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Geological cartography in Poland in the 19th century

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The history of modern geological mapping in Poland began with the *Carta Geologica totius Poloniae, Moldaviae, Transylvaniae, Hungariae et Valachiae* by S. Staszic, often called the "father of Polish geology". Before Staszic, a general map of Poland had been published by J.-E. Guettard (1764a); ones of the Sudety Mts. by J. Jirasek (1791), L. von Buch (1797), and Raumer (1813); and that of the Tatra Mts. by Hacquet (1796). In times of the partition of Poland (1772 to 1918), areas annexed by Prussia were covered by systematic geological surveys. These cartographic projects resulted in the compilation of two geological atlases comprising maps of the standard sheet type, in the period from 1826 to 1836. These atlases were compiled by teams of outstanding geologists, under the leadership of L. von Buch and F. Hoffmann. Another outstanding contribution to the geology of Poland was made by G.G. Pusch, the author of the excellent *Geognostische Beschreibung von Polen* (1833–1836), subsequently supplemented by *Geognostyscher Atlas von Polen*. One of the greatest achievements of L. Zejszner was the geological map of the Tatra Mts., *Carte de la chaine du Tatra*, published anonymously in Berlin in 1844, and a series of geological maps prepared as drafts of *Geognostic maps of the Eastern District of the Polish Kingdom*. Special attention should be also paid to two extensive studies which covered areas of Upper and Lower Silesia. The first of these, *Geognostische Karte von Oberschlesien und den Angrenzenden Gebieten*, was completed by a team led by F. Roemer, and published in 1870. The second, *Geologische Karte von dem Niederschlesischen Gebirge und den angrezenden gegenden*, was compiled by a team led by R. von Carnall, and published in the same year. Out of all the studies carried out by Austrian geologists, it is necessary to mention those of E. Tietze, as they produced excellent geological maps of the Carpathians and vicinities of Kraków and Lviv. It is also worth mentioning the contributions made by the Physiographic Commission, active from 1866 until the beginning of the First World War. Its members decided to prepare the *Geological Atlas of Galicia*. The final product of works of this commission was a set of 25 booklets, with over a hundred geological maps at a scale 1:75000, issued in the years 1885–1912. From 1881, the commission was also publishing its famous *Physiographic Diaries*, which include papers on the geology of areas annexed by Russia, written by famous Polish geologists such as J. Siemiradzki, A. Michalski, and E. Habdank-Dunikowski, illustrated with relevant geological maps prepared by them.

Key words: old geological maps, history of geology, Poland, Central Europe.

INTRODUCTION

In Europe, geological cartography began to emerge in the mid-18th century, with dynamic development at the beginning with the 19th century. These were the times when Poland began to lose its independence and was partitioned in the years 1772, 1793, and 1795 by Prussia, Russia, and Austria and disappeared from the map for 123 years. These partitions also led to some problems for cartographic analysis, especially those connected to the repeated shifts of political borders and the resulting changes in the geographic setting of specific areas (Fig. 1). The aim of this paper is to draw attention to the cartographic achievements of geologists of Polish origin and of foreigners taking part in the mapping of areas of our country.

In order to have a solid starting point to discuss the developments of geological cartography, we provide a brief review of scientific works on issues currently deemed to be a part of broadly understood geology, namely those which concern the geology of Polish territories. Here, we should start with Jan Długosz (1415–1480), who provided much information on the natural resources of Poland in his monumental chronicle *Annales seu cronicae incliti Regni Poloniae*. In general, his description of the country included numerous references to deposits of iron, lead, salt, and sulphur. He devoted much attention in that monograph to earthquakes as dangerous phenomena often occurring in Italy and other European countries, and occasionally also affecting Poland. A detailed collation of information on naturalia described or mentioned in the Jan Długosz chronicle was provided by Zygmunt Gloger (1888).

Caspar Schwenckfeldt (1563–1609), a Hirschberg (Jelenia Góra) physician and naturalist – called by his contemporaries the Silesian Pliny – was the author of an impressive monograph, *Stirpium & fossilium Silesiae catalogus*, published in 1601. A third part of that monograph entitled *Omnis generis mineralia, metallica, metalla, succros, terras, lapillos, fontes medicatos thermas*, 59 pages long (pages 349–407), deals

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Fig. 1. Sketch of the Polish borders from 1772 (before the partitions) to the present

with mineral raw materials (gold, silver, copper, iron, decorative stones, quartz, alum, and others) and their existence in Lower Silesia and other regions, and their use in medicine. He also studied the thermal waters of Lądek and Jelenia Góra, especially their balneological value. The thermal waters of Cieplice became the subject of his last two publications, *Hirschbergischen warmen Bades* in Schlesien (1607a) and *Thermae Teplicenses* (1607b).

Jan Jonston (1603–1675), a philosopher, physician, and naturalist, presented results of his studies on inanimate nature in the first four chapters of his monograph, *Thaumatographia naturalis* (1632), as well as in *Notitia regni mineralis* (1661). In writing the latter, Jan Jonston used *Musaeum Metallicum in Libros IV distributum Bartholomaevs Ambrosinus* (1648), by Ulisses Aldrovandi (1522–1605), as an inspiration. In that book, he offered his own systematic proposal for the classification of natural objects based on subdivision into earthy ones, curdled juices, resins, stones, and metals (ores) (Samsonowicz, 1848). He provided only scant information on mineral raw materials in Poland (such as rock salt in Podolia or *terra sigillata* clays from the Strzegom area) (Skoczylas, 2011).

Gabriel Rzączyński (1664–1737) was the author of two large monographs, *Historia naturalis curiosa regni Polonia*... (1721) and *Auctuarium historiae naturalis*… (published after his death in 1742). These books provided much information on ore deposits in Poland, either based on previous publications or collected by the author, and markedly contributed to filling some gaps in knowledge of the natural history of the then Polish territories. Although in the opinion of Aleksander Kremer (1853–1855, *vide* Kołodziejczyk, 1932) the decision to publish these books in Latin significantly limited potential readers in Poland to only the scientific community, it made them much better

known in Europe. For example, references and citations from Rzączyński's books can be found in *Magnalia dei in locis subterraneis*… by Franz Ernst Brückmann (1730) and in *A History of Fossils* by John Hill (1748). His books also served as the main source of information on the geology of Poland for J.-E. Guettard in his fact-finding missions conducted in our country from 1760–1762.

Jan Filip Carosi (1744–1799) published three books on the geology of Poland. The most important one, *Reisen durch verschiedene polnische Provinzen, minealogischen und anderen Inhalts* (in two volumes, published in 1781 and 1784, respectively), has the form of a collection of letters describing areas through which he travelled. Due to his geological and mining background, he paid special attention to the accuracy of the descriptions of geological profiles and mining operations. His studies mainly focused on the Holy Cross Mountains, which made him a precursor of geological surveys of that region. It is worth adding that he was the first author to report mineral waters from Busko Zdrój.

A two-volume book by Krzysztof Kluk (1739–1796), entitled *Mining matters, especially useful ones – exploration, recognition and utilization* (*Rzeczy kopalnych, osobliwie zdatnieyszych, szukanie, poznanie i zażycie*), was published in Warsaw in 1781–1782. It presents the most complete descriptions of mineral resources in the area of Poland, the best practices in prospecting and extraction, and the possibilities of their practical use. The idea behind this book was to advise on how to use natural resources to enhance economic development. Therefore, Kluk gave that book the form of a comprehensive and easily accessible guide, written especially for small- and medium-sized landlords – noblemen managing their own lands.

MAPS OF EARLY NATURAL HISTORIANS – STANISŁAW STASZIC EPOCH

Carta Geologica totius Poloniae, Moldaviae, Transylvaniae, Hungariae et Valachiae by Stanisław Staszic (1815a) is the first map of Poland, compiled by a Polish geologist (Grigelis et al., 2011). It consists of four sheets and covers an area from the Baltic Sea in the north to the Black Sea in the south, and from the Sudety Mountains in the west to Vitebsk in the east. The map is a hand-coloured copperplate engraving, with beautiful cartouche with the title and date of compilation (Fig. 2). In drawing that map, Stanisław Staszic (1755–1826) used an ancient form of relief depiction, known as hill profiles, marking lithology and/or instances of usable raw material with numbers. The map was an illustration for his essays published by the Warsaw Society of the Friends of Learning since 1805. The essays were subsequently collected and published with minor changes, in the form of a truly monumental monograph entitled *O ziemiorództwie Karpatow i innych gor i rownin polskich* (*On the earth-formation of the Karpaty Mountains and other mountains and plains of Poland*, 1815b). The map is the core part of that atlas, and is accompanied by: by two geological cross-sections; a beautiful panoramic artistic vision of the Tatra Mountains, drawn by Zygmunt Vogel on the basis of Staszic's suggestions in 1804; a portrait of a young mountaineer, by Jan Zachariasz Frej; a drawing of a great eagle and chamois mountain goat; three tables of fossils; six tables with lists of foundries, metal works, and other factories and smitheries, as well as rock salt, brine, sulphur, and coal mines, surface effusions of crude oil, and the locations of amber.

Stanisław Staszic was a supporter of Wernerian Neptunist theory. Thus, in his work he adopted the stratigraphic classification of Werner with minor modifications (Grigelis et al., 2008), and distinguished on his map (using the French language): montagne primitive, montagne secondaire ou primitive stratiforme, montagne antemarine, montagne marine, and terres d'alluvien.

The Staszic's map was preceded by the publication of several other maps of the area of Poland. Of these, the map published by Jean-Etienne Guettard (1715–1786) in *Historie de l'Académie Royale des Science*, a print of the Royal Printing House in Paris from 1764, is regarded as the oldest (Daszkiewicz and Tarkowski, 2009). This map, based on the results of his studies in 1760–1762 and named as mineralogical by the author (*Carte minéralogique de Pologne*), was enclosed as an illustration for his two-part paper, entitled *Nature du Terrain de la Pologne, et des Minéraux qu'il renferme* (1764a). It is fairly simple, showing a sandy formation extending throughout the major part of Poland and a salt formation in the southern part (Fig. 3). In the same volume of *Historie de l'Académie Royale des Science*, Guettard also published one more important paper on the geology of Poland, dealing with the famous salt mine at Wieliczka (*Les mines de sel Wieliczka en Pologne*, 1764b). The latter paper was illustrated by a lithograph, showing the location of major objects of the Wieliczka Mine, and a cross-section through mine excavations (Fig. 4).

Here it worth emphasizing the special importance of the Wieliczka Salt Mine as one of the best known mines in the world. The special status of this mine was well-reflected in extensive descriptions given in many books on natural history and encyclopaedias. Robert Townson was one of the first foreign researchers to describe and draw cross-sections of the Wieliczka salt structures (Fig. 5). Attention should be paid to the descriptions and drawings of the mine (Fig. 6) given in the 18th-century great French encyclopaedia by Denis Diderot and other authors (*Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers*, 1751–1766), a monumental work of unquestionable scientific and political impact (see Krzywiec, in preparation).

The oldest known map of the Karkonosze Mountains – *Petrographische Charte eines Theils de Böhmischen Riesengebirges an der Schlesischen Grenze* (1791) of Johann Jirasek (1754–1797) shows the distribution of granites, gneisses, schists, limestones, and the location of quarries, mining excavations, and smitheries (Fig. 7). Attention should be paid to the atypical orientation of this map, as north is at the right and west is at the top. This is a hand-coloured copperplate engraving on high quality handmade paper, with beautiful watermarks and with the clear edges of an original plate clearly imprinted. The map was published as an integral part of a book by J. Jirasek and his co-authors (T. Haenke, A. Gruber and F. Gerstner), entitled *Beobachtungen auf Reisen nach dem Riesengebirge*.

The Karkonosze area was also studied by Carl von Raumer (1783–1865), who drew a sketch map *Geognostische Skizze von einem Theile des schlesischen, böhmischen, und lausitzer Gebirges* from 1813.

The map *Mineralogische Karte von Schlesien* (Fig. 8), compiled by Leopold von Buch, a leading German geologist, volcanologist, and palaeontologist, shows the southwestern parts of

Fig. 2. Stanisław Staszic – *Carta Geologica totius Poloniae, Moldaviae, Transylvaniae, Hungariae et Valachiae*, 1815 (1806)

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Fig. 3. Jean Etienne Guettard – *Carte minéralogique de Pologne*, 1764

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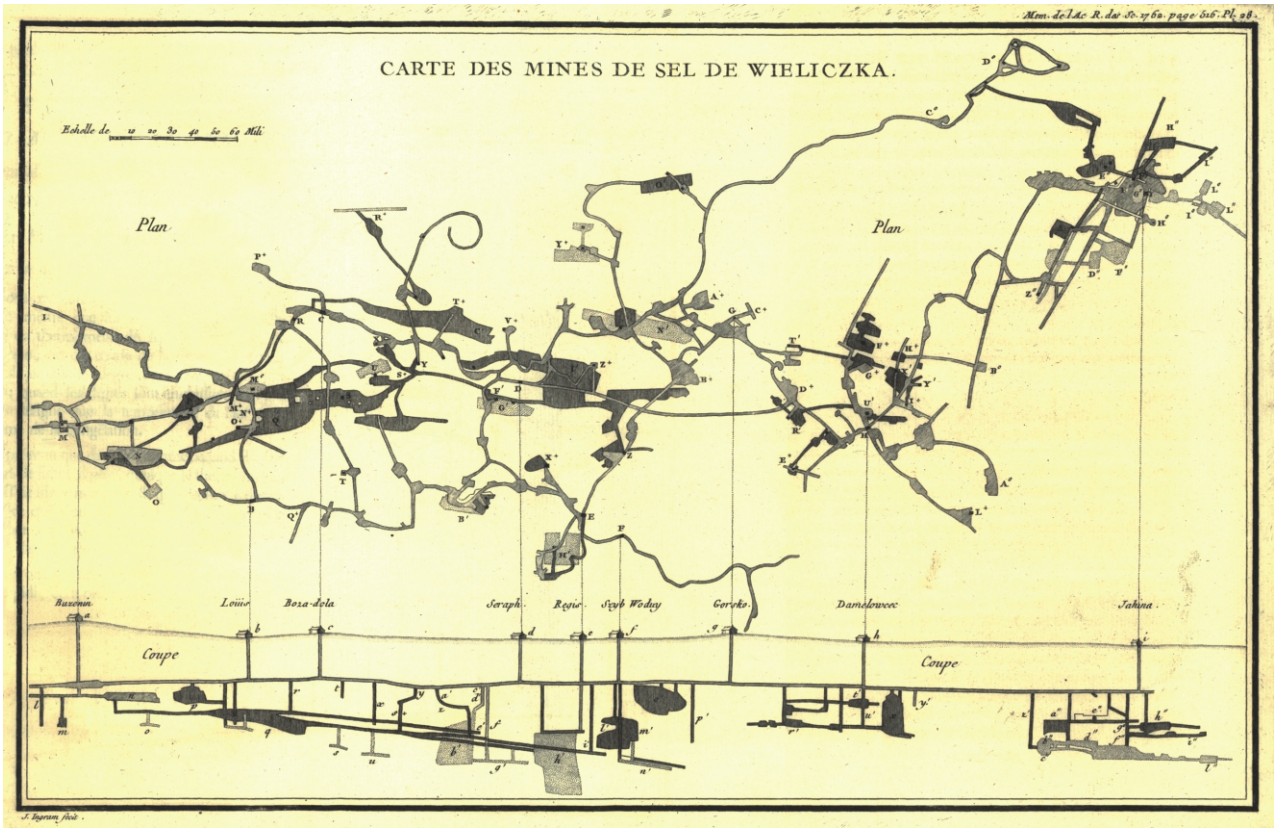
Poland. Although dated at 1797, it was published as an insert to the book *Geognostische Beobachtungen auf Reisen durch Deutschland und Italien*, in 1802. This hand-coloured copper-plate engraving clearly shows the main features of structural units of the Sudetes Mountains: the Karkonosze Massif, Kaczawa structure, Intra-Sudetic Depression, Sowie Góry Block, Kłodzko-Złoty Stok Massif, a belt of metamorphic rocks of the Bystrzyckie and Orlickie Mountains, and the Upper Nysa Kłodzka Trough. There are also marked outcrops of limestone and ”Older Sandstone” (Alterer Sandstein) in areas of present-day Opole Silesia and Upper Silesia. Large parts of that book are devoted to extensive descriptions of the landscape and country through which the author travelled, which is typical of the literature of the time. Special attention should be paid to generally accurate descriptions of mineral resources, together with brief characteristics of the individual types of rocks.

The first decades of the 19th century were a time of significant advance in the cartography of Silesia. In 1818(?), August Kaluža (1776–1836), a high-school teacher from Wrocław, published a map *Mineralogische Karte von Schlesien*, in four sheets, comprising territories of Poland that were generally the same as in the map of Leopold von Buch. The explanatory note to that map was entitled *Übersicht der Mineralien Schlesiens und Glatz nebst ihren Fundörtern und vielen neuen Hőhenmessungenauf 4 Karten dargestellt* (Kaluža, 1818). In mapping the area, A. Kaluža differentiated 14 lithological units, not much more than the ten units in the map of L. von Buch. However, his map shows much more detail than the latter, especially in the case of the Sudetes Mountains, thus reflecting marked progress in the knowledge of the geology of these areas (Fig. 9). In turn, the cartographic image of Opole Silesia and Upper Silesia in the two maps remained generally similar.



EXPLICATION DE LA CARTE.

	plan.	coupe.
Buzenin	A	a
Lois	B	b
Boza-vola	C	c
Seraph	D	d
Szyb-regis	E	e
Szyb-wodny	F	f
Szyb-gorsko	G	g
Danielowiec	H	h
Szyb-jahina	I	i
Szyb-woyciech	L	l
Augustew	M	m
Woyniez	N	n
Tworzyanki	O	o
Grzmigea	P	p
Osolin	Q	q
Tarnow	R	r
Marcyn	S	s
Ruczkow	T	t
Jakubowiec	V	u
Smack	X	x
Rorisno	Y	y
Zembech	Z	z
Szyb		a'
Przykos	B'	l'
Tarnow	C	c'
Przykos		d'
Szyb		e'
Szyb-Cyglar	F'	f'
Nadachow	G'	g'
Kloski	H'	h'
Szembek	I'	i'
Nadachow	L'	l'
Krosiewsky		m'
Krosiewsky	N'	n'
Krofnowiec	O'	o'
Nowy-krosiewsky		p'
Szyb-clemens	Q'	q'
Alexandrovice	R'	r'
Szyb-clementis	S'	s'
Michalovice	T'	t'
Szyb-antony	U'	v'
Przed bord	X'	x'
Steinhauser	Y'	y'
Szib-airow	Z'	z'
Adamow	A''	a''
Dohne		b''
Grunerowie		c''
Nad-grunerowie	D''	d''
Iſabella	E''	e''
Dydakow	F''	f''
Czartoryn	G''	g''
Oſolin	H''	h''
Felix	I''	i''
Wyſzyn	L''	l''
Balun	M	+
Szybyk	N	+
Na-Sniecach	O	+
Zeleznik	P	+

	plan.	
Stoza-voda	Q	+
Pocieka	R	+
Korymo	S	+
Lipowiec	T	+
Koniecyna	V	+
Betta	X	+
Wolczyn	Y	+
Szyb-Sulow	Z	+
Pawlikowice	A	+
Danielowek	B	+
Frydrychovice	C	+
Krecyny	D	+
Szyb-nowy clementis	E	+
Drozdowice	F	+
Zafniky	G	+
Morkek	H	+
Olſbrink	I	+
Sielec	L	+
Kunegunda	A°	
Kl. Blum	B°	
Leſyno	C°	
Kunegunda	D°	
Szyb-alexandrowice	E°	
Gakloryz	F°	
Szyb	G°	
Szyb-bruhl	H°	
Kl. borlach	I°	
Kl. gruzezyn	L°	
Crishan	M°	

Fig. 4. Jean Etienne Guettard – *Carte des mines de sel de Wieliczka; Explanation de la carte,* 1764b

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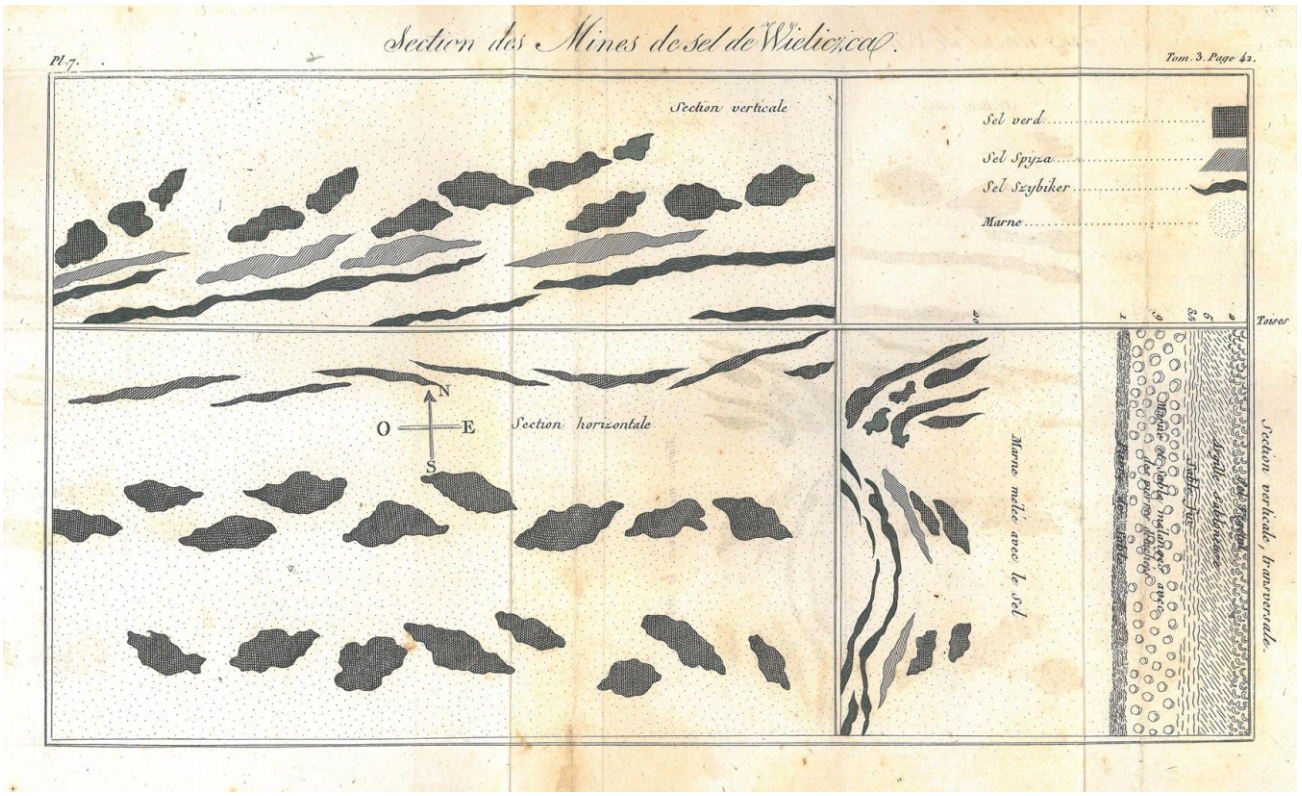

Fig. 5. Robert Townson – *Section des Mines de Sel de Wieliczca*, 1797

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The above-mentioned Carl von Raumer map, *Geognostische Karte von einem Theile des schlesischen böhmischen und lausitzer Gebirges*, also dated to 1818, shows the area from the Nysa Łużycka River to the areas of Strzelin. Although the map key is limited to eight lithological units with moderately complex explanations, C. von Raumer (1818) differentiated numerous local lithological units on the map by introducing rock names not shown in the key (Fig. 10). Therefore, this could be the first attempt to introduce a regional subdivision of the Sudetes Mountains into lithological units. It is also worth noting a large-scale map of the Waldenburg (presently Wałbrzych) area and its coal resources, placed as an insert in the upper-right corner of the eastern sheet of that map. Moreover, the map is supplemented with six geological cross-sections. The quality of the map and accompanying cross-sections makes it possible to recognize C. von Raumer as one of the best and most creative geologists studying the Sudetes Mountains at the time.

Prints of maps of August Kaluža and Carl von Raumer are very rare in Poland and copies in collections of the National Library in Warszawa are the only ones identified by the authors of this paper.

In 1826, a team headed by Leopold von Buch published *Geognostische Karte von Deutchland*, presumably one of the first series of geological maps in the world. It consists of 42 sheets at a scale close to 1:1,000,000. The maps show a large part of Europe from Paris and Clermont Ferrand in the west, to Klaipėda (German Memel) in the east, and Torino in the south. Areas of present-day Poland are shown on several sheets: Stralsund, Breslau (Wrocław), Brűnn (Brno), Eperies (Presov), Danzig (Gdańsk), and Königsberg (Królewiec, now Kaliningrad); this is presumably the first modern geological map of north-east Poland (Fig. 11). Comparisons show that the maps were mainly based on a compilation and/or reinterpretation of earlier ones, such as those of C. von Raumer and A. Kaluža, as well as some still unidentified sources of geological data.

A successive edition of geognostic maps of Germany, compiled by a team headed by Fredrich Hoffmann, was published in 1836. This atlas, *Geognostische Charte von Sachsen, Schlesien einem Theile Bőhmens und der Rheinlande in 50 Blättern zur östlichen und westlichen Erweiterung der geognostischen Charte vom nordwestlichen Deutschland*, comprises 50 sheets published at a scale close to 1: 200,000. The present-day area of Poland is covered by the Spremberg, Bunzlau, Zittau, Hirschberg, Breslau, Brieg, Kreutzburg, Műnchengrätz, Trautenau, Glatz, Oppeln, Gleiwitz, Königgrätz, Mittelwalde, Troppau and Ratibor sheets. The map key comprises 44 units of a mixed character: from lithological (for example, granite, syenite, and syenitoporphyry units) to lithostratigraphic (for example, sandstones of Jurassic age with coal layers). The map key includes explanations in German as well as in English and/or French. The Hirschberg (Jelenia Góra) sheet (Fig. 12) may be treated as further evidence of remarkable progress in the knowledge of the geology and cartography of these areas in the 1820s and 1830s. This map is generally similar to present-day maps of that area. Complete copies of that atlas are very rare. The National Geological Archives of Polish Geological Institute – National Research Institute hold only 15 sheets of this map.

Fig. 6. Diderot et al. – *Vue générale de la Mine de Sel de Wieliczka en prés Cracovie*; supplement 1772

Reproduced courtesy of Piotr Krzywiec, Warszawa, Poland (private collection)

Progress in geological mapping of the areas of present-day central and eastern Poland has been much slower. In the case of Upper Silesia, the most important map from these times is *Geognostiche Karte von Ober-Schlesien*, compiled by Carl von Oeynhausen (1795–1865), a widely recognized mining expert (Fig. 13). It was compiled most probably in 1819 to be published in 1822, as an enclosure to an extensive study, entitled *Bersuch einer geonostischen Beschreibung von Oberschlesien und den nachst angrenzenden Gegenden von Polen, Galizien und Östreichisch-Schlesien*. It is one of the first geological maps of this region and at the same time may serve as an example of a modern approach to geological mapping. Its map key comprises 18 lithological units. Moreover, it provides information on the location of mineral raw material extraction and processing operations, from metal ore mines to intakes of mineral water.

The oldest map of the Tatra Mountains, *Tatra versus Septemtrionem*, was compiled by Baltazar Hacquet (1739 or 1740–1815) (Fig. 14), a French mineralogist and professor at the Jan Kazimierz University in Lviv and, subsequently, the Jagiellonian University in Kraków. The map was drawn in 1796 as an enclosure to the book *Hacquets neueste physikalisch-politische Reisen durch die Dacischen und Sarmatischen oder nordlichen Karpathen*. It shows types of rocks (granites, gneisses, and limestones) as well as silver, copper, and iron ore in that region. This map may be treated as a geological sketch that is much simpler in form and context than the above-mentioned Karkonosze map of Johann Jirasek, published several years earlier.

The south-easternmost parts of Poland became a subject of interest to researchers involved in the exploration of Hungary and adjacent areas. In 1797, Robert Townson (1762–1827), an English scholar, scientist, medical practitioner by profession, and a born traveller, published a book entitled *Travels in Hungary with a short account of Vienna in the 1793* and *A new map of Hungary, particularly of its rivers and natural productions by Math. Korabinsky*. Petrography and post roads added by the author as an enclosure. As emphasized in its title, the map was drawn on the basis of that of Johann Matthias Korabinsky (1740–1811), and presents extensive information on the occurrences of the main mineral resources, the main crops, livestock and wild animals, sites of food and mineral raw material processing, supplemented by R. Townson with information on the

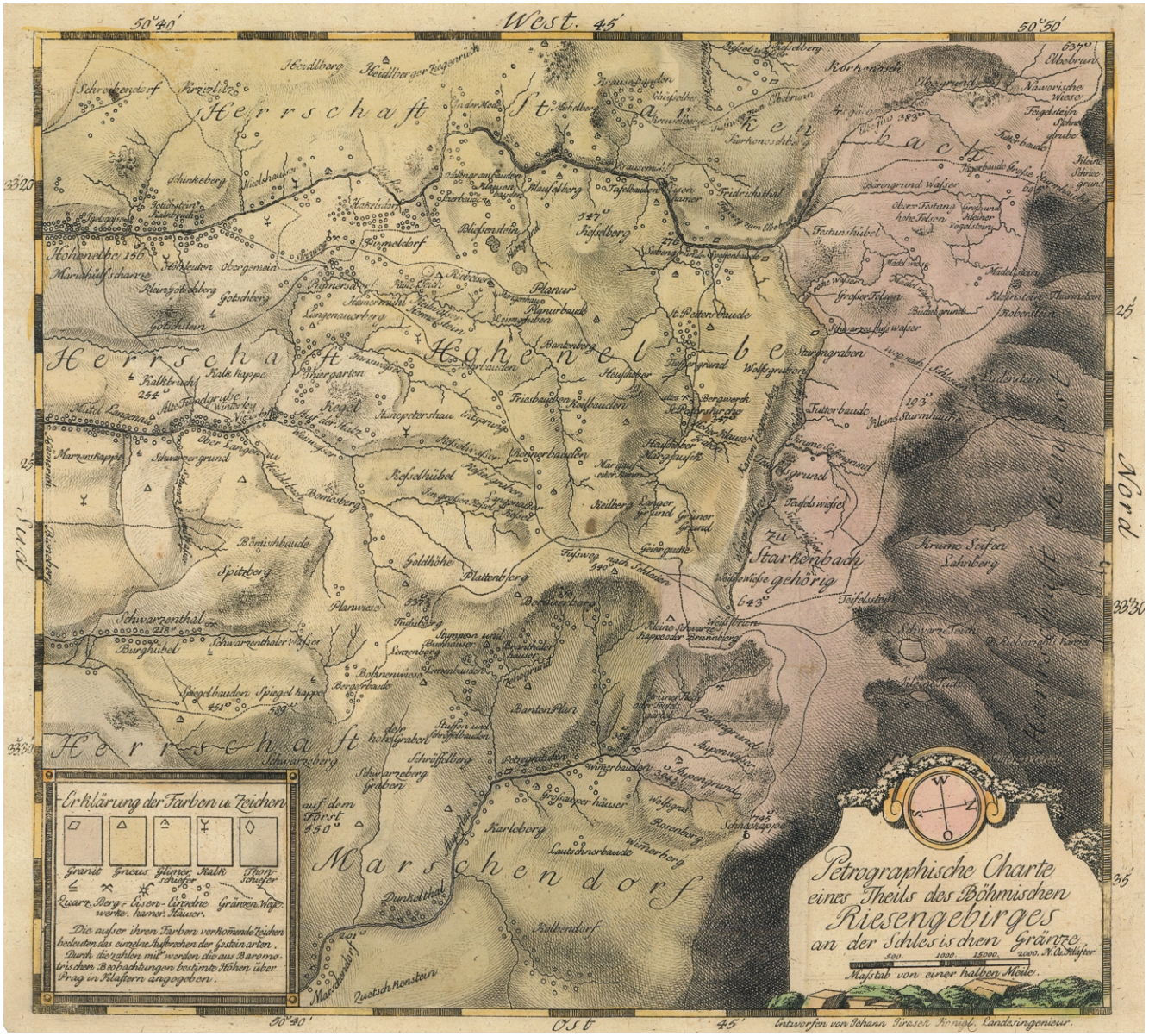

Fig. 7. Johann Jirasek –
***Petrographische Charte eines Theils de Bőhmischen Riesengebirges an der Schlesischen Gränze*, 1791**

Private collection of the authors

petrography of the rocks (map key with 13 petrographic units) (Fig. 15) in areas through which he travelled. In one of these travels he visited the Tatra Mountains and the Podhale region, from where he reported the presence of granites of the Tatra crystalline core as well as of stratified sandstones and limestones. In the third volume of his book, 58 pages are devoted to descriptions of his travels to the Tatra Mountains, Wieliczka and Kraków, illustrated with four copperplate engravings of the Wieliczka salt structures.

Carte Géologique de la Hongrie et de la Transylvanie avec une partie des pays limitrophes was compiled most probably in 1822 by Francois Sulpice Beudant (1787–1850), an outstanding French mineralogist. This map originates from an atlas that was a part of his monograph, *Voyage minéralogique et géologique en Hongrie, pendant l'annee* 1818. The map clearly shows the arc formed by the Carpathian mountain ranges, the presence of granite in the Tatra Mountains, and the sedimentary formations in the Outer Carpathians.

The group of maps compiled by geologists and travellers during that epoch should also include *Carte géologique du bassin de la Gallicie et de la Podolie Autrichienne*, by Karl Lill von Lilienbach (1798–1831). It was published as an enclosure to his 60-page paper, *Description du bassin de la Gallicie et de la Podolie in Mémoires de la Société Géologique de France*, in 1833. Special attention should be paid to the very detailed mapping of deeply incised valleys of the Dnister River and its tributaries (Fig. 16). The map key comprises 14 units of a lithostratigraphic nature. The map is supplemented with two geological cross-sections and 14 profiles of natural exposures and quarry walls, drawn with the use of a separate key of eight units. In com-

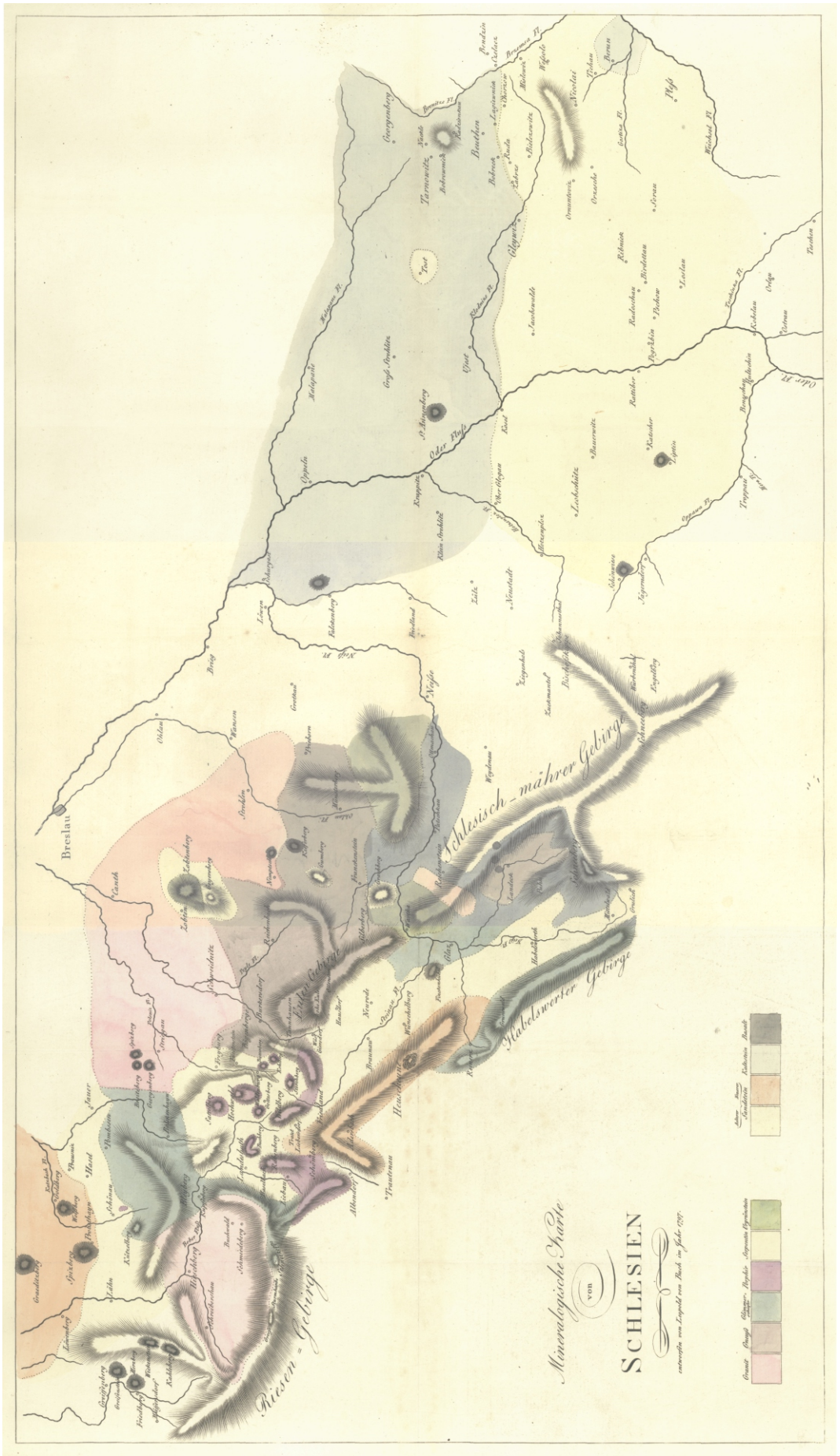

Fig. 8. Leopold von Buch – *Mineralogische Karte von Schlesien*, 1802 (1797)

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Fig. 9. August Kaluža – 1818, *Mineralogische Karte von Schlesien* (sheet SE)

Collection of National Library, Warszawa, Poland

Fig. 10. Carl von Raumer – 1818, *Geognostische Karte von einem Theile des Schlesischen Bőhmischen und Lausitzer Gebirgs*

Collection of National Library, Warszawa, Poland

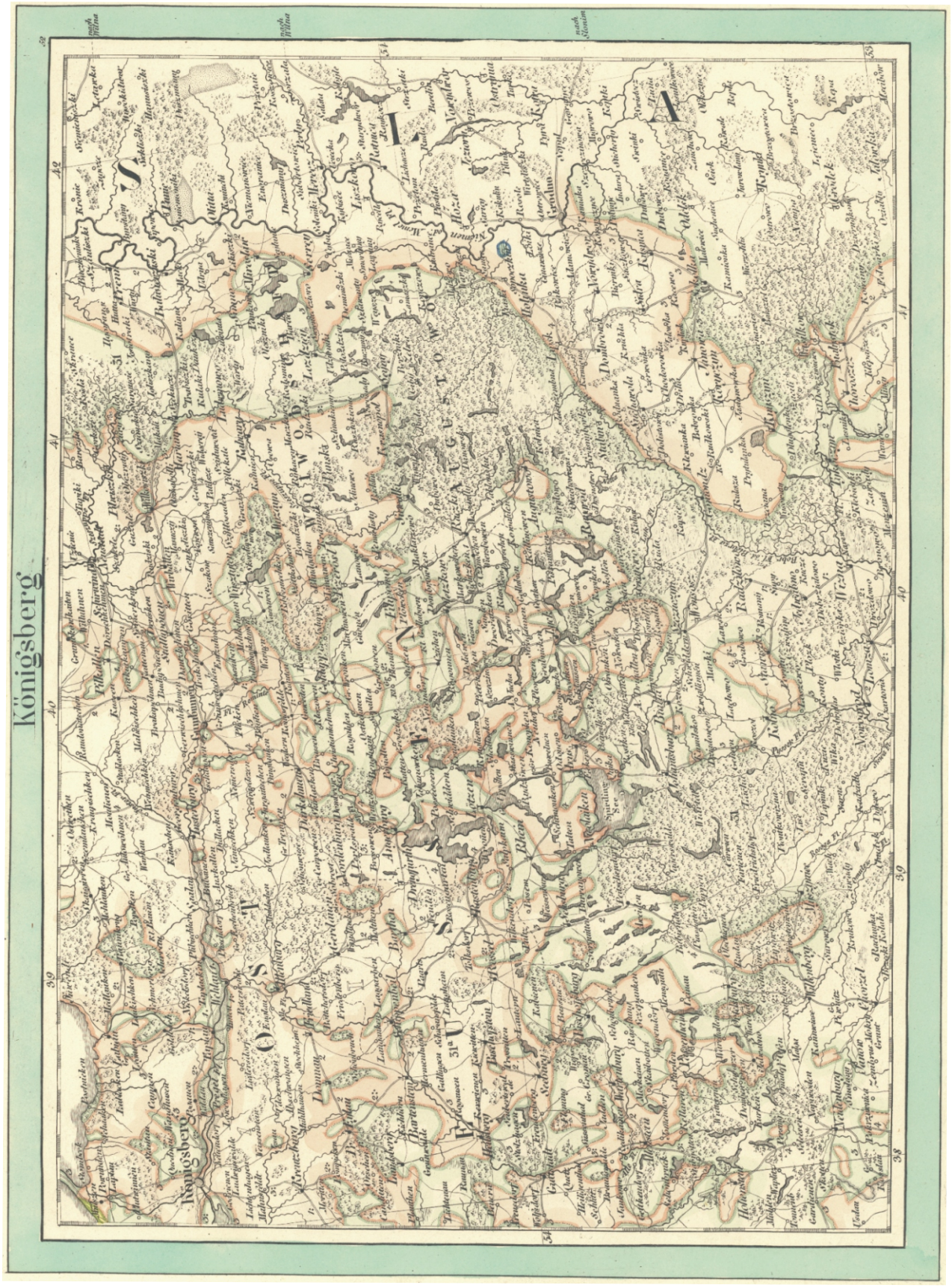

Fig. 11. Leopold von Buch et al. – 1826, *Geognostische Karte von Deutschland* (sheet Königsberg)

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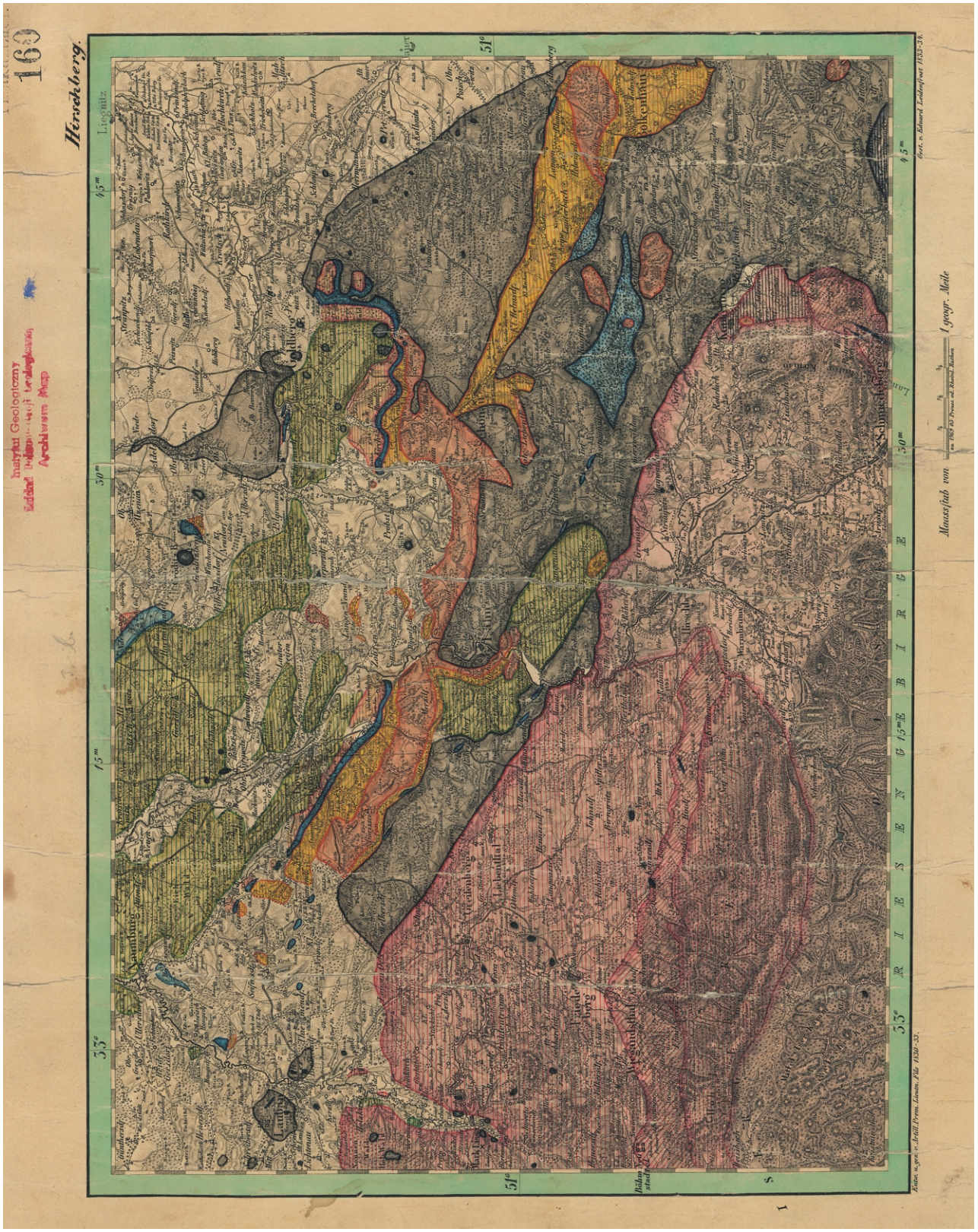

Fig. 12. Fredrich Hoffmann – 1836, *Geognostische Charte von Sachsen, Schlesien einem Theile Böhmens und der Rheinlande in 50 Blättern zur östlichen und westlichen Erweiterung der geognostischen Charte vom nordwestlichen Deutschland* (sheet Hirschberg)

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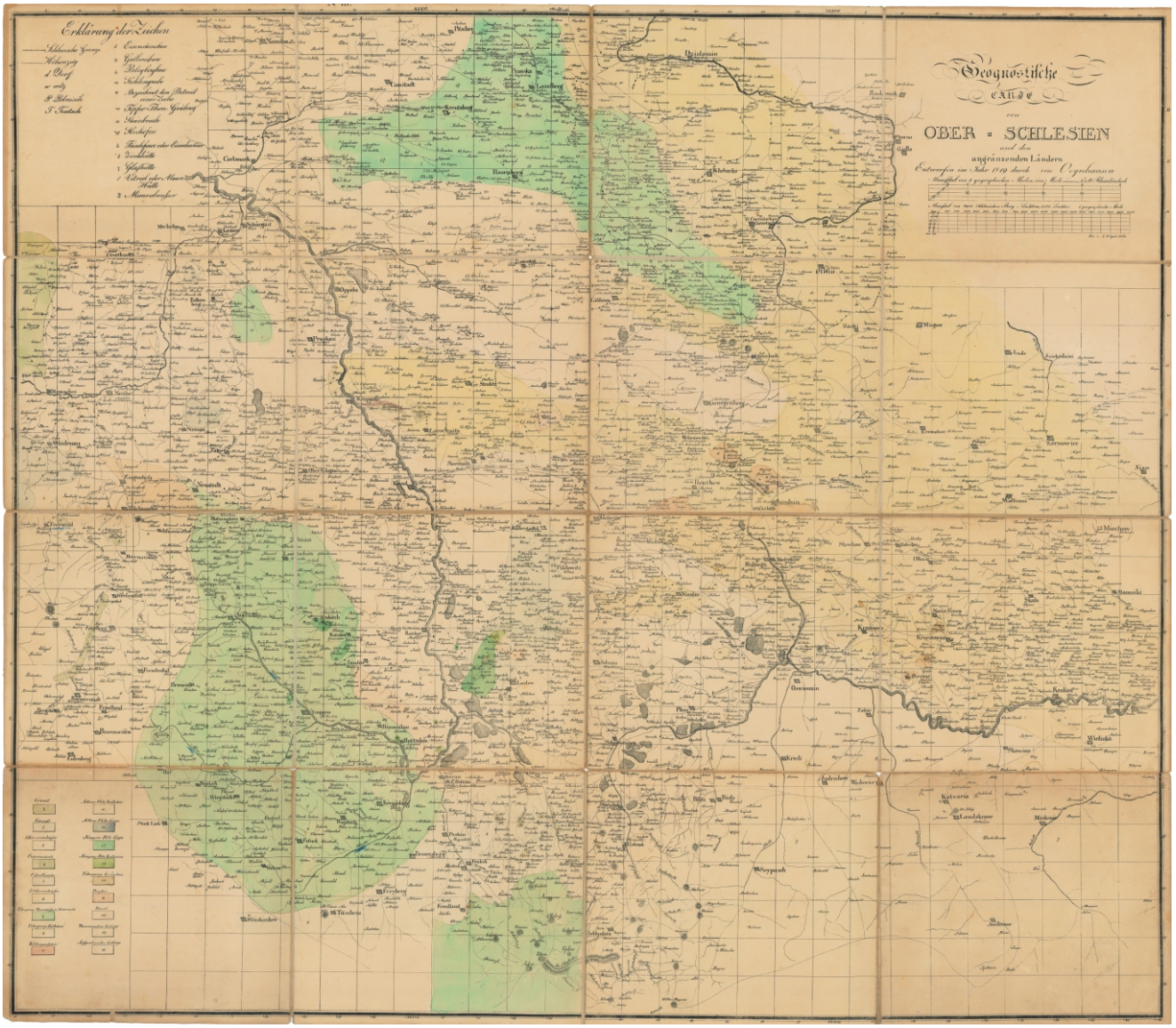

Fig. 13. Carl August Ludwig von Oeynhausen – *Geognostische Karte von Ober-Schlesien*, 1822

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parison to most of the above publications, the text is devoid of any colourful descriptions of nature and adventure travel experiences. It rather focuses on the purely scientific side – characteristics of the geological structure of the regions visited.

FROM PUSCH TO ZEJSZNER

A significant role has been played by foreign explorers in the history of Polish geology. This is especially the case of Georg Gottlieb Pusch (1790–1846), a student of Abraham Gottlob Werner (1749–1817) at the Freiberg Mining Academy. He came to Poland at the invitation of Stanisław Staszic, to assume the post of lecturer in geology, mineralogy, chemistry, and metallurgy at the Mining Academy in Kielce, and to commence his own extensive regional studies. He easily assimilated to become well known under a Polish-sounding name, Jerzy Bogumił. He and his children are buried at the Evangelical-Augsburg Cemetery in Warszawa (Miecznik, 2009). Georg G. Pusch devoted several years to completing his great monograph, *Geognostische Beschreibung von Polen*, which was published in two volumes in Tübingen in 1833–1836. Its text was immediately translated into Polish by Adam Maksymilian Kitajewski (1789–1837), a professor of chemistry at Warszawa University, to be first published (in 1829–1830) in parts in the Sławianin magazine, a common practice at the time in the case of novels. Editors of that magazine dedicated to "...crafts, agriculture, commerce, households and other needs of practical life in general..." decided to illustrate some parts of this text with geological cross-sections (Fig. 17). Pusch's monograph was subsequently supplemented with *Geognostyscher Atlas von Polen,* published in Stuttgart in 1836. This atlas comprises *General Karte von den Koenigreichen Polen und Gallizien* in four sheets of detailed maps and two sheets of geological cross-sections.

Georg G. Pusch's findings proved to be so important that even his unpublished drafts and notes gained much attention. Therefore, notes and papers made available by Pusch's sons were published together with the Polish version of his geo-

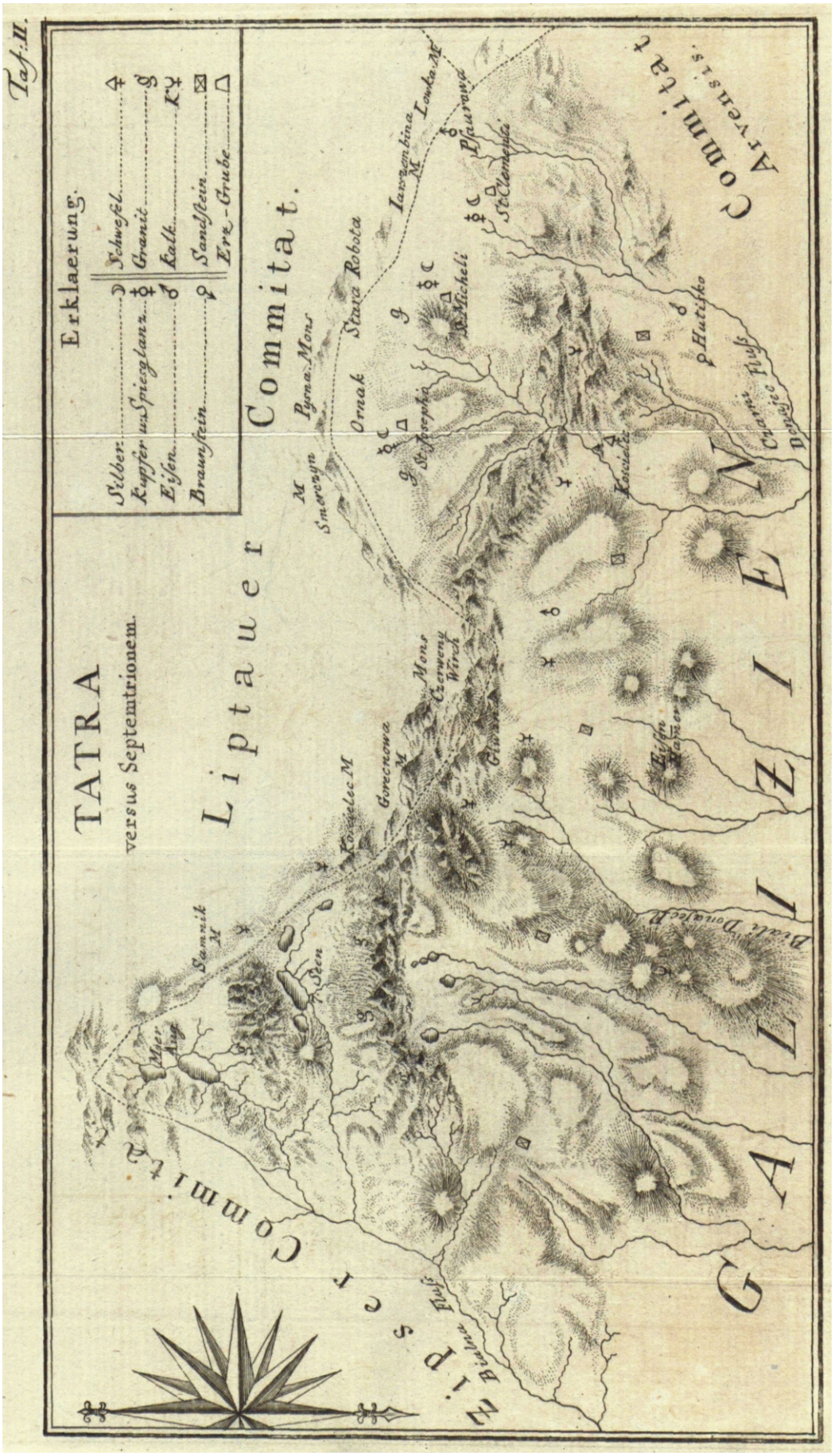

Fig. 14. Baltazar Hacquet – 1796, *Tatra versus Septemtrionem*

Collection of Earth Museum, Polish Academy of Science, Warszawa, Poland

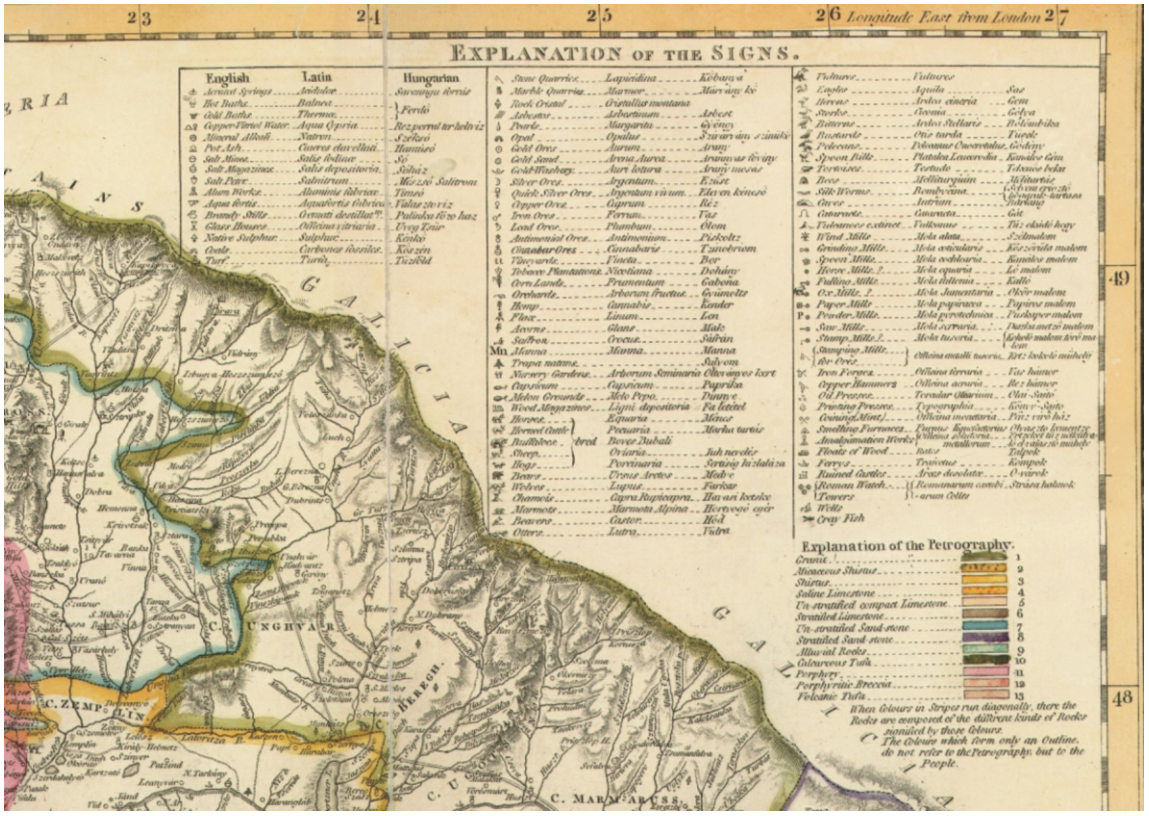

Fig. 15. Robert Townson – 1797, explanation for: *A new map of Hungary, particularly of its rivers and natural productions* by in. Math. Korabinsky

Petrography and post roads added by the author; reproduced courtesy of Piotr Krzywiec, Warszawa, Poland (private collection)

gnostic map of the Polish Kingdom (*Mapa Geognostyczna Królestwa Polskiego*) in the first series of *Physiographic Memoirs* (*Pamiętnik Fizyjograficzny*) that have been appearing since 1881. A reprint of large parts of the monograph from 1833–1836 was published in 1903, still being topical and important at the time. It may be added here that the map *Geognostische Karte des Polnischen oder Sandomirer Mittelgebirges* (Fig. 18) is regarded as a good example of Pusch's craft, which made possible such an outstanding contribution to the knowledge of the geology of Poland.

In 1836–1837, an attempt to draw a geological map of Poland was also made by Ignacy Domeyko (1802–1889), a romantic, Philomath, and freedom fighter, still very well remembered in Poland, Lithuania, Belarus, France, and Chile as one of the greatest scientists, explorers and educators of the 19th century (Domeyko, 2005). During studies at the École Nationale Supérieure des Mines de Paris in Paris, he drew such a map on the basis of a reinterpretation of those of L. von Buch, L. von Lillienbach, G.G. Pusch and other authors (Wołkowicz et al., 2009). Before leaving for Chile in 1838, he asked Adam Mickiewicz, the most famous Polish poet and his personal friend, to ensure that the map was published. Unfortunately, his request was not met, despite repeated reminders from Chile. However, it is highly probable that this map was finally enclosed as unsigned in the *Atlas de l'Ancienne Pologne* of Auguste Henri Dufour 1795–1865) and Feliks Wrotnowski (1803–1871), published in Paris in 1850 (Chałubińska, 1969).

Another important map was drawn by Ludwik Zejszner (his family name was the original German spelling: Zeuschner) (1805–1871), an outstanding Polish geologist with a biography reflecting the history of Poles in the 19th century. After the November Uprising (1830), he was apprehended and expelled from the Jagiellonian University for the possession of illegal political publications and was reinstated in the post of professor at that university after the Spring of Nations Uprising (1848). He lost his job again after the January Uprising (1863), to find another one following recommendations from Ignacy Łukasiewicz, his famous student; this time it was in the emerging oil industry as an expert in exploration and development of oil resources in the Carpathian Mountains (Graniczny et al., 2007). In 1844, he anonymously published the map *Carte géologique de la chaine du Tatra et des soulèvements parallelles* in Berlin (Fig. 19). It is worth noting that Sir Rodrick I. Murchison (1792–1871), an outstanding geologist of the time, clearly stated in explanations to a map enclosed with a book describing his geological wanderings in Russia and Poland, that he used the new map of L. Zejszner in mapping the Carpathian region (Murchison et al., 1845: p. 656, *vide* Graniczny et al., 2007; Narkiewicz et al., 2012). The Zejszner map was the first and the only detailed map of the Tatra Mountains until Victor Uhlig, an outstanding Austrian geologist, published his own more than half a century later (Uhlig, 1899). At present, copies of the Zejszner map are very rare (Szaflarski, 1972). There may be only four copies of this rare map preserved in Polish collections (including two copies in very good condition in collections of the PGI-NRI National Geological Archives).

Ludwik Zejszner also devoted many years to mapping the area between Sandomierz and Kielce in the Holy Cross Mountains, thus greatly contributing to the knowledge of the very complex geological structure of that area. Hand-drawn originals

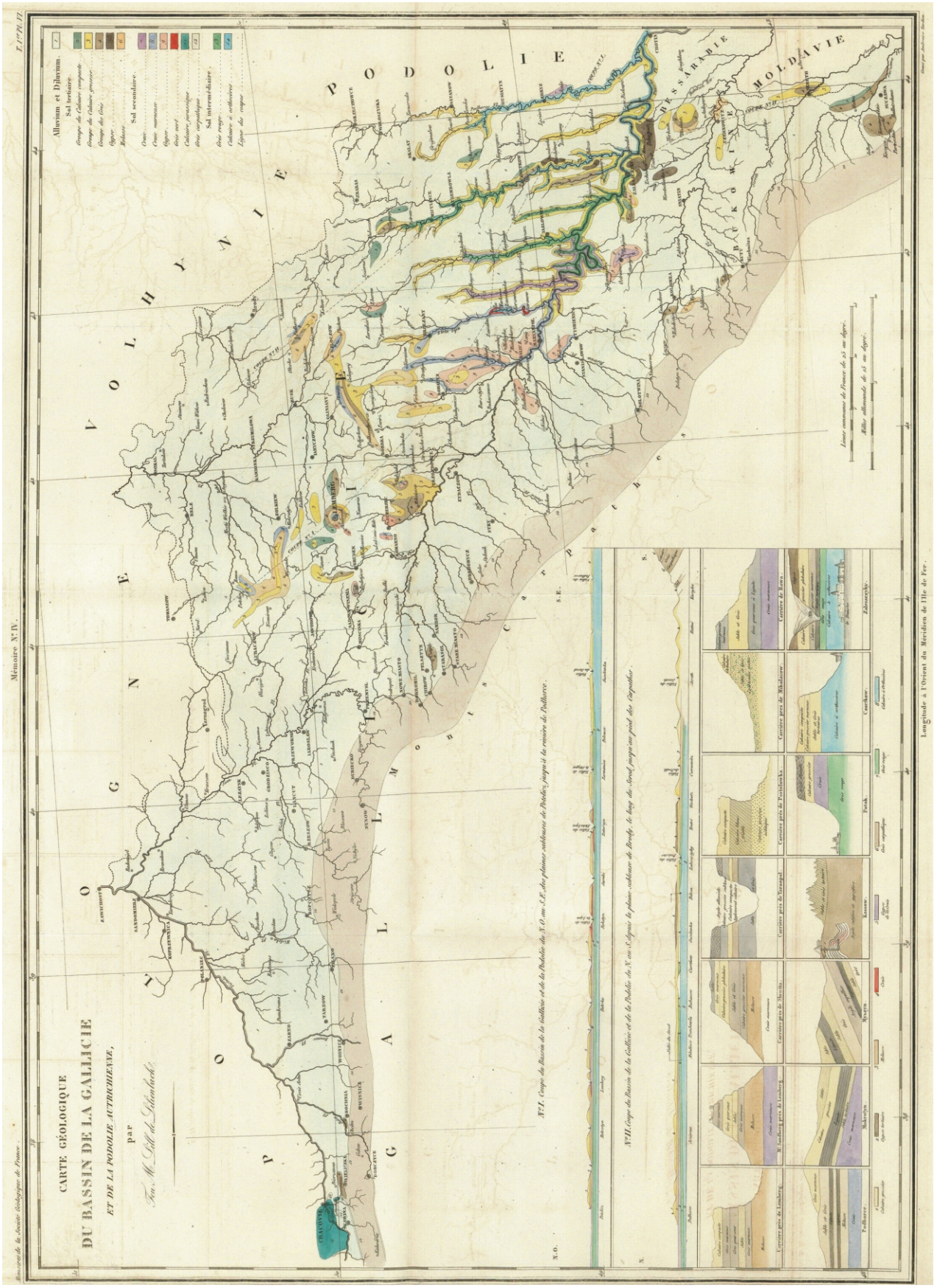

Fig. 16. Karl von Lill Lilienbach – 1822, *Carte géologique du bassin de la Gallicie et de la Podolie Autrichienne*

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Fig. 17. Georg Gotlieb (Jerzy Bogumił) Pusch – 1829, approximate geological cross-section taken from Inowlodz to Kraków, Group of Sandomirer Mountains belonging to the geognostic system of central Poland (P*rzybliżone przecięcie wzięte od Inowłodza aż do Krakowa, Grupy Gór Sandomierskich należącej do Systemu geognostycznego środkowej Polski*)

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Fig. 18. Georg Gotlieb (Jerzy Bogumił) Pusch – *Geognostyscher Atlas von Polen. Geognostische Karte des Polnischen oder Sandomirer Mittelgebirges zwischen Sandomierz und Małogoszcz,* 1836

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of these maps are kept in collections of the Silesian Library in Katowice (Graniczny et al., 2007).

In 1844, the *Geognostische Karte von Ober-Schlesien* (Fig. 20), of Rudolph von Carnall (1804–1874), was also published. In comparison to the above map of Oeynhausen, he differentiated geological units of a lithostratigraphic type with regional elements as, for example, the Opatowitzer Kalkstein (Wołkowicz et al., in press). He used only 17 units, yet the map is very detailed in the Tarnowskie Góry and other areas. This is especially the case of iron, zinc, and lead ores.

In 1848, Hieronim Łabędzki published a translation of a F. Beudant manual of mineralogy and geology, supplemented with his compilation of *An outline of geology of mountains and plains of the Polish Kingdom and adjoining areas* (*Zarys ziemioznawczy gór i równin Królestwa Polskiego i krain przyległych*). This manual, designed for secondary school students, was characterised by a very good translation and well written chapters on the geology of Poland.

Editorial work on producing the Agriculture Encyclopaedia started in the late 1860s. In its second volume (Lubomirski et al., 1874), three geological maps were published, which showed the growing role of geology as a separate discipline in Polish scientific centres. These maps were compiled by: Wincenty Kosiński (*Geological map of the Polish Kingdom – Mappa Geologiczna Królestwa Polskiego*), Jakub Stanowski, Albin Kohn (1820–1880) and August Lubomęski (1820–1889) (*Geological Map of the Great Duchy of Poznań – Mappa Geologiczna Wielkiego Księstwa Poznańskiego*) (Fig. 21), and Karol Langie (*Geological Map of the Kingdom of Galicia and Lodomeria – Mappa Geologiczna Królestwa Galicji i Lodomerii*). The maps represented an integral part of the encyclopaedia entry about geology, 100 pages long.

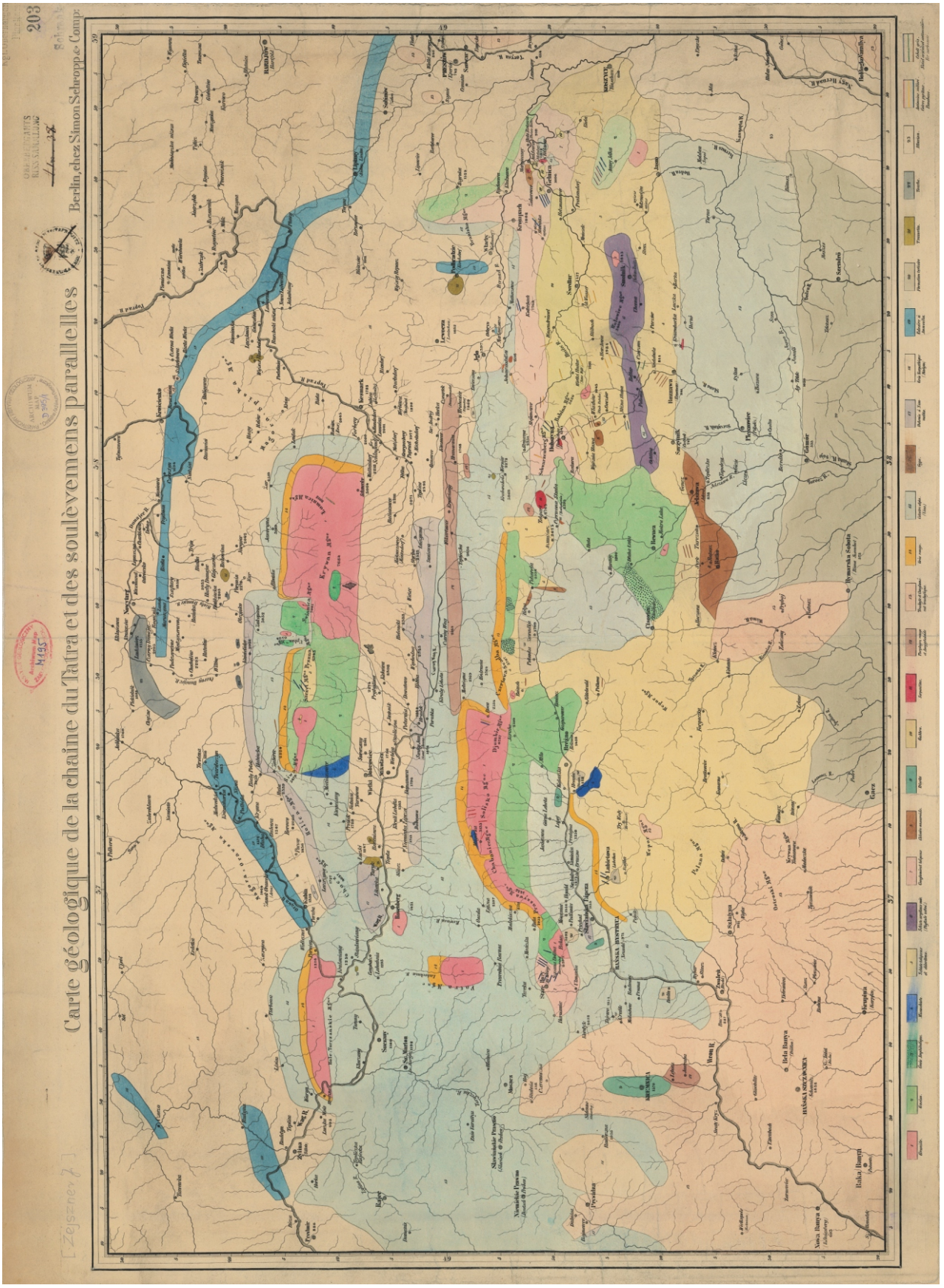

Fig. 19. Ludwik Zejszner – 1844, *Carte géologique de la chaine du Tatra et des soulèvements parallelles*

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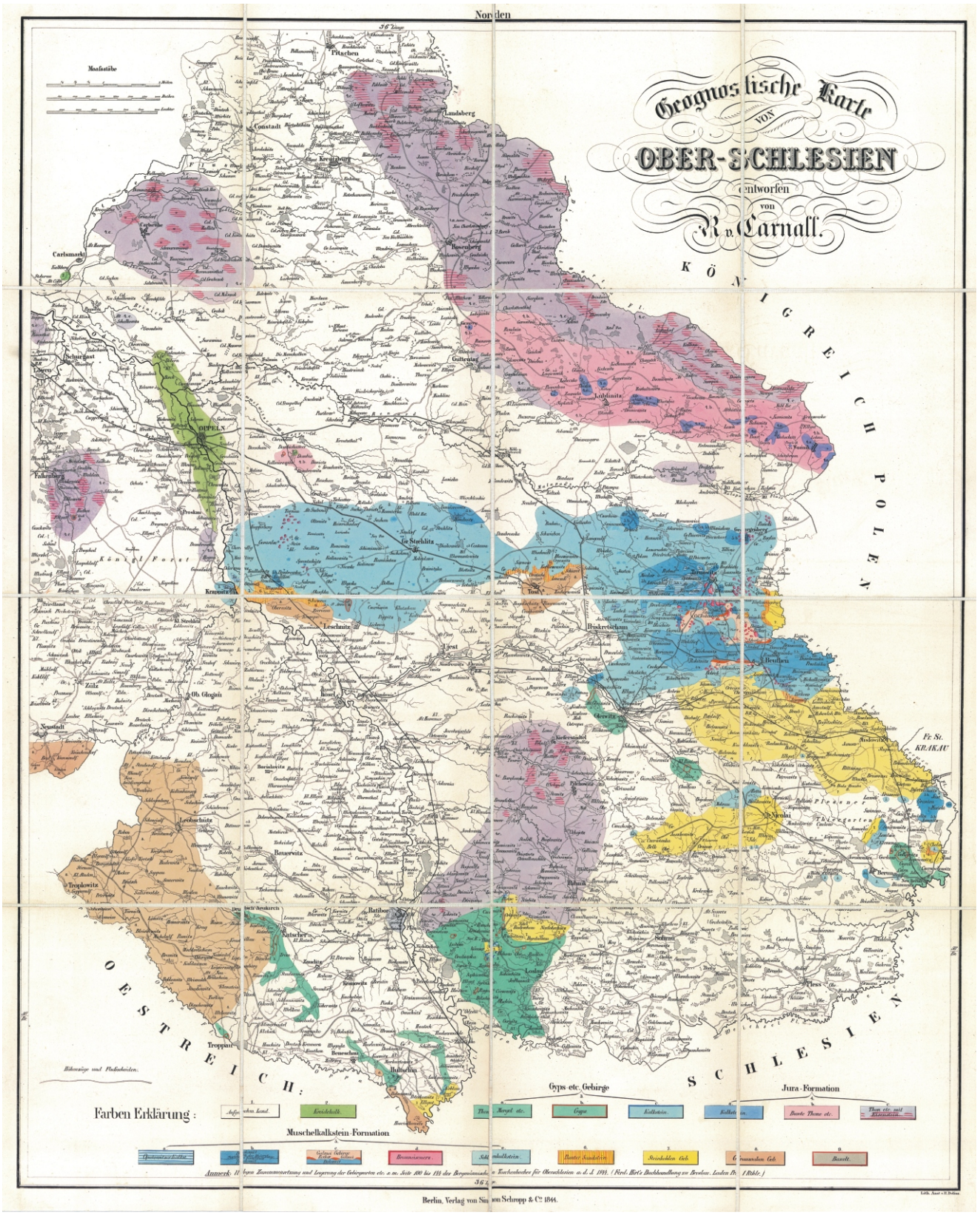

Fig. 20. Rudolph von Carnall – 1844, *Geognostische Karte von Ober-Schlesien*

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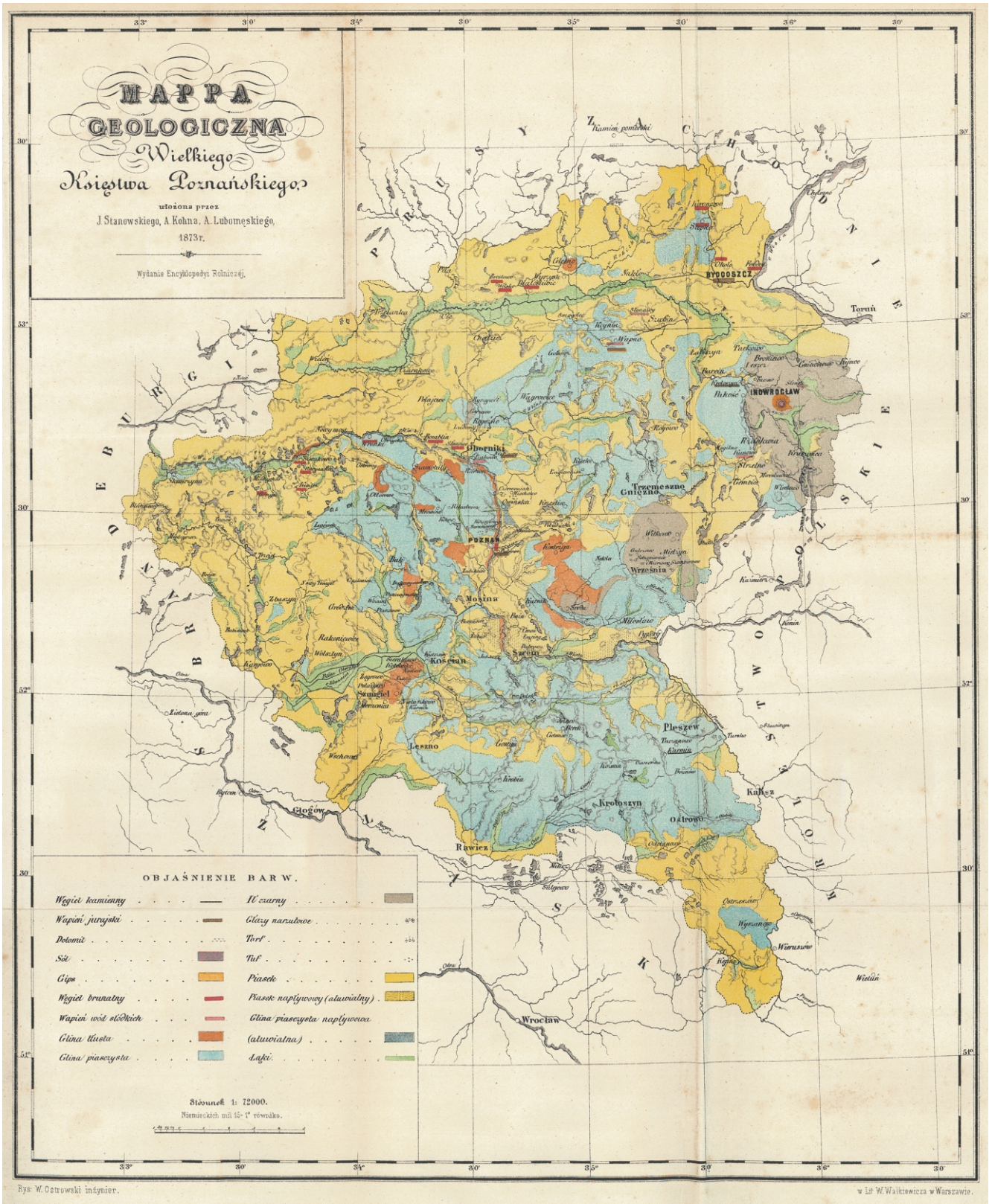

Fig. 21. Jakub Stanowski, Albin Kohn, August Lubomęski – 1873, *Geological Map of the Great Duchy of Poznań* (*Mappa Geologiczna Wielkiego Księstwa Poznańskiego*)

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AUSTRO-HUNGARIAN AND PRUSSIAN/GERMAN MAPS

Rapid growth of industry and mining in Upper Silesia resulted in the need to conduct new extensive cartographic studies. Such studies, ordered by the Prussian Ministry of Commerce, led to the compilation of a monumental atlas, *Geognostische Karte von Oberschlesien*, compiled and edited by a team headed by Ferdinand Roemer (1818–1891), and published in 1870. This atlas comprises 11 map sheets, one sheet of symbols and explanations (Fig. 22), text in two volumes, and numerous graphical annexes (geological cross-sections and profiles, thematic maps). Individual maps were very carefully compiled, providing key information on lithology and on the age of rocks as well as mineral deposits and sites of their extraction and processing, namely information that is currently very helpful in the analysis of geochemical surveys and the explanations of the origins of certain geochemical anomalies (Pasieczna, 2014). Also, in the same year that the map *Der Oberschlesisch-Polnische Bergdistrict Hinweglassung der Diluviums* was published, a supplement to the above atlas was compiled by Oskar Degenhardt, a member of Roemer's team. Due to the peculiar combination of the very complex geological structure of the mapped area and exceptionally well-designed graphics, this is one of the most beautiful geological maps, so decorative that it would make an excellent addition to the decor of even the most sophisticated office (Fig. 23).

In 1870, the atlas *Geologische Karte von dem Niederschlesischen Gebirge und den Angrezenden gegenden* was

Fig. 22. Ferdinand Roemer – 1870, *Geognostische Karte von Oberschlesien und den Angrezenden Gebieten; Farben und Zeichen – Erklaerung*

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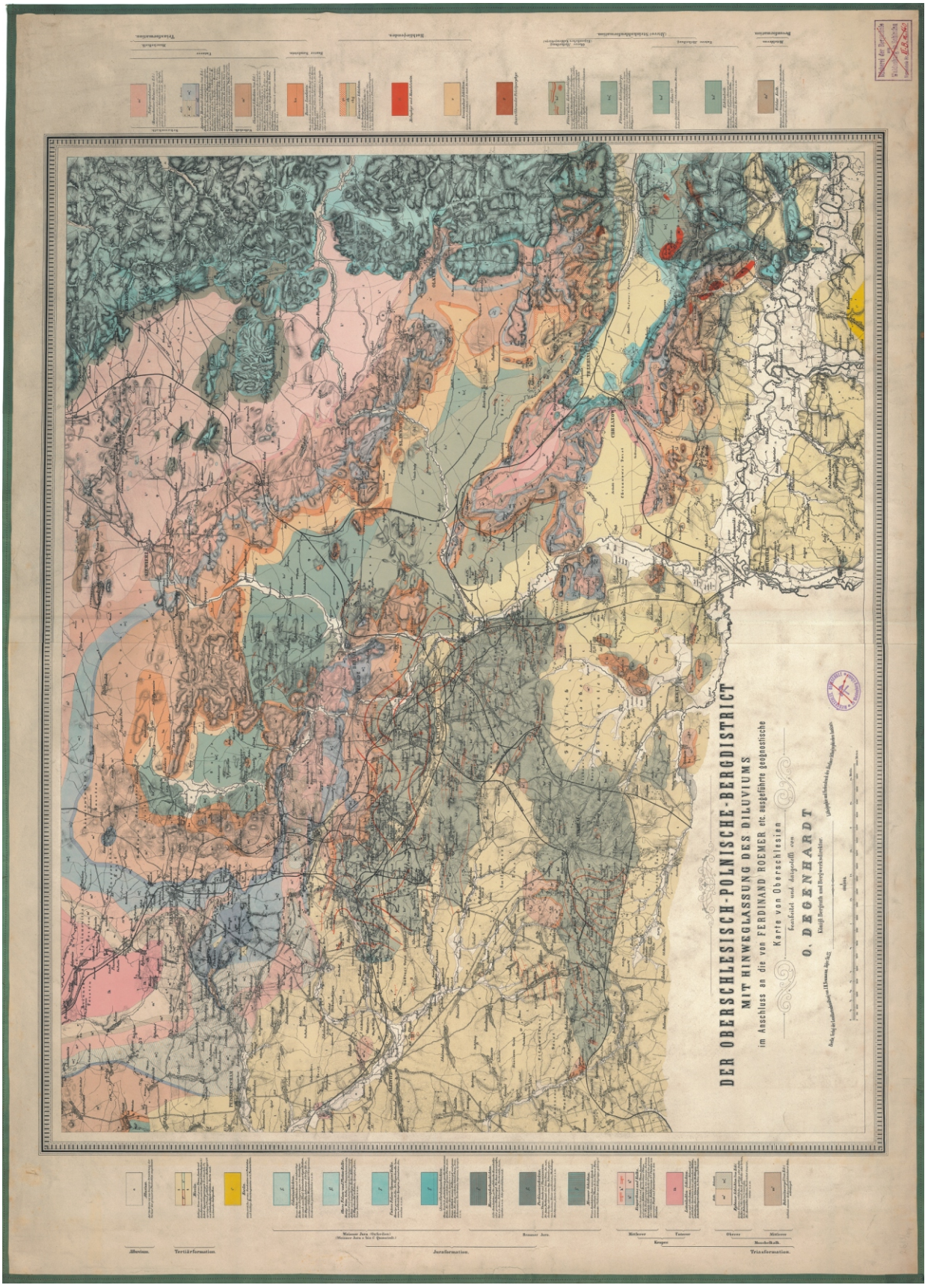

Fig. 23. Oskar Degenhardt – 1870, *Der Oberschlesisch-Polnische Bergdistrict Hinweglassung der Diluviums*, 1870

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Fig. 24. Rudolph von Carnall – 1870, *Geologische Karte von dem Niederschlesischen Gerbirge und den Angrezenden Gegenden; Farben – Erklärung*

Private collection of the authors

compiled and edited by a team led by Rudolph von Carnall, working at the order of the Prussian Ministry of Commerce. It consists of eight map sheets and one sheet with the title as well as symbols and explanations (Fig. 24).

Until the start of World War I, intense geological-cartographic works continued in Lower and Upper Silesia due to the importance of these regions to the economy. In the case of Upper Silesia, the main results of these works were presented in a monographic study, *Die Geologie des oberschlesischen Steinkohlenbezirkes* (1913) by Richard Michael (1869–1928). It comprises over a dozen thematic geological maps. Of these, special attention should be paid to a map entitled *Geologische Übersichtskarte des Oberschlesischen Steinkohlenreviers und seiner Nachbargebiete*, as it shows a very modern approach to the geological structure of the coal formation of Upper Silesia (Fig. 25). This is especially the case of fault tectonics and deformation. Faults began to be used in the interpretation of geological cross-sections in the 1860s and in the mapping of geological structures at the start of the 20th century. The monograph of R. Michael seems to be the first cartographic study of that type, stressing the role of faults in the geological structure of Upper Silesia.

During that time, attempts were made to attain full coverage of the Lower Silesian region with map sheets. At the beginning of the 20th century this region was mapped by Emil Dathe (1903), Georg Ernst Wilhelm Berg, and other outstanding geologists, which resulted in the high accuracy of the maps (Fig. 26). When this region became a part of Poland in 1945 after World War II, Polish geologists found these maps suitable for compilation of reambulated maps. The process of reambulation was often limited to a certain simplification of cartographic images drawn by German geologists. Similar procedures were also followed in the case of Western Pomerania, Mazury, and other regions.

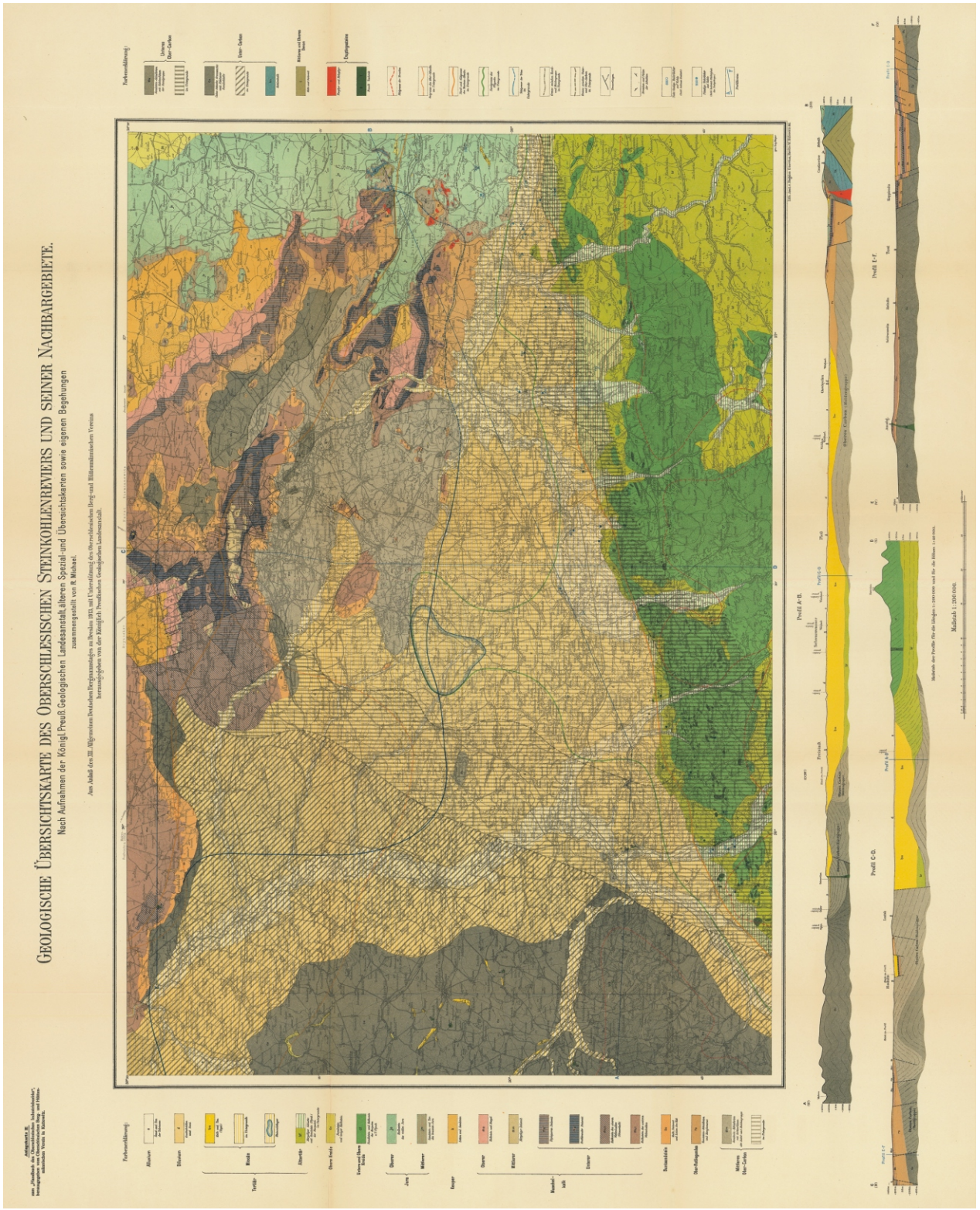

Fig. 25. Richard Michael – 1913, *Geologische Übersichtskarte des Oberschlesischen Steinkohlenreviers und seiner Nachbargebiete*

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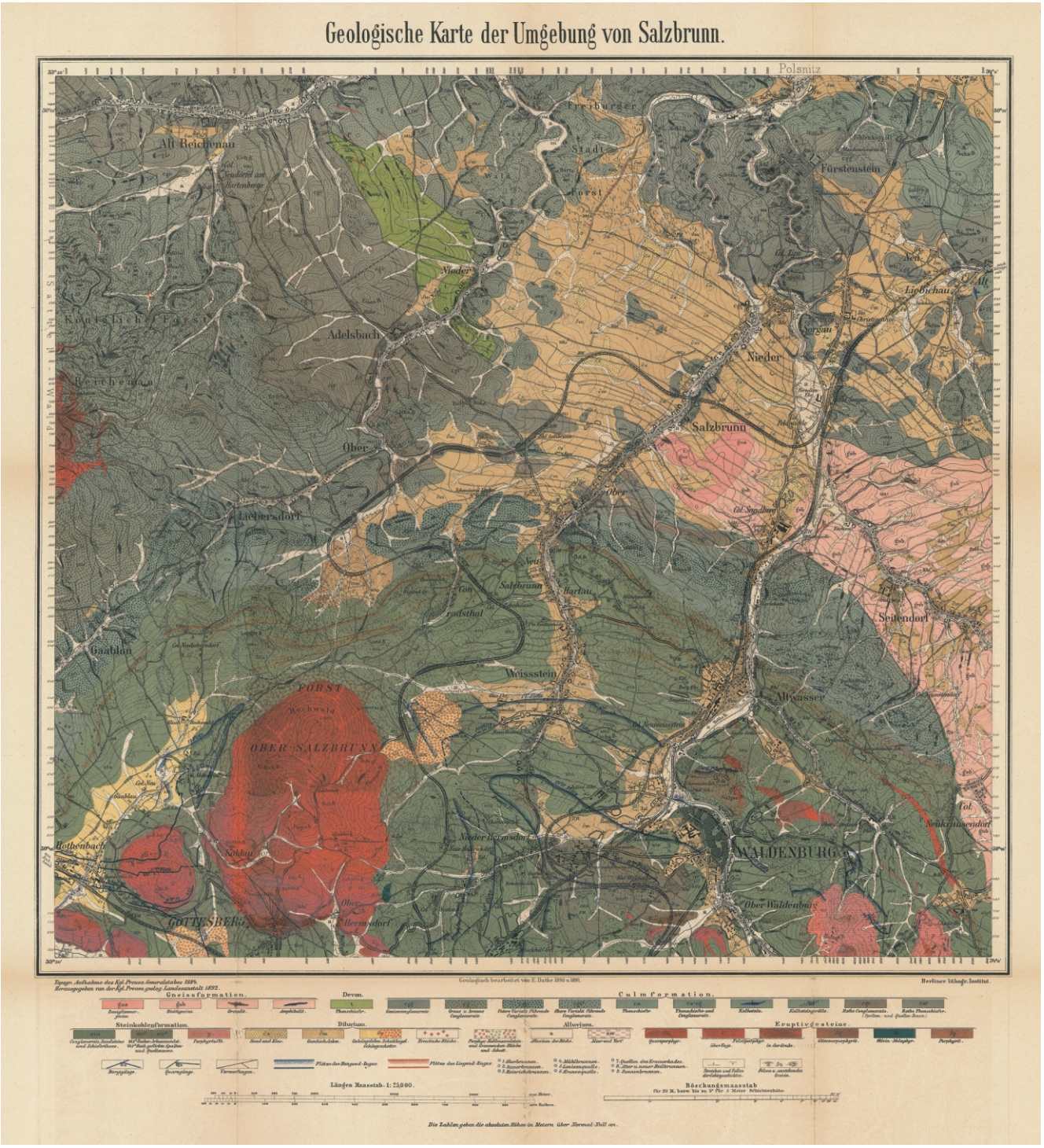

Fig. 26. Emil Dathe – 1903, *Geologische Karte der Umgebung von Salzbrunn*

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Until 1918, most of southern Poland belonged to the Austro-Hungarian Empire, therefore, it had to be covered by detailed maps, conducted by the K.K. Geologische Reichsanstalt. The first director of that office was Wilhelm von Haidinger (1795–1871), an outstanding mineralogist, who paid special attention to the appropriate coverage of areas of the empire with review geological maps. Mapping programs of the K.K. Geologische Reichsanstalt also comprised a compilation of numerous detailed maps. Good examples of the latter include maps of Franz von Hauer (1822–1899) (such as *Geologische Űbersichtkarte der Österreichischen Monarchie. Blatt III*, 1869), Emil Tietze (1845–1931) (*Geologische Karte der Umgebung von Lemberg* (1882), *Geologische Karte der Umgebung von Krakau* (Fig. 27) and *Geologische Karte der Umgebung von Chrzanów und Krzeszowice*, 1888), as well as those of Victor Uhlig (1857–1911), an outstanding researcher of the Tatra Mountains region, published at the beginning of the 20th century (Uhlig, 1899, 1903).

CARTOGRAPHIC ACHIEVEMENTS OF THE PHYSIOGRAPHIC COMMITTEE

Geological mapping of Polish territories gathered momentum in the late 1870s, that is, times corresponding to the fourth stage in the history of geological studies of the Polish territories, as differentiated by Władysław Szajnocha (1918). He named these main stages after Stanisław Staszic, Georg Gottlieb Pusch, Ludwik Zejszner, and the *Geological Atlas of Galicia*. The idea to compile the *Geological Atlas of Galicia* was put forward by members of the Physiographic Committee, a body established in 1866. Work on an atlas of such vast territories was a true challenge, as this would require significant means to cover the costs of extensive geological, stratigraphic, and palaeontological studies, as well as surveys of mineral raw materials. The initiative came from Alojzy Alth, a dignified-looking man educated in law and a naturalist at heart, very voluble in speech as is often the case with skilled lawyers. Together with Stanisław Olszewski and Franciszek Bieniasz, he compiled initial map sheets of that atlas, which were published in 1885. By 1912, 25 map booklets were published with over 100 map sheets at a scale 1:75,000 (Alexandrowicz, 2008). Of the planned map sheets, only two were not compiled (Wadowice and Sambor sheets) (Fig. 28). This atlas was prepared by a very small team of 16 authors. In addition to those mentioned above, this team comprised such outstanding geologists such as Emil Habdank-Dunikowski, Wilhelm Friedberg, Jan Grzybowski, Marian Łomnicki, Jarosław Łomnicki, Piotr Miączyński, Władysław Szajnocha, Wawrzyniec Teisseyre, Tadeusz Wiśniowski, Kazimierz Wójcik, Stanisław Zaręczny, Rudolf Zuber, and the only non-Pole – the above-noted Victor Uhlig, the famous Austrian geologist. Nevertheless, individual map sheets and their explanatory notes vary dramatically in quality. In some cases explanatory notes are only several pages long, whereas Booklet no. 3, comprising explanatory notes to two map sheets from 1894 (*Okręg Krakowski* – Fig. 29 and *Oświęcim-Chrzanów-Krzeszowice*), is practically a 290-page monograph in two volumes, with seven tables and inserts of 24 geological cross-sections. Compiled by Stanisław Zaręczny, this booklet is widely regarded as the crowning piece of the entire initiative.

Special attention should be also paid to three map sheets of the Tatra Mountain region (*Tatry, Nowy Targ i Zakopane* and *Szczawnica* map sheets – Fig. 30), compiled by Victor Uhlig and published after his death in 1912. These sheets are characterized by precisely differentiated geological units and intense colours, characteristic of the Austro-Hungarian school of geological cartography.

From 1881, the Physiographic Committee began to publish Physiographic Memoirs to which geological maps were very often added as inserts. At least one map was added to each volume of the memoirs in the first few years. The first volume included the *Geognostic Map of the Polish Kingdo*m of J.B. Pusch, compiled by the editorial office on the basis of unpublished sketches, drafts, and notes made available by his sons. It is also worth noting the *Geological Map of a Part of the Kielce Province* of Aleksander Michalski from volume IV (1884) (Fig. 31), the *Geological Map of the Kielce-Sandomierz Mountains* of Józef Siemiradzki from volume VII (1887), and the *Geological Map of the Lublin Province* of Jan Trejdosiewicz from volume XII (1892). Special attention should be paid to the *Geological Map of the Polish Kingdom, Galicia and Adjoining Countries* of Józef Siemiradzki and Emil Habdank-Dunikowski, published together with an extensive explanatory note in volume IX (1891). In that explanatory note to that map, Józef Siemiradzki laid the foundation for the geology of glacial deposits, so it is treated as a milestone in the knowledge of the geology of areas of Poland (Graniczny et al., 2008). It is beyond the scope of this paper to list all maps published in the memoirs, but it should be noted that these maps mainly show areas of Poland under Russian occupation.

Among main cartographic studies published at the start of the 20th century, it is worth recalling Józef Grzybowski's compilation, *A Review Geological Map of Poland and Adjoining Areas with an Explanatory Note* from 1912. Although that map was compiled more than 20 years after the above map of Józef Siemiradzki and Emil Habdank-Dunikowski, it appears to be far less detailed than the latter.

FINAL REMARKS

The 19th century witnessed remarkable progress in natural science. These were times of the emergence of geology as a separate branch of science, as represented in the first decades of that century by such outstanding personalities as L. von Buch, F.S. Beudant, and R. Murchison, and in Poland by Georg G. Pusch and L. Zejszner. In earlier times, rocks, minerals, and mineral raw materials, called "unearthed objects" by the priest K. Kluk (1797), used to be the subject of interest of scientists known as naturalists. Growing specialisation in geological science gave rise to new disciplines – palaeontology, stratigraphy, and mineralogy, together with rapid industrialisation and a resulting increase in demand for mineral resources – economic geology. This led to the steadily increasing accumulation of geological information, making it necessary to find the best manner of its presentation. Cartographic presentation was found to be the solution, and maps showing geological information began to be named mineral, petrographic, geognostic, and, finally, geological maps. As shown by Oldroyd (2013), S. Staszic, with his "Carta geologica" from 1815, may be viewed as a precursor to the idea of using the term "geological map".

Comparisons of maps compiled from the time period covered in this paper show how they evolved from very simple drawings with several geological units, to very detailed maps, often with extensive map keys comprising several dozen various geological units. The units were initially of a lithological type to be supplemented and later replaced by various increasingly complex combinations of lithostratigraphic and stratigraphic units. Finally, elements of fault tectonics began to be introduced at the start of the 20th century.

Fig. 27. Emil Tietze – 1888, *Geologische Karte der Umgebung von Krakau*

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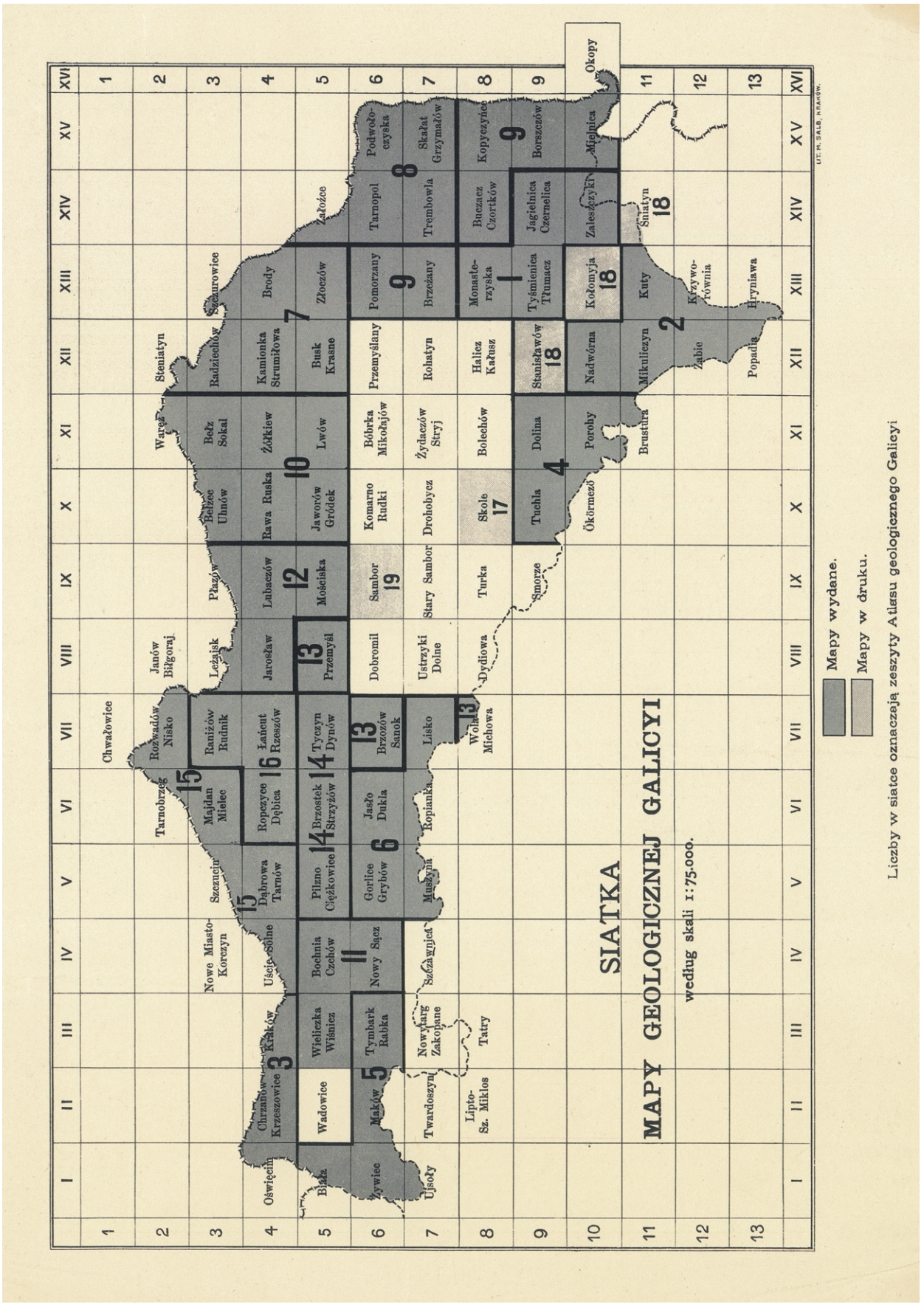

Fig. 28. Index of Geological Atlas of Galicia (*Siatka mapy geologicznej Galicyi według skali 1:75 000*)

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Fig. 29. Stanisław Zaręczny – 1894, *Geological Atlas of Galicia*. Booklet III. Sheet Okręg Krakowski (*Mapa geologiczna krakowskiego okręgu. Części ogólnej arkusz pierwszy*)

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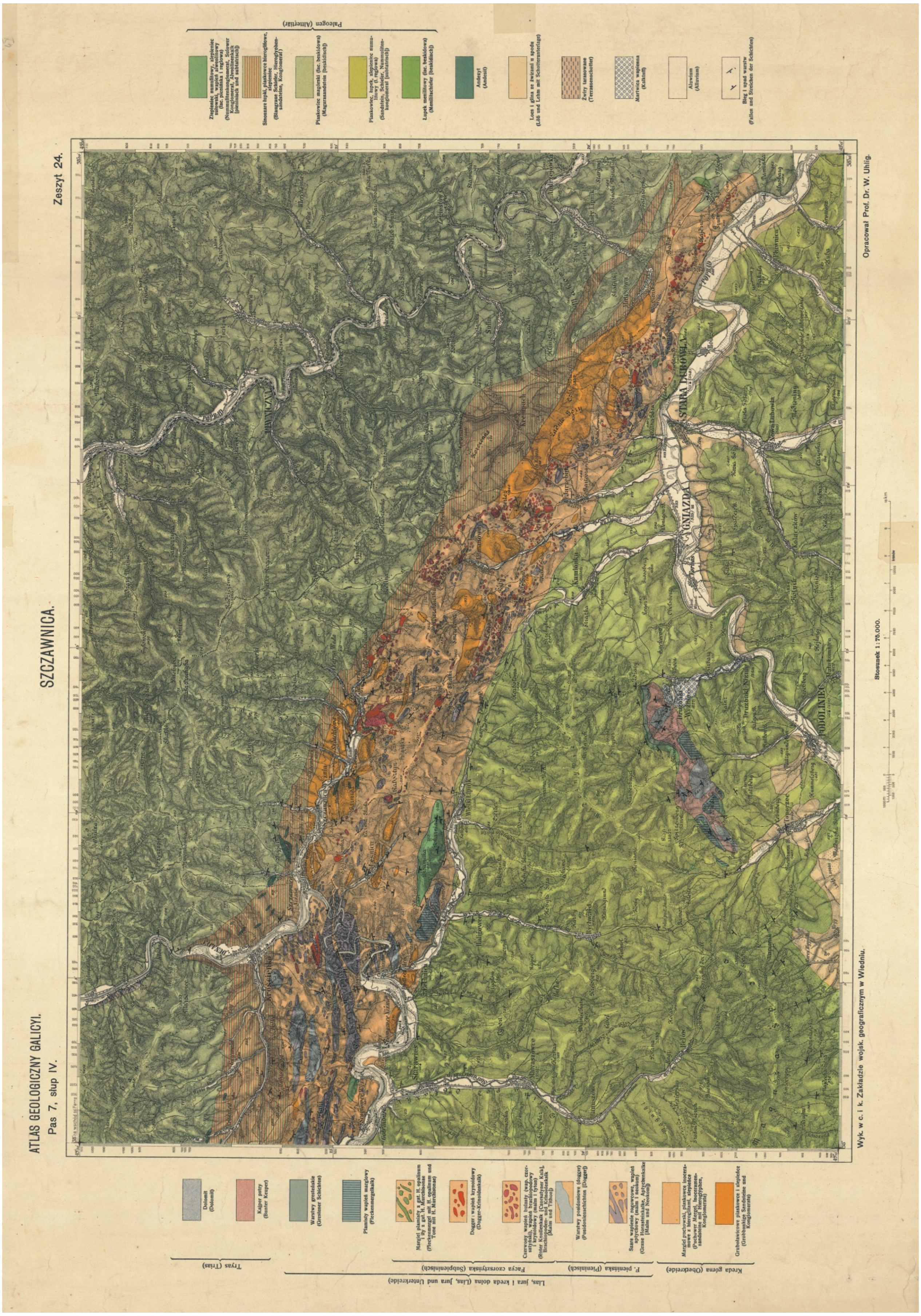

Fig. 30. Victor Uhlig – 1912, Geological Atlas of Galicia. Booklet 24. Sheet Szczawnica (*Atlas Geologiczny Galicyi – Szczawnica*)

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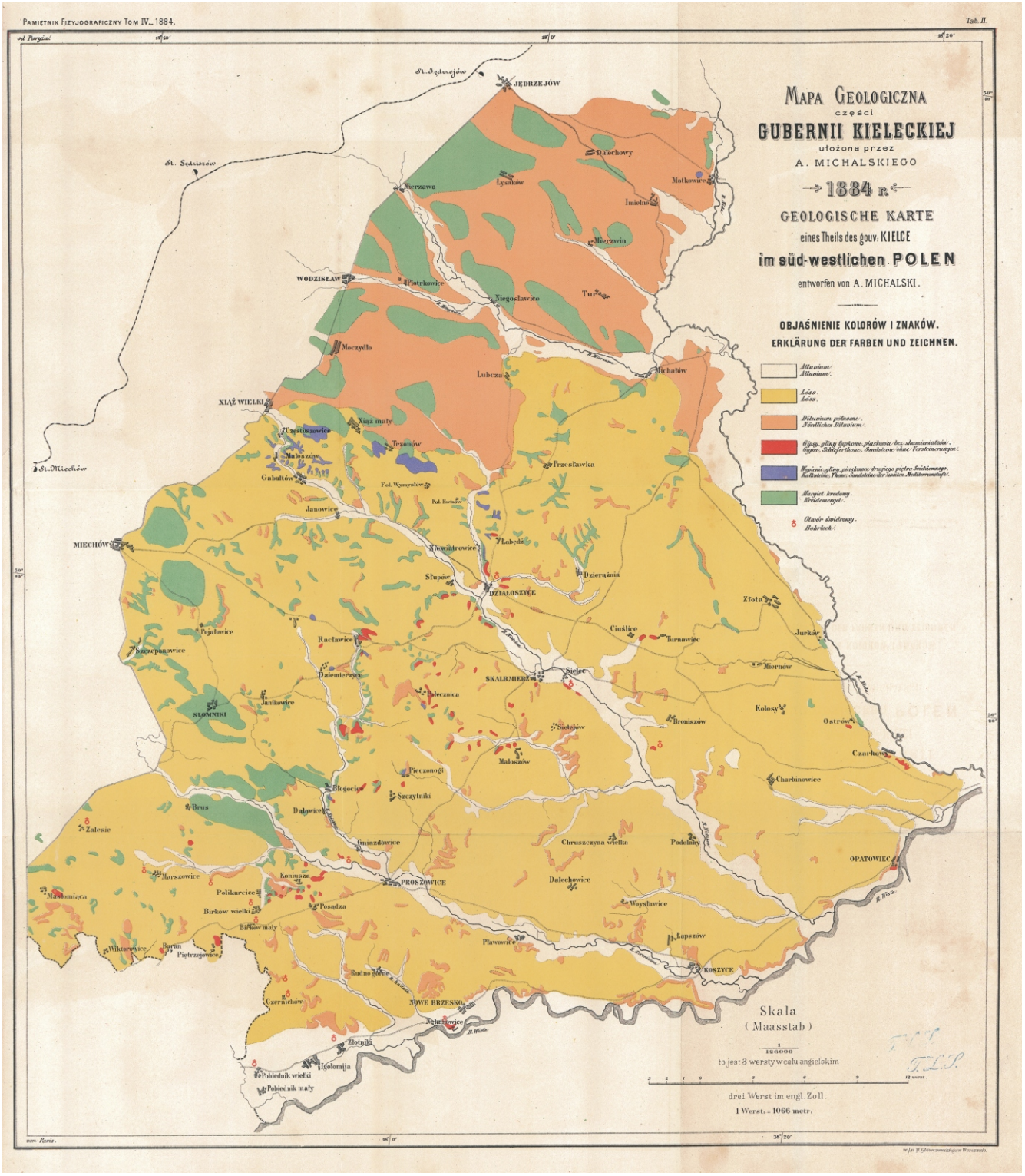

Fig. 31. Aleksander Michalski – 1884, Geological Map of a Part of the Kielce Province
(Mapa geologiczna części Gubernii Kieleckiej)

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At present, these classic maps can be also seen as unique pictures or graphic designs. The use of colours depended on adopted convention, with assignment of colours to individual rocks depending on their age and, in the case of igneous rocks, also lithology. Therefore, the final colouring of a given map solely depends on nature, that is, on the types of rocks exposed at the surface. Moreover, editorial offices often took special care to elaborate the graphic form of such maps, especially the lettering and layout, as well as highly elaborate beautiful cartouches with map titles. As a result, the viewing of classic geological maps as works of art may be a real pleasure.

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