Geological Survey under Sir Henry Thomas De la Beche, 1835–1835

From Earthwise

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Sir Henry Thomas De la Beche (From an engraving by W. Walker after a painting by H. P. Bone, 1848.)

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II. The Geological Survey under Sir Henry Thomas De La Beche

That the geologically coloured Ordnance Survey maps prepared by De la Beche in the years 1832 to 1835 were received with much approbation by geologists and highly commended by the Presidents of the Geological Society, who were at that time the most competent critics, is sufficiently evident from the laudatory notices quoted from the Presidential addresses. A movement arose to make the enterprise continuous and to establish it on a firmer basis, and in this the most conspicuous members of the Society played a very active part. In this respect the Geological Society may be regarded as the mother of the Geological Survey, and there can be no doubt that it was principally owing to the hearty support given to the proposal by many distinguished and influential members of the Society that it was ultimately carried to a successful conclusion. At that period geology was firmly established as a vigorous and even a fashionable science. Sedgwick in Cambridge and Buckland in Oxford were the professors of the subject; both were men of outstanding personality, much honoured in academic circles and among the most prominent and famous scientists in the country. The Geological Society included in its ranks members of the peerage, Members of Parliament, great landowners and eminent bankers, men of a class which was likely to be able to exert considerable influence upon ministers. The proposal, moreover, was put forward in a very modest way, not likely to arouse the criticism that it would involve great expenditure; and the probable advantages to commerce, agriculture, manufactures and mining were no less obvious than the services it would render to geological science. Many circumstances had already prepared the public mind to view favourably such a proposal and there was a widespread and intelligent interest in the geology of the country and in the preparation of geological maps of a better standard than those which were at that time before the public.

The initiative appears to have come actually from the Ordnance Survey which applied to Buckland, Sedgwick and Lyell for a recommendation or report. The transaction has been described by Lyell in his Presidential Address to the Society delivered on 20th February, 1836.

> Early in the Spring of last year an application was made by the Master-General and Board of Ordnance to Dr. Buckland and Mr. Sedgwick, as professors of Geology in the Universities of Oxford and Cambridge, and to myself as President of this Society, to offer our opinion as to the expediency of combining a geological examination of the English counties with the geographical survey now in progress. In compliance with this requisition we drew up a joint report, in which we endeavoured to state fully our opinion as to the great advantages which must accrue from such an undertaking, not only as calculated to promote geological science, which would alone be a sufficient object, but also as a work of great practical utility, bearing on agriculture, mining, road-making, the formation of canals and railroads, and other branches of national industry. The enlightened views of the Board of Ordnance were warmly seconded by the present Chancellor of the Exchequer, and a grant was obtained from the Treasury to defray the additional expenses which will be incurred in colouring geologically the Ordnance county maps. This arrangement may justly be regarded as an economical one, as those surveyors who have cultivated geology can with small increase of labour, when exploring the minute topography of the ground, trace out the boundaries of the principal mineral groups. This end, however, could only be fully accomplished by securing the co-operation of an

> experienced and able geologist, who might organize and direct the operations; and I congratulate the Society that our Foreign Secretary, Mr. De la Beche, has been chosen to discharge an office for which he is so eminently qualified.

In 1835 Henry Thomas De la Beche was thirty-nine years of age. For some years he had been one of the most active members of the Geological Society and though not so conspicuous in the world of science as Buckland, Sedgwick, Murchison and Greenough, he was recognized as an eminent geologist. In 1831 and 1832 he had been Secretary to the Society, and in 1834 he was one of the Vice-Presidents during the Presidency of Greenough. From 1835 to 1847 he was Foreign Secretary, one of the most honourable on the Society's list of offices.

De la Beche had already published numerous memoirs and made his mark as a geologist. His first paper seems to have been 'Observations on depth and temperature of the Lake of Geneva' (1819), *Bibliothèque Universelle,* also *Edin. Phil. Journ.* (1820). Thereafter he visited Jamaica (1824), on which island his family possessed estates, and he wrote a memoir 'Remarks on the Geology of Jamaica' published in the *Trans. Geol. Soc.,* 1826, 2nd Ser., vol. ii, p. 143, and illustrated by a coloured map. He had travelled in Switzerland, France and Italy, and wrote some papers on the geology of Savoy and La Manche. He also translated a series of Memoirs from the 'Annales des Mines' and edited them with notes. In 1831 a 'Manual of Geology' was issued by his hand, a second edition of which work appeared in 1832. Among other contributions from his pen was a series of 40 sections and views illustrative of Geological Phenomena (1829) and in 1834 he published a volume entitled 'Theoretical Researches in Geology.'

De la Beche, whose father was a military man, though born in London in 1796, spent his youth in Devon and Dorset. For some time he seems to have lived at Char-mouth. In 1810 he was sent to the Royal Military School of Great Marlowe (which was afterwards replaced by Sandhurst). He entered the Army after passing through the Military School, but soon retired from the service and for some time apparently lived the life of a man of leisure with sufficient means to keep him in comfort. In 1817 he joined the Geological Society of London and thereafter his interests were principally in foreign travel and in geology.

For a man of good education to become a geologist it was not necessary in those days to have any sort of academic training. There were Schools of Geology, of course, at Oxford, presided over by Buckland, and at Cambridge, where Sedgwick was professor. But Murchison, Scrope, Lyell and others had achieved distinction as geologists practically by their own exertions. Murchison, like De la Beche, had been in the Army, but he never learnt geology in any school, and he used to say that all a man wanted to become a geologist was industry, common sense and a sound pair of legs. The papers and discussions at the Geological Society were by far the best intellectual training in the subject that could be obtained at that time. De la Beche was diligent in his attendance and submitted papers frequently, but he does not seem to have taken a prominent part in the debates.

So far as can be gathered from his works, he was very fond of travel and of an open air life. He knew foreign languages well and perhaps this was one of the reasons for his long tenure of the Foreign Secretaryship of the Society. Like Murchison and Lyell, who were also great travellers, De la Beche had many friends among Continental geologists. From the first he had a strong taste for mapping and drawing and his early volume of 'Sections' indicates this propensity. He was a man of very methodical habits and business-like, and any task which he took in hand he finished in good time. He was a handsome man, with very agreeable manners, who was at home in all classes of society; and to the end he retained traces of his early military associations, though he was a great favourite with those who worked under him.

The reason why De la Beche took on the task of colouring Ordnance maps can now only be inferred. Probably he chose himself, that is to say he liked that sort of work and started it spontaneously. Lyell was busy building up the philosophical principles of Geology and expounding them to the multitude; Murchison was exploring new ground and creating new geological formations out of the neglected rocks of old ‘grauwacke’; Buckland was engrossed in cave researches and ‘diluvial’ geology. De la Beche seems to have been a man of the type who likes to take a piece of complicated unmapped country and to follow out its geological lines day by day, gradually unravelling the details of structure and filling it in bit by bit till he completes a scientific whole. This task can be very engrossing, as many field geologists know well. It offers a combination of life in the open air, constant novelty, the interest of scientific work and at the same time the advancement of geological science. Many geological surveyors who have spent years in such work continue to carry it on after their retirement so long as their legs will stand the exertion. It is a healthful, varied, pleasant and interesting manner of spending their leisure time.

De la Beche also had very special qualifications for the work. He was diligent and methodical, and he had devoted much attention to the study of the methods of collecting and interpreting geological field evidence. His book on ‘Methods of Observing’ proves that he was both well informed and very critical. It is fortunate that at the time when circumstances were ripe for the production of a series of official geological maps a man with capacity and habits such as those of De la Beche was available. He had that combination of qualities which eminently suited him for the task.

Subsequent events were to prove that he was an organizer of extraordinary ability. When practical difficulties arose his ingenuity and patience were remarkable. He had especially well developed the sense of fathoming the official mind, and knew perfectly what arguments were likely to carry most weight with administrative persons. This is really a natural gift which many scientific men completely lack. Even in the inception of his scheme this faculty was obvious. He put it forward in such a plausible manner; it was so inexpensive and promised to be of such general usefulness and was backed by so many wise and authoritative persons that no one could possibly raise any objections. And naturally in due course the scheme expanded, but as it was running smoothly and was applauded by everyone its subsequent growth was inevitable.

Mapping Devonshire and Cornwall

At the time when De la Beche began his official geological work the Ordnance Survey had published one-inch maps of most of the South of England and part of Wales. A wide choice of districts was consequently open to De la Beche in which to execute his survey. He decided to begin in Devonshire and Cornwall and at the present day we can only surmise what were the reasons for this programme. The geology of other parts of England such as the Bath district and the Weald of Kent was much better known. Perhaps he avoided these because other geologists were busy there and were soon to bring their work to fruition. Perhaps he intended to make a clean sweep across the South of England and, like many other geologists, he underestimated the time required for such a task. We may note, however, that his favourite field of work was in the West of England, Dorset and Devon, and possibly he had already made a preliminary examination of Cornwall and had been fascinated by the strange new problems involved in its complex geology. Mining was very active in Cornwall at that time, and many of the engineers had taken great interest in mineralogy and geology and had acquired much information likely to be useful, and as yet unpublished. De la Beche also was always strongly attracted by the economic side of geology and insisted on the practical value of the science. For this reason Cornwall may have held special attractions. He was not a mining engineer, but, as his subsequent work showed, he was prepared to devote special attention both to the theoretical and practical aspects of the study of ore deposits. The rocks of Cornwall presented a great variety of structures, many of which were not exhibited elsewhere in the South of England,

and De la Beche excelled as a structural geologist. But whatever may have been the reason of his choice, it was final, and his fame is linked with the researches which he carried out there and subsequently published in his maps and his classic 'Report.'

A very considerable amount of information had already been published regarding the geology of Cornwall and Devon. The Transactions of the Royal Geological Society of Cornwall started in 1818, and by 1832 four volumes had appeared containing many interesting memoirs. The list of literature on the geology of Cornwall and Devon given in De la Beche's 'Report' (1839) is a considerable one and includes the names of Berger, De Luc, Macculloch, Conybeare, Sedgwick and Majendie. The distribution of the principal granite masses was well known and many of the elvan dykes had also been located. In Devonshire the main outcrops of limestone had been traced and many of them were extensively worked. The rest of the country was regarded as grauwacke, killas or clay-slate, and no real advance had been made in the interpretation of its structural relationships. The basic igneous rocks now known as greenstones, diabases, spilites and schalsteins were recognized and were called 'blue elvans'; many of their exposures were well known. Hence the outlines of Cornish geology had already been sketched out. Of some districts, such as the Lizard, very useful maps had already appeared and De la Beche did not modify them greatly. It is clear, however, that he traversed the whole country and examined all the coast sections. This was a tremendous task for one man, single-handed, and we can only marvel at his energy. The four maps which he had finished in 1832 represent about a thousand square miles and bear witness to his enthusiasm and power of work. In the Preface to his 'Report' (1839) he mentions the names of the Ordnance Surveyors, Still and Maclauchlan, but he seems to have had no other helpers. These two gave him the lines of many mineral veins and elvans, and in some places the boundaries of the granite, along with other assistance from the information they had collected in course of their work in the field. He was also thoroughly conversant with the literature, but he seems to have checked the results of previous observers by a personal examination of the outcrops.

His great Report on the Geology of Cornwall, Devon and Somerset was not published till 1839. It runs to 648 pages with many plates and must have been compiled from the notes he had taken during his field surveys. When we recollect that in the decennium 1830–1840 De la Beche had prepared eight geological one-inch maps, published his 'Geological Researches,' two editions of his 'Geological Manual,' and his voluminous 'Report,' besides conducting all the negotiations and business arising from the institution of the Geological Survey, we are led to wonder at the display of energy he exhibited in these years.

His 'Report' and maps show that he was diligent, cautious and thorough. Judged by the standard set up by the revision of part of Cornwall and Devon carried out by Clement Reid and his staff of geologists in the years 1900–1909 the maps are mere sketch work. The outlines of the granites stand with little alteration, but the elvans, greenstones and mineral lodes have much increased in number in the new maps and the details of boundary lines have often been greatly modified. This does not lessen our admiration for the pioneer work of De la Beche. Subsequently additional details of the lodes were added to De la Beche's maps about 1860 by Warington W. Smyth.

It is a saddening commentary on the geological cartography of Great Britain that the original one-inch maps of parts of North Devon and Somerset have not yet been revised but are still on sale essentially unmodified from the form given them about the year 1844.

The most valuable part of De la Beche's Report at the present day is the very full description of the geology of the mineral lodes and of the methods of working them. As at that time mining in Cornwall was very active and prosperous, while now it has fallen into decay, we have an authentic and most authoritative description, both geological and practical, of a state of things that has passed away.

De la Beche's work, however, in one respect was incomplete, for little attention had been given to the subdivisions of the killas and to the evidence of their geological age. At first De la Beche seems to have been of the opinion that the 'grauwacke' and 'killas' of Western Cornwall were rocks of very great geological age, probably as old as or even older than Sedgwick's Cambrian. But in 1836 Sedgwick and Murchison showed that in Devonshire the Culm Measures were presumably of Carboniferous age. Continuing their researches, they arrived at the conclusion that many of the strata of this region were, if older' than the Carboniferous, at least not so old as Murchison's Silurian. By 1839 they had decided to create a new division of the Geological Series to include these rocks, and had given them the name of the Devonian System. In this they have been proved by subsequent researches to be fully justified, but on account of the intense folding and crushing of the strata the stratigraphical evidence was not completely convincing. Lonsdale, however, who was an able palaeontologist and at that time Curator of the Geological Society's museum, showed in 1840 that the fossils of the Torquay Limestones were intermediate in many characters between those of the Silurian and those of the Carboniferous. In this way, following the precepts of William Smith, the Devonian System was founded on a secure basis. De la Beche's Report (1839) describes these rocks as Grauwacke and Carbonaceous rocks, and gives no clear indication whether he supported the now accepted nomenclature or opposed it. In the map which forms the frontispiece of his Report there is no mention of Devonian. It seems clear, therefore, that he missed the greatest discovery that was made in his special geological province, and in 1839 was at any rate doubtful whether the new classification was worthy of acceptance.

About 1839 also C. W. Peach discovered fossils in the Gorran Haven Quartzite. These have subsequently been recognized as Ordovician (Lower Silurian). De la Beche seems to have known of this discovery, but its importance was not appreciated and the Gorran Quartzite was included in the 'Grauwacke.' The relation of these rocks to the rocks that adjoin them on the north has been much discussed and the question how far the West of Cornwall is made up of strata older than the Devonian is yet by no means settled. Only last year (1934) De la Beche's successor announced that fossil evidence had been obtained showing that some of the so-called Ordovician rocks of the South of Cornwall were mos probably Middie Devoman.

Incorporation of the Geological Survey of Ireland into Geological Survey of Great Britain

About the year 1832 Colonel Colby of the Ordnance Survey had appointed Captain Joseph Ellison Portlock, R.E., Geologist to the Trigonometrical Survey of Ireland.

This post seems to have been similar to that which Macculloch received in Scotland in 1814, and Portlock had started by 1834 to make a geological map of Ireland. A small staff of assistants was placed at his service and he had a museum and a laboratory for the examination of soils. The survey was intended to assist the Ordnance Survey by collecting information on agriculture, geology, natural history and statistics, but Portlock did most of the geological work. After a time the preparation of memoir and maps was suspended, but Portlock continued his work and published his memoir 1843. Thereafter he discontinued and his assistants were removed to England. His great memoir is a classic of Irish geology and is worthy to stand comparison with De la Beche's memoir on Cornwall and Devon.

Subsequently (in 1845) the Geological Survey of Ireland was established as a branch of the Geological Survey of Great Britain and was placed under the control of De la Beche.

Selection of stone for the new Houses of Parliament

In 1838 a Commission was appointed to ascertain the most suitable stone for the building of the new Houses of Parliament at Westminster. This included a number of famous geologists, such as William Smith (the founder of stratigraphical geology) and De la Beche and Charles Barry, with C. H. Smith, a sculptor who was an expert on building and ornamental stones. They travelled extensively and made a great collection of specimens. In the long run the stone chosen was from Bolsover, but unfortunately the quarries proved incapable of yielding sufficient quantities, and as an alternative the dolomite of Anston near Mansfield was taken. The problem was a difficult one. It was desired to obtain a stone more durable than the limestones commonly used in London, such as Portland, Bath, Caen and Ketton. On the other hand, as a vast amount of carved and sculptured detail had to be produced, it was hardly possible to use such hard and intractable materials as granite or sandstone. As a middle course, the selection of a dolomitic limestone was decided on, and an inspection of ancient buildings such as Southwell Cathedral and other early English churches seemed to indicate that this choice was unexceptionable. Much criticism has been directed at this selection. The stone has weathered unequally and is full of flaws; the best Anston stone has all the desired qualities, but much of the material used in the Houses of Parliament is of inferior quality and is traversed by ‘vents’ or lines of weakness. Unfortunately no satisfactory inspection was made at the quarry and no care was taken to reject unsuitable rock. Not more than about 15 per cent. of the stone actually used need have been discarded. For this De la Beche cannot justly be blamed. He showed his confidence in Anston rock by using it for the building of his new Museum in Jermyn Street in 1849. It has proved sufficiently durable, but only really good stone was used and deeply cut carving was avoided. The doorway of the Museum in Jermyn Street retained all the ornamental detail in perfection after eighty years of exposure to the London atmosphere. The stone used in the Houses of Parliament was so perishable that in 1861 a Commission was appointed to consider the ‘Decay of the Stone of the New Palace at Westminster’ and the best means of preserving the building: its conclusions led to no practical results.

Establishment of the Museum of Practical Geology

To this investigation, however, we are largely indebted for the establishment of the Museum of Practical Geology, for the large number of specimens of building stones collected by the Commission of 1838, and tested by them, was eminently suitable for preservation. De la Beche had previously made the suggestion that a Museum should be attached to the Geological Survey, in which rocks and minerals which had a bearing on the applications of geology to industry should be exhibited. This suggestion was approved and in 1837 a building in Craig’s Court, Whitehall, was obtained for Survey Offices and Museum.

The extensive collections already made by De la Beche served to illustrate many useful applications of geology, and in a short time, by private generosity and the work of official collectors, the exhibited series grew to considerable dimensions. The Museum was established in 1837 but not opened to the public till 1841, and about the same time Richard Phillips was attached to the service as a chemist to make analyses of minerals and rocks. He acted also as Curator of the Museum. Phillips was one of the founders or original members of the Geological Society of London. He was well known for his researches in chemistry and became President of the Chemical Society. His brother, William Phillips, was a distinguished geologist and wrote standard works on geology and mineralogy. Richard Phillips died in 1851 and was succeeded as Curator of the Museum by Trenham Reeks, who had joined the Survey in the same year as Phillips (1839).

An active coadjutor in the equipment and arrangement of the new Museum was Thomas Sopwith. He was a land and mineral surveyor and he brought out a descriptive account of the Museum in 1843.

He took much interest in mining geology and ultimately became Crown Agent for the Mines in the Forest of Dean. The making of geological models was a work in which he specially excelled, and he prepared a large model of the coalfield of the Forest of Dean on the scale of 5 inches to a mile and another on the scale of 10 inches to a mile which is still preserved and shows wonderful skill and knowledge of the local geology. Sopwith also made small wooden models to illustrate geological structures, such as folds and faults, and the effects of surface configuration on the outcrops of stratified rocks. These models are still used in many colleges and schools to illustrate geological lectures. Sopwith appears to have had a considerable practice as a civil engineer and a surveyor of mines. His geological knowledge was of a high standard and he was a prominent member of the Geological Society. Apparently he was never a regular member of De la Beche's staff, but as he held an appointment under the Crown Estates he seems to have considered himself as semi-officially attached to the Geological Survey and he gave very hearty support to De la Beche's schemes.

Sopwith's 'Account of the Museum of Economic Geology' was published by John Murray and gives a full description not only of the purposes of the Museum but also of its principal exhibits. The striking fact is that almost nothing was shown that had not a practical bearing. For example, there was no collection of classified minerals or rocks and no stratigraphical series of fossils. The collection of building stones, ornamental stones, marbles, granites and serpentines occupied a principal place on the ground floor. Along with these were exhibits of cements, plasters, tiles, pottery, earthenware and other manufactured products. On the first gallery were shown British and foreign ores of the metals, coals and other fuels, with specimens of lodes, veins and other mineral deposits. In this collection tin, Copper, iron and coal held a principal place, as illustrating British industries. Many of the specimens came from Cornwall, Devon and South Wales and were evidently collected during the survey of those districts, but generous donors had also presented large numbers of specimens of foreign ores. Among others, the Imperial Mining Institute of Russia had sent a varied series of Russian exhibits. Scattered through the Museum were examples of metallurgical products, such as castings, electrotypes, gun barrels, etc., and objects of art such as encaustic tiles, statuary, pottery and cameos.

Adjacent to the Museum of Economic Geology there was a Mining Records Office. T. B. Jordan, the officer in charge, was a skilled mechanic and instrument maker and had been Secretary of the Royal Polytechnic Society of Cornwall. Apparently the initial impetus for the establishment of the Mining Records Office came from a great mining disaster that happened in Co. Durham in 1836, when water from old workings burst into a mine and many miners lost their lives. At the British Association Meeting in Newcastle in 1838 Sopwith read a paper urging the importance of collecting and preserving the plans of abandoned mines. A resolution in support of this proposal was carried in the Council of the British Association and an influential committee appointed to submit the matter to the Government. It was urged that similar measures were already being taken by the Board of Woods and Forests in the case of the coal mines of the Forest of Dean, and in Northumberland by the Natural History Society of Newcastle. In March 1839 it was decided to place the work in the hands of De la Beche, and Jordan was appointed Keeper of Mining Records in October 1840.

At the same time it was decided that the Mining Records Office should contain an exhibit of models of coalfields, of various kinds of mines, and of the apparatus used in dressing mineral ores. Apparently Jordan had a workshop connected with the Museum in which models were prepared. In addition to Sopwith's models of the Forest of Dean coalfield, already mentioned, there were models of Dolcoath mine and of Northumbrian coal mines. Sopwith contributed a model of the Alston Moor lead-mining district and other models were presented. Some of them were of an elaborate construction showing shafts, levels and pumps. There were also models of many kinds of mining machinery, buddles, stamps, tilt hammers and jigs. Among this collection Ramsay's original model of the Geology of the Island of Arran makes a somewhat incongruous appearance. A few maps and

plans of mining districts were shown, and a series of sections illustrating the geology of railway-cuttings newly made for the rapidly spreading railway lines of England. A special committee of the British Association had been appointed to get together as large a collection of these railway sections as possible, and the sections which this committee collected were deposited in the Museum.

Although no special exhibits were provided to show the connexion of geology with agriculture, it was announced that Mr. Phillips, Curator of the Museum, would make analyses of rocks and soils at moderate charges.

Cartography — Index of colours

According to a statement made by Horace B. Woodward in the 'Summary of Progress' for 1907, a second Index of Colours to be used in the Geological Survey Maps was issued by De la Beche in 1839. Devonian does not make its appearance in the list, though by that time this controversy was regarded as virtually settled. Sheets 20 to 27 were now being published in a revised edition; they comprise a large part of Devonshire and cover an area bounded by north and south lines drawn on the east though Lyme Regis and on the welt through Liskeard. In addition to these, Sheets 28 to 33 were on sale. This completed the survey of Devon and Cornwall. The 'Report' was published in 1839.

The third Index of Colours was published probably in 1844, but the exact date is not known. In 1846 a reduced edition was prepared; both tablets and writing being on a smaller scale. At that time all the Sheets from 19 to 43 were published except Sheet 34. From this it is clear that the survey of South Wales had made rapid progress between 1839 and 1844, and most of the maps had been engraved. Sheet 34 (which was not published at that time) includes the district around Cirencester.

Geological mapping of South Wales

The reason why De la Beche transferred the work of the Survey from Devon and Cornwall to South Wales is not difficult to perceive. Obviously it was his intention to keep his staff as closely as possible on work that had a definite economic bearing, and the coal and iron industries of South Wales were of paramount importance. The district was one with which he was not unacquainted, as several years previously he had published a memoir on the Geology of Pembrokeshire.

His staff at this time received an accession of numbers. In addition to Phillips and Reeks, employed in the Museum and Laboratory, and Jordan, in charge of the Mining Records Office, he had as assistants W. T. Aveline, T. E. James and A. Murray. In 1841 A. C. Ramsay joined the service. Josiah Rees and D. H. Williams were appointed in 1839, and in 1842 H. W. Bristow began work.

Quite obviously the work of the Geological Survey was receiving public approbation and official support, and in the Presidential Addresses to the Geological Society many encomiums were passed on the newly published maps. The area now taken in hand for survey was very different from Cornwall and Devon. Great exposures of Old Red Sandstone, almost free from plication and disturbance, and singularly barren of fossils, replaced the intensely sheared grauwacke of the southern province. No more was seen of the richly fossiliferous Devonian Limestones of Plymouth and Torquay. The Carboniferous of Devonshire is represented by crushed and broken Culm Measures; in South Wales the beds of the same age are the Carboniferous Limestone and Coal Measures which yield abundance of fossils and contain many workable coals and ironstones. General maps of the South Wales coalfield and the surrounding rocks had been published by Greenough and others, and there had been detailed surveys of a few special districts. But the task of reducing the geology of the whole region to a uniform standard corresponding to the improved cartography of the new Ordnance maps was a difficult one. In the eastern part of the district the tectonic structures are

comparatively simple, but in the west there is great complication and the geology of Pembrokeshire was to remain obscure for many years and to give rise to much controversy.

It was a fortunate circumstance that in South Wales at that time one of the most patient and accurate geologists who ever undertook coalfield survey had been at work for several years. De la Beche was on very friendly terms with him and readily secured his active collaboration in the survey of that coalfield.

William Edmond Logan

William Edmond Logan was a member of a Scottish family which had emigrated to Canada but subsequently returned to Scotland. Logan was educated in Edinburgh, at the Royal High School and subsequently at the University, where he studied logic, chemistry and mathematics for one session only. He then went to London, and entered the counting house of his uncle, a successful business man. From 1817 to 1828 Logan worked in London, and though he was a serious minded young man, and very fond of reading, there does not seem to be evidence that he took any interest in geology. In 1828, however, his uncle became a partner in a firm that proposed to extract copper from metallurgical slags in South Wales, and William Logan went to Swansea as local representative of the firm. From the nature of his work he began to study anew chemistry and mineralogy and he collected shells, fossils and minerals. The business enterprise was not very successful and Logan soon found himself involved in many practical difficulties which increased his interest in mineralogy and metallurgy. After a time his firm undertook coal mining and Logan acquired some geological instruments and started to take notes and make surveys. He seems to have been most1y self-taught, though no doubt he learned much from the practical mining engineers with whom he came in daily contact. From the first his observations were very carefully made and recorded, and his measurements and descriptions were models of exactness, possibly as the result of his thorough business training. He obtained the Ordnance Survey Sheets and laid down on them the outcrops of the coal seams and the other geological information which he collected, and in addition to this he made vertical sections of the strata, and horizontal sections across the Coal Measures, with considerable accuracy and skill. He read all the geological books and papers on which he could lay his hands and became an enthusiastic geologist. In 1837 he joined the Geological Society and in the same year he exhibited a geological map of part of South Wales at the meeting of the British Association. By this time he had made the acquaintance of De la Beche, who was much impressed by Logan’s maps, and recognized that for accuracy and detail they were ahead of anything that had been produced in England up to that time. When the Geological Survey entered South Wales, Logan very generously placed at their service all the results of his observations and De la Beche welcomed them with enthusiasm. In some of the Sheets that were published in 1845 Logan’s name appears as joint author and he gave very active assistance to De la Beche for several years. Apparently he was never a regular member of the Survey staff but continued to be an enthusiastic amateur who rendered gratuitous assistance.

Logan was the first to understand the meaning of the underclays or root-clays that lie beneath coal seams, and he read a paper on this subject to the Geological Society of London in 1840. His views have been fully confirmed by subsequent workers.

In 1840 Logan visited Canada and published several geological papers containing the results of his geological observations during his travels. In 1842 the Canadian Parliament decided to institute a Geological Survey and Logan was appointed geologist. De la Beche wrote a letter supporting Logan’s application and expressing in the highest terms his appreciation of the accuracy and thoroughness of Logan’s work in South Wales. This opinion was subsequently justified, for Logan became one of the most famous men in Canada and one of the most distinguished geologists of the Western Hemisphere. He was the founder of the Geological Survey of Canada, a national institution

of great renown and distinction which has contributed enormously to our knowledge of the geology of that country. Logan's name is held in great reverence, and one of the highest mountains in Canada has been called Mount Logan in his memory. He was knighted by Queen Victoria in 1856 and died in 1875 at the age of 77. For a man who was of middle age before he began the study of geology he attained great distinction in his chosen field of scientific work. Logan was essentially a field geologist and a surveyor, and till advanced age he thought little of hardships and of dangers in travelling through pathless woods and along turbulent rivers. The confidence reposed in him by De la Beche was thoroughly justified and his work in South Wales laid a safe foundation for future researches in that difficult field.

Andrew Crombie Ramsay

Andrew Crombie Ramsay joined the Geological Survey in South Wales in 1841. In due course he rose to be Director for England and subsequently Director-General; consequently more will be heard of him in future chapters. His appointment was due to a recommendation by Sir Roderick Murchison, who had met him at the meeting of the British Association in Glasgow in September 1840. At that meeting he had exhibited a map, sections and model of the geology of Arran. Since the time of Hutton, and even previously, that island had been a centre of interest not only to Scottish geologists but also to eminent Continental scientists, and it had been the subject of numerous descriptions and controversies. But nothing so thorough as Ramsay's work had yet appeared and the exhibits were scrutinized in Glasgow with much interest. Ramsay also read a descriptive paper on the geology of the island.

In 1841 Ramsay was 27 years of age. Like Logan, he was a born geologist, that is to say he took to geological work without any external impulse but purely from his natural love of the subject, and without any regular or systematic training he brought himself into notice by the quality of his amateur work. His family was by no means wealthy, and by the loss of his father when he was thirteen years old he had to start work in a Glasgow office in order to help to support his mother. He was a clever boy and a great reader, and though he never studied at the University, he had many friends among the students. One of these was Lyon Playfair, afterwards to become his colleague in Jermyn Street. Ramsay's holidays were sometimes spent in Arran in company with Playfair, who was studying chemistry and geology. On one occasion Playfair met Lyell on the Arran steamer and Lyell, who took an interest both in Playfair and in Ramsay, allowed them to accompany him on his journeys through the island. This was in 1836, and Ramsay went on working at the subject till by 1840 he was ready to bring his results to the notice of the British Association. At this time of his life he got advice and encouragement from Professor Nichol, an astronomer who was also interested in geology. In 1840 Ramsay prepared a small handbook of the Geology of Arran, but before it was published Murchison had secured for him an appointment to the Geological Survey. This was not difficult, as he was already known to De la Beche, who had been present at the Glasgow meeting; and in March 1841 Ramsay started work at Tenby in South Wales.

William Talbot Aveline

The other recruit to the Geological Survey at this period was William Talbot Aveline. He was eighteen years of age and nothing seems to be known about his geological training and qualifications. De la Beche's selection of him, however, was fully justified by his subsequent career. Aveline was a man of great strength and singular taciturnity. He was an enthusiastic worker and not only diligent but extremely accurate, and a most competent observer. In the hard work subsequently entailed by the survey of the mountainous tracts of North Wales Aveline positively revelled, and the friendship between him and Ramsay was based on perfect mutual confidence and esteem. Aveline had begun work in Somersetshire, where part of Sheet 19 had still to be finished, but he was

transferred to South Wales in 1841. In one respect Aveline differed from Ramsay, for he was by no means a ready writer and, though he furnished notes to many of his colleagues, he wrote few geological memoirs and he is principally remembered for his excellent maps.

Mapping progress

De la Beche's work in South Wales started near Swansea and was continued towards the east and the west. At first his progress was easy and rapid. The Old Red Sandstone was comparatively simple and the Coal Measures of the Forest of Dean and of Glamorgan were rapidly surveyed. In the Swansea district the excellent results of Logan's work were placed at the service of the surveyors. No doubt this improved the quality of the maps, for much of this initial survey can be regarded only as sketch work. The main areas of the formations were laid down and their boundaries located with fair precision, but not much time was spent on the details of the sequence and much ground was covered in a comparatively short time. Imperfect as this survey was, however, it remained little altered till 1891 when Aubrey Strahan was sent down by Sir Archibald Geikie to begin the first revision of the South Wales coalfields.

As the work progressed more and more difficult country was entered. The western part of the South Wales coalfield and the rocks that surround it, especially in Pembrokeshire, form one of the most difficult and complicated tracts in Great Britain. This did not worry De la Beche's staff; they hurried onwards with unhesitating footsteps. No doubt they were aware of the numerous pitfalls that beset them, but refined and critical geological classification of the older strata had not yet been invented. The older rocks were grouped together under the general designation 'grauwacke' and subdivisions were not recognized.

The geological survey of South Wales was making rapid progress in the hands of De la Beche, Ramsay and Aveline. They were assisted by John Phillips, who was an expert palaeontologist and determined the fossils that were collected. He had previously been employed on his memoir on the Palaeozoic fossils of Devon, Somerset and Cornwall, which was published in i841. The field work was entirely done on maps of the scale of 1 inch to one mile, the only ones at that time available, and consequently it was more of the nature of a reconnaissance than of a survey as that term is now understood.

In Pembrokeshire and the western part of the coalfield the strata had been intensely folded and a great series of older rocks emerged below the Carboniferous. This country is now known to contain pre-Cambrian, Cambrian, Ordovician and Silurian, but at that time these rocks were supposed to belong mostly to Sedgwick's Cambrian. Ramsay, whose knowledge of these formations was of course extremely limited, made a bold attempt to solve the intricate problems presented by the geology, but many years were to elapse and much controversy to ensue before an approximate solution was attained.

The whole of the Old Series one-inch Sheets of South Wales, including a considerable area of the older rocks that lie to the north of the coalfield, were published in 1844 and 1845. A year later (1846) the first volume of the Memoirs of the Geological Survey of Great Britain and of the Museum of Economic Geology in London made its appearance. It contained a descriptive account 'On the Formation of the Rocks of South Wales and South-Western England' by De la Beche which is in fact a general summary of the results hitherto obtained by the work of the Survey. Details of coalfield structure are not given, but it was intended to publish an account of the 'economic value of the coal districts of South Wales and South Western England' in a subsequent volume.

To supplement the maps, however, a number of engraved and hand-coloured sheets of Vertical and Horizontal Sections was issued. These relate to South Wales, the Bristol area, the Forest of Dean

and the Mendips. The first of them made its appearance in 1844 and six or eight of them had been published before the end of 1845. ‘The Vertical Sections of South Wales were prepared by Logan, De la Beche and D. H. Williams. Some of them were founded on shaft sections and other information taken from colliery records and are still of interest; the majority, however, have been replaced by a new series in the years subsequent to 1895.

The Horizontal Sections were regarded at that period as a valuable addition to the information shown on the one-inch maps. They were drawn on the scale of 6 inches to a mile. The line taken across country was very carefully surveyed and the heights measured by level or by barometer. At the same time complete notes were made of the geology traversed and as much detail was shown as the scale of the drawing would allow. The time spent on this work was justified by the precision attained, which was far higher than was possible on a one-inch map. Such sections, however, are no longer published, as the issue of six-inch maps thoroughly contoured, with more accurate boundary lines and details of the local geology, has rendered it a comparatively simple matter to compile a section along any line across country that may be specially interesting.

Reorganization

In 1845 the Geological Survey underwent the first of its numerous reorganizations. It was formally transferred from the control of the Master-General and Board of Ordnance to the First Commissioner of Her Majesty’s Woods, Forests, Land Revenues, Works and Buildings. At the same time the staff was increased and several new poets were created. The most important change was the incorporation of the Geological Branch of the Ordnance Survey of Ireland which had been under the charge of Captain Portlock. He was succeeded by Captain James, R.E., who became Local Director for Ireland, and the Irish Survey which was centred in Dublin was strengthened and reorganized by De la Beche. Its staff now consisted of F. McCoy, A. Wyley, E. Lewis, and W. L. Wilson, with J. Flanagan and J. Haragan as fossil collectors and J. Penny as general assistant.

Under De la Beche as Director-General, Ramsay became Local Director for Great Britain. The English geological staff consisted of Aveline, Trevor James, D. H. Williams and H. W. Bristow, previously acting, with the addition of W. H. Baily, and A. R. C. Selwyn. The fossil collector was R. Gibbs, who had been on the staff since 1843. Edward Forbes was appointed Palaeontologist (1844) and Charles Bone, Artist, to make drawings of fossils. Lyon Playfair became Chemist, while Richard Phillips continued to make analyses in the Museum. Robert Hunt succeeded T. B. Jordan as Keeper of Mining Records. Warington W. Smyth was appointed Mining Geologist in 1845.

It was evidently the intention of the authorities to extend and accelerate the Survey’s work. In this they were no doubt stimulated by the interest shown by prominent geologists. The new maps and sections were equal or superior to those produced in any other country and were adding precision to the knowledge of important districts of England and Wales. The rapidity of publication was very striking. In 1834 four Sheets had been published (20, 21, 22, 23, mostly Devonshire); in 1835 four Sheets (24, 25, 26, 27, Cornwall and Devon); in 1839 six Sheets (28, 29, 30, 31, 32, 33, completing Cornwall and Devon). In 1844 and 1845 ten Sheets appeared from the press (19, Somersetshire; 35, 36, 37, 38, 39, 40, 41, 42, 43, South Wales). Thus in ten years twenty-four Sheets had been surveyed and brought to publication, representing the geology of two important mineral districts (Cornwall and Devon, and South Wales) and over 6,000 square miles of difficult ground.

By 1845 about twenty Sheets of Horizontal Sections had also been engraved and about seventeen of Vertical Sections. It is not possible to give exact figures as the dates of publication are in some cases not precisely known.

It was evidently intended to launch two new series of publications which were to expound the results

of the Survey's work and to take the form of Memoirs. One series was to contain general reports on geological topics and special descriptions of various districts prepared by the English staff; the other was to be devoted to Irish geology. As has been mentioned above, the first volume of Memoirs of the Geological Survey of Great Britain appeared in 1846 and contained two notable memoirs on South Wales by De la Beche and by Ramsay, together with other less important contributions. The second volume appeared in 1848 and contained John Phillips's memoir on the Malvern Hills, and various papers on palaeobotany by Sir Joseph Hooker and on palaeontology by Edward Forbes. In this volume (Part 2) there was also the 'First Report on the Coals suited to the Steam Navy' by De la Beche and Lyon Playfair. The third volume, containing Ramsay's description of North Wales, did not appear till 1866.

From this time onward De la Beche was to a large extent confined to the office in London, where he had many important schemes in hand and much official business to transact He had been knighted in 1842 and was recognized as the principal official authority on questions in which British geology was involved. The field work was under the superintendence of Ramsay, who showed extraordinary activity and capacity. Ramsay and Aveline, with the aid of the fossil collectors, were busily engaged in completing the primary survey of Central and North Wales, a task which they brought to completion in 1850 or 1851. The whole series of Welsh maps was then published except Sheet 78, containing Anglesey and part of Snowdonia, which appeared in 1852. These two men were geologists of the highest ability and their great achievement in preparing the first complete survey of the geology of Wales has received full recognition from all succeeding geologists. They were assisted by Selwyn, who joined in 1845, and at a later stage by Jukes, who started work in 1846, both geologists who later achieved distinction and fame. D. H. Williams assisted in the survey of the coalfield of South Wales, but left the Survey in 1845 and died in 1849.

Many interesting descriptions of the progress of work in North Wales can be found in the letters of Ramsay and Jukes which have been published in Geikie's 'Life of Ramsay' and the biography of Jukes which was edited by his sister, Mrs. Browne, and published in 1871. They attacked the geological problems with great energy, spending long days in the field in good weather tracing the boundary lines of the subdivisions of Cambrian and Silurian rocks which were then recognized. In North Wales particularly the physical difficulties were great and the geology extraordinarily complex. In the determination of the fossils they had the assistance of Edward Forbes, but as yet the microscope had not been applied to the study of rocks in thin sections, and the fine-grained lavas and ash beds of the Snowdonian Mountains presented many puzzling questions on which the geologists were by no means unanimous. On the other hand, however, they did not concern themselves with the Drift deposits; and the glacial phenomena, which subsequently became of paramount interest and importance, were passed over almost without scrutiny. In after years Ramsay was to be captivated by this subject and became a leader in the interpretation of the glaciation of North Wales.

The maps of South Wales have now been completely revised by a survey on the six-inch scale, but Ramsay and Aveline's maps of North Wales have never been revised and are still on sale, with the exception of those of Anglesey. A vast amount of geological research has been carried on in this district since 1850, and many discoveries have been made of the greatest interest and importance. So far as possible, these advances have been incorporated into the colour-printed maps which the Geological Survey has issued since 1920 on the scale of four miles to 1 inch. The original survey of Ramsay and his colleagues was a pioneer effort, for very little was known of the detailed sequence and distribution of the Palaeozoic rocks of Central and North Wales before they began their work. They laid down only the main outlines of the geology of the region, but many of their detailed descriptions have served as a guide to subsequent workers and have proved of great value. Moreover, their work was done with such rapidity that by modern standards it might be described as only a reconnaissance. For example, the survey of Anglesey occupied them about a year, but

subsequently a highly trained geologist, Dr. Greenly, spent twenty years on a detailed examination of that island. Although Ramsay's survey work in Anglesey was the subject of special care and enthusiasm, some of his most fundamental conclusions have been abandoned by recent workers.

In fact, as the work went on, and more and more was learnt regarding these Palaeozoic strata and their complex tectonics, the geological surveyors realized more and more clearly how difficult was the task and how much remained to be done. But De la Beche Was remorselessly pushing forward and impatient of delay. When the writing of the descriptive memoir came to be undertaken these imperfections. became only too apparent. Ramsay was much engaged in administrative work and involved in the geology of other districts, and though the maps had been completed in record time the preparation of the memoir occupied 15 years. When it was published in 1866, however, Sir Roderick Murchison described it as the most important work which had been issued by the Geological Survey during the ten years that had elapsed since 'I became Director.' A second edition appeared in 1881, and the work remains the greatest monument to Ramsay's industry and skill as a field geologist.

New museum at Museum of Practical Geology, Jermyn Street

Although De la Beche continued to visit the field regularly as often as other duties permitted and sometimes gave very sage advice to his field lieutenants, which they were not wise enough to follow, his time was now much occupied by other matters of great importance. His collections had quite outgrown the space provided for them at Craig's Court, and the additional staff now enlisted made the congestion painfully' obvious. De la Beche accordingly had prepared a scheme for a new and larger Museum, with offices and laboratories, and he had made great progress with the preliminary negotiations. A site had been selected at 28, Jermyn Street (221, Piccadilly), a very desirable location for a public office. The plans of the building were prepared by Pennethorne, and from the drafts which survive it is clear that De la Beche criticized them very fully and gave minute attention to all the details. For the building-stone he selected the much-criticized Anston dolomite, but he took the precaution to see that all the material sent up was examined before it 'was used in the building. His prudence was justified by the results, as after 87 years the state of preservation of the plain and carved work on all the walls was eminently satisfactory.

The building was in hand in 1848 and was probably completed in 1849: then began the furnishing of the interior, in which the usual delays were experienced. In 1850 the work of installing the exhibits was in full course, mainly under the superintendence of Reeks, Ramsay and Edward Forbes. Very special efforts were made to get the Museum ready for opening in 1851, the year of the Great Exhibition, and it was formally opened in May of that year by His Royal Highness the Prince Consort.

As was remarked at the time, this was the first important building in Great Britain designed to be occupied by the staff of a purely scientific institution. Its creation was certainly the crowning achievement of De la Beche's official life, even more important than the establishment of the Geological Survey. It proved that his work had been well done and had earned public approbation, including that of all the most competent critics. The Geological Survey which had started in a very modest way, sixteen years previously, was now regarded as a permanent institution of great value and importance.

For his success De la Beche was probably more indebted to the Prince Consort than to any other individual, for under his fostering care and wise foresight the advancement of scientific research and the dissemination of knowledge were regarded as objects of prime importance, deserving of Royal patronage and most beneficial to all the highest interests of the nation.

From the contemporary reports also it is clear that Sir Robert Peel was one of the strongest

supporters of De la Beche's programmes. Though himself not versed in scientific matters, Sir Robert Peel was much interested in them and ready to encourage any practical proposals for scientific progress. The Marquis of Northampton was an amateur geologist whose encouragement also was unfailing. The Geological Society of London probably played a great part. As has been noted previously, its membership included many members of Parliament, country gentlemen, bankers and others, who carried great influence, and the laudatory notices of the Survey's work that were an almost constant feature of the Presidential Addresses in the 'forties and 'fifties of last century no doubt had a considerable effect in moulding public opinion.

In May 1851 the bustle of preparations was over and the new Museum was opened to the public on the 12th of that month. In presence of a brilliant assemblage comprising ambassadors, peers and peeresses, members of Parliament and prominent scientists, H.R.H. the Prince Consort, after an address by Sir Henry De la Beche, made the following speech:

> In thanking you for the address which you have just read to me, I would also express the sincere gratification with which I witness the opening, in a form more likely to make it generally and practically useful, of an institution, the progress of which I have long watched with much interest, and the want of which had long been felt in this country.
>
> I rejoice in the proof thus afforded of the general and still increasing interest taken in scientific pursuits, while science herself, by the subdivision into various and distinct fields of her study, aims daily more and more at the attainment of useful and practical results.
>
> In this view it is impossible to estimate too highly the advantages to be derived from an institution like this, intended to direct the researches of science, and to apply their results to the development of the immense mineral riches granted by the bounty of Providence to our isles, and their numerous colonial dependencies.
>
> It will always give me the greatest pleasure to hear of, and, as far as I am able, to contribute to the continued success of the Museum of Practical Geology.

His Royal Highness then made a general inspection of the building.

When we consider the state of London museums and of scientific education in Great Britain it is clear that De la Beche had broken new ground in several directions. The institution he had created in Jermyn Street was not only a museum under Government control but also a centre of research and a School of Science. No other Government museum in this country, even at the present day, has a centre of scientific instruction attached to it. He had also provided a large lecture hall which was to serve not only the needs of the teachers and students of the School but also, and principally, to be used for a series of popular lectures to men and women interested in the progress of science and its application to manufactures and the arts. The chemical laboratory was intended to furnish analyses of minerals and soils for moderate fees. The maps and memoirs of the Geological Survey were to be freely accessible to the public in search of information, and a special staff was to continue the compilation of records of British mining and the collection and preservation of mining plans.

At least four different services were acting in conjunction under the superintendence of the Director, viz. the Geological Survey, the Museum of Practical Geology, the School of Mines and the Mining Records Office. The staffs were to co-operate freely. The Professors of Chemistry, Zoology, Mining and Geology also took part in the activities of the Geological Survey and did much work in preparing and arranging exhibits in the new Museum. They gave lectures in turn to the general public in the

Lecture Hall; they assisted in special researches such as the selection of coals suitable for the steam Navy and they contributed scientific memoirs to the publications of the Geological Survey.

The staff of scientists which De la Beche assembled in the new Museum was probably, for its size, the most brilliant that has ever served in a British educational institution. Apparently De la Beche did not lecture, but Ramsay, the Professor of Geology, was the best field geologist and the greatest physiographer of his time. The chemist was Lyon Playfair, afterwards Lord Playfair of St. Andrews, who proved to be not only an able scientist but a great administrator and educational reformer. Richard Phillips, who had been Chemist since 1839, was in bad health and died on the eve of the opening ceremony (11th May). Edward Forbes, who was Palaeontologist to the Survey and Professor of Natural History, became Professor of Natural History in Edinburgh University in November 1854 and died in December of that year at the early age of 39. His contemporaries regarded Forbes as probably the most brilliant member of the group. Sir Joseph Hooker was attached to the service for a time as Palaeobotanist. Sir Warington Smyth was the first Professor of Mining and Mineralogy. Robert Hunt, well known for his works on British mining districts, was Professor of Mechanical Science and at the same time Keeper of Mining Records. Among others who were at work in the Museum at this time were such well-known scientists as J. B. Jukes, J. W. Salter, H. W. Bristow, Trenham Reeks, W. T. Aveline, A. R. C. Selwyn.

The further progress of the School of Mines does not belong properly to the present story, but it may be remarked that among the professorial staff who subsequently taught in the Museum at Jermyn Street were Thomas Henry Huxley, John Tyndall, John Percy, Gabriel Stokes and A. W. Hofmann, and much brilliant and original scientific work was done in the old laboratories.

At first the attendance at the School of Mines seems to have been a disappointment, and complaints were made by the staff that it was discouragingly small. It has always, however, maintained its prestige as the premier institution of its class in Great Britain and worthy to rank with the great mining schools of the Continent. Under the auspices of the Government, schemes were soon on foot either to expand the School of Mines into a College of Science or to establish such a College and to absorb the existing institution. Much discussion took place on these projects, but progress was only slow. In 1854 the School of Mines, the Geological Survey and the Museum were transferred to the Department of Science and Art, which had been created under the Board of Trade after the Great Exhibition of 1851. These changes seem to have been unwelcome to De la Beche and some members of his staff. It was only the beginning, however, of a gradual and complicated series of changes which ultimately resulted in the dismemberment of the School of Mines in Jermyn Street and the transfer of the laboratories and teaching staff to South Kensington. The Professors of Physics, Biology and Chemistry were first to go. Mining under Warington W. Smyth and Metallurgy under Percy remained at Jermyn Street; these professors regarded the connexion with the Museum and Survey as of fundamental importance. The formal appellation Royal School of Mines seems to have been first used in 1862.

Closing years of De la Beche’s Directorship

When these changes were started, however, in 1853, De la Beche was already a sick man. Neither his mental nor his physical capacities maintained the vigour of his prime. The letters which passed between his lieutenants at this period show that they observed his tendency to vacillation and delay. De la Beche continued to attend regularly at the office though suffering from a form of paralysis, and his last appearance there was on Wednesday, 11th April, 1855, only two days before his death. He had lived to see the fruition of his great designs, and to-day at South Kensington the Geological Survey and Museum and Royal School of Mines, housed in magnificent buildings, form a striking monument to his far-sighted policy and sound judgment. Nothing that he did has failed and with the

progress of the years all his projected enterprises have expanded and developed.

During these closing years of De la Beche's directorship Ramsay, Aveline, Selwyn, Jukes and Warington Smyth were very busy in finishing the Welsh maps and getting them through the press. The principal additions to the field staff were H. H. Howell and Edward Hull. Work was now being carried eastwards into Warwickshire, Worcestershire and Gloucestershire. The most striking progress, however, had been made in the South Staffordshire coalfield, which had been entrusted to J. B. Jukes after his task in assisting Ramsay in North Wales had been completed. These maps were ready for publication in 1852, and in 1853 the descriptive memoir by Jukes appeared from the press. This was the first special coalfield memoir which the Geological Survey had produced and it was heartily welcomed by the mining industry. A second edition, much enlarged, was issued in 1859, as the first edition had been sold out for several years. This remained the standard work on that very interesting and important coalfield till the re-survey was completed in 1926.

When Oldham, of the Irish staffs was appointed Director of the Geological Survey of India in December 1850, Jukes went over to Ireland to succeed him. In 1850 Selwyn became Director of the Geological Survey of New South Wales and in 1869 he became Director of the Geological Survey of Canada. Wyley and McCoy had already left the Irish staff to fill important poets. In 1853 Lyon Playfair became Secretary of the Science and Art Department and in 1854 Edward Forbes went to Edinburgh to fill the Chair of Natural History which was rendered vacant by the death of Jameson. De la Beche's able young men were scattering fast and the success of his Geological Survey was inciting the principal British Colonies to start official surveys after his model. J. W. Salter, who had joined the service in 1846, was appointed Palaeontologist in succession to Edward Forbes, and in 1854 a further notable name appears for the first time on the staff lists, that of Thomas Henry Huxley. His post was defined as that of Naturalist and his work was principally done on the fossils in the Museum. He also lectured that year in the 'Metropolitan School of Science applied to Mining and the Arts' (as it was then called) and chose as his subject 'The Natural History of Man.' In 1853 Hofmann lectured on Chemistry, Dr. Percy on Metals, Warington Smyth on Minerals and Professor Willis on Mechanism in the course of Evening Lectures to Working Men. The whole of the 600 tickets were applied for and allocated in two days.

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