

ART. XV. – *The Sixth Duke of Somerset, Thomas Robinson and the Newlands Mines.*
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THE history of the Company, or Society of Mines Royal and of its servants and lessees in sixteenth century Cumberland is well known; the activities of the Hechstetter dynasty of German mining experts in the Newlands Valley, west of Keswick, have been thoroughly described by several scholars.

The last document which deals with the most active period of the Germans' operations is the report of the Mines Royal's Commission of 1602, which described all the Company's Cumberland sites. In Elizabethan times the most productive and best documented of the Hechstetters' mining concessions at Newlands had been Goldscope (named 'Gottesgab', i.e. God's Gift, by the Germans) on Scope End (surface remains at NY 227 185). However, the shaft below the great pump-wheel within the mine, which the Commissioners of 1602 inspected and admired as a new and promising enterprise, likely to drain a large volume of ore for exploitation, was apparently a failure and Goldscope was probably idle before the Civil War began.¹

The opinion of Sir John Pettus, Deputy Governor of the Mines Royal Society, was that the Newlands operations had ceased because of "the death of the first German artisans and the neglect of a continuous stock, and want of fuel in those parts, and the succeeding wars".²

Recent discussion of the decline of the English copper industry in the early seventeenth century has emphasised the importance of low demand, rather than that of Royal monopoly, as exercised through the Mines Royal, or of fuel shortages.³ Towards the end of the century there was growing optimism regarding the demand for copper and brass, particularly that of English manufacture. Household goods and horse-accountrements, copper pans for the brewing and sugar industries, wire for wool cards, and copper to remedy the chronic shortage of small currency were among the uses discussed. Reliance upon Swedish copper for the coinage was resented, partly because the Swedish kings had been known to levy a 25% export duty. Finally, dependence upon an overseas supplier was contrary to the 'economic nationalism' of the day, which discouraged trade deficits such as England had with Sweden, and advocated national self-sufficiency as an ideal.⁴

A legal case in 1568 between the Queen and the Earl of Northumberland had established the 'royal' status of the Newlands mines because of their alleged gold content. Consequently the Crown possessed the sole right to license mining of copper or silver-bearing lead there and to collect royalties, a prerogative which was to be exercised there, as it was through much of England, by the Mines Royal Company until 1694. In that year, after a long struggle, and the imposition of a Royal veto in 1693, the Crown was forced to accept the Second Royal Mines Act, relinquishing its right to licence mining and retaining only the right to buy precious ores at "The value of the base metal which it is supposed to be", if it could be located within thirty days of raising.⁵

Charles Seymour, Sixth Duke of Somerset (1662-1748), married the Percy heiress, Elizabeth, in 1682, though the estates she had inherited were managed by trustees until

1688, when debts were finally paid off. The repayment gave Somerset full control of the Percy estates and this new freedom enabled him to undertake such projects as the virtual rebuilding of Petworth House between 1688 and 1696 and also to pursue his career at Court. Although he was disappointed in his expectations of high office under William III, he moved constantly in Court circles, particularly important during Anne's reign. He retired to his estates in 1716.

Whilst Somerset attended most of the Lords' sittings which discussed the Royal Mines Bills in 1689, 1693 and 1694, he seems to have left the work of attacking the Society, and implicitly the prerogative, to others, a tactic unsurprising in an ambitious courtier, especially one known for his sympathy for Princess Anne. There was no shortage of mining landowners willing to do the work of assassination, including men with Cumbrian interests, like Philip, 4th Baron Wharton (d. 1696) in the Lords and Sir Christopher Musgrave, M.P. for Westmorland, in the Commons who currently attacked any 'Court' institution on principle, especially when the Marquis of Halifax, a minister, was President of the Mines Royal Society. Wharton's mines at Caldbeck were apparently unworked, despite constant interest expressed by applicants to the Society in the two best, namely a copper mine and a silver-lead mine, presumably at Roughtongill. By 1697, Thomas Wharton, the First Marquis and son of Philip, was having Caldbeck lead smelted by Somerset's lessee, David Davies.⁶

Although Somerset was not a strong party man, he moved by the end of William's reign into the Whig connection. In 1701 he chose his first Whig candidate for the Cockermouth election and by 1703 his liaison had contributed to the formation of the Kit Kat Club, which comprised many of the leading Whig statesmen and intellectuals of the day, including Thomas Wharton and three past Presidents of the Royal Society, John Vaughan, Charles Montagu and John Somers. Montagu and Somers were active in the Whig 'Junto' of 1695-8, which has been called "our first real cabinet".⁷

The recoinage schemes of Montagu, imposed while Chancellor of the Exchequer after 1694 and of his nominee at the Mint, Isaac Newton, as Warden from 1696 and Master from 1699, stimulated the mining industry. The replacement of the vulnerable hammered silver by milled pieces led to a search for domestic silver supplies which offered opportunities for the workers and owners of lead-silver and copper-silver lodes, as well as for owners of unwanted silver plate; the Mint purchased both silver ingots and plate in quantity. In 1693, petitions flooded into the Treasury for the right to coin new copper halfpence and farthings, the popular opinion, which Newton rejected, being that they were in short supply. An extensive programme went ahead in 1694, the work being contracted out as in 1672. The despised tin coinage of Charles II and James II was replaced using significant quantities of English copper in conjunction with Swedish, though not until 1717 was English copper alone used. The whole question of the penny would soon have to be decided; made in silver, it was small and inconvenient; Newton was beginning to think by 1702 that it might have to be wholly or partly of copper.⁸

Since the prospects for the copper industry seemed to be improving, Sir Daniel Fleming of Rydal (1633-1701) obtained in 1684 a detailed survey of his unworked mines at Coniston and his servants "enquired for such men as had both money and experience to carry on such a great work". He received a number of letters and visitors seeking leases, though the London businessmen involved were deterred by the high royalties, namely the one eighth which Fleming required "for breaking of the soil". Sir Daniel

considered that lessees might favour Coniston as a site in preference to restoring the established but derelict works at Keswick because Coniston was nearer the coast and to a cheaper supply of coal by sea.⁹

Fleming had apparently encouraged Sir John Lowther of Whitehaven, who began to take an interest in Caldbeck in 1684, particularly after Dr Martin Lister of the Royal Society had made enquiries at Coniston and Keswick as to prospects for re-opening. The answers Lister received were published in the *Philosophical Transactions* of 1693 and will be discussed later. Sir John may have considered that a copper project would fit in well with his mining and industrial complex on the coast and his ambitions in the colonial trade. He had no copper mines of his own, though he was keen to encourage those who had ore, to bring it for smelting to his collieries. In October 1699 Lowther wrote to Somerset, mentioning recent experiments with a coal-burning copper smelter at Moresby, which used ore from Millom, and suggesting that ore from the Newlands mines might supply it. Somerset's reply is not recorded; serious work had only begun at Goldscope in late 1698 and, as we shall see, Somerset proposed to smelt his own ore.¹⁰

Local difficulties with timber supplies in parts of the north, though they may well have been exaggerated, together with vigorous marketing by the coal producers of the North West and North East, encouraged experiments with a smelting technology using coal. Great interest was shown in the development of the reverberatory furnace, where heat was provided by coal which did not come into contact with the metal being treated. Sir John Lowther of Lowther, placeman, crony of Somerset's during the Revolution, and cousin to Sir John of Whitehaven, was the first Governor of the 'Company for Making Iron with Pit Coal', chartered in 1693. As early as 1685, Fleming was reading rumours about such experiments with lead smelting near Newcastle, "a mystery they keep secret".¹¹

By 1692, Dr Edward Wright was operating at Caldbeck and Keswick for the new 'Company of Royal Mines, Copper', which had somehow come by the old Society's assets. Wright was having increasing success with smelting metals with pit coal. At Caldbeck he might have been re-working lead slags, which were acknowledged to still contain significant quantities of lead, besides perhaps some of their original silver. It seems likely that Wright worked at Carrock End Mine (NY 352 338), in the area known as Dutchman's Moss. It is unclear whether Tobias le Gros, who leased copper and lead rights from the old Mines Royal Society in 1692, ever worked them or whether he was connected with Wright. The legend that "the Dutch who came with William, Prince of Orange" re-opened the Keswick works may derive from his interest.¹²

The information about the Keswick and Caldbeck mines which Dr Lister published in 1693 came from David Davies of Braithwaite, who managed certain lead-mining enterprises on the Percy estates for John Bathurst of London and who was the chief practical expert on the spot. Bathurst had obtained his lease in 1676 from the trustees of the estates; it was for the term of twenty-one years and included the right to work all non-ferrous minerals on the Percy lands in Cumberland, together with the rights to prospect and refine. A "Mr Bathurst" ran into trouble with the Mines Royal for raising copper illegally at Keswick in 1685, and on 8 October 1689 Davies took over the lease himself for a nominal sum of five shillings, apparently in lieu of unpaid salary as manager, consequent upon a fall in output and a cessation of mining. Davies surrendered this lease to Somerset on 17 August 1692, in return for an advantageous new twenty-one

year rent free substitute, for lead only, in the manor of Braithwaite and Coledale, dated 30 August, 1692. In October he raised cash for his operations by leasing a quarter share back to George Thornton, the Duke's steward, in return for £100; Thornton acted for the Duke, as did another servant, George Coles, to whom Davies made over a further eighth before the end of the year. Davies received a salary as manager of the Duke's share; he seems to have given up the lease in 1702.¹³

Davies seems to have shown little interest in seeking a new lease of the copper mines for himself for, although he considered that the Hechstetters had been forced to abandon their works because of "ill-management", he had also advised Dr Lister in 1684 that the expense of re-opening at Goldscope would be considerable, "For the old workmen have wrought down the ore far below the adits by the benefit of water-engines and pumps; so that there can be no good done without new adits." He also had doubts about smelting the ore, since this process was more complicated for the prevailing ores of copper at Newlands than for lead, and "all the ancient men that wrought in the smelting of it being dead". He had perhaps experimented with the copper slags which were abundant at Newlands and used as a flux by lead smelters.

Davies' reservations were presumably well-known to Somerset, though the publication of the Davies letter in 1693 may have been unwelcome, since the legal position of the Mines Royal Society was not yet settled. However, at the Duke's Michaelmas Audit at Cockermouth Castle in 1693, approval was given for the payment of £5. 8s. 1d. to Davies, "for getting some copper ore to make trials thereof and for trying some part thereof".¹⁴

The Davies letter, as published in 1693, was remarkably evasive with regard to Goldscope, considering its author, as Bathurst's employee, had enjoyed access to Somerset's estates. Although the Royal Society had, from its foundation, taken an interest in mining matters, Lister was by no means a disinterested enquirer, for he was making a serious attempt in 1684 to revive the Mines Royal Society and this was leading to many awkward questions being asked in the North. On 5 May 1684, Lister was elected to the Society and both he and his colleague Sir Robert Reading, also elected in May, were soon pushing schemes to revitalise it. They proposed to provide assay facilities and also to re-open the Cumberland mines, possibly using managers, as in the sixteenth century, or finding lessees. A proposal for a lease at Caldbeck was on the table by 5 June. A further cause for concern among landowners was John Wren's request for a licence to search for Mines Royal in Cumberland and Yorkshire, first discussed in 1682 and supported by Sir John Pettus. The Howards were also showing interest; in May 1684 they took a lease in the Helvellyn field for silver-lead working. Enquiries initiated by the Mines Royal Society were to reveal Bathurst's illegal mining operations at "Keswick", meaning, presumably, at Newlands.

Davies emphasised the superior prospects at Caldbeck, where Somerset had no interest until he bought the Wharton estates in 1739; yet even at Caldbeck Davies reckoned that recovery would take six or seven years at least, "and by that time £10,000 will be stock little enough". The finishing of an old adit at Caldbeck might cost anything from £1 to £10 per fathom (i.e. six feet), besides which "many inconveniences which now lie hid, will in the working of it appear, as the sinking of air shafts, or other engines for that use".¹⁵

If a speculative copper venture were to be undertaken in this remote province, it was

likely that Somerset himself would have to supply what G. E. Mingay has called “the tinder of capital and the spark of enterprise”. However, the most vigorous promoter of the Newlands re-opening scheme was the Rev. Thomas Robinson, who was Rector of Ousby from 1672 to 1719. Robinson gathered much local geological information and developed intricate, though generally conventional, views about prospecting and ore genesis, these being published in a number of works, the best known being the *Natural History* of 1709. Robinson’s theological works attacked his important contemporaries, Burnet and Woodward, as “very ill-grounded; many of their notions being inconsistent with common sense and experience, with Scripture and reason”. By 1696 Robinson was claiming “twenty years experience and observation . . . in the inspection of underground works of several kinds” and was pestering landowners with his projects for the geological exploitation of their estates.¹⁶

In 1696 Robinson became lessee of the Duke’s colliery at Bolton, near Caldbeck, the terms being £60 per year for twenty-one years; the Hechstetters had used fuel from Bolton in their Keswick works. Robinson had a long and unhappy association with Bolton Colliery; in 1692, while his brother held the lease, he claimed to have lost £150 of his own money in driving a level there. He did no better when he obtained the lease himself; he petitioned the Duke for an abatement of rent at some date in the late 1690’s, because of capital expense and competition. By Somerset’s Michaelmas Audit at Cockermouth in 1701, he owed £139 in unpaid rent; none of the other debtors on the Duke’s rental in the county owed as much. He was still struggling in May 1706 when he petitioned for an abatement of the rent because of faulting in the colliery which made yet another new level necessary. The estate officials now reckoned his arrears to be £460, though Robinson argued that his expenses, approved abatements, and his salary as manager of the copper works more than covered this. Disputes about these debts became confused with those over expenditure at Newlands; it seems neither was ever settled.¹⁷

On 13 November 1697, Thomas Robinson submitted to the Duke’s “own hand” a preliminary survey of the Goldscope copper mine. He easily ascertained the geological attitude of the vein, observing that “the vein of copper goes through the body of the mountain from the very top of it to the basis”. It lies roughly west-east. When he entered the main level or adit, i.e., the Germans’ near horizontal tunnel for access and drainage, he failed to spot the extent to which the ore had been exploited above it by stopes, and below it, by shafts, which mines call “sumps”, despite Davies’ warning, published in 1693. The Hechstetters had tunnelled right through the mountain, along the vein from west to east; it seems likely that they had worked Goldscope chiefly from the west side, rather than from the prominent, though certainly old, level still visible on the east.¹⁸

Robinson proposed to drive a new lower adit along the vein, again from the east side, in order to drain the greatest possible volume of ore for exploitation. David Davies was asked for his opinion of the project in December 1697, apparently by Thornton, the Duke’s steward; he replied in a letter of March 1698. Davies was considered an expert on adits; he had been honeycombing Barrow Mountain with them for several years, a formidable task because of the unstable ground. Whilst he accepted that Robinson’s scheme was possible, Davies reckoned it would take ten years and cost £1,275. Despite a growing exasperation with Robinson, who was interfering in the lead mines, Davies seems to have done a fair calculation, saying that 24 fathoms of ore might be freed of water below the bottom of the Germans’ shaft. He seems to have been thinking of 3 feet

of progress per week at £5 per fathom, using round the clock working. Those figures were not untypical for pre-gunpowder work in Derbyshire, though less than Davies' recent 5 feet per week at £3 per fathom on Barrow, where the ground was softer, though unstable.¹⁹

In May 1698, Sir John Lowther of Whitehaven wrote to his steward from London to say that Somerset "is in correspondence with Davies and with undertakers here to set up the old copper works at Keswick"; presumably Davies would have been the manager. There seems to have been little commercial interest. Mining speculation had peaked in 1694 and the copper companies which had been founded did not fulfil the inflated expectations of investors. Speculative capital was absorbed, from September 1698, by the Mine Adventurers' Lottery, Mackworth's silver-lead project. Besides, the account in *Philosophical Transactions* of 1693 was hardly an encouraging prospectus.²⁰

The Rector appears to have talked himself into the management of the copper enterprise by the end of 1698, though he was later to excuse himself on the grounds that he had been "importuned first by Mr Beach (the Duke's Cumberland steward) and then by His Grace himself". There can be little question that he sought the position; his works of 1694 and 1696 had been dedicated to "the Gentlemen Miners", the second publication stressing, prophetically perhaps, that in "subterranean projects" what is lost "in purse" is gained "in experience", and touting for commissions; he was certainly pestering Somerset with "projects" in 1697, notably with a scheme to enclose Westward Common and mine it for coal.²¹

A variety of pressures upon Robinson may explain his eagerness. His debts for Bolton Colliery have already been described; by 1714 they were assessed at £500 and by that year he had been arrested six times on their account. Since he had left Cambridge in 1668, he must have been about fifty when he became involved in the copper enterprise; there were eight children to provide for and the Duke's service was one way of doing so. One son, Thomas, was made Rector of Egremont by Somerset in 1700; one, perhaps the same one, or John, was used as an intermediary in London; in 1704 a petition was presented to the Duchess, begging that Bridget be taken into her service. Robinson's cash flow problems must indeed have been great; the colliery was often suffering from flooding and competition; the severe winters of the 1690s must, one presumes, have affected the tithe income. Although the Rector's *New Observations* ran to a second edition in 1699, his writings are unlikely to have generated much income, at least not until 1709, when the *Natural History* must have had considerable sales, it still being a relatively common book.²²

Robinson also had a local reputation to maintain. He had already attacked both Burnet and Woodward in the *New Observations* of 1696; indeed his "Advertisement" in that work alleged that many of Woodward's ideas were plagiarised from Steno and he attacked "piratical rovers, who set themselves up for stupendous and miraculous discoverers". He might well feel that life had passed him by; appointed young, out of the active Christ's College and by the reforming Bishop Rainbow, he might distinctly feel he had gone to seed in his rural backwater.

Whilst it is true that his works of 1694 and 1696 derived a great deal from those of earlier writers, such as Robert Fludd (d. 1637) and the Jesuit Kircher (d. 1680) with certain alchemical characteristics, the majority of his views were fairly typical of the period. Transmutation of metals, their regeneration in worked-out mines, sources of

springs deep within the Earth, formation of mineral veins by vapours and “moisture made solid” from within the Earth, spontaneous generation of animals from dead matter, were all common beliefs.²³

Although Thomas Robinson was on the outermost fringe of the scientific community, he made the most of his opportunities. William Nicolson (bishop of Carlisle 1702-1718) received him occasionally and loaned him the works of Burnet and Woodward. Theories of the Earth were more than fashionable reading in the 1690s, they were also a means to promotion within the Church, if one was able to impress superiors with one’s orthodoxy, by reconciling Scriptural and natural evidence, or rather, by showing that both were aspects of a coherent Revelation. Regrettably, Robinson did not secure promotion; nor was the Royal Society sufficiently impressed to review his works or to offer him membership: when he attempted to correspond with them in 1703 about the surprising effects of mineral “exhalations” upon human hair, “the Society doubted very much of Mr Robinson’s relation”.²⁴

Robinson had read and thought about an impressive variety of works, including those of Hooke, Ray, Plot, Steno and Lister, as well as technical mining works, if only in summary form in some cases, “the books themselves being not to be come by in a remote province”. The *Anatomy* of 1694, in which he presented a description of the Earth as though it was a living being, might well appear dated to the sophisticates of the Royal Society, but it was not necessarily out of place in one constantly sermonising in a remote corner of the kingdom. He had a definite contribution to make, particularly in his views about the classification of the strata in 1709, and he had sufficient knowledge of the coal measures to describe their lithology and rhythms, an important task since Woodward had thrust the strata into the centre of the debate.

Regrettably, mastery of the coal-finding arts did not guarantee success with other minerals, which did not occur in beds. Robinson promised a quick and cheap job, to be achieved by using the folk memories of the local miners, the Hechstetters’ books and the new technique of gunpowder blasting. But the miners exaggerated; the books could not show even Davies, a smelter, how to make copper, so he said; since Robinson started with “none that understood blasting” it was probable that powder would be used wastefully, as well as dangerously.²⁵

When we come to examine the various accounts of Robinson’s operations at Newlands, the outstanding omission is that of the new lower level which he had proposed. A sketch section headed “A Map of the Old Copper Mine at Keswick”, which seems to date from 1697, clearly shows a lower “level begun in the vein”, though this was perhaps only marked thus to illustrate Robinson’s proposals. We find, in the Managerial Accounts for May to October, 1699, a payment to John Bonner “for finding Goldscope Vein at the foot of the mountain”; but if a level was ever begun, it was certainly not finished; the mouth would now be concealed under the more recent lead-mining debris on the site.

Early emphasis in Goldscope was placed upon clearing the old German level, where the bunnings, or stageing built to assist burrowing upwards, or stopeing, into the vein, had collapsed, bringing their stacks of ‘deads’ with them. Robinson claimed very good ore had been recovered in the German level, though John Hutchinson, viewing the works in 1704, could find “not one whole forefield” or hewing position on the vein, exposed.²⁶

An air of desperation is detectable: blasting was employed to chase narrow strings of ore into the cheeks, or boundary walls, of the vein and to drive upwards into the vein itself above the old level, in defiance of Robinson's view that the ore should become richer at depth and that the Germans' shaft below the level had proved rich in silver.

Somerset would not accept the expense of clearing this old German shaft until Robinson had succeeded in refining copper ore into malleable metal, for expensive pumps would be needed to clear the shaft of water, after the initial adit scheme had been abandoned. Although Robinson felt justified in drafting a contract with a group of miners to clear the old shaft in March 1703, Somerset did not confirm it. The machinery laid in at Robinson's expense, including "trees" and pumps, remained on site, unused and unpaid for, until 1714 at least, when they were used by Thomas Acherley during his short and fruitless lease.²⁷

Enterprise had rapidly moved away from Goldscope and easier ground was being exploited further south up Newlands Beck at "St. Thomas' Work", where more than a ton of "shining ore of the yellow glimmer", or copper pyrites (CuFeS_2), had been mined by March 1699. Several new prospects were promoted; the "New Goldscope Vein" lay "fifty fathom to the sun" from the first; Robinson seemed to envisage slicing the Scope End ridge along this vein from west to east in exact imitation of the Germans' operations. We hear little more of this, nor of two new veins bearing "Brown ore, curiously glazed, with a copperish coat", perhaps the north-south lead-zinc veins which intersect the copper veins.²⁸

By late 1704 Robinson was in serious difficulty. His detailed report of 15 November showed work at a standstill; it was addressed, as requested, to John Hutchinson, who Nicolson refers to as Somerset's "Master of Mines", rather than to the Duke himself as previously. A re-survey and re-think in late 1702, in co-operation with a new refiner, "Middleton Shaw, a Staffordshire gentleman, of good birth and education", a visit to London in early 1703 to settle accounts and exhibit refined copper, and proposals to exploit the Wasdale iron deposits, which Shaw reported "would supply three kingdoms", had all come to nothing. Although Robinson had made the trip to London, he was either dismissed or resigned early in 1703, with the expenses owed by Somerset unpaid and, according to his wife in a petition to the Duchess, "mightily cast down", his health broken and the works closed from May onwards. As if this were not enough, Bishop Nicolson's visitation at Ousby in August 1703 revealed a deterioration in his parochial work. The Church fabric was in need of repair; "the Church is in such a condition as is usual when boys are taught in it. The Master has no salary, and must be removed hence."²⁹

Hutchinson was in the North for the Duke's Audit of September 1704; he visited all the mining sites, apparently for the first time, since he needed a guide, and was at Bolton Colliery and Newlands in October, that is before he had received Robinson's report. His fragmentary notes show that he was not impressed by any of Robinson's activities; previously lauded veins are dismissed with, "no signs of riches", "no great streak", "black stones with dies of sulphur . . . no ore in them". Goldscope was unpromising too; after describing the Germans' method of working, Hutchinson pointed out, in contradiction of Robinson's claims, that he could not "learn how deep they have sunk below their level, nor how it was left, only that it was thrown up long before the rest of the works." There was "not a bit of ore to be seen except where it is twitched to 2 or 3

inches thick and so left, and that very bad and sulphury". A brief survey of surviving Hechstetter records revealed that their value had been exaggerated by Robinson; it proved impossible to reconstruct the financial position of the business, "for the disbursements is intermixed with their own affairs" and the values of stock in hand and debts owed to the business were ignored. These old records were of little technical value either; Joseph Hechstetter, "the chief artist" had kept his secrets until he died.³⁰

John Hutchinson (1674-1737), son of a Yorkshire farmer, had begun his career in 1693, as a land agent to the Bathurst family, who had metal mining enterprises in the Yorkshire Dales and, as we have seen, in Cumberland also. So far as we can tell from his polemical writings, he had worked at Bathurst's enterprise in Arkengarthdale, driving lead mines on Scatterscar Vein. Work for the Earl of Scarborough is poorly documented, but by the time Hutchinson enters our story in 1704, he was an experienced mine surveyor for the Duke of Somerset. He was to rise to become Somerset's steward by 1710, though he later retired on a Royal sinecure which the Duke found him in order to concentrate upon his writings, which promoted his extreme literal interpretation of the Mosaic creation story against Burnet's more allegorical reading.³¹

Hutchinson met John Woodward (1665-1728) while in London, perhaps as early as 1702, almost certainly by 1704. Woodward, Somerset's physician and Professor of Physic at Gresham College, where the Royal Society generally met, seems to have treated Hutchinson for "the bellons, a disease that invades, not only the men that slave, as Mr Hutchinson had done all his life, in the lead works of the North, but even the very horses, and other cattle thereabouts". The two men made a form of verbal contract, in which each was convinced, or became convinced, that the other was merely a research assistant in a project to publish a detailed geological argument in support of the literal truth of the Book of Genesis. Woodward certainly financed Hutchinson's tour in the West Country and Wales in 1706, the traveller sending specimens and descriptions of sites which were better than Woodward later claimed. Hutchinson rarely appears as a donor in Woodward's catalogue, the *Attempt* of 1729; by the time it was published the Doctor was regarding him as having been merely another "missionary", as Nicolson, who himself supplied many specimens for Woodward's collection, dubbed those collector-correspondents.³²

The bitter verdict of Woodward's old age was that Hutchinson, on the journey of 1706, had "shaken off the miner, and started off at once into a philosopher, displaying what he calls a most sublime philosophy concerning those ores, and their formation at the Deluge". Hutchinson's *Observations* of 1706 mark his emergence as an independent author, though strongly influenced by Woodward. He used remarkably little Cumberland material in this work; perhaps the whole Newlands episode reflected badly upon Somerset, his patron. But in his notes relating to his northern inspection tour of 1704, he was already using the language of the current controversy and of Woodward. He displayed an interest, beyond the call of immediate duty in structures, bedding and fissures in general; he used the significant phrase "the waters upon the Earth", in discussing the formation of coal seams at Bransty, that is he related them to the Flood. He employed the word "corpuscles", a Woodwardian concept associated with the formation of mineral deposits, as the Doctor claimed, laterally from the adjoining strata, while discussing the aspect of the Goldscope copper vein. He was fascinated by the iron ore "bellies" at Langaran, near Egremont, perhaps because there was no evident

possibility of their having been deposited from below, as some theorists had suggested was the case with all minerals. He sketched the exposure, described its lithology in detail, and seems to have communicated his findings to Woodward; the sketch duly appeared in Woodward's notes, as did numerous Langaran specimens in Woodward's collection, all unattributed.³³

Hutchinson's visit killed the Newlands re-opening enterprise; whatever clashes of personality and theory there might have been, Robinson's geological analysis was demonstrably unsafe. The traditional 'signs' of ore, based on vegetation, soil and water, while sufficient for the speculative part-time miner, were not a firm basis upon which to venture other people's money. The blunt visitor was of the opinion that "the miner's art can be reduced to no rule that is certain, and will hold everywhere".

It is likely that Hutchinson met Robinson at Bolton in October 1704. It is doubtful whether there was much sympathy between them. Hutchinson and Woodward were not likely to accept Robinson's allegation that mining debris could "grow" into new ores after mining, as was supposed to happen in Elba, "by virtue of the mineral spirit". The Doctor later quoted the interesting case of a dump of copper ore left at Goldscope by the Hechstetters, whose quality was supposed to have been improved by its century-long exposure to the air. As usual he demolished the story, arguing that the copper salts had merely sunk to the bottom, thus enriching the lower layers of the pile.³⁴

Robinson considered that the "mineral spirit" and vapours rising from the interior of the Earth not only produced veins initially, but also reinforced those not already "dead", rendering them "stronger", i.e., with increased metal content; vertical veins could still send ore "flowing" along horizontal "flats" between strata. His adit project at Goldscope was designed to drain the vein by cutting the "natural feeders" of the ore from below.

These views led Robinson to believe what observation and reading seemed to confirm, that at depth, the veins, "getting more moisture" would contain not only better quality ore, but superior minerals also, in the sense of those preferred by Man, and this gradation was due to Design rather than coincidence. The Rector's view was, as we have seen, a common one, held by many alchemists, and dependent upon his belief that "all metals are generated of sulphur and quicksilver", an idea popularised by Paracelsus and encountered, for instance, in the works of Milton.³⁵

Experience of the Bristol entrepreneurs with Cornish mines, seemed to prove that tin lodes, at depth, gave way to copper; it was also true that, in the parts of Cumberland Robinson knew best, the copper ores appeared to follow a downward progression towards "perfection". The blue and green carbonates, nearer the surface, which were in fact poorly represented at Newlands, though they contained more copper and were easier to smelt than the complex yellow sulphide, also contained less silver. The 'spirit' from below enhanced the quality of the whole column in the vein, in other words transmutation of metals took place, essentially as Aristotle had visualised it. Woodward and Hutchinson did not believe this proposition, being quite certain that one metal could not be changed into another. Woodward also considered that any reinforcement of veins there might be was so slow as to be unworthy of the attention of miners.

Thus in these ways it was perfectly possible for Thomas Robinson to convince himself, if not his hard-headed visitor, Hutchinson, that meagre sulphurous veins appearing on the surface would improve at depth; anyway Goldscope vein had certainly done so.³⁶

It is hardly surprising that the ores presented Robinson with a problem from the

outset. His efforts to have them analysed were endlessly frustrating. The list of experts, both theorists and analysts, who were said to have approved of them is very impressive – Lister, Stringer, Woodward, among others. There were also payments made to “miners of good judgement” for opinions volunteered at Newlands, as well as simple distinguishing tests in the field using “crucibles, Aqua Fortis and Saltpetre” and conducted upon well-established German principles. Test refinings of partly treated ore were also attempted in London and Robinson was encouraged when “two of the masters of the great copper works at Bristol” approved of his ores.³⁷ Gabriel Wayne’s Bristol works at Conham might be meant. He was one of the associates of Sir Talbot Clerke, who had approved of some of Robinson’s ores. His father, Sir Clement (d. 1693) had been a leading figure in the revival of English copper smelting in London and Bristol. Woodward, writing of copper reverberatory furnaces, claimed Sir Clement’s in Putney as “the pattern and original of all the rest”.³⁸

Robinson supervised certain “trials” or assays in London, some of which he reported upon, probably in September 1700. Of the seven tests reported, five were alleged to have proved one-seventh copper content; this figure is not unrealistic for the better ores, but a number of qualifications should be made. Copper content was not the same as industrial yield, which was far less; these Cumberland copper contents were also very low by Continental standards, as was the expected silver content. Large quantities of ore must be mined if the enterprise were to pay; thus quantity of ore became a problem for Thomas Robinson as well as quality and identification.³⁹

Woodward remained faithful to the yellow ore, or copper pyrites, advancing its copper content to one-sixth. Like Robinson he was confused by the complicated sulphides known as the “Grey Coppers”, which presumably are Robinson’s “Grey Ores”. The Rector said that these predominated in Goldscope when he first surveyed it in 1697, not surprisingly, since this suite of related minerals, chief of which is tetrahedrite $[(\text{Cu},\text{Fe})_{12}\text{Sb}_4\text{S}_{13}]$, are notoriously variable in content and chemical behaviour, containing not only iron but often antimony, arsenic and bismuth, which “evil humours” had defeated even the German experts.

Woodward isolated many of the components and considered the “grey ore” contained “perhaps a little copper”; it was “like what they call White Mundick in Cornwall, grey and shining with an appearance not very unlike bismuth, some of which mineral it seems to hold”. Thomas Robinson had very little chance of smelting this; some of it is still to be seen in Goldscope.⁴⁰

It is not clear whether attempts were made to smelt the grey ore; however, we know that the ore from the Black Vein proved a serious disappointment. It seems probable this was the “Pitchy Copper” found at Dale Head, at the head of Newlands Beck, which is chrysocolla $(\text{CuSiO}_3 \cdot 2\text{H}_2\text{O})$, plus an iron compound; the copper content is rarely more than ten per cent. Woodward had allegedly told Robinson that the Black Vein was worth working and Stringer at least had assayed it at one-seventh copper content. Woodward’s methods, explained in his manuscript *Art of Assaying*, appear to be thorough, though Hutchinson was later to claim that Woodward “did not know one species from another”. However, Woodward made no comment regarding copper content of the black ore in his catalogue, printed in 1729; he described it as “of a dusky colour, with spots of green and blue, and also bright shining sparks appearing to be either lead or wadd”.

By 1729 other things had gone from the catalogue, notably the name of Hutchinson from among the donors.⁴¹

By June 1702, when it looked possible that Robinson's first "operator" Baker, might refine copper, the question of the mining arrangements became crucial, for the reverberatory furnace needed to be kept "at constant work". He therefore paid off the miners, who had hitherto worked by the shift, and entered upon the first of two piecework contracts; miners were to raise ore at £2. 10s. od. per ton in the drained 'German' veins south of Goldscope. This seems to have fallen through; a new contract pledged miners to produce five tons of ore every week for £12. os. od. There can be little doubt that the quality of ore produced was low; Baker, who quit in November 1702 after failing to produce copper, had apparently argued with the workmen over the question of quality. Robinson alleged that Baker was a charlatan; but the Rector was surely an easy dupe for his workmen; his reliance upon rigid geological theory and his relative inability to distinguish among ores ensured this, as, sadly did his well-documented sympathy for his humbler parishioners and his preference for their company.⁴²

By 4 March 1703, Robinson again thought he was nearing success, since Shaw, the second "operator" had re-assayed the ores and was about to make copper. A further contract was therefore drafted; the old shaft in Goldscope was finally to be cleared, for a fixed sum of £130, Robinson to provide materials. Thomas Hansom, the miner, was to have the option of a further contract to produce ore at the bottom of the shaft, being paid £2 per ton, "provided it be free of stone and spar". Robinson was to meet the Duke in London on Easter Monday, with "some hundredweight of fine copper", made by Shaw but he seems to have failed to provide it. The Duke did not confirm the contract, Robinson resigned or was dismissed and from May 1703 the Newlands works were under the supervision of a caretaker.⁴³

Was the failure to produce malleable copper simply due to "Rubbish in: rubbish out"? Or were there other failings in smelting and refining? Thomas Robinson's *Natural History* of 1709 described a smelting and refining technique, saying it was practised by Shaw at Newlands. He placed blame for the failure upon an "ignorant operator", who fluxed the sulphides with powdered coal, perhaps a treatment appropriate to carbonates and oxides. Whilst it may be argued that the geological merit of the *Natural History* has been insufficiently appreciated, the work had other characteristics; it was in part an exculpation for Robinson's past failures and a promotional document for his schemes.⁴⁴

The processes he described are remarkably similar to those in use at Bristol, particularly at Wayne's works at Conham, as described in a surviving manuscript account by the Swedish expert Cletscher. In a letter to Somerset of 16 July 1702, Robinson explained that he had "waited upon two of the masters of the great copperworks at Bristol" and that Baker, his first "operator" was known to them. Yet Gabriel Wayne was only successful in producing malleable copper after much frustrating effort, despite considerable advantages, such as his long and close association with the Clerke family, the Costers and Sir Joseph Herne, all pioneers in the revival of copper smelting in England. Wayne had cheap and plentiful supplies of Cornish ore, "lean" though it was, as well as access to carbonates to mix with the sulphides, which helped the smelting along. Yet he was still unable to produce copper acceptable to the Bristol brass industry, established in 1702, until Swedish experts had been consulted.⁴⁵

If we are to judge from the limited number of processes which Robinson claimed to

have employed, he was using reverberatory furnaces, and this with only Baker's already dated experience to build upon, plus the Hechstetter records, which referred to less sophisticated furnaces requiring far more operations. The jumble of ores and their uneven quality made matters worse; the black ore was a non-starter and the grey ores still caused problems in the present century, due to their antimony content.⁴⁶

But, of course, Robinson sought silver, and perhaps gold, as well as copper, and his geological ideas led him to expect them. Yet, when the Germans operated the works, they had found the Caldbeck ores contained the highest proportion of silver, though they were "lean" by Continental standards; Caldbeck being Wharton territory, was beyond Robinson's reach. The Hechstetters had also used Caldbeck lead ores to extract silver from the Newlands copper ores, mixing them in the furnace when the copper was partly smelted, in "matte" form, and the silvers from both copper and lead were run off together. The Hechstetters' books seemed to describe the method employed, though the sixteenth century experts in Germany had said that the Goldscope ore was so poor in silver "it will not quit the charge of drowning it with lead". Again, the method was hard to copy using the new furnaces. Although Hutchinson managed to see "the Refining Furnace at Newcastle", perhaps Wright's at Ryton, which was capable of extracting silver from lead ores, the process was complicated, a separate cupellation furnace being needed.

Bishop Nicolson's diary for 25 July 1702 gives the garbled statement that Thomas Robinson thought that the Hechstetters "refined their metal with the hoofs and parings of horses", suggesting that the Rector was concerned about the bone ash needed in cupellation, whose preparation was itself a matter of controversy. He might, however, have been considering bone charcoal for the final refining of his copper, for the coal fuel employed at a late stage had made even Conham copper unsuitable for brass making before Cletscher's visit of 1698.⁴⁷

The complexity of Robinson's task is evident; it is attested by all his contemporaries, including Woodward; it seems that his two "operators" achieved different stages in the complex series of operations. Baker never proceeded further than making a "matte" or "regulus", which is about half way. He never managed to smelt this into malleable copper, despite taking it to a London refinery for the purpose in 1702, perhaps to Sir Talbot Clerke's in Lambeth. After his return he "fled" to Alston and Northumberland, taking certain advance payments with him, according to Robinson. The Rector had constantly criticised him as a charlatan because, "the regulus had too much fire", and for the failure with the Black Vein. So far as one can discover from the documents, Shaw, the second "operator", produced copper, though its quality was inferior for some reason. Perhaps the brass makers turned it down; the Bristol men had examined the ores and regulus in 1702 and they were apparently willing to pay £100 per ton of malleable copper and to refine it from the regulus themselves, as soon as Robinson had proved its potential. Wayne was eager to obtain copper, not only for the new Bristol brass industry, but also for his former associate, Herne, who was falling behind on his coinage contract.⁴⁸

No trace has so far been found of the Duke's copper smelter at Newlands. Postlethwaite considered it "probable that the furnaces were situated in the valley between Dale Head and Goldscope", quoting in support mounds of spoiled copper ore, perhaps those referred to by Robinson, as "fifty tons of the best Goldscope ore" destroyed by an "ignorant operator". Hutchinson's notes of 1704 certainly marked a mill on Newlands

Beck about a mile north of the Long Work, which would put it close to the mine at Castlenook (NY 227 170). Hutchinson also provided, among various plans of processing plants, a diagram and detailed description of a copper works which could well be the one at Newlands, though there is no proof of this. These works had water powered stamps for crushing ore and two reverberatory furnaces, one for roasting and the other presumably for smelting; the works are clearly unfinished, having "the places for the grates for three furnaces to stand upon". Rather surprisingly Robinson seems to have purchased some of his fuel, complaining in 1702 that peat and coal doubled in price during the winter. The Hechstetters had needed twenty tons of fuel to produce a ton of copper; although the reverberatory processes were more economical of fuel, a coastal or coalfield location for the smelter would have been preferable.⁴⁹

The refining furnace, and presumably the cupellation furnace, if any, were in Cocker-mouth Castle, perhaps because of the secrecy of the processes. Firebricks, Windsor bricks, as used at Bristol, were diverted from their original destination in the Egremont iron works and there was soon a major dispute in Cocker-mouth over pollution, which came to a head during the election campaign of July 1702, when the Duke evidently intervened. Thomas Robinson argued that the insinuations were "idle and malicious", since not only was the material "calcined from its sulphur" before being brought to Cocker-mouth, but the furnace was placed too high above the town to do any damage. He also pointed out that the furnaces at Lambeth, presumably Clerke's, which might be the ones Woodward called "Fox Hall" (Vauxhall?), did no harm to the Spring Gardens nearby.⁵⁰

We may never know why Somerset finally lost interest; Thomas Robinson's explanation of "discouragement" caused by the spoiling of the ore, is surely not the whole story; nor even, is Woodward's view that the Duke was frustrated by the tangle of conflicting opinions as to the quality of the ores, being rescued when he "had the good fortune to fall into the hands of one who was capable of giving him better information", meaning, presumably Hutchinson, or the writer himself.⁵¹

Somerset was personally neglectful of the northern estates; though he ran them with a competent pyramid of officials, whom he could not afford to antagonise. Robinson's privileged position in corresponding directly to the Duke's "own hand" and his being "very earnest for money" began to be a disadvantage when the alienation of officials was not compensated for by quick and cheap results. By the end of 1702 the situation had begun to run out of control; not only had £797 been disbursed to Robinson between October 1701 and May 1702, but Robinson's pollution in Cocker-mouth was alienating the very burgesses in the town whose votes were being sought at the expense of money and patronage.⁵²

The Duke's political career had become more promising from 1702 and the mining speculation, which was looking increasingly like a conceit, was pushed into the background. Anne favoured Somerset, appointing him Master of the Horse, and he was very active during the winter of 1703 to 1704 in preparing the military expedition to Portugal, in support of the Archduke Charles, pretender to the throne of Spain. From 1706 he was deeply involved in the complexities of the union with Scotland. Whilst the re-opening of the French wars in 1702 had given Somerset opportunities to impress his sovereign, hostilities were often seen as a disincentive to the new copper industry, since

the war closed markets, spawned privateers around the coasts and pushed up the price of powder.⁵³

There was indeed a rising demand for English copper by 1710, yet this increase was by no means exceptional in real terms, total output being, at the lowest estimate, 160 tons in 1697 and perhaps 1000 tons in 1712. The Mint was not satisfied with the quality until 1717; exports of copper remained relatively low; most copper was consumed by the brass industry, yet brass sales were limited by the relatively poor quality of the English product, which the government refused to protect with tariffs. Innovation came to be concentrated in the south-west and South Wales, where a smelters' ring developed, paying relatively low prices for the Cornish ores over-produced by companies of adventurers, in which no individual ran any great risk. A large deposit of ore on the coast or nearer the coalfield might have competed; the Newlands mines could not do so. Defoe wrote that "the charge of working them was too great for the profits"; that was true in the context of the marketing and technical possibilities of the early eighteenth century; little copper has been obtained from Goldscope since, though it has proved very rich in lead.⁵⁴

From May 1703, John Scott was paid as caretaker at Newlands and this payment continued until 1713. The furnaces at the castle certainly survived in 1706, when they were repaired. The works in the valley were probably scrapped in 1738; a list of "gear belonging to the copper work" was arranged in weighed lots, including "stamper heads", "grates and plates", and "four pair of pincers, broke and whole, with old iron".⁵⁵

Thomas Robinson was last heard of when he petitioned the Duke on 21 March 1715. He wrote that he was owed £695 and he complained that Hutchinson, as the Duke's steward, had seized tools and equipment at Bolton Colliery, in lieu of unpaid rent. The Rector had apparently been arrested six times on account of these debts, or others incurred at Bolton or Newlands. It is ironical that the *Natural History* of 1709, probably Robinson's greatest achievement, had been, in part, a justification for his greatest failure. It had, sadly, come too late to relieve the tragedy of his life and he died in 1719. However, he might have consoled himself with the thought that, "in subterranean projects", what is lost in purse is commonly gained in experience; it was not a lesson Somerset was eager to learn a second time.⁵⁶

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Printed Works cited in the References

- D. B. Barton, *A History of Copper Mining in Cornwall and Devon* (Truro, 1961).
- J. V. Beckett, *Coal and Tobacco* (Cambridge, 1981).
- Sir W. Blackstone, *Commentaries On the Laws of England* (London, 1811 Edition).
- J. W. Clark and T. M. Hughes, *The Life and Letters of the Rev. Adam Sedgwick* (Cambridge, 1890).
- J. Clarke, *A Survey of the Lakes* (London, 2nd Edn. 1789).
- K. B. Collier, *Cosmogonies of Our Fathers* (New York, 1934).
- W. G. Collingwood, *Elizabethan Keswick*, C.W.A.A.S. Tract Series 8. (Kendal, 1912).
- W. G. Collingwood, 'Germans at Coniston in the Seventeenth Century', CW2, 1910.
- W. G. Collingwood, 'The Keswick and Coniston Mines in 1600 and later', CW2, 1928.
- W. Crookes and E. Röhrig, *A Practical Treatise on Metallurgy*, vol. 2 (London, 1869).
- Cumbria Amenity Trust, *The Mine Explorer*, vol. 1 (1984).
- J. Day, *Bristol Brass* (Newton Abbot, 1973).
- J. Day, 'The Costers: Copper-Smelters and Manufacturers'. *Trans. Newcomen. Soc.*, vol. 47 (1974-6).
- D. Defoe, *A Tour Through the Whole Island of Britain* (London, 1742 Edition)
- 'D.N.B.', *Dictionary of National Biography* (London).
- M. B. Donald, *Elizabethan Copper: The History of the Company of Mines Royal, 1568-1605* (London, 1955).
- V. A. Eyles, 'John Woodward, F.R.S.: A Bio-Bibliographical Account of His Life and Work', *Jnl. of the Soc. for the Bibliography of Natural History*, 5 (1971).
- R. S. Ferguson, *Cumberland and Westmorland M.P.s* (London, 1871).
- R. S. Ferguson, *Miscellany Accounts of the Diocese of Carlisle*, CW Extra Series, 1.
- R. F. Fieldhouse and B. Jennings, *A History of Richmond and Swaledale* (Chichester, 1978).
- M. W. Flinn, 'The Growth of the English Iron Industry, 1660-1760', *Economic History Review*, 2nd Series, 11 (1958).
- J. C. Greene, *The Death of Adam: Evolution and its Impact on Western Thought* (Ames, Iowa, 1959).
- R. T. Gunther, *Early Science in Cambridge* (Oxford, 1937).
- D. R. Hainsworth (ed.), *The Correspondence of Sir John Lowther of Whitehaven, 1693-1698* (Oxford, 1983).
- A. R. Hall and L. Tilling (eds.), *The Correspondence of Isaac Newton*, vol. 5 (Cambridge, 1975).
- H. Hamilton, *The English Brass and Copper Industries to 1800* (London, 1926).
- G. Hammersley, 'Technique or Economy? The Rise and Decline of the Early English Copper Industry, ca. 1550-1660', *Business History*, 15 (1973).
- J. R. Harris, *The Copper King* (Liverpool, 1964).
- R. Hopkinson, 'The Electorate of Cumberland and Westmorland in the Late Seventeenth and Early Eighteenth Centuries', *Northern History*, 15 (1979).
- J. Hutchinson, *The Philosophical and Theological Works*, 12 vols. (London, 3rd Edn. 1748).
- R. Jenkins, 'The Reverberatory Furnace with Coal Fuel, 1612-1712', *Trans. Newcomen Soc.*, 14 (1933-4).
- R. Jenkins, 'The Copper Works at Redbrook and at Bristol', *Trans. Bristol and Gloucestershire Archaeological Soc.*, 63 (1943).
- R. Jenkins, 'Copper Smelting in England: Revival at the End of the Seventeenth Century', *Trans. Newcomen Soc.*, 24 (1943-5).
- S. Jefferson, *The History and Antiquities of Allerdale Ward* (Carlisle, 1842).
- A. J. Kuhn, 'Glory or Gravity: Hutchinson vs. Newton', *Jnl. of the History of Ideas*, 22 (1961).
- H. H. Lamb, *Climate, History and the Modern World* (London, 1982).
- A. A. Locke, *The Seymour Family* (London, 1911).

- G. E. Mingay, *English Landed Society in the Eighteenth Century* (London, 1963).
- F. J. North, "The Anatomy of the Earth" – a Seventeenth Century Cosmogony', *Geological Magazine*, 71 (1934).
- D. Ogg, *England in the Reigns of Charles II and William III* (London, O.U.P., p/b edition, 1969).
- P.D.M.H.S., *Peak District Mines Historical Society Bulletin* (Leicester)
- Sir J. Pettus, *Fodinae Regales* (London, 1670).
- R. Porter, *The Making of Geology* (Cambridge, 1977).
- J. Postlethwaite, *Mines and Mining in the English Lake District* (Whitehaven, 1913).
- A. Raistrick, *The Lead Industry of Wensleydale and Swaledale*, 2 Vols. (Buxton, 1975).
- A. Raistrick, *Two Centuries of Industrial Welfare: The London (Quaker) Land Company, 1692-1905* (Buxton, 2nd edn. 1977).
- A. Raistrick and B. Jennings, *A History of Lead Mining in the Pennines* (London, 1965).
- A. Raistrick, 'The Wharton Mines in Swaledale, North Yorks', *County R.O. Publication 31* (Northallerton, 1982).
- H. H. Reed (ed.), *Rutley's Elements of Mineralogy* (25th edn., London, 1962).
- W. Rees, *Industry Before the Industrial Revolution*, 2 Vols. (Cardiff, 1968).
- E. E. Rich and C. Wilson (eds.), *The Cambridge Economic History of Europe*, Vol. 4 (Cambridge, 1967).
- T. Robinson, *The Anatomy of the Earth* (London, 1694).
- T. Robinson, *New Observations on the Natural History of this World of Matter and this World of Life* (London, 1696).
- T. Robinson, *An Essay Towards a Natural History of Westmorland and Cumberland* (London, 1709).
- Royal Society, *Philosophical Transactions* (London).
- J. F. Scott (ed.), *The Correspondence of Isaac Newton*, Vol. 4 (Cambridge, 1967).
- W. R. Scott, *The Constitution and Finance of English, Scottish and Irish Joint Stock Companies*, Vol. 2, Div. 4 (Cambridge, 1910)
- W. T. Shaw, *Mining in the Lake Counties* (Clapham, Yorks., 1970).
- F. S. Taylor, *Alchemy* (St. Albans, 1976).
- J. Thirsk and J. P. Cooper (eds.), *Seventeenth Century Economic Documents* (Oxford, 1972).
- R. F. Tylecote, *A History of Metallurgy* (The Metals Society, London, 1976).
- J. and J. A. Venn, *Alumni Cantabrigiensis* (Cambridge, 1924).
- J. Woodward, *An Essay Towards a Natural History of the Earth* (London, 1695).
- J. Woodward, *An Attempt Towards a Natural History of the Fossils of England* (London, 1729).

Notes and References

- ¹ The best material is to be found in Collingwood (1910, 1912, 1928), Donald, Hamilton, Rees and W. R. Scott; Donald, 165 ff., 367-8, deals with the 1602 Commission; C(umbria) R(ecord) O(ffice) (Carlisle), Leconfield Papers, (D/Lec), (Box) 81, mining folder, c 1704 has scraps of history relating to the early 17th Century; Hammersley, an essential analysis of this period of decline.
- ² Pettus, 32.
- ³ Hammersley.
- ⁴ Hamilton, Chap. 2; Harris, 6-8; Jenkins (1943-5), 73-4; Rich & Wilson, 509; Thirsk and Cooper 572-3.
- ⁵ Donald, Chap. 6, 'The Law Case'; For Act of 5 William and Mary, c. 6, Rees 492-3.; Quotation, Blackstone, Bk. 1, Chap. 8; The obstructive nature of the Company is minimised by Raistrick and Jennings, 184-6; also by Hammersley, 18-19.
- ⁶ D.N.B. for Musgrave, Seymour (Somerset), Wharton; Locke, Chap. 7; Commons' and Lords' Journals; B(ritish) Lib(rary), Loan MS.16, Part 2, Mines Royal Minutes, e.g. 82v; Ferguson (1871) for Musgrave;

- Raistrick (1982), 20; C.R.O. (Carlisle), D/Lec 81, mining folders, Davies to Thornton, 4 Aug. 1697; Shaw, 40.
- ⁷ Ogg, 337 for the 'Junto'; Hopkinson, 96-7.
- ⁸ DNB – Montagu; Newton; J. F. Scott, 202, 388-90; Hall and Tilling, 357-60; Harris, 6; H.M.S.O., Cal. of Treasury Books, Vol. 10, 330, 415 etc.
- ⁹ R(oyal) C(ommission) on H(istorical) M(anuscripts), 12th Report, Le Fleming MSS, Nos. 2817, 3003, 3055, 3219; Royal Society, Philosophical Transactions (P.T.R.S.), 1693, 741-5; Collingwood (1928), 30-1.
- ¹⁰ R.C.H.M., 12th Report, Le Fleming MSS, 2769, Sir J. Lowther of Whitehaven to Fleming, 14 June 1684; Beckett, 132-3; C.R.O. (Carlisle), D/Lons/W, Gilpin to Lowther, 16 June, 24 July, 2 Sept., 1697.; C.R.O. (Carlisle), D/Lons/W, Sir John Lowther's Letter Books, 29 Sept. 1698, 5 Oct. 1699.
- ¹¹ C.R.O. (Carlisle), D/Lons/W, Gilpin to Lowther, 16 June 1697; D.N.B.: both Sir Johns are under Sir John of Lowther's entry; Cal. State Papers, Domestic, 28 April 1693; Raistrick (1977), 108-10, 129; Rees, 494 ff.; Hammersley, 19-20; Flinn, 148-50.
- ¹² Hamilton, 101-6; Rees, 467-8, 499-508; Raistrick (1977), 97-103, 130; Clarke, 85; Shaw, 47-8, on Wright at Caldbeck; Woodward (1729), Specimen q.9, lead slags from Caldbeck.
- ¹³ C.R.O. (Carlisle), D/Lec/17/101, Lease of mines by Bathurst to Davies, 8 Oct. 1689. This document recites the terms of Bathurst's original lease; C.R.O. (Carlisle), D/Lec/169, Estate Correspondence, Petition of David Davies, 1689; C.R.O. (Carlisle), D/Lec/17/102, Surrender 17 Aug. 1692; C.R.O. (Carlisle), D/Lec/17/74, Lease, Somerset to Davies, 30 Aug. 1692; C.R.O. (Carlisle), D/Lec/17/77, Lease, Davies to Thornton, 19 Oct. 1692; C.R.O. (Carlisle), D/Lec/81, Memorandum of agreement. Henry Inman sub let Barrow Mountain Lead Mines (Summit NY 227 218) to John Scott and Wm. Ormond 1 Mar. 1702/3. For Bathurst, see Rees, 468, 505; also Note 31 below.
- ¹⁴ Royal Society, P.T.R.S., 1693, 737-40; Woodward (1729), specimens q.10, q.11; C.R.O. (Carlisle), D/Lec/27/24, Receivers Accounts, Michaelmas Audit, 1693.
- ¹⁵ Royal Society, P.T.R.S., 1693, 737-40; B.Lib., MS. Loan 16, 77r-86r, on Mines Royal's re-opening schemes; D.N.B., Martin Lister (1638?-1712).
- ¹⁶ Mingay, 191; D.N.B. Robinson, Thomas Burnet (1635?-1715); Robinson (1696), quotations from Dedications to the Rev. William Nicolson and the "Gentlemen Miners".
- ¹⁷ C.R.O. (Carlisle), D/Lec/17/145, lease of Bolton Colliery to T. Robinson, 26 Aug. 1696; C.R.O. (Carlisle), D/Lec/17/169, T. Robinson to ? 12 Nov. 1692; West Sussex R.O. P(eterworth) H(ouse) A(rchives), P.H.A. 6349. Petition of T. Robinson to Somerset. n.d.; Duke of Northumberland's Alnwick Castle MSS., ALN. X.II.3.10(h), Arrearages of Rents, Mich. 1701; C.R.O. (Carlisle), D/Lec/265/200 and 201, T. Robinson's Petitions, Bolton Colliery; C.R.O. (Carlisle), D/Lec/169, T. Robinson's Accounts for Bolton Colliery, 22 May 1706; West Sussex R.O., PHA, 17, Petition of T. Robinson for Somerset, 21 Mar. 1715.
- ¹⁸ C.R.O. (Carlisle), D/Lec/81, T. Robinson to Somerset, 13 Nov. 1697; Cumbria Amenity Trust, 'The Mine Explorer', Vol. 1., 33 has a plan of Goldscope.
- ¹⁹ C.R.O. (Carlisle), D/Lec/81, T. Robinson to Somerset, 13 Nov. 1697; C.R.O. (Carlisle), D/Lec/81, Davies to Somerset, report on lead works, possibly 3 Feb. 1698; C.R.O. (Carlisle), D/Lec/81, Davies to Thornton, 30 March 1698; For drainage: P.D.M.H.S., Vol. 7 (1979-80), No. 3, 125, and No. 5, 249-51, 269; Hammersley, 13-14.
- ²⁰ Hainsworth, Letter 529, page 602; W. R. Scott, Vol. 2, Div. 4., Sections 4 and 5.
- ²¹ Earliest Accounts run from 11 Nov. 1698; C.R.O. (Carlisle), D/Lec/81, T. Robinson's Accounts, 13 May 1699; West Sussex R.O., P.H.A. 17. Petition of T. Robinson 21 March 1715; Robinson (1696), 2nd Dedication; C.R.O. (Carlisle), D/Lec/81, T. Robinson to Somerset, 13 Nov. 1697.
- ²² West Sussex R.O., P.H.A. 17 (see Note 21): Venn, Pt 1, vol. 3., 474; For the children: D.N.B., Robinson; Jefferson, 29; Robinson (1709), 85; ALN. X.II.3.10.b, T. Robinson to Somerset, 11 June 1702; C.R.O. (Carlisle), D/Lec/169, Petition of Jane Robinson, 29 Mar. 1704; For climate: Lamb, Chap. 12; For tithes: Ferguson (1877), 181-3.
- ²³ Robinson (1696), 'Advertisement', 2; Robinson (1709), 67-73; Porter, 14, 15, 70, 71, 86, 87; Collier, Chaps. 2, 5, 7, 8.
- ²⁴ Robinson (1696), Preface; Porter, 44-5; Collier, 17-18; Royal Society's MSS, London: LBC 13.461 Robinson's letter, 11 June 1703; Journal Book, 20 and 27 Oct. 1703.
- ²⁵ Robinson (1696), 'Addit. Preface', 8-10; North, a Philistine account of Robinson (1694); Porter, 35-6, 60, 80.: On the Hechstetter books: C.R.O. (Carlisle), D/Lec/81, Robinson to Somerset, 13 Jan. 1698; P.T.R.S., 1693, 740, Davies may have seen the major book, i.e., ALN. Y.II.7, which has been thoroughly discussed by

- Donald (1955) and Hammersley (1973); On powder and blasting: C.R.O. (Carlisle), D/Lec/81, Robinson's Disbursements to the Copper Works, since 14 May 1699; ('50 pound of Cannon Powder' bought for £1. 15s. od.); C.R.O. (Carlisle), D/Lec/81, Robinson to Hutchinson, 15 Nov. 1704; P.D.M.R.S., Vol. 7, No. 5, 259 ff.
- ²⁶ C.R.O. (Carlisle), D/Lec/81, Nov. 1697?; C.R.O. (Carlisle), D/Lec/81, Robinson's Disbursements since 14 May 1699; ALN. X.II.3.8.f, Robinson to Somerset, 16 July 1702; C.R.O. (Carlisle), D/Lec/81, Mining Bundle, 1704, Hutchinson's sketch and notes on Goldscope; C.R.O. (Carlisle), D/Lec/81, Robinson to Hutchinson, Report on Mines, 15 Nov. 1704.
- ²⁷ Robinson (1709), 63; ALN. X.II.3.8.f, Draft Agreement to drain Goldscope shaft, 4 Mar. 1703; West Sussex R.O., PHA. 17, Petition of Thomas Robinson, 21 March 1715; C.R.O. (Carlisle), D/Lec/17/66, Lease Somerset to Thos. Acherley, Newlands mines, 7 May 1713; C.R.O. (Carlisle), D/Lec/27/78A, Receivers Account Book.
- ²⁸ C.R.O. (Carlisle), D/Lec/81, Robinson to Somerset, Report on the works, 26 Mar. 1699; C.R.O. (Carlisle), D/Lec/81, 'A Map of the Old Goldscope Vein' 1698? (strictly a vertical section); For modern maps and sections see: Donald, 167; Postlethwaite, 76-7.
- ²⁹ ALN. X.II.3.10.b, Robinson to Somerset, 23 Nov. 1702, 22 Feb. 1703; C.R.O. (Carlisle), D/Lec/27/44, Audit, Michaelmas 1703 (payment to caretaker); C.R.O. (Carlisle), D/Lec/169, Petition of Jane Robinson to Duchess of Somerset, 29 Mar. 1704; C.R.O. (Carlisle), D/Lec/81, Robinson to Hutchinson, Report, 15 Nov. 1704; Tullie House Library (Carlisle), Nicolson's Diary, 5 Dec. 1705; C.R.O. (Carlisle), D/Lec/169, Robinson to financial official re coal and copper works, 22 May 1706; Robinson (1709), 62, 87; Ferguson (1877), 65-6.
- ³⁰ C.R.O. (Carlisle), D/Lec/81, Mining bundle, 1704 (Attribution of these fragmentary notes of 1704 to Hutchinson depends upon a comparison of their script with that in MSS Gough; Wales 8, in the Bodleian Library, Oxford).
- ³¹ For contemporary geological ideas: Greene, Ch. 3; Porter, Ch. 3; For Hutchinson in particular: D.N.B., Hutchinson; Hutchinson, Vol. 5, 269-71, 282, 285, 349-51; Kuhn, 303-22; Fieldhouse and Jennings, 199-200; Raistrick (1975), vol. 1, 75-7; B. Lib. MSS, Additional 5860, 306-7, Extract from a destroyed MS of Woodward's, 1728.
- ³² D.N.B., Woodward, Ray, Arbuthnot, Lister; Clark and Hughes, Ch. 5; Gunther, Ch. 16; Eyles, 399-427; Hutchinson, Vol. 5, 241-2; Woodward (1729); B. Lib. MSS, Lansdowne 219, 29, Nicolson to Lluyd, 7 Nov. 1700; B. Lib. MSS, Additional 5860, 306-7 (See note 31 above); B. Lib. MSS, Additional 25095, Woodward's note book; Bodleian Library (Oxford) MSS, Gough, Wales, 8, Hutchinson's letters to Woodward, 1706.
- ³³ B. Lib. MSS, Additional 5860, 306-7 (see note 31 above); Hutchinson, Vol. 12, 259-359, 'Observations' of 1706; Woodward (1695), Pt. 4, Origin and formation of metals and minerals; C.R.O. (Carlisle), D/Lec/81, Mining Bundle, 1704, Hutchinson's notes on Bransty and Goldscope; B. Lib. MSS, Additional 25095 79r, Langaron Iron Mine; Woodward (1729), Specimens o/46 to o/78, from Langaron.
- ³⁴ Hutchinson, vol. 12, 273; Woodward (1695), 195-7; Woodward (1729), specimen r.1; Robinson (1696), 72-3; Robinson (1709), Chaps. 12, 14; B. Lib. MSS, Additional 25095, 73v. ff.
- ³⁵ Robinson (1709), 37-8, 41-2, 69; C.R.O. (Carlisle), D/Lec/81, Robinson to Somerset, 13 Nov. 1697; Porter, 70-1; Taylor, 151; Collier, 424; Milton, *Paradise Lost*, I, 670-674.
- ³⁶ Robinson (1709), 64 and Chap. 12; Taylor, Chap. 2; Woodward (1695), 195-7; Hutchinson, Vol. 12, 341-3.
- ³⁷ Rees, 658 ff., on Stringer; B. Lib. MSS, Loan 16, Mines Royal MSS, on Stringer; ALN. X.II.3.10.b, Robinson to Somerset, 11 June 1702; ALN. X.II.3.8.f, Robinson to Somerset, 16 July 1702; ALN. X.II.3.10.b, Robinson to Somerset, 3 Aug. 1702; C.R.O. (Carlisle), D/Lec/81, Robinson's Accounts for the copper works, 13 May 1699; Donald, 369 ff., on assay methods.
- ³⁸ Rees, 499-504; Jenkins (1943-5), 74; Day (1974-6) passim; B. Lib. MSS, Additional 25095, 99r.
- ³⁹ C.R.O. (Carlisle), D/Lec/81, Robinson to Somerset, 18 Sept. 1700; C.R.O. (Carlisle), D/Lec/81, Robinson, 'An Account of the Several Trials', Sept. 1700?; Hammersley, 24.
- ⁴⁰ Woodward (1729), Specimens i.62 and i.22 (yellow ores), i.23 and i.24 (grey ores); Reed, 233-6; C.R.O. (Carlisle), D/Lec/81, Robinson to Somerset, 13 Nov. 1697; Donald, 212-4; B. Lib. MSS, Additional 25095, 83v, 'Of the copper ore and the veins in which it lies, in Cumberland'.
- ⁴¹ Postlethwaite, 63; Reed, 239; C.R.O. (Carlisle), D/Lec/81, Robinson, 'An Account of the several trials', Sept. 1700?; Hutchinson, Vol. 12, 243; ALN. X.II.3.10.b, Robinson to Somerset, 3 Aug. 1702; B. Lib.

- MSS, Additional 25096, 44r-45r, Woodward, 'The Art of Assaying', 3, 'The Copper Proof'; Woodward (1729), Specimen 1.59 (the Black Vein?).
- ⁴² ALN. X.II.3.10.b, Robinson to Somerset, 11 June 1702; ALN. X.II.3.8.f, Robinson to Somerset, 16 July 1702; ALN. X.II.3.10.b, Robinson to Somerset, 23 Nov. 1702; Robinson (1696), Dedication 'To the Gentlemen Miners', praises 'experimental philosophy': (Whilst Robinson prided himself on his observational powers and experience, he did not encounter, or did not recognise, any phenomena which challenged his geological concepts.); D.N.B., for Robinson's social activities at Ousby.
- ⁴³ ALN. X.II.3.8.f, Contract between Robinson and Thomas Hansom for clearance of the shaft in Goldscope, 4 March 1703; ALN. X.II.3.10.b, Robinson to Somerset, 22 Feb. 1703; ALN. X.II.3.8.f, Robinson to Somerset, 4 March 1703; C.R.O. (Carlisle), D/Lec/27/44, Audit, Michaelmas, 1703.
- ⁴⁴ Robinson (1709), 64-6.
- ⁴⁵ ALN. X.II.3.8.f, Robinson to Somerset, 16 July 1702; Day (1973), Chap. 2; Day (1974-6), 49-50; Jenkins (1933-4), 73; Jenkins (1943), *passim*; Jenkins (1943-5), 80; Rees, 499-504; Tylecote, 95.
- ⁴⁶ ALN. Y.II.7., discussed by Donald (1955), *passim*. and Hammersley (1973), *passim*. Crookes and Röhrig, 5.
- ⁴⁷ ALN. Y.II.7 contains analyses of the ores; Day (1974-6), 50; Donald, 199-205; Hammersley, 24; Raistrick (1977), 100-110, 146-149; Rees, 171-175, 506-7; C.R.O. (Carlisle), D/Lec/81, Mining bundle, 1704, 'The Refining Furnace at Newcastle; Carlisle Library: Nicolson's Diary, 25 July 1702.
- ⁴⁸ ALN. X.II.3.10.b, Robinson to Somerset, 11 June 1702; ALN. X.II.3.8.f, Robinson to Somerset, 16 July 1702; ALN. X.II.3.10.b, Robinson to Somerset, 3 Aug. 1702; ALN. X.II.3.10.b, Robinson to Somerset, 23 Nov. 1702; ALN. X.II.3.10.b, Robinson to Somerset, 22 Feb. 1703; B.Lib. MSS, Additional 25095, 98v-99r, Woodward's Notebook, 'Of the Copper Reverberatory furnaces'; West Sussex R.O., P.H.A. 17, petition of Robinson to Somerset, 21 Mar. 1715; Rees, 497-9, on furnaces, demand and progress of coinage contracts; Day (1974-6), 49.
- ⁴⁹ Postlethwaite, 81; C.R.O. (Carlisle), D/Lec/81, Mining bundle, 1704: Hutchinson's sketch maps and particulars of a copper works; Robinson (1709), 63-4; ALN. X.II.3.10.b, Robinson to Somerset, 11 June 1702; Tylecote, 94; Hammersley, 19-20.
- ⁵⁰ ALN. X.II.3.8.f, Robinson to Somerset, 16 July 1702; ALN. X.II.3.10.b, Robinson to Somerset, 3 Aug. 1702; B.Lib. MSS, Additional 25095, 99r Woodward's Notebook.
- ⁵¹ Robinson (1709), 63-4; B.Lib. MSS, Additional 25096, 4.
- ⁵² ALN. X.II.3.10.b, Robinson to Somerset, 11 June 1702; ALN. X.II.3.10.b, Robinson to Somerset, 3 Aug. 1702; C.R.O. (Carlisle), D/Lec/169/1702, Estate Correspondence, Ewart to Relfe, 30 Nov. 1702, 10 Dec. 1702.
- ⁵³ D.N.B., Seymour (for Somerset); R.C.H.M., 15th Report (1899), Appendix VII, MSS of the Duke of Somerset, 113-120; C.R.O. (Carlisle), D/Lec/81, Davies to Thornton, 4 Aug. 1697, 30 Mar. 1698.
- ⁵⁴ Tylecote, 95; Day (1974-6), 49; Hamilton, 105-121; Barton, 11-18; Defoe, Vol. 2, 683; Postlethwaite, 79 ff.
- ⁵⁵ C.R.O. (Carlisle), D/Lec/Vouchers, Lady Day 1706; C.R.O. (Carlisle), D/Lec/81, 6 Mar. 1738.
- ⁵⁶ West Sussex R.O., P.H.A., 17, Petition of Robinson to Somerset, 21 Mar. 1715.