



Maps with Geological Content

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Summary

The article presents a brief history of the national thematic maps with geological topics in the European context. Despite considerable character and information fullness of these works and their difficult readability, they represent in every historical phase leading cartographic products, which are awarded by appropriate social valuation.

New technological trends in geological mapping and cartographic presentation of the results, at present almost exclusively in the digital environment of the Internet, also uses the Czech Geological Survey in creating thematic state map series. Valuable map works with the geological theme, however, are also part of comprehensive national atlases, such as the Atlas Landscape of the Czech Republic.

Keywords: historical .map, geological content, Böhmen, A. L. Hickmann

Introduction

Topographic and detailed (cadastral) maps they were gradually changing its content and technical and graphic design during its long evolution. As a means of high utility value they also gradually formed cartographic literacy of its users, with respect to the particular purpose for which the cartographic work was intended or to a specific function, that it should actually perform. Forming of cartographic literacy in this way was very quick and efficient, as there was immediate feedback between the cartographic landscape model and reality. Many cartographic works, at first sight, didn't bring such effect and in principle could not do that. Reason is either they display too many different types of landscape structure (even extra-terrestrial), to which the user has no experience nor they display in the form of thematic (purpose) map objects and phenomena that were the result of such an analytical perspective of specialist to a certain part of the landscape, and so confrontation such map with reality requires the informed user. Topographic maps of undermined and karst areas and detailed maps of underground space, including mining and speleological map, interests with using generally little known cartographic characters. The time factor affect negatively, because between the date of publication of cartographic works and the date of its distribution may, with regard to the character of the landscape and the intensity of economic activity in it, happen significant changes. This risk is currently greatly reduced by production of digital maps of the updated database sources. A classic example of thematic maps, which mentioned the time factor, does not acquire more serious meaning and which the reading of it makes uninformed users uncomfortable, are generally all maps with geological issues. The time factor in them

may play a role in changing professional view of the mapped objects or phenomena, such as age, composition and genesis of a geological formation.

Geologists have always belonged to a very active part of topographic mapping also of little-known territories. They performed it parallelly with the geological prospection and production of thematic maps with departmental charge. Their positive contribution was evident in every historical stage of cartography development and it is an important and inspiring even in the current age of digital and internet cartography. Without any claim to completeness in this article we aim to recall some significant milestones, which geologists and specialists of related expertise importantly wrote to the theory and practice of primarily national thematic cartography and despite the difficult accessibility of mapped objects and phenomena they gave the public contently and graphically attractive cartographic works.

History

Geological issues usually constricted only on the occurrence and extraction of interesting minerals appears on the old geographic sketches and the first maps practically since the beginning of their creation. In this sense is known the map of Pharaoh's gold mines in Nubia (about 1200 BC). Papyrus scroll discovered around 1824 shows part of the Wadi Hammamat in the eastern Egypt, with settlements, roads, quarries and mines for gold mining. On the south-facing drawing can be seen the primary distinction of different types of rocks and sand, and therefore is considered the oldest geological map of the world. In the literature it is possible to trace the place of today's storage in the Turin Museo Egizio as "the Turin papyrus map".

Places of precious metals mining, respectively places of their treatment are often displayed in the old cartographic work with topography content (see the following examples of our country). However, we cannot always count on it. In the Middle Ages in the absence of information included graphically individually rendered myths and legends, such as the occurrence of gold, which can initiate many of later exploration trips, such as Columbus did.

Map of the Kingdom of Bohemia ("*Regni Bohemiae Nova et exacta descriptio*") by Paul Aretin of Ehrenfeld in scale 1:504 000 from around 1619 shows, using the dealt code, except populated sites and so mines. A similar content of this nature has a map of Mauritius Vogt and maps of Johann Christoph Müller and his followers. Map of the Kingdom of Bohemia ("*Nova Totius Regni Bohemiae Tabula Reverendissimis, celsissimis, Illustrissimis et excellentissimis, illustrissimis, perillustribus et praenobilibus Dominis Dominis inclyti Regni Boemiae Statibus Dominis Dominis Suis Gratosissimis, benignissimis data, dicata et consecrata ...*") by Mauritius Vogt from 1712 in scale about 1:396 000 presents topographic map with an enhanced thematic content, which consists of mines for gold and silver, ore mines and also glassworks, vineyards, iron works, customs and postal stations, roads, etc. From the period of the Müller mapping are on the so called estates map of Moravia ("*Tabula generalis marchionatus Moraviae in sex circulos divisae quos mandato caesareo accurate emensus hac mappa delineatos exhibet Joh. Christoph Müller S.C.M. capitaneus*"), processed during the years 1708–1712 and published in 1716, marked with dealt map symbols among other mines, spas and healing springs.

In terms of the type of raw material is more detailed, for example, the Comenius map of Moravia "*Moraviae nova et post omnes priores accuratissima delineatio. Auctore I.A. Comenio*", known mostly from copy from 1627, taken by Claes Janszoon Vischer (Nicolaus Piscator). Her map legend consists of, among others, the characters for the healing springs, iron ore, gold and silver mines.

Maps with purely geological content (petrographic, mineralogical, etc.) appear in Europe in a mass scale until the mid of 18th century. Noteworthy according to [9], [11] and others mainly maps processed by Christopher Pack (map of southern England, 1743), Jacques Étienne Guettard (map Switzerland, 1752), Johann Charpentier ("*Petrographische Karte des Churfürstenthums Sachsen und der Lande incorporirten*", 1778), Abraham Gottlob Werner (map of Saxony elaborated in the years 1799–1806), William "Strata" Smith, who has published probably the first national geological map titled "*A delineation*

of the Strata of England and Wales with part of Scotland" in 1815, and others. Franz Xaver Riepl formed and issued in 1819 in Vienna first regional geological map covering a significant part of the territory of today's Czech Republic, titled "*Geognostische Karte von Bohemia*" in scale of about 1:576 000.

On the territory of the Czech countries launched the era of classical thematic maps with scientific themes also geologists. The oldest map with the geological themes [9] is likely Johann Jirasek's map from 1786 ("*Petrographische Karte Derer Kameral-Herrschaften Zbirow, Tocznik, Königshof, Miröschau und Wossek*"), who made it within his geographic studies of Zbirožsko areas. Rocks in it were first distinguished by colored surfaces, which is still an essential characteristic of geological maps.

Kaspar von Sternberk issued in 1836 in Prague book "*Umrisse einer Geschichte der böhmischen Bergwerke*", to which was annexed map of past and present sites and mines of mineral resources "*Charte der älteren und neueren Bergbaue in Bohemia*" in scale of about 1:964 000. Often, as evidence of a long history of geological mapping, is also quoted "*Geognostische card (Übersichtskarte von) Bohemia*" by Franz Xaver Maximilian Zippe, which had been first published in Prague in 1832 and again in 1837. It probably existed only in manuscript form, because it has not been documented anywhere. Its relationship to existing manuscript map "*Geological map of the Kingdom of Bohemia and adjacent areas*" (in Czech) in scale of approximately 1:1 100 000, which was published in 1837 in Vienna and whose authorship is attributed to Adreas Preininger, is not yet satisfactorily explained.

Johann Ferdinand von Schmidt Bergenhold issued in the years 1854–1855 in scale of about 1:750 000 "*Geognostisch montanistische Geschäftskarte des Königreichs Bohemia*", which is fitted with a decorative frame with a picture of 42 selected species of paleontological findings from different geological formations of Bohemia. The map is made in two colored versions, one with color showing geological formations and the other showing the areas of competence of the mining authorities and courts.

In 1863, is issued in Vienna under the editorial leadership of Wilhelm Haidinger set of 40 sheets of colored manuscript map titled "*Geological map of the Kingdom of Bohemia*" (in Czech). Geological situation is drawn into the printed topographic base maps of the Austrian General Staff in scale 1:144 000. On the greater part of the leaves are on the edge registered, with a pencil, the name of a particular author and date of mapping (approx. in the period from 1853 to 1862). In the years 1867–1871 Wilhelm Haidinger signifi-

cantly contributed to the release of 12 sheets “*Geological Übersichts-card-der Österreichische ungarischen monarchy nach dem der k.k. Aufnahmen Geologischen Reichsanstalt bearbeitet von Franz Ritter von Hauer*” in scale 1:576 000, which in turn were issued in Vienna. Czech territory is on the leaves I – III.

In 1873 in Prague, was issued the second edition of “*Kohlen-Revier-card-der Österreichische ungarischen Monarchie*”, produced by Johann Pechar in scale about 1:2 200 000. On the edges of the map sheet are more detailed maps of selected coal fields in scale of 1:288 000. In scale of 1:1 000 000 was published in Prague in 1883, “*Geological map of the Kingdom of Bohemia*” (in Czech). The author is Joseph Klvaňa.

The map is already mentioned in 1878 as an annex to the Štěpán Bačkora’s book “*Practical learning of geography of Bohemia*” (in Czech), but Klvaňa’s authorship is not confirmed there. In 1907, are issued in Olomouc two sheets “*Geological maps of the Czech Crown Lands*” (in Czech) by Karel Absolon and Zdeněk Jaroš in scale of 1:300 000. A number of maps with geological theme was part of the “*Otto’s Encyclopaedia*” (1888 - 1909) or “*Otto geographic atlas*” (1924, in Czech).

During the existence of the Austrian (Habsburg) Empire and Austria-Hungary Empire were created a whole series of maps with geological theme that displayed the entire empire in a relatively small

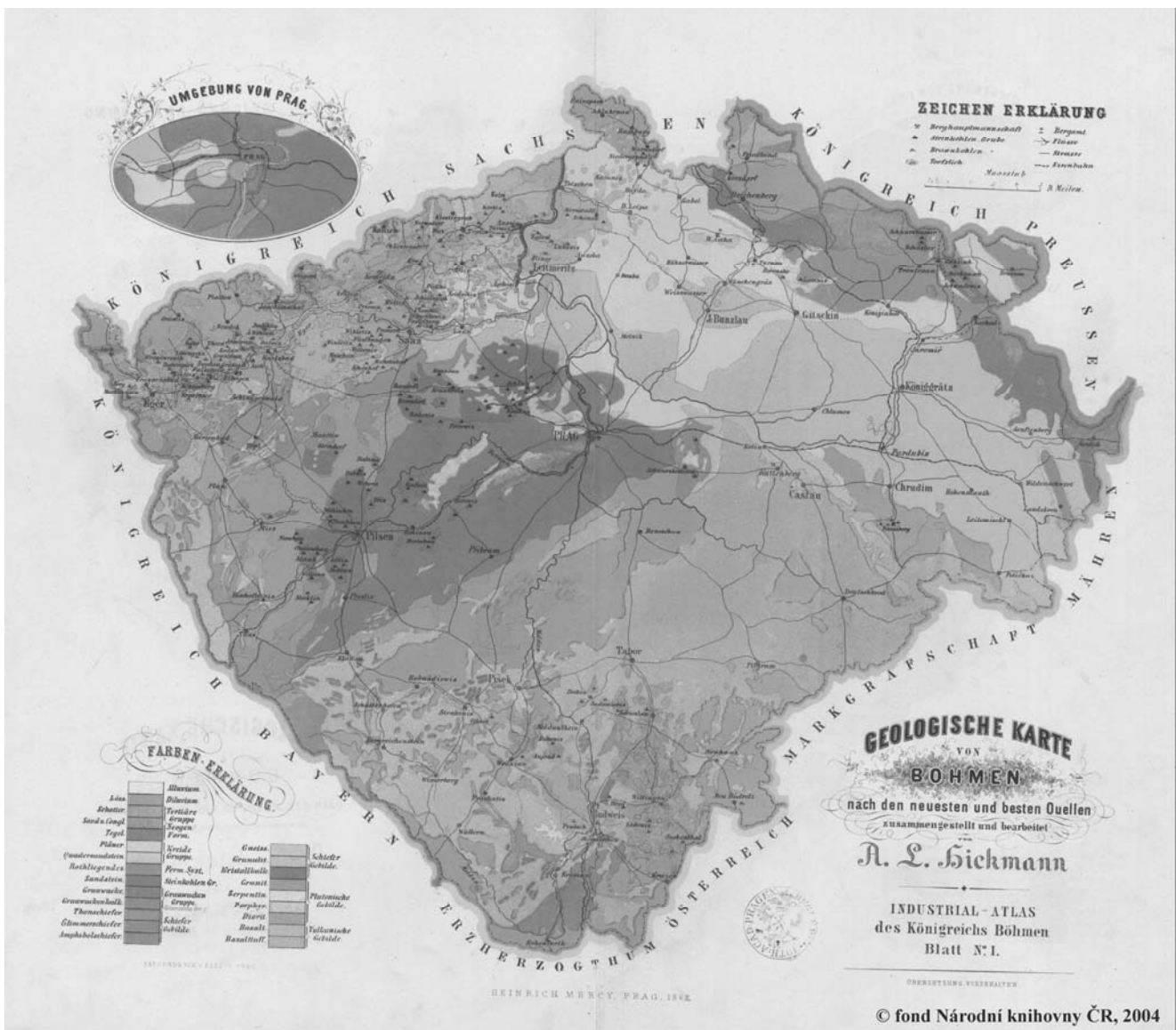


Fig. 1. Geologische Karte von Böhmen nach den neuesten und besten Quellen zusammengestellt und bearbeitet von A.L.Hickmann, 1 : 910 000 (original 328×390 mm, scaled), Praha 1862 (http://www.geology.cz/demo/dvd_hm/pgs_cze/mapy_id_70679.html)

Rys. 1. Mapa geologiczna Bohemii - najnowsze i najlepsze źródło zestawione razem i edytowane przez A. L. Hickmann, 1 : 910 000 (przy 328×390 mm, skalowana), Praga 1862 (http://www.geology.cz/demo/dvd_hm/pgs_cze/mapy_id_70679.html)

scale, or dealing with purely regional studies in a larger scale. Many of these mapping works is to trace to [8], [9], [12] and [13].

Significant cartographic monuments in our country related, since the early Middle Ages, with the mining industry. The oldest preserved mining map with the Czech description is the map of Zikmund Prášek from about 1534, taht shows Poličany Drift near Kutná Hora on the southern edge of the mining district in the valley of Vrchlice. Other highlights of Kutná Hora cartography include a map of driving “Panské jáma” was made by Jiřík of Řásná in 1578. Considering the Slovak territory, then is historically noteworthy map of drift in Banská Bystrica from 1535, which has not been preserved and the oldest preserved map of this type, map of “Boží dar” drift in mine Mondenschein in Jarabí near Brezno from 1568.

Unique work of mine, called “Rudolfova štola”, bringing under Letná water from the Vltava river to the Royal Park (Stromovka), shows manuscript map from 1593, made by Isaac Phendler in 1:540 scale. It is one of the first mining outline map in our area.

Present

Geological mapping and mapping associated with surface and subsurface mineral extraction was carried out with big intensity also throughout the existence of an independent Czechoslovakia, so with significant support from state authorities. Meaning of the geological service in its time was confirmed by Act 2/1969 Coll. Czech National Council about the establishment of ministries and other central organs of state administration, by which was established Czech Geological Office, which included among other the Central Geological Institute (later the Czech Geological Institute). But with the Act No. 288/1990 Coll. about the measures in the system of central organs of state administration of the Czech Republic was abolished and its competences transferred to the Ministry of Environment of the Czech Republic, under whose auspices is concentrated power of the state geological services to the state contributory organization Czech Geological Survey (<http://www.geology.cz>). Despite this, maps with the geological theme have always been important national thematic or special purpose works, which have the character of official maps, by today's terminology character of state map work.

According to [12] was a detailed geological mapping in scale of 1:25,000 already started in 1970 and continued until the early 90th years and after the series of maps 1:50 000 were finished, in 1998 it was again selectively restarted. Information obtained in the course of new geological mapping was deposited into a complex Geographic Information System GEOČR 25.

Digitised “Basic Geological Maps 1:25 000” (in Czech) forming geoscience layer of GEOČR 25, are the basis for building a “National Geological Map Database of the Czech Republic”. Project (1998–2002) “The basic and purpose geological mapping of the Czech Republic 1:25,000” (http://www.geology.cz/demo/CD_GEOL_MAP25/install.html) builds on an established and mostly printed geological map 1:25,000 Czech Geological Institute, produced in the previous period. Since 2006, the Czech Geological Survey began the gradual implementation of the concept of “National Geological Map Database of the Czech Republic”, which should represent an integrated geological information system, including all data and information stored in specialized maps archives and also serve as a data storage for geoscience data and information generated in contemporary geological mapping programs produced in different scales.

On its website Czech Geological Survey (ČGS) currently allows on-line maps preview by map server and WMS services through the Internet application “Digital map archive ČGS”, which provides access to a variety of printed geoscientific maps, both from Czech Republic and from abroad and offers overview of printed geoscience maps produced by ČGS, provided data and mapping projects. Its “Localization and mapping applications”, actual version 2.0 (<http://www.geology.cz/app/ciselniky/lokalizace/>) allows easy and quick access to geological maps. It uses the API services of the server AMAPY.cz including spatial information of third sides (eg ČÚZK topographic data ZABAGED[®], RZM 10, 50 RZM, Administrative boundaries). It was created within the research project DE08P04OMG002 “Creating of the information system of the Czech Geological Survey – Revision and paleontological processing of selected older funds from ČGS collections”.

Information about the accessibility features of geological maps and maps related to geological sciences are also available on the website <http://www.geologicke-mapy.cz/>.

The current activity of the Czech Geological Survey in creating maps with geological themes is properly moving toward digital geoinformation technologies. A printed map does not remain outside the interest of the institution. In 2007, ČGS released a new geological map of the Czech Republic in the scale of 1:500,000 [10], on which were participated dozens of leading geologists and specialists. Its content, cartographic and technical quality appreciated Cartographic Society of the Czech Republic by granting award Map of 2007. High cartographic and expert professionalism is indeed the standard feature in maps with geological theme. For example set of geological maps by Dionysus Štúr from 1860 was

awarded the gold medal already at the World Exhibition in London in 1862.

Comparison of the content of the latest map with its ancient predecessors is not good deal, but looking at them is a picture where today's geological mapping has shifted. While the regional geological map of Franz Riepl has legend containing 20 rocks, the new geological map in scale 1:500,000 already shows the distribution and relationships of 320 rock types. Besides its own geological map and its legend includes the accompanying diagrams (eg of the main geological units of Europe) or information about the absolute age range of igneous rocks and metamorphic processes. Not to mention the advantages of interactive digital maps created on the principle of contextual cartography.

Thematic atlases

In the 19th century appeared very high quality content and rich thematic atlases. E.g. “*Physikalischer Atlas*” by Karl Heinrich Berghaus, published in Gotha in two volumes in the years 1837–1848 and included meteorological, hydrographic, geological, botanical and other thematic maps. We can find single concepts of “geological atlas” in Czech and world cartographic literature, although it may more or less differ from the ideas of classical atlas. As one example, the “*Geological atlas of Czechoslovakia 1:1 000 000*”, which summarizes the most important information collected during regional geological survey of Czechoslovakia from 1945 to 1960 and was formed by maps of the Geology section [4] of “*Atlas of Czechoslovak Socialist Republic*” from 1966 (geological, tectonic map of quaternary and weathering mantle, map of mineral deposits) and 3 more maps of the same scale (hydrogeological map, metal-genetic map and aeromagnetic map). The second example is from the 1985 generating “*Geological atlas of the Czech Republic Stratigraph*” (Klomínský, J., ed., Czech Geological Survey, Prague 1994, ISBN 80-7075-167-3), which consists of 17 stratigraphic tables of geological formations in the Czech Republic.

Geological theme is rightfully an integral component of any comprehensive or national atlas. It was the same in Czechoslovak/Czech national atlases, such in “*Atlas of the Czechoslovak Republic*” from 1935 [3], in “*Atlas of the Czechoslovak Socialist Republic*” from 1966 [4], which represents “general, geographically statistical and national economic atlases of the Czechoslovak Republic”. A very important part is devoted to this topic in the “*Landscape Atlas of the Czech Republic*” [5].

This cartographic work was carried out within the research projects SK 600/1/03 “*Landscape Atlas of the Czech Republic*” and MSM 6293359101 “*Research of resources and biodiversity indicators of*

cultural landscape in the context of the dynamics of its fragmentation” with financial support from the Ministry of Environment and the State Environmental Fund of the Czech Republic. On its creation in the final issue involved 356 authors from 133 institutions, including foreign ones and it was cooperated in the review process, with 24 experts from various disciplines. It is made on 332 A1 format pages and contains 1,137 numbered objects, of which 906 maps and 767 not-map elements (graphs, charts, photographs and images). In the basic scale 1:500 000 is processed 41 maps. The most frequent scale is 1:2,000,000 (342 maps), 83 map is processed in scale of 1:1 million, 29 maps in scale of 1:1.5 million, 218 maps in scale of 1:3 million or 1:4 million and 193 map segments has different, mostly larger scale.

In 2010, this work was awarded as a Map of year 2010 from the Czech Republic Cartographic Society in category Atlases, files a series of maps and on the occasion of the 25th International Cartographic Conference in 2011 in Paris received from the International Cartographic Association award for the best atlas of the year.

Landscape Atlas of the Czech Republic is divided into eight basic sections, in which, of course, geology is explicitly mentioned. These are the sections:

1. Landscape – the object of study, where is displayed in the samples landscape from topical to makrochoric level and presents a variety of map-making from 1518 to the present.
2. Geographical position, which defines the position of the Republic in a global scale of Europe and the world. Includes maps of geological division of Europe and the mineral composition of Europe in scale of 1:15 million.
3. Historical landscape, which is aimed, among others, to the development of the national territory, employment, land use and natural and anthropogenic risks. In part “Historical Natural Risks” is given attention to the mining disasters since 1900 (1:1 150 000) and to the historical landslides and earthquakes.
4. Natural landscape, which is made up of parts dedicated to individual landscape components, including geological structure. In scale of 1:2 000 000 is monitored energetical potential of the geomagnetic field, radiometric field, gravitational field and temperature in a depth of 100 m below the surface, in scale of 1:1 000 000 is made the hydrogeological regionalization of the state. Geological conditions in the Czech Republic are covered by a separate sub-chapter 4.3. Basic maps in scale of 1:500 000 forms in there “Geological setting” and “Qua-

ternary deposits”, which accompanying maps in scale of 1:1 000 000 (Geological division, Engineering geological zones), 1:2 000 000 (Geological setting at a depth of 3 km, Geological periods) and 1:3 000 000 (Geological boreholes), geological profiles, graphs and photos.

5. Contemporary landscape, which deals with the population, places and settlements, economic activities in landscape with using it.
6. Landscape as the heritage, which includes among others, maps of nature and landscape protection and maps of natural resources and historical objects. From the geological point of view should be noted the map in scale of 1:500 000 “Significant geological and geomorphological localities”.
7. Landscape as the environment for society, which includes a number of synthetic map outputs. The natural and anthropogenic hazard is paid significant attention to seismicity, radon stress of the natural environment and mining. In scale of 1:1 000 000 are presented mining anthropogenic landforms, undermined areas and important mining regions, landslides and rayons with an increased risk of geophysical and geodynamic phenomena. Among the complex thematic maps in scale of 1:500 000 is to be noted map “Geological limits and geofactors in the landscape”.
8. Landscape in Art, which contains 45 paintings and prints from leading Czech landscape painters.

Geological structure and rock composition is an essential component of the landscape, so it is not surprising that a number of synthetic and comprehensive map of the Atlas Landscape of the Czech Republic adapts at least parts of its legends to this situation. It is for example the map of Natural landscape types, Land cover, Landscape character types, Natural limits and threats, Stress factors of environment, Carrying capacity of the landscape, etc.

Conclusion

Geological theme is perceived by the public majority significantly only in the form of rock outcrops and surface mining activities or expressions of karst processes. Such objects can be very well interpreted from a detailed topographic map, because it compares the character presentation with direct experience in the field. Thematic maps with geological content of various topics already require certain knowledge. Despite this, they are popular and generally widespread, not only because they show a “mystery” of Planet Earth, like maps of the celestial sphere or space objects do. Their graphic, character and Information fullness is in historical section always handled with the utmost cartographic care. These works in every historical phase represent high cartographic products, which are awarded by appropriate social valuation. Czechoslovak (Czech) cartographic work was not an exception.

Geological mapping is basically an endless process, not only because there is a need to fill uncharted places in the world, but also because a professional view on already mapped geological formation is changing or because there are always new technologies of cartographic presentation of results of mapping, currently almost exclusively in the digital environment of the Internet. Valuable map works with given expert content, however, are also part of comprehensive national atlases, such as the Atlas Landscape of the Czech Republic. Historical cartographic works with geological theme forms very good basis for the current national thematic state map series, which is accessed for the general public by care of Czech Geological Survey.

All cartographic works with geological theme, including only briefly mentioned mining, pit, speleological and similar maps belongs to the national cartographic “treasure” that deserves constant attention.

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Mapy z zawartością geologiczną

Artykuł przedstawia krótką historię krajowych map tematycznych zawierających aspekty geologiczne w kontekście europejskim. Mimo znaczącego charakteru i ilości informacji tych prac oraz problemów związanych z ich odczytaniem, stanowią one na każdym etapie historycznym wiodące produkty kartograficzne, które są nagradzane.

Nowe trendy technologiczne w kartografii geologicznej i kartograficznej prezentacji wyników, obecnie niemal wyłącznie w środowisku cyfrowym w internecie, również korzystają Czeskich Badań Geologicznych podczas procesu tworzenia map tematycznych. Wartościowe mapy skupiające się na geologii są również częścią atlasów krajowych takich jak choćby Atlas Krajobrazowy Republiki Czeskiej.

Słowa kluczowe: mapa historyczna, zawartość geologiczna, Bohemia, A. L. Hickmann