Pierre Joseph Macquer

EARLY ATTEMPTS TO MELT PLATINUM

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The name of the chemist Pierre Joseph Macquer, who was born on 9 October 1718 and died two hundred years ago on 15 February 1784, is unknown to many historians of science, for he discovered few new substances and made no lasting contributions to chemical theory. He was, nevertheless, one of the most influential French chemists of his day (1).

Even before becoming a medical student he was interested in chemistry and after graduating in 1742 he practised for only a short time before devoting himself to chemical research. He was elected to the Paris Academy of Science in 1745 and began to concentrate on the practical applications of chemistry. In 1749 he found a method of dyeing wool and silk with Prussian blue, previously known only as an insoluble artists' pigment. He became more widely known through his two textbooks *Élémens de chymie théorique* (1749) and *Élémens de chymie pratique* (1751) which were reprinted several times and translated into English and other languages.

Jean Hellot (1685–1766), the government

Pierre Joseph Macquer

1718–1784

Originally a physician, Macquer was elected to the Académie des Sciences in 1745 and devoted himself to chemistry and its applications. He did much unpublished research as a consultant to various government establishments, but became well known through his text books and lectures. In 1758, with Antoine Baumé, he carried out the first investigation of platinum in France. Using a powerful burning mirror they melted the metal, but only in very small quantities, and he had no more success with a large alcohol-filled burning lens sixteen years later

Antoine Baumé
1728–1804

A pharmacist and manufacturer of fine chemicals, Baumé wrote successful text books on both pharmacy and chemistry, did much research, and was elected to the Académie des Sciences in 1772. From 1757 to 1773 he gave an annual course of chemistry with Macquer and, following their joint research on platinum in 1758, he continued to work on the metal and showed that it could be consolidated by heating and forging

inspector of the dyeing industries, appointed Macquer as his assistant, and in 1763 Macquer published an account of the art of silk dyeing, *"Art de la Teinture en Soie"*, part of the Academy's *Descriptions des Arts et Metiers*, a series of volumes intended to cover all the crafts practised in France. He also assisted Hellot at Sèvres, a small town between Paris and Versailles, known as "Seve" or "Seves" in the eighteenth century (2), where he was scientific adviser to the Royal Porcelain Works, and when Hellot died in 1766 Macquer succeeded him in both the dyeing and porcelain industries. In addition, he was appointed consultant to the Bureau de Commerce, the government department that controlled trade and industry. This highly-paid post was no sinecure and involved him in investigations, some of them secret, of other industries as well as porcelain and dyeing.

Macquer possessed two fine houses. "Clairefontaine" was his country retreat in the small village of Gressy about six leagues (30 km) east of Paris. His town house was in the Rue St. Sauveur, a street in an old part of Paris, north of the central markets, which ran off the Rue St. Denis, then one of the principal thoroughfares into the city. He was acquainted with Antoine Baumé (1728–1804), a pharmacist who at that time lived and worked in the Rue St. Denis and was building up a substantial business as a manufacturer of fine chemicals as well as supplying medicaments to the public. Baumé also carried out chemical research and read papers to the Academy, to which he was elected in 1772 (3). In the winter of 1757–58 Macquer and Baumé gave the first of sixteen annual courses of chemistry lectures, Macquer expounding the theory and Baumé demonstrating the experiments, so they were already colleagues when Macquer learnt about the properties of platinum and Baumé acquired a specimen of the metal.

Since 1750 Macquer had been one of the royal censors, responsible for approving books on chemistry, medicine and natural history. He was therefore the first person, after the author, to read the anonymous manuscript of a book entitled *La Platine, L'Or blanc ou le huitième métal*, to which he gave his approval on 20 October 1757 (4). It may be noted that the French called the metal "la platine" until the reform of chemical nomenclature in 1787 when it was decided that all metals should have the masculine gender, and it then became "le platine" (5). This interesting book, written by one Morin, who was most probably Jean Morin (1705–1764), a priest and scientist at Chartres, was published early in 1758 and contained an account of all the research so far published on the metal, which originated in

Spanish America and had only recently been introduced into Europe. In the summer of 1757, not long before Macquer approved Morin's manuscript, Baumé was given about a pound of native platinum by José Ortega y Hernandez (1703–1761), Apothecary to King Ferdinand VI of Spain, secretary of the Royal Academy of Medicine of Madrid since its foundation in 1734, and a corresponding member of the Paris Academy (6). The Spanish government was planning to found an Academy of Science in Madrid and wished to invite a few distinguished foreign scientists to be members. Ortega was sent abroad and entrusted with the delicate task of making discreet enquiries about the merits of potential candidates in different countries (7). He presumably made a report to the King and government on his return, but nothing came of the plan, possibly because most European countries were embroiled in the Seven Years War (1756–1763), and the Madrid Academy of Science was not founded until the nineteenth century.

During 1758 Macquer and Baumé carried out many experiments on Ortega's platinum, and Macquer read an account of their results at a public meeting of the Paris Academy of Science in November of that year, although it was not published until 1763 (8). Baumé could not be named in the title as one of the authors for he was not yet a member of the Academy, but Macquer made it clear that they were co-authors. They confirmed most of the early research described by Morin. They also recognised that the physical properties of platinum could be studied properly and any potential applications developed only if an ingot was prepared, so they attempted to melt it by subjecting it to intense heat. Most of the work was done at Sèvres. Heating platinum in the porcelain oven achieved nothing, so they then subjected it to five days and nights in the hottest part of the furnace of the Sèvres glassworks, which was associated with the porcelain factory and specialised in the production of wine bottles (9). Again, the platinum did not melt. Finally, they used their own laboratory forge, specially adapted with three bellows to provide a more powerful blast than usual, but even this severe treatment led only to partial agglutination of the original granular material. Macquer and Baumé decided that the platinum was contaminated with a base metal, probably iron, and they removed most of it by cupellation with lead in the porcelain oven at Sèvres, but still the platinum did not melt.

The Abbé Bouriot's Burning Glass

In a final attempt they heated a small portion in the focus of a burning mirror, a method tried by no previous workers on platinum. Burning mirrors were common in eighteenth-century chemical laboratories. They were often made of polished metal, but Macquer and Baumé used an exceptionally large one of silvered glass, 22 inches in diameter and with a focal length of 28 inches, which belonged to the Abbé Bouriot (10). At noon on 16 October 1758 when the sun was shining in a clear sky and their piece of platinum had been agglutinated in the Sèvres glass furnace they were at last able to melt it in five or six places. The molten globules solidified as soon as they were moved out of the focus of the mirror and could then be detached and examined. The platinum was found to be malleable, and Macquer and Baumé considered that its resistance to air, water and most reagents meant that it was suitable for making burning mirrors, telescope mirrors and vessels for the kitchen and the chemical laboratory.

They mistakenly thought that it had the same density as gold and might therefore be used to adulterate gold. They added an account of some of the reactions of a solution of platinum in aqua regia and announced that more details would be given in a subsequent paper, but this never appeared, and it seems that the joint research was not continued, probably because both men had other and more important occupations. Macquer's account of platinum in the first edition of his widely read *Dictionnaire de Chymie* (1766) contained no new information (11), but Baumé evidently carried out further research, and in his *Chymie expérimentale et raisonée* (1773) he announced the important discovery that cupelled platinum

The opening page of the paper by Macquer which was read to the Académie des Sciences in November 1758, but not published until 1763. The footnote indicates that Baumé was associated with the work but that as he was not then a member of the Académie his name could not appear as joint author

MÉMOIRE
SUR UN NOUVEAU MÉTAL
*Connu ſous le nom d'*Or blanc *ou de* Platine.

Par M. MACQUER. *

IL n'y a pas plus de dix-ſept ou dix-huit ans qu'on a commencé à avoir quelques notions, mais encore fort imparfaites & fort peu répandues, de la ſubſtance métallique qui eſt le ſujet de ce Mémoire. Ce métal duquel on peut eſpérer les plus grands avantages, eſt reſté enſéveli dans les mines de l'Amérique, & ignoré de toute la terre vrai-ſemblablement depuis le commencement du monde juſqu'à ces derniers temps. On ne peut néanmoins douter qu'il n'ait été connu des habitans du pays, & ſur-tout de ceux qui travaillent aux mines d'or dont on le retire, pluſieurs années avant que de l'être en Europe; mais probablement la première époque de ſa découverte ne remonte pas beaucoup au-delà, & quoiqu'elle ſoit encore ſi récente, il paroît qu'on n'en connoît guère mieux les circonſtances que de celles des anciens métaux dont les hommes ſe ſervent, pour ainſi dire, de temps immémorial. La difficulté preſqu'inſurmontable qu'il y a à fondre la platine, & par conſéquent à en tirer le même ſervice que des autres métaux, eſt peut-être la véritable raiſon pour laquelle on a fait ſi peu d'attention à ſa découverte.

Dès l'année 1741, M. Charles Wood, Métallurgiſte anglois, avoit déjà fait quelques expériences ſur ce nouveau métal; les travaux de ce Chimiſte ont été communiqués à la Société royale de Londres par M. Watſon en 1750, & ſe trouvent dans les Tranſactions philoſophiques de la même année. Depuis ce temps, M.rs Scheffer & Lewis ont donné chacun pluſieurs

* Ce Mémoire a été compoſé par M. Macquer, concurremment avec M. Baumé.

could be forged by hammering, without the addition of any other metal. He also corrected the error about its density, showing that it was in fact more dense than gold and was therefore less likely than previously supposed to be used as an adulterant. However, he described chemical tests that would detect platinum in gold and *vice versa*, for he considered the possibility that there might eventually be a time when platinum was the more valuable metal and gold an adulterant (12).

The government of Ferdinand VI had been reluctant to permit the export of platinum from Spain—the gift taken by Ortega to Baumé must have been an exception—but after Carlos III came to the throne in 1759 small samples were freely sent to foreign scientists, including Macquer (13). However, he did no further research on platinum until 1772, though he was, of course, very busy with other work, often concerning the applications of chemistry. In 1763, with Hellot and Mathieu Tillet (1714–1791), the Royal Commissioner for Assays and Refining at the Paris Mint, he improved and standardised the ancient method of assaying gold and silver by cupellation; he found that rubber, a recent introduction from South America, was soluble in ether; in 1768, after many years of research, he eventually located French deposits of kaolin from which

the craftsmen of Sèvres soon made fine porcelain; and in 1770 he was appointed to the prestigious chair of chemistry at the Jardin du Roi, now the Muséum d'Histoire Naturelle.

In 1772 Macquer collaborated with A. L. Lavoisier (1743–1794) and other academicians in research on the effect of heating diamonds. They were given permission by the Academy to use a very large burning lens, three feet in diameter, constructed by E. W. von Tschirnhaus (1651–1708), that had been given to the Academy about 1707, used only a few times and then kept in storage (14). Mirrors such as that used by Macquer and Baumé in 1758 had the disadvantage that they focused light on the heated specimen from below and it was difficult to keep it in the focus for any length of time. The glass of a lens absorbed some sunlight, but the specimen could be put on a fixed mount and by rotating the lens to follow the sun prolonged heating was possible. The lens was therefore preferred in 1772.

Further Experiments with Improved Burning Lenses

A similar Tschirnhaus lens, owned by the Comte de la Tour d'Auvergne, was lent to Macquer and his colleagues, and they used both lenses in a series of experiments between 14 August and 18 October 1772, generally adding a small auxiliary lens in the converging cone of light to bring the sun's rays to a smaller focus and reach a higher temperature. Only one experiment was performed on a diamond, but many other substances were heated and the results recorded. Manuscript notes were preserved by Macquer (15) and Lavoisier (16), and the preliminary results were reported to the Academy and published by Macquer (17). On several occasions platinum had been heated, but it never melted, and no more success was achieved when the work was resumed in the summer of 1773.

The glass of both lenses was badly flawed, causing excessive absorption of light, and it was recognised that a lens of water, enclosed in two segments of a glass sphere, would be better. Such a lens had been made and used by Buffon (18), but now alcohol was preferred, because it was less dense and had a higher refractive index. The lens, four feet in diameter, was made at the expense of J. C. P. Trudaine de Montigny (1733–1777), president of the Academy in 1773. With an auxiliary lens it brought the sun's rays to a focus less than an inch in diameter. A preliminary account of its use, read to the Academy on 12 November 1774, showed that it was more powerful than either of the Tschirnhaus lenses but, even so, native platinum was not melted. However, a specimen of purified platinum, prepared as a powder by the Count of Sickingen, was consolidated into a mass that could be flattened by hammering, and it was hoped that in more favourable weather it might be possible to melt this metal which had always proved so refractory (19).

Macquer's manuscripts contain details of further experiments with the Trudaine lens carried out on various dates in 1775 and 1776 (20). Purified platinum was at last melted on 28 April 1775, but there was no success with the same specimen on 29 April, even though the sky was still clear. In 1776 he published a short account of these later experiments and stated that the academicians intended eventually to publish all their results in a substantial book (21). However, this never appeared, and the lens does not appear to have been used regularly after 1776.

The explanation can be found in the long account of burning lenses given by Macquer in 1778, in the second edition of his *Dictionnaire de Chymie* (22). Dust and vapours in the atmosphere had a far greater effect than could have been anticipated. Before starting work he found it advisable to view a distant object and to note how clearly it could be seen. Often, in the course of an experiment lasting only a few minutes, the heated substance would suddenly cool and even solidify if it had been molten. In such a case there might be no noticeable change in the strength of the sun but on looking again at the distant object it was seen to be less distinct, indicating a small but important increase in atmospheric dust or vapour. Macquer went so far as to assert that there were

perhaps hardly seven or eight days in the year when conditions were entirely suitable, and he could not say how many times he had deserted essential occupations at ten o'clock in the morning in order to work with the lens when the weather appeared good, only to have to abandon his experiments as the air lost its clarity.

Lavoisier also became disillusioned with large lenses, and by 1789 was convinced that their great expense was not justified. He pointed out that they could not reach a high enough temperature to melt native platinum. Mirrors of comparable size were more effective, as had been shown by the success of Macquer and Baumé in 1758, but he reminded his readers that mirrors could only heat an object from below, and it could not be supported properly or heated for a long time (23). Macquer died five years before these words were written, but he had lived long enough to see platinum successfully melted by Lavoisier in 1782 at the very high temperature produced by the combustion of charcoal in a blast of oxygen (24).

References

1 See W. A. Smeaton, "P. J. Macquer" in C. C. Gillispie (ed.), "Dictionary of Scientific Biography", Scribner's Sons, New York, vol. 8, 1973, 618–624. A concise account of Macquer's published work is given by L. J. M. Coleby, "The Chemical Studies of P. J. Macquer", Allen & Unwin, London, 1938

2 Anon., "A Gazetteer of France", 3 vols., G. G. J. and J. Robinson, London, vol. 3, 1793, unpaginated

3 René Davy, "L'apothicaire Antoine Baumé", Imprimerie Coueslant, Cahors, 1955; H. Bonnemain *et al.*, "250^{e} anniversaire de la naissance d'Antoine Baumé", *Revue d'histoire de la pharmacie*, 1979, **26**, 5–60

4 D. McDonald and L. B. Hunt, "A History of Platinum and its Allied Metals", Johnson Matthey, London, 1982, 44–45

5 L. B. Guyton de Morveau *et al.*, "Méthode de Nomenclature Chimique", Cuchet, Paris, 1787, 54

6 José Ortega has sometimes been confused with his nephew Casimir Gomez Ortega (1741–1818), also a member of the Madrid Academy of Medicine and a corresponding member of the Paris Academy. They are clearly identified in "Index biographique ... de l'Académie des Sciences, 1666–1967", Institut de France, Paris, 1968, 413–414

7 Anon., "Noticia histórica ... de la Real Academia Médica de Madrid", *Memorias de la Real Academia Médica de Madrid*, 1797, 1, i–xiv (especially ix)

8 P. J. Macquer, *Mém. Acad. R. Sci.*, 1758 (1763), 119–133. See also Ref. 11

9 The glassworks is mentioned by A. Baumé, in the account of "Verrerie" in his "Chymie expérimentale et raisonée", Didot, Paris, vol. 3, 1773, 278

10 Bouriot, who has not been identified, was named as the owner by A. L. Lavoisier, "Traité élémentaire de chimie", Cuchet, Paris, vol. 2, 1789, 552–553

11 P. J. Macquer, *Dictionnaire de Chymie*, Lacombe, Paris, vol. 2, 1766, 248–263 (250–265 in some copies, see Ref. 22)

12 A. Baumé, *op. cit.* (Ref. 9), vol. 3, 121–206. In addition to his new work, Baumé gives further information about the joint work done with Macquer in 1758

13 *Op. cit.* (Ref. 4), 24

14 *Op. cit.* (Ref. 4), 66–69

15 Bibliothèque Nationale, Paris, MS. français 9132, ff. 261–290, nearly all in Macquer's hand. His last note refers to 18 October 1772

16 Archives de l'Académie des Sciences, Paris, Lavoisier dossier 1389* bis. These notes are fair copies, in the hand of a scribe, the last one being dated 13 October 1772. The same dossier includes rough notes in several hands, including those of Lavoisier and Macquer, of experiments performed in July and August 1773 and October 1774. The notes for 1772 and 1773 were published by J. B. A. Dumas (ed.), *Oeuvres de Lavoisier*, Imprimerie Impériale, Paris, vol. 3, 1865, 284–348

17 P. J. Macquer, *Observations sur la Physique*, 1772, December, 93–106; reprinted in *Introduction aux Observations sur la Physique*, 1777, **2**, 612–616

18 G. L. Leclerc de Buffon, *Mém. Acad. R. Sci.*, 1748 (1752), 308–309

19 J. C. P. Trudaine de Montigny *et al.*, *Mém. Acad. R. Sci.*, 1774 (1778), 62–72. Reprinted in *Oeuvres de Lavoisier* (Ref. 16), vol. 3, 274–283. The illustration of the lens is reproduced by D. McDonald and L. B. Hunt, *op. cit.* (Ref. 4), 67

20 *Op. cit.* (Ref. 15), ff. 181–182 and 291–294

21 P. J. Macquer, *Journal des Sçavans*, 1776, 561–563

22 P. J. Macquer, "Verre ardent" in *Dictionnaire de Chymie*, 2nd Edn., Didot, Paris, vol. 4, 141–194, especially 161–2. This edition was reprinted several times, with different volume numbers and pagination: see R. G. Neville and W. A. Smeaton, "Macquer's Dictionnaire de Chymie: a bibliographical study", *Annals of Science*, 1981, **38**, 613–662

23 A. L. Lavoisier, *op. cit.* (Ref. 10)

24 *Op. cit.* (Ref. 4), 69–71