The Platinum Notebooks of William Hyde Wollaston

By Melvyn C. Usselman

Department of Chemistry, University of Western Ontario, London, Canada

Examination of the laboratory notebooks of W. H. Wollaston makes possible a complete reconstruction of his platinum researches, and valuable insights into the financial details of his platinum business, originally in partnership with Smithson Tennant, may be obtained. The leading role played by Wollaston in both the research and marketing aspects of the business is confirmed. Although the use of platinum for laboratory ware and vessels for the concentration of sulphuric acid were important applications, the gunmakers provided the greatest market for malleable platinum over the years 1808 to 1820. The business ground to a halt in 1820 when Wollaston could no longer procure supplies of crude platinum.

In November of 1801 William Hyde Wollaston wrote from his newly purchased house at 14 Buckingham Street (now Greenwell Street), London to his close friend at Bury St. Edmunds, Henry Hasted:

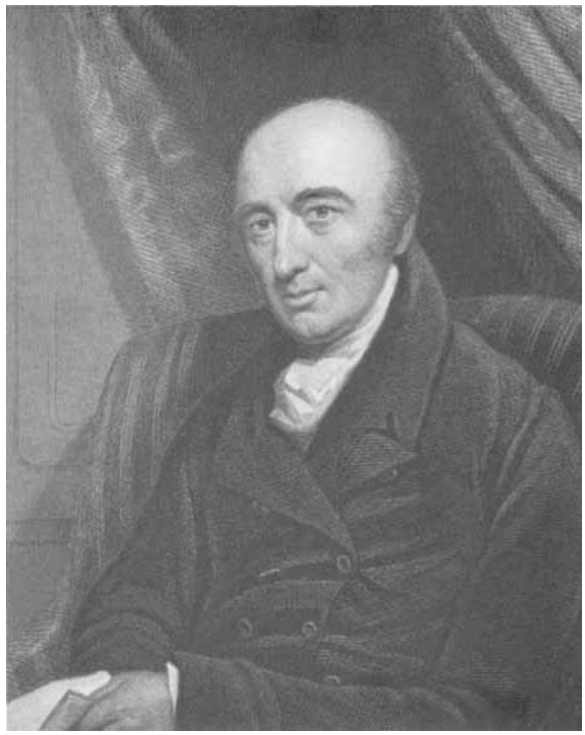
> I do not publish for the gratification of idle curiosity but to friends I make no mystery of my intentions. I am partial to Chemistry; I have here room for a laboratory, and though many have spent fortunes in such amusements more have made fortunes by the same processes differently conducted. Is it impossible to mix the *utile dulci*—if it be I have erred egregiously and may be ruined, but I have no fears at present. When I quitted the terra firma of Physic this was my sheet anchor, though not my only hope. I thought it possible that something more eligible might offer, (therefore kept my own counsel till it was decided), nothing has appeared equally so, and I now hope that I am fixed for life. If I make £40 it is as good as most curacies and I may be content excepting that there need then be no obstacle to my making 10 times as much (1).

Wollaston's decision to quit the practice of medicine at 35 years of age and devote his time to chemistry marked the beginning of a glittering scientific career, one that would place him in the forefront of English scientists. and bring him financial returns many times greater than his most optimistic estimates. Over the course of the first three decades of the nineteenth century, Wollaston published nearly 60 papers, each characterised by careful, yet often highly imaginative, reasoning and rigorous attention to experimental detail. He made fundamental discoveries in physiology, optics, crystallography, electrochemistry, astronomy and botany, but his fame derives principally from his contributions to chemistry and metallurgy. Of his chemical researches, those on the platinum metals are of greatest general interest, for his isolation and characterisation of palladium and rhodium remain a highlight of early nineteenth-century analytical chemistry, and the production of pure, malleable platinum represents a milestone in the history of powder metallurgy (2).

Despite the scientific achievements which placed Wollaston with Humphry Davy, Thomas Young, and John Dalton as the major figures of English science in the early nineteenth century, he has been little studied by historians of science. A significant factor contributing to this neglect was the disappearance of Wollaston's laboratory notebooks and personal records shortly after his death in 1828. We now know that they passed on to his close friend Henry Warburton, who intended to publish a full biography, but was prevented from completing the task by an increasingly active political career. Late in the

William Hyde Wollaston
1766–1828

During a brilliant scientific career, which followed an early retirement from medicine, Wollaston made fundamental discoveries in many different branches of science, although it is for his contribution to chemistry and metallurgy that he is principally remembered. During the course of his work he discovered palladium and rhodium, and put the production of malleable platinum on to a scientific basis thus encouraging its use as an industrial material



nineteenth century, the Wollaston papers could no longer be traced. By immense good fortune, a collection of notebooks and documents was discovered in the Department of Mineralogy and Petrology of the University of Cambridge in 1949, and they were identified as the valuable Wollaston papers. The collection, now in the Cambridge University Library, was examined by L. F. Gilbert and a brief but fascinating description of the material was published (3). The collection includes twenty laboratory notebooks in Wollaston's hand, eight of them devoted entirely to the purchase, purification, production and sale of platinum. One pertains to the metal palladium, and three contain miscellaneous experiments on a wide range of subjects, including early research on crude platinum. Although the notebooks contain no coherent, continuous record of his investigations, the wealth of detailed information contained in them will allow a reconstruction of Wollaston's entire research programme from its inception about 1800 to his death in 1828, especially with respect to his efforts at rendering platinum malleable. In this paper I will present a brief summary of the contents of the platinum notebooks, together with some of the most interesting information which they have yielded.

Included in the Cambridge collection is a notebook in Warburton's hand containing references to the Wollaston notebooks under alphabetical headings. By careful study of the entries it is possible to correlate the notebooks in Warburton's possession with those now in the collection—there appear to be none missing. In fact, there are two notebooks currently in the collection which were not referred to by Warburton. One of them, a short entry notebook containing both personal and scientific details, is not mentioned in Gilbert's 1952 paper, so it appears as if the collection is at least as complete as it was in Warburton's time, and perhaps even somewhat expanded.

Platinum Purchases

Full records were maintained in the notebooks on the acquisition and sale of platinum. Crude platinum was purchased at irregular

intervals from 1800 to 1819 from various suppliers. Over this period, 47,000 troy ounces were purchased at a total cost of £7,123, at an average price of 3s. per ounce. The prices ranged from a low of 2s. 2d. for 684 ounces in 1818 to a high of 4s. per ounce for 800 ounces in 1801. The prices paid by Wollaston include interest charges at 5 per cent of the purchase price, paid to the supplier from the time the order was placed until delivery. In one instance Wollaston did not receive the ordered platinum until 670 days after the order was placed, and delays of 200 days were the norm. This suggests that platinum was not immediately available in London, but was imported, likely from Jamaica, to which platinum smuggled out of Colombia—the major source at the time—found its way. Thus the average price of crude platinum given by Gilbert as 2s. 10d. represents the average ordered price, a price slightly lower than the final cost to Wollaston given here (4).

Of the total amount purchased over the years at least 36 per cent was purchased from John Johnson, whose son, Percival Norton, was the founder of Johnson Matthey and Co Limited. In a few instances (1806, 1807), Johnson is actually identified as the supplier, while in others (1818), payments to him by draft on Wollaston's bank account agree in date and amount with records of platinum purchases. It is quite possible that Johnson supplied much more than 36 per cent, for only 18 per cent of the total purchased can be definitely traced to other suppliers.

There has been some debate over the reason why purchases of platinum ceased in 1819, but it was certainly not due to lack of demand, which remained strong. Evidence in the notebooks suggests that Wollaston could no longer purchase crude platinum at a price he felt reasonable. There are notes which reveal that he sought to purchase crude platinum in the early 1820s in Jamaica and Colombia. The request for platinum in Jamaica was made on Wollaston's behalf by a Mr. Hibbert to Messrs. Taylor and Simpson of Kingston, who replied by letter on June 12, 1820.

> Upon enquiring amongst the Spaniards we find that this article [platinum] has never been brought to this Island, but in very small Quantities and from the Information we have yet received, we have not been able to ascertain that the Quantity can be materially increased by offering an adequate encouragement for its import (5).

Presumably, the amounts brought to the island acknowledged by the Spaniards represented the legal imports, for there is much evidence that Jamaica was the source of a great deal of smuggled platinum in the early nineteenth century. On a piece of paper in one of the notebooks, Wollaston wrote:

> By a letter from Mr. Henderson English Consul General at Bogota in his enumeration of articles prohibited to be exported is Platina under penalty of loss of metal and also a fine of 50 dollars per pound (6).

In a different notebook, Wollaston dates the prohibition as November, 1824.

Although Wollaston could not obtain platinum, his competitors in the platinum vessel business, the French, had ample supplies, for about 1819, Jean Bréant, assayer of the Paris mint, was given permission by the Spanish Government to process the nearly 30,000 ounces of crude platinum held by Spain since late in the eighteenth century (7). With such a large amount of crude platinum at their disposal, the French quickly began producing platinum vessels, thus ending Wollaston's monopoly in the market. An entry in one of the notebooks reads:

> Feb., 1819. I understand from Mr. Tennant that [platinum] retorts have been made in Paris of about 30 gallon capacity and weighing about 900 ounces at 15 shillings per ounce (8).

Thus it appears that the lack of crude platinum in England in the early 1820s was the determining factor in the cessation of Wollaston's platinum business, and French manufacturers gradually moved to meet the demand for malleable platinum.

Partnership with Smithson Tennant

The account books present in the collection reveal that Wollaston formed a partnership with Tennant in 1800, a collaboration unannounced and unsuspected at the time. The

two originally agreed to share the cost of all platinum, chemicals and apparatus, and to divide the income evenly. The account books from 1800 to 1815 (the year of Tennant's death) confirm that Wollaston was by far the most active of the two. Up to February 22, 1815, the gross expenditures by the two men had totalled £8,334, of which Wollaston had contributed £7,050. The leading role played by the younger Wollaston is even more dramatically illustrated if the amount spent on the purchase of crude platinum is excluded. Over the 15 year period of the partnership, a total of £3,998 was paid out for chemicals and apparatus. Of this, only £74, or 2 per cent, was contributed by Tennant. The inequity of this situation was partially rectified early in 1809, when the two men came to a new agreement which stipulated that Wollaston was to receive some payment for platinum sold before division of the profit. From the account books there is evidence that from April 1, 1809 onwards Wollaston received 10 per cent of the profits before division. Although the notebooks provide much evidence for the diminishing role played by Tennant, there is little doubt that he rendered much assistance in the early years of the partnership, and it is quite possible that Wollaston might not have chosen to pursue chemistry as a career without the initial financial and intellectual support of Tennant. Many more details of the chemical partnership of these two men could be cited, but a thorough treatment is beyond the scope of this paper.

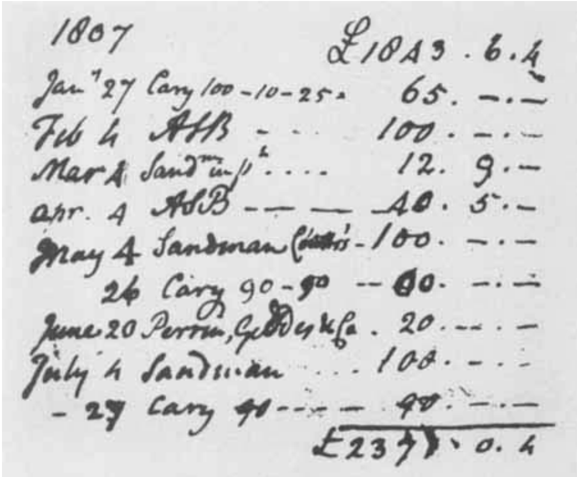


Fig. 1 An entry in one of Wollaston's account books detailing income for the first half of 1807. The entry for January 27 indicates that, of £100 brought in, Cary retained £10 as commission, £25 went to Tennant, and £65 to Wollaston. Wollaston's larger share is proportional to his greater expenditures. Entries on March 4, May 4 and July 4 represent payment by Philip Sandmann for the platinum boiler purchased early in 1806. The totals reflect accumulated income from January 1, 1800

Platinum Sales

From the crude platinum processed over the years, a little over 38,000 ounces of purified, malleable metal were sold at an average price of nearly 16s. per ounce, for a total income of approximately £30,000. Of this amount roughly half was accumulated during Tennant's lifetime and was shared by the two men, and the remaining half was Wollaston's alone. Thus Wollaston's profit from the platinum business can be estimated as close to £14,000, and Tennant's as £3,000, after expenditures have been deducted from income. Wollaston obviously became a wealthy man through his platinum business. The ultimate success of the endeavour, however, was not foreshadowed in the early years of the partnership, for only in 1805 did yearly revenue begin to exceed expenditure, and it was not until 1809 that the entrepreneurs began to show an overall profit from the platinum operation.

Information concerning the commercial market for platinum is also available in the notebooks. Nearly all the platinum was sold in ingot form by William Cary, a respected London instrument maker, who received 10 per cent of the selling price as commission. Cary's selling price was generally 17s. per ounce, which yielded Wollaston nearly 15s. per ounce after the vendor's deduction, see

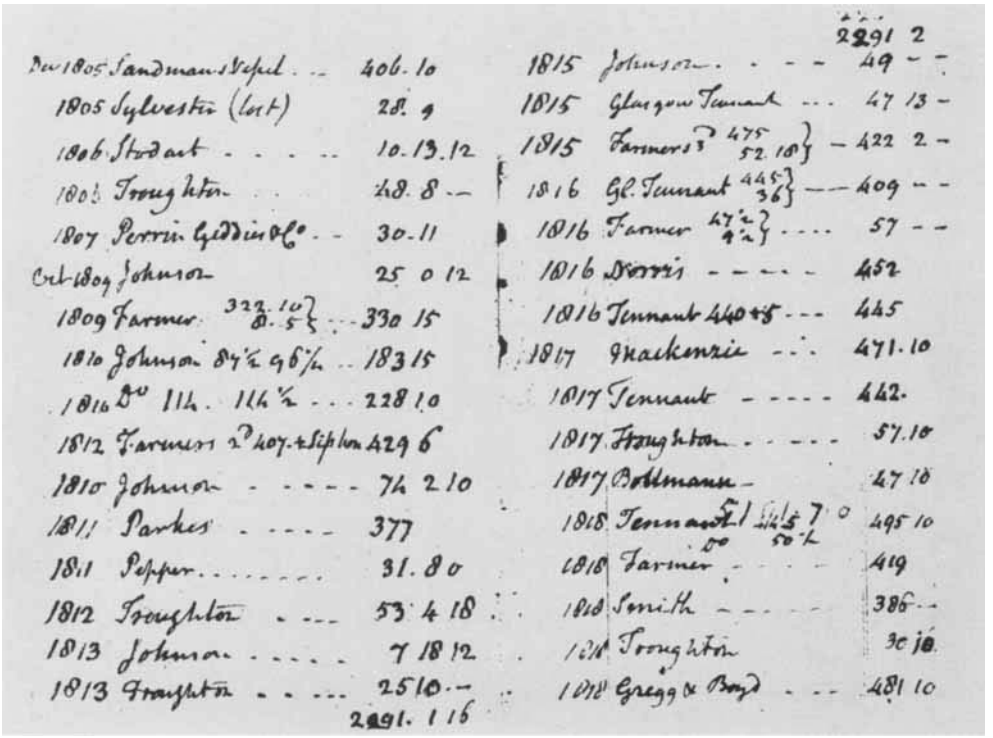


Fig. 2 A nearly complete record of the Troy weights of platinum sold personally by Wollaston from 1805 to 1818. The larger weights were used for the construction of boilers, and the smaller for various accessories, such as siphons, etc. The amounts sold to Johnson in 1810 were for the construction of a boiler for Pepper, one of the few boilers not fabricated by Wollaston or Kepp

Figure 1. One of the notebooks records the weights of platinum delivered to Cary, and from the nature of the entries it is possible to determine the use to which the platinum was put (9). Of the nearly 30,000 ounces sold by Cary, 19,000 ounces are denoted as of "touch-hole" quality. As mentioned by Gilbert, the use of platinum for the touch-holes or ornamentation of guns began in England about 1805—Wollaston's first sale of "touch-hole" platinum was made in 1806—and it is obvious that gunmakers were by far the largest consumers of malleable platinum (10). In addition to the amount specifically noted as "touch-hole" ingots, nearly 9,000 ounces are referred to simply as "bars", or "ingots". Of this total, 8,000 ounces were sold during the years 1819 to 1821 when no ingots were specifically referred to as of "touch-hole" quality, and consequently were in all likelihood also sold to gunmakers, since there is no evidence that the gunmaking market suddenly disappeared in 1819. If this assumption is correct, then 27,000 ounces, or 70 per cent of the total weight of platinum sold, was consumed by the gunmaking industry. In retrospect, this figure should not be too surprising, for even at 17s. per ounce malleable platinum was only one-fifth the cost of gold, which continued to be employed in the finest firearms for touch-holes and decoration. The remaining 3,000 ounces sold by Cary were put to use for crucibles, balance pans, evaporating dishes, wire and other miscellaneous items.

In addition to the amounts sold by Cary, Wollaston disposed of 8,000 ounces himself, all but 625 ounces of which were used in the

manufacture of boilers for the concentration of sulphuric acid, see Figure 2. Over the years 1805 to 1818, sixteen boilers were fashioned and sold. They ranged in weight from 320 to 470 ounces, and sold for £300 to £400. The selling price was based on the weight of platinum employed, usually at 15s. per ounce, and the costs of construction were added on. For all but the first few, Wollaston had the boilers made to his specifications by local metal-workers, principally John Kepp of Chandos Street, who fabricated the last ten boilers.

An interesting entry in a notebook devoted primarily to boiler construction attests to the value of the platinum boilers to the manufacturers of sulphuric acid (11). The entry, dated February, 1816, states that at Charles Tennant's acid works in Glasgow:

> They boil off 3 times per day [oil of vitriol] and turn out 50 bottles of 150 lb per week. They reckon to save the prime cost [of a £300 boiler] in 2 years, oil of vitriol being now at 3¼s. to 3½s. per lb.

Tennant's production of nearly four tons of oil of vitriol per week was no doubt made possible by his use of five platinum boilers, four of which had been purchased from Wollaston, and one from Sandmann, who had used it for ten years after purchasing it from Wollaston in 1805.

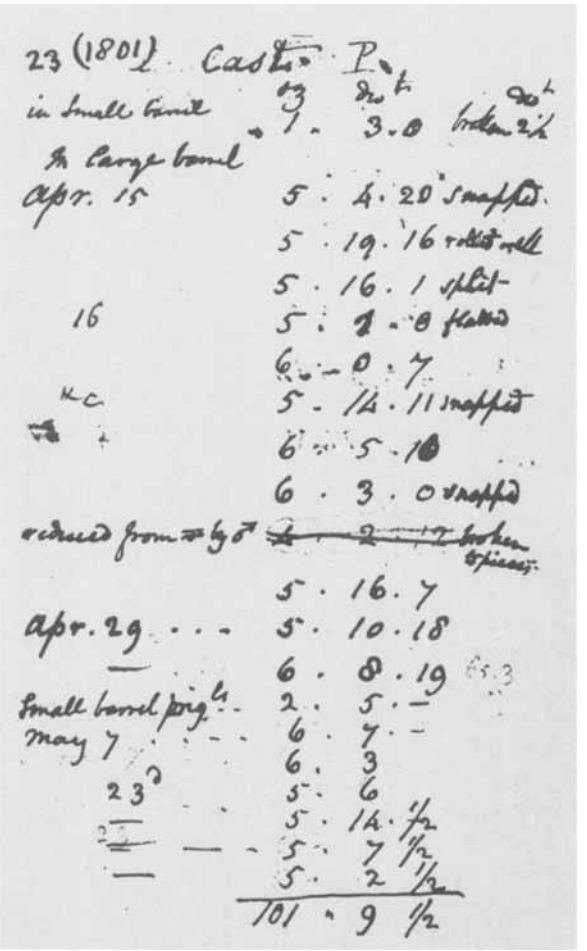


Fig. 3 A record of some of Wollaston's earliest attempts at consolidation (incorrectly labelled 'casts') of his partially purified platinum in 1801. The unsuitability of the product is evident from the frequent mechanical failure of the ingots during forging

Demand for boilers remained strong in the early 1820s. The notebook lists seven orders for boilers which remained unfilled, due, as noted earlier, to Wollaston's inability to obtain the 4,000 ounces of crude platinum required.

The Production Process

The chemical analysis of the crude platinum by Wollaston and Smithson Tennant which was carried out in the years 1801 to 1803 and resulted in the isolation and characterisation of the metals osmium, iridium, rhodium and palladium is now widely recognised as a brilliant example of early nineteenth-century analytical chemistry. There is sufficient data in the notebooks to reconstruct Wollaston's meticulous, and often frustrating, analysis of the aqua regia-soluble fraction of the crude platinum, but the details must wait for a future paper. It is perhaps sufficient to say that he was plagued initially by the same problems as his predecessors. After the

platinum was precipitated from solution as ammonium chloroplatinate, $(NH_3)_2PtCl_6$, and ignited to obtain a somewhat purified spongy metal, the platinum was consolidated under pressure, and forged. The earliest ingots produced frequently cracked on hammering or blistered badly on heating, see Figure 3. Wollaston at first attributed the source of such difficulties to impurities, and refined his purification technique to minimise the inclusion of base metals and the newly discovered platinum metals in the spongy precipitate. Even with improvements in the chemistry of the process, an inconsistent product was frequently obtained. As a consequence, Wollaston directed his attention more to the metallurgical aspects of the process, and improved it to a point where a consistently malleable product was the rule. Only by about 1808 could Wollaston confidently market platinum with the mechanical properties required by the purchasers, and the business then began to prosper rapidly.

In general, the crude metal purchased by Wollaston contained roughly 75 per cent platinum, 16 per cent iron, 3 per cent copper, 3 per cent sand, 2 per cent osmium and iridium, and 1 per cent rhodium and palladium. The processing began and continued over the years in 16 to 30 ounce batches, and Wollaston early calculated the average cost of processing as 2s. per ounce. This, coupled with the 3s. per ounce paid out for platinum, made Wollaston's expenses 5s. per ounce. Consequently, at a selling price of 15s. per ounce, Wollaston turned a considerable profit, but not an unreasonable one when all the hours required for the purification and forging are considered.

Some Remaining Questions

The notebooks discussed here provide a wealth of information on the technical aspects of Wollaston's platinum researches, information which is of great interest to the student of chemistry and metallurgy. However, there is a paucity of information on the broader aspects of Wollaston's endeavour. Why did Wollaston and Tennant guard so carefully the secret of their partnership? Why were the details of the platinum process only published in 1828, eight years after Wollaston had brought the business to a halt? Did Wollaston's success stimulate the pursuit of chemistry in the early nineteenth century, or did his retention of information hinder the development of the English platinum industry?

These and other questions intrigue historians of science and I am optimistic that answers will soon be forthcoming.

Acknowledgements

This research was made possible by a grant from the Canada Council.

The photographs are reproduced through the courtesy of the Syndics of Cambridge University Library, and I am much indebted to Mr. A. E. B. Owen of that library for his continued kind assistance.

References

1 Letter from W. H. Wollaston to H. Hasted, November 16, 1801. Copies of the Wollaston/Hasted letters are in University College Library, London; the originals, once in possession of Wollaston's descendants, can no longer be found

2 (a) A history of platinum, and Wollaston's place in it, has been admirably and capably compiled; see Donald McDonald, "A History of Platinum", Johnson Matthey, London, 1960
(b) A brief assessment of Wollaston's platinum researches has also been published by the same author: D. McDonald, "William Hyde Wollaston; the Production of Malleable Platinum", *Platinum Metals Rev.*, 1966, **10**, (3), 101–106

3 L. F. Gilbert, "W. H. Wollaston MSS at Cambridge", *Notes and Records Roy. Soc. Lond.*, 1952, **9**, 311–332

4 Ibid., 318

5 Wollaston MSS, Cambridge University Library, letter enclosed in notebook **F**

6 Wollaston MSS, note enclosed in notebook **F**

7 Op. cit. (Ref. 2(a)), 136

8 Wollaston MSS, notebook **H**, 57. The Tennant referred to is Charles Tennant, a Glasgow acid manufacturer who purchased four platinum boilers from Wollaston

9 Wollaston MSS, notebook **I**

10 Op. cit. (Ref. 3), 319

11 Wollaston MSS, notebook **H**, 4