Merchandising Malleable Platinum

THE SCIENTIFIC AND FINANCIAL PARTNERSHIP OF SMITHSON TENNANT AND WILLIAM HYDE WOLLASTON

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In the year 1800 Tennant and Wollaston agreed to share the expenses of a joint chemical enterprise, the most profitable aspect of which was to become the production and sale of malleable platinum. It is generally known that Wollaston was responsible for the chemical and metallurgical innovations which yielded a reliable process for the production of the metal. Although the role of Tennant was crucial in the establishment of the partnership, his well-known inability to bring projects to a successful conclusion created strain in the partnership, and his practical contributions amounted to little. Thus Wollaston fully deserves the credit given to him for the production of malleable platinum.

William Hyde Wollaston is recognised as "the outstanding figure in the history of platinum" (1). His researches on the chemical purification of alluvial ore, which had begun in 1800, led to the production of malleable platinum containing less than 2 per cent impurities (2). The platinum ingots he produced were retailed by William Cary from 1805 onwards (3), but the chemical and metallurgical details of the process that yielded the malleable metal were not publicly revealed until 1828, just a few weeks before Wollaston's death (4). In that paper, and others relating to his platinum researches, Wollaston made no reference to a co-worker, so the historical literature initially gave him sole credit as the discoverer of the successful process. With the discovery of a most important collection of Wollaston and Tennant manuscripts and notebooks at Cambridge in 1949, further information came to light (5). Account books in the collection reveal that Wollaston and Tennant had agreed in 1800 to become equal partners in a chemical business. The most profitable aspect of this enterprise, by far, was the merchandising of malleable platinum. The first expense incurred by the two men was substantial—the purchase of 5,959 ounces of platinum ore at a total cost of £794.10s.6d. (6). Of this sum, Wollaston contributed £474.10s.6d. and Tennant £320. Thereafter, the account books detail the expenses incurred by both men in their chemical researches, together with income generated by the sale of their products. Up to the time of Tennant's death on 22nd February, 1815, a total profit of £6,017.5s.0d. had been realised on income of £14,351.9s.7d. and expenses of £8,334.4s.7d. (7). This financial record suggests a close working relationship between Tennant and Wollaston and has led many people to assume that Tennant made important contributions to the platinum enterprise. McDonald and Hunt, for example, state that "their combined achievements over a relatively short span of years included the successful production for the first time of malleable platinum on a truly commercial scale" (8).

In an attempt to substantiate this premise, I have studied the relevant manuscripts and notebooks. The documentary evidence reveals, however, that Tennant's contribution was almost entirely a financial one. The information suggests that Tennant's experimental work on platinum processing was negligible, and that the partners negotiated a distribution of the profits in a way that would reward Wollaston for his much greater contributions. Not surprisingly, there is even a suggestion that

Wollaston became somewhat disenchanted with the exertions of his partner.

Before the Partnership

Wollaston and Tennant first met each other as students at Cambridge in the 1780s. Although both would ultimately obtain M.D. degrees, their shared interest in chemistry formed the main bond between them. Intellectual interests aside, they were as different as could be. Tennant was an only child who had inherited an adequate fortune after the early death of his father in 1772 and his mother in 1787. He had a restless childhood which began to acquire direction only after a brief sojourn at Edinburgh with Joseph Black in 1781 (9). As a fellow commoner of Christ's College, he displayed already those traits which were to be his lifelong distinguishing features. He had

> "extraordinary powers of memory and understanding, . . . and of reading with great rapidity, and of collecting from books, by a slight and cursory inspection, whatever was most interesting and valuable in their contents . . .
>
> [His] extraordinary attainments derived an additional interest, and peculiar grace, from the simplicity of his manners, the playfulness of his wit, and the careless, fascinating beauties of his conversation . . .
>
> Yet, . . . there was a singular air of carelessness and indifference in his habits and mode of life; and his manners, appearance, and conversation, were the most remote from those of a professed student. His College rooms exhibited a strange, disorderly appearance of books, papers, and implements of chemistry, piled up in heaps, or thrown in confusion together. He had no fixed hours or established habits of private study, but his time seemed to be at the disposal of his friends" (10).

In utter contrast, Wollaston had been raised in a house swarming with family and friends. He was one of 15 children of Francis and Althea Wollaston, all of whom had been brought up in an environment where free inquiry and rationality were emphasised. His father was a Fellow of the Royal Society, and had as close friends some of the leading scientific men of the day, such as the physician William Heberden and the chemist Henry Cavendish. Wollaston's older brother, Francis John, the senior wrangler at Cambridge for 1783, was Mathematical Examiner there when William arrived. William, then, had the stable, carefully planned and supervised childhood that Tennant lacked, and his meticulous, ordered manner of doing science mirrored his personal behaviour. As Charles Babbage was to write:

> "The most singular characteristic of Wollaston's mind was the plain and distinct line which separated what he knew from what he did not know; [and yet] there were very few so perfectly free from vanity and affectation". (11)

The politician Henry Warburton was a close friend of both men, and in his account of their Cambridge years, he writes:

> "About this time [1787], if not somewhat sooner, began Wollaston's acquaintance with Smithson Tennant. Tennant was five years older than Wollaston, and at this time, when Wollaston was only just emerging from Boyhood, had already acquired some reputation as a young man of great abilities, ardent in a pursuit of knowledge. He had been two years elected a Fellow of the Royal Society and thoroughly versed in the whole science of chemistry, and having the means which a competent fortune gave him of indulging his own wishes, had travelled in France and Sweden . . . From Gahn, the Swede, especially, he had learnt the art of conducting analyses on the small scale, by the united means of chemical tests and the Blowpipe . . . These experiments, and others of the same kind of his own devising, on his return to Cambridge after these excursions he delighted in exhibiting to his acquaintances . . .
>
> Tennant had an enthusiasm for chemistry. "The Chemist", he would say, "doesn't call new elements into existence, but the elements which exist he discovers and then combines them in various combinations that never before existed in nature and this is next to creation". This strengthened in Wollaston a passion for Chemistry which Milner had kindled. Wollaston held Tennant's knowledge of Chemistry in profound admiration, and not now only, but many years later expressed to a common friend his despair of ever becoming Tennant's equal . . . he applied himself sedulously to Chemistry, making experiments on a small scale in his own rooms, and for those on the large scale, availing himself of a laboratory which brother Francis, for his own amusement had fitted up. Platina, at this early period engaged Wollaston's attention and his contemporaries remember that he made several persevering attempts to affect its fusion in a Blacksmith's forge" (12).

Shortly before 1790, Tennant and Wollaston left Cambridge, and each for a while subjugated

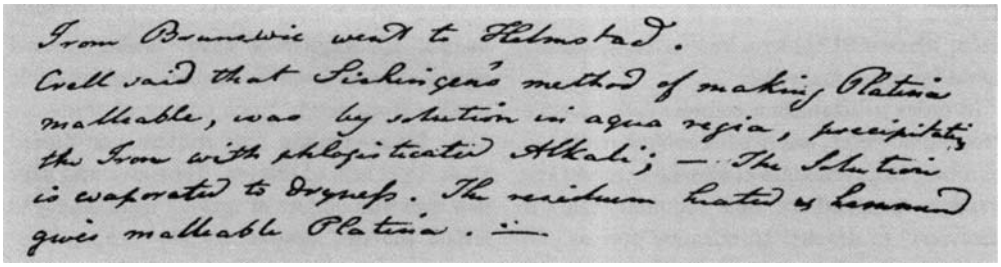
From Brunswic went to Helmstad.
Crell said that Sickingen's method of making Platina malleable, was by solution in aqua regia, precipitating the Iron with phlogisticated Alkali; — The Solution is evaporated to dryness. The residuum heated by Lemond gives malleable Platina. —

Fig. 1 This entry in Tennant's notebook for 4th October 1784, when he was visiting Helmstädt, describes Count von Sickingen's process for producing malleable platinum, as told to him by Lorenz Crell. This was done by solution in aqua regia, precipitating the iron impurities with alkali, then evaporating the solution. The platinum residue was later consolidated by heating and hammering

his chemical interests to medical ones. Both, however, were adversely affected by the mental anguish that attended the practice of medicine and by 1797 they were living close together in London, Wollaston in Cecil Street, off the Strand, and Tennant in Garden Court, Temple. It is likely that the two saw each other frequently, for we know that Wollaston assisted Tennant in his chemical study of diamond (13). In Thomson's words:

> "During the year 1796 he [Tennant] made his experiments to prove that the diamond is pure carbon . . . A characteristic trait of Mr. Tennant occurred during the course of this experiment, which I relate on the authority of Dr. Wollaston, who was present as an assistant, and who related the fact to me. Mr. Tennant was in the habit of taking a ride on horseback every day at a certain hour. The tube containing the diamond and saltpetre were actually heating, and the experiment considerably advanced, when, suddenly recollecting that his hour for riding was come, he left the completion of the process to Dr. Wollaston, and went out as usual to take his ride" (14).

Clearly, forming a partnership with Tennant had its risks, for a man who could be so easily distracted from the task at hand could not be relied on to carry a long, involved chemical process through to completion.

The Years of Discovery

Despite his lack of commitment, the participation of Tennant was probably crucial for the initiation of the joint platinum venture. As a consequence of his travels, Tennant had a broad knowledge of contemporary chemistry, and ideas of what might be commercially feasible. We know, for example, that when Tennant met Gahn at Fahlun, Sweden, on 14th August, 1784, they experimented with platinum. His notebook entry is as follows:

> "Platina precipitated by Sal Ammoniac was very fusible with sal mic [probably sal microcosmicus, sodium ammonium phosphate, $NaNH_4HPO_4.4H_2O$]; but by continuance of heat became infusible, but malleable. Mr. Gahn supposes it might be a mineralisation of the Platina with the Phosphoric acid: during the fusion it gave the flame a tinge of green" (15).

Later, on the same trip, Tennant visited Lorenz Crell at Helmstädt and his notebook entry for 4th October, 1784, shown above, gives details of von Sickingen's platinum process (16).

It is tempting to draw on these notes to suggest that Tennant was the one most likely to have thought of joining forces with Wollaston for the production of malleable platinum. But there are reasons to believe that Wollaston could also have first formulated the idea. It was generally known in the late eighteenth century that malleable platinum could be produced, but the processes employed were unreliable and seemed to depend more on chance than on science. Wollaston tried to fuse the metal in a blacksmith's forge while at Cambridge, and the details of its precipitation as a powder were even being taught by his brother Francis at Cambridge in 1794. Under the title "Platina", Francis' printed notes contain the headings:

> "224. Natural history of platina. Its properties
> 225. Action of fire, nitre, and lead on platina
> 226. Platina dissolved in nitro-muriatic acid. Precipitates from the solution
> 227. Action of sulphur on platina
> 228. Action of arsenic on platina
> 229. Purification of platina" (17).

Thus, it would have been a poor chemist, indeed, who would not have known that platinum could be made malleable.

In order to establish a commercially feasible process, however, one needed enough money to purchase large amounts of alluvial ore, and the freedom to spend the time required (years if necessary) to develop an effective process. To minimise the financial risks, Wollaston and Tennant agreed in 1800 to share all expenses and profits (18). Although such a joint venture may have been novel to Tennant, Wollaston was quite familiar with such endeavours, for in 1799 he had purchased Bank of England stock and government securities jointly with his elder brother George, in one case, and with his younger brother Henry, in another. Clearly, William was no stranger to financial partnerships. In fact, we probably owe the existence of the platinum account books to the partnership, for an equitable division of profits depends on accurate records.

Wollaston's account books reveal that he was by far the most industrious of the two. After the amounts paid out for platinum ore are excluded, Wollaston incurred 98 per cent of the nearly £4,000 in expenses accrued over the 15 year life of the partnership (19). All the experimental details of the platinum process, as published in 1829, were discovered by Wollaston himself and all 47,000 ounces of the impure ore were processed in 16- to 30-ounce batches by Wollaston and his paid assistant, John Dowse, in a laboratory at the rear of Wollaston's residence (20). There is not one single mention of Tennant's name in connection with the production of malleable platinum, apart from occasional expenditures totalling £74 over a period of 15 years. The only visible sign of the involvement of Tennant was the one paper he published relevant to the partnership. This was the announcement of his isolation of the new elements osmium and iridium from the insoluble residue that remained after prolonged action of aqua regia on alluvial platinum (21). Although the discovery of the two new metals was a considerable chemical accomplishment, it was made easier by the fact that Tennant worked with an ore highly enriched in both metals. By August of 1803, Wollaston had separated, and given to Tennant, the insoluble residue from nearly 7,000 ounces of crude ore (22). Since osmium and iridium constituted about 2 per cent of this ore, Tennant could have had over 100 ounces of residue from which to isolate the two substances. Meanwhile, Wollaston was working with the soluble residues that remained after the precipitation of platinum with ammonium chloride. From these residues he isolated and characterised rhodium and palladium. Obviously, the discovery of the four metals was made possible by the enrichment of the metals in the various residues that were a by-product of Wollaston's platinum purification process. In their publications neither Wollaston nor Tennant acknowledged each other's contribution, but this was by design. They wished to keep their collaboration a secret, and in this they were successful.

The Division of Profits

An equitable division of profits between the two men became a matter of concern as soon as the business began to be profitable. By the end of 1803, expenses had exceeded gross income by £1,671. In 1805, when the first malleable platinum was sold, the business had a surplus on the year of £227, but it was only in 1809 that total income first exceeded the sum of all expenses (23). It was during this year that an agreement on profits was put on paper. The agreement is shown here as Figure 2 (24).

The agreement itself does not indicate how much Wollaston was to be paid before equal division of the profits from the manufacture of the salt of sorrel (SS) or the platinum (Pl) consolidation. The spaces left before the statements pertaining to these two facets of the business seem to suggest that the fraction of profit that would go to Wollaston alone had yet to be decided. The best evidence that Wollaston received 10 per cent of the profits before equal division comes from calculations done to settle Tennant's estate in 1815. At the time of Tennant's death on 22nd February, 1815, Wollaston had the financial records of the

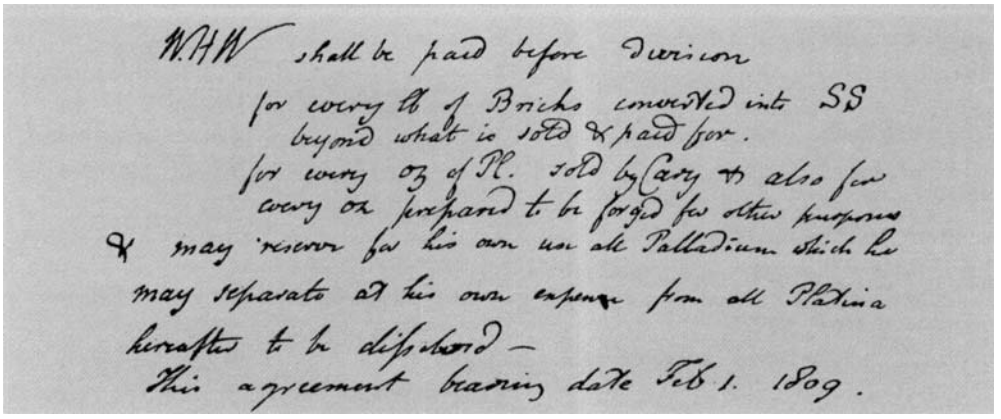
W.H.W shall be paid before Division
for every th of Bricks converted into SS
beyond what is sold & paid for.
for every oz of Pl. sold by Cary & also for
every oz prepared to be forged for other purposes
& may reserve for his own use all Palladium which he
may separate at his own expence from all Platina
hereafter to be disposed of —
This agreement bearing date Feb 1. 1809.

Fig. 2 It was only in 1809, when the total income from the business exceeded the accumulated expenses, that a written agreement on the distribution of the profits was drawn up. Even at this stage the fraction of the profits to go to Wollaston had not been entered on the document

partnership verified. One slip of paper records the income still due to the partnership from the platinum business, see Figure 3 (25). From the £499.12s.10d. due from William Cary, 10 per cent is deducted. This represents his commission on all the platinum sold (26). However, a further one-tenth is deducted before the amount due the partnership is calculated. A similar calculation for the income from unsold platinum sets aside 10 per cent for Cary and another one-tenth before equal division. Since the unspecified one-tenth in both calculations is deducted after Cary's share, but before equal division, it probably represents Wollaston's personal share of the profits. If this premise is correct, the credit entries in Wollaston's account books can be interpreted in a new way. If one looks at the credits from Cary in early 1805, Figure 4, for example, the one-tenth deducted as "commission" on 6th April represents Wollaston's personal share, not Cary's. The 10 per cent selling commission due to Cary would have been taken off before the sums received for platinum sold were transferred to the partners. The amount entered as a credit for Wollaston's half of the partnership (£31.0s.0d.) is that which remains from the £40 remitted by Cary, after Wollaston's personal share of £4, and Tennant's partnership share of £5 have been deducted. Thus, all the credits and debits in the account books for Wollaston and Tennant represent the amounts evenly shared by the two men, and do not include the 10 per cent of the gross income from platinum sales that went to Wollaston alone. From the start of the partnership in 1800 to 22nd February, 1815, the total income recorded in the account books of Tennant and Wollaston is given as £14,351, on expenses of £8,334, for a combined profit of £6,017, or nearly £3,000 each (27). Since income from platinum sales accounted for approximately 75 per cent of the total, the personal share of Wollaston before division can be estimated as £1,076. His one-tenth share of gross income gave him a total profit over the 15 years of partnership of £4,076, compared with Tennant's £3,000.

Wollaston's extra profit from the other aspects of the joint enterprise were negligible by comparison. For palladium, we know that Wollaston in May 1805 paid Tennant £20 for the sole rights to all income generated by future sales of the metal (28). Up to that time, total revenue of £16.16s.0d. had been shared equally (29). But, thereafter, no further entries for palladium appear in the joint accounts. In a notebook devoted to palladium matters, Wollaston records his gross income from the post 1805 sale of the metal (to October 1814) as £32.5s.0d. The payment of £20 to Tennant thus amounted to more than half of the total income from sale of the metal. Obviously, sole rights to

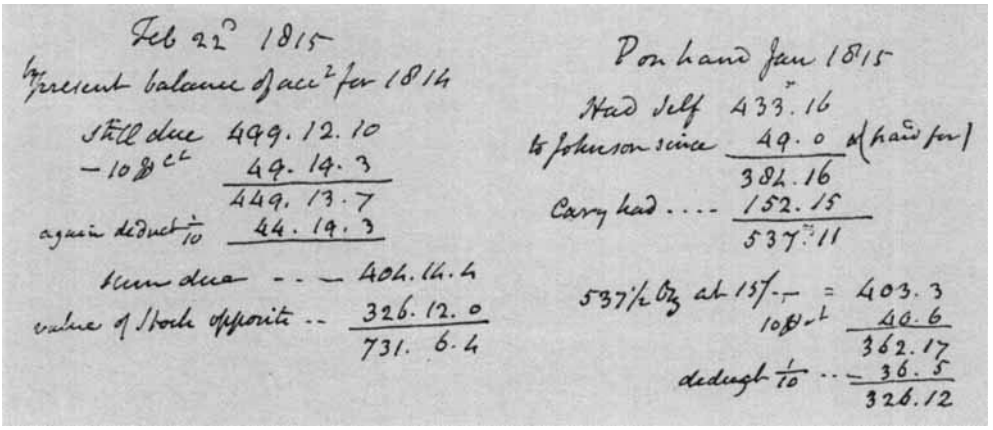

Fig. 3 At the time of Tennant's death, Wollaston had the accounts of the partnership verified. From the record dated 22nd February, 1815, it is possible to deduce that after Cary's commission of 10 per cent had been subtracted a further 10 per cent was deducted before the remaining sum was divided equally between the two partners

the profits from palladium sales were of no great benefit to Wollaston.

The agreement dated 1st February, 1809, thus refers to arrangements that, for both the platinum and palladium aspects, had been in effect from 1805. For the production of salt of sorrel and its sale to the textile industry, it appears as if all profits were divided equally right up to the time of Tennant's death. This may reflect the fact that Tennant was more active in this part of the business. He certainly played a major role in the marketing and sale of salt of sorrel, although there is no evidence that he was involved in its chemical production. Perhaps in recognition of this increased contribution, the two men decided not to reward Wollaston with a greater share of the salt of sorrel business, as implied by the 1809 agreement.

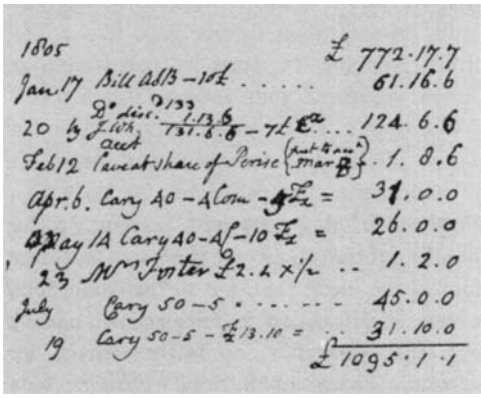

Fig. 4 Using these entries of credits from Cary, which occur in Wollaston's account book, it is possible to deduce the financial arrangements of the partnership. From the entry dated 6th April, the £40 remitted by Cary first has Wollaston's personal share deducted and then Tennant's partnership share of £5, leaving £31.0s.0d. as a credit for Wollaston's half of the partnership

The calculations shown in Figure 3 were part of the final accounting done after Tennant's death in order to reach a settlement with his executor. After calculating the income still due to him from the outset of the partnership, Wollaston determined that a payment of £304.16s.6d. to Tennant's executor would equalise the accounts. The person to whom the money was to be paid, Tennant's second cousin George Pryme, claimed however that Wollaston had failed to include in his calculations the value of the platinum scraps and salt of sorrel remnants that remained in his possession. Wollaston then added up the value of the sundry amounts of platinum residues, various salts, and acids. The total amounted to £234.16s.0d. Beside the sum is the comment "really due to survivor alone. Therefore offer 1/4. accepted" (30). When the quarter share (£58.14s.0d.) was added to the £304.16s.6d. originally offered, Pryme accepted. Some time after making

the payment Wollaston wrote in an account book "I paid too much forgetting the property tax which I should have to pay on joint account" (32). A decade later, after the salt of sorrel remnants and the various acids had been sold off, Wollaston had realised a net gain of only £2.14s.0d. and commented that this was all he had to show "at the end of 10 years, beside loss of labour etc. etc. and an amount of Property tax overlooked" (25). This written comment, placed on paper several years after the settlement, suggests that Wollaston judged the payment to have been too generous.

Tennant as the Indolent Partner

It becomes apparent that, apart from his financial involvement, Smithson Tennant's contributions to the success of the partnership were minimal. He took no part in the chemical purification or metallurgical processing that led to malleable platinum. Thus the agreement allowing Wollaston a greater portion of the profits of the joint business seems a just way of rewarding his greater efforts. Nevertheless, as the comments noted above suggest, Wollaston must at times have been irritated by the inequities of the partnership. One overt expression of such exasperation can be found in Wollaston's collection of offprints of his own published papers. In the paper in which Wollaston announced his discovery of palladium (33), he mentions the very hard grains of osmiridium which occur in the alluvial ore. Because of their anomalously high specific gravity, Wollaston suspected they might contain an unknown heavy metal. For their analysis, he separated some and gave them to Tennant. He wrote:

> "For this purpose I have selected a portion of them, and have requested Mr. TENNANT to undertake a comparative examination, from whose well known skill in chemical inquiries, as well as peculiar knowledge of the subject, we have every reason [*] to expect a complete analysis of this ore." (34)

Into this public affirmation of Tennant's chemical abilities Wollaston has pencilled into his private copy, at the point indicated by the asterisk, the words "barring indolence" (35). Wollaston's premonition was correct, for Tennant never published another paper relating to platinum metals. This reference to Tennant's indolence is not unique to Wollaston. Indeed, Tennant's inability to bring a task to completion was perhaps his most outstanding feature, evident even in his student years at Cambridge. In detailing the strengths and weaknesses of Tennant's intellect, his very close friend and biographer John Whishaw wrote:

> "His curiosity and activity were incessant; he had a vigilance of observation which suffered nothing to escape him, and was continually gaining new information from a variety of interesting sources. But although the knowledge thus acquired was remarkable for its correctness and complete for the purposes of its possessor; yet the industry and perseverance, by which it ought to have been embodied and made permanent for the benefit of others, were too often altogether wanting. The ardour and energy of Mr. Tennant's mind cooperated, unfortunately in this respect, with his want of method and of systematic habits of application; since he was constantly pressing on to new discoveries, instead of arranging and bringing to perfection those . . . he had already made." (36)

Tennant was aware that his lack of purpose could prove costly in the competitive world of science, and it almost cost him his priority in the discovery of iridium and osmium. As Tennant reveals in the paper, read to the Royal Society on 21st June, 1804:

> "Upon making some experiments, last summer, on the black powder which remains after the solution of platina, I observed that it . . . contained some unknown metallic ingredients. Intending to repeat my experiments with more attention during the winter, I mentioned the result of them to Sir JOSEPH BANKS, together with my intention of communicating to the Royal Society, my examination of this substance, as soon as it should appear in any degree satisfactory." (37)

Only the publications, in 1803, by Collet-Descotils, Fourcroy and Vauquelin, on the possible new metal in platinum residues prompted Tennant to publish his findings. His publication in *Philosophical Transactions* was Tennant's greatest chemical achievement, and earned him the Copley Medal of the Royal Society. In his congratulatory address, the President Joseph Banks deviates from the more usual formal words of praise to admonish

Smithson Tennant for failing to fulfil his potential:

> "Into your hands then Mr. Hatchett as the friend of Mr. Tennant, I deposit this unequivocal testimony of the gratitude and esteem of his applauding brethren, exhort him, Sir, I entreat you to continue his scientific labours and to increase if possible his diligence and assiduity. Talents like his deserve to be cultivated with increasing industry and uninterrupted patience; his chemical rivals admire him, the Royal Society esteem him, and the public looks up to him for farther improvements in his most useful pursuit.
>
> Assure him, Sir, that confiding in the gratitude with which the sight this medal will inspire him, I offer myself a willing pledge to the chemist, to the Royal Society, and to the public, that their expectations shall not be disappointed, but that his diligence in unraveling the mysteries of nature shall be unabated in future and that he will deserve at least as eminent success hereafter in disclaiming her eternal laws, as he has hitherto engaged." (38)

Yet neither the words of Banks nor the encouragement of his friends could bring Tennant to focus his energies on chemistry. His research work was essentially complete by 1804, and it was only through the efforts of Wollaston that the joint platinum business flourished.

Tennant has a place in the history of the platinum metals as the discoverer of iridium and osmium, but his contributions to the establishment of an effective, reliable process for malleable platinum were minor and predominantly financial. Wollaston's reputation as "the outstanding figure in the history of platinum" needs no revision.

Acknowledgements

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