Swedish Contributions to the Discovery of Platinum

THE RESEARCHES OF SCHEFFER AND BERGMAN

By L. B. Hunt

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Two major contributions to the discovery of platinum and its identification as a distinct metal were made by Swedish chemists during a short span of years in the eighteenth century when chemistry and metallurgy were flourishing and when several other new elements were isolated and their properties determined.

For fifty years, from the end of a disastrous series of wars and the conclusion of a peace treaty with Russia in 1721 until a *coup d'état* by King Gustav III in 1772, Sweden enjoyed a period not only of peace and parliamentary government, known as The Era of Liberty, but also of most fruitful activity in chemistry and metallurgy (1). A country rich in minerals, it also produced a number of distinguished scientists anxious to study these deposits and to identify the metallic elements they contained.

Beginning with Georg Brandt (1694–1768), the list includes Johann Gottschalk Wallerius (1709–1785), Henrik Theophil Scheffer (1710-1759), Axel Fredrik Cronstedt (1722–1765), Torbern Olof Bergman (1735–1784), Karl Wilhelm Scheele (1742–1786) and Johann Gottlieb Gahn (1745–1818), all extremely well known for their contributions to early metallurgical science.

Brandt studied under Boerhaave in Leyden and on his return to Sweden in 1727 he was given charge of the laboratory of the Royal College of Mining in Stockholm and three years later was appointed Warden of the Royal Mint where his assistants included both Scheffer and Cronstedt. In 1733 Brandt discovered cobalt and carried out a systematic investigation of arsenic and its compounds; in 1751 Cronstedt discovered nickel in a mineral from a cobalt mine, while Scheffer, in the same year, made a major contribution to our early knowledge of platinum.

H. T. Scheffer studied at the University of Uppsala, where he learnt mathematics from Anders Celsius, but as there was then no course available in chemistry he entered the Mining College, where his father was secretary, at the age of twenty-one and became one of Brandt's most enthusiastic pupils. He also established a private laboratory for analytical work. For ten years from 1739 he was managing a mine and a metal works producing copper and a little gold but the enterprise did not succeed and in 1749 he returned to Stockholm to work in the Mining College and also as an assayer at the Mint, while he also gave lectures in chemistry. He was elected a member of the Royal Swedish Academy of Sciences in 1746 and published a number of papers in their transactions. By far the most important of these, however, was his contribution to the discovery of platinum in 1751.

The sequence of events that led to this classical work is somewhat complicated, but it stemmed from a report by Don Antonio de Ulloa (1716–1795), a Spanish mathematician, astronomer and naval officer who took part in a French expedition in 1736 to Quito in Ecuador to measure the arc of a meridian at the equator in order to establish whether or not the earth was an oblate spheroid. After a number of years

Don Antonio de Ulloa
1716–1795

The Spanish astronomer and mathematician who was a member of a French expedition to Ecuador and whose journal of his voyage, published in 1748, contained a reference to the existence of a new metal, platinum, which quickly aroused the interest of chemists in Europe. In 1751 he visited Stockholm, was elected to the Swedish Academy of Sciences and may well have discussed platinum with Scheffer

in South America the expedition set out on their return journey, sailing round Cape Horn. North of the Azores their ship was captured by an English privateer but managed to escape, only to be seized by a British naval vessel when they reached Louisbourg in Nova Scotia in August 1745. Ulloa and his companions were imprisoned and conveyed to London, where all his papers were confiscated by the Admiralty. However, he was befriended by Martin Folkes, then President of the Royal Society, and by William Watson, who was himself to play a major part in the discovery of platinum. Ulloa was elected a Fellow of the Royal Society in 1746, had his papers restored to him, and in the same year was allowed to return to Spain. Here, with a colleague, Don Jorge Juan, he compiled an account of the expedition, published in Spanish in 1748 (2) and soon translated into several other languages. A dozen copies were sent to members of the Royal Society in London, and undoubtedly copies were sent to scientists in other European countries.

It was in this book that a reference was made to platinum:

> "In the district of Choco are many mines of lavadero or wash gold, like those we have just described. There are also some where mercury must be used, the gold being enveloped in other metallic bodies, stones and bitumens. Several of the mines have been abandoned on account of the platina, a substance of such resistance, that, when struck on a anvil of steel, it is not easy to be separated; nor is it calcinable; so that the metal enclosed within this obdurate body, could only be extracted with infinite labour and charge."

It has often been stated that Ulloa brought home to Madrid a sample of platinum, but there is no real evidence for this. Some large samples were, however, brought to England in 1741 by Charles Wood, the son of William Wood, famous for his copper coinage, who had spent some years in Jamaica, first supervising a lead mine and then as Assay Master to the government. He came across some samples of the platina, or "little silver" that was causing trouble to the gold miners in the Choco district and undertook a preliminary examination of them. He found that the metal was present as small white grains in a black magnetic sand and that it could be melted only after mixing with more readily fusible metals such as copper or

tin. Wood also tried cupellation with lead and found that it remained unaltered and also that it was not attacked by nitric acid. On retiring from his appointment in 1741 he returned to England, re-entered his family business by setting up a forge near Whitehaven in the Lake District, and here he met Dr. William Brownrigg, a physician and scientist who was elected a Fellow of the Royal Society in the following year (3).

Not until 1749 however—and again possibly arising from the publication of Ulloa's report—did Wood and Brownrigg decide to present the samples to the Royal Society, and that Brownrigg should report on Wood's experimental findings and give his own views on the material (4). William Watson, a friend of Brownrigg's and a Fellow of the Society, was asked to undertake the presentation, and this he did by reading Brownrigg's letter on December 13th, 1750. He followed this with a short paper of his own in which he referred to

> "our worthy Brother Don Antonio d'Ulloa, who in the History of his Voyage to South America, Vol II, Book 6, Chap 10 which I have here extracted and translated from the Spanish." (5)

XII. *Several* Papers *concerning a new* Semi-Metal, *called* Platina; *communicated to the* Royal Society *by Mr.* Wm. Watſon *F. R. S.*

I.

Extract of a Letter from William Brownrigg *M. D. F. R. S. to* Wm. Watſon *F. R. S.*

Dear Sir, *Whitehaven, Dec. 5, 1750.*

Read Dec. 13, 1750. I TAKE the Freedom to incloſe to you an Account of a Semi-metal call'd *Platina di Pinto*; which, ſo far as I know, hath not been taken notice of by any Writer on Minerals. Mr. *Hill*, who is one of the moſt modern, makes no mention of it. Preſuming therefore that the Subject is new, I requeſt the Favour of you to lay this Account before the *Royal Society*, to be by them read and publiſhed, if they think it deſerving thoſe Honours. I ſhould ſooner have publiſhed this Account, but waited, in hopes of finding Leiſure to make further Experiments on this Body with ſulphureous and other Cements; alſo with Mercury, and ſeveral corroſive *Menſtrua*. But theſe Experiments I ſhall now defer, until I learn how the above is receiv'd. The Experiments which I have related were ſeveral of them made by a Friend, whoſe Exactneſs

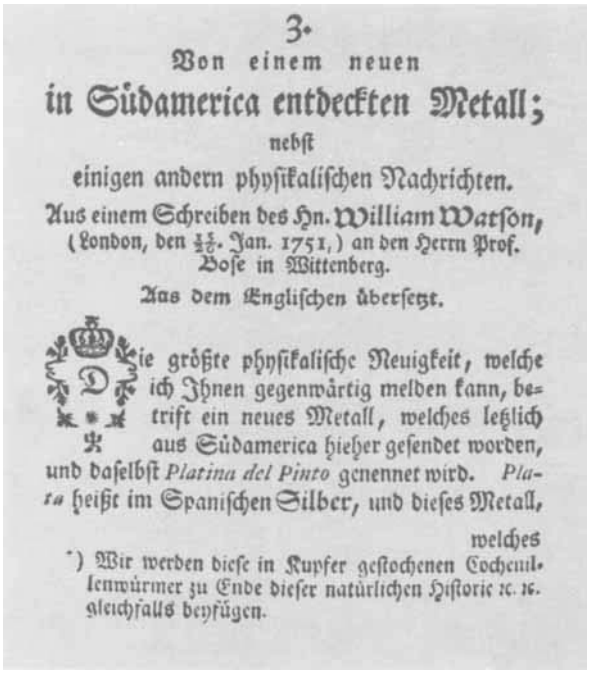
1

The first page of the letter from Dr William Brownrigg, read to the Royal Society by William Watson on December 13th, 1750, describing his and Charles Wood's experiments on platinum

In the following January Watson wrote an informative letter to his friend Georg Matthias Bose, Professor of Natural Philosophy at the University of Wittenberg, with whom he had been in constant correspondence on the new subject of static electricity. Bose immediately published the letter in German in the first number of a journal on popular science, *Physikalische Belustigungen*, just established by Christopher Mylius (6). A second letter from Watson followed in May of the same year in which Watson apologised for the delay in answering Bose's letter of acknowledgement of

Sir William Watson
1715–1787

The English physician and scientist, well known for his researches on electrical phenomena, whom William Brownrigg chose to present his findings on platinum to the Royal Society



3.

Von einem neuen

in Südamerica entdeckten Metall;

nebſt

einigen andern phyſikaliſchen Nachrichten.

Aus einem Schreiben des Hn. William Watſon, (London, den 1/12. Jan. 1751,) an den Herrn Prof. Boſe in Wittenberg.

Aus dem Engliſchen überſetzt.

Die größte phyſikaliſche Neuigkeit, welche ich Ihnen gegenwärtig melden kann, betrift ein neues Metall, welches letzlich aus Südamerica hieher geſendet worden, und daſelbſt *Platina del Pinto* genennet wird. *Plata* heißt im Spaniſchen Silber, und dieſes Metall, welches

*) Wir werden dieſe in Kupfer geſtochenen Cochenillenwürmer zu Ende dieſer natürlichen Hiſtorie ꝛc. ꝛc. gleichfalls beyfügen.

The opening of Watson's first letter to Professor G. M. Bose of Wittenberg in January 1751 in which he gives an account of Wood and Brownrigg's investigations on platinum. This letter, and a second one four months later, also served to stimulate interest among chemists throughout Europe

February 20th occasioned by the death of the Prince of Wales (Frederick, elder son of George II, a most popular prince, had died of pneumonia on March 31st at the early age of forty-four) and in which he gave more details on platinum and referred to Ulloa's published work.

These two letters aroused great interest among chemists throughout Europe and almost certainly prompted Scheffer to undertake a more detailed examination of some specimens he had been given by Ulric Rudensköld, then President of the Swedish Academy of Sciences. Rudensköld had spent the years from 1740 to 1744 in the Swedish embassy in Madrid and must have been acquainted with many people in influential positions in Spain.

Now Don Antonio de Ulloa, after his adventures and his return to Madrid, had been commissioned by King Ferdinand VI to undertake a mission throughout Europe to study scientific developments and in the autumn of 1751 he was for some weeks in Stockholm (7). Here he was welcomed by the Swedish scientists and, at a meeting of the Academy on October 12th, he was proposed for membership by the secretary, Pehr Wilhelm Wargentin, also an astronomer and mathematician who would have known of Ulloa's work, and duly elected (7).

Whether or not he met Scheffer and discussed platinum with him is not known, but it is most likely that, in seeking out those who could advise him on science and industry among the small number of scientists in Stockholm, such a meeting took place. (There were only sixteen members present at the meeting which elected Ulloa.)

Scheffer's Two Papers

However that may be, Scheffer, undoubtedly prompted by Ulloa or Bose or possibly both, very soon produced a paper for the Academy, submitted on November 19th and read on the 28th, with the title "The White Gold or Seventh Metal, called in Spain 'Platina del Pinto', Little Silver of Pinto, Its Nature Described" (8). In this he records that in June 1750 he received from Rudensköld a sandy specimen containing "flat triangular scales, white as silver" that were not attracted by a magnet, that the sample had been obtained from Spain and that he understood it came from the West Indies. After removing the sandy content he was left with only forty grains of a metallic nature; these he found could be melted readily with copper, that they were not attacked by sulphuric or nitric acid but dissolved in aqua

regia, while with the addition of a small amount of arsenic the material melted easily. (His choice of arsenic must surely have occurred to him from the work of his master, Georg Brandt, on this element). His conclusions were:

> "1. That this is a metal hard but malleable, but of the hardness of malleable iron.
>
> 2. That it is a precious metal of durability like gold and silver.
>
> 3. That it is not any of the six old metals; since first it is wholly and entirely a precious metal, containing nothing of copper, tin, lead, or iron because it allows nothing to be taken from it. It is not silver, nor is it gold; but it is a seventh metal among those which are known up to now in all lands."

Finally he recommended that:

> "This metal is the most suitable of all to make telescope mirrors because it resists as well as gold the vapours of the air; it is very heavy, very dense, colourless and much heavier than ordinary gold, which is rendered unsuitable for this particular use by lacking these two latter properties".

This was the first accurate examination of platinum, carried out on an extremely small quantity, but immediately afterwards, and also dated November 28th, 1751, Scheffer read a short paper to the Academy "An Addendum on the Same Metal" (9), in which he refers to another sample of material that he had received from Brandt, who had also had it from Rudensköld. In this supplementary communication he reported that the metal, unlike gold, was not precipitated from solution in aqua regia by ferrous sulphate, but that it was precipitated by alkalies and by ammonia in the form of a red powder.

Scheffer was raised to the nobility in 1756, but sadly he died three years later at the age of only forty-nine. A long appreciation of his life and work was read to the Academy of Sciences on September 17th by his younger colleague Cronstedt, in the course of which he declaimed:

> "In his time a new metal happened to be discovered which had evidently not been found in two thousand years, and it was most fitting that the first investigation of such a rare substance should fall to this man who was worthy of it.
>
> Your literary Member, Herr Rudensköld, brought this honour to him and to us; for no sooner had Mr Watson in London let Herr Bose in Wittemberg known that something resembling a metal of unknown properties had been brought over from America under the name of *Platina di Pinto*, than Herr Rudensköld arranged to get some of it through his acquaintances in Spain.
>
> The little bit that came he handed over to Scheffer, who, driven by his customary zeal, soon solved the mystery of its nature and showed in a paper that it was a peculiar metal different from all others, almost infusible when alone, just as noble as gold and less pliable."

Cronstedt had worked closely with Scheffer from some years and must have been well aware

Det hvita Gullet, eller ſjunde Metallen, kalladt i Spanien, Platina del Pinto, *Pintos ſmå Silfver, beſkrifvit til ſin natur*

Af

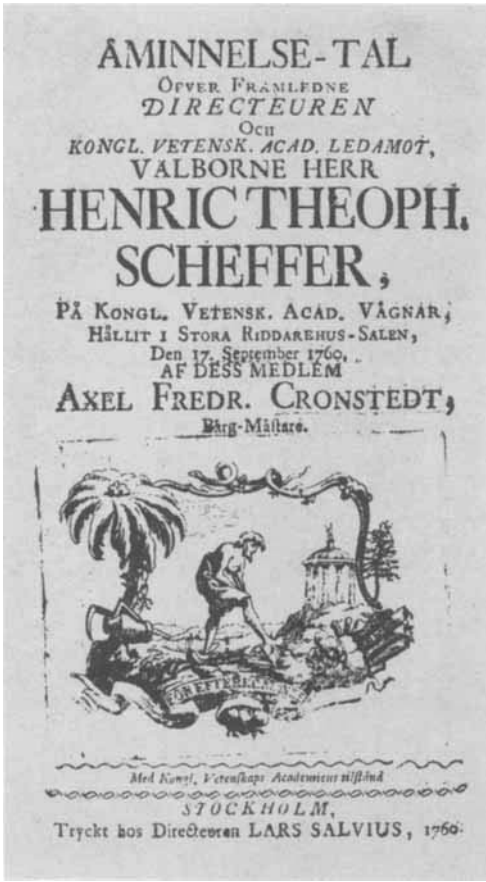
HENR. THEO. SCHEFFER.

Å r 1750 i Juni Månad, fick jag af Herr Aſſeſſor RUDENSKÖLD en mörk ſand, hvilken Herr Aſſeſſoren hade fått i Spanien, med den underråttelſe, at den vore ifrån Väſt-Indien.

Denna ſand beſtod i af mörka ſarn-korn. 2. af järn-färgade Järnmalms korn, hvilka drogos af Magneten. 3. af få gedigna gullkorn. 4. af flata ſcalena Trianglar, hvita ſom Silfver, hvilka Magneten aldeles icke drog.

Deſſa trekantiga Metall-ſmulor ſyntes vara Jern, hvilket af något tilfälle hade blifvit hvitt utan uppå; men det beſynnerligaſte var, at det icke drogs af Magneten, fått än det var ſå ſmidigt, ſom något järn kan vara; ſå at det, denna Metall, oförſkylt tillägges at vara oſmidig: iden han-

The opening of Henrik Theophil Scheffer's paper read to the Royal Swedish Academy of Arts on November 28th, 1751. The title reads: "The White Gold or Seventh Metal called in Spain 'Platina del Pinto', Little Silver of Pinto, its Nature Described"


ÅMINNELSE-TAL
ÖFVER FRÄMLEDNE
DIRECTEUREN
Och
KONGL. VETENSK. ACAD. LEDAMOT,
VÄLBORNE HERR
HENRIC THEOPH.
SCHEFFER,
PÅ KONGL. VETENSK. ACAD. VÄGNAR,
HÅLLIT I STORA RIDDAREHUS-SALEN,
Den 17. September 1760.
AF DESS MEDLEM
AXEL FREDR. CRONSTEDT,
Berg-Mästare.
STOCKHOLM,
Tryckt hos Directeuren LARS SALVIUS, 1760.

The title page of the eulogy read by Scheffer's younger colleague Axel Fredrik Cronstedt, the discoverer of nickel, on September 17th, 1760. Scheffer had died at the early age of forty-nine, but was held in very great respect by his contemporaries

of the events that led up to the latter's investigation, but Scheffer claims that he obtained his first sample from Rudensköld in June 1750. It seems likely therefore that the first intimation of the new metal came from Ulloa's book arriving in Stockholm. As Professor Arne Fredga has pointed out, Wargentin, who became secretary of the Academy in 1749, was very active in acquiring new books on natural science for the Academy library, and the report of a quite new metal would have caused something of a sensation at that time (12).

Nothing further happened in connection with platinum in Sweden for a quarter of a century. In 1777, however, a remarkable paper was presented to the Academy by a man curiously just twenty-five years younger than Scheffer. This was the great Torbern Olof Bergman, whose early career was devoted to the study of mathematics, astronomy, geography and natural history.

Bergman's Contribution

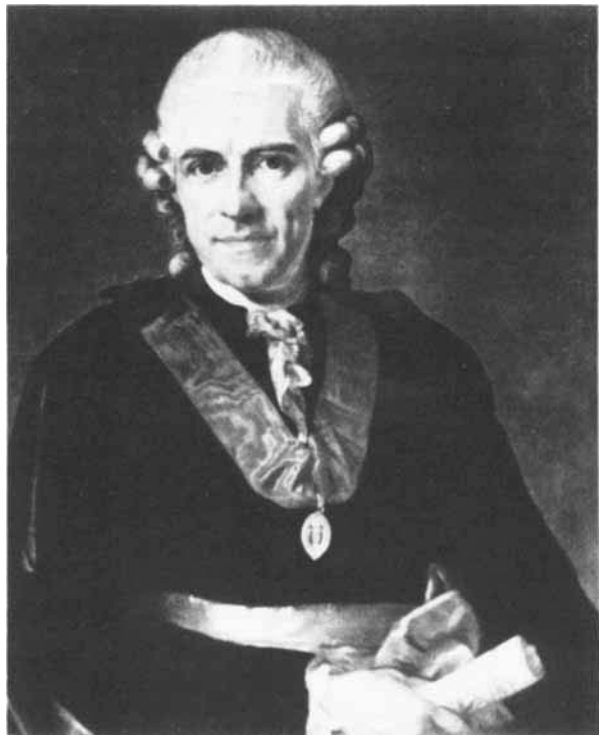
In 1767 Wallerius, who was the first professor of chemistry appointed in Sweden in 1750 and who had published his lectures on metallurgy, decided to take early retirement at the age of fifty-eight. There were several likely candidates with good qualifications in chemistry, but on the influence of the Crown Prince, later King Gustav III, who was chancellor of the University, the chair at Uppsala was offered to Bergman who had in fact contributed only one paper in chemistry up to that time, on the manufacture of alum.

The choice was more than fortunate and proved to be well justified. Bergman rapidly reorganised the chemistry department, acquired suitable apparatus and combined lectures with laboratory work. Many Swedish students, as well as those from other countries, attended his courses. Bergman had earlier been a follower of Linnaeus, the famous classifier of plants, and he emulated his teacher in setting out to classify minerals and chemical compounds and to systematise their nomenclature. His work on affinities and his treatise *De Attractionibus Electivis* are well known, but he may also be regarded as the founder of chemical analysis. In short, he was one of the greatest chemists of the eighteenth century.

In the meantime chemists in other countries had been interesting themselves in the exciting new metal platinum. The first of these was William Lewis, a physician and lecturer of

Torbern Olof Bergman
1735–1784

The greatest chemist of his generation, and professor of chemistry at the University of Uppsala from 1767 until his death, Bergman developed methods of quantitative analysis and wrote a treatise on chemical affinity. He was a great teacher, and received many honours from other countries including Fellowship of the Royal Society in 1765; in 1776 Frederick the Great of Prussia invited him to come to the Berlin Academy of Sciences at a greatly increased salary but he preferred to remain in and serve his native country



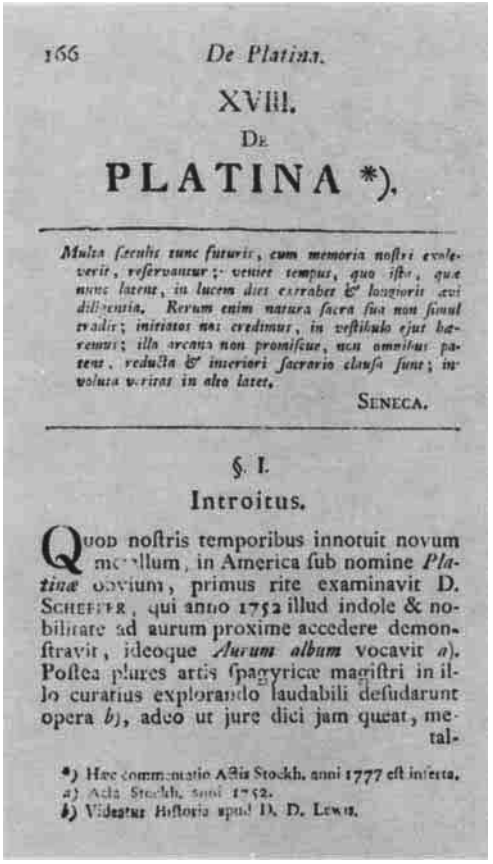
From a portrait in oils painted by Lorens Pasch the Younger in 1778 in the possession of the University of Uppsala

Kingston upon Thames near London, who had begun his experiments in 1749 and who presented his researches to the Royal Society in two papers in 1755 and 1757 (13). In Germany work on platinum was carried out by Andreas Siegmund Marggraf in 1757 (14). Not until 1758 was the interest of French chemists aroused, and then by the appearance of an anonymous little book, *"La Platine, L'Or Blanc, ou le Huitieme Metal"*, published in Paris in 1758. (The arithmetic seems to have gone a little astray but no doubt the missing element was mercury.) This comprised a short preface by the author, the two letters from Watson to Bose, Scheffer's two papers, and Lewis's first report. It is generally understood that the author was one Morin, most probably Jean Morin, a priest and a professor of philosophy at Chartres and a corresponding member of the Academie des Sciences since 1736.

This publication immediately prompted P. J. Macquer and Antoine Baumé to begin an investigation on platinum, published by the Academie in the November of 1758 (15), but other French chemists, including Buffon, Guyton de Morveau and the Comte de Milly, still maintained that the 'new metal' was nothing but an alloy of iron and gold (16).

Bergman, some ten years after his appointment as Professor, turned his attention to platinum and presented a paper to the Swedish Academy in 1777. This was subsequently printed in Latin in 1779 in Bergman's collected "Opuscula", in French in 1780, and in English in 1784 (17). He began by giving his reasons for feeling that a further study of the metal was desirable:

> "The Royal Academy informed the learned world in 1752 of the first investigation carried out with Platina by which its proper nature could be judged with some certainty. Later on this new metal has been investigated in several places with diligence, but we still lack precise information about many of its longest known properties; quite a number of circumstances need further investigation.
>
> Mr Marggraf published in the year 1757 in the Berlin Transaction the statement that mineral



166 De Platina.

XVIII.

De

PLATINA *).

Multa ſæculis tunc futuris, cum memoria noſtri evaneſcerit, reſervantur: venient tempus, quo iſta, quæ nunc latent, in lucem dies extrahet & longioris ævi diligentia. Rerum enim natura ſacra ſua non ſimul tradit; initiatos nos credimus, in veſtibulo ejus hæremus; illa arcana non promiſcue, nec omnibus patent, reducta & interiori ſacrario clauſa ſunt; involuta veritas in alto latet.

SENECA.

§. I.

Introitus.

QUOD noſtris temporibus innotuit novum metallum, in America ſub nomine *Platinæ* obvium, primus rite examinavit D. SCHEFFER, qui anno 1752 illud indole & nobilitate ad aurum proxime accedere demonſtravit, ideoque *Aurum album* vocavit *a*). Poſtea plures artis ſpagyricæ magiſtri in illo curatius explorando laudabili deſudarunt opera *b*), adeo ut jure dici jam queat, metal-

*) Hæc commentatio Actis Stockh. anni 1777 eſt inſerta.
a) Acta Stockh. anni 1752.
b) Videatur Hiſtoria apud D. D. Lewis.

Bergman's paper on platinum was first published in Swedish in the proceedings of the Academy in 1777. This opening page is from the Latin version in his six-volume collected works, Opuscula Physica et Chemica, which appeared over several years beginning in 1779. It was also translated into French and English

alkali was incapable of precipitating Platina, which Dr Lewis has confirmed. Such an extraordinary circumstance is unique, since all other metals yield to this alkali, no matter what solvent they are dissolved in.

Although two of the most outstanding chemists of our time have affirmed this strange result beyond all doubt, still I have sought by experiment to find the solution to this exception, and to my astonishment I have found the answer quite contrary to my expectations."

He then proceeded to explain that since solutions of platinum were always acidic, they must first be neutralised before they could be precipitated with soda (mineral alkali). When this was done, platinum precipitated as a pale golden powder.

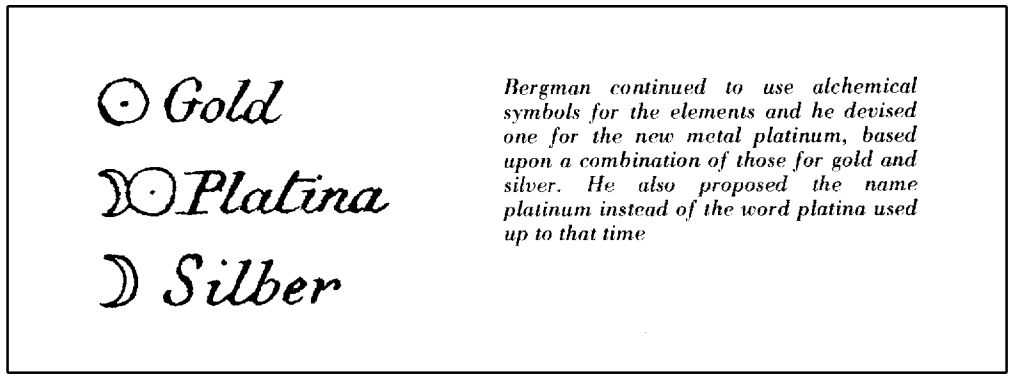
Bergman also obtained a precipitate of platinum by means of sal ammoniac and correctly supposed this to be a triple salt. He washed and dried this precipitate (ammonium chloroplatinate) and successfully caused it to melt, finding that the resulting globules were malleable and could be hammered out into thin sheet, but that it could then not be melted by a burning mirror. (Bergman's platinum was undoubtedly contaminated—he reported its specific gravity as only 18.)

Platinum a Distinct Metal

The concluding part of Bergman's paper dealt with the question of whether platinum was in fact a distinct metal:

> "Since platina surpasses all metals except gold in weight, and is always found to be contaminated by iron, some scientists have believed that it could not be freed from this, that platina is nothing but a mixture of gold and iron. The names of Messrs Marggraf, Buffon and Morveau are sufficient to give weight to this opinion. However Dr Lewis has, for several reasons, rejected this opinion. By melting together gold and iron, in whatever proportion, no such alloy is obtained which in specific gravity or other properties resembles platina in the least. Furthermore the amount of iron in the natural platina can be so reduced that it becomes hardly detectable. We do not know of any native metals that are found entirely pure. Gold contains silver, copper and sometimes iron; silver is contaminated with gold or copper; copper with gold, silver and iron; nickel with cobalt, iron and arsenic; etc. When we add to this the fact that the last traces of a foreign contaminant are infinitely difficult to remove, because they are the smallest part making up the whole mass, so it is not strange if iron adheres to platina in this most obstinate manner, and rather that the difficulty in melting of platina has up to now put a special obstacle to their separation".

In a final paragraph Bergman expressed his view that it was a great pity that more platinum was not available in Europe so that



Bergman continued to use alchemical symbols for the elements and he devised one for the new metal platinum, based upon a combination of those for gold and silver. He also proposed the name platinum instead of the word platina used up to that time

it could be melted in some quantity, and that in the supplies of metal that do arrive there are many impurities that must be sought for with great attention to separate them all.

Bergman's work on classification and nomenclature has already been mentioned. He continued to make use of many of the old alchemical symbols and added new ones, including one for platinum, as illustrated here, combining the old symbols for gold and silver. He also proposed the use of the name platinum instead of the older platina in line with a number of other metals for which he had adopted the Latin ending "um".

In 1775 Bergman paid a great tribute to his predecessor Scheffer in publishing the latter's lectures as a text book of chemistry (18). This contained a considerable amount of comment and additional matter contributed by Bergman himself, but in his preface he gives full credit to Scheffer's work and only Scheffer's name appears on the title page.

Bergman's health was never strong, and it was undermined by the vast amount of work he undertook. He died in 1784, curiously at just the same age as Scheffer, forty-nine.

Acknowledgements

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