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COLLECTION: MONOGENETIC VOLCANISM

Early volcanological research in the Vulkaneifel, Germany, the classic region of maar–diatreme volcanoes: the years 1774–1865

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Abstract The Vulkaneifel (Volcanic West Eifel) in the western part of the Rhenish Slate Mountains, Germany, played a major role in the early history of volcanology in general and especially so with respect to the recognition and volcanology of maar–diatreme volcanoes. In 1819, the volcano term "maar" was introduced into the scientific literature by Johann Steininger, a teacher from Trier (Treves) who established the Vulkaneifel as the type region for this kind of volcano. At that time, only a few pioneers—in the earliest days practically all of them were amateurs—had visited this part of western Central Europe in the late eighteenth and earliest nineteenth century. Despite many making important contributions to knowledge of volcanoes, not all were appreciated. In consequence, only in the second half of the twentieth century did new ideas and concepts concerning volcanism in general and phreatomagmatic activity in particular arise that were not previously presented by these pioneers. Their pathbreaking ideas have so far been mostly ignored, we feel, because of the old literature's limited availability. This paper tries to shed new light on these trailblazers. A selection of early geological maps of the Vulkaneifel and its neighbouring regions demonstrates the enormous advancements that had been achieved during those early days, to a large extent, in this part of Western Europe.

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Introduction

Remarks: In the following text and in the references, we use the original spelling and give the complete titles which otherwise are often cited in a more or less abbreviated form. In using Belgian and German, we indicate the regions of the present countries where these early volcanologists originally lived. All translations into English by HL and VL are given in brackets using the modern names for the localities.

The Vulkaneifel (Volcanic West Eifel) is located in the western part of the Rhenish Slate Mountains. Today, the old name Vulkaneifel refers to nearly 280 monogenetic volcanoes of Quaternary age that are scattered over a NW–SE trending area of c. 600 km^2 (West Eifel Volcanic Field (WEVF)). Here, the volcano term "maar" was coined by Johann Steininger in 1819. Shortly afterwards, in 1823, an anonymous writer wrote in a short communication to Johann Jacob Noeggerath [*1788–†1877] that the so-called Kesseltäler (kettle valleys), a common phenomenon in the Vulkaneifel, which are crater-like enlargements of V-shaped valleys but not surrounded by tephra, also seem to be closely related to the maars. This opinion was shared by Noeggerath (Anonymous 1823: footnote on page 215: "Aus eigener Anschauung ist es auch uns klar geworden, dass die eigentlichen Kesselthäler der Eifel mit den Maaren dieser Gegend nur ein und dieselbe Entstehungsursache haben können. D. H."). ["From our own observations it has become obvious to us, that the real kettle valleys of the Eifel and the maars of this area can only have one and the same origin. D. H."].

Along its north-eastern margin, the WEVF overlaps with the Tertiary Hocheifel Volcanic Field (THV) which comprises more than 400 deeply eroded volcanoes distributed over an area of c. 1,800 km^2. The oldest and best studied one

is the Middle Eocene Eckfeld Maar (e.g. Fekiacova et al. 2007; Lutz et al. 2010 and references therein; see also http://www.eckfelder-maar.de). East of the THV lies the Quaternary East Eifel Volcanic Field (EEVF) with another c. 100 monogenetic volcanoes and four larger phonolitic eruption centres. Most famous among these is the Laacher See Volcano that erupted c. 12,900 years BP (e.g. Büchel 1994; Ritter and Christensen 2007; Lorenz and Zimanowski 2008; Schmincke 2009).

Until the late nineteenth century, the central and western parts of the Eifel had been comparatively poorly developed economically and not well connected to the travel infrastructure along the rivers Rhine and Moselle, i.e. they had not been accessible as easily as the regions along the immediate banks of these rivers. In addition, the locals had such a bad reputation that M. Par and Behr (1819) [personal data unknown] explicitly wrote that they, as he had experienced on his travels, were not robbers and highwaymen but really friendly and peaceful people. Also, the harsh climate in the Hocheifel and in the nearby Schnee-Eifel (Snow-Eifel) kept many travellers from visiting this region. Therefore, as compared with the situation in the EEVF and in the Siebengebirge (The Seven Mountains), respectively, the systematic scientific exploration of the Vulkaneifel started rather late (e.g. Langer 1997; Schmincke 2002; Lutz and Lorenz 2009).

Pioneer researchers in the Vulkaneifel

In the following, starting with the year 1774, the very first researchers and their most important results are presented. The earliest among these were practically all amateurs. After the end of the Napoleonic Wars in 1815, the number of geologists visiting the western parts of the Eifel rapidly increased. This paper also focuses on some of the less known among these workers, or on those who, in our opinion, have published papers of special relevance for the early history of volcanology in general or that of maar–diatreme volcanoes in particular. Although the first monograph focusing on the Vulkaneifel was written by Heinrich von Dechen in 1861 (von Dechen 1861a), we have chosen the year 1865 for the end of our presentation. Our reason for this is that the important contributions of Eilhard Mitscherlich—read at the Royal Academy of Sciences in Berlin in the years 1848, 1854 and 1858—were edited and published posthumously as late as 1865. In that 1865 paper, the path-breaking map of the Vulkaneifel (Fig. 5) was published for the first time. Later, in 1886 (von Dechen 1886), it was published again in the second and enlarged edition of von Dechen's important 1861a monograph.

We consider that many of the first West Eifel volcanologists' great early ideas were later neither recognised by many of their coeval colleagues, nor, later on, by geochemically focused volcanologists. The works were unknown to most physical volcanologists worldwide, in large extent, due to the very limited availability of the early publications.

In the scope of this paper, we cannot trace possible influences the early researchers presented might have had on their contemporary colleagues. Especially with respect to the formation of maar–diatreme volcanoes, it would be of historical interest to browse the early literature and archives for such influences on researchers who worked in other volcanic fields, e.g. in the Czech Republic (Bohemia, Ohře Rift), in Hungary (Pannonian Basin, Bakony-Balaton Highland Volcanic Field), Spain (e.g. Calatrava Volcanic Field) and elsewhere. With respect to Central France (e.g. Auvergne, Cantal, Velay), we know that François Dominique de Reynaud Comte de Montlosier visited the Vulkaneifel and met Johann Steininger who guided him in the field (Montlosier 1822). Steininger travelled to the Auvergne soon afterwards and compared it with his home country (Steininger 1823, 1824), but we do not know who he met there. George Poulett Scrope also visited the Vulkaneifel where he too met Steininger. Certainly, he did not only take from Steininger the local term maar to introduce it to the English-speaking world in 1825 but also exchanged ideas with his German colleague (Scrope 1825, 1826).

Robert de Limbourg [*1731–†1808]

The very first time that a volcano in the Vulkaneifel was recognised as such was when the Belgian geologist Robert de Limbourg visited the West Eifel in 1774 (de Limbourg 1777; Langer 1997). This was relatively early, if we consider that it was only in 1756 that Jean-Etienne Guettard [*1715–†1786] published the first account of extinct volcanoes in Europe, which he and his colleague Chrétien-Guillaume de Lamoignon de Malesherbes [*1721–†1794] had discovered in 1751 near Volvic, Chaîne des Puys, Auvergne, France (Guettard 1756). After Guettard and prior to Limbourg, there were only Nicolas Desmarest [*1725–†1815] (1768, 1774: Auvergne, France), Rudolf Erich Raspe [*1736–†1794] (1771: Habichtswald, Hesse, Germany) and Ignaz Edler von Born [*1742–†1791] (1773: Kammerberg/Komorní hůrka, Ohře Rift, Bohemia, Czech Republic) who left written accounts presenting evidence about extinct volcanoes right in the heart of Europe. Limbourg described the Quaternary Steffelner Kopf north-west of Gerolstein, West Eifel, a small scoria cone with spatter and palagonite which, in recent decades, was quarried to a large extent and which is under protection today. Unfortunately, his paper was published in a journal that even in those days was not widely distributed, and his work remains widely ignored (de Limbourg 1777).

Carl Wilhelm Nose [*1753–†1835] and his assistant Johann Heinrich Wilhelm Perz [personal data unknown]

Following Limbourg, the German physician and convinced neptunist Carl Wilhelm Nose published valuable information

Fig. 1 Copper-engraved map showing the region visited and sampled by Carl W. Nose's assistant Johann H. W. Perz prior to 1789. The map shows many Quaternary scoria cones and even a few basaltic cones of Tertiary age, as e.g. the Nierenburg [Nürburg] and the Arensberg, but not yet any maar–diatreme volcano (format of this map, 20×25 cm)

about the Vulkaneifel. This became possible after his assistant Johann Heinrich Wilhelm Perz [a boatman and citizen of Oberwinter near Bonn: [Nose CW] (1792)] had visited parts of the Hocheifel and of the Vulkaneifel prior to 1789. Perz brought home thrilling news about the occurrence of many scoria cones and basaltic necks in this remote part of the Eifel. He had also sampled a great variety of volcanic rocks and minerals which very much resembled those in the EEVF. Nose published a first small sketchy map of the Hocheifel and the Vulkaneifel in his voluminous books to the volcanic regions on both sides of the Rhine River. This map showed the most important locations visited and sampled by Perz (Nose 1789, 1790, 1791) (Fig. 1). In none of his publications, however, did Nose mention the striking round and deep lakes which are so typical of the Vulkaneifel.

Laurent-François Dethier [*1757–†1843]

Laurent-François Dethier, a revolutionary and mayor of Theux, in present-day Belgium, published in 1803 a report on his travels to the Vulkaneifel during the years 1800–1802 (Dethier An XI / 1803). In 1794, the Vulkaneifel had become part of France and to a large extent became part of the Département des Forêts. In his report, Dethier mentions that a young German physician from Hillesheim named Smits, (most likely Schmitz, a common name in the Eifel) not only showed him scoria cones but also pointed out that the round and deep lakes so characteristic of the Vulkaneifel are the craters of extinct volcanoes. It was Smits who—as far as we know—for the first time recognised that maar lakes fill volcanic craters. However, neither Dethier nor Smits used the local term maar. This term had been in use for these round Eifel lakes at least since 1544 when Sebastian Münster (*1488–†1552) (Münster 1544: 341) used the old word for maar, i.e. marh. According to Noll (1967), the local term maar might even have been derived from the Latin word mare (i.e. sea) and been introduced into local language during Roman occupation of the West Eifel.

Dethier's book published in 1803 was sold without the remarkable geological map drawn in 1801 by his friend J.-L. Wolff [personal data unknown; he called himself an *éditeur, naturaliste et marchand de minéraux*]. This first coloured *carte géologique* for the Eifel is a mixture of topographic and petrographic colouration and used different signs for geological features like volcanoes, cold and hot springs, caves, etc. (Langer 1997) (Figs. 2 and 3). It might have been engraved as early as 1801 or soon after and may also have been printed and distributed as a single sheet. However, it remains unclear why it was not added to Dethier's book published in 1803. It probably came on the market for the first time as late as 1814 together with Dethier's anonymously published excursion guide ([Dethier L-F] 1814; comp. Lutz and Lorenz 2009).

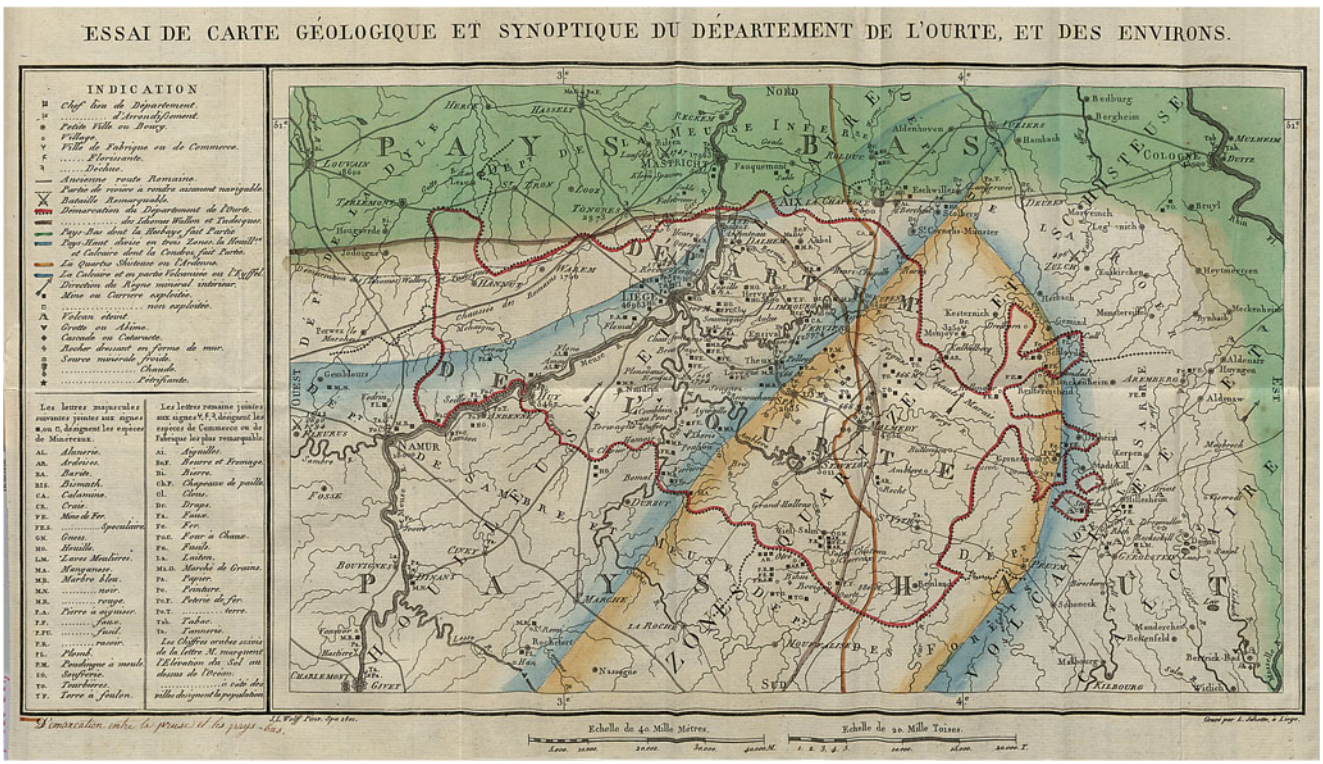

Fig. 2 First coloured geological map of the Eifel, drawn in 1801 by the Belgian JL Wolff. This copy is from Dethier's book that was published anonymously in 1818. Note the *borderline* between France and Prussia a bit to the right of the middle which has been added by hand in *brown* ink, most likely by Wolff himself who also signed the foreword [at least in our copy] ([Dethier L-F] 1818; format of this map, 49.5×29 cm)

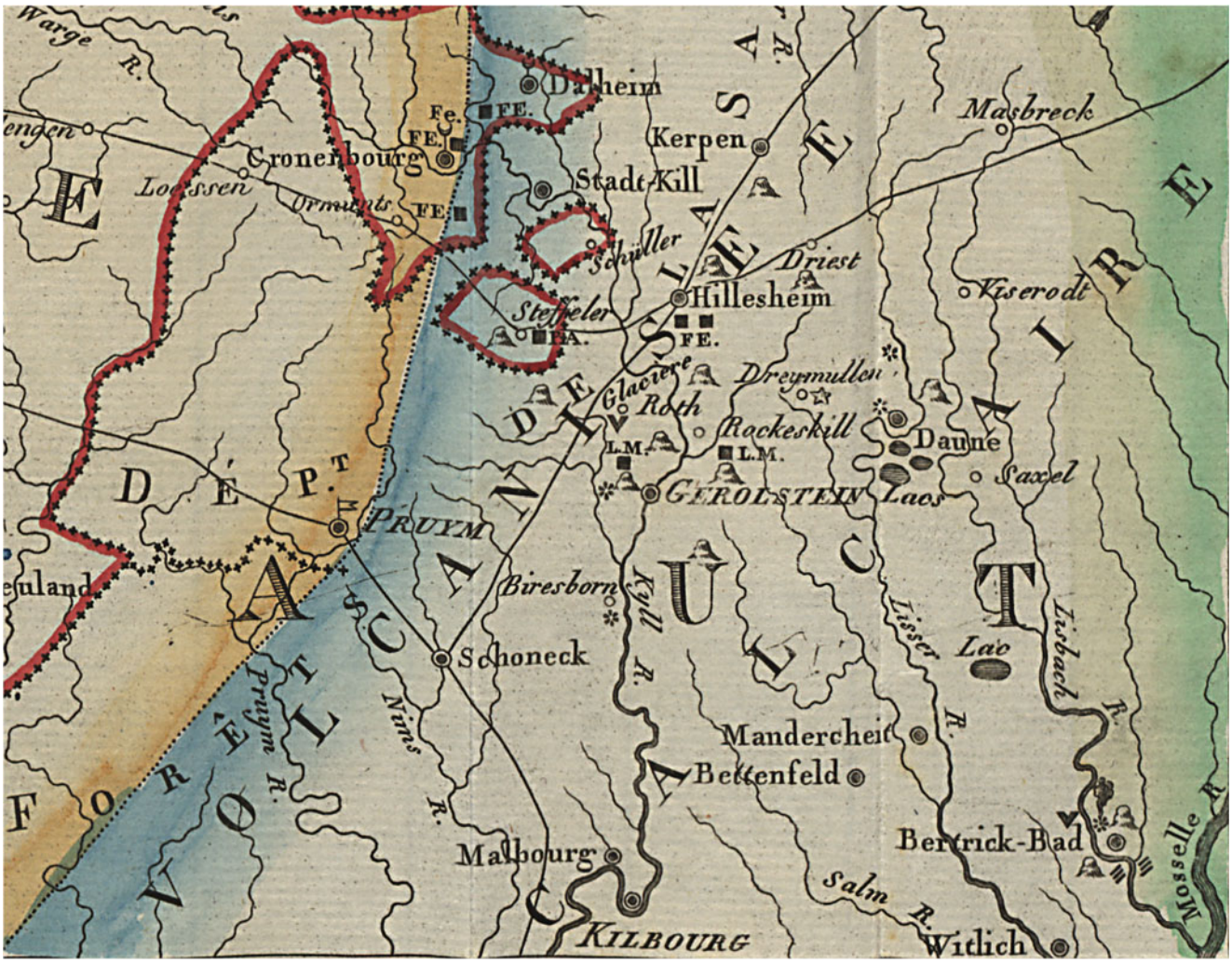

Fig. 3 Detail of Fig. 2. Between the villages Steffeler [Steffeln] and Bertrick-Bad [Bad Bertrich] *symbols* indicate all volcanoes, cold and warm springs, etc. of the WEVF which Dethier had found. Surprisingly, the three maars of Daun and the Pulvermaar are shown on the map but not the Mosenberg scoria cones and the Meerfeld Maar near Bettenfeld ([Dethier L-F] 1818; format of this map section, 13.5×9.5 cm)

The great awakening—after the end of the Napoleonic Wars

After the Eifel became part of Prussia in 1814, a rapidly increasing number of geologists travelled to the Vulkaneifel and the Hocheifel in order to study the volcanoes and their products. Among them were famous men like Jean-Baptiste Julien D'Omalius D'Halloy [*1783–†1875] (1808), Moritz von Engelhardt [*1779–†1842] and Karl von Raumer [*1783–†1865] (1815, 1816), Christian Keferstein [*1784–†1866] (1819, 1820), François Dominique de Reynaud Comte de Montlosier [*1755–†1838] (1822), Johann Steininger [*1794–†1874] (1819, 1820, 1821, 1822, 1824, 1853), George Poulett Scrope [*1797–†1876] (1826), the philosopher and renowned socialist Jean Ernest Reynaud [*1806–†1863] (1832), Leopold von Buch [*1774–†1853] (1824), Hermann Johann van der Wyck [*1769–†1843] (1826, 1836), Alexander von Humboldt [*1769–†1859] (1845–1862) and Heinrich von Dechen [*1800–†1889] (1861a, b, 1886). Since their contributions have already been discussed by Lutz and Lorenz (2009), we will refer in the following to only a few aspects and will especially discuss some maps which illustrate their publications and are remarkable for various reasons.

Two persons who have contributed much to volcanology should be highlighted here. One, A. Stengel, was largely ignored by his contemporaries, who did not really see the relevance of his findings and ideas. The other, Eilhard Mitscherlich, already during his lifetime a famous chemist, died before he could publish the results of his studies in the Eifel, where he had spent much of his recreational time.

A. Stengel [personal data unknown]

In our opinion, it was A. Stengel, a Prussian administrator of a steel furnace near Adenau in the Hocheifel, who in 1822 and 1823 published pathbreaking ideas that, unfortunately,

did not attract attention as they should have done, neither in his days nor in ours. During his extensive travels through the Vulkaneifel—he was searching for coal seams near his furnace—Stengel converted from a neptunist to a true vulcanist. Already, in 1822, he published the first coloured geological map of the Hocheifel and Vulkaneifel showing the basalt hills, scoria cones and nine maars he had found on his journeys (Fig. 4). Karl Caesar von Leonhard recommended this map in 1832 to all those who wanted to visit this region (von Leonhard 1832). Besides this, Stengel was a keen observer and, since he was no tough-minded member of the neptunist party, could formulate his own independent ideas and come up with respectable conclusions.

Stengel described in papers published in 1822 and 1823 in Noeggerath's journal, *Das Gebirge in Rheinland-Westphalen nach mineralogischem und chemischem Bezuge*, geological phenomena in the region he had visited. These phenomena he could only explain by subterranean fire. Here, his experience from his profession as head of a smelter was of great advantage to him. In 1823, after his many observations in his neighbourhood, he published his ideas—one may say, his own theory of volcanic activity—under the title "Ueber die Entstehung des Basalts hinsichtlich seines Vorkommens in der Eifel" [On the formation of basalt in respect to its occurrence in the Eifel]: The fact that lava at some places includes enamelled or partially vitrified granitic xenoliths shows that basalt becomes hot enough to be able to melt the hanging Granite (Stengel did not speculate about the source of this heat). The molten basalt then melts the feldspars of the overlying granite. This means that Stengel did not regard granite as the oldest rock (!) as it was commonly assumed in those days. This red-hot mass melts its way up through the crystalline rocks of the lower crust by melting and absorbing these. Today, we call this magmatic assimilation. When this melt reaches the overlying sedimentary rocks, it comes into contact with groundwater. This water is immediately vaporised. Thus, for him, the interaction of magma and groundwater was of major importance for the start of volcanic eruptions, as already assumed by e.g. Montlosier (1789) and Nose (1791). Due to the load of the overlying crust—for Stengel, vapor forms at the base of the sedimentary rocks that overlie the crystalline basement—the steam is extremely pressurised. In consequence, along cracks and fissures it fragments the wall rocks and blows out of a narrow funnel—without disturbing the inclination of the surrounding wall rocks—just as a bullet goes through a board

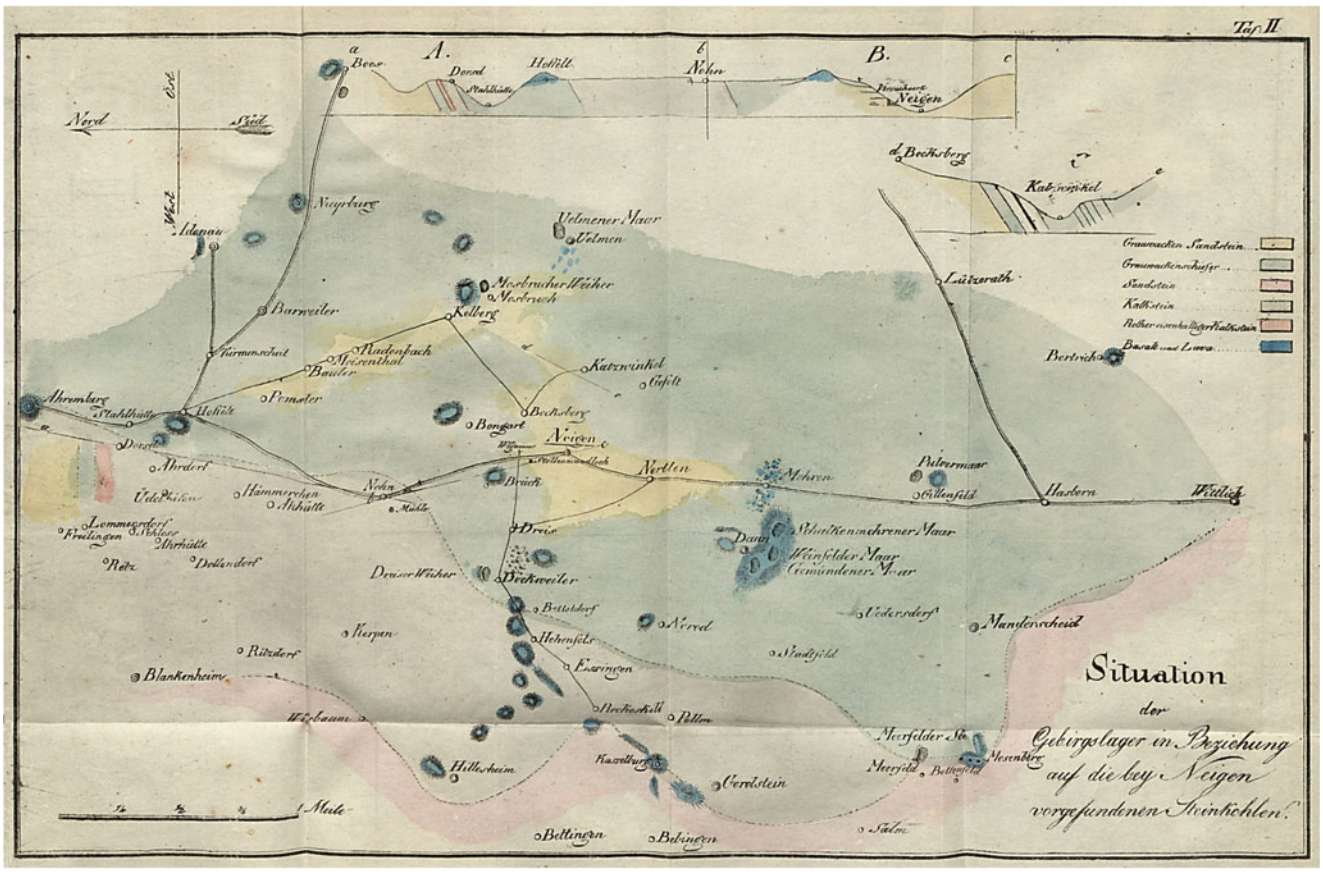

Fig. 4 **a** Stengel published the first regional geological map for the Vulkaneifel and parts of the Hocheifel, the still water-filled Ulmener Maar, Mosbrucher Weiher, Pulvermaar, Schalkenmehrener Maar, Weinfelder Maar and Gemündener Maar. The map also shows the scoria cones and the lava flow of the Mosenberg. The Meerfelder Maar, however, is called Meerfelder See (Stengel 1822; format of this map, 30.5×19 cm)

(Stengel 1823: 208: "Wenn die Kohäsionskraft gering gegen die bewegende Kraft ist, so zerreißen die Nebentheile nicht. Eine Kugel schlägt durch ein Holz, ohne den Rand des Loches zu zerstückeln" [original text but marked in italics by us]). ["When the force of cohesion is less than the kinetic force, the surrounding parts do not get torn apart. A bullet passes through wood without the margin of the hole getting torn into small pieces"].

Thus, already, in these early years of the nineteenth century, Stengel thought of mechanisms and processes (Stengel 1822, 1823) which, much later, in 1998, have been analysed and described in modern scientific detail by Ralf Büttner and Bernd Zimanowski as thermohydraulic explosions (Büttner and Zimanowski 1998). These so-called thermohydraulic processes are the motor of what we consider as highly explosive phreatomagmatic eruptions and the origin of the formation of the maar–diatreme volcanoes worldwide (Büttner and Zimanowski 1998; Lorenz and Kurszlaukis 2007; Lorenz and Zimanowski 2008). Since he certainly has influenced at least some of his German successors, for example, Eilhard Mitscherlich, we think that we may count Stengel among the leading pioneers in volcanology in the early nineteenth century, especially with respect to the formation of maars.

Eilhard Mitscherlich [*1794–†1863]

Last but not least, we present in some detail the ideas of Eilhard Mitscherlich. He presented his volcanological conclusions to

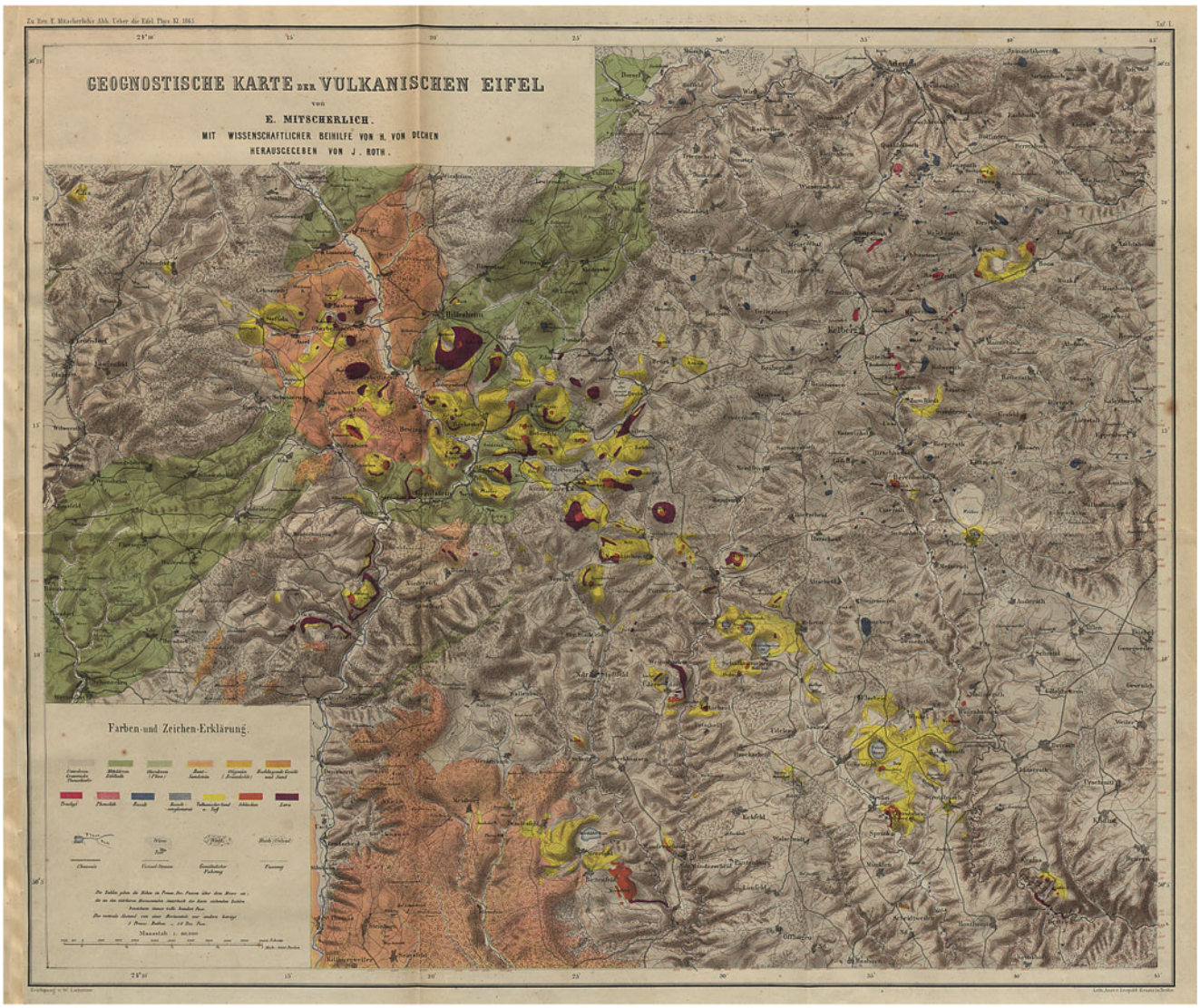

Fig. 5 The classical geological map of the Vulkaneifel produced by Eilhard Mitscherlich and Heinrich von Dechen (format of this map, c. 58×48 cm). This is the first large-scale geological map combining geological map colour selection and contour lines. It nicely shows the NW–SE-oriented Quaternary WEVF between Ormont and Bad Bertrich with its scoria cones, lava flows, maar lakes and dry maars. It also shows a large number of deeply eroded volcanoes of the THV and the sediments of the Eckfeld Maar which, however, had not yet been recognised as a maar of Tertiary age (Mitscherlich 1865)

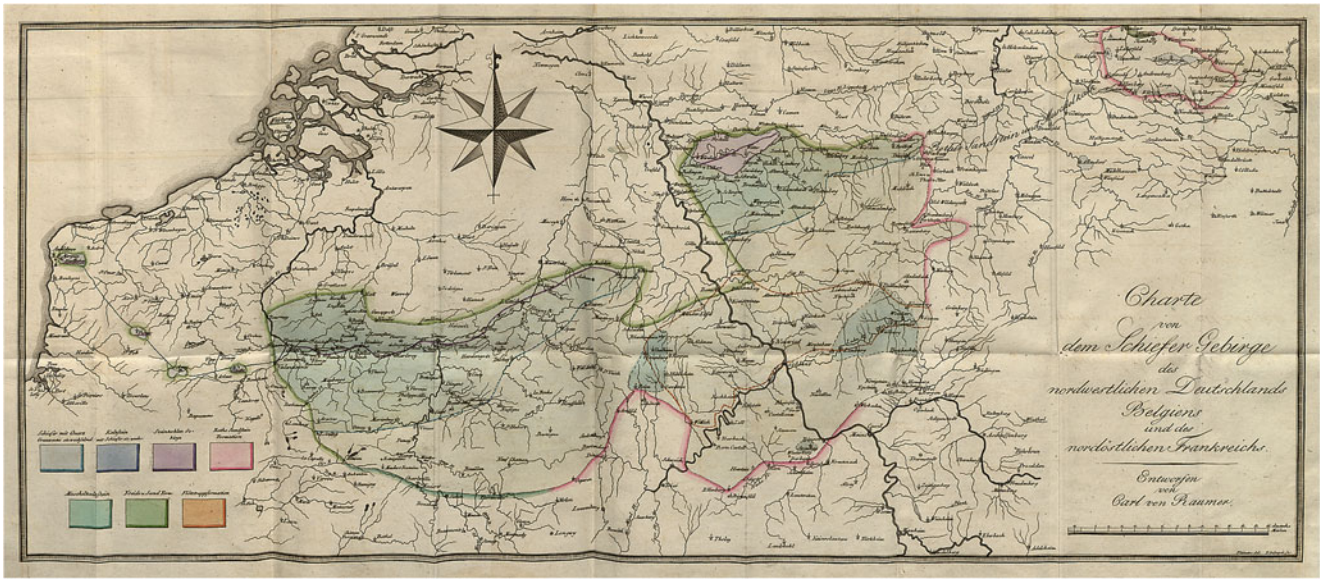

Fig. 6 This map of Engelhardt and Raumer for the first time shows the Rheinisches Schiefergebirge [Rhenish Slate Mountains] as a geological unit. The distribution of volcanoes and their products—here named Flöztrapp-Formation, a term coined by Abraham G. Werner for a series of aquatic sediments in his neptunian system—is indicated by a *brown dotted line*. It includes the WEVF, THV, EEVF, Siebengebirge volcanic field and Westerwald volcanic field (Engelhardt and Raumer 1815; format of this map, 62.5×26.5 cm)

the Royal Academy of Sciences in Berlin during their sessions in the years 1848, 1854 and 1858. As already mentioned, however, his important contributions were edited and posthumously published in 1865 by his colleague Justus Roth [*1818–†1892] (Mitscherlich 1865).

In three talks, Mitscherlich proposed the following important ideas: (1) phenomena observed at the Ulmen Maar can only be explained by explosive interactions of water and rising (basaltic) magma (today: thermohydraulic explosions). (2) Steam forms at great depths (he thought of 100,000 feet, i.e. >30 km!). At those depths, it is under high pressure and may reach temperatures of up to 1,000 °C. (3) This overheated steam is the driving force for an initial eruption. It initiates fissures and faults and partly melts the surrounding rocks to form magma. It opens a pipe which is crowned by a crater. Lava may flow and/or degas explosively to form cinders and scoria. (4) Maars form when just gases and fragmented country rocks are erupted. Thus, he calls them gas-volcanoes (comp. Steininger 1820: kalte Windvulkane [cold wind-volcanoes]; Branco 1894–1895: Vulkanembryonen [embryonic volcanoes]).

Since Mitscherlich was a renowned scientist in his time, his ideas concerning volcanic activity had more influence than those published by Stengel. As already mentioned, he influenced later volcanologists, at least among his German countrymen, and, regarding the formation of maars and diatremes, his ideas were accepted for many decades and had great influence on, e.g., Wilhelm Branco [*1844–†1928; since 1895: Wilhelm von Branca] (1894–1895), Archibald Geikie [*1835–†1924] (1897) and Hans Cloos [*1885–†1951] (1941). Contrary to our initial assumption, we have found no evidence that Mitscherlich had also influenced Gabriel Auguste Daubrée [*1814–†1896] who is famous for his spectacular experiments using explosives to produce hot gases penetrating through and interacting with natural rock samples. [It was Daubrée who introduced the term "diatreme" for pipe-shaped volcanic structures like those of the diamondiferous kimberlite pipes or the feeder structures of the Eifel and Auvergne maars (Daubrée 1893, 1891).]

Based on Wilhelm Branco's intensive studies (Branco 1894–1895) Theodor Engel [*1842–†1933], a Swabian priest, in 1928 more than 100 years after Stengel, described the way that the maar–diatreme volcanoes of the Swabian Alb formed in a surprisingly similar way: "Vielmehr glaubt Branca an Vorgänge erinnern zu sollen, …wobei jeweils nur ein einmaliger Ausbruch stattfindet und mit dieser ersten zugleich alle weitere vulkanische Tätigkeit erlischt. Es handelt sich dabei um eine plötzliche und gewaltige Explosion, indem, vielleicht durch Gasblasen an irgend einer Stelle der Erdrinde, Massen des heißen Breis ans Tageslicht gefördert werden. Die Erdkruste wird unter diesen Umständen wie ein Brett von der Kugel eines Schusses durchlöchert [original text but marked in italics

Fig. 7 This geological map was published by Engelhardt and Raumer (1816). In 1814, Karl von Raumer had met George Bellas Greenough in Paris, who, like himself, was working on a geological map. Greenough allowed Raumer to copy information from his own work. The result is a unique map which depicts the distribution of five rock types and indicates their strike. Remarkably, on this map for the Eifel, the Flöztrappformation has not been marked, although this is the case on their map published 1 year earlier (see Fig. 6) (format of this map, c. 59×43.5 cm)


Versuch
einer
GEOGNOSTISCHEN KARTE
von
Frankreich Grossbrittanien einem
Theile Deutschlands und
Italiens.
I
Ur- und Uebergangsgebirgsarten.
I*
Gebirgsarten der Alpen, Pyrenaen, Ardennen und der nordöstlichen Fortsetzung der Ardennen. Siehe die Einleitung § 3
II
Rothe Sandsteinformation und das ihr angehörige Steinkohlengebirge.
III
Muschelkalksteinformation nebst der Kreide- und Sandformation.
IV
Flötztrappformation.

by us]; die sämtlichen Gesteinsschichten, durch die der Schußkanal führt, werden von der Explosion in feinste Teile zerrissen und als vulkanische Asche in die Luft geschleudert" (Engel 1928: 233). ["Moreover, Branca believed he ought to remind (colleagues) of processes …whereby in each case only a single eruption occurs and with this one all further activity ceases. This eruption he considered to be a sudden and powerful one by which, possibly via gas bubbles at some place within the Earth's crust, masses of the hot mash get transported to light. Under these conditions the Earth's crust gets pierced similar to a wooden board getting pierced by a bullet. All rock layers that the bullet hole transected are torn into smallest particles and get ejected as volcanic ash into the air" (Engel 1928: 233).].

Hans Cloos, one of the most influential German geologists of his time, also compared these processes with a Durchschuss, i.e. a full penetration (of a bullet, e.g. through a board) (Cloos 1941: 710). Thus, this Durchschuss theory

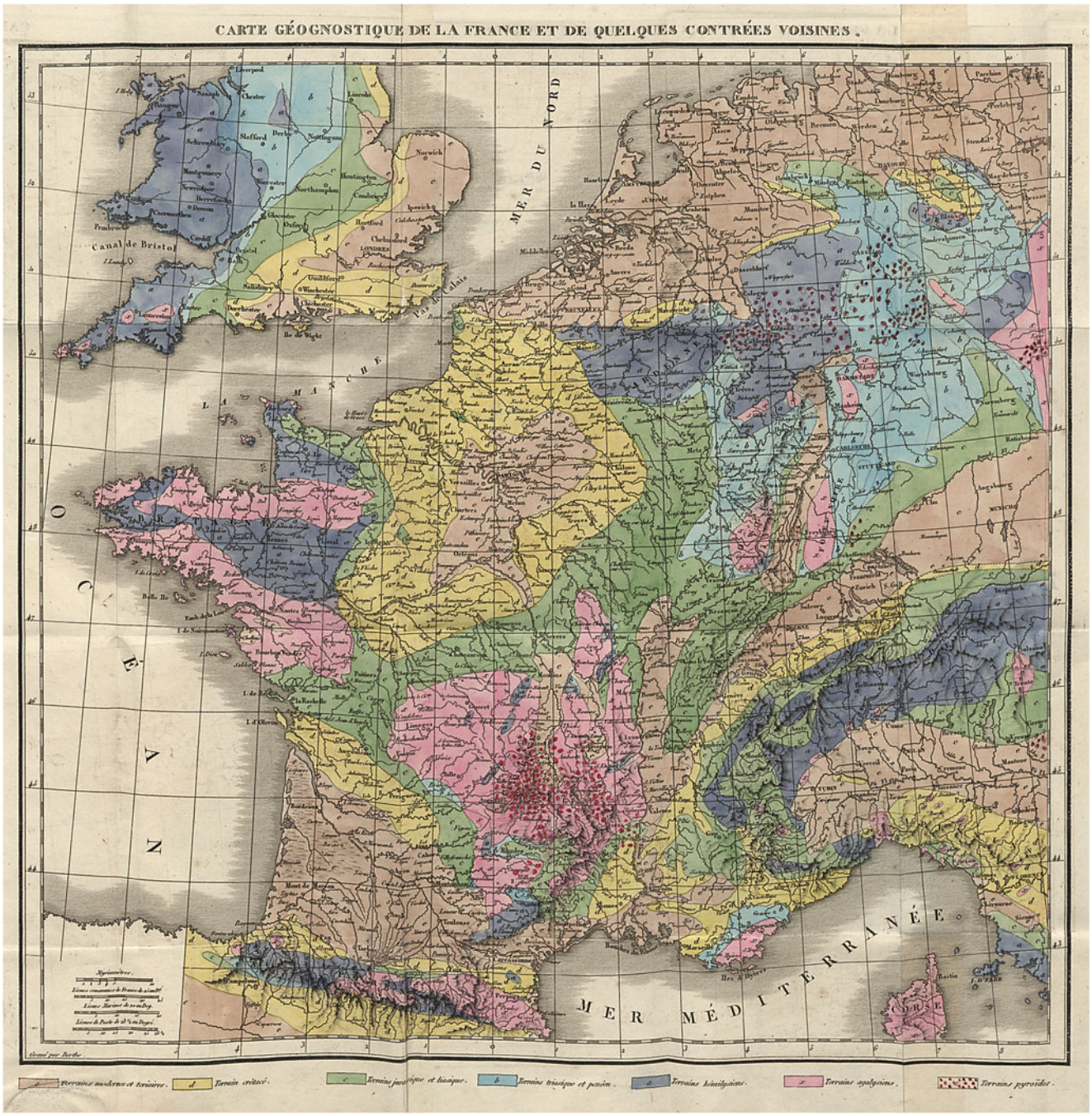

Fig. 8 On his beautiful geological map of Europe, for the first time published in 1822, Jean-Baptiste J. d'Omalius d'Halloy (Omalius d'Halloy J-BJ d' 1835) depicts all Tertiary and Quaternary volcanic fields, i.e. the whole Central European volcanic province (format of this map, c. 38×40 cm)

was widely accepted until the second half of the twentieth century (e.g. Schweizer V unter Mitarbeit von [with the cooperation of] R Kraatz 1982: 90: " …daß im Vulkanstiel explosionsartig eine Schußröhre bis zum damaligen Erosionsniveau ausgeräumt wurde.") ["… that similar to an explosion the volcanic conduit is cleared to form a pipe up to the erosion surface."]. With respect to the formation of kimberlite diatremes, it is still held in high esteem by some researchers (e.g. Sparks et al. 2006; Wilson and Head 2007a, 2007b; Cas et al. 2008; Kavanagh and Sparks 2008).

To Mitscherlich, we also owe a geological map of the Vulkaneifel in 13 colours (Fig. 5) which is the first large-scale geological map of a modern type, i.e. a map combining geological information and topographical contour lines (Mitscherlich 1865).

Heinrich von Dechen had already in 1861 published such a path-breaking map for the Siebengebirge near Bonn—for the very first time in the history of geology (von Dechen 1861b). This was of a much smaller size, however, and may be considered as a forerunner since Mitscherlich's map has been drawn with the scientific assistance of Dechen. In addition to this large map of the complete Vulkaneifel, three smaller but very detailed maps were drawn and produced with this advanced technique that combines geological information and topographical contour lines. These depict the Ulmen Maar, the volcanoes of Bad Bertrich and Gerolstein (Mitscherlich 1865). It was not until 1994 that this great map was succeeded by the Vulkanologische Karte der West- und Hocheifel, i.e. Volcanological Map of the West- and Hocheifel, edited by Georg Büchel.

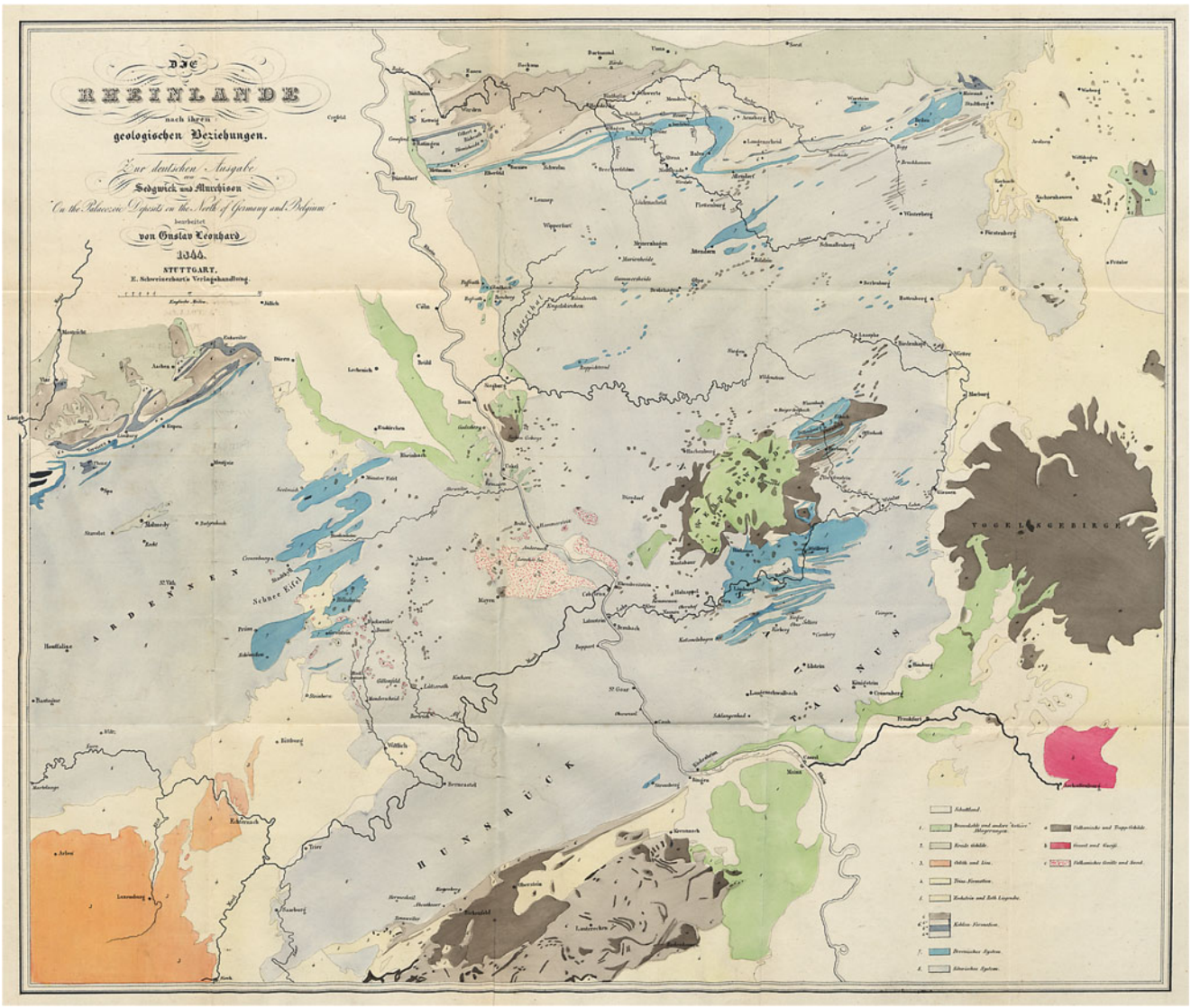

Fig. 9 This excellent geological map was first published in 1842 by Adam Sedgwick and Roderick Murchison. For the German edition, the map was redrawn with minor modifications regarding names, legend and colours. In an astonishing accuracy, it not only shows all important geological units of the whole Rhenish Slate Mountains and adjacent regions but also the Quaternary WEVF and EEVF with their widespread volcaniclastic deposits. In between, many of the deeply eroded volcanoes of the THV are already shown on this map (Leonhard 1844; format of this map, 51.5×44 cm)

The early maps

In addition to the map of Mitscherlich, a small selection of rare early maps on the Vulkaneifel will finally illustrate not only progress in exploration of this region but also improvements with geological mapping in general.

First, the works and maps of Moritz von Engelhardt and his colleague Karl von Raumer are noteworthy. In their first book, published in 1815, they show for the first time the Rheinisches Schiefergebirge (Rhenish Slate Mountains) as a geological unit. The volcanic districts in this large area are marked on their map by a brown dotted line (von Engelhardt and von Raumer 1815) (Fig. 6).

Another map published by them 1 year later has remained almost unknown, and we reproduce it here. It gives an overview of the geology of France and Great Britain including parts of Germany (as, e.g. Eifel) and Italy (von Engelhardt and von Raumer 1816) (Fig. 7). The continental part of this map had already been sketched by Raumer in 1808–1809 but had remained unfinished. Then, in 1814, Raumer met George Bellas Greenough [*1778–†1855] in the Ecole des Mines in Paris while both were collecting information in these eminent French mineralogical and regionally arranged petrographic collections. Greenough was completing his geological map of England (Greenough 1819) which is considered as a plagiarism of William Smith's map (e.g. Winchester 2001). With Greenough's aid, Raumer finished his postponed project. Raumer distinguished five rock types and showed their occurrence by underlining all the counties and departments with thin colour bands that are supposed to indicate the predominant geological rock units occurring in the respective areas. He even tried to indicate their general strike. The result is a map which is very striking in so far as it resembles military maps showing the positions of deployed troops. For the

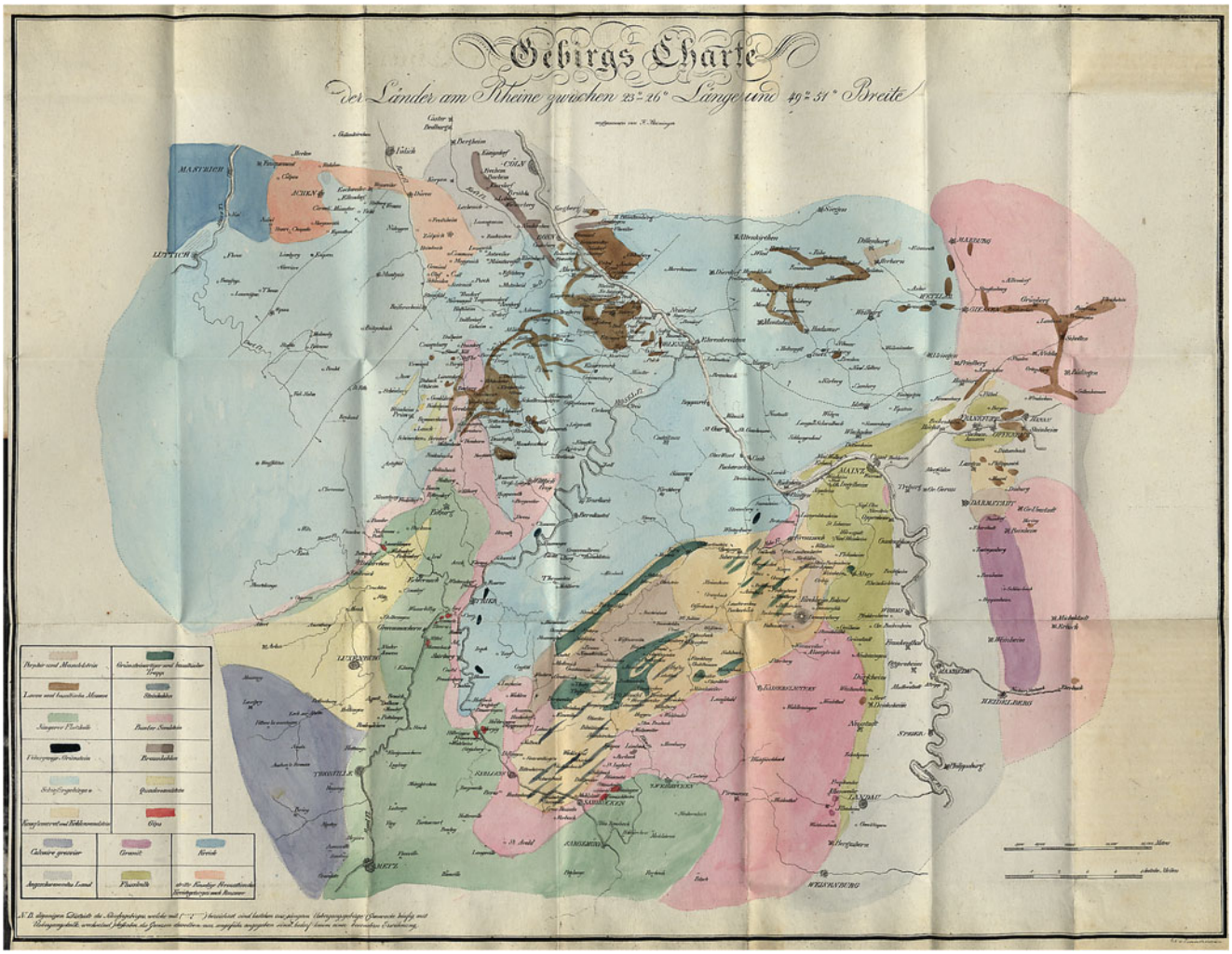

Fig. 10 Johann Steininger published his first geological map of the Eifel and neighbouring regions in 1822. With this pioneer work, he sums up what he knew about the geology of this part of Germany. Still very schematically, it shows, among others like, e.g. the volcanic Siebengebirge near Bonn, the widespread volcanics of the WEVF and the EEVF. In between, Steininger also mapped regionally distributed "Laven und basaltische Massen" [lava and basaltic masses]. These represent the first hint to what we today call THV (Steininger 1822; format of this map, 62×47.5 cm)

former French *département Rhin et Moselle*, Engelhardt and Raumer mention: (1) Basalt. (a) dichter, (b) poröser. Mennich. Mühlstein [Basalt (a) compact, (b) porous. Mendig. millstone]; (2) Basalttuff mit Holzkohle von Pleit [Basaltic tuff with charcoal from Plaidt]; (3) Lavaartige Steine. Gegend von Laach, Bertrich, Lutzerath [Lava-like rocks. Area of Laacher See, Bad Bertrich, Lutzerath]. Raumer, however, did not mark these members of the Flöztrappformation sensu A. G. Werner on the map (von Engelhardt and von Raumer 1816: 112).

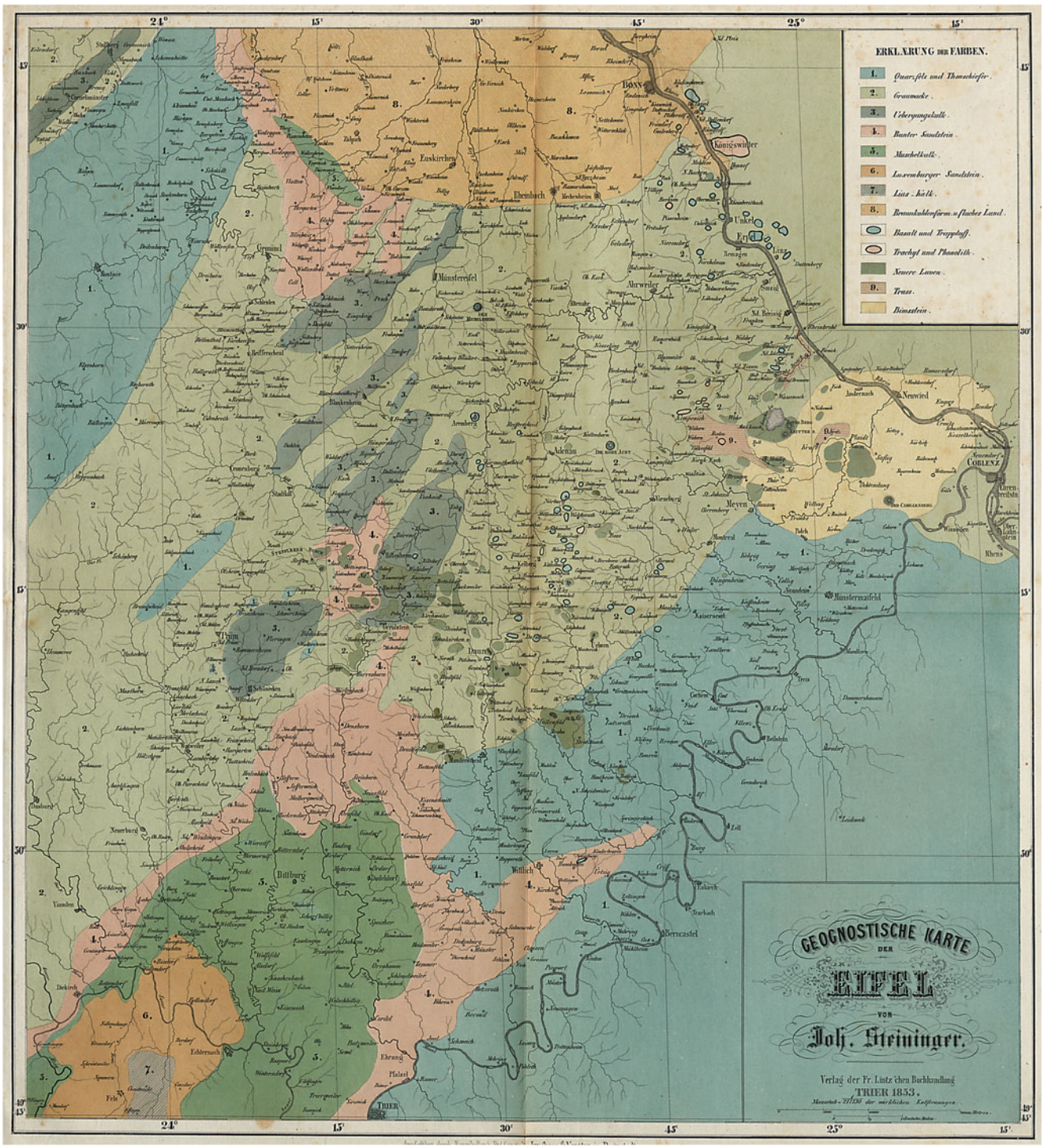

Fig. 11 To his last publication, Johann Steininger added this Geognostische Karte der Eifel. In this, he clearly distinguishes between the young Quaternary WEVF and EEVF with their widespread ejecta and the tertiary THV with the deeply eroded remnants of ancient volcanoes (Steininger 1853; format of this map, c. 40×44 cm)

The next map reproduced here is by Jean-Baptiste Julien d'Omalius d'Halloy [*1783–†1875] and was published for the first time in 1822. It very nicely draws the observer's attention to all volcanic fields (Omalius d'Halloy J-BJ d' 1822, 1835; comp. Ashworth 2004) (Fig. 8) now known to be associated with the European Cenozoic Rift System (Dèzes et al. 2004). The first time d'Omalius d'Halloy published on the Eifel was in 1808. In that early paper, he distinguished between young scoria cones and older basalt hills. According to him, basalt layers interbedded with sediment layers were not of aquatic origin but lava pressed in between the sediments (sills). Like Nicolas Desmarest (1774, 1806)), he discussed the temporal and spatial relationships between basalts, lava flows and valleys.

Here, we mention the rather sketchy but nevertheless beautiful small map of George Julius Poulett Scrope [*1797–†1876] (1826) that not only shows several maars still filled with water but—as far as we know—for the first time also shows two dry maars (Dreiser Weiher and Walsdorf Maar with the Goßberg scoria cone).

Another beautiful map was published in the Transactions of the Geological Society of London by Adam Sedgwick [*1785–†1873] and Roderick Impey Murchison [*1792–†1871] to illustrate their paper "On the Distribution and Classification of the older or Palaeozoic Deposits of the North of Germany and Belgium, …." (Sedgwick and Murchison 1842). It was soon translated into German by Gustav von Leonhard [*1816–†1878], and the map was redrawn and modified especially with respect to the names of towns, villages and regions but also with respect to the colour selection and specification of some stratigraphic units (von Leonhard 1844) (Fig. 9). In a wonderful way, for that time, this map shows the geology of the Eifel and adjacent areas, and it clearly distinguishes between the deeply eroded volcanoes of the THV and the young volcanoes of the WEVF and the EEVF which still display their ejecta, i.e. scoria, pumice and ashes.

Finally, Johann Steininger's [*1794–†1874] first (Fig. 10) and last maps (Fig. 11) on that subject which he published in 1822 and 1853 respectively illustrate not only his personal progress during the three decades of his pioneering research in the Vulkaneifel but once again the improvements in geological mapping in general during these years (for more references on this subject, see Lutz and Lorenz 2009).

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