Annual Report **2019**

CZECH GEOLOGICAL SURVEY

1919/2019

Content

Strategic research plan 2016–2020

(SPV) Research on the structure and evolution of the Earth's crust

(SPV) Research on the biodiversity and global changes in the past

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(SPV) Research on geohazards

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Organizational Structure

Situation as of 31 December, 2019

Advisory bodies

Scientific Board
Review Board
Editorial Board
CGS Map Approbation Committee

Directorate

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Project Management
Management and Administration
of the Brno Branch

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Human Resources Section
Internal Audit

Advisory bodies

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of the Bulletin of Geosciences
and Geoscience Research Reports
CGS Portal Board
Library Board

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Management

From the left: Vít Štrupl – Head of the Geofond Division, Dana Čápová – 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

A CENTURY AS THE STATE GEOLOGICAL SURVEY

In 2019, the Czech Geological Survey (CGS) celebrated a centenary as the state geological survey. It was established by a decree of the Government of the Czechoslovak Republic on 7 July 1919 as the State Geological Survey of the Republic of Czechoslovakia operating under the Ministry of Public Works. The founding charter emphasized a close link between the importance of scientific research and the national economy, which controlled the assignment of tasks – putting first applied and basic science and then advisory and educational functions, as well.

During its 100-years' existence, the institute has changed significantly, but what remains the same today when comparing with the foundation charter is the fulfilment of our mission. It consists of providing high-quality expertise from many spheres of geoscience so that state authorities can make competent decisions on economic growth and security of inhabitants with regard to the management of mineral resources, soil and groundwater, environmental protection, and natural disaster prevention and mitigation.

What is the Czech Geological Survey like in 2019? The State Geological Survey of the Republic of Czechoslovakia has grown into a thoroughly modern institute, where a multidisciplinary approach in geoscience is combined with the use of current information technologies, indispensable for acquiring new data and providing reliable information and expertise to the public. The state geological survey's mission reflects the CGS dual role of furnishing the state administration with expert support, based on research, which has been achieving excellent results over many years.

In 2019, we dedicated a number of events and activities to the CGS centennial celebration, which you can learn more about in this yearbook. The highlight was a science seminar, which introduced to the public our most interesting current achievements, followed by a gala evening in the historic building of the National Museum on 17 October 2019. It was attended by 500 current and former staff members of the Czech Geological Survey, colleagues from ministries and other cooperating institutes, as well as by Minister of the Environment Mr. Richard Brabec, and the Secretary of the Ministry of the Environment Mr. Jan Landa. Former directors Messrs. Vladimír Sattran and Miloš Růžička also honored us with their presence. During the festive day, the Cyril Purkyně Medal was awarded to the exceptional workers Messrs. Jan Čurda, Josef Klomínský, Jiří Kříž and Tomáš Pačes for their lifelong merits and contributions to the great renown of the Czech Geological Survey.

The organization of the 47th Meeting of Directors of European Geological Surveys, which I had the honor to chair as President of EuroGeoSurveys – Association of European Geological Surveys, gave the centennial anniversary an international dimension.

What else did 2019 bring us? The Czech Geological Survey plays an active role in the National Coalition for Combating Drought and, after a year-long preparation, the Ministry of the Environment approved the new Groundwater in Crystalline Rocks project (2019–2023), which is a very important part of the national strategy and a suitable follow-up project to the successful Review of Groundwater Resources project. Our organization was tasked, pursuant to Government Resolution No. 713/2017, with a project examining the Czech Republic's strategic mineral potential, currently at full swing as well.

A major contribution to applied research involved the preparation of an extensive project for the Technology Agency of the Czech Republic programme "Environment for Life" regarding the topic Rock Environment and Minerals with a budget of CZK 226M/€ 8,7M over six years, which was subsequently approved. Thanks to this project, we can continue to develop the research commenced during the Competence Centre for Effective and Ecological Mining of Mineral Resources project, which was also funded by the TACR and completed during 2019. Other topics of applied research in this project include geological and anthropogenic hazards, such as landslides and undermining, and groundwater protection in karst areas.

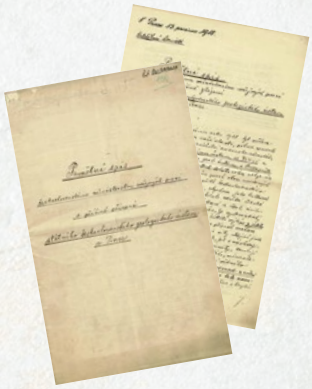
The Czech Geological Survey celebrated one hundred years in a great shape from a professional, economic as well as human resources views. For future years of our operation, it is necessary to closely follow trends of our society's needs as well as a rapid evolution of the surrounding world, to respond flexibly, and continue to take part in the world-class research. With all my heart I thank and credit my dear colleagues in CGS for our current success.

Zdeněk Venera

Zdeněk Kukal

100 YEARS OF THE CZECH GEOLOGICAL SURVEY 1919/2019

One hundred years is too short of a period as far as geology is concerned yet quite long for a person. And for the institute, the period is a suitable time to reflect and embark on challenges in upcoming years in order to follow up on the best that it has achieved. During its 100-year existence, the Czech Geological Survey has faced turbulent times as well as serene periods of development. Since the beginning, it has always been a state survey, thus reflecting both political and economic changes. From its humble beginnings with several employees in rented workspaces, it gradually expanded its facilities to include historic palaces of the Lesser Town in Prague as well as newly built buildings. After periods of international isolation, it became part of the European and global network of state geological surveys and the scope of its activities corresponds to the concept of these surveys in developed countries.



▶ *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.*

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 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 3rd 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,

▲ *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.*

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

Changes in the name of the Czech Geological Survey

1919	1939	1943	1945	1950	1952	1953	1990	2002
State Geological Survey of the Republic of Czechoslovakia	Geological Survey of Bohemia and Moravia	Bureau for soil investigation in Bohemia and Moravia	State Geological Survey of the Republic of Czechoslovakia	Central Geological Institute	Central Geological Institute of the Czechoslovak Academy of Sciences	Central Geological Institute	Czech Geological Institute	Czech Geological 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

▲ *Self-help painting and cleaning of the institute's facilities. Photo by R. Hylský, 1949.*

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

▲ *DTA apparatus for identifying clay minerals. Photo by J. Bárta, 1960.*

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

▲ *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.*

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 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 partitition 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

▲ *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.*

▲ *After an intensive search and demanding negotiations, the Czech Geological Institute acquired the building of the former Klar Institute for the Blind, located beneath Prague Castle and near the Czech government headquarters.*

subsequently modernized to make this branch one of the most important centres for environmental studies.

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.

DIRECTORS
OF THE CZECH GEOLOGICAL SURVEY 1919/2019

In all, fifteen directors have led the state geological survey during its century-long existence. The first director Cyril Purkyně was the longest serving director over a span of fifteen years. However, during this centennial year, he was surpassed by Zdeněk Venera, who thus became the longest acting director in the survey's entire history. Let us recall his predecessors.

Cyril Purkyně, Prof. RTDr. et RNDr. h. c., Knight

**1862, director 1919–1934, staff member 1919–1934*

Josef Woldřich, Prof. PhDr.

**1880, director 1934–1937, staff member 1934–1937*

Vojtěch Smetana, RNDr.

**1890, director 1937–1943, staff member 1919–1943*

Alois Matějka, Doc. RNDr. DrSc.

**1898, director 1943–1945, staff member 1921–1966*

Ladislav Čepek, Dr. mont. Ing. DrSc.

**1899, director 1945–1953, staff member 1928–1953,1958–1959*

Vladimír Zoubek, RNDr. DrSc.

**1903, director 1953–1956, staff member 1931–1962*

Jan Kořan, DrSc.

**1905, in charge 1956–1958, not appointed as director, staff member 1942–1958*

Karel Žebera, RNDr. DrSc.

**1911, director 1958–1963, staff member 1941–1978*

Josef Svoboda, RNDr. DrSc.

**1908, director 1963–1970, staff member 1938–1981*

Vladimír Šibrava, RNDr. DrSc.

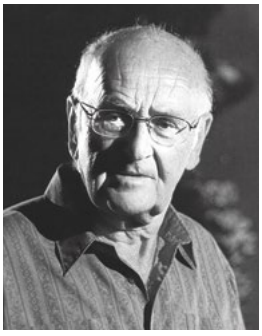
**1930, director 1970–1978, staff member 1953–1990*

Jaroslav Vacek, RNDr.

**1929, director 1978–1990, staff member 1978–1990*

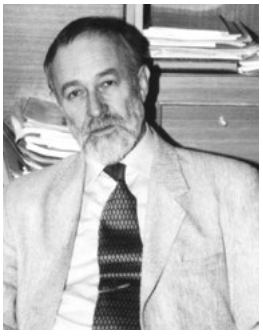
Vladimír Sattran, Ing. RNDr. CSc.

**1930, director 1990–1992, staff member 1955–1992*



Zdeněk Kukal, Doc. RNDr. DrSc.

**1932, director 1992–1997, staff member since 1955*



Miloš Růžička, RNDr. CSc.

**1938, director 1997–2004, staff member since 1961*

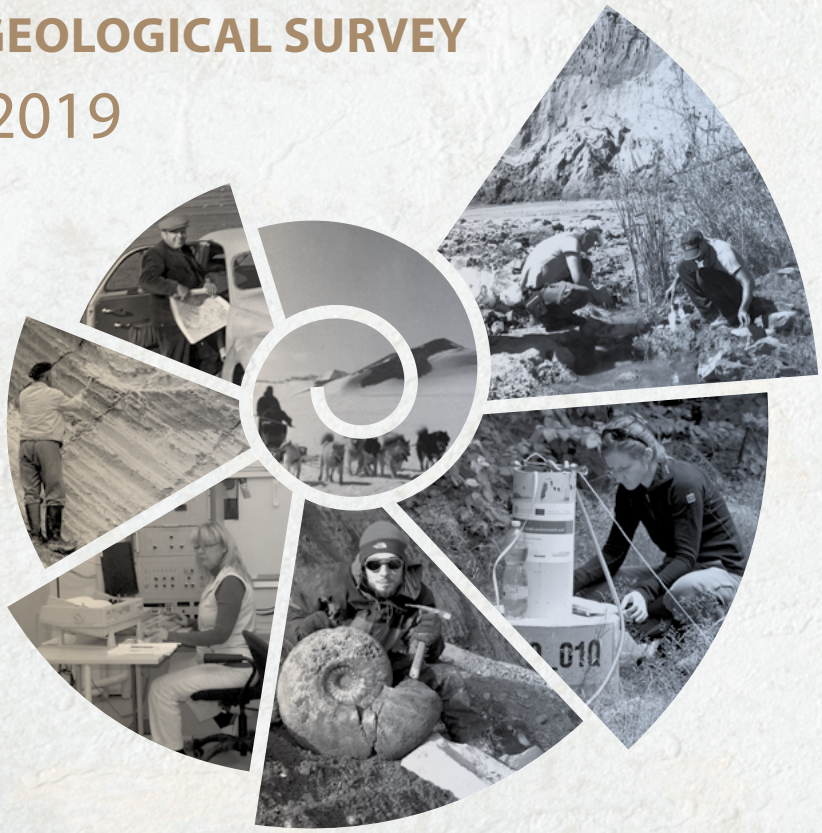
Zdeněk Venera, Mgr., Ph.D.

**1965, director since 2004, staff member since 2004*

HOW WE CELEBRATED 100 YEARS

The history of the Czech Geological Survey dates back nearly to the founding of Czechoslovakia. The State Geological Survey of the Republic of Czechoslovakia, which is the original name of today's Czech Geological Survey, was established in 1919. In 2019, the Czech Geological Survey celebrated the 100th anniversary of its founding. A number of events and activities throughout the year commemorated the significant anniversary. Invitations to individual events, related photos and other relevant information were published on a CGS extranet page specifically dedicated to the anniversary.

CZECH GEOLOGICAL SURVEY
1919–2019



Redesigned CGS logo

old

CZECH GEOLOGICAL SURVEY

new

CZECH GEOLOGICAL SURVEY

"100 Years of CGS" logo

100 YEARS CZECH GEOLOGICAL SURVEY 1919/2019

Templates of electronic documents with the "100 Years of CGS" logo

Information banner on the CGS headquarters building

CZECH GEOLOGICAL SURVEY 1919–2019
Geology for Czech society for the next hundred years

R-sticker and commemorative stamp of the Czech Post with the "100 Years of CGS" logo

CZECH GEOLOGICAL SURVEY 1919/2019
100 YEARS

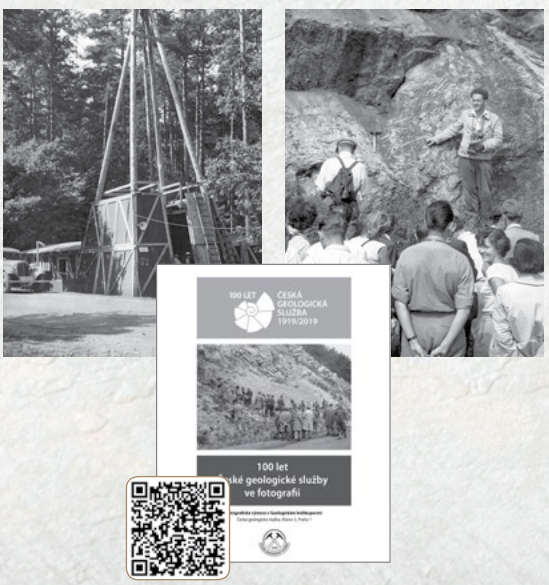
HOW WE CELEBRATED 100 YEARS

Defining moments for the Czech Geological Survey

An exhibit of historical photographs, documents and artefacts, installed in the foyer and corridors of the building in Klárov, displayed the institute's defining moments from its foundation to the present.

Czech Geological Survey in works of art

An exhibit featured the art works of academic painter Marie Zábranská that were created specifically for the Czech Geological Survey. A number of portraits of prominent geologists were complemented by some of her art medallions.



"Czech Geological Survey in Photography"

The *Česká geologická služba ve fotografii* ("Czech Geological Survey in Photography") exhibit provided visitors with an overview of the survey's history and activities captured in historical photographs.

A century as the Czech Republic's largest publisher of geoscience literature

The exhibit presented a summary of selected unique and timeless geoscience works – maps and publications – produced by the CGS Publishing House.

"Czech Geological Survey Abroad" exhibit in Skuteč

The Czech Geological Survey prepared the *Česká geologická služba v zahraničí* ("Czech Geological Survey Abroad") exhibit, which was on view at the Municipal Museum in Skuteč from January until March. The exhibit acquainted visitors with the wide range of activities conducted by CGS staff in various countries throughout the world. Particular attention was paid to the geological research in Antarctica not only because of the environment's uniqueness and the extreme living and research conditions that researchers were confronted with, but also because Czech geologists achieved unprecedented success in making globally significant discoveries. The information presented at the exhibit was provided with QR codes linking to other facts or additional information, which allow visitors to take away many interesting facts, material and inspiration.

"Liberec Region in the Shadow of Volcanoes"

The Czech Geological Survey co-organized the *Liberecko ve stínu sopek* ("Liberec Region in the Shadow of Volcanoes") exhibit, which lasted from April until October at the Rumburk Museum. The exhibit was also complemented by animations depicting the formation of the Bořeň and Milešovka volcanoes, the film Sopky v srdci Evropy ("Volcanoes in the Heart of Europe"), guided tours and field trips.

HOW WE CELEBRATED 100 YEARS

Exhibit of works from the "My Piece of the Earth 2019" competition

The art competition for students, which was announced by the Czech Geological Survey, focused on the topic of Antarctica. The awarded works were subsequently exhibited at the Antarctic Treaty Consultative Meeting held in Prague in July.

"Fire-Spitting Mountains or Volcanoes in Our Region" at the Karlovy Vary Museum

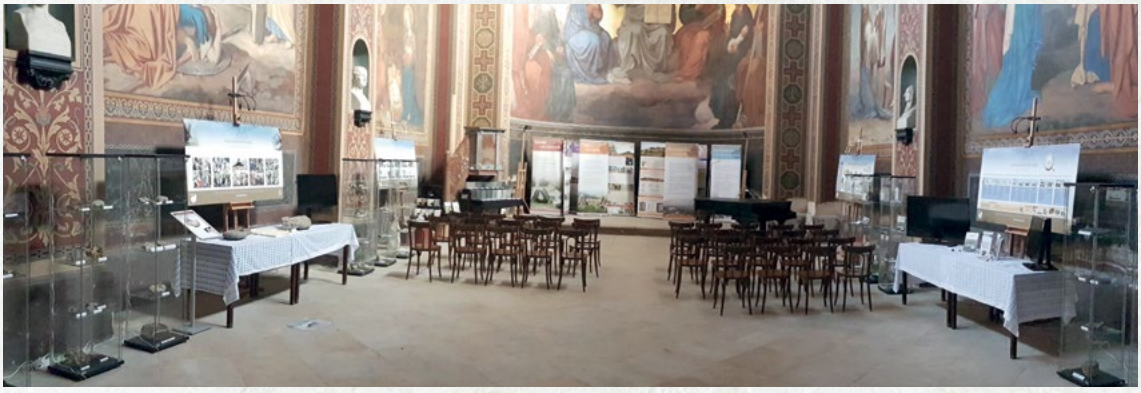
The Czech Geological Survey co-organized the *Hory oheň plivající aneb Sopky našeho kraje* ("Fire-Spitting Mountains or Volcanoes in Our Region") exhibit, which was on view from September until December at the Karlovy Vary Museum. The exhibit introduced visitors to the origin and evolution of selected volcanoes in the Karlovy Vary Region, such as Komorní hůrka, Krásný vrch, Podhora and Pustý zámek. Animations of the volcanic activity of Šemnice Rock and Komorní hůrka Hill were admired as well. The exhibit also included interactive elements – a volcano model, a "carillon" of phonolite slabs, or a search for leaf and mineral imprints in lahar deposits.

"100 Years of the Czech Geological Survey" at the Ministry of the Environment

The "100 Years of the Czech Geological Survey" exhibit opened in October in the lobby of the Ministry of the Environment. The Czech Geological Survey was presented as a dynamic and modern geoscience research institute with a wide range of activities of social significance. In addition to a historical overview of the CGS, the exhibit presented a selection of contemporary activities and knowledge that may be of use in daily life – such as animations, films and applications for the public.

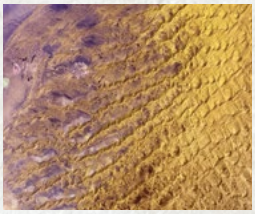
"100 Years of the Czech Geological Survey" in the chapel of St. Raphael

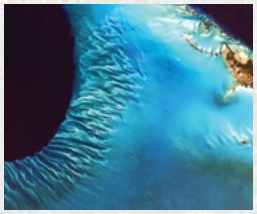
An exhibit dedicated to the survey's centennial anniversary took place in the chapel of St. Raphael in the CGS headquarters building. On display were unique samples from the CGS material collections, animations of selected geosites, an overview of the most common rocks in the Czech Republic in the form of polished slabs or preserved material from the 23rd International Geological Congress held in Prague in 1968, which was terminated prematurely due to the occupation of Czechoslovakia by allied troops.

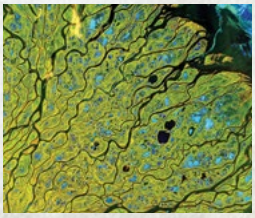


Global geological phenomena from satellite images

The exhibit was launched in November as part of the Czech Geological Survey's presentation during the Science and Technology Week of the CAS (Czech Academy of Sciences). Satellite images provided an entirely different perspective on well-known localities in countries around the world, displaying geological and geomorphological phenomena as viewed from space and also areas, in which the Czech Geological Survey has throughout history conducted or still continues to conduct projects. The possibilities of using satellite images for routine work performed by geologists were also presented.







HOW WE CELEBRATED 100 YEARS

Earth Day with the CGS

In April, the Czech Geological Survey organized Earth Day with a programme for the young and old. The survey's specialists presented specific details of their research and prepared a number of fun and practical tasks for visitors, who were given an opportunity to try out activities that are of use in geology – for instance, working with a microscope or geological hammer, specialized analyses or flying a drone. An exhibit of decorative stones as well as fossils and lectures on foreign geological expeditions to Ethiopia, Nicaragua and Georgia were also held.

Geology Olympiad

The regional round of the Geology Olympiad for the capital city of Prague was held on 8 April 2019 at the Czech Geological Survey. Participants had to take a test and identify minerals, rocks and fossils and also viewed the collections of the CGS and a 3D animation of the Palaeozoic ocean. The whole competition culminated in a national round held on 7 May 2019 in Brno. The Geology Olympiad is a competition in geoscience knowledge designed for primary and secondary school students. It is organized by Masaryk University, the Czech Geological Survey, Charles University and the Association of Museums and Galleries of the Czech Republic.

Science Fair

The Czech Geological Survey participated in the largest popular science education event of its kind – the Science Fair, organized by the Czech Academy of Sciences. The fair was held in June at the PVA EXPO Prague and visitors were greeted by countless novelties and interesting facts from the world of science. The CGS exhibit focused on celebrating the 100th anniversary of its founding, which was reflected by a rich programme, during which for three days CGS specialists presented selected methods from the breadth of CGS research activities, such as 3D bedrock modelling, thermal imaging, practical examples of modern analytical methods in mineralogy, paleontological samples, and the latest findings from volcanology and geohazard research.

Panning for gold in Nový Knín and a visit to the Mining Museum in Příbram

In July, an informal gold panning competition for Czech Geological Survey employees took place in Nový Knín as well as a visit to the open-air mining museum in Březové Hory, which is managed by the Příbram Mining Museum.

Ceremonial launch of the book *100 let ČGS ("100 Years of the CGS")* in the Bio Oko cinema

The launch of the book *100 let České geologické služby* ("100 Years of the Czech Geological Survey") on 12 September 2019 at the Bio Oko cinema was held in the form of a series of recollections accompanied by photographs from the working careers of the authors of the book's individual chapters. Guests were welcomed by the Director of the Czech Geological Survey Zdeněk Venera, who introduced the event as part of the year-round celebrations of the 100th anniversary of the Czech Geological Survey. A presentation by Klára Froňková and Patrik Fiferna ensued presenting the activities held throughout the year to ensure a successful centennial celebration. The programme was also moderated by Tomáš Pačes, a long-time CGS specialist, who shared the authors' work experiences and successes, introducing them with a healthy dose of wit in an informal way. The book launch was subsequently undertaken by Czech Radio's popularizer of science Petr Sobotka.

Seminar at the National Museum

The year-round celebrations of 100 years of the Czech Geological Survey culminated on Thursday 17 October 2019 with a ceremonial seminar dedicated to the activities of the CGS, which was held at the National Museum. The seminar featured lectures on current research topics by selected CGS specialists, including Zdeněk Venera, Martin Novák, Jan Franěk, Zita Bukovská, Petra Maierová, Tomáš Magna, Anna Vymazalová, Michal Poňavič, Lucie Kondrová and Filip Oulehle. During the ensuing ceremony, the medal of Prof. Cyril Purkyně was presented to Jan Čurda, Tomáš Pačes, Josef Klomínský and Jiří Kříž by the Director of the Czech Geological Survey Zdeněk Venera in recognition of their lifelong merit and contributions to the good name of the Czech Geological Survey. The celebrations of the survey's significant anniversary ended with a reception, with introductory statements by CGS Director Zdeněk Venera, Minister of the Environment Richard Brabec, Secretary of the Ministry of the Environment Jan Landa and Vladimír Sattran, who served as CGS Director from 1990–1991.

HOW WE CELEBRATED 100 YEARS

Week of Science and Technology

The Czech Geological Survey co-organized the Week of Science and Technology of the CAS, which was held in November. The largest science festival in the Czech Republic included lectures, exhibitions or open days, and the event's 19th year focused on global threats and the 30th anniversary of the Velvet Revolution. For instance, the Czech Geological Survey organized open days at its headquarters and laboratories, a lecture on global threats, and thematic exhibits.

Launch of the book *Oživlé sopky České republiky* ("Revived Volcanoes of the Czech Republic") at the CGS Geological Bookstore

The launch of the book Oživlé sopky České republiky ("Revived Volcanoes of the Czech Republic") was held on 26 November 2019. A novelty is the book's innovative format, which serves not only as a traditional pocket guide to many interesting volcanoes in Czechia but which can also display three-dimensional objects thanks to modern technologies. The formation of volcanoes can be viewed in augmented reality or as animations by installing the necessary applications on a smartphone or tablet. The book's "godfather" was the Czech Radio moderator Petr Sobotka.

Launch of the book *Klárov* at the CGS Geological Bookstore

A ceremony presenting the book Klárov was held on 19 December 2019 at the CGS Geological Bookstore. The book launch was introduced and conducted by the CGS Director Zdeněk Venera and Radek Mikuláš from the CAS. The publication is devoted to Prague's Klárov, particularly to the history of the premises of the former Klar Institute for the Blind, which serves as the current Czech Geological Survey headquarters, and its immediate surroundings.

Interactive web presentation of 3D geological models

A website on 3D geological models constructed at the Czech Geological Survey was published in connection with the celebrations involving the 100th anniversary of the founding of the CGS. Among other things, the site contains an overview map of selected interactive static 3D geological models of the Czech Republic's bedrock.

"100 Years of the Czech Geological Survey"

The publication commemorating 100 years of the Czech Geological Survey consists of a diverse mosaic of memories and accounts of Czech geologists who were long-term employees of the CGS. They share important moments from their careers with readers, such as important mapping projects, foreign research expeditions as well as long-term projects in various parts of the world.

Oživlé sopky České republiky ("Revived Volcanoes of the Czech Republic")

Vladislav Rapprich

The book presents 15 Czech volcanoes from various perspectives. Aerial and microscopic images are complemented by augmented reality and animations, which lend the printed book a new dimension. The book allows readers to travel through time and, by installing a QR-code reader, to witness molten hot lava and massive explosions in the distant past of the Czech Republic's territory.

HOW WE CELEBRATED 100 YEARS

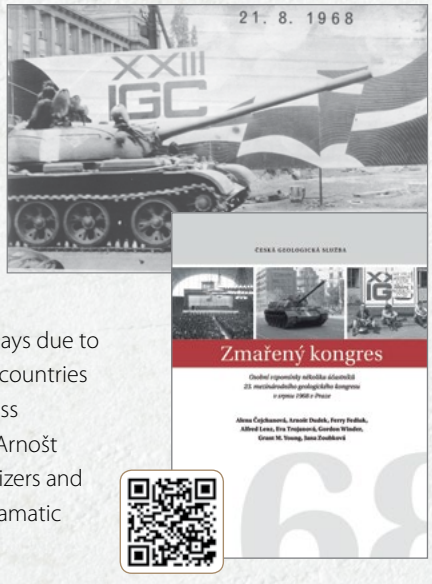
Klárov. I. Klarův ústav ("Klárov I. Klar Institute")

Petr Maděra

The first part of the publication dedicated to Prague's Klárov focuses mainly on the history of the premises of the former Klar Institute for the Blind, currently the headquarters of the Czech Geological Survey, and its immediate surroundings. In addition to a detailed description of the buildings and their artistic decoration, the author deals with the interesting destinies of the Klar family members and their colleagues, often including artists or philanthropists of extraordinary character, talent and diligence. Of course, the author does not neglect their blind patients and touches on many other interesting facts and situations, including the close relationship between Alois Klar and Karel Hynek Mácha, the founding and beginnings of the Czech congregation of Sisters of Mercy of St. Borromeo, or the visits by Emperor Franz Joseph I. or Ottla Kafková. The final part of the book, conceived as a detailed guide, takes visitors to the institute's chapel of St. Raphael. The text is richly accompanied by unique historical photographs and diagrams.

Zmařený kongres ("Derailed Congress")

Alena Čejchanová, Arnošt Dudek et al.



The 23rd International Geological Congress in Prague in 1968 was probably the most significant geology event held in the Czech Republic. The meeting of nearly 3,000 geologists from 91 countries, which was four years in the making and planned to last for one month, focused on presenting the advanced level of Czechoslovak geology and on opening doors abroad particularly to young geologists. However, the congress was terminated prematurely after five days due to the occupation of Czechoslovakia by the allied troops of five Warsaw Pact countries led by the Soviet Union. In addition to basic information about the congress and an interview with the general secretary of the organizing committee Arnošt Dudek, the publication features highly personal memories of Czech organizers and foreign congress participants, who had to hurriedly leave Prague under dramatic circumstances.

CGS presentation at professional meetings

- 5th CE-GIC Meeting, 11–12 April 2019 in Prague
- XLII Antarctic Treaty Consultative Meeting, 2–11 July 2019 in Prague
- Open Congress of the Czech and Slovak Geological Societies, 3–6 September 2019 in Beroun
- EuroGeoSurveys General Meeting, 8–9 October 2019 in Prague

SELECTED PROMOTIONAL ITEMS

▾ Geological hammer with the engraved “100 Years of CGS” logo

▾ Phonolite pint glass

▾ Thermos

▾ Set of light Pramen beer and dark Magma beer

▾ Dry bag

▾ Badge with the “100 Years of CGS” logo

▾ Folding knife with the “100 Years of CGS” logo

▾ Flash drive

▾ Flash drive in the shape of a geological hammer

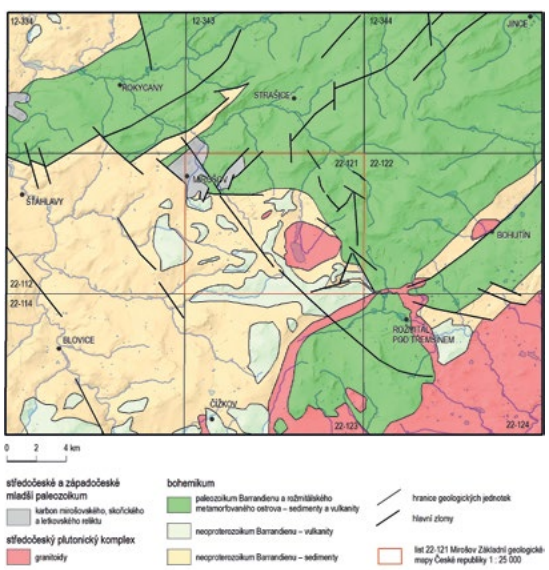
David Buriánek
Project leader for geological mapping
of the Czech Republic 1:25,000

GEOLOGICAL 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.

Geological mapping

Geological mapping is one of the main activities of the state geological survey since its foundation in 1919. During its hundred-year existence, its experts, geologists and technicians have processed thousands of geological maps at various scales. The territory of the Czech Republic was the first in the world to be mapped at a scale of 1:200,000 in the early-1960s, and an edition of 1:50,000 scale geological maps was completed by the end of the 1990s.



▲ *Geological map depicting the wider surroundings and highlighted location of the the Mirošov map sheet 22-121.*

In recent decades, a number of geological and derived maps were compiled, focusing mainly on protected landscape areas and other places of public interest in the Czech Republic. However, the Czech Geological Survey has also been involved in foreign projects over the long-term mainly in the form of foreign development cooperation, in recent years particularly in Ethiopia and Georgia.

Geological maps at 1:25,000 scale

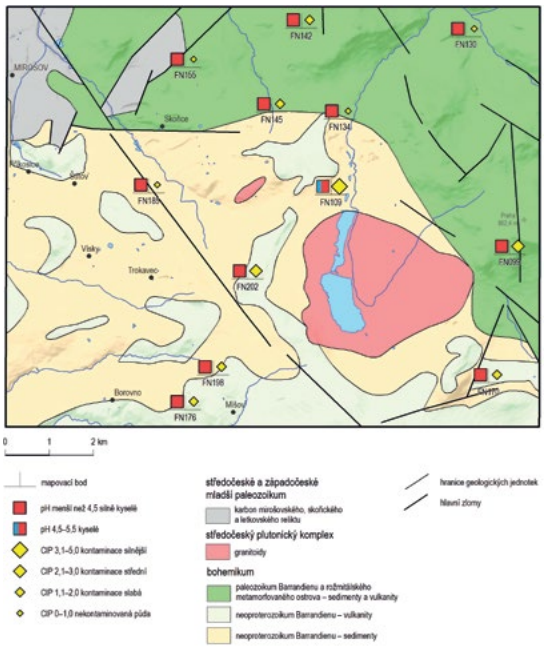
At present, the research activities of the Czech Geological Survey focus mainly on mapping at a scale of 1:25,000. Map sheets and explanatory notes to these sheets are compiled on the basis of a unified geological legend, which makes it easy to build on adjacent geological maps. Since 2003, the completed geological maps have been gradually made available to the public on the geological map server www.geology.cz.

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 project also includes derived 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. The notes provide readers with detailed information regarding the map sheet area in terms of geochemistry, geophysics, hydrogeology,

engineering geology, structural geology, economic geology, pedology and environmental geology.

New geological maps are one of the main sources of information regarding the safeguarding and inventory of important geosites. The database of geological documentation points currently contains 109,724 records, with 954 new geological documentation points having been added in 2019.

At present, the Regional Geological Mapping Project at 1:25,000 scale includes 20 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 Pošumaví region (Bohemian Forest Area), the Bohemian Paradise, Central Moravia and the former Brdy military district. During 2019, explanatory notes and maps were completed for the Mirošov map sheet 22-121. A geological map of the surroundings of the Brno Reservoir was compiled based on geological mapping data.



▲ *Geochemical scheme showing pH and CIP values in surface soil layers in the area covered by the Mirošov map sheet 22-121.*

Contribution to territorial development and to the ecosystem

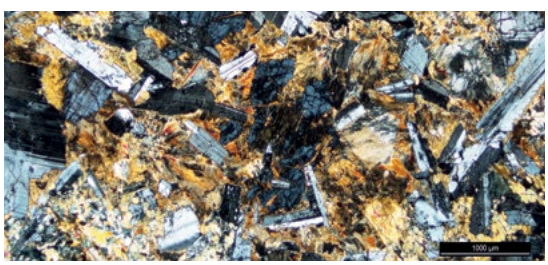
An integral part of the newly completed set of geological maps at 1:25,000 scale are maps of environmental geofactors, which summarize data gathered during field surveys as well as the results from laboratory analyses of soil, rocks and water. They provide state authorities and the professional community with information on groundwater management zones, on the extent of slope instabilities and mineral resources. The data are used to define hazardous areas in terms of potential contamination of the rock environment or slope instabilities, or areas prone to contamination of water sources. Areas deserving protection with regard to geology or landscape ecosystems are being identified as well.

Follow-up research

The data obtained during the geological mapping contribute to a better understanding of the geological evolution of the mapped areas and aid in preparing many scientific publications. In 2019, for instance, the origin of Miocene subvolcanic rocks intruding into the sediments of the flysch nappes of the Outer Western Carpathians was reinterpreted. The new mineral phases, lonecreekite and sabieite, were identified among the products of a long-term subsurface fire in the heap of the Schoeller coal mine in Libušín near Kladno. The chemical composition of ferrocolumbite from the Vydra Pluton in the Šumava Mts was described in detail.

A new perspective on the origin of Ordovician oolitic ore from the Skalka deposit near Mníšek pod Brdy in the Prague Basin of the Barrandian area and a provenance study of clastic sediments at the periphery of the Carpathian Foredeep were published.

Abroad, attention was paid to the origin of Permian subvolcanic dykes in the western Mongolian Altai or to the mechanism of emplacement of the post-collision Chewo Pluton in northern Ethiopia.



▲ *Metagabbro from the Horušice locality, which is located on the Chvaletice map sheet 13-411. Photo by D. Buriánek.*

(SPV)

Jaroslava Pertoldová
Head of the Regional Geology
of Crystalline Formations Department

Tomáš Hroch
Head of the Regional Geology
of Sedimentary Formations Department

REGIONAL GEOLOGICAL RESEARCH

Research into the structure and evolution of the Earth's crust is interconnected with geological mapping, remote sensing and structural and sedimentological studies, which are applied nationally and globally in basic and applied research.

Applied research in the Czech Republic

A significant task in 2019 was the development and application of a method for constructing 3D geological models. In cooperation with other institutes, a 3D model of the rock environment was compiled, depicting the geological conditions for the construction of tunnels of the high-speed railway line between Prague and Dresden. An example of how these methods are applied in hydrogeology is a 3D geological model demarcating aquifer bodies, which is used to model groundwater reserves and flow in order to assess the impact of mining activities in the Polish part of the Zittau Basin on the groundwater in Hrádek and Frýdlant (Turów project).

▲ *3D geological model of the bedrock for the Turów project guided the placement of hydrogeological borehole 1420_5 near Oldřichov. Photo by R. Nádaskay.*

As a follow-up to the geological interpretation of geophysical data, 3D structural geology models of nine potential localities were updated in 2019. At the same time, more than 600 km of geological sections were mapped, and 44 geological maps and map sections were compiled. The 3D geological models are widely used to evaluate the geological and tectonic characteristics at potential sites for the construction of a deep repository for radioactive waste, including a determination of new tectonic structures and their hydraulic functions.

An essential part of the evaluation of potential sites for the construction of a radioactive waste repository was an expert assessment of areas of interest in terms of the homogeneity of the rock environment, hydrogeological and geodynamic characteristics, and potential conflicts of interest as key criteria for the repository's long-term safety and stability.

Experimental research simulating storage conditions in a real geological environment continued at the Bukov Underground Research Facility (SÚRAO). For this purpose, 10 exploratory boreholes were drilled horizontally into the rock massif based on a new 3D geological model. Each of these boreholes simulates a storage Container placed in the deep repository.

The aspects of deep repositories were also dealt with by research during the Transport 8 and Data Acquisition from the Deep Horizons of the Rožná Mine projects. The objective of the latter project is to characterize and evaluate the rock environment in terms of its disintegration

by fractures and to determine the impact of significant tectonic zone on the rock massif for the purpose of constructing a deep geological repository, including the development of discrete fracture network (DFN) models, determination of geotechnical properties, etc.

The GEOTRANS project, launched under the TACR programme, will include aspects of geological evolution in simulations in hydraulic and transport models for assessing the safety of the deep repository. The study includes the use of models predicting the evolution of the relief and of the climatic, hydrological and hydrogeological characteristics over the span of 200,000 years.

Another new project addresses the issue of water resources in hydrogeological zones consisting of crystalline rocks. The work focuses on the most drought-affected areas. The aim of the project is to specify a method for determining shallow groundwater sources, to define these sources by using a combination of long-distance and ground methods, and to propose measures for their use, possibly for their enhancement.

Basic research in the Czech Republic

In 2019, a study at the well-known mineralogical locality of Jizerka addressed the origin of sapphire and zircon. In connection with this study, the origin of a significant morphological structure in the Jizerské hory Mts, referred to as the Pytlácká jáma Hollow, was re-evaluated. It was newly interpreted as being a structure of volcanic origin (a maar), which may be the source of the minerals mentioned. This hypothesis is being further verified using geophysical and geochronological methods.

With regard to sedimentary geology, basic research focused on fossil communities, sedimentary processes and palaeoclimatic changes. These activities include, for instance, the processing of valuable material from drilling projects carried out for the Review of Groundwater Resources project. A multi-year research project in the Bohemian Cretaceous Basin will be summarized in a forthcoming monograph.

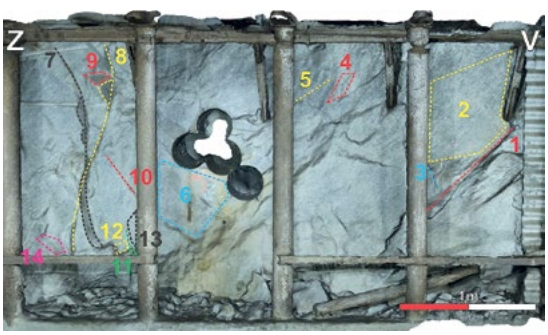
Tasks for the Regional Geological Mapping Project at 1:25,000 scale continued with work on map sheets of the Pošumaví (Bohemian Forest Area), the Novohradské hory Mts, Brdy, the Bohemian Paradise and the Železné hory Mts.

Activities abroad

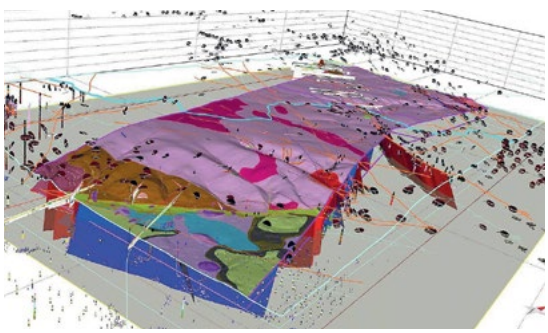
A new project of the Czech and Ethiopian geological surveys together with local authorities followed up the successfully completed development cooperation activities conducted in recent years. Its aim is to compile geological, hydrogeological and soil maps of selected areas of Ethiopia, and to determine areas potentially affected by geohazards, the elaboration of detailed geoscience studies for the land use plans in areas threatened by severe natural hazards, particularly soil degradation.

At the same time, the European Commission's three-year PanAfGeo project was successfully completed, during which colleagues from African geological surveys were trained in geological mapping methods and in the compilation of geological maps by CGS experts. A total of 175 geologists from 39 countries were trained during the project.

The processing of data from previous foreign projects helped determine the age and origin of rocks from the central Mongolian Altai.



▲ *Photogrammetric model of a wall in the Rožná mine with highlighted structural elements. O. Švagera et al.*



▲ *Geological model of the area and course of the planned Prague–Dresden high-speed rail line. J. Franěk et al.*

(SPV)

Jiří Frýda
Coordinator of research
on global changes in the past

RESEARCH ON BIODIVERSITY AND GLOBAL CHANGES IN THE PAST

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 Czech Geological Survey's research team analyzes changes in selected abiotic characteristics of the palaeoenvironment, such as seawater temperature or the carbon cycle in the marine ecosystem, and changes in parameters characterizing the evolution of palaeodiversity in periods prior to, during and after global crises. The analysis of palaeodiversity evolution, therefore, involves time-consuming taxonomic, palaeoecological and paleobiogeographic research.

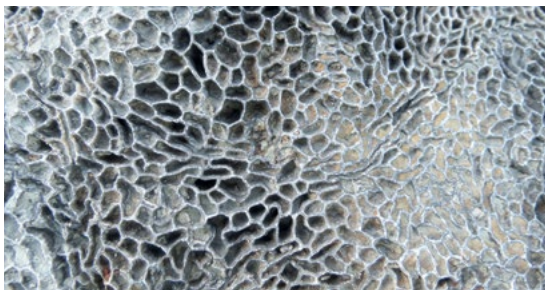
▲ *Selectively weathered limestone surface exposed to tropical climate. Queensland, Australia. Photo by J. Frýda.*

▲ *Silurian oncolytes in Queensland, Australia, indicate the dominance of microbial calcium carbonate precipitation during the Ludfordian carbon isotope excursion. Photo by J. Frýda.*

The results of the team's research in 2019 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 2019, the research team published 20 articles in scientific journals with impact factors and presented their results at many international conferences.

Several members of the "Global Changes" team also participate in research activities in two IUGS subcommittees, namely the Subcommission on Devonian Stratigraphy and the Subcommission on Silurian Stratigraphy (International Commission on Stratigraphy).

The members of a team studying the marine Palaeozoic provide full editing and technical support for the international journal ***Bulletin of Geosciences***, which has an impact factor. In 2019, the journal included 25 scientific papers comprising approximately 480 pages (*Bulletin of Geosciences*, Volume 94, 2019). The bulletin's recent impact factor is 1.5. Today, thanks to the current editorial board's many years of effort, the *Bulletin of Geosciences* is one of the most important scientific journals published in the Czech Republic and ranks among the world's twenty most prominent palaeontology journals.



▲ *Silurian coral from the Swedish island of Gotland. Photo by J. Frýda.*

The members of the "Global Changes" team present their research results at global and international conferences. They are also engaged as "instructors" for Ph.D. students at Charles University and at the Czech University of Life Sciences, where they serve as guarantors of several fields and also give a number of lectures to master's and postdoctoral students, such as "Evolution of Global Ecosystems", "Geochemistry", "Palaeoecology" and partly "Zoology".

▲ *Cross-section of the Silurian strata in central Queensland, Australia, which records the largest collapse of the global carbon cycle in the marine ecosystem. Photo by J. Frýda.*

(SPV)

Petr Rambousek
Head of the Department
of Mineral Resources Research and Policy

MINERAL RESOURCES

Mineral resources as one of the pillars for the development of civilization has been a socially important research topic of our institute since its foundation. The first task set forth by the then Ministry of Public Works involved a "systematic survey of all coal, ore, salt and petroleum deposits, an inventory and inspection of all stone quarries providing building materials and deposits of other useful materials, providing raw materials for the ceramics, glass, cement and other industries, as well as the prospecting for new deposits".

Critical and strategic raw materials study

The final conference in December 2019 at TU-VŠB (Technical University of Ostrava) in Ostrava completed the extensive five-year research project "Competence Centre for Effective and Ecological Mining of Mineral Resources" (https://www.hgf.vsb.cz/511/cs/Projekty/CEEMIR/) focusing on critical raw materials in the Czech Republic. The consortium of the research project, funded by the Technology Agency of the Czech Republic and led by TU-VŠB Ostrava, included the Czech Geological Survey, which presented a finalized map of the Czech Republic with the locations of potentially prospective as well as other resources, including selected critical resources. The research part documented techniques developed for mineralogical study of critical raw materials and demonstrated their application in innovated processing of graphite raw materials. The main commodity discussed were graphite resources, which served to present the entire deposit acquisition process, including basic research, processing technology, a mining model and an economic evaluation of mining, in the subsequent research topics of the project. A bilingual promotional film about the project "Study of Critical Raw Materials in the Czech Republic" (https://www.facebook.com/svetgeologie/videos/668564683557311/) was presented at the conference as well.

▲ *Safeguarding measures at an exploration shaft of the Křižanovice deposit. Status in February 2019. Photo by P. Rambousek.*

As a follow-up to the project results, the strategic study "Mineral Resource Potential of the Czech Republic Regarding Raw Materials Suitable for Industrial Applications for Advanced Technologies" was prepared for the Ministry of Industry and Trade.

The project "Acquisition of strategic raw materials deposits", which was launched in 2018 based on

▲ *Sampling of a heap from past mining in the Havlíčkův Brod ore district. Photo by P. Rambousek.*

▲ *Feldspar pegmatite from the Barbora Adit in Horní Krupka. Photo by T. Peterková.*

Government Resolution No. 713/2017 and which was carried out for the DIAMO state enterprise with regard to economical use of selected strategic raw materials of the Czech Republic, continued to make inventory reports for deposits and resources of Li, W, Ge and V. Innovative methods of extracting lithium mica (e.g., by dry method) and increasing the metal content of Li concentrate were tested experimentally. Field research focused on Li-Sn raw materials in the area of the Smrčiny Mts, on Ta-Nb resources of the Homolka-type Moldanubian Pluton, and on W, Au and REE resources in the northern part of the Přibyslav Zone around Havlíčkův Brod. Mo and REE resources were studied on archived samples from the Čistá-Jesenice Massif. With the aid of trace element geochemistry of quartz, the work on the study "Magmatic-hydrothermal transition during the formation of Mo-W mineralization in granites" showed that the Knöttel stock generally reaches a geochemical differentiation of pegmatite and that its evolution occurred in three separate trends, which differs from the Cínovec deposit located nearby.

With regard to critical raw materials, the department's staff was also engaged in the European GeoERA (www.geoera.eu) projects, specifically in the sub-projects "Mintel4EU" (update of the EU Minerals Yearbook and Minerals Inventory) and "FRAME" (www.frame.lneg.pt/; resources of the so-called critical battery raw materials and raw materials from critical countries). In addition to data collection and evaluation of national resources, the CGS organized an excursion to the Kutná Hora and Příbram ore districts and defined new indications of phosphates with REE in the Bohemian Cretaceous Basin.

The Czech Geological Survey also participated in a study of elements of critical raw materials from secondary sources through the Technology Agency of the Czech Republic project "Study of Be, Ge, Ga and In contents in tailings ponds of ash from coal combustion in the Czech Republic", which is led by GET Ltd.

Raw material research in the selection of potential sites for nuclear waste disposal

As part of the sub-project "Obtaining data from the deep horizons of the Rožná Mine", a team of raw material specialists dealt with the revalidation of mineral potential, thereby helping to resolve metallogenic issues regarding the Rožná deposit. A detailed mineralogical study of accompanying mineralizations with regard to Nb, Ta, Y and REE showed that the remaining reserves, accompanying mineralizations and prognostic resources in the other parts of the deposit are currently non-economic.

During the project, the department's staff also evaluated the raw material potential of the K-1 tailings pond in Dolní Rožínka. The contents of "critical raw materials" (Nb, Ta, REE and Y) were evaluated as well as other elements in sludge left over from uranium ore treatment. A calculation of potential resources showed that the tailings pond contains thousands of tonnes of Cu, Pb, Zn, Mn, U, V, Ba, Zr, hundreds of tonnes of Ni, Co, Cr, Sc, Li, Ga, La, Ce, Nd, Y, and tens of tonnes of Mo, Th, Cd, Sb, W, Be, Hf, Nb, Cs, Se, Tl, Pr, Sm, Eu, Gd, Dy, Ho, Er and Yb. The total amount of rare earths amounts to 1,800 t. However, the concentrations of useful elements in the tailings pond are very low.

MINERAL RESOURCES

Environmental impact of mining

Research into the influence of vegetation on the stabilization of potentially toxic elements (As, Cd, Cu, Zn, Mo, Ba and U) in spent coal and uranium heaps in the Žacléř region continued with publication outputs. Vegetation cover is highly useful in stabilizing these elements. Birches, in particular, extract a considerable amount of these elements from the heap material and store them in the leaves in the form of organic complexes that are no longer soluble.

The Czech Geological Survey participated in a foreign study of contamination from mining and processing of ore as part of a GA ČR (Czech Science Foundation) project, led by the Faculty of Science, Charles University. Near the city of Kabwe in Zambia, where the lead concentration reaches up to 1.4% Pb from nearby smelters, it was determined, among other things, that contamination in dust can be reduced by the sprinkling of a superphosphate solution, with which it forms non-soluble complexes. A careful analysis of airborne dust in contaminated mining areas in Namibia identified new forms of highly soluble As salts with high biomobility. The measured exposure rates exceeded the daily dose limits set by the WHO many times over.

In accordance with Decree No. 52/1997 of the Czech Mining Authority, 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 365 sites in 2019.

As part of the project involving geological mapping of the Czech Republic at a scale of 1:25,000, a map of mineral resources, including explanatory notes, was completed for the Mirošov map sheet 12-121.

The Czech Geological Survey provides administrative authorities with expert assessments, studies and documents for administrative and strategic decision-making, the most important of which are the following:

Ministry of the Environment of the Czech Republic

- The study "Defining of prognostic resources of moldavites in South Bohemian basins", aiming, among other things, to help protect land from illegal mining;
- An evaluation supplementing the information provided in the environmental impact assessment regarding the expansion of the Turów mine;
- Issues regarding the mining expansion at the Stříbrná Skalice quarry;
- Expert assessment regarding the approval of the Pernink exploration permit for prospecting for reserved mineral deposits;
- Documents for administrative proceedings regarding a preliminary approval for submitting a mining lease application for Bakov nad Jizerou.

▲ *Portal of a drainage (hereditary) adit at Schweidrich near Šluknov. Photo by P. Rambousek*

▲ *Verification of moldavite-bearing sediments at the Třebanice locality. Photo by T. Peterková.*

Government Council of the Czech Republic

- Aspects regarding sufficient supplies of raw materials for important line structures, discussed at the 27th meeting of the Government Council for the Energy and Raw Materials Strategy of the Czech Republic.

Regions of the Czech Republic

- Update No. 2 of the Regional Raw Materials Policy of the Liberec Region submitted for public discussion in Frýdlant, Ralsko, Mimoň and Liberec in September and October;
- Update of the Regional Policy of the South Bohemian Region commenced in mid-2019, to be completed in 2021;
- Assessment of the issuance of an opinion by the Liberec Region regarding EIA documents involving the "Continuation of mining at the Turów lignite deposit" project;
- Evaluation of the developments involving the planned exploitation of the crushed stone deposit of Brniště-Tlustec-Luhov in the Luhov mining lease;
- Expert assessment on the necessary extension of the Hroznětín mining lease and the possibility of economic exploitation of kaolin for porcelain manufacture and simultaneous exploitation of bentonite;
- Consultancy on the remediation of a heap from past mining and treatment of pyrite in Lukavice near Chrudim.

International cooperation and foreign projects

In addition to the afore-mentioned foreign projects, the department's employees participated significantly in the Czech-Saxon border project "ResiBil", focused on the joint protection of groundwater along the Lužice Fault. With respect to mineral resources, mineralizations that may influence groundwater quality were evaluated in the affected areas monitored.

The department's experts represented the CGS in expert groups on minerals, energy minerals and geochemistry at EuroGeoSurveys. They participated in the preparation of joint projects and consultations regarding amendments of pan-European legislative standards.

▲ *Participants of an excursion to the Kutná Hora-Kaňk deposit during the FRAME project. Photo by P. Rambousek.*

▲ *Remediation of a heap from past mining and treatment of pyrite in Lukavice near Chrudim. Status in June 2019. Photo by P. Rambousek.*

▲ *Meeting of the ResiBil project consortium in Freiberg. Photo by B. Mlčoch.*

(SPV)

Lenka Rukavičková
Hydrogeological
research coordinator

GROUNDWATER RESEARCH AND EVALUATION

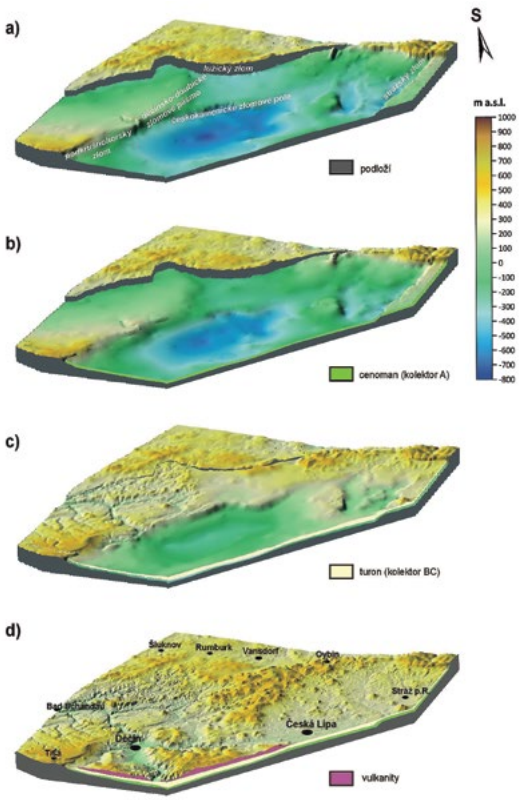
The main focus of hydrogeological research was the influence of human activities on natural groundwater resources. The study included an assessment of the impact of climate change and raw material extraction on groundwater quality and quantity. At the same time, the formation dynamics of groundwater reserves, the sustainable use of water resources, and the possibility of their safeguarding were evaluated. A significant part of the research focused on finding a suitable environment for the location of underground repositories and on hydrogeological aspects of geothermal energy use.

Groundwater assessment of selected hydrogeological structures

In the second half of 2019, work began on the initial stages of the "Groundwater in Crystalline Rocks" project, which deals with the formation of groundwater reserves in crystalline rocks. The project also processes material for adaptation scenarios for ongoing climate changes.

The results of the evaluation of groundwater reserves in four hydrogeological zones were published in the form of expert books. The publications provide state authorities and the public with information on the groundwater status in specific areas.

In terms of international cooperation, work continued on the ResiBil project – "Water resources balance in the eastern part of the Czech-Saxon border area and assessment of their sustainable use". A 3D model of the geological bedrock of the entire study area was created and the mutual relations between crystalline units and Cretaceous sediments were clarified.



▶ *Conceptual 3D geological model of the study area of the ResiBil project. Created by Z. Skácelová.*

The results of a study focused on the formation of karst conduits in the calcareous sandstones of the Bohemian Cretaceous Basin published in a research article confirm the rapid flow of groundwater through karst conduits even beyond the larger karst areas. Water sources linked to such a system are more susceptible to pollution.
The Regional Study of the Urban Geology of Jablonec nad Nisou included an evaluation of hydrogeological conditions as well as a hydrogeological map.

Study of the vulnerability and protection of groundwater resources

A study of climate change manifestations and the effect of coal mining (in the Polish Turów mine) on the dynamics of surface and groundwater flow continued in the border area of the Frýdlant and Hrádek nad Nisou in the Liberec Region. The CGS staff also focused on the transport of undesirable substances into the water-bearing system of the Moravian Karst. The conducted analyses indicated considerable pesticide contamination of groundwater. An evaluation was conducted of a slag heap in the Rudické propadání (Rudice Sinkhole) National Nature Monument and the possibility of slag transport through the water-bearing karst system. At the same time, in cooperation with the Czech Hydrometeorological Institute and the Nature Conservation Agency of the Czech Republic, work commenced on a conceptual model of aquifers in the Moravian Karst and its recharge areas.
The results of a study of factors influencing the concentration of nitrates in the aquifers of Quaternary sediments near the Jizera River were published in research journals. A study of the vulnerability of a quantity of natural groundwater resources due to dry periods began in the second half of 2019. The ability of individual aquifer types to compensate for a multi-year deficit in recharge from precipitation was evaluated.
The flow rate of streams in Central Bohemia with a relatively large hydrological catchment area was studied. The possible effect of evapotranspiration on a decrease in the flow rate of streams was observed in floodplains, where the roots of vegetation lie near the groundwater level.

Applied hydrogeology

Specialists in hydrogeology and hydrochemistry were engaged in a number of applied projects dealing with the underground disposal of highly active waste. The work in underground laboratories mainly included hydrogeological monitoring near in-situ mockups of the storage site. At the same time, the hydrogeological function of geophysical indications of faults was investigated at nine sites pre-selected for the location of a deep nuclear waste repository.
Groundwater associated with geothermal energy was dealt with as part of an interdisciplinary collaborative effort, during which a map application was developed, making hydrogeological information from the Aš and Cheb areas accessible to the public.

▲ *Employees of the Czech Geological Survey collect groundwater samples in the Rudické propadání cave. Photo by V. Baldík.*

▲ *Inventorizing an artesian well with outflowing mineral water in Vřesovice near Prostějov. Photo by E. Kryštofová.*

International cooperation

Another important activity involving groundwater research and assessment is the Czech Geological Survey's international cooperation in EuroGeoSurveys – Water Resources Expert Group network, which allows for participation in consortia dealing with cross-border and pan-European projects focused on hydrogeology, such as RESOURCE, CHAKA and HOVER.

(SPV)

Vít Hladík
Geo-energy
research coordinator

GEO-ENERGY RESEARCH

Recent developments in the climate and energy policy at EU and national levels confirmed the social significance of geo-energy research. In light of the EU's proposed climate neutrality in 2050, both renewable resources, including geothermal energy use, and mitigation measures to reduce CO_2 emissions into the atmosphere, such as CCS technology, are becoming increasingly significant. New trends are reflected in new national policy documents, but also in rising prices of greenhouse gas emission allowances, which are increasingly leading industrial companies to take an interest in technological solutions aimed at reducing emissions. The role of research and development of related technologies will therefore continue to strengthen in the future, which represents a challenge for research institutes.

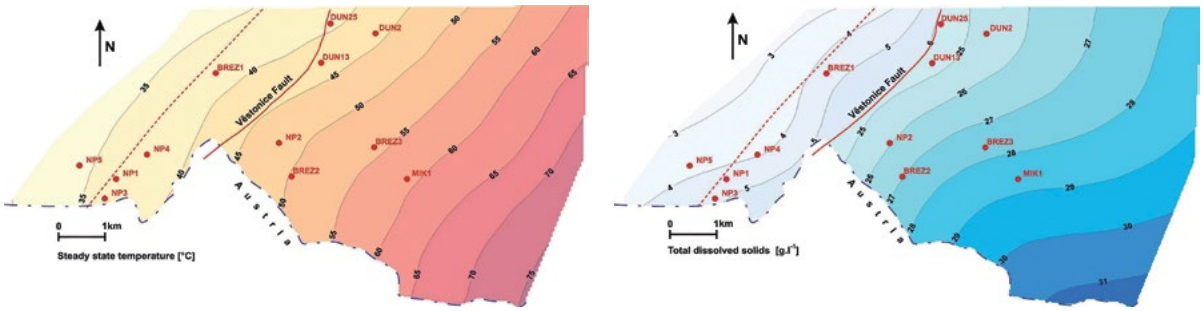
The Czech Geological Survey's geo-energy research in 2019 was primarily focused on increasing the technological readiness level of individual technologies studied. The main focus was on research into geothermal energy and geological storage of CO_2. However, aspects regarding subsurface management and use of underground spaces created by mining were also addressed. Work continued on the implementation of several multi-year core projects, supplemented by other newly launched activities.

Geothermal energy

The international project GeoPlasma-CE (Interreg CENTRAL EUROPE programme) focused on studying shallow geothermal energy in Central Europe, was finalised in 2019. The main outcomes are available to the professional and general public on the project web portal https://portal.geoplasma-ce.eu/. Two publicly accessible workshops were organized in the Czech pilot areas in Broumov and Aš, which also included training on the use of the project outcomes. Maps of geothermal potential and 3D models were published on the project map portal, as well as databases of field measurements in the pilot areas.

The RINGEN project, co-funded from the Large Infrastructure Projects for R&D&I programme of the Ministry of Education, Youth and Sports, focusing on deep geothermal energy research in the locality of Litoměřice and on construction of related research infrastructure,

▲ *Wellhead of the exploratory geothermal well PGV LT-1 in Litoměřice during hydraulic injection tests. Photo by J. Holeček.*



▲ *Maps of steady-state temperatures (left) and total dissolved solids of the formation waters (right) at the surface of the Kurdějov Limestone of the Upper Jurassic in the area of Nový Přerov, Březí and Mikulov.*

was also completed. The follow-up project RINGEN+ (Operational Programme RDE) continues the activities of the above-mentioned project. The most significant research activity of the RINGEN/RINGEN+ projects included the revitalization of the damaged deep geothermal well LTV-01 in Litoměřice. After the casing was pulled out, the well was reopened and is ready for subsequent hydraulic microstimulation activities aimed at determining the preferential tectonic and hydraulic pathways in the near-well environment.

The international project MUSE, which is co-funded by the Horizon 2020 programme, continued in 2019. It focuses on studying collisions during the exploitation of geothermal energy using heat pumps in urban agglomerations. The project pilot area in the Czech Republic is Prague.

The European project HotLime (Horizon 2020 programme) included the construction of a cross-border 3D model of Jurassic sediments in the border zone of South Moravia and Lower Austria and temperature maps at the surface and base of Jurassic sediments, which represent the CGS contribution to the European study of deep geothermal resources in carbonate rocks.

A new project is the "Analysis of the Geothermal Energy Potential in the Czech Republic Based on Available Data" (TACR – THÉTA programme). The objective is to update the maps of geothermal potential and to analyze the legislative framework regarding geothermal energy. In 2019, available data were collected from archives and entered into a unified database of geothermal wells in 2019.

The Czech Geological Survey also joined the European Geothermal-DHC project (COST programme), the priority of which is to strengthen international cooperation in the use of geothermal energy in district heating and cooling grids.

Geological storage of carbon dioxide

Throughout 2019, 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. Particular attention was paid to the study on possible transboundary impacts of CO_2 storage on the adjacent territory of Slovakia and to the assessment of CO_2-driven enhanced oil recovery in the wider area of the Vienna Basin.

Use of underground spaces created by mining

The main activities involved the ongoing project "Controlled biological methane production in situ" (2018–2022) of the TACR THÉTA programme, which 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 coal mines that are being closed down 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.

Subsurface management

The Czech Geological Survey has also joined the multidisciplinary international project GeoConnect^{3}d, co-funded by the Horizon 2020 programme, which focuses on the use of geological modelling for resource management and use of underground structures.

(SPV)

Martin Novák
Head of the Environmental Geochemistry
and Biogeochemistry Department

GEOSPHERE–ATMOSPHERE–HYDROSPHERE–BIOSPHERE INTERACTION

Environmental geochemistry studies (biogeo)chemical processes in individual compartments of the heterogeneous near-surface environment called Critical Zone. These complex interactions involve rock, soil, water, air, and living organisms. During the last year, we continued to use state-of-the-art empirical and modelling approaches, including hydrochemical monitoring, field manipulations, laboratory experiments, and isotope techniques, to investigate the impact of anthropogenic processes, mainly pollution and land use changes, on ecosystems. Pools and fluxes of macro- and micronutrients and toxic substances were quantified in forest catchments and wetlands, with a special focus on the changing function of soils in an era of climate change. We closely collaborated with a number of domestic and international research institutions whose expertise, including, *e.g.*, microbiology, helped us to broaden the scope of our investigations.

Hydrochemical monitoring in a network of small forested catchments

Input–output mass budgets of environmentally relevant elements were calculated for individual sites of the hydrochemical monitoring network GEOMON using monthly concentration and flux data. Collaboration of the Czech Geological Survey with the Department of Ecosystem Biology, Faculty of Science, University of South Bohemia, České Budějovice has shed light on the influence of microbial communities on nutrient retention in soils under changing environmental conditions, such as eutrophication, acidification, and climate change.

Acidification–nutrients experiments were conducted in the Ore Mts (Krušné hory) where acid rain had caused chronic changes in the structure of fungal and bacterial communities. These changes were closely related to disturbances in the cycling of carbon, nitrogen, phosphorus, and other nutrients in forest ecosystems. We combined the mass-balance approach with stable isotope techniques, paying a special attention to nitrogen.

We constructed a biogeochemical model describing the complex interaction between acidification, eutrophication, and bark-beetle disturbance for the Plešné Lake catchment in the Bohemian Forest National Park (Šumava Mts). We have shown that the forest biomass pool had a significant positive effect on soil chemistry and the biological recovery of the entire lake ecosystem.

Non-tradition isotopes

Our MC ICP MS laboratory continued to develop and apply new methodologies for the determination of abundance ratios of novel isotope systems, including, *e.g.*, chromium, zinc, copper, magnesium and cadmium. We focused on densely populated regions and mountain-top ecosystems affected by industrial pollution. Zinc isotope systematics were investigated in the GEOMON catchment "U dvou louček" in the Eagle Mts (Orlické hory), north-eastern Czech Republic. Annual export of Zn *via* surface runoff at this site was five times lower than its atmospheric input. Most anthropogenic Zn deposited on the surface of the catchment was, at least temporarily, immobilized within the ecosystem, mostly in the organic soil horizon. The behaviour of Zn in the Critical Zone is similar to that of lead (Pb), a considerably more toxic trace element. Zinc exported from the catchment was isotopically more similar to atmospheric deposition than to orthogneiss bedrock.

Nitrogen cycling in upland and wetland ecosystems

Isotope ratios of nitrogen ($^{15}N/^{14}N$) were used to study the reactivity of atmospheric N species, mostly nitrate (NO_3^-) and ammonium (NH_4^+), in mountain-slope catchments situated along a pollution gradient. Three study sites (U dvou louček, Pluhův Bor, and Na Zeleném) were characterized by upland (*i.e.*, normally well aerated) soils, while the fourth site (Brumiště) was dominated by wetland soils. We quantified the proportion of recent atmospheric N in catchment runoff, and estimated how much of deposited N was organically cycled prior to its hydrologically-controlled export. We developed a model of runoff generation using oxygen and hydrogen isotopes in water. The model was based not just only on a time-series of H_2O isotope data in precipitation and runoff, but considered also O and H isotope composition of soil solutions collected by lysimeters. Pools and fluxes of dissolved inorganic N were also quantified. The N isotope study made it possible to assess the ecosystem health status and the role of N cycling in greenhouse gas budgets, needed for predictive scenarios of global change.

Cadmium in montane ecosystems

Cadmium (Cd) is a highly toxic trace element. Its environmental cycling has been largely affected by human activities over the past 200 years. We determined Cd content in winter-time horizontal and vertical deposition (ice accretions and snow) at 10 mountain-top locations near the Czech borders with Poland, Germany, and Austria. Our data documented that more than 90% of total Cd was deposited in an easily soluble form including bioavailable Cd species. Ice accretions contained on average six times more Cd than snow. During the study period, horizontal deposition supplied as much as 40% of the total Cd deposition. While Cd concentrations in snow and ice accretions varied significantly among sites, they never reached limit values for drinking water.

▲ *Sampling of horizontal deposition. Photo by L. Bohdálková.*

▲ *Regular monitoring in the GEOMON network of forested catchments in the Polomka catchment in the Železné hory Mts. Photo by Filip Oulehle.*

Chemical weathering studies

Continued collaboration with the British University of Bristol, UK generated new data sets on the rate of chemical weathering of a lithium-bearing leucogranite in the Lysina catchment situated in the Slavkov Forest (Slavkovský les). We jointly published a study of granite weathering at sites on five continents differing in climatic conditions. We focused our attention on parameters of bedrock dissolution in mafic and ultramafic areas (in amphibolites, and serpentinites, respectively). A pilot project in the Pluhův Bor catchment commenced in October 2019 in collaboration with the French University of Lorraine, Metz. Our objective was to assess the ecotoxicity of surface waters for algae in a serpentinite-dominated area. We are currently quantifying runoff patterns of highly toxic elements, chromium, nickel, and mercury.

(SPV)

Oldřich Krejčí
Geohazard
research coordinator

GEOHAZARD RESEARCH

The main research topics of Czech Geological Survey are the following:

- Documenting and investigating geohazards including their classification on a regional and local scale. Activities focused on detailed regional investigation of slope instabilities, of the population's radon exposure and on selected sites of past mining activity resulting in the development of slope failure.
- Expansion of the geological survey's portal and online access to geohazard data for professionals and the general public. The main task involved the development of the geodatabase Inventory of Slope Instabilities of the Czech Republic.
- Research results are used by cities, municipalities and the State Environmental Fund of the Czech Republic to evaluate grant applications from European funds from the Operational Programme Environment 2014–2020 in accordance with valid programme documents.
- An assessment of the relevance of research and its implications, conducted by the Government Council for Research, Development and Innovation, confirmed the Czech Geological Survey's leading position among departmental and research organizations with a level 1 ranking. A truly significant achievement, in the recent evaluation of selected results, is the nationwide top ranking in the field of geosciences for the Comprehensive Radon Information for Municipalities map application (Ivan Barnet et al.). Additional landslide prediction maps were compiled and transmitted to the international database system INSPIRE of EU countries.
- The Strategy on Adaptation to Climate Change in the Czech Republic (Adaptation Strategy, ASZK) and the National Action Plan on Adaptation to Climate Change (NAP Adaptation) were updated.
- Two meetings of the thematic working group for floods and flash floods (TPS 2) at the Ministry of the Environment specified adaptation plans on climate change. The work was coordinated by the employees of the Ministry of the Environment.

Slope instabilities

In the Czech Republic, work continued on monitoring and processing the results from the landslide area threatening the D8 motorway near Dobkovičky. Four detailed maps of geodynamic phenomena at 1:10,000 scale of the surroundings of the Bojkovice water reservoir and two thematic engineering geology maps of stability conditions from the surroundings of the Vír regional water supply system near Doubravník were completed.

Engineering geology research was also carried out in cooperation with the State Office of Nuclear Safety and the Radioactive Waste Repository Authority. A map file was completed, including 3D geological models for the Prague–Dresden high-speed rail project. A 3D structural geological model along the planned high-speed corridor was created using MOVE software, which is suitable for the complex geological structure of the crystalline rocks of the Bohemian Massif and which enables simple import and export of various data formats. Most of the modelled area is located in the crystalline rocks of the Krušné hory Mts, which belong to the Saxothuringian Unit.

An article on Pleistocene landslides and their influence on the settlement of Gravettien hunters in the Pavlov Hills was completed in cooperation with the Institute of Archeology of the Czech Academy of Sciences in Brno. We actively participated in four national professional conferences, and two workshops were organized.

Important contributions were the presentations made at the conference Engineering Geology and Geotechnics for Developing Countries on 11–16 May 2019 in Kathmandu (Nepal) and at the 2019 Annual Conference "Models and Misconceptions" in Cambridge.

Radon risk in the geological bedrock

Radon risk from the geological bedrock is one of the most serious geohazards that directly affects the population. Dealing with the problem of radon occurrence in the geological bedrock is important, among other things, with regard to interdisciplinary monitoring of radon concentrations in potable water and building materials. The planned work complies with Czech Government Resolution No. 594/2009 and with its item II "Radon Programme of the Czech Republic for 2010–2019 – Action Plan" according to the action plan item No. 4 – "Expert scientific and technical support of the Action Plan task implementation" and sub-

▲ *Stabilized landslide above the D8 motorway near Dobkovičky. Photo by Martin Dostalík.*

item 4.5. "Development of geophysical methods for radon risk assessment", and 4.6. "Development and elaboration of map data for risk assessment in the geological bedrock, updating and detailing of radon risk prognosis maps of the Czech Republic" (action plan tasks implemented by the Ministry of the Environment). The project content complies with the objectives of the State Environmental Policy of the Czech Republic 2012–2020, chapter 4. "Safe environment", section 4.1. "Risk prevention".

On 11 November 2019, the State Office for Nuclear Safety (SÚJB) organized a ceremonial seminar to mark the twentieth anniversary of the Radon Programme of the Czech Republic. Two blocks of lectures presented the historical context of radon issues, the results achieved over time, and the outlook for the next decade of the radon programme, which will bear the new designation RANAP (National Action Plan for Radon Exposure Control). On the occasion of the seminar, the new 2019 issue of the Radon Bulletin was published by the National Radiation Protection Institute (SÚRAO). At the same time, a comprehensive report on the MoE's activities involving the Radon Programme of the Czech Republic in 2009–2019 was prepared for the SÚJB. Profile measurements of radon and dose rate variations at anthropogenic inhomogeneities were based in the Krušné hory Mts and foothills. The work results contributed to a detailed assessment of natural radioactivity as one of the geohazards.

▼ *A landslide area above the right bank of the Nechranice reservoir threatens a high voltage pylon. Photo by Martin Dostalík.*

Jan Čurda
Head of the Regional
Geological Administration

REGIONAL GEOLOGICAL ADMINISTRATION

The Regional Geological Administration has continuously and systematically performed the tasks of the state geological survey within the Czech Geological Survey since 1998. It does so according to the provisions of Section 17 of Act No. 62/1988 Coll., on geological work, as amended.

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. The most frequently performed tasks of regional geologists and specialists include written expert assessments, which primarily involve geohazards, conflicts of interest, land-use planning, environmental impacts of structures and technology, zoning and construction management, mitigation of old ecological burdens, mining-related problems and nature conservation planning, and which are based on requests by public authorities.

▲ *View from the bottom of a rock formation in Řetenice u Stach showing three main systems of discontinuities. The overall loose rock formation and the self-help retaining rope system are clearly visible. Photo by J. Novotný.*

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, and for principles securing the ecological stability of areas.

In 2019, regional geologists prepared a total of 989 expert opinions, such as:

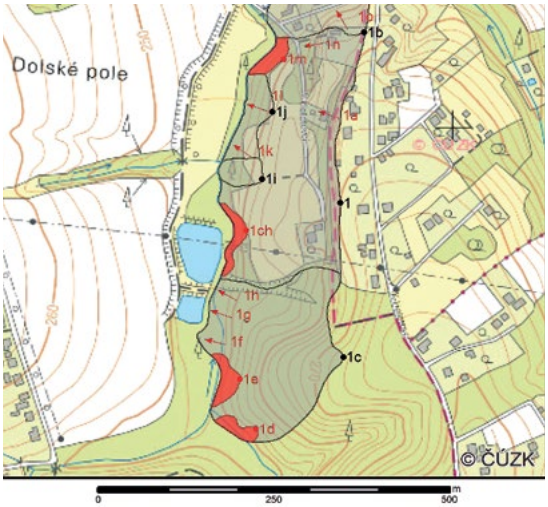
- Assessment of the notification of the commencement of proceedings regarding the protection zone and conditions enabling the safeguarding of the area of the National Cultural Monument Hřebčín Kladruby nad Labem

- Aspects of securing sufficient raw materials for important line structures discussed by the Government Council for the Energy and Raw Materials Strategy of the Czech Republic
- Expert opinion on the issue of the Pernink exploration permit for prospecting for reserved minerals deposits
- Expert assessment of the mining leases for reserved deposits of crushed stone in the Bruntál area
- Expert opinion and assessment of the continuation of mining activities in the Straškov mining lease and its environmental impact
- Supplemental expert assessment regarding the use of the important reserved deposit of crushed stone at Bernartice-Borovsko
- Evaluation of a model of the hydrogeological impact of the Production of Hydraulic Binders Štramberk project
- Expert evaluation of geological activities at the Skalka locality near Prostějov, including exploratory technical wells
- Evaluation of aspects of groundwater protection in the municipality of Bašť
- Revised hydrogeological assessment of an evaluation of the planned well drilling in the cadastral area of Drahotuše in the Olomouc Region
- Assessment regarding the need or use of the proposed construction of monitoring wells in a selected part of the hydrogeological zone in the administrative district of the city of Litomyšl
- Assessment of the potential risk to the groundwater source for the village of Komorovice posed by a new well in the village of Vystrkov
- Reinvestigation of an appeal regarding a groundwater level decline in the village of Slavníč
- Information on background values of arsenic in groundwater in the Přerov district
- Assessment of the possibilities of finding new sources of drinking water for the village of Přehvozdí
- CGS assessment of the safeguarding of the historical water source Boží Voda
- Opinion on the construction of two wells in the village of Dürnau for Bad Leonfelden

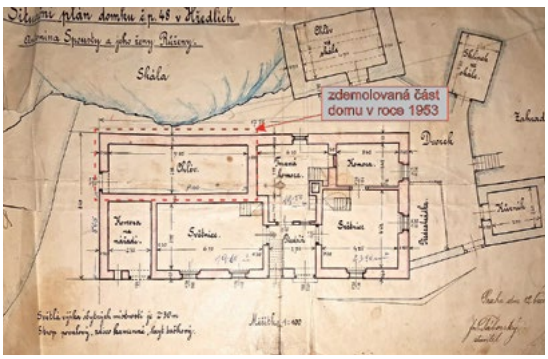
▲ *Drone photo of a rock slope in Vimperk, with a white dashed line outlining an area of potential rock fall. Sections D and E marked in red threaten a garden community, the accumulation area for section F is the Volyňka riverbed. Photo by M. Dostalík.*

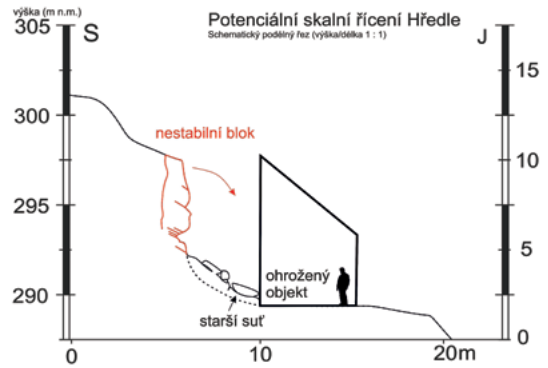
REGIONAL GEOLOGICAL ADMINISTRATION

- Agricultural management in the protection zone of the Káraný water source and its influence on the quality of collected/pumped groundwater
- Exploration study on drinking water sources in the village of Petrovice, Příbram district
- Expert geological evaluation of the stability and risk classification of rock walls and slopes in the cadastral area of Loket
- Evaluation and classification of a landslide hazard at the Technical Services complex in Havířov
- Reconnaissance and classification of landslide hazard in connection with the planned route of a gas pipeline construction
- Evaluation of slope stability on the grounds of a kindergarten in the cadastral area of Zdiby
- Reconnaissance and hazard classification of unstable rock blocks that threaten to collapse into the Lovětínská and Hedvikovská ravines with steep rocky slopes, where official tourist routes are located
- Evaluation and hazard classification of a bank slide of the Střelenka Stream after a local flood on 22 May 2019
- Evaluation and hazard classification of an unstable rock slope in Srbsko near Karlštejn for the purpose of including this locality in the CGS Slope Instability Inventory
- Reconnaissance and hazard classification of slope instability in the cadastral area of Úštěk
- Reconnaissance and hazard classification of unstable rock slopes and rock massifs above road II/160 in the Český Krumlov area for their inclusion in the CGS Inventory of Slope Instabilities
- Expert evaluation of a serious landslide on the Děčín railway line
- Evaluation of the stability of a massive rock beneath Trosky Castle's "Baba Tower"
- Detailed revised geological evaluation of a massive rock beneath Hrubý Rohozec Castle
- Evaluation of the condition of a rocky block of Mariánská Rock in Ústí nad Labem
- Landslide hazard evaluation and classification along road II/292 near Semily
- Reconnaissance report on the state of a massive rock along a road in Březanské údolí
- Review and hazard classification of a landslide area in Petřvald near Karviná



▲ *Map depiction of slope instability in Petřvald near Karviná. Red-coloured polygons and arrows (dimensions up to 50 m) are active slope instabilities, grey-coloured polygons indicate a temporarily dormant status.*



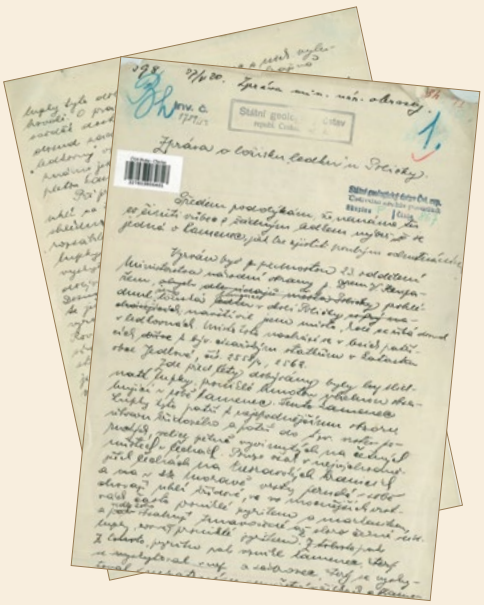


▲ *The collapse of a rock above a house in Hředle in 1953 demolished a barn, as evidenced by the site plan lent by its owner Jaroslav Spousta. Currently, the house is threatened by an unstable rock block. Author M. Dostalík.*

History of assessment and consulting activities

During the 100-year history of the Czech Geological Survey, the Regional Geological Administration, which has existed for only a small fraction of that time, has handled a total of 10,500 traditional outputs and roughly 750 specific assessments of old ecological burdens. However, this does not mean that the organization did not perform assessment activities prior to 1998, when the existing organizational structure of the national 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 at the beginning of its existence provided mainly expert evaluations and consultation on practical geological problems accompanying the formation of the young 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 by focusing 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 can 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.

As a result of the post-war reconstruction of the Czechoslovak state, the geological survey led by Ing. Dr. Ladislav Čepek 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



▲ *The report on an ammonium nitrate deposit near Polička, written in May 1920 by Vojtěch Smetana, is one of the first assessments in the hundred-year history of today's Czech Geological Survey.*

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 1918, which states that "the institute shall document and provide evaluations of important technical and mining 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, the new state and public administration realized that placing important decisions in 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;
- experts with considerable theoretical and practical experience and the necessary background can respond flexibly to the often varying needs of the state;
- as a state institution, the geological survey was an objective body unaffected by commercial interests.

Jaromír Starý
Head of the Mineral Resources Department

Zdeňka Petáková
Head of the Geological Exploration Department

Milada Hrdlovicsová
Head of the Department of Geological Documentation

Jolana Šanderová
Head of the Mining Impacts Department

STATE GEOLOGICAL SURVEY AGENDA OF THE GEOFOND DIVISION

The Geofond Division 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 (Act No. 62/1988 Coll., on geological work), the Mining Act (Act No. 44/1988 Coll., on the protection and use of mineral resources), the Mining Waste Act (Act no. 157/2009 Coll., on mining waste management) and the Building Code (Act No. 183/2006 Coll.).

Geofond was originally established in 1952 as part of the then Central Geological Institute. It was split off from the institute and became independent in 1975. It has been part of the Czech Geological Survey since 2012.

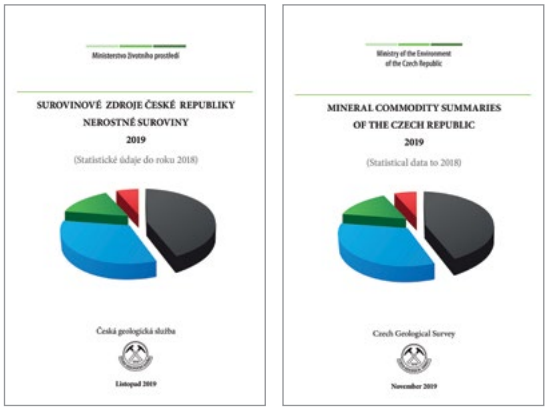
Inventory of geological projects

Organizations carrying out geological projects in the Czech Republic submit related documents to the Czech Geological Survey, which inventorizes them according to § 7 of the act on geological work and according to relevant decrees. The CGS was tasked by the Ministry of the Environment with the inventory's management. In 2019, the CGS recorded 244 geological projects and registered 6,122 registration forms involving geological work, which is a slight decrease compared with the previous year.

Mineral resources

The Mineral Information System (SurIS) collects and provides all available data on the mineral potential of the Czech Republic in coherent form. It is based on the database of mineral deposits and resources of the Czech Republic, with which other sub-databases are linked, such as companies, mining leases, protected deposit areas, preliminary mining lease approvals, exploration areas, approval of reserves, and spatial features. SurIS includes economic databases as well. Basic SurIS data are available in the map application on the Czech Geological Survey's website (https://mapy.geology.cz/suris/).

As of 31 December 2019, SurIS included 10,079 objects, of which 1,511 were registered reserved deposits, 729 registered non-reserved deposits, 817 unregistered



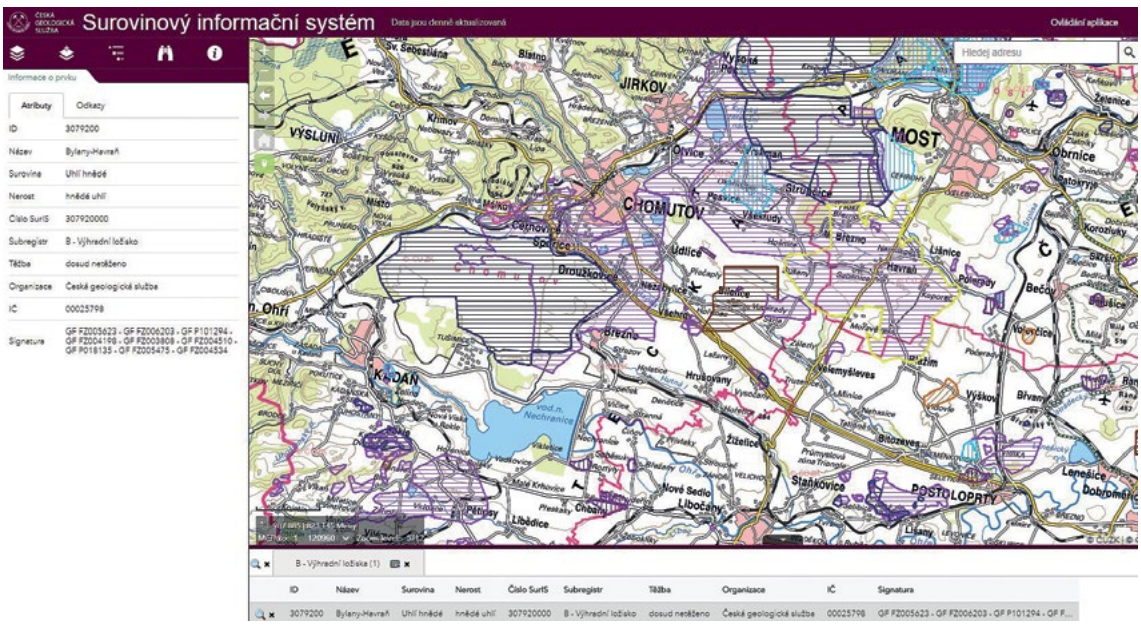
▲ *Czech and English title pages of the "Mineral Commodity Summaries of the Czech Republic".*

resources, 257 approved prognostic resources, 1,043 other prognostic resources, 1,424 negative exploration results, non-prospective areas and mineral occurrences, 4,162 abandoned and exhausted deposits, and 24 geological structures serving as gas storage facilities or underground repositories. A total of 24 new objects were added and 2,780 objects updated in 2019.

According to § 8 of the Mining Act, the CGS is tasked with the safeguarding and inventory of reserved deposits. As of 31 December 2019, it recorded 363 reserved deposits and 347 protected deposit areas.

The following monographs were compiled based on the data of the Mineral Information System:

- *Review of Reserved Mineral Deposit Reserves of the Czech Republic as of 1 January 2019* based on the departmental statistical report Geo (MoE) V 3-01: Part I: Ores, Trace Elements, Part II: Mineral Fuels, Part III: Industrial Minerals, Reserved Deposits of Construction Minerals.
- *Inventory of Mineral Deposit Reserves of the Czech Republic as of 1 January 2019*, containing deposits of non-reserved minerals (construction minerals).
- *The yearbook Mineral Resources of the Czech Republic – Mineral Resources 2019 (Statistical Data 2018)*, published in Czech and English versions, containing 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 2009–2018* is a nonpublic review prepared for the Ministry of Industry and Trade, the Ministry of the Environment,



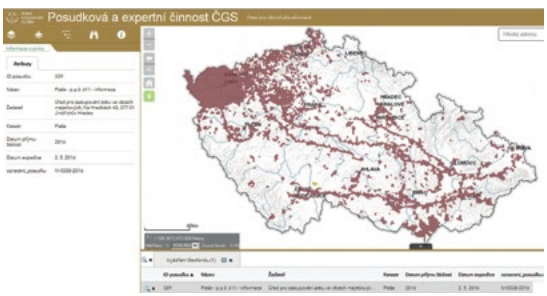
▲ *Display from the publicly available SurIS web map application.*

and the State Mining Administration. It is also used by the CGS to prepare background materials for the state raw materials policy.

- *Summary of Mineral Reserves in Mining Leases and Other Exploited Deposits of Non-Reserved Minerals as of 1 January 2019*, a nonpublic review compiled with the data from the Hor – MPO records on mining technology, provided to the Ministry of the Environment, the Ministry of Industry and Trade, the Czech Mining Authority and to other authorized organizations.

Expert assessment of land use planning documents

The Geofond Division provides comprehensive assessments of land development and land-use plans with regard to areas with specific geological structures by virtue of § 13 of the Geological Act and § 18 and § 19 of the Mining Act. This involves cases of undermined areas and reserved deposits, which the CGS is authorized to safeguard and record. In 2019, 1,108 requests for assessments concerning mineral deposit safeguarding and 123 assessments of undermined areas were handled. The activities were carried out in close cooperation with the assessment activities of the CGS organ of district geologists and associated specialists (http://www.geology.cz/extranet-eng/sgs/expertises).



▲ *Display of the map application for viewing prepared assessments.*

Provision of territorial data for land-use analysis documents

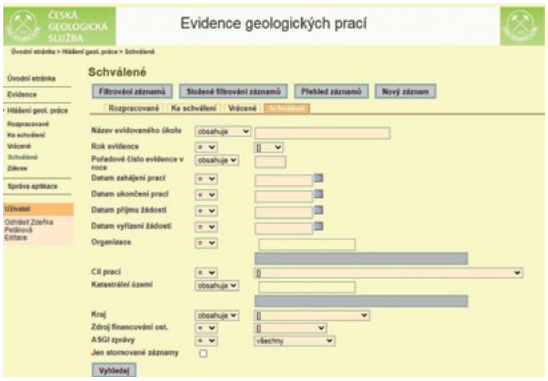
The CGS provides selected data in accordance with § 27 of the Building Act. A digital data delivery module for land-use analysis documents allows users to download relevant data from their areas free of charge based on specifically generated login data. According to the Standards for Monitored Phenomena, this involves protected deposit areas, protected areas for special intervention into the Earth's crust, mineral deposits – reserved deposits, probable deposits of reserved minerals, undermined areas, landslide areas and other geohazard areas, and mine working impacts. In 2019, this service was used by 37 municipalities with extended scope and 12 regions, downloading data on reserved deposits (2,162 objects), prognosticated resources (321 objects), protected deposit areas and protected areas for special interventions into the Earth's crust (1,228 objects), reported mine workings (3,135 objects), undermined areas (5,415 objects) and landslides (29,329 objects).

Borehole surveys and hydrogeological database

The Czech Geological Survey maintains and manages the geologically documented objects database, including hydrogeological and geophysical data. The database contains mainly information on geological, exploratory and other boreholes/wells drilled in the Czech Republic. Information is provided as individual outputs or via the Borehole Logs and the Geologically Documented Objects web applications.

Borehole surveys include the following datasets maintained by the CGS: the Geologically Documented Objects Database (GDO), the Borehole, Shaft and Well

▲ *Interior of the Mining History Department of the Czech Geological Survey in Kutná Hora with a section of the mining literature library. Photo by J. Šanderová.*



▲ *Display from the EGP database application – dialogue box for filtering records.*

Record Database (GEO), the Hydrogeological Database (HYD), and the Drill Logging Database (KAR), the Material Documentation Database and the Technical Parameters of Well Drilling Database (TECH).

The **GDO Database** contains basic information on geological exploration work and, as of 31 December 2019, contained nearly 703,920 objects, mainly boreholes. The database includes data on more than 116,907 economic geology objects, more than 115,570 hydrogeological objects, more than 437,193 engineering geology objects, nearly 979 structural objects and more than 22,396 mapping-related objects. Specialized databases are linked to GDO.

The **GEO Database** was established in 1976 and is the most extensive and longest-running CGS database. It contains detailed data on objects with a geological description of rocks encountered, as well as a link to evaluations – primary final reports. In 2019, nearly two thousand newly received reports were processed and 2,389 objects were selected for further processing. A total of 610 objects with geological profile descriptions were added to the GEO database. As of 31 December 2019, the database contained 622,137 objects with geological profiles.

In 2019, 2,381 objects were entered into the **HYD Database**. As of 31 December 2019, it contained data on more than 106,928 objects. The data is provided through the Borehole Surveys and Geologically Documented Objects applications.

The **Technical Parameters of Well Drilling Database (TECH)**, which is linked to the HYD database, contains information on well construction and casing parameters for nearly 3,500 objects.

The **Groundwater Data and Information Dataset** collects data on groundwater reserve estimation polygons and data on regional hydrogeological resource evaluation polygons. It currently contains 791 polygons.

The **Drill Logging Database (KAR)** contains digitized drill-logging data from more than 5,500 boreholes and directional log data from more than 2,900 objects.

Mining impacts

Information on activities associated with mine workings, undermined areas and mining waste 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 Kutná Hora office, located in the historical centre of the city, holds more than 17,000 copies of mining maps from various map collections. Their data are entered into the information system and made publicly available through the Mining Maps application. The office's professional library has undergone a fundamental change in recent years and has been a full-fledged part of the CGS professional library since 2018. A part of the ID codes for the Resource Reports Collection (FZ) from the CGS Archive is stored at the Kutná Hora office. Roughly half of the collection was digitized in 2012–2019.

Vít Štrupl
Deputy Director
and Head of the Geofond and ICT Divisions

MINE WORKINGS AND MINING WASTE

The Czech Geological Survey, which performs tasks of the state geological survey, maintains the Mine Working Impacts Database and the Inventory of Hazardous Waste Facilities. These activities are based on the Mining Act (§ 35 of Act No. 44/1988 Coll.) and the Mining Waste Management Act (§ 17 of Act No. 157/2009 Coll.).

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 extract 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.

▲ *A collapse of a ventilation shaft from the 4th sinking near the former Mine 2 (Schacht II) at the Sn deposit between Jelení and Rolava was dealt with during the Mine Working Impacts Inventory project. Photo by Pavel Šír.*

The web application Report a Mining Impact, accessible through the CGS website, is available 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 were funded by the Ministry of the Environment. These site assessments are based on a long-established method that includes the locations and descriptions of detected sites, as well as up-to-date photo documentation. Data are being continually added to the database and also provided to the Ministry of the Environment.

In 2019, CGS employees inspected 1,241 mine working sites and documented their impacts. Their activities largely rely and are based on information contained in unpublished reports stored in the CGS 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 2019), the mine workings database representing a comprehensive inventory of underground mines (data on 28,843 sites and more than 25,000 digital charts as of 31 December 2019), and the database of mining maps (data on nearly 17,936 maps and related scans as of 31 December 2019). The Mine Working Impacts

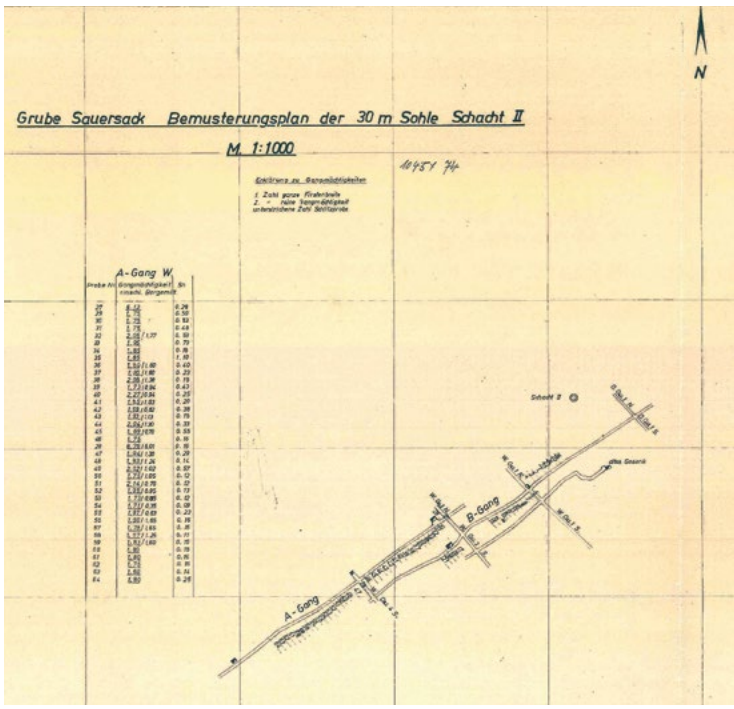
Inventory comprises files containing all the relevant documents for each reported case. The inventory data are stored in the mine working impacts database. As of 31 December 2019, the Mine Working Impacts Inventory contained 2,889 case reports on a total of 2,232 sites. Information on the status and location of reported mine working impacts is permanently accessible to the public through map applications on the CGS website.

Inventory of Hazardous Waste Facilities

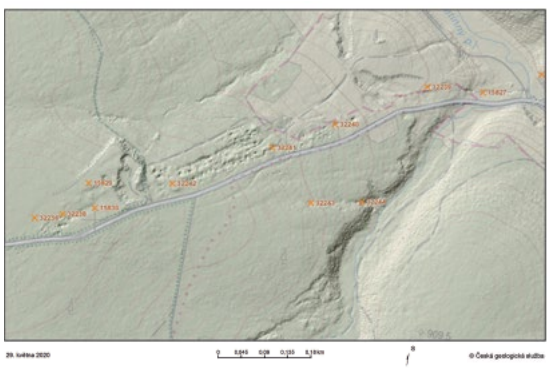
Past mining activities have left behind visible traces in the landscape in the form of spoil heaps, tailing ponds, dumps and abandoned placers. In some cases, they have become significant land-forming features with unique flora and fauna, or they may represent secondary sources of minerals or even pose a serious threat to the environment and human health. In particular, tailings left over from ore mining and dressing contain a wide spectrum of toxic elements which, when released by weathering, contaminate not only the surrounding soil but groundwater and surface water as well. 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. As part of the Operational Programme Environment, the Czech Geological Survey 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 the Inventory of Waste Facilities, which was included in the CGS Information System. As of 31 December 2019, 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, which was launched on 1 May 2012 as an independent web application in Czech and English versions. Along with precise locations, it also contains basic data on the type and degree of risk.



▲ *A mining map section displaying a ventilation shaft in the middle of vein A (A-Gang), which was driven during the 4th sinking and which recently collapsed. Map MA-B/0228 (1943, CGS – Kutná Hora office).*



▲ *Location of recorded mine workings on a topographic base map and digital relief model 5G. Taken from the publicly accessible CGS web application "Mining Impacts".*

Lucie Kondrová
Head of the Geoinformation Systems Department

GEOLOGICAL INFORMATION SYSTEM

The Czech Geological Survey gathers data on the geological setting of the Czech Republic. The development of a geological information system is essential to ensuring the uniform processing, efficient maintenance and provision of information for state authorities and for research and other scientific activities of the CGS. 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 infrastructures.

Geological Information System

The core of the Geological Information System (GeoIS), designed by the Czech Geological Survey to be compatible with national and international standards, is the Central Data Store (CDS), which contains 135 thematic databases. It stores both graphical data – maps, geological cross sections, inventories of hazardous waste facilities, slope instabilities and other items – as well as descriptive data – code lists, results of analyses, the digital Geofond archive, etc. The GeoIS contains a wide variety of thematic subsystems: geological maps – National Geological Map Database (NGMD); mineral resources – Mineral Information System (SurIS), mining waste – an inventory of waste facilities, a subsystem for geologically documented objects (boreholes, test pits, etc.), geohazards (Inventory of Slope Instabilities and complex radon information), hydrogeology, geophysics, soil and other data.

The CGS Metadata Information System (MIS; micka.geology.cz) that allows for orientation in the datasets, services and applications provided by the CGS 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 international geoportals (inspire-geoportal.ec.europa.eu, europe-geology.eu). In 2019, 498 public metadata records on CGS data sources were managed in the MIS. For the CGS information portal, the MIS is used to automatically generate thematic lists of a total of 107 services – web map services WMS (http://www.geology.cz/extranet-eng/maps/online/wms) and services based on Esri ArcGIS for Server technology (http://www.geology.cz/extranet-eng/maps/online/esri), and 70 public web applications (applications.geology.cz, maps.geology.cz). In 2019, the schematic content of the CDS was made available in the CGS Data Guidepost (http://www.geology.cz/extranet-eng/science/information-systems/data-management/databases-cgs), which is also generated from the MIS and allows for filtering of databases according to data access or geoscience themes (see Fig. 1).

A newly modified metadata profile for the description of 3D geological models was used to describe the currently developed models, which are available, in addition to the MIS, also through an overview map at www.geology.cz/extranet-eng/science/earths-crust/3d.

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 Czech Geological Survey is actively involved in the implementation of the directive in the Czech Republic mainly by participating in the technical working groups of KOVIN (Coordinating Committee for INSPIRE).

In 2019, the harmonized dataset "Radon Index Map of the Czech Republic 1:50,000" was published, and the datasets Geophysical Surveys, Seismic Profiles and Geoelectrics – Vertical Electrical Sounding (VES) were prepared for publication as part of the CzechGeo/EPOS project, which was drawing to a close. Work also continued on harmonizing the geological code lists of the CGS with the INSPIRE requirements and on harmonizing data for other themes, such as Soil or Natural Risk Zones.

▲ *Fig. 1. The newly available thematic overview of CGS databases containing information on types of access to them.*

Development of the technology and content of data sources

The consolidation of existing data sources continued in 2019. The operational logic of the ASGI database was changed after the launch of a new editing application. Updating procedures were replaced by new procedures, which feed updated data from the now primary operational database to the original database, from which data are consumed by operational applications for use in the CGS study room. A new data structure was created for technical annotations (records of scanned pages of reports and their hierarchy) and stored procedures were created for processing data in CSV format into this structure. A sample of test records was inserted into the technical annotation database.

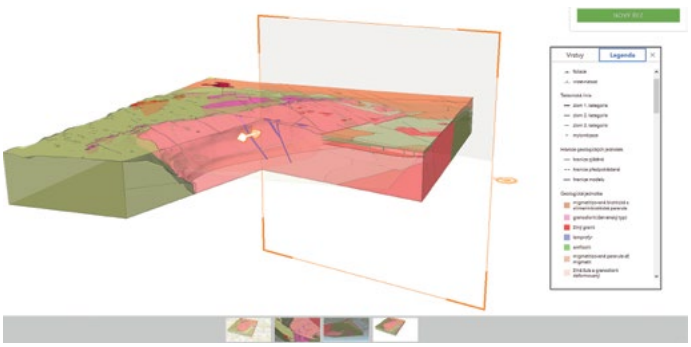
Within the Mineral Information System (SurIS), stored procedures were created for basic manipulation with Geo-V records, their resetting, storage in the archive of reviews, and review year change. The metadata database of attached SurIS documents was modified. After testing, digitized documents are inserted into SurIS as assigned by a professional supervisor.

In 2019, the National Geological Map Database has been further developed, in which mainly older maps compiled prior to 2009 were integrated in the Intergraph Bentley environment (change in data structure, data transfer, legend unified with the areas of Brno, the Moldanubian Zone, the Žďárské vrchy Hills and the Polabí region); 30 maps from 105 sheets were processed.

The first version of the legend for the 1:200,000 geological map (GEOČR200) was completed. The legend was modified further for GEOČR500 (addition of map symbols, preparation of English and Czech descriptions).

A plan for processing of new map sheets was prepared for approval in connection with the transformation of the State Map Series of the Czech Republic, which is based on the Surveying Development Concept of the Surveying Office (to be completed by 31 December 2022 and valid from 1 January 2023). The mapping plan will be altered and changes to records in databases will be prepared. In

GEOLOGICAL INFORMATION SYSTEM



▲ *Fig. 2. 3D web scene – a newly used web display method for 3D geological models.*

2019, work continued on consolidating the data structure of the geoscience code lists of the CGS, which involve geological, geophysical, hydrogeological, engineering-geological and other code lists.

Geographic Information System

The Geographic Information System (GIS) continued to be used as the enterprise 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 2019, this involved geological mapping at 1:25,000 scale, contracts for SÚRAO (geological maps and cross sections of 180 profiles at 1:10,000 scale), DIAMO (deposits and sources of strategic raw materials), and the CEEMIR project (use of selected critical raw materials). Work also commenced on the project "Targeted replenishment of groundwater as a tool to reduce drought impact in the Czech Republic". The Study of the Urban Geology of Jablonec nad Nisou was completed, and its outputs in the form of GIS data will be used by the municipal authority.

GIS methods were also used in foreign cooperation projects, such as RESIBIL, focusing on the review of water resources in the eastern part of the Czech-Saxon border, Turów, focusing on investigating the mining impact of the Polish Turów mine on the Czech territory, including data for a hydrogeological model, HSR–PrD, focusing on the development of rail transport in Saxony and the Czech Republic, as well as in foreign projects in Ethiopia (submission of map and geodatabase) and Mongolia (map and paper Geological Map of the Southeastern Mongolian Altai), and for the book Geologists in Central America. All foreign map data created since the 2000 began to be transferred to the CDS. GIS data were also presented by the CGS staff at the Doors Open Days on the occasion of the Earth Day.

In 2019, work continued on examining the future use of ArcGIS Pro software, on the conversion of GIS data into Adobe Illustrator, and on modifications to style libraries (polygon, line and point symbols). This part was tested during the preparation of a print file of the Geological Map of James Ross Island – Northern Part 1:25,000 (to be released in 2020).

The entire GIS infrastructure was upgraded to ArcGIS version 10.6.1, which is currently stable and fully functional. The new architecture of two independent map servers guarantees much higher stability of map services provision, fast data rendering and also service availability without downtime.

Providing access to geoscience data and information

In 2019, in addition to the already mentioned modifications to the GeoIS databases and the development of applications for their access through the CGS Information Portal (see chapter CGS Website), the general functionality of map applications operated on the CGS Map Server was developed and extended. Based on the requirements collected from users and on the long-term development concept, several improvements were gradually implemented in all applications, such as the ability to generate bibliographic references of the map application within the print component, displaying hint bubbles and descriptions in the layer list, or highlighting of related objects on maps.

In 2019, a new application was developed displaying the hydrogeological data for the Aš and Cheb areas. Individual map layers contain information on the chemical composition of groundwater, on the occurrence of mineral waters and CO_2 emissions, on hydraulic properties of rocks, and on the hydrogeological environment type, including the results of field measurements and photo documentation of verified hydrogeological objects (see https://mapy.geology.cz/hydrogeologie_assko_chebsko/).

The Surface Water Chemistry map application was upgraded to a new version, and with the new functionality and appearance, the map content was expanded as well. The application now provides access to all the results of chemical analyses for individual surface water sampling points in the Czech Republic in 1984–2018. At the same time, it is possible to obtain an overview of the chemistry of surface water in the Czech Republic in 2007–2010 (https://mapy.geology.cz/povrchove_vody/).

The creation of English versions of applications for datasets that contain only data translated into English continued in 2019. The Geological Map 1:500,000, Geophysical Measurements and Significant Geological Localities applications were published.

As part of the national geological survey's centennial, a story map was created that traces the development of the Czech Geological Survey, presenting it as a modern and open organization, which uses modern methods for data collection, analysis and publication not only in the Czech Republic but also in many projects abroad.

In 2019, a methodology for converting data from 3D SW (MOVE) to GIS (ArcGIS Pro) was completed, including their transformation and modification for 3D scene publishing. Based on this methodology, four 3D geological models were published (see Fig. 2), which are available through a simple overview map (www.geology.cz/extranet-eng/science/earths-crust/3d).

International cooperation

In 2019, the Czech Geological Survey continued to maintain and update the metadata catalogues of the European projects Minerals4EU, ProSUM and the European Geological Data Infrastructure (EGDI; egdi.geology.cz). By the end of 2019, 1,924 metadata records of data sources from thirty European geological organizations and five European projects were administered in the EGDI catalogue.

The GeoInformation Platform project of the GeoERA programme continued in cooperation with other geological surveys of EuroGeoSurveys, whose top representative is the CGS Director Zdeněk Venera as of 1 January 2019. The platform is being built as an extension of EGDI, for which the CGS prepared a new metadata catalogue version, including the possibility of a structured description of 3D geological models created within other GeoERA research projects. Active cooperation also continued in the development and coordination of other infrastructure components.

In April 2019, Dana Čápová was elected chairwoman of the Spatial Information Expert Group (SIEG), the expert advisory body of EuroGeoSurveys. The group's main objective is to propose a procedure and to assess European information policy solutions (implementation of the INSPIRE directive, EGDI rules, cooperation with EPOS infrastructures, EOSC, recommendation of priorities for calls under European programmes, etc.). The group also proposes follow-up GeoERA activities in order to create a permanent coordinated pan-European information infrastructure. In June 2019, the CGS signed a cooperation agreement with the EPOS Thematic Core Service (TCS) "Geological Information and Modelling", and Dana Čápová was elected chairwoman of this group.

The staff of the Informatics Division attended the 34th Geoscience Information Consortium (GIC) conference, organized by IGME in Madrid, and the workshop 5th European Meeting on 3D Geological Modelling, organized in Bern by the Swiss Geological Survey. The staff organized the fifth meeting of geoinformaticians of the Central European geological surveys (CE-GIC) in Prague.

▲ *Fig. 3. For a joint photo, the participants of the fifth meeting of geoinformaticians of the Central European geological surveys (CE-GIC) in Prague chose the spectacular chapel interior at the CGS Headquarters in Klárov, Prague. Photo by L. Kondrová.*

Veronika Strnadová
Head of the Remote Sensing Centre

REMOTE SENSING

Thanks to new space programmes and fast developing technologies, remote sensing is nowadays the most widespread method of acquiring spatial data on the Earth's surface and objects. Parameters of remote sensing data, primarily spectral resolution, imaging speed and spatial resolution are continually improving and available free of charge for a wider range of research applications, for instance, from NASA's Landsat and ESA's Copernicus programmes. This contributes to rapid development of new methods and cloud applications that allow for systematic monitoring of the Earth and linking of various geoscientific disciplines.

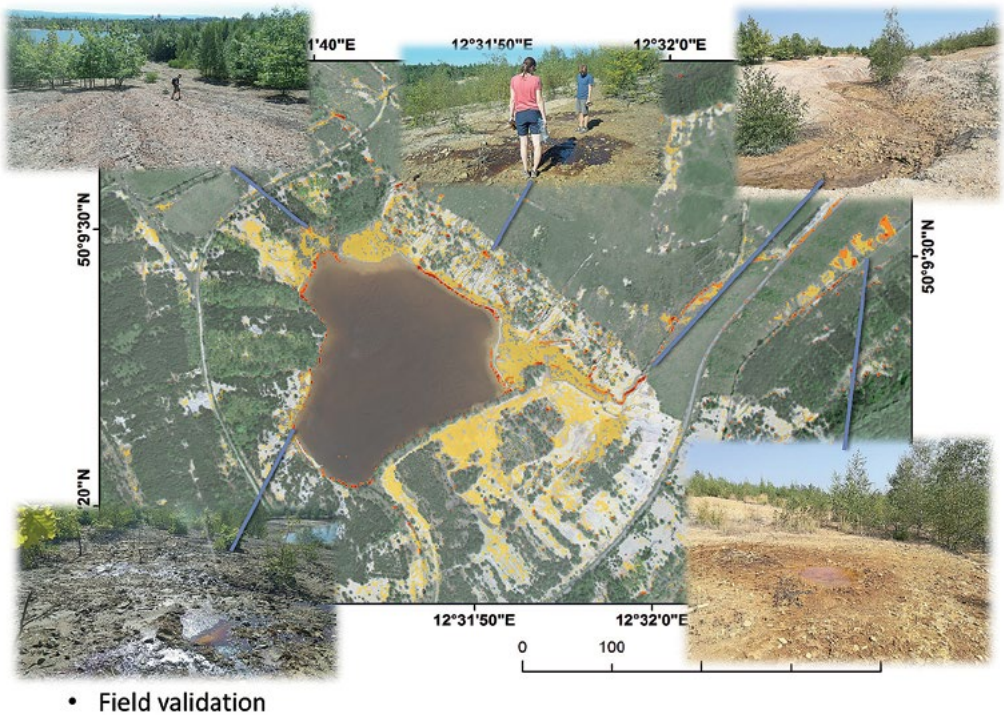
Over the long-term, the Remote Sensing Centre (RSC) works with quantitative image spectroscopy methods by using optical and thermal hyperspectral (HS) image data. The centre's team employs the quantitative spectroscopic methods as a modern tool for monitoring and studying the interactions of all environmental constituents – rocks, vegetation and water.

During national and international long-term research projects, models were constructed using RS image data to determine the surface pH gradient in exposed substrates and the contamination of surface mine waters, or a model to assess the overall health of spruce-dominated forest stands that thus far do not exhibit any signs of visible damage. The above-mentioned image spectroscopy applications have great potential for environmental monitoring because they enable, for instance, the 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/quantitative mineralogical application, 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.

In addition to HS technologies, the centre was engaged in other fields of remote sensing. New methods and tools developed by the centre's team include a procedure for the classification of morphometric features and their ensuing geomorphological interpretation, a method that enables the updating of tectonic and hydrogeological elements based on ALOS PALSAR satellite radar data, and automation of optical data processing in the Google Earth Engine.

Radar interferometry methods (SBAS-DInSAR or PSI) are used to detect vertical movements and deformations. Radar interferometry was employed, for instance, to identify landslide movement along the D8 motorway in the České středohoří Mts, to evaluate land stability near the Polish Turów mine, to interpret post-seismic phenomena including neo-tectonics in the East African



▲ *Detection and mapping of acid substrates (Acid Mine Drainage) using aerial hyperspectral data at the Lítov dump near Sokolov.*

Rift System, or to evaluate the impact of the devastating earthquake and subsequent post-seismic phenomena in New Zealand in 2016. Due to their ability to respond to changes in surface parameters, radar data are also used to detect landslides and mudslides after heavy precipitation or earthquakes.

The RSC has successfully implemented unmanned systems for the acquisition of optical and thermal image data. The centre's equipment includes two drones, a Flydeo Y6 hexacopter and a DJI Phantom 4 quadrocopter, for which the following sensors were acquired: a hyperspectral Resonon Pika L, multispectral Parrot Sequoia, multispectral MAPIR Survey2 NDVI, thermal FLIR Duo R and a thermal Workswell WIRIS 2nd gen 640.

Unmanned imaging allows for independent scanning of study localities on a local scale with high resolution, which supplements existing airborne or satellite data, while enabling operational data acquisition for new scientific topics and projects. The RSC's laboratory is also equipped with a Spectral Evolution spectroradiometer, which makes it possible to supplement image data with high-quality in-situ measurements of samples.

The results of research focused on the above-mentioned fields are continuously published in IF-indexed, international peer-reviewed professional journals. In 2019, the general public as well as CGS employees and other visitors of Earth Day, held in April, had the opportunity to familiarize themselves with remote sensing in geology at an exhibit in the bookstore from November 2019 to June 2020. The science popularization activity in 2019 ended with the ceremonial launch of a calendar celebrating the 100th anniversary of the Czech Geological Survey's founding, which depicts selected global geological phenomena on satellite images.

The Remote Sensing Centre cooperates scientifically with the following organizations:

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

INTERNATIONAL ACTIVITIES AND COOPERATION

The Czech Geological Survey is engaged in a number of international projects in cooperation with other European geological surveys and foreign partners as well. The principal activities in 2019 included development cooperation projects in Africa and the study of geological phenomena in foreign localities. The Czech Geological Survey is an active member of many international organizations.

COOPERATION WITH EUROPEAN GEOLOGICAL SURVEYS

The Geological Surveys of Europe

The Czech Geological Survey is an active member of the association of European geological surveys EuroGeoSurveys (EGS). This non-profit organization representing 38 national geological surveys and some regional surveys provides European institutions with expert pan-European consultancy and information, such as problem-solving assistance, policy-making, regulation and programme preparation. The Director of the Czech Geological Survey Zdeněk Venera was elected President of EuroGeoSurveys for 2019–2020 and, as a member of the Executive Committee, actively contributes to the fulfilment of this organization's strategic goals. CGS experts are members of many EGS expert groups. In

▲ *47th EuroGeoSurveys General Meeting. Photo by O. Man.*

▲ *Participants in the General Meeting of Directors of European Geological Surveys in Prague in October 2019. Photo by O. Man.*

October 2019, the CGS organized the General Meeting of the directors of European geological surveys in Prague, in connection with the workshop "The role of science in geological surveys" and an excursion to geologically important localities in West Bohemia.

Successful completion of a training programme for geological surveys in Africa

PanAfGeo
Geoscientific Knowledge & Skills in African Geological Surveys

Together with European geological surveys, the CGS implemented the project PanAfGeo – Pan-African Support to the EuroGeoSurveys – Organization of African Geological Surveys (EGS–OAGS) Partnership in 2017–2019, during which geoscience experts from a number of countries on the African continent were trained. The excellent qualifications of the experts from the Czech Geological Survey, which coordinated most of the geological mapping, and from other participating organizations were appreciated. The outstanding organization of individual courses and their effectiveness were highly rated. The mapping courses involved colleagues from the Geological Survey of Ethiopia as the main partner in Africa, French geologists from the BRGM, and experts from the Geological Survey of Slovenia (GeoZS). The project has helped to establish close relations with African geological surveys. *(Funded by the European Union)*

▲ *Participants of a PanAfGeo geological mapping course in a historical phonolite quarry for stelae of the Aksumite culture, Aksum, Tigray, Ethiopia. Photo by J. Jelének.*

GeoERA projects contribute to optimal use and management of subsurface resources

GeoERA

In 2019, as part of the EGS, the CGS participated among other things in the continuation of the research programme Establishing the European Geological Surveys Research Area to Deliver a Geological Service for Europe (GeoERA), partly funded by the European Commission through the Horizon 2020 Framework Programme for Research and Innovation (ERA-NET Cofund). CGS experts actively worked on nine of the fifteen GeoERA projects in four thematic areas:

Geoenergy

- Managing Urban Shallow geothermal Energy (MUSE)
- Mapping and Assessment of Geothermal Plays in Deep Carbonate Rocks – Cross-domain Implications and Impacts (HotLime)
- 3D geomodeling for Europe (3DGEO-EU)
- Cross-border, cross-thematic multiscale framework for combining geological models and data for resource appraisal and policy support (GeoConnect^{3}d)

Groundwater

- 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 (HOVER)
- Resources of groundwater, harmonized at cross-border and pan-European scale (RESOURCes)

Raw Materials

- • Mineral Intelligence for Europe (Mintell4EU)
- • Forecasting and Assessing Europe's Strategic Raw Materials Needs (FRAME)

Information platform

- GeoERA Information Platform Project (GIP-P)

INTERNATIONAL ACTIVITIES AND COOPERATION

COOPERATION WITH OTHER FOREIGN PARTNERS

In 2019, in cooperation with foreign partners, the Czech Geological Survey was engaged in the following projects:

ENOS – Enabling Onshore CO_2 Storage in Europe

Throughout 2019, work at the LBr-1 research site, which is being studied as a potential pilot carbon dioxide repository, continued as part of the European ENOS project. Particular attention was paid to the study of the repository's possible transboundary impacts on the nearby territory of Slovakia and to an assessment of potential residual crude oil recovery through CO_2 injection in the wider area of the Vienna Basin. *(Supported by the EU Framework Programme for Research and Innovation Horizon 2020)*

e-shape – Next-generation satellite data and creation of innovative applications

The three-year international project e-shape (EuroGEO Showcases: Applications Powered by Europe) was launched in 2019. The project focuses on increasing the use of next-generation satellite data (Copernicus Programme) and on developing innovative applications that will contribute to the goals of sustainable development (Sustainable Development Goals, SDGs). The Czech Geological Survey's expert group on remote sensing is involved in the project. *(Funded by the EU Framework Programme for Research and Innovation Horizon 2020)*

MINLAND – Mineral Resources in Sustainable Land-Use Planning

The project, led by the Geological Survey of Sweden, focused on minerals and land-use planning in an effort to define the principles for accessing domestic mineral resources. As a third party to EGS, the Czech Geological Survey participated in researching national legislation related to land-use planning and to the acquisition of mineral deposits. The project results are actively used in similar national projects and, through the CGS, recommended for use by local authorities. *(Funded by the EU Framework Program for Research and Innovation Horizon 2020)*

Intermin – International Network of Raw Materials Training Centres

The project aims to create a self-sufficient long-term international network of raw materials training centres for professionals. It involves educational and research institutes in the EU and in third countries based on specific country expertise in the primary and secondary raw materials sector. As a third party to EuroGeoSurveys, the CGS participates in the project by processing relevant information for the Czech Republic. *(Funded by the EU Framework Program for Research and Innovation Horizon 2020)*

COST Geothermal DHC – New geothermal sources for carbon-free heating grids

More information on this project can be found in the chapter on geoenergy. *(COST Action funded by the EU Framework Program for Research and Innovation Horizon 2020)*

GeoPLASMA-CE – Shallow Geothermal Energy Planning, Assessment and Mapping Strategies in Central Europe

The GeoPLASMA-CE project, which deals with aspects of using shallow geothermal sources for heating and cooling in both urban and rural regions, was completed in 2019. The project involved geological surveys, universities, non-profit organizations, administrations and private companies in six Central European countries at pilot sites in Vogtland/West Bohemia (DE-CZ), Valbřich/Broumov (PL-CZ), Krakow (PL), Vienna (AT), Bratislava (SK) and Ljubljana (SI). The project developed strategies for sustainable use of shallow geothermal energy in order to share knowledge and expand methods for effective

▲ *International information portal for the professional and lay public – https://portal.geoplasma-ce.eu.*

use of shallow geothermal energy for heating and cooling. Locally available geothermal heat sources do not burden the environment with emissions. That is why they are currently considered key to reducing emissions and improving air quality. In cooperation with project partners, an international web information portal was created for the professional and lay public. *(Funded by the Operational Programme Central Europe – Interreg)*

ResiBil – Water resources balance in the eastern part of the Czech-Saxon border area and assessment of their sustainable use

The international Czech-Saxon EU project ResiBil focused on reviewing and assessing the sustainability of long-term groundwater use in the border region in view of the expected climate change impacts. The project involves the cooperation of 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. Detailed information on this project can be found in the chapter "Groundwater Research and Evaluation". *(Funded by the Cooperation Programme Free State of Saxony – Czech Republic 2014–2020)*

Cross-border cooperation for the development of railway transport Saxony – Czech Republic

The aim of the project is to intensify and strengthen the cooperation between institutes in order to improve and develop cross-border rail transport between the Czech Republic and Saxony. Employees of the Czech Geological Survey together with colleagues from the Geological Survey of Saxony completed a 3D geological model, which is an important basis for further preparations involving the project of a new Prague – Ústí nad Labem – Dresden railway line. The model was compiled based on archived map data, on the borehole database, and on archived and newly measured geophysical profiles. Valuable geological information obtained during the model's construction will also be used for other strategic decisions of both countries related to the rock environment. *(Funded by the Cooperation Programme Free State of Saxony – Czech Republic 2014–2020)*

GECON – Geology Cooperation Network

For the Czech-Polish GECON project, the staff of the Czech Geological Survey provides all promotional and publicity activities. During 2019, in cooperation with Polish partners, three multi-day study trips, three workshops and a week-long summer school were organized in the Polish Łuk Mużakowa Geopark, focused on utilizing former mining sites and facilities for geotourism. (Funded by the for Cross-Border Cooperation Operational Programme INTERREG V-A CR–Poland)

▲ *An excursion organized as part of the HSR-PRD project on October 8 and 9 near Ústí nad Labem aroused great media interest. Its participants were interested in several proposed routes planned based on a 3D model developed by experts from the Czech Geological Survey. Photo by P. Fiferna.*

▲ *A geotourism trail in the Łuk Mużakova Geopark near the former Babina mine. Geopark workers participate in the reclamation of the former mineral extraction area and in its subsequent use for geotourism. Photo by K. Froňková.*

INTERNATIONAL ACTIVITIES AND COOPERATION

TravelEX – travelling exhibition on minerals

The project's objective was to organize a travelling exhibit that will introduce visitors to the importance of specific minerals, without which we could no longer manage today. Thus, a unique international exhibit called "Minerals got talent! From underground to home" was developed and launched at TalTech University in Tallinn. Attention is paid to the amount of minerals needed for the existence of our society as well as to their geological evolution. The exhibit will travel to museums throughout Europe over the next five years. *(Funded by EIT RawMaterials – European Institute of Innovation and Technology)*

Paleogeographic maps of the Permian river basins of Central Europe

In cooperation with Polish colleagues, the CGS staff studied a cross-section at the Janików locality near the Božanovský Stream and are currently processing the Permian flora discovered. They also visited other sites with poor flora – Ratno Dolne and Tłumaczov. The project also included a museum-related review of the genus *Cordaites* and an article about them was published in the journal Geologia Croatica (72, 3, 163–172). *(Funded by the National Science Centre, Harmonia Programme)*

▲ *Field work of the Harmonia project near the village of Janików in the Intra-Sudetic Basin. Photo by Z. Šimůnek.*

Crustal and upper-mantle structures from seismic anisotropy analysis and gravity data in Mongolia

The main purpose of this project is to obtain seismic and gravity constraints on lithospheric discontinuities in order to determine the crustal and upper-mantle structures along the southern part of the MOBAL 2003 seismic experiment south of the Central Asian Orogenic Belt (CAOB). Broad-band seismic and gravity data, which were already aquired, were re-analyzed to reduce the uncertainties and build pivotal constraints on the architecture of this part of the CAOB lithosphere, primarily in the region where a relaminated arc was identified. *(Funded by the Ministry of Education, Youth and Sports under the Mobility Programme)*

▲ *Field camp near Taishir. Photo by I. Soejono.*

UNESCO International Geoscience Programme (IGCP)

In 2019, CGS researchers participated in the following projects:

IGCP 637 – Heritage Stone Designation

IGCP 640 – Significance of Modern and Ancient Submarine Slope LandSLIDEs (S4SLIDE)

IGCP 652 – Reading geologic time in Palaeozoic sedimentary rocks

IGCP 653 – The onset of the Great Ordovician Biodiversification Event

IGCP 668 – Equatorial Gondwanan History and Early Palaeozoic Evolutionary Dynamics

RESEARCH INFRASTRUCTURES FUNDED BY THE EUROPEAN UNION

Distributed System of Permanent Observatory Measurements and Temporary Monitoring of Geophysical Fields, CzechGeo/EPOS-Sci

The CzechGeo/EPOS-Sci project focuses on the completion and modernization of observatories and their networks and on funding five research programmes using a modernized research infrastructure. The modernization aims to improve the quality of data in terms of accuracy and sensitivity, to improve spatial coverage, and to increase the number of stations with better quality equipment and with online transmission to data centres. *(Funded by the Operational Programme Research, Development and Education 2014–2020)*

Research on key ecosystem interactions of soil and water in the SoWa research infrastructure

The project included an investigation of biogeochemical and hydrological relationships between forest soil, vegetation, precipitation, and soil and surface water in small forested catchments. The main finding was that the relationships in a forest ecosystem are controlled directly and indirectly by climate changes (such as drought and subsequent dying of spruce stands) after decreased acidification and that these periods have a major influence on leaching/retention of all biogeochemically important elements (C, N, P, K). *(Funded by the Operational Programme Research, Development and Education 2014–2020)*

Upgrade of the RINGEN research infrastructure

The RINGEN+ project focused on developing a professional environment for research on the effective use of deep geothermal energy. This included the construction of a geothermal research centre in Litoměřice, where key equipment, technologies and laboratory facilities for research teams are located. Research activities focused on the development and testing of methods for assessing the energy potential of underground heat, on a method for stimulating rock permeability for creating geothermal heat exchangers, and on seismic monitoring. The project activities followed up current international interdisciplinary research on deep geothermal energy using EGS technology. The RINGEN+ project involved a consortium of partners consisting of the Czech Geological Survey and leading Czech academic institutes (Faculty of Science Charles University, Technical University of Liberec, Czech Technical University in Prague, Czech Academy of Sciences, Institute of Rock Structure and Mechanics, J.E. Purkyně University, VSB – Technical University of Ostrava). CGS research activities focused mainly on studying the properties of the rock environment, geology, hydrogeology, tectonics and 3D geological modelling of the study site in Litoměřice. *(Funded by the Operational Programme Research, Development and Education 2014–2020)*

FOREIGN DEVELOPMENT COOPERATION PROJECTS IN ETHIOPIA

Ethiopia has long been one of the priority areas of the Czech Republic's development cooperation, which continues the rich tradition of mutual relations between both countries. In Ethiopia, the Czech Geological Survey is successfully conducting two foreign development cooperation projects, the main content of which is basic and applied geoscience research with an emphasis on pedagogical activities and increasing professional capacities.

▲ *Example of the degradation of agricultural land in the central part of the Ethiopian Rift in the Sidama Region, which is the long-term focal point of Czech development aid in geoscience. Photo by K. Verner.*

▲ *Interpretation of field data during a geological mapping course for experts of geoscience institutes in Ethiopia. Photo by K. Verner.*

▲ *Practical use of a fault structure of the rift system's eastern margin northeast of the city of Arba Minch. Photo by K. Verner.*

Enhancing the quality of doctoral geoscience studies

In 2019, the CGS successfully completed the project "Implementation of a methodical approach in geological sciences to enhance the quality of doctoral studies at Addis Ababa University, Ethiopia". The project focused on introducing 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. *(Funded by the Czech Development Agency)*

Geoscience mapping for sustainable land management

The "Ensuring sustainable land management in selected areas of Ethiopia based on geoscience mapping" project, which is currently one of the most important Czech development assistance projects in Ethiopia, was launched in July 2019. The five-year project of the Czech Geological Survey is being carried out in cooperation with the Geological Survey of Ethiopia. The project's main focus is on halting degradation of agricultural land, its restoration and on enhancing natural diversity (SDGs 15). The main project outputs include the compilation of a set of geoscience map layers of the important Sidama and Gedeo regions at a scale of 1:100,000 followed up by the processing of new land-use and landscape plans of key areas with rapid population growth, including practical application of new knowledge.

The project outputs will be the cornerstone for effective safeguarding and use of potable water sources, land development planning, sustainable agriculture, improving the quality of agricultural land and, last but not least, a basic and necessary prerequisite for successful and financially effective interventions in problem areas. An important part of the project also focuses on enhancing the professional capacity of Ethiopian experts of government and local authorities. *(Funded by the Czech Development Agency)*

STUDY OF GEOLOGICAL PHENOMENA IN FOREIGN LOCALITIES

Under national grant programmes, CGS experts also study geological phenomena in foreign localities, such as Antarctica, Africa and Asia.

Contrasting mechanisms of formation of the Pangea supercontinent: new insights into the formation of the continental crust

The project aims to develop a model of continental growth, exemplified by the supercontinent Pangea, and to characterize the primary oceans of the Mongolian CAOB, the timing and mechanisms of their transfer into the interior of the continental realm and the processes of their transformation into a continent. *(Funded by the Grant Agency of the Czech Republic)*

Principal mechanisms of peripheral continental growth during the supercontinental cycle

The project aims to characterize contrasting orogenic cycles, to model the formation of the hybrid oceanic lithosphere, and to propose a model for the incorporation of this lithosphere into the heart of the supercontinent Pangea. *(Funded by the Grant Agency of the Czech Republic)*

Did the orogens of western Gondwana form through inversion of rift domains?

The fieldwork for the project took place in northwestern Namibia and southern Brazil. In both areas, research focused on the structural and metamorphic evolution

▲ *Czech Geological Survey geologists and their Mongolian colleagues document deformed sequences of the Upper Proterozoic carbonate platform of the Zavkhan block. Photo by I. Soejono.*

of units, which during the Neoproterozoic represented the marginal (Brazil) and central (Namibia) parts of the "Adamastor Rift". Laboratory work focused mainly on the dating of individual tectonic events, which would shed light on how much time elapsed between the end of the crustal extension and subsequent inversion of the resulting rift domain. *(Funded by the Grant Agency of the Czech Republic)*

The subglacial geology of Dome F (East Antarctica) determined by new aeromagnetic data

Aeromagnetic data obtained during summer research covered an area of approximately 170,000 km^2 with a line spacing of 10–15 km. The analysis of magnetic data in combination with radar topography and gravity data from the ANTGG database enabled the mapping of geological domains and their boundary structures, thus providing a regional tectonic interpretation. The German Alfred Wegener Institute collaborated on the project. *(Funded by the Ministry of the Environment from funds for long-term conceptual development of research organizations)*

Use of satellite radar data to detect glacier movement on James Ross Island

The project dealt with the possibility of determining the flow rate of glaciers from satellite radar data. These data are suitable for use in polar regions, where there is a lack of images in the optical part of the electromagnetic spectrum due to frequent cloud cover. Using normalized cross-correlation (Offset Tracking method), researchers detected movement of glaciers and determined its direction and speed. They found that the horizontal movement of glaciers on James Ross Island was limited, and the algorithm was tested on glaciers in an adjacent part of the Antarctic Peninsula. *(Funded by the Ministry of the Environment from funds for long-term conceptual development of research organizations)*

Geotectonic evolution of the eastern part of the Mongolian Altai

In 2019, in cooperation with the GACR EXPRO 611270 project, the Geotectonic Development of the Eastern Part of the Mongolian Altai (Central Asian Orogenic Belt) project included field work in southwestern Mongolia. On several key cross-sections, geologists studied the magmatic, deformation, and metamorphic evolution of the southern and northern margin of the Zavkhan and Baydrag microcontinents. Based on data mainly from preceding projects, they prepared several expert publications, as well as an excursion guide for the international conference Altai Accretionary Orogeny. A dissertation was compiled and defended at the Faculty of Science of Charles University. The project results were also presented at several international conferences. *(Funded by the Ministry of the Environment from funds for long-term conceptual development of research organizations)*

INTERNATIONAL ACTIVITIES AND COOPERATION

Membership in international organizations

AAPG	American Association of Petroleum Geologists	J. Franců
AGU	American Geophysical Union	A. Andronikov, I. Andronikova
CAAG	Czech Association of Geophysicists, a member of the Council of Scientific Societies of the Czech Republic (CSS), a member of the Union of Geological Associations (UGA), and an associated society of the European Association of Geoscientists and Engineers (EAGE)	D. Čápová, board member
CBGA	Carpathian-Balkan Geological Association	M. Bubík, national representative
Central European Initiative	Central European Initiative Association of Central European Geological Surveys: Czech, Slovak, Austrian, Hungarian, Polish and Slovenian	Z. Venera
CEP – ATS	Committee for Environmental Protection – Antarctic Treaty	Z. Venera, D. Nývlt
CETEG	Central European Tectonics Group	Z. Venera, P. Mixa
CO2GeoNet	European Network of Excellence on the Geological Storage of CO2	V. Hladík
EAGE	European Association of Geoscientists and Engineers	V. Hladík
ENeRG	European Network for Research in Geo-Energy	V. Hladík, president 2018–2019
EPOS TCS GDM	EPOS Thematic Core Service, Geological Information and Modelling	D. Čápová, co-chair
EUG	European Geosciences Union	A. Andronikov
EuroGeoSurveys (EGS)	Association of European Geological Surveys	Z. Venera, president (since 2019)
EGS Earth Observation and Geohazards Expert Group		V. Strnadová, vice-chairwoman (since 2015)
EGS Geoenergy Expert Group		V. Hladík
EGS Geochemistry Expert Group		M. Poňavič
EGS Mineral Resources Expert Group		P. Rambousek
EGS Spatial Information Expert Group		D. Čápová, chairwoman (since 2019)
EGS Urban Geology Expert Group		J. Jelének
EGS Water Resources Expert Group		E. Kryštofová
GEO – GEO4MIN	Group on Earth Observation, Community Activity GEO4MIN on Earth Observation Data for Managing Mineral and Non-Renewable Energy Resources	V. Strnadová, co-chair (since 2018)

GIC	Geoscience Information Consortium, gathering the managers of informatics of 32 geological surveys around the world	D. Čápová, steering committee member
GIC CE	A consortium gathering the managers of informatics of the Central European geological surveys: Czech, Slovak, Austrian, Hungarian, Croatian, Polish and Slovenian	D. Čápová, L. Kondrová, O. Petyniak and P. Fiferna
GRSG	Geological Remote Sensing Group	V. Strnadová, steering committee member, newsletter editor (since 2017)
IAEG	International Association for Engineering Geology	J. Novotný, secretary of the Czech national group since 1993, member of Commission 25 – Use of Geological Models since 2009
IAGOD	International Association on the Genesis of Ore Deposits	B. Kříbek, J. Pašava, international committee member
ICDP-SAG	International Continental Scientific Drilling Program – Science Advisory Group (evaluation of submitted projects)	J. Kotková
ICL	International Consortium on Landslides	P. Kycl
IMA	International Mineralogical Association	F. Laufek, Commission for Ore Mineralogy, J. Kotková, IMA Medal Committee
INQUA	International Union for Quaternary Research	D. Nývlt
IOP	International Organisation of Palaeobotany	Z. Šimůnek
ISCS	International Subcommission on Carboniferous Stratigraphy	Z. Šimůnek
ISOS	Subcommission on Ordovician Stratigraphy	P. Budil, member correspondent
ProGEO	The European Association for the Conservation of the Geological Heritage	P. Budil, chairman of the Czech national group
SDS	Subcommission on Devonian Stratigraphy	P. Budil, member correspondent
SEG	Society of Economic Geologists	J. Pašava, international committee member
SGA	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 the prestigious journal Mineralium Deposita	J. Pašava, executive secretary, A. Vymazalová, vice-president for student affairs, B. Kříbek, I. Knésl
SGS	Slovak Geological Society	P. Budil, honorary member
SRG	The Society of Resource Geology (Japan)	J. Pašava
UNESCO – IGCP Scientific Board	UNESCO International Geoscience Programme (Paris) – Scientific Board	J. Pašava, council member

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 Preparation Laboratory

LABORATORIES

In the Commemorative Document written in 1918 for the purpose of establishing an independent state geological survey, its authors specified the main theoretical, scientific and practical goals. In order to achieve them, they emphasized the need for establishing an in-house chemical laboratory with their own chemists. Today, the Czech Geological Survey has erudite experts and laboratories equipped with state-of-the-art instruments, and their work results are internationally respected.

Central Laboratory Prague

The central laboratory plays a significant role in the basic and applied research of the Czech Geological Survey by performing the tasks of DKRVO (Long-term Conceptual Development of Research Institutions 2018–2022) and of the state geological survey. It performs chemical analyses for internal projects of the CGS as well as for projects funded from other national and international sources (GACR, TACR, MoE, MIT, MoA, EU and others).

Since 1993, the laboratory has been accredited by the Czech Accreditation Institute (CAI) according to the ČSN EN ISO 17025 standard, and its outputs are valid in all countries of the European Union. The recent re-accreditation, from September 2017, is valid until 29 September 2022. As part of the accreditation, the central laboratory has developed a quality system, described in the Quality Manual, in the Confirmation Procedures for Instruments and in the laboratory's Metrological Rules. The methods used are documented in Notes on Analytical Methods. The accreditation pertains to inorganic analysis of geological materials, inorganic analyses of surface water, and inorganic analyses of leachates.

Water analyses

The central laboratory performs complete analyses of various types of surface water and precipitation. Analytical methods used for water analysis have been tested over the long-term by CGS experts in programmes that monitor the status of selected river basins in the Czech Republic.

A comprehensive water analysis includes the determination of Li, Na, K, NH_4, Mg, Ca, Mn, Zn, Fe, Al, SiO_2, pH, F, Cl, NO_3, HCO_3, SO_4, conductivity. Trace elements determined in concentrations of µg/l include Al, As, Be, Cd, Co, Cr, Cu, Mo, Ni, Pb, V and Hg.

Analysis of solid samples

The laboratory's analysis of solid samples includes the determination of SiO_2, TiO_2, Fe_2O_3, FeO, Al_2O_3, SrO, BaO, Li_2O, MnO, CaO, MgO, Na_2O, K_2O, P_2O_5, moisture, bound water, CO_2, C_{tot}, S_{tot}, F, loss on ignition. All these components are included in the silicate analysis. The laboratory performs three types of silicate analyses – total, simplified and technical silicate analysis, which differ with regard to the number of analyzed components and to the total sum of all components.

The laboratory also performs inorganic analyses of special materials, such as wood, peat, needles or leaves, according to pre-approved procedures listed in the Quality Manual or in the Notes on Analytical Methods.

Equipment

Trace element analyses are performed on FAAS or ICP-MS instruments, and rare earth elements are measured by ICP-MS. Trace elements are also determined by X-ray spectrometry without decomposition of the sample from the tablet.

For solid sample analyses, the central laboratory uses Perkin Elmer AAnalyst 100 and AAnalyst 200 flame AA spectrometers, Agilent Technologies 7900 series inductively coupled plasma mass spectrometers, an AMA 254 mercury analyzer, Eltra CS-500 analyzers, state-of-the-art water deionization equipment, a Rigaku BE 67000104 X-ray spectrometer, modern automatic titrators, and a Radiometer pX-meter.

For water analyses, the laboratory is equipped with a pH-meter from XS Instruments (Italy), a pX-meter, a conductometer, an AMA 254 mercury analyzer, a Perkin Elmer Hitachi 200 absorption photometer, a Knauer ion chromatography detector with conductivity detection, Perkin Elmer AAnalyst 100 and AAnalyst 200 flame AA spectrometers, a Perkin Elmer AAnalyst 700 AA spectrometer with electrothermal atomization, and an Agilent Technologies 7900 series inductively coupled plasma mass spectrometer.

Commemorative year of 2019

In the first report on the activities of the State Geological Survey of the Republic of Czechoslovakia, its first director Cyril Purkyně stated that the chemical laboratory is temporary with regard to the mineralogical and geological status of Czech technology and that it cannot adequately tackle the institute's tasks, particularly due to very limited space and to the then very insufficient funding. The enthusiasm of the then "chief chemist" Josef Šplíchal was probably all the more greater, because in the three months he conducted 12 analyses of rocks, ores and mineral water while also handling demanding organizational work and completing the manuscript for the institute's compendium. Purkyně placed great emphasis on obtaining suitable premises and equipment, because not only was the officially requested laboratory work at stake but also the development of scientific and practical activities initiated by the institute's members.

The then representatives of the geological institute would certainly be pleased to see what equipment and with what kind of experts the laboratory now performs demanding tasks.

In 2019, the laboratory's work involved mainly grant and internal projects of the survey's staff. The measurement results are handled by the Unified Integrated Processing System for Analytical Data and their network-oriented database management system Personal III, which meets the requirements of geologists for delivery of analysis results in electronic form. The system also facilitates the transfer of data to a central database and their link to geological data, which relate to a given sample. Electronic data processing also meets the requirements stemming from the accreditation for statistical processing of control analyses at individual laboratories (control diagrammes/charts, etc.). Compliance with the quality system is regularly checked and supervised by visiting CAI employees.

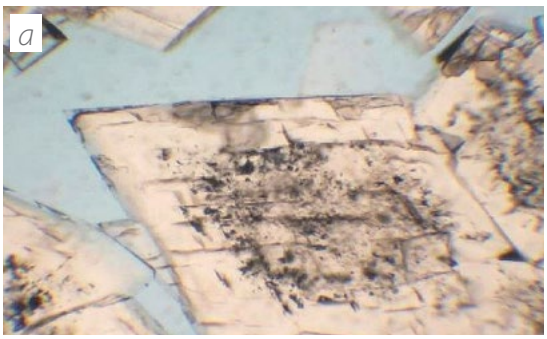
Central Laboratory Brno

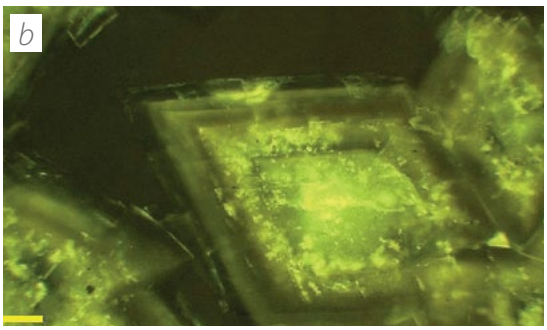
The accredited Central Laboratory in Brno focuses organic and gas geochemistry, recently also on microscopic porosity.

Analysis of rocks and crude oil

The laboratory determines the concentrations of organic and mineral carbon and of total sulphur in sedimentary rocks and soils. On selected samples of rocks and crude oil, it measures the molecular composition of extractable compounds, especially biomarkers indicating the biological origin of organic matter, such as from deciduous trees, conifers or algae. Reflected

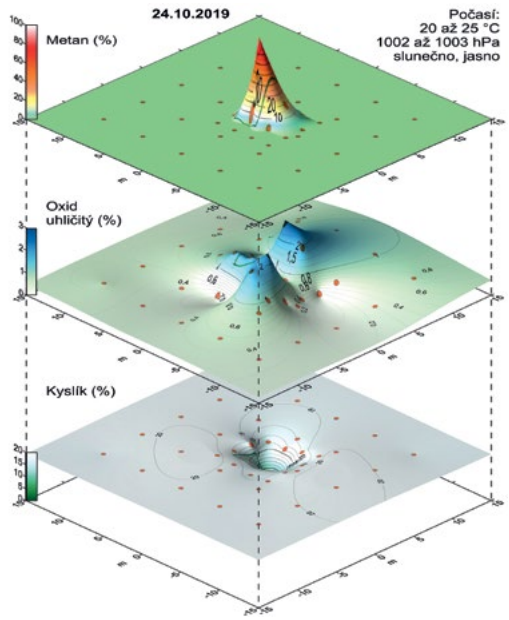
LABORATORIES





▲ *Photomicrograph of a thin section of Vranovice limestone in transmitted (a) and fluorescent light (b). The open pores are filled with blue polyester. A subhedral zonal crystal of dolomite fills the pore space (NP-1, 1075 m). Incremental zones reflect changes in the composition of the pore solution. Photo by L. Jurenka.*

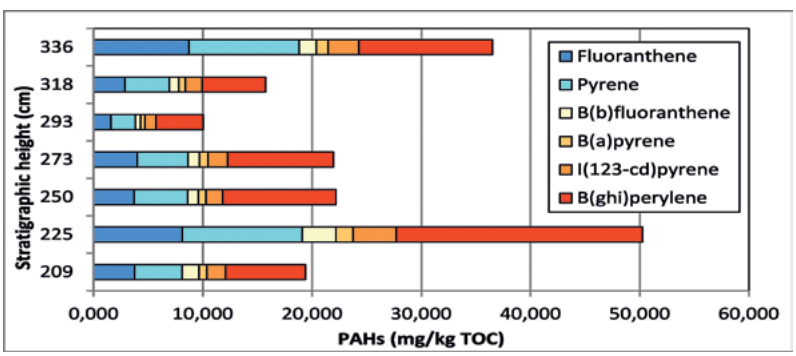
light fluorescence microscopy helps characterize organic petrographic constituents such as pollen grains, cuticles, plant tissues or fossils. The laboratory also uses the same method to measure the degree of dolomitization of limestones. Vitrinite reflectance is used in reconstructing the thermal history of sedimentary basins, the burial depth, the uplift height or erosion of overlying rocks.



▲ *Methane, carbon dioxide and oxygen concentrations detected in the soil cover above the plugged Zu-108 well. P. Jirman, 2019.*

Ecology

Persistent organic pollutants (POPs) are analyzed in soils and airborne dust. A detailed analysis 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. Recently, the laboratory began to study polycyclic aromatic hydrocarbons (PAH) as indicators of large-scale fires in terrestrial vegetation (Laurin et al. 2019).



▲ *Indeno(123)pyrene and benzo(ghi)perylene in a rock outcrop indicate many fires in geological history. J. Laurin et al., 2019.*

Gases

Field measurements of gases are carried out by the laboratory's staff using Ecoprobe 5 and Draeger portable instruments. Accredited detailed chromatographic quantitative analysis determines 20 compounds including helium and argon. These measurements along with the analysis of isotopic composition of carbon in methane and in higher hydrocarbons help determine the origin of gases, for instance, from collieries, and microbial activity at depths of several kilometres or above plugged wells of crude oil deposits.

Specialized Laboratories

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

Isotope Geochemistry and Geochronology Laboratory

The laboratory focuses on the analysis of traditional isotopic systems (Rb → Sr, Sm → Nd, Re → Os), following up on 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 majority of samples are prepared using ion selective chromatography in a specialized pressurized ultra-trace laboratory with controlled sterility (USL). In addition to methodological development, the laboratory's research focuses mainly on the origin of igneous rocks of the Bohemian Massif. The laboratory staff is also involved in the application of isotope systems in a number of geological and interdisciplinary research projects.

The laser ablation laboratory, equipped with a HelEx two-volume ablation cell in conjunction with an Agilent 7900× 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 staff members of the X-ray Diffraction Laboratory, which is equipped with powder diffractometers (Bruker D8 Advance and Philips X´Pert), perform mineralogical analyses of a wide range of geological materials, including rocks, minerals, clays and soils. In particular, they analyze various crystalline synthetic materials, waste products, fly ash, sludge, mine precipitates, construction materials and others.

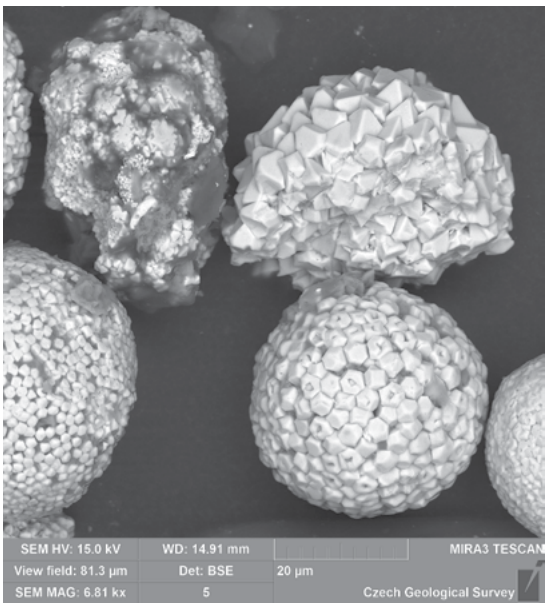
Electron Microscopy and Microanalysis Laboratory

Materials studied in the laboratory, which is equipped with a Tescan Mira3 GMU FEG-SEM high resolution electron microscope, are characterized based on morphology and chemical composition, as well as on capturing 3D images of objects. 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.

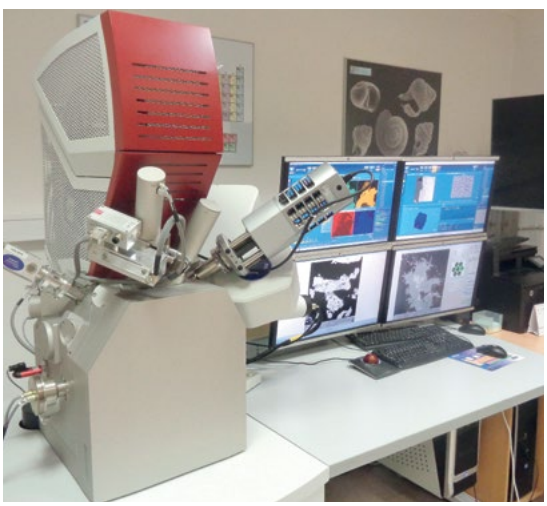
▲ *Thermal ionization mass spectrometer (TIMS). Photo by V. Erban.*

LABORATORIES

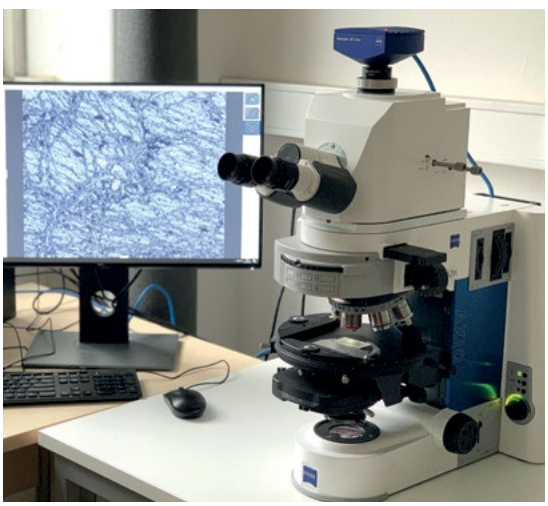
▲ *Cerusite crystals in backscattered electrons, Krušné hory Mts. Photo by O. Pour.*



▲ *Framboidal pyrite in backscattered electrons. Photo by O. Pour.*



▲ *Tescan Mira3 GMU electron microscope, equipped with an FEG cathode and EDS, WDS, EBSD and CL detectors. Photo by O. Pour.*



▲ *Zeiss polarizing microscope for reflected and transmitted light. Photo by M. Tuhý.*

Fluid Inclusion Laboratory

The Fluid Inclusion Laboratory is 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.

Experimental Mineralogical Laboratory

Research focuses on the synthesis of chalcogenides, on phases of Pt metals, and on the study of phase relationships.

Laboratory of micropaleontology, ecostratigraphy and paleobiology

The laboratory studies the influence of global changes in the palaeoenvironment on marine and terrestrial communities.

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

The separation laboratory at Barrandov combines several methods to achieve the purest possible mineral concentrates. The process includes crushing and grinding of rocks below 0.75 mm, initial wet separation on a gravity concentration table, heavy mineral separation, separation in heavy liquids and final magnetic separation. Zircon is most often separated, and there is also increased interest in the separation of garnets, monazites, apatites and mica. In 2019, 2,200 samples were processed in the grinding facility, the most common being polished thin sections, and also covered thin sections and polished sections.

Sample Preparation Laboratory

For nearly half a century of its operation, the Sample Preparation Laboratory in Brno has processed thousands of samples. Its activities focused mainly on the preparation of samples for micropalaeontology and particularly the separation of foraminifera, conodonts and calcareous nannofossils.

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, magnetic and electromagnetic separation using a Cook electromagnetic separator and eventually, manual separation.

During the commemorative year of 2019, the laboratory processed more than 200 samples, thereby contributed to a total solution of fifteen projects. The main volume of work involved separation for the Deposits and Resources of Strategic Raw Materials of the Czech Republic project and also the preparation of samples for the regional geological mapping of the Czech Republic. Other work activities involved co-research projects of the GACR and projects of the Ministry of the Environment, or external contracts.

▲ *Foraminifera* Trocholina *conica from the Těšín Limestone, Český Těšín. Photo by M. Bubík.*

▲ Eoguttulina ichnusae, *Těšín Limestone, Český Těšín. Photo by M. Bubík.*

Over the long term, contracting parties have been greatly interested in the separation of microfossils (128 samples, 33%) and the separation of heavy minerals (145 samples, 37%). A total of 22 samples were processed for geochronological dating in 2019.

Hana Breiterová
Head of the Information Services Department
and Geological Library

LIBRARY AND COLLECTIONS

The Commemorative Document written by Cyril Purkyně, František Slavík, Karel Vrba and Jaroslav Perner for the purpose of establishing a state geological survey in December 1918 already emphasized the significance of a professional library for the proper functioning of this institution. The authors stressed the necessity of "a large science library, which the institute must be furnished with immediately upon its establishment ... and in which documents will then be stored systematically in collections". Today's vast selection offered by the library and collections are used not only by experts of the CGS 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 Branch, where study material from the library and collections are provided. Mining literature can be studied at the Kutná Hora office.

CGS Library

Access to the largest collection of geoscience literature in the Czech Republic is provided by the Czech Geological Survey Library, which also includes a specialized archive from the former library of the Ministry of the Environment (MoE) since 2013. 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.

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, it 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,

Popis tavících zkoušek
veškerých minerálů, rud a
hornického umění vcelku
i každé jeho jednotlivosti
Jeho podstaty a vlastností
a jak určovat všechny kovy,
jak tavit a zkoumat kovy včetně
zlata a stříbra pomocí mosazného
hořáku a kyseliny dusičné
také různé solné sloučeniny zkoumat je
obsaženo v pěti knihách
jimž podobné nebyly dosud
nikdy vytištěny
Všem milovníkům ohňového umění,
mladým prubířům a horníkům
K použití, s pěknými obrázky a popisem
přístrojů výstižně a pilně sestaveno
Nově s lepšími popisy a více obrázky
Vysvětleno od
Velice slavného Lazara Eckerta,
nejvyššího hormistra a účetního
jeho výsosti římského císaře
v království českém etc.
S privilegiem jeho majestátu římského císaře
Vytištěno ve Frankfurtu na Mohanem
1580

▲ *Title page of the oldest publication in the library's collection and its translation.*

which continues to this day. The library currently includes about 200,000 volumes. In addition to modern literature, the library 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. The bibliography was published in printed form until 2003 and, since then, it has been processed only electronically. The articles that are processed cannot be searched for in any other way in the databases, whether licensed (WOS, SCOPUS) or freely available (RIV – https://www.rvvi.cz/riv). Older yearbooks, currently starting with 1973 onward, are 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 the researchers of the Czech Geological Survey, as well as the findings made by other institutions or private collectors. The most valuable samples from a science perspective are housed in geological, mineralogical and palaeontological collections. These museum-quality collections are stored, made accessible and recorded by the department in the CES national register by virtue of Act No. 122/2000 Coll., as amended, and Decree 275/2000 Coll. The maintenance of these items is subject to strict conditions defined in the above-mentioned and subsequent legal regulations. The documented supporting material – geological and palaeontological samples from geological mapping, thin sections and drill cores from boreholes – is stored by the CGS in accordance with Act No. 62/1988 Coll., as amended by Act No. 66/2001 Coll.

Additions to the collections

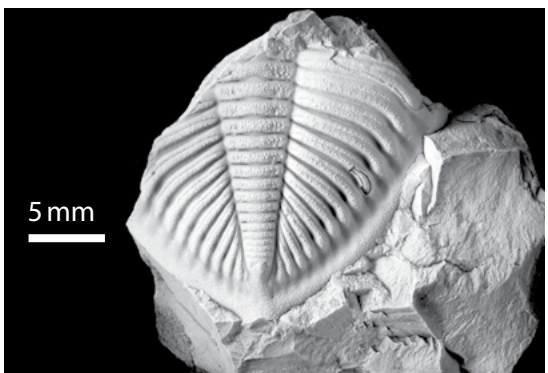
The most significant additions to the collections in 2019 were samples of Ordovician malformed trilobites provided to the collections by Š. Rak, Ordovician echinoderm material *ex coll.* of O. Zicha, and samples of Cambrian fossils *ex coll.* of O. Fatka. The careful maintenance of the CGS collections, which include a total of 300,000 pieces, involves intensive publishing activity as well.

A brief history of the collections

The CGS collections were founded in 1960. They were successively managed by Dr. J. Svoboda, Dr. J. Šetlík, Dr. M. Šnajdr, Assoc. Prof. J. Kraft, Prof. M. Mergl and Dr. Petr Štorch. Palaeontological collections, especially type and original material used for publication, became increasingly important. Drill cores and documentation material for maps were stored in the depositories in Lužná near Rakovník and maintained by virtue of Act No. 54/1959 Coll. In 1988, part of the regional geology collections were taken over by the Technical University of Ostrava. In 1995–2001, electronic 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, and other material is being included upon physical review. The basement depository in Klárov was flooded in August 2002 and reconstructed and modernized 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, specifically the palaeontological and mineralogical-geological collections, were completely processed and entered into the CES, the Virtual Museum of CGS (http://muzeum.geology.cz/) was made available to the vast public, and a catalogue of the collections was published. The drill cores in Lužná have been maintained by the CGS – Geofond Borehole Material Documentation Department since 2017.

Since 2014, the Collections and Material Documentation Department has been processing the vast collection of Assoc. Prof. J. Sekyra from his research in Antarctica, deserts, and the world's high mountains.

▲ *Tail shield of the trilobite* Zlichovaspis (Zlichovaspis) rugosa rugosa *(Hawle & Corda, 1847). Lower Devonian, Pragian, Prague Formation, Dvorce-Prokop Limestone Facies. The original specimen was depicted in the publication by P. Budil et al. (2008, Fig. 7I).*



Milada Hrdlovicsová
Head of the Department
of Geological Documentation

GEOLOGICAL DOCUMENTATION

In order to perform the duties of the state geological survey, the staff of the Department of Geological Documentation collect, processes, evaluate, permanently store and provide access to geological documentation and the results of geological projects, with which the Czech Geological Survey is furnished by individuals and organizations in accordance with Act 62/1988 Coll., on geological work. The data from the documentation submitted are then entered into specialized datasets and databases of the Geological Information System.

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 graphic supplements amounting to roughly 3,600 metres. Over 5,000 records on geological project results, mainly from engineering geology and hydrogeological surveys, were added to the archive in 2019. In addition to new surveys, documents from older sources and outputs from CGS research activities were also included in the collections by the department's staff. All the archive additions were processed and the records were made available for parametric search in the "ASGI" application, available on the CGS web portal. Selected data from the reports obtained continue 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. In 2019, more

▲ *Archived reports and map-related work.*

▲ *Geological map of the Kingdom of Bohemia, as modified by Josef Klvaňa for publication in 1883 (Del. A sc. J.E. Wagner. Lithogr. A. Vítek, Prague, published by F. A. Urbánek, Prague). The map was already used as an appendix to Štěpán Bačkora's book Praktické učení zeměpisu Čech ("Practical Teaching of Geography of Bohemia"), Prague 1878, but it is not clear whether it was also prepared by J. Klvaňa. The map is included in the CGS map archive collection.*

than 500 maps were added to the collection, often including accompanying texts or explanatory notes. An independent part of the collection comprises mining maps. Most of the collection is also available in digital form. 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 scientists, students and by a large community of professionals as well. In 2019, study room visitors were provided with more than 9,000 archival documents and other material in digital form.

Digital archives

The systematic digitization of archive collections takes place at specialized offices in Prague and Brno, where unique archival documents are effectively and permanently preserved, and also made accessible through modern methods. The digitization offices perform many tasks and execute requests, and are equipped with modern scanning technology, including

▲ *Department employee in the process of preserving old reports. Photo by J. Bezák.*

large-format map or book scanners. The digitization of archival materials may be requested by researchers as a paid service, with the documents being subsequently provided online. Over 45,000 archive reports in digital form, representing more than 3.8 million files, are currently available.

Borehole core material documentation

A special system of sample containers holds a set of more than 34,000 metres of material samples, which are available upon request. It contains rock samples or continuous drill cores from structural and other important boreholes in the Czech Republic. Thus, a total of more than 2,700 objects are stored in the sample repositories in Kamenná, Stratov and Lužná. New samples are continuously added to the set, as older temporarily stored drill cores and documented samples are discarded and restored.

▲ *The drill cores are clearly arranged in storage troughs. Photo by J. Bezák.*

Patrik Fiferna
Head of the CGS
Publishing House

CGS PUBLISHING HOUSE

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 exhibits, fairs, conferences, educational activities, the CGS information portal, social networks and other modern technologies.

Books and maps

Each year, the Czech Geological Survey publishes expert publications devoted to individual geosciences, periodicals, monographs, geological and thematic maps of various scales as well as popular science titles, including those that use modern technologies such as augmented reality. The publishing, project and commercial activities included the release of 22 titles in 2019.

▲ *In 2019, a total of 22 titles were published, most of which are available in the CGS e-shop.*

Ceremonial book launches

The Czech Geological Survey organized four book launches in 2019 – the Geological Bookstore presented the books *Veselé prázdniny v říši geologie* ("Happy Vacation in the World of Geology" by Václav Ziegler), *Klárov* (by Petr Maděra) and *Oživlé sopky České republiky* ("Revived Volcanoes of the Czech Republic" by Vladislav Rapprich). The Bio Oko cinema hosted the launch of the anthology

▲ *The ceremonial launch of the anthology* 100 let České geologické služby *("100 Years of the Czech Geological Survey") was held at the Bio Oko cinema in Prague.*

100 let České geologické služby ("100 Years of the Czech Geological Survey").

Promoting CGS activities and popularization of geology

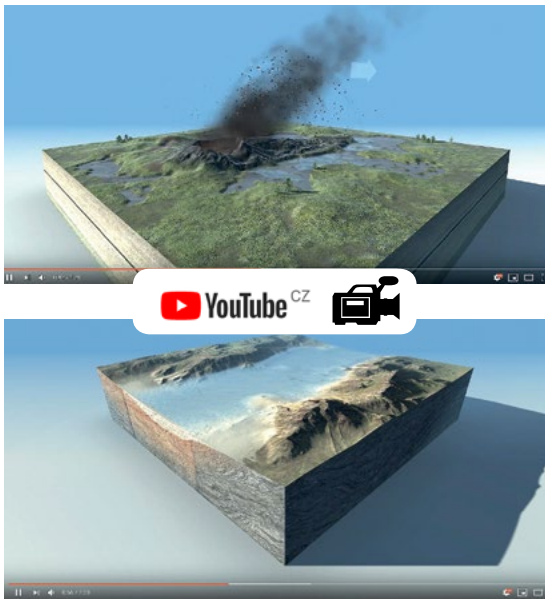
In addition to maps and publications, the Czech Geological Survey also conducts promotional activities. It systematically acquaints the public with the research results of CGS specialists and promotes the popularization of geoscience in various forms, manages the World of Geology on Facebook (https://www.facebook.com/svetgeologie) and Geology TV on YouTube (https://www.youtube.com/user/Geologycz). The year of 2019 was highlighted by the 100-year celebration of the Czech Geological Survey and thus by year-round events held for the institute's staff and public as well.

During the year, nearly 300 articles were published on the Facebook page World of Geology and 25 films and animations on the YouTube channel. The animations on the origin of geosites and videos documenting the work of geology specialists aroused the greatest interest.

▲ *Visitors were able to experience Earth Day with the Czech Geological Survey on April 26 and 27. During the interactive programme, they tried out various methods and technologies used in geology – traditional field equipment, microscopes, specific analyses as well as drones.*

Nine new animations on the origin of geosites

Multimedia content promoting the activities of the Czech Geological Survey and geology is a permanent feature of the publishing house's production. This includes, for instance, mobile applications, animations depicting the formation of selected geological features and also animations with augmented reality. Nine animations on the geological evolution of the localities Děvín and Hamerský Špičák, Komorní hůrka Hill, Šemnice Rock, Šumná Volcano, on the formation of river terraces and volcanoes – maars, lahars, rootless vents and cinder cones – were published on the YouTube channel in 2019.



▲ *In 2019, nine additional animations on the geological evolution of localities were published on the YouTube channel.*

Publishing and project activities

The publishing house is engaged in the projects GECON – Geology Cooperation Network, TravelEx, CEEMIR and Cross-Border Cooperation for the Development of Railway

▲ *During the GECON – Geology Cooperation Network project, the publishing house staff provide promotional activities and a visualization of the project and entire network.*

CGS PUBLISHING HOUSE

▲ *The publishing house provides publicity services for project* Cross-Border Cooperation for the Development of Railway Transport Saxony – Czech Republic.

Transport Saxony – Czech Republic. Its main task is to provide project publicity and promotional activities. During the GECON – Geology Cooperation Network project, three multi-day study trips, three workshops and a week-long summer school were organized throughout the year in the UNESCO Łuk Mużakowa Geopark in Poland, focusing on innovative use of former mining sites and facilities for geotourism.

Geological exhibit opened to schools

An outdoor educational geological exhibit was organized by the Czech Geological Survey at the Mozartova primary school in Jablonec nad Nisou. The exhibit focuses not only on presenting basic rock types but primarily on the geological structure and evolution of the Liberec Region. It is complemented by other educational material, which may be downloaded via QR codes located on information panels, such as animations of the origin of geological formations, worksheets for students or excursion guides. The ceremonial opening of the exhibit was followed by a geology lesson with Vladislav Rapprich, a specialist of the Czech Geological Survey. Starting with the upcoming school year, the geological exhibit will be opened to other schools as well.

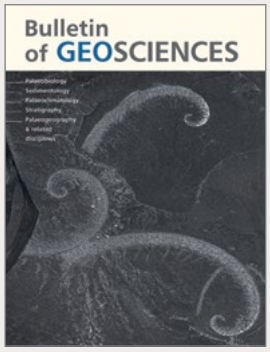
▲ *The geological exhibit at the Mozartova primary school in Jablonec nad Nisou also serves to educate students from other schools.*

Happy Vacation in the World of Geology

The launch of Václav Ziegler's book *Veselé prázdniny v říši geologie* ("Happy Vacation in the World of Geology") was organized by the publishing house in the Geological Bookstore. Miroslav Fořt launched the book with a geological hammer, expressing his belief that the book will not only be successful but that it also has the potential of providing young readers with an alternative to the ever-present electronic entertainment. The launch also included a presentation of the philatelic R-sticker, issued on the occasion of the Czech Geological Survey's 100th anniversary.

▲ *The launch of Václav Ziegler's book* Veselé prázdniny v říši geologie *("Happy Vacation in the World of Geology") included the presentation of a philatelic R-sticker issued on the occasion of the Czech Geological Survey's 100th anniversary.*

Periodicals



The *Bulletin of Geosciences* is the most important scientific journal published by the Czech Geological Survey. Its predecessor *Věstník Státního geologického ústavu Československé republiky* was founded at the request of the scientists of the State Geological Survey of the Republic of Czechoslovakia and the first volume was issued in 1925. Since then, thousands of scientific papers have been published 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 on 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, currently 1.500, from the prestigious American company Thomson Reuters. 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. ISSN 1802-8225 (online), 1214-1119 (print)

The Czech Geological Survey is a co-publisher of the *Journal of Geosciences*, 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 (64th 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 mineralogy, structural geology, petrology, and with the geochemistry of igneous and metamorphic rocks. In addition to regular volumes, special monothematic issues are also published. 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. Thanks to this fact, the journal received an impact factor, which was 1,279 in 2019, from the Thomson Reuters company in 2011. ISSN 1803-1943 (online), 1802-6222 (print)

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, involving regional geology, stratigraphy, Quaternary research, engineering geology, palaeontology, mineralogy, petrology, geochemistry, hydrogeology, minerals, geophysics, geoinformatics and research abroad. The published papers have a high professional standard and are peer-reviewed. The multicolour publication with English summaries 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. ISSN 2336-5757 (online), 0514-8057 (print)

SELECTED PUBLICATIONS ISSUED BY THE CGS

Books

Happy Vacation in the World of Geology
Václav Ziegler

100 Years of the Czech Geological Survey
Collective of authors

Revived Volcanoes of the Czech Republic
Vladislav Rapprich

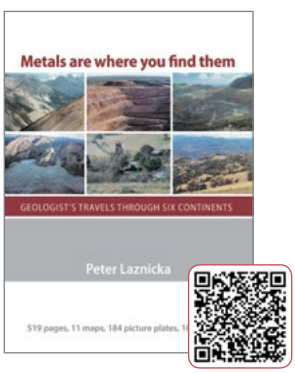
Klárov
Petr Maděra

The Stone Castle of Prague
Václav Rybařík

Derailed Congress – Memories of Participants of the 23rd IGC in August 1968 in Prague

Geoscience Research Reports, vol. 52, 1, 2019

Geoscience Research Reports, vol. 52, 2, 2019



Metals Are Where You Find Them: A Geologist's Travels Across Six Continents (E-book)
Peter Laznička

Review of Groundwater Resources

Cretaceous of the Orlice hory Mts Piedmont in the Úpa and Metuje River Catchments Hydrogeological Zone 4221

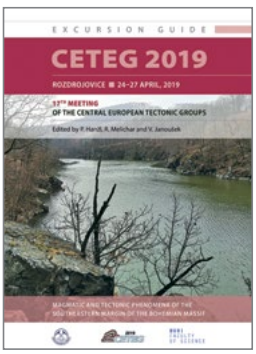
Děčínský Sněžník Mt. Hydrogeological Zone 4630

Cretaceous of the Lower Elbe Down to Děčín – Left Bank, Northern Part Hydrogeological Zone 4612

Conference compendiums

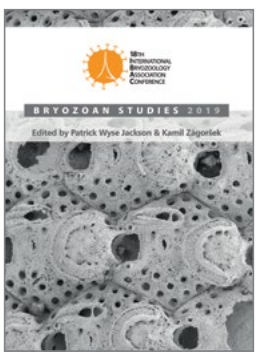
Cretaceous of the Orlice hory Mts Piedmont in the Orlice River Catchment Hydrogeological zone 4222

CETEG 2019. 17th Meeting of the Central European Tectonic Groups. Abstract volume



CETEG 2019. 17th Meeting of the Central European Tectonic Groups. Excursion Guide

Calendars



Bryozoan Studies 2019. 18th International Bryozoology Association Conference
Patrick W. Jackson & Kamil Zágoršek, Eds

Fire-Spitting Mountains or Volcanoes in Our Region

100 Years of the Czech Geological Survey

CGS IN THE MEDIA

IN PRINT

Czech Geological Survey 2019 – One hundred years since its founding

An identically titled article on the Czech Geological Survey and its history was published in the journal *Ochrana přírody* ("Nature Conservation Journal") by the Nature Conservation Agency of the Czech Republic. *[20 February 2019]*

The Czech Geological Survey celebrates 100 years

An article on the CGS anniversary on the NášREGION.cz news portal by editor Andrea Cerqueirová. *[2 April 2019]*

A crisis in construction is not far off. Sand and gravel will not be available

CGS economic geologists Josef Godány and Petr Rambousek were interviewed by MF Dnes editor Jitka Vlková regarding a possible crisis in building materials and their available resources.

[28 June 2019]

Quarries are needed if we want high-speed railways

CGS economic geologists Josef Godány and Petr Rambousek were interviewed by the editor of MF Dnes Jitka Vlková. They draw attention to the need of using local natural resources yet emphasize the importance of nature protection and landscape preservation. *[30 June 2019]*

Czech diamonds are only micro...

An article in the Lidové noviny newspaper on the study of processes deep below the Earth's surface with the aid of microdiamonds and other inclusions in minerals of rocks. It was written by editor Eliška Nová based on an interview with Jana Kotková. *[30 December 2019]*


Diamanty z Čech jsou jen mikro

TV

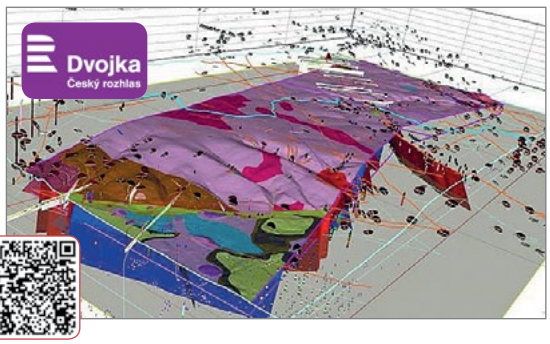
Is lithium dead? Jaromír Starý from the CGS on the programme Štrunc!

Jaromír Starý, Head of the Mineral Resources Department of the Czech Geological Survey, gave an interview to the news portal Info.cz during the Seznam TV show Štrunc! under the caption "Is lithium dead? The Germans are ahead, the Czech deposit may never be developed", discussing the topic of lithium as well as the reserves and usability of other minerals in the Czech Republic with moderator Pavel Štrunc. *[17 June 2019]*

Zdeněk Venera as guest on Czech Television: Meeting on Antarctica in Prague

Zdeněk Venera, Director of the Czech Geological Survey, and his colleague Daniel Nývlt were guests on Czech Television's Studio 6 in July, explaining to the audience the significance and goals of the Antarctic Treaty Consultative Meeting, which took place in Prague for the first time in history. *[2 July 2019]*

AUDIO



How do you plan the Prague–Dresden high-speed rail line?

Jan Franěk from the Czech Geological Survey was a guest on Czech Radio's Meteor programme, during which he provided information on a joint project of the Czech Geological Survey, the Geological Survey of Saxony, the Railway Administration and several other important institutes cooperating on the future Prague–Dresden high-speed rail line. The interview focused on the construction of a 3D model of the geological structure of a part of the Krušné hory Mts crystalline complex, of the Ohře Rift and of the České středohoří Mts. The purpose of the work is to obtain the most accurate depiction of the rock environment for the planning of two long rail tunnels. *[29 June 2019]*

Jaromír Starý: The Cínovec lithium deposit is exceptionally large from a European perspective

In an interview for Czech Radio, Jaromír Starý, Head of the Mineral Resources Department of the Czech Geological Survey, spoke about lithium mining in the Krušné hory Mts and the potential of their lithium deposits. *[23 July 2019]*

The hammer and magnifying lense have remained, but lasers and radars were added...

The hammer and magnifying lense have remained, but lasers and radars were added, said Zdeněk Venera, Director of the Czech Geological Survey, while discussing its past century on the Czech Radio Plus programme Leonardo Studio. He also gave listeners an insight into how the field work of geologists has changed as a result of technological progress.

[6 August 2019]

Geologist Arnošt Dudek for Czech Radio: How the occupation dispersed 4,000 geologists

In 1968, geologist Arnošt Dudek was the general secretary of the organizing committee of the 23rd International Geological Congress held in Prague the very same year. It was probably the most significant event in the history of geology that took place in our country. However, the congress was prematurely terminated after five days due to the occupation of Czechoslovakia by the allied troops of the five Warsaw Pact countries, led by the Soviet Union. Arnošt Dudek shared his memories of the difficult situation with Czech Radio listeners.

[22 June 2019]

Jana Kotková for Czech Radio: What do microdiamonds tell us?

For instance, the fact that the Czech Himalayas stood here during the Proterozoic. Jana Kotková from the Czech Geological Survey gave an interview to Czech Radio's Leonardo Studio programme, in which she gave listeners a taste of the research process that confirmed the occurrence of microdiamonds in the rocks of the Krušné hory Mts.

[1 December 2019]

SOCIAL MEDIA

World of Geology

Nearly 300 postings were published on the Facebook page "World of Geology", which is managed by the Czech Geological Survey. A total of 25 videos and animations were published on YouTube. The animations on the formation of geosites and the videos documenting the work of CGS specialists aroused the greatest interest.

SELECTED YOUTUBE POSTS

Center for Lithospheric Research Czech Geological Survey

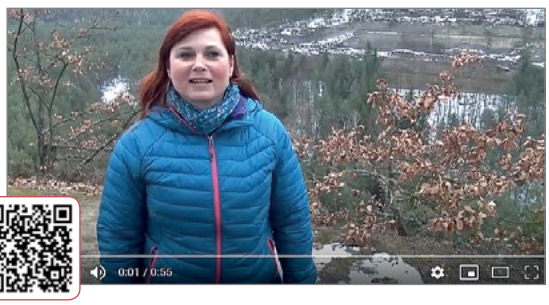
19 February 2019

The film describes the mission and tasks of the Center for Lithospheric Research, headed by Prof. Karel Schulmann from the Czech Geological Survey. The centre deals with the mechanisms of growth of continents and supercontinents, focusing mainly on the youngest supercontinent – Pangea, which is best preserved, thereby providing the most knowledge on the continent formation process.

Děvín Castle – An invitation with a geological twist

11 April 2019

The ruins of Děvín Castle, founded by the Markvartice family before 1250, stand on top of an identically named hill. It is not only a cultural monument offering breathtaking views of the surrounding countryside near Hamr na Jezeře but also an interesting geosite with occurrences of polzenite dykes, where iron ore was mined in the Middle Ages. Geologist Petr Mužák from the Ralsko National Geopark provides more information in the video.



Stohánek Castle – An invitation with a geological twist

18 April 2019

Stohánek Castle – a lighthouse in the middle of forests in the former military area of Ralsko. The sandstone knob is a remnant of a tabular hill and provides a unique view of the surrounding landscape and also of three other castles – Ralsko, Bezděz and Děvín. Lenka Mrázová, Director of the Ralsko National Geopark, provides more information in the video.

Ralsko Geopark

25 April 2019

The Ralsko National Geopark is located in the former military area of Ralsko. It covers an area of 294 km^2, where wilderness has returned. Secluded nooks, where you hear yourself think, are hidden in endless pine forests spread between the medieval castles of Ralsko, Bezděz and Děvín. In May 2016, the Ralsko Geopark was officially recognized and joined the network of national geoparks.

Sudetic Foreland Geopark

2 May 2019

The Sudetic Foreland Geopark is located in Lower Silesia and its main attraction is its interesting geological structure and diversity of rocks and minerals. The area is also known for its long history of mining, with many preserved mining and metallurgical heritage sites. There are also unique cultural monuments, including important nature conservation areas.

Critical minerals research in the Czech Republic

7 May 2019

As other European countries, the Czech Republic pays considerable attention to minerals research. Currently, the Competence Centre Programme of the Technology Agency of the Czech Republic focuses on the "Competence Centre for Effective and Ecological Mining" project, which is being carried out by the VSB – Technical University of Ostrava in cooperation with the Czech Geological Survey and other partners.

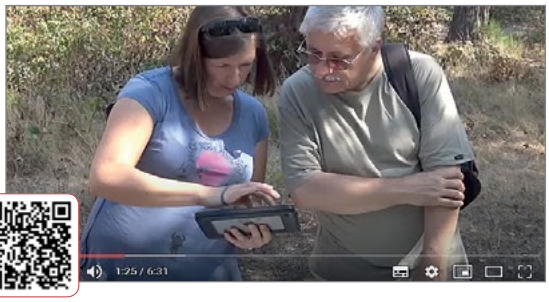
Lubań Museum

9 May 2019

The Regional Museum in Lubań, Poland, is housed in the Renaissance town hall in the town centre and in the medieval Bracka Tower. It is devoted to the development of the border area of Silesia and Upper Lusatia.

YouTube CZ

SELECTED YOUTUBE POSTS

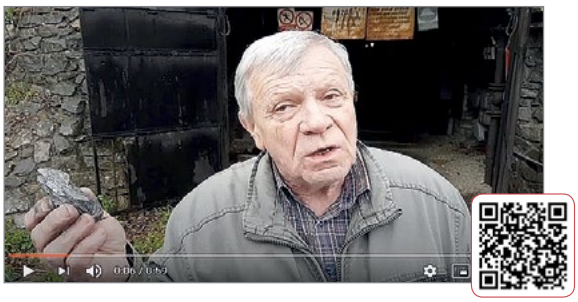


Geology and modern technology
16 May 2019

In the video, CGS specialists introduce, for example, the use of modern technologies in geological research, in the collection, processing and subsequent practical application of data, in education and popularization of geoscience, or in geotourism.

Graphite – a geologist's perspective
20 May 2019

Graphite formed by thermal transformation of algae. This occurred under high temperatures and pressure in the Lower Palaeozoic. Graphite is one of our national raw materials and it is introduced in the video by Bohdan Kříbek, a specialist of the Czech Geological Survey.



Formation of volcanoes – rootless vent
29 July 2019

When lava flows onto wet sediments (for instance, on a lakeshore or in a riverbed), the water enclosed beneath the lava begins to boil. The produced steam then explodes through the still liquid lava. This process forms rootless vents. They are "rootless" due to not having their own magma conduit.

Šumná – geological evolution
29 July 2019

Šumná, the youngest volcano of the Doupovské hory Mts rises directly above Klášterec nad Ohří. It is only 20 million years old and the castle known as Šumburk stands on its summit. The Šumná Volcano grew at the foot of the Doupovské hory Mts, where it covered the deposits of massive lahars, which flowed down to this area from the slopes of older volcanoes of the Doupovské hory Mts. Šumná's relatively calm eruptions were classified as Strombolian eruptions. At the end of its activity, lava flow flowed from its crater. Despite its age, Šumná is incredibly well preserved and, at the top, the remains of the original crater are still visible inside the castle.

Czech Geological Survey for Society

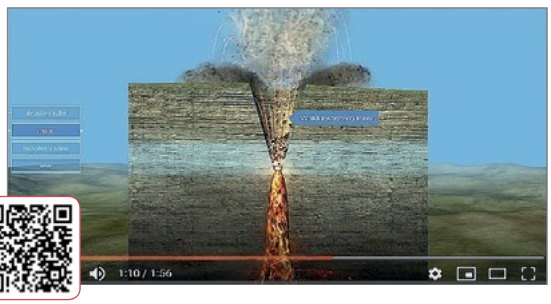
1 August 2019

A film about the mission of the Czech Geological Survey, whose history dates back to 1919. The Czech Geological Survey collects and processes data on the geological setting of the Czech Republic's territory and passes them on to administrative authorities for political, economic and environmental decision-making. The film introduces some CGS specialists, who provide essential insights into their research activities.

Formation of volcanoes – lahar

5 August 2019

A growing volcano produces distinctive topographic features. In addition, volcanic slopes are often formed from incoherent rocks, which may be set in motion by earthquakes, other volcanic eruptions or heavy rains. Such massive slides of volcanic material are referred to as lahars.



Formation of volcanoes – maar

12 August 2019

If rising magma encounters a layer of rocks saturated with water, the temperature contrast causes the water to flash to steam. An explosion occurs, ripping out rocks above the area of the explosion, and a funnel-shaped crater is formed. It is partly filled with breccia, but a circular lake may form in the upper part. This is how a volcanic crater referred to as a maar is formed.

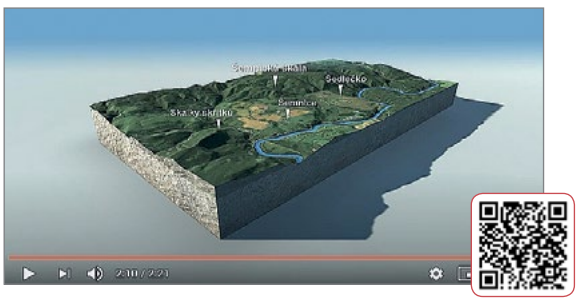
SELECTED YOUTUBE POSTS

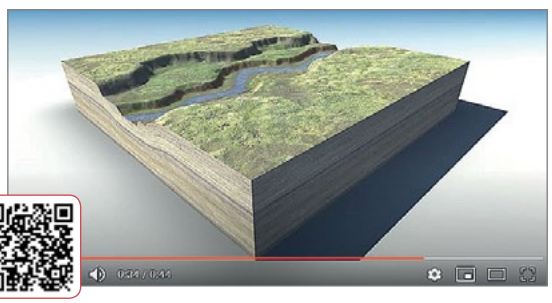
Formation of volcanoes – cinder cone
19 August 2019

A volcanic eruption is driven mainly by gases dissolved in magma. As the magma rises to the surface, the pressure decreases and gas bubbles begin to be released from the magma. As the number and size of bubbles grow, they begin tearing the magma into smaller particles, and the escaping gas ejects volcanic debris from the volcano's throat onto the surface.

Šemnice Rock – geological evolution
4 September 2019

Šemnice Rock, which rises above the Ohře River near Karlovy Vary, is one of the few phonolite outcrops in the Doupovské hory Mts. The vent of this volcano formed along a marginal fault of the Ohře Rift. Initially, a massive basaltic lava flow occurred. Subsequently, viscous phonolite lava was forced to the surface, solidifying in the form of a volcanic spine.





River terrace formation
11 October 2019

The construction industry is the most mining-dependent activity undertaken by man. The basic building materials are, for example, sand and gravel. These unconsolidated sediments were gradually deposited by rivers and often occur as river terraces. They contain gravel, which was formed by sediment deposition and river incision. River flow reflects climate change during the alternation of glacial and interglacial periods in the Quaternary.

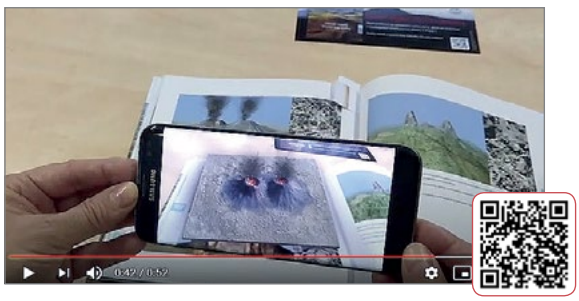
Use of drones for monitoring sapphire mining in Jizerka

24 October 2019

Jizerka in the Jizerské hory Mts Protected Landscape Area one of the most well-known localities for precious stones in the Czech Republic, which were mined here in the 1960s. Illegal mining at the site continues to this day. A CGS investigation focuses on determining the extent of past mining, estimating the volume of excavated soil and sapphire quantity. Monitoring aims to safeguard the Jizerské hory Mts Protected Landscape Area and reservations.

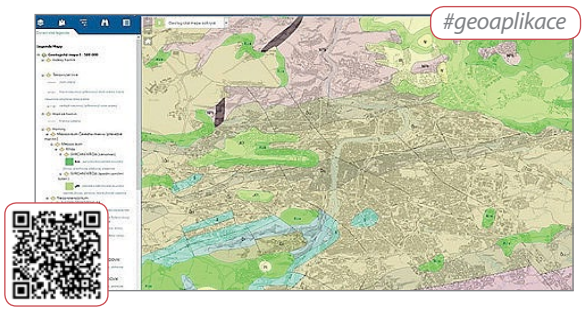
Revived Volcanoes of the Czech Republic

28 November 2019



The Czech Geological Survey's volcanologist Vladislav Rapprich introduces his book *Oživlé sopky České republiky* ("Revived Volcanoes of the Czech Republic"), which was published by the CGS Publishing House. The book can display three-dimensional objects and allows you to travel through time. You can read and view the book with or without a smartphone. By installing a QR-code reader, the book transforms into a gateway to a world of scorching lava and massive eruptions in our planet's ancient past.

CAUGHT YOUR EYE ON FACEBOOK



Geoscience maps 1:500,000
21 January 2019

The Czech Geological Survey's map server application displays a geological bedrock map of the Czech Republic at a scale of 1:500,000. Users also have access to other geoscience layers, which are based on this map: "radon risk", "engineering geological zones", "mineral water", and "Quaternary cover".

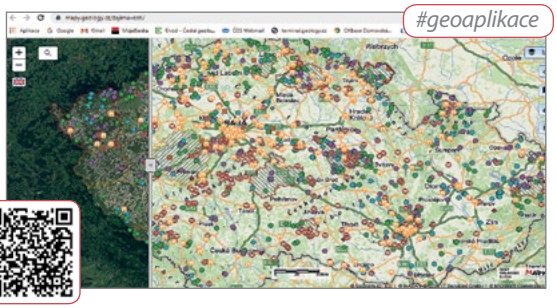
Fracture networks
1 March 2019

Fracture networks can be a nightmare for an engineering geologist, or they can act as a hydrogeological aquifer. On Lake Ugii Nuur in Mongolia, they produce fascinating 3D geometric shapes due to the expansion of a metre-thick ice shell.

Earth Day with the Czech Geological Survey
11 April 2019

You don't have to be a geologist to easily find out what type of bedrock lies beneath your feet, what interesting geosites occur locally, or where a landslide may take place. The map applications of the Czech Geological Survey provide a geological map of the entire Czech Republic, information on important geosites, slope instabilities and borehole surveys, and much more for your mobile phone or tablet as well!

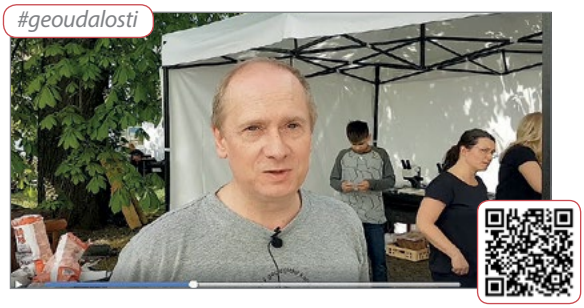
- Geoscience Maps: https://mapy.geology.cz/geo/
- Popularization of Geology: https://mapy.geology.cz/pop/
- Geohazards: https://mapy.geology.cz/haz/



Interesting Geosites of the Czech Republic
15 May 2019

The Interesting Geosites application (https://mapy.geology.cz/zajimavosti) of the Czech Geological Survey was upgraded to a new version with a new appearance, functionality and content. With regard to maps, the main novelty is the possibility of accessing a layer with the Geological Map of the Czech Republic at 1:50,000 scale. Interesting Geosites now use "mappky" technology, which the CGS utilizes to display map content on websites and in simple map applications. Compared with the previous version, the map layers control is now unified in one place, including transparency settings and legend display. In comparison with the similar Popularization of Geology application (https://mapy.geology.cz/pop/), which is mainly intended for mobile devices, the Interesting Geosites application is also intended for use on classic desktops. Therefore, it also offers a tool for measuring distances, coordinates and areas. Both applications also differ in map content: Interesting Geosites also include the Decorative Stones and Mining Impacts layers, while Popularization of Geology also includes the Significant Geosites layer. Interesting Geosites are also available in English (https://mapy.geology.cz/geosites).

Science Fair 2019
2 June 2019

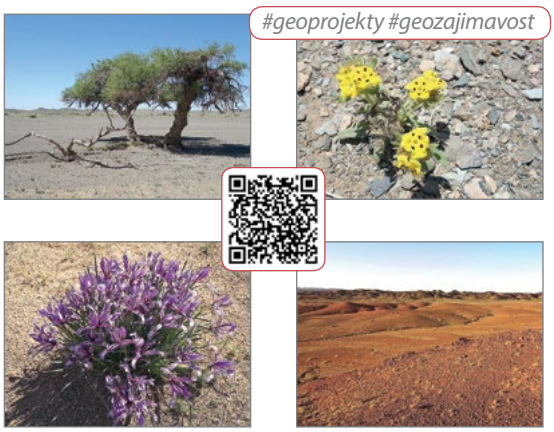


Did you know what treasures lie hidden in the collections of the Czech Geological Survey? At the CGS stand of the Science Fair, you will find out what index fossils are and why they are so important on Saturday, 8 June, between 10 am and 2 pm. You will learn what organisms lived in the Czech Republic's territory when it was covered by a sea. Do you know how many seas have existed in our geological past?

Deblov in the Železné hory Mts
12 June 2019

Are you tired of driving to the ocean? Drive to Deblov in the Železné hory Mts instead and walk along the bottom of a Palaeozoic sea with preserved ichnofossils!

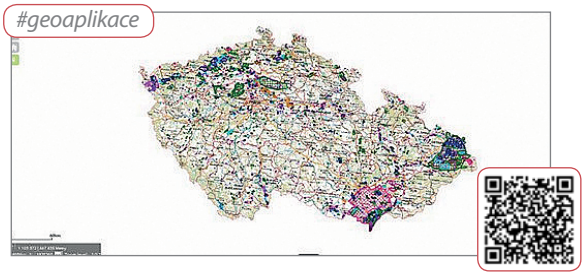
CAUGHT YOUR EYE ON FACEBOOK



Life in the Gobi
21 June 2019

The Mongolian Gobi is a real wasteland, but the stony desert is sometimes enlivened by small colourful flowers, prickly shrubs and, in some valleys, solitary poplars. Unique springs and rare flowing water attract various forms of life, such as tufts of blue irises or large flocks of sandgrouses in the spring.

Mineral Information System
31 July 2019



The Czech Geological Survey made the Mineral Information System (SurIS) web map application more user friendly (https://mapy.geology.cz/suris). Individual SurIS layers were renamed in order to correspond to legally established terminology. All objects entered in SurIS were converted to polygons. Since July 2019, data on mining leases are being transmitted via the WFS service from the State Mining Authority, which is responsible for their update and content accuracy. At present, the map application records are constantly up-to-date and linked with the newly launched SurIS Database in the CGS Central Data Store.

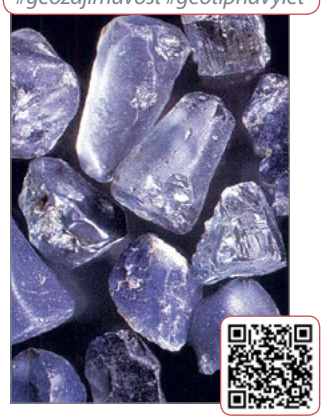
Semi-precious stones from Kozákov
26 September 2019

The semi-precious stones from the surroundings of Kozákov and, particularly, from the vicinity of the Votrubec quarry were sought after as early as the 14th century and are the pride of many museum collections. They include agate, jasper, calcite, amethyst, fluorite and other interesting minerals, which were formed in cavities produced by volcanic gases in the local melaphyre lavas. Even today, you can visit the well-known Votrubec quarry and search for semi-precious stones. In a nearby museum, it is possible to obtain an entrance permit, to view an inspiring exhibit of minerals from all over the world, and then to have your find professionally classified and ground.

The unique Suché Rocks
29 October 2019

Suché Rocks – one of the wonders of the Bohemian Paradise, of the Czech Republic, Europe or the world! Who is aware of this fact when observing them? And yet it is so. Here, on a small and seemingly narrow strip of the Earth's surface, something remarkable happened about thirty million years ago. The mighty internal forces of the Earth revived an ancient massive fracture in the Earth and raised the rocks that covered it, thus forming sloping, perpendicular or even inverted layers. In addition to the soft sand strewn from the rocks, you can find the remains of ancient marine life and periods when the Suché Rocks were uplifted. This did not occur from day to day, but it did so quickly from a geological perspective. The layers fractured, moved over each other, rubbing against one another as when grinding a stone, leaving with slickensides – smooth and locally shiny surfaces. The phenomenon is rare in nature! And the Suché Rocks possess another remarkable characteristic. In cold and windy autumn or winter weather, musical tones can virtually be heard coming from them. They are also, not without reason, called the "Cantor's Organ". You will hardly come across a similar natural phenomenon in the world. So let us appreciate the Suché Rocks, because they really are unique!

Safírový Stream – a European rarity
10 December 2019



Did you know that… the Safírový Stream and Jizerka River represent a rich deposit of precious stones, which in the past was one of the most important ones in all of Europe? Even today, this site yields rare sapphires as well as leukosapphires, rubies, spinel, zircon, smoky quartz, citrine and other similar stones and, along with these, still abundant iserine, a variety of ilmenite, and various other minerals. The boom in semi-precious stone mining occurred at the turn of the 16th and 17th centuries. Long and often bloody disputes arose over the site between Emperor Rudolf II and the local nobility. Well-known prospectors were Italians, also called Vlaši in old Czech, after whom the ridge Vlašský hřbet is named from which the Safírový Stream emerges. Another person involved in the mining was the nobleman Zikmund Smiřický (residing at Hrubá Skála Castle), who developed a precious stone mine in this area. Today, however, a strict ban on panning is in effect and the area is being carefully guarded, because it lies in the Jizerka Peat Bog National Nature Reserve.

CAUGHT YOUR EYE ON FACEBOOK

Glass mountain in Ethiopia
18 December 2019

Imagine being tasked with an intergovernmental assistance project to find out whether there is any natural hazard in southern Ethiopia. After arriving at your destination point, you discover a volcano in the immediate vicinity of two large cities with half a million inhabitants. A volcano that the locals are not even aware of as being a volcano. During an investigation, you find out that it is basically a glass mountain, because it is covered with black volcanic glass – obsidian. The volcanologist of the Czech Geological Survey Vladislav Rapprich has never encountered such an amount of obsidian in his life. Furthermore, the Corbetti volcano threatens to erupt again. The geologist shared his experiences and the results of analyses on the Czech Radio programme Meteor.

Cotopaxi from orbit
26 December 2019

Satellite image: Cotopaxi, Ecuador. Cotopaxi is an active stratovolcano and also the second highest mountain in Ecuador (5,897 m ASL). From a height of 5,000 metres, its peak is covered by one of the few equatorial glaciers. An expedition of the Central Geological Institute (now the Czech Geological Survey) in 1972 made the first descent into the volcano's crater. The expedition included the compilation of the first geological map of the volcano's surroundings, which still serves visitors today.

100 Years of the Czech Geological Survey
31 December 2019

Dear friends, Happy New Year! Let us drink to your health and happiness from a limited-edition phonolite pint, made for the 100-year anniversary of the Czech Geological Survey. Good luck to you all! The phonolite pints come from Chlum near Maršovice in the Ralsko Upland. Glassmakers often substitute alkaline feldspars in the glass batch with phonolite, but its use as a basis for melting glass is unique. The reason for this was its fine-grained structure and high alkali content, facilitating melting. Phonolite is chemically similar to alkaline obsidian and hydrated obsidian – pitchstone, used in the distant past for manufacturing glass in the Middle East as well as in Meißen.

GEOLOGY
FOR CZECH SOCIETY
FOR THE NEXT HUNDRED YEARS

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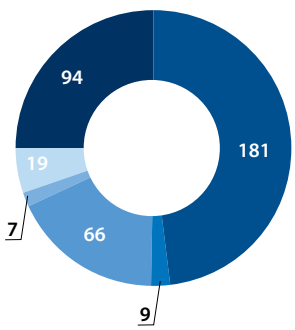
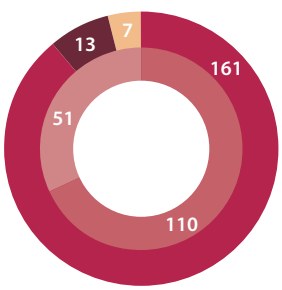


CGS publishing activity in 2019

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

Zdeněk Cilc
Head of the Economic Division
and Deputy Director for Economics

FINANCIAL REVIEW FOR 2019

In 2019, the Czech Geological Survey reached a profit of CZK 10,248,000, of which CZK 9,766,000 represented primary activities and CZK 482,000 secondary activities.

The positive financial result was achieved due to an increase in the own activities, particularly those involving contracts and projects. The total income from these activities represents roughly 65% of the organization's total income.

In 2019, the Czech Geological Survey continued to successfully perform the tasks of the state geological survey and to increase income from external contracts – with a year-on-year increase of CZK 7,083,000.

The staff's performance secured sufficient revenue to cover the organization's expenditures and its further development. Total personnel cost increased by CZK 15,163,000 year-on-year. The total volume of investments amounted to CZK 28,806,000, of which CZK 18,249,000 were funded by programmes.

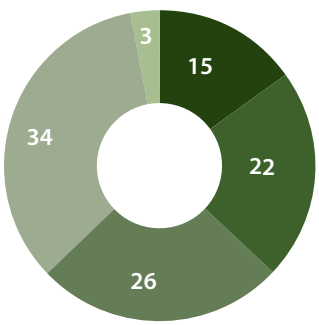
With its results in research and development (R&D) in 2019, the Czech Geological Survey maintained its top ranking in the R&D evaluation system, thus securing the necessary funding for the long-term conceptual expansion of its research activities – totalling CZK 104,861,000.

Total expenditures of the organization

Total expenditures (CZK)	**393,192,819**
Material and power consumption	22,618,907
Services	71,624,220
Total personnel cost	237,669,347
Depreciation of tangible and intangible assets	20,882,747
Other expenses	40,397,598

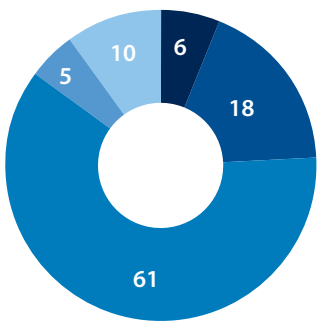
Total income of the organization

Total income (CZK)	**403,441,017**
Sales and other own-source revenue	60,570,492
Allocation for activities of the organization	88,109,937
Institutional funding for development of research organizations	104,861,046
Funds for projects and commissioned services	137,484,856
Income from transfers	12,414,686



Percentage distribution of income in various categories for 2019

- 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



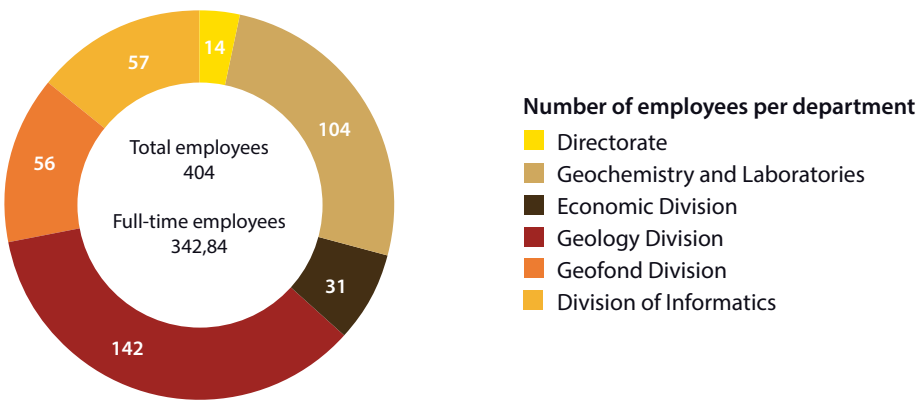
Percentage distribution of expenditure in various categories for 2019

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

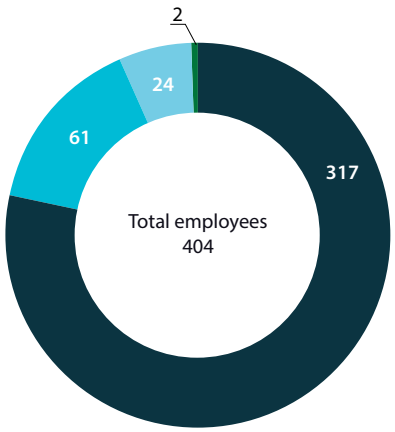
Helena Žemličková
Head of the Human
Resources Department

HUMAN RESOURCES

In 2019, the Czech Geological Survey had 404 employees, which is the equivalent of 342.84 persons working full-time. The number of women was 196, with a full-time equivalent of 168.90.



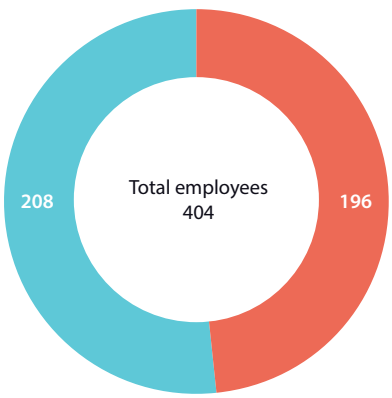
The indicators given above not only underline the high level of competitiveness in the labour market, but they also emphasize the organization's economic growth and prestige among research institutes in the Czech Republic.



Education background of the CGS staff

- University
- Secondary with graduation exam
- Apprentice
- Elementary

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



Gender ratio of the CGS staff

- Women
- Men

The CGS 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.

Radek Svítil
Web administrator

WEBSITE OF THE CZECH GEOLOGICAL SURVEY

In the early years of the state geological survey, director Cyril Purkyně was able to present its work and results only in printed reports on activities, published annually in compilations. In the year celebrating the 100th anniversary since its founding, the Czech Geological Survey has the most modern technologies at its disposal, enabling it to swiftly familiarize the general public at home and abroad with its work. It does so through dozens of web applications, which are constantly being updated and upgraded.

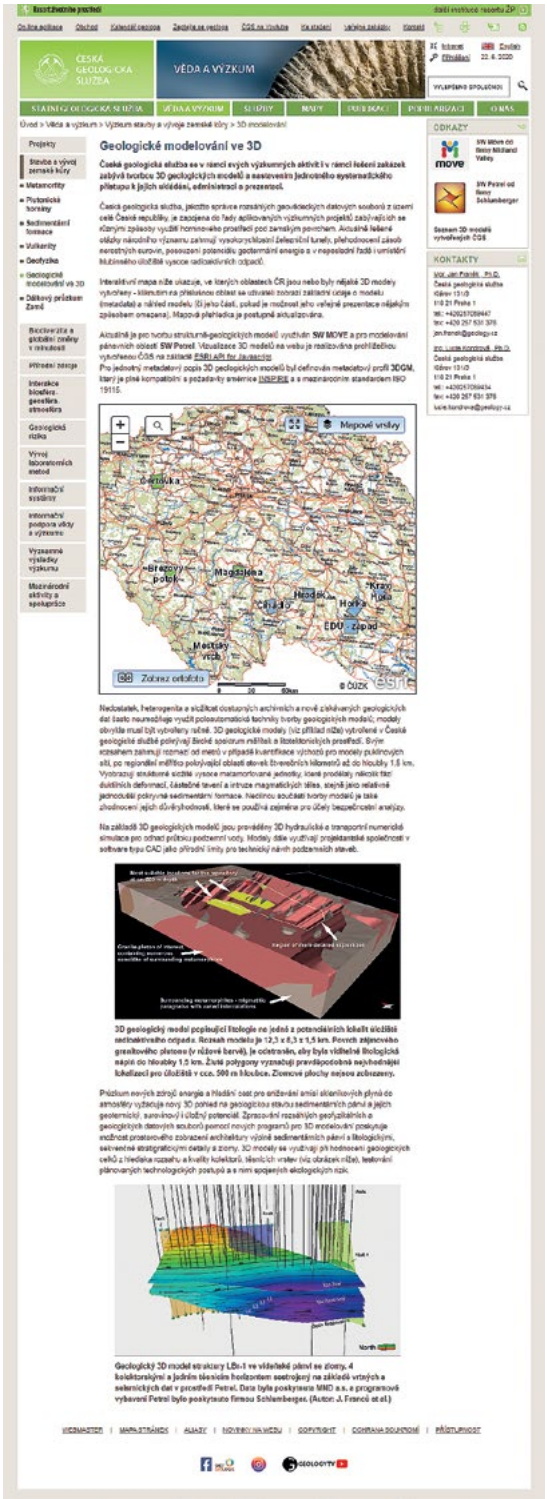
During 2019, the Interesting Geosites map application was updated in terms of technology and content – https://mapy.geology.cz/geosites. From a technical perspective, it is now based on the so-called "mappky" technology, which the CGS uses for simple map applications as well as for maps embedded on web pages on the portal and in applications. In terms of content, the displayed information on decorative stones was expanded significantly and the Interesting Geosites map application now includes the thus far separate Decorative Stones application, which was shut down.

▲ *Information on Prague's Petřín quarry, where decorative stones were extracted, in the Interesting Geosites map application.*

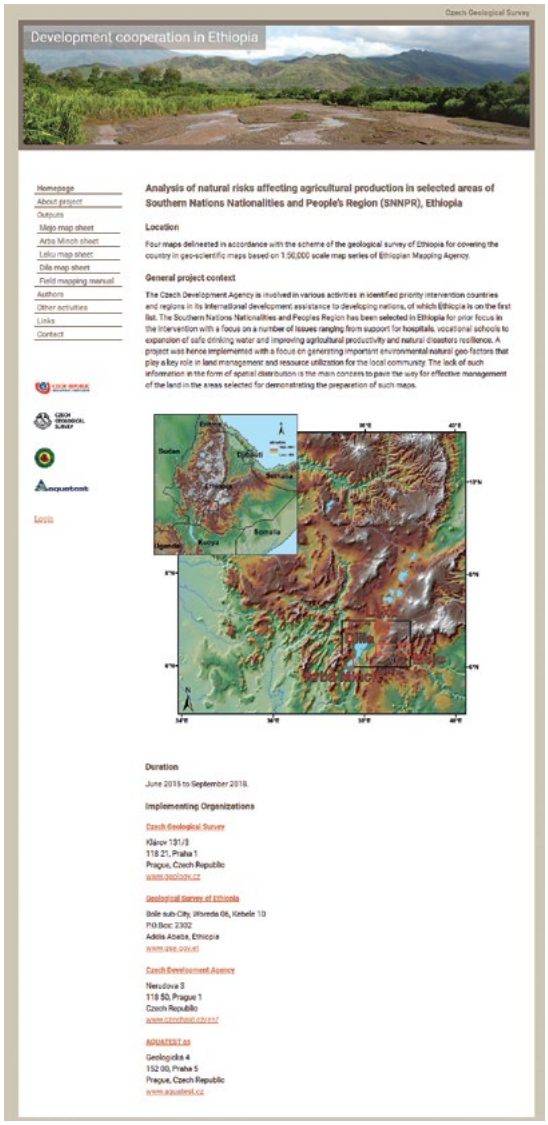
The Geological Modelling in 3D webpage was placed on the Czech and English extranet, at http://www.geology.cz/extranet/vav/zemska-kura/3d and http://www.geology.cz/extranet-eng/science/earths-crust/3d. It also includes an overview map of 3D models created thus far, which was compiled using the mentioned "mappky". Users can view selected models with the Esri 3D Scene Viewer.

A website was created for the project "Analysis of natural risks affecting agricultural production in selected areas of the Southern Nations Nationalities and People's Region (SNNPR), Ethiopia", see http://www.geology.cz/etiopie-2018.

From a technological perspective, work focused on testing the open source content management system Drupal (version 8.x) as a replacement for the existing CGS portal, and on practical testing of using modern web technologies (such as reactive javascript frameworks, specifically the VueJS framework) for developing website front ends and web applications.



▲ *Geological Modelling in 3D, available at* http://www.geology.cz/extranet/vav/zemska-kura/3d.



▲ *Website of the project "Analysis of natural risks affecting agricultural production in selected areas of the Southern Nations Nationalities and People's Region (SNNPR), Ethiopia"* http://www.geology.cz/etiopie-2018.

PRINCIPAL EVENTS IN 2019

Events related to the centennial celebrations of the founding of the state geological survey are listed in the chapter **HOW WE CELEBRATED 100 YEARS**.

▾ Zdeněk Venera as President of the Executive Committee of EuroGeoSurveys

1 January 2019

The Director of the Czech Geological Survey Zdeněk Venera was elected President of the Executive Committee of EuroGeoSurveys (EGS) as of 1 January 2019. EuroGeoSurveys is an association of 37 geological surveys throughout Europe with thousands of geological experts. The main objectives are to provide public scientific knowledge about the Earth, to support the EU's competitiveness and to participate in environmental management and international commitments. The EGS Executive Committee, as the primary decision-making body, implements the strategy and coordinates the activities of the organization. *Author: Klára Froňková*

▾ Evaluation of ICDP projects

12–14 March 2019

The Science Advisory Group (SAG) meeting held on 12–14 March in Muscat, Oman, included an evaluation of ICDP (International Continental Scientific Drilling Programme) projects submitted by 15 January 2019. It took place in Oman, because an extensive drilling project, co-funded by the ICDP, is successfully underway in the area of the Semail Ophiolite. The independent SAG expert committee consists of fifteen internationally recognized experts with expertise in ICDP projects. Its members are nominated to four-year terms of office by the national funding agencies of ICDP member countries (now 22), including the Czech Republic. Panel members compiled a list of priority projects based on their expected scientific contribution. *Author: Jana Kotková*

▾ 5th CE-GIC meeting in Prague

11–12 April 2019

On 11–12 April, the geoinformaticians of the Central European geological surveys from Austria, Hungary, Slovakia, Croatia, Slovenia, Romania and the Czech Republic met at the CGS headquarters in Klárov. The CGS staff presented the preliminary results of the CzechGeo/EPOS project, the centennial celebrations of the CGS, and a proposal for joint activities involving interesting geosites of Central Europe. *Author: Otmar Petyniak*

The new look of the Interesting Geosites application

6 May 2019

The application was upgraded to a new version, ushering in a new appearance, functionality and content. With regard to maps, the main novelty is the possibility of accessing a layer with the Geological Map of the Czech Republic at 1:50,000 scale. In terms of appearance and functionality, Interesting Geosites now use "mappky" technology, which the Czech Geological Survey uses to display map content on websites and in simple map applications. The appearance and control of the Interesting Geosites application are thus compatible with other similar map applications. Compared with the preceding version, the map layer control is now unified in one place, including transparency settings and legend display. In comparison with the similar Popularization of Geology application, which is mainly intended for mobile devices, the Interesting Geosites application is also intended for use on classic desktops. Therefore, it also offers a tool for measuring distances, coordinates and areas. Both applications also differ in map content: Interesting Geosites also include the Decorative Stones and Mining Impacts layers, while Popularization of Geology also includes the Significant Geosites layer. Interesting Geosites are also available in English.

Author: Radek Svítil, Markéta Vajskebrová

European workshop on 3D geological modelling

21–24 May 2019

About 100 experts from 23 countries took part in the 5th European Meeting on Geological Modelling held on 21–24 May in Bern. J. Franěk, L. Kondrová, O. Švagera and J. Jelének, who attended the meeting on behalf of the CGS, presented the current aspects of geological modelling in the Czech Republic, posters on calculating model uncertainty and on the use of new technologies for geological model construction.

Author: Lucie Kondrová, Jan Franěk

Geological exhibit opened to schools in Jablonec nad Nisou

19 July 2019

The Czech Geological Survey installed an outdoor educational geology exhibit at the Mozartova primary school in Jablonec nad Nisou. The exhibit 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 other educational material, which may be downloaded via QR codes located on information panels, such as animations of the origin of geological formations, worksheets for students or excursion guides. The ceremonial opening of the exhibit was followed by a geology lesson with Vladislav Rapprich, a specialist of the Czech Geological Survey. Starting with the upcoming school year, the geological exhibit will be opened to other schools as well. *Author: Klára Froňková*

General Meeting of Directors of European Geological Surveys in Prague on 8–9 October 2019

8 and 9 October 2019

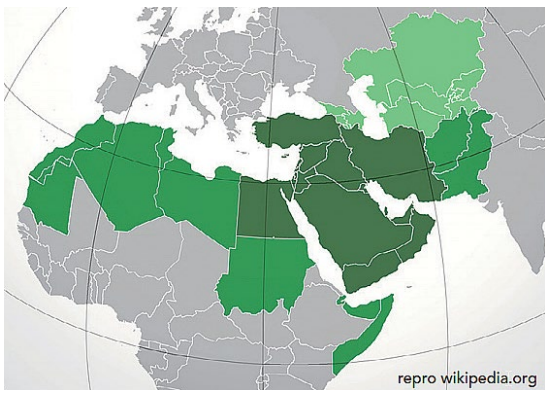
During the year celebrating the 100th anniversary of the state geological survey's founding, the Czech Geological Survey organized the 47th General Meeting of Directors of European Geological Surveys on 8 and 9 October. As President of EuroGeoSurveys, Zdeněk Venera chaired the meeting in the congress hall of the Masaryk Dormitory in Prague-Dejvice. The meeting was complemented by a workshop on the role of science in geological surveys and by an excursion to significant geosites in West Bohemia, during which participants visited an adit in Jáchymov and toured Karlovy Vary. *Author: Klára Froňková*

Celebrating eighty years of Mongolian geology
16–18 October 2019

The celebrations of the 80th anniversary of the Mongolian Geological Survey were held on 16–18 October in Ulaanbaatar. As part of the scientific programme, CGS representatives gave two lectures and presented a poster summarizing Czech-Mongolian geological cooperation. Prof. Karel Schulmann gave a speech honouring Mongolian geology on Friday, 18 October, during a solemn ceremony held in the parliament building and attended by Mongolia's top political representatives. *Author: Pavel Hanžl*

CGS Director Zdeněk Venera spoke at the international conference of MENA countries
11 December 2019

The international conference of MENA (Middle East and North Africa) countries with ambassadors, geological experts and representatives of the business sector from fourteen countries in the Near East and North Africa was organized by the Ministry of Trade and Industry on Wednesday, 11 December. The aim of the meeting was to support mutual cooperation in the prospecting for and extraction and processing of minerals, crude oil and natural gas. It was the first major international conference on the subject with several countries simultaneously. At the conference, the Director of the Czech Geological Survey Zdeněk Venera presented the institute's range of activities and expert potential as well as its specialists, thus laying the foundation for potential cooperation on geological mapping projects with, for instance, Jordan, Oman or Morocco. Other common priorities of the negotiating countries involve the transfer of Czech technologies and the education of experts from MENA countries with the goal of modernizing the entire region. *Author: Klára Froňková*



PROJECTS implemented in 2019

Czech Science Foundation (GACR)

• GACR 16-17457S: Melting the metagranitoids: important but poorly understood aspect of crust evolution, 1 January 2016 – 31 December 2020	P. Štípská
• GACR 17-17540S: 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: Did the West-Gondwana orogens form by inversion of long-lived rift domains?, 1 January 2018 – 30 June 2021	J. Konopásek
• GACR 1824378S: Petrogenesis of (ultra-)potassic magmas in the European Variscides – implications for the development of collisional orogens and crustal growth models, 1 January 2018 – 30 June 2021	V. Janoušek
• GACR 18-17295S: Climatic and air pollution effects on forest productivity, 1 January 2018 – 30 June 2021	J. Hruška
• GACR 18-15390S: Experimental and mineralogical study of selected platinum-group chalcogenides and alloys, 1 January 2018 – 31 December 2020	A. Vymazalová
• GACR 18-27454S: Element transfer in a deep subduction environment: evidence from ultrahigh-pressure metamorphic terranes, 1 January 2018 – 30 June 2021	J. Kotková
• GACR 18-15498S: Calcium and magnesium isotope mass balances in acidified small catchments with contrasting lithologies, 1 January 2018 – 31 December 2020	M. Novák
• GACR EXPRO 19-27682X: Principal mechanisms of peripheral continental growth during supercontinent cycle, 1 January 2019 – 31 December 2023	K. Schulmann
• GACR 19-25035S: Granulite-migmatite domes – insights to Devonian and Carboniferous evolution in the Variscan belt, 1 January 2019 – 31 December 2021	P. Štípská
• GACR 17-06700S: Přídolí Series in the Prague Synform – proposal for chronostratigraphic subdivision, cooperation with the Institute of Geology of the Czech Academy of Sciences, 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 Geophysics of the Czech Academy of Sciences, 1 January 2017 – 31 December 2019	S. Čech
• GACR 17-15700S: 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 Czech Academy of Sciences, 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. Strnadová
• GACR 17-10233S: The oldest vascular land plants and palynomorphs from the Silurian–Lower Devonian of the Barrandian area, Czech Republic, cooperation with the Institute of Geology of the Czech Academy of Sciences, 1 January 2017 – 31 December 2019	P. Tonarová
• GACR 17-22207S: 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: 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

• GACR EXPRO 19-29124X: Evolution and post-emplacement history of carbonatites: Implications for the mobility and concentration of critical metals, 1 January 2019 – 31 December 2023	T. Magna
• GACR 19-17435S: Palaeoclimatologic significance of Palaeozoic red pelagic carbonates: time specific facies or products of microbial activity, 1 January 2019 – 31 December 2021	J. Frýda
• GACR 19-07516S: Cretaceous-Paleogene boundary in the Carpathians – multidisciplinary search for local variations in a global cataclysm event, 1 January 2019 – 31 December 2021	M. Bubík
• GACR 19-04682S: Bioaccessibility and environmental interaction of antimony near busy traffic nodes, 1 January 2019 – 31 December 2021	F. Bůzek

Technology Agency of the Czech Republic (TACR)

• TACR – Competence Centre for Effective and Ecological Mining of Mineral Resources, 2014–2019	M. Poňavič
• TACR – Controlled and enhanced microbial methane production in situ, 1 June 2018 – 31 December 2022	J. Franců
• TACR – Engineered barrier 200C, 1 June 2018 – 31 December 2025	F. Laufek
• TACR – Impact of geosphere evolution on radionuclide transport from a deep repository of radioactive waste to the biosphere, 1 July 2019 – 30 September 2022	T. Hroch
• TACR – Analysis of the geothermal energy potential at medium and great depths in the Czech Republic based on available data	J. Holeček, M. Kloz
• TACR – Study of concentrations of Be, Ge, Ga and In in tailing ponds of ash from coal combustion in the Czech Republic (TITSMPO816), 1 September 2019 – 31 July 2021	M. Poňavič

Internal Projects of CGS

• Project drafting (timesheets recording the preparation of all projects), ongoing	P. Mixa
• 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, 1 January 2019 – 31 December 2019	E. Kadlecová, P. Budil
• Inventory of Slope Instabilities, ongoing	O. Krejčí
• Geological base mapping of CR at a scale of 1:25,000, ongoing	D. Buriánek, J. Pertoldová
• Development of 3D geological models and related CGS databases, ongoing	L. Kondrová, J. Franěk
• Editing of the journal Geological Research in Moravia and Silesia, CGS, ongoing	D. Buriánek
• Editing and preparation of the electronic version of the Bulletin of Geosciences, 2010, ongoing	J. Frýda
• Development of the CGS www information portal, ongoing	R. Svítil
• Data sources and the CGS meta-information system, ongoing	J. Sedláček
• Administration and development of the digital archive of the CGS, ongoing	J. Sedláček
• Development and administration of the National Geologic Map Database of the Czech Republic, ongoing	Z. Krejčí
• Implementation of the European INSPIRE Directive in the CGS, ongoing	L. Kondrová
• Enhancement of the ICT infrastructure of the CGS, ongoing	R. Binko
• Inventory, protection and popularization of geosites of the Czech Republic, ongoing	M. Vajskebrová

PROJECTS

• Upgrade of the CGS Map Server, 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, ongoing	J. Sedláček
• 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
• Presidency of the international research network ENeRG, 2018–2019	V. Hladík
• Database of open-cast mines, 2018–2019	J. Večeřa
• Assessment of suitable locations for a SNF and RAW repository in terms of long-term safety, 2019	J. Pertoldová, Z. Bukovská
• Characteristics and evolution of the provenance area of Cambrian and Devonian clastic sediments, 2018–2019	H. Gilíková
• 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. Collett
• The subglacial geology of Dome F (East Antarctica) determined by new aeromagnetic data, 2018–2019	A. Guy
• 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. Miková
• 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 – addition of results from the Review of Groundwater Resources, 2018–2020	I. Kůrková
• 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
• 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
• Czech Geological Survey in Central America 2019	P. Hradecký

• Origin and pre-collision geodynamic evolution of crustal units of the Central European part of the Variscan orogenic belt, 2019–2020	I. Soejono
• Publishing-related evaluation of borehole, geophysical and geochemical data from the "Review of Groundwater Resources" project, 2019–2020	R. Lojka
• Preparation and organization of the event Earth Day with the Czech Geological Survey, 2019	Z. Bukovská
• Testing of drones for research purposes, 2019–2020	L. Koucká
• Formation and evolution of atypical circular depressions in Hodonínská Dúbrava in the context of Pleistocene periglacial processes, 2019–2020	J. Hošek
• Selected Mesozoic and Cenozoic taphocenoses II: stratigraphy, palaeoecology, taxonomy and palaeobiogeography, 2019–2020	R. Vodrážka
• Geology of the Křivoklátsko Protected Landscape Area, 2019–2020	T. Vorel
• Origin and metamorphic evolution of allochthonous units in the eastern French Massif Central, 2019–2020	P. Pitra
• Volcanic systems V, 2019–2020	V. Rapprich
• Phytopaleontological, sedimentological and palynological study of Permo-Carboniferous basins, 2019–2020	Z. Šimůnek
• Microfacies analysis and fossil communities of selected intervals of the Prague Basin, 2019–2020	S. Vodrážková
• Study of silver solubility in chalcopyrite in nature and in experiments and characteristics of gold mineralization in the mining district of Kongsberg, Norway, 2019–2020	J. Kotková
• Comparison of the diagenesis of Jurassic, Paleozoic and Tertiary aquifer rocks in a selected area on the southeastern slopes of the Bohemian Massif, 2019–2020	J. Franců, P. Jirman
• Dynamics of chromium isotopic composition ($\delta^{53}Cr$) of runoff from a small mafic rock-dominated catchment, 2019–2020	A. Andronikov
• Toward an isotopically constrained mass balance in catchments variably affected by soil nitrogen saturation, 2019–2020	D. Petráš
• Aluminium fractions in surface waters of European catchments of the International Cooperative Programme – Integrated Monitoring, 2019–2020	P. Krám
• Monitoring of small forest catchments GEOMON, 2019–2020	F. Oulehle
• Development of a method for measuring ^{15}N and ^{18}O in nitrates, 2019	F. Buzek
• Development of methods for the mineralogical study of Zn-smectites (sauconites) using X-ray diffraction and subsequent modifications of samples (saturation, annealing), 2019	M. Koubová
• Development of a method for analyzing biomarkers using GC-MS, 2019–2020	J. Franců, P. Pařízek
• Continuous inventory of CGS material documentation in Brno, 2019	M. Bubík
• Mobile device support for field documentation, 2019	P. Čoupek
• Publication of soil maps 1:50,000, ongoing	J. Janderková
• Variscan evolution of the MECS micro-plate examplified by the Maures-Tanneron massif (SE France): A link between European and North-African variscan belt?, 2019–2020	J. M. Lardeaux
• Study of mechanisms of global crises in the geological past (III): Multidisciplinary study of Silurian sediments and of the Homerian stratotype, 2019–2020	J. Frýda
• Impact of global change on Phanerozoic communities: Evolution of selected Cambrian to Devonian groups of invertebrates; study of selected Cenozoic fauna (Gastropoda, Amniota) – palaeontological revision of CGS collections, 2019–2020	P. Budil

PROJECTS

• Homerian – paleontological, sedimentological and geochemical study of the stratotype, 2019–2020	Z. Tasáryová
• The geodynamic significance of ultrabasic-basic rock association in orogens (example of the Bohemian Massif), 2019–2020	P. Deiller
• Specification of the geotechnical properties of overconsolidated clays based on samples collected from the vicinity of the Brno agglomeration and subjected to laboratory analyses, and modelling of a landslide body based on the laboratory analyses, 2019	K. Fárová
• Decorative and building stones of the Czech Republic. Compiling maps of decorative and building stones for individual regions of the Czech Republic, 2018–2019	B. Dudíková
• Peru – slope stability (trip to Peru and publication preparation), 1 September 2018 – 1 September 2019	J. Novotný
• 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
• Geology of the Bohemian Cretaceous Basin, 1 March 2017– 31 December 2021	S. Čech
• Special studies, research methodology, doctoral studies and theses, 1 January 1999 – 11 November 2050	E. Břízová
• Assessment services of regional geologists, 1 January 1999 – 31 December 2030	J. Čurda
• Geological supervision of landslide remediation at Dobkovičky (D8), CGS, ongoing	P. Kycl
• Environmental impacts of mining and processing of minerals, 1 January 2005 – 31 December 2019	P. Rambousek
• Completion of projects (timesheets recording the technical completion of outputs), 1 January 2009 – 31 December 2030	D. Skácelová
• Printing of geological and applied maps, 1 January 2010 – 31 December 2030	V. Žáček
• Mobile device support for field documentation, 1 January 2019 – 31 December 2019	P. Čoupek

▾ Internal projects funded by the Ministry of the Environment (MoE) for 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, 2014–2019	A. Horáková
• Revitalization of selected parts of geological documentation held in the CGS Geofond archives, 2016–2019	M. Hrdlovicsová
• CGS archives – relocation of sample materials from old boreholes to the standard storage system of the CGS Geofond Division, 2016–2019	A. Donát
• 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, 2014–2019	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, 2014–2019	J. Šanderová
• Revision of safeguarding measures for old and abandoned exploratory mine workings, 2014–2019	P. Šír
• Inventory of abandoned waste facilities from historical mining, 2014–2019	V. Štrupl
• First-hand investigation of reported mine working impacts, 2019	V. Štrupl
• Updating of soil maps at 1:50,000 scale, ongoing	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 www.geology.cz. Access to landslide points in the slope instability map (SI), 2016–2019	O. Krejčí
• Mineral deposit information system (LIS) – files of ore deposits and exploration areas, including written records, from the OG archives, 2014–2019	J. Mojžíš
• Advisory and expert services provided for the Department of Geology of MoE, including services regarding landslides for the Operational Programme Environment, 2014–2019	J. Čurda
• Geological map of the Brdy Protected Landscape Area – mapping at 1:25,000 scale, thematic maps, 2016–2019	T. Vorel
• Upgrading hydrogeological ground data for the Železné hory Geopark, 2016–2019	S. Čech
• Revision of the unpublished reports collection stored at the Brno office and inclusion in the Geofond archive system, 2017–2019	M. Hrdlovicsová
• Monitoring of hydrogeological boreholes, 2017–2020	J. Grundloch
• Risk assessment of pond sediments in submerged areas of the Moravian Karst, spring phase 2019	V. Baldík
• Determination of prognostic resources of moldavites (category Q) in South Bohemian basins at the localities Jakule, Třebanice and Jankov, 2019	T. Peterková
• ASGI information subsystem, 2018–2019	V. Štrupl
• SurIS information subsystem, phase 2019	D. Mašek
• GDO information system, 2018–2019	J. Sedláček
• Methane measurement at the site of the plugged Žu-108 production well, 2019	J. Franců
• Current negative impacts/processes in the Moravian Karst Protected Landscape Area, 2019–2020	V. Baldík
• Skalka near Prostějov, Natural Curative Source – thematic study of geological and hydrogeological conditions, 2019	E. Kryštofová
• Operational geological documentation of transport line structures, 2019	J. Hošek
• Transfer of borehole logs from the archived reports of the FZ and P collections into the GDO and GEO systems, 2019	Z. Petáková
• RANAP, 2020, Influence of anthropogenic inhomogeneities on the distribution of Rn and H values in the rock environment and update of the radon index map at www.geology.cz, 1 January 2016 – 31 December 2020	I. Barnet
• Methane measurement at the site of the plugged Žu-108 production well, 1 January 2018 – 31 December 2019	J. Franců
• Groundwater in crystalline rocks, 1 January 2019 – 31 December 2023	J. Novotná
• Mineral Commodity Summaries of the Czech Republic 2017 and Changes in Reserves of Reserved Mineral Deposits 2009–2019, 1 January 2019 – 31 December 2019	J. Starý
• Executing the tasks of the state geological survey apart from approved projects – Geological Division, 1 January 2009 – 31 December 2030	P. Mixa
• Executing the tasks of the state geological survey apart from approved projects – Geofond Division, 1 January 2009 – 31 December 2030	V. Štrupl

▾ Projects for the Ministry of Environment (MoE) and other ministries

• Implementation of the Czech Republic commitment to the Convention on Long-Range Transboundary Air Pollution UN ECE, 2017–2025	J. Hruška

PROJECTS

• Turów, MoE (Water Protection Department), 2016–2020	R. Kadlecová
• Turów – CGS support, 2016–2020	R. Kadlecová
• Institutional support for long-term conceptual development of the research organization based on its achieved results, ongoing	J. Pašava
• MIT – FV30153: Development of an inventory and monitoring system for geotechnical risk management, 1 January 2018 – 31 December 2021	P. Kycl
• MoA– ZEMĚ Programme (VÚRV) QK1810186: Improving soil structure stability and infiltration through agricultural practices, 1 January 2018 – 31 December 2022	M. Koubová

International grants and Ministry of Education, Youth and Sports (MEYS)

• Research infrastructure RINGEN, MEYS, 2016–2019	J. Holeček
• LM 2015079: Distributed system of observational and field measurements of geophysical fields (CzechGeo/EPOS), MEYS (consortium of the Institute of Geophysics of the CAS (Czech Academy of Sciences), 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	D. Čápová
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• EC, EuroGeoSurveys: MinLand, 1 December 2017 – 31 December 2019	P. Rambousek
• GECON – Geology Cooperation Network, Cross-border Cooperation Operational Programme INTERREG V-A Czech Republic – Poland, 1 March 2018 – 28 February 2021	P. Fiferna
• RawMaterials: TravelEX – Underground resources travelling exhibition, EU-EIT, 1 March 2018 – 31 December 2020	P. Fiferna
• Palaeogeographic maps of the Permian land basins of Central Europe, PL – National Science Centre, Programme Harmony, 19 April 2018 – 18 April 2021	Z. Šimůnek

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• 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. Čápová
• 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
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• 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
• EC–COST–Horizon 2020 – New geothermal sources for carbon-free heating grids, 15 October 2019 – 15 October 2023	V. Hladík
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Czech Geological Survey website > ***www.geology.cz /extranet-eng/***
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About us > *www.geology.cz/extranet-eng/**about-us***

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World of Geology – portal dedicated to the geosphere > ***www.svet-geologie.cz***

Journals

Bulletin of Geosciences > *www.geology.cz/**bulletin***
Journal of Geological Sciences > *www.geology.cz/**sbornik***
Special Papers > *www.geology.cz/**spec-papers***
Geoscience Research Reports > *www.geology.cz/**zpravy/en***

Web applications

Guidepost to applications > *http://**applications**.geology.cz*
Photoarchive > ***fotoarchiv**.geology.cz*
Map server > ***maps**.geology.cz*
Geological Encyclopedia > *www.geology.cz/**encyklopedie***
Virtual Museum > ***http://muzeum.geology.cz/?l=e***
Geological Localities > ***lokality.geology.cz/d.pl?item=1&l=e***
Interesting Geosites > *https://mapy.geology.cz/**geosites***
Decorative Stones > ***dekoracni-kameny.geology.cz/index_eng.pl***
Dictionary of Geology E-C and C-E > ***http://www.geology.cz/aplikace/encyklopedie/gslov.pl?l=e***

Other web presentations

Online obchod > ***obchod**.geology.cz*
The CGS channel on YouTube > *www.youtube.com/**geology.cz***
Geology Olympiad > ***www.geologicka-olympiada.cz***
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