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'A devotion to the experimental sciences and arts': the subscription to the great battery at the Royal Institution 1808–9[1]

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Abstract. A significant but neglected theme in the history of British science in the nineteenth century is the funding of institutional research. The subscription to the 'great battery' at the Royal Institution in 1808 and 1809 provides the first instance of named individuals prepared to commit themselves to the provision of apparatus to be used for research in the new field of electrochemistry. This paper analyses the subscribers who were deemed to be 'enlightened' and whom Humphry Davy subsequently described as 'a few zealous cultivators and patrons of science'. Using information from the subscription list, a distinction is made between the individual subscriptions pledged and the sums actually paid. In contextualizing the subscription, insights are provided into the Royal Society, the contemporary scientific community and the politics of metropolitan science. The voltaic subscription represents an early example of the repercussions of the nature of research funding for institutional finances and governance.

The Royal Institution (RI), founded in London in 1799, entered the year 1808 with mixed fortunes. It had achieved acknowledged scientific breakthroughs but was in a state of financial uncertainty. Humphry Davy, the resident professor, had recently gained outstanding experimental successes in the RI laboratory using different combinations of the voltaic pile. His first Bakerian lecture (1806), which had centred on 'some chemical agencies of electricity', had been internationally acclaimed. Of equal if not greater significance was the fact that in autumn 1807 Davy had isolated the metallic elements potassium and sodium.[2] Shortly after his second Bakerian lecture, read to the Royal Society on 19 November 1807, Davy became seriously ill and was virtually confined to his quarters at the institution for more than two months.[3] In January 1808 it was announced in Paris that Davy had been awarded Napoleon's prestigious prize of three thousand francs for the recently published paper in *Philosophical Transactions* of

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1 The phrase in the title of this paper is taken from Humphry Davy's introductory lecture on electrochemistry, expressing gratitude for the new battery at the Royal Institution. See *The Collected Works of Sir Humphry Davy* (ed. J. Davy), 9 vols., London, 1839–40, viii, 355–9.

2 H. Davy, *Elements of Chemical Philosophy*, London, 1812, 331.

3 J. Davy, *Memoirs of the Life of Sir Humphry Davy*, London, 1836, 110.

his first Bakerian lecture. Yet the postponement of Davy's lecture courses in chemistry and geology, due to illness, was already having serious effects on the institution's revenue.

The institution's battery, used by Davy for lecture demonstrations in the Theatre and for research purposes, had been in service for more than five years. Various attempts were made at the RI to provide more effective galvanic combinations with minimum financial outlay. However, when Davy read a further paper on electrochemical researches to the Royal Society on 30 June, a note was included on 'the state of the batteries' in which he conceded that the apparatus was 'quite worn out'.[4] By then Davy, prompted partly by intense Anglo-French rivalry, had become convinced that further development in electrochemistry, the 'new department of science', required the construction of a more powerful battery. In July a subscription was thus launched 'for constructing a voltaic apparatus on a great scale'. The 'great battery' was not to be for popular demonstration in the Theatre but 'for pursuing new researches in chemistry and natural philosophy' in the Laboratory.[5] The appeal was organized under RI auspices, but it quickly became known as 'Davy's subscription'. The response to it provides a rough measure of his esteem and popularity. In November 1809, in the fourth Bakerian lecture, Davy referred to 'a fund of upwards £1,000' having been raised by subscription.[6] The earliest biographies of Davy and family reminiscences provide highly favourable interpretations of the outcome of the subscription. Modern authorities have tended to write in similar terms.[7] There are, however, differences between the various published works about the precise details of the subscription for the RI battery. For example, statements of the sum raised range from £520 to about £1,000, the latter figure that which Davy himself used.[8]

The following paper attempts to resolve the differences in respect of the total sum pledged and that actually raised for the great battery and to provide an analysis of the subscribers who were deemed to be 'enlightened'. The subscription list is also examined in a broader context, providing insights into the politics of early nineteenth-century metropolitan science. Such approaches suggest the need for the revision of long-accepted views. Why did many of the subscription pledges fail to materialize in support of the country's most prestigious chemist, particularly when the battery appeal was couched in patriotic terms? Why did the battery subscription attract so little paid-up support from leading members of the RI and the Royal Society? What insights can be gleaned in respect of the support provided by different interests – agricultural,

4 H. Davy, 'Electro-chemical researches, in the decomposition of the earths …', *Philosophical Transactions of the Royal Society of London* (1808), **98**, 333–70, 334.

5 H. Bence Jones, *The Royal Institution: Its Founder and Its First Professors*, London, 1871, 355–6.

6 H. Davy, 'The Bakerian Lecture for 1809. On some new electro-chemical researches', *Philosophical Transactions of the Royal Society of London* (1810), **100**, 16–74, 74.

7 J. A. Paris, *The Life of Sir Humphry Davy*, 2 vols., London, 1831, i, 317; J. Davy, op. cit. (3), 117; M. Berman, *Social Change and Scientific Organization: The Royal Institution, 1799–1844*, London, 1978, 68; D. Knight, *Humphry Davy: Science and Power*, 2nd edn, Cambridge, 1992, 84.

8 Bence Jones, op. cit. (5), 356n.; and J. Z. Fullmer, 'Humphry Davy: fund raiser', in *The Development of the Laboratory* (ed. F. A. J. L. James), 1989, 11–21; J. Golinski, *Science as Public Culture*, Cambridge, 1992, 215.

commercial, artistic and professional – towards electrochemistry as a new field of scientific research?

Funding crisis at the Royal Institution of Great Britain

The postponement of Davy's lecture courses contributed significantly to the RI's funding crisis in 1808, although the underlying causes of near bankruptcy were systemic. The institution was proprietary and hereditary in character and, after the books were closed to new proprietors, partly dependent on life subscribers. Yet above all it relied on annual subscribers who could be attracted to the lecture courses in the experimental sciences and the arts as well as to other institutional benefits, including public experiments, the library and reading rooms, and the collections of models and minerals. In 1807 and 1808, with no new proprietors or life subscribers and with a fall of almost 50 per cent in annual subscriptions, the institution's income fell from £4,141 to £1,560, of which sum annual subscriptions made up more than 90 per cent.[9] This was a low point in the institution's early history, comparable to the crisis of 1803, and its acute financial state prompted the Visitors to include a valuation of the institution's assets.

In mid-January 1808 the managers authorized the publication of a circular on 'New discovery in chemistry', which provided a bulletin on Davy's health and emphasized the institution's role in Davy's successful decomposition of potash and soda, which 'may justly be placed amongst the most brilliant and valuable discoveries which have ever been made in chemistry', so that his 'country, with reason, will be proud of him; and it is no small honour to the Royal Institution that these great discoveries have been made within its walls'.[10]

In mid-March Davy resumed his professional duties. His courses on electrical–chemical science, the first ever on the new subject, and on geology attracted large audiences to the Theatre.[11] His research experiments in the Laboratory recommenced on 19 April but efforts to isolate the alkaline earth metals proved difficult given the further deterioration of the institution's battery.[12] The managers decided to construct in the basement Laboratory 'a new and much more powerful combination … consisting of 500 pairs of double plates of 6 inches square', no doubt by using those parts of the voltaic apparatus still functioning. Experiments were restarted in May but, once again, gave somewhat disappointing results.[13]

International competition in the new field of electrochemical analysis was intense. Volta's pile, which Davy would term the 'alarm bell for experimenters', was being developed in more than a dozen European cities. At a time of major European war, an international race was under way for more powerful voltaic apparatus to be used for the isolation of further elements. In France, for example, an order was given, apparently

9 Bence Jones, op. cit. (5), Appendix III, 425.
10 RI Archives, 'New discovery in chemistry' (printed circular), 18 January 1808.
11 H. Hartley, *Humphry Davy*, London, 1966, 60; Paris, op. cit. (7), i, 294–5; Davy, op. cit. (2), 128.
12 T. E. Thorpe, *Humphry Davy*, London, 1896, 126.
13 Davy, op. cit. (4), 336.

at government level, to construct a new voltaic pile of unprecedented power.[14] The direction of Davy's work at this time was largely shaped by rivalry with Joseph-Louis Gay-Lussac, professor of physics at the Paris Faculty of Science, and his associate Louis Jacques Thenard, professor at the Collège de France. Rivalry also persisted between Davy and the Swedish chemist Jons Jacob Berzelius, professor at Stockholm University. In June 1808 the experiments of Berzelius on the isolation of barium were repeated by Davy, although this work has been described by at least one later authority as 'hurried'.[15]

A sponsored appeal to the enlightened

In his paper 'Electro-chemical researches on the decomposition of the earths', read to the Royal Society on 30 June 1808, Davy indicated that the metal plates of the RI battery were so eaten away as to make them useless.[16] Thus on 11 July, frustrated by the continued shortcomings of the laboratory apparatus and apprehensive that more powerful batteries were becoming available elsewhere, particularly in Paris, Davy petitioned the managers, his employers:

> A new path of discovery having been opened in the agencies of the electrical battery of Volta, which promises to lead to the greatest improvements in Chemistry and Natural Philosophy, and the useful arts connected with them; and since the increase of the size of the apparatus is absolutely necessary for pursuing it to its full extent, it is proposed to raise a fund by subscription, for constructing a powerful battery, worthy of a national establishment, and capable of promoting the great objects of science. Already, in other countries, public and ample means have been provided for pursuing these investigations. They have had their origin in this Country, and it would be dishonourable to a nation so great, so powerful, and so rich, if, from the want of pecuniary resources, they should be completed abroad. An appeal to enlightened individuals on this Subject can scarcely be made in vain. It is proposed that the instrument and apparatus be erected in the Laboratory of the Royal Institution, where it shall be employed in the advancement of this new department of science.[17]

For Davy electrochemical research was a fertile but largely unexplored territory that could be opened up with a more powerful battery. Given the unsatisfactory state of the institution's finances a subscription seemed an appropriate mode for funding the new battery. Subscription by proprietors had marked the foundation of the institution and the method had been adopted, with varied degrees of success, in the case of both the library and the Collection of Minerals.

In the institution's early years three managers – Thomas Bernard, Charles Hatchett and Lord Dundas – had provided Davy with support and encouragement. They proved

14 For the French background see G. Sutton, 'The politics of science in early Napoleonic France: the case of the Voltaic pile', *Historical Studies in the Physical Sciences* (1981), **11**, 329–66.

15 Hartley, op. cit. (11), 61: 'In a race with Jacob Berzelius in Sweden, [Davy] isolated the alkaline earth metals'; D. Knight, 'Establishing the Royal Institution: Rumford, Banks and Davy', in *'The Common Purposes of Life': Science and Society at the Royal Institution of Great Britain* (ed. F. A. J. L. James), Aldershot, 2002, 113.

16 F. Kurzer, 'William Hasledine Pepys FRS: a life in scientific research, learned societies and technical enterprise', *Annals of Science* (2003), **60**, 137–83, 165.

17 Quoted in Paris, op. cit. (7), i, 316.

particularly active in promoting the new battery. During an earlier period of financial difficulty they had played a key role in urging the institution to enlarge and re-equip the basement Laboratory and an adjacent theatre 'for those who attend the experiments of research'.[18] The Laboratory as improved in 1803 and 1804 was said to be equal to any in the country and was one of the best in Europe.[19] When these three managers (together with William Watson) considered Davy's proposal of 11 July 1808, it was minuted that

> their indispensable duty [was] instantly to communicate the same to every member of the Royal Institution, lest the slightest delay might furnish an opportunity to other Countries for accomplishing this great work, which originated in the brilliant discoveries recently made at the Royal Institution.[20]

In planning the voltaic subscription a number of preliminaries were necessary: agreement on a notional if publicly unstated figure as to the sum likely to be required for the construction and installation of the battery, compilation of a list of sponsors or 'underwriters' whose names could be published to attract subscribers, and agreement on a statement of intent to accompany the printed appeal. These procedures required skills of personal tact and persuasion, particularly since an earlier RI subscription for a mineral collection, with which Bernard, Hatchett and Davy had been associated, had not been a success. In the ten years after 1799 laboratory expenditure was shown in the institution accounts under the heading 'Lectures'. The average annual expenditure for the Laboratory was approximately £600, of which some £140 was spent on apparatus and chemicals and the remainder on the salaries of professors and their assistants.[21] The statement of the accounts published for the years 1809–10, in which the new battery appears as a specific expenditure item, shows that approximately £600 was laid out on the voltaic apparatus. Given that actual expenditure on an undertaking has a tendency to exceed projections, it seems probable that such a sum would represent a notional understanding of the maximum fund required, at least as perceived in July 1808.

Within a fortnight of Davy's letter sixteen sponsors together with the five managers who approved an accompanying printed circular represented the initial core pledges for the undertaking. The wording of the appeal to proprietors, life subscribers and annual subscribers was almost identical to that of Davy's petition to the managers, but with greater emphasis on national pride. It was addressed to 'enlightened Individuals' and the arrangement of the names provides an insight into the breadth of the appeal 'towards this important National Object' (Table 1). The sponsors' list was headed by three of the leading patrons of science. In the thirty years since his election to the presidency of the Royal Society, Sir Joseph Banks had come to dominate science in England. Little could happen in the scientific community without his cognizance. It was Volta's letter to Banks in 1800 that has sometimes been regarded as instigating the 'age of current electricity' in England. Sir James Hall, a distinguished chemist and mineralogist, was

18 D. Chilton and N. G. Coley, 'The laboratories of the Royal Institution in the nineteenth century', *Ambix* (1980), **27**, 173–203, 176, Plates 1 and 2.

19 F. A. J. L. James (ed.), '*The Common Purposes of Life': Science and Society at the Royal Institution of Great Britain*, Aldershot, 2002, 8.

20 RI Managers Minutes (hereafter RI MM), 11 July 1808.

21 Chilton and Coley, op. cit. (18), 179.

Table 1. *Sponsors of the 'great battery': 25 July 1808 (arranged seriatim from 'Subscription for constructing a Voltaic Apparatus on a Great Scale', RI Archives)*

Name	Pledged (Pl) £	Paid (Pd) £	Description (1) *c.*1885–1895	Description (2) *c.*2004	LGS
Banks, Sir J.	30		president of Royal Society	naturalist; patron of science	1808
Hall, Sir J.	30		geologist; chemist	chemist; geologist	1808
Greville, C. F.	30			mineralogist; horticulturist	1808
Clifford, R.	5g (guineas)		*mineralogist and crystallographer*		–
Pepys, W. H.	10		man of science	instrument-maker; nat. phil.	1807
Allen, W.	10		man of science; philanthropist	philanthropist; scientist	1807
Greenough, G. B.	10	10	geographer; geologist	geologist	1807
Solly, R. H.	10	10	*mercantile/professional/landed*		1813
Solly, S. R.	10	10	*family with geological interests*		1823
Solly, S.	10	10			1810
Davy, H.	10g	10g	natural philosopher	chemist; inventor	1807
Garthshore, M.	10g		physician	physician accoucheur	–
Children, J. G.	10		secretary of Royal Society	chemist	1808
Moore, D.	10g		*barrister; legal adviser to RI*		1812
Dundas, Lord	30	30		landowner; politician	1812
Bernard, T.	21	21	philanthropist	philanthropist	–
Watson, W.	10g	10g			–
Hatchett, C.	21	21	chemist	chemist	1809
Auriol, J. P.	5g		*RI secretary*		–
Home, E.	10g		surgeon	surgeon	1819
Englefield, Sir H.			antiquary; scientific writer	antiquary; writer on science	1811
TOTAL 21	295	133	(level of response – sums pledged/sums paid = 45%)		

Notes

Description (1) = *Dictionary of National Biography* (*DNB 1885–c.1895*).

Description (2) = *Oxford Dictionary of National Biography* (*ODNB 2004*).

Descriptions: As recorded in (1) and (2) these are authored or editorial interpretations of selected life or career features, and may highlight short periods or episodes e.g. John George Children was RI secretary 1826–7 and 1830–7. The term 'scientist' (W. Allen) was not coined until the 1830s. *Descriptions in italics are for individuals who do not have discrete entries in either DNB or ODNB.*

LGS (date): membership of Geological Society of London and entry date. Banks and Davy withdrew in 1809; Davy later re-elected 1815.

RI Proprietors (1807 list): Auriol, Banks, Bernard, Clifford, Dundas, Englefield, Garthshore, Hatchett, Home, Moore, Pepys, Solly (S. R.), Solly (S.), Watson.

RI Managers: Auriol (*manager and secretary*), Bernard (*manager and vice-president*), Dundas, Hatchett, Watson.

one of the leading members of the scientific community in Scotland and sometime president of the Royal Society of Edinburgh. Charles Francis Greville, a distinguished collector of minerals, is described, contentiously, in a recent biographical sketch as 'a patron of science almost on a par with Joseph Banks'.[22] Together, Banks, Hall and

22 RI Archives, printed circular to proprietors and subscribers, 25 July 1808. For Banks, Hall and Greville see *ODNB* (2004).

Greville pledged more than 30 per cent of the sponsors' promises, though none materialized in actual payment.

Accounting for differences

Secondary sources provide varying accounts of how much was actually raised by the subscription for the great battery. These estimates range from £520, according to Bence Jones (1871) and Fullmer (1989), to £1,000, as claimed by Golinski (1992) and Kurzer (2003).[23] Printed primary sources present similar differences: the *State of Accounts ... 1809* recorded the figure of £578 for the voltaic battery; whereas Davy, in the same year, referred to 'a fund of upwards £1,000' having been raised for the battery and 'other instruments applicable to new researches'.[24] Although it was the managers who had taken the necessary steps to launch the voltaic subscription, it quickly became referred to as 'Davy's subscription' and he was advised to adopt a high profile. Thus when the managers met on 1 August 1808 they agreed that 'the subscription books for prosecuting Mr Davy's Discoveries be laid upon the Tables in the Public Rooms, and that they be written up every evening'. At the same time Davy was asked 'to consider of the Propriety of advertising the Subscription for the Encrease [*sic*] of the Galvanic Battery, and to give directions accordingly'.[25]

Given that the battery subscription provided a measure of the esteem in which Davy was held, it was perhaps to be expected that he would emphasize a successful outcome of the appeal: 'the promptitude with which the subscription filled was so great, as to leave no opportunity to many zealous patrons of science for showing their liberality'.[26]

The earliest biographies and family memoirs also provided a highly favourable interpretation of the subscription. When *The Life of Sir Humphry Davy* was published shortly after his death, the biographer concluded, 'To the great gratification of Davy, and to the honour of the country, the list of subscribers was soon completed, and one of the most magnificent batteries ever constructed was speedily in full operation'.[27] In the mid-1830s Davy's brother offered a similar interpretation: 'When it appeared advantageous to have a battery still more powerful, one of 2000 plates was constructed without delay, through the munificence of a few individuals, for the service of science'.[28] Later authorities have tended to write along similar lines. For example, the standard modern study of Davy has affirmed that he was provided with a bigger and better voltaic battery 'thanks to the generosity of the supporters of the Royal Institution'.[29]

23 Bence Jones, op. cit. (5), 356n.; Fullmer, op. cit. (8), 15; Golinski, op. cit. (8), 216; Kurzer, op. cit. (16), 163.

24 *State of Accounts ... 1809*. British Library (BL) 1889.e.11 Pepys Papers; Davy, op. cit. (6), 74. Davy's fourth Bakerian lecture, read to the RS, 16 November 1809.

25 RI MM, 1 August 1808.

26 Davy, op. cit. (1), viii, 355.

27 Paris, op. cit. (7), i, 317.

28 Davy, op. cit. (3), 117.

29 Knight, op. cit. (7), 84.

However, to understand fully the battery appeal of 1808 and 1809 it is necessary to examine the manuscript subscription book in the institution's archives.[30] An analysis of the list permits a distinction to be drawn between the sums *pledged* and the pledges *honoured*, an important factor when considering the timing and dynamics of the voltaic subscription. Thus it appears that eighty pledges were made, totalling £1,012 10s. 0d. Of those pledges, fifty were made good by payments that amounted to £573 5s. 0d. This latter sum corresponds well to the figure of £578 that appears in the published *State of Accounts … 1809*.[31] The primary source also provides evidence that the subscription, usually considered to be both straightforward and speedily accomplished, was more complex. For example, the subscription book remained open for thirty-six weeks from July 1808 until 26 March 1809, to raise a sum of less than £600. Although there was a favourable initial response, at least in terms of pledges, payments came in slowly. By 10 August thirty-nine names had pledged a total of £530, close to the notional sum required. Those managing the subscription, Bernard and Hatchett, were faced with a dilemma: should the list be closed with the expectation that the pledged sums would, in time, be paid? With their experience of subscriptions, another course was adopted. Bernard doubled his original subscription of ten guineas, and paid up – almost certainly an attempt to influence those who had pledged to actually pay. Two months later, when the sums pledged stood at more than £900, Hatchett also made a second subscription and paid a further ten guineas. Significantly, of the last ten subscribers on the list, nine are recorded as having fulfilled their pledges; this is in contrast to the first ten, of whom six did not pay the sums affixed to their names, including the president of the Royal Society of London and the sometime president of the Royal Society of Edinburgh. There appears to have been no official 'closure' date for the subscription, merely the initial 'B' alongside the last name on the list (most likely that of the vice-president and leading sponsor Thomas Bernard) as he signed off the account. Bernard had served as first treasurer of the RI and was also treasurer of the Foundling Hospital between 1795 and 1806.

Levels of expectation and response

The identifiable group that might most have been expected to contribute to the battery were the twenty-one sponsors who had agreed to their names being circulated with the printed appeal (Table 1), representing 26 per cent of the final subscription list of eighty. Their pledges amounted to £295 (29 per cent of the total pledged). However, only nine of this group (43 per cent) honoured their pledges and paid £133 (45 per cent response), representing 23 per cent of the total sum of £573 5s. 0d. raised. This response was well below expectation given that, overall, 63 per cent of eighty subscribers actually honoured their pledges and paid 57 per cent of the total sums promised. According to the standard work on the institution's early years, 'the cost of the new battery was

30 RI Archives, Box File IIA, Item 81, 'Subscription for constructing A Voltaic Apparatus on a Great Scale for pursuing New Researches in Chemistry and Natural Philosophy'.

31 *State of Accounts … 1809*, op. cit. (24).

Table 2. *Comparisons of RI subscriptions 1804–9: The library, Mineral Collection and voltaic apparatus*

Position in RI	No. (1807 list)	No. subscr. (library and books)	Amount subscr. (library and books)	%	No. subscr. (mineral collection)	Amount subscr. (mineral collection)	%	No. paid (battery)	Amount paid (battery)	%
			£5,720.00.00.			£992.00.00.			£573.05.00.	
President	1	1	£100.00.00.							
V. Pres.	3	2	£200.00.00.		1	£100.00.00.		1	£21.00.00.	
Secretary	1	1	£10.10.00.							
Treasurer	1	1	£100.00.00.							
Managers	11	10	£707.05.00.		1	£100.00.00.		4	£91.10.00.	
Visitors	15	10	£409.10.00.		4	£121.00.00.		2	£20.00.00.	
Office-holders	32	25	£1,527.05.00.	27	6	£321.00.00.	32	7	£132.10.00.	23
Non-Officials	342	144	£4,192.15.00.	73	10	£671.00.00.	68	43	£440.15.00.	77
TOTAL	374	169	£5,720.00.00.	100	16	£992.00.00.	100	50	£573.05.00.	100

Note

RI Archives: A List of the Subscribers to the Library of the Royal Institution, 10 June 1804; Subscription to the Mineralogical Collection and Office of Assay; Subscription for constructing A Voltaic Apparatus on a Great Scale for pursuing New Researches in Chemistry and Natural Philosophy.

RIMM 22 April 1805. 'The number of the Proprietors of the Institution shall be limited to 400; and for all new elected Proprietors the qualification shall not be less than 150 guineas.'

heavily subscribed to by the governors and Proprietors'.[32] That interpretation can be re-examined by comparing the voltaic subscription with two other quasi-contemporary subscriptions that were taken earlier in 1804 (Table 2). The sums subscribed, £5,720 in the case of the library and £992 for the Mineralogical Collection and Office of Assay, reveal differences in the level of official support. Analysis of the sources provides evidence that, in respect of sums actually paid, the battery subscription was the least well supported by the office-holders of the RI. Of the 374 proprietors listed in 1807, a total of thirty-two were designated office-holders: eleven of these (eight managers and three Visitors) pledged £209 15s. 0d. in total; however, only seven pledges materialized, amounting to £132 10s. 0d. Of those proprietors accorded an official RI role in the 1807 list, twenty-five (78 per cent) did not support the battery subscription. These included the RI president, two of those designated vice-president and the RI treasurer, while the RI secretary pledged five guineas but did not pay. Such statistics suggest that the battery appeal, even when pitched in patriotic and institutional terms, did not receive the kind of official endorsement that later authorities have often implied.

A similar situation of unredeemed pledges is apparent when the proprietorship as a whole is examined (Table 3). Nineteenth-century society was marked by an acute awareness of, and deference to, title and social rank. Thus it might be expected that

32 Berman, op. cit. (7), 68.

Table 3. *Analysis of proprietors (1807): titles and non-titles and the sums pledged and paid to the voltaic subscription (1808–9)*

	No. pledged	%	Sums pledged	%	No. paid	%	Sums paid	%	% Pledged/ paid
Proprietors with titles	10	12	£191.15.00.	19	5	10	£95.00.00.	17	50
Proprietors with no titles	40	50	£519.05.00.	51	26	52	£343.15.00.	60	66
Non-proprietors with titles	7	9	£131.15.00.	13	0	0	–	0	0
Non-proprietors with no titles	23	29	£169.15.00.	17	19	38	£134.10.00.	23	79
TOTAL	80	100	£1,012.10.00.	100	50	100	£573.05.00.	100	

Analysis based on *A List of the Proprietors of The Royal Institution of Great Britain* (April 1807); subscriptions for: RI Library/Books (1804), Mineralogical Collection and Office of Assay (1804) and 'Subscription for constructing a Voltaic Apparatus on a Great Scale for pursuing New Researches in Chemistry and Natural Philosophy'. RI Archives.

titled RI proprietors would have contributed generously to the voltaic subscription, particularly since it was promoted partly in terms of patriotism and science and of meeting a perceived challenge from France. Of the 374 proprietors listed in 1807, a total of ninety-six are accorded titles. But only ten of these pledged a total of £191 15s. 0d., of which £95 (approximately 50 per cent) was actually paid, constituting approximately 17 per cent of the final sum (Table 4). In marked contrast, nineteen life and annual subscribers pledged £169 15s. 0d. and paid £134 10s. 0d. (79 per cent response), which exceeded the contributions and levels of response of both the twenty-one sponsors and the RI officers.

Given the connection between the RI and the Royal Society, it might be expected that the Fellows would contribute generously to the voltaic subscription. Davy was one of the secretaries of the Royal Society (1807–12) and his seminal work on galvanism and electrochemistry had been announced in the Bakerian lectures and subsequently published in *Philosophical Transactions*, for which Davy had editorial responsibilities. Of the 374 proprietors of the RI listed in 1807 it appears that sixty-two were Fellows of the Royal Society (FRS). Of that number, twelve FRS pledged a total of £209 5s. 0d., although their associations were often multifarious in relation to both the RI and the Royal Society. Thus five FRS paid a total of £112 towards the battery, but three of these were managers of the RI. Those FRS who failed to pay towards the new RI battery included the president, who pledged but did not pay, and the vice-presidents of the Royal Society, neither of whom subscribed. Nor is there any record of support from William Hyde Wollaston, the other Royal Society secretary at this time, and a friend of Davy. Another FRS who pledged £30 towards the battery but did not pay was Henry Cavendish, the outstanding natural philosopher of the age.

The standard history of the RI emphasized the close managerial links between the RI and the Board of Agriculture. However, of the RI proprietors who were also important members of the Board of Agriculture only two, Thomas Bernard and the Earl Spencer,

Table 4. *Proprietors: titled proprietors (1807) and battery subscription (1808–9) – analysis*

Title	No.	No. pledged	Subscription pledged	No. paid	Subscription paid
Duke	3	–	–	–	–
Marquis	2	1	£30.00.00.	–	–
Earl	21	1	£30.00.00.	1	£30.00.00.
Viscount	3	–	–	–	–
Count*	1	–	–	–	–
Rt. Hon.	24	2	£40.00.00.	2	£40.00.00.
Hon.	10	1	£5.05.00.	–	–
Baronet	27	4	£55.00.00.	2	£25.00.00.
Knight	3	–	–	–	–
Bishop	2	1	£31.10.00.	–	–
TOTAL	96	10	£191.15.00.	5	£95.00.00.

* Count Rumford – Count of the Holy Roman Empire.

Analysis based on *A List of the Proprietors of The Royal Institution of Great Britain* (April 1807); subscriptions for: RI Library/Books (1804); Mineralogical Collection and Office of Assay (1804) and 'Subscription for constructing a Voltaic Apparatus on a Great Scale for pursuing New Researches in Chemistry and Natural Philosophy'. RI Archives.

made contributions to the battery. Neither the bishop of Durham nor Sir Joseph Banks redeemed their substantial pledges. Earl Spencer, an RI manager and member of the Committee of Science that had been instrumental in the development of the basement Theatre and Laboratory in 1803 and 1804, was a leading agricultural improver. By 1808 he had retired from national politics to devote his time to scientific, literary, artistic and philanthropic interests. He was one of the leading bibliophiles in Europe and later served as president of the RI.[33] Another landowner and Whig politician with scientific interests was Lord Dundas, an early RI proprietor, member of the RI Chemistry Committee and promoter of the Mineralogical Collection. His estates included an alum works and an alkali works. As an improving landowner with an interest in agricultural chemistry, he had employed Davy to carry out soil analyses.[34] The combined contributions to the 'great battery' from Spencer, Dundas and Bernard amounted to £81. The relative responses of the different occupational groups that supported the subscription contrasts markedly with the accepted view of the composition of the RI management in its early years, that accorded pride of place to the agricultural interest (Table 5).

Science, metropolitan politics and the arts

Given that support for the new voltaic battery from the RI's and Royal Society's principal office-holders and from the landowning interest almost certainly fell below the

33 *ODNB* (2004), entry for George John Spencer, second Earl Spencer (1758–1834).

34 *ODNB* (2004), entry for Thomas Dundas of Kerse (1741–1820).

Table 5. *The battery subscription: occupational groups and interests*

Group category	No. in group	Pledged *expectation*	Paid *response*	% *response*
Commerce, banking, insurance	14	£187.00.00.	£151.05.00.	81
Manufacturers	4	£36.05.00.	£25.15.00.	71
Lawyers, barristers	4	£36.05.00.	£25.15.00.	71
Medicine: doctors, surgeons	6	£62.10.00.	£41.10.00.	66
Official posts	3	£25.15.00.	£15.05.00.	59
Philanthropists	2	£42.00.00.	£21.00.00.	50
Landowners	7	£176.10.00.	£60.00.00.	34
Independent (*geological interest*)	7	£75.15.00.	£20.10.00.	27
Chemists/instrument-makers	6	£101.00.00.	£21.00.00.	21
Churchmen/clergy	4	£47.05.00.	£5.05.00.	11
No located category: *proprietors*	9	£113.10.00.	£103.00.00.	91
No located category: *non-proprietors*	14	£98.05.00.	£83.00.00.	84
SUB-TOTAL		£1,002.00.00.	£573.00.00.	
Not accounted (1%)		£10.00.00.	£10.15.00.	
TOTAL	80	£1,012.00.00.	£583.15.00.	

promoters' expectations, who were the subscribers prepared to fund research in the new field of electrochemistry? The best response came from two groups who cannot be readily categorized in terms of occupational background or interest, but who can be distinguished in terms of RI proprietorship (Table 5). The non-proprietors who paid for the great battery were almost all annual or life subscribers who, like the proprietors, had been impressed by Davy's consummate ability in communicating enthusiasm for chemistry and geology. One later authority described his skills in the RI Theatre as a fund-raiser:

> Were Davy to have a newer and stronger battery, which he indeed wanted, money to buy it could come from one source, his audience. Discreetly he implied that the noble tradition of 'British science' should be continued. In his lectures Davy proved deft at stirring the hearts of his hearers, at engaging them intellectually, and especially at arousing those impulses that opened pocket books.[35]

A concentration on Davy as catalyst for the subscription almost certainly underplays the multifarious activities of Thomas Bernard and his role in promoting the RI in the years after the withdrawal of its founders, Count Rumford and Sir Joseph Banks. The shift of institutional direction away from the application of science 'to the common purposes of life' and towards the provision of fashionable lectures in a broad range of science and arts subjects was manifested in the programme that Bernard, as director of RI courses and with Davy's assistance, succeeded in promoting. Bernard and Davy had

35 J. Z. Fullmer, 'Humphry Davy, reformer', in *Science and the Sons of Genius: Studies on Humphry Davy* (ed. S. Forgan), 1980, 59–74, 70.

a devotion to both the experimental sciences and the arts, moving easily between different intellectual pursuits in an age as yet undivided by 'two cultures'.[36]

Response to the battery subscription requires an understanding of metropolitan institutions and intellectual life that goes beyond a view of the appeal as merely an episode in the internal affairs of the RI. For example, more than a quarter of the money provided for the great battery came from mercantile, banking and insurance interests, who were RI proprietors and library patrons, and leading figures in the London Institution (LI), which was partly conceived to bring 'science and commerce into contact'. These subscribers were also associated in the British Institution (BI) of Fine Art, which Thomas Bernard had founded in 1805. They included Sir Francis Baring, the most prestigious financier of the day with an annual income of some £80,000;[37] John Julius Angerstein, a leading figure in the Lloyd's insurance market;[38] and the banker Claude Scott, a self-made entrepreneur and government corn contractor, reputed to be worth £300,000.[39] Other noteworthy battery subscribers included Thomas and Henry Philip Hope, descendants of a leading family of Amsterdam and London merchants and bankers. As connoisseurs of the fine arts they were associated with Baring, Angerstein and Scott in the BI. David Pike Watts, LI member, BI associate and an RI proprietor, library patron and subscriber to the Mineralogical Collection, also gave generous support to the battery. Watts, uncle of the painter John Constable, had inherited a considerable fortune from his employer, a London wine merchant, and gave large sums to charity.[40] Thus these highly successful businessmen, Angerstein, Baring, Scott, Watts and the Hopes, whose presence is recorded at the *conversaziones* of Hanoverian London and at the art exhibitions of the Royal Academy and the BI, were also supportive of the great battery of the RI.

Medical connections

The influence of Thomas Bernard, whose enlightened philanthropy embraced a number of 'improvement' causes, can also be identified among the medical subscribers to the great battery. With fellow philanthropist William Wilberforce, whose battery pledge of £21 went unpaid, Bernard favoured the promotion of the new practice of vaccination, endeavouring to secure appropriate recompense for its pioneer, Edward Jenner, an annual subscriber to the RI. Among the battery subscribers may be noted 'Dr Jenner'

36 For example, in 1805 Davy contributed the prologue to *The Honey Moon*, a comedy performed at the Theatre Royal, Drury Lane; two years later Davy wrote 'Parallels between art and science', an essay for a short-lived journal, *Director*, of which Bernard was founder–proprietor. J. Z. Fullmer, *Sir Humphry Davy's Published Works*, Cambridge, MA, 1969, 47, 50.

37 R. G. Thorne, *History of Parliament: The House of Commons 1790–1820*, 5 vols., London, 1986, iii, 140. Sir Francis Baring (1740–1810) sat for four Parliamentary constituencies in the years 1784–1806, when he retired from the House of Commons.

38 *ODNB* (2004), entry for John Julius Angerstein (1735–1823).

39 Thorne, op. cit. (37), v, 104–5. Scott was MP for Malmesbury 1802–6 and Dungannon 1809–12.

40 D. P. Watts hosted a number of dinner engagements attended by the artist Joseph Farington. See *The Diary of Joseph Farington RA, 1793–1821* (ed. K. Garlick, A. MacIntyre and K. Cave), 17 vols., New Haven, CT, 1978–99.

(five guineas). The varied career of John Walker, who paid a battery contribution of £21, encompassed engraved metalwork, teaching, authorship and medicine. From 1800 Walker became involved in vaccination and, after a controversy with the Royal Jennerian Society, set up the London Vaccine Institution, the most successful vaccine charity of its day. Walker, an early RI proprietor, espoused a number of enlightened causes, including opposition to slavery, to the employment of children as chimney sweeps and to animal cruelty.[41] Another medical subscriber, the physician and army surgeon John Warren (who made a battery contribution of £10), had, like Davy, explored the possibilities of pneumatic therapy.[42]

During his time at Beddoes's Pneumatic Institution at Clifton between 1798 and 1801, where he had first encountered the challenge of raising funds for research, Davy had become acquainted with various members of the Boulton and Wedgwood families. Before his early death Thomas Wedgwood had engaged in experiments in the RI Laboratory on 'silver pictures'.[43] As early as the 1750s Matthew Boulton, the Birmingham engineer and manufacturer, had a small collection of books on electricity and was prominent among the group of industrialists and men of science in the Lunar Society that also included Josiah Wedgwood and Joseph Priestley.[44] The names of Matthew Boulton and Josiah Wedgwood II appeared in the 1807 list of RI proprietors and are included as battery subscribers in 1808, the former contributing ten guineas and the latter pledging £10, which went unredeemed. Another battery contributor with manufacturing associations was Alexander Blair (£10 paid), who had interests in a chemical works at Tipton near Birmingham. In the early years of the RI, Blair was the only manufacturer who rose to governorship.[45] The Lunar men of the Midlands, several of whom Davy had visited in Birmingham and with whom he had 'a great deal of chemical conversation', provide regional examples of the conjunction of personal interests in chemistry, geology and mineralogy that were manifested on a larger scale in the RI Theatre and encouraged new forms of chemical and electrochemical analysis in the basement Laboratory.

Electrochemistry, geology and mineralogy

The development of electrochemistry as a new department of the older science of chemistry was associated with two relatively novel fields of study, namely geology and mineralogy. At the RI three developments helped to establish the important position of these subjects alongside chemistry: the Mineralogical Collection, Davy's new lecture

41 *ODNB* (2004), entry for John Walker. To supplement his income from teaching, Walker wrote *Elements of Geography and of Natural and Civil History*, London, 1788, and *Universal Gazetteer*, London, 1795.

42 Golinski, op. cit. (8), 111.

43 For Davy's fund-raising at Clifton (Bristol) see Fullmer, op. cit. (8). *ODNB* (2004), entry for Thomas Wedgwood (1771–1805).

44 J. Uglow, *The Lunar Men*, London, 2002, 16. By 1808 Matthew Boulton, aged 80, was in a feeble state and it is conceivable that the battery subscription was that of his son Matthew Robinson Boulton.

45 Berman, op. cit. (7), 75.

course in geology and the growing reputation of the Laboratory for the chemical, and later electrochemical, analysis of mineral compounds.

From his early years Davy had taken a keen interest in rock-collecting and geology, an enthusiasm he shared with Charles Hatchett and Thomas Bernard.[46] Chairman of the RI Committee of Chemistry, Hatchett had a chemical laboratory at Hammersmith and a reputation as a mineral chemist through his expert experimental work for the Committee of Coinage on the wear of various metals and through his analysis of lead molybdate.[47] Within two years of his appointment at the RI Davy had amassed a collection of some three thousand samples that constituted the core of the RI Mineralogical Collection. In 1802 Davy included a section on mineralogy in his lecture course on chemistry and, two years later, following a meeting with Thomas Bernard at Brighthelmstone (Brighton), agreed to deliver a course entitled 'Geology or the chemical history of the earth'. First delivered in 1805, the new course was an outstanding success and was regularly repeated. Davy illustrated the lectures with samples from the growing RI Mineralogical Collection, demonstrations involving chemical analysis, specially commissioned paintings of landscapes and geological formations and, from 1808 onwards, 'transparencies'.

The re-equipped RI Laboratory witnessed seminal change as chemical analyses were augmented by electrochemistry, a transformation evidenced in Davy's papers read to the Royal Society. In 1805 Davy's research focused on 'experiments on a mineral production from Devonshire' and 'analysing stones' by the use of boracic acid. Eighteen months later after a geological trip to Cornwall with Thomas Bernard, his electrochemical experiments led to the first Bakerian lecture.[48] If, as Davy subsequently acknowledged, the supporters of the great battery were 'patrons' and 'cultivators', then the principal field of cultivation in which the agency of electrochemical analysis would be applied was mineralogy. The eighteen-month period roughly covering the time from Davy's experiments on the decomposition of potash and soda (October 1807) to the closure of the battery subscription (March 1809) was one of heightened activity amongst the geologists and mineralogists in the metropolis. On 13 November 1807, six days before the second Bakerian lecture, Davy invited William Hasledine Pepys, a close associate in the development of the galvanic apparatus at the RI Laboratory and in the Askesian and British Mineralogical Societies, to attend 'a little talking Geological Dinner Club, of which I hope you will be a member'.[49] Later the same day the

46 The purchase by the British Museum of Hatchett's mineral collection proved an important acquisition in its subsequent rise to international status. Hatchett valued Davy's samples, collected during his recent tour to Scotland, at 100 guineas. RI MM, January 1805.

47 W. P. Griffith and P. J. T. Morris, 'Charles Hatchett FRS (1765–1847), chemist and discoverer of Niobium', *Notes and Records of the Royal Society of London* (2003), **57**, 299–316.

48 H. Davy, 'An account of some analytical experiments on a mineral production from Devonshire, consisting principally of alumina and water', *Philosophical Transactions of the Royal Society of London* (1806), **95**, 155–62. H. Davy, 'On a method of analysing stones containing fixed alkali, by means of the boracic acid', *Philosophical Transactions of the Royal Society of London* (1806), **95**, 231–2.

49 H. B. Woodward, *The History of the Geological Society of London*, London Geological Society, 1907, 10. For a more recent study of geological and mineralogical interests see M. J. S. Rudwick, 'The foundation of the Geological Society of London', *BJHS* (1963), **1**, 325–55.

Table 6. *The battery subscription: the geological and mineralogical 'interest'*

Group	Pledged	Paid	% response	Pledged	Paid	% response
(1) LGS members	28	16	57	£360.00.00.	£168.10.00.	47
(2) Other geological	15	8	53	£196.00.00.	£98.05.00.	50
(3) Non geological	37	27	73	£456.00.00.	£317.00.00.	70
TOTAL	80			£1,012.00.00.	£583.15.00.	

Notes

(1) The membership lists of the Geological Society of London (LGS) can be found in Horace B. Woodward, *The History of the Geological Society of London*, London Geological Society, 1907.

(2) Other geological – those subscribers where there is a clear geological and/or mineralogical interest but who were not members of the Geological Society of London.

(3) Non geological – those subscribers where there is no discernible geological or mineralogical interest.

Geological Society of London (LGS) was instituted at a meeting at the Freemasons' Tavern.

Of the eighty subscribers to the great battery, twenty-eight can be located in the early membership list of the LGS. Together they pledged £360 and the response level (£168 10s. 0d.) was 47 per cent. In terms of 'interest', this constitutes an important discrete element (Table 6). Common ground among the battery sponsors (Table 1) and the LGS subscribers, between whom there is considerable overlap, can also be attributed to their personal or professional associations with Davy. This is well evidenced in the case of the London-born geologist George Bellas Greenough, first chairman (later president) of the LGS and the first of the pledged names on the battery appeal list for whom payment (10 guineas) is actually recorded (Table 1). Greenough and Davy were exact contemporaries with common interests. Both assembled large mineralogical collections and placed emphasis on the mineral and chemical character of rocks, and in summer 1806 they toured Ireland together, devoting attention to geological formations and the collection of samples.[50] Another prominent collector of minerals and battery sponsor, Charles Greville, was chosen patron of the LGS in 1807.[51]

Among the LGS members and battery sponsors who fulfilled their pledges may be noted three members of the Solly family (£10 each). By the early nineteenth century the former mercantile background of the Solly family in the Italian and Levant trades had been broadened into the professions and property ownership. Richard Horsman Solly (1778–1858), who graduated from Cambridge before studying for the bar, was a minor patron of science. Elected FRS in 1807, he was active in the foundation of the Horticultural and Geological Societies and was associated with the City Philosophical Society.[52] Samuel Solly made substantial contributions to the RI Mineralogical

50 *ODNB* (2004), entry for George Bellas Greenough (1778–1855).

51 *ODNB* (2004), entry for Charles Francis Greville (1749–1809).

52 F. A. J. L. James, 'Michael Faraday, the City Philosophical Society and the Society of Arts', *Royal Society of Arts Journal* (1992), **140**, 192–9, 194.

Collection. In April 1813 'the Sollys' were numbered among Davy's recreational party to Cornwall, 'who will combine mineralogy and fishing'.[53]

The standard modern histories of the RI identify Benthamite or Utilitarian influences on the RI only from the second decade of the nineteenth century.[54] However, these studies have overlooked the fact that Jeremy Bentham himself was a subscriber to the RI from at least 1801. Utilitarian influences may have been at work in the early undertakings promoted by the RI. For example, Greenough had an interest in the politics of the Utilitarians.[55] Henry Warburton, an early LGS member, contributed £20 towards the battery. Succeeding to his father's timber business in 1808 and inheriting a proprietary share at the RI, Warburton had graduated from Trinity College, Cambridge, where he obtained distinction as a 'scholar and man of science'.[56] Later, Greenough and 'philosophical Warburton' were among the founders of University College London, while Warburton became a pioneer of medical reform.[57]

A number of those who supported the battery subscription had a keen interest in geology but were not LGS members. Robert Clifford, for example, who pledged £5, was a young Catholic who had studied the new science of crystallography in Paris.[58] The 'Hon Mrs Murray', pen name of Sarah Aust (née Mease), was known in London society as 'a great Fossolist' (*sic*). Sarah Aust was a blue-stocking par excellence, having published guidebooks based on her travels and adventures in Scotland and northern England. She presented the RI with mineral specimens.[59] Something of her other interests, wealth and connections with Thomas Bernard can be glimpsed from her subscription to the BI.[60] Sarah Aust and husband George, who each contributed five guineas towards the battery, provide evidence of the range of pursuits shared by many of those resident in London's West End. Interests in the fine arts, horticulture and rock-collecting could be shared at the fashionable courses on offer at the reshaped RI.

Laboratory tests and an 'independent' report

Given that the battery promoters proposed raising a sum in excess of the total valuation of the RI Laboratory and its apparatus in 1808 and that the managers were in the final

53 Davy, op. cit. (3), 161–2.

54 Berman, op. cit. (7), 130–6; James, op. cit. (19), 147.

55 *ODNB* (2004), entry for George Bellas Greenough (1778–1855): 'In his early years he was involved in politics, linked with the utilitarians'. Jeremy Bentham's name is recorded on *List of Life Subscribers to the Royal Institution of Great Britain, 1 May 1801*.

56 RI MM, 4 January/1 February 1808: 'Henry Warburton of Parliament Street to succeed to the share of his father John Warburton.'

57 *ODNB* (2004), entry for Henry Warburton (1784–1858). Warburton was elected FRS in February 1809 and secretary of the LGS, 1814–16.

58 Sir Charles Blagden (Paris) to Sir Joseph Banks, 18 December 1802. BL. Add. MS. 33272 fols. 214–15.

59 In the early nineteenth century Sarah, now the widow of naval officer William Murray, married George Aust, who had served as under-secretary for foreign affairs in the 1790s and later as secretary and registrar of Chelsea Royal Hospital. George and Sarah Aust, both in their sixties, built a new residence (Noel House) on the site of Palace Gate, Kensington, for which Sarah laid out the grounds.

60 In June 1805 Hon. Mrs Murray (Sarah Aust) is recorded as one of four 'lady' subscribers to the British Institution (100 guineas). *Diary of Joseph Farington*, op. cit. (40).

instance accountable to the proprietors, attempts were made to determine the most appropriate kind of apparatus for installation. The visit by Davy, William Hasledine Pepys and William Allen in August 1808 to the galvanic laboratory at Ferox Hall, owned by the banker George Children and his son John George, is well documented. It is usually stated that the natural philosophers were concerned with melting platinum wire using a battery larger than any previously constructed, after which Davy was encouraged to build a still larger battery at the RI.[61] Such an interpretation is only partially correct. The visitors were in fact concerned with gathering experimental evidence to compare the quantity (voltage) and intensity (current) of different kinds of voltaic apparatus and their suitability for melting and/or decomposition.[62] The Ferox Hall laboratory at Tonbridge offered favourable research facilities and the juxtaposition of a new large-plated battery with a more traditional small-plated apparatus.

Even before his visit to Tonbridge between 20 and 22 August 1808, Davy had made plans for the publication of the outcome of the comparative laboratory experiments. Something of his manipulative approach towards the RI and the Royal Society, towards the leading patrons of science and towards his friends can be seen on this occasion. Davy, who clearly determined the experiments' direction, requested John George Children, one of the battery sponsors, to provide all necessary apparatus and was anxious that any report should appear 'neutral'. Thus Davy informed Children that he had described the Ferox Hall apparatus to 'the Scientific Men' in London, and assured John George that 'Sir Jos. Banks, Mr Cavendish, Wollaston etc. all expressed a strong wish that the results should be published – I am most happy you have drawn up the account'.[63]

On 24 November 1808 Children presented a paper to the Royal Society on the work undertaken at Ferox Hall, 'with a View to ascertain the most advantageous Method of constructing a Voltaic Apparatus, for the Purposes of Chemical Research'.[64] Comparative experiments had been conducted using a large battery with copper and zinc plates constructed 'on the new method'. The set-up consisted of twenty pairs of plates, four feet high by two feet wide, then used the *couronne des tasses* of two hundred pairs of small plates each about 2 inches square. They were placed in half-pint pots of common queen's ware, 'and made active by some of the liquor used in exciting the large battery'. In deciding which kind of battery to construct for scientific research, Children advised that consideration be given 'to the purposes for which it is designed'. Significantly, the small-plated battery was effective on imperfect conductors and readily decomposed potash and barytes, 'although its whole surface is more than 30 times less

61 See, for example, D. R. F. West and J. E. Harris, *Metals and the Royal Society*, IOM Communications, Cambridge, 1999, 116–18.

62 W. Allen, *Life of William Allen with Selections from his Correspondence*, 3 vols., London, 1846, i, 107–8.

63 Humphry Davy to John George Children. Undated letter but evidentially July 1808. BL Add. MS. 38625. Royal Institution. Guard Book Vol. 1 (3) Life Subscribers 1 May 1801 includes John George Children.

64 J. G. Children, 'An account of some experiments, performed with a view to ascertain the most advantageous method of constructing a voltaic apparatus, for the purpose of chemical research', *Philosophical Transactions of the Royal Society of London* (1809), **99**, 32–8.

than that of the great battery; but in point of number of plates, it consists of nearly 10 times as many as the large one'.

The RI managers were concerned about the efficiency, length of life and maintenance of different kinds of galvanic apparatus. One objective of the Ferox Hall experiments was to ascertain the mode of constructing a voltaic battery 'by which the greatest effect may be produced, with the least waste of power and expense'. In respect of maintenance, Children recognized that in many experiments it would be necessary to keep the battery active for long periods. In acknowledging this, he recommended that the cells should be of sufficient capacity to hold a large volume of dilute acid, 'by which much trouble of emptying and filling the troughs is avoided'. But he cautioned that in using a large number of cells it was necessary to have sufficient space between each pair of plates to prevent 'spontaneous discharges'. In describing the benefits of batteries 'on the new construction', Children emphasized the advantages of using moveable copper and zinc plates connected by leaden straps, soldered on the top of each pair and 'joined together only in one point'. In contrast to the older method of soldering all the plates together and cementing them into the troughs, such flexibility meant that the voltaic apparatus had 'a double quantity of surface' and could be 'more easily cleaned and repaired'. Finally, Children favoured a suggestion that had apparently originated with William Babington, a physician at Guy's Hospital, namely that the troughs should be constructed of 'Wedgwood's ware' (rather than wood), and with glass partitions in the troughs to ensure the most effective insulation.[65]

Within a short time Children's paper to the Royal Society was accorded or had acquired a reputation as a useful reference report. It was reprinted in *Journal of Natural Philosophy, Chemistry and the Arts* (*Nicholson's Journal*) and was reported in the *Edinburgh Review*. The 'independent' report provided Davy and the RI managers with considerable scope in their choice of a new battery and confirmed that a voltaic apparatus with a small number of large plates was more appropriate for the ignition and melting of metals. Batteries with a large number of small plates were preferable for imperfect conductors and chemical researches directed towards decomposition and electrochemical analysis.

Building and operating the great battery

The construction of the 'great battery' at the RI was supervised by William Hasledine Pepys, who had worked closely with Davy for eight years. Payments to Wedgwood and Co. for parts of the voltaic apparatus indicate that Babington's suggestions respecting the troughs were probably followed.[66] From January 1809 expenditure on electrochemical research and apparatus was kept as a distinct account.[67] On 13 September 1809 Davy

65 William Babington (1756–1833), chemist and mineralogist. A physician at Guy's Hospital (1802–11), FRS (1805) and president of the LGS, 1822–4.

66 RI MM, 20 February 1809 Payment of £41.17.3 to Messrs Wedgwood & Co as part of the Voltaic Apparatus to 18 February 1809. In a subsequent description, Davy described the 'cells of porcelain'; Davy, op. cit. (2), 152.

67 RI MM, 23 January 1809: 'to Mr Fidler for Apparatus for Electro-Chemical Researches to 31 December 1808 £47.0.6'.

set down in the laboratory notebook the deficiencies observed during the course of an inspection. He also sought to clarify the responsibilities of the two assistants. It was noted that 'the laboratory is constantly in a state of dirt and confusion' and that objects much wanted were 'cleanliness, neatness, and regularity'.[68] The assistants were instructed to clean the Laboratory each morning and to keep all the apparatus in regular order. Each week a whole morning was to be set aside 'to the inspection and ordering of the (new) voltaic battery'. Davy conceded that his notes were written 'with a pen and ink such as was never used in any other place'. He instructed that pen, ink, papers and wafers should be on hand 'and these must not be kept in the slovenly manner in which they usually are kept'. The needs of the Laboratory were then listed in terms of the apparatus and chemicals that should be on hand, some of which were produced 'in house', such as graduated glass tubes and retorts and metallic and saline solutions. This flurry of activity, which included the instruction that 'all the wine-glasses should be cleaned', was probably occasioned by the imminent visit of a number of distinguished chemists, including Henry Cavendish, Sir Charles Blagden and William Hyde Wollaston. Amongst the experiments conducted for the visitors to the Laboratory and Theatre were a number 'on the excitation of radiant heat and electricity in different gases'.[69]

Different combinations of the new battery came into service as ready or as required. When Davy delivered his fourth Bakerian lecture to the Royal Society on 16 November 1809 he described some new electrochemical researches using a voltaic apparatus of one thousand double plates. He noted that 'as yet, the whole combination has not been put into action'. An accompanying engraving depicted one of the two hundred instruments. It was not until 12 July 1810 that Davy could refer to 'some late experiments made with 2000 double plates'.[70] Far from being carried out expeditiously, more than eighteen months elapsed between Davy's petition to the RI managers and the new battery coming into full service.

Conclusion

The public subscription to the 'great battery' constitutes a significant episode in the history of British science in the early nineteenth century. It was the first of many such appeals for the provision of laboratory equipment and would be widely imitated from the nineteenth century onwards in many parts of the world.[71] This paper has demonstrated the need to revise the long-held view that the subscription was a straightforward matter, accomplished with apparent ease. The examination of the manuscript subscription list, long available in the RI archives as a prime source, has clearly demonstrated that the sums cited in all previously published secondary works are incorrect.

68 Anne Treneer, *The Mercurial Chemist: A Life of Sir Humphry Davy*, London, 1963, 137.

69 Bence Jones, op. cit. (5), 360–1. Davy referred to the RI Laboratory visit in a letter to John George Children dated 23 September 1809. Other visitors included Dr Herschel and Henry Warburton.

70 H. Davy, 'Researches on the oxymuriatic acid', *Philosophical Transactions of the Royal Society of London* (1810), **100**, 231–57.

71 Chilton and Coley, op. cit. (18), 179; James, op. cit. (19), p. xiv.

The survival of what in effect amounts to two lists in one, namely of pledges and of payments, provides evidence of those mainly metropolitan contemporaries prepared to support a leading British chemist working at the cutting edge of research.

Primary and secondary sources, collective biography and record linkage of subscribers have provided scope for the isolation of discrete but often overlapping institutional groups or broader economic, social, scientific and artistic interests. In general a greater understanding is required of the dynamics of the subscription lists that permeated Hanoverian society. In many instances those who 'lent their names' to subscriptions and headed the published lists of sponsors can be regarded as 'underwriters' of an appeal, their presence intended to encourage others. Only in the case of a shortfall would the underwriters be called upon to fulfil their pledges. Given the number and range of subscriptions that the leaders of society were called on to support, it seems unlikely that they would be expected to redeem all their pledges. Naturally, much depended on those managing a subscription and, in the case of the RI battery, the real credit lies less with Davy, to whom success has traditionally been accorded, and more with Thomas Bernard, whose role in the undertaking has gone largely unrecognized. For example, the list of sponsors (Table 1) was carefully crafted. Not only did it provide the necessary group credentials for a scientific subscription, it also provides evidence of the important connections between the 'new department of science', electrochemistry and the fields of geology and mineralogy.

The discrete interest and occupational groups identified (Table 5) can be set against the long-accepted view of the predominance of the landed class and improving landlords, the groups traditionally identified as being responsible for the founding and initial direction of the RI, hence for the shaping of Davy's career. The agricultural interests were not significantly forthcoming in support of the new battery. On the other hand, support was available from those who might seem to have even less to gain from electrochemistry: members of the commercial and professional middle classes of the metropolis, doctors, lawyers and, above all, merchant bankers. Many of these subscribers were of mature years and wealthy. Their interests were multifarious – economic, social, political, artistic, as well as scientific. Two groups are particularly noteworthy: those with commercial and banking interests who were associated with Bernard's British Institution of Fine Arts and those who were members of the Geological Society of London (Table 6). In the final instance, the 'great battery' received its greatest support from financiers who had a strong interest in the fine arts and from those committed to the pursuits of geology and mineralogy. These subscribers – like Bernard, Hatchett and Davy themselves – had 'a devotion to the experimental sciences and arts'. There are also one or two hints of Utilitarian influences at work.

In his introductory lecture on electrochemistry in 1809, Davy expressed gratitude for the outcome of the battery appeal to his natural constituency, his auditors in the RI Theatre: 'my inclination, my feelings, my duty render this necessary'.[72] Although the names of those pledging support and the dates when the pledges were made had been

72 Davy, op. cit. (1), viii, 355–9.

open to 'institutional gaze', the precise timings of 'pledge redemptions', where applicable, are unknown. However, by March 1809 it was clear to those privy to the real state of the appeal, certainly to Davy and also to Bernard and Hatchett, the only two subscribers to make second contributions, that only 60 per cent of pledges had been made good. Whilst numerous five-guinea contributions had been received, many substantial promises from the patrons of science and from some of the leading office-holders of the RI and Royal Society had not been forthcoming.

The personalized nature of the battery subscription merits some consideration of the relationships between Davy and would-be contributors. A surprising fact is that some of those closest to Davy did not fulfil their subscription pledges (Table 1). In particular may be noted W. H. Pepys, a member of the Chemistry Committee with whom Davy had worked almost daily since 1801 and who supervised the work on the great battery; William Allen, who taught natural philosophy at the RI and whose Plough Court firm provided the RI with chemicals; and John George Children, whose friendship Davy first assiduously cultivated during the period when the battery subscription was open. It is perhaps conceivable that Pepys and Allen, who joined Davy at the laboratory at Ferox Hall, were distancing themselves financially from the 'neutral' report on experiments using different kinds of battery, in which they were specifically named as witnesses. Also surprisingly absent from the battery subscription are William Hyde Wollaston, and William Babington, to whom Davy would later dedicate *Salmonia* 'in gratitude for an uninterrupted friendship of a quarter of a century'.[73]

The prospect of a 'great battery' in Davy's hands probably failed to impress those concerned at what was perceived as the exclusive nature of the RI. In December 1808, for example, Thomas Allan, proprietor–editor of the newspaper *Caledonian Mercury* and a sometime auditor at Davy's lectures, told Charles Greville, one of the battery's sponsors, that for 'the sake of science I wish the Splendid institution had been more come-at-able and that the world might have had more frequent opportunities of reaping the benefit of your exertions & munificence'.[74] There are also hints that some felt Davy and his closest associates had aspirations of material gain beyond their class. Thus when Davy and Hatchett appraised the mineral collection of the recently deceased Charles Greville in 1809, with a view to its possible acquisition by the RI, a friend of Robert Greville, the deceased's brother, expressed the view that it was 'very Clear Mr Davy, & others of His Class wish to get It [the mineral collection] at a Bargain; & Make Their profit'.[75] Whether such views were widely held is unclear, but it is certainly the case that only 17 per cent of the sums actually paid over for the new battery were provided by those with titles (Table 4) – that is, from among the classes to membership of which Davy almost certainly aspired. There were, of course, exceptions, such as the sustained support that Davy received from Earl Spencer and Lord Dundas.

The managers of the battery subscription, Bernard and Hatchett, cannot have failed to notice that the hereditary proprietors of the RI, the principal beneficiaries from any

73 [H. Davy], *Salmonia: Or Days of Fly Fishing*, London, 1829.

74 Berman, op. cit. (7), 91; quoting a letter from Thomas Allan to Greville, 19 December 1808, BL Add MS 42071, fols. 155–6.

75 J. Harpur to R. F. Greville (Letter n.d.), BL. Add. MS 40716 ff. 56, 107.

improvement of facilities or enhanced institutional reputation, were slow or reluctant to subscribe or to fulfil their pledges, whereas more than 80 per cent of the annual and life subscribers actually paid (Table 3). When Davy expressed gratitude for the new battery, he challenged the RI managers to think in terms of public science:

> The language expected by the members of a scientific body from the directors ought not to be 'We have increased your property, we have raised the value of your shares'. It ought rather to be, 'We have endeavoured to apply your funds to useful purposes, to promote the diffusion of science, to encourage discovery, and to exalt the scientific glory of your country.'

Davy asserted that 'a scientific institution ought no more to be made an object of profit than an hospital, or a charitable establishment'.[76]

In this sense, the battery subscription can be regarded as one of the factors that galvanized the more forward-looking RI managers towards confrontation with the systemic funding problem manifested in proprietorship. From the early months of 1809 a core group can certainly be identified which recognized that institutional reform could not be long delayed. On 20 March 1809, one week before the closure of the voltaic subscription, the committee of Managers advised the committee of Visitors of the acute financial difficulties facing the RI: 'If the support of scientific men is to be obtained, something must be done to give the Institution more the form of a public establishment than of private and hereditary property'.[77] Within eighteen months the RI had taken the first steps towards ensuring its future by restructuring, under the statutory authority of an Act of Parliament, changing from a proprietary body politic into a corporation of members.

When Davy referred to the great battery in his major book on chemistry, *Elements of Chemical Philosophy*, his reference to the support he had received is of interest:

> The most powerful combination that exists in which the number of alternations is combined with the extent of surface, is that constructed by the subscriptions of a few zealous cultivators and patrons of science, in the laboratory of the Royal Institution.[78]

In an age of patronage and preferment it was perhaps inevitable that Davy should make some acknowledgement to the 'patrons of science'. Significantly, they were preceded by the 'zealous cultivators' who had recognized the potential of the battery as an agent for electrochemical analysis. Even with the 'great battery' Davy was not destined, in the event, to realize further experimental discoveries in electrochemistry analogous to those he had made in 1806 and 1807.

76 RI MM, 20 March 1809.
77 Quoted in Bence Jones, op. cit. (5), 287.
78 Davy, op. cit. (2), 152.