS Library Board
<b>Geochemical Division and Central Laboratories</b>	<b>Economic Division</b>	<b>Geological Division</b>	<b>Geofond Division</b>	<b>Division of Informatics</b>
Jan Pašava Head of Division & Deputy Director for Research jan.pasava@geology.cz	Zdeněk Cílc Head of Division & Deputy Director for Economics zdenek.cilc@geology.cz	Petr Mixa Head of Division & Deputy Director for Geology petr.mixa@geology.cz	Vít Štrupl Head of Division vit.strupl@geology.cz	Dana Čáková Head of Division & Deputy Director for Informatics dana.capova@geology.cz
<b>Environmental Geochemistry and Biogeochemistry</b>	<b>General Economics</b>	<b>Regional Geology of Crystalline Complexes</b>	<b>Mineral Raw Materials</b>	<b>CGS Publishing House</b>
Martin Novák Head of Department martin.novak@geology.cz	Jana Kuklová Head of Department jana.kuklova@geology.cz	Jaroslava Pertoldová Head of Department jaroslava.pertoldova@geology.cz	Jaromír Starý Head of Department jaromir.stary@geology.cz	Patrik Fífera vedoucí vydavatelství patrik.fiferna@geology.cz
<b>Rock Geochemistry</b>	<b>Economics and Administration</b>	<b>Regional Geology of Sedimentary Formations</b>	<b>Mining Impacts</b>	<b>Information Services</b>
Anna Vymazalová Head of Department anna.vymazalova@geology.cz	Mirko Vaněček Head of Department mirko.vanecek@geology.cz	Tomáš Hroch Head of Department tomas.hroch@geology.cz	Jolana Šanderová Head of Department jolana.sanderova@geology.cz	Hana Breiterová Head of Department hana.breiterova@geology.cz
<b>Mineral Resources Research and Policy</b>		<b>Applied Geology</b>	<b>Geological Exploration</b>	<b>Information Systems</b>
Petr Rambousek Head of Department petr.rambousek@geology.cz		Petr Kycl Head of Department petr.kycl@geology.cz	Zdeňka Petáková Head of Department zdenka.petakova@geology.cz	Zuzana Krejčí Head of Department zuzana.krejci@geology.cz
<b>Central Laboratory Prague</b>		<b>Regional Geology of Moravia</b>	<b>Geological Documentation</b>	<b>Computer Administration</b>
Věra Zoulková Head of Department vera.zoulkova@geology.cz		Jan Vít Head of Department jan.vit@geology.cz	Milada Hrdlovicsová Head of Department milada.hrdlovicsova@geology.cz	Richard Binko Head of Section richard.binko@geology.cz
<b>Central Laboratory Brno</b>		<b>Environmental Geology and Geophysics</b>		
Juraj Franců Head of Department juraj.francu@geology.cz		Jan Šíkula Head of Department jan.sikula@geology.cz		
		<b>Litospheric Research</b>		
		Karel Schulmann Head of Department karel.schulmann@geology.cz		
		<b>Jeseník Office</b>		
		Vratislav Pecina Head of Section vratislav.pecina@geology.cz		

# Management



From the left: Vít Štrupl – Head of the Geofond Division, Dana Čápková – Deputy Director for Informatics, Oldřich Krejčí – Director of the Brno Branch, Zdeněk Venera – Director of the Czech Geological Survey, Petr Mixa – Deputy Director for Geology, Zdeněk Cilc – Deputy Director for Economics, Jan Pašava – Deputy Director for Research and Head of the Geochemical Division and Central Laboratories.

---

## Czech Geological Survey

The Czech Geological Survey is a highly respected state organization that compiles, stores, interprets and provides objective expert geological information for the state administration, the private sector and the public. It is a state-funded body, the departmental research institute of the Ministry of the Environment responsible for functioning as the state geological survey in the Czech Republic. It is the only institution tasked with the systematic investigation of the geological structure of the entire Czech Republic.

The well-established reputation of the Czech Geological Survey is based on the optimum combination of services to society with top-ranking research in geological science, natural resources, geohazards and environmental protection.

As an internationally respected scientific institution, it responds to the requirements of society for sustainable development and plays a significant role in education and in the popularization of geology.

### Main fields of activity

- Geological research and mapping
- Rock environment and its protection
- Mineral resources and environmental impacts of mining
- Geohazards, prevention and mitigation of their impact
- Geoinformation management and delivery

### Mission

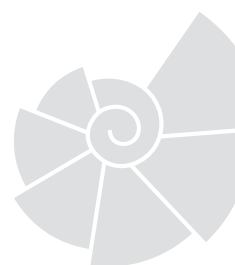
- Geological mapping and regional research within the territory of the Czech Republic
- Basic and applied research on geohazards, mineral resources, groundwater sources, rock environments and environmental protection
- Serves as the state geological survey in accordance with Act No. 62/1988 Coll. (on geological work)
- Gathering, compilation and interpretation of data on the geological structure, mineral resources and geohazards of the CR
- Provision of geoscientific information and expert advice to support decision-making on issues of state and public interest
- International cooperation and foreign development aid
- Education in geosciences and environmental protection

### Vision

Through innovative research and use of the most up-to-date technology, the Czech Geological Survey will continue to provide the Czech State with the geoscientific information needed to make crucial policy decisions about energy, water and other critical resources, natural hazards and sustainable development, while working to maintain its position as a leading research institution in the field of Earth sciences.



# Director's Introduction



In 2019, when this annual report is issued, the Czech Geological Survey is celebrating the centenary since its foundation. Based on a decision of the Government of the Czechoslovak Republic, the Ministry of Public Works established our institution originally as the State Geological Institute of the Czechoslovak Republic on the 7<sup>th</sup> July 1919 as one of the first state expert organizations. Although the institution has changed significantly during its 100-year existence, what remains the same today when looking at its original foundation charter is the fulfillment of our mission – to provide the country with high-quality geoscience expertise in order to make competent decisions on economic growth, on security of the citizens, on management of mineral resources, soil and groundwater, on environmental protection, and on natural disaster prevention and mitigation.

How is the Czech Geological Survey doing in 2019? The Czech Geological Survey has developed into a modern institution, where a multidisciplinary approach in Earth science is combined with the use of current information technologies, indispensable both for data acquisition, and for delivering our information and expertise to the public and professional community. The CGS mission reflects a dual character of our organization that consists in providing the state administration with high-quality expert support based on first-class research, which has been achieving excellent results over many years. The expertise scope of the CGS has expanded, and so has the number of our staff (currently 330 full-time employees). Unlike many other organizations, the CGS

does not suffer from a lack of young scientists because we are an attractive employer, with a successful practice of experience transfer from senior to junior employees. On the other hand, retiring experts can be granted emeritus status that allow them to continue with their professional life. Part-time jobs and home-office option are common reflecting different life-work situations, often for parents caring for young children, etc. We encourage our employees to expand their education and skills. As a state-subsidised organization, we provide maximum employee benefits and strive for a top position on labour market. Our funding depends on our performance, but that is not the only reason to hire the best experts in our sector. The 100-year existence of the CGS represents a tradition and evokes respect, yet it does not guarantee a future prosperity. Our anniversary also raises our sense of responsibility and challenges us – as heirs of a distinguished history – to be at least as good, today and in the future, as all the excellent researchers and specialists of our institute who came before us. It is not only a commitment towards CGS employees, but also to the entire Czech geoscience community, in which the CGS plays a key role. It is my wish for the Czech Geological Survey to be continuously progressive, to be mindful of its history, continuity and context, to strengthen its domestic and international reputation, and to be an irreplaceable cornerstone of the Czech Republic in the field of geosciences. Our staff and the Ministry of the Environment, as our founder, deserve a great deal of gratitude for the good shape we find ourselves in, allowing us to celebrate the past century of the CGS.



Zdeněk Venera

100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



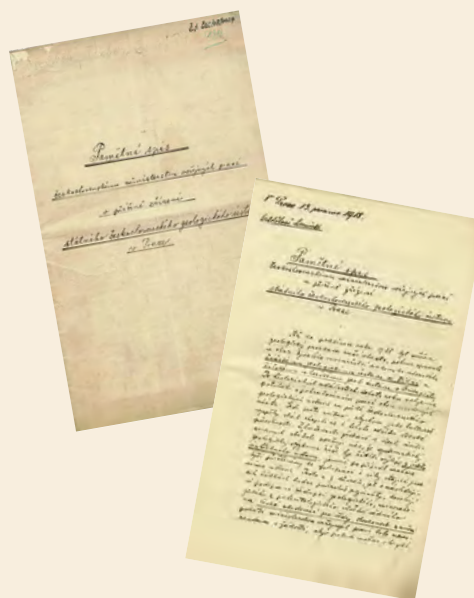
# History of the Czech Geological Survey

*From its foundation in 1919 the Czech Geological Survey rapidly developed to become a highly regarded member of the network of state geological surveys established in the different countries of the world. The Survey has survived many political and economic events in its history, some happy and some quite difficult. Periods of turbulence have alternated with periods of quieter evolution, periods during which basic geological research and regional studies prevailed have alternated with periods when intensive prospecting for mineral resources and geological services were emphasized. The Survey underwent numerous reorganizations and changes of its supervisory bodies but, like the state geological surveys of other developed countries, it has always fulfilled its statutory tasks by continuing to provide the geological services and information required under the different political circumstances that affected Czechoslovakia and, later, the Czech Republic.*



Zdeněk Kukal

In December 1918 the Czechoslovak Ministry of Public Works received a letter of memorandum formulated and signed by four renowned Czech geologists proposing the foundation of a state geological survey. This document set out the programme, the budget and the staff required for this institute. The proposal was accepted by the Cabinet and, on 7 July 1919, the Geological Survey of the Czechoslovak Republic was established. The work of the Geological Survey started with a staff of only 8 employees, the director and his assistant, a secretary, one chemist, a custodian and a few administrators. Numerous individuals, such as university professors and volunteers, gave their support to the Survey by helping to carry out systematic



📖 Commemorative document from 1918 recommending the establishment of the state geological survey. It demonstrates how the elite Czechoslovak geologists at that time perceived the evolving future of geology.



🚩 *Snapshots taken by Dr. J. Svoboda from an excursion of the Carpathian Geological Association in 1931. Several buses had to be used to accommodate so many foreign participants. Discussions at outcrops and picnics on grass have not changed to this day.*

geological investigations of the Czechoslovak Republic. The scope of their work embraced regional geology with geological mapping, assessments of mineral resources, surveys and documentation for various technical projects and construction, and a short time later publication of geoscience literature also began. By 1921, the Survey was already publishing a Bulletin, and a number of books and maps had appeared. A library, together with archives of documentation relating to collections and a centre for quarries and drilling were founded. Without donations from private persons and organizations the library and archives could not have been established.

Soon, the chemical laboratory had also started to operate and new methods of mineral and rock analyses were introduced step by step.

In 1931 the 3<sup>rd</sup> Congress of the Carpathian Geological Association was chaired by the director of the Czech Survey. This was the first of many important international activities organized by the Survey.

The number of members of staff increased progressively until the German occupation in 1939. During the war years, the activities of the Geological Survey were limited, and a restrictive editorial policy was enforced. Despite these obstacles, geological mapping and soil investigation, surveying of mineral deposits with the establishment of a database of mines and quarries took place. After the end of World War II the former activities of the Survey were revived. By 1950, the number of employees had increased dramatically. In 1950, the geological surveys in Prague and Bratislava (Slovakia) were united to create a single organization, and the Brno Branch was established. The new Brno Branch focused on the investigation of Moravian geology, as well as

on the search for oil and gas. Later, the laboratory for organic geochemistry was opened and modernized. In 1952, the Survey became part of the Czechoslovak Academy of Sciences and simultaneously, the Geofond was established as a centre for documentation. In 1953, the Geological Survey, as a Central Authority, was promoted to be an organ of government under the direction of the Prime Minister.

The organization of the International Geological Congress in 1968 was an important milestone in the activities of the Geological Survey, even though the programme of the Congress had to be ended prematurely because of the invasion of Czechoslovakia by the armies of the Warsaw Pact.

## **The scope of the activities of the Geological Survey**

The Survey has progressively developed a comprehensive programme of research based on the core activities of geological mapping and surveys for special applications including soils, engineering and hydrogeology. Evaluation and assessment of all types of mineral resources and ground waters are economically and strategically important themes, and all field-based research is supported by specialist studies of mineralogy, petrology, geochemistry and geophysics. Periods of more basic geological investigation have alternated with periods of applied research, the results of which have been compiled in hundreds of expert reports, many of great economic importance. By 1965 the mapping of the republic at a scale of 1 : 200,000 was completed. During the seventies, a series of maps at a scale of 1 : 100,000 were published, together with monographs. The deep drilling programme



and geophysical research provided insights into the structure of the Earth's crust and upper mantle. The rock formations beneath the Cretaceous cover of the Bohemian Massif were studied, and new oil and gas reserves were discovered in the Carpathian Foredeep, coal deposits were located beneath the Cretaceous cover of the Bohemian Massif and surveys of non-traditional industrial minerals were also carried out. After 1990, new environmental projects were started and new programmes of international cooperation were begun. Soon, nearly 50 per cent of the scientific activity of the Geological Survey was devoted to environmental problems, and the chemical laboratories obtained international accreditation for the quality of chemical and other special analyses of geological materials and waters. A major project to model the structure of Western Bohemia based on the results from the KTB (the Continental Deep Borehole) borehole in Germany not far from the Czech border was successfully completed. In 1994 the Geological Survey established a GIS department and the use of computer graphics for map printing began. In 1996 the geological and applied mapping of the Czech Republic at a scale of 1 : 50,000 were completed, making it the first country in the world to be comprehensively covered by a series of maps at this scale. Basic and applied research projects have been progressively incorporated into national and international scientific programmes funded through dedicated grants. The Czech Geological Survey now functions successfully like the Geological Surveys of other developed countries, taking into account the adaptations necessary to meet the specific requirements of the Czech Republic.

### **The changes in the supervisory bodies responsible for the Geological Survey**

The Survey was established by decree of the Ministry of Public Works and remained its supervisory body up to World War II. During the German occupation, the Survey was placed under the supervision of the Ministry of Labour and, after the war, the Survey was placed under the Ministry of Industry for a short period. From 1948, and during the following years of political turbulence the authorities responsible for supervising the Survey changed rapidly from the State Planning Bureau to the Centre for Scientific Research and, finally to a special

committee of the Office of the Prime Minister. In 1958 the Central Geological Office was established as the prime organ of 'United Geology' which operated under the mandate of the ministries in many socialist countries, in most cases the Ministry of Geology. Under this system, the Geological Survey was reduced to the level of a subsidiary institute.

The Central (later Czech) Geological Office was abolished soon after the 'Velvet Revolution' in November 1989 and the Czech Geological Survey was placed under the authority of the Ministry of the Environment of the Czech Republic. The Survey reclaimed and stressed its role in the research, objective service and education and firmly joined the European and world network of the state geological surveys.

### **The directors of the Geological Survey**

Fourteen geologists, together with one expert in mining history, have occupied the position of director of the Geological Survey. The first director was the university professor, Cyril Purkyně, who was renowned not only as a palaeontologist, but also as an expert in regional and applied geology. Before World War II, the directors were mostly specialists in applied geology, as the political and economic situation dictated. After the war, three Quaternary geologists were among the appointed directors of the Survey, a fact which undoubtedly reflects the high standard of Quaternary research in the Czech Republic. The other directors have all ranked among leading specialists in economic geology, regional geology, oil and gas geology, stratigraphy, petrology and sedimentology.

### **The changes in the name of the Geological Survey**

The name of the Czech Geological Survey has been changed six times during its history. It was established as the 'State Geological Survey of the Republic of Czechoslovakia'. During the German occupation (1939–1945) it was renamed the 'Bureau for soil investigation in Bohemia and Moravia' (the term 'soil' was a misunderstanding in literal translation because, in geology, the German term 'der Boden' is also used to describe the 'soil with rocks, i.e. earth'). In 1945, the Survey regained its original pre-war name. In 1952, however, it was renamed the 'Central Geological Institute' and for a short period it bore the title 'The



⤵ Temporary facility of the Central Geological Institute in Zbuzkova Street. Photo by B. Červený, 1956.



⤵ Library of the Central Geological Institute at 9 Hradební Street. Photo by H. Vršťalová, 1964.



⤵ DTA apparatus for identifying clay minerals. Photo by J. Barta, 1960.



⤵ Chemical laboratory of the Central Geological Institute in Kostelní Street. Photo by H. Vršťalová, 1964.



⤵ Polishing samples in the Central Geological Institute workshop, located in the Green Frog house in Prague-Břevnov. Photo by S. Bártlová, 1964.



⤵ Micropaleontological laboratory of the Central Geological Institute at 9 Hradební Street. Photo by H. Vršťalová, 1964.

Central Geological Institute of the Czechoslovak Academy of Sciences'.

Finally, soon after 1989, the Survey was given its present name, 'The Czech Geological Survey' which corresponds to the format used in naming the state geological surveys of other developed countries.

## Some other important milestones in the history of the Geological Survey

At the end of World War II, the Slovak Geological Institute in Bratislava became part of the Central Geological Institute. This lasted until 1965, when the Slovak Institute of Dionýz Štúr became a fully independent institute, responsible for the geological investigation of Slovakia. This circumstance was quite fortunate in view of the subsequent partition of Czechoslovakia into the Czech and Slovak Republics in 1993. The two institutes now continue to cooperate in many branches of geological research.

The branch of the Survey in the City of Brno was established in 1950. It focused on the investigation of Moravian geology, as well as on oil and gas research. Later, the laboratory of organic geochemistry was opened and subsequently modernized to make this branch one of the most important centres for environmental studies.



⤵ Cyril Purkyně, the first director of the Survey, at the wedding of his niece Olga Purkyňová, where he took the place of her deceased father (1928).



# 100 YEARS



⤴ Opening ceremony of the 23<sup>rd</sup> International Geological Congress at the Congress Hall of the Julius Fučík Park of Culture and Leisure in 1968.



⤴ For the entire geological community, international geological congresses represent a pinnacle of scientific and personal relations between institutions and individual geologists.



⤴ The geological congress officially ended after the invasion by Warsaw Pact troops. Photo by an unknown person, which circulated among the delegates.



⤴ Series of stamps with geological motifs issued for the 23<sup>rd</sup> International Geological Congress. The institute's staff helped design the stamps.



⤴ Reaction by the participants of the International Geological Congress to the August events of 1968. Photo by J. Rudolský.





➤ The main building of the Central Geological Institute and Geofond in the Malostranské Square (Smiřický Palace on the left, Šternberk Palace on the right) in a photograph from 1964. It now serves as the seat of the Parliament of the Czech Republic. Photo by H. Vršťalová.



➤ Rudolf Hylský and František Kohout, employees of the Geological Survey, carrying out well logging to a depth of two meters, near Pohodnice close to Ejpvovice. Photo by R. Hylský, 1951.

The Geofond was established as an integral part of the Survey in 1952 to fulfil the task of gathering and storing documentation and providing an information service. This union functioned until 1975, when the Geofond became a fully independent organization.

The incorporation of the so-called Technical Department, later renamed the Drilling Enterprise, into the structure of the Geological Survey in the 1950s is also a notable event. This resulted in an enormous increase in personnel and the predominance of technical over scientific staff. Fortunately, this situation lasted only for a few years.

After 1990, important changes took place. Some geologists left for the universities, some for the ministries. Four researchers from the Survey became cabinet members: One of them even became vice premier of the Government of the Czech Republic, another two became Ministers of the Environment and the last was appointed Minister of Defence. Four of the Survey geologists joined the diplomatic service and two of them were appointed Czech ambassadors, one in Morocco and one in Chile. About fifteen geologists abandoned geology completely for the market economy and three founded private geological consulting companies.

In 2001, the legal form of the Geofond CR changed to the state-funded body, with the Ministry of the Environment as its founder. Since 1 April 2002, its designation changed to 'Czech Geological Survey – Geofond'. Eventually, the organization was abolished by the Ministry of the Environment as of

31 December 2011 and its activities, offices, and employees have become a part of the Czech Geological Survey since 1 January 2012.

## The headquarters of the Geological Survey and its other branches

In 2003, the headquarters of the Geological Survey was relocated to the Klar Palace in the Malá Strana quarter of Prague. Most of the scientific and administrative staff with the library, archives and the publishing department is now based there. The laboratories, with the departments of mineral resources and environment geochemistry, are located in the southwestern suburbs of Prague at Barrandov. The Brno Branch is situated in the very centre of the city of Brno. There is also a small Survey office in the town of Jeseník in Northern Moravia.

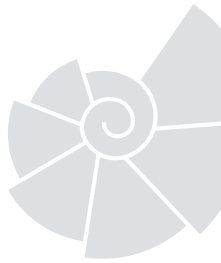
Since 2012, the Geofond office at Kostelní street, Prague 7, has become a part of the CGS. It includes a geological reports archive, a study room, a room for scanning and specialized offices for data processing. The mining history department, including collection of the archive mining maps and specialized library is located in a historical building in the centre of Kutná Hora. Another buildings of the CGS are used as archives of material documentation (i.e. borehole cores, samples, written documentation) and they are situated in Lužná u Rakovníka, Kamenná near Příbram, Stratov, and Kovanice near Nymburk. Finally, the geological documentation of gold deposits is stored at the Regional Museum in Jílové u Prahy.







# Geological (SPV) and thematic maps



*Geological maps provide comprehensive information on the geological structure of the Czech Republic. They are used for environmental protection, geohazard assessment, mineral deposit exploration and for land use planning.*



**David Buriánek**

Project leader for geological mapping of the Czech Republic 1:25,000

## Geological mapping

The construction of geological maps has been one of the main tasks of the Czech Geological Survey since its foundation. This activity is not limited to the territory of the Czech Republic but takes place in foreign countries as well, mainly in the form of foreign development cooperation projects (Nicaragua, Salvador, Costa Rica, Mongolia, Ethiopia) in recent decades. During the last century, the Czech Geological Survey participated in the construction of a number of geological and derived maps. Maps at a scale of 1:200,000 were

completed in the early 1960s. As the world's first geological survey, the CGS also completed an edition of 1:50,000 geological maps for the entire territory of the Czech Republic. These maps were gradually published in 1985–1998. Current research of the Czech Geological Survey focuses on mapping at a scale of 1:25,000. This extensive work began already in 1970 and still continues intermittently. A total of 217 map sheets have been processed since 1975. Mapping at a scale of 1:25,000 is an important part of the Czech Geological Survey's research programme. Map sheets

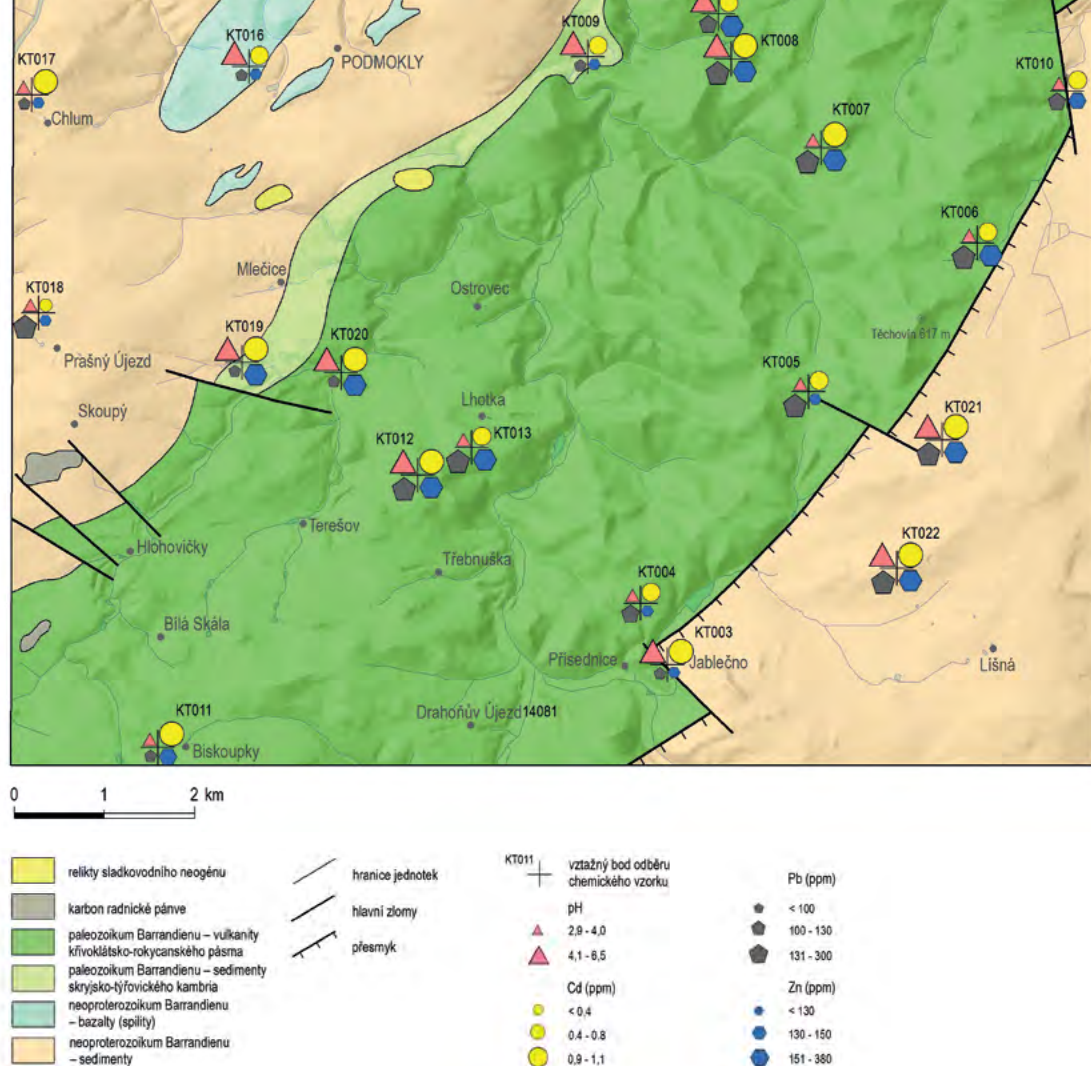
« Rock outcrops of Bíteš orthogneisses on Michovec ridge.  
Photo by P. Gürtlerová.







» Schematic map showing the concentrations of selected elements in soils on the Podmokly (12-323) map sheet.



and explanatory notes to these sheets are compiled on the basis of a unified geological legend, which makes it easy to build on adjacent geological maps. Since 2003, the completed geological maps have been gradually made available to the public on the geological map server [www.geology.cz](http://www.geology.cz).

### Geological maps at 1:25,000 scale

The geological mapping project at a scale of 1:25,000 includes the creation of geological maps with a graphic legend, supplemented by graphic information outside the map frame. The geological map are usually supplemented by thematic maps such as maps of mineral deposits and environmental geofactors. Bedrock maps, tectonic maps and others were compiled for certain areas.

The explanatory notes to these maps contain information on the character and quality of the rock environment. They provide readers with detailed

information regarding geochemistry, geophysics, hydrogeology, engineering geology, structural geology, economic geology, pedology and environmental geology.

All field and laboratory data obtained, including information on thin sections and chemical analyses, are stored in a central geological database. The database of geological documentation points currently contains 104,787 records. In addition to this basic database, which contains data on locations, relationship between lithological members, lithology, palaeontology and tectonic measurements, there are also specialized databases such as a database of hydrogeological field documentation. All of the data and information mentioned are used in the national Geological Information System (GeoS), which includes map and data layers (for instance, geological maps and maps of mineral resources), geological sites, geochemical analyses, environmental impacts and

conflicts of interest maps, and explanatory notes. The findings serve as an important source of information for the needs of state and local authorities. They are mainly used in land use planning, expert assessments, regional research, and also provide invaluable source of information for the general public.

At present, the Regional Geological Mapping project at 1:25,000 scale includes 24 map sheets in various stages of completion. The work is being carried out in the following seven areas: the Železné hory National Geopark, the Novohradské hory Mts, the Bohemian Forest Area, the Bohemian Paradise, Central Moravia, the former Brdy military district and the Moravian Karst Protected Landscape Area. A geological map, derived maps and explanatory notes were completed this year for the Lipník nad Bečvou map sheet as part of the project "Regional Geological Mapping of the Czech Republic at 1:25,000 Scale". In addition, the geological maps of Lenora, Žďárská Hora and Vltavice were transferred to the archive. A 1:15,000 scale thematic geological map of Jablonec nad Nisou and its surroundings was completed as well. The geological maps of Unhošť and Podmokly were prepared for publication.

### **Contribution to territorial development and to the ecosystem**

Maps of environmental geofactors are an integral part of the newly completed set of geological maps at 1:25,000 scale. The mentioned maps and accompanying chapter containing explanatory notes summarize data gathered during field surveys as well as the results from laboratory analyses of soil, rocks and water. They provide state authorities and the professional community with information on groundwater management zones, on the extent of slope instabilities, soil types and mineral resources. In addition to inorganic pollutants, polycyclic aromatic hydrocarbons, polychlorinated biphenyls and organochlorinated pesticides are being monitored in



➤ *Documentation of a metamorphic rock outcrop near the state castle Velhartice. Photo by D. Buriánek.*

the soils near large conurbations as well. The data are used to define hazardous areas in terms of potential contamination of the rock environment or conflicts of interest. Areas deserving protection with regard to geology or landscape ecosystems are being identified as well. Geological mapping at 1:25,000 scale is one of the main sources of information for the safeguarding and inventory of important geological sites.

### **Follow-up research**

Geological mapping represents a source of new information used in expert publications. During 2018, the results of a study of the palaeoenvironment of the formation of Cenozoic sediments in the vicinity of Brno were published, and the origin of stromatolitic structures of Neoproterozoic silicites (cherts) was interpreted. The geochemical differentiation of the Vydra and Prášíly pluton was interpreted based on the areal distribution of radioactivity. A mineralogical study of chromium rich spinels from the Upper Carboniferous Balinka conglomerates of the southern part of the Boskovice Graben was conducted.







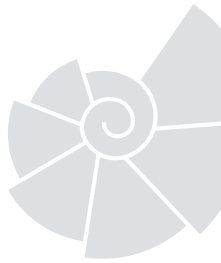
100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Regional geological research (SPV)



*Geological mapping and geoscientific research in the Czech Republic and throughout the world are interconnected with research on the structure and evolution of the Earth's crust. A number of internationally significant research and applied outputs were achieved in 2018.*



**Jaroslava Pertoldová**  
Head of the Department of Regional  
Geology of Crystalline Complexes



**Tomáš Hroch**  
Head of the Department of Regional  
Geology of Sedimentary Formations

Progress was made in correlating the palaeomagnetic evolution of the entire European Variscan Belt with the regional tectonic record, as well as the movement of large megablocks of Laurasia and Gondwana. The metamorphic and geochronological evolution of the eclogites of the Mariánské Lázně Complex was also studied. Mechanisms of melt and its deformation at high pressures through porous rocks were studied in the Saxothuringian area, including exhumation mechanisms of high-pressure rocks in a subduction channel. A study was conducted on the formation

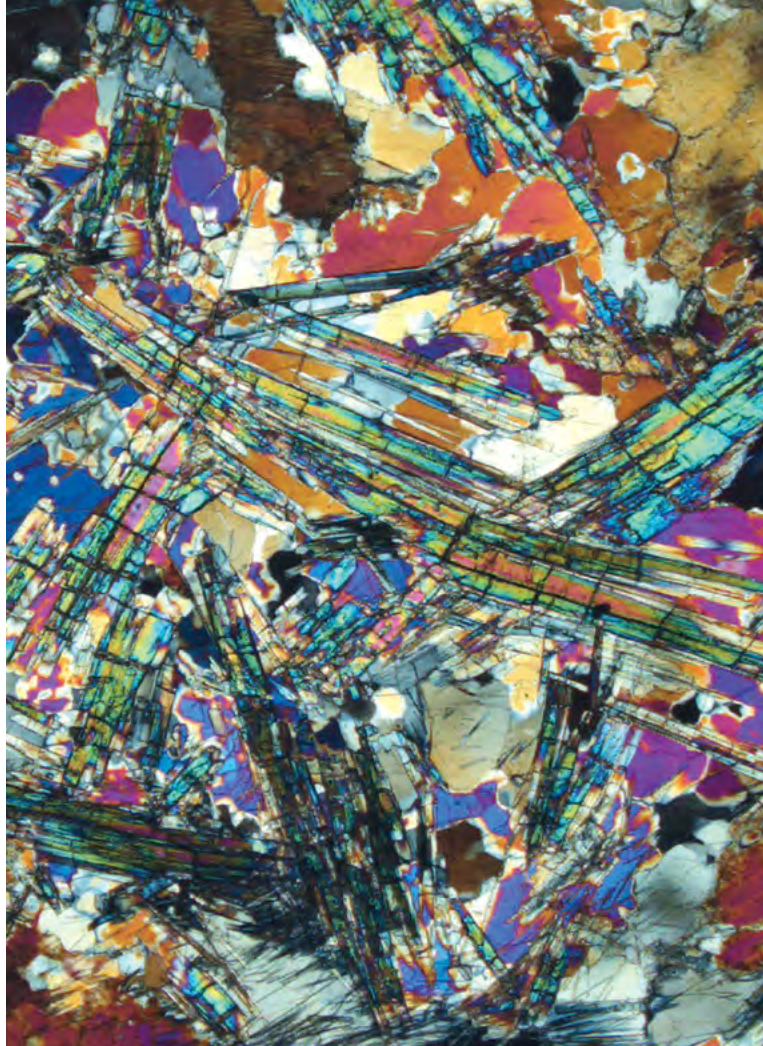
mechanisms of high-pressure melts and their transfer through the crust during continental subduction and collision in the Silezicum and Moldanubicum. An EXPRO grant was awarded for a prestigious project of excellent research that focuses on the growth of continents during the supercontinent cycle. A lithosphere study for the purpose of radioactive waste disposal included a preliminary evaluation of nine sites with regard to long-term safety. All relevant information was summarized and evaluated in nine separate reports. The resulting assessment

« Cut bank of the Hron River in southwestern Slovakia, up to 1 km of exposed loess and fossil soils from the end of the Last Glacial.

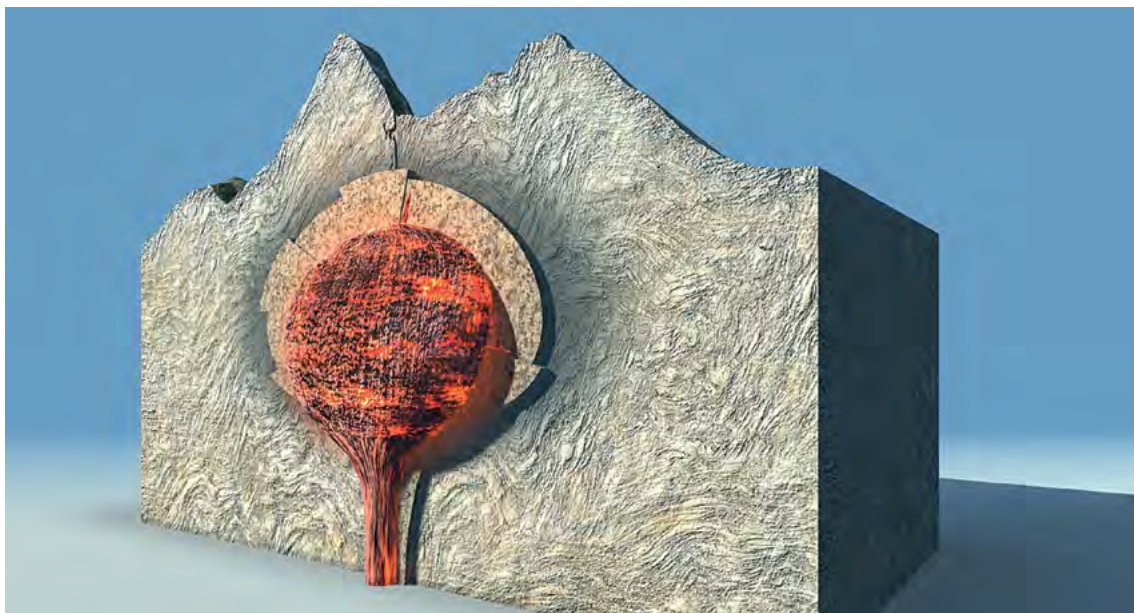




and recommendations are given in the final report "Evaluation of site suitability for a deep repository for SNF and RAW with regard to long-term safety". The project "Evaluation of geological and other information in the southern part of the Třebíč Pluton for the location of a potential deep repository for RAW" was successfully completed. The project "Deep Horizons of the Rožná Mine" involves the acquisition of spatial geologic data and their evaluation. Experiments are being carried out at the Bukov Underground Research Facility in order to verify the behavior of groundwater-saturated bentonite sealing layers including their interaction with cement materials and under increased thermal load. The final report "3D Structural Geological Models" summarizes the findings known thus far from nine sites selected for a planned deep repository. Regional and detailed 3D structural geologic models and DFN models were constructed with the aim of creating the most mathematically accurate models of brittle rock mass failure. Subsequently, homogeneous



⚡ Photomicrograph of dumortierite from the Vysoká locality near Kutná Hora. Photo by R. Nahodilová.



⚡ Excerpt from an animation for the general public showing the mutual relationship of the Liberec and Tanvald granites of the Krkonoše-Jizera pluton.



rock blocks were recommended at the planned depth of the anticipated repository for RAW roughly 500 m below the surface. In 2018, geological, hydrogeological and gamma-spectrometric mapping of geophysical profiles at nine sites was conducted during the project "Geological interpretation of geophysical field data for updating 3D structural-geological models of potential DGR sites". A website and tools of a more general nature were developed simultaneously.

As far as exogenous geology is concerned, work focused on defining and specifying the geometry, architecture and evolution of individual basins, including palaeontological content and associated tectonic and volcanic activity. New data from the Turonian–Coniacian boundary enabled multi-proxy correlation between the Bohemian Cretaceous Basin (BCB) and a potential stratotype locality in Germany and North America, which contributed to the understanding of the global carbon cycle and sea level changes in the Upper Cretaceous greenhouse climate. Another key interval around the Cenomanian–Turonian boundary was evaluated biostratigraphically and compared with profiles in England and the Midwestern United States. A study of glauconitic and phosphatic sediments in the Cenomanian and Turonian helped clarify the biogeochemical processes associated with periods of condensed sedimentation in the BCB. Strontium isotopes were newly applied to the study of Cretaceous sequences. Research focusing on the arsenic concentration in a basal Cretaceous aquifer was of social benefit. A palaeontological and biostratigraphic study of the Jurassic and Cretaceous was also conducted in the Western Carpathians and Northern Limestone Alps, and a unique collection of macrofossils and micropalaeontological specimens from the James Ross Basin (Antarctic Peninsula), discovered during the CGS expeditions in 2008–2013, was processed as well.

Quaternary research focused on the palaeopedology of the Late Glacial or on the reconstruction of



⚡ *Clast-supported volcanic cinders show the preserved surface layers of the Chmelník cinder cone near Děčín.*

periglacial processes. A new detailed map of the distribution of loess and associated sediments in Central Europe and the Pannonian Plain was compiled. A significant event was the discovery of a maar of Pleistocene age at the western edge of the Cheb Basin. This volcanic structure is filled with up to 80 m of lacustrine sediments, which could be used for a detailed study of the Quaternary palaeoenvironment. Research on volcanic systems continued to focus on the ascent and emplacement of magma near the surface, possibly directly in the environment of a pyroclastic cone, and also on geochemically diverse small cones. The hydrogeologically significant Altenberg-Teplice Caldera was studied from a geophysical and physical-volcanological perspective. Lithosphere research also involved the development of appropriate practices for popularizing Earth science, for regional cooperation, and for providing expert support to regional museums and geoparks.







100 YEARS

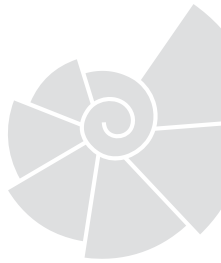


CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Research on biodiversity and global changes in the past

(SPV)



*The study of global changes in the geological past and of the evolution of life focuses mainly on global events (bioevents), which have significantly affected the development of the entire biodiversity of the marine or terrestrial ecosystem.*

*With the aid of palaeontological, sedimentological and geochemical methods, the CGS research team analyzes changes in selected abiotic characteristics of the palaeoenvironment (such as changes in seawater temperature or carbon cycle in the marine ecosystem) and parameters characterizing the palaeodiversity evolution in periods prior to, during and after global crises.*

*The analysis of palaeodiversity evolution, therefore, involves time-consuming taxonomic, palaeoecological and paleobiogeographic research.*

**Jiří Frýda**

Coordinator for research into global changes

---

« Jack Hills Gorge (Queensland, Australia) exposes one of the most complete records of positive isotope carbon anomaly in the Silurian. This Ludfordian anomaly represents the greatest perturbation of the global carbon cycle in the entire Phanerozoic. Photo by J. Frýda.





The results of the team's research were published in the form of articles in scientific journals with impact factors and in peer-reviewed professional periodicals, and presented in the form of lectures and posters at international conferences. In 2018, the team published or submitted 22 articles in scientific journals with impact factors.

A team studying the marine Palaeozoic provides full editing and technical support for the international journal *Bulletin of Geosciences*, which has an impact factor. In 2018, the journal included 26 scientific papers comprising approximately 500 pages (*Bulletin of Geosciences*, Volume 93, 2018), 80% of whose authors were foreign scientists. The impact factor ranks this periodical among the world's most prominent palaeontology journals.

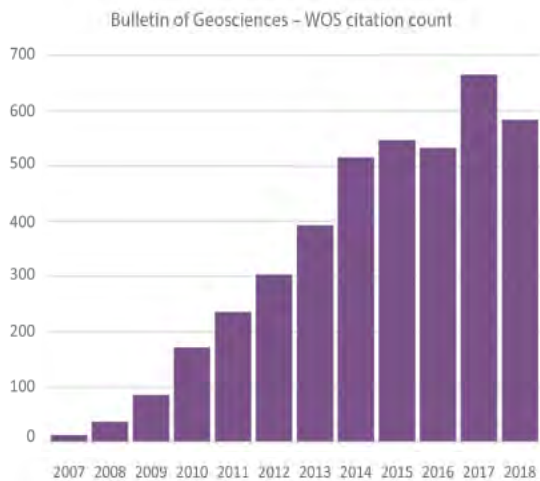


➤ *Silurian stromatoporoid biostromes on the island of Gotland. Photo by J. Frýda.*



➤ *Silurian (Wenlock) limestone on the island of Gotland, recording the extinction event known as the Ireviken Event. Photo by J. Frýda.*





➤ Citation histogram of the *Bulletin of Geosciences* according to Web of Sciences.

The members of the “Global Changes” team present their results at global and international conferences. They also act as “instructors” for postgraduate students at Charles University and at the Czech University of Life Sciences in Prague, where they serve as guarantors of several fields and often give lectures to master’s and postdoctoral students (“Evolution of Global Ecosystems”, “Geochemistry”, “Palaeoecology” and partly “Zoology”).



➤ A–D. Samples of fossiliferous (A, C, D – Gotland Silurian) and modern (B – Lady Elliot Island, Great Barrier Reef) limestones. Photo by J. Fryda.





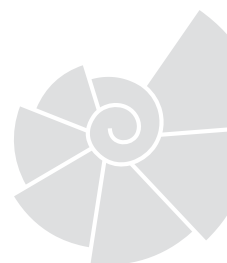
100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Mineral resources



*Mineral resources have been one of the main areas of work since the establishment of the state geological survey. Research that serves to secure the Czech Republic's raw material resources, coupled with the necessary technical work, has provided vast new knowledge, which is used in the exploitation of mineral resources and also to define the country's geological structure.*



**Petr Rambousek**

Head of the Department of Mineral Resources Research and Policy

## 100 years of mineral deposit investigation

The investigation of mineral resources significantly reflects the economic and political development of the Czech Republic. Initially, in the pre-war period, the geological survey met the needs of individual mining administration offices in order to identify aggregate resources for transport infrastructure construction. This resulted in a systematic inventory of quarries and their output, which was published since 1936 in the edition *Soupis lomů ČSR* ("List of Quarries of the

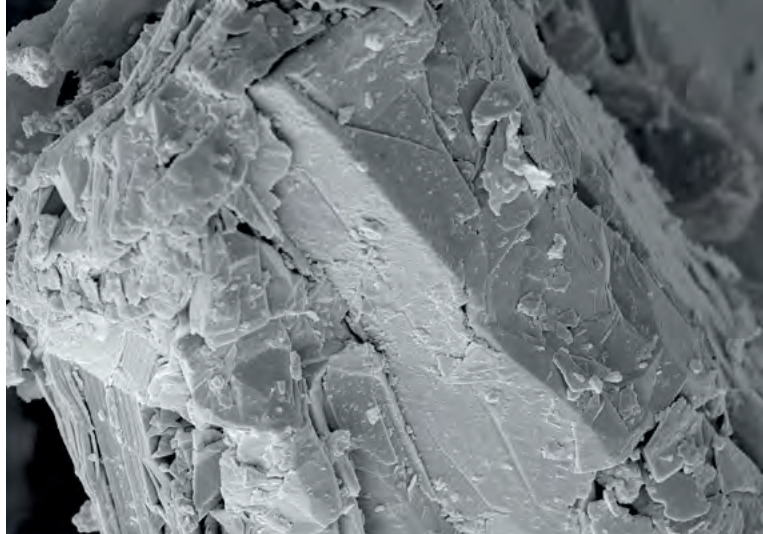
Czechoslovak Republic") for 25 years. An increased need for raw materials in the wartime period in 1941 led to the establishment of the first minerals department, which was handed over to specialists in regional branches after the war. In 1958, some of the mineral experts and specialized laboratories were tasked with the technological study of mineral raw materials in the newly established Institute of Mineral Raw Materials. The need for systemized and unified minerals research led to the establishment of an

« Žumberk quarry in the Železné hory Mts. Photo by P. Rambousek 2018.





⤴ Dispersed uranium mineralization associated with carbonatized, chloritized and haematitized rocks of the graphite zone. Rožná deposit, 21<sup>st</sup> level. Photo by B. Kříbek.



SEM HV: 15.0 kV WD: 14.91 mm MIRA3 TESCAN  
View field: 52.5 µm Det: SE 10 µm  
SEM MAG: 10.5 kx Czech Geological Survey

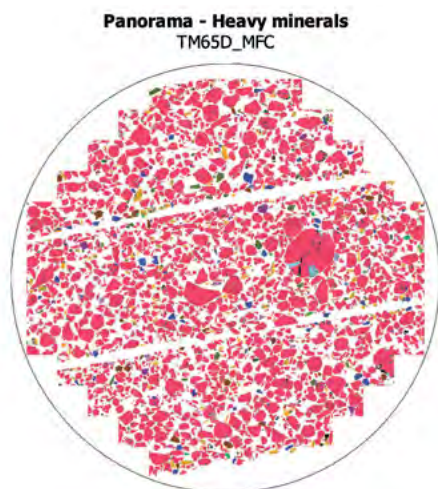
⤴ Graphite flakes intergrown with feldspar prior to disintegration. Photo by M. Pour.

independent mineral research department in 1964, which continues to operate today having undergone various organizational changes. During intensive periods of research, up to 80 specialists, supported by a technical staff and laboratories, were involved in post-war minerals research involving coal, crude oil, natural gas, iron ore, non-ferrous metals, and industrial and construction minerals. Currently, 13 experts and one technician perform the tasks mentioned below.

### Critical raw materials study

As in past years, a consortium led by TU-VŠB Ostrava (Technical University of Ostrava) continued to work on the research project "Competence Centre for Effective and Ecological Mining of Mineral Resources" (CEEMIR,

<http://www.hgf.vsb.cz/ceemir/cs/>), funded by the Technology Agency of the Czech Republic. The work of the CGS concentrated on initiating a synthesis of previous research. A study of the basic minerogenesis of graphite in the Český Krumlov varied group continued, and another phase of an innovative study into the processing of graphite raw materials was successfully completed with an application for a patent. Attention was also paid to a mineralogical study of waste products from kaolin washing, specifically the study of Rb and Li content in micas. Research involving a mineralogical-geochemical subtheme was completed in cooperation with Geomin, Ltd, which included an automated mineralogical analysis of heavy minerals during prospecting, indicating sources of critical



Heavy minerals									
Cassiterite	Wolframite	Gahnite	Fe_oxides	Ilmenite	Leucoxen				
Rutile	Goethite	Monazite	Apatite	Garnet	Zircon				
Al <sub>2</sub> SiO <sub>5</sub>	Tourmaline	Pyroxene	Amphibole	Biotite	Chlorite				
Pyrrhotite	Muscovite	Quartz	Albite	Plagioclase	Kaolinite				
Orthoclase	[Undclassified]	Holes							
Mosaic			Heavy minerals			TIMA TESCAN			
View field: 32.0 mm			Date(m/d/y): 03/28/18			10 mm			
TM65D_MFC			Liberation analysis #1			mass			

⤵ Automated classification of a heavy mineral sample (Tescan laboratory in Brno, 2018).



raw materials. Sample preparation techniques and automated processing parameters were refined using a microprobe. Additionally, a set of 60 heavy mineral samples tested on a modelled area in the southern part of the Slavkovský les Mts revealed newly discovered anomalies with increased concentrations of W, Nb, Sn-W ( $\pm$  Nb-Ta), REE, U, Th, Cs, Ga, Hf and an extensive Cu and Zn anomaly. Work commenced in cooperation with GET, Ltd, on the subtheme “Determination of general limit indicators for the exploitation of deposits and sources of critical minerals in the Czech Republic”. The results of this research phase were presented to the professional community at the IMA 2018 conference in Melbourne, Australia, and at the autumn meeting of the Mining Association in Seč.

The aim of the newly defined project “Acquisition of strategic raw material deposits”, based on Czech Government Resolution No. 713/2017, is to implement the objectives of the Czech Republic in the economic use of selected strategic raw materials within its territory, to implement the design phase of strategic mineral resource acquisition with state intervention (including tailing ponds and dumps), and to analyze the importance of superstrategic/critical raw materials of the EU listed in the Czech Republic’s minerals balance (including dumps and tailing ponds) for the Czech economy. In 2018, research was carried out at deposits and resources of fluorite, barite and lithium, and the possibilities of obtaining accompanying elements of lithium minerals were evaluated experimentally.

This year, economic geologists verified the possible continuation of deposit structures in the anticipated location of a spent nuclear fuel repository and monitored concentrations of accompanying elements (Ta, Nb, REE, Sc) in uranium ores as part of the project “Obtaining data from the deep horizons of the Rožná Mine”, which deals among other things with the revalidation of the mineral potential and with the construction of a conceptual 3D deposit model.

## Environmental impact of raw materials mining and dressing

In 2018, the impact of contamination from burned-out and unburned coal on surface water and stream sediments was investigated in the Czech Republic in connection with a completed Czech Science Foundation project. The weathering of a partially burned-out heap of the former Novátor coal and uranium mine (Brzkov near Trutnov) revealed that discharged water contained high concentrations of sulphate (up to 400 mg/L), U (up to 585  $\mu$ g/L), Se (up to 50  $\mu$ g/L) and Mo (up to 28  $\mu$ g/L). However, uranium concentrations and potentially hazardous elements decreased rapidly downstream due to dilution of the effluent with the inflow of uncontaminated water and due to their sorption by the organic matter of stream sediments. But even at a great distance from the heap (3 km), the U concentration still remains higher than in the surrounding, uncontaminated streams. The investigation revealed the important role that stream sediments rich in organic matter play in rapidly reducing the amount of toxic metals in contaminated streams. The results were published in a periodical with an impact factor. In accordance with Decree No. 52/1997 of the Czech Mining Office, the Ministry of the Environment tasked the department’s employees with the long-term monitoring of the safeguarding measures and environmental impacts of old and abandoned exploratory mine workings. They inspected 1,078 sites in 2018.



⚠ Inspected abandoned exploration adit – the Pauli adit near Nové Město pod Smrkem in the Jizerské hory Mts. Photo by T. Peterková.



### Mining heritage research – enhancing information on the mining history in the Czech Republic

A final international conference in Dippoldiswalde and the publication of anthologies completed the “ArchaeoMontan” project ([www.archaeomontan.eu](http://www.archaeomontan.eu)), a Czech-Saxon archaeological, mining-heritage and geological investigation of medieval mining in the Krušné hory Mts. Archaeologists, historians, surveyors, geologists and informaticians have worked on both sides of the border to document and interpret traces of medieval mining in the Krušné hory Mts since autumn 2015. The project followed up on the investigation results of the preceding “ArchaeoMontan 2012–2015” project of Ziel 3.

The internal research project “Description and Evaluation of Mining Objects” included a preliminary proposal for describing and evaluating mining monuments, and additional work continues to compare the parameters of mining-heritage objects in historical mining districts. The professional community was familiarized with terminological issues at a mining seminar at the National Technical Museum in December 2018.

### Production of mineral resources maps

Economic geologists are involved in regional mineral deposit exploration and in the compilation of mineral deposit maps and of relevant chapters in explanatory notes as part of the internal project “Regional Geological Mapping of the Czech Republic at 1:25,000 Scale”. This year, six maps were completed in four survey areas.

### International cooperation and foreign projects

The geological surveys participating in EuroGeoSurveys GeoERA ([www.geoera.eu](http://www.geoera.eu)) launched a joint three-year project in Brussels in July 2018 with the commencement of the sub-projects “Mintell4EU” (updating the EU Minerals Yearbook and the EU Minerals Inventory) and “FORAM” (resources of the



⚡ Excursion of the Mineral Resources Expert Group (MREG) of EGS at a disposal site of waste from the chemical treatment of bauxite (red mud) on the banks of the Danube River north of the city of Tata, Hungary. Photo by P. Rambousek.

so-called critical battery raw materials and raw materials from critical countries). The CGS was engaged in an initial output that compiled a European map of battery mineral resources.

In 2018, another phase of the Czech Science Foundation project “Mining and processing of Cu, Pb, Zn and Co ores in Sub-Saharan Africa – a natural geochemical laboratory for pollutant behavior study” (in cooperation with the Faculty of Science at Charles University Prague) focused on studying the isotope composition of non-sulphide zinc ores at the Skorpion deposit in Namibia. The results showed that the isotope composition of Pb, Cu and Zn can be used to define the extent of soil contamination caused by mining.

In 2018, the international Czech-Saxon EU project “ResiBil” reached additional milestones with the completion of a joint Czech-Saxon geological map and of a correlated stratigraphic scheme. A set of geophysical measurements was carried out at five selected sites along the Lužice Fault, and two cored boreholes were drilled to a depth of 101 m near Dolní Podluží and to a depth of 220 m near Jiřetín pod Jedlovou. Ore samples from surface sampling were examined for potential impacts on groundwater chemistry in aquifers. Joint field excursions and work meetings took place on both sides of the border. The department’s experts represented the CGS in expert groups on raw materials, energy minerals and geochemistry in the EuroGeoSurveys consortium, worked on the preparation of joint projects, and



participated in consultations on modifications of pan-European legislative standards. The staff was also engaged in a number of projects in the H2020 programme, including “MinLand” (safeguarding and use of mineral resources in relation to land use planning), “InterRIM” (training of mineral resources experts in Latin America), and “PanAfGeo” (a comprehensive training programme for experts from African countries).

### **Tasks of the state geological survey regarding raw materials policy**

The “Report on the Review of the Current Status of Protected Deposit Areas Safeguarding Lignite Deposits in the Ústí nad Labem Region” was prepared for the Ministry of the Environment as stipulated by Government Resolution No. 536/2017. The report on the inspection conducted in the protected deposit areas also focused on classifying deposits with residual and previously mined lignite reserves with regard to their removal from inventories according to valid legislation of the Czech Republic. This resulted in defining residual and previously mined lignite reserves, which occur outside the existing mining lease and which can realistically be recommended for removal from inventories, and in other recommendations for individual deposits under consideration.

The Inventory of Natural Construction Aggregate Quarries in the Czech Republic was updated for the needs of the Road and Motorway Directorate of the Czech Republic and of the professional community, which resulted in the selection of 168 mining operations and in a description of their geological, technological quality and capacity characteristics (<http://www.pjpk.cz/kamenivo-a-vyrobnny-kameniva>). Regional and mineral resource specialists assessed significant mining and exploration plans, such as the sand and gravel quarry near Uherský Ostroh, the resumption of mining at the Luhov-Brniště-Tlustec deposit, the assessment of a preliminary mining lease

approval for the Cínovec IV deposit, the assessment of the proposed mining lease at Bakov nad Jizerou with regard to the regional raw material policy of the Central Bohemian Region, a justification of the future use of the Žerotín-Liboš sand and gravel deposit in relation to the land use concepts of the Olomouc Region, and they provided expertise on the proposed kaolin extraction in the Skytaly mining lease area at the Skytaly-Vrbička deposit in the Ústí nad Labem Region. The specialists also evaluated a number of land use plans of municipalities and the updates of land use development principles of the regions in the Czech Republic.

### **State raw materials policy and communication with the professional community**

CGS experts were engaged in commenting the update of the Raw Materials Policy of the Czech Republic in accordance with Government Resolution No. 713/2017. In addition, they also commented on documents related to lithium extraction and on government materials regarding the acquisition of critical raw material resources. The results of projects and expert discussions concerning the strategies were presented at domestic conferences, such as the Mining Association meeting, and at regional offices and universities.



« HAN-JIN  
D&B drilling  
rig used for  
drilling cored  
boreholes  
during  
the “ResiBil”  
project.  
Photo by  
Š. Mrázová.





100 YEARS

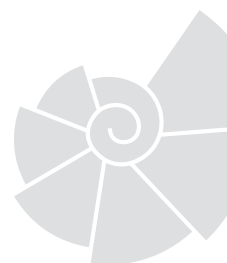


CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Groundwater research and evaluation

(SPV)



*Hydrogeological research in 2018 focused on publishing the results of the projects "Review of Groundwater Resources" and "Innovation of Farming Production Systems in the Environment of Quaternary Sediments". In the field of groundwater protection, CGS experts focused on obtaining data that will allow them to evaluate the impact of coal mining at the Turów mine on ground and surface water in the Hrádek nad Nisou and Frýdlant areas.*

*The applied part of the hydrogeological investigation focused on the problems of hazardous waste disposal in the rock environment and on geothermal energy use. A project evaluating the status of water resources in the eastern part of the Czech-Saxon border area was conducted through international cooperation. A hydrogeological investigation and mapping that was completed in Ethiopia identified phenomena threatening agricultural production in evaluated areas.*



**Lenka Rukavičková**  
Coordinator for research in hydrogeology

« Intensive seeps of carbon dioxide in the floodplain of the Plesná stream near Milhostov. Photo by L. Rukavičková.





» Downloading data from a monitoring well of the "Review of Groundwater Resources" project. A Fiedler H40 datalogger is installed in the well recording the water level and water temperature at one-hour intervals. The water level is measured using a handheld water level meter while the automatically measured data is downloaded. Photo by I. Kůrková.



### Groundwater assessment of selected hydrogeological structures

The outputs from the completed "Review of Groundwater Resources" project continued to be prepared for publication. The accompanying documents and final reports for all of the 58 hydrogeological zones selected and evaluated during the project were reviewed and made available to the public on-line. An interactive map of the zones and outputs are available at: <http://www.geology.cz/extranet/vav/prirodni-zdroje/podzemni-vody/rebilance>. As a follow-up to the project results, a study of karst conduits and groundwater flow commenced in the western part of the Bohemian Cretaceous Basin. The preliminary results were presented at a professional conference and prepared for publication. The wells drilled for hydrogeological purposes during the "Review of Groundwater Resources" continue to be monitored, and they expand the national monitoring network of the Czech Hydrometeorological Institute. The greater extent of information on the movement of groundwater levels will aid in documenting the current recharge dynamics of natural groundwater resources and the manifestations of global climate change over time. The groundwater levels in many of the wells monitored in 2018 showed a downward trend.

### Study of the vulnerability and protection of groundwater resources

As part of the "Turów – Phase II" project, financed by the Ministry of the Environment of the Czech

Republic from the State Environmental Fund of the Czech Republic, CGS specialists focused on studying the hydrogeological and hydrochemical conditions of glaciofluvial and Tertiary sediments in the border region of the Zittau Basin and Frýdlant Salient.

The study also includes an investigation into the effects of coal mining on the Polish side of the border and the manifestations of climate change (including the current drought) on hydrogeological conditions, specifically on the natural groundwater resources in the study area.

The results of the project "Innovation of farming production systems in the environment of Quaternary sediments, their evaluation and application in water source protection zones" were processed and evaluated. The project results were published in the *Hydrogeology Journal* (Bruthans *et al.* 2018) and presented at expert seminars. The article provides a detailed description of factors affecting the nitrate concentrations in the collector wells near Káraný.

### Applied hydrogeology

In 2018, a number of projects related to radioactive waste disposal in a deep repository continued.

Experimental hydrogeological research was conducted, for example, at the Bukov Underground Research Facility in the Rožná mine, in the Bedřichov water supply tunnel, and in the Josef Underground Laboratory near Mokrsko. Here, the natural variability in the chemical composition and flow of groundwater is being studied. The study is focused on changes



in groundwater in the surroundings of experiments, which simulate temperature conditions and isolation barriers in the repository.

Hydrogeologists collaborated at nine selected sites in the Bohemian Massif in order to interpret the results of geophysical measurements on profiles and examined the function of newly indicated faults and geological boundaries with regard to groundwater flow.

The purpose of the research projects is to select a suitable site for the location of a deep radioactive waste repository and to obtain hydrogeological data for a safety analysis of the repository and for mathematical models.

Three projects are currently designed to study the use of geothermal energy. CGS specialists are evaluating the environmental impact of geothermal energy use and studying the influence of groundwater flow on thermal heat extraction procedures.

### International cooperation

Four hydrogeological maps at a scale of 1:50,000 were compiled during the project "Study of natural hazards harmful to agricultural production in selected areas of SNNPR". The project results serve as a basis for constructing potable water sources and for irrigation and water management interventions, which will help protect areas from the effects of water erosion and aid in securing sufficient water for agricultural production. Work also continued on the ResiBil project –

"The balance of water resources in the eastern part of the Czech-Saxon border area and assessment of their sustainable use". In 2018, the researchers of the CGS and LfULG (Saxon State Office for the Environment, Agriculture and Geology) compiled a final joint Czech-Saxon geological map at 1:100,000 scale and a 3D geologic model for the Děčínský Sněžník pilot site, which are an important basis for a 3D hydrogeological model of pilot areas.



➤ Contraction cracking of soil caused by a prolonged drought in 2018. Interesting features are the raindrop imprints creating tiny circular depressions in the soil. Photo by J. Holeček.



➤ Measurement of the floodplain altitude of the Jizera River near Sojovice in the vicinity of the Káraný waterworks using a Topcon GRS-1 GPS with an accuracy of  $\pm 5$  cm. From time to time, these areas of the floodplain are flooded in the spring. Photo by I. Kůrková.



100 YEARS

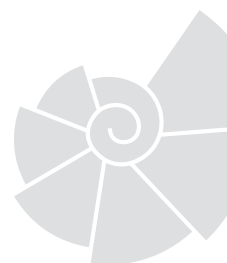


CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Geoenergy research

(SPV)



*The principal focus of geoenergy research is based on the National Priorities of Oriented Research, Experimental Development and Innovations and on areas of the European Strategic Energy Technology Plan, especially those parts that relate to the geological environment. In 2018, research focused mainly on geothermal energy and geological storage of CO<sub>2</sub>; however, the use of subsurface voids created by mining was also addressed. Work continued on several multi-annual principal projects, including some newly commenced activities. Research was carried out in close cooperation with other research organizations in the Czech Republic as well as with foreign partners, and also with private companies and state administration authorities.*



**Vít Hladík**  
Research coordinator – geoenergy

## Geothermal energy

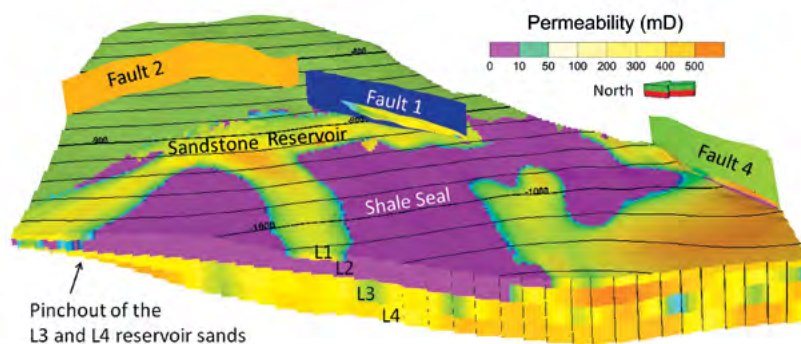
In 2018, work continued on the international GeoPlasma-CE project (Interreg CENTRAL EUROPE), addressing the use and promotion of shallow geothermal energy, the mapping of the geothermal

potential and conflicts of interest in pilot areas in Central Europe. The project reached its final phase; field research was completed and efforts focus on finalizing planned outputs. The project's final phase in 2019 will be devoted to publishing results, raising public awareness

« Geothermal well, "hot dry rock" installation near the village of Rittershoffen in France.



» 3D model of the Láb sands (Middle Badenian of the Vienna Basin) in the area of the planned LBr-1 carbon dioxide storage site with permeability distribution in the partial reservoir horizons. Prepared by M. Pereszlényi and J. Franců.



and disseminating acquired knowledge. As part of the project, the CGS organized two thematic workshops focused on the preparation of a unified geological-geothermal map of the Broumov/Wałbrzych cross-border area and on a method for evaluating thermal response tests in geothermal wells. The new three-year international project MUSE (Managing Urban Shallow Geothermal Energy), co-funded by Horizon 2020 (GeoERA – Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe) was launched in the middle of the year. The project involves 16 partners from European geological surveys including the CGS; it aims to manage conflicts arising from the use of shallow geothermal energy in densely populated areas. The project's pilot area in the Czech Republic is Prague. The national projects RINGEN and RINGEN+ (OP VVV, Ministry of Education, Youth and Sports) dealt with deep geothermal energy, including the first phase of field work, geochemical laboratory experiments focused on water-rock interaction, and corrosive

experiments. A proposal was also prepared involving a follow-up project for the Technology Agency of the Czech Republic (TACR) – Theta Programme, whose purpose is to drill a new deep geothermal well in Litoměřice and to design an experimental geothermal rock heat exchanger.

The inhouse CGS project “3D geothermal and hydrogeological model of the foredeep and slopes of the Bohemian Massif in the southeastern part of Moravia” was concluded. In addition to the actual model, a methodology was developed to determine the temperature-energy potential of the selected area, the so-called Pavlov Block on the border of the Czech Republic and Austria. The results will also be used in the new European project HotLime (Horizon 2020 – GeoERA), which was launched in mid-2018. HotLime focuses on studying deep geothermal sources in carbonate rocks.

### Geological storage of carbon dioxide

In 2018, as part of the European project ENOS (Horizon 2020 programme), work continued at the LBr-1 research site, which is being investigated as a potential pilot storage site for carbon dioxide. The research focused mainly on the risk of CO<sub>2</sub> leakage from the storage reservoir along old wells or faults and on evaluating the possibility of enhancing recovery of residual oil through CO<sub>2</sub> injection. The ENOS project unites 30 European research institutions; the CGS is a member of the steering committee and responsible for the work package on international cooperation and on the development of CO<sub>2</sub> storage pilot and demonstration projects in Europe.



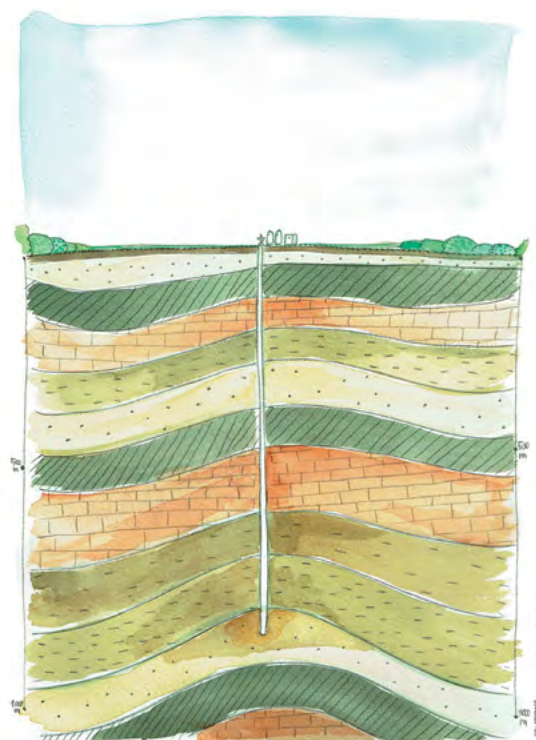
» The geothermal research centre in Litoměřice, built as part of the RINGEN+ project. Photo by J. Holeček.





➤ An artist's rendition of surface equipment of a CO<sub>2</sub> geological storage site from the project brochure "ENOS: Participating in CO<sub>2</sub> Geological Storage Research". Illustration by Giuditta Gaudioso.

The LBr-1 site also is also associated with the inhouse CGS project "Carbon dioxide and methane in soil gas as an indicator of gas migration from hydrocarbon fields and inadequately plugged wells", which focused on evaluating the effects of the rock environment and atmospheric agents on the escape of the above-mentioned gases into the atmosphere. The study is of crucial importance for the atmogeochemical monitoring of CO<sub>2</sub> storage sites. The work methodology developed and verified in the above-mentioned project was used in full extent in performing the tasks of the state geological survey, specifically in the project "Measurement of methane at the site of the abandoned Žu-108 production well" commissioned by the Department of Geology of the Ministry of the Environment. The project results include a model of the spatial distribution of the



➤ Vertical cross-section of a CO<sub>2</sub> geological storage site. Illustration from the project brochure "ENOS: Participating in CO<sub>2</sub> Geological Storage Research". Illustration by Giuditta Gaudioso.

concentration of methane and accompanying gases in soil air in a grid of 40 measurement points, methane flow rates at monthly intervals, and an analysis of the dependence of measured parameters on climatic conditions.

### Use of subsurface voids created by mining

A new project "Controlled and assisted microbial methanogenesis in situ" (2018–2022) funded by the TACR commenced in 2018. It is a collaborative effort of the CGS, EPS Biotechnology and Tomáš Baťa University in Zlín. The objective is to monitor the occurrence of microbial activity in closing coal mines and to devise a method for exploiting renewable energy sources from the rock environment. The project combines gas and coal geochemistry methods with microbiological technologies, including analyses of DNA genomes.





100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Geosphere-biosphere-atmosphere interaction (SPV)

*Environmental geochemistry research is increasingly becoming a part of complex interdisciplinary studies. Our team is currently working with experts from twenty domestic and foreign institutions. In addition to biogeochemistry and ecology, joint projects involve other science disciplines such as microbiology, plant physiology, pedology, hydrology, atmospheric chemistry, structural and economic geology, toxicology and applied mathematics. Changes in biogeochemical cycles, which determine the quality of surface water, groundwater and soil, the health status of forests, or the degree of wetland vulnerability due to climate change are studied with the aid of long-term monitoring of elemental fluxes, mass balance calculations in small catchments, laboratory and field experiments, and isotope methods.*



**Martin Novák**

Head of the Department of Environmental Geochemistry and Biogeochemistry

## Small forested catchments and study sites

The study of biogeochemical cycles of the landscape relies on monitoring the mass balance of elements. We were among the first in the world to begin such monitoring already at the beginning of the 1970s.

The aim was to clarify the processes of eutrophication and acidification in forested and field catchments and areas. The findings were published at that time in a main article in the prestigious journal *Nature*. Since then, the monitoring was expanded to study 14 small

« Studied peat bog. Photo by E. Přečová



» The small  
forested catchment  
Lysina –measuring weir.  
Photo by P. Krám.



catchments. In addition to the actual monitoring, this network of catchments, referred to as GEOMON, also involves the study of biogeochemical processes, which either negatively affect ecosystems or, conversely, stabilize them.

Our data from the monitored forest ecosystems are unique in that they show the long-term trends in the mass balance of biologically important as well as toxic elements. These findings were included in publications that evaluate environmental changes in pan-European networks of small river catchments. In 2018 alone, the results of this research were published in 18 articles in international journals. Over the course of the research, more than 350 articles have been published, including chapters in monographs dealing with this topic.

### Monitoring of aquatic and terrestrial ecosystems

In 2018, we studied the reduction of acidification and, at the same time, the spread of damage caused by bark beetles in the forested catchment of Plešné Lake in the Šumava National Park. We found that the increased amount of mineralized basic cations from



» Sampling of the Soumar spring  
in the Jizerské hory Mts. Photo by T. Pačes.

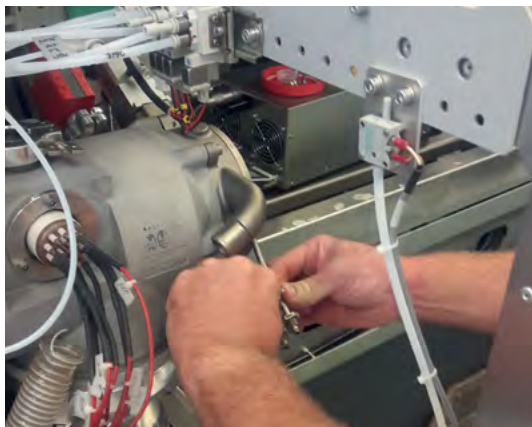
decomposing biomass had a positive effect on the cation exchange capacity in soil and that the saturation of the sorption complex of soils increased. The soil nutrient supply has improved in this catchment during the period following the bark beetle outbreak. Long-term changes in atmospheric deposition and surface runoff of sulphate and inorganic nitrogen were studied in relation to a decrease in anthropogenic air pollution and in relation to climate change.

### Biogeochemical processes in the landscape

An experiment was conducted in the Krušné hory Mts to quantify the effect of increased nitrogen deposition on the size of the carbon reservoir in soil during the period that followed several decades of high atmospheric sulphur deposit. The study observed the effects on the concentration of dissolved organic carbon in soil, on soil respiration, microbial communities and enzyme activity. The study concluded that the increase in the carbon reservoir in soil, previously attributed solely to increased nitrogen deposition, is influenced by concurrent acidification. Historical changes in pollution in the ore district of the Krušné hory Mts were studied in the Kovářská Bog. A peat profile dated with  $^{14}\text{C}$  served as a record of environmental changes caused by mining, metallurgy and other human activities.

Nitrous oxide ( $\text{N}_2\text{O}$ ) is one of the greenhouse gases whose atmospheric concentration has risen in the last century. In the peat bog of the Krušné hory Mts, we therefore compared the gradients in the isotopic composition of nitrates in pore water ( $\text{NO}_3^-$ ) and of nitrous oxide ( $\text{N}_2\text{O}$ ) in the vertical profiles of the waterlogged bog. The results show that  $\text{N}_2\text{O}$  emissions





⚙️ *Work with a Neptune mass spectrometer.*  
Photo by O. Šebek.



⚙️ *Discharge from the Pozdátky landfill.*  
Photo by T. Pačes.

in Czech peat bogs are low due to continued reduction to molecular nitrogen ( $N_2$ ), a gas that, unlike  $N_2O$ , does not contribute to atmospheric warming. Most of the peat bogs derived from peat moss currently help cool the Earth's climate.

### Use of isotopes in geochemistry and environmental research

A time series of the ratio of zinc isotopes in atmospheric precipitation and surface runoff was measured in the Orlické hory Mts. Isotope ratios of zinc were measured in soil profiles. Samples of Polish and North Bohemian coal, Silesian ore from museums and metallurgical plants, and fly ash from power plants and incinerators were collected. These samples and their isotopic composition of zinc will help determine the sources of this element and, analogically, also of other heavy metals in the forest ecosystem of the Orlické hory Mts.

Cosmogenic and geogenic isotopes of beryllium were used to quantify the rate of weathering, erosion and denudation in three small forested catchments in West Bohemia, each with geologically diverse parent rocks. The denudation rate hovered around 140 mm per thousand years. The results of the study are important for estimating changes in the alkalinity of global ocean

water, a quantity that regulates the amount of  $CO_2$  in the atmosphere.

A study was published on the ratio of chromium isotopes in two industrially contaminated sites in the USA. It was determined that dissolved organic carbon acted as the main reducing agent in an aquifer contaminated with chromium. Our isotope data showed the risk of re-dissolution of precipitated trivalent chromium and its oxidation to toxic hexavalent chromium.

### Contamination by organic pollutants and heavy metals, including their transport, capture and degradation in landscape units

We identified substances produced from the pyrolysis of dust particles in the air and in the wash load of rivers and water reservoirs. We measured the concentrations of polychlorinated hydrocarbons and organic chlorinated pesticides in samples from the Moravian Karst in relation to the environmentally oriented project "Risk assessment of pond sediments in submerged areas of the Moravian Karst". The organic pollutants mentioned and their degradation products were identified.





100 YEARS

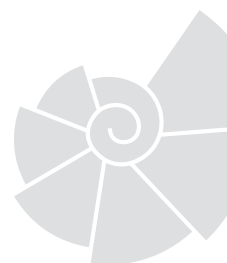


CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Geohazard research

(SPV)



*The Czech Geological Survey is engaged mainly in the following areas of research:*

- *Documenting and investigating geohazards including their categorization on a regional and local scale, dealing with negative anthropogenic impacts on the quality of environmental components (impacts of mining, contamination of the rock environment and potential health risks).*
- *Development of a geological survey portal and online access to geohazard data for professionals and the general public.*
- *Engineering geological mapping and radon risk from the bedrock.*

*Research results are used by cities, municipalities and the State Environmental Fund of the Czech Republic to evaluate grant applications in accordance with valid programmes. To meet these research goals, geohazard research focuses on the following priority topics.*

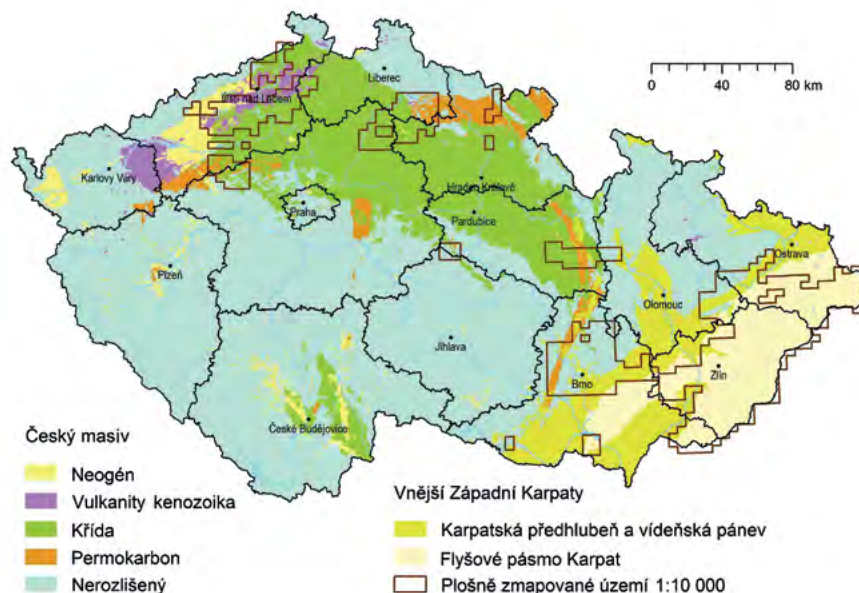


Oldřich Krejčí  
Geohazard research coordinator

« Exposed part of a rock wall after a gabion wall collapse along road I/62 near Hrabyně. Photo by O. Krejčí.



» Extent of areas mapped in detail at 1:10,000 scale in the Ground Instabilities Inventory as of 31 December 2018.



## Slope instability

Landslide data, recorded thus far in the geodatabase Ground Instabilities Inventory (RSN), have been continuously acquired and updated since 1961. The CGS is developing a detailed RSN with an accuracy of 1:10,000 for the current dataset. As of 1 January 2019, this continuously updated database covered 17% of the Czech Republic's territory. At the end of 2018, a total of 19,242 sites were recorded in the RSN, of which 5,220 were point data and 14,022 spatial data. In 2018, 1,618 objects were added to or updated in the RSN. Slope instabilities have been thoroughly documented since July 1997, when extreme rainfall triggered hundreds of landslides causing considerable material damage. A shortening of intervals between individual flood events with occurring landslides has been observed since 1997; landslide calamities were documented in 2002, 2006, 2009, 2010, 2013 and 2014. Geohazard research relies on historical chronicles, on findings from archaeological sites and on modern dating. Methods that are used include DMR 5G (LiDAR), unmanned aerial photography, and geophysical methods are also being developed. There is a growing demand for information on landslides that threaten specific structures or building complexes. It is therefore necessary to create thematic catalogues of slope deformations, that determine the most endangered localities or sections of constructed transport routes.

Engineering geological research is one of the principal fields because it investigates and deals with the interaction of the rock environment, geohazards and structures. Engineering geology zones are determined based on similarity or homogeneity of properties that are significant for engineering geology and geotechnics. Specialized slope susceptibility maps continued to be developed for selected urban agglomerations (Liberec, Brno) and important transport routes. Continuous inventory of existing and new slope instabilities should be ensured within five years on a uniform level throughout the Czech Republic, which will aid in the construction of an interactive slope susceptibility map.

The most important examples of practical applications of engineering geology research included a study and assessment of the slope instability risk along planned major transport corridors (Technology Agency of the Czech Republic), geological supervision of the remediation and monitoring of a landslide at Dobkovičky (D8), an assessment of slope movements on the northeastern slope of the Pavlovské vrchy Hills, and a proposal of effective measures to eliminate a serious hazard in the vicinity of Dolní Věstonice. Exposed areas in temporary excavations and trenches continued to be documented and evaluated, and hazardous areas were determined along major class I roads and motorways. In addition to the Road and Motorway Directorate of the Czech Republic, the main



recipients of engineering geological information in recent years included regional road administrations, the Railway Infrastructure Administration, Czech Transmission System Operator, the Radioactive Waste Repository Authority, and the National Heritage Institute. Geohazard research abroad focused on the Dusheti region in Georgia, on selected localities and educational activities in Ethiopia, and on the area of the Somoto geopark in Nicaragua. Cross-border cooperation continued for the development of high speed railway transport Saxony – Czech Republic. The CGS organized the 10<sup>th</sup> conference “Slope Deformations and Pseudokarst” held in Mikulov on 10–12 April. The conference was attended by 62 participants and included 23 lectures, five excursions, and the publication of an excursion guide and a collection of abstracts.

### Radon risk in the geological bedrock

The radon risk from the geological bedrock is one of the most serious geohazards that directly influences the radiation exposure of the population.

The importance of dealing with the problem of radon occurrence in the geological bedrock is, among other things, related to the monitoring of radon concentrations in potable water and building materials. The radon programme is coordinated by the State Office for Nuclear Safety. The legislative basis of the research complies with Czech Government Resolution No. 594/2009 and with its item II “Radon Programme of the Czech Republic for 2010–2019 – Scientific and Technical Support for Implementing Tasks of Item 4E ‘Development of Geophysical Methods for Radon Risk Assessment’”. In cooperation with Radon, v. o. s., the CGS organized the 14<sup>th</sup> International Workshop on the Geological Aspects of Radon Risk Mapping held on 17–21 September 2018 at the Masaryk Dormitory. The workshop was attended by 90 radon experts predominantly from EU countries and included 51 lectures and the publication of an anthology.



Participants of the “Slope Deformations and Pseudokarst” conference at the Znojmo dam, endangered by rock falls. Photo by O. Krejčí.



Construction of a tunnel (excavated from the surface) along road I/58 Příbor–Skočnice near Prchalov. Photo by O. Krejčí.



Removal of the Řečice landslide, threatening the Šance reservoir on the Ostravice River. Photo by O. Krejčí.







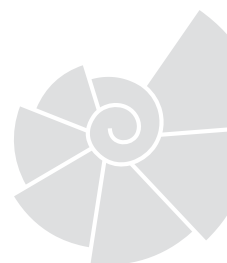
100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Regional Geological Administration



*Since 1998, the Regional Geological Administration has methodically been performing and organizing the tasks of the state geological survey on a daily basis within the Czech Geological Survey (CGS) according to the requirements of section 17 of Act No. 62/1988 Coll., on geological work, as amended.*



**Jan Čurda**  
Head of the Regional Geological Administration

According to the requirements of the above-mentioned act, the activities of regional geologists and specialists for economic geology and hydrogeology, linked with consultancy report preparation, cover the entire territory of the Czech Republic and are therefore based on a regional principle. This implies a subdivision of the country's territory into variously defined regions for which a relevant regional geologist or specialist bears responsibility. Their activities are governed by existing internal methodological guidelines that define the operational reach and responsibilities of regional

geologists and specialists (basic research, practical and organizational activities, documentation, consulting reports, etc.). The most frequently performed tasks of regional geologists and specialists involve assessments, which primarily involve hazardous geofactors, conflicts of interest, land-use planning, environmental impacts of structures and technology, zoning and construction management, elimination of old ecological burdens, mining-related problems and nature conservation planning, and which are based on written requests by public authorities.

« Biskoupky serpentine steppe. Photo by K. Motýčková.





» View of an unstable rock slope in Ostrava-Koblov, consisting of greywacke-sandstone of the Ostrava Formation.

The white dashed line divides the slope into two parts; on the left, toppling and sliding occurs along

a predetermined fracture surface and subsequent transport of sliding rocks along a talus cone slope. The accumulation from this movement is highlighted by the red-coloured polygon. The large red ellipse highlights the main scarp.

The smallest red ellipse highlights the main scarp zone of a rock block fall that separated from the edge of the slope, which was triggered by the movement of a dump truck. The red ellipse on the left indicates the approximate original location of a toppled block, which hit a farm building. Falling and toppling of rock fragments, including mass movement by free-fall, occur on the slope section to the right of the white dashed line. The red dashed polygon highlights a rock pillar that separated along a fracture surface with an identical direction and dip as in the case of the "slip surface" of a 2015 rockfall. The inner red polygon, pointed out by the dashed arrow, highlights a rocky object in dynamic equilibrium, whose base is expected to fail leading to a fall, as indicated by the dotted yellow polygon.

The solid red arrows on the left and pointing right indicate two rock formations that are disintegrating due to wind-dispersed trees. The solid red arrows on the right and pointing left indicate areas from which individual rock fragments and boulders amounting to cubic decimetres in size have fallen.



This systematic acquisition, collection, conservation and, in particular, expert processing and ensuing provision of data on the geologic setting of the national territory, on the protection and use of natural resources and groundwater, and on geohazards, subsequently serve as a basis for political, economic, judicial and ecological decision-making, for instance, in land-use planning, environmental protection, remediation of old ecological burdens and slope instabilities, landscape and natural resource protection, or for principles securing the ecological stability of areas, etc.

In 2018, both the external and internal filing agenda of the Regional Geological Administration was run completely on-line via the Regional Geological Administration's agenda application on the CGS internet portal. The agenda management system continues to be fine-tuned and upgraded so that it continues to accommodate the requests made to the Regional Geological Administration, which seeks to manage the ever-increasing demand for high-quality consulting activities.

In 2018, an application was developed allowing for easy regional geological integration of relevant

cadastral districts. In addition to using the Regional Geological Administration's agenda application to communicate with relevant regional geologists or specialists, maximum effort was made to introduce the possibility of adding written documents in the application in order to be subsequently digitally signed and expedited via the CGS document management system.

As part of the project "Access to outputs involving the expert activities of regional CGS geologists, regional CGS specialists for economic geology, regional CGS specialists for hydrogeology, and CGS specialists for engineering geology", funded in the past by increased contributions from the founding institution, the Regional Geological Administration prepared all backfiles of its agenda for on-line access, dating back to 2003, via an interactive chart regarding consulting reports, which provides interested parties with an overview of all activities administered on a regional level for any relevant cadastral area by the Regional Geological Administration in 2018 and also an overview of nearly 9,000 outputs stored in the database.



## Brief history of assessment and consulting activities

From a historical perspective, the Regional Geological Administration has existed for two decades. For 21 years of its operation, it has handled a total of 10,500 traditional outputs and roughly 750 specific assessments of old ecological burdens, which represents only a small fraction of the 100-year history of the CGS, or its legal predecessors. However, this does not mean that today's CGS did not perform assessment activities prior to 1998, when the existing organizational structure of the state geological survey was established. The opposite holds true and it should be borne in mind that it was the State Geological Survey of the Republic of Czechoslovakia, which in the first years of its existence after 1919 provided mainly expert assessments and consultation on practical geological problems accompanying the formation of the then Czechoslovak state and subsequently expanded its expert activity. It is no coincidence that the survey was under the Ministry of Public Works, when its main activity, despite its small staff, was to conduct geological surveys in the state territory that focused on practical aspects involving mineral production and structural engineering, and to safeguard potable water sources and mineral waters. Despite this fact, the results of the practical activities under the first director, Prof. Cyril Purkyně, led to the publication of many geological maps, explanatory notes and other works, to the establishment of a library and laboratory, and to the initial development of many specialized geological disciplines. However, it was after the tenure of the geological survey's second and third directors, Dr. Josef Woldřich (1934–1937) and mainly Dr. Vojtěch Smetana (1937–1943), that the CGS archive contained many assessment reports, whose complexity and professional approach may serve as prime examples for performing current tasks of the state geological survey. During the difficult years of World War II and under the leadership of Dr. Alois

Matějka (1943–1945), the focus shifted to pedological mapping and to documenting quarries and boreholes, and to the inventory of mineral resources, which were crucial for the war economy.

During the post-war reconstruction of the Czechoslovak state, the geological survey led by Ing. Dr. Ladislav Čepěk performed many practical tasks, primarily concerning water-related structures.

However, the transfer of applied geology projects to departmental exploration organizations led to a significant reduction in assessment and service activities of the then Central Geological Institute, which in compliance with the state's political doctrine focused on mineral resources and technical geology as well as on geological mapping of the entire state territory at various scales.

Not until after 1989 did the then Czech Geological Institute resume one of the basic ideas of the founding fathers from 1919, which states that "the institute shall document and provide assessments on important technical and mining work projects". Assessment activities along the lines of other European geological surveys truly became one of the main areas of work as the Czech state was being established, when the new state and public administration realized that entrusting important decisions into the hands of the state geological survey had many indisputable advantages: the geological survey employed professionals who were familiar with relevant areas having conducted geological mapping projects or other systematic surveys; they were educated professionals with considerable theoretical and practical experience capable of responding flexibly to the often varying needs of the state; as a state institution, the geological survey was an objective organization unaffected by commercial interests.

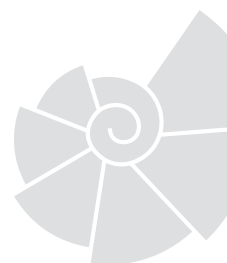








# State geological survey agendas of the Geofond Division



*The Geofond Division, which has been a part of the Czech Geological Survey since 2012, performs the tasks of the state geological survey set forth in current laws and the organization's foundation charter.*

*These include mainly the relevant provisions of the Geological Act, the Mining Act, the Mining Waste Act and the Building Code.*



**Zdeňka Petáková**  
Head of the Geological Exploration Department

## Inventory of geological projects

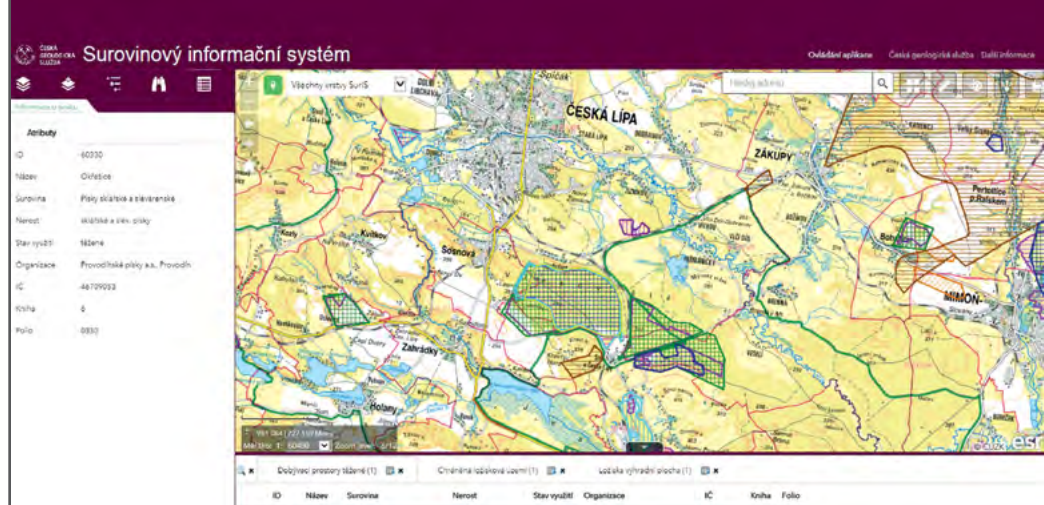
According to the Geological Act and related Decree, the CGS records all geological projects made within the territory of the Czech Republic by specialized

companies. The CGS provides this inventory as authorized by the Ministry of the Environment. In 2018, nearly 8 thousands of registration forms were filed. Their number as well as the number





» *Design of the SurlS  
map application.*



of registered organizations has been growing since 2010.

### Expert assessment of land use planning documents

As authorized by the Ministry of the Environment, the Geofond Division provides comprehensive assessments of land-use plans with regard to areas with specific geological structures in cases involving reserved mineral deposits (including relevant protected deposit areas), which are safeguarded and inventoried by the CGS, and in the case of undermined areas. In 2018, more than 1 thousand of requests for assessments of mineral deposits were handled as required by state administration authorities, organizations and other authorized entities. Concurrently, it was processed 104 assessments and studies of undermined areas. The activities were carried out in close cooperation with the CGS Regional Geological Administration and its assessment activities.

### Provision of territorial data for land-use analysis documents

The CGS provides territorial data for land-use analysis documents in accordance with the Building Act. A new version of a digital data delivery module based on java-script application was launched in 2018. This module allows users to download relevant territorial data free of charge. According to the Standards for Monitored Phenomena for land-use analysis documents, this involves protected mineral deposit areas, reserved mineral deposits, probable deposits of non-reserved minerals, undermined areas, mine working impacts, landslide areas

and other geohazard areas. In addition, data from all over the Czech Republic are provided free of charge to the Ministry of the Environment, the Ministry of Regional Development, Ministry of Industry and Trade.

### Borehole surveys and hydrogeological database

As part of its statutory obligations of collecting, storing, processing and providing geological documentation, the Czech Geological Survey also compiles and retains data in the geologically documented objects database, including hydrogeological and geophysical data. The database of geologically documented objects is used to obtain basic information on geological explorations conducted in the Czech Republic and provides a detailed view on its geological structure. It is the most comprehensive database of the Czech Geological Survey and has been managed and used for the longest time. In 1991–1993, the database was expanded with the information about hydrogeological data kept since 1966. Because many cases involved wells, springs and other sources of water rather than boreholes, the designation “borehole surveys” was replaced by “geologically documented objects”. The database currently retains information provided to users as individual outputs or via the Borehole Logs map application and via the Geologically Documented Objects web application. Borehole surveys include the following databases maintained by the CGS: the Geologically Documented Objects Dataset (GDO), the Borehole, Shaft and Well Record Dataset (GEO), the Hydrogeological Database (HYD), and the Drill Logging Dataset (KAR).





The **Geologically Documented Objects Dataset (GDO)** contains basic information on geological exploration work carried out in the Czech Republic. The dataset contains nearly 700,000 objects, mainly boreholes. The dataset includes data on more than 110,000 economic geology objects, more than 110,000 hydrogeological objects, more than 430,000 engineering geology objects, nearly 1,000 structural objects and more than 22,000 mapping-related objects. A database of borehole core material documentation is linked to the GDO. The **Borehole, Shaft and Well Record Dataset (GEO)**, whose development began in 1976, is the most extensive and longest-running database maintained by the Czech Geological Survey. It supplements the basic GDO data with more comprehensive evaluations – final reports, detailed object data, and geological descriptions of the rocks encountered at specific depths. The dataset includes more than 620,000 objects with geological profiles.

The borehole surveys also include a **Hydrogeological Database (HYD)**, which contains data on more than 100,000 objects. It was developed in 1991–1993 and converted to an automated system.

It contains the results of hydrogeological measurements – hydrodynamic tests, chemical analyses, groundwater regime monitoring, yield, temperature or free carbon dioxide content – taken at individual sites. The hydrogeological database also includes data on more than 1,000 objects with various geothermal impacts. In addition, the database includes data on anthropogenic impacts on groundwater. These are data from more than 24,000 monitoring and remediation wells and from objects of the CHMI national monitoring network. There are additional data on sources of curative and natural mineral water, large-scale water supply facilities, and on individual objects used as groundwater sources. The data from the hydrogeological database



➤ Entrance hall of the Czech Geological Survey office at Kostelní Street 26, Prague 7.



» *The mining history department  
of the Czech Geological Survey  
in Kutná Hora.*



are provided to the public through the Borehole Surveys map application and the Geologically Documented Objects application.

### Mineral resources

The Mineral Information System (SurlS) collects and provides all available data on the mineral potential of the Czech Republic in coherent form. It is based on a database of mineral resources of the Czech Republic, with which other sub-databases are linked: companies, mining leases, protected deposit areas, preliminary mining lease approvals, exploration areas, approval of reserves, and spatial features. A unique feature of SurlS are several smaller, independent and mainly economic databases. As of 31 December 2018, the Mineral Deposit Database of SurlS included 10,027 objects, of which 1,495 were registered reserved deposits, 758 registered non-reserved deposits, 821 unregistered resources, 256 approved prognostic resources, 1,047 other prognostic resources, 1,411 negative exploration results, non-prospective areas and mineral occurrences, 4,088 abandoned and exhausted deposits, and 24 geological structures serving as gas storage facilities or underground repositories. A total of 2,842 objects were updated and 24 new objects added in 2018.

According to § 8 of the Mining Act, the CGS is tasked with the safeguarding and inventory of 363 reserved deposits of ores, mineral fuels, industrial and construction minerals. A total of 364 protected deposit areas were established in order to safeguard 362 reserved deposits as of 31 December 2018. Based on the Mining Act, the Geofond Division is tasked with

the protection and inventory of reserved deposits as part of its agenda.

Based on the updated Mineral Information System (SurlS), the following monographs were compiled as required by the foundation charter, applicable laws and the founding institution:

- *“Review of Reserved Mineral Deposit Reserves of the Czech Republic as of 1 January 2018”* based on the departmental statistical report Geo (MoE) V 3-01: Part I: Ores, Trace Elements, Part II: Mineral Fuels, Part III: Reserved Deposits of Industrial Minerals;
- *“Inventory of Mineral Deposit Reserves of the Czech Republic as of 1 January 2018”*, containing deposits of non-reserved minerals (construction minerals) in printed and electronic form. The publication was distributed to 37 institutions of the Czech Republic’s state administration as authorized by the Department of Geology of the Ministry of the Environment.
- The yearbook *“Mineral Resources of the Czech Republic – Mineral Resources 2018 (Statistical Data 2017)”*, published in Czech and English versions, is the only currently publicly available publication on the Czech Republic’s mineral potential. It contains data on mineral resources from a global perspective, information on resources, reserves and domestic mineral production, and on mineral prices and foreign trade in the Czech Republic. The publication is available on the CGS website (<http://www.geology.cz/extranet-eng/publications/online/mineral-commodity-summaries>).
- *“Changes in Reserves of Reserved Mineral Deposits in 2008–2017”* is a nonpublic review prepared for state authorities, i.e. the Ministry of Industry and Trade,





➤ Czech and English cover sheets of the “Mineral Commodity Summaries of the Czech Republic”.

the Ministry of the Environment, and the State Mining Administration. It is also available on CD for authorized users. It is used by the CGS to prepare background materials for the state's raw materials policy.

- *Summary of Mineral Reserves in Mining Leases and Other Exploited Deposits of Non-Reserved Minerals as of 1 January 2018*, in accordance with § 29a of the Mining Act and MPO Decree No. 29/2017 Coll., on mining technology records, is a nonpublic review compiled with the data from forms that provide information for the Hor – MPO records on mining technology. The summary was provided to the Ministry of the Environment, the Ministry of Industry and Trade, the Czech Mining Office and to other authorized organizations according to a distribution list.

## Mining impacts

Information on activities associated with mine workings, undermined areas and mining waste sites is given in the chapter Mine workings and mining waste.

## Geological documentation

Information on the activities of the geological reports archive, map archive, archive services and on borehole core material documentation is provided in the chapter Geological documentation.

## Mining history department of the Czech Geological Survey in Kutná Hora

The building of the office in Kutná Hora was originally established in the beginning of 20<sup>th</sup> century as the office of the Mining Authority. Since 1953 it became part of the CGS. Historical mining maps, a specialized library, and part of geological documentation are deposited here. The abandoned mine lands database is processed here as well.

The Kutná Hora office holds 16,402 mining maps from various map collections. Since 1990, the information on these maps has been entered into a database, which is continuously updated. The specialized library, which contains more than 3,240 monographs and 228 periodicals, books, magazines and other written documents related to mining, geology and history, became a full-fledged part of the CGS specialized library during 2018. It also holds all the ID codes of the collection of resource reports. As of 31 December 2018, the abandoned mine lands database included 5,676 sites.







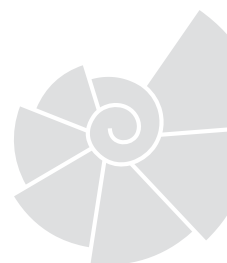
100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Mine workings and mining waste



*Under the authority of the Ministry of the Environment, the Czech Geological Survey maintains the Mine Working Impacts Inventory and the Inventory of Hazardous Waste Facilities. These activities are based on the Mining Act and the Mining Waste Management Act.*



**Vit Štrupl**  
Deputy Director and Head of the Geofond Division

## Mine Working Impacts Inventory

According to the Mining Act, old mine workings are defined as abandoned underground mines, whose original operator or legal successor does not exist or is unknown. Mine working impacts also include abandoned open pits used in the past to extraction of reserved minerals. On the surface, mine workings usually form areas of collapsed or subsided soil, or occur simply as open adits and shafts. If such mining impacts are detected, the Mining Act imposes obligations

on reporting, recording and dealing with these phenomena.

In 2017, the web application **Report a Mining Impact**, accessible through the CGS website, was launched online to report and record all newly detected cases of mine workings. CGS experts subsequently conduct initial on-site investigations in areas with occurring mining impacts and regular inspections of safeguarding measures taken at all mines, which are funded by the Ministry of the Environment. These locality assessments

« Old flooded shaft at the Michael vein, Potůčky, Karlovy Vary district.



## Mine workings and mining waste



» Section of the mining map RD507 (Fischer, 1773, CGS – Geofond, Kutná Hora). In the middle, mine workings near the church of St. Catherine, on the left, the buildings of today's village of Stříbrné Hory.



» Collapse of an old shaft at Stříbrné Hory, Havlíčkův Brod district. In the background, the mining church of St. Catherine, the thicket on the right is the former Boží pomoc mine.



» Entrance of the old Antonín adit near Potůčky, Karlovy Vary district.

employ a long-established method that focuses on locating and describing the detected sites, including up-to-date photo documentation. The data are added to the database and also provided to the Ministry of the Environment. In 2018, 1,982 mine working sites and their impacts were inspected and documented. These activities largely rely on information contained in unpublished reports stored in the CGS Geofond Archive, publications, map collections and in other databases of the CGS Information System. This mainly involves the abandoned mine lands database containing records on areas with deep underground mines (data on 5,676 sites as of 31 December 2018), the mine workings database representing a comprehensive inventory of underground mines (data on 28,330 sites and more than 25,000 digital attachments as of 31 December 2018), and the database of mining maps (data on nearly 16,402 maps and related scans as of 31 December 2018). The Mine Working Impacts Inventory contains all the relevant documents for each reported case. Data are stored in the mine working impacts database. As of 31 December 2018, the database contained 2,854 case reports on a total of 2,287 sites. Information on the status and location of reported mine working impacts is permanently accessible to the public through map applications on the CGS website.

### Inventory of Hazardous Waste Facilities

The environmental impacts of past mining are still visible in the landscape in the form of spoil heaps, tailing ponds, dumps and abandoned placers. In some cases, they have become significant land-forming features





⚡ Remediation work in 2018 at the Kuntery mine (Staročeská lode, 16<sup>th</sup> century) in Kaňk, Kutná Hora district: foil laying.



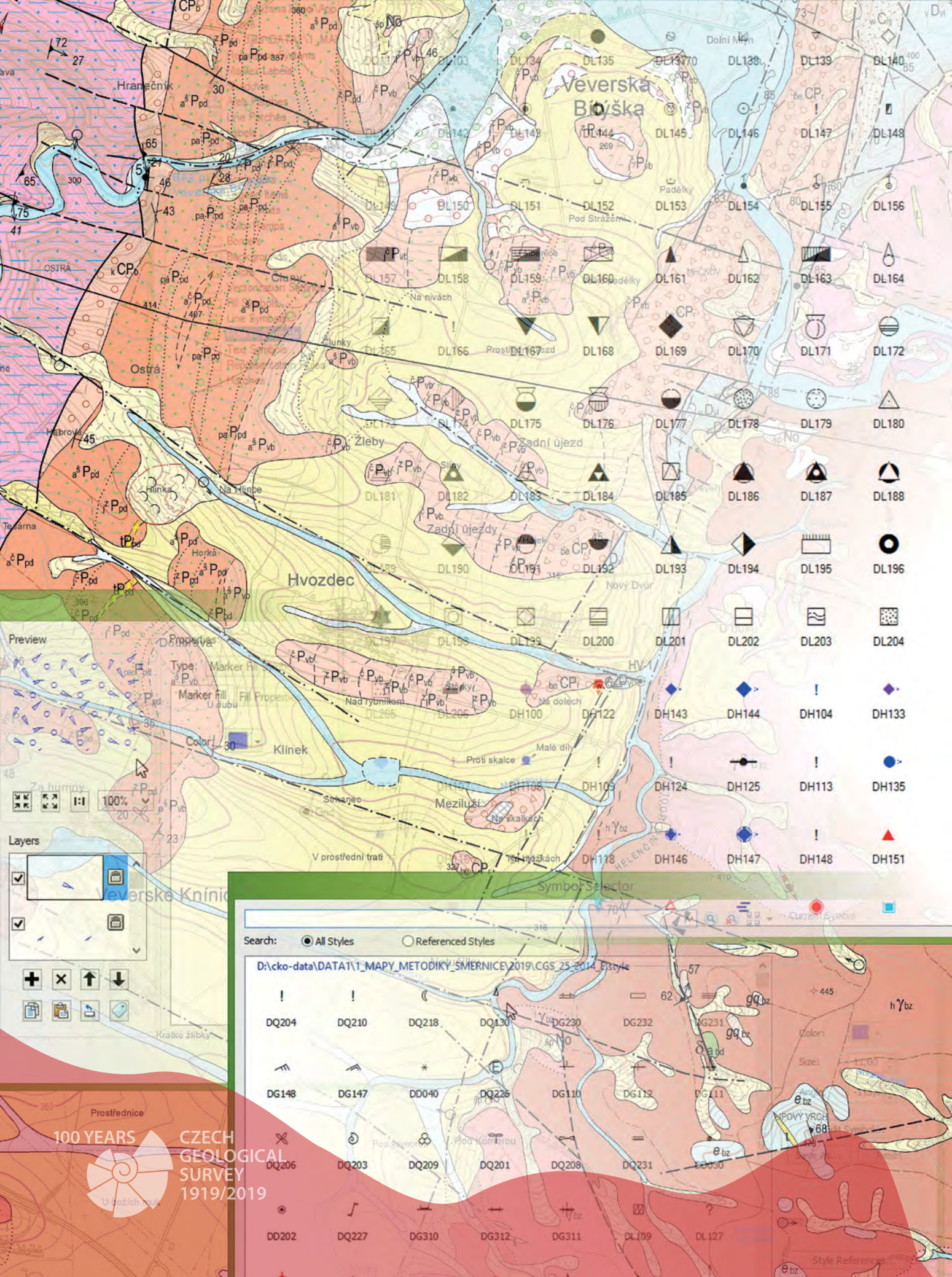
⚡ Mixing of mine and surface waters beneath adit No. 113 near Oloví, Sokolov district.

with unique flora and fauna, or they may represent secondary sources of minerals or even pose a serious threat to the environment and human health. In particular, tailings left over from mining and ore dressing contain a wide spectrum of toxic elements which, when released by weathering processes, contaminate the surrounding soil and groundwater as well as surface water. Some old mine working sites are also prone to the risk of landslides or subsidence. In 2001, the Czech Geological Survey established a database of dumps, which was gradually expanded to include new sites. The Mining Waste Management Act that came into force in 2009 included a comprehensive inventory of mining waste disposal sites in the Czech Republic. Within the framework of the Operational Programme Environment, the CGS developed the project "Identification of closed and abandoned mining waste disposal facilities posing serious environmental or health hazards", which was carried out in 2009–2012. This also resulted in the output of a new Inventory of Waste Facilities, which was included in the CGS Information System. As of 31 December 2018, it contained 7,112 sites and is

constantly updated. Detailed data, including locations, are publicly available through a map application on the CGS website. Upon evaluating the analyses of samples collected at 300 selected sites, 20 localities were included in the Inventory of Hazardous Waste Facilities. This inventory was launched on 1 May 2012 as an independent web application in Czech and English versions. In addition to precise locations, it also contains basic data on the type and degree of risk. Remediation of one abandoned hazardous waste facility occurred for the first time in 2018, specifically involving the spoil heap of the Kuntery mine at Kaňk near Kutná Hora, which was assessed as being dangerous due to extreme concentrations of arsenic (As). Another site is being prepared for remediation in 2019. This should gradually reduce the number of inventoried hazardous sites, which is also the objective of the entire mining waste agenda.







Věverská Bříška

Hvozdec

Klinek

Preview

Type: Marker Hill  
Marker fill: Fill Properties  
Color: 30

Layers

100%

20

Symbol Selector

Search: ☒ All Styles ☐ Referenced Styles

D:\ciko-data\DATA\1\_T\_MAPY\_METODIKY\_SMERNICE\2019\CGS\_25-2014\_Estyle

DQ204	DQ210	DQ218	DQ130	DG230	DG232	DG231	gq bz	445	h γ bz
DG148	DG147	DO040	DQ226	DG110	DG112	DG111	e bz	68	NP OVY VRCH
DQ206	DQ203	DQ209	DQ201	DQ208	DQ231				
DD202	DQ227	DG310	DG312	DG311	DL109	DL127			

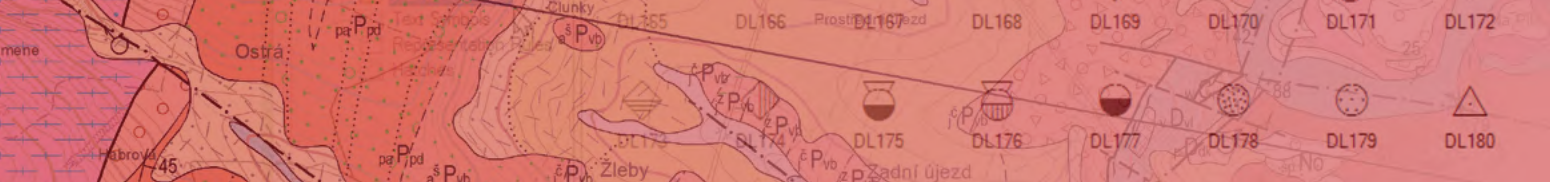
Style References

100 YEARS

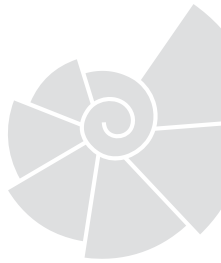


CZECH  
GEOLOGICAL  
SURVEY  
1919/2019





# Geological Information System



*The Czech Geological Survey gathers data on the geological setting of the state territory. The processing, management and distribution of the data are the chief prerequisites for performing the tasks of the state geological survey in the Czech Republic. The development of the geological information system is essential to providing information to state authorities and for the research and other professional activities of the Czech Geological Survey. The concept of the system is compatible with Czech and EU legislation governing access to information. The use of international standards safeguards the interoperability of data sources and their integration into the national and European spatial data infrastructure.*



**Zuzana Krejčí**  
Head of the Information Systems Department

## Geological Information System

The Geological Information System (GeolS) is designed by the CGS to be compatible with national and international standards. The core of the GeolS is

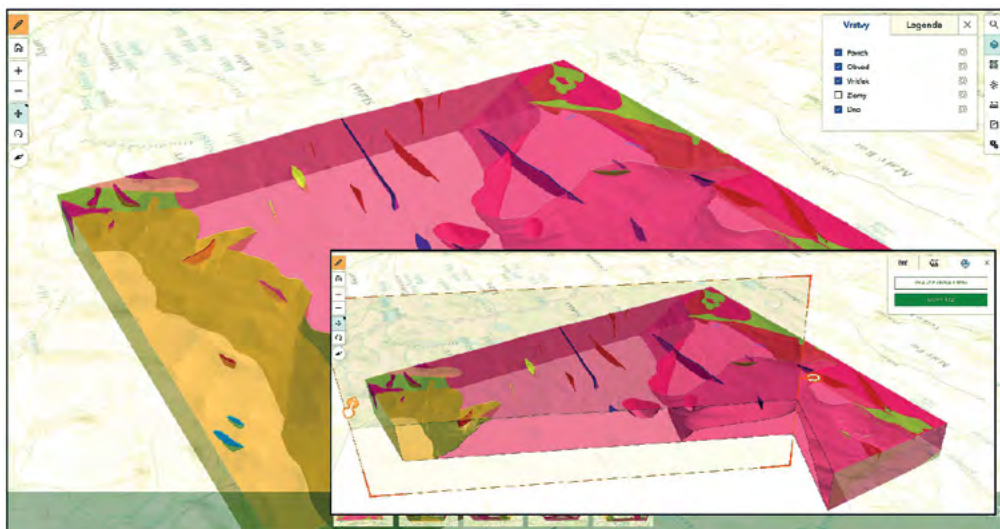
the Central Data Store (CDS), which contains 120 thematic databases ([www.geology.cz/geodata](http://www.geology.cz/geodata)). The CDS stores both graphical data (maps, geological cross sections, inventories of hazardous waste

« On printed maps and in applications, the data stored in the Central Data Store must use symbology that is easily understandable by users. The symbols are based on points, lines and polygons.





» 3D geologic model  
of the Březový stream locality  
in the ArcGIS Online environment.  
The viewer generates a dynamic  
slice of the model.



facilities, slope instabilities, etc.) as well as descriptive data (code lists, results of analyses, the digital Geofond archive, etc.). The GeolS contains a wide variety of thematic subsystems: geological maps – National Geological Map Database (NGMD); mineral resources – Mineral Information System (SurlS); mining waste – inventory of mining waste facilities; a subsystem for geologically documented objects (boreholes, test pits, etc.); geohazards (an inventory of slope instabilities and complex radon information). It also contains hydrogeological, geophysical, soil and other data. The consolidation of the GeolS and its harmonization continued in 2018.

The CGS Metadata Information System (MIS; micka.geology.cz) allows for management and orientation in the datasets, services and applications provided by the CGS. The MIS is fully compatible with the current national metadata profile as well as with the INSPIRE Implementing Rules and serves as a source of up-to-date information for the national (geoportal.gov.cz) and European INSPIRE geoportals (inspire-geoportal.ec.europa.eu) and EGDI (europe-geology.eu). In 2018, 295 public metadata records on CGS data sources were managed in the MIS. For the CGS information portal, the MIS is used to automatically generate a thematic list of web map services (31 services; wms.geology.cz), thematic lists and guideposts to public web applications (71 items; applications.geology.cz), and to map applications (33 applications; maps.geology.cz). Newly available

is a thematic overview of map services based on Esri ArcGIS for Server technology (53 items; <http://www.geology.cz/extranet-eng/maps/online/esri>). Applications and services are classified into 18 geoscientific themes.

In 2018, a metadata profile for describing 3D geological models was implemented, and descriptions of models that are currently being developed were processed and published.

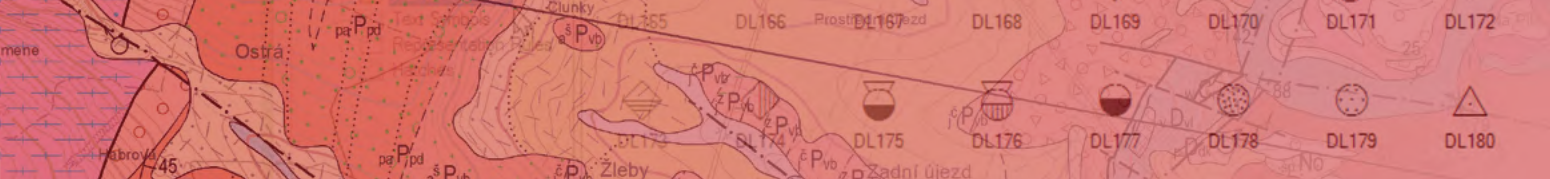
### INSPIRE and interoperability of geodata

The INSPIRE Directive of the European Commission and the Council requires the CGS to provide up-to-date metadata and to publish data related to geology, soil, mineral resources, energy resources and geohazards. The CGS is actively involved in the implementation of the INSPIRE directive in the Czech Republic mainly by participating in the technical working groups of KOVIN (Coordinating Committee for INSPIRE).

A customized solution for providing download services using the ATOM feed continued to be developed during 2018, and the first two harmonized sets were published for testing – GEOČR500 and Landslides in the Czech Republic (to be validated and modified).

As part of the CzechGeo/EPOS project, the content of the INSPIRE data specification for geophysical data was analyzed. The geological code lists of the CGS continued to get harmonized as required by





INSPIRE, and the harmonization of data for other themes continued as well. For example, a procedure for calculating the landslide susceptibility layer was tested for the theme Natural Risk Zones.

### **Development of the technology and content of data sources**

The consolidation of existing data sources continued in 2018. The consolidated system of Geologically Documented Objects (GDO) was transferred to the development environment. The ASGI database was made operational along with stored update procedures. A new procedure for creating spatial data was developed for the SurlS system. A subsystem for acquiring and recording the Geov-03 annual statistical reports was completed and tested, and tools were developed for viewing and compiling selections and reports from individual SurlS parts (including the possibility of export to Google KML, Garmin GPX, PDF, MS Excel XLS). Work on the field documentation database, which is of vital importance to the NGMD (National Geological Map Database) continued as well. At present, it contains nearly 125,000 objects of various types documented by experts in the Czech Republic, which are linked to other geoscientific data sources. Field documentation data are a source for ArcGIS tools and scripts. An example is the newly developed version of the GeoSol extension ([is.muni.cz/www/175417/GeoSol.html](http://is.muni.cz/www/175417/GeoSol.html)), which is used to calculate the orientation of surfaces. CGS database records use code lists. In 2018, work began on consolidating the data structure of the geoscience code lists of the CGS, which involves geological, geophysical, hydrogeological, engineering-geological as well as other code lists.

### **Geographic Information System (GIS)**

The GIS continued to be used by the entire CGS as a tool for processing, utilizing and providing

spatial data. Thanks to the Enterprise License Agreement with Esri, GIS methods for spatial data analysis, 3D modelling, and digital cartography could be routinely used, without limitations on the number of licenses, by CGS staff for research projects in the Czech Republic. In 2018, this involved geological mapping at 1:25,000 scale, contracts for SÚRAO (Radioactive Waste Repository Authority) – geological work at deep repositories, DIAMO – assessment of graphite and fluorite-barite deposits, a CEEMIR (Competence Centre for Effective and Ecological Mining of Mineral Resources) project – use of selected critical minerals. GIS methods were also used in international cooperation projects, such as ResiBil – review of groundwater resources in the eastern part of the Czech-Saxon border area, Turów – the mining impact of the Turów mine on the Czech territory, HSR-PrD – development of the railway transport Saxony – Czech Republic, as well as foreign projects in Ethiopia and Mongolia. The use of ArcGIS Pro with regard to map construction continued to be examined in 2018. Due to the Esri development, ArcGIS Desktop will have to be replaced with ArcGIS Pro over the next three years. This involves access to map data sources as well as development of symbology (area symbols – hatches, points) and their prepress production. Therefore, new prepress preparation methods for maps began to be developed.

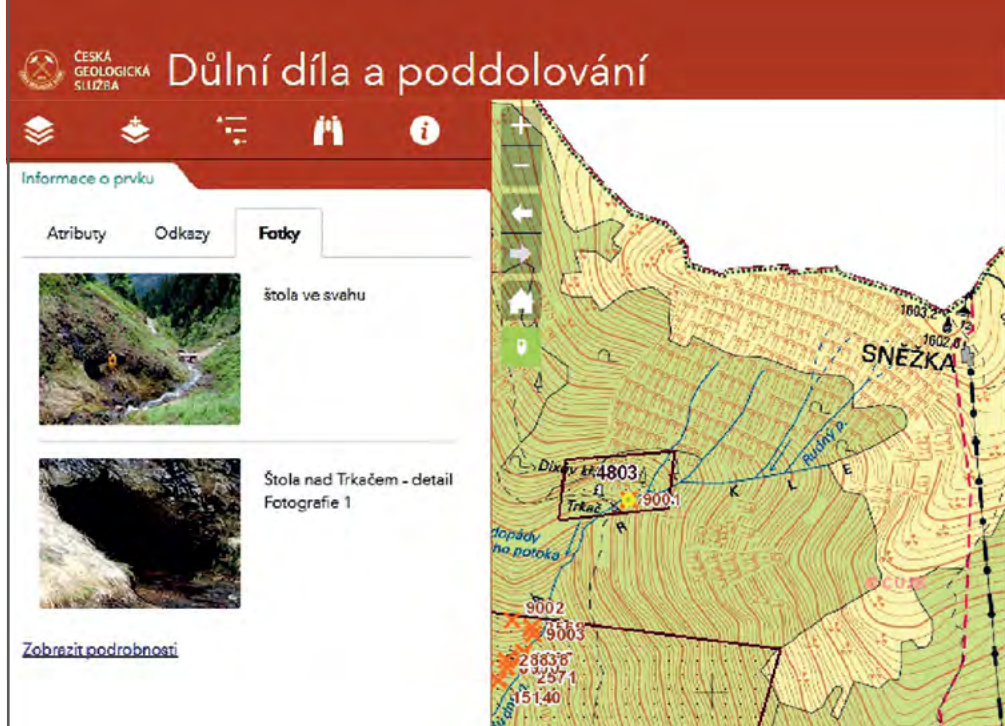
### **Providing access to geoscience data and information**

The **CGS Information Portal** (CGS IP) is a GeoIS integration platform that provides free access to data stored in the CGS archive, NGMD or CDS. Database applications (mainly data from CDS) and map applications (mainly data from NGMD and CDS) provide access to the data. Individual applications continued to be maintained and modernized in 2018. The modernization was the result of a transfer





» Mining Impacts application – display of photos that appear for the given item selected on the map.



to upgraded versions of database and map server, server environment, and updates of links between the modified systems. The development of customized applications included the following systems: Field Documentation, Mine Workings, Regional Geological Administration, Geological Localities and Historical Mining Records. The CGS IP includes the **CGS Map Server** (MS), which provides map applications. In 2018,

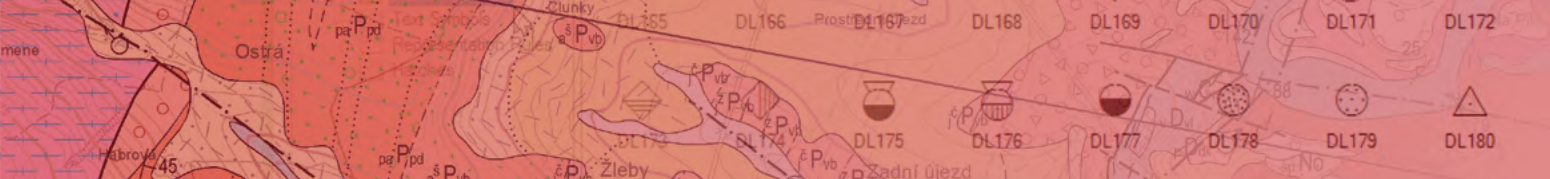
the Geophysical Measurements application was developed, which presents three topics: seismic data (well shoots, seismic reflection profiles), vertical electric sounding (VES campaigns, profiles and measurement points) and geophysical surveys in the Czech Republic (regional, local). Applications continued to be developed in the Web AppBuilder (WAB) environment. A new Map Layer tab was created, grouping map layers and selected groups for identification in the map window. The Information tab can also display thumbnail images of individual objects. Currently, the results of queries and selections are displayed only as outlines on the map. In addition, the Results Table (now with more entries) was modified, and the print function now allows the user to use the JPG format for printing. The new URL Locations add-on allows the user to launch an application displaying a selected object on the map.

Mobile map applications were launched in 2018 allowing for CGS data to be displayed on mobile devices. The following CGS data that are of interest to mobile device users in the field were selected: Geoscientific Maps, Geohazards, and Geology for

« The mobile application Geology for all displays interesting geosites, geoparks, geological expositions in museums or in natural settings, and an excursion guide. The display of map objects is optimized for mobile devices.







➤ Participants of the “4<sup>th</sup> European Meeting on 3D Geological Modelling”.

all (interesting geosites). All the applications use the Hiking Map from Seznam.cz as the topographic background, which is the best option for navigation in the field.

### International cooperation

In 2018, the CGS continued to maintain and update the existing metadata catalogues of the European projects Minerals4EU ([m4eu.geology.cz](http://m4eu.geology.cz)), ProSUM ([prosum.geology.cz](http://prosum.geology.cz)) and European Geological Data Infrastructure (EGDI; [egdi.geology.cz](http://egdi.geology.cz)), which are included in the portals of the given projects. The OneGeology-Europe metadata catalogue was discontinued (spring 2018), and the metadata from this project (100 entries from 31 countries) are still maintained and updated in the EGDI catalogue. By the end of 2018, 2,090 metadata records (1,946 data sets, 142 services, 2 applications) of 30 European geological organizations and 5 European projects were managed in the EGDI catalogue. The GeoInformation Platform project of the

GeoERA programme was launched in mid-2018 in cooperation with other geological surveys of EuroGeoSurveys. The platform is being built as an extension of EGDI, for which the CGS is preparing a new version of the metadata catalogue. The staff of the Informatics Division attended the 33<sup>rd</sup> Geoscience Information Consortium (GIC) conference, organized by Geoscience Australia, the fourth meeting of geoinformaticians of the Central European geological surveys (CE-GIC) in Zagreb, Croatia, and the “4<sup>th</sup> European Meeting on 3D Geological Modelling” (organized by the French geological survey BRGM). Subsequently, at the Esri International User Conference in the USA, the representatives of several geological surveys discussed the future development of this software with regard to visualization of 3D geological models, which brought positive changes already during the course of the year.







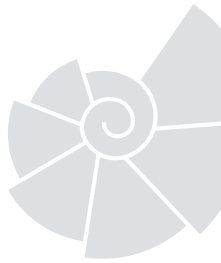
100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Remote sensing



*Thanks to new space programmes and fast developing technologies, remote sensing is nowadays the most widespread method of acquiring spatial data regarding the Earth's surface and objects.*

*Long-distance data parameters are continually improving (for instance spectral resolution, range, spatial resolution), and there is an increasing global trend of providing free non-commercial satellite data (such as NASA's Landsat and ESA's Copernicus programmes), which contributes to rapid development of new methods and applications that allow for systematic global monitoring of the Earth and that link various geoscientific disciplines.*



**Veronika Kopačková**  
Head of the Remote Sensing Centre

---

« Flydeo Hexacopter with a MAPIR multispectral sensor.





» UAVs have a wide variety of applications such as, in this case, the monitoring of river bank failure at the Nechranice reservoir.

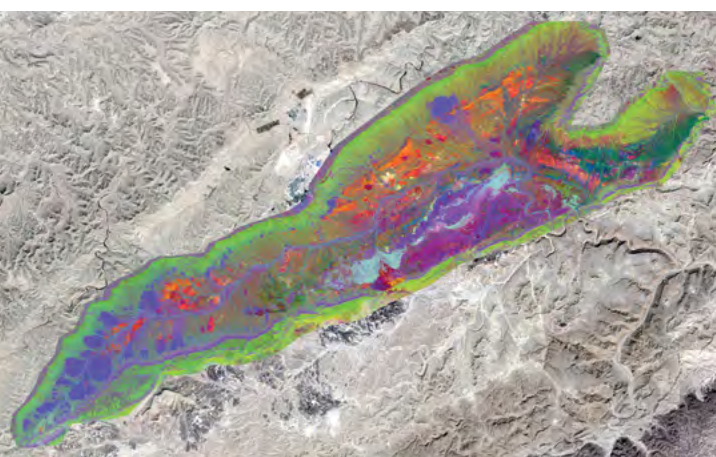


The Remote Sensing Centre (RSC) concentrates, over the long-term, on the application of quantitative image spectroscopy methods by using optical and thermal hyperspectral (HS) image data. The RSC team employs the quantitative spectroscopic methods as a modern tool for monitoring all environmental constituents (rock – vegetation – water) and for studying their interactions. During national and international long-term research projects, models were constructed using RS image data to determine the surface pH gradient in exposed substrates, to evaluate the contamination of surface mine waters, or to assess the overall health of spruce-dominated forest stands that have yet to exhibit any signs of visible damage. As a matter of fact, the above-mentioned image spectroscopy

applications have great potential for environmental monitoring, since they allow for identification of acid substrates and their relation to “Acid Mine Drainage” (AMD) or to the quality of surrounding surface waters and vegetation.

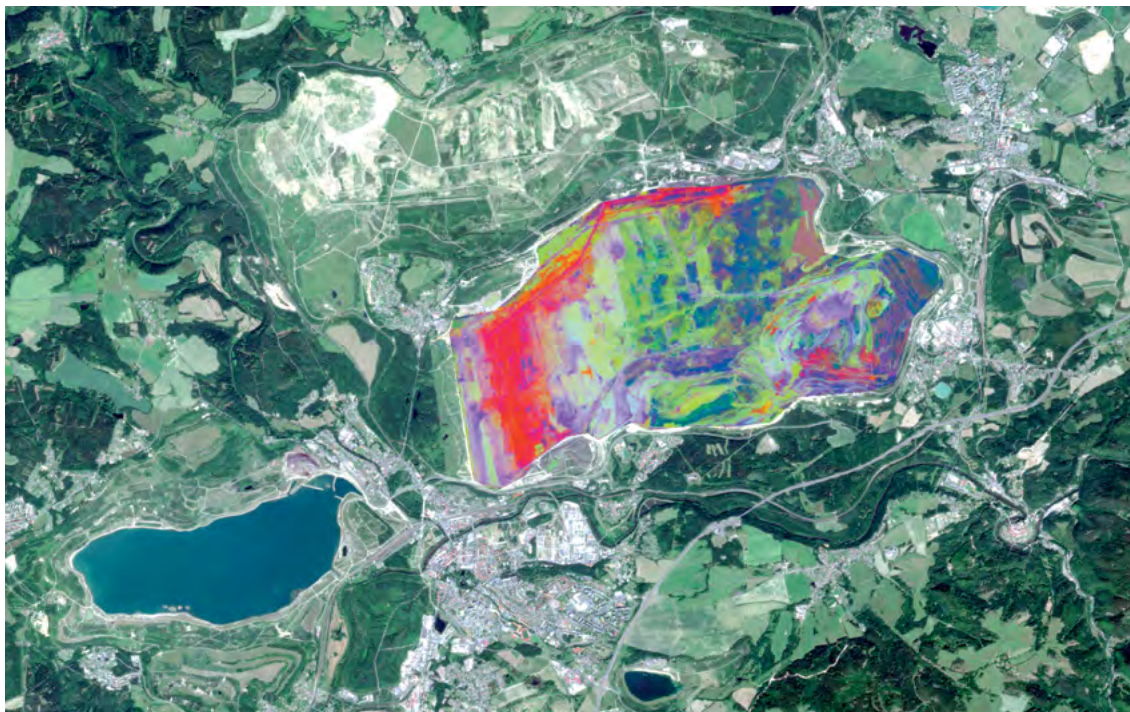
The team is presently focusing in particular on designing new approaches and algorithms in the field of quantitative analysis and classification of RS image data. Conceptually, these activities target three areas of development: (1) quantitative modelling of soil parameters, (2) creation of new algorithms/models combining optical and thermal HS data, (3) creation of models using new-generation satellite data (for instance Sentinel-1-3 and EnMAP).

The RSC newly introduced the use of unmanned aerial imaging and upgraded its technical equipment with the addition of two unmanned aerial vehicles – a Flydeo Y6 hexacopter and a DJI Phantom 4 quadcopter, which can be fitted with sensors – a multispectral Parrot Sequoia, a multispectral MAPIR Survey2 NDVI, and a thermal FLIR Duo R. Unmanned imaging allows for independent scanning of study



« Modified Sentinel-2 (ESA) image of the Makhtesh Ramon locality in Israel, shown in false colour in combination with the principal component analysis (PCA) method. In 2014–2018, the RSC collaborated with Tel Aviv University on science projects involving soil spectroscopy.





⤴ The Jiří Open Pit Mine in the Sokolov region depicted by the PCA (Principal Component Analysis) method from Sentinel-2 satellite data.

localities, which supplements existing airborne or satellite data, while enabling operational data acquisition for new scientific topics and projects. In addition to HS technologies, the RSC was engaged in other fields of remote sensing. Procedures were developed for the classification of morphometric features and their ensuing geomorphological interpretation, and a new method was devised that enables the updating of tectonic and hydrogeological elements based on ALOS PALSAR satellite radar data. Radar interferometry methods (SBAS-DInSAR or PSI) for detecting vertical movements and deformations were also used. Radar interferometry was employed, for instance, to detect landslide movement along the D8 motorway in the České středohoří Mts, to interpret post-seismic phenomena including neo-tectonics in the East African Rift System, or to evaluate the impact

of the devastating earthquake and subsequent post-seismic phenomena in New Zealand in 2016. The results of RSC's activity focused on the above-mentioned fields are continuously published in IF-indexed, international peer-reviewed professional journals.

Scientific cooperation:

- Faculty of Science, Charles University in Prague
- CzechGlobe, Academy of Sciences of the Czech Republic
- Deutsches Geoforschungs Zentrum (GFZ)
- Tel Aviv University
- NASA – Goddard Space Flight Center
- EuroGeoSurveys: Earth Observation and Geohazards Expert Group (EOEG)







100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019





# International activities and cooperation

*The experts of the Czech Geological Survey are engaged in many transnational and international projects. Ongoing projects include international development cooperation of the Czech Republic in Ethiopia, several international projects with participation of the Czech Science Foundation, programmes of international cooperation in research, development and innovation, projects of the Horizon 2020 programme, and also cooperation with foreign partners in the international geoscience programmes of UNESCO. The Czech Geological Survey is a permanent and active member of many international organizations.*



Jana Procházková  
project manager

## **Projects of the Czech Science Foundation** **The earliest Carboniferous greenhouse-icehouse climate oscillations – a multidisciplinary approach, 2016–2018**

Three Czech institutions – Masaryk University in Brno, Palacký University in Olomouc, and the Czech

Geological Survey – participated in this project.

The main project objective was to significantly improve global correlation regarding the Tournaisian Stage. The Tournaisian represents the first phase of extensive Carboniferous glaciation, which followed the greenhouse–icehouse transition of the Late Devonian.

« Traditional village huts in southern Ethiopia.  
Photo by K. Verner.





» Great Barrier Reef,  
one of the sites studied.  
Photo by J. Frýda.



Although the Early Tournaisian is of decisive importance in the sequence of events leading to this glaciation, it was outside the realm of scientific interest partly due to the amount of non-conformity and low completeness of shelf sedimentary records, specifically on a global scale. However, palaeoclimatic interpretation of the sedimentary and geochemical record was impossible without significant progress in biostratigraphy. Many of the project's publications led to advances in global biostratigraphy and refined global correlation of Tournaisian strata by studying selected profiles in Europe, North America and China.

**Mining and processing of Cu, Pb, Zn and Co ores in Sub-Saharan Africa – a natural geochemical laboratory for pollutant behavior study, cooperation with the Faculty of Science, Charles University Prague, 2016–2018**

In 2018, field work was conducted at the Kanye manganese ore deposit in Botswana in cooperation

with the Institute of Mineralogy, Geochemistry and Mineral Resources of the Faculty of Science, Charles University.

The project results showed that the principal environmental problems at this deposit involve erosion of ore and flotation waste depositories, and transport of potentially toxic metals (As, Ba, Cu, Mo, Pb, and V) to local watercourses. The contamination of the watercourses was observed across a distance of several kilometres from the deposit itself.

The project results were presented in a number of contributions at the 34<sup>th</sup> conference of the Society for Environmental Geochemistry and Health in Livingstone (Zambia).



» Sampling of a flotation waste profile at the Kanye deposit in Botswana. Washing out of flotation waste during the rainy season is a source of local water contamination with potentially toxic metals (As, Ba, Cu, Mo, Pb and V).



» Sampling of manganese ore flotation waste at the Kanye deposit in Botswana. Washing out of flotation waste during the rainy season is a source of local water contamination with potentially toxic metals (As, Ba, Cu, Mo, Pb and V).



**Integrated multidisciplinary study of the Jurassic–Cretaceous boundary in marine sequences: a contribution to the global boundary definition, cooperation with the Institute of Geology of the Czech Academy of Sciences, 2016–2018**

CGS specialists in micropalaeontology (foraminifera and calcareous nannoplankton) participated in a multidisciplinary study of the Jurassic–Cretaceous boundary in the Western Carpathians. Together with other specialists from Czech as well as foreign research institutions, they carried out the study using integrated stratigraphy involving various magneto-, chemo- and biostratigraphic methods. Profiles in Kurovice and Kotouč in Štramberk were examined layer by layer. The Kurovice profile in particular, which includes the Lower Tithonian to Lower Berriasian, provided valuable stratigraphic information. This will help define the Jurassic–Cretaceous boundary, which is the last boundary lacking definition and a global stratotype.

**Cooperation Programme Free State of Saxony – Czech Republic, 2014–2020**

**ARCHAEO-MONTAN 2018**

The international and interdisciplinary project “ArchaeoMontan 2018” focused on research regarding medieval mining in the Saxon and Czech parts of the Krušné hory Mts. It was funded by the Cooperation Programme for the Promotion of Cross-border Cooperation between the Free State of Saxony and the Czech Republic 2014–2020, which is financed by the European Union from the European Regional Development Fund. The project followed the first phase of research carried out during the project “ArchaeoMontan, Medieval Mining in the Krušné hory Mts”, which was completed in 2014. In comparison with the original project that focused on the reference area of Přísečnice, the research was expanded to include the reference areas of Krupka and Jáchymov. The research also targeted the newly discovered preserved medieval underground mine systems

beneath the town of Dippoldiswalde in Saxony. The extensive subsurface spaces, located directly beneath the historic core of Dippoldiswalde, were documented and studied with modern methods including 3D spatial scanning. The explored mine workings, where mining commenced around 1160, are an important European mining heritage site primarily due to the original condition of the medieval mine workings and due to many wooden artefacts discovered in the mining cavities, which are being preserved. A study of the environs of an extinct medieval mining community from the 14<sup>th</sup> century at the Kresmsiger locality near Přísečnice and of other medieval finds throughout the Přísečnice area were completed on the Czech side. The discovery of an extensive medieval mining settlement in the Černý Potok area near the former royal mining town of Přísečnice, which now lies submerged in a reservoir, showed that the medieval settlement, which is associated with mineral extraction in the area of the main ridge on the Czech side and which dates



➤ Reconstructed charcoal blast furnace – Schmalzgrube, Saxony.



» *Joint Czech-Saxon meeting in Freiberg.*  
*Photo by B. Mlčoch.*



back to the first half of the 14<sup>th</sup> century, is larger than previously thought. During archaeological surveys, a number of slag heaps and other remnants from the processing of Fe and Ag ores were discovered, and a subsequent geochemical analysis confirmed that they were of local origin and associated with local Fe ore deposits and hydrothermal Ag ore deposits. A survey of the Krupka reference area focused on slag whose age was dated with the aid of utility ware as well as technical ceramics. A detailed geochemical, mineralogical and economic geology study of uncovered artefacts and primary deposit sources demonstrated the connection between the metallurgical plants and the mining of tin and copper ores in the Steinknöchen and Preiselberg districts. The most significant find in the reference area of Jáchymov was the discovery of demonstrably medieval remnants of Fe ore processing in the Pstruží area near Pernink. Additional important evidence revealed that the production capacities originally intended for metallurgical processing of tin ore were also used for subsequent production of cobalt paints. A geochemical analysis of peat profiles from the Kovářská Bog provided an important contribution to understanding the long history of ore deposit exploitation in the Krušné hory Mts. The results of the geochemical analysis and carbon-14 dating show that the use of ore resources in the Krušné hory Mts dates back to at least the Bronze Age. The research results were published in a professional journal. The project included two international conferences, one organized in Kadaň in 2017 and the final project conference in Dippoldiswalde in August 2018. Compendiums of both conferences were published and summarize the most important discoveries and studies carried out during the project. Important project outputs included the design of an exhibit displaying the most important finds of medieval mining in Dippoldiswalde, the construction of a mining landscape information centre in Krupka, and

the creation of two educational mining heritage and archaeology trails in Dippoldiswalde and Krupka.

### **ResiBil – The balance of water resources in the eastern part of the Czech-Saxon border area and assessment of their sustainable use**

ResiBil is an international Czech-Saxon EU project focused on reviewing and assessing the sustainability of long-term groundwater use in the border region with regard to expected climate change impacts. The project involves the cooperation of three institutions, the Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (Saxon State Office for Environment, Agriculture and Geology), the Czech Geological Survey, and the T.G. Masaryk Water Research Institute, p.r.i. The project's milestones in 2018 included the drilling of two geological boreholes in the area of Dolní Podluží and Jedlová near Jiřetín. A Czech-Saxon geological map and a correlatable stratigraphic scheme were compiled. Joint field excursions and work meetings were held, such as the joint Czech-Saxon meeting in Freiberg.

## **Horizon 2020**

### **GeoERA**

A total of 45 national and regional geological surveys from all over Europe participate in the GeoERA programme. This is the so-called multi-thematic ERA-NET, co-funded by the Horizon 2020 programme, as part of Societal Challenge 3 (Secure clean and efficient energy) and Societal Challenge 5 (Climate action, environment, resource efficiency, raw materials). The main purpose of this programme is to integrate information and knowledge on subsurface energy, water and raw material resources and to promote their sustainable use.

Two calls for sub-project proposals addressing the four GeoERA topics geoenery, groundwater, minerals





and the creation of a common information platform took place from April 2017 to January 2018. The CGS co-submitted nine proposals, all of which were successfully evaluated and selected for funding. The implementation of the sub-projects commenced in July 2018 and is scheduled to end in June 2021. Projects with CGS participation addressing individual themes of GeoERA:

#### **Geoenergy**

- MUSE – Managing urban shallow geothermal energy
- HotLIME – Mapping and assessment of geothermal plays in deep carbonate rocks – cross-domain implications and impacts
- 3DGEO-EU – 3D geomodelling for Europe
- GeoConnect<sup>3d</sup> – Cross-border, cross-thematic multiscale framework for combining geological models and data for resource appraisal and policy support

#### **Groundwater**

- HOVER – Hydrogeological processes and geological settings over Europe controlling dissolved geogenic and anthropogenic elements in groundwater of relevance to human health and the status of dependent ecosystems
- RESOURCes – Resources of groundwater, harmonized at cross-border and pan-European scale

#### **Minerals**

- Mintell4EU – Mineral intelligence for Europe
- FRAME – Forecasting and assessing Europe's strategic raw materials needs

#### **Information platform**

- GIP-P – GeoERA Information Platform project

#### **BASE-LINE Earth (Brachiopods As SENSitive tracers of gLOBAL marINe Environment: Insights from alkaline, alkaline Earth metal, and metalloid trace element ratios and isotope systems), EU, 2015–2018**

This international EU-funded project studies the isotope composition of selected elements (Li, Mg, etc.) in brachiopod shells in the global ocean

from the Palaeozoic to the present, which is roughly 540 million years. The new data may furnish important information on the chemical evolution of seawater (temperature, salinity, pH and other data), on the palaeoclimate conditions and their changes, or on the intensity of weathering processes on ancient continents. During 2018, the isotopic composition of Li was determined in brachiopods cultured experimentally under different conditions (Mg/Ca, pCO<sub>2</sub>, T, pH), reflecting a wide range of conditions in the global ocean. The isotopic composition of Li in nutrient solutions simulating seawater was measured concurrently and collected during this two-year experiment. The results reveal that these physico-chemical parameters have a negligible effect on the Li isotope system. The Li isotope system that was studied in recent brachiopod individuals in relation to the current ocean shows a standard deviation from the isotopic composition of Li of modern seawater, and the elemental and isotopic composition of the suite of brachiopods from the Permian–Triassic boundary, a historically significant extinction event, was determined, which represents a tool for understanding global geological events. In addition, the isotopic composition of Mo was determined in a number of international reference materials, particularly low-temperature carbonates and selected silicate matrices, which should act as a springboard for biogenic carbonate studies.

#### **GeoERA – GE5-Advancements in developing and using 3D transnational geomodels**

The summer of 2018 saw the launch of a three-year international GeoERA project entitled “3D Geomodelling for Europe”, with participation of a CGS team on Work Package 4 “Uncertainty in geomodels”. Its main purpose is to develop and test the methodology of the most common computational procedure for quantifying uncertainties in 3D geological models and their subsequent visualization.



» End of the mapping phase of the WP1-N3 course in the Tsaobis Nature Park.  
Photo by V. Žáček.



Finding a sufficiently credible and universal solution is important primarily for subsequent use of 3D geological models – for example, in numerical simulations of rock environment development, in planning work associated with the design of underground structures or in security analyses, where it is necessary to provide professionals lacking a deeper understanding of geology with very precise and clearly defined data on the accuracy and credibility of geological models and their individual parts. Work on this project was and will be closely coordinated with other CGS projects.

### International research and development programmes and follow-up research

#### **PanAfGeo: Geoscience skills and qualification in African geological surveys, 2017–2019**

During the European PanAfGeo project, three field mapping courses were completed in Namibia, Ethiopia and Morocco. A representative of the EU's permanent mission in Windhoek was present for the completion of the second field mapping course for participants from 17 African geological surveys in the Tsaobis Nature Park west of Windhoek. A methodology course and month-long practical field training was provided by a Czech Geological Survey team with a representative of the Slovenian GeoZS and experts from the Geological Survey of Namibia. In addition, experts from the University of Namibia took part in introductory lectures. The results of the mapping of polygons with an area of 5x3 km were presented at the end of the training course. Each geological map, including a geological cross section and legend, was based on processed geological and structural data in the QGIS environment, and many groups also compiled digitized geological maps. The course in Windhoek, Namibia, followed the first

PanAfGeo mapping course held by a Czech-Ethiopian team in Ethiopia. The last, third French-language course in Tafraout, Morocco, was provided on behalf of the CGS by a team of French geologists from BRGM and by Moroccan partners.

#### **Study of natural hazards harmful to agricultural production in selected areas of SNNPR, Ethiopia, 2015–2018**

#### **Implementation of a methodical approach in geological sciences to enhance the quality of doctoral studies at Addis Ababa University, Ethiopia, 2018–2019**

The Czech Geological Survey has successfully carried out two development cooperation projects in Ethiopia, which has long been one of the priority areas of Czech Republic's development cooperation, built on a rich tradition of mutual relations between the two countries. The main focus of the projects involves basic and applied research in the geosciences with an emphasis on pedagogical activities and enhancing professional capacities.



» School lesson in the northern Ethiopia.  
Photo by K. Verner.





➤ Farewell to field work in southern Ethiopia. Photo by K. Verner.

During the project “Study of natural hazards harmful to agricultural production in selected areas of SNNPR”, 16 geological and thematic maps at a scale of 1:50,000 were compiled in the tectonically active region of the East African Rift System. The purpose of the project was to mitigate the negative impact of geological processes on agricultural production and to ensure sustainable use and protection of agricultural land, water sources and local infrastructure.

The project “Implementation of a methodical approach in geological sciences to enhance the quality of doctoral studies at Addis Ababa University, Ethiopia” focuses on close cooperation during the introduction of new methods, on theoretical and practical training regarding the preparation of professional publications for renowned international periodicals, and on teaching advanced methods of processing field and analytical data in geological disciplines at Addis Ababa University.

#### **Czech National Committee for IGCP (UNESCO International Geoscience Programme)**

This programme was founded in 1972, specifically at the initiative of Czechoslovak geologists. After the dissolution of Czechoslovakia, the original Czechoslovak National Committee for IGCP (1973–1993), which was incorporated into the Academy of Sciences of the Czech Republic, split into the Czech National Committee for IGCP and the Slovak National Committee for IGCP. The newly established Czech National Committee for IGCP was affiliated to the Czech Geological Society via an agreement on 5 October 1994 (available at <https://igcp.cz/>). The committee works on a voluntary basis and receives sponsorship donations, which are distributed through an annual transparent competition to project promoters to cover costs associated with their participation in major international meetings, or to organize workshops and meetings (domestic/ international). The committee has long been a national



» Shop in Ethiopia.  
Photo by K. Verner.



representative of the IGCP-UNESCO programme (now known as IGGP) – each year it compiles an annual report on its activities, which is submitted to the IGGP/UNESCO Secretariat in Paris. In 2018, the Czech Republic participated actively in the following five IGCP projects:

- **Project 637 – Heritage Stone Designation**

The project coordinator, Dr. Dudíková Schulmannová, who was present at the committee meeting was asked, by the committee secretary, to briefly report on the project activities. The project coordinator provided information on the objectives and positive results of several excursions organized during 2018. The committee secretary added that financial contributions were approved for these excursions. The committee members agreed that the funding of such activities is very beneficial.

- **Project 640 – S4LIDE: Significance of Modern and Ancient Submarine Slope LandSLIDEs**

The national coordinator of this project is Dr. Stemberk (Institute of Rock Structure and Mechanics of the Czech Academy of Sciences – IRSM AS CR), who was unable to attend the meeting due to work obligations. Dr. René (also with IRSM AS CR) informed the attendees about the ongoing work on the tectonically and volcanically active island of El Hierro (part of the Canary Islands), and about the monitoring of a major continental and submarine landslide and the installation of dilatometers that were developed years ago by the IRSM staff. He provided detailed information on the scientific work of the Czech group regarding this issue. He also informed the attendees that Dr. Blahůt, who is involved in the project, is preparing an article to be published next year in a prestigious geoscience magazine. The committee secretary added that Dr. Blahůt received a financial contribution from the committee this year for field work on El Hierro.

- **Project 649 – Diamonds and Recycled Mantle**

Dr. Kotková (CGS), who is involved in the project, announced that she did not work on the project this year. This was disclosed to those present by the committee secretary, who added that no funds were drawn.

- **Project 652 – Reading geologic time in Paleozoic sedimentary rocks**

Dr. Vodrážková (CGS), the national coordinator of this project as well as committee member, was forced to excuse herself from the meeting due to illness. However, she sent a list of articles published or approved for publication in 2018, which summarize the project activities. The information was provided to those present by the committee secretary, adding that financial contributions were drawn for two conference contributions dedicated to this project.

- **Project 653 – The onset of the Great Ordovician Biodiversification Event**

The committee chairman, and a participant in this project, informed attendees about the project activities that are being conducted on a very active basis primarily due to a grant from the national coordinator of the project O. Fatka (Faculty of Science, Charles University). He also informed of the highly interesting fossils from the Letná Formation. The project coordinator Dr. Fatka was unable to attend the meeting due to a business trip abroad. However, he did send a comprehensive list of project activities carried out over the past year (publications, abstracts, active participation in international conferences). The information was again disclosed by A. Svobodová, who also informed attendees about the funds used for this project in 2018.

RNDr. Jan Pašava, CSc., is a member of the IGCP Scientific Board UNESCO, where he has been involved in the evaluation of new proposals and ongoing IGCP projects since 2012. The Czech National Committee is a well-functioning organization, whose activities are highly valued by UNESCO.





## International membership

<b>AAPG</b>	American Association of Petroleum Geologists
<b>CAAG</b>	Czech Association of Geophysicists, a member of Council of Scientific Societies of the Czech Republic (CSS), a member of Union of Geological Associations (UGA), and an associated society of European Association of Geoscientists and Engineers (EAGE) (member of the board D. Čápravá)
<b>Central European Initiative</b>	gathering of Central European geological Surveys: Czech, Slovak, Austrian, Hungarian, Polish and Slovenian
<b>CETEG</b>	Central European Tectonic Groups
<b>CGMW</b>	Commission for the Geological Map of the World
<b>CO2GeoNet</b>	European Network of Excellence on the Geological Storage of CO <sub>2</sub>
<b>COMNAP</b>	Council of Managers of National Antarctic Programs
<b>DGGV</b>	German Geological Society
<b>EAGE</b>	European Association of Geoscientists and Engineers
<b>ENERG</b>	European Network for Research in Geo-Energy (president 2018–2019 V. Hladík)
<b>EUG</b>	European Geosciences Union
<b>EuroGeoSurveys</b>	gathering of 32 European geological surveys
<b>GIC</b>	Geoscience Information Consortium, gathering the managers of informatics of 32 geological surveys around the world (Czech representative D. Čápravá)
<b>GIC CE</b>	a consortium gathering the managers of informatics of the Central European geological surveys: Czech, Slovak, Austrian, Hungarian, Croatian, Polish and Slovene (Czech representatives being D. Čápravá, L. Kondrová, P. Fiferma and O. Petyniak)
<b>IAGOD</b>	International Association on the Genesis of Ore Deposits (leader of the Czech team B. Kříbek)
<b>ICOGS</b>	International Consortium of Geological Surveys
<b>INQUA</b>	International Union for Quaternary Research
<b>KBGA</b>	Carpatho-Balkan Geological Association
<b>ProGEO</b>	European Association for the Protection of Geological Heritage
<b>SCAR</b>	The Scientific Committee on Antarctic Research
<b>SEG</b>	Society of Exploration Geologists (member of the steering committee J. Pašava)
<b>SGA</b>	Society for Geology Applied to Mineral Deposits – a scientific society gathering over 1,300 specialists in the field of geology and mineral deposits from over 80 countries around the world; the SGA publishes a prestigious journal Mineralium Deposita, which has a highest IF number from all economic geology journals (executive secretary J. Pašava, student representative A. Vymazalová)
<b>SGG</b>	Swiss Geological Society
<b>SRG</b>	The Society of Resource Geology (Japan)





100 YEARS



CZECH  
GEOLOGICAL  
SURVEY  
1919/2019



# Laboratories

(SPV)



**Věra Zoulková**  
Head of the Central  
Laboratory Prague



**Juraj Franců**  
Head of the Central  
Laboratory Brno



**Anna Vymazalová**  
Head of the Department  
of Rock Geochemistry



**Irena Sedláčková**  
Head of the Sample  
Separation Laboratory

## Central Laboratory Prague

The Central Laboratory is located in Barrandov, Prague. It is responsible for the chemical analysis of minerals, rocks and sediments as well as the biogeochemical analysis of organic materials such as conifer needles, wood, and peat. It also performs analyses of water. The laboratory has been accredited since 1993, and it conducts regular national and international interlaboratory tests of analytical quality, achieving excellent results.

### Analyses of solid samples

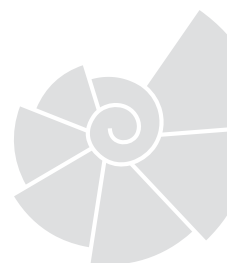
Silicate analysis is the main service requested by the CGS and other clients. The analysis of major elements provides fundamental information on

the stoichiometry of minerals and the chemical composition of rocks. In addition, the contents of trace elements are determined using a variety of instrumental methods (ICP-MS, FA AS, HGA AS and RFA). Special procedures are also available for fire assay of gold and platinum group metals (PGM).

### Water analyses

The analysis of groundwater and precipitation is an important task of the laboratory at Barrandov. The contents of metals and anions, and total carbon and nitrogen dissolved in water are important environmental indicators. Aquifers and surface waters must be monitored regularly. Analysis of trace elements is carried out using ETAAS and ICP-MS.

« Preparation for separating heavy minerals with LST.





» Storage of heavy liquid in an incubator.  
Photo by T. Pecka.



### Central Laboratory Brno

The Central Laboratory Brno has been accredited since 1993 and focuses on organic and gas geochemistry.

#### Rocks and crude oil

Concentrations of organic and mineral carbon and of total sulphur are determined in sedimentary rocks and soils. Selected samples of rocks and crude oil are subjected to analyses of the molecular composition of extractable compounds, especially biomarkers indicating the biological origin of organic matter, for instance from deciduous or coniferous trees or algae. Reflected light fluorescence microscopy helps characterize organic petrographic constituents such as pollen grains, cuticles, plant tissues or fossils. Vitrinite reflectance is utilized in reconstructing the thermal history of sedimentary basins, the depth of burial or erosion.

#### Ecology

Persistent organic pollutants (POPs) are analyzed in soils and airborne dust. A detailed examination of their composition indicates whether they come from natural sources or pollution. The total concentration of polycyclic aromatic hydrocarbons or their mutual ratios are used to compile environmental load maps.

#### Gases

Field measurements of gases are carried out using Ecoprobe 5 and Draeger portable instruments.

Detailed accredited chromatographic quantitative analysis determines 20 compounds including helium and argon. These measurements along with the analyses of isotopic composition of carbon in methane and in higher hydrocarbons help determine the origin of the gases, for instance, either from collieries, microbial activities or from oil deposits.

### Specialized Laboratories

The staff members of the Specialized Laboratories provide expert services, primary data and their subsequent interpretation. They are actively involved in a number of national, international and multidisciplinary projects; their findings are published in peer-reviewed journals and presented internationally. Many are prominent experts in their fields, who are also engaged in university education and other activities involving the teaching and training of students.

#### Laboratory of Isotope Geochemistry and Geochronology

The laboratory focuses on the analysis of traditional isotopic systems ( $\text{Rb} \rightarrow \text{Sr}$ ,  $\text{Sm} \rightarrow \text{Nd}$ ,  $\text{Re} \rightarrow \text{Os}$ ), building upon decades worth of knowledge gathered by the CGS. A high-quality Triton Plus thermal ionization mass spectrometer (Thermo Fisher Scientific, Germany) was acquired in 2017. The preparation of many samples using ion selective chromatography is performed in a specialized pressurized ultra-trace laboratory (USL). In addition



to methodological development, the laboratory research focuses mainly on the genesis of igneous rocks of the Bohemian Massif. The laboratory staff are also involved in the application of isotope systems in a number of geological and interdisciplinary research projects.

The laser ablation workstation (equipped with a HelEx two-volume ablation cell) in conjunction with an Agilent 7900x ICP-MS quadrupole inductively coupled plasma mass spectrometer (Agilent Technologies Inc., Santa Clara, USA) allows for in situ measurement of trace elements and isotope ratios of a wide range of petrogenetically significant elements in a number of natural and synthetic materials. The laboratory employs methods for geochronology using U-Th-Pb isotopes in zircon and for determining trace element concentrations in different matrices.

#### **X-ray Diffraction Laboratory**

The X-ray Diffraction Laboratory, equipped with Bruker D8 Advance and Philips X'Pert powder diffractometers, performs mineralogical analyses on a wide range of geological materials, including rocks, minerals, clays and soils. The analyses focus in particular on various crystalline synthetic materials, waste products, fly ash, sludge, mine precipitates, construction materials and others.

#### **Laboratory of Electron Microscopy and Microanalysis**

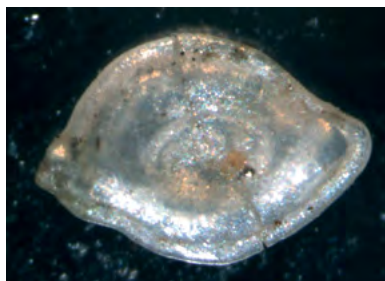
Materials studied in the Laboratory of Electron Microscopy and Microanalysis (LAREM), which is equipped with a Tescan Mira3 GMU FEG-SEM high resolution electron microscope, are characterized based on morphology and chemical composition, and 3D images of objects can be captured as well. The microscope is equipped with the EDS, WDS and EBSD (Oxford Instruments) analysis systems and AzTec 3.3 acquisition software, enabling easy characterization of materials with respect to chemical composition and crystallographic orientation on a microscale.

#### **Fluid Inclusion Laboratory**

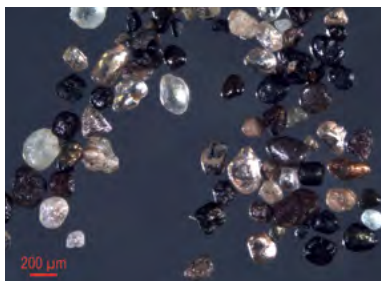
In 2018, the Fluid Inclusion Laboratory was equipped with an Olympus BX53M polarizing microscope, with a fluorescent light source and a LINKAM THMSG thermometric instrument. This apparatus is used to study the temperatures of inclusions (from -180 to +600 °C) and the composition of aqueous and gaseous fluids in inclusions (up to 5 mm) in minerals from diverse geological environments.

#### **Laboratory of Experimental Mineralogy**

The Laboratory of Experimental Mineralogy focuses on the synthesis of chalcogenides, phases with platinum-group metals, and on the study of phase relations.



➤ *Microfossil Rzehakina fissistomata.*  
Photo by M. Bubík.



➤ *Heavy mineral association in a binocular microscope.*  
Photo by H. Gilíková.



➤ *Automorphic zircon grain.*  
Photo by A. Zavřelová.



» Fluid Inclusion Laboratory.  
Photo by P. Dobeš.



» Cook electromagnetic separator.  
Photo by T. Pecka.



» WILFLEY 800 separation table.  
Photo by T. Pecka.

### Laboratory of Micropaleontology, Ecostratigraphy and Palaeobiology

The research of this laboratory deals with the influence of global changes in the palaeoenvironment on marine and terrestrial communities.

An integral part of the work at the Department of Rock Geochemistry involves mineral separation and production of microscopic material for further research.

### Sample Preparation Laboratory

The Sample Preparation Laboratory was established by the Regional Geology of Moravia Department at the Brno Branch located at Leitnerova 22. The laboratory has been used to process samples for micropalaeontology since the 1970s. Foraminifera, conodonts and calcareous nannofossils in particular have been separated. Equipment is gradually being upgraded and, with increasing demand by contracting authorities, the laboratory is expanding its range of methods on offer.

The laboratory is currently preparing rocks and sediments for palaeontological and mineralogical study, geochemical analysis and geochronological dating. The basic methods of sample processing include crushing, sieving (wet and dry, pebble analysis, granulometry, flotation), gravitational separation (separation table, heavy liquid), magnetic and electromagnetic separation (Cook electromagnetic separator) and if need be manual selecting.





➤ MAGSY MR VVM magnetic grate. Photo by T. Pecka.

### Microfossil separation

Methods employed to separate microfossils allow for their extraction from incoherent sediments as well as from solid clays and shales (disintegration by means of sodium bicarbonate solution, hydrogen peroxide, in combination with mechanical methods). From solid limestones and marlstones, calcareous microfossils are extracted by a special acetolysis using concentrated acetic acid.

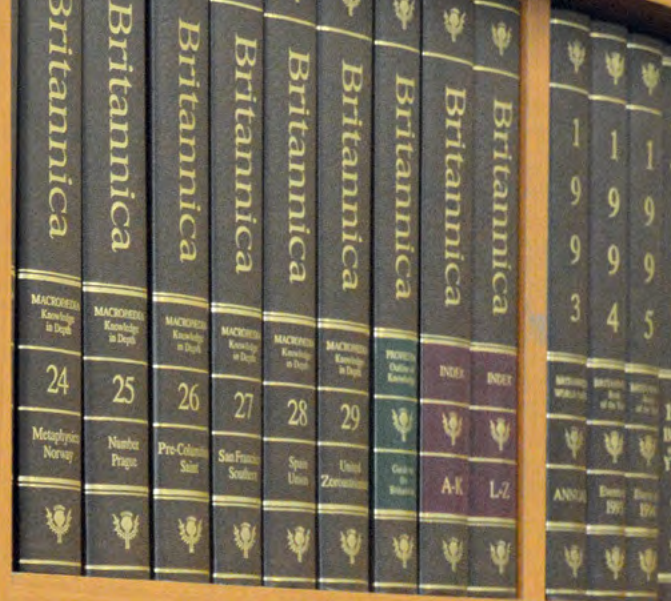
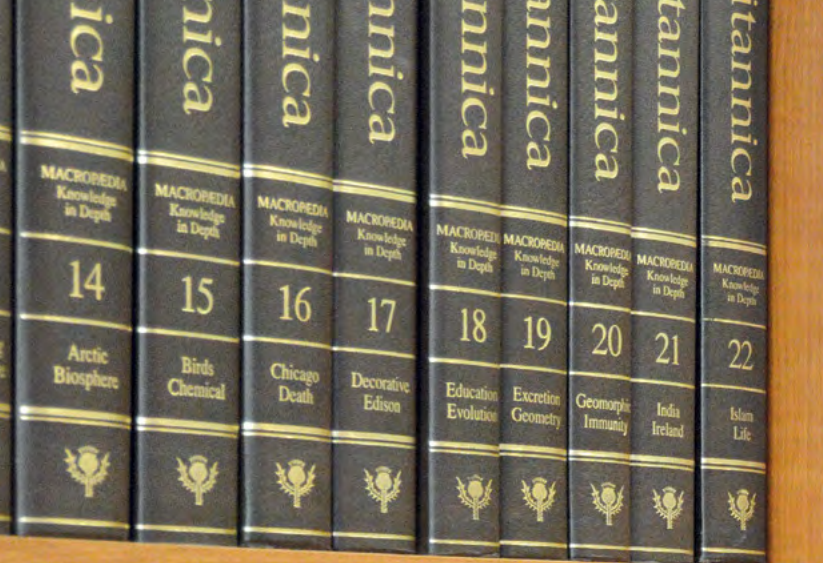
### Mineral separation

The non-toxic heavy liquid LST is used for the separation of minerals. Heavy minerals are used to help determine provenance and as an auxiliary stratigraphic tool. High-quality mineral specimens suitable for dating by laser ablation are obtained by separation in heavy liquid in combination with electromagnetic separation supplemented by manual selection under a binocular magnifier.



➤ Instrument for producing demineralized water. Photo by T. Pecka.





100 YEARS

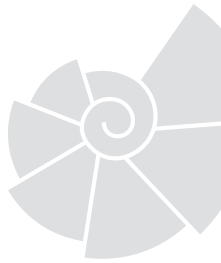


CZECH  
GEOLOGICAL  
SURVEY  
1919/2019





# Library and collections



*The library and collections are part of the Information Services Department, in which a new Records Management Department was established on 1 August 2017. The library and collections are used not only by experts from the Czech Geological Survey or other scientific institutions but also by students, private researchers and other interested members of the public. Researchers may use the study rooms in Klárov, Prague, and at the Brno office located at Leitnerova 22, where study material from the library and collections are provided. Mining literature can be studied at the Kutná Hora office.*



**Hana Breiterová**

Head of the Department of Information Services and Head of the Geological Library

## CGS Library

The Czech Geological Survey Library provides access to the largest collection of geoscience literature in the Czech Republic. Since 2013, it also includes a specialized archive from the former library of the Ministry of the Environment (MoE). It is the only library in the Czech Republic that also offers literature on waste management. Nine proprietary and two article databases may be accessed by all registered readers

using the library catalogue. Internationally recognized full-text databases (Science Direct, SpringerLink, Willey Interscience, Blackwell, GeoscienceWorld) and bibliographic databases (Web of Knowledge, Scopus, Georef and Geobase) are accessible through the CzechELib consortium, of which the CGS Library is a member. Of all the libraries administered by the MoE, the CGS Library provides the widest range of online information sources.





» Mining ledger from 1698, compiled from all the knowledge about mining available at that time (Frankfurt am Main).



» Sample from the historical collection.

The processing of a mining literature collection, stored at the Kutná Hora office, was nearly completed in 2018. The processing of periodicals was completed. The publications processed may be found in a common catalogue and are available at the Kutná Hora office.

### A brief history of the library

The CGS Library was established in 1924 as the central information service of the State Geological Survey (founded in 1919). At that time, the collection included 4,130 volumes and 89 maps. In 1947, a basic information system was developed, the collection held 28,683 volumes, and an international exchange of publications was launched, which continues to this day. The library currently includes about 200,000 volumes and, besides modern literature, it also holds a collection of historical books, the oldest of which dates back to 1580. Bibliographic records of geoscience articles have been compiled by various bibliographers since 1897. A decision to process the articles systematically was made in 1930, and J. Sv. Procházka was entrusted with the task of compiling the bibliography. The scope of the bibliography was to be as broad as possible so as to include anything written in the Czechoslovak Republic regarding mineralogy, geology and palaeontology and other related fields, and anything written about the republic by foreigners, and anything published by Czechoslovak authors abroad. Therefore, the press appealed to the public to cooperate in the compilation of the bibliography and to authors to provide their offprints or bibliographic information. The bibliography was published in printed form until 2003. Now it is processed only electronically. Individual yearbooks, starting with

1976 onward, are currently being transcribed into the database. The oldest records of works in the bibliographic inventories date back to 1528.

### Collections

The Department of Geological Collections stores and provides access to fossils, mineral and rock samples, thin sections and other geology-related items collected by CGS researchers or other institutions, as well as by private collectors. The most valuable samples from a science perspective are located in geological, mineralogical and palaeontological collections. Museum-quality collections are stored, made accessible and recorded in the CES national register by virtue of Act No. 122/2000 Coll. and Decree 275/2000 Coll. The management of these items is subject to strict conditions defined by the above-mentioned and subsequent legal regulations. The documented material (geological and palaeontological samples from geological mapping, thin sections and drill cores from boreholes) is kept in accordance with Act No. 62/1988 Coll., as amended by Act No. 66/2001 Coll.

### Additions to the collections

The most significant additions to the collections in 2018 included two pieces of the enigmatic arthropod *Archeolimulus hanusi* (Chlupáč, 1963) and other material donated by Ing. O. Zicha, representative and study material of the thylacocephala *Concavicaris viktoryni* (Rak *et al.* 2018), type and original material of the ostracods from the Králův Dvůr Formation (K. Lajblová), cornute echinoderms from L. Kašička, original dacryoconarida (*ex coll.* P. Lukeš and L. Ferová), original material from Vokáč *et al.* (2018),



Peršín *et al.* (2018), etc. The care of the CGS collections (300,000 pieces in total) was accompanied by intensive publishing activity.

### A brief history of the collections

The CGS collections were founded in 1960. They were managed by Dr. J. Svoboda, followed by Dr. J. Šetlík, Dr. M. Šnajdr, Assoc. Prof. J. Kraft, Prof. M. Mergl and Dr. Petr Štorch. Palaeontological collections (type and original material from publications) became increasingly important. Documentation material for maps and drill cores were stored in the depositories in Lužná near Rakovník and managed by virtue of Act No. 54/1959 Coll. In 1988, part of the regional geology collections were handed over to the Technical University of Ostrava. In 1995–2001, computer records were introduced and the depositories in Lužná were partially reconstructed. As of 30 May 2002, parts of

the collections were entered into the Central Registry of Collections (CES) of the Ministry of Culture of the Czech Republic; other material was included upon physical review. The basement depository in Klárovo was flooded in August 2002 and reconstructed in 2002–2003. In 2008–2011, the expansion of the collections was supported by R&D project No. DE08P04OMG002 of the Ministry of Culture of the Czech Republic. All the museum-quality collections (palaeontological collection, mineralogical-geological collection) were processed and entered into the CES; the Virtual Museum of CGS (<http://muzeum.geology.cz/>) was launched, and a catalogue of the collections was published. The drill cores in Lužná have been managed by the CGS – Geofond Borehole Material Documentation Department since 2017. The collection of Assoc. Prof. J. Sekyra (Antarctica, deserts, and high mountains) has been processed since 2014.

» *Phacopid trilobite*  
*Pedinopariops superstes*  
*superstes Chlupáč,*  
*exuvia of juvenile specimen.*  
Lower Devonian, Upper Emsian  
(= Dalejan), Daleje-Třebotov  
Formation, Daleje Shale  
facies; Čeřínka near Bubovice.  
Specimen CGS PB 801a.



» *Remains of the phyllocaris*  
*crustacean Ceratiocaris papilio Salter.*  
Silurian, Ludlow, Kopanina Formation,  
Všeradice. Specimen CGS PB 506.



» *Phacopid trilobite Illaenula*  
*illaenoides.* Lower Devonian, Emsian,  
Stínava-Chabíčov Formation, Stínava.  
Specimen CGS ICh 4527.



» *Star-shaped ichnofossil*  
from the Dobrotivá Formation  
(Middle Ordovician, Darriwilian);  
Praha-Šárka. Specimen YA 610.

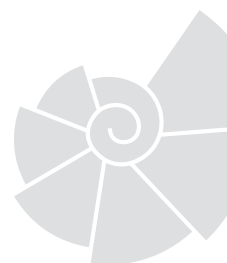








# Geological documentation



*Within the scope of duties of the state geological survey, the Geofond Division is tasked with collecting, storing and maintaining, evaluating and providing access to geological documentation and to the findings of earth science investigations, furnished by individuals and organizations in accordance with Act No. 62/1988 Coll., on geological work. These data are entered into specialized datasets and databases of the Geological Information System.*



**Milada Hrdlovicsová**  
Head of the Geological Documentation Department

## Archives

The **Archive of Geological Reports** is a specialized archive with the largest collection of unpublished geoscience documents in the Czech Republic. The collections include more than 260,000 archive records, mostly written documents with many graphic

supplements in the range of 3,600 metres. Over 5,000 records on geological project results were added to the archive in 2018. In addition to the final reports from newly conducted surveys, documents from older sources and outputs from CGS research activities were included in the collections as well. All the archive

« CGS Map Archive: Franz Eduard Suess (1903); Tektonische Skizze der Böhmisches-Masse, scale 1: 1,500,000, ID code M 2 B 329/71.





additions were processed and entered into an archive database, and the records were made available for parametric search in the new “ASGI” user application. Selected data from the reports obtained continued to be processed thematically in specialized datasets and databases.

The **Map Archive** collects map outputs from CGS activities and other geoscience maps from the Czech Republic as well as foreign countries. A total of 592 maps were added to the collection in 2018. An independent part of the collection comprises mining maps. Map documents may be searched for and browsed online in the “Map Archive” and “Mining Maps” applications.

The **archive services** of the main study room located at Kostelní 26, Prague 7, are used by a large community of professionals, scientists and students. In 2018, the study room staff provided visitors with 10,000 archival documents and other material in digital form.

The **systematic digitization of archival collections** provides quick and easy access to sources of geological information, and it also permanently preserves the oldest documents that are gradually fading. In August 2018, the digitization office in Prague was equipped with a new high-performance document scanner. Digitization of archive materials is provided to

researchers upon request as a paid service. Over 44,000 archive reports, representing more than 3.5 million files, are currently available in digital form as well as nearly all the Map Archive holdings containing more than 67,000 files.

### Borehole core material documentation

The repositories of the CGS Geofond Division hold a continually updated set of over 34,000 m of material samples, which are available upon request, in a special filing system of sample containers. These are rock samples or continuous drill cores from structural and other important boreholes in the Czech Republic.

### Borehole logs, hydrogeological database, geophysical records and archives

Information on geological exploration activities carried out in the Czech Republic is stored in individual specialized datasets based on point-diagram and planar-diagram systems. An updated “Borehole Surveys” application that displays attributes of selected sites with links to primary documents was released in 2018. Selected data from databases, including drilling profiles and hydrogeological data, can be ordered online using the “Geologically Documentated Objects” (GDO) application. Comprehensive outputs involving the



⚡ Prague digitization office with a new powerful XINO S713 scanner.



⚡ Archive study room.





interaction of individual datasets are provided upon request.

### The **Geologically Documented Objects**

**Dataset – GDO** contains basic information on geological exploration work. It is the most comprehensive dataset with more than 699,993 objects. A total of 3,363 objects were added to the dataset in 2018.

### The **Borehole, Shaft and Well Record**

**Dataset – GEO** specifies the basic GDO data with more comprehensive information, detailed object data, and petrographic descriptions of rocks encountered. A total of 982 objects were added in 2018, and the dataset now contains information on 621,527 objects.

The **Hydrogeological Database – HYD** contains hydrogeological data including measurements, analyses and tests. Data were continually updated for 2,392 objects in 2018. The database currently contains information on more than 104,547 objects.

### The **Technical Parameters of Well Drilling**

**Dataset – TECH** contains information on well construction and casing parameters for nearly 3,500 boreholes.

The **Drill Logging Dataset – KAR** contains digitized drill-logging data from more than 5,500 boreholes and



➤ *Discarding of drill cores – selection of representative samples for permanent storage.*

directional log data from more than 2,900 objects.

### The **Groundwater Data and Information Dataset**

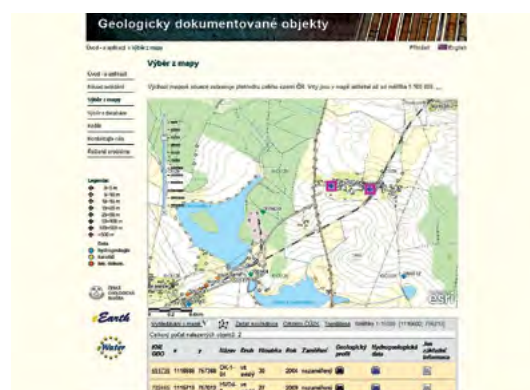
contains data on groundwater reserve estimation polygons and data on regional hydrogeological resource evaluation polygons. In 2018, 68 polygons from assessment reports prepared in 2000–2017 were processed and prepared for entry into the database, which currently contains 791 polygons.

### The **Geophysical Exploration Dataset**

includes the locations of significant geophysical surveys (gravimetric, magnetometric, airborne geophysical, VES measurements, seismic, petrophysical) contained in primary archival documents.



➤ *New ASGI application for archival document search.*



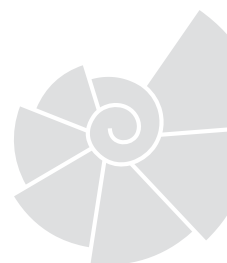
➤ *Geologically Documented Objects application.*







# CGS Publishing House and promotional activities



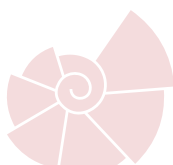
*The Publishing House of the Czech Geological Survey is the largest publisher of geological literature in the Czech Republic. At the same time, it publishes multimedia content promoting the activities of the Czech Geological Survey and geology as a field of study.*

*Each year, it releases expert publications dedicated to various Earth sciences, geological and thematic maps at various scales, and popular science and education literature, including those using modern technologies such as augmented reality.*

*The research results of CGS specialists and the popularization of Earth sciences are also presented to the public through geoscience exhibitions, fairs, conferences, educational activities, the CGS information portal, social networks and other modern technologies.*



**Patrik Fiferka**  
Head of the CGS Publishing House





## Book production

The Czech Geological Survey's work on various projects, and its publishing and commercial activities culminated in the release of 35 titles in 2018.

The best selling new release of the past year was the book *Jílovské zlaté doly* ("Jílové Gold Mines") by Petr Morávek and Jiří Litochleb.

The sales section menu of the CGS e-shop now includes English headings for easier orientation for foreign customers. The series of brochures *Journeys into the Geological Past* with augmented reality photos, which illustrate the geological evolution of selected localities, includes the newly released title ***Zkameněliny*** ("Fossils"), published in Czech and English.

## All the Way Down... Cotopaxi!



E-shop ČGS

The publication colorfully depicts the events experienced by the participants of the Cotopaxi Expedition in 1972. It recounts the sorrows and pleasures of the then very exotic journey to Ecuador, the ascent to the highest active volcano in the world, and the historic first descent to the bottom of its crater, the experience of standing on a glacier amid hot lava, the encounter with natives, and dramatic as well as humorous events. The narration is all the more interesting because it illuminates the events from two perspectives – as perceived by both of its authors Mydlík and Gábina. The honest portrayal of all possible and nearly impossible situations is illustrated by the authors' drawings and photographs.

## Statues, Memorials and Other Stone Monuments of Prague



E-shop ČGS

The book deals with the past and present history of stone sculptures, which adorn the squares, streets, parks, gardens and other open spaces in the capital city of Prague. These include statues, memorials, sacred, plague and memorial columns, wayside shrines, obelisks, candelabras and fountains, which are referred to in conservation as small monuments. The oldest date back to the first half of the 17<sup>th</sup> century, to the Post-White Mountain period, and the youngest to the early 21<sup>st</sup> century. Due to their extraordinary quantity, the book highlights virtually all the monuments located in the Historic Centre of Prague and only the most important ones located outside this area. In addition to basic information, it also mentions often neglected facts such as who created the monuments and what type of stone was used. This book is the first work of such broad scope devoted to this topic. It should not only serve art historians, conservators and restorers but also the residents and visitors of Prague.



### Jílové Gold Mines



E-shop ČGS

The landscape around Jílové u Prahy is not only full of natural beauty. The picturesque hills were not created by nature alone, man did his share as well. When the Celts discovered gold a thousand years ago, it was mostly obtained by panning from stream, fluvial and slope sediments, in which gold had accumulated for millions of years. The Celts were thorough, and much of the desired metal was not left behind. Their descendants had to venture underground, obtaining gold in adits tens and hundreds of metres deep. History has seen several "gold rush" periods as well as periods of decline. All of this is recounted in the publication written by renowned authors, who are leading experts on the occurrence and mining of gold in the Czech Republic. It takes into account the geological evolution of the area, describes the formation of gold-bearing deposits and their minerals, the attempts to restore mining, and the complexity faced by the prospecting for and mining and production of gold. Photographs and drawings illustrate the two-thousand-year history of gold mining at Jílové, highlighting unique old maps and preserved monuments of historical surface and subsurface mining, some of which are open to inquisitive visitors.

### Geology for Inquisitive Minds – Fossils



E-shop ČGS

This brochure shows those interested in palaeontology how various types of fossils form. It illustrates individual plants and animals from which fossils formed and helps explain the process of petrification. It is an ideal teaching material and contains photographs with augmented reality. Photos are displayed using the application *Geology for Inquisitive Minds – Fossils*, which can be downloaded for free from Google Play to your smartphone or tablet. It was also released in English.

### Geoscience Research Reports



E-shop ČGS

Both issues of the 51<sup>st</sup> edition of the journal *Geoscience Research Reports*, which has been released twice a year since 2017, were published. The articles are also published in PDF format on the Reports website during the course of the year.



#### Launch of the book *Až na dno... Cotopaxi!* ("All the Way Down... Cotopaxi!")



The launch of the book by Gabriela Zoubková and Miroslav Krůta *Až na dno... Cotopaxi!* ("All the Way Down... Cotopaxi!") was held on 9 October 2018 at the CGS Geological Bookstore. The book's "godmother" was CGS specialist Jaroslava Pertoldová.

#### Launch of the book *Pražské sochy, pomníky a jiné kamenné památky* ("Statues, Memorials and Other Stone Monuments of Prague")



The book *Pražské sochy, pomníky a jiné kamenné památky* ("Statues, Memorials and Other Stone Monuments of Prague") by Václav Rybářik was launched on 28 June 2018 at the CGS Geological Bookstore.

#### Book fairs and exhibitions

The Czech Geological Survey participated in the largest popular science education event of its kind in the Czech Republic – the *Science Fair of the Academy of Sciences of the Czech Republic*, held on 7–9 June in Prague.

We also assisted the Museum of the Bohemian Paradise in Turnov in organizing the exhibition *Liberecko ve stínu sopek* ("Liberec Region in the Shadow of Volcanoes"), which presented six volcanic formations that are representative examples of the types of volcanoes characteristic of the Liberec Region.

The Czech Geological Survey prepared a permanent geology exhibit for the purpose of school education at the Mozartova primary school in Jablonec nad Nisou. It focuses not only on presenting basic rock types but primarily on the geological structure and evolution of the Liberec Region. The exhibit is complemented by animations showing the geological evolution of selected localities – Jizerské hory Mts, Ještěd and Tachov – and by worksheets and excursion brochures of nearby areas.

Throughout the year, the visitors of the CGS Geological Bookstore were treated to diverse photographic exhibitions – *Krajinou Kuby* ("In the Cuban Landscape") by geologist Přemysl Zelenka was followed at the end of the year by Petr Kycl's photography exhibit *Gruzie* ("Georgia").

#### CGS at the Science Fair 2018

The Czech Geological Survey participated in the largest popular science education event of its kind in the Czech Republic – the *Science Fair of the Academy of Sciences of the Czech Republic*, held on 7–9 June in Prague. Visitors were greeted by countless novelties and interesting facts from the world of science and had the opportunity to learn about the results of work conducted by elite Czech scientists and innovative companies. Some stands resembled improvised



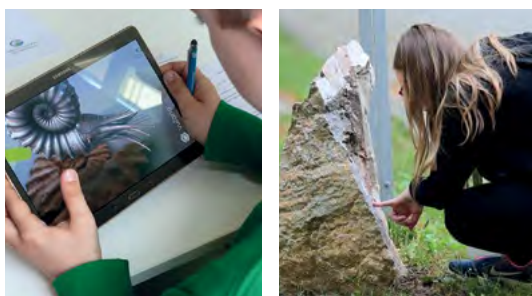
CGS at the Science Fair –  
videoreport on YouTube



laboratories and others included special exhibits. For instance, the Czech Geological Survey presented the results of its research, a 3D animation of life in the Palaeozoic ocean, and the use of augmented reality in popular science activities.

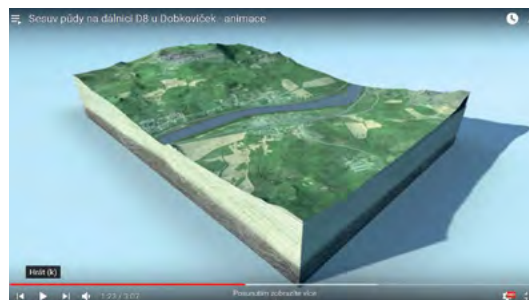
### Geology Olympiad

The competition took place during the course of the school year, culminating in a national round held on 9 May at the Faculty of Science of Masaryk University. Students successfully completed various theoretical and practical tasks at ten work stations. During summer vacation, the most successful participants of category B represented the Czech Republic at the International Earth Science Olympiad in Thailand. The Czech Geological Survey is a regular organizer of the olympiad's regional round for the capital city of Prague. The Geology Olympiad is organized by the Czech Geological Survey, Masaryk University, Charles University and by the Association of Museums and Galleries of the Czech Republic.



GO – web

### Sesuv půdy na dálnici D8 u Dobkoviček ("D8 Motorway Landslide Near Dobkovičky") animation

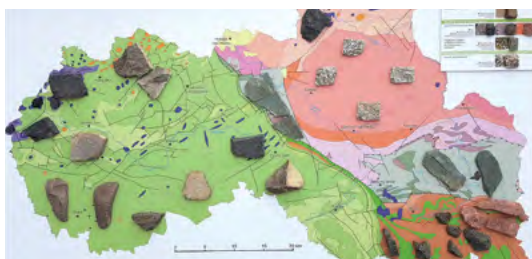


Animation on YouTube

The Czech Geological Survey produced an animation depicting the landslide on the D8 motorway near Dobkovičky. The landslide occurred on the unfinished highway in June 2013. The animation depicts the gradual evolution of the surroundings of Dobkovičky, from the initial sediment deposition on the ocean floor, subsequent volcanic activity and formation of the Labe valley, to the construction of a railway line, the development of a stone quarry, and the construction of the motorway. The geological processes that gradually formed the landslide-prone slope and the sequence of individual events leading up to the landslide are shown.



### Geology exhibit in Jablonec nad Nisou



Geology  
exhibit – web

A permanent geology exhibit was prepared by the Czech Geological Survey for the purpose of school education at the Mozartova primary school in Jablonec nad Nisou. It focuses not only on presenting basic rock types but primarily on the geological structure and evolution of the Liberec Region. The rocks are presented from different perspectives in three groups. It goes without saying that experts who study the geological structure characterize a much wider range of rock types. However, only basic rock types that commonly occur in the Liberec Region were chosen because the exhibit is intended mainly for primary school students. The exhibit is complemented by animations of the geological evolution of selected localities – Jizerské hory Mts, Ještěd and Tachov – and by worksheets and excursion brochures of nearby areas.



### Summer school of the GECON project in the Železné hory National Geopark

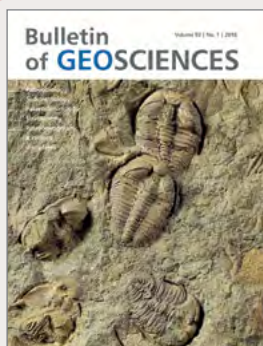


The Publishing House of the Czech Geological Survey is engaged in implementing the GECON (Geology Cooperation Network) project, which aims to establish and develop a cross-border cooperation network of institutions involved in the study, protection and presentation of the geological wealth of the Czech-Polish border region, and to strengthen cooperation and mutual exchange of knowledge among institutions. One of the activities includes summer schools for participating partner organizations and the interested public, including students of Czech and Polish universities. The theme of the first summer school – Geology and Modern Technology – attracted nearly 40 participants to the Železné hory National Geopark from the Czech Republic and Poland during the week of 20–24 August 2018. The rich summer school programme offered participants the opportunity to get acquainted, for instance, with the use of modern technologies in geological research, and with the collection and processing of data and their subsequent practical application and use in education and popularization of Earth sciences or in geotourism.





## Periodicals



The *Bulletin of Geosciences* ([www.geology.cz/bulletin](http://www.geology.cz/bulletin)) is the most significant scientific journal published by the Czech Geological Survey. This journal – formerly called “Věstník” – was founded at the request of the scientists from the State Geological Institute of the Czechoslovak Republic. The first volume was issued in 1925. Since then, thousands of scientific papers have been published in the journal and it now constitutes an archive of the most important scientific research on the geology of the Bohemian Massif. In 2006, a new editorial board set the focus of the journal on *palaeoenvironmental research and the evolution of life on Earth*. In 2007, the *Bulletin of Geosciences* was included with other international scientific journals in the most prestigious scientific databases. In 2010, based on its high-quality scientific content, the journal received an impact factor from the prestigious American company Thomson Reuters. Its impact factor in 2018 was 1.5. Thanks to the long-term efforts of the current editorial board, the *Bulletin of Geosciences* is one of the top 10 most important scientific journals published in the Czech Republic.



The Czech Geological Survey is a co-publisher of the *Journal of Geosciences* (<http://www.jgeosci.org>), released by the Czech Geological Society with the grant support of the Council of Scientific Societies of the Czech Republic and the Czech Literary Fund Foundation. Being a periodical with a long tradition (64<sup>th</sup> volume), it follows its predecessors *Časopis pro mineralogii a geologii* (“Journal of Mineralogy and Geology”) and *Journal of the Czech Geological Society*. Since 2006, it has been focusing on process-oriented studies dealing mainly with the mineralogy, structural geology, petrology and geochemistry of igneous and metamorphic rocks. In addition to regular volumes, special monothematic issues are also published. Two such issues were released last year, the first of which (editors J. Cempírek and M. Novák) is dedicated to selected articles from the “Tourmaline 2017” conference in Nové Město na Moravě and the second (editors T. Magna, V. Rappich and B. van Wyk de Vries) to the “Basalt” conference in Kadaň. The *Journal of Geosciences* maintains a high standard and is indexed in a number of database services, including the prestigious Web of Science, Scopus and GeoRef. Due to this fact, the Thomson Reuters company gave the journal an impact factor in 2011, which is currently 1.415.



The *Geoscience Research Reports*, a compilation of reports, has been published as a periodical in printed form by the Czech Geological Survey since 1952. In recent years, free access has been provided to the full texts of published papers in electronic form as well. The reports have been available since 1991. The *Geoscience Research Reports* acquaint the general public with current knowledge from a wide range of geological fields. Readers are provided with the research findings of academia, state institutions and private companies as well. The papers are clearly classified according to individual science topics – regional geology, stratigraphy, Quaternary research, engineering geology, palaeontology, mineralogy, petrology, geochemistry, hydrogeology, minerals, geophysics, geoinformatics and research abroad. The published articles have a high professional standard and are peer-reviewed. The multicolour publication with English abstracts is included in the List of Reviewed Non-Impact Periodicals approved by the Czech government’s Research, Development and Innovation Council. The CSAB (Content Selection and Advisory Board) has recommended the inclusion of this title in Scopus, for whose content Elsevier B.V. is responsible.

# Selected publications issued by the CGS



## Books



J. Křemáček  
**The Krkonoše-Jizera Composite Massif – never ending granite stories**



J. Starý et al.  
**Review of Reserved Mineral Deposit Reserves of the CR, Parts I and II**



J. Starý et al.  
**Review of Reserved Mineral Deposit Reserves of the CR, Part III**



J. Starý et al.  
**Changes in Reserves of Reserved Mineral Deposits in 2008–2017**



J. Starý et al.  
**Inventory of Mineral Deposit Reserves of the Czech Republic**



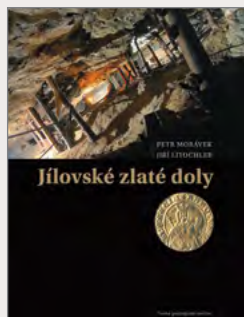
J. Starý et al.  
**Mineral Resources of the Czech Republic 2017**



J. Starý et al.  
**Mineral commodity summaries**



**Summary of Mineral Reserves in Mining Leases and Other Exploited Deposits of Non-Reserved Minerals as of 1 January 2018**



P. Morávek, J. Litochleb  
**Jílové Gold Mines**



G. Zoubková, M. Krůta  
**All the Way Down... Cotopaxi!**



J. Křemáček  
**Anatomy of Plutonic Bodies in the Czech Republic**



V. Rybářik  
**Statues, Memorials and Other Stone Monuments of Prague**



## Brochures with augmented reality photos



Journeys into the Geological Past – Kamenický vrch



Geology for Inquisitive Minds – Fossils (in Czech)



Geology for Inquisitive Minds – Fossils (in English)

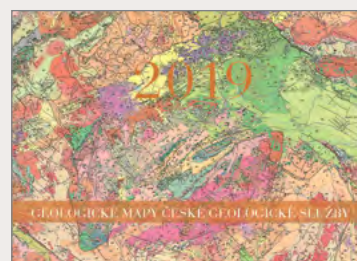
## Calendars



CEEMIR – Precious Stones

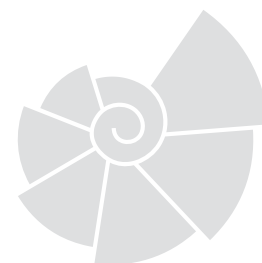


Liberec Region in the Shadow of Volcanoes



Geological Maps of the Czech Geological Survey

# Selected scientific papers



Al-Bassam, K. & Halodová, P. 2018, "Fossil bacteria in Cenomanian–Turonian phosphate nodules and coprolites, Bohemian Cretaceous Basin, Czech Republic", *Annales Societatis Geologorum Poloniae*, vol. 88, no. 3, pp. 257–272.

Al-Bassam, K. & Magna, T. 2018, "Distribution and significance of rare earth elements in Cenomanian–Turonian phosphate components and mudstones from the Bohemian Cretaceous Basin, Czech Republic", *Bulletin of Geosciences*, vol. 93, no. 3, pp. 347–368.

Altunkaynak, Ş., Aldanmaz, E., Güraslan, I.N., Çalişkanoglu, A.Z., Ünal, A. & Nývt, D. 2018, "Lithostratigraphy and petrology of Lachman Crag and Cape Lachman lava-fed deltas, Ulu Peninsula, James Ross Island, north-eastern Antarctic Peninsula: Preliminary results", *Czech Polar Reports*, vol. 8, no. 1, pp. 60–83.

Andronikov, A.V., Andronikova, I.E., Subetto, D.A. & Rudnickaitė, E. 2018, "Geochemical records of paleocontamination in Late Pleistocene lake sediments in West Flanders (Belgium)", *Geografiska Annaler, Series A: Physical Geography*, vol. 100, no. 2, pp. 204–220.

Barnet, I., Pacherová, P. & Poňavič, M. 2018, "Detection of faults using the profile measurements of radon concentration and gamma dose rate (Bohemian Massif, Czech Republic)", *Environmental Earth Sciences*, vol. 77, no. 9: 330.

Bohdálková, L., Bohdál, P., Břizová, E., Pacherová, P. & Kuběna, A.A. 2018, "Atmospheric metal pollution records in the Kovářská Bog (Czech Republic) as an indicator of anthropogenic activities over the last three millennia", *Science of the Total Environment*, vol. 633, pp. 857–874.

Broda, K., Collette, J. & Budil, P. 2018, "Phyllocarid crustaceans from the Late Devonian of the Kowala quarry (Holy Cross Mountains, central Poland)", *Papers in Palaeontology*, vol. 4, no. 1, pp. 67–84.

Broussolle, A., Aguilar, C., Sun, M., Schulmann, K., Štípská, P., Jiang, Y., Yu, Y., Xiao, W., Wang, S. & Miková, J. 2018, "Polycyclic Palaeozoic evolution of accretionary orogenic wedge in the southern Chinese Altai: evidence from structural relationships and U–Pb geochronology", *Lithos*, vol. 314–315, pp. 400–424.

Chalupa, F., Vilhelm, J., Petružálek, M. & Bukovská, Z. 2018, "Application of T-matrix model for static moduli approximation from dynamic moduli determined by sonic well logging", *International Journal of Rock Mechanics and Mining Sciences*, vol. 112, pp. 281–289.

Collett, S., Štípská, P., Schulmann, K., Peřestý, V., Soldner, J., Anczkiewicz, R., Lexa, O. & Kylander-Clark, A. 2018, "Combined Lu–Hf and Sm–Nd geochronology of the Mariánské Lázně Complex: new constraints on the timing of eclogite- and granulite-facies metamorphism", *Lithos*, vol. 304–307, pp. 74–94.

Čopjaková, R. & Kotková, J. 2018, "Composition of barium mica in multiphase solid inclusions from orogenic garnet peridotites as evidence of mantle metasomatism in a subduction zone setting", *Contributions to Mineralogy and Petrology*, vol. 173, no. 12: 106.

Correia, P., Šimůnek, Z., Artur, S.A. & Flores, D. 2018, "A new Late Pennsylvanian floral assemblage from the Douro Basin, Portugal", *Geological Journal*, vol. 53, no. 6, pp. 2507–2531.

Dannhaus, N., Wittmann, H., Krám, P., Christl, M. & von Blanckenburg, F. 2018, "Catchment-wide weathering and erosion rates of mafic, ultramafic, and granitic rock from cosmogenic meteoric <sup>10</sup>Be/<sup>9</sup>Be ratios", *Geochimica et Cosmochimica Acta*, vol. 222, pp. 618–641.

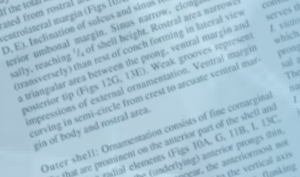
Drage, H.B., Laibl, L. & Budil, P. 2018, "Postembryonic development of Dalmanitina, and the evolution of facial suture fusion in Phacopina", *Paleobiology*, vol. 44, no. 4, pp. 638–659.

Drahota, P., Kulakowski, O., Culka, A., Knappová, M., Rohovec, J., Veselovský, F. & Racek, M. 2018, "Arsenic mineralogy of near-neutral soils and mining waste at the Smolately–Lišnice historical gold district, Czech Republic", *Applied Geochemistry*, vol. 89, pp. 243–254.

Dworkin, J.P., Adelman, L.A., Ajluni, T., Andronikov, A.V., Aponte, J.C., Bartels, A.E., Beshore, E., Bierhaus, E.B., Brucato, J.R., Bryan, B.H., Burton, A.S., Callahan, M.P., Castro-Wallace, S.L., Clark, B.C., Clemett, S.J., Connolly, H.C., Cutlip, W.E., Daly, S.M., Elliott, V.E., Elsila, J.E., Enos, H.L., Everett, D.F., Franchi, I.A., Glavin, D.P., Graham, H.V., Hendershot, J.E., Harris, J.W., Hill, S.L.,



- Hildebrand, A.R., Jayne, G.O., Jenkins, R.W., Johnson, K.S., Kirsch, J.S., Lauretta, D.S., Lewis, A.S., Loiacono, J.J., Lorentson, C.C., Marshall, J.R., Martin, M.G., Matthias, L.L., McLain, H.L., Messenger, S.R., Mink, R.G., Moore, J.L., Nakamura-Messenger, K., Nuth, J.A., Owens, C.V., Parish, C.L., Perkins, B.D., Pryzby, M.S., Reigle, C.A., Richter, K., Rizk, B., Russell, J.F., Sandford, S.A., Schepis, J.P., Songer, J., Sovinski, M.F., Stahl, S.E., Thomas-Keprta, K., Vellinga, J.M. & Walker, M.S. 2018, "OSIRIS-REx Contamination Control Strategy and Implementation", *Space Science Reviews*, vol. 214, no. 1: 19.
- Edel, J.B., Schulmann, K., Lexa, O. & Lardeaux, J.M. 2018, "Late Palaeozoic palaeomagnetic and tectonic constraints for amalgamation of Pangea supercontinent in the European Variscan belt", *Earth-Science Reviews*, vol. 177, pp. 589–612.
- Elbra, T., Bubík, M., Reháková, D., Schnabl, P., Čížková, K., Pruner, P., Kdýr, Š., Svobodová, A. & Švábenická, L. 2018, "Magneto- and biostratigraphy across the Jurassic-Cretaceous boundary in the Kurovice section, Western Carpathians, Czech Republic", *Cretaceous Research*, vol. 89, pp. 211–223.
- Ellis, B.S., Szymanowski, D., Magna, T., Neukampf, J., Dohmen, R., Bachmann, O., Ulmer, P. & Guillong, M. 2018, "Post-eruptive mobility of lithium in volcanic rocks", *Nature Communications*, vol. 9, no. 1: 3228.
- Farkaš, J., Frýda, J., Paulukat, C., Hathorne, E.C., Matoušková, Š., Rohovec, J., Frýdová, B., Francová, M. & Frei, R. 2018, "Chromium isotope fractionation between modern seawater and biogenic carbonates from the Great Barrier Reef, Australia: Implications for the paleo-seawater  $\delta^{53}\text{Cr}$  reconstruction", *Earth and Planetary Science Letters*, vol. 498, pp. 140–151.
- Fatka, O. & Budil, P. 2018, "Digestive structures in the Middle Ordovician trilobite *Prionocheilus* Rouault 1847, from the Barrandian area of Czech Republic", *Geologica Acta*, vol. 16, no. 1, pp. 65–73.
- Ghienne, J., Benvenuti, A., El Houicha, M., Girard, F., Kali, E., Khoukhi, Y., Langbour, C., Magna, T., Míková, J., Moscardello, A. & Schulmann, K. 2018, "The impact of the end-Ordovician glaciation on sediment routing systems: A case study from the Meseta (northern Morocco)", *Gondwana Research*, vol. 63, pp. 169–178.
- Gholizadeh, A., Saberioon, M., Carmon, N., Boruvka, L. & Ben-Dor, E. 2018, "Examining the performance of PARACUDA-II data-mining engine versus selected techniques to model soil carbon from reflectance spectra", *Remote Sensing*, vol. 10, no. 8: 1172.
- Gnojek, I., Sedlák, J., Rapprich, V., Skácelová, Z., Mlčoch, B., Krentz, O. & Casas-García, R. 2018, "Structure of the Carboniferous Altenberg-Teplice caldera (Eastern part of the Krušné hory/Erzgebirge Mts.) revealed by combined airborne and ground gamma-ray spectrometry", *Journal of Geosciences (Czech Republic)*, vol. 63, no. 1, pp. 3–20.
- Grösslová, Z., Vaněk, A., Oborná, V., Mihaljevič, M., Ettler, V., Trubač, J., Drahota, P., Penížek, V., Pavlů, L., Šrámek, O., Kříbek, B., Voegelin, A., Göttlicher, J., Drábek, O., Tejnecký, V., Houška, J., Mapani, B. & Zádorová, T. 2018, "Thallium contamination of desert soil in Namibia: Chemical, mineralogical and isotopic insights", *Environmental Pollution*, vol. 239, pp. 272–280.
- Hanáček, M., Nývlt, D., Skácelová, Z., Nehyba, S., Procházková, B. & Engel, Z. 2018, "Sedimentary evidence for an ice-sheet dammed lake in a mountain valley of the Eastern Sudetes, Czechia", *Acta Geologica Polonica*, vol. 68, no. 1, pp. 107–134.
- Herrera, G., Mateos, R.M., García-Davalillo, J.C., Grandjean, G., Poyiadji, E., Maftai, R., Filipciuc, T.C., Jemec Auflíč, M., Jež, J., Podolski, L., Trigila, A., Iadanza, C., Raetzo, H., Kociu, A., Przyłucka, M., Kułak, M., Sheehy, M., Pellicer, X.M., McKeown, C., Ryan, G., Kopačková, V., Frei, M., Kuhn, D., Hermanns, R.L., Koulermou, N., Smith, C.A., Engdahl, M., Buxó, P., Gonzalez, M., Dashwood, C., Reeves, H., Cigna, F., Lik, P., Paudits, P., Mikulénas, V., Demir, V., Raha, M., Quental, L., Sandić, C., Fusi, B. & Jensen, O.A. 2018, "Landslide databases in the Geological Surveys of Europe", *Landslides*, vol. 15, no. 2, pp. 359–379.
- Holmberg, M., Aherne, J., Austnes, K., Beloica, J., De Marco, A., Dirnböck, T., Fornasier, M.F., Goergen, K., Futter, M., Lindroos, A.J., Krám, P., Neirynck, J., Nieminen, T.M., Pecka, T., Posch, M., Pröll, G., Rowe, E.C., Scheuschner, T., Schlutow, A., Valinia, S. & Forsius, M. 2018, "Modelling study of soil C, N and pH response to air pollution and climate change using European LTER site observations", *Science of the Total Environment*, vol. 640–641, pp. 387–399.
- Homonnay, E., Corsini, M., Lardeaux, J., Romagny, A., Münch, P., Bosch, D., Cenki-Tok, B. & Ouazzani-Touhami, M. 2018, "Miocene crustal extension following thrust tectonic in the Lower Sebtides units (internal Rif, Ceuta Peninsula, Spain): Implication for the geodynamic evolution of the Alboran domain", *Tectonophysics*, vol. 722, pp. 507–535.
- Jankovská, V., Baroň, I., Nývlt, D., Krejčí, O. & Krejčí, V. 2018, "Last Glacial to Holocene vegetation succession recorded in polyphase slope-failure deposits on the Maleník Ridge, Outer Western Carpathians", *Quaternary International*, vol. 470, pp. 38–52.

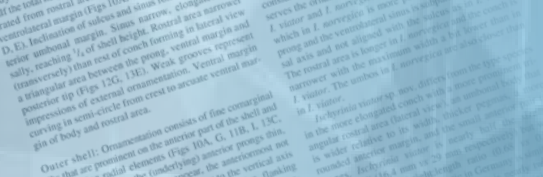


- 102
- Annual Report Czech Geological Survey 2018*



- Mihaljevič, M., Jarošíková, A., Ettler, V., Vaněk, A., Penížek, V., Kříbek, B., Chrástný, V., Šrámek, O., Trubač, J., Svoboda, M. & Nyambe, I. 2018, "Copper isotopic record in soils and tree rings near a copper smelter, Copperbelt, Zambia", *Science of the Total Environment*, vol. 621, pp. 9–17.
- Moldan, F., Jutterström, S.E.A., Hruška, J. & Wright, R.F. 2018, "Experimental addition of nitrogen to a whole forest ecosystem at Gårdsjön, Sweden (NITREX): Nitrate leaching during 26 years of treatment", *Environmental Pollution*, vol. 242, pp. 367–374.
- Nguyen, H., Hanžl, P., Janoušek, V., Schulmann, K., Ulrich, M., Jiang, Y., Lexa, O., Altanbaatar, B. & Deiller, P. 2018, "Geochemistry and geochronology of Mississippian volcanic rocks from SW Mongolia: Implications for terrane subdivision and magmatic arc activity in the Trans-Altai Zone", *Journal of Asian Earth Sciences*, vol. 164, pp. 322–343.
- Novák, M., Šebek, O., Chrástný, V., Hellerich, L.A., Andronikov, A., Martinková, E., Farkaš, J., Pachterová, P., Čuřík, J., Štěpánová, M., Přechová, E., Housková, M., Zoulková, V., Veselovský, F., Svobodová, I., Janotová, P. & Komárek, A. 2018, "Comparison of  $\delta^{53}\text{Cr}_{\text{Cr(VI)}}$  values of contaminated groundwater at two industrial sites in the eastern U.S. with contrasting availability of reducing agents", *Chemical Geology*, vol. 481, pp. 74–84.
- Novák, M., Štěpánová, M., Bůzek, F., Jačková, I., Čuřík, J., Veselovský, F., Přechová, E., Antalová, E., Brychnáčová, J., Buřková, I. & Komárek, A. 2018, "The Fate of  $^{15}\text{N}$  Tracer in Waterlogged Peat Cores from Two Central European Bogs with Different N Pollution History", *Water, Air, and Soil Pollution*, vol. 229, no. 3 :70.
- Novák, M., Suarez, S.P., Gebauer, G., Thoma, M., Bůzek, F., Čejková, B., Jačková, I., Štěpánová, M., Přechová, E., Čuřík, J., Veselovský, F., Válková, I., Blaha, V., Fottová, D. & Komárek, A. 2018, "Relationship between nitrogen isotope ratios of  $\text{NO}_3^-$  and  $\text{N}_2\text{O}$  in vertical porewater profiles through a polluted rain-fed peat bog", *Soil Biology and Biochemistry*, vol. 123, pp. 7–9.
- Opluštil, S., Lojka, R., Pšenička, J., Yilmaz, Ç. & Yilmaz, M. 2018, "Sedimentology and stratigraphy of the Amasra coalfield (Pennsylvanian), NW Turkey – New insight from a 1 km thick section", *International Journal of Coal Geology*, vol. 195, pp. 317–346.
- Oulehle, F., Tahovská, K., Chuman, T., Evans, C.D., Hruška, J., Růžek, M. & Bárta, J. 2018, "Comparison of the impacts of acid and nitrogen additions on carbon fluxes in European conifer and broadleaf forests", *Environmental Pollution*, vol. 238, pp. 884–893.
- Petri, B., Skrzypek, E., Mohn, G., Mateeva, T., Robion, P., Schulmann, K., Manatschal, G. & Müntener, O. 2018, "Mechanical anisotropies and mechanisms of mafic magma ascent in the middle continental crust: The Sondalo magmatic system (N Italy)", *Bulletin of the Geological Society of America*, vol. 130, no. 1–2, pp. 331–352.
- Petronis, M., Valenta, J., Rappich, V., Lindline, J., Heizler, M., van Wyk de Vries, B., Shields, S., Balek, J., Fojtíková, L. & Tábořík, P. 2018, "Emplacement History of the Miocene Zebín Tuff Cone (Czech Republic) Revealed From Ground Geophysics, Anisotropy of Magnetic Susceptibility, Paleomagnetic, and  $^{40}\text{Ar}/^{39}\text{Ar}$  Geochronology Data", *Geochemistry, Geophysics, Geosystems*, vol. 19, no. 10, pp. 3764–3792.
- Poňavič, M., Wittlingerová, Z., Čoupek, P. & Buda, J. 2018, "Soil geochemical mapping of the central part of Prague, Czech Republic", *Journal of Geochemical Exploration*, vol. 187, pp. 118–130.
- Ponocná, T., Chuman, T., Rydval, M., Urban, G., Migala, K. & Tremel, V. 2018, "Deviations of treeline Norway spruce radial growth from summer temperatures in East-Central Europe", *Agricultural and Forest Meteorology*, vol. 253–254, pp. 62–70.
- Rálek, P., Sosna, K., Hokr, M. & Franěk, J. 2018, "In situ measurements of thermally loaded rock and evaluation of an experiment with a 3D numerical model", *International Journal of Rock Mechanics and Mining Sciences*, vol. 105, pp. 1–10.
- Saleh, F., Candela, Y., Harper, D.A.T., Polechová, M., Lefebvre, B. & Pittet, B. 2018, "Storm-induced community dynamics in the Fezouata biota (Lower Ordovician, Morocco)", *Palaios*, vol. 33, no. 12, pp. 535–541.
- Schneider, S.C., Oulehle, F., Krám, P. & Hruška, J. 2018, "Recovery of benthic algal assemblages from acidification: how long does it take, and is there a link to eutrophication?", *Hydrobiologia*, vol. 805, no. 1, pp. 33–47.
- Shalev, N., Farkaš, J., Fietzke, J., Novák, M., Schuessler, J.A., Pogge von Strandmann, P.A.E. & Törber, P.B. 2018, "Mg Isotope Interlaboratory Comparison of Reference Materials from Earth-Surface Low-Temperature Environments", *Geostandards and Geoanalytical Research*, vol. 42, no. 2, pp. 205–221.
- Šimůnek, Z. 2018, "Cuticular analysis of new Westphalian and Stephanian *Cordaites* species from the USA", *Review of Palaeobotany and Palynology*, vol. 253, pp. 1–14.





- 104
- Annual Report Czech Geological Survey 2018*

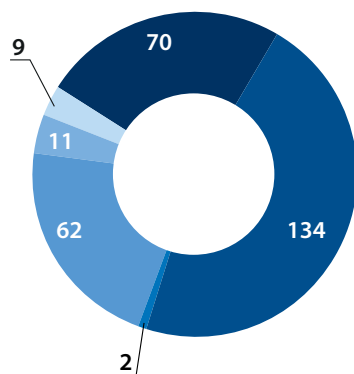


Vymazalová, A., Laufek, F., Sluzhenikin, S.F., Kozlov, V.V., Stanley, C.J., Plášil, J., Zaccarini, F., Garuti, G. & Bakker, R. 2018, "Thalhammerite,  $\text{Pd}_9\text{Ag}_2\text{Bi}_2\text{S}_4$ , a new mineral from the Talnakh and Oktyabrsk deposits, Noril'sk Region, Russia", *Minerals*, vol. 8, no. 8: 339.

Walasek, N., Loydell, D.K., Frýda, J., Männik, P. & Loveridge, R.F. 2018, "Integrated graptolite-conodont biostratigraphy and organic carbon chemostratigraphy of the Llandovery of Kallholn quarry, Dalarna, Sweden", *Palaeogeography, Palaeoclimatology, Palaeoecology*, vol. 508, pp. 1–16.

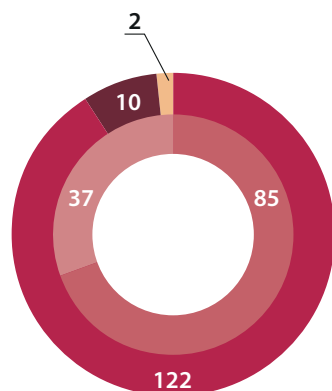
Závada, P., Schulmann, K., Racek, M., Hasalová, P., Jeřábek, P., Weinberg, R.F., Štípská, P. & Roberts, A. 2018, "Role of strain localization and melt flow on exhumation of deeply subducted continental crust", *Lithosphere*, vol. 10, no. 2, pp. 217–238.

Zyval, V., Køenová, Z., Raus, M., Štrupl, V., Zyvaljun, V. & Zyvalova, J. 2018, "Effects of deicing salt in protected areas: Water quality monitoring in the river basin with the occurrence of a rare pearl mussel", *Inżynieria Mineralna*, vol. 19, no. 1, pp. 99–102.



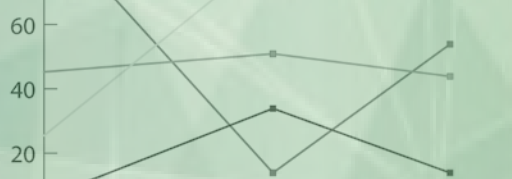
#### CGS publishing activity in 2018

- Papers in journals
- Papers in peer-reviewed compilations
- Papers in non-peer-reviewed compilations
- Scientific book
- Book chapter
- Maps

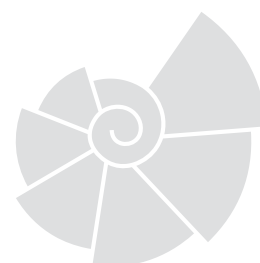


#### Number of papers in journals

- Papers in peer-reviewed scientific journals
  - in journals with impact factors
  - in journals without impact factors
- Papers in non-peer-reviewed scientific journals
- Papers in popular science and education periodicals and newspapers



# Financial review for 2018



*In 2018, the Czech Geological Survey reached a positive financial balance of CZK 2,466,343, of which CZK 2,041,100 represent primary activities and CZK 425,243 secondary activities.*



**Zdeněk Cilc**

Head of the Economic Division and Deputy Director for Economics

## Objectives achieved

In 2018, the Czech Geological Survey continued to successfully perform the tasks of the state geological survey and to increase income from its own activities – a year-on-year increase of CZK 22.7 million.

The staff secured enough revenue to cover the organization's expenditures and continued development. Total personnel cost increased by CZK 23.1 million.

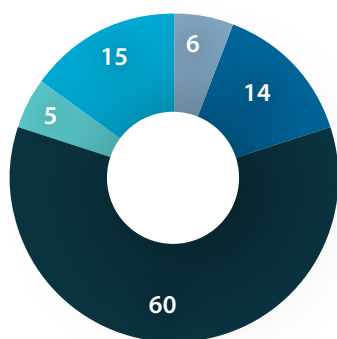
With its results in research and development (R&D) in 2018, the organization retained its top ranking in the R&D evaluation system and secured the necessary funding for development of research organizations – a total of CZK 101.7 million.

In order to ensure adequate competitiveness and highly qualified expertise, considerable investments were made in 2018 – CZK 46 million (of which nearly CZK 39 million was covered by the organization's founder) on the update and upgrade of technical equipment, ICT and on property management.



## Total expenditures of the organization

Total expenditures (CZK)	370 087 556
Material and power consumption	23 807 879
Services	50 739 095
Total personnel cost	222 506 252
Depreciation of tangible and intangible assets	17 576 519
Other expenses	55 457 811

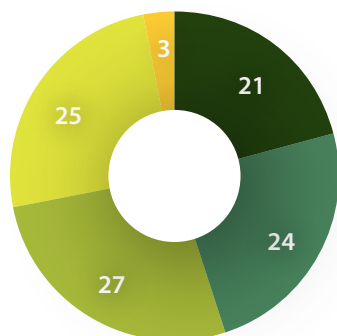


### Percentage distribution of expenditure in various categories for 2018

- Material and power consumption
- Services
- Total personnel cost
- Depreciation of tangible and intangible assets
- Other expenses

## Total income of the organization

Total income (CZK)	372 553 899
Sales and other own-source revenue	76 830 454
Allocation for activities of the organization	88 876 584
Institutional funding for development of research organizations	101 732 911
Funds for projects and commissioned services	94 643 345
Income from transfers	10 470 605

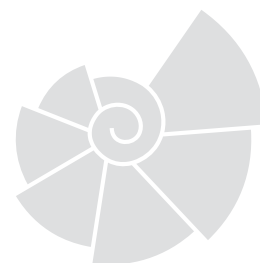


### Percentage distribution of income in various categories for 2018

- Sales and other own-source revenue
- Allocation for activities of the organization
- Institutional funding for development of research organizations
- Funds for projects and commissioned services
- Income from transfers



# Human resources



*In 2018, 405 employees and 127 freelance workers worked for the Czech Geological Survey, which is the equivalent of 343.84 persons working full-time.*

*In comparison with 2017 (390 employees), this represents an increase of nearly 4%.*



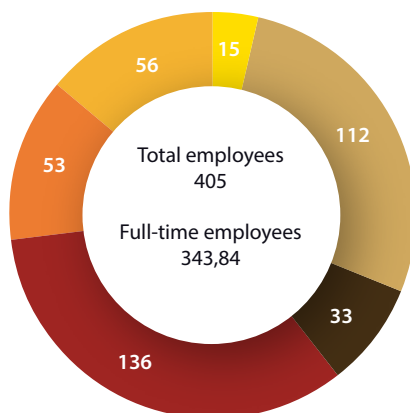
**Martin Pastierik**  
Head of the Human Resources Department

These indicators not only underline the high level of competitiveness in the labour market, but they also emphasize the organization's economic growth and prestige with regard to research institutions in the Czech Republic. The Czech Geological Survey actively supports the professional development of its employees and takes an interest in enhancing their qualifications. It provides training for its employees through a wide range of courses and seminars, such as language courses, legal and

economic courses, expert training, specialized seminars and so on.

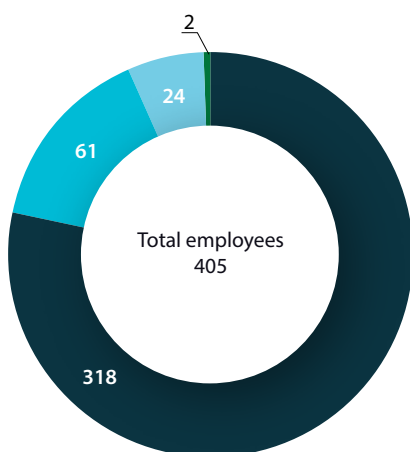
The CGS also observes the principles of equal employment opportunity for all age groups, women and men alike covering a wide range of employment conditions. This is reflected by the fact that employees returning from maternity or parental leave are offered the opportunity of working part-time as in the case of working seniors and staff members involved in university or PhD study programmes.





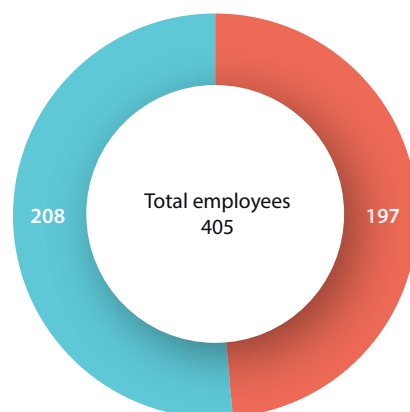
Number of employees per department

- Directorate
- Geochemistry and Laboratories
- Economic Division
- Geology Division
- Geofond Division
- Division of Informatics



Education background of the CGS

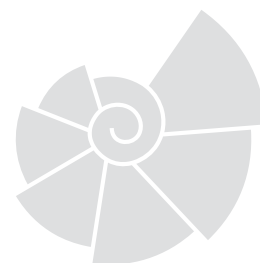
- University
- Secondary with graduation exam
- Apprentice
- Elementary



Gender ratio of the CGS staff

- Women
- Men

# Website of the Czech Geological Survey

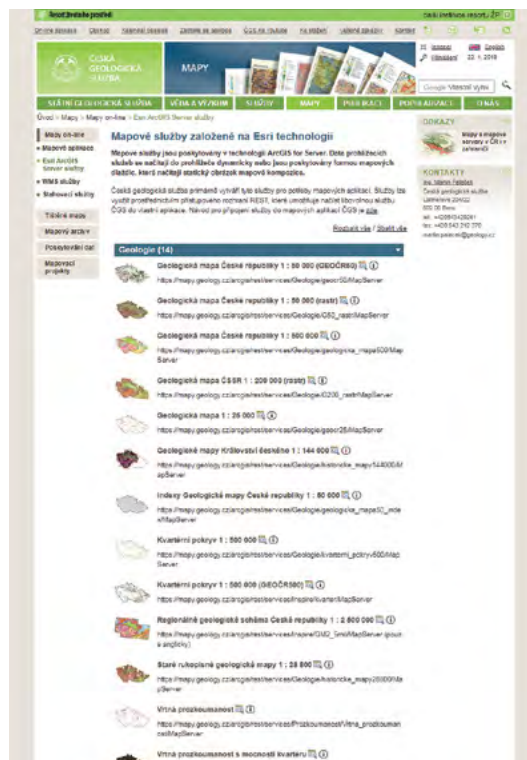


*The Czech Geological Survey publicizes the results of its activities through dozens of web presentations. Their content and technical background are being constantly updated and upgraded.*



**Radek Svítal**  
Web administrator

During 2018, a new version of a tool for displaying maps on the website was completed. The new version of the tool, which is called "Mappy" and which uses ESRI's API for JavaScript, was used to develop map applications optimized for mobile touch screen devices (<https://mapy.geology.cz/geo>, <https://mapy.geology.cz/haz>, <https://mapy.geology.cz/pop>) and also for interactive




↗ Signposts with ArcGIS server map services  
<http://www.geology.cz/extranet/mapy/mapy-online/esri>





maps embedded in web pages (for example, on the home page of the National Geoparks Council at <http://www.geology.cz/narodnigeoparky>).

Signposts with ArcGIS server map services were placed on the Czech and English extranets, see <http://www.geology.cz/extranet/maps/maps-online/esri> and <http://www.geology.cz/extranet-eng/maps/online/esri>.

There has been a major technological upgrade of all four extranet application signposts that are now fully responsive and easier to maintain. They also include highlighted web-based online applications that are optimized for mobile devices .

At the same time, the signpost page detects the type of device with which a user is accessing the page, and applications optimized for mobile devices are displayed on the first position on these devices. See:

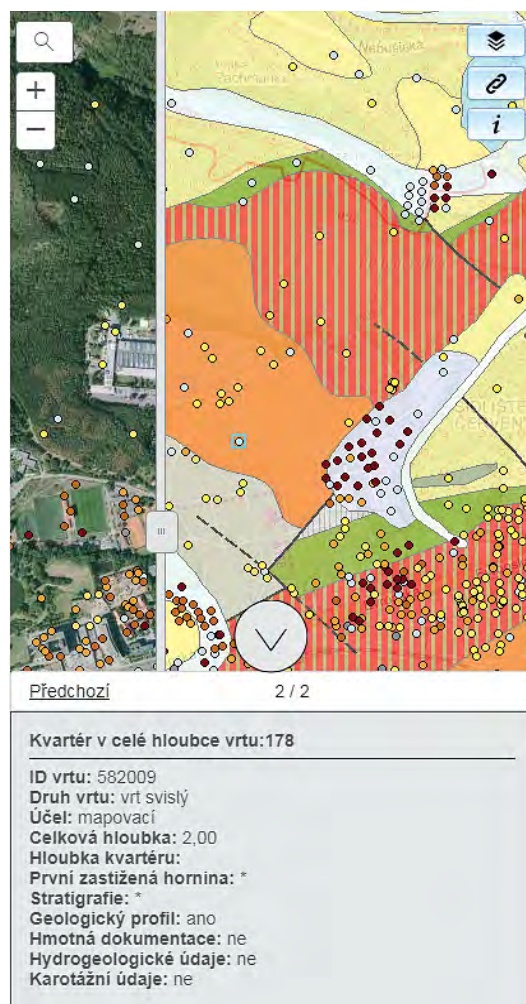
<http://aplikace.geology.cz>

<http://mapy.geology.cz>

<http://applications.geology.cz>

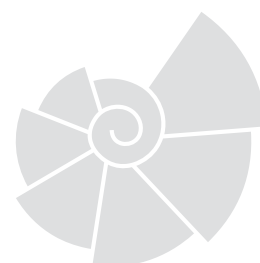
<http://maps.geology.cz>

The search for a solution to replace the existing Oracle Portal (from 2005) continued. Deployment of the open-source content management system Drupal is being considered as an optimal alternative. A preliminary analysis of functions was conducted (starting with LDAP and ending with individual web editing functions), which are necessary for its successful deployment in CGS conditions and for which suitable technical solutions are gradually being sought. In connection with the planned transfer of current websites built with Oracle Portal to a new future solution, existing websites began to be added to the metadata catalogue, some apparently unnecessary and outdated sites were shut down, and guidelines for creating new websites were developed and their end-of-life date clarified.



⚡ "Geoscience Maps" application for mobile devices.

# Principal events in 2018



22–23 JANUARY

## Successful completion of the ProSUM project in Brussels



The deputy head of the Informatics Division RNDr. Dana Čápková and Mgr. Pavla Kramolišová took part in the presentation and successful completion of the ProSUM project, funded by the European Commission under the Horizon 2020 work programme. The meeting was held in front of representatives of the European Commission, and the Czech Geological Survey was commended particularly for its work involving the creation of the Metadata Catalogue. The project also extended the data model for raw materials to include mining waste data. According to this model, the mining waste dataset was then harmonized and an updated INSPIRE download service for mineral resources was published.

21 MARCH

## Release of the Mineral Commodity Summaries of the Czech Republic

The CGS published the 25<sup>th</sup> anniversary edition of the Mineral Commodity Summaries in Czech and English. The yearbook provides a comprehensive overview of mineral deposits in relation to the geological structure, environmental protection and mining economics, including an overview of foreign trade in mineral resources. The yearbook is unique from a global perspective and has received many awards, for instance, from the European Commission (DG Enterprise and Industry). It was first published in May 1993 and has successfully represented Czech economic geology for 25 years.



21–23 MARCH

## Launch of the GECON (GEology-COoperation-Network) project



The Czech-Polish GECON (GEology-COoperation-Network) project was launched in the Ralsko Geopark. The project's aim is to establish and develop a cross-border cooperation network of institutions involved in the study, protection and presentation of the geological wealth in the Czech-Polish border region, and to strengthen cooperation and mutual exchange of knowledge among institutions. A meeting of the cooperating organizations took place in Hamr na Jezeře and a field trip included the following adjacent localities: Děvín, Schachtenstein, Široký kámen, Ostrovské vrchy, Stohánek or Dlouhý kámen.

9 APRIL

## Geology Olympiad 2018



The regional round of the Geology Olympiad for the capital city of Prague was held at the Czech Geological Survey. Participants had to take a test, identify minerals, rocks and fossils, and also viewed the collections of the CGS and a 3D animation of the Palaeozoic ocean. The Geology Olympiad is a competition in geoscience knowledge designed for primary and secondary school students. The national round was held on 9 May at the Faculty of Science of Masaryk University, and students successfully completed various theoretical and practical tasks at ten work stations. During summer vacation, the most successful participants of category B represented the Czech Republic at the International Earth Science Olympiad in Thailand. The Geology Olympiad is co-organized by Masaryk University, the Czech Geological Survey, Charles University and the Association of Museums and Galleries of the Czech Republic.



22-23 JANUARY

14-19 MAY

SEPTEMBER

21-23 MARCH

13-16 JUNE

17 J

9 OCTOBER

2

10 APRIL

**Old geological maps online**

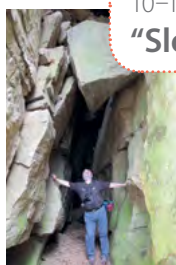
A new version of the map application History of Geological Mapping in the Czech Republic was launched in April 2018. It provides access to two unique sets of geological maps from the second half of the 19<sup>th</sup> century (manuscript geological maps at a scale of 1:28,800 and geological maps of the Kingdom of Bohemia at a scale of 1:144,000 – referred to as the Haidinger maps). More information regarding the maps and their processing is available on the CGS archives webpage.



10-12 APRIL

**"Slope Deformations and Pseudokarst" conference**

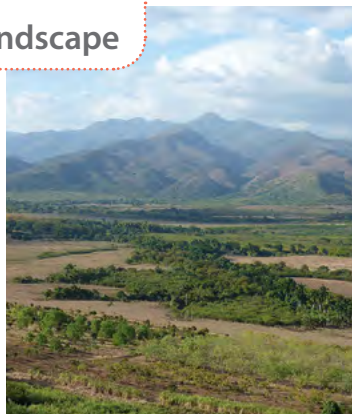
The 10<sup>th</sup> "Slope Deformations and Pseudokarst" conference was held in Mikulov.



3 MAY

**In the Cuban Landscape**

The launch of the photography exhibit *Krajina Kuby* ("In the Cuban Landscape") by geologist Přemysl Zelenka was held at the CGS Geological Bookstore.



14-19 MAY

**Spring school of geological storage of CO<sub>2</sub>**

The European research project ENOS, in which the Czech Geological Survey is engaged, organized the Spring School of Geological Storage of CO<sub>2</sub>, designed for doctoral students, young researchers, scientists and advanced students focusing on geoscience or environmental and low carbon technologies. The week-long course was held in Latera near Rome.



16 MAY

## First finalized and approved milestone of the “Cross-Border Cooperation Project for the Development of Railway Transport Saxony – Czech Republic”



The “Cross-Border Cooperation Project for the Development of Railway Transport Saxony – Czech Republic” included another planned meeting hosted by Jan Evangelista Purkyně University in Ústí nad Labem, which is one of the project partners. During the meeting, all project partners finalized a report on the project’s first milestone and assigned further activities, priorities and deadlines for the ensuing period. The employees of the Czech Geological Survey provided information on completed partial outputs, which include a cross-border geological map and a methodology for conducting surveys and data collection.



7-9 JUNE

## Czech Geological Survey at Science Fair 2018



The Czech Geological Survey participated in the largest popular science education event of its kind in the Czech Republic – the Science Fair of the Academy of Sciences of the Czech Republic held in Prague. Visitors were greeted by countless novelties and interesting facts from the world of science and had the opportunity to learn about the results of work conducted by elite Czech scientists and innovative companies. Some stands resembled improvised laboratories and others included special exhibits. For instance, the Czech Geological Survey presented the results of its research, a 3D animation of life in the Palaeozoic ocean, and the use of augmented reality in popular science activities.



13-16 JUNE

## GECON: Field trip in the Sudetic Foreland Geopark



The GECON project (GEology-COoperation-Network) included a second field trip in the Polish Sudetic Foreland Geopark. The geopark lies in Lower Silesia and attracts visitors mainly with its interesting geological structure and variety of rocks and minerals. The area is also known for its long history of mining, which left behind many technical monuments related to mining and metallurgy. There are also unique cultural monuments, including important conservation areas. A rich programme, corresponding to the project objectives that include the establishment and development of a cross-border cooperation network of institutions involved in the study, protection and presentation of the geological wealth in the Czech-Polish border region, was prepared for the representatives of individual institutions participating in the project.





22–23 JANUARY

21–23 MARCH

14–19 MAY

13–16 JUNE

17 J

SEPTEMBER

9 OCTOBER

2

28 JUNE

### Launch of the book *Statues, Memorials and Other Stone Monuments of Prague*

The launch of Václav Rybařík's book *Pražské sochy, pomníky a jiné kamenné památky* ("Statues, Memorials and Other Stone Monuments of Prague") was held at the CGS Geological Bookstore.



17 JULY

### The "Liberec Region in the Shadow of Volcanoes" exhibit in Turnov



The "Liberec Region in the Shadow of Volcanoes" exhibit was ceremonially opened at the Bohemian Paradise Museum in Turnov. The exhibition was co-organized by the Czech Geological Survey, whose leading volcanologist Vladislav Rapprich was given the floor, along with Jan Bubal, the geologist of the Turnov museum. The exhibition presented six volcanic formations, which are typical volcanoes of the Liberec Region. Models and descriptions of the volcanoes were complemented with rock samples, of which the volcanoes are composed, and with animations showing the types of volcanic activity.

7 AUGUST

### CGS laboratories contribute to Egyptological research

The laboratory of isotope geochemistry and geochronology of the Czech Geological Survey successfully contributed to Egyptological research. The study, which determined the origin of copper artifacts from the 3<sup>rd</sup> millennium BC, provided the first evidence of a connection between Early Dynastic Egypt and Anatolia (present-day Turkey). In the study published in the *Journal of Archaeological Science*, a team headed by Jiří Kmošek focused on determining the origin of ores used to manufacture the items. Metallurgical, archaeological and chemical analyses were conducted by scientists from the University of Pardubice, the Faculty of Arts of Charles University in Prague, and the Nuclear Physics Institute of the Academy of Sciences of the Czech Republic. Julia Kočergina of the CGS carried out lead isotope analyses using a MC-ICP-MS Neptune instrument. The project is also a promising example of the interdisciplinary cooperation among our specialized laboratories.



20–24 AUGUST

## Summer school of the GECON project



One of the activities of the Czech-Polish cross-border project GECON includes summer schools for participating partner organizations and the interested public, including students of Czech and Polish universities. The theme of the first summer school – “Geology and Modern Technology” – attracted nearly 40 participants from the Czech Republic and Poland to the Železné hory National Geopark during the week of 20–24 August 2018. The rich summer school programme offered participants the opportunity, for instance, to get acquainted with the use of modern technologies in geological research, and with the collection and processing of data and their subsequent practical application and use in education and popularization of Earth sciences or in geotourism. CGS specialists Zita Bukovská and Ondřej Švagera prepared a presentation entitled “From Field Data to 3D Models and Visualizations” and also demonstrated the use of drones in fieldwork. Vladislav Rapprich gave the participants an insight into geological field data collection and their subsequent use, for example, in mobile applications.

10 SEPTEMBER

## Czech TV report on 3D imaging of the Železné hory Mts conducted by CGS



In its regional news coverage, Czech TV aired an extensive report on the work performed by specialists of the Czech Geological Survey. Using the example involving the imaging of rock cliffs in Rabštejnská Lhota in the Chrudim region, Zita Bukovská and Ondřej Švagera explained how geologists perform geological surveys by employing modern technologies, such as drones and mobile applications, and how the acquired data are applied. Vladislav Rapprich emphasized the use of new technologies for the purpose of popularizing geology and other Earth sciences.



15 SEPTEMBER

## Launch of the book *Jílové Gold Mines*

The launch and signing of the book by Petr Morávek and Jiří Litochleb *Jílovské zlaté doly* (“Jílové Gold Mines”) was held at the Regional Museum in Jílové u Prahy.





22-23 JANUARY

21-23 MARCH

14-19 MAY

13-16 JUNE

17 JULY

1-3 SEPTEMBER

9 OCTOBER

2

30 SEPTEMBER

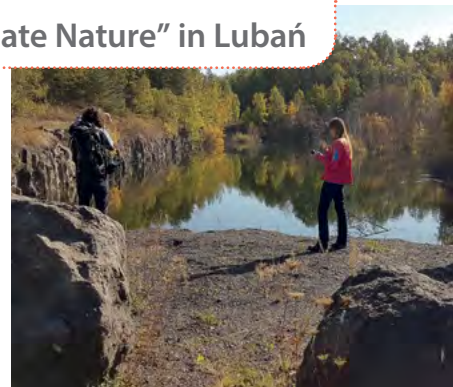
## Completion of the Czech-Georgian cooperation project

The bilateral development cooperation project in disaster preparedness and prevention entitled "Evaluation of Landslide Susceptibility in the Mountainous Parts of Georgia on the Example of Endangered Settlements, International Roads and Energy Pipelines in the Dusheti Municipality", conducted from October 2014 to September 2018, was successfully completed. The project led by Mgr. Aleš Havlín, PhD was carried out by the Czech Geological Survey in cooperation with the Czech companies Watrad and IsaTech. The Georgian project partner was the geological department of the Georgian National Environment Agency (NEA). A total of CZK 12,565,858 were released from development cooperation funds for the implementation of the project. The project was carried out at the foot of the Caucasus Mts north of Tbilisi in the Mtskheta-Mtianeti region, which is frequently affected by various types of landslides, causing loss of life and property. The aim of the project was to increase the capabilities of the geological department of NEA in preventing hazards posed by slope instabilities in the region. Primarily the identification of landslide-prone areas, specifically based on newly acquired knowledge and field survey experience and based on prioritization of slope instabilities, helped achieve this objective. Modelling in a GIS environment was also used as well as the CGS slope instability database, which was handed over to the Georgian side and modified to meet local needs. In connection with the installation of a pilot monitoring system, the Georgian side was acquainted with theoretical and practical knowledge on the use of modern monitoring systems and their link to an early warning system. As requested by the Georgian partner, the project was expanded in 2017 to include geophysical measurements and modelling of the slope stability at the Bazaleti locality, where an extensive landslide in 1988 led to the displacement of dozens of inhabitants. The village that is located 50 km north of Tbilisi is still threatened by landslides. All of the above-mentioned work was carried out in collaboration with Georgian colleagues in order to enable the Georgian workers of NEA to independently use these methods in the future.

4-5 OCTOBER

## Workshop on "Geopark and Human Fascination with Inanimate Nature" in Lubań

The first in a series of workshops that are being prepared during the GECON project took place in Lubań, Poland. The theme "Geopark and Human Fascination with Inanimate Nature" was a great opportunity to introduce the current exhibition "Minerals of the Western Sudetes" to the participants in the local regional museum, which organized the event for the other project partners. For the participants, the local researchers prepared presentations focusing on the area's specific geological features and their benefit for local geotourism, including a presentation on the historical, artistic and archaeological monuments of the city. A geological excursion to local volcanoes, some of which are active quarries producing Tertiary volcanic rocks, was organized as well.



9 OCTOBER

## Launch of the book *All the Way Down... Cotopaxi!*



The launch of the book by Gabriela Zoubková and Miroslav Krůta *Až na dno... Cotopaxi!* ("All the Way Down... Cotopaxi!") was held at the CGS Geological Bookstore, with an introductory speech by geologist Jaroslava Pertoldová.



25 OCTOBER

## Conference of the “Cross-Border Cooperation Project for the Development of Railway Transport Saxony – Czech Republic”



The “Cross-Border Cooperation Project for the Development of Railway Transport Saxony – Czech Republic” included another planned meeting that took place on 25 October 2018 at Jan Evangelista Purkyně University in Ústí nad Labem, which is one of the project partners. On behalf of the Czech Geological Survey, Ing. Petr Kycl provided information on the progress of sub-projects and evaluated the advantages and disadvantages of individual variants under consideration from a geological point of view.



12–14 NOVEMBER

## Old geological maps and modern CGS map applications at GIS Day 2018 in Liberec



The Czech Geological Survey was again engaged in the annual fruitful three-day event GIS Day 2018, which was held at the Technical University of Liberec as part of a global awareness-raising campaign. Its purpose was to inform the public about what geographic information systems are and how they affect our daily lives.

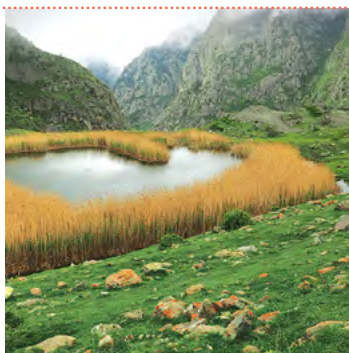
This year's theme “100 years on maps of the Czech Republic” included a CGS presentation of old geological maps in comparison with the latest map applications adapted to mobile devices. Visitors could view the old maps via the web map application “Historical Geological Mapping of the Czech Republic”, which provides access to about 450 maps of a unique collection from the second half of the 19<sup>th</sup> century, including two map sets covering nearly the entire territory of today's Czech Republic.

The old hand-coloured geological maps, which resemble works of art, contrasted with modern CGS map applications, which visitors could view directly on their personal phones (such as “Popularization of Geology”) with the aid of QR codes. GIS Day is one of the largest events in Liberec. It opened its doors to primary and secondary school students, their teachers and to the public as well. Due to the number of participants, this year's event was among the most successful in its 18-year history. A total of 870 students from 20 different schools in the Liberec Region took part.

13 NOVEMBER

## Petr Kycl's photography exhibit *Gruzie* (“Georgia”)

The opening of Petr Kycl's photography exhibition *Gruzie* (“Georgia”) was held at the CGS Geological Bookstore.





22–23 JANUARY  
14–19 MAY  
21–23 MARCH  
13–16 JUNE  
9 OCTOBER  
17 J  
2

16 NOVEMBER

### CGS data in ArcGIS Living Atlas of the World



The CGS managed to publish its first map layers in the prestigious ArcGIS Living Atlas of the World from Esri. The Living Atlas of the World is the foremost collection of digital geographic information from around the world. It includes maps, applications and data layers available through the ArcGIS Online platform. Data from the Living Atlas of the World can also be displayed in ArcGIS Pro. Our Geological Map at 1:500,000 scale and other derived geoscience maps at 1:500,000 scale, Significant Geological Localities and Slope Instabilities, have been published thus far. Other CGS map layers that have also been selected for publication in the Living Atlas of the World will gradually be published after approval by Esri.

20 NOVEMBER

### Centre for Lithospheric Research in the spotlight



At the beginning of October, the American Geophysical Union (AGU) approached the management of the Czech Geological Survey for permission to produce a short six-minute film featuring the Centre for Lithospheric Research and its scientific activities. Filming took place at Klárov and at the Barrandov laboratories on 20 November under the supervision of producer Cath Sheehan from WebsEdge and the video was shown at the AGU conference in Washington, DC on 10–14 December. It is available on YouTube and other websites as well.

21–23 NOVEMBER

### “Didactics of geology and cooperation with schools” workshop in Hejnice



The “Didactics of geology and cooperation with schools” workshop was held in Hejnice as part of the GECON project. It was organized by the Technical University of Liberec and attended by the representatives of individual institutions involved in the project and also by teachers from various universities or educational centres, such as the Didactic Centre of Geology. The topics of lectures focused mainly on teaching geology at primary and secondary schools and universities, and suitable teaching methods and innovations that are effective and motivate students were thoroughly discussed as well.

4 DECEMBER

### New Application “Report a Mining Impact”



The CGS created a new version of the online application **Report a Mining Impact** for the public. This modern application is accessible from the CGS website and is part of the mine information system according to § 35 of the Mining Act.

5 DECEMBER

### CzechGeo/EPOS workshop



The workshop of the “Large Research Infrastructure CzechGeo/EPOS” was held in the lecture hall of the Institute of Geophysics of the Czech Academy of Sciences. In addition to providing teleconferencing for foreign evaluators, the morning session included a presentation by the Czech Geological Survey on the activities being carried out during the fifth phase of the Geological and Geophysical Databases project headed by Dana Čápková as part of the CzechGeo/EPOS project. The workshop was held in English, and O. Moravcová, E. Hudečková and V. Kolečka lectured on behalf of the CGS.

# Projects

## Projects implemented in 2018

Abbreviations: **CAS** – Czech Academy of Sciences; **CDA** – Czech Development Agency; **MEYS** – Ministry of Education, Youth and Sports; **MFA** – Ministry of Foreign Affairs; **MIT** – Ministry of Industry and Trade; **MoA** – Ministry of Agriculture; **MoE** – Ministry of the Environment; **NCA** – Nature Conservation Agency; **TACR** – Technology Agency of the Czech Republic

## Other national programmes

• Competence Centre for Effective and Ecological Mining of Mineral Resources, TACR, 2014–2019	M. Poňavič
• Development of an inventory and monitoring system for geotechnical risk management (ČVUT, DATASYS, STRIX Chomutov a.s.), 1 January 2018 – 31 December 2021, MIT-FV30153 (STRIX Chomutov, a.s.)	P. Kycl
• Improving soil structure stability and infiltration through agricultural practices, 1 January 2018 – 31 December 2022, MoA– ZEMĚ Programme (VÚRV) QK1810186	M. Koubová
• Controlled and enhanced microbial methane production in situ, 1 June 2018 – 31 December 2022, TACR	J. Franců
• Engineered barrier 200C, 1 June 2018 – 31 December 2025, TACR	F. Laufek

## Internal projects of CGS

• Project drafting (timesheets recording the preparation of all projects), ongoing	P. Mixa
• Corrections and amendments to project outputs after their termination, ongoing	D. Skácelová
• Inventory of Slope Instabilities, ongoing	O. Krejčí
• Geological base mapping of CR at a scale of 1:25,000 in CGS, ongoing	D. Buriánek, J. Pertoldová
• Production of synoptic geological maps based on satellite imagery and airborne geophysical data and their utilization for crustal block interpretation in the Mongolian Altai area, CGS, 2016–2018	P. Hanžl
• Geology of the Bohemian Cretaceous Basin, 2017–2018	S. Čech
• Publishing-related evaluation of borehole, geophysical and geochemical data from the “Review of Groundwater Resources” project, 2017–2018	R. Lojka
• Usselo soils in the Czech Republic – pedogenesis dynamics during the Late Glacial, 2017–2018	J. Hošek
• Testing of the DJI Phantom 4 drone for research purposes, 2017–2018	L. Koucká
• Decorative and building stones of the Czech Republic – editing of the on-line database and use of stones for ornamental and construction purposes (in progress), 2017–2018	B. Dudíková Schulmannová
• Volcanic systems IV: origin, evolution and ascent of magma, volcanoclastic sedimentation, tectonics and landslides in volcanic regions, 2017–2018	M. Stárková
• Special studies, research methodology, doctoral studies and theses, 2017–2018	E. Břízová
• UNESCO IGCP project, transfer of funds, 2017–2018	E. Břízová



• Sedimentological, paleobotanical and palynological study of Permo-Carboniferous basins, 2017–2018	Z. Šimůnek
• Printing of geological and applied maps, ongoing, 2018	V. Žáček
• Editing of the journal Geological Research in Moravia and Silesia, CGS, ongoing	D. Buriánek
• Editing of scientific publications (timesheets), 2010–2013, ongoing	V. Janoušek
• Editing and preparation of the electronic version of the Bulletin of Geosciences, 2010, ongoing	J. Frýda
• Editing and preparation of the printed version of the Bulletin of Geosciences, 2010, ongoing	J. Frýda
• The Kačák Event in the shallow- and deep-water facies of the Devonian of the Prague Basin: Hlubočepy and Koněprusy area, 2017–2018	S. Vodrážková
• Kongsberg deposit, Norway: conditions for the formation of silver-bearing mineralization and sources of ore-bearing fluid, 2017–2018	P. Dobeš
• Cementation of Jurassic aquifer rocks of the southeastern part of the Bohemian Massif, 2017–2018	L. Jurenka
• Carbon dioxide and methane in soil air as an indicator of gas migration from hydrocarbon deposits and inadequately plugged boreholes, 2017–2018	O. Prokop
• Experimental analysis of Pt-group minerals, 2017–2018	A. Vymazalová
• 3D geothermal and hydrogeological model of the foredeep and slopes of the Bohemian Massif in the southeastern part of Moravia, 2017–2018	M. Pereszlényi
• Dynamics of chromium fluxes and isotopic composition in runoff from catchments on felsic bedrock, 2017–2018	A. Andronikov
• Relationship of the supply of selected nutrients in forest soils and wood biomass in GEOMON catchments as an environmental factor, 2017–2018	T. Chuman
• Monitoring of small forest catchments GEOMON, 2017–2018	F. Oulehle
• Development of a pyrolysis-gas chromatography method for fingerprint identification of the origin of organic matter in airborne dust as a carrier of organic pollutants, 2017–2018	P. Pařízek, J. Franců
• Understanding magma mingling processes in the Krkonoše-Jizera Plutonic Complex using crystal isotope stratigraphy: an opportunity to develop low-blank microsampling methods for the new TIMS laboratory, 2017–2018	J. Hora
• Determination of zinc isotope ratios in selected small catchments of the Geomon monitoring network, 2017–2018	A. Andronikov
• Study of mechanisms of global crises in the geological past – continuation 338800, 2017–2018	J. Frýda
• Development of the CGS www information portal, ongoing	R. Svítal
• Data sources and the CGS meta-information system, ongoing	J. Sedláček
• Administration and development of the digital archive of the CGS, CGS, ongoing	J. Sedláček
• Development and administration of the National Geologic Map Database of the Czech Republic, CGS, ongoing	Z. Krejčí
• Implementation of the European INSPIRE Directive in the CGS, ongoing	L. Kondrová
• Enhancement of the ICT infrastructure of the CGS, CGS, ongoing	R. Binko



• Inventory, protection and popularization of geological sites of the Czech Republic, CGS, ongoing	M. Vajskebrová
• Upgrade of the CGS Map Server, CGS, ongoing	M. Paleček, V. Pospíšil
• Administration, maintenance and development of the PMČR50 geo-database in relation to the compilation of new soil maps and their safekeeping, printing and presentation, CGS, ongoing	J. Sedláček
• Development of the fieldwork documentation database, 2017–2018	P. Čoupek
• Inventory of micropalaeontological material documentation – Phase III, 2017–2018	M. Bubík
• Photo collection of portraits of important Czech and world-renowned geoscientists in the CGS Photoarchive web application, 2017–2018	A. Čejchanová
• Geology of the Křivoklátsko Protected Landscape Area, 2017–2018	T. Vorel
• Development of 3D geological models and related CGS databases, 2016–2018	J. Franěk, L. Kondrová
• Inventory of Slope Instabilities, ongoing	O. Krejčí
• Carpathian Balkan Geological Association, 2017–2018	L. Švábenická
• Activities of CGS strategic research plan coordinators, ongoing	J. Pašava
• Activities of the project-review board and the Geoscience Research Reports editorial board, ongoing	P. Mixa
• Conference, department 480, Chateau Hotel Třešť, anniversary of Prof. Schulmann, internal, conference fees, 2018	P. Nahodilová
• Granulite-migmatite domes – insights into Devonian and Carboniferous evolution in the Variscan belt on the examples of the Náměšť granulite and Góry Sowie massifs, 2017–2018	C. Aguilar, A. Tabaud
• Presidency of the international research network ENeRG, 2018–2019	V. Hladík
• 1:50,000 soil maps – lay-out of digital maps produced by NCA CR according to requirements for CGS map outputs, supplemented with explanatory texts to maps and printing for the archive, 2018	J. Janderková
• Completion of the sub-tasks “Proposed concept for further development of CGS material collections” – re-discarding and redepositing of findsite palaeontological collections and safekeeping of J. Sekyra’s sample collections at Lužná near Rakovník, Phase III, 2018	E. Kadlecová
• Database of open-cast mines, 2018–2019	J. Večeřa
• Travelling exhibition commemorating the 100 <sup>th</sup> anniversary of the CGS, 2018	P. Fiferna
• Origin of the post-orogenic granites of the Aaj Bogd massif in the Trans-Altai Zone in southwestern Mongolia, 2018–2019	K. Hrdličková
• Characteristics and evolution of the provenance area of Cambrian and Devonian clastic sediments, 2018–2019	H. Gilíková
• Evolution of peraluminous melts in the vicinity of the Třebíč pluton, 2018–2019	A. Zavřelová
• Late Paleozoic dismembering of Gondwana and Pangea amalgamation: the Moroccan meseta witness, 2018	F. Chopin
• Krkonoše Piedmont Basin, map completion and editing of monograph text, 2018–2019	M. Stárková



• Use of satellite radar data to detect glacier movement on James Ross Island, 2018–2019	K. Fárová
• Isotope geochemistry of Nd-Hf basic rocks of the Teplá-Barrandian Unit, 2018–2019	L. Ackerman
• Provenance of eclogite in the Bohemian Massif: geochemical and geochronological study of eclogite from the Krušné hory, Mariánské Lázně, and Velké Vrbno units, 2018–2019	S. Collet
• The subglacial geology of Dome F (East Antarctica) determined by new aeromagnetic data, 2018–2019	A. Guy
• Multiple phase thermobarometry for silicic magmas, 2018	J. Hora
• Metamorphism and formation of metasedimentary rocks of the outer and inner mica schist zone of the Kutná Hora Crystalline Complex in relation to surrounding high-pressure migmatites, 2018–2019	P. Hasalová, R. Nahodilová
• Testing of a method for in situ determination of Hf isotopes in zircon using laser ablation in conjunction with a Neptune multicollector ICP-MS, 2018–2019	J. Mikova
• Geotectonic evolution of the eastern part of the Mongolian Altai (Central Asian Orogenic Belt), 2018–2019	I. Soejono
• Isotopic and petrographic analysis of carbonatites and alkaline rocks of the USA and Africa, 2018–2019	T. Magna
• Unified system of CGS code lists, 2018–2019	Z. Krejčí
• Wetlands and their importance in the landscape, 2018–2019	E. Břízová
• Description of the evaluation of mining objects, 2018–2019	J. Večeřa
• Karst conduits and groundwater flow in the western part of the Bohemian Cretaceous Basin – additon of results from the Review of Groundwater Resources, 2018–2020	I. Kůrková
• Mobilization of inputs of precipitation-borne nitrogen to the runoff of selected river basins, 2018	F. Buzek
• Processing of data and finalizing of publications: (a) High-moors-based study of historic mining and ore dressing in the Krušné hory Mts, (b) Atmospheric deposition of cadmium in the Czech Republic: comparison of soluble and insoluble fractions in icings and snow with varying levels of pollution, 2018–2019	L. Bohdálková
• Effects of altitude on the concentrations and isotopic composition of toxic metals: fractionation or mixing of different sources?, 2018–2019	E. Přechová, O. Šebek
• Interdisciplinary research in the Slavkov Forest Critical Zone Observatory, 2018–2019	P. Krám
• Development of X-ray diffraction analysis methods: microdiffraction, temperature chamber and optimal sample preparation using a McCrone mill, 2018–2019	F. Laufek
• Operational geological documentation of transport line structures, 2018	J. Hošek
• Establishing LA-ICP-MS analytical protocols to study trace elements in sulfides and implementation of this method at the Czech Geological Survey, 2018–2019	I. Andronikova
• Selected Mesozoic and Cenozoic taphocenoses: stratigraphy, palaeoecology, taxonomy and palaeobiogeography, 2018–2019	R. Vodrážka
• Peru – slope stability (trip to Peru and publication preparation), 1 September 2018 – 1 September 2019	J. Novotný



## **Internal projects funded by the Ministry of the Environment for executing the tasks of the state geological survey**

• Revision of charts of undermined areas and old mine workings based on new acquisitions of digital map documents as a basis for investigating old mine workings and for consolidating data on abandoned exploratory mine workings, CGS, 2014–2018	A. Horáková
• Revitalization of selected parts of geological documentation held in the CGS Geofond archives, 2016–2018	M. Hrdlovicsová
• CGS archives – relocation of sample materials from old boreholes to the standard storage system of the CGS Geofond Division, 2016–2018	A. Donát
• Inclusion of the professional library collection of the Kutná Hora office in the CLAVIUS filing system within the CGS, 2016–2018	J. Šanderová
• Interactive map of and access to “Assessments” of the Geofond Division, 2016–2018	Z. Petáková, H. Skarková
• Processing and evaluating the final reports of the Mineral Deposit Collection (FZ) at the Kutná Hora office as a tool for investigating old mine workings, 2014–2018	J. Šanderová
• Evaluation and processing of map documents stored in the state archives of the Czech Republic as a basis for investigating old mine workings, 2014–2018	J. Šanderová
• Revision of safeguarding measures for old and abandoned exploratory mine workings, 2014–2018	P. Šír
• Inventory of abandoned waste facilities from historical mining, 2014–2018	V. Štrupl
• Mineral Commodity Summaries of the Czech Republic – Czech and English publication for 2016 (printed version and CD), 2016–2018	J. Starý
• Radon 2017 within the R-programme: Spatial variations of radon concentrations and dose rates at tectonic structures in clastic sediments (flysch, basins), 2016–2018	I. Barnett
• Completion of 1:50,000 scale soil maps, compilation of map sheets of cross-border areas of the Krušné hory Mts, Final Phase IV: Chomutov and Cheb map sheets, 2016–2018	J. Janderková
• Updating of geofactors in databases and maps of the Czech Republic 2017 (except D8), documentation of major transport line structures and updating of the Slope Instability Inventory at <a href="http://www.geology.cz">www.geology.cz</a> . Access to landslide points in the slope instability map (SN), 2016–2018	J. Hošek
• Mineral deposit information system (LIS) – files of ore deposits and exploration areas, including written records, from the OG archives, 2014–2018	J. Mojžíš
• Advisory and expert services provided for the Department of Geology of MoE, including services regarding landslides for the Operational Programme Environment, 2014–2018	J. Čurda
• Interactive map of OG assessments in 2004–2014/17, 2016–2018	H. Skarková
• Geological map of the Brdy Protected Landscape Area – mapping at 1:25,000 scale, thematic maps, 2016–2018	T. Vorel
• Upgrading hydrogeological ground data for the Železné hory Geopark, 2016–2018	S. Čech
• Revision of the unpublished reports collection stored at the Brno office and inclusion in the Geofond archive system, 2017–2018	M. Hrdlovicsová
• Mapping of slope instability and geofactors near the planned Vlachovice dam – 6xIGM 1:10, 2018	R. Novotný



• Verification of the gravimetric modelling of Cenozoic sediments of the Nesvačilka depression in the Brno area and its influence on terrain stability, 2018	O. Krejčí
• Risk assessment of pond sediments in submerged areas of the Moravian Karst (co-operation with NCA), 2018	V. Baldík
• Determination of prognostic resources of moldavites (category Q) at the localities Nesměň, Lužice and Dolní Chrášťany, 2018	T. Peterková
• Monitoring of hydrogeological boreholes, 2017–2020	J. Grundloch
• ASGI information subsystem, 2018–2019	V. Štrupl
• SurlS information subsystem, 2018	T. Hodková
• First-hand investigation of reported mine working impacts, 2014–2018	V. Štrupl
• GDO information system, 2018–2019	J. Sedláček
• Methane measurement at the site of the plugged Žu-108 production well, 2018	J. Franců
• Methodical guidelines for using the geophysical methods ERT and GPR to specify locations of old mine workings, 2018	M. Dostálík
• Skalka near Prostějov, Natural Curative Source – expert support for state administration tasks, 15 September 2018 – 15 November 2018	E. Kryštofová
• Geological setting as a factor determining land-use and development of the Czech Republic's territory (advisory and expert service), ongoing	J. Čurda
• Geological supervision of landslide remediation at Dobkovičky (D8), CGS, ongoing	P. Kycl
• Assessment of movement activity on the northeastern slope of the Pavlovské vrchy Hills and a draft of effective measures for eliminating imminent danger in the surroundings of Dolní Věstonice, 1 June 2016 – 31 December 2018	R. Novotný
• Executing the tasks of the state geological survey apart from approved projects – Geological Division, ongoing	P. Mixa
• Executing the tasks of the state geological survey apart from approved projects – Geofond Division, ongoing	V. Štrupl



## Major state contracts

• 3D structural geological models of the rock environment for a deep geological repository, contract owner ÚJV Řež – SURAO, 2014–2018	J. Franěk, Z. Bukovská, O. Švagera
• Evaluation of geological and other information of selected parts of the Bohemian Moldanubicum with regard to a potentially suitable location of a DGR – Dukovany site, contract owner SURAO, 2016–2018	P. Hanžl
• Mathematical modeling of brittle fractures in rock mass by means of the DFN method, contract owner ÚJV Řež – SURAO, 2016–2018	P. Kabele, O. Švagera
• Assessment of a suitable location for a SNF and RAW repository in terms of long-term safety, contract owner ÚJV Řež – SURAO, 2016–2018	J. Pertoldová, P. Mixa, Z. Bukovská
• Supporting research for the project involving a deep geological repository – thematic maps of engineering geological zoning 1:10,000, contract owner SURAO, 2018	P. Kycl, J. Malík, J. Novotný, M. Aue



• Geological interpretation of geophysical field data for updating 3D structural geological models of potential sites for a deep geological repository, contract owner ÚJV Řež – SURAO, 2017–2020	P. Mixa, J. Pertoldová
• Interactive physical models in-situ at the Bukov Underground Research Facility, contract owner SURAO, 2018–2022	J. Franěk
• Preliminary evaluation of the EDU-west and ETE-south sites in terms of long-term safety, contract owner ÚJV Řež – SURAO, 2018	J. Pertoldová
• D3 0310 / II Hodějovice–Třebonín – EG supervision of a survey of landslide sites located at kilometres 141.900–142.200 and 142.820–143, 180, contract owner Road and Motorway Directorate of the Czech Republic, 2018–2019	J. Novotný, P. Kycl, J. Malík
• Update and specification of the Project of Work at a Hypothetical Site, 2018–2019, SURAO	J. Franěk, P. Mixa
• Text preparation for the Technical Conditions TP76B for the Road and Motorway Directorate of the Czech Republic, contract owner ČAIG, 2018	J. Novotný



## Czech Science Foundation (GACR)

• GACR 16-18079S (Panel P504): Isotope evidence of microbial nitrogen fixation in ombrotrophic wetlands, 1 January 2016 – 31 December 2018	M. Novák
• GACR 16-17457S (Panel P210): Melting of metagranitic rocks: an important, but little understood aspect of continental-crust evolution, 1 January 2016 – 31 December 2018	P. Štípská
• GACR 17-17540S (Panel P210): Contrasting mechanisms of formation of the Pangea supercontinent: new insights into the formation of the continental crust, 1 January 2017 – 31 December 2019	K. Schulmann
• GACR 18-24281S (Panel 210): Did the orogens of western Gondwana form through inversion of rift domains?, 1 January 2018 – 31 December 2020	J. Konopásek
• GACR 1824378S (Panel 210): Petrogenesis of (ultra-) potassic magmas in the European Variscides – implications for the development of collisional orogens and crustal growth models, 1 January 2018 – 31 December 2020	V. Janoušek
• GACR 18-17295S (Panel P504): Climatic and air pollution effects on forest productivity, 1 January 2018 – 31 December 2020	J. Hruška
• GACR 18-15390S (Panel 210): Experimental and mineralogical study of selected chalcogenides and Pt-metal alloys, 1 January 2018 – 31 December 2020	A. Vymazalová
• GACR 18-27454S (Panel 210): Element transfer in a deep subduction environment: evidence from ultrahigh-pressure metamorphic terranes, 1 January 2018 – 31 December 2020	J. Kotková
• GACR 18-15498S (Panel 210): Isotope mass balance of calcium and magnesium in small acidified catchments on bedrock with contrasting chemical composition, 1 January 2018 – 31 December 2020	M. Novák
• GACR EXPRO 19-19-27682X (EX1): Main mechanisms of peripheral continental growth during the supercontinental cycle, 1 January 2019 – 31 December 2023	K. Schulmann
• GACR 19-25035S (Panel 210): Granulite-migmatite domes – insight into the Devonian and Carboniferous development of the Variscan belt, 1 January 2019 – 31 December 2021	P. Štípská





## Projects for the MoE and other ministries

• National centre for impacts – implementation of the Czech Republic's commitment to the international agreement on long-distance transport of contaminants, OOO MoE, ongoing (on an annual basis)	J. Hruška
• Turów, MoE (Water Protection Department), 2016–2044	R. Kadlecová
• Turów – CGS support, 2016–2044	R. Kadlecová
• Institutional support for long-term conceptual development of the research organization based on its achieved results, ongoing	J. Pašava



## Co-partnership in GACR projects

• GACR 16-11563S (Panel P210): The earliest Carboniferous greenhouse-icehouse climate oscillation – a multidisciplinary approach, cooperation with Masaryk University, Brno, 2016–2018	J. Frýda
• GACR 16-09979S (Panel P210): An integrated multidisciplinary study of the Jurassic–Cretaceous boundary in marine sequences: contribution to global boundary definition, cooperation with the Geological Institute of the Academy of Sciences of the Czech Republic, 2016–2018	M. Bubík
• GACR 16-13142S (Panel P210): Mining and processing of Cu, Pb, Zn and Co ores in Sub-Saharan Africa – a natural geochemical laboratory for pollutant behavior study, cooperation with the Faculty of Science, Charles University Prague, 1 January 2016 – 31 December 2018	B. Kříbek
• GACR 17-06700S (Panel P210): Přídolí Series in the Prague Synform – proposal for chronostratigraphic subdivision, cooperation with the Institute of Geology of the Academy of Sciences of the Czech Republic, 1 January 2017 – 31 December 2019	Š. Manda
• GACR 17-10982S: Global carbon cycle and sea-level change in the greenhouse climate: transatlantic correlation of Turonian (Cretaceous) sedimentary archives, cooperation with the Institute of Geology of the Academy of Sciences of the Czech Republic, 1 January 2017 – 31 December 2019	S. Čech
• GACR 17-15700S (Panel P210): Black shale formations as a geochemical marker of paleoenvironmental changes and tectonic setting along active continental margins, cooperation with the Institute of Geology of the Academy of Sciences of the Czech Republic, 1 January 2017 – 31 December 2019	J. Pašava
• GACR 17-05743S, New spectral insight into the biogeochemistry of small forested catchments, cooperation with CzechGlobe, 1 January 2017 – 31 December 2019	V. Kopačková
• GACR 17-10233S (Panel P210): The oldest vascular land plants and palynomorphs of the Silurian–Lower Devonian of the Barrandien area, cooperation with the Institute of Geology of the Academy of Sciences of the Czech Republic, 1 January 2017 – 31 December 2019	P. Tonarová
• GACR 17-22207S (Panel P210): The role of inherited continental margin architecture on early Variscan convergence, cooperation with the Faculty of Science, Charles University, 1 January 2017 – 31 December 2019	P. Štípská
• GACR 18-14575S (Panel P210): Fossil assemblages of the Libeň and Letná formations (Upper Ordovician) – keys to understanding the Fezouata and Tafilalt biotas of Morocco, cooperation with the Faculty of Science, Charles University, 1 January 2018 – 31 December 2020	P. Budil



## International grants and MEYS

<ul style="list-style-type: none"> <li>• Horizon 2020: BASE-LINE Earth (Brachiopods As Sensitive tracers of gLobal marlNe Environment: Insights from alkaline, alkaline Earth metal, and metalloid trace element ratios and isotope systems), EU, 1 January 2015 – 31 December 2018</li> </ul>	T. Magna
<ul style="list-style-type: none"> <li>• ArchaeoMontan 2018, cooperation with the Free State of Saxony 2014–2020, funded by the EU and CR, 1 September 2015 – 31 August 2018</li> </ul>	P. Bohdálék
<ul style="list-style-type: none"> <li>• Research infrastructure RINGEN, MEYS, 2016–2019</li> </ul>	J. Holeček
<ul style="list-style-type: none"> <li>• LM 2015079: Distributed system of observational and field measurements of geophysical fields (CzechGeo/EPOS), MEYS (consortium of the Institute of Geophysics of the CAS Masaryk University Brno, Charles University Prague, Institute of Geonics of the CAS, Institute of Rock Structure and Mechanics of the CAS, Research Institute of Geodesy, Topography and Cartography), 1 January 2016 – 31 December 2019</li> </ul>	D. Čápková
<ul style="list-style-type: none"> <li>• LM 201575: National SoWa (Soil and Water) infrastructure for complex monitoring of soil and water ecosystems in the context of sustainable landscape use, MEYS (consortium of the Biology Centre of the CAS, University of South Bohemia in České Budějovice, Charles University Prague, Czech Geological Survey), 1 January 2016 – 31 December 2019</li> </ul>	J. Hruška
<ul style="list-style-type: none"> <li>• 8G15004, Czech-Israeli cooperation: A novel approach for modelling soil degradation using super-spectral orbital data, 1 June 2016 – 31 May 2018</li> </ul>	V. Kopačková
<ul style="list-style-type: none"> <li>• Strategy for the use of shallow geothermal energy in Central Europe: planning, assessment and mapping (Geoplasma), Interreg Central Europe, 1 July 2016 – 30 June 2019</li> </ul>	J. Holeček
<ul style="list-style-type: none"> <li>• Possibilities of land-based CO<sub>2</sub> storage in Europe, European Commission, Innovation and Networks Executive Agency, 653718 — ENOS — H2020-LCE-2014-2015/H2020-LCE-2015-1, 1 September 2016 – 31 August 2020</li> </ul>	V. Hladík
<ul style="list-style-type: none"> <li>• ResiBil – The balance of the water resources in the eastern part of the Czech-Saxon border area and assessment of their sustainable use, cooperation of the Czech Republic and the Free State of Saxony 2014–2020, 13 January 2016 – 30 June 2019</li> </ul>	Š. Mrázová
<ul style="list-style-type: none"> <li>• Cross-border cooperation project for the development of railway transport Saxony – Czech Republic, Cooperation Programme Free State of Saxony – Czech Republic 2014–2020, January 2017 – December 2020</li> </ul>	P. Kycl
<ul style="list-style-type: none"> <li>• Distributed system of observational and field measurements of geophysical fields, CzechGeo/EPOS-Sci, MEYS infrastructure, 1 April 2017 – 31 July 2020</li> </ul>	D. Čápková
<ul style="list-style-type: none"> <li>• Upgrade of the RINGEN research infrastructure, 1 June 2017 – 31 May 2020</li> </ul>	J. Holeček
<ul style="list-style-type: none"> <li>• Research on key ecosystem interactions of soil and water in the SoWa research infrastructure, 1 May 2017 – 30 April 2020</li> </ul>	J. Hruška
<ul style="list-style-type: none"> <li>• Horizon 2020: Geohazard impact assessment for urban areas – Ugeohaz, 1 January 2018 – 31 December 2019</li> </ul>	V. Kopačková
<ul style="list-style-type: none"> <li>• EC, EuroGeoSurveys: MINLAND 1 December 2017 – 31 December 2019</li> </ul>	P. Rambousek



• GECON – Geology Cooperation Network, Cross-border Cooperation Operational Programme INTERREG V-A Czech Republic – Poland, 1 March 2018 – 28 February 2021	P. Fíferna
• EU-EIT RawMaterials: TravelEX – Underground resources travelling exhibition, 1 March 2018 – 31 December 2020	P. Fíferna
• PL-National Science Centre, Programme – Harmony, Palaeogeographic maps of the Permian land basins of Central Europe, 19 April 2018 – 18 April 2021	Z. Šimůnek
• EC-Horizon 2020 International Network of Raw Materials Training Centres (INTERMIN) 3 May 2018 – 28 February 2021	D. Mašek
• EC-Horizon 2020 Eranet: HotLime – Mapping and Assessment of Geothermal Plays in Deep Carbonate Rocks - Cross-domain Implications and Impacts, 1 July 2018 – 1 July 2021	J. Franců
• EC-Horizon 2020 – GeoERA Information Platform Project (GIP-P), 1 July 2018 – 30 June 2021	D. Čápková
• EC-Horizon 2020 – MUSE – Managing Urban Shallow Geothermal Energy, 1 July 2018 – 30 June 2021	J. Holeček
• EC-Horizon 2020 – 3D geomodelling for Europe, 1 July 2018 – 30 June 2021	J. Franěk
• EC-Horizon 2020 – Cross-border, cross-thematic multiscale framework for combining geological models and data for resource appraisal and policy support, 1 July 2018 – 30 June 2021	V. Hladík
• EC-Horizon 2020 – Hydrogeological processes and geological settings over Europe controlling dissolved geogenic and anthropogenic elements in groundwater of relevance to human health and the status of dependent ecosystems, 1 July 2018 – 30 June 2021	J. Grundloch
• EC-Horizon 2020 – Resources of groundwater, harmonized at cross-border and pan-European scale, 1 July 2018 – 30 June 2021	E. Kryštofová
• EC-Horizon 2020 – Mineral Intelligence for Europe, 1 July 2018 – 30 June 2021	T. Peterková
• EC-Horizon 2020 – Forecasting and Assessing Europe's Strategic Raw Materials Needs, 1 July 2018 – 30 June 2021	P. Rambousek



## International development cooperation projects

• Study of natural hazards harmful to agricultural production in selected areas of SNNPR (Southern Nations, Nationalities and People's Region), Ethiopia, CDA, 19 June 2015 – 31 December 2018	K. Verner
• Evaluation of Landslide Susceptibility in the Mountainous Parts of Georgia on the Example of Endangered Settlements, International Roads and Energy Pipelines in the Dusheti Municipality, MFA (CDA), 1 January 2014 – 30 September 2018	A. Havlín
• CDA – Implementation of a methodical approach in geological sciences to enhance the quality of doctoral studies at Addis Ababa University (Ethiopia), 2018–2019	K. Verner
• PanAfGeo: Geoscientific Knowledge and Skills in African Geological Surveys, 2017–2019	V. Štědrá

# Information Portal

## Web

Czech Geological Survey website > [www.geology.cz/extranet-eng/](http://www.geology.cz/extranet-eng/)

State Geological Survey > [www.geology.cz/extranet-eng/sgs](http://www.geology.cz/extranet-eng/sgs)

Science and Research > [www.geology.cz/extranet-eng/science](http://www.geology.cz/extranet-eng/science)

Services > [www.geology.cz/extranet-eng/services](http://www.geology.cz/extranet-eng/services)

Maps > [www.geology.cz/extranet-eng/maps](http://www.geology.cz/extranet-eng/maps)

Publishing activity > [www.geology.cz/extranet-eng/publications](http://www.geology.cz/extranet-eng/publications)

Promotion > [www.geology.cz/extranet-eng/geology-for-all](http://www.geology.cz/extranet-eng/geology-for-all)

About us > [www.geology.cz/extranet-eng/about-us](http://www.geology.cz/extranet-eng/about-us)

## Thematic portals

Slope Instabilities > [www.geology.cz/svahovenestability](http://www.geology.cz/svahovenestability)

World of Geology – portal dedicated to the geosphere > [www.svet-geologie.cz](http://www.svet-geologie.cz)

## Journals

Bulletin of Geosciences > [www.geology.cz/bulletin](http://www.geology.cz/bulletin)

Journal of Geological Sciences > [www.geology.cz/sbornik](http://www.geology.cz/sbornik)

Special Papers > [www.geology.cz/spec-papers](http://www.geology.cz/spec-papers)

Geoscience Research Reports > [www.geology.cz/zpravy/en](http://www.geology.cz/zpravy/en)

## Web applications

Guidepost to applications > <http://applications.geology.cz>

Photoarchive > [fotoarchiv.geology.cz](http://fotoarchiv.geology.cz)

Map server > [maps.geology.cz](http://maps.geology.cz)

Geological Encyclopedia > [www.geology.cz/encyklopedie](http://www.geology.cz/encyklopedie)

Virtual Museum > <http://muzeum.geology.cz/?l=e>

Geological Localities > [lokalita.geology.cz/d.pl?item=1&l=e](http://lokalita.geology.cz/d.pl?item=1&l=e)

Interesting Geosites > <https://mapy.geology.cz/geosites>

Decorative Stones > [dekoracni-kameny.geology.cz/index\\_eng.pl](http://dekoracni-kameny.geology.cz/index_eng.pl)

Dictionary of Geology E-C and C-E > <http://www.geology.cz/aplikace/encyklopedie/gsllov.pl?l=e>

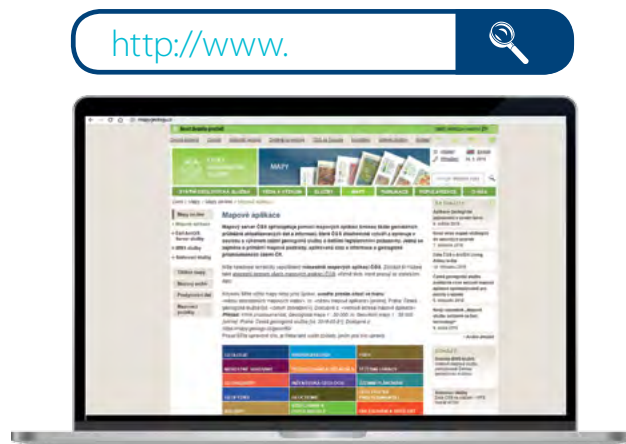
## Other web presentations

Online obchod > [obchod.geology.cz](http://obchod.geology.cz)

The CGS channel on YouTube > [www.youtube.com/geology.cz](http://www.youtube.com/geology.cz)

Geology Olympiad > [www.geologicka-olympiada.cz](http://www.geologicka-olympiada.cz)

Facebook – World of Geology > [www.facebook.com/svetgeologie](http://www.facebook.com/svetgeologie)



↗ Access to CGS web map applications  
at [mapy.geology.cz](https://mapy.geology.cz).



## Principal Offices of the Czech Geological Survey



**Klárov** Headquarters

Klárov 3, 118 21 Praha 1,  
Phone: 257 089 411, Fax: 257 531 376

Directorate | Regional and Applied  
Geology | Library | Archive Collections |  
GIS and DB | Publishing House | Bookstore  
| Reprographic Centre



**Barrandov** Laboratories

Geologická 6, 152 00 Praha 5,  
Phone: 251 085 111, Fax: 251 818 748

Central Laboratory  
(inorganic geochemistry)  
| Geochemistry | Special Laboratories



**Kostelní** Office

Kostelní 26, 170 06 Praha 7,  
Phone: 234 742 111, Fax: 234 742 290

Geofond | Study Room | Video Archive  
| Document Archive (part.) | Specialized  
Offices



**Electron Microprobe and Microanalysis  
Laboratory, Faculty of Science, MU Brno**

Kotlářská 2, 611 37 Brno,  
Phone: 541 129 496, Fax: 541 211 214

Electron Microprobe and Microanalysis  
Laboratory



**Jílové** Regional Museum and Centre  
for Documentation of Gold Deposits

Masarykovo nám. 16, 254 80  
Jílové u Prahy, Phone: 241 950 455

Archive of Geological Samples and Written  
Documentation



**Lužná** Archive of Material  
Documentation

270 51 Lužná u Rakovníka, čp. 432,  
Phone/Fax: 313 537 849

Archive of Geological Samples | Collections  
| Publications and Maps

# 100 YEARS

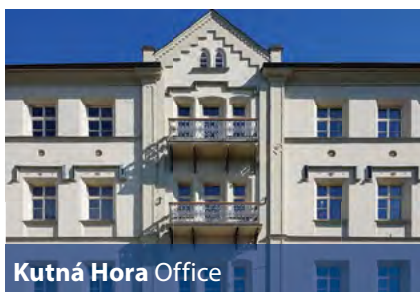




**Brno Branch**

Leitnerova 22, 658 69 Brno,  
Phone: 543 429 200, Fax: 543 212 370

Regional and Applied Geology,  
Geophysics | Geochemistry | Testing  
Laboratory (organic geochemistry)  
| Library and Archive | Bookshop |  
GIS and DB



**Kutná Hora Office**

Dačického náměstí 11, 284 01  
Kutná Hora, Phone/Fax: 327 512 220

Geofond – Mining Impacts Department



**Jeseník Office**

Erbenova 348, 790 01 Jeseník,  
Phone/Fax: 584 412 081

Regional Office | Archive of Geological  
Samples | Bookshop



**Stratov Archive of Material  
Documentation**

289 22 Stratov, čp. 184,  
Phone: 234 742 205

Archive of Geological Samples  
and Written Documentation



**Kamenná Archive of Material  
Documentation**

Kamenná 42, 262 31 Milín,  
Phone: 234 742 205

Archive of Geological Samples



**Kovanice Archive of Material  
Documentation**

288 02 Kovanice, čp. 184,  
Phone: 234 742 205

Archive of Written Documentation

**CZECH  
GEOLOGICAL  
SURVEY  
1919/2019**



Czech Geological Survey Annual Report 2018

Editor Petr Maděra

Executive editor Šárka Sedláčková

English translation Robert Alger

Graphic design Eva Šedinová

Photo on the cover Pavel Hanžl

Printed by the A.R. Garamond s.r.o., Prague

Published by the Czech Geological Survey, Prague 2019

03/9 446-412-19

ISBN 978-80-7075-964-6

© Czech Geological Survey, 2019



[www.geology.cz](http://www.geology.cz)



9 788070 759646