

1834. Etrickbridge bridge, probably widening of an older bridge

1837. Merton Bridge, design and evidence on the Bill in Parliament, four spans, timber on stone piers

1841. Ashkirk Bridge, designed and built?

1846–1848. Ashiestiel Bridge over river Tweed, designed and built, whinstone arch of 133½ ft. span, collapsed 15 July 1847, rebuilt 1848

SMITH, Robert, Colonel (1787–1873), military engineer, was the son of James and Mary Smith of Bideford, Devon, baptised at Nancy, France, on 13 September 1787. He served in the Bengal Engineers from 1805 to 1830, when he retired with the rank of major. He was later made an honorary colonel and created CB.

In his first years in India, he helped to construct the lighthouse at Kirji (Kedree) in Diamond Harbour, Calcutta, between 1808 and 1810. He saw service in the capture of Mauritius from the French in 1810, in the invasion of Java in 1811 and in the Nepal War of 1814–1815. He also took part in the siege of Bharatpur near Agra in 1825–1826.

Smith was a highly skilled surveyor whose detailed maps proved invaluable to the military as they settled newly acquired territories. He made a map of the wild jungle area of the Palamau, Shahabad and Mirzapur districts of the Ganges Plain in 1813–1814 and then spent some time in Penang (Prince of Wales Island). On return from his three-year furlough in 1822 he was appointed Garrison Engineer and Executive Officer, Delhi, and had among his duties the repair of great Mughal monuments in and around Delhi. From this post he was detailed in March 1823 to complete the survey of an ancient Mughal canal, the Doab or Eastern Jumna (Yamuna) Canal, in succession to Henry Debudé (q.v.), and in 1827 was appointed Superintendent of the Doab Canal. This canal had been constructed by Ali Mardan Khan in the seventeenth century, largely by joining water-courses together, but is thought not to have functioned for long because of the steepness of its slope and the interference it suffered from mountain torrents crossing its path in the north.

Under Smith the channel was excavated to a depth of 4 ft. below the surface of the country, following as far as possible the natural courses of rivers, but straightening out the most tortuous parts of the channel. A new head was established at Fyzabad using temporary bunds, and a new cut made from Gokulpur to Selimpur to deal with the tail-water. Various strategies were employed to deal with the seasonal torrents in the north. The worst of these, the Muskurra torrent, had a dam built across it, originally with eighteen openings of 7 ft., the centre six with gates; it later had to be increased in length. It operated in conjunction with a regulating-bridge at Kulsea, which had three spans, a centre one of 20 ft. and two side ones each of 15 ft., all controlled by gates and sleeper planks. Similar arrangements were made at Nogong and Nyashur; there was a slightly

longer dam at Nogong, and at Nyashur a dam and regulating-bridge arrangement. Smith usually used curtain walls front and rear in the foundations of his structures, but for works in difficult locations, such as at Muskurra, curtain walls were formed by parallel rows of wells sunk between 6 ft. and 12 ft., with the spaces between them filled by piling. This was an adaptation of a traditional Indian method of using wells in foundations. The lack of hydraulic knowledge in this period meant that irrigation work was largely empirical and much work had to be undertaken later to introduce falls to reduce the slope and to provide larger regulating-works.

From 1825, Smith had as his assistant Lieutenant Proby Cautley (1802–1871), whose delightful surviving sketch-book gives details of the structures and their foundations. Water was admitted in 1830 but Smith had already taken sick leave and retired at that time.

Smith combined his ability as an engineer and surveyor with the gifts of architect and artist. A number of his paintings survive in the India Office Records. Among other buildings in Delhi he repaired the Red Fort, the Qutb Minar, the Jami Masjid mosque, as well as producing designs for St. James's Church, Delhi (built in 1836), and Mughal-style palaces for himself in Nice and Paignton. He died on 16 September 1873.

JOYCE BROWN

[J. Colvin (1833) On the restoration of the ancient canals in the Delhi Territory, *Journal of the Asiatic Society of Bengal*, 15, 116–117; P. T. Cautley (1833) Doab Canal sketches, Department of Civil Engineering Library, Imperial College, London; P. T. Cautley (1839) A description of the use of wells for foundations, *Journal of the Asiatic Society of Bengal*, 8, 47–64; P. T. Cautley (1853) *Notes and Memoranda on the Eastern Jumna or Doab Canal*; E. W. C. Sandes (1933) *The Military Engineer in India*, I, 232, 240, 261; E. W. C. Sandes (1935) *The Military Engineer in India*, II, 4, 260; R. H. Phillimore (1950) *Historical Records of the Survey of India*, II, 442; M. Archer (1972) An artist engineer—Colonel Robert Smith in India (1805–1830), *The Connoisseur*, 79–88; J. Brown (1978) Sir Proby Cauley (1802–1871), a pioneer of Indian irrigation, *History of Technology*, 3, 44–49; C. A. Bayley (ed.) (1990) *The Raj—India and the British, 1600–1947*, National Portrait Gallery Publications, 208–209]

Works

1823–1830. Eastern Jumna (Doab) Canal, 134 miles

1823–1830. Muskurra dam, Kulsea

1823–1830. Nogong dam, Budhi Jumna

SMITH, Thomas (1752–1815), tinsmith and lighthouse engineer, was born in Ferryport-on-Craig, Fife. In 1764 he was apprenticed to a metal worker in Dundee after which he came to Edinburgh, probably in 1770, at the time the building of the 'New Town' was gathering momentum. He was employed by an established metal worker

and by 1781 was trading as a tinsmith in the city, manufacturing oil lamps, brass fittings, fenders and other household metal articles. His business prospered, particularly from 1786 when he took an enterprising interest in improving the illumination of lighthouses.

Smith's earliest known lighthouse illumination proposal was made in 1786 but not implemented until 1815–1816. He proposed that a lamp with metallic reflectors be substituted for the coal-fire light at the private lighthouse built on the Isle of May in the Firth of Forth in 1635. In support of this idea he wrote on 16 June 1786 'A comparative view of the superior advantages of lamps above coal light when applyd to light houses', in which he confirmed that he had 'constructed 2 small reflectors & lamp with a view to demonstrate by experiment what has been only laid down in theory'. Soon afterwards, at the expense of the Board of Manufactures in Edinburgh, he successfully tried out his reflector lamp experimentally at Inchkeith in the Firth of Forth.

Smith's pioneering work in illumination brought him to the notice of the Northern Lighthouse Board of Commissioners which had been formed later in 1786 to improve the almost non-existent lighting of Scotland's dangerous coast and on 22 January 1787 they appointed him as their first Engineer. Several weeks later he was sent to Norfolk to receive a short course of instruction in lighthouse construction and illumination from Ezekiel Walker of Kings Lynn.

On his return Smith enthusiastically set to work on the provision of new lighthouses for the Northern Lighthouse Board. At first this was in an honorary capacity and it was not until 1793 that the Board awarded him a salary of £60 p.a. over and above his expenses. The Board had appointed Smith primarily for his lighting expertise and did not regard his lack of building and architectural experience as an impediment as such skills could be and were brought in under his direction from Alexander Kay, architect and others. During the next two decades, commencing in 1787 with the conversion of Kinnaird Castle, into a lighthouse, Smith was responsible for providing or improving thirteen lighthouses. Independently of the Board, he was responsible for harbour lights at Leith and Portpatrick and lights on the rivers Clyde and Tay.

In 1789 Smith was elected to the Edinburgh Guild of Hammermen becoming its Master and a city magistrate in 1802. From 1797 he delegated and allowed almost complete autonomy in lighthouse matters to his apprentice and stepson Robert Stevenson (q.v.) who married his daughter Jane and formally succeeded him as Engineer to the Northern Lighthouse Board on 12 July 1808. This delegation of work enabled Smith to concentrate on lamp manufacture and the expansion of his shipping and other interests particularly his general and street lighting business. By 1800 his lamps were lighting much of eastern Scotland and the central belt as far west as Glasgow. In 1804 he was the public lighting contractor for both the Old

and New towns of Edinburgh and, by 1807, for lighting the streets of Perth, Stirling, Ayr, Haddington, Aberdeen. He retired from business in 1808 and died on 21 June 1815 at his home, 1 Baxter's Place, Edinburgh.

In terms of technical innovation Smith developed and made arrays of parabolic reflector oil lamps. Each lamp had a light source at its focus and a curved reflector formed of small pieces of mirror glass set in plaster that produced a beam of light. The adoption of glass rather than metal had the advantages of being more resistant to distortion and also to wear from frequent cleaning before the use of glass chimneys. Smith's expedients undoubtedly represented the most practicable means of achieving an immediate improvement in Scottish lighthouse lighting before the Argand lamp, patented in 1784, was eventually applied to this purpose.

Smith's first operational lighthouse light, at Kinnaird Head, had an intensity of about 1,000 candlepower, which although feeble compared with its modern counterpart of 690,000 candlepower, nevertheless represented a worthwhile improvement on coal lights. He continued to adopt glass-faceted reflectors for new lights until 1801, after which, because of Robert Stevenson's influence, he started to manufacture Argand lamps with silvered-copper reflectors. This improvement which produced a significantly brighter light was probably first installed in Scotland at Inchkeith lighthouse in 1804.

Details of Smith's reflectors became more generally known from an article 'Reflector for a lighthouse' in the supplement to the third edition of *Encyclopaedia Britannica* (1801). In it Smith is described as 'an ingenious and modest man [who] has carried [his inventions] to a high degree of perfection without knowing that something of the same kind had been long used in France'. This tribute was omitted from later editions, including the last carrying the article (1823), after the editor had learned of Ezekiel Walker's prior development of the glass facet reflector lamp concept. Nevertheless, Smith was the first to introduce brighter lights into Scottish lighthouses. More generally, he deserves to be remembered chiefly for his important contribution in improving both public and private lighting in Scotland and for laying the foundation of the Stevenson dynasty of engineers through his encouragement of Robert Stevenson.

Smith has a good claim to be regarded as Scotland's first lighting engineer.

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[Private information; National Library of Scotland. Business records of Robert Stevenson & Sons, MS. Acc. 10706; Obituary notice, *Edinburgh Advertiser*, 30 June 1815; Obituary notice, *Edinburgh Evening Courant*, 1 July 1815; Obituary notice, *Caledonian Mercury*, 1 July 1815; D. A. Stevenson (1959) *The World's Lighthouses before 1820*; C. Mair (1978) *A Star for Seamen—The Stevenson family of engineers*; J. Leslie and R. Paxton (1999) *Bright Lights—The Stevenson Engineers 1751–1971*]

Works (all lighthouses)

1787. Kinnaird Head
 1787–1788. Mull of Kintyre
 1789. North Ronaldsay
 1789. Eilean Glas
 1789. Tay Lights (improved 1789)
 1790. Pladda
 1790. Leith (improved 1790)
 1790. Portpatrick
 1793. Little Cumbrae (improved 1793)
 1794. Pentland Skerries
 1797. Cloch
 1802–1806. Start Point
 1804. Inchkeith

Street lighting in various cities and towns in Scotland including Edinburgh, Glasgow, Perth, Stirling, Aberdeen, and Haddington.

The extent of Smith's private work is not known but it was probably considerable.

SMITH, William (1769–1839), the 'father of British geology', was the son of John Smith (d. 1777) and his wife Ann (*née* Smith) and was born on 23 March 1769 at Churchill, Oxfordshire; he was the eldest son of a family of three boys and a girl. After the death of his father, of farming stock and 'a very ingenious mechanic', at the age of eight, he was supported by his uncle, William, and educated at the village school. At the age of eighteen he became assistant to Edward Webb, surveyor of Stow-in-the-Wold, in whose house he lived. He worked for him on landscaping the grounds of Warren Hastings' house.

Webb arranged for him to survey the estate of Lady Elizabeth Jones at Stoney in Somerset in 1791. He settled in the area. After undertaking work on his own account for the High Littleton Coal Company and other clients (in Somerset), he became responsible in 1793—under John Rennie (q.v.)—for survey work on the Somersetshire Coal Canal, as a precursor to which he made a tour to inspect completed canal schemes, travelling as far north as Tyneside in the late summer of 1794. His salary was then a guinea a day plus expenses. After work began, Smith was appointed as sub-engineer in 1795 with a salary of £450 p.a., holding the post until 1799 when he left the company following a disagreement. By this time he had developed a keen interest in geology fostered by his work in the coalfield and developed a stratigraphical theory. He had been elected to the Royal Bath and West of England Society in 1796, and by 1799 had produced a manuscript geological map of the Bath area and section of the strata. He became an independent consulting engineer and between 1800 and 1810 reporting on land drainage, sea defences, water supplies, canal routes and the siting of coal mines. His living was precarious because of debts he had accumulated and a large mortgage on Tucking Mill House. In the course of his work at this time he met some wealthy patrons, including Joseph Banks in 1801, and took in as an assistant John Farey (q.v.) while working on the

Bedford Estate at Woburn. He moved to London in 1803, occupying 15 Buckingham Street, Adelphi, later the premises of the Institution of Civil Engineers in 1804. He married his wife Mary Ann (b. 1791/1792) in 1808. Aside from Farey, his chief assistant was his nephew John Phillips (b. 1800), who joined him in 1815.

In 1801 was published his 'tabular view' of the strata around Bath and in 1815, after financial difficulties, he published a geological map of England and Wales to a scale of 5 miles to the inch, dedicating it to Sir Joseph Banks. The cost of this work placed him under a heavy burden, as a result of which he sold his mineral specimens to the British Museum in 1818, and in the summer of 1819 suffered ten weeks in a debtors prison. On his release he left London for Yorkshire. Between 1819 and 1824, a period during which his wife's health failed, Smith produced a series of county maps and in 1828 he became land agent to Sir John V. B. Johnstone of Hackness, Yorkshire, remaining there for six years.

One of his most significant achievements was the identification of the presence of coal in the eastern parts of County Durham, beneath the overlying Magnesian Limestone. The advice he gave to the landowners there led to the establishment of new collieries, in turn resulting in the construction of port and dock facilities at both Hartlepool and Seaham Harbour during the 1830s; both ports were connected by rail to the new mines.

The Geological Society of London, which had earlier ignored his work, awarded its first Wollaston Medal to Smith in 1831 and four years later he received an honorary doctorate from Trinity College, Dublin. In 1838 he became a member of the commission which advised the government on the type of stone to be used for the new Houses of Parliament but very soon after signing the commission's report, when travelling to the meeting of the British Association in Birmingham and staying with friends in Northampton, he died on 28 August 1839. He was buried at St. Peter's church and is commemorated by a tablet and bust. Little is known of his family life save that his wife survived him by five years, spent in an asylum in York. There were no known children

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[J. Phillips (1844) *Memoirs of William Smith ...*; DNB; K. R. Clew (1969) *The Somersetshire Coal Canal and Railways*; D. A. Robson (1986) *Pioneers of Geology*; S. Winchester (2001) *The Map that Changed the World*]

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1801. *General Map of Strata found in England and Wales*
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 1808. *Observations on the Utility, Form and Management of Water Meadows*