Hermann Vogelsang (1838-1874), 'Européen avant la lettre'.

Jacques L.R. Touret

The name of Hermann Vogelsang, the first professor of mineralogy and petrology at the Polytechnic School of Delft (Fig. 1), is only known to-day among fluid inclusion specialists. They recall that, with the help of his assistant, Theodore Geisler, he succeeded in analysing the strange fluid that Brewster had found in cavities within some topaz and quartz crystals (Vogelsang and Geisler, 1869). He did not write too many publications, but his major essays, notably the *Philosophie der Geologie*, published in Bonn in 1867, reach high prices in sales of ancient books, because of the spectacular colour plates and exquisite drawings (Fig. 2). Vogelsang was, however, an important figure of European mineralogy and petrology during the nineteenth century, together with recognised authorities like Ferdinand Zirkel and Harry Rosenbusch. From his country of adoption, the Netherlands, he established constant bridges between the two major schools of England and Germany, without forgetting the French, with whom he was in an almost open conflict (in the line of the French-Prussian war, which would mark the fall of Napoléon III). Vogelsang's short life (he died at the age of only 36) started as a dream and ended in a nightmare. His influence was, however, much greater than commonly realised and, as much as H. C. Sorby, who was his direct inspirator and mentor, he deserves to be recognised as one of the founders of modern microscopic mineralogy and petrology.

The student years in Bonn

Vogelsang was born in Minden near Hannover in 1838, but after the death of his father, his mother moved to Bonn, where his education was mainly supervised by one of his uncles. The family counted four children, one daughter and three sons, who all died at a relatively young age, even by the standard of the time: 13 years for the daughter and 17 and twice 36 for the sons. All died from lung infection, which might indicate some genetic weakness in the family.

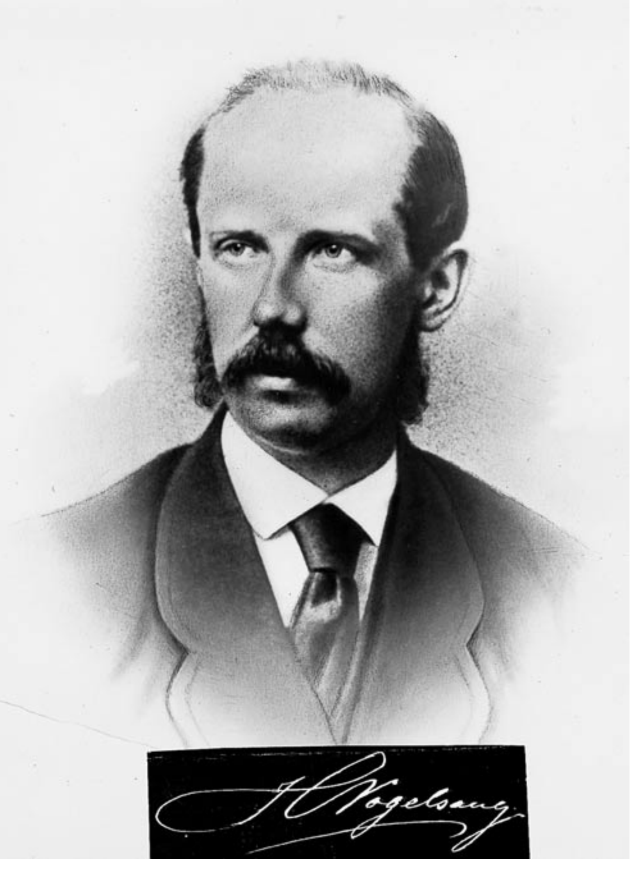


Figure 1 Official portrait of Hermann Vogelsang, about 1870 (Courtesy, Museum Technical University, Delft).

Hermann was a gifted, brilliant child and a successful student at the Bonn gymnasium, from which he obtained his 'Abitur' in 1856. The Bonn region counted a number of mines at the time, notably of iron and copper, and the young Hermann decided to choose the career of mining engineer. He became 'Bergbeflissen' immediately after his 'Abitur' and was rapidly promoted to 'Bergexpectant' in 1857, after having visited and worked in a number of mines, particularly in Saxony and at the famous locality of Freiberg. The influence of the old master of Freiberg, A.G. Werner, was still very important in Germany at this time, especially for practical mining purposes and the essence of the 'art of mining' was learned in the field, from experienced miners.

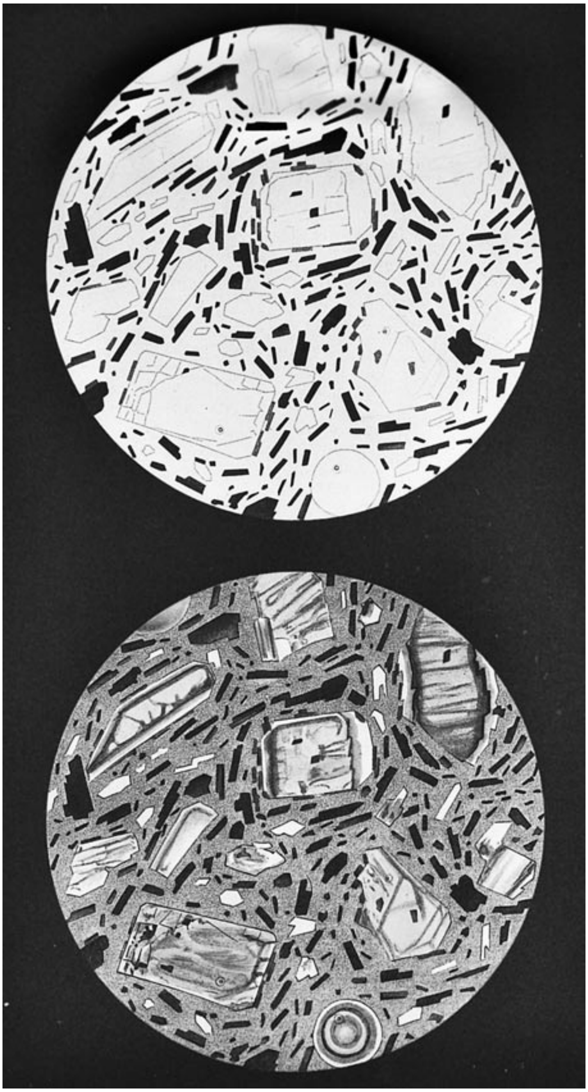


Figure 2 Colour plate (Tafel II) from the *Philosophie der Geologie*, (quartz-bearing trachyte from Campiglia). Polarised light, parallel (top) or crossed nicols (below).

In 1858, the political situation in Germany was not very stable and military forces were slowly building up. Vogelsang had to go into the army, which he could luckily do in his hometown, Bonn. Military duty in those days allowed a number of possibilities and the young Hermann was able to spend much time at the university, where he resumed his university education. He ended up deciding to quit mining, keeping, however, always a keen interest for mining geology, which proved to be helpful for the immediate follow-up of his career, but which should also lead to a real drama at the end of his life.

At the end of the two years that he had to serve in the army, Hermann, at the recommendation of his professors, chose science instead of mining. He engaged in the preparation of a thesis on the formation of metal-bearing veins, a subject typically in line with Werner's thinking. As with the mines, he could not consider geology without extensive travelling. He was sent to Corsica, in order to study the orbicular diorite recently discovered

Figure 3 The 'Allégorie de la Science', by Abel de Pujol (1846). This monumental painting, together with a number of spectacular geological landscapes (Mont-Blanc, Gavarnie, Etna, Giant causeway, and so on) decorates the ornamental staircase of the Ecole des Mines in its post-napoleontic location (Hôtel de Vendôme, near the Jardin du Luxembourg). All these paintings had just been completed when the young Hermann Vogelsang paid a visit to the School's director, Elie de Beaumont. (Musée de Minéralogie, ENSMP.)

on the island, a spectacular rock, which was the object of much discussion among the petrologists at the time.

Selecting this subject was probably not an innocent choice. The orbicular diorite of Corsica was then known in France – as it continues to be called by non-geologists today – under the name of 'napoléonite' and the local people consider it a symbol of the Napoleontic era.

We can surely assume that a part-time soldier of Bonn was already in a mood of revenge after the Napoleontic wars and preparing for the war that would burst out ten years later (1870). Scientifically speaking, the major question was to find out if the special features of the orbicular diorite deserved a special name – an idea favoured by the French – or if it was just a question of texture, not sufficient to justify a special name. On his way to Corsica, Vogelsang stopped in Paris to meet the great man of the time, Léonce Elie de Beaumont, newly installed in the brand new Hôtel de Vendôme, where the Ecole des Mines is still located today. Napoléon III was the new 'Empereur des Français' and France was then at the top of its industrial power, with a number of international exhibitions (1855, 1862 etc.) showing the world the beauties of science and the miracles of new techniques. In 1862, the monumental staircase of the Hôtel de Vendôme had just been decorated with magnificent paintings: the 'Allégorie de la Science' on the ceiling (Fig. 3), the 'Vue du Mont-Blanc' (first price at the 1855 International Exhibition) and other famous geological sites on the wall, together with magnificent panels of 'faux-bois' and 'faux-marbres', imitations of natural rocks slabs. Among these, the 'napoléonite' occupies a place of honour, painted from a sample exhibited at the International Exhibition of 1855 (Fig. 4).

Vogelsang must have seen then how important this rock was to the French. He was not impressed: neither by the dictatorial authority of Elie de Beaumont nor by the rock itself. Upon his return to Germany, he concluded that the special texture of the orbicular diorite was only a local phenomenon (very rightly, as it occurs only very sporadically in an otherwise homogeneous intrusion), and that it would by no means deserve a special name. This opinion has definitely prevailed in the international literature since then. It may not be a coincidence that, since the end of the nineteenth century, the Museum of the Paris Ecole des Mines has accumulated an amazing collection of rocks with orbicular textures, from a wide variety of rock types (granites to ultrabasic rocks) and provenances, which incidentally have never been the object of detailed studies.

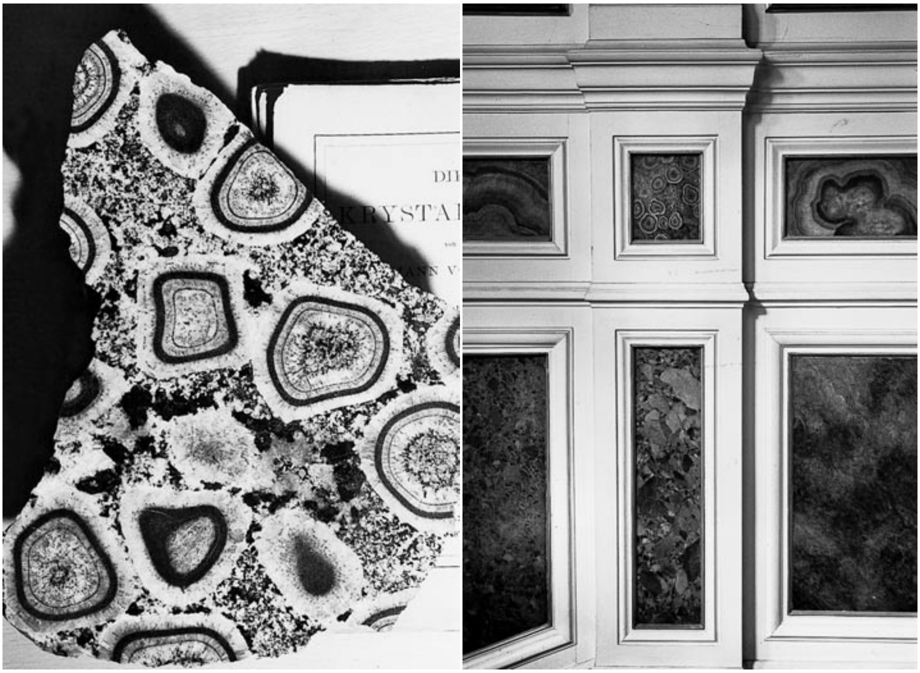


Figure 4 Sample of orbicular diorite ('Napoléonite'), exhibited at the International Exhibition of 1855 (first in Paris, second in the world) (left), which served as a model for the 'trompe l'oeil' wall painting in the staircase (right). (Collections Musée de Minéralogie, ENSMP.)

ZIRKEL AND SORBY, THE GREAT INSPIRATORS

The year 1862 would definitely become important in the life of Vogelsang. At Bonn University, he became a close friend of Zirkel who, together with H. Rosenbusch, would become a major figure of the golden era of the German descriptive mineralogy and petrography. Vogelsang married Zirkel's sister and he remained extremely close to him during all his life. Zirkel took care of the publication of his major work on crystallites after his death (Vogelsang, 1875). During their university years, both friends used to travel the countryside around Bonn to make geological observations and one day, by chance, they met Henry Clifton Sorby, who was travelling through the Rhine valley with his mother.

Sorby was a typical example of a British aristocrat, rich enough to carry out his scientific activities in his own office, but without any formal link to an established university or research centre. This position of distinguished amateur caused him immense resentment when, at the end of his life, he was denied the presidency of Sheffield College, which was, however, only known internationally because of him. As President of the British Geological Society, member of a number of academies and learned societies, he was well known for having introduced the microscope in mineralogical studies, as well as for having developed the technique of thin-section preparation.

This was a major technological breakthrough, which makes Sorby the founder and now recognised inventor of a number of scientific disciplines, such as microscopic petrology and structural geology, metallurgy and meteorite science. At the time, however, the idea of 'looking at mountains with a microscope' was received with much condescension and mockery by many of his established colleagues, notably Honorace Bénédict de Saussure. In the current petrographical literature, Sorby is dubbed as the father of inclusion studies (e.g. Roedder, 1984), but it must be recognised that his work was much more devoted to melt inclusions than to fluid inclusions (Fig. 4). A few drawings of fluid inclusions appear here and there, but – in marked contrast with his treatment of melt inclusions – without any attempt of explanation or interpretation. We might add 'fortunately', as the blind application of Sorby's principles of melt inclusion interpretation to fluid inclusions would later have dramatic effects on the development of fluid inclusion studies, leading in fact to their almost complete disappearance from petrology in the middle of the twentieth century (see discussion in Touret, 1984). With all his merits, Sorby is thus less the real 'father' of fluid inclusion studies than some of his contemporaries, among which, as argued hereafter, Vogelsang stands out as a most serious candidate.

Luckily, the young Zirkel and Vogelsang had a more open mind than De Saussure and both were impressed by Sorby to the point that this encounter had a decisive influence on the rest of their careers. Vogelsang would become an ardent defender of microscopic studies for the rest of his life, as illustrated by his detailed and magnificent drawings. He visited Sorby at Sheffield to learn how to make thin sections and later developed this technique at Delft so well that, at the time of his death, the thin-section collection at his university amounted to several thousand specimens, by far the most important collection worldwide in those days.

THE PRIZE COMPETITION OF THE HOLLANDSCHE MAATSCHAPPIJ DER WETENSCHAPPEN

In 1863, Vogelsang successfully defended his thesis at Bonn University (*Quomodo venarum spatia primum formata atque deinde mutata sint*, freely translated: How the space of the veins is first formed, then transformed). This work has not left much of a trace in the later literature, but was obviously found very satisfactory by his professors. In the same period, he travelled extensively through the Eifel, in order to answer a question posed in a prize competition organised by the Hollandsche Maatschappij der Wetenschappen in Haarlem. This society was a typical example of the learned societies, which flourished in the Netherlands during the eighteenth century, founded and supported by the establishment of wealthy bourgeois who had a marked interest in science and the arts. The Hollandsche Maatschappij, closely associated with Teyler's Museum, was established in a superb monumental building in the heart of the historical city of Haarlem (Wiechmann, 1987). The society still exists today, keeping the same tradition of collegial membership and complete independence of any form of state administration. During the short reign of Napoléon's brother, Louis-Napoléon, the society had superbly refused the offer of the king to become a national academy. Besides regular meetings and discussions among the members, one of the most important activities of the Maatschappij was the yearly 'prijsvraag', presenting an, at the time, important question to the whole international community.

In the framework of the great debate between followers of neptunism and plutonism, which would last during the major part of the nineteenth century, questions on the origin of volcanoes had a central role. Leopold von Buch, a former student of Werner, was convinced of the igneous origin of the volcanoes in Auvergne and became an ardent propagandist of the new theories. On May 28th, 1817, he presented before the Academy of Berlin a communication entitled *Ueber die Zusammensetzung der basaltischen Inseln und über Erhebungskratere*.

Under the name of 'Erhebungskratere', the idea that volcanic cones were uplifted by the rise of underlying magmas was enthusiastically adopted by some great geologists of the time, notably Alexander von Humboldt and Léonce Elie de Beaumont. If, to a point that today may sound rather strange, this theory was almost unanimously accepted for ancient volcanoes, critical comments were immediately issued concerning the formation of recent volcanoes. Especially Sir William Hamilton had made a number of precise observations in southern Italy, leading to the obvious conclusion that falling debris after an eruption caused the conic structure of a volcano.

In 1864, the question was still much debated and it was proposed for that year's 'prijsvraag'. Written in French, the language commonly spoken by educated people in Holland at the time, it read, 'Dans la contrée montagneuse de la rive gauche du Rhin, connue sous le nom de l'Eifel, on remarque plusieurs montagnes côniques. – La société désire voir décider par des recherches exactes faites sur les lieux mêmes, si l'on y trouve des traces de soulèvement des roches anciennes, ou bien si ces montagnes ne sont que des cônes d'éruptions'.

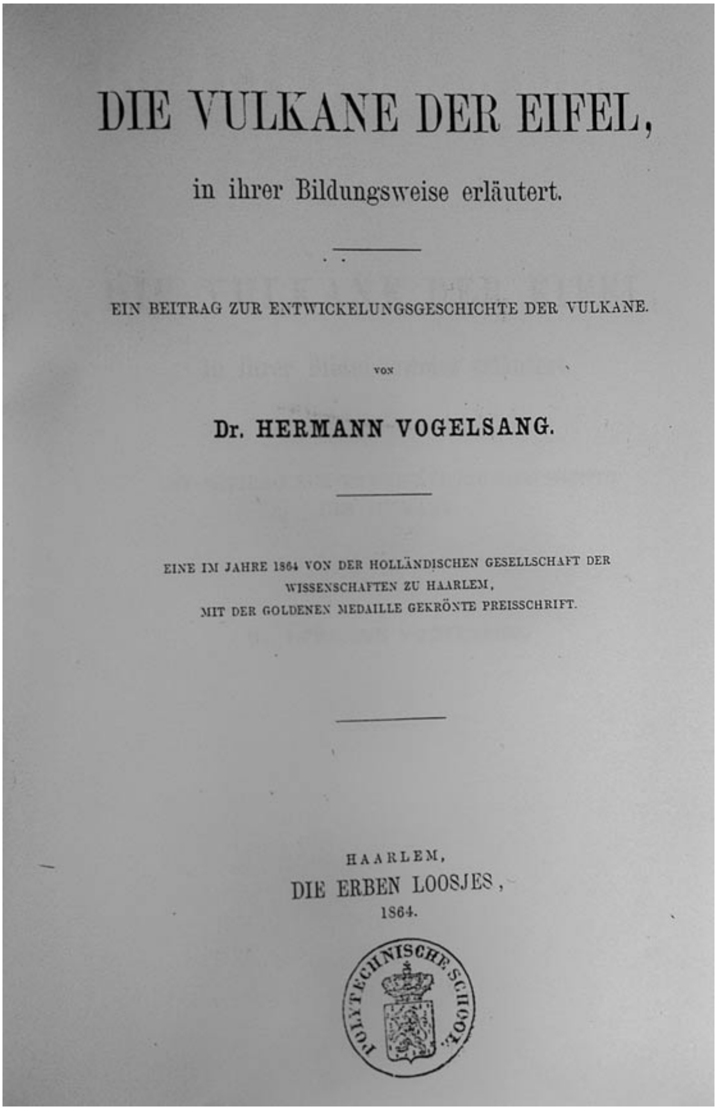
Vogelsang took the challenge very seriously and in few months' time made extremely detailed field studies, precisely mapping the most important volcanoes and, especially, the 'maars', which are so typical of the Eifel. His answer was very elaborate, in the form of a 76-page book divided into three parts: more than ten pages of historical introduction, which prefigures the later first part of his *Philosophie* and in which his preference for the British school is clear, followed by the description of the various volcanoes with associated sketch maps (about 30 pages), and a long conclusion, which constituted almost half of the entire book. This conclusion was written 'au fil de la plume', without any interruption and, to tell the truth, with a rather confusing internal organisation. However, the first statement is very clear, and it does directly respond to the 'prijsvraag', 'Erhebungskratere und Erhebungskegel gibt es in der Eifel nicht.' But might volcanoes indeed be eruption cones, corresponding to the alternative hypothesis proposed by the Society? Vogelsang, again after a long historical introduction, discussed in detail the mechanism of a volcanic eruption, relying extensively on his experience in underground mining. He showed that the fractures around a volcanic cone do not match the pattern found in underground blasting, and he concluded, very rightly, that most craters couldn't be due to simple explosions. This idea was commonly accepted as an alternative to uplift craters, but Vogelsang rather attributed the crater depression to the sinking of solidified lava in the void provoked by the eruption ('Einsenkungs-Kratere'). This interpretation later proved to be correct and it is evidence of a rare maturity and sense of observation for such a young man (Vogelsang wrote the essay at the age of 25).

The Maatschappij received three answers, but the quality of H. Vogelsang's work was so much above that of his two competitors that his was the only one taken into consideration. Understandably, the members of the Society must have been satisfied, as by the end of the same year (1864), his essay received the gold medal and was published in Haarlem by the house of Loosjes, the usual printers of the Hollandsche Maatschappij (Fig. 5).

A gold medal, a book printed: Vogelsang must have been happy. Nevertheless, the most important was still to come: in July 1864, at the age of 26 – as a matter of fact before having officially received his price – he was appointed as the first professor of mineralogy and petrology at the newly created Polytechnic School of Delft.

A BRIEF BUT BRIGHT CAREER IN THE NETHERLANDS

Hermann Vogelsang moved to Holland with his family and, even though he always kept in close contact with his home country, assimilated very rapidly in his new position. He quickly mastered the Dutch language and was obviously



DIE VULKANE DER EIFEL,

in ihrer Bildungsweise erläutert.

EIN BEITRAG ZUR ENTWICKELUNGSGESCHICHTE DER VULKANE.

VON

Dr. HERMANN VOGELSANG.

EINE IM JAHRE 1864 VON DER HOLLÄNDISCHEN GESELLSCHAFT DER WISSENSCHAFTEN ZU HAARLEM, MIT DER GOLDENEN MEDAILLE GEKRÖNTE PREISSCHRIFT.

HAARLEM,
DIE ERBEN LOOSJES,
1864.

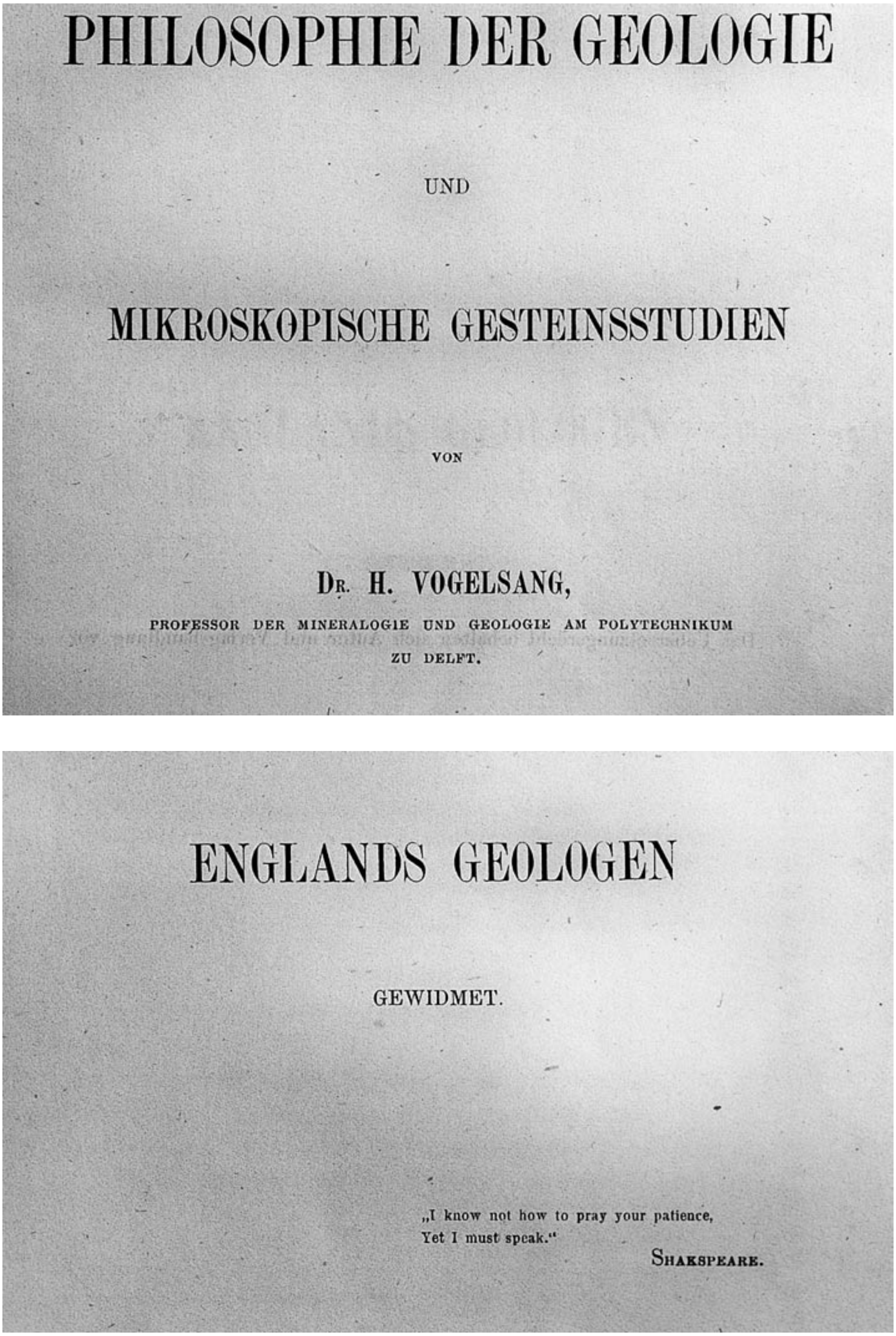
Figure 5 Front page of *Die Vulkane der Eifel*, the printed answer of H. Vogelsang to the ‘Prijsvraag’ of the ‘Hollandsche Maatschappij der Wetenschappen’ in Haarlem.

an extremely good teacher, praised and admired by students who were only few years younger than he. He could also count on dedicated technical staff, who helped him develop his extensive collection of rock thin sections. Most of his work was related to microscopic studies, but he also tried to analyse some of the objects that he saw under the microscope, notably fluid inclusions (see hereafter) – and succeeded. His skillful technician Theodore Geisler assisted him with this and he had the integrity to include Geisler in his publications systematically. These intense teaching and organisational activities did not delay the writing of a major book, the *Philosophie der Geologie*, which was published in Bonn in 1867, the year of his election as member of the Hollandsche Maatschappij. One year later, he became a member of the Koninklijke Nederlandsche Academie van Wetenschappen in Amsterdam.

PHILOSOPHIE DER GEOLOGIE

The *Philosophie* is a very interesting book and still very readable today. The front page (Fig. 6), with a quotation from Shakspeare (sic) 'I know not how to pray your patience, Yet I must speak', is a clear homage to Sorby and his countrymen, 'Englands Geologen gewidmet' (Dedicated to the geologists of England). The book is divided in two parts, of which the first one is an historical account of the development of geology as a science, whereas the second one ('Moderne Geologie-Mikroskopische Gesteinstudien') is entirely devoted to microscopical description of rock thin sections. Polarised light was known, particularly through the work of Brewster and Nicol, but not the power of this mode of observation in the interpretation of the mineral structure. At that time, the observers were mostly impressed by the vivid polarisation colours that Vogelsang reproduced superbly in a number of colour plates (not less than twenty in total for the whole book) (Fig. 2).

The scientific content is more difficult to grasp. The book was written during the last phase of the Werner-Hutton controversy and Vogelsang, educated in the Werner system but converted to the Huttonian views, was only interested in volcanic rocks, a direct continuation of his field experience in the Eifel. His major interests focussed on two subjects: the small elongated crystals that he called 'Mikroliten' and that indicated a fluidal texture in solidified magmas, and – in the direct continuation of Sorby's famous paper of 1858 – the melt and fluid inclusions contained in some rock-forming minerals, notably quartz and feldspar (Fig. 7). These two topics would continue to dominate his research activities for the rest of his life: the inclusions, for which he would soon develop extremely effective analytical instruments, and the 'Kristalliten', were the subject of his second (and last) book (Fig. 8 and 9).



PHILOSOPHIE DER GEOLOGIE

UND

MIKROSKOPISCHE GESTEINSSTUDIEN

VON

DR. H. VOGELSANG,

PROFESSOR DER MINERALOGIE UND GEOLOGIE AM POLYTECHNIKUM
ZU DELFT.

ENGLANDS GEOLOGEN

GEWIDMET.

„I know not how to pray your patience,
Yet I must speak.“

SHAKSPEARE.

Figure 6 Title page of the *Philosophie der Geologie*. Below the back of this page with the dedication to England's geologists.

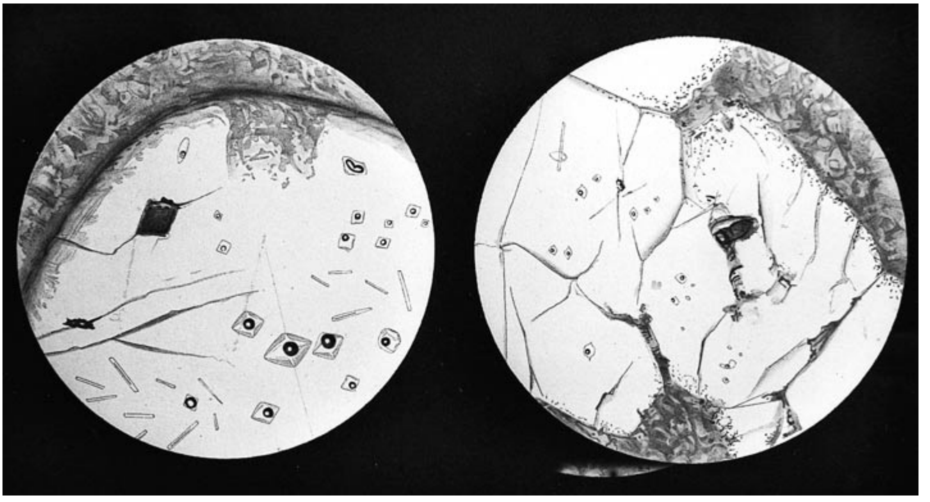


Figure 7 Drawings of melt inclusions from the *Philosophie der Geologie* (Tafel X). Left, porphyry (quartz trachyte?) from Cima di Potosi in Bolivia. Right, red porphyry from Halle, Germany. The different magnifications (left 300, right 100) have been chosen to illustrate the shape of individual inclusions (negative crystals, left) and right the relationships between the inclusions and their quartz crystal host.

However, the first part of the *Philosophie*, on the definition and historical development of geology, is not less interesting. Devoted to an elaborate discussion of the historical development of the geological sciences, it displays a rare maturity and freedom of style for a young man of 26 years. It should be acknowledged that, by today's standards, the text is often too compact, badly organised, with diversions that may hinder the prime objectives of the author. Vogelsang wrote from the heart, and his heart could be quite tough. His opinions are direct, straightforward, with strong words against dogmatism and the suffocating influence of some grand old men of the time. Most of the discussions relate to the disputes between neptunism and plutonism, with a clear preference for the second theory, even if the historical importance of Werner and the validity of some of his conceptions for the art of mining are fully recognised. The most acute criticisms are against the French authority figures of the time, notably Elie de Beaumont, as well as some of his German countrymen, especially A. von Humboldt, who was far too 'francophile' in his eyes. A few excerpts of the book may give an idea of the tone.

About Elie de Beaumont and the theory of 'Erhebungskratere':

p. 88: 'Endlich wird jede Insel, jeder Berg zum mehr or minder Hebungskrater, und schliesslich thut Elie de Beaumont seinem Freunde den Gefallen, den Gedanken zu einem geologisch-mathematischen Chaos zu verarbeiten, vor welchem sich die ganze Welt bekreuzte,- ob der grossen Gelehrsamkeit. Die französische Schule is aus Bewunderung ernstlich krank davon geworden'. (At the end, every island and every mountain becomes an uplift crater to some degree and finally, Elie de Beaumont does his friends the pleasure of working out this idea into a geological-mathematical chaos, for which the entire world should cross itself, in view of its great knowledgeability. As a result of admiration, the French school has become seriously ill.)

About A. Von Humboldt ('ein hochgebildeter, vielvermögender und vielbewirkender Dilettant, viel weniger Geologe als L. von Buch') (a highly educated, very competent and accomplished dillettante, much less of a geologist than L. von Buch):

p. 91: 'So lange der unwürdige, frasenhafte Humboldtcultus fortdauert, wirdt man erwarten müssen dass von böswillige Händen diesem wahrhaft grossen Menschen der reich verdiente Lorbeer frevelhaft entrissen und zertreten werde. Die Naturwissenschaft fordert nun einmal demokratische Institutionen. Keine Monarchen, keine Thronreden, keine gesetzgebende Körper, aber auch keine bombastischen Huldigungadressen. Die absichtliche Verkleinerung is schändlich, die maasslose Vergötterung ist gemein'.
(As long as the unworthy, bombastic Humboldt cult continues, one will have to wait until malevolent hands will grab away and trample the well-deserved laurels of this truly great man. Science needs, after all, democratic institutions. No kings, no inaugural speeches, yet neither bombastic honorary speeches. The horrible diminution is a disgrace, the unlimited idolisation is mean.)

p. 93: 'Was soll man aber zu solchen Grundzügen sagen, die bereits nach 43 Jahren von keinem verständigen Geologen mehr zu Ende gelesen werden können? So oft ich daran denke, freue ich mich, dass das Buch französisch geschrieben ist. Schwülstige Sprache und nebliche Begriffe, aber kein einziger verständiger Gedanken'.
(However, what should one say about such principles, which already after 43 years no geologist can read to the end. Each time I think of this, I am pleased that the book was written in French. Bombastic language and vague ideas, yet not a single sensible thought.)

The same type of discussion continues for at least ten pages. Vogelsang especially addresses his criticisms at some views defended by Elie de Beaumont, particularly his theory of a universal 'réseau pentagonal'. The idea was that contraction of the earth upon secular cooling would result in mountain chains oriented along certain directions, forming a pentagonal grid on the surface of the globe. During his many travels through many countries, Elie de Beaumont had claimed to have actually measured these orientations, transposed on elaborate models of the Earth by his disciples, such as Béguyer de Chamcourtois. A number of geologists knew that these data did not reflect reality, but very few had the courage to say it openly as long as the powerful secrétaire perpétuel of the Académie des Sciences (Elie de Beaumont) remained active.

THE DISCOVERY OF CO_2 IN FLUID INCLUSIONS

Besides his *Philosophie*, the great achievement of Vogelsang during his Delft period was the identification of a mysterious fluid 'with remarkable physical properties' found by D. Brewster in 1823. One year earlier, Davy (1822) had identified 'water and aeriform matter in cavities of certain crystals', but the nature of this aeriform matter, was to remain a mystery for almost half a century. Brewster, with remarkable technical skills, refined the determination of the physical properties of the mysterious fluid: a refractive index found to be significantly lower than that for pure water, and especially, an expansion coefficient of the liquid at moderate temperatures, found to be equal to 0,01497 / °C in the temperature interval of 10.6 to 26.7ºC (Brewster, 1826) (This amazing precision, as well as for the refractive index, is correct to the second decimal!). In 1835, a French physicist, J. Thilorier, investigated physical phase changes in pure CO_2, and found the expansion coefficient of liquid CO_2 to be equal to 0.015 / °C in the temperature interval of 0 to 30°C. More than twenty years would elapse before R.T. Simler (1858) noted the very close match between the values found by Brewster and Thilorier and proposed that the 'fluide aeriforme' of Davy might be CO_2. But he did not provide any confirmation and most scientists remained extremely sceptical.

Upon his arrival in Delft, Vogelsang re-attacked the problem in a systematic manner. With the technical help of T. Geisler, he imagined a very simple and effective model of heating stage, a simple thermometer with an annullar reservoir, heated by an electric resistance. Basically, the same set-up is still used today in microthermometry, which allowed much more precise and systematic measurements than done by Sorby and Brewster. In quartz of unknown origin (most probably Madagascar), he discovered a large amount of relatively small (a few tens of micrometers in diameter) and relatively dark inclusions, each showing spectacular 'negative crystal' shapes, and a gas bubble ('libelle'), the size of which rapidly decreased until it disappeared upon heating to 30-32°C. The expansion coefficients were of the same order of magnitude as those measured by Brewster and Thilorier, with, however, significant differences that Vogelsang attributed to measurement errors. In fact, we now know that another factor intervened, the fluid density, which might explain these differences and which is far more important than Vogelsang had supposed: very dense CO_2 may homogenise at as low temperatures as about -70°C (Touret and Bottinga, 1979).

In any case, the similarities between the fluid in quartz and CO_2 were such, that Vogelsang thought that the hypothesis of Simler might well be correct. But proof needed to be found, and again it relied on the construction of a simple, ingenious and efficient instrumental device: a small glass vessel, connected to a vacuum pump by a tube traversed by two electrical conductive wires, in turn connected to an electric generator.

A few fragments of quartz containing inclusions were placed in the glass vessel and the air was evacuated. The vessel was then heated by a gas flame, provoking the explosion (decrepitation) of inclusions and the expansion of the gas contained in inclusions in the glass tube. A high-intensity electric current in the tube would cause an electric arc, the light of which could be analysed spectrographically. Vogelsang found a very strong line corresponding to pure CO_2, together with a weak line for hydrogen (known now to be due to a small quantity of water, decomposed by the electric arc). In any case, the proof was there: the mysterious fluid of Davy and Brewster is dense CO_2.

The experimental setting conceived by Vogelsang and Geisler looks surprisingly modern, and as a matter of fact could be used today without major modifications. Only, today, most 'decrepitation lines' combine stepwise heating and crushing under vacuum. The results (including a few erroneous interpretations, notably on the complicated 'three-fluid phase' inclusions found in certain topaz crystals) were published simultaneously (1869) in German ('Über die Natur der Flüssigkeitseinschlüsse in gewissen Mineralien') in *Poggendorff's Annalen*, and in French ('Sur la nature des liquides renfermés dans certains minéraux') in the *Archives Néerlandaises des Sciences exactes & naturelles*, the scientific journal of the Hollandsche Maatschappij. As it happened, the German publication, the only one that survived in the international literature, was divided into two parts, published in the same issue of the *Annalen*. The second part was omitted in further references, and remained ignored until a few years ago (Touret, 1982, 1984). Only then it was discovered that Vogelsang had already described CO_2 inclusions in Saxonian granulites, rediscovered at a global scale more than hundred years later (Touret, 1971).

Unfortunately, the premature death of Vogelsang did not leave him time to elaborate on his important discovery, and his 1858 publication remained the only one of its kind. It must also be recognised that Vogelsang's further interests went into other directions, particularly concerning the systematic

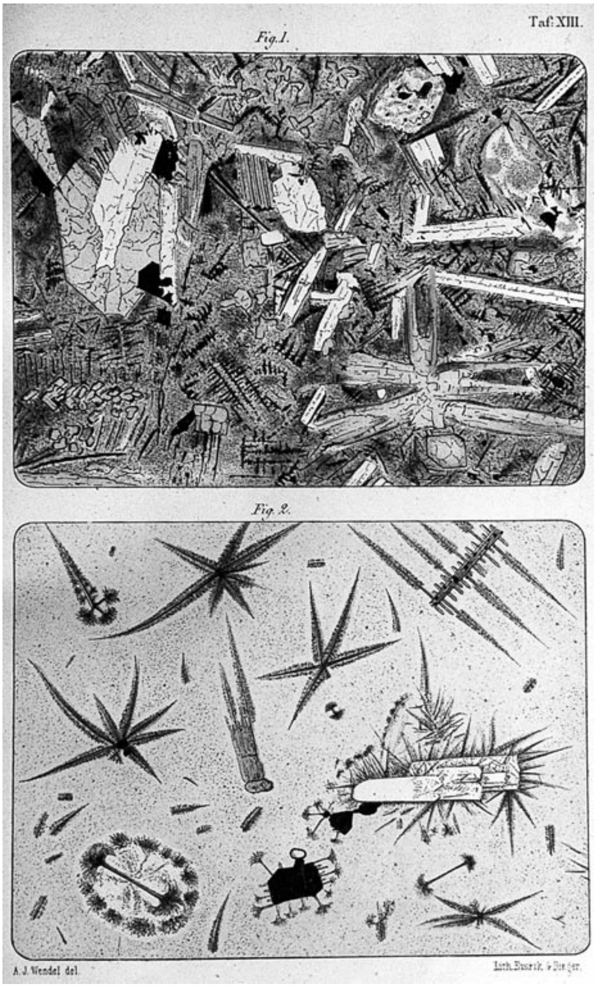


Figure 8: Examples of crystallites in natural rocks (Vogelsang 1875, Tafel XIII). As Sorby did for melt inclusions, Vogelsang interpreted the crystallites in effusive lavas by comparison with metallurgical slags. The drawings refer to the basalt of Podlie-Craig near North-Berwick, Scotland (above) and to the pechstein of Tormore on Aran, Ireland (below).

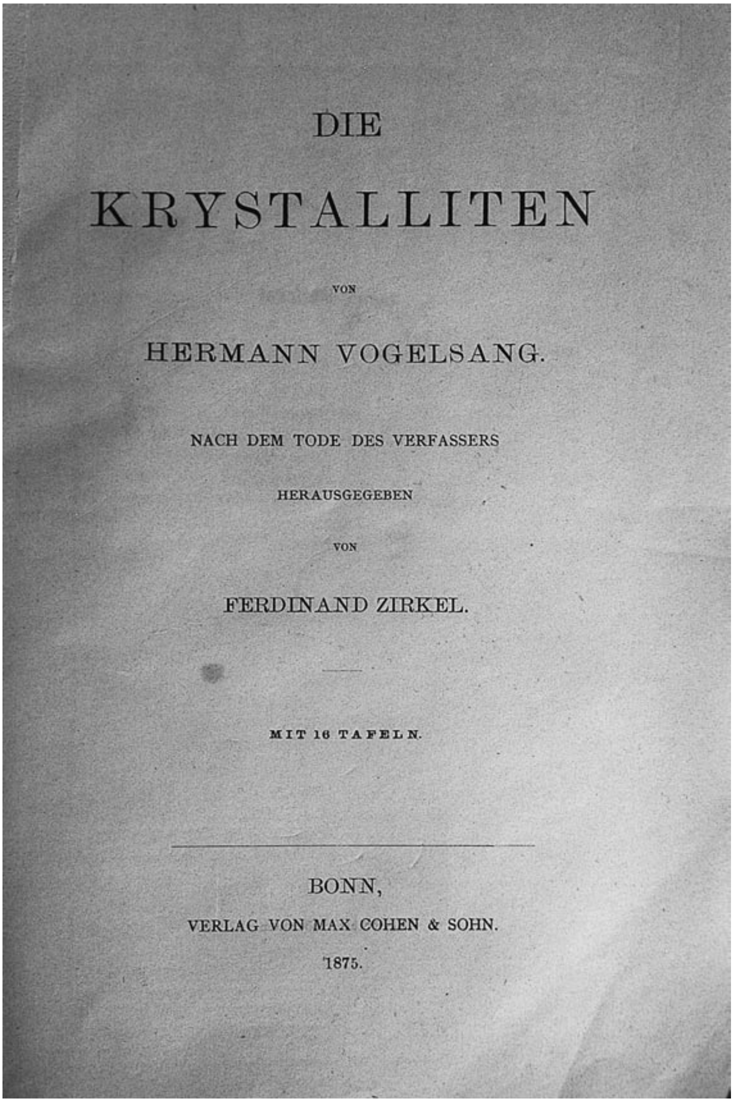
study of the shapes and mode of formation of crystallites, as well as on the iridescence effects shown by certain minerals, notably plagioclase. These works, partly published after his death (Vogelsang, 1875), are interesting, but as a whole less significant than his work on fluid inclusions. For this latter achievement, Vogelsang deserves to be recognised as the modern initiator of fluid inclusion studies, at the same level as H.C. Sorby for melt inclusions.

A DRAMATIC END

Vogelsang had only a few years of happiness in Delft. The French-Prussian war took place in 1870, and it is possible that the former soldier at Bonn derived some satisfaction from the fall of Napoléon III, even though there is no indication of this. He soon ran into a number of problems, which ended in a real drama. During the first half of the nineteenth century, the gold rush in California had led to intense speculation in precious metals. The gold rush ceased rapidly, but was followed by a silver rush where lucky strikes were much more rare than great losses. An American adventurer came to the Netherlands, and he was convincing enough to persuade a number of Dutch investors to create a mining company ('Nederland'), which first bought a small silver mine in California, and then the larger Cariboo mine in Canada. In both cases, Vogelsang was taken aboard as the national expert and, remembering his former experience of 'Bergexpectant' in the region of Bonn, he gave the green light for buying the mines. However, the profits were much less than expected, covering only one tenth of the huge investment during the first year of exploitation. By present-day mining standards, this would probably be considered acceptable, but it was far below the expectations of the investors. The relationship of Vogelsang with the group of investors deteriorated, and he had to resign abruptly. In addition to these professional problems, he had to face the tragic and premature death of his only child. This was too much for his fragile constitution and the recurrent lung problems of his family. After a short illness, he died of pleuritis in the winter of 1874. Very shortly after his death, his book on 'Krystallite' (crystallites) was published, again in Bonn, thanks to the efforts of his brother in law, Zirkel (Fig. 9).

VOGELSANG'S HERITAGE

The tragic and premature death of Vogelsang severely affected the young school of Delft. In a few years, he had succeeded in creating a major research centre and in building a thin-section collection that, as said before, had no equivalent in the world. The tone of his obituaries, notably those written in the local student journals, shows how much he had been appreciated and how much his death was regretted. His reputation, at least at his university, had not been affected by the Cariboo affair. Unfortunately, his successors failed to maintain his standard and the Delft Polytechnic slowly lost its reputation in geology. When some twenty years later, the future founder of the Dutch Geological Survey, Willem van Waterschoot van der Gracht – born in 1873, one year before Vogelsang's death – decided to study mining geology, he



DIE

KRYSTALLITEN

VON

HERMANN VOGELSANG.

NACH DEM TODE DES VERFASSERS

HERAUSGEGEBEN

VON

FERDINAND ZIRKEL.

MIT 16 TAFELN.

BONN,

VERLAG VON MAX COHEN & SOHN.

1875.

Figure 9 Title page of the posthumously published *Die Krystalliten* (1875).

had to go to Freiberg, where he obtained his title of 'Diplom Ingenieur mit Auszeichnung' in 1903. Only after the First World War would the Polytechnic, later University of Delft, again reached the level of excellence that it still has today.

The influence of Vogelsang on science continued, especially within the monumental works written by the two great men of the German descriptive petrography, F. Zirkel and H. Rosenbusch. Both were esteemed colleagues but also direct competitors and their paths would soon diverge. Zirkel, who succeeded Carl Friedrich Naumann in 1870 in the chair of Leipzig, concentrated on the crystallography and the description of mineral species (Zirkel, 1873). Rosenbusch was more of a petrologist, and highly interested in mineral microscopical investigations for the determination of rocks. In this respect, he appears to be have been closer to Vogelsang, whose influence can be traced easily in his works. Rosenbusch's major book, still a reference work in descriptive magmatic petrology today, is the *Mikroskopische Physiographie der Mineralien und Gesteine*, which counted five editions between 1873 and 1924, almost quadrupling in size and number of pages between the first and the last edition.

In the first edition (1873), the first part (Band 1), devoted to the general properties of rock-forming minerals, contained three parts: Morphological (I), Physical (II) and Chemical (III) properties. In the later editions, Parts I and III remained roughly unchanged, but Part II, which includes the whole theory of polarised light, evolved from less than 50 pages in the first edition to 122 pages in editions 2 and 3 (1885-1887), 309 pages in edition 4 (1905, with E.A. Wulfing) and 728 pages in the last edition (1924, E.A. Wulfing-O. Mugge). At the same time, the general organisation changed. The second part (in the first editions) became the first part in editions 4 and 5, whereas the former part I is rejected at the end of the volume. Still, it remained practically unchanged through the different versions, dealing only with two topics, 'Kristallite und Einschlüsse' (crystallites and inclusions), which came almost word for word from Vogelsang's work. Each of the various aspects, namely the crystallite classification, the principles and methods of inclusion study, examples and case studies can be found in one of the two Vogelsang books. Rosenbusch's successors would not maintain this tradition. They would go a step further, not pushing this aspect of petrological studies to the very end of their introductory text, but ignoring it completely. A long 'traversée du désert' for inclusion studies, which would last for almost half a century. Nowadays, with the endless analytical possibilities of modern instruments, melt and fluid inclusion studies are among the most rapidly developing fields of mineralogy, petrology and geochemistry. From his central position in the Netherlands, Vogelsang succeeded masterly in bridging two schools: the highly specialised, technically inspired English (and Scottish) geologists, such as Sorby, Brewster and Nicol, and the encyclopaedic German masters of descriptive mineralogy and petrology. In this sense, he was a real European, a good century ahead of his time.

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