POLISH GEOLOGICAL INSTITUTE
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ON THE HISTORY OF GEOLOGICAL SCIENCES

POLISH GEOLOGICAL SOCIETY • POLISH ACADEMY OF ARTS AND SCIENCE

SPONSOR PGE Górnictwo i Energetyka Konwencjonalna S.A.

48TH INTERNATIONAL COMMISSION ON THE HISTORY OF GEOLOGICAL SCIENCES (INHIGEO) SYMPOSIUM

CRACOW
POLAND
31 JULY – 4 AUGUST
2023

Book of Abstracts • Tour Guide

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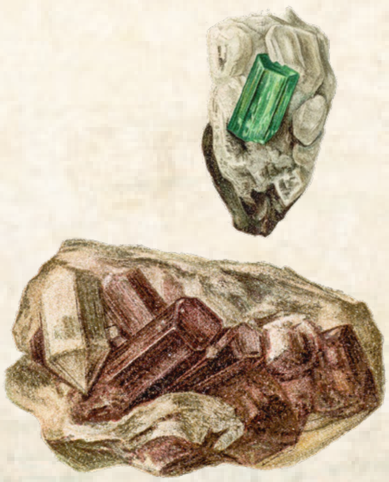
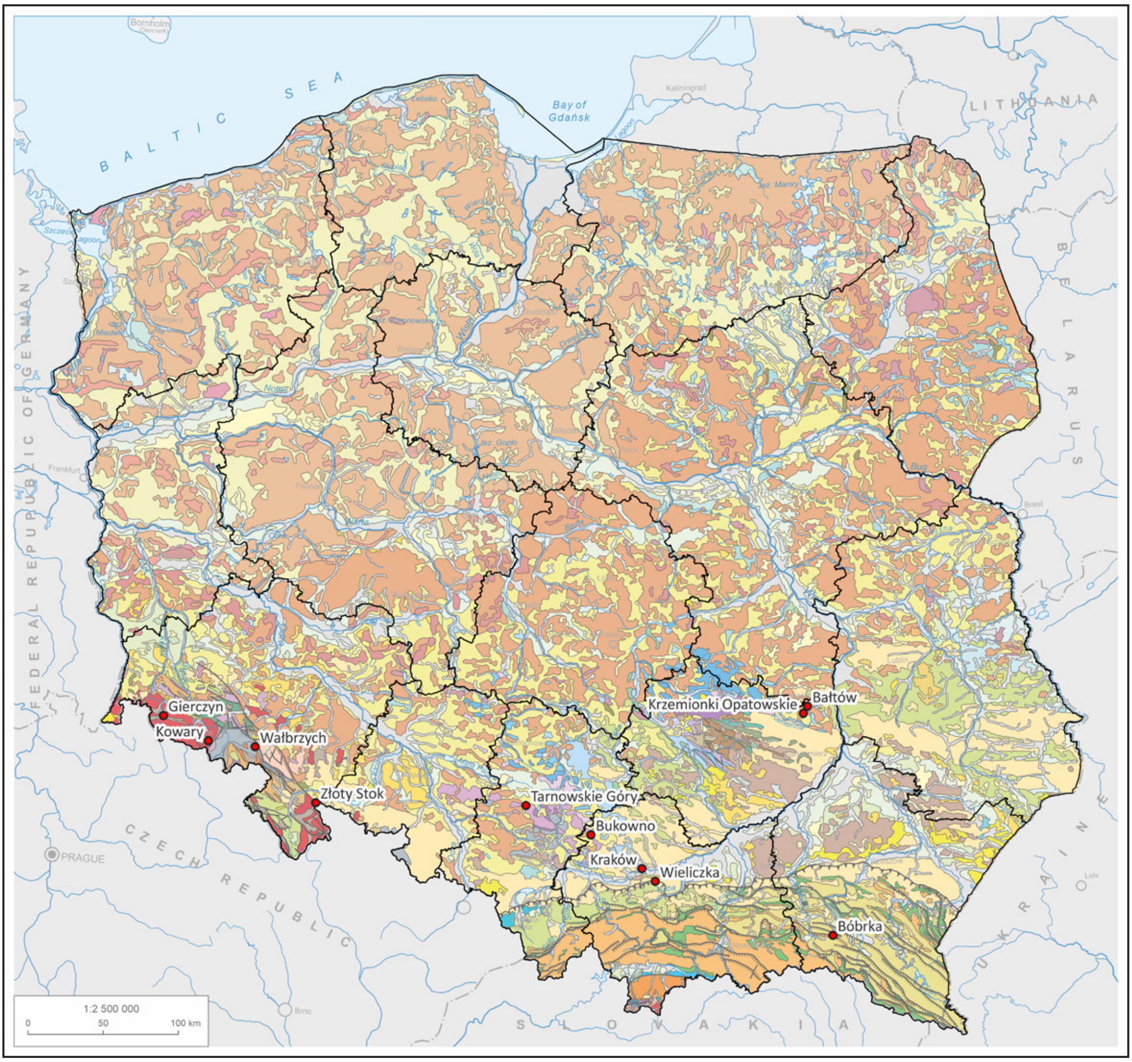


INTRODUCTION

The 48th Symposium of the International Commission on the History of Geological Sciences (INHIGEO) is being organised for the second time by Poland, but for the first time in traditional form. The previous one, organised in 2021, was held in an on line format due to the SARS Covid 19 pandemic. It was therefore not possible to present Poland's geology and historical mining sites in a face-to-face manner. During the 6-day pre-conference fieldtrip, participants will be able to gain an insight into the centuries-old history of mining in the Polish lands, even is several thousand years old. The itinerary of the trip leads through the geological structures of southern Poland: the Sudety Mountains, which are part of the Bohemian Massif, the Kraków-Częstochowa Upland and the Holy Cross Mountains.
Gold has always aroused many passions in people and has often brought misfortune to individuals as well as entire communities. The excavations in Złoty Stok show us this history. The history of polymetallic ore mining is explored in the excavations of tin, cobalt and copper ores located in the metamorphic shales of the Karkonosze-Izera Block (Western Sudetes). Tarnowskie Góry and Bukowno, on the other hand, have a history of silver-bearing zinc and lead ore mining lasting several hundred years, which has just come to the end. These deposits belonging to the Mississippi Valey Type (MVT) were the largest deposits of this type in the world. The Sudetic town of Kowary is associated with a centuries-old tradition of iron ore (magnetite) mining and the recent, short-lived but turbulent exploitation of uranium ores. The Sudetic part is complemented by a visit to The Old Mine Science and Art Centre in Wałbrzych, which is located in a recently closed coal mine. An extremely interesting site scheduled for touring is the Neolithic striped flint mine in Krzemionki Opatowskie in the Holy Cross Mountains. On the final day of the pre-conference tour, its participants will follow the tracks of Jurassic dinosaurs in Bałtów.
But conference participants will meet real geology not only during the pre-conference excursion, but also during the conference itself. A one-day mid-conference excursion will take us to Bóbrka - the world's cradle of the oil industry, where oil production facilities have been in operation continuously since the mid-19th century. One day of the conference will take place in the underground salt mine in Wieliczka. It is a world-famous UNESCO World Heritage Site, visited by some 1.7 million tourists a year in the pre-pandemic period.
The link between geology and mining is obvious. It is now impossible to find and exploit mineral deposits without a good knowledge of geology. In the past, miners were largely guided by intuition supported by good observation of the terrain. They were a valued and well-paid social and professional group, enjoying privileges not available to other professions. Their work was extremely dangerous. There is a saying in Polish: a miner lives well, but for a short time. The artefacts that conference participants will see clearly show that there is no development of civilisation without the use of natural resources. This was the case in the Neolithic and medieval periods, and it is still the case today. But the current development of post-mining areas shows that the exploitation of mineral resources does not only mean environmental degradation. Former mines can be excellent tourist sites supporting local economic development, they can be centres of geological education and even important art objects, as the Salt Mine Museum in Wieliczka is the best proof.



Location of geological sites to be visited during the 48th Symposium in Cracow (Poland) and pre-conference excursion on the background of the geological map of Poland.

IVAN OLEKSYSHYN – AMERICAN PROFESSOR OF GEOLOGY

Ihor BUBNIAK[1, 2] and Andrij BUBNIAK[1, 2]

We present the life and scientific career of Professor Ivan Oleksyshyn, a distinguished member of the Shevchenko Scientific Society and several American scientific societies. Ivan Oleksyshyn is a person who, through his life and dedication to science, has earned the right to have his name alongside renowned Ukrainian naturalists such as Ivan Puluj, Ivan Horbachevsky, Stepan Rudnytsky, Yuriy Poliansky, and Severyn Pasternak. His scientific activity can be characterized by two significant periods: one in Ukraine and the other in the United States. Ivan Oleksyshyn was born on September 1, 1901, in the village of Khreniv, Kamianka-Strumylovskyi district (now Kamianka-Buzka district), in a peasant family. He received his primary education in his native village and the neighbouring village of Didyliv, and his secondary education at the Ternopil Ukrainian State Gymnasium in 1924, upon returning from the internment camp as a sub-lieutenant of the Ukrainian Galician Army. He obtained higher education in the field of geography, geology, and natural sciences at Lviv University in 1929. Ivan Oleksyshyn began his scientific career as a student at the University and later continued as an assistant to Professor Wojciech Rogala, who headed the Geological Institute of Lviv University. His first scientific works were the results of independent research conducted in the Podillya region. One of them is titled "Report on a Geological Excursion during the summer break of 1927, north of Terebovlia along the Seret River to Ternopil, and north of Terebovlia along the Hnizna River to Stupky near Velyki Borky". In 1947, he defended his dissertation at Leopold-Franzens University in Innsbruck (Austria) and obtained a Ph.D. degree in Geology and Mineralogy. He settled in the state of Pennsylvania in the United States and for three years worked various physical jobs to support his family and pay for his daughters' education at the University of Pennsylvania. In 1953, he obtained a job in the Department of Bacteriology at Jefferson Medical College. And once again, just like in Ukraine, during summer vacations, he conducts palaeontological research in the states of New Jersey, Maryland, and Virginia. The results of his research were published in the Proceedings of the Pennsylvania Academy of Sciences in three articles, where among other things, he described ten new species of mollusks. These publications served as recommendations for his appointment to a position at Boston University in 1955, where he initially worked as a geology instructor (1955/1956) and later as an assistant and associate professor. In 1963, Ivan Oleksyshyn became a permanent faculty member at the University, and from March 1, 1963, he held the position of full professor of geology. While in the United States, Ivan Oleksyshyn continued to publish the results of research conducted in Ukraine. Among them, it is worth mentioning publications about the coal of the Lviv-Volyn Basin and Roztochia; about gypsum and its stratigraphic position in the Podillya, Opillia, and Roztochia regions; and general works on the geology of Ukraine. These works were written in English, allowing foreign researchers to familiarize themselves with the geology and valuable minerals of his homeland. The mentioned scientific societies, of which the professor was a member, are described. The scientist's extraordinary and highly productive public activities are characterized. Several photographs of Miocene fauna specimens from Ivan Oleksyshyn's collection, preserved in the Natural History Museum of the National Academy of Sciences of Ukraine in Lviv, are presented. Even in retirement, for one year (from July 1, 1967, to July 1, 1968), Ivan Oleksyshyn taught physical and historical geology at Camden County College in South Jersey. He passed away on December 19, 1987, at the age of 86, due to a heart ailment.

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ESTABLISHMENT AND EARLY DEVELOPMENT OF THE MISSISSIPPI GEOLOGICAL SURVEY, USA

Renee M. CLARY[1] and David T. DOCKERY, III[2]

Many American state geological surveys were established in US southern states prior to the 3 March 1879 establishment of the United States Geological Survey (USGS) by the United States Congress; Mississippi's survey preceded the federal USGS. Admitted as the 20th US state in 1817, the Mississippi Legislature authorized the Mississippi Geological Survey on 5 March 1850. John Millington (1779–1868), University of Mississippi Professor of Chemistry and Natural Philosophy, was named the first State Geologist. Because of his age and teaching duties, Millington allocated field work to his assistant, Oscar Lieber (1830–1862), and directed him to investigate northeastern and northwestern Mississippi, and down the flood plain toward Vicksburg. Lieber resigned shortly after Millington's report was published in 1852; his decision was likely influenced by Millington's mishandling of his reports. Lieber eventually published the first geological map of Mississippi outside the Survey in 1854 and became State Geologist of South Carolina. Benjamin L.C. Wailes (1797–1862) replaced Lieber, and under new State Geologist John C. Keeney, traveled over 7000 miles and collected thousands of specimens to investigate geology's influences on the state's agriculture. This resulted in Wailes' 1854 "Report on the Agriculture and Geology of Mississippi", with no map and less than 25% of the volume (89 pages) devoted to geology. However, Wailes left the survey when he was passed over for promotion and Lewis Harper was named Keeney's replacement. Harper struggled with university administration and under his tenure the Survey suffered the indignation of being moved to the penitentiary in Jackson, MS. Fortunately, Eugene Hilgard (1833–1916) became the next Assistant Geologist and toured the state with Harper. Hilgard focused on agriculture, and like Lieber, was dissatisfied when the State Geologist inaccurately referenced his notes. Harper's 1857 report on Mississippi's geology and agriculture was filled with errors. The legislature proposed to abolish the survey, and with Harper's resignation, the survey was suspended briefly. Hilgard returned in early 1858 to become Mississippi's first effective State Geologist. In 1860, the legislature reestablished the survey, allowed it to return to the university, and even appropriated monies for Hilgard's 1860 two-part "Report on the Geology and Agriculture of the State of Mississippi". The report languished in a warehouse throughout the American Civil War (1861–1865) before becoming the definitive source of Mississippi geology for the next half century. Even though Hilgard resigned as State Geologist in 1866, he returned in 1870 when his successor left the position. He would be Mississippi's last State Geologist in the 1800s. The 1872 withholding of Survey appropriations hobbled the survey for the remainder of the century and a new State Geologist would not succeed Hilgard until 1903.

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A PHILOSOPHER IN THE MINES. LEIBNIZ IN THE HARZ, MINING AND EVIDENCE FOR THE HISTORY OF THE EARTH

Claudine COHEN

"We occupy the highest region of lower Germany, one that is especially rich in metals".

These words, from the first section of *Protogaea*, suggest the ambition that first drew Leibniz to the Harz silver mines as, in 1679, he was called by Duke Ernst August of Hannover to produce a new windmill technology that would supplement waterpower in the mines. For some six years, between 1680 and 1686, he worked tirelessly to install his inventions there, but his efforts ultimately failed. Though Leibniz invested countless hours in these projects, the Duke finally called the whole thing off in 1686.

The frequent references to mines and miners in *Protogaea* make it clear that Leibniz's failed project in the Harz had a lasting significance for his "natura geography".

In this paper, I will argue that *Protogaea* not only reflects Leibniz's detailed knowledge of the region and its mines. The knowledge about mining he had accumulated during his stay in the Harz is also a basis for the system of evidence at work in Leibniz's demonstration of the history of the earth. Leibniz described the formation of the globe in terms of mining and smelting operations, and he drew on detailed local knowledge of the Hartz to identify fossil objects found under the ground as remains of formely living beings and their position in successive layers to fashion a plausible history of the Earth.

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DESCRIPTION OF THE HISTORY OF GEOLOGICAL RESEARCH OF COMOROS

Mohamed Maanloumi DAROUECHI

The Comoros are located in the Indian Ocean halfway between the African plate and the Madagascar plate. They mainly include 4 islands aligned in the NW-SE direction: Grande Comore (Ngazidja), Moheli (Mwali), Anjouan (Ndzuani) and Mayotte (Maore). These four volcanic islands, which cover an area of 2,236 km². Its average population is estimated at 800,000.
The Comores Archipelago lying in a WNW–ESE line at the northern end of the Mozambique Channel. The Islands are almost entirely volcanic and show a simple age progression from Grande Comore, with its active shield volcano Kharthala (2650 m), east-south-eastwards through Moheli and Anjouan, which are quite deeply dissected, to Mayotte, which is in an advanced stage of erosion and subsidence, and is encircled by a barrier reef. There is also evidence of mino volcanic rejuvenation in relatively recent times in Mayotte, and perhaps Anjouan and Moheli. The lavas of Kharthala and the neighbouring extinct shield volcano (Grid Massif) on Grande Comore are all basaltic, ranging from oceanitic and ankaramitic to aphyric types. Numerous tuff cones occur, especially on the flanks of Massif de la Grille. Basaltic lavas, similar to those of Grande Comore, form the bulk of the dissected volcanic shields of Moheli and Anjouan, but there is also evidence of differentiation towards alkali under-saturated end products, both as lavas and as intrusive bodies. Lherzolitic and gabbroic nodules are locally abundant on each of the islands, while xenoliths of sandstone and quartzite have been found on the three westernmost islands. Petrochemical data are presented for a considerable variety of Comores rocks, and the volcanic activity is discussed in terms of the major structural features of the Madagascar-Mozambique region.
It is above all Grande Comore and in particular its active volcano of Karthala that have been the subject of the studies conducted by Esson and Flower (1970); Strong and Jacquot (1971).
The Comores Archipelago and the banks of the northeastern Mozambique Channel mark the boundary between the Mesozoic oceanic Somali Basin and the continental substratum of the Comores Basin. The basaltic magma appears to have been intruded along the north-west trending fracture zones related with southward movement of Madagascar relative to the African mainland (Segoufin, 1982), the age of Comorian volcanism and its relationship to plate tectonics (Hajash and Armstrong, 1986).
More recently, Bachèlery and Coudray (1986) undertook the systematic geological study of Grande Comore (cartography, petrography, geochemistry, dating) and, in collaboration with the Institute de physique de Globe de Paris, the monitoring of seismic activity and its deformations of the Karthala volcano.
The volcanic archipelago of the Comoros is in many ways a center of scientific interest of the first order. The establishment of a permanent volcanic observatory on Karthala and the first exhaustive studies of the volcanoes of Grande Comore will probably contribute to strengthening and attracting Comorian volcanism.
Thanks to the efforts of the French mission for cooperation and cultural action in the Comoros, important long-term programs have been carried out, involving, in collaboration with the National Center for Documentation and Scientific Research (C.N.D.R.S), researchers from various French research organizations (University of Reunion, Institute Paris Globe Physics Center and Clermont-Ferrand Volcanology Research Center).
Research carried out since 1985 has led to a better definition of the volcanic risk in Grande Comore, and to the production of this volcano-tectonic map (Bachèlery and Coudray, 1993). Simplified geological map from Grande Comore and showing ages of historic lava flows and our sampling locations. Inset shows location of the archipelago.
Between 2014 and 2017, in-depth studies in geology, geochemistry and geophysics, carried out on Karthala by the Geological Office of the Comoros (BGC) and the New Zealand Company Jacobs, GNS Science and the General Company of Geophysics-Veritas (CGG) estimated a geothermal potential of 45MW in the Karthala area.
Geoscientific studies were carried out in 2008 in northern Karthala and on the grid massif (Grande Comore) by

the Kenyan Electricity Company (KenGen) to confirm the existence of geothermal potential.
The results of these studies gave the model of the subsoil structure with a diagram of the spatial extent of the reservoir, its depth and associated structures.
In addition to geological, geochemical and geophysical studies, others have been carried out:

- Volcanic risk studies for installations (boreholes and power stations).
- Environmental and Social Impact Assessment (ESIA) for the construction of the access road to the drilling site (Bahani – Soufriere).

However, the summary geological studies carried out by (Marzban 2009) showed mining potential throughout the national territory.
This potential has been highlighted following the identification and characterization of certain useful mineral substances such as:

- Heavy minerals;
- Pidjani sand olives;
- Pozzolan deposits identified throughout the national territory and more particularly in Ngazidja;
- Lateritic bauxite deposit east of the village of Ongoni in Anjouan;
- Clay deposits.

The mining sector is at an embryonic stage. Its development could make it one of the growth driving sectors. This is why the BGC is considering in the near future the development of a mining code and priority application texts, as well as geological ma,pping to locate these mineral resources and possibly others.
Geophysical and geological data from the North Mozambique Channel acquired during the (2020–2021), oceanographic cruise reveal a corridor of recent volcanic and tectonic features 200 km wide and 600 km long within and north of Comoros Archipelago. Here we identify and describe two major submarine tectono-volcanic fields: the N'Droundé province oriented N160°E north of Grande-Comore Island, and the Mwezi province oriented N130°E north of Anjouan and Mayotte Islands.

REFERENCE

Bachèlery, P., Coudray, J., 1986. The Comores archipelago in the western Indian Ocean: volcanology, geochronology and geodynamic setting. Journal of African Earth Sciences, Tome 5, Numéro 2: 135–145.
Bachèlery, P.; Coudray, J., 1993. Volcano-tectonic map of Grande Comore (Ngazidja) at 1:50,000 with explanatory note. Ed. French Ministry of Cooperation.
Esson, J., Flower, M., 1970. Geology of the Comores Archipelago, Western Indian Ocean. Geological Magazine, Volume 107, Issue 6: 549–557.
Hajash, A., Armstrong, R.L., 1986. The Comores archipelago in the western Indian Ocean: volcanology, geochronology and geodynamic setting. Journal of African Earth Sciences, Numéro 2: 135–145.
Marzban, M., 2009. Economic Geology of Comoros. Reports Scientist. Volume 2: 128.
Segoufin, J., 1982. Geomorphology and origin of the reef-banks of the north-eastern Mozambique Channel-Western Indian Ocean. Marine Geology, Volume 47, Issue 1–2: 37–55.
Strong, D.F., Jacquot, C., 1971. Tectonic and structural evolution of Gough volcano: A volcanological model. Journal of Volcanology and Geothermal Research, Volume 33, Issue 4: 325–336.
Thinon, I. et al., 2022. Volcanism and tectonics unveiled in the Comoros Archipelago between Africa and Madagascar. Reports Geoscience: 7–34.

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"GEOGNOSTISK KORT OVER DANMARK OG DE NÆRMESTE NABOLAND" 1835
The first geognostik map of Denmark

Françoise DREYER

In 1818, the Kingdom of Denmark, though it definitively had acquired Schleswig-Holstein in 1806, has lost Norway in 1814 and consequently, its mineral resources. The need to find on Danish territory the natural resources necessary for the economic development of a country in full recession, led King Frederick VI to the appointment of a commission to search for raw materials, coal in particular, on the island of Bornholm where traces of charcoal have been described. Two successive missions (1818 and 1819) were entrusted to the physicist Hans Christian Ørsted who enlisted the assistance of his young assistant and secretary, Johann Georg Forchhammer (1794–1865), a Danish chemist and mineralogist native from Schleswig-Holstein. The opportunity was given to Forchhammer to meet Swedish geologists and to get a solid knowledge of geology. Forchhammer, after defending a doctoral thesis in chemistry on manganese ("de Mangano") in 1820, spend a year in England and Scotland, during which he met English scientists and studied geology and its practical applications. During this study-trip, his global theory of the geognostic relations in northern Europe took shape. This theory will underlie all of his later geological work, until the development of the first geognostic map of Denmark published in his book (entitled "Danmarks geognostiske Forhold"), of 1835. The theory of Forchhammer is based on the work of Werner, on his own observations made in Europe (France, England, Germany) and probably on geognostic maps of London and Paris basins, that he extended to all of northern Europe. It can be summarized as follows: all of northern Europe, from the Faroe Islands to England, northern France and Germany, would constitute a large basin filled with a distinctive and unique series of formations, presently submerged by the North Sea. However, after visiting the Faroe Islands in 1821, in the hope of finding coal and mining resources there, but instead having found almost only volcanic formations, he had to restrict his large geological basin to a strip of land extending from England to Germany through Denmark, where he searched for outcrops (often masked by Diluvium) corroborating (or not) his theory and thereby the continuity between Scania and Denmark. The search for the limits between the different formations led him to describe at Stevns Klint, the Cretaceous-Tertiary limit, a genuine discovery though contradicted by Lyell and later introducing to the Danian stage. All the data collected allows him to draw the first geological map of Denmark in 1835.

The present paper is an attempt to present the intellectual evolution of Forchhammer, which resulted in this map, and discuss the difficulties he encountered before imposing himself on the scientific scene.

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THE NATURALIST, THE SAINT, AND THE MINERAL WATERS: THE "CHÂLETS OF SAINT NÉRÉE", FROM HYDROTHERAPY TO SUMMER CAMP

Silvia F. de M. FIGUEIRÔA

The village of Bagnères-de-Luchon and its surroundings have been known for centuries for their sources of health-giving mineral waters. Located in the Pyrenees region (southern France), since Roman times, its springs and baths have been frequented by a varied population, from the nobility to the common people. In the mid-19th century, around 1840, the naturalist Simon-Suzanne Nérée Boubée (1806–1862) acquired a relatively large property containing two thermal mineral springs. In his words (translated by me), "two mineral springs, very anciently known in the commune of Ferrère, canton of Mauléon in Barousse (Hautes-Pyr.[énées]), venerated in the whole valley for the numerous cures they had produced, were however possessed until now only by good mountaineers incapable of exploiting them and making them known far and wide" (Boubée, 1843: p. 3). Boubée, born in Toulouse, not far from Luchon, was a self-taught naturalist, one of the founders of the Société Géologique de France, and a regular, active presence in the sessions, besides belonging to several scientific associations. After the acquisition, the place was reformed to receive a greater number of patients. Boubée wanted, first, to evaluate the therapeutic value of these waters, to recognize their special virtues and their type of action. For this purpose, he devoted the seasons of 1841 and 1842 to experimenting with these waters on nearly two hundred patients from the surrounding area who came to take the baths. In parallel to his investigative and scientific side, Boubée put into practice his entrepreneurial quality, which had already manifested itself in the creation of the weekly journal "L'Écho du Monde Savant" in 1834 and also present in the business Éloffe & Cie., a mix of a publishing house and shop of Natural History objects he would maintain in Paris. Boubée baptized the balneological establishment with the name of "Châlets Saint-Nérée", referring to the holy Roman martyr St. Nérée and a pun on his first name. Chemical analyses of the two sources indicated that the waters of the Châlets seem to have no analogs either in the Pyrenees or in the rest of France, but they were indeed quite similar to the famous waters of Wildbad, in Wurtemberg: "We will be struck to find at the Châlets Saint-Nérée, the same physical and geological conditions. (...) our baths can lend themselves to the same applications as those of Wildbad, give rise to the same observations, thus producing the same results" (Boubée, 1843: p. 15). With this outcome in hand, plus the experiences mentioned above with patients, Boubée proposed to some physicians and "influential capitalists" to join the enterprise, formally entitled Société Thermale des Châlets Saint-Nérée, with headquarters in Toulouse, envisaged to last for forty years. Sadly, Boubée died two decades later, precisely in Luchon, but the business remained. We have not yet found precise data on the further development of this project. However, it is certain that, over this century-old journey, the Châlets became a holiday camp, still in operation under the same name (https://www.sejourpyreneesbarousse.fr/). This paper, therefore, aims to analyse and contextualise the ancient exploitation of a mineral resource by a company that connected geology and medicine – i.e., a balneological object – later transformed into a source of leisure and tourism.

REFERENCES

Boubée, N., 1843. Notice sur les eaux minérales des Châlets Saint-Nérée, dans la vallée de Barousse, entre Saint-Bertrand de Comminges et Bagnères-de-Luchon. Toulouse, Impr. de J.-B. Paya.

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DISCOVERY OF NEOLITHIC STRIPED FLINT MINES AT KRZEMIONKI OPATOWSKIE

Anna FIJAŁKOWSKA-MADER[1] and Sylwester SALWA[1]

The discovery of Neolithic striped flint mines in the area of Magonie and Krzemionki situated north of Ostrowiec Świętokrzyski was made by geologist Jan Samsonowicz, an employee of the Polish Geological Institute in the years 1919–1935. The discovery was made on 19 July 1922 during fieldwork for the Opatów sheet of the Geological Map of Poland in the scale 1:100 000. J. Samsonowicz's attention was drawn to the numerous hollows in this area which had a characteristic funnel shape. On the other hand, local people, who were involved in the extraction of limestone rock, indicated underground tunnels in which they found horn and stone tools. J. Samsonowicz investigated several of these by measuring shafts and mining galleries and collected artefacts in the form of horn tools and flint crumbs. He had no doubt that he had discovered Stone Age striped flint mines (Brociek, 2008; Ryszewska, 2020). He informed archaeologist Stefan W. Krukowski – conservator of the State Conservator of Prehistoric Monuments and curator of the State Museum of Archaeology (SMA) in Warsaw - about the sensational discovery. He published the results of his observations in 1923 (Samsonowicz, 1923). In the same year, S. W. Krukowski together with the archaeologist Zygmunt Szmit began comprehensive archaeological research, which, with interruptions, lasted for several decades and was continued by subsequent generations of archaeologists.

They resulted in the delineation of a mining field with an area of 78 ha, within which over 4,000 mines of various types (cavity, niche, pavement, pillar and chamber) were found. On its part in 1926 the archaeological reserve Krzemionki Opatowskie was established, which until 1978 was taken care of by the SMA and later by the Regional Museum in Ostrowiec Świętokrzyski (since 1986 by the Historical and Archaeological Museum). In 1995 the Krzemionki Opatowskie nature reserve was established with an area of 378 ha (Bąbel, 2015).

The culmination of the archaeological research was the creation of the Krzemionki Region of Prehistoric Striped Flint Mining, which, apart from the Krzemionki archaeological and natural reserve, included the Borownia and Korycizna mining fields and a prehistoric mining settlement on Gawroniec Hill in Ćmielów. The region was inscribed on the UNESCO World Heritage List in 2019.

REFERENCES:

Bąbel, J.T., 2015. „Krzemionki Opatowskie" monument prahistorii Europy. Muzeum Historyczno-Archeologiczne w Ostrowcu Świętokrzyskim, Ostrowiec Świętokrzyski.

Brociek, W.R., 2008. Prof. Jan Samsonowicz, życie i działalność, 1888–1959. Muzeum Historyczno-Archeologiczne w Ostrowcu Świętokrzyskim, Ostrowiec Świętokrzyski.

Ryszewska, K., 2020. Osiągnięcia Jana Samsonowicza (1888–1959) w badaniach pradziejów regionu świętokrzyskiego. Almanach Historyczny, 22: 213–235, DOI 10.25951/4233

Samsonowicz, J., 1923. O złożach krzemieni w utworach jurajskich północno-wschodniego zbocza Gór Świętokrzyskich. Wiadomości Archeologiczne, 8: 22.

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THE ANCIENT MANGANESE MINE OF PRABORNA (AOSTA VALLEY, ITALY): TRACE OF THE MULTI-CENTENARIAN EVOLUTION OF MINERALOGY AND GLASSMAKING

Gaston GODARD[1], Silvana MARTIN[2] and Simone TUMIATI[3]

The history of the ancient manganese mine of Praborna (Aosta Valley, Italian Alps), known since 1415, is linked to the invention in Venice of the glass known as "cristallo veneziano", which used manganese oxide as bleaching agent. The technique, probably due to Angelo Barovier (1405–1460), allowed to obtain for the first time a totally transparent and colourless glass. Its manufacturing secret consisted in a very simple chemical reaction:

Fe^{2+} (coloured, in glass) + Mn^{3+} (added) → Fe^{3+} (colourless) + Mn^{2+} (almost colourless).

While glass is naturally coloured by ferrous iron, the addition of braunite powder ($Mn_7Si_1O_{12}$) caused its discoloration. Moreover, if Mn^{3+} become in excess relative to Fe^{2+}, it can in turn tint the glass, so that it was deliberately used to obtain colours ranging from purple to brown, depending on the degree of oxidation.

The archives of the Challant family (Aosta, Italy) contain numerous documents on this mine, dating from 1612 to 1780. For example, in 1707, 5 miners worked from May to October at the mine, from which they extracted about 10,000 "rubs" (80 m^3?) of *manganés*. Several contracts with the glassmakers of Murano, dating back to 1460, and with French merchants from 1714, indicate that the ore was used in Venice and France, which is explicitly stated by Antonio Neri in his "L'Arte Vetraria" (1612).

The "cristallo veneziano" was widely produced in Murano for the processing of luxury artifacts and mirrors, until the invention of the lead crystal at the end of the 17th century. In 1665, Jean-Baptiste Colbert, minister of Louis XIV, founded the Fabrique royale des Glaces, now the Saint-Gobain Company, which managed, through espionage, to reproduce the Venetian technique, allowing to produce in particular the glass of the Hall of Mirrors of the Palace of Versailles. Even today, manganese is used by the company Barovier & Toso, in the form of about 375 ppm of $Mn^{4+}O_2$, in the composition of the glass known as "Cristallo di Murano".

The mine of Praborna also took a remarkable place in the history of mineralogy. Horace-Benedict de Saussure went to Praborna in August 1792, identifying manganèse noir and manganèse rouge. Cordier (1803) recognized in the latter an épidote manganésifère, to which Kenngott (1853) gave the name piedmontite. Beudant (1832) gave the name marcelline to *manganèse noir*, later identified with Haidinger's braunite (1831). Bertrand de Lom (1840) also discovered a new mineral species, romeite, and a variety of titanite, which he called greenovite. Praborna became the type locality of several rare minerals: piemontite (Mn epidote); romeite (Ca antimoniate); violan (blue-violet Mn-rich omphacite); alurgite (Mn-rich phengite). These minerals are associated with braunite, Mn-rich garnets (spessartine, calderite), pyroxmangite, hausmannite, tephroite, rhodochrosite, etc., and rare earth minerals such as manganiandrosite and wakefieldite. Due to the strongly oxidizing conditions related to Mn^{3+}, sulphides are not stable in such Mn-rich rocks; therefore, chalcophile elements enter the structures of certain silicates and oxides, giving very particular compositions, like ardennite-(As), hydroxycalciromeite, Sb-rich pyrophanite, As-rich rutile and apatite. Over the last 4 decades, many petrologists interpreted Praborna as a hydrothermal oceanic Mn-rich deposit, metamorphosed at high pressure during the subduction of the Piedmont ocean that preceded the Alpine orogenesis. It is still today a precious mineralogical and industrial heritage.

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"NOTHING IS MORE IMPORTANT THAN HEALTH" Eduard SUESS (1831–1914)

Eduard Suess was a leading contributor to the City of Vienna's projects of the century: the 1st Viennese spring water pipeline and the regulation of the Danube

Margret HAMILTON

Eduard Suess not only played an important role as a professor of paleontology and geology at the University of Vienna, but as a member of the Vienna City Council he also submitted his expertise on the two century projects of the city of Vienna.
In the Archive of the Geological Institute at the University of Vienna exist handwritten notes by E. Suess between 1861 and 1869 dealing with the meetings of the Vienna City Council with regard to the quality of the water for the city and, as a result, the health of the population.
In his memoirs, which were published posthumously in 1916, Suess points out in an essential conversation with the then major Andreas Zelinka (1802–1868) and the Viz major Cajetan Felder (1814–1894) that "nothing is more important than the health" of the population of Vienna.
The rapid population increase, the infections with dysentery, typhus and cholera in 1855 were a significant problem, also poor water quality and a lack of sewerage.
Between 1869 and 1873 a 90 km long canal was built from the springs in the foothills of the Eastern Alps via tunnels and aqueducts to the water towers of the city of Vienna.
This first Vienna high spring water main was officially opened on October 24, 1873 with the commissioning of the high jet fountain on Schwarzenbergplatz in the presence of Emperor Franz Josef I.
There also exist a copy of the piano piece "Die Hochquelle" ["the highspring"] composed by Eduard Strauss (1835-1916) in 1911. The piece is dedicated to the initiator of the first Vienna spring water main Eduard Suess.
The second major project to improve water quality and thus improve the health of Vienna's population was the regulation of the Danube bed.
With the Danube Regulation Commission established in 1868, not only should the devastating floods of the Danube river be prevented, but also new facilities for the creation of shipping and trade should be made possible.
Work began on May 14, 1870 in the presence of Emperor Franz Josef I, and just 5 years later, on April 15 and 16, 1875, the two breakthroughs were made on the north and east of the Danube.
In the geological archive exist three soil maps of Vienna from the years 1873–1875 showing the course of the Danube in the old and new beds.
A copy of a letter from the Emperor to E. Suess from 1911 has also survived, in which the Emperor praised E. Suess for his achievements for the benefit of the people of Vienna.

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MINING AND ITS MORAL PURPOSES

Ernst HAMM

Histories of mining and the geosciences have given much attention to the explanatory and instrumental aspects of those activities, and with good reason. The earth and life sciences over the past two centuries would be unthinkable without the historical understanding of nature that was first achieved by the geosciences. Likewise the technologies that shape the world and have done so for centuries are unthinkable without mining. Thinking about science in terms of explanations and applications of knowledge, of the interactions between understanding the world and manipulating it, can offer powerful insights, as has been shown by Ian Hacking in "Representing and Intervening" (Cambridge 1982) and Peter Dear in "The Intelligibility of Nature" (Chicago 2006). This paper will consider something related, but different: the moral aims or puposes of the geosciences, particularly with respect to mining. Despite mining's connections with environmental destruction, it also has a long history of being imbued with moral purposes. This was already evident in Agricola's "De re metallica" (1556), where the moral character of the miner is an important consideration. Natural theology played an important role in seventeenth and eighteenth century Europe, and reading the "book of nature" had a deep, reverential sense for countless natural philosophers and naturalists. However, as this paper will show, even as natural theological approaches began to wane, the geosciences retained moral aims, including by some who explicitly disavowed any traditional religion (Goethe), or atheists (Georg Christoph Lichtenberg). Friedrich von Hardenberg (Novalis), the young Romantic who studied at the Freiberg Mining Academy and worked as a mining assessor in the salt mines of Weissenfels, offered a deeply moral view of mining and the study of the earth that melded traditional theism with mythological elements. Romanticism also offered a sense of the sublime that could be sustained even in a secular framework. The aims of this paper are in the first instance to show how and why the moral purposes of mining have changed; I also want to make the case for the ongoing relevance of such purposes, especially in an age such as ours which has come to see mining in wholly instrumental terms.

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GEOLOGICAL MAPPING OF COUNTY DONEGAL (IRELAND): INNOVATIONS AND CONTROVERSIES IN THE 19TH AND 20TH CENTURIES

Kathleen HISTON

Topographical mapping of Ireland commissioned in 1824 at a scale of 6 inches to one mile, directed by Colonel Thomas Colby (1784–1852) under the British Army Ministry of Defence, was historically important as the world's first large scale survey of a country. The campaign carried out by officers of the Royal Engineers, miners and civil assistants began in 1825 in the county of Donegal located in the north-west of Ireland and memoirs and maps were published from 1836 onwards. These maps were used in 1846 by the Irish geologist and mining engineer Richard Griffith (1784–1878) for later editions of his geological map of Ireland first issued in 1815 that were published in 1835, 1839, 1853 and 1855 respectively (Herries Davies, 1983).

The Geological Survey of Ireland was established in 1845 and Henry James was appointed as the first local director. Geological field mapping of County Donegal began in the 1850's and the geological maps and memoirs were published under the authorship of then director Edward Hull (1829–1917), and survey geologists James Robinson Kilroe (1848–1927) and George Henry Kinahan (1829–1908) for east and south Donegal (Hull et al., 1890) and northwest and central Donegal (Hull et al., 1891). Rock exposure in Donegal was excellent so the maps and descriptions were detailed and accurate; however, interpretation of the Donegal granites caused much heated debate among the geologists at the end of the 19th century both among the geological Survey of Ireland staff and scientists abroad. Comparisons with rocks in Scotland and in Canada gave rise to debates about the evidence in Donegal for the age of the rocks and many studies were done regarding the origin of these granites, however, none resolved the enigma (Herries Davies, 1995).

After WWII at the 18th International Geological Congress held in London in 1948 Herbert H. Read (1889–1970), Professor of Geology at Imperial College London, took on the task of a detailed study of the Donegal granites to resolve the problem of the origin of granites. In the 1950's he sent students to do detailed field studies there – one was Wallace S. Pitcher (1919–2004) who later published "The Geology of Donegal" with fellow student Antony R. Berger in 1972. This remains a reference publication for granite studies worldwide (Pitcher and Berger, 1972). The aim of this presentation is to highlight the role of key figures, innovative surveying methods and controversies related to interpretation of field data in support of contemporary theories that emerged from the mapping of County Donegal in the 19th and 20th centuries.

REFERENCES

Herries Davies, G.L., 1983. Sheets of many colours: the mapping of Ireland's rocks, 1750–1890. Royal Dublin Society, Dublin.

Herries Davies, G.L., 1995. North from the Hook: 150 years of the Geological Survey of Ireland. Geological Survey of Ireland Publication, Dublin.

Hull, E., Nolan, J., Cruise, R.J., McHenry A., 1890. Explanatory memoir of Inishowen, County Donegal, to accompany sheets 1, 2, 5, 6 and 11 (in part) of the maps of the Geological Survey of Ireland (with petrographical notes by J.S. Hyland).

Hull, E., Kinahan, G.H., Nolan, J., Cruise, R.J., Egan, F.W., Kilroe, J.R., Mitchell W.F., McHenry, A., 1891. Explanatory memoir to accompany sheets 3, 4, 5 (in part), 9, 10, 11 (in part), 15 and 16 of the maps of the Geological Survey of Ireland, comprising north-west and central Donegal (with petrographical notes by J.S. Hyland).

Pitcher, W.S., Berger, A.R., 1979. Geology of Donegal: A Study of Granite Emplacement and Unroofing (Regional Geology Series). John Wiley & Sons, New York and London.

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INTERACTION BETWEEN MODERN PHYSICS AND MATERIALIST PHILOSOPHY

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There is a close interaction between modern physics and materialist philosophy.
In the 19th century, the famous atomic theory was proposed by Dalton. Dalton's atomic theory believed that the smallest unit of the material world is an atom, which is singular, independent, indivisible and maintains a stable state during chemical changes. The properties of similar atoms are also consistent. Atomic theory influenced the development of materialist philosophy, especially Marxist theorists such as Engels and Lenin, who strongly supported atomic theory. Because atomic theory points out the smallest entity of matter, it provides crucial scientific support for materialism, and the world has a minimum material starting point, and everything is a product of its arrangement and combination. As a result, the ontological point of view that "the world is material" has sufficient scientific support. This is also an important reason why Marxist materialism was able to develop in the 19th century.
However, the development of physics began to challenge materialism. In 1897, Thomson discovered electrons. Previously, people believed in materialism largely based on the determinism of "atoms". However, the discovery of electrons overturned the "atomic theory" and led many philosophers to doubt whether "matter" is a definite thing. This leads to a question: Does the world have a definite, primitive, and stable entity as the starting point for materialism to explain the world? Lenin of Russia attempted to answer this question. He wrote many books to explain that although atomic theory has been overturned, there will still be smaller material entities than electrons, so the world is still material.
From the 1920s, modern quantum mechanics began to take shape. In 1927, Heisenberg proposed the famous "uncertainty principle", and in 1935, Schrodinger proposed the famous "Schrodinger's cat" hypothetical experiment. It once again challenged the basic viewpoint of materialism: there is no objective entity in the world as the origin of "matter", and matter itself will also be influenced by the will. In order to respond to the challenge of quantum mechanics, the former Soviet Union and China have organized scientists to criticize quantum mechanics, but the results were not good because they did not follow scientific principles. Therefore, the challenge of quantum mechanics to materialism is still an unresolved issue today.
From this historical context, we can see that physics can become the basis for the development of philosophy under certain conditions, and philosophy can become a deep-seated factor in political development.

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JAPANESE GEOLOGISTS IN CHINA FROM THE LATE NINETEENTH CENTURY TO THE EARLY TWENTIETH CENTURY: GEOLOGICAL EXPLORATIONS IN THE CONTEXT OF JAPAN'S IMPERIALISM

Shigeo KATO

The first Sino-Japanese war broke out in July 1894. A trading merchant Shirai Shintaro visited Kin-tshang in the Liaodong Peninsula and he prospected for gold in January 1895 during the war. After Shirai realised the possibility of the production of gold, he reported it to the Imperial General Headquarters in Japan. The Imperial General Headquarters ordered the director of the Geological Survey of Japan, Kochibe Tadatsugu and a mining engineer of the Bureau of Mines, Oki Tatsuo to make a geological and mineral survey in the Liaodong Peninsula. They made a geological expedition to the Liaodong Peninsula in China from March to April 1895. Twenty six years before Kochibe's expedition. German geographer and geologist, Ferdinand von Richthofen investigated in the Liaodong Peninsula. Kochibe discovered igneous rock, which Richthofen had not found in the same area. Kochibe conjectured that the gold veins were derived from igneous rock, especially the quartz porphyry. Moreover, Kochibe suggested that if someone wanted to find the place of production of gold in an newly occupied territory by Japan then he should look for the layer of igneous rock. However, Oki supposed that there were very few underground resources in the Liaodong Peninsula and he concluded that the mining industry could not develop in the Liaodong Peninsula. Tokyo Geographical Society also dispatched Jimbou Kotora, professor of geology at Tokyo Imperial University to Liaodong peninsula from July 6 to October 3. Jimbou reported that all mines in Liaodong peninsula were extremely poor. Jimbou's former student and a geologist at the Geological Survey of Japan, Ogawa Takuji visited China several times and explored for mineral resources from 1902 to 1903. Those explorations were planed by WADA Tsunashiro who was a mineralogist, the first director of the Geological Survey of Japan, ex-director of the Bureau of Mines, and ex-director of the Yahata Ironworks. Wada was interested in importing iron ore from China to Japan and he had strong personal connection with geologists, politicians and business leaders in Japan. The Russo-Japanese War broke out in February 1904. The Imperial General Headquarters needed coal for army as fuel in winter, so intended to use Yantai coal mine. The Imperial General Headquarters ordered Ogawa Takuji and a mining engineer of the Bureau of Mines, Hosoi Iwaya to investigate Yantai coal mine on August 30 before the end of the battle. In the same month, Kiyoura Keigo, the Minister of Agriculture and Commerce asked Terauchi Masatake, the Minister of Army to employ eight geologists for geological survey of gold ore in area under Japanese occupation in Manchuria. The Imperial General Headquarters had taken the initiative of this geological survey. Geologists were divided to four groups which explored each of four areas. They explored for gold ore from October 1904 to January 1905. But they could not discover promising gold vein. After that survey in Machunia, a part of geologists joined the geological survey in the whole Korea, which was conducted by the Ministry of Aguriculture and Commerce (December 1904 – January 1906). On the other hand, comprehensive survey of various industries was done in Manchuria immediately after the Russo-Japanese war from October to December 1905. That survey was originated by Ishizuka Eizo, the Civil Administrator of Kwantung Leased Territory. In the survey of mining industry, the whole area was divided to five areas. Each area was examined by geologists and mining engineers. They explored mines of gold, silver, copper, iron, lead and coal. The area 2 was investigated by Ogawa Takuji and Ohashi Takichi of the Geological Survey of Japan. They explored around Houten, especially Fushun coal mine. And they found that the Fushun coal mine could product 2 million tons per year for several decades at least.

Japanese Army took initiative in some geological surveys of mineral resources in China between 1895 and 1905. A trading merchant proposed geological exploration of gold to the Imperial General Headquarters. The Imperial General Headquaters were interested in military and industrial value of mineral resources. The Imperial General Headquarters did not concern only to the battle itself but also the administration of Manchuria. Japanese geologists and mining engineers explored underground resources in China and reported that there were very few underground resources except for coal by 1905. However, the Japanese military kept their interest in underground resources in China.

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THE RETREAT OF THE PLANET'S OCEANS, FROM DANTE TO SUESS: FROM EVERYDAY OBSERVATIONS TO CONCEPTS, THE CIRCULATION OF KNOWLEDGE AND THE CREATION OF FEARS

Marianne KLEMUN

This study is based on the question of how everyday observations, embedded in concepts, have led to divergent assumptions. On different shores seafarers, travellers and diplomats observed a clear and constant retreat of the oceans, independent from tides. Over the course of the centuries, these similar observations led to wildly disparate explanations, depending on culture, historical context and theoretical background. Despite their heterogeneity, they can be subsumed either under the theory of evolution or under that of gravity. While the Italian poet and scholar Dante in his speech "De Aqua et Terra" stated that the earth alone could not create an elevation and that the stars are responsible for the retreat of the oceans, Northern European scholars such as Celsius and Linné believed the reason for the constant decrease of the sea volume was either down to the humidification of sea water into space, or the process of solidification of the earth. Many scholars were fascinated by this phenomenon, among them Goethe and Hoff, who both disagreed with von Buch's "elevation Crater" theory. Alongside Lyell, Darwin, Dana and others it was Chambers in particular who used global data. In times of crises, these statements propelled political counter measures on the one hand and public apocalyptic fears on the other. The ones that occurred in 1817 are evidence of what Capil Raj has termed the "circulation" of knowledge with reconfigurating elements of the produced knowledge, rather than the dissemination of knowledge.

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ROLAND BRINKMANN IN POLAND – TRACES LEFT IN GERMAN ARCHIVES

Martina KÖLBL-EBERT

Roland Brinkmann (1898–1995) studied geology at the University of Freiburg i.Br., where he received his doctorate in 1921. He became an assistant to Hans Stille (1876–1966) in Göttingen, where he also qualified for professorship in 1923. In 1929, Brinkmann was named professor without chair at the same university. In 1933, he became a professor of geology and palaeontology in Hamburg and openly endorsed the new national-socialist rule. Over time, however, his political attitude grew more critical, and in 1935, he was expelled from membership in the Nazi party (NSDAP), and later on also lost his professorship. He then worked as an ore geologist for a German company in Spain and Portugal, but also wrote a geological textbook (published in 1940), which would make his name well-known to generations of German geology students right into the 1980s. In 1940, his company was merged with the "Reichsamt für Bodenforschung", which was the nationwide geological survey of Germany, and the staff recalled. Apparently, Brinkmann then unsuccessfully tried to emigrate to the USA, but the *Reichsamt's* President Wilhelm Keppler (1882–1960) prevented him from doing so. Thus, Brinkmann worked for the *Reichsamt für Bodenforschung*. In 1939, he was politically rehabilitated, and in 1940, he was ordered to Kraków in Poland. In Kraków but also in Warszawa, he headed the local geological survey as representative of the German occupation force. He returned to Germany in 1944, and was appointed professor of geology and palaeontology in Rostock (East-Germany) in 1946. In 1949, he was arrested and extradited to Poland, together with other people who had held high offices during the German occupation of Poland. Until 1951 Brinkmann was in detention pending trial, but in the following court-martial he was cleared of all charges and rehabilitated. In 1952, Brinkmann became successor to Hans Cloos in Bonn (west Germany). After his retirement in 1963, Brinkmann was given the task of establishing a new geological institute at the university in Izmir (Turkey). In 1973, he returned to Germany. The talk will present the traces, Brinkmann's time in Poland – both as a powerful survey director representing the Nazi regime and as a prisoner and defendant – has left in German archive material.

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BEGINNINGS OF SEISMIC STUDIES IN THE N CARPATHIANS AND THE CARPATHIAN FORELAND BASIN

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First seismic profile was acquired in 1921 by John Clarence Karcher and a team of faculty members from the University of Oklahoma in Belle Isle and Vines Brach, Oklahoma, USA. Only two years later, in 1923, first seismic refraction survey was completed in Poland in vicinity of Kraków in S Poland. Its goal, fully achieved, was to map Miocen salt deposits of the Carpathian foredeep, very well-known from the nearby located famous Wieliczka and Bochnia salt mines, active since the 13th century. After this successful first seismic study application of seismic surveying rapidly increased, mostly due to intense exploration for oil and gas in the N Carpathians and the Carpathian foreland basin – i.e. the area, presently located in SE Poland and W Ukraine, that in the late 19th and in early 20th centuries belonged to the most prolific hydrocarbon provinces in the world. Surface hydrocarbon occurrences (oil seeps and gas exhalations) have been known in the Outer Carpathians for centuries. In mid-19th full-scale commercial mining operations began, first focused on natural oil, and then on ozokerite and eventually on natural gas. In 1928 Polish government established state-controlled "Pionier" company with the main goal of exploration for hydrocarbons in new areas and development of new, promising exploration techniques, including geophysical surveying. Within this company Department of Geophysics was soon established and its key employees were sent to Germany, USA and France in order to obtain necessary training and first-hand experience with modern geophysical exploration techniques. Two geophysicists were instrumental for these early seismic surveys. Dr Zygmunt Mitera, who graduated from AGH University of Science & Technology in Kraków, Poland, continued his studies in exploration geophysics in Germany, Sweden and France, and, since 1931, at the Colorado School of Mines. He obtained Ph.D. degree from the CSM in 1933 under the supervision of Prof. Carl August Heiland, a pioneering geophysicist, author of a very first textbook "Geophysical Exploration" and founder and owner of Heiland Research Corporation that produced geophysical equipment and carried our geophysical surveys. Upon his return to Poland Dr Z. Mitera was appointed as a head of "Pionier" Department of Geophysics; in 1936 co-founded "Geotechnika" company. Additionally, in years 1938–1939 he worked as a lecturer at the Jan Kazimierz University in Lwów (Lviv), working towards his Habilitation degree. At the onset of WWII, in October 1939, Dr Z. Mitera was imprisoned by the Soviet Army and eventually murdered in Kharkiv, and then buried in mass grave ("Katyń Massacre"). His close colleague and partner was Dr Stanislaw Wyrobek. He graduated from AGH University of Science & Technology, Kraków, Poland and then studied the University of Strassburg in France. In 1932–1933 S. Wyrobek worked at the Polish Geological Institute as field geophysicist, and from 1934 as a head of seismic crew of "Pionier" company. In 1938, together with Dr Z. Mitera, he co-founded "Geotechnika" company. During WWII S. Wyrobek emigrated to the UK, where, in 1945, he obtained Ph.D. degree at the University of St. Andres. His doctoral dissertation was based on results of his seismic studies in Poland. Since 1945 he worked for British Petroleum as a head of their very first seismic crew. In 1950 Dr S. Wyrobek was appointed as head of seismic interpretation group in BP Research Centre. Between others, he and his team located first discovery wells in the North Sea Basin. "Pionier" company conducted its first seismic refraction survey in 1933 in vicinity of Truskawiec (now W Ukraine). First seismic reflection survey was acquired in 1934 in Nahujowice near Boryslaw; this was followed by surveys in Daszawa, Tustanowice and Stryj (now in W Ukraine). Obtained data greatly helped to understand subsurface geology of the Carpathian foreland basin, where gas deposits are hosted by flat-lying Miocene strata, and of the Carpathian fold-and-thrust belt, where traps are related to complex fault-related folds. Obtained results have been published in numerous journals including, between others, first issues of SEG "Geophysics".

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GEORG ANDREAS HELWING (1666–1748) AND HIS LITHOGRAPHIA ANGERBURGICA

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Georg Andreas Helwing (1666–1748) was born in Węgorzewo (Latin: *Angerburgum*), then in Duchy of Prussia and fief of the Crown of Poland, now in NW Poland, and spent most of his adult life there as a Lutheran pastor. He studied at several universities, and graduated in Jena in Germany. Helwing maintained close contacts with famous naturalist Johann Jakob Scheuchzer (1672–1733) from Zurich, often nicknamed "father of paleobotany". Helwing helped Scheuchzer with preparation of an index for the second edition of one of the Scheuchzer's most famous book *Herbarium Diluvianum* (1723, first ed. 1709), that included also Polish names of various palaeobotanical specimens, all provided by Helwing. The natural scientist, called "Prussian Plinius", published two books on minerals and fossils from the territory of Poland: "Lithographia Angerburgica" (1717) and "Lithographiae Angerburgicae pars II" (1720), both richly illustrated. First one contains 11 plates, the second one 6 plates, each of the plates containing several illustrations that were drawn with high attention to detail and even today could be used in order to perform palaeontological analyses. His first book is divided into 7 chapters, with the first two chapters containing general information about Węgorzewo and its surroundings, and about various types of rocks and soils (*Terrae*, "earths"); these are followed by chapters devoted to various "stones" (*Lapides*). Helwing's classification of these objects depended on their external character and visual characteristics: he distinguished "Shapeless stones" (*De lapidibus certa figura carentibus*; chapter III), "Translucent stones" (*De lapidibus Diaphanis*; chapter IV) and "Shaped stones" (*De lapidibus certa figura praedatis*; chapter V). Chapter VI is devoted to "Stones representing natural objects" (*De Lapidibus res naturales repraesentantibus*) and is further subdivided into 3 parts on the "Plant Kingdom" (*Ex Regno Vegetabili*), "Animal Kingdom" (*Ex Regno Animali*), and "Mineral Kingdom" (*Ex Regno Minerali*). Part 1 consists of 4 sections: "Petrified fruits and seeds" (*Lapideos fructus & semina exhibit*), "Plants, fungi, leaves, wood and roots" (*Plantas, Fungos, folia, ligna & radices offert*), "Carbonate incrustations" (*Osteocollae generationem examinat*) and finally "Fossil corals" (*Corallia fossilia recenset*). Descriptions of individual objects and entire rock formations (e.g., mud, sand) are usually enriched with practical details on the collection and use of these "stones". For example, medical and pictorial "earth" (*Terra medicamentosa & pictorial*), pottery sand (*arena alba & tenuis*), "riverine chert" (*silex fluviatalis*) were written as "Shapeless stones" (*De lapidibus certa figura carentibus*; chapter III). "Translucent stones" (*De lapidibus Diaphanis*; chapter IV) contains many examples of precious stones (*gemmae*) and other decorative and collectible ones. Helwing frequently refers to the literature available to him on the subject – both ancient (Pliny the Elder) and modern (Agricola, Lang, Lhuyd, Mylius, Scheuchzer, Woodward etc.). He encrusts his argument with relevant quotations from ancient poetry, and also introduces the "human factor", i.e. quoting short stories about the ways in which the inhabitants of Węgorzewo and the surrounding areas acquired and processed underground wealth. Both of these elements enliven the "technical" narrative. Similar structure was used by Helwing for the *Lithographiae Angerburgicae pars II*. Helwing collected his specimens in the Warmia – Masuria region, usually in close vicinity of Węgorzewo. This region is covered by mostly flat-lying Phanerozoic sedimentary succession. In many instances the collected fossils could have included both locally derived Cretaceous or Cenozoic fossils as well as Paleozoic fossils transported from Scandinavia by glaciers. This was not known to Helwing, but he was aware that objects he had been collecting could be classified as fossil organic remains. Detailed analysis of Helwing's books based on their new scrupulous translation to Polish revealed that he was vivid follower of the diluvial theory – not a big surprise for pastor and head of local church in Węgorzewo for many years. His opinions were to a large degree based on works of Scheuchzer and English physician and geologist John Woodward (1665–1728), "founding fathers" of the diluvial theory.

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EARLY PROTO-PALAEONTOLOGICAL DISSERTATIONS FROM ACADEMIC GYMNASIUM IN TORUŃ

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In year 1600 Caspar Schwenckfeld published his "Stirpium & Fossilium Silesiae Catalogus" with description of minerals and rocks from the Silesia region (SW Poland). It was followed by Georg Andreas Helwing's two volumes of "Lithographia Angerburgica" (1717, 1720) with geological and palaeontological description of the Mazury region (NW Poland), and by Georg Volkmann's "Silesia Subterranea" (1720) dealing with fossils, minerals and rocks of the Silesia region. These books defined beginnings of Earth sciences on the territory of Poland. However, there are two much less known booklets published in Toruń at the turn of the 17th and 18th centuries that also dealt with certain aspects of the proto-Earth sciences. These are (1) *Passio Christi, Mirandis quibusdam Figuris in Regno Mineralium repraesentata* (The passion of Christ in the most amazing forms reproduced in the kingdom of minerals, 1699, 6 pages) and (2) *Naturae pictricis Specimen Thoruniense h. e. figuratos quosdam Lapillos prope Thorunium in Vistulae praeterlabentis Littoribus collectos* (Toruń example of Nature-Painter's activity, i.e. some stones with pictures collected near Toruń on the banks of the Wisła river, 1704; 3 pages). These dissertations were prepared by students of the Academic Gymnasium in Toruń (N Poland), that was established in 1568 and for several centuries was one of the most respected institutions of higher education in the Kingdom of Poland and its dependent territories such as Royal Prussia. Both dissertations were prepared under the supervision of Georg Wende (1635, Wrocław – 1705, Toruń), educated in Frankfurt an der Oder, Leiden and Wittenberg, since 1695 professor and then rector of the Academic Gymnasium. Wende wrote poetry and occasional speeches, in addition, he was the author of many school programs. His interests also included history, numismatics, and natural sciences. Themes of both dissertations revolve around the concept of "figured stones". This concept, known since ancient times and popular in Middle Ages, was based on the idea that, because of deliberate actions of Nature or deities, rocks frequently display curious forms or markings resembling plants, animals, castles, cities etc. First dissertation was submitted by Johann Christian (Jan Krystian) Herzog from Silesia. Its main thesis is that "figured stones", described by various authors from around the world, have been created by God's action and contain pictures of the Holy Cross, of I.N.R.I. inscriptions, of the Holy Lamb, and of the crucified Jesus Christ. Main reason for creation of such "figured stones" by God was strengthening of the religious faith. Healing properties of some of such stones have been also postulated. Second dissertation was prepared by Antonius (Antoni) Giering (1685–1759), from well-known and wealthy family residing in Toruń for several centuries. Later in his life he served as member of a City Council and mayor of Toruń. His dissertation was focused specifically on "figured stones" found in vicinity of Toruń, on banks of the Wisła River. He distinguished two main classes of such stones. First one includes stones characterized by imitations of natural patterns such as Sun, stars, plants, animals etc. Second class includes stones characterized by depictions of non-natural specimens such as various geometrical patterns, although also in this class various depictions of natural specimens such as echinoderms, sea urchins, daylilies etc. are also mentioned. In his dissertation Giering, together with his supervisor, provided quite detailed description of "figured stones" they found in northen Poland. This kind of approach of curious observers to fossils, rocks and minerals eventually led to the development of geology and palaeontology as we understand them today.

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SIR RODERICK I. MURCHISON IN KRAKÓW, WIELICZKA AND THE CARPATHIANS

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A Scottish geologist, sir Roderick I. Murchison (1792–1871), was one of the most eminent scientists of the 19th century. His major scientific achievements include identifying the Silurian, Devonian (together with Adam Sedgwick) and Permian systems, compilation of geologic maps of Wales, Scotland, Russia and Europe, publication of more than 180 scientific papers and three major books. In years 1840–1841 Murchison conducted two geological expeditions in Russia that resulted in publication of a seminal book "The Geology of Russia in Europe and Ural Mountains" (1845) together with a map entitled "Russia in Europe and the Ural Mountains" that covered also most of the territory of the present-day Poland, then partitioned between Russia, Prussia and Austro-Hungary. In 1843 he embarked on geological trip to Poland. First part of his geological studies was devoted to the Holy Cross Mts., from where he travelled to Kraków and further to the south, to the Carpathians. Details of this geological field trip, undertook on June 18–30, are known from Murchison's field notebook, letters to his wife Charlotte, and from the notebooks of Ludwik Zejszner, Polish geologist, palaeontologist and geological cartographer that accompanied Murchison on his trip. Geological results of Murchison's trip to the Carpathians were published in "The Geology of Russia in Europe and Ural Mountains" and in his paper entitled "On geological structure of the Alps, Apennines and Carpathians" (Quarternaly Journal of the Geological Society of London, 1849) that in 1850 was published in extended form in German and Italian. During his trip to the Carpathians Murchison made several important geological observations: (1) that evaporites known from the Wieliczka Salt Mine, located near Kraków within the most frontal part of the Carpathian foreland fold-and-thrust belt, are of Miocene age and are partly unconformably covering Carpathian sandstones, that (2) Carpathian sandstones are mostly Eocene and Cretaceous in age, that (3) carbonates from the high Tatra Mts. located in the inner part of the Carpathians are Jurassic in age, that (4) numullitic carbonates from the Tatra Mts are Eocene in age, and that (4) actions of glaciers could be observed in the High Tatra Mts. Murchison was a very keen observer, and his notebooks are full of interesting remarks regarding history of Poland and of the Polish cities (for example Kraków, where he met with general Chłopicki, key figure of the 1794 Kościuszko Uprising and the 1830–1831 November Uprising, both fought with the Russian occupants after partitioning of Poland), opinions of Poles regarding current political situation of their dismembered country, state of economy and industry, etc. He also vividly described everyday customs of people he had met during his trip, and highly appreciated hospitality of Poles that wholeheartedly welcomed him and Ludwik Zejszner to their homes.

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SALT AND ALCHEMY – ADAM SCHRÖTER (1525–1572) AND HIS POEM ON THE WIELICZKA SALT MINE

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Wieliczka Salt Mine, located in S Poland near Kraków, within the deformed Miocene evaporitic succession deposited in front of the Carpathian orogenic belt, is without any doubt one of the globally known "geological wonders". It was inscribed on the World Heritage List in 1978, and remains one of the key tourist attractions in Poland. In the 15th and 16th centuries, several descriptions of this mine have been published. The most important of them is the Latin poem Salinarum Vieliciensium iucunda ac vera descriptio carmine elegiaco (Joyful and detailed description of salt mine located in Wieliczka and belonging to the Kingdom of Poland, written in elegic couplet) published in 1553 by Adam Schröter (ca. 1525–ca. 1572). Its second, extended and supplemented edition, was published in 1564 under slightly modified title "Regni Poloniæ salinarum Vieliciensium descriptio carmine elegiaco, iam denuo ab ipso authore Adamo Schrötero revisa et aucta" (Joyful and detailed description of salt mine located in Wieliczka and belonging to the Kingdom of Poland, written in elegiac couplet, once again revised and expanded by the same author). Adam Schröter was born in Zittau in Lusatia region (SE Germany). Schröter was well educated having studied in Frankfurt an der Oder, Prague and Kraków, where he arrived in 1552. Schröter's writings included both translated from German to Latin works of renowned alchemist and pioneer of iatrochemistry Paracelsus as well as his own poems. His best-known and most popular poem is his poem about Wieliczka, in which the influence and inspiration of both classic antique (e.g., Vergil and Ovid) and Renaissance poets could be observed. The first part of Schröter's poem contains a legend on the beginnings of the Wieliczka Salt Mine. In its second part he provided a detailed description of the mine that was based on his first-hand experience gained during his underground trip into the Wieliczka "abyss", organization of mining activities, short information on key figures from the mine, description of various technical aspects of exploitation of salt, history of mining shafts etc. Our copy of Schröter's poem contains his handwritten dedication to "Abraham Bakssay, secretary of Albert a Lasko", and the signature of Franciszek Wężyk (1785–1862). Albert a Lasko refers to Olbracht Łaski (1536–1604), a very important political figure of the Kingdom of Poland, senator, palatine of Sieradz, lord of

Kežmarok in Slovakia (where he was born), staroste of Lanckorona and of Marienburg, also alchemy afficionado and adventurer. Łaski aspired to the throne of Moldova, was involved in wars with the Ottoman Empire, was one of the signatories of the Union of Lublin, converted from Calvinism to Catholicism and became a vivid activist of the Counter-reformation. Financial troubles caused by his adventurous political and personal life prompted Łaski's interest in alchemy, especially in the transmutation of sand and metals into gold. In 1583 he travelled to London where he met renowned alchemists John Dee and Edward Kelley. He travelled with them to Poland and then, in 1585, to Prague. Łaski's interest in alchemy led to his invitation for Adam Schröter who was supposed to embark on alchemy studies in the castle of Kežmarok. Most probably this prompted Schröter's visit to Wieliczka as it was regarded as an almost magical place. Abraham Bakssay mentioned in Schröter's is Ábrahám Baksay (Abrahamus Bakchsay Schemnicensis Pannonii; ca. 1530–after 1577), born in Selmecbánya (Banská Štiavnica, Slovakia), in a noble family. Baksay started his studies at the University of Vienna in 1555, but its length is not known. After his homecoming, he became the secretary of Olbracht Łaski. His relationship with Adam Schröter is dated to that period. There is an assumption in scholarship that Łaski's court in Kežmarok included an alchemical laboratory with the participation of Schröter and Baksay. Franciszek Wężyk, whose signature is on the title page of our copy of Schröter's poem, was a playwriter, writer, poet, translator, literary critic, publicist, member of Towarzystwo Warszawskie Przyjaciół Nauk (Warsaw Society of Friends of Science), president of Towarzystwo Naukowe Krakowskie (Kraków Learned Society), member of parliaments of Duchy of Warsaw and Congress Kingdom of Poland, senator, freemason. One of his best-known publications is a poem Okolice Krakowa (Environs of Kraków) that contains a detailed description of Kraków and its environs. It was written in 1809–1813, first published in 1820 and then in 1823, 1833 and 1869. It contains an extensive description of the Wieliczka Salt Mine, clearly composed under the significant influence of Schröter's poem, published ca. 300 years earlier.

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INTEREST IN THE OCEAN'S MINERAL RESOURCES IN BRAZIL (1960–1970)

Maria Margaret LOPES

Since the mapping of manganese nodules by H.M.S. Challenger Expedition (1872–1876) and systematised by John Murray (1841–1914) and Alphonse François Renard (1842–1903) in their classic text "Report on the Deep-Sea Deposits" of 1891, polymetallic nodules and other mineral resources of the Ocean floors attracted scientific and economic attention, as indicated by the literature of different decades. Towards the end of the 1950s, the pioneering works of John Mero (1929–2001) marked a systematic scientific and economic renewed interest in resources such as polymetallic nodules, also in Brazil. This paper is based on marine geology research that began in those years in Brazil regarding the continental shelf, carried out by Geology and Oceanography courses at universities and Brazilian government agencies. Moreover, since the late 1960s great projects began bringing together several Brazilian institutions in international cooperation. These projects addressed the resources of the sea, such as The Global Reconnaissance of the Brazilian Continental Margin – REMAC (Reconhecimento global da Margin Continental Brasileira) – (REMAC, Project 1972–1978), developed by Petrobras – state oil company/CPRM-DNPM-Geological Survey with international agreements (Woods Hole, Lamont-Doherty, Centre National pour I 'Exploitation des Océans). To this day, this is considered one of the largest marine geological research programs ever carried out in Brazil. REMAC's main purpose was the *reconnaissance of the form and nature of the entire Brazilian Continental Margin, particularly geological mapping, gathering information on shallow and deep structure and on the distribution of rocks and sediments in the ocean floor; mapping of submarine topography; and the locations of areas with potential economic interest related to oil and mineral deposits*. This article intends to collaborate in overcoming the gap present in the Brazilian historiography of science, which has dedicated little attention to investigate the interest in the ocean's mineral resources in recent decades.

Reconhecimento global da margem continental brasileira. Projeto REMAC: coletânea de trabalhos técnicos, 1971 a 1975. CPRM: Brasília, Rio de Janeiro: Petrobrás, 1977

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THE ART OF SALT MINING IN ITALY: FROM SALT SPRINGS TO MODERN UNDERGROUND MINES AND SOLUTION MINING

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In Italy, salt is mined since time immemorial. Mining and salt production technologies have evolved over the centuries, the most common ones being evaporation of brine, later described in several Renaissance mining treatises, such as Agricola's "De Re Metallica" (1556). In antiquity, apart from the salt produced in salterns along the coast, in Italy the production of salt in the inland areas probably dates back to Etruscan and Roman civilization; these were mainly located in Tuscany (near Volterra), thanks to the widespread presence of salt water seepages. It is worth recalling that the boiling of salt water was well known in Italy from the Final Bronze to the Early Iron Age, around 1000 BCE. This technology used coarse thick-walled ceramic materials (briquetage) to shape the evaporation vessels and, of course, heat produced by burning wood. In the Middle Ages, the salt water seepages of Volterra were systematically exploited; it is documented that in the 10th century salt production and the related mineral rights belonged to the Bishop of Volterra. It is worth mentioning that Biringuccio's "Pirotechnia" (1540), the first Italian treatise on the production of minerals and metals, reports that, similarly to what happens in "Hall in the Duchy of Austria" (modern Hall in Tyrol), even in Volterra salt is produced from salt water extracted from some wells (book 2 on "common mineral salt"). Salt production is still active in Volterra and since the early 1900s the process is carried out with modern solution mining technologies, albeit brine production is more and more striving to comply with severe environmental regulations and landscape protection policies.

In modern times, salt production was – and still is – associated with the 19th century development of a dedicated chemical industry for the production of sodium carbonate (or soda, Na_2CO_3), sodium bicarbonate $NaHCO_3$ and other chemical by-products (in an early stage with the Leblanc process and later with the Solvay-Mond one). In 1913 the Belgian Ernest and Alfred Solvay chose Rosignano, along the Tuscan coast, as the most suitable place to build their soda factory. The reason of this choice was at least threefold: the presence of the railroad heading to the port of Livorno, the nearby limestone quarries and, above all, the salt water of Volterra.

In the last decades of the 20th century, solution mining started also in Southern Italy, at Belvedere Spinello (Calabria), which has a salt production history similar to the one of Volterra. Unfortunately, a huge sinkhole and a landslide developed here in 1984, causing a large flood of brine to the surface, and so the gradual interruption of the mining activity and of the nearby salt refining plant. Both sites concluded the production in 2009.

Finally, even in Sicily since the early 1900 many underground mines of massive salt deposits of Messinian age were intensely exploited until a few decades ago, and today three large underground mines are still active (Realmonte, Racalmuto and Petralia Soprana). Here, salt production (from food-grade to industrial-grade) is carried out with completely mechanized room-and-pillars mining technology; significant reserves of Kainite (KCl) are also present and already exploited in the past. The paper outlines the historical development of the Italian salt production sites and the evolution of mining technologies used in different geological contexts.

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EARLY HISTORY OF GEOLOGICAL MAPPING IN SOUTH AFRICA

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In 1850, about 20 separate polities of indigenous Khoisan, Sotho-Tswana, and Nguni peoples were scattered in the interior of South Africa. By the end of the 19th Century, they came under the control of the two British Colonies of the Cape of Good Hope and Natal, and the Boer republics of the Transvaal and the Orange Free State. The Colony of the Cape of Good Hope, originally established in 1652 by the Dutch with the founding of Cape Town, was taken over by the British in 1806. The Colony of Natal was established by the British 1843, after wresting it from the control of Boer settlers. The Union of South Africa was established in 1910, following the victory of the British over the Afrikaner Boer Republics at the end of the Anglo-Boer War (1899–1902). The modern Republic of South Africa was established in 1961.

Geological studies were initiated in the early 19th Century in the Cape Colony by the likes of John Barrow, Dugald Carmichael, Basil Hall, Clark Abel, W.B. Clarke and others, but the first geological map of the Cape of Good Hope was only published in 1844 by Jules Itier. The first geological map of the Cape Colony (scale: 1":34 miles) was published by Andrew Geddes Bain in 1856. Edward J. Dunn (1872) published an updated map of the Cape Colony (scale: 1":24 miles). Dunn (1875, 1887) produced the first geological maps of the whole of South Africa, including the Orange Free State and Transvaal Republics (scale: 1":35.4 miles). In 1885, A. Moulle published the first geological map of the whole of Southern Africa (scale: 1:25 million). He also included two detailed roughly N–S and E–W geological cross-sections, at a scale of 1:1.66 million. In the Cape Colony, the parliament initially hired geologists such as Andrew Wyley, Dunn, and George Stow, before the establishment of the Geological Commission of the Colony of Cape of Good Hope in 1895. After that, systematic geological mapping began in the Cape. In Natal Colony, the first geological maps were produced by P.C. Sutherland (1868) and by C.L. Griesbach (1871). In 1899, a geological surveyor, William Anderson, was appointed to do geological mapping in Natal, the results of which were published in three reports (no maps) between 1901 and 1907. The Natal Mines Department published a Geological Map of Natal in 1910 (1":20 miles, or 1:1,267,200) from information supplied by C.J. Grey. In the Transvaal, geological mapping started with the work of J.A. Roorda-Smit (1881), with a sketch map (scale: 1:3.4 million), and Charles Alford (1891) whose Eastern Transvaal sketch map was at a scale of 1" to 16 miles (~1:1.01 million). Gustaaf Molengraaf was appointed State Geologist, and he started the systematic mapping of the Transvaal Republic. Molengraaf presented two Annual Reports, before the outbreak of the Anglo-Boer War. After that war, Molengraaf published the first detailed Geological Map of the Transvaal in 1901 (scale: 1:1.5 million). A Transvaal Geological Survey was established in 1903, with Herbert Kynaston as its first Director. In the Orange Free State republic, George Stow was appointed as State Geologist. His work there led to the discovery of the Vereeniging Coalfield. In 1905 Arthur Rogers published the Geology of Cape Colony, with a Geological Map compiled from recent mapping (2nd edition by Rogers and du Toit, 1909). Hatch and Costorphine (1905) published the first Geology of South Africa, with Geological Maps of South Africa (1:5 million) and Transvaal (1:1.25 million) (2nd edition 1909). After the Union of South Africa was formed, a national Geological Survey of South Africa was established in 1912 with its headquarters in Pretoria. Over the past century the Geological Survey of South Africa (which changed its name to the Council of Geoscience three decades ago) has succeeded in geologically mapping the entire country at various scales, compiled into 1:250,000 scale map sheets. It has embarked on a program of mapping at 1:50,000 scale, and has extended its activities to other countries in Africa and beyond.

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HISTORICAL ACCOUNTS OF THE MAITLAND ARGENTIFEROUS GALENA DEPOSIT, EASTERN CAPE – THE FIRST LEAD DISCOVERY IN SOUTH AFRICA (1792)

Sharad MASTER

The Maitland prospect is a polymetallic Pb-Ag-Cu-Zn deposit located in the Eastern Cape, some 35 km west of Gqeberha (Port Elizabeth). It consists of quartz-calcite veins with argentiferous galena, together with copper sulphides and sphalerite, hosted by marbles of the Neoproterozoic to Early Paleozoic Gamtoos Complex. It is of great historical interest as the first known lead prospect in South Africa, and early descriptions of its geology and mineralization are given here. It was first prospected in 1792, by a Major Von Dehn who found rich Pb-Ag ores. The possibility is suggested that the Maitland polymetallic deposit may have been originally discovered and exploited by the indigenous Xhosa clan, the AbaThembu, who manufactured copper-silver ear rings which were described from this area by the Swedes Anders Sparrman and Carl Peter Thunberg in 1772.
The Maitland prospect was visited by Englishman John Barrow in 1797, and by the Germans Hinrich Lichtenstein and Baron von Dankelmann in 1803 and 1804 respectively, who had further assays made of the ores in Germany. Economic prospects of the deposit were encouragingly described by Centlivres Chase in 1843. The Maitland Mining Company, formed in 1846, issued £10,000 worth of shares. During the development stage, the Maitland mines were visited from 1845 to 1857 by the road builder Andrew Geddes Bain, the physicians William Atherstone and Richard Rubidge, and the geologist Andrew Wyley. The mining operations were unprofitable, and the mines were closed. Renewed prospecting was done from 1924 to 1931, and from 1970 to 1975, without success. In over 200 years of exploration, the Maitland deposit has been repeatedly investigated, but the lack of continuity of the mineralisation at depth, and the lack of rich mineralised lodes, has meant that it is completely uneconomic, even for a small-scale mining operation. The Maitland prospect, abandoned since the 1850s, continues to arouse interest today, and curious visitors still enter the shafts and adits that were mined during the prospecting operations

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HISTORY OF THE GEOLOGICAL COMMISSION OF THE COLONY OF CAPE OF GOOD HOPE (1896–1912)

Sharad MASTER

The Colony of the Cape of Good Hope was a British colony in South Africa, since 1806, when it was taken over from the Dutch, who had originally established the Colony with the founding of Cape Town in 1652. In the 19th Century, the Cape Government hired geologists such as Edward J. Dunn, Charles D. Bell, Andrew Wyley and Fred W. North to report on the occurrences of copper, diamonds, gold and coal deposits. In 1871, Britain annexed the diamondiferous territory of Griqualand West, in the Northern Cape, and it was ruled as part of the Colony of Cape of Good Hope. A geologist, George W. Stow, was appointed to map Griqualand West. In the 1890s the need was felt for a proper government department responsible for geological mapping of the Colony to be set up, and on 9 November 1895 the Geological Commission of the Colony of Cape of Good Hope (GCCCGH) was established, falling under the Department of Agriculture. Its geologists were Prof. George Costorphine (Director), Arthur W. Rogers and Ernest H.L. Schwarz, later joined in 1903 by Alexander L. du Toit. Costorphine left in 1902, and Schwartz resigned in 1905, leaving just Rogers and du Toit in the field, with Maria Wilman as Assistant at the SA Museum in Cape Town, where the Commission was based. At the time the GCCCGH was established there was a lot of economic interest in the diamond deposits near Kimberley, and in newly established coal mines in the Eastern Cape, and copper mines in Namaqualand in the Northern Cape. It was felt that proper geological mapping would aid in the discovery of new mineral deposits. One of the prime movers in the establishment of the GCCCGH was its Chairman, John Xavier Merriman, who was to be the last Prime Minister of the Colony of Cape of Good Hope, prior to the formation of the Union of South Africa in 1910. Other founding members of the GCCCGH were Thomas Muir FRS (Superintendent of Education), Sir David Gill FRS (Her Majesty's Astronomer at the Cape), Thomas Stewart FRS, and Charles Currey (Under Secretary for Agriculture), with Theodore McKenzie as Secretary.

The main activity of the Commission was geological mapping (Geological Map of Cape Colony) at a published scale of 3.8 miles to 1 inch (1:238,000). The GCCCGH existed for only 17 years, from 1895 to 1912 – but during this time the outstanding quality of its mapping was unequalled anywhere else in Africa. All four of its geologists were Fellows of the Geological Society (of London), two of whom also became Fellows of the Royal Society (Arthur Rogers and Alex du Toit), while the other two (George Costorphine and Ernest Schwarz) were or became professors at local universities. Their work was achieved on foot and on horseback, often without pre-existing topographic base maps, which they had to produce as well. The Commission's tasks were affected by the Anglo-Boer War of 1899–1902. The results of the Commission's work, which covered the geology of the Cape and Karoo basins, and part of their basement (an area of ~300,000 km^2), were published in its Annual reports (1896–1912), 22 map sheets, various papers, as well as in three books: a "Bibliography of South African Geology" by Saunders (1897), "An Introduction to the Geology of Cape Colony" (2nd Edition, 1909) by Rogers and du Toit; and "The Geology of South Africa" (1905, 1909) by Hatch and Costorphine. In 1912 the GCCGH was incorporated into the Geological Survey of the Union of South Africa, which had its headquarters in Pretoria.

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OF OFFICERS, CLERGYMEN, NATURALISTS AND ASSORTED GENTLEMEN: THEIR FIRST IMPRESSIONS OF THE GEOLOGY AND LANDFORMS OF COLONIAL NEW SOUTH WALES AND TASMANIA, 1788–1843

Wolf MAYER

When the First Fleet of seven convict ships left England in 1787, bound for Botany Bay in New South Wales, there was not a single person with scientific qualifications on board. It was not until 1852 that the first qualified government geologist was appointed. The initial exploration of the unknown territory around the tiny settlement at Sydney Cove fell therefore largely to the better educated military officers and some of the civilian staff. Predictably, the search for limestone by these novice geologists in the sandstone-dominated Sydney Basin proved unsuccessful but later discoveries of large shell middens, provided the urgently needed lime to make mortar for use in the building of houses. They also reported on the discovery of coal measures. Free settlers arriving in subsequent years included well-educated persons with a considerable knowledge of geology. They were the first to describe the stratigraphic succession of coastal exposures to the north and south of Sydney and later studied the geology of part of the inland regions of New South Wales and of Tasmania. Prominent among them was Alexander Berry (1781–1873), a native of Fife in Scotland, who settled in Australia in 1819 where he became a wealthy landowner and merchant. His interest in geology led him to examine and describe long stretches of the New South Wales coast and comment on the geology and landforms of the Blue Mountains. He is believed to have been the first to apply Huttonian views to Australian rock formations. Another was Pavel Strzelecki (1797–1873), who was of Polish descent but received part of his education in Scotland. After lengthy travel in the Far East, he arrived in Sydney in 1839. Governor Gipps, aware of his interest in the natural sciences, particularly in geology, commissioned him to explore the interior of New South Wales. He later continued his exploration in Tasmania. Strzelecki was the first to draw geological maps of some of the areas he had surveyed and the first to discover gold in the interior of New South Wales. He also named Australia's highest peak, Mt. Kosciuszko. After his return to England, he published the results of his work, including a map and sections in a highly acclaimed book "Physical description of New South Wales and Van Diemen's Land".

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GEOLOGICAL AND MINING HERITAGE OF TWO HISTORICAL MINING LOCALITIES (ROMANIA)

Viorica MILU

The aim of this work is to underline the importance of the geological and mining heritage of two localities (Roşia Montană and Brad) situated in the South Apuseni Mountains (Western Romania). The region is worldwide known for the numerous ore deposits of Neogene age – Au-Ag-(Te) or Pb-Zn-Cu-(Au, Ag) epithermal and porphyry Cu-(Au-Mo) deposits – forming the richest metallogenic region of Romania. It is also famous for the minerals discovered here for the first time in the world (http://cnmnc.units.it).

According to the archaeological and historical data, the oldest mining activities (mainly for alluvial gold) in this region date back to Late Neolithic. During the Roman Dacia (from 106 to 271 A.D.), but also in the Medieval period and in the 18–20th centuries, it was one of the most important gold mining regions of Europe. The region was so rich in gold and other precious metals, that, at the beginning of the 20th century, the name of Golden Quadrilateral started to be used for the area containing all these deposits.

Roşia Montană (known as *Alburnus Maior* in Roman times) is a village in the Alba County in which, starting with the Roman Dacia period, the ore mining was well-developed. Roşia Montană is renowned as a high-grade gold-silver deposit of epithermal type. It is also the type locality for the mineral alburnite. Within the protected zone of the historic centre of the village, there is the "Cătălina Monuleşti" Mining Gallery, a national historical heritage (Roman, Medieval and Modern periods). Opened in 1981, the Gold Mining Museum itself is on the list of national heritage (historical monument). The open-air part of the museum exposes archaeological vestiges, equipment for mining and ore processing etc. In the underground part of the museum, the visitors can see Roman galleries and learn about the mining technics used at that time. Two natural monuments of geological interest, namely Piatra Corbului and Piatra Despicată, are located not very far away from the village centre. Since 2021, the Roşia Montană Mining Landscape is both on the World Heritage List of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and on the UNESCO's List of World Heritage in Danger (https://whc.unesco.org/en/list/1552/).

Brad (Hunedoara County) is a historical mining locality too. In the middle of the town, there is the Gold Museum. Founded in 1912, nowadays the museum collections contain around 2000 pieces; hundreds of them are of native gold or gold-bearing samples. The majority of samples were collected from the gold mines of Romania (most of them from the Golden Quadrilateral); there are also samples from Europe and other continents. To note that the museum detains a collection of minerals including minerals discovered for the first time in the world on the present territory of Romania. Due to the importance of collections of minerals and mineralized rocks of the museum, I consider that it is a significant *ex situ* geodiversity site. The museum collections also contain old mining tools and mining-related documents. It is to mention that in the Ruda-Brad Village (the town of Brad), the "Roman Stairs" Mine Gallery, a mining heritage from the Roman Dacia, is a national historical monument (archaeological site) and cultural heritage (industrial heritage category).

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SCIENTIFIC PARADIGMS AND COMPLEXITY IN MODERN AND CONTEMPORARY VOLCANOLOGY: THE CONTRIBUTION OF *STUDIA* ON ETNA AND VESUVIUS

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The evolution of modern volcanology is very complex, both from an epistemological and from an historiographical point of view, due to its interdisciplinary and, since the last century, transdisciplinary nature. If we look at the last few millennia of the European history, it's noticeable how Italy has always played a privileged role in the understanding of volcanic phenomena, starting with the study of the eruption of Mt. Vesuvius in 79 A. D., which is still today the subject of scientific debate among volcanologists and archaeologists. Although Mt. Vesuvius has been for centuries the focus of both observations by casual travellers and studies by scholars, the entire Mediterranean area has always been a great source of volcanic and seismic events; for example, this is the case of Mt. Etna and the Aeolian volcanoes. In this speech we will analyse the most important contributions in the volcanological field produced by research efforts on Mt. Etna and Mt. Vesuvius. The contributions of naturalists, travellers and scientists between the 17th and 20th centuries will be reviewed, in order to make an initial comparison among research paradigms that individual scholars and research groups have applied to the study of these two volcanoes, and the consequent influence they have had on the international scientific community.

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CROSSING HERITAGES: GEODIVERSITY AND THE ARTS

Maddalena NAPOLITANI

This contribution explores how geodiversity has been represented by figurative arts. Although the concept of geodiversity is recent, and connected to those of geoheritage and the preservation and management of geosites (see for instance Gray, 2004; Serrano, 2007; Brilha, 2014, 2017), the history of scientific images shows how the multiple features of the Earth, its processes and its materials (fossils, rocks, minerals) were constantly represented and often considered as a whole.

Our analysis will focus on the 19th and the beginning of the 20th century. The 19th century is marked by major progress in the field of Earth sciences, especially geology and palaeontology, while these disciplines were simoultanously institutionalised. At the same time, the figurative arts as well-experienced some major innovation, such as the advent of impressionism, cubism, and other avantgardes. The divulgation press (journals and books) offers a wide range of images (lanscapes, fossils reconstructions, maps, tools, etc.), that could be implemented by and compared with the pictorial production of the time. In some cases, the artists worked in close collaboration with geologists, sharing the fieldwork – such is the case of Paul Cézanne and the geologist Antoine Marion.

Thus this communication proposes an overview on how figuratives arts have rendered and visualized what is now defined as geodiversity. The aim is also to cross this artistic heritage with the geological one, and to finally reflect on how, nowadays, they can enhance each other. We will thus conclude the analysis and open-up the research perspectives with some exemples of art works of the 20th century, marked by a renewed environmenental consciousness towards geological processes: that is the case, for instance, of the Land Art movement and of what has been explicitely defined as *Earthworks*.

REFERENCES

Brilha, J., Reynard, E.,2018. Geoheritage: a multidisciplinary and applied research topic. In: José Brilha and Emmanuel Reynard (eds.) Geoheritage: assessment, protection, and management, Elsevier: 433–438.

Brilha, J., 2014. Inventory and quantitative assessment of geosites and geodiversity sites: a review. Geoheritage, 8: 119–134.

Gray, M., 2004. Geodiversity: Valuing and Conserving Abiotic Nature. Wiley.

Serrano, E., 2007. Geodiversity. a theoretical and applied concept. Geographica Helvetica, 62: 140–147

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RAW MATERIALS IN PREHISTORY IN THE CZECH REPUBLIC AREA: A REVIEW

Zdeňka PETÁKOVÁ

The broad spectrum of data on the raw materials in the prehistory in the Czech Republic (CR) area is caused for three contributory reasons: an excellent state of the archeological and geological research, a long period of using this territory by man and its predecessors, and a broad geodiversity on the Czech Republic territory.

Geodiversity

A broad geodiversity of the Czech Republic is well documented by geological mapping in all scales (see for example online geological maps on the Czech Geological Survey websites[1]) and by borehole surveys (more than 700 thousand boreholes in the Czech Geological Survey database). There are 2,100 rock types on the 78,871 km^2 of total area of the CR. The main rock types are: sedimentary rocks, metamorphic rocks in all grades of metamorphism, and magmatic rocks. Many of these rock types were suitable for use by man in prehistory.

Prehistory and protohistory of raw materials used in the Czech Republic territory – the most important facts

The oldest stone tools discovered in CR near Beroun (central Bohemia) were quartzite, lydite and quartz cobbles, which were used 1,6–1,8 million years ago. Not only stone (for tools), but also clay (Venus of Dolní Věstonice, ceramic stattuette, 29,000–25,000 BCE) and hematite (Venus of Petřkovice, stattuette, 23,000 BCE) were used in mammoth hunters culture (Gravettitan Industry) on the Moravia territory. The Venus of Dolní Věstonice is one of the oldest known ceramic artefact in the world.

The Middle Paleolithic quartzite mining is situated in the area of Písečný hill near Bečov in the NW part of the CR. White fine grained quartzite was mined and used for stone tools (chipped industry).[2]

Fine grained silicite (chert) surface and subsurface mining from the Mezolithic to the Hallstatt Age and stone tools production (chipped industry) is situated in Krumlovský les area near Brno, in the Southmoravian region[3].

Stone axes were made from Maršovský hill metabazite rock near Jistebsko in Jizerské hory Mts. (northern part of the CR) in Neolithic (7,150–6,920 BCE). Maršovský hill surface mining reached 0.2 km^2.[4]

The first stone buildings constructed in the Czech Republic territory were Bronze Age (2,000–0,8 BCE) hillforts and tumuli.

The Celts (Iron Age inhabitants of the CR territory, 0,8–0,1 BCE) mined gold by panning in many places in the southern and central part of Bohemia. Their oppidas (hillforts) were mainly built near gold placer-mining sites. They also produced iron from iron ores in many places. Graphite mined by surface mining was used for their ceramic vessels production mainly often in the southern part of the CR territory (South Bohemian, Třísov oppidum and many other places). The graphite amount in ceramic was up to 24% wt.[5] Bracelets, beads and some other black coloured jewellery made from sedimentary rock called „švartna" were often used by Celts. Švartna was supposedly mined by them in the surface parts of sediments of the Carboniferous age near Kounov in Central Bohemia.

The regression of civilisation took place in Middle Europe between Celts and the historical period (0–600 AD). The Germans and Slavs moved to the CR territory in this Migration Period. During this time, they used clay for vessels production, for example.

REFERENCES

[1] http://www.geology.cz/extranet-eng/maps/online/map-applications

[2] Fišer, J. (2021): Význam kamenných surovin ve společnostech mladší a pozdní doby kamenné: příklad severozápadočeských křemenců. – MS, Diplomová práce, Západočeská univerzita v Plzni, Fakulta filozofická.

[3] Oliva, M. (2022): Mining landscape of Our ancestors. On the mysterious underground of "Krumlovský les" (In Czech.) – Moravské zemské muzeum. Brno.

[4] Šída, P. – Prostředník, J. (2011): Současný stav poznání neolitické těžby a zpracování metabazitu v Jizerských horách./ Actual stage of research on neolithic quarrying and processing of Jizera mountains metabasites. – Praehistorica, XXIX, UK Praha, 369–380.

[5] Procházka, V. – Petáková, Z. – Thomová, Z. – Laufek, F. (2011): Suroviny pro výrobu jihočeské keramiky bohaté grafitem v několika prehistorických a historických obdobích. – Archeologické výzkumy v jižních Čechách 24, 299–315.

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THE EVENTS DEDICATED TO THE 175TH BIRTHDAY OF THE GEOLOGIST DUKE ANTANAS KAROLIS GIEDRAITIS

Violeta PUKELYTĖ and Valentinas BALTRŪNAS

This year, Lithuanian society celebrated the 175th anniversary of the famous geologist, Duke Antanas Karolis Giedraitis (Antoni Karol Giedroyć, 1848–1909). On that occasion, the scientific conference was organized on May 18 at Vilnius University. It presented fourteen reports about the cultural environment of the end of the 19th century, scientific research and geological mapping by A.K. Giedraitis in Lithuania and other countries, contemporary research on the outcrops described by him, etc. On the second day, a tour was organized in Vilnius and the objects that he researched 130–140 years ago were visited. A.K. Giedraitis' birthplace, fatherland, and the place of his burial in the town of Karvys (Vilnius district) were visited too. The grave site and tombstone of the geologist and his parents in the cemetery were renovated by the Geological Society of Lithuania. The book "Duke and Geologist Antanas Karolis Giedraitis" (Duke..., 2023), which consists of 17 articles, was also published. The authors of these articles are talking about A.K. Giedraitis's biography, education, expeditions, and research.

A.K. Giedraitis' professional achievements are well-known and evidenced by detailed research reports and scientific publications in German, Polish, and Russian. In the history of science in Lithuania and neighbouring countries, he is known as the first to compile a geological map in accordance with international standards, understand Quaternary deposits, and take a courageous stance for that time in maintaining that the region was covered by two or three glaciations.

A.K. Giedraitis' works and the geological map (1:420,000) of the western part of the Russian Empire were published in 1895 (Giedraitis, 1895). The map showed the areas of the Quaternary, Tertiary, Cretaceous, and Jurassic rocks. It was compiled based on the author's observational data and description of Quaternary and Pre-Quaternary rock outcrops. The main Pre-Quaternary rock provinces marked on A.K. Giedraitis' map are confirmed by modern mapping data. It was a pioneering work in modern geological mapping using international stratigraphic standards.

A.K. Giedraitis, as a representative of the Russian Geographical Society, related an expedition in Turkmenistan organized by the Russian Ministry of Roads (1879–1882) to investigate the old courses of the Amu Darya River. While researching the valleys of the Uzboy and Amu Darya rivers, using the characteristics of sediments, their stratification, and the fossils found in them, A.K. Giedraitis performed a valuable comparative study of the sediments that made up the old riverbeds.

When the construction of the Gate Siberian Railway started in the last decade of the 19th century, the main method of geological research was geological mapping. A.K. Giedraitis was involved in the team together with V. Obruchev and A. Gerasimov in Transbaikalia (Zabaykalsky Kray) to compile a geological map on a scale of 1:680,000, corresponding to a contemporaneous level of knowledge.

The articles published in the new book (Duke..., 2023) reveal that A.K. Giedraitis was a very active and adventurous person who carried out extensive geological research work not only in Lithuania but also in other countries that was very important to the development of geological science.

REFERENCES

Giedraitis, A., 1895. Geological research in the provinces of Vilna, Grodno, Minsk, Volyn and the northern part of the Kingdom of Poland (in Russian). Materials for the geology of Russia, 14: 133–325, St. Petersburg.

Duke and Geologist Antanas Karolis Giedraitis (Comp. and ed. V. Baltrūnas) (in Lithuanian with English summary). Vilnius: Geological Society of Lithuania, 2023.

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DANTE'S INFERNO AND GEOTHERMAL AREAS: MORE THAN COINCIDENCES

Antonio RASCHI

Dante's interest in science has often been considered by scholars, that underlined his knowledge of physics, in particular astronomy. A minor effort has been devoted to Dante's interest in nature. In fact, in the Commedia Dante often focuses his interest on natural phenomena, using them as examples for the description of landscapes, or as metaphors. A detailed analysis of some cantos, depicting landscapes usually attributed to the Poet's fantasy, reflects a thorough direct observation of natural phenomena, probably in the light of environmental knowledge as it was being constructed by contemporary Authors. This can be noticed, for instance, in the Cantos XII–XVI of the Inferno, in which the fiction built by Dante's fantasy in deeply interwoven with Dante's nonfictional knowledge of geothermal phenomena, such as mofettes. Mofettes, natural geothermal emissions of sulphur and carbon dioxide often located near thermal springs, had been described by ancient geographers. Sometimes, they have been used in classic poetry (by Virgilius, above all) as a metaphor for chthonian world, in consequence of their strange and frightening features. In Dante's time, they have been dealt about by Albert the Great and Ristoro D'Arezzo, that tried to explain them in accordance with Aristotle's cosmology. There is consensus about the fact that their works were known by Dante, but his detailed description of some natural phenomena, never described, apparently, by other Authors, suggests a thorough direct observation of mofettes and a deep interest about what we call "geology" (still not existing as a science, in Dante's time). Yet, these points have seldom been noticed by critics, resulting in attributing to the Poet's fantasy some powerful descriptions that are, first of all, a testimony of his curiosity about nature. This topic is discussed on the basis of a comparison between Dante, his contemporary authors, and recent scientific papers.

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THE DEVELOPMENT OF GEOLOGICAL SCIENCE OVER SEVEN CENTURIES OF VILNIUS HISTORY

Eugenija RUDNICKAITĖ

The development of geology in Vilnius can be divided into stages:
1) geological knowledge in folklore – Neolithic production of stone tools – construction in the 9th and 12th centuries – new geological know-how brought by artisans invited by Gediminas in the 13th century – the beginning of local iron mining.
2) Vilnius College was founded in 1570 and Vilnius University in 1579. The Faculty of Philosophy teaches Aristotle's physics, often called natural philosophy or natural science. Geological knowledge was also provided. In the 18th century, scientific works on natural philosophy appeared at Vilnius University, which also dealt with geology. Mention should be made of Professors A. Skorulskis, B. Dobševičius, Ž. Ševalje.
3) The Department of Natural History was founded in 1781, with the aim of linking science with practice and economic needs. Expeditions were organised to study the resources of the region, and collections of minerals, rocks and fossils were made. The most successful and distinguished professors were Ž.E. Žiliberas, J.G. Forster and S.B. Jundzil.
4) The Department of Mineralogy was established in 1803. R. Simonavičius was its first head and organiser. He taught mineralogy until 1813, assembled a huge collection of mineralogy, created a classification of mineralogy, and is considered the pioneer of geological science in Lithuania. He was succeeded by Feliksas Dževinskis, who taught mineralogy from 1814 to 1817, Ignotas Horodetsky (1817–1824), Juozapas Jundzilas (1824–1825), Ignotas Jakovickis (1825–1832). The latter, after the closure of Vilnius University in 1832, stayed on to teach mineralogy at the Vilnius Academy of Medicine and Surgery, until its closing in 1842. Geology as a science stopped to develop in Lithuania.
The first textbooks were published: by R. Simonavičius (1806), F. Dževinskis (1816), I. Jakovickis (1825, 2nd edition 1827). E.K. Eichvaldas, who took the position of professor at the Department of Zoology in 1827, raised the idea of the evolution of the organic world, was interested in the geology and palaeontology of Lithuania, and described the ammonite fauna of Papilė.
Tsarist government had no interest in prospecting local minerals. That is why geologists who originated in Lithuania tried to organise geological expeditions in an atempt to fill the gaps in the geological survey of Lithuania. Most notable example of such attempts are the geological researches in 1878, 1883, 1884 and 1885 by Antanas Giedraitis (Antoni Karol Giedroyć, 1848–1909). Since 1882 A. Giedraitis was an associate of the Geological committee. This allowed him to carry out these geological expeditions, which (as he writes) began from his homeland, Karvio manor in Maišiagala region near Vilnius. He performed three main expeditions.
5) Geological research at Vilnius and Kaunas Universities before World War II.
6) Detailed geological work in Vilnius during the Soviet period.
7) Geological research centres in Vilnius after independence.
At all stages, Vilnius University geologists were open to the public: lectures were open to Vilnius residents along with students; the museum was open to schoolchildren. When the University was closed, some of the collections were transferred to the Museum of Antiquities and later to the Natural History Museum at the Vilnius Public Library. In 1928, the Natural History Museum with a geology-mineralogy section was established at the Faculty of Mathematics and Natural Sciences of the University of St. Stephen Batory. The museum was open to the public 2 days a week.

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GEOPOLITICS, WAR, AND SOIL SCIENCE: THE LIFE AND CAREER OF A TWENTIETH CENTURY UKRAINIAN FARM BOY

Dorothy SACK

Vasyl M. Gvosdetsky (1901–1989) was born into a Ukrainian farming family who lived in a small village located approximately 200 km north-east of Kyiv. As a young man, Gvosdetsky developed academic interests in geology, physiography, and soil science. After attending a regional teacher's college, he earned his B.S. (1927), M.S. (1930), and Ph.D. (1936) degrees at Kyiv University. Between degrees, Gvosdetsky worked at an agrochemical laboratory, taught soil science and geology, and conducted soil science field research in various locations throughout the Soviet Union. His post-secondary education occurred during an interval that included major Soviet efforts to restructure universities and to collectivize farms, with the latter spawning widespread famine and starvation in Ukraine. Distressed by these and perhaps other consequences of Soviet rule in Ukraine, Gvosdetsky moved to Poland in 1933, where he continued his doctoral studies and then post-doctoral soil research in association with Kyiv University.

Gvosdetsky was appointed assistant professor at Kyiv University upon completion of his master's degree, and associate professor upon completion of his doctoral degree; both appear to have been research positions. During this time, he became a member of the International Association of Soil Science as well as the Quaternary Commission of the Ukrainian Academy of Sciences. Gvosdetsky produced 15 maps, papers, and reports that were published in Kyiv or Moscow between 1930 and 1939.

Gvosdetsky survived World War II in Poland, then Germany, and at the war's end became a displaced person in the American occupation zone. He eventually emigrated to the U.S. under the sponsorship of a fellow Ukrainian expert in sugar beet agriculture and arrived in Utah in 1949 to assist in Utah's efforts to boost production of that crop. Soon after arriving in Salt Lake City, Gvosdetsky introduced himself to Professor H. Bowman Hawkes, who was chair of the Department of Geography at the University of Utah. Hawkes helped give Gvosdetsky the opportunity to teach a class on the geography of the Soviet Union while the latter was working on the sugar beet project. Gvosdetsky eventually earned a permanent full-time tenured faculty position in the department and rose to the rank of professor. At the University of Utah, Gvosdetsky taught popular courses in soil science, physical geography, and the geography of the Soviet Union. He continued his research specialization in soil science and sediments and was one of the first researchers to apply soil science to the study of Utah's late Pleistocene Lake Bonneville, of which Great Salt Lake is a remnant. Gvosdetsky's research and publications were well received and contributed to an improved understanding of the oscillations and stillstands of that great paleolake and its predecessors. He also contributed to research on radioactive fallout in areas of Utah located downwind from mid-century atomic bomb testing in Nevada, and to other important topics. Despite the challenges of geopolitics and war that he faced during the first half of his life, Gvosdetsky managed to make many solid contributions to Quaternary and environmental geology during the second half of his life in the post WWII era.

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RESEARCH ABROAD BY GEOLOGISTS FROM THE POLISH GEOLOGICAL INSTITUTE

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The Polish Geological Institute in its more than 100-year history has always been an institution open to international cooperation. PGI was the initiator of the Carpatho-Balkan Geological Association (1925), and PGI staff participated in International Geological Congresses. Drawing on international experience was somehow inscribed in the way PGI operated, as its founders and leading academics, such as Józef Morozewicz, Karol Bohdanowicz, Józef Zwierzycki, Stanisław Doktorowicz-Hrebnicki or Gejza Bukowski von Stolzenburg, before Poland regained independence, worked for many years in foreign geological services, often holding high professional positions. The period immediately following the Second World War was the time of the Cold War and the so-called Iron Curtain. In the early 1960s, a certain breakthrough was the possibility of scientific internships organised by the Commissariat à l'Energie Atomique in the exploration and exploitation of uranium ore deposits, under scholarships funded by the French government. It was also during this period that PGI began exploration work abroad, but only countries politically close to the Eastern Bloc were covered by institutional cooperation. The first larger-scale geological exploration was carried out in Vietnam at the request of the government there. A group of a dozen or so geologists led successively by Roman Osika, Stanisław Kubicki and Eugeniusz Cieśla took part in exploration of iron deposits. In the late 1970s, PGI undertook another geological survey in Vietnam. This time, geological and technological research was conducted on the Nâm Nâm Xe rare earths deposit, located just across the border from China. This promising cooperation was unexpectedly ended by the Sino-Vietnamese armed conflict (February 1979). But the PGI geologists' Asian adventure is primarily linked to Mongolia. In 1961–1964, an expedition led by Edmund Rutkowski worked in the western part of Mongolia, with more than a dozen geologists from PGI and Polish geological companies. In the Altai, a geological map in the scale of 1:500,000 and geochemical, geophysical and laboratory studies in the scale of 1:200,000 were made in areas where metal ores occur. Between 1975 and 1989, the so-called International Geological Expedition worked in Mongolia on the basis of a multilateral agreement, with the participation of practically all Eastern Bloc countries. In this veiled way, the Soviet Union carried out reconnaissance of the resource base of an independent state on the basis of so-called "brotherly assistance". Neither this exploration nor the exploration of REE ore deposits conducted as part of Polish-Mongolian bilateral cooperation brought Poland any economic benefit. On the other hand, a definite benefit was the acquisition of a very large field experience by dozens of Polish geologists. It was largely used during a major contract signed in 1984 by the Polish company specialising in the export of geological services, GEOPOL, with the Algerian company EREM (Enterprise Nationale de Recherches Miniere). Polish geologists, mainly from PGI, carried out reconnaissance of deposits of raw materials such as clay raw materials, rock salt, sulphur, phosphorites, coal and metal ores. They also produced detailed geological maps. The social disturbances that took place in Algeria in 1990 resulted in the withdrawal of Polish geologists from that country. But PGI geologists also worked in a great many countries around the world as individual experts. They were employed by the governments of these countries or were experts working on projects funded by the United Nations. Such individual contracts were carried out in Morocco, Niger, Benin, Burundi, Gabon, Guinea, Libya, Mauritania, Zambia, Nigeria, Madagascar, India or Haiti, among others (Salski, 2020). Interestingly, many experts working in francophone countries have participated in scientific internships organised by the Commissariat à l'Energie Atomique. Many of the experiences were written up and published in the very comprehensive monograph *Polish geologists on five continents* (ed. Śliżewski et al., 2005).

REFERENCES

Salski, W., 2020. Works of geologists of the Polish Geological Institute abroad (in Polish with English abstract). Przegląd Geologiczny, 68, 5: 437–448.

Śliżewski, W., Salski, W., Werner Z. (ed.); 2005. Polscy geolodzy na pięciu kontynentach (in Polish). Państwowy Instytut Geologiczny, Warszawa.

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AMI BOUÉ (1794–1881) AND HIS JOURNEY ACROSS THE EUROPEAN TURKEY: UNPUBLISHED CORRESPONDENCE ON THE TOPIC

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In various German and Austrian archives several unpublished letters, written by Ami Boué (1794–1881), have been found, which relate to Boué's journey across the European Turkey (La Turquie d'Europe, 1840). This main work by Boué not only comprises results of his geological research, but also geographical, cultural, anthropological and statistical examinations. This wide spectrum of interests corresponds to various topics in Boué's correspondence. Particularly instructive is his letter to Franz Xaver Miklošić (1813–1891), a slavist who also took interest in the southern European linguistic areas. Other letters from Boué have been addressed to Felix Philipp Kanitz (1829–1904), scientist, ethnologist and archaeologist, as well as to yet unknown addressees. Of particular interest is also Boué's discussion of other travellers' scientific findings inasmuch as they refer to corresponding regions. The presentation is aiming at the synopsis of the amply gathered information out oft the mentioned correspondence.

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THE HISTORY OF GEOPARKS IN ROMANIA

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In Romania, first discussions about new geoparks initiatives started after the ProGeo meeting held in Belogradchik in 1998. Boosted by the creation of the European Geoparks Network (EGN) in 2000, the Hateg Country Dinosaurs Geopark project was launched as grass root efforts of universities, museums and local administrations coordinated by the University of Bucharest. Located in the south-west of Transylvania, the territory has joined the EGN in 2005 and the University of Bucharest assure the geopark management as partner for local socio-economic development. Based on its expertise, the university became the focal point for the UNESCO Geoparks Program and partner in new geoparks projects in Romania.
The Buzău Land Geopark project, located in the East Carpathians bend zone, was launched by the Buzau County Council and the University of Bucharest in 2007. After multidisciplinary studies and public debates, in 2010 the County Council accepted the geopark's strategy developed by the University of Bucharest. The GeoSust project (2014–2017), funded through EEA Grants, has set the management objectives and the Buzău Land Association as management body. Funding is ensured by the County Council within a renewed partnership with the University of Bucharest, as well as through various smaller projects. In 2022, the Buzău Land became member of the UNESCO Global Geoparks Network.
Carpaterra Geopark project, coordinated by Carpaterra Association, is located in the southeastern part of Transylvania. The project was initiated in 2008 as Perşani Geopark project by the Perşani Geopark Association. Due to political and administrative constrains, the initial territory was reduced to four mayoralties and the name of the geopark and leading association were also changed. Funded from several sources, successful educational, tourism and promotion projects were implemented and the geopark became a mature one and prepares its application.
Oltenia de sub Munte Geopark project, located in the South Carpathians, started in 2018 as an NGO initiative. The project is quite advanced in terms of heritage inventory, infrastructure, development strategy and management. The application dossier to UNESCO was delayed due to misunderstandings with some local mayoralties.
The Cimmerian Dobrogea Geopark (NW of the Black Sea) was launched in 2022, as a partnership of University of Bucharest, GeoEcoMar, Tulcea County EPA and two NGOs. The idea of this geopark dates back to 2018, when multidisciplinary studies have started and meetings with local stakeholders were organised. GeoEcoMar and University of Bucharest projects are supporting the inventory of the geological and cultural heritage, in order to identify the optimum geopark territory and to introduce the geopark projects to local communities.
The Baia Mare Geological and Mining Park located in a famous gold mining area, in the northwestern East Carpathians, was first presented in a 2009 paper. The initiative was relaunched in 2023, as Gutâi Geopark, supported by the Mineralogical Museum in Baia Mare, the Maramureş County Council, mayors and NGOs.
Since 2016, the Romanian National Geoparks Forum is strongly supporting the establishment of a Romanian Geoparks Network and other new geopark initiatives.

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ALEXANDER MACMILLAN HERON AND THE FIRST GEOLOGICAL MAP OF THE EVEREST REGION (1921–1922)

Ezio VACCARI

In January 1921, during a meeting held in London, the Royal Geographical Society and the Alpine Club established a joint Everest Committee in order to organize the first reconnaissance expedition to Mount Everest, which took place from April to October 1921 (Howard-Bury et al., 1922). The members of the expedition, led by colonel Charles Howard-Bury, included four mountaineers, two cartographers, a medical officer and geologist Alexander Macmillan Heron (1884–1971), who had the task to study the geology of the region, with particular attention to the age and the structure of the Himalayan range. Heron was considered a competent geologist and stratigrapher, particularly skilled in fieldwork, who had published since 1911 a series of papers in the "Records of the Geological Survey of India" and in 1917 a detailed memoir on the geology of the north-eastern Indian region of Rajputana. During the expedition, although he had no previous climbing experience, Heron undertook a series of excursions and fieldwork also on high grounds: at the end of June he explored the area around the Kyetrak Glacier up to the passes of Nangba La and Khumbu La to Nepal (west from Everest) with Howard-Bury. Later, they continued for a longer expedition to Rongbuk, Kharta and Kama valleys (east from Everest). Heron worked usually alone, as during several excursions in the valleys north-west from Tingri: in October, on the way back to Darjeeling, he also explored the Teesta valley in Sikkim. While the major alpinistic success of the 1921 expedition was to reach the North Col on Everest (at about 7000 metres) by a group led by George Mallory on late September 1921, from the point of view of the geological survey the work undertaken by Heron, with the assistance of cartographers Henry Morshead and Oliver Wheeler, produced a preliminary geological map of the region, over about 8000 square miles, based on Morshead topographical map at the scale 1:750,000 (11,84 miles to an inch). The aim of this paper is to present the results of Heron's fieldwork and mapping (Heron, 1922), which led to the preparation and the publication in 1922 of the first geological map of the Everest region.

REFERENCES

Heron, A.M., 1922. Geological Results of the Mount Everest Expedition, 1921. Read at the afternoon meeting of the [Royal Geographical] Society, 10 april 1922. The Geographical Journal, 59: 418–431.

Howard-Bury, C.K., et al., 1922. Mount Everest. The reconnaissance, 1921. Longmans, Green & Co. New York / Edward Arnold & Co., London.

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EMPHASIZING THE GEOLOGICAL SIGNIFICANCE OF THE OLDEST MINES IN MALAYA AND THEIR IMPACT ON GEO-TOURISM: A CASE STUDY OF PERAK STATE, MALAYSIA

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This study focuses on mining history in Malaysia, particularly emphasizing the tin mining industry's transformative potential, the geological implication of mining heritage, and the historical importance of old mines and their potential in the present economy. It highlights the geological formations that have shaped the mining sector and focus on how tin mining sites are repurposed for tourism, education, and recreation. It also looks into converting abandoned mines into geo-tourism destinations and their use for balneological reasons, focusing on conservation activities. The research draws on historical records, surveys, and case studies to investigate Malaysia's mining history and provide insights into heritage preservation, tourism development, and sustainable mining site utilization. In the 1820s, Hakka Chinese immigrants to Perak began settling, which sparked the development of the tin mining industry in Malaysia. Alluvial deposits ranging from Kedah to the Kinta Valley provided the primary tin mining area in Perak, home to cities like Ipoh, Gopeng, Kampar, and Batu Gajah. Tin-rich sands were pit-worked, and tin mining soon extended throughout the West Coast. Malaya produced 50,000 tonnes of tin yearly by 1904 to fulfil the rising demand from Europe, more than half of the global output. Malaya had its highest Tin production ever by 1937. However, this industry experienced a significant decrease between 1929 and 1932 due to a global recession. Due to the dramatic drop in tin prices brought on by the lack of demand from European markets, numerous tin mines had to close. In 2011, the Malaysian Chambers of Mines reported more than 113,700 ha of former tin mining locations in Peninsular Malaysia, with most of these regions being former tin mining sites. The oldest abandoned tin mining sites in Perak state have seen substantial changes due to the state's rapid expansion and modernisation. One of the main concerns of this paper is to highlight the change of these sites into more lucrative land uses without considering their heritage value is a worry raised by this research, followed by remote sensing and GIS. The result indicated that residential, commercial, institutional, agricultural, and recreational developments had overshadowed the preservation of these abandoned mining sites. It was concluded that the current affairs stress the value of protecting and conserving the historical relevance of tin mining locations in Perak. The state is well-known for its natural beauty and cultural legacy. It has several national historical monuments, including Lenggong geopark (a national and an international geological heritage site), inscribed on the UNESCO Archaeological Heritage List 2012. The Malaysian government turned several abandoned tin mines into tourism spots and preserved them in their prime geological condition. The marketing of Perak tourism frequently emphasizes its tin mining history. These historic tin mining sites must be maintained to protect the evidence of past mining operations and give visitors an engaging "living museum" experience. Additionally, cultural preservation can provide prospects for future growth through education, research, and tourism-related revenue for the state.

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UNRAVELLING THE HISTORY OF THE TSODILO HILLS: WORLD HERITAGE SITE IN NW BOTSWANA

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The Tsodilo Hills are three inselbergs that occur in NW Botswana, west of the Okavango River, rise over 420 m above the surrounding Kalahari Desert covered by the Kalahari Group sands and expose Palaeo- to Mesoproterozoic metasedimentary rocks. The rock faces are adorned by magnificent examples of rock art – about 4,000 paintings of animals, humans and geometric patterns.

The first very general observations of geology, geomorphology & paintings at Tsodilo were undertaken by S. Passarge in 1898 and published in 1907. The next explorer, F. Balsan, in 1951 printed the first photographs and traced images of some of the rock paintings. Sir L. van der Post, in 1955 & 1958 published observations on the Tsodilo environment and paintings and considered that the "Hills were inhabited by spirits". The results of the earliest geological survey conducted in 1956 by E.P. Wright were summarised in a brief report of 4 pages. The first geological map and report were authored in 1962 by C.F. Vermaak, who described a series of rock types and presented a succession of lithological complexes, their distribution and a predominantly monoclinal structure.

The first systematic study of paintings and classification into two groups was presented by M. Hoare in 1958. The earliest archaeological work was published by I. Rudner in 1965, but methodical archaeological investigations started much later. L.H. Robbins, L. Murphy, and A.C. Campbell stated in 1998 that Tsodilo was occupied since the Middle Stone Age by farmers and pastoralists. These authors dated the ancient mining of specular hematite at ca. AD 800–1000 and demonstrated that the miners traded this product with inhabitants of the eastern coast of Africa. The continuation of archaeological and ethnographic studies over the following decade was largely stimulated by A. Campbell – archaeologist, founder and first Director of the National Museum of Botswana. This activity, conducted by a growing number of researchers culminated in a book summarising this effort and edited by A. Campbell, L. Robbins, and M. Taylor and titled "Tsodilo Hills – Copper Bracelet of the Kalahari". Excavations led by J. Denbow documented a rich collection of pottery, iron and copper artefacts: jewellery, arrowheads, chisels, and blades.

Geomorphological and hydrological research by G.A Brook and team in 1993 provided evidence for a shallow lake at the SW foot of Tsodilo Hills during the Late Pleistocene humid period. This finding was addressed in a broader regional context by D. Thomas and co-authors in 2003. A subsequent detailed study by M. Geppert and team (2021) enabled the reconstruction of the palaeolake size (ca. 70 km2), depth (16 m) and three maxima of the oscillating water level.

The results of gradually advancing stages of geological mapping and sedimentological study leading to the interpretation of sedimentary environments in which the Tsodilo strata originated were published by M. Wendorff, starting in 1999 as conference papers. The first synthesis appeared as a journal paper in 2005, and a new detailed geological map and lithostratigraphic classification in 2019. This work generally shows that the Tsodilo succession deposited on an open marine siliciclastic shelf, covered by submarine dunes and sand waves, influenced by tides and two regressions. The deposition age of the rocks was established by detrital zircon geochronology as the Late Palaeoproterozoic by R.B.M. Mapeo and co-authors in 2019. In the same year, J. Bezuidenhout published the results of a gamma ray survey showing high uranium concentrations in the sediments adjacent to the Hills. The Tsodilo Hills were declared a UNESCO World Heritage Site in 2001. A synthesis was published in 2022 by Wendorff comprising the Tsodilo environment; geology including stratigraphy, sedimentology, palaeogeography and tectonics; geomorphology including weathering, erosion and palaeokarst; and ancient human activities including mining and rock art. This has appeared in the book "Landscapes and Landforms of Botswana".

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FROM FORMER MINES TO THE UNESCO AREAS IN HOLY CROSS REGION

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The Holy Cross (Świętokrzyskie) Mountains, the oldest orogen in Poland, belong to the central Polish highlands. They comprise the Paleozoic core and the Permian-Mesozoic margin. The Paleozoic core's complex geological structure encompasses rocks from the Lower Cambrian to the Carboniferous, resulting from multiple tectonic events that affected the area during various orogenies, from the Middle Cambrian Old Caledonian movements to the Neogene Late Alpine tectonics (Salwa, 2017). This tectonic activity is associated with multi-stage mineralization of calcite, copper, lead, zinc, barium ores (Rubinowski, 1971), and iron ores. Consequently, the Świętokrzyski region has been an industrial district for centuries, with raw materials processed mainly in metallurgical operations.

Historical mining of copper and lead ores in the region, from the 14th to the 19th century, focused on a small area between Kielce and Chęciny. From the 16th century, the extraction and processing of decorative carbonate rocks, known as Chęciny, Kielce, or Świętokrzyskie marbles, became prominent. These marbles have been widely used in architecture in Poland and Europe, symbolizing the region (Wardzynski, 2014). Abandoned open-pit mines and adits bear witness to this past mining activity, now protected and accessible to visitors through educational paths. Notably, the Rzepka quarry near Chęciny is the European Center for Geological Education of the University of Warsaw, while the Wietrznia quarry in Kielce houses the Center of Geoeducation (Poros, Wesołowski, 2022). The Holy Cross Mountains Geopark, with its exposed rocks and minerals, has become an open-air geological museum (Urban, Wróblewski, 2004), recognized internationally and nominated as a UNESCO Global Geopark in 2021.

In the Krzemionki area north of Ostrowiec Świętokrzyski, Neolithic striped flint mines were discovered in 1922. Flint was extracted from Upper Jurassic limestones and marls, forming the Krzemionki Prehistoric Striped Flint Mining Region within the Permian-Mesozoic Margin. More than 2,700 interconnected shafts and galleries have been found, and since the 1985, the first professional underground tourist route has been available (Bąbel, 2015). The mines have been managed by the Historical and Archaeological Museum in Ostrowiec Świętokrzyski since 1978 and added to the UNESCO World Heritage List in 2019.

The Holy Cross Mountains Archaeological and Geological Trail connects the region's significant heritage sites, starting from Krzemionki and ending at the Geopark. This trail unites two UNESCO sites in the region.

REFERENCES

Bąbel J.T., 2015. „Krzemionki Opatowskie" monument prahistorii Europy. Muzeum Historyczno-Archeologiczne w Ostrowcu Świętokrzyskim, Ostrowiec Świętokrzyski.

Poros M., Wesołowski W., 2022. Geotourism – a journey through the history of the Earth and Man, European Geoparks Network Magazine, 19: 67

Rubinowski Z., 1971. Rudy metali nieżelaznych w Górach Świętokrzyskich i ich pozycja metalogeniczn. Biuletyn Instytutu Geologicznego 247.

Salwa S., 2017, Góry Świętokrzyskie. In: Nawrocki J., Becker A. (eds.), Atlas Geologiczny Polski. Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, Warszawa, p. 32–33.

Urban J., Wróblewski T., 2004. Chęciny-Kielce landscape park – an example of officially not proclaimed geopark. Polish Geological Institute Special Papers, 13: 131–136

Wardzyński M., 2014. „Marmury" świętokrzyskie i ośrodek kamieniarsko-rzeźbiarski w Chęcinach w XVI-XIX wieku, Spotkania z Zabytkami, 7–8. Dodatek specjalny Aedifico et Conservo. Eskalacja jakości kształcenia zawodowego w Polsce, t. 3.

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THE CONTRIBUTIONS OF THE POLISH GEOLOGICAL INSTITUTE TO THE GREAT DISCOVERIES OF MINERAL RESOURCES DEPOSITS OF POLAND

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Established in 1919 The Polish Geological Institute had as one of its most important tasks the identification of the country's raw material potential in order to ensure economic development, both industrial and agricultural. The greatest discoverer of raw material deposits during this period was the cartographer and outstanding expert on the Holy Cross (Świętokrzyskie) Mountains, Professor Jan Samsonowicz. As early as 1922, in the course of his cartographic work, he discovered a deposit of iron ore in Rudki near Nowa Słupia. This discovery was followed by the establishment of the "Staszic" mine, where high-grade iron ore was mined. The main ore minerals were haematite, pyrite and siderite. This mine operated, intermittently from 1925 to 1973. It is worth mentioning that after the war about 40 tonnes of uranium were recovered from the ores exploited in this mine.

Two years later, he discovered phosphorite deposits at Rachów-on-Vistula, a mineral that was extremely important for pre-war agriculture. The exploitation of this mineral and the production of fertilisers for agriculture began one year later. The exploitation of these phosphate deposits, the richest in Poland, continued until the exhaustion of the resources in 1971. In the peak period of activity (1960s) in the "Annopol phosphate mines" there were about 600 employees and the annual output was 80,000 tonnes. The total amount of mineral extracted from these deposits was only about 1.15 million tonnes, i.e. Poland's current annual demand for this raw material, but taking into account the needs of the time it is difficult to overestimate the significance of this discovery for Polish agriculture.

In 1927, Samsonowicz began his research in Volhynia, then within the boundaries of Poland, and found flint pebbles with Carboniferous fauna in the alluvium of the Pełcza River. Intensive research works carried out by a team of PGI employees led by Józef Porzycki in 1960–1971 allowed to the documentation of the "Łęczna" deposit, from which the first tonnes of coal were extracted in 1982. The establishment of the Lublin Coal Basin became a fact. Exploitation is now carried out on both the Polish and Ukrainian sides of the border.

Gravimetric measurements were carried out in the area of the Polish Lowlands between 1937 and 1939. On the basis of their interpretation, Prof. Edward Janczewski came up with a concept of the presence of a large salt diapir in the Izbica (Kujawy) area. The war interrupted the research, but already in 1947 the Kłodawa 1 borehole was drilled by PGI, in which rock salt was discovered at a depth of 350 m. Exploration of rock salt and potash deposits was carried out with great intensity and led to the documentation of huge deposits. In 1964, a team of scientists from PGI discovered deposits of potassium and magnesium salts in the Puck Bay area. By 1972, five deposits of polyhalite had been documented there.

The discovery of copper-silver deposits in the so-called Zechstein copper-bearing shales (Kupferschiefer) is the most spectacular mineral resource discovery in Europe in the 20th century. Exploration began in 1951 with seismic surveys. Their interpretation was followed by subsequent boreholes, until finally, on 23 March 1957, copper ore of industrial significance was found in borehole Sieroszowice IG 1, designed by Jan Wyżykowski, at the depth of 655.95 m. The first geological documentation for the Lubin-Sieroszowice deposit was compiled in 1959, and copper resources were estimated to 19.3 million t. Documentation work on Cu-Ag ores continues to the present day, and the prospective copper resources are estimated at 180 million t. The total copper resources found in copper-bearing shale in Poland amount to 12–15% of the world's reserves of this metal.

In 1953, in Mokrzyszów in the Podkarpacie region, Professor Stanisław Pawłowski and his wife Katarzyna Pawłowska discovered the presence of native sulphur. Intensive geological research resulted in a new deposit being documented almost every year, and exploitation began as early as 1958. In a short time, Poland became a major producer of sulphur. Between 1975 and 1990 extraction reached 5 million tonnes per year, and to date total extraction has exceeded 130 million tonnes.
In the years 1954–1955, Prof. Jerzy Znosko conducted research on the Middle Jurassic rocks in the Kłodawa-Łęczyca anticline area, where he documented the deposits of refractory siderite. These deposits were exploited for about 20 years. From 1958 to 1962, he conducted research in the area of a strong positive magnetic anomaly in NE Poland. The boreholes he designed drilled the top of the crystalline rocks of the East European Platform, and further led to the discovery and documentation of magmatic iron ore deposits with reserves of 1.34 billion tonnes, also containing admixtures of titanium and vanadium. These deposits, due to their depth, their insufficient metal content and their location in an area of very high landscapes value, are not currently planned for exploitation.
At present, the generation of energy from coal is subject to enormous criticism, but for Poland, both in the past and today, lignite is the cheapest source of energy. The role of deposit geologists is to discover and document mineral deposits. In the case of lignite, this task was excellently fulfilled by a team led by Prof. Edward Ciuk and later by Prof. Marcin Piwocki. Starting in 1952, the PGI team of scientists discovered several dozen lignite deposits, including the largest ones in Bełchatów, Złoczew, Adamów or Gubin. In total, their resources are estimated at around 24 billion tonnes.
In conclusion, the geologists of the Polish Geological Institute have fulfilled the tasks they had to perform. Are we still awaiting further discoveries of large mineral deposits in Poland? Rather not, as the geological structures are well recognised to a depth of several kilometres.

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HISTORY OF GEOLOGICAL EXPLORATION AND EXPLOITATION OF URANIUM DEPOSITS IN SUDETES (SW POLAND)

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The history of the study of uranium mineralization in the Sudety Mountains is relatively long, as it began in 1853, when M. Websky described a new mineral – uranophane – in the ore veins of Miedzianka deposit, and during the construction of a railway tunnel in Trzcińsko near Jelenia Góra concentrations of autunite and torbernite in the granites were discovered. These manifestations of uranium mineralisation, as well as the presence of pitchblende found in Kowary in 1912, did not arouse wider interest. Larger concentrations of uranium minerals were found only in 1926 in the ore field "Wulkan "of the "Wolność" Mine in Kowary (German: Schmiedeberg, mine Bergfreheit Grube). But the search for large-scale uranium concentrations began shortly after the end of the Second World War. On the basis of an agreement, signed on 15 September 1947, between the Government of the Republic of Poland and the USSR Government, the Russians carried out uranium exploration practically without any control by the host country in the area, until 1956, gradually limiting their activity, and Soviet geologists were replaced by Polish personnel. As a result of their exploration, the Russians discovered more than 100 points of uranium mineralisation throughout Poland and 16 deposits, the vast majority of which were in the Sudetes. These were small deposits, and the largest of these, "Wolność", "Podgórze" and "Radoniów", had resources ranging from 100 to 450 t U, with an average uranium content of 0.2% in the ore. Total uranium mining in Poland is estimated at around 700 tons. In comparison, about 220–250 000 tons of uranium were exported from the former German Democratic Republic, and annual uranium production on the territory of the former Czechoslovakia remained at the level of several thousand tons per year for a number of years (Strzelecki and Wolkowicz, 2019).

From 1956 prospecting for uranium ore deposits began at the Polish Geological Institute, in which the Laboratory of Radioactive Elements was established in 1956. The subject was also dealt with by researchers at the AGH University of Science and Technology and the Production Plant R-1, which operated in Kowary until 1967. In the initial phase, Polish geologists found it very difficult to carry out exploration work. First of all, they did not have the necessary experience and, in addition, when the Russians left Poland, they took almost all geological documentation related to their activities in Poland to the Soviet archives. As a result of quite intensive exploration in 1960–1990, the presence of uranium mineralisation was found in sedimentary formations of the Polish Lowlands, mainly in the Lower Ordovician Dictyonema shales of the Podlasie Depression and in the Lower Triassic sandstones of the Peribaltic Syneclise. However, they are not of economic importance (Miecznik et al., 2011).

REFERENCES

Miecznik, J.B., Strzelecki, R., Wołkowicz, S., 2011. Uranium in Poland – history of prospecting and chances for finding new deposits (in Polish with English abstract). Przegląd Geologiczny, 59: 688–697.

Strzelecki, R., Wołkowicz, S., 2019. History of Uranium Research in the Polish Geological Institute (in Polish with English abstract). Przegląd Geologiczny, 67: 75–90.

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100 YEARS OF GEOLOGICAL CARTOGRAPHY AT THE POLISH GEOLOGICAL INSTITUTE

Stanisław WOŁKOWICZ[1] and Krystyna WOŁKOWICZ[1]

The Polish Geological Institute was founded in 1919, only a few months after the country became independent. The first statute of the institute clearly specified the tasks of the PGI as a state survey and indicated as its most important duties the compilation and publication of geological maps and the study of the occurrence of mineral deposits necessary for the economic development of the country. However, it should be remembered that during the period of the Partitions of Poland, especially in the second half of the 19th century, cartographic activity conducted by the Physiographic Commission of the Academy of Arts and Sciences was very actively developed on the territory of the Austrian partition, with the greatest achievement being the preparation of more than 100 sheets of the "Geological Atlas of Galicia" (Wołkowicz, Wołkowicz, 2014). The continuity of the cartographic work carried out is evidenced by the fact that the first publication of the PGI was the Geological Map of the central part of the Świętokrzyskie Mountains 1:100 000, published in 1919. The most outstanding cartographic achievements of the interwar period are Geological Map of Poland by Czesław Kuźniar (1926) and Map of Mineral Resources of the Republic of Poland by Stefan Czarnocki (1931). The cadre of experienced geologists in this period was quite small, but a number of cartographic studies were developed at that time which are still of high scientific value. These include sheets of Geological Map of Poland in the scale 1:100,000: Opatów (Samsonowicz, 1932), Nadwórna and Skole (Bujalski, 1938), Kielce (Czarnocki, 1938) and the reference Sheet Grodziec of the Detailed Geological Map of the Polish Coal Basin in the scale 1:25 000 (Doktorowicz-Hrebnicki, 1934).

After the Second World War there was a remarkable development of geological cartography at the PGI, which was largely due to Professor Edward Rühle, long-time director of the Institute and an excellent cartographer. Numerous editions of serial geological maps at various scales, thematically very diverse, covering all the fields that make up geology in its broadest sense, were undertaken. There were also produced geological, geological-structural, hydrogeological, geological-engineering, mineral raw material – by type of minerals, geophysical maps. In addition to maps and atlases covering the whole Poland, there were also developed regional atlases and maps whose creation was most often motivated by raw material issues. After the social and economic transformations which took place in 1989, issues of environmental protection, protection of raw mineral deposits, geochemistry focused on geogenic and anthropogenic pollution affecting living standards of the population became important. Popularisation of geological knowledge also became important, hence the appearance of geological-touristic maps. New data collection technologies in the form of digital databases and the resulting editing possibilities have significantly modified the form in which maps are made available to the public. Now we are no longer talking about maps, but rather about databases that make it possible to generate maps, the content of which can be created by the recipient. Numerical information is also important: during its 100 years of existence, the Polish Geological Institute has compiled and published more than 15,500 geological maps and atlases (Wołkowicz, 2020)!

REFERENCES

Wołkowicz, S., Wołkowicz, K., 2014. Geological cartography in Poland in the 19th century. Geological Quarterly, 58 (3): 623–658.

Wołkowicz S., 2020. 100 lat kartografii geologicznej w Państwowym Instytucie Geologicznym: ważny etap na drodze od 1764 r. z perspektywą na następne lata. W: Wołkowicz S. [ed.] Atlas map Państwowego Instytutu Geologicznego. Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, Warszawa.

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EARLY HISTORY OF GEOPARKS IN JAPAN

Michiko YAJIMA[1] and Takako HONJO[2]

Geological Society of Japan (JSG) was founded in 1893. The number of members were 128 in 1897, 5300 (maximum) in 1999 and now 3000. Around the end of 20th Century, all mineral mines and coal mines in Japan were closed, geologists in Japan worried about the future of geological studies. At that time, news about geoparks came from Europe. Some Japanese geologists attended the first International Geopark meeting at Beijing in 2004, the second meeting at Belfast in 2006, and then in 2008 four Japanese applicants attended in Osnabruck meeting.

In December 2007, the Japanese Geopark Liaison Council was established with support from Japanese geologists and private organizations that were conducting geological surveys, and some local authorities and others who wish to establish Geoparks began exchanging ideas. In December 2008, seven Japanese Geoparks were designated as national geoparks. In May 2009, the Japanese Geopark Liaison Council became the Japanese Geoparks Network (JGN). Geoparks in Japan started in 2009.

In order to spread the concept of geoparks, JGS and the Geological Survey Japan (GSJ) invited Dr Wolfgang Edder, man of geoparks, and made provincial tours around Japan. He found "Rock Green Café" in the countryside of south-east Japan, and he lectured Rock Green Café is very Geopark, the spirit of geoparks. Japanese geoplogists used "Rock Green Café" for advertising geoparks.

Before this geopark moving in Japan, Itoigawa City, north-east Japan, had the original idea with geoparks in 1987. The city prepared the outcrop of Fossa Magna in 1990, had plan of Geopark in 1991, and founded Fossa Magna Museum in 1994. Fossa Magna is the large fault, divided Japan, and named by Edmund Naumann, the father of geology in Japan.

As of April 2023, the JGN regular membership consists of 9 UNESCO Global Geoparks in Japan and 37 Japanese National Geoparks. There are 7 aspiring geoparks listed as associate members. Every year, the JGN National Conference and workshops are held. Active support is given to areas which have suffered from natural disasters through sharing information about natural disasters, such as earthquakes.

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RECONSIDERING THE SCIENTIFIC REVOLUTION BY "COSMOGRAPHICAL REVOLUTION" INCLUDING COPERNICAN AND STENONIAN REVOLUTIONS

Toshihiro YAMADA

This paper aims to reconsider the narrative of the Scientific Revolution, which have placed importance on the origin of modern physics from Copernicus to Newton. The intellectual change has been sometimes called "Copernican revolution" such as Thomas Kuhn's famous book of 1957. Although Kuhn mentioned to two spheres in the cosmos i.e. the Earth and the Heavens, he scarcely treated with the former, focusing on the latter, an astronomical revolution. When we review the history of cartography, however, we easily recognise the diffusion of revised Ptolemy's geography as "cosmographia" in the 15th and 16th centuries, which apparently featured first mathematical geography such as the Ulm edition of 1482 and then descriptive geography like Sebastian Münster's "Universal Cosmography" of 1550. If we admit what the American historian of geography Denis Cosgrove suggested about the cosmographical projection, which changed the way of view of the world before the Copernican turn on the macrocosm, we have to rather call it "cosmographical revolution" in which Copernican one was included. Moreover, the French historian Frank Lestringant investigated the mythological meaning behind particular indigenous legends reported in such cosmography as André Thevet, a successor of Münster. This implied one more step in the revolution which would be led to the universal history in the 17th century. Thus, in this context, we can rethink the Stenonian revolution, which the Irish geologist historian Gordon Herries Davies claimed, as a result of this kind of enlarged cosmographical revolution, which historicised natural history into geological history.

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Tour Guide

48 th INTERNATIONAL COMMISSION ON THE HISTORY OF GEOLOGICAL SCIENCES (INHIGEO) SYMPOSIUM

Day 1.

Złoty Stok – old gold and arsenic mine

Krystyna Wołkowicz

On the northern edge of the northwestern part of the Góry Złote ("Golden Mountains"), in Złoty Stok, there are located deposits of gold and arsenic ores. The first information about mining activity in the area of this deposit dates back to 1273. They lasted, with only minor interruptions, until 1962, when they were stopped due to unprofitability. Work was carried out on the three northernmost elevations of the Góry Złote range, namely Góra (Mount) Haniak, Góra (Mount) Krzyżowa and Góra (Mount) Sołtysia, aligned in a W-E direction (Fig. 1). In the earliest period of exploitation, the most important deposits were those on the eastern slope of Góra Haniak, known since the 15^{th} century under the names "Goldener Esel" and "Reicher Trost". In the 14^{th} century, extraction developed in the "Himmelfahrt" deposit on the eastern slopes of Góra Krzyżowa. The deposit on Sołtysia Góra had a lower value. The slopes of the hills were the area where mining and ventilation shafts were deepened, while the lower parts of the hills had the outlets of adits. The Złoty Jar, located between the Krzyżowa Góra and the Sołtysia Góra, was important for mining. The Złoty Potok ("Golden Brook") flowing there provided a source of energy for the equipment in which the excavated material was processed (1.).

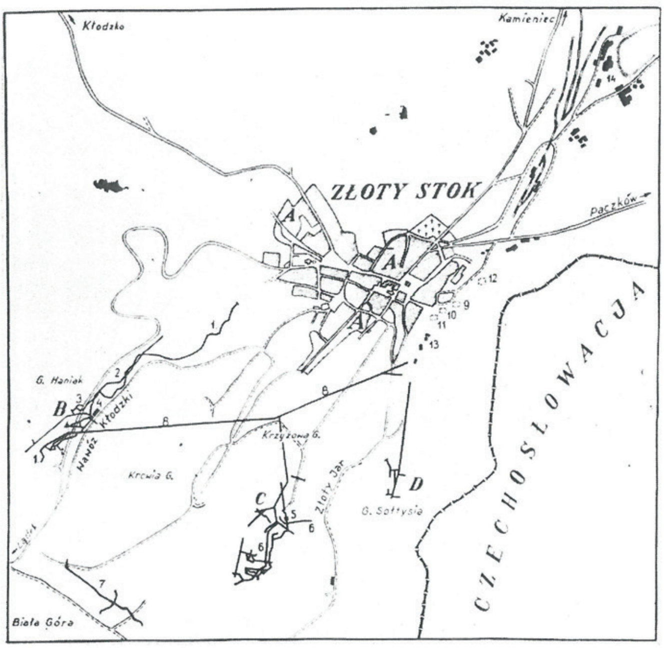


Fig. 1. Plan of the area around Złoty Stok with marked excavations, buildings and equipment associated with former mining and smelting works. (1.).

Mining exploitation in Złoty Stok from its beginnings, i.e. from the 13^{th} to the end of the 17^{th} century, was mainly focused on the extraction of ores for gold production. Gold mining reached its maximum level at the turn of the 15^{th} and 16^{th} centuries, when the Złoty Stok mines supplied 8% of total gold production of Europe (2.). It was not until the 18^{th} century that the local smelter began to use the rich arsenic ores to produce, among other things, arsenic trioxide. Arsenic trioxide became the main product of Złoty Stok for many years. It was used to dye glass, tan leather and produce rodent poison (2.). Between 1545 and 1549, 190 adits and mining excavations were in operation, and gold production reached over 140 kg/year. Ores of 11.4 ppm Au were mined in 1514 and 17 ppm Au in 1744 (1.). In 1507, the ducal mint was moved here from Ząbkowice Śląskie and gold ducats began to be minted (Fig. 2) (3.). After the World War II, the balance arsenic ores contained up to 6% As and about 2.8–3.5 ppm Au. According to the geological documentation of the Złoty Stok deposit made in 1954, the proven reserves of the deposit were 714,000 t of ore containing 25500 t of arsenic trioxide As_2O_3 (2.). In addition to it, up until the last years of the mine's operation, up to 20 kg of gold per year was extracted (2.). As mining developed, ore exploitation was concentrated in four mining fields: in the Krzyżowa Góra field on the western slopes of Złoty Stok, in the Sołtysia Góra field east of this valley, in the Western Field under Góra Haniak and in the Biała Góra field (under the Ciecierza ridge).

Fig. 2. A gold ducat, minted at the mint in Złoty Stok in 1586 by W. Rosenberg, then owner of the town. The obverse depicts St Christopher, the reverse - the family coat of arms (1.).

In 1920, the two-kilometers-long Gertruda adit was built to connect all the mine fields. According to various estimates, the total gold production was about 9 tonnes, with an average gold content in the ore of about 2.3 ppm (1.) to 16 tons, with an average Au content in the ore of 3 ppm (2.). Before World War II German geologists considered gold to be isomorphic admixtures in löllingite (up to 30 ppm Au) and arsenopyrite (5.2-34.8 ppm Au). More recent mineralogical work carried out by scanning electron microscopy has shown numerous sub- and microscopic sized inclusions of native gold in the deposit (4.). The formation of the deposit took place in the Carboniferous, during the Variscan orogenesis. It was associated with contact metamorphism at the boundary of the granitoid intrusion of the Kłodzko-Złoty Stok massif and the Lądek-Śnieżnik metamorphic complex (2.). The genesis of the arsenic-gold-bearing mineralisation is linked to the development of metasomatic-hydrothermal processes in this contact zone (4.). This type of deposit is referred to as intrusive-hydrothermal (2.). A typical example of an ore consisting mainly of arsenopyrite-löllingite is shown in Fig. 3. The resource documented in 1954 was estimated at 2 Mg gold in balance ore and 490 kg in off-balance ore. The average gold content of the arsenopyrite-löllingite ore is 2.8 ppm ore (resource balance). Prospective gold resources in the area are estimated at approximately 6 Mg.

The centuries-long mining activity in the Złoty Stok area was ended in April 1961, due to its unprofitability. The mine was closed shortly after that. In 1964, Prof. Dziekoński attempted to create an Underground Tourist Route here. However, these plans were not realised. In 1966, on the initiative of the local authorities, a Gold Museum – the Chamber of Gold Mining and Metallurgy, was established in Złoty Stok. Three years later, as part of a tourist route run by a branch of the PTTK (Polish Tourist and Sightseeing Society), the Princes' Adit in the underground of the Złoty Stok mine was opened to the public. Unfortunately, this venture fell through. 30 years later, on 26.05.1996, a new attempt was made to open the mine in Złoty Stok to the public. The underground tourist route was created as a result of the efforts of the town authorities and private investors. Initially, it included sections of quite distant workings: the Gertruda and Czarna Górna adits. As part of the development of this tourist facility, elements of the surface infrastructure were renovated, the Czarna Dolna adit was made accessible, and in 2008 a 200-metres section of the underground railway was opened. In 2010, approximately 950 metres of adits and 23 metres of shafts were open to the public, representing approximately 0.03% of the length of all the excavations of the former mine (5.).

Fig. 3. Arsenopyrite - Złoty Stok, coll. S. Wolkowicz (608.IV.16). From the collection of the PGI-NRI Geological Museum. Photo: K. Skurczyńska-Garwolińska.

REFERENCES:

1. Dziekoński, T., 1972. Wydobywanie i metalurgia kruszców na Dolnym Śląsku od XIII do połowy XX wieku (in Polish). Ossolineum, Wrocław.
2. http://geoportal.pgi.gov.pl/zrozumiec_ziemie/wycieczki/sudety_1/dzien_I/punkt_1_3
3. https://kopalniazlota.pl/historia-kopalni-zlota-w-zlotym-stoku/
4. Mikulski, S., 1996. Złoto z kamieniołomu Złoty Jar k. Złotego Stoku (Sudety) (in Polish). Prz. Geol. 44, 12: 1205–1210
5. Zagożdżon, P.P., Zagożdżon, K.D., 2010. Podziemna trasa geoturystyczna w „Kopalni Złota w Złotym Stoku" – propozycja. Dzieje górnictwa – element europejskiego dziedzictwa kultury 3 (in Polish). Ofic. Wyd. Polit. Wr., Wrocław: 520–538

Kowary – iron and uranium mining

Stanisław Wołkowicz

Mining in the Kowary (German name – Schmiedeberg) area had a very old and rich tradition. In 1513 Kowary was granted the rights of a mining town, and at the beginning of the 16th century there were 11 forges (smithies) working there. All the work was related to iron mining (1.) In the second half of the 17th century, during the general collapse of mining activity in Lower Silesia, textile manufacturing developed in Kowary. When, in the second half of the 18th century, intensive exploration for ore deposits began in one of the former iron ore mines in Kowary, a vein 30 cm thick was unexpectedly found, containing lead minerals with some silver content. The iron deposits in the Kowary area are metamorphosed sedimentary deposits with magnetite (Fig. 1) as the main ore mineral overlapping with later (Variscan) polymetallic mineralisation with uranium. This polymetallic mineralisation is associated with the Upper Carboniferous granite intrusion of the Karkonosze massif.

In 1799, a mining company was founded under the name of "Redens Glück", whose main share was acquired by the local weaving mill. Two pumps were installed in the shaft. A washing plant with three blunts for crushing and ore enrichment was also installed, but further development of the works did not live up to expectations. The vein proved to be poorer and often disappeared. As a result, the owners of the shares, mainly the weaving mill, stopped making subsidies and in 1808 the Higher Mining Authority suspended the works. The data on mining production during the six years of the mine's operation is very fragmentary. We learn from them, among other things, that in 1803 a total of 200 tonnes of ore was obtained, of which sorted 140 tonnes and unsorted 60 tonnes. It is likely that some of it came from workings carried out in previous years. All concentrates were smelted in Miedzianka, located a few kilometres east of Kowary. In 1803 – 1.5 kg of silver, 0.7 tonnes of lead and 0.1 tonnes of gley were obtained, and in 1806 3.5 kg of silver, 0.2 tonnes of copper, 1.2 tonnes of lead and 0.4 tonnes of gley (litharge) were obtained (2.).

Fig. 1. Magnetite, "Wolność" mine, Kowary, (37.I.2) coll. Exhibition of the Regained Territories. Photo: K. Skurczyńska-Garwolińska.

History of geological exploration and exploitation of uranium deposits in Sudetes (SW Poland)

Geological exploration of uranium ore, not only in Poland, has been practically dated back to the 1940s, when the military use of uranium was discovered and later also as an energy source. This less than 80-year history of geological exploration of uranium ore in the earth's crust is an example of the rapid development of research methodology for the exploration work documenting raw material resources, which are currently sufficient for the needs of nuclear power for decades. Unlike other raw materials, in the initial period when uranium was needed for the construction of nuclear bombs, the costs of exploration, extraction and processing of uranium ore were not a determinant for geologists dealing with prospection. It was perfectly evident in the Soviet Union, which immediately after World War II began the search in addicted countries, and what may seem strange today, even financed them. It was a time of great uranium "starvation". The another characteristic feature of uranium ore has been the direct or indirect control of its exploration and extraction by the state. In the 1950s, such monopolies had the companies strictly controlled by the US, the Soviet Union, France and the United Kingdom. Later this monopoly has weakened somewhat, but these countries still control the extraction and processing of uranium ore to prevent the proliferation of nuclear weapons. Iran in the second decade of the 21st century is the best example. The history of exploration and exploitation of uranium ores in Poland is partially included in this scenario.

Occurrence of uranium minerals for the first time in the present Polish Lands was found in the Sudetes long time before the discovery of the phenomenon of radioactivity.

In 1853, M. Websky described a new mineral – uranophane – in the ore veins of Miedzianka deposit, and during the construction of a railway tunnel in Trzcińsko near Jelenia Góra were discovered concentrations of autunite and torbernite in the granites. These manifestations of uranium mineralisation, as well as the presence of pitchblende found in Kowary in 1912, did not arouse wider interest. Larger concentrations of uranium minerals were found only in 1926 in the ore field "Wulkan"of the "Wolność" mine in Kowary (German: Schmiedeberg, mine Bergfreheit Grube). With a lack of interest the extracted ore was stored on piles and only in the years 1936–1939 were sold to research facilities in Oranienburg near Berlin and industrial plants Stahlwerk A.G. in Hamburg. In total, 64,756 kg of ore with an average radium content of 73 micrograms per ton were delivered to these plants (2.).

It was only in the years after the World War II that the uranium ore in the Sudetes suddenly became, for a short time, of great importance. Their search including project works, field investigations and documentation works were carried out in the years 1948–1990. The exploitation of uranium deposits and uranium occurrences took place in the period 1948–1967. In the search works conducted in Poland in the years 1948–1990 can be divided into three periods:

PERIOD OF 1948–1956 – can be called "Russian" because geological research works were conducted by Soviet specialists only. Poles were only auxiliary personnel such as drillers, miners, drivers etc. Moreover, the geological survey, which was the Polish Geological Institute, the state geological administration and universities, had no right to conduct any uranium exploration or research work in the country. This was the result of an agreement, signed on 15 September 1947, between the Government of the Republic of Poland and the USSR Government on the exploitation of the Kowary (former Schmiedeberg) deposits and the supply of ores from these deposits to the USSR. The agreement was signed for 20 years, and under it a special enterprise was established, which since January 1, 1948 has taken up the exploitation and exploration of uranium deposits in Poland.

The Russians carried out prospecting works in Poland based on the commonly used model in the USSR, based on the operation of the geological expedition which carried out works by exploration groups operating on separate geological structures. Search groups were "self-sufficient", and were composed of geologists, geophysics, technicians, geophysical equipment operators, laborers and miners. Depending on needs, they have drilling equipment. Specialistic laboratory research, among others, chemical analytics, mineralogical and petrographic studies were conducted at the expedition headquarters in Kowary. A specific feature of this work system was, in the case of finding of uranium mineralisation, that the ore was immediately exploited. The only condition was that the weighted average uranium content was at least 0.2%. As a result, uranium was extracted from the ore occurrences which, during further exploration, turned out to be negative due to the uranium small reserves.

In the first stage, the Russians carried out geological surveys, mainly gamma-ray measurements and rock sampling, in all active and inactive underground and open pit mines, old tunnels and piles. These works were conducted mainly in the Sudetes, to a lesser extent in Upper Silesia and in the Holy Cross Mountains. How detailed were these explorations may indicate that they also conducted in the Tatra National Park, where uranium mineralisation was discovered in Triassic limestone in Dolina Białego. Fortunately, it turned out that it was a mineralisation without any industrial value.

From the beginning of the exploration works, radon emanation measurements were used as a basic prospecting method, performed in regular grids of 200 x 5 m. For the most perspective areas emanometric measurements were made in detailed scales e.g., in the eastern metamorphic border of the Karkonosze massif between Miedzianka and Śnieżka was a grid of 50 x 5 m. In the zones of discovered anomalies, emanation measurements were more detailed, performed gamma radiometry, geological mapping and rock sampling in specially prepared trenches, shafts and adits. The efficiency of the emanation measurements in the outcrops of crystalline rocks was high and it was discovered numerous uranium occurrences and deposits located at shallow depths. This method was also used, on a smaller scale, in the Holy Cross Mountains, the Carpathians and Upper Silesia. During the existence of the ZPR-1 was made enormous amount of – approx. 15 million measurement points of radon emanation.

Starting from 1951, the method of radiohydrogeological mapping was applied on a scale of 1:25 000 and 1:10 000. The natural watercourse, springs and wells were sampled. Approximately 20 000 water samples were collected in 1957, in which radon concentrations were determined, and in the case of increased concentrations, radium and uranium were chemically determined. Car gamma radiometric measurements were also used, and in 1954–1956 an aeroradiometric measurements were taken in the Sudetes, Carpathians and Upper Silesia.

The enormous quantity of exploration works, especially in the years 1948–1953, allowed to discover in the Sudetes of about 100 points of uranium mineralisation (85 of which were discovered by 1953) and 16 uranium deposits of 18 known in the Sudetes (Fig. 2).

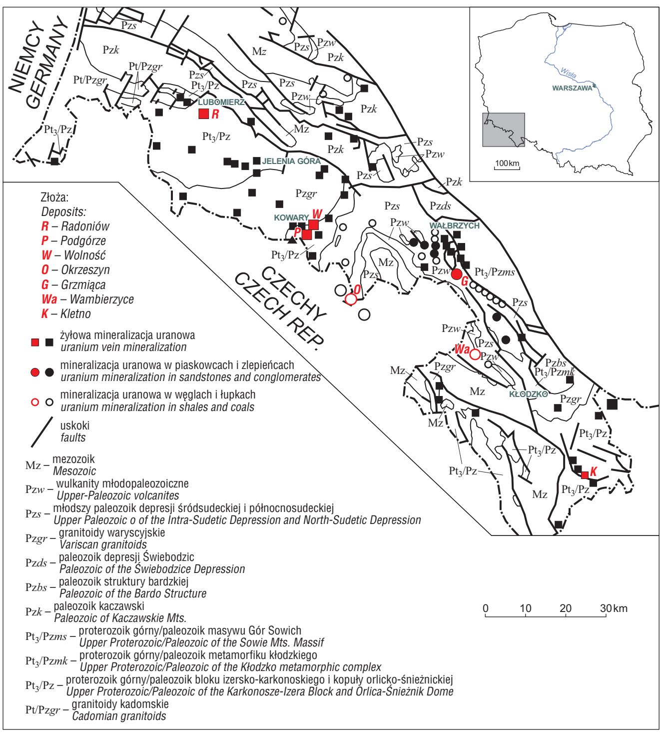


Fig 2. Uranium deposits and occurences in Sudetes (3.)

The knowledge obtained by the Russians about the uranium geology of Poland could cause them to take a decision to withdraw from the search for this element in Poland only after 8 years of Polish-Soviet agreement (delivery of uranium ores to the USSR lasted 6 years, until 1962). Political turmoil of 1956 undoubtedly accelerated this decision. The results of the exploration work indicated the lack of possibility for the discovery of easily accessible large (i.e., resources >1000 tons) uranium deposits. Discovered vein-type deposits were characterised by small uranium resources. The three largest ones: "Wolność", "Podgórze" and "Radoniów", had reserves of between 100 and 350 tons of uranium, in ore with an average content of 0.2%. An additional argument for stopping uranium exploration in Poland could have been the discovery of large uranium deposits in the former GDR and Czechoslovakia.

Deposits related to sedimentary rocks: "Okrzeszyn", "Grzmiąca" and "Wambierzyce", were characterised by low uranium content, costly technology of uranium recovery from hard coal in the case of the Okrzeszyn deposit and small resources not exceeding 1000 tonnes each.

It should be emphasized that after 1956 no "new" uranium deposits were discovered in the Sudetes.

During the years 1948–1956 in a similar way the company operated the Soviet-Czechoslovak and Soviet-East-German. They discovered and exploited the largest uranium deposits in Europe. Uranium was obtained and exported to the USSR until the political changes in 1990. Only in the case of deposits from the area of the former GDR were excavated about 200–250 thousand tons of uranium. For comparison, only about 700 tonnes of uranium have been mined in Poland, of which 600 tonnes from deposits in the Sudetes and 100 tonnes from the "Staszic" pyrite mine in the Holy Cross Mountains (3.).

THE PERIOD 1957–1967 – was a period of continuation of exploration work in the Sudetes by Industrial Plant R-1 (ZPR-1), but already with the participation of Polish geologists and geophysics, and the beginning of exploration and research works by the Geological Institute in Warsaw and some universities, among which stood out activity of Academy of Mining and Metallurgy (AGH) in Cracow.

At the ZP R-1 at the turn of 1955/1956 the gradual withdrawal of Soviet personnel began, and its replacement by Polish geologists, geophysicists, but who had no experience in exploration of uranium deposits. The lack of geological documentations containing the results of previous exploration work in the Polish language was also an important obstacle. This was the reason for the request of the Polish government at that time to keep several Soviet geologists and geophysicists in Kowary during the transition period. They finally left Kowary in 1958.

In the ZPR-1, the Polish staff prepared a summary of the results of the search conducted until 1957 in the document entitled "Evaluation of the uranium potential of the Sudetes". Independent expert opinions related to the results of previous work and the program of further uranium exploration in Poland were developed at the Geological Institute in Warsaw, and later at AGH in Cracow.

PERIOD 1968–1990. Projects of construction of the first nuclear power plant have intensified the exploration work of uranium, which has been carried out exclusively by the Geological Institute (in 1973 formally closed the ZPR-1 in Kowary). They were large projects of geological work carried out with the use of geophysics and drilling works, and their main goal was to identify occurrences of uranium which have been discovered in northern Poland – Triassic of Peribaltic Syneclise (east and south-east of Gdańsk and Elblag) and in eastern Poland – Ordovician of Podlasie Depression (south of Białystok) during the parallel research in the years 1958–1967 (Fig. 3). Returned to studies verifying the uranium potential of Sudetes. Exploratory projects were carried out for the study of uranium potential of the Upper Carboniferous sedimentary formations od Intra-Sudetic Depression in the Grzmiąca-Nowa Ruda area and the Lower Permian Walchia shale in the Wambierzyce region. Also returned to the Karkonosze massif research to explain the possibility of occurring there the so-called intra-granitic uranium deposits, known from the granite massifs in France.

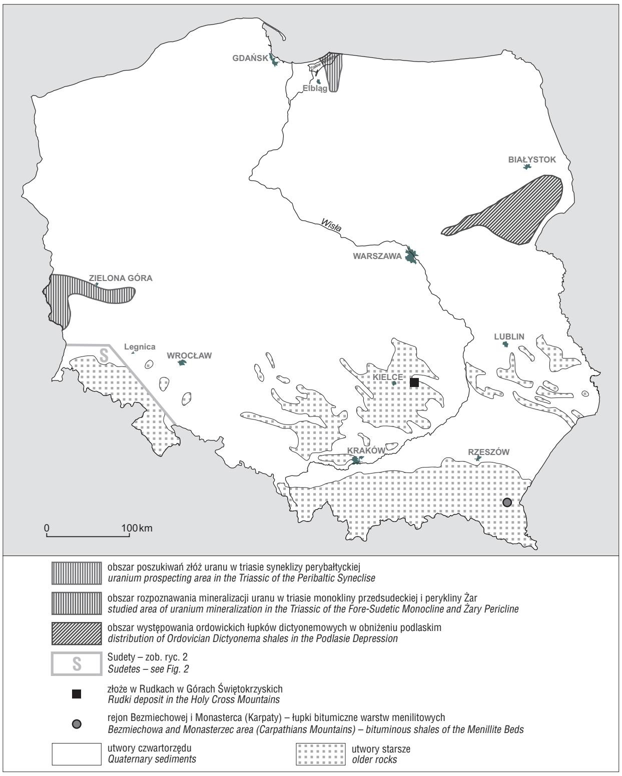


Fig. 3. Selected areas of uranium research in Poland (3.).

REFERENCES:

1. Dziekoński, T., 1972. Wydobywanie i metalurgia kruszców na Dolnym Śląsku od XIII do połowy XX wieku (in Polish). Ossolineum, Wrocław.
2. Cieszykowska, I., Fornalski, K., Gajda, D., Gajda, P., Janczyszyn, J., Latek, S., Mikołajczak, R., Rabiński, M., Rzymkowski, K., Sobieszczak-Marciniak, M., Strzelecki, R., Szreder, T., Wołkowicz, S., 2017. Polska atomistyka/Polish Nuclear Science. Wydawnictwo Instytutu Zrównoważonej Energii, Kraków.
3. Miecznik, J.B., Strzelecki, R., Wołkowicz, S., 2011. Uranium in Poland – history of prospecting and chances for finding new deposits (in Polish with English abstract). Prz. Geol., 59: 688–697.

Day 2.

Gierczyn-Krobica area – tin and cobalt mining

Krystyna Wołkowicz

The Krobica-Gierczyn area in the Western Sudety Mountains, within the **Karkonosze-Izera-Lusatian Block** (Fig. 1), is known for its historic mining exploitation of tin and cobalt. These ores were the object of mining exploitation carried out, with varying intensity, from the 16th to the mid-19th century. Most of the historic deposits were located in the zone between Krobica, Gierczyn and Przecznica (Fig. 2, 3). Initially, only tin ores were exploited. Information dating from 1512 and 1517 mentions a tin ore extraction in the vicinity of Gierczyn, in the area of the later discovered deposits – "Reicher Trost" and "Morgenröthe". The first documented mention of a mine located there dates from 1572, and already 8 years later, the annual extraction of tin ore made it possible to produce 7 tonnes of the metal. The owner of the mining concession was the Schaffgotsch family (1.). Initially, richer and more easily accessible parts were selected, often in a robbery-like manner, which resulted in an increase in extraction - during the next 14 years, 267 tonnes of tin were extracted (equivalent to about 20 tonnes of tin per year). The scale of production is evidenced by the fact that, at the same time, the tin manufactures of Bohemia and Saxony - the main European tin producers – were producing 20–50 tonnes of tin a year. At the end of the 16th century, the Świdnica Mining Authority, the manager of the Stara Kam-

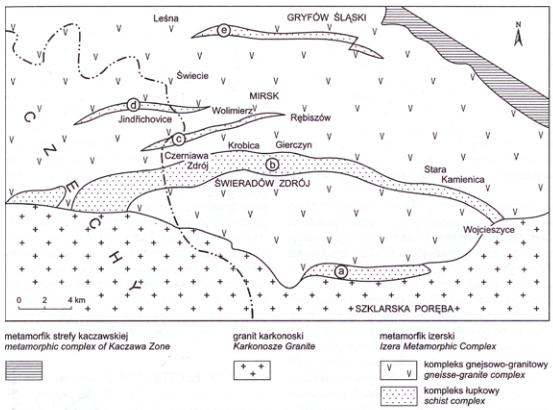


Fig. 1. The schists belts within the eastern part of the Izera Metamorphic Complex.
a – Szklarska Poręba Schist Belt,
b – Stara Kamienica Schist Belt,
c – Mirsk Schist Belt, d – Jindrichovice Schist Belt,
e – Złotniki Lubańskie Schist Belt (2.).

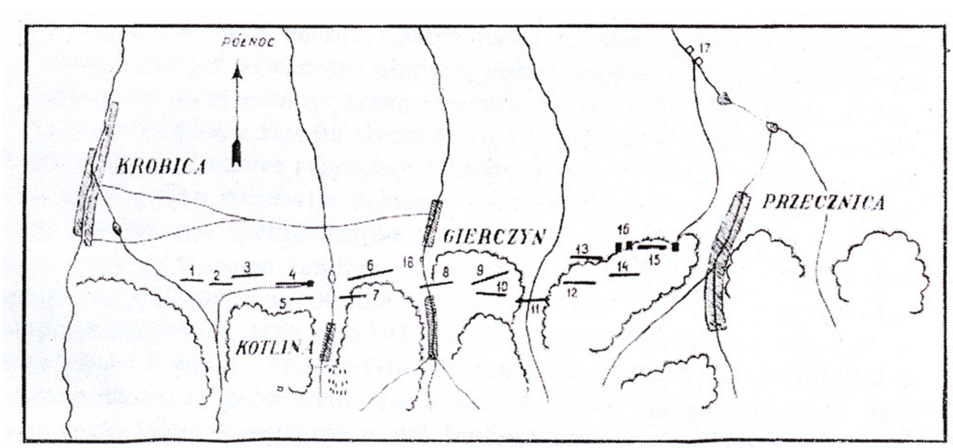


Fig. 2. Overview plan of mining areas in the vicinity of Gierczyn and Przecznica, dated 1776, indicating each deposit where prospecting or mining was carried out (1.).

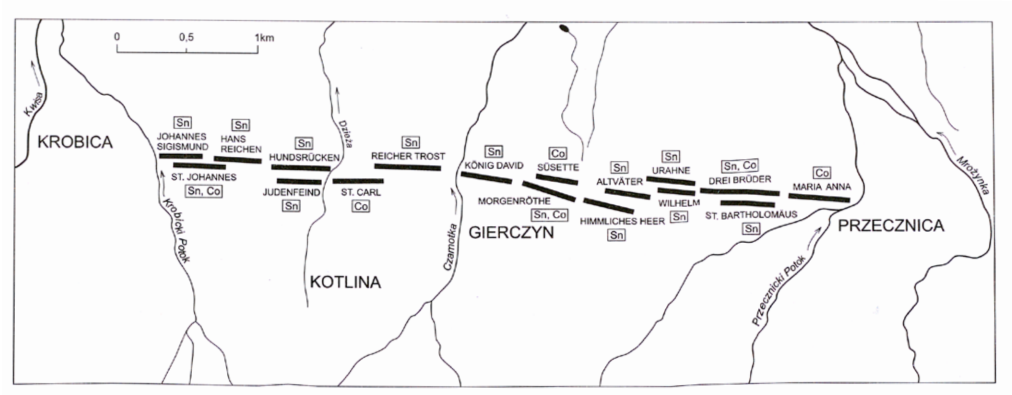


Fig. 3. Location sketch of tin and cobolt (Sn, Co) ore deposits in the Krobica, Gierczyn and Przecznica region. Mining and prospecting areas in the 17th–19th centuries (2.).

ienica tin-bearing schists belt deposits, established by decree the principles of systematic exploitation, including a proscription on robbery. Already while these rules were in force, the exploitation of copper ores accompanying the tin deposits was also undertaken locally. The regulations introduced resulted in a decline in tin extraction, which never again reached the level of the late 16th century; by the end of the 17th century it was oscillating around 1.5–4 tonnes of metal per year, despite the opening of new mining facilities (including a new shaft on the "St. Johannes" deposit in 1756). In the second half of the 17th century, the mining concession was withdrawn from the Schaffgotsch family, and it was granted to the Gierczyn mining company. Further recession of the local mining industry led to the collapse of the Gierczyn mining company in 1788. At the beginning of the 19th century small-scale tin mining was still carried out at the "Leopold" adit in the Krobica region (where mining had been carried out since the mid-18th century). Before the World War II, the German mining industry took an interest in the tin ore deposit at Gierczyn, but mining work was not restarted. Similarly, in the 1950s, the then-documented tin ore resources in the Gierczyn area did not represent, for those times, sufficient economic and mining value (1., 2.). The period of the decline of tin mining in the Stara Kamienica shale band coincided with the beginning of the exploitation and processing of the local cobalt ores mineralisation in the Przecznica area (Fig. 4). This was at a time when the only European sources of supply for these ores, which were the raw material for the manufacture of cobalt paint for the weaving and ceramic industries, were the deposits in Bohemia and Saxony. The prince of the Schaffgotsch dynasty, ruling at the time, opened the cobalt ore mine "Maria Anna" in Przecznica in 1769 and was granted a mining concession in 1773. Cobalt ores were also found in the Kotlina region ("St. Carl" mine), as well as in some former tin ore pits in the Przecznica ("Drei Brüder"), Gierczyn ("Morgenröthe") and Krobica ("St. Johannes") regions, but the resources of most of these deposits were exhausted within a dozen years. Only at the "Maria Anna" mine did mining work continue until 1840, and metallurgical work until 1844. The maximum mining production, at an average of about 2,200 tonnes of ore, occurred between 1796 and 1799, and thereafter there was a gradual decline in mining, although periodic fluctuations were marked. At the end of the 18th century, during the optimum period, production at Przecznica averaged 50–70 tonnes of dye per year,

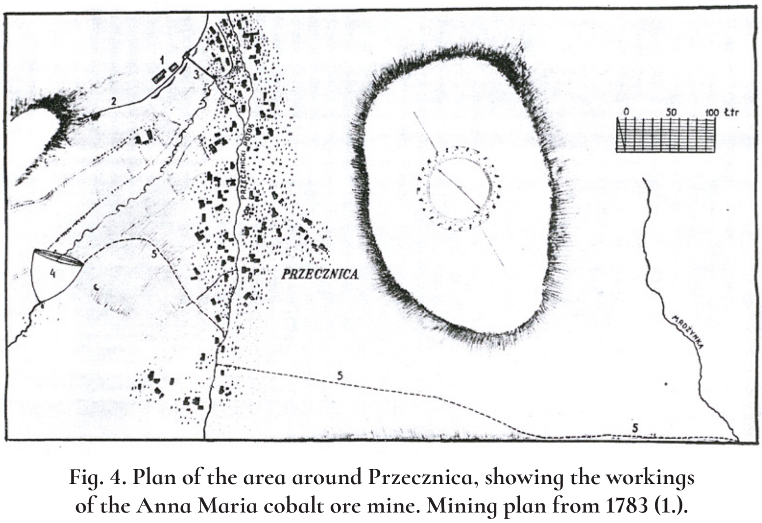
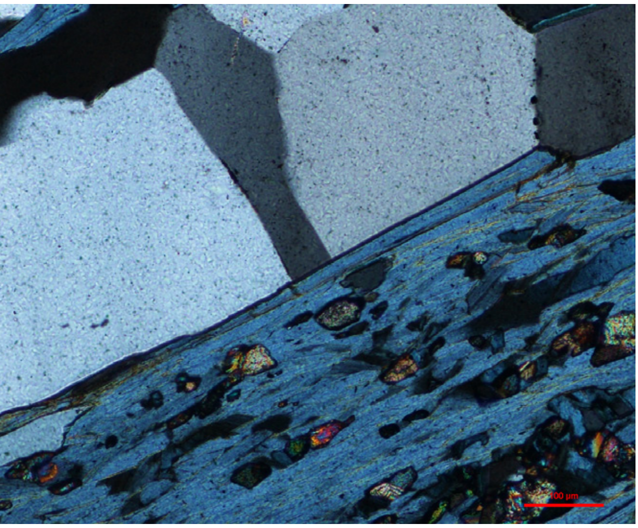
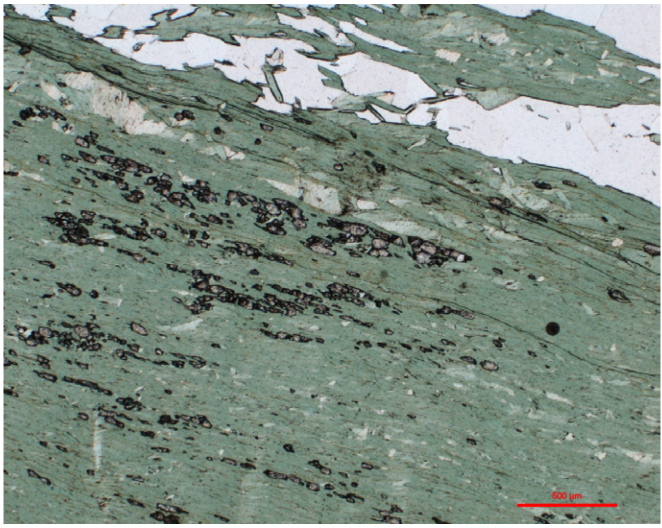


Fig. 4. Plan of the area around Przecznica, showing the workings of the Anna Maria cobalt ore mine. Mining plan from 1783 (1.).





Figs. 5 and 6. Cassiterite grains in a microscopic image. Photo: R. Małek.

which represented about 10% in relation to the Saxon production and played an important role in the European balance of cobalt dyes.

The cassiterite-cobalt mineralisation is associated with the Stara Kamienica Range – one of five narrow, latitudinally elongated bands of schistose schist occurring among the Izera metamorphic formations (2.) (Fig. 1).

The shales with cassiterite-sulphide mineralisation are fine-grained rocks of light grey or silvery grey colour (often with a greenish tinge) and granolepidoblastic structure with clearly visible foliation and lamination. The tin-bearing shales are 50 to 180 m thick and lie between packets of the feldspathic shale, from which they differ by higher amounts of biotite, garnets, chlorite and higher iron content (2., 3.). The main rock-forming minerals of the shales are quartz, muscovite, chlorite and biotite; less frequent are feldspars (mainly albite), garnets (mainly almandine), chloritoid; occasionally staurolite, gahnite and margarite. Accessory minerals include: apatite, tourmaline (szerl), zircon, monazite, xenotime, ilmenite, pyrotite and chalcopyrite. Also present: adular, epidote, calcite, fluorite, titanite, barite and others. The main tin mineral is cassiterite, which was observed in the form of small grains scattered singly or in larger groupings – clustered or corded [Figs. 5, 6 (2.)]. Stannins have rarely been found (4.).

There are two varieties of cassiterite: the older schistose variety (cassiterite forms inclusions in various schist minerals) and the younger quartz variety. The quartz assemblage contains fragments of the schistose assemblage, which is often cataclasised and tectonically stretched. The quartz that builds it, described as "blue" quartz, also contains accessory sulphide mineralisation (2., 5.).

Elevated concentrations of tin ores occurs mainly in the central part of the band.

Among the sulphides and other ore minerals of hydrothermal origin, arsenopyrite, glaucodite, safflorite and löllingite have been described as cobalt-bearing, as well as smaltyn (skutterudite) and cobaltite (2., 6.). Cobalt minerals were more abundant at the Anna Maria mine, but are now only trace, and cobalt is found in arsenopyrite and löllingite as isomorphic admixtures or as minor cobaltite inclusions.

Other hydrothermal mines include sphalerite, galena, bismuthinite, native bismuth, post-pyrite pyrite, molybdenite, electrum, native silver, Bi-sulphosalts, bornite, and others (2.).

The dominant structural direction corresponds to foliation and schistosity, which run, in different parts of the shale band, from about 75 to 100°, with dip angles in the range of 40–70°, usually to the N (2., 7.). The generalised profile of the shale band looks as follows (7., 8.): the lowest link is leptinite, above it there is a zone of metamorphic feldspathic shale

with a gneiss link and a shale-bearing cinnabar complex 50–200 m thick.
The genesis of the mineralisation was defined as sedimentary, post-metamorphic hydrothermal, associated with the Karkonosze massif, pre-metamorphic hydrothermal and according to more recent studies, metasomatic-hydrothermal, associated with the multi-stage development of intrusive-metamorphic processes of the pre-Variscan and Variscan cycles (9.).
Currently, according to the latest Mineral Resource Balance of 2022, tin ores occur in the Lower Paleozoic shale band of the Stara Kamienica in two deposits: Gierczyn and Krobica. The resources of these deposits have been classified as off-balance sheet. Recognised resources in the C2 and C1 categories amount to 5.5 million t of ore with an average content of about 0.5% Sn. The prospective resources in this area were determined to be 25.24 million tonnes of ore containing over 100,000 tonnes of metallic tin (9.). In the western part of the range, on the Czech side, the resources of the Nové Měsť̌o deposit have been documented (2.).

REFERENCES:

1. Dziekoński, T., 1972. Wydobywanie i metalurgia kruszców na Dolnym Śląsku od XIII do połowy XX wieku (in Polish). Ossolineum, Wrocław.
2. Michniewicz, M., Bobiński, W., Siemiątkowski, J., 2006. Mineralizacja cynowa w środkowej części pasma łupkowego Starej Kamienicy (Sudety Zachodnie) (in Polish). Prace PIG CLXXXV.
3. Małek, R., Mikulski, S., Chmielewski, A., 2019. Charakterystyka mineralogiczno-geochemiczna mineralizacji kasyterytowo-siarczkowej w historycznych sztolniach św. Jana i św. Leopolda w paśmie łupkowym Starej Kamienicy (Sudety Zachodnie) (in Polish). Prz. Geol., 67 (11): 914–925.
4. Karwowski, Ł., Włodyka, R., 1981. Stannine in the cassiterite-sulphide deposits of the Izera Mts (Sudetes). Acta Geol. Pol., 31 (1–2): 41–47.
5. Jaskólski, S., Mochnacka, K., 1959. Złoże cyny w Gierczynie w Górach Izerskich na Dolnym Śląsku i próba wyjaśnienia jego genezy (in Polish). Arch. Miner., 22 (1): 17–106.
6. Lis, J., Sylwestrzak, H., 1986. Minerały Dolnego Śląska (in Polish). Wyd. Geol., Warszawa
7. Moczydłowska, H., Zagrożdżon, P., 2013. Cyfrowy model trasy podziemnej turystycznej „Kopalnia Św. Jan" w Krobicy (in Polish). Mining Sc., 20: 27–38.
8. Michniewicz, M., 2003. – Surowce metaliczne w strukturze bloku karkonosko-izerskiego (in Polish). W: Ciężkowski W., Wojewoda J., Żelaźniewicz A. (red.) – Sudety zachodnie: od wendu do czwartorzędu (in Polish). Wyd. WIND, Wrocław: 155–168.
9. Mikulski, S., Małek, R., 2020. Rudy cyny (tin ores) W: Bilans perspektywicznych zasobów kopalin Polski, wg stanu na 31.12.2018 r. (in Polish). PIG-PIB: 162–167.

The Old Mine Science and Art Centre in Wałbrzych

Grzegorz J. Nowak

The centuries-long exploitation of hard coal deposits in Lower Silesia appears to be over. The coal seams exploited here are located in very difficult geological conditions, and the miners working there have always been exposed to methane explosions. It was in this small coal basin that the biggest mining disasters that have occurred in what is now Poland took place. In July 1930, 151 miners died in a disaster, and in May 1941, 187. During the period of communist regime in Poland, coal mining in the Wałbrzych region was very intensive, and coking plants operated on the basis of the extracted coal. Nobody particularly cared for the environment. After the political and economic changes of 1989, coal mining soon began to decline, and the last mine was closed in 2000. A year before this date, the local authorities decided to donate the premises of the mines to the local museum. This developed the concept of using the post-industrial buildings for museum, exhibition and educational purposes. The Old Mine Science and Art Centre was officially opened in 2014. It is an excellent example of how old post-industrial buildings can be revitalised and used.

Geology of Lower Silesian Coal Basin

The Lower Silesian Coal Basin (LSCB) is located in southwestern Poland in the region of Wałbrzych and Nowa Ruda. Its area – in terms of the conventional area of Carboniferous deposits – is approx. 1,200 km². The area of occurrence of coal seams eligible for exploitation is much smaller and is approx. 350–450 km². Geologically, the LSCB is located in the northwestern part of the Intrasudetic Synclinorium, the largest geological unit of the Sudetes, constituting a basin filled with rocks from the Mississippian to the Upper Cretaceous. The Carboniferous coal-bearing rocks are grouped in two lithostratigraphic units – the Wałbrzych and Żaclerz formations, representing the time period from Namur to Westphalian in age. The top of the Carboniferous is covered with Permian deposits and lies at various depths – up to 500 m in the Wałbrzych region, up to 300 m in the Nowa Ruda region, while in both regions the Carboniferous formations also form outcrops on the ground surface (Fig. 1).

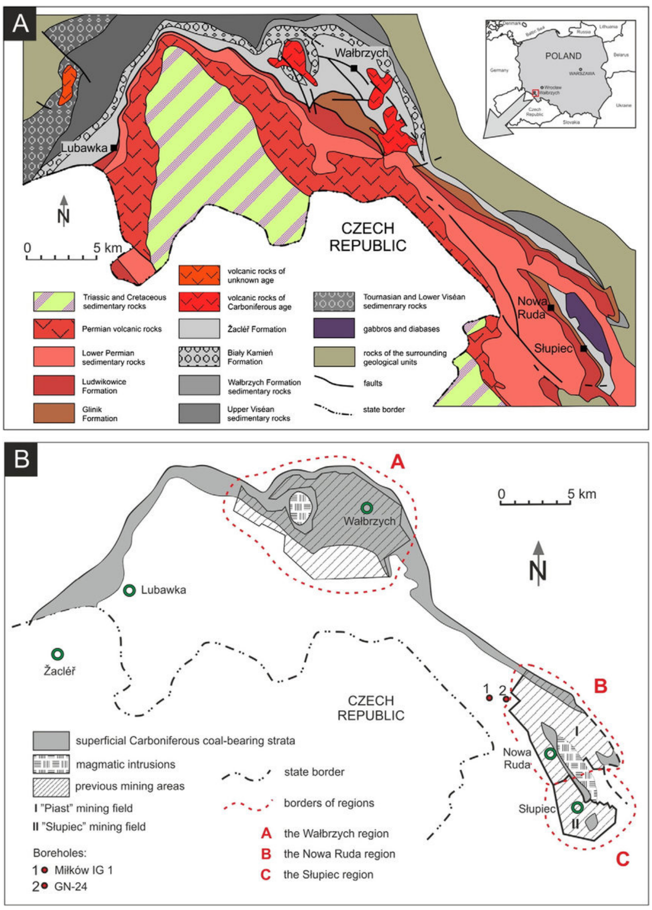


Fig. 1. Simplified geological map of the Lower Silesian Coal Basin (LSCB).

Due to the presence of productive Carboniferous sediments, the area of the Lower Silesian Coal Basin was until recently important for bituminous coal and anthracite mining (Fig. 2, 3). Their exploitation definitely ended in 1999, but coal mining has a long tradition here. The coal mining began in the 14th century under the grants of the Bolko II Świdnicki Duke. Several small mines in the vicinity of Wałbrzych, Nowa Ruda, Słupiec and Bożków were there in the 17th century. Four bituminous coal mines were active in LSCB – three in the Wałbrzych region ("Julia", formerly "Thorez", "Victoria" and "Wałbrzych") and one in the Nowa Ruda region ("Nowa Ruda") with two mining fields ("Piast" and "Słupiec") before starting the restructuring of the mining industry in 1989. They together covered an area of 187 km^2, and their extraction amounted to 2.6 million tonnes. The depth of mining in the Wałbrzych region was 1,250 m, in the Nowa Ruda region – 1,000 m. The coal seams of both the Wałbrzych and Żacler formations were exploited. The coal seams of the first of these formations were mined only in the "Julia" mine in Wałbrzych. The number of coal seams of the Wałbrzych Formation is 28 in the Wałbrzych region and 32 in the Nowa Ruda region. The main series of deposits in the LSCB were coal seams of the Żacler Formation, the number of which in the Wałbrzych region is 48, while in the Nowa Ruda region – 25. The exploitation conditions were difficult and dangerous in the LSCB. The presence of methane and significant amounts of carbon dioxide was found in all mines. An additional difficulty in the exploitation was the strong tectonical involvement of the Carboniferous deposits.

Figs. 2 and 3. Hard coal types from the Lower Silesian Coal Basin. Specimens 17.I.2 i 17.I.5a. From the collection of the PGI-NRI Geological Museum. Photo: K. Skurczyńska-Garwolińska.

History of Książ Castle (after: www.ksiaz.walbrzych.pl/en/turystyka/zamek)

Książ's first centuries were marked by a number of stormy events. It changed hands often, belonged to various states, and was destroyed during the numerous wars that were waged there. We indeed know little about the beginnings of today's castle, and much is missing and unclear, and even contradictory, in its earliest records.

We present below some key historical events which have had a particular influence on the castle's appearance and cultural significance.

1288–1292

The first written mention of today's Książ Castle (in German, Fursteinstein). During these years, one of the many strategically significant defensive castles of Bolko I "the Strict", Prince of Świdnica and Jawor, was being built; the construction was thus acknowledged to be the "key to Silesia". The newly-built fortress, known from the beginning as "Książęca Góra" or "The Prince's Heights", was distinguished from other buildings of this type not only by its militarily advantageous setting, but also for its picturesque location, in the heart of the forest. Bolko I also conferred upon himself the title "Lord of Książ," which his successors also held.

1392–1463

After the extinction of the Piasts from the Świdnica-Jawor line, Czech kings from the Luxembourg dynasty became the castle's owners, by virtue of the succession treaty. Later, from 1463 to be exact, Książ belonged to the Czech King Jiř (George) of Poděbrady.

1482–1490
Książ came under the authority of the Hungarian king Matthias Corvinus, and was governed by the commander of his army, Georg von Stein. It was this officer who first brought about changes in Ksiaz's character, from that of a fortress to one of a castle, transforming the majority of its defensive areas into residential ones. During this period, the south part of the castle arose, known from that time as the Matthias Wing in honour of the sovereign.
From 1497 to 1508 the castle belonged to Vladislaus II (Władysław Jagiellończyk), the Czech and Hungarian king. Later, the ruler transferred the Książ property to his chancellor, Johann von Haugwitz.

11 June 1509
For an undisclosed sum, Johann von Haugwitz transferred the castle, and its neighbouring property, to the knight Konrad I von Hoberg (until 1714, the name was written without the letters "ch"), also known as Kunz von Hoberg. It was his line that most influenced the history of Książ (which stayed in the hands of the von Hochberg family until its confiscation by the Nazis in 1941). It is thanks to this powerful Silesian family that the castle experienced numerous "metamorphoses." They began with Hans Heinrich I, who brought about the creation of the French gardens, replacing the ramparts, trenches and moats, as well as part of the walls. Two dates stand out among the most important for the Hochbergs: they received the hereditary title of count in 1683 and, in 1848, the hereditary title of prince.

5 April 1605
Konrad III von Hochberg received, from the Emperor Rudolf III, the right of inheritance to the castle, in place of a lease. The castle became the hereditary property of the Hochberg line.

1705–1742
Konrad Ernest Maximilian von Hochberg initiated what became known as the first great castle reconstruction. During that time, there arose: the distinctively Baroque extension, the Honorary Courtyard and buildings near the entrance to the castle (outbuildings, baths, gate building, sentry post and library). On the Poplar Heights, the summer pavilion was also constructed, becoming the family mausoleum in the second half of the nineteenth century (the sepulchral chapel).

1789–1833
Hans Heinrich VI developed the castle's immediate surroundings. Christian Wilhelm Tischbein's plan provided for new structures, as well as imitation ruins on medieval foundations, known as Old Książ.

1856
Hans Heinrich XI became the new master of Książ, and would go on to be one of the outstanding figures in the castle's history: Count von Hochberg, the Prince of Pless and, in his final years, Herzog von Pless. The title of archduke was one of the highest ducal titles that one could receive outside of the governing family; unfortunately it was not a hereditary privilege.
It is difficult to number, today, the projects and changes that Hans Heinrich XI brought about. However, the following stand out: the establishment of roads, parks, and wooded areas; the creation of free cooking schools for the daughters of Walbrzych's miners; the organization of evening classes for young workers; and support for those in the parish, regardless of their faith or financial means. He provided for burials, for help for those who needed medical care, and for the widowed, disabled and elderly. The Hochberg family was strongly committed to helping the poorest; at the end of the nineteenth century, the family members' charity amounted to 60,000 marks per year.
Hans Heinrich XI's reforms became the basis of German Chancellor Otto von Bismarck's later social reforms.

8 December 1891
In London Hans Heinrich XV, Hans Heinrich XI's son, married Mary Theresa Cornwallis-West, known today as Princess Daisy. Queen Victoria herself conferred her personal blessings upon the newly married couple. Princess Daisy, a woman well ahead of her time, was to become one of the best-known figures in the history of Książ Castle. To this day, her story fascinates visitors.

1907–1938
The period when Hans Heinrich XV ruled the castle. The son of Hans Heinrich XI, he brought about what is known as the second great castle reconstruction. In the years 1908 to 1923, there arose the neo-Renaissance west and north wings. The tower was to

reach a height of 47 metres, covered by a domed helmet with a lantern. The castle terraces took their present shape. In 1908, Hochberg also began the construction of the Walbrzych Palm House, a present for his wife, Princess Daisy.

1941

The Nazi regime confiscated the castle. During the Second World War, the collection of Berlin's Royal Prussian Library was kept in Książ. It should be pointed out that Daisy and Hans Heinrich XV's sons fought against Hitler: Hans Heinrich XVII in the British forces, and Alexander in the Polish army.

1943 – 1945

"Todt", a Nazi paramilitary organization, occupied Książ Castle. Intensive works were carried out including, apparently, what was meant to be one of Hitler's main quarters. The changes brought about by Hitler's soldiers are called the third castle reconstruction.

During this time, underground tunnels were also dug below the castle and the Honorary Courtyard.

1945–1946

The Russian army was stationed here and lay further waste. The library, part of Książ's entailment, was plundered. It is probable that the better part of the collection, which had numbered over 64,000 volumes, was transported to what was then the Soviet Union. In April 2015, one of these volumes, the "XVIIIth-century Saxon Chronicles" by Johann Christian Crell(ius), returned to Książ. In May 2015, the famous porcelain of Carl Tielsch, dating from 1873, was also returned to the castle. It probably was in the castle at the beginning of the XXth century. This authentically Silesian (even Walbrzych) porcelain was taken away in the war's confused aftermath, and was returned by anonymous donors.

1946–1967

The castle fell into further ruin, plundered by local people. As it was considered a legacy of the Germans, it attracted looters. Only from 1956 - 1962 was protection provided for Książ, gradually, by the Provincial Conservator of Monuments in Wrocław. Damaged and missing parts of exterior doors and windows were repaired and replaced, so that break-ins were no longer possible. During this period there was found, under the Honorary Courtyard, a huge lift shaft dug by the Nazis; it was filled in in 1967.

1974

A team lead by Professor Zofia Wnuk, of the Academy of Fine Arts in Gdańsk, began extensive renovation works in the Baroque rooms. The beautiful wall tapestries in the Baroque salons were designed; today these rooms are the most distinctive areas of Ksiaż Castle.

1991

The Walbrzych district government (gmina) became the owner of the castle. The building was in the hands of the Walbrzych Książ Castle Management Group (Zamek Książ w Walbrzychu Sp. z.o.o.).

2015

The opening of the exhibition titled "The Metamorphoses of Książ Castle", organized with the National Museum in Wroclaw. The former Hochberg works have returned to the castle after 70 years. The opening of the exhibition to visitors, on 11 July 2015, has been recognized as the most important event in Ksiaz Castle's post-war history: ten works of art, from the collection of Hans Heinrich XV von Hochberg and his wife Princess Daisy, have returned to the castle after several decades. Up to 38 works may be found, each associated either with the history of the building or the pursuits of the former owners. All the works are from the collections of the National Museum in Wrocław, and have been selected to decorate the castle rooms.

Day 4.

Tarnowskie Góry – silver, lead and zinc mining

Wojciech Retman, Krystyna Wołkowicz, Stanisław Wołkowicz

Documented zinc and lead deposits occur in the area of the northern and northeastern margin of the Upper Silesian Coal Basin in southern Poland. The Zn-Pb deposits occurring in this area are related mainly to a carbonate rocks formation of the Silesian-Cracow region built of the Permo-Mesozoic successions resting monoclinally on the Paleozoic sedimentary deposits. Along the regional tectonical Cracow-Lubliniec zone these Paleozoic deposits are riddled by the acidic and alcaline igneous-volcanic deposits of the Carboniferous-Permian age (Fig. 1)(1.). The rock hosting zinc and lead mineralisation ranges in age from the Devonian to Jurassic. Resources of the economic importance are mainly related to the ore accumulations in the so-called ore-bearing dolomites of the Middle Triassic (Muschelkalk). The zinc-lead ores occur in the form of pseudo-layers, sub-horizontal lenses, nest-like replacements and pipes. The Silesian-Cracow region is regarded as the world's largest area of Zn-Pb deposits occurrence of the so-called Mississippi Valley-type deposits (MVT) (2.).
As of 31.12.2022, there was not any exploitation concession valid for zinc and lead deposits, therefore the exploitation of zinc and lead ores in Poland was not recorded (2.).

Tarnowskie Góry is located on the border of the Upper Silesian Foredeep (also known as the Upper Silesian Coal Basin) and the Silesian-Cracow Monocline. The Upper Silesian Foredeep is filled with Carboniferous sediments, while the Silesian-Cracow Monocline is essentially built up by Triassic and Jurassic formations, with a general NW–SE extension and NE decline. Tarnowskie Góry lies on the NE edge of the Bytom Trough (with a NW–SE long axis direction), the genesis of which is mainly associated with the Asturian phase of the Variscan orogenesis. Carboniferous formations have undergone folding and faulting. The Triassic formations also have numerous tectonic disruptions, which are related to the Early Cimmerian orogenesis (3.). The base of Tarnowskie Góry is build up by Upper Carboniferous, Triassic, Jurassic and Quaternary formations, with the Quaternary covering a significant part of the city area.

The Carboniferous formations belong to the Malinowice beds, which are the lowest part of the Upper Carboniferous in the area. They are formed as shales with sandstone interbeds. They are strongly folded (3.).

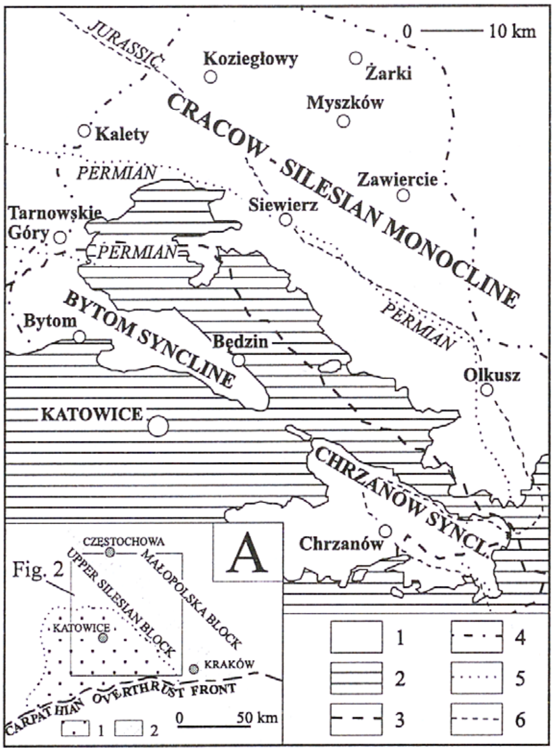


Fig. 1. Geological setting of the Silesian-Cracow district (sketch without units younger than Triassic).
1 – Rot and Muschelkalk, 2 – Upper Carboniferous and Permian, 3 – borders of the district, 4 – boundary of the Upper Silesian Coal Basin, 5 – range of Permian, 6 – range of Jurassic.
A - Structures of the Triassic substratum:
1 – Upper Silesian Coal Basin, 2 – Cracow–Myszków tectonic zone (1.).

The Triassic formations lie discordantly on Carboniferous rocks. They comprise sediments of middle and upper Buntsandstein (Lower Triassic) and lower, middle and upper Muschelkalk (Middle Triassic). The middle Buntsandstein is represented by terrestrial sediments. These are fluvial sands covered by a layer of red and chert clays, with a total thickness of 10–25 m. The sediments of the upper Buntsandstein (Röt) are developed as marine thick-bedded, cavernous and dolomitic limestones and dolomites. The total thickness of the rhett series reaches up to 55 m (3.).

The Muschelkalk in the bedrock of the Tarnowskie Góry area comprises 5 units: the Gogolin Beds and Ore-Bearing Dolomites (Lower Muschelkalk), the Diplopora Dolomites (Middle Muschelkalk) and the Tarnowice Beds and the Wilkowice Beds (Upper Muschelkalk). The Ore-Bearing Dolomites were formed by metasomatic processes involving carbonate rocks of the upper part of the Lower Muschelkalk. These rocks are finely crystalline and quite coarsely bedded, grey and in places yellowish or rusty-brown, from disseminated iron hydroxides. Their thickness reaches up to 60 m. The ore minerals are mainly galena with an admixture of silver. They are deposited at a depth of up to 65 m below sea level. They were the subject of historical exploitation, after which the historic mine and the "Black Trout" adit remained (3.).

Ore mineralisation in these deposits belongs to the Hercynian and Alpine metallogenic epochs. Mineralisation related to the Hercynian cycle is of polimetallic character and represents subvolcanic type, co-magmatic with acid magmatism of the Asturian phase. Ore mineralisation of the Alpine cycle is represented by zinc and lead ores; it is of hydrothermal origin and forms the root parts of Silesian-Cracow Zn-Pb ores, occurring in Mesozoic, predominantly Triassic rocks (4.)

The Diplopora Dolomites are fine crystalline, light grey or cream-coloured rocks, often porous. Their thickness is 14 m. Tarnowice Beds are developed as grey marly dolomites, locally as marly limestone in the upper part; their thickness is 15–18 m. Wilkowice Beds are representing by conglomerates covered by limestones. The limestones are pale yellowish, marly and dolomitic, hard; their thickness does not exceed 10 m.

The Triassic carbonate formations in the area of Tarnowskie Góry are strongly karstified.

Jurassic formations in the bedrock of the Tarnowskie Góry occur locally and are developed as the Połomia Beds. These are Lower Jurassic (Lias) refractory clays, sandstones, sands, gravels and conglomerates. The sandstones are locally limonitised ("ferruginous").

The Quaternary cover, up to 40 m thick, is made up of Pleistocene sediments from the glaciations: Middle-Polish and Baltic glaciations and Holocene formations (1.).

The oldest traces of lead and silver ore mining in the vicinity of Tarnowskie Góry date back to the 3rd to 4th century AD. This was confirmed by archaeological excavations in Repeck near Tarnowskie Góry. The first documentation of non-ferrous metal ore mining in the Tarnowskie Góry area dates back to 1136 (3.). Exploitation was possible due to the relatively shallow occurrence of ore bodies. Ores with a high silver content were mainly extracted. Galena, thanks to its low melting point, could be smelted directly at the mining site, in small pits or on woodpiles. Galena was mainly extracted from deposits located only above groundwater, i.e. up to about 20–25 m depth, as miners could not cope with the drainage of the mines. The most important mining centre was Repty (now a part of Tarnowskie Góry). The ore reserves were exhausted already in the 12th century. It was not until the first half of the 16th century that mining flourished here. In 1526, Prince Jan Opolski issued a document granting personal freedom and mining rights to all people employed in mining on his lands, promising a reward for finding an ore. It is assumed that the foundation charter of the town of Tarnowskie Góry is also linked to this date. At that time, deep shafts were being dug in Tarnowice (currently the western part of the town). They were also created in the surrounding settlements. It is believed that between 1529 and 1600, more than 6,000 shafts were made in Tarnowskie Góry and the surrounding area, with depths ranging from 30 to 60 metres (3.).

The boom of Tarnowskie Góry mining was in the 1540s and 1550s (5.). At that time, lead production in Tarnowskie Góry averaged 600–800 tonnes per year, occasionally reaching 3000 tonnes. Only towards the end of the 16th century did it drop to a few tens of tonnes per year (5.). During the period of greatest development, an average of 600–1000 kg of silver per year was obtained, but by the end of the 16th century it was only 100 kg. Exploitation went progressively deeper and deeper, which created problems with the drainage of the mine excavations.

These problems and the gradual depletion of resources brought silver-bearing ore mining to a standstill. Attempts were made to solve the water problems by building adits to drain the mines. From the middle of the 16th century, 7 such adits were built around Tarnowskie Góry, the most important of which, the St. Jacob's Adit, was constructed between 1563 and 1602, operated until 1624, and after renovation also in the period from 1667 to 1718. This adit survived for a long time thanks to its excellent maintenance. The miners prevented collapses by constantly replacing damaged casing, repairing skylights and shafts (6.). After the end of its operation, the mining industry in the Tarnowskie Góry region came to a great standstill, which lasted for more than 100 years. Its re-development came in the mid-18th century as a result of the discovery in 1742 of new ore deposits in the village of Bobrowniki (now a SE part of Tarnowskie Góry) (3.).

In the years 1821–1834, a new adit named "Głęboka-Fryderyk", now known as the "Black Trout Adit", was excavated. The excavation was the deepest to date (56.5 m). It drained, among other things, the Bobrowniki Śląskie mining area. Mining of Pb and Ag ores in the second half of the 19th century averaged 21,000 tonnes a year. At the turn of the 19th and 20th centuries, due to the gradual depletion of resources, there was a significant decline in production. In 1922, mining was stopped at the Frederick mine (in operation since 1784). This closed the 700-year history of Tarnowskie Góry mining (3.).

The historic Black Trout Mine and Adit was inscribed on the UNESCO World Heritage List in 2017.

Detailed description of the geological sites and outcrops to be visited

1. Mining And Metallurgical Plant (ZGH) "Bolesław" S.A. – Bukowno "Mine of Knowledge about Zinc" Museum

The museum includes the geological part (along with a collection of surrounding rocks, types of Zn-Pb ores, ore minerals) (Figs. 2, 3), the history of the Olkusz Region and the ZGH Bolesław Plant in Bukowno, the history of Zn-Pb ore mining, a presentation of zinc production processes, an overview of the mining machines used.

2. Bobrowniki Śląskie–Piekary Rudne – a district of Tarnowskie Góry

The oldest towns in the district: Bobrowniki and Piekary Rudne, mentioned for the first time in 1369 in a document of division of the land of Bytom between the Dukes of Cieszyn and Oleśnica.

Former Dolomite Mine "Bobrowniki"

- is a quarry opened in 1903 (area approx. 35 ha, depth up to approx. 50 m, exploited on several levels);
- ore-bearing dolomites (flux for the nearby iron smelting industry) were mined here, and later also marls and limestones; mining was carried out until 1998 (loss of profitability);
- in the walls of the quarry there are several outlets of underground workings (from the former, nearby mine of silver-bearing lead ores "Fryderyk");
- according to the old mining books, only in Bobrowniki area (in the years 1533–1632) 966 mining shafts were made and 9 scrubbers for washing galena and calamines were in operationl;
- in the vicinity of similar closed quarries of ore-bearing dolomites Lazarówka, Blachówka.

Heap of washing material from the 19th Century (near to the Dolomite Mine "Bobrowniki")

- formed from the accumulation of dolomite waste from the extraction of Pb (+ Ag) – Zn ores in the Fryderyk Royal Mine (German: Königliche Friedrichsgrube) in Bobrowniki;
- protected as the Cultural Park "Hałda Popłuczkowa" since 2017 on the UNESCO World Heritage List;
- area about 7 ha, height about 17 m, estimated volume at about 26.5 million m^3;
- the heap began to be built in the years 1830–1840. the 19th century (on the border of Bobrowniki and Sucha Góra) in the area belonging to the Royal Mine "Fryderyk" (between the shafts "Sophia" and "Frieden"); a modern processing plant was built here – a washer in which Pb+Ag (Ag-bearing galenite), Zn and Fe ores deposited in ore-bearing dolomites were processed;
- in 1867 the processing was modernised (in order to increase the production of Zn), in the years 1882–1887 the plant processed up to 30,000 tonnes of ore per year; the capacity of the plant reached 9.3 tonnes of ore/h (from 100 tonnes of ore, up to 7.5 tonnes of enriched ore was obtained);
- the scrubber operated until 1912; at the end of World War II, the heap was included in the German defense system (4 reinforced concrete bunkers and trenches remained);

Fig. 2. Cerusite on galena (463.IV.10). Zinc and lead minerals from the Trzebionka mine, coll. K. Matyja. From the collection of the PGI-NRI Geological Museum. Photo: K. Skurczyńska-Garwolińska.

- the heap is currently overgrown with mountain elms, limes, silver birches, rowans and Scots pines;
- a characteristic element of the heap vegetation are the so-called calamine grasslands, with calamine plants resistant to high concentrations of heavy metals in the soil, especially Zn and Pb; the heap is also overgrown with plants characteristic of xerothermic grasslands (e.g., yellow-leaf and cornflower);
- next to it, on the east side, there are overgrown with forest ***post-mining heaps on the Sucha Góra*** (252 m a.s.l.); in the 19th century, there was a triangulation tower on the top, which was one of several nodal points of the Prussian geodetic network;
- ***Kunszt Park – Nature Monument*** (north of the Bobrowniki quarry, Parkowa street 33);
- located in the former lead and silver mine "Fryderyk" – founded on the initiative of Friedrich Wilhelm von Reden (about 1780);
- ***Friedrich Wilhelm von Reden*** – German director of the State Mining Authority in Wrocław, later a minister in the Prussian government, distinguished for the development of industry in Lower Silesia (hard coal mine – Wałbrzych) and Upper Silesia (Zn-Pb ore mines Tarnowskie Góry; hard coal mines – Gliwice, Zabrze; the first coal blast furnace in Gliwice – 1796 and the founder of Królewska Huta – 1802);
- the park currently includes 8 small-leaved lime trees (natural monuments) growing around the memorial heap of the "Rudolphine" shaft (an urban monument since 2004; on the UNESCO World Heritage List – 2017);
- the historic heap commemorates the discovery of the first deposit of Pb ores in 1784 (it is located in the area of the former mining colony of Kunszt;
- in the Kunszt mining colony (on Reden's initiative) a steam pump was used to drain the underground workings of the Pb ore mine in 1788 (it was the 3rd steam engine in Europe !!!).

3. Historic Ore Mine – Tarnowskie Góry

- to the west of Bobrowniki, within the Śródmieście-Centrum district, there is a Historic Zn-Pb and Silver Ore Mine;
- it is the main tourist attraction of Tarnowskie Góry (***together with the "Black Trout" adit***) and the above-ground open-air museum of steam engines;
- since 2017, a ***UNESCO World Heritage Site:*** Mine of lead, silver and zinc ores together with the underground water management system in Tarnowskie Góry (tourist route, length 1740 m, of which about 300 metres are accessible by boat), presenting history and traditions ore mining in the vicinity of Tarnowskie Góry;
- the tourist route is part of the underground mining galleries in the ore-bearing dolomites at a depth of 40 metres (galleries and drainage adits) of the Fryderyk Royal Lead Mine (Königliche Friedrichsgrube), with a total length of over 150

kilometres, which extracted Pb and Zn ores from 1784 to 1912;
- there is the Open Air Museum of Steam Engines next to the mine building.

History of Zn-Pb ore mining in the Tarnowskie Góry Region
- in the Silesia-Cracow area (which the Tarnowskie Góry area is a part of) one of the world's richest deposits of Zn-Pb ores of the Mississippi Valley type were located with estimated primary resources above 1 billion tonnes;
- mining of silver-bearing lead ores in the Silesian-Cracow area began before the 12th century (according to archaeological research, probably from the 3rd–4th century) and from the turn of the 18th/19th century zinc ores were also mined;
- out of 10 Zn-Pb ore mines operating after World War II in the Silesia-Cracow area, 4 were closed in the Bytom region: Nowy Dwór, Marchlewski, Waryński, Orzeł Biały-Dąbrówka Wielka (1977–1989), in Chrzanów 3: Jaworzno, Matylda, Trzebionka (1958–2009) and 2 mines in the Olkusz region: Bolesław, Olkusz (1998–2003);
- despite significant increases from additional recognition (including Retman, 2002–2006; 2005–2008), in 2020 the extraction of Zn-Pb ores from the Pomorzany deposit was completed in the Olkusz-Pomorzany mine, the last mine of this type in Poland;
- Zn-Pb ore deposits in the area of Tarnowskie Góry occur in Triassic formations (Permo-Mesozoic platform cover) forming the Silesian-Cracow monocline; below the platform cover lies folded Carboniferous (Wisen, Namur) (and Middle Devonian?);
- below the Triassic formations, there are Lower Permian formations (up to 400 m): red sandstones and conglomerates (porphyry, limestone, shale pebbles, clay or tuff binder);
- the lower part of the Lower Triassic (up to 25 m): mottled clays, sandstones, conglomerates (Devonian dolomite pebbles!); above the Rhetian formations (40–80 m): dolomites, limestones, below clays, marls and gypsum;
- Zn-Pb ore deposits occur in the Middle Carbonate Triassic formations: (25–60 m = dolomitized Gorażdże, Terebratula, Karchowice beds + the top of the Gogolin beds + to the top of the diplopora dolomites) forming ore-bearing dolomites (gray, granular, cavernous crystalline dolomites with clay inserts);
- the existing ore bodies are nest-type (Miotek-Zielona deposit 0.2–1.5 m) or stratified-nest type (Bibiela-Kalety deposit 0.2–4.0 m, up to 20.0 m in fault zones). The mineralisation in these deposits is sub-

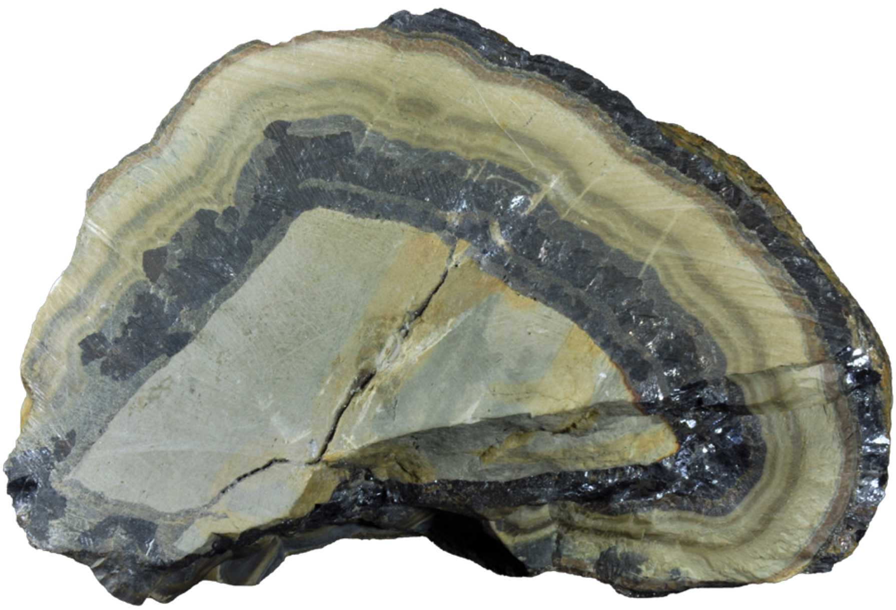


Fig. 3. Galena and zinc blende (sphalerite) on dolomite – Nowa Helena mine (16.I.15). Zinc-lead ores from Upper Silesia, coll. W. Bobrowiecki. From the collection of the PGI-NRI Geological Museum. Photo: K. Skurczyńska-Garwolińska.

ject to minor variability but is generally represented by sphalerite, minor galena, limonite, marcasite, pyrite and smitsonite in the deposit Miotek-Zielona, and by sphalerite, galena, minor marcasite and pyrite in the deposit Bibiela-Kalety;
- the ore bodies mined in the past (including the Fryderyk mine in Bobrowniki) were mainly in the form of stratified galena ores (thickness 0.1–1.0 m) lying on limestones; additionally, calamine ores were of typical nest type and were present mainly in outcrops of ore-bearing dolomites;
- the Triassic formations are dominated by faults with the course of NWW–SEE, NW–SE (Variscan directions) and younger ones (Alpine directions) with the course of NNW–SSE, NNE–SSW;
- mining of ores in the Tarnowskie Góry region was carried out from 1528 (with breaks) and was partially completed before World War I and finally in the period between World War I and II (as a result of exhaustion of richer parts of deposits or lack of profitability of mining);
- initially, galena was mined for the recovery of Pb and Ag (from "Ag-bearing" galena); in the years 1800–1850, began the exploitation of calamine ores;
- metals Pb, Fe, As, Tl (dominant) and Zn, Ba, Cd, Ag (main) had the main share in the ores it is difficult to verify due to the lack of accurate historical data and geological exploration; the additionally recognised Zawiercie region presents completely different proportions than previously reported;
- mining was initially carried out using the shaft method and later the shaft-corridor method; the number of shafts existing in the area of Tarnowskie Góry and nearby Bytom in the years 1529–1627 is estimated at 20,000 (the area of Tarnowskie Góry around 7,500);
- the estimated recovery of metals from Zn-Pb ores mined in the Silesia-Cracow (from the beginning of mining until 1950) is estimated at about 20 million tons, of which from the Bytom and Tarnowskie Góry regions (in total) about 14.4 million tonnes of Zn and 3.4 million tonnes of Pb (approximately 1.0 million tonnes of Pb were obtained from the Tarnowskie Góry region);
- estimated Ag content in Zn-Pb ores – 132 g/t Zn+Pb;
- estimated Cd content in Zn-Pb ores 308 g/t Zn;
- numerous concentrations of limonites associated with zones of Zn-Pb ore outcrops and their oxidation zones were also exploited here.

REFERENCES:

1. Szuwarzyński, M., 1996. Ore bodies in the Silesian-Cracow Zn-Pb ore district, Poland. Prace PIG, CLIV: 924.
2. http://geoportal.pgi.gov.pl/surowce/metaliczne/rudy_zn-pb/2022
3. Dzięgiel, M., 2008. Podziemne trasy turystyczne w Tarnowskich Górach (Górny Śląsk) (in Polish). Geoturystyka, 4 (15):51-62
4. Górecka, E., 1972. Mineralizacja kruszcowa w utworach paleozoicznych północno-wschodniej części obszaru śląsko-krakowskiego (in Polish). Acta Geologica Polonica 22, no. 2.
5. Molenda, D., 1969. Ziemia powiatu tarnogórskiego w epoce feudalnej (in Polish). W: Rechowicz H., (red.). Tarnowskie Góry. Zarys rozwoju powiatu. Wydawnictwo „Śląsk". Katowice: 51–92
6. Piekarnikarczyk, J., 1933. Historia górnictwa i hutnictwa na Górnym Śląsku. Katowice (in Polish).

Krzemionki Opatowskie – Neolithic striped flint mines

Krystyna Wołkowicz

In 1922, in July, Professor Jan Samsonowicz made, in Krzemionki near Ostrowiec Świętokrzyski, the discovery of a prehistoric mine – one of the most interesting archaeological monuments in our country. In the course of compiling a geological map of the area, he came across mining pits which he found extremely interesting from a historical point of view. It should be mentioned that in the area of the villages of Krzemionki and Magonie the local population, unaware of the historical past of their area, extracted limestone from the underground Neolithic mines for the production of lime (1.). During the World War I, German archaeologists G. Wilke and G. Kosina began mapping artifacts made of striped flint found loosely or in graves categorised as part of the Amphora spherical culture. These researchers believed that the source of the striped flint was the then eastern Galicia , where, in their opinion, the tools found were produced. This hypothesis was criticised in 1920 by the eminent Polish archaeologist Professor Stefan W. Krukowski, who considered the Malopolska Upland together with the Kraków-Wieluński range to be "the most general and certain homeland of the original striped flint deposits". At the time, Stefan W. Krukowski was conservator of the State Conservatory of Prehistoric Monuments and curator of the State Archaeological Museum in Warsaw.

Jan Samsonowicz, the first researcher aware of his discovery, called for the area of the mine to be cared for to prevent its destruction. In Wiadomości Archeologiczne he published the results of his flint research and information about the discovery of the mine. He informed Stefan Krukowski of his discovery, who together with his student Zygmunt Szmit made a preliminary reconnaissance of the mining field and secured the monument, while Józef Żurowski, the then State Conservator of Prehistoric Monuments of the West-Małopolska and Silesian Districts, started archaeological excavation work (1.). Legal protection was given to the area in 1926. At that time part of the fields were bought from the local people living in the village of Krzemionki, in the 1960s the inhabitants of this village were displaced and the name Krzemionki remained only for the reserve. Professional excavation work carried out under the direction of Józef Żurowski led to the deconstruction of the underground of 7 shafts. In 1926 the engineer Mieczysław Radwan from the AGH University of Science and Technology in Kraków, a researcher of ancient iron metallurgy in the Holy Cross Mountains, postulated the creation of a reserve in Krzemionki. He was the first to report that at the Ćmielów-Gawroniec site there was a "striped flint axe factory" and that there were more such sites. In 1928 Stefan Krukowski started excavations in the northern part of the mining field, near the crowbars. In 1945, the Provincial Conservator of Monuments in Kielce issued a decision declaring the area of the Neolithic flint mine a monument and establishing a reserve. For tourist traffic the first tourist route was opened in 1985 and the second in 1990. In 2004 a joined 480 m long underground tourist route was opened, leading through the deepened bottom of the excavations.

Geological structure of the Krzemionki nature reserve and origin of flints

Striped flints occur on the NE margin of the Holy Cross Mountains (Fig. 1) within the Skarbka oolitic limestone assemblage, the age of which can be described as late Oxfordian (2.). They represent one of three flint horizons that have been treated as convenient correlative horizons since Samsonowicz's research. The uppermost of these, the chocolate flint level, occurs throughout the Upper Jurassic outcrop in the roof of the oolitic limestone assemblages from Skarbka (including in the quarry of the Ożarów cement plant). The middle, banded flint horizon occurs in the middle part of the oolitic limestone assemblage from Skarbka in the Bałtów area and continues NW to Błazin (2.).

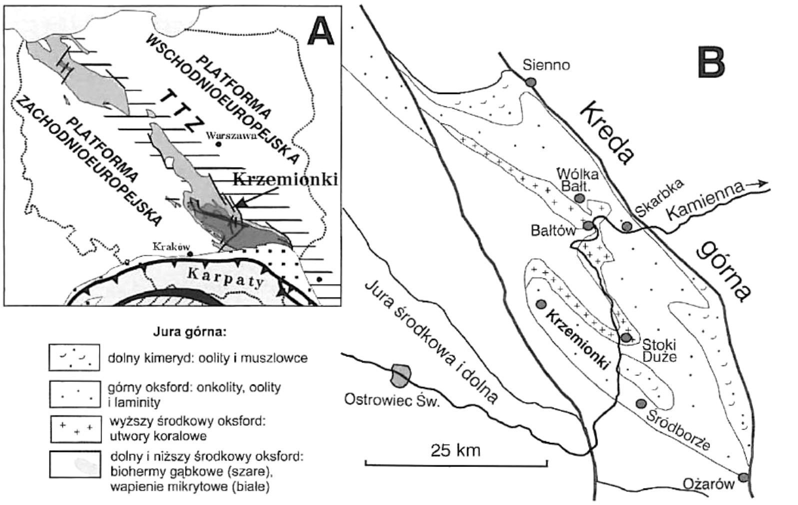


Fig. 1. Location of the Krzemionki Opatowskie on the background of the main geological units of Poland (A) and of the Upper Jurassic formations of the Bałtów area (B) (2.).

The Krzemionki mine area includes the NW part of the Jurassic Magonie-Folwarczysko syncline (1.). Samsonowicz, for the SE part of the Magoń-Folwarczysko basin, estimated the thickness of the formations of the Upper Oxfordian complex at 30–35 m. He determined that lithologically it is a homogeneous complex, except that at the bottom it is fine-bedded limestone with inserts of oolitic limestone, while at the top these proportions reverse; in the roof of the profile fine-bedded limestone gradually transforms into marl.

W. Pożaryski (3.), for the area to the N of the Krzemionki reserve, distinguished 3 rock packages with a thickness of about 160 m in the rocks of the Upper Oxfordian complex. On the lower level of reef limestones, fine-plastic, oolitic and dolomitic limestones without flints were found the limestones of the middle package with flints (Figs. 2–4). These are oolitic limestones co-occurring with fine-plastic limestones containing single ooids. In this rock series, there are two continuous and very regular banks of loaf-like balls of banded flints separated by a layer 2.9 m thick. Above this, the upper package contains increasingly clayey limestones. In the ceiling layers, clayey limestones co-occurring with marls are present (4.).

The following profile (2.) was observed in the shafts and adits made available during archaeological investigations in the Krzemionki reserve: In the lower level (thickness 2.2 m), silty micritic limestones showing indistinct lamination and/or wrinkle layering were described; in the upper part of the assem-

Figs. 3 and 4. Forms of occurrence of striped flints in Jurassic rocks in the region of Krzemionki Opatowskie. Specimens 133.IV.24 i 4. 133.IV.29. From the collection of the PGI-NRI Geological Museum. Photo: K. Skurczyńska-Garwolińska.

Fig. 2. Prof. G. Pieńkowski in the excavations of the Neolithic striped flint mine in Krzemionki Opatowskie.

blage, two levels of banded flints were observed arranged along the boundaries of the layers; moreover, the flints are loosely arranged within the uppermost layer with a thickness of 20 cm (2.). Above the oolitic limestones occurring above, Pieńkowski and Gutowski (2.) found numerous burrows in the micrite limestones. According to the aforementioned authors, these may be, as described in the literature, burrows of decapod crustaceans (Decapoda), similar to modern shrimps. These crustaceans leave branching burrow systems that may be potential centres of silica precipitation (5.), sometimes allowing their morphology to be preserved. In the profile, a correlation of striped and chert flint levels with crustacean burrow levels filled with diagenetic silica has been observed (2.). It was found, however, that most often the silica nodules grew in later stages of diagenesis beyond the original extent of the burrows at the expense of the surrounding carbonate sediment, leading to distortion and obliteration of the original shapes of the burrows (centres of silica crystallisation). This is most likely how the silica boules and nodules were formed in the Opatów Silicones, although an important factor for the precipitation of silica in and around the burrows was the increased content of organic matter within them. The decomposition of organic matter caused a local drop in pH, which meant that pool solutions with a higher pH (and therefore with a greater amount of dissolved silica) became supersaturated in the shellfish burrows, leading to rapid precipitation of silica. In addition, the presence of the burrows facilitated the circulation of solutions in the sediment (2.).

REFERENCES:

1. Barcicki, M., 2013. Krzemionki Opatowskie jako unikatowy produkt turystyczny (in Polish). Autobusy. Technika, Eksploatacja, Systemy Transportowe, 3/2013: 893–905.
2. Pieńkowski, G., Gutowski, J., 2004. Geneza krzemieni górnego Oksfordu w Krzemionkach Opatowskich (in Polish). W: Tomy Jurajskie, 2.
3. Pożaryski, W., 1948. Jura i kreda miedzy Radomiem, Zawichostem i Kraśnikiem (in Polish). Biul. PIG, 27: 5–141.
4. Michniak, R., 1992. Krzemienne złoże i geologia rezerwatu Krzemionki (in Polish). Prz. Geol., 3: 173.
5. Radwański, A., 2003. Wapienie pasiaste dolnego kimerydu Gór Świętokrzyskich: przykłady prolapsji, diastazy, oraz systemu nor piętrowych (in Polish). Tomy Jurajskie, 1: 71–76.

Day 6.

Bałtów – Tracking Bałtów Dinosaurs

Gerard Gierliński

Fig. 1. The rock called Devil Foot according Bałtow folklore. Photo by Gerard Gierliński.

Fig. 2. Bałtów devil painted by Karolina Pytlik.

According to the legend, a devil made a bet with an angel about jumping over Kamienna River Valley in Bałtów and jumped with such an impetus, that his birdlike foot left an impression in stone. In Polish folklore, devils sometimes had hooves, following the Mediterranean tradition and sometimes, three-toed birdlike feet (a dinosaur heritage). The devil from Bałtów evidently resembled that described by the 19th century Polish poet Adam Mickiewicz in his ballad "Pani Twardowska" as having "cock's feet and sparrohawk's talons". In 2001, dinosaur fossilized footprint found on Devil Foot in Bałtow proved partly the local legend, partly because the track-maker seems to be of non-hell origin.

STOP 1 – Devil Foot

Fig. 3. Juratyrant at the Bałtów JuraPark reconstructed by Only Dinosaurs Science & Technology Co., Limited. Photo by Gerard Gierliński.

The legendary devil footprint is the track of large theropod dinosaur. This kind of footprints is originally described from the Middle Jurassic of China and named Changpeipus. This ichnogenus stratigraphic range exceed up to the Lower Cretaceous and recently also knows in Moroccan High Atlas. The probable trackmaker of Changpeipus was an early member of basal tyrannosauroid similar to Juratyrant. The skeleton reconstruction of Juratyrant is exhibited along the front wall of the JuraPark Baltów.

The Devil Foot is a so-called rock spur formed by the weathering of softer rock formations surrounding harder rock that is more resistant to erosion. Thus,

Fig. 4. Changpeipus track on the top of Devil Foot. Photo by Gerard Gierliński.

protruding from the slope, the lonely rock called Devil Foot is built from a different rock than its surroundings. Surrounding facies are the deposits of loess and limestones whose are of marine origin. Most of the dinosaur footprints in this area are preserved in that limestone, the sediment of carbonate beaches of the Jurassic island named Liszkowski Island in honor of the geologist who proved island nature of some rocks in the area half century ago. Later discoveries of dinosaur tracks confirmed his observations. Moreover, the tracks found are smaller than the same types of footprints elsewhere in the world. This in turn supports the so-called island dwarfism. The island's environment has had an impact on its inhabitants as revealed by the finds at Jewish's Gully in Bałtów. The fossilized tracks found there are about 30% smaller than similar tracks discovered in places where larger land masses or continental existed during the Late Jurassic. Limited food resources in the island environment contribute to the dwarfing of the warm-blooded (endothermic) animals living there, which were the dinosaurs. The endothermic terrestrial vertebrates, due to their faster metabolism, need ten times more food than ectothermic reptiles. The reduction in body size is therefore an adaptation of the endotherms animal to the limited food resources. The Changpeipus footprint from the Devil' Foot, however, is no smaller than Changpeipus specimens found in China or Morocco. This may suggest a different and yet unknown world of Bałtów dinosaurs? Piotr Szrek from the Polish Geological Institute-NRI in Warsaw agrees with such hypothesis. Firstly, he noted that the Devil Foot rock does not contain the remains of marine organisms, while the rhizoids (terrestrial plant roots) are well visible there. Secondly, Devil Foot rock is arenaceous dolomite not Oxfordian Bałtów coral limestones nor Kimmeridgian oolite limestones of Bałtów vicinity. Such sediment may have formed on the mainland at a different time and under different environmental conditions from Liszkowski Island.

STOP 2 – Jewish Gully entrance

Fig. 5. Jewish Gully loess gorge.
Photo by Gerard Gierliński.

According the old local tradition, the Jewish Gully is named because of being the trail to the tavern owned by the Jewish family and located up the hill. This gully is a typical loess gorge. The loess is periglacial silt-sized sediment that is formed by the accumulation of wind-blown dust. At the time when the gorge was formed the first human groups inhabited the region. The oldest flint tools discovered in Bałtów were made by the Magdalenian people, who were the Late Palaeolithic reindeer hunters. Their cultures were geographically widespread, from Portugal, in the west, to Poland, in the east.
The Late Jurassic carbonates are exhibited only at the mouth of this gorge. During the Late Jurassic times (in the Oxfordian, about 160 mya), a limestone rocks of the Jewish Gully, were the carbonate mud, which built the wide coast of flat carbonate island. Very similar "white tropical worlds" occur today on the Indian Ocean.

STOP 3 – coated limestone pebble at Jewish Gully

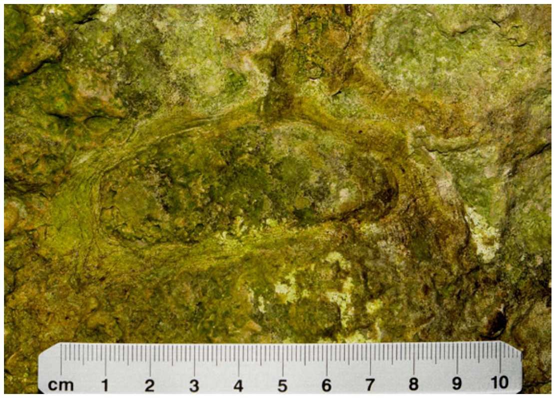


Fig. 6. Coated limestone pebble at Jewish Gully. P
hoto by Gerard Gierliński.

Here we see the coated limestone pebble. Such reworked and coated limestone grain is one of an indicator of a high energy nearshore-foreshore palaeoenvironment, in the Jewish Gully. Such regularly coated pebbles are found recently on the beaches. They are formed by being permanently rolling by waves and then they are surrounding steadily by algae layers.

STOP 4 – assemblage of theropod and ornithopod dinosaur tracks at Jewish Gully

Fig. 7. Theropod and ornithopod dinosaur
ichnoassemblage at Jewish Gully.
Photo by Gerard Gierliński.

Here is an interesting assemblage of theropod and ornithopod dinosaur tracks. Two step trackways of two ornithopod dinosaurs (dryomorphs – small herbivorous bipeds) are visible in the center of slab. This kind of footprints is named Dinehichnus.

Fig. 8. Dineichnus at Jewish Gully.
Photo by Gerard Gierliński.

The single theropod (carnivorous dinosaur) footprint lies close to the ornithopod tracks. This type of track belongs to the ichnogenus Therangospodus, which comprise footprins possibly left by the well-padded feet of the medium theropods, such as neoceratosaurians.

Fig. 9. Therangospodus from the theropod and ornithopod dinosaur ichnoassemblage at Jewish Gully. Photo by Gerard Gierliński.

STOP 5 – isolated footprint of drafted neoceratosaurian at Jewish Gully

Fig. 10. The isolated Therangospodus footprint in situ at Jewish Gully. Photo by Gerard Gierliński.

Here we can see another track of drafted neoceratosaurian. The plant remains found in the neighbouring site of Wólka Bałtowska suggest that Oxfordian island was inhabited by little diversed xerofilous vegetation, which indicate climatic aridization. Such harsh environment, limited area of island and limited productivity of xerofilous flora, was responsible for dwarfism among dinosaurs. Dwarfism is also observed recently among the mammal species, which inhabited islands.

Fig. 11. Jialingpus track roofing at Jewish Gully.
Photo by Gerard Gierliński.

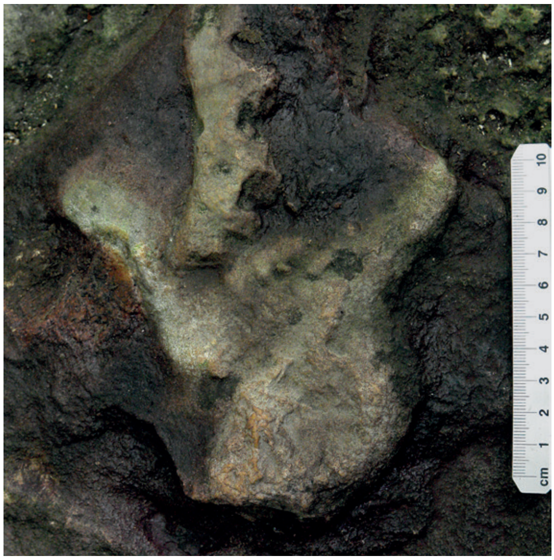


Fig. 12. Jialingpus at Jewish Gully.
Photo by Gerard Gierliński.

STOP 6 – natural cast of small theropod track at Jewish Gully

Under the roof we see the track of small theropod - basal tyrannosauroid. The footprint is preserved as natural cast on the weathered limestone slab, which is displaced downslope and rotated upside down. The ichnite resembles Late Jurassic tracks originally described from China named Jialingpus. The fossilized tracks are preserved as the regular imprints or the natural casts of imprints. If the tracks were left in the silty sediments and they were buried by a layer of siliciclastic or carbonate sand, then they are preserved today as convex natural casts on the bottom surface of sandstone or limestone layer. So, this dinosaur tracks, in the Jewish Gully, is preserved as natural cast, not mold like other dinosaur tracks in Bałtów.

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