1835 De la Beche starts alone - Geological Survey of Great Britain (by E.B. Bailey)

From Earthwise

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PLATE I.

Sir Henry Thomas De la Beche, C.B., F.R.S.

Plate 1 Sir Henry Thomas De la Beche C.B. F.R.S.

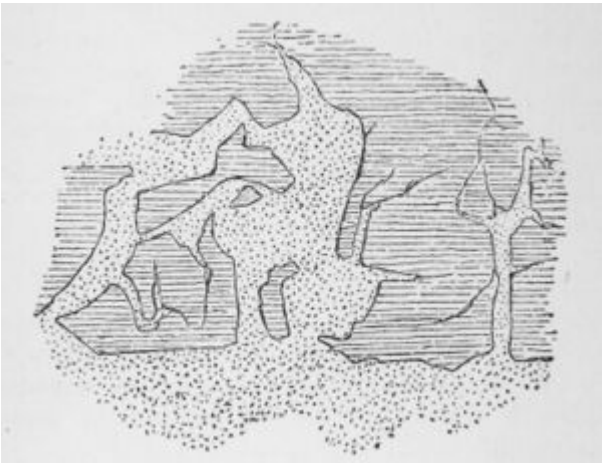

Figure 2 Plan on large scale of contact of slate and granite. (Quoted from De la Beche,

Report on Cornwall, 1839, p. 169.)

Figure 3 Unconformity of New Red Sandstone on Coal Measures, South Wales. (Quoted from De la Beche, Mem., vol. i, 1846, p. 248.)

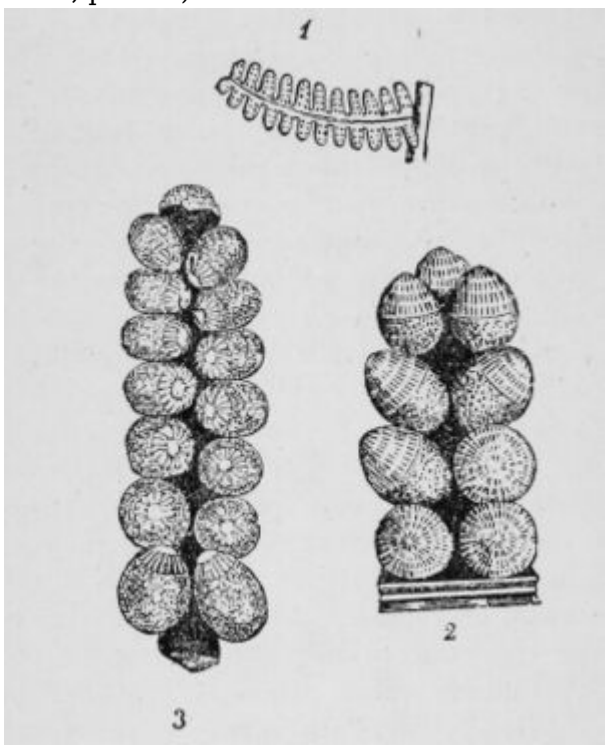

Figure 4 Carboniferous Seftenbergia corda (1, 2) compared with Recent *Aneimidiclyon* (3). (Quoted from Hooker, Mem., vol. ii, pt. 2, 1848, p. 402.)

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1835 De La Beche starts alone

Henry Thomas De la Beche, last male representative of a family of Norman barons who came over with the Conqueror, was also first officer of the Geological Survey ; in fact from 1835 to 1839 he constituted its whole scientific staff. De la Beche was born in 1796, a year, that is, before Hutton died, and three years before Count Rumford (Benjamin Thompson of Massachusetts) founded the Royal Institution—from which latter De la Beche seems to have derived much of his inspiration. In 1810 he was sent to the Military School of Great Marlow, the Sandhurst of those days; but on the close of the Napoleonic wars he decided to renounce martial ambition and devote himself to scientific research on a moderate income derived from a landed estate in Jamaica. In 1817, when only twenty-one years of age, De la Beche was elected to the Geological Society, and two years later to the Royal Society. His connection with the former was particularly close, for he was Secretary 1831-32, Vice-President 1833-34, Foreign Secretary 1835-47, President 1847-49, and Wollaston medalist 1855. In this last year he died. He had been knighted 1842.

De la Beche loved field geology, because he delighted in nature, both as scientist and artist, and because he had a physique which made him an active pedestrian, not to mention a bold swimmer. He travelled considerably, and his first paper, 1819, deals with Observations on depth and temperature of the Lake of Geneva; but his main work lay in south-west England where he had spent much of his boyhood. He read widely and critically and published a number of books, besides papers and official memoirs. The best known, perhaps, is his Manual of Geology, 1831, which was so well received that we find him in the preface of the third English edition, 1833, speaking of German, French and American editions, actually published or in preparation.

Another of De la Beche's publications, his Theoretical Researches in Geology, 1834, furnishes a compact statement of the scientific outlook with which its author took up his appointment on the Geological Survey—and here one may interpolate that this appointment marked the second stage in the development of continued governmental scientific research in Britain, initiated in 1675 by the founding of the Royal Observatory at Greenwich ; the position of the Natural History branch of the

British Museum is a little difficult to assess, because in early days its research activities tended to be intermittent. In this little book we find De la Beche willing to accept La Place's hypothesis ' that our solar system is a condensation of nebulous matter,' and to consider it extremely probable that the earth has consolidated from a hot fluid spheroid. In his discussion of this and other matters he shows a commendable knowledge of geo-chemistry and physics. He thinks that Elie de Beaumont is probably correct in attributing mountain chains to wrinkling of the earth's surface consequent upon loss of internal heat. He does not follow Hutton and Lyell in the view that the geological record shows ' no vestige of a beginning—no prospect of an end.' On the other hand he interprets gneiss and mica-schist as ' inferior stratified rocks' formed in the earliest hot ocean, and not, as Hutton and Lyell claimed, normal rocks affected by regional metamorphism. He also shows himself a mild catastrophist, rebuking Lyell for thinking that man in his brief experience has seen the full power of Nature's activities. He himself considers the contortion of the Alpine strata as a product of rapid yielding, and commends de Beaumont's ' very simple suggestion …that during the last elevating movement which took place in the Alps, the heat evolved from the necessary fissures suddenly melted the snows which previously existed on these mountains, and by these means a large body of water was produced, which swept the blocks through the valleys into those situations where we now find them.' He is also prepared to invoke floods actuated by sudden submarine elevation of mountains as an explanation for the distribution of northern erratic blocks and for much erosion of land forms. He accepts granite as well as basalt as igneous; though for some purposes he prefers to divide rocks into unstratified and stratified, rather than igneous and aqueous, so as not to prejudge every question connected with their origin.' He is fully aware of the existence of ancient lavas, as well as intrusions, a matter over which Hutton had stumbled ; and he recognises ancient volcanic ashes. He gives much attention to the use of fossils in geology. Certain aspects of his treatment of this matter are outlined below, starting with a quotation from his Chapter xi, which will serve among other things as a further illustration of its author's tangled style of expression, strongly reminiscent of translated German.

> After the remains of animals and vegetables, entombed at various depths and at different periods in the crust of the globe, were fully recognised as the exuvi. of organic life which had once existed on the surface of the earth, it became a somewhat prevalent opinion, particularly after the researches of Cuvier and Brongniart round Paris, and those of Smith in England, that contemporaneous deposits were characterized by the presence of similar organic remains. During the time that such deposits were supposed to be distinguished by similar mineralogical composition, and viewing the subject the other way, that similar mineralogical structure at once proclaimed the geological date of the rock, it was considered somewhat heretical to doubt the possibility of discovering any other than a certain series of organic remains in a given fossiliferous rock wherever found.

> This opinion, though somewhat modified, is still so far entertained that similar organic remains are supposed to characterize contemporaneous deposits to considerable distances ; at least to this extent, that if a belemnite be discovered on the flanks of the Himalayan mountains, there is a disposition to consider, a priori, that it must belong to some part of a series of rocks in which this genus is found in Western Europe. Fossil shells of similar species are also supposed to characterize the same deposit over considerable areas.

> In the present comparatively advanced state of geology, it behoves us carefully to weigh the conditions under which animal and vegetable life now exist, before we assume that a given deposit can or cannot be determined.

Then follows a long discussion which takes into account the complexities of modern distribution of life-forms controlled, as they are, by habitat-condition and also by pure geography. De la Beche points out that without any change in the sum total of species mere migration consequent upon local alteration of depth, climate, etc., would furnish successive strata with contrasted faunas, and he emphasises that these faunal successions would be apt to give totally erroneous time-correlations if subjected uncritically to what may be called Smithian analysis. All this is true ; but almost, despite himself, De la Beche accepted as a fact, proved by geological observation, that change of life-forms has been in large measure controlled by time, and not merely by migration. His summary includes the following: fossils ' teach us that man is a comparatively recent creature on the face of the globe ; that creation has succeeded creation on its surface.' As regards this last point, in so far as it concerns the cause of the observed time-controlled life-changes, he is less dogmatic in another passage, which reads: ' There are likely to be few, seeing the beauty of design manifest in creation and so apparent in animals and vegetables, who will not rather consider there has been a succession of creations as new conditions arose, than that there should be an accommodating property in organic existence which might ultimately convert a polypus into a man.'

There is no doubt that sometimes a horse runs better in blinkers. Thus De la Beche might well have gone farther if, in his own work, he had been content to follow more closely in Smith's footsteps without an ever-present consciousness of the difficulties that beset the path. All the same he managed to escape from the indecision and procrastination that might have been expected to accompany his unusually clear perception of these same difficulties. De la Beche realised that within a comparatively short time he could obtain positive results of intrinsic value ; and he was prepared to publish such results without waiting for what might prove to be unattainable refinements. If we now compare him with a dog instead of a horse, he was assuredly one who seldom dropped a bone in pursuit of a shadow. This explains the amazing rapidity with which he, and later his staff, produced serviceable geological maps of much of England and Wales, maps that in many cases, as their own authors knew, might have benefited from revision as soon as they appeared.

Ordnance Survey and Geological Society

Our discussion of De la Beche as a scientist on the threshold of his appointment to the Geological Survey has led on to mention of his subsequent publications. Before going farther in this direction let us consider some of the circumstances that attended the actual appointment.

It will be recalled that in 1832 De la Beche was given a preliminary appointment, as one may call it, to colour geologically the Ordnance Survey one inch to a mile maps of south-west England. He made such good progress that Greenough, when President of the Geological Survey in 1834, was able to say that during the previous year: Mr. De la Beche, one of our Vice-Presidents, acting under the Direction of the Board of Ordnance, has produced a geological map of the county of Devon, which, for extent and minuteness of information and beauty of execution, has a very high claim to regard. Let us rejoice in the complete success which has attended this first attempt of that honourable Board to exalt the character of English topography by rendering it at once more scientific and very much more useful to the country at large.' And again, in 1835, speaking of 1834: ' The researches of your Vice-President in the counties of Devon and Somerset have been carried on this year with increased energy. Of the eight sheets of the Ordnance Map upon which he has been engaged, four were published last spring, three others are complete, the eighth is nearly complete, and an

explanatory memoir with sheets of sections applying to the whole are to be published before our next anniversary. Let us hope that the work so admirably begun may not be suffered to terminate here.'

The map sheets, to which Greenough referred, are what are now called the Old Series one-inch sheets, each covering an area of some 965 square miles, including in coastal districts a proportion, small or big, of sea. The explanatory memoir, which he mentioned, actually appeared in 1839, after it had been extended to include Cornwall as well as Devon and West Somerset. At the time Greenough spoke he probably knew that his hope for a continuance of De la Beche's survey was likely to be fulfilled. At any rate, at the next anniversary meeting of the Society, on the loth February, 1836, his successor in the chair, Charles Lyell, was able to say:

> Early in the Spring of last year an application was made by the Master-General and Board of Ordnance [Col. Colby once again] 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, td 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 alone would 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 accomplished by securing the cooperation of an experienced and able geologist, who might organise 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.

The steps taken in 1835 confirmed the policy adopted in 1832 and opened up a prospect of its application to the country at large. There has been a little confusion in certain quarters as to what it meant financially. F. J. North, who took extracts from Ordnance Survey correspondence, since destroyed by enemy action, tells us that De la Beche seems to have already received £300 expenses to cover his eight sheets of Devon (completed to their rectangular margins). Now that he was instructed to commence the Geological Survey of Cornwall without delay,' it was on the understanding that the expenses of the new work would come to about £1,000 a year, and that he would be given a salary of £500. A limited amount of mapping assistance was supplied by two geologically minded officers of the Ordnance Survey, and other help by private geologists investigating the same field. Previous publications were also very useful, many of them in the Transactions of the Royal Geological Society of Cornwall, which had been founded in 1814.

First memoir

In 1839 De la Beche marked the completion of his mapping of the Devon peninsula, from Bridgwater and Axminster to the Scilly Isles, by publishing the first memoir of the Geological Survey, entitled: Report on the Geology of Cornwall, Devon and West Somerset. It contains 648 pages of letterpress, with a frontispiece-map in colours, along with numerous other plates presenting geological and mining sections, mining plans and views. It is replete with observation and reasoned deduction, and its methodical arrangement has furnished a pattern for all subsequent Survey memoirs descriptive of particular areas. It is typical of its author that economic geology is given close attention in a chapter of 64 pages dealing with mining, quarrying and agriculture. As all know, the region is of particular variety and interest, with a major unconformity separating folded from unfolded sediments. It has in addition lavas, ashes and intrusions, including granites, these last confined to the folded formations; while its china clay and china stone and many of its mineral veins are unique in Britain. It is sometimes said that the Report owes most of its permanent value to the description which it gives of mineral lodes both as regards geology and method of working. Mining in Cornwall was at the time very prosperous and afforded opportunities for investigation that have since passed away. On the theoretical side De la Beche thought that many of the veins had resulted from admission of sea water through fissures to depths where they found granite still incandescent though consolidated.

De la Beche's handling, in 1839, of the problems presented by the folded sediments of the peninsula affords an example of limited achievement. Tacitly accepting a fundamental structural correction advanced by Sedgwick and Murchison in 1837, he separately mapped the Culm Measures, or ' carbonaceous rocks,' as an upper, later formation, flanked to north and south by outcrops of the ' greywacke series' ; but he opposed the fossil-inspired correlation, which the same two authors had put forward, of these Culm Measures with the Carboniferous system of the rest of England and South Wales: the lithological contrast seemed to him in certain particulars too great.

In their 1837 paper Sedgwick and Murchison had considered the underlying greywacke as probably of Cambrian, or in part perhaps of Lower Silurian, date. This opinion they soon altered, but not sufficiently early, in print, for De la Beche to take notice of the fact in his 1839 Report. The new interpretation came to W. Lonsdale, the gifted Curator of the Geological Society's Museum, in December, 1837 ; and was, during 1838, communicated by him in conversation to Murchison, Sedgwick, De la Beche and others. It resulted from a brilliant application of Smithian principles with due allowance for difficulties introduced by local conditions of sedimentation ; how brilliant, may be gathered from the fact that its author, with the help of fossils and field relations, correlated limestones of the greywacke of South Devon with some part of the Old Red Sandstone of Wales, in spite of the fact that their faunas are strikingly dissimilar! Lonsdale concluded from the fossils that the limestones in South Devon are of intermediate age between Silurian and Carboniferous; and he knew from field relations, already published, that the Old Red Sandstone in Wales occupies this time interval—with in places a conformable passage g bottom into Silurian and at top into Carboniferous. We shall return to this subject presently.

Houses of Parliament

Meanwhile we may note that De la Beche in 1838 served along with William Smith and others on a Commission to find the most suitable stone for building new Houses of Parliament at Westminster, in place of those destroyed by fire in 1834. The bulk of the work fell upon De la Beche. The commissioners drove about the country in an old carriage and pair, visiting quarry after quarry and procuring rough samples which were later shaped into six-inch cubes. Eventually Permian dolomite from Anston near Mansfield was selected. Its state of preservation in the Norman front of Southwell

church, Nottinghamshire, furnished a good testimonial, though perhaps insufficient for a stone intended for a city atmosphere. Unfortunately, in the sequel, sufficient care was not exercised at the quarry to secure rejection of inferior material, with the result that some 15 per cent. of the stone actually used weathered very badly. De la Beche, however, showed his continued confidence in the Anston stone by using it for the building of his new Museum in Jermyn Street, started in 1848. Here it retained all ornamental detail in perfection until the building was demolished when new quarters were found for the Survey more than eighty years later.

As a postscript we may perhaps quote from the Summary of Progress of the Geological Survey for 1934: ' A joint committee of officers of H.M. Office of Works, of the Building Research Station and of the Geological Survey was set up in connexion with the selection of stone suitable for the repair of the stonework of the Houses of Parliament.'

Museum and staff

Having successfully launched his scheme for a geological survey of the kingdom, De la Beche proceeded to point out to the Chancellor of the Exchequer the advantages that would accrue to the country from possession of a museum for display of rocks and minerals of economic significance. The suggestion was approved in 1837, and a building in Craig's Court, Whitehall, adjoining Scotland Yard, was assigned for Survey offices and museum. The latter was opened in 1841 under the title of Museum of Economic Geology. Its first Curator, also Chemist, was Richard Phillips, appointed along with an Assistant Curator in 1839. Phillips was one of the founder members of the Geological Society, and at the time of his death, which occurred on the eve of the opening of the Jermyn Street Museum in 1851, had come to be President of the Chemical Society. Phillips was furnished with a laboratory at the Museum, where the public might obtain analyses of rocks, minerals and soils. Although De la Beche was Director of the new Museum,, this institution was administered by the Office of Woods, Forests, etc., and not by the Ordnance Survey, to which for the time being the Geological Survey still remained attached.

The exhibits were all of economic appeal: building stones, including the specimens collected by the Parliament Commission, ornamental stones, marbles, granites, serpentines; plasters, tiles, pottery, earthenware ; ores of the metals, with Devon and Cornwall strongly represented, but with many other examples, British and foreign ; metallurgical products such as castings, electrotypes, gun barrels; coal and other fuels.

Another extremely important addition to the responsibilities of the Geological Survey dates from this period. In 1836 there was disastrous loss of life in a Co. Durham coal mine due to flooding from old forgotten workings. Following upon this the Council of the British Association approached the Government, who in 1839 placed De la Beche in charge of the collection and preservation of plans of abandoned mines. A Mining Record Office was established alongside the Museum, and in 1840 T. B. Jordan, who had previously been Secretary of the Royal Polytechnic Society of Cornwall, was appointed Keeper. This Record Office acted in some ways as an extension of the Museum, for it exhibited models of mines and mining machinery. It continued to function under the Director (presently Director General) of the Survey until 1883, when, as we shall see, it passed to the Mines Department of the Home Office.

Andrew Crombie Ramsay

From 1839 to 1844 seven prospective field geologists were added to the staff of the Geological Survey, most of them with no previous training; and two paleontologists. Among the fieldsmen the most interesting proved to be W. T. Aveline, 1840, A. C. Ramsay, 1841, and H. W. Bristow, 1842.

Andrew Crombie Ramsay, destined to be third Director General of the Survey, was 27 years old when he got his great opportunity. Till then his life had been one of mixed fortunes. His father had been a successful manufacturing chemist,<reference>Whose grandson, William Ramsay, was co-discoverer of argon.</reference> but died in 1827, leaving a young family of four. Thus Andrew at thirteen years of age had to forego further schooling and enter an office in Glasgow. However, he kept contact with teachers and students at the University and elsewhere. Among them was a brilliant boy, Lyon Playfair, some five years younger than himself, who lived as a boarder in Mrs. Ramsay's house, while studying under the famous chemist, Thomas Graham, at the Andersonian Institute. Playfair joined the Survey a few years later ; but at the moment a holiday trip, which he made to Arran in 1836, is all that concerns us.

Playfair tells how, while sitting on the steamer and reading Lyell's Principles, a prize won in Professor Graham's class, he spoke to a charming lady by his side, and, showing her the book, expressed admiration for the author. As luck would have it, he was addressing the author's wife, who straightway called to Charles Lyell to come and be introduced. Ramsay followed Playfair to Arran within a few days, and was asked by Lyell to join in the geological excursions which the latter was making in the island. This proved a great tonic to young Ramsay, as also did his share in preparing for a visit of the British Association to Glasgow, due for 1840.

When the British Association assembled Ramsay was able to display a geologically coloured model of Arran on the scale of two inches to the mile, along with a map, sections and specimens in illustration of his first scientific paper. Lyell was geological President and arranged for Ramsay to read this paper on Friday—which he did successfully to a very distinguished audience—and next day to help in leading an excursion to examine some of the features he had just described. Alas, when Saturday morning came the excited leader overslept and missed the boat !

Murchison had been one of Ramsay's audience at Glasgow, and, apparently not frightened at the subsequent contretemps, he wrote asking the young man to join him as companion and assistant on a projected trip to America, Ramsay was delighted, but on reaching London found that Murchison had changed his mind. Fortunately, however, the latter had no difficulty in persuading De la Beche, who had also been at the Glasgow meeting, to secure for Ramsay a post on the Geological Survey.

William Edmond Logan

About 1839 De la Beche had transferred his operations from South-west England to South Wales and neighbouring English counties. Most of the geological formations ranged from Ordovician to Coal Measures inclusive, and the dominant structure was the South Wales coal basin. De la Beche received important help from William Edmond Logan, a member of a mining firm operating in the district. Logan had commenced mapping coal seams and other geological data on the one-inch Ordnance sheets as soon as these were issued, and in 1837 had exhibited his handiwork at the Liverpool meeting of the British Association, where it attracted the attention of De la Beche. When the Geological Survey entered South Wales, Logan placed his accumulated results at De la Beche's disposal ; and, until he left the country in 1842, to found the Geological Survey of Canada, he continued an enthusiastic amateur, eager to render gratuitous assistance.

Logan, like De la Beche and his staff, mapped on the one inch to the mile scale, but he introduced an important refinement, which was soon adopted officially. He surveyed certain selected lines of country instrumentally, with chain, theodolite and level, to get the topographical detail accurate on a scale of 6 inches to a mile; and along these selected lines he made particularly close geological observations and plotted the combined results (true to scale) on paper in the form of sections with comparatively shallow vertical depth and comparatively long horizontal extension. Such sections are

usually spoken of as horizontal sections by the Geological Survey. In addition to horizontal sections Logan drew vertical sections, in which the horizontal breadth is very small compared with the vertical depth. Commonly these vertical sections aim at furnishing a graphical record on a large scale, say one inch to 40 feet, of the thicknesses of all items in a local geological succession. Where the strata of the district lie flat, a vertical section corresponds with the record furnished by a vertical shaft or bore. Where the strata are tilted, if thicknesses are to be presented, rather than depths, correction has to be made for angle of dip. The Geological Survey since 1844 has published, in two separate series, large numbers of sheets carrying groups of horizontal or vertical sections, as the case may be ; but the preparation of horizontal sections has latterly been discontinued as an aftermath of the availability of contoured six inch to a mile maps. Another legacy from Logan is the true interpretation of the underclays found beneath coal seams. Here he introduced the growth-in-place interpretation of coal origin, a very great advance.

Progress to 1846

De la Beche, though now responsible for the training and supervision of a field staff, and for the care of a Museum and Record Office, still for some years found time for personal mapping. By 1846 the combined efforts of the little party were so successful that one-inch geological maps, advertised for sale, covered a compact block of country south of Cardigan and Hereford and west of Gloucester and Bath, with a shorter eastern limit on the English Channel at Lyme Regis (Fig. 8). This represents over 6,000 square miles, and includes Cornwall and Devon with their metalliferous riches, and South Wales, the Forest of Dean and Bristol with their coal and iron. In addition, a large number of sections, both 'horizontal and vertical, had been issued.

We have already mentioned the early appointment of two paleontologists. Unlike most of the field staff, both were men of established reputation: John Phillips, 1841, and Edward Forbes, 1844, the latter not long home from the Aegean.

John Phillips, who remained on the Geological Survey until 1849, was a nephew of William Smith, and one of the ablest geologists of his day. He had been Professor at King's College, London ; and after leaving the Survey went on to be Professor at Trinity College, Dublin, and later at Oxford. His first big contribution to the Survey was its second memoir: Figures and Descriptions of the Palceozoic Fossils of Cornwall, Devon and West Somerset, 1841. While in the main descriptive, this memoir discusses the age significance of the pre-Culm-Measure fossils. Phillips had already been responsible for grouping geological systems under the three terms, Paleozoic, Mesozoic and Cainozoic ; and his cautious conclusion regarding the stratigraphical equivalence of the South Devon limestones appears to be conveyed in the following statements: the Palceozoic may be divided into Lower, with Primary Strata followed by Transition ; Middle, including both Eifel and South Devon Strata ; and Upper with the Carboniferous System followed by the Magnesian Limestone Formation. In other words, Phillips seems, after very detailed and critical examination, to follow Lonsdale in correlating the limestones of South Devon, that is the lower part of De la Beche's greywacke, with some portion of the Old Red Sandstone of Wales; but he also seems to hesitate whether to go the whole way with Sedgwick and Murchison, who included the upper as well as the lower part of De la Beche's greywacke in the Old Red correlation. Nowadays Sedgwick and Murchison's view is very generally adopted.

Ireland and reorganisation

The geological branch of the Ordnance Survey in Ireland, referred to previously, may be said to have ended in 1843, when Portlock produced his Report on the Geology of the .County of Londonderry and of Parts of Tyrone and Fermanagh. It is a magnificent memoir, written by a single author and

yet combining areal and palaeontological features such as were dealt with separately in De la Beche's Report, 1839, and Phillips' Figures and Descriptions, 1841. Among other points of interest Portlock emphasises that the local Silurian fauna (in which he included Ordovician, as we call it today) is ' remarkable in supplying species as yet undiscovered in England …thus serving as a link of connexion between the Silurian deposits of Great Britain and those of the Continents of Europe and America.'

A new beginning was made in 1845, when De la Beche was appointed Director General of the Geological Survey of Great Britain and Ireland, with Ramsay and Henry James, R.E., as Local Directors for Great Britain and Ireland respectively. James resigned next year to be followed by Thomas Oldham, 1846-50.

Jukes went to Ireland in 1850 as Local Director in succession to Oldham, who left to take charge of the Geological Survey of India. The same year Edward Hull and H. H. Howell joined the staff. Both later played a particularly important part in coalfield research. Both eventually became Directors: Hull for Ireland, 1869 ; Howell for Scotland, 1882, and for Great Britain, 1888. It is of course impossible to notice more than a few of the accessions to the Survey, which occurred from time to time ; but those who have the cause of Irish geology at heart like to remember that G. H. Kinahan was appointed to the Survey in 1854.

The Irish surveyors started with a great advantage over their colleagues in England and Wales, in that from the irst they conducted their mapping on Ordnance sheets on the scale of six inches to the mile. In course of time they covered the whole country, publishing on the one inch scale, and accompanying each of their one-inch sheets with an explanatory memoir. In this last accomplishment they have been more successful in Dublin than their fellows in London or, in later years, in Edinburgh. It would, however, be idle to suggest that existing Irish maps and memoirs do not in many cases call out for revision.

Ramsay's field staff, centred on London in 1845, consisted of six in addition to himself. Among them was A. R. C. Selwyn, who eventually succeeded Logan in Canada ; while J. B. Jukes came in next year, bringing with him geological experience won in New South Wales and Newfoundland.

Several changes occurred at headquarters in 1845: Robert Hunt took Jordan's place as Keeper of Mining Records; Warington W. Smyth was appointed as Mining Geologist ; Lyon Playfair as an additional Chemist ; A. Henfrey as Botanist, soon giving place to Joseph Dalton Hooker, 1846-7; and C. R. Bone as Artist. Next year, 1846, J. W. Salter was added as Assistant Paleontologist.

There is music in the name of some of the men whom De la Beche gathered around him. It is good to think of Hooker, already confidant of Darwin in relation to natural selection, finding time to devote to fossil plants while completing his Flora Antarctica. He was newly returned from serving under Captain Ross on the voyage of the Erebus and Terror ; in front of him rose the Himalayas.

Playfair was of a rather different type. We have already met him as a boy in Ramsay's home. During 1839-40 he worked with Liebig in Germany, when the latter was taking up the chemistry of agriculture and plant physiology. After his return, in 1842, he joined Liebig and Dean Buckland on a visit to different parts of England, and was present when abundance of coprolites in the Lias near Clifton suggested manurial applications. Liebig presently analysed the material and expressed himself in memorable words: ' What a curious and interesting subject for contemplation ! In the remains of an extinct animal world England is to find the means of increasing her wealth in agricultural produce, as she has already found the great support of her manufacturing industry in fossil fuel—the preserved matter of primeval forests—the remains of a vegetable world !' The same year Sir Robert Peel persuaded Playfair not to leave the country for a professorship at Toronto. His

appointment under De la Beche in 1845 introduced into the Survey circle an organiser equal in calibre to that of the chief himself. His influence manifests itself later in our story. Meanwhile we may anticipate by noticing that he is the only member of staff who has had quite such intimate relations with royalty as to be Gentleman Usher in the household of the Prince Consort, 1851, or who has attained to the title of Baron, 1892.

The expansion of De la Beche's field of activities from 1839 to 1845 was symptomatic of the times: in 1840 Kew Gardens were adopted as a national establishment ; in 1843 Lawes and Gilbert, in some respects bitterly antagonistic to Liebig, started the Rothamsted Experimental Station for Agriculture as a private venture; and in 1845 A. W. Hofmann, isolator of benzine from coal tar, was appointed first professor of a newly founded Royal College of Chemistry, of which the Prince Consort had accepted the presidency.

The reorganisation of De la Beche's command in 1845 led to transfer of the Geological Survey from the Ordnance Survey to the Office of Woods, Forests and other things, which already administered the Craig's Court Museum of Economic Geology. One outward and visible sign brightened the carry of the field staff. They were no longer called upon to carry out their arduous duties arrayed in blue uniform, brass buttons and top hat.

Early memoirs

De la Beche now decided to initiate two serial publications entitled Memoirs of the Geological Survey of Great Britain (or Ireland as the case might be) and the Museum of-Economic Geology in London or Dublin). Each volume of these Memoirs was to contain independent essays, as is ordinarily the case with publications issued by a learned society. In actual fact Irish Memoirs on this pattern never materialised.

The system cannot be recommended for routine publication by a geological survey, since users should be able to buy a separate memoir on any particular map sheet in which they happen to be specially interested ; at the same time vol. i, 1846, vol. ii, pt. t, 1846, and vol. ii, pt. 2, 1848, of the Memoirs for Great Britain furnish very convenient indications of the activities of much of De la Beche's organisation at this period. The series ended with volume iv. in 1872.

In volume i, 296 pages, constituting more than half of the whole, are supplied by De la Beche in the form of an essay on the Formation of the Rocks of South Wales and South-Western England. It is essentially stratigraphical, and when it comes to South-West England it takes the opportunity of rediscussing the Devonian-Old Red Sandstone correlation. After elaborate fossil analysis, in which recent publications by R. J. Griffith on Ireland are considered, De la Beche adopts much the same attitude as John Phillips, but with a stronger bias towards placing some of the upper part of the pre-Culm greywacke into the Carboniferous. Ramsay supplies the second essay on the Denudation of South Wales and the adjacent Counties of England. The horizontal sections issued by the Survey allow him to give minimal quantitative estimates of the prodigious achievements of denudation. Unfortunately, at this time, he had not yet attained to Hutton's realisation of the full significance of subaerial erosion, including the work of rivers. Like Lyell, he considers marine erosion of much greater importance, and in imagination distributes its effects by slowly raising or lowering land masses through the fretful surf. His introduction of the conception of plain of marine denudation still has much value, though replaced in many applications by the American idea of peneplane, produced subaerially. His acceptance of De la Beche's catastrophism so far as folded mountains are concerned leads him to speak of ' the mighty catastrophe that closed the coal measure period' in the Mendip region (and brings letters of protest from both Lyell and Darwin). The third essay, by Edward Forbes, is on the Connexion between the Distribution of the existing Fauna and Flora of the British

Isles and the Geological Changes which have affected their area, especially during the epoch of the Northern Drift. It is one of the most famous attempts ever made to account for geographical distribution of species. It will always be remembered for its discussion of the arctic-alpine elements found on our mountain tops, and of certain cold water assemblages isolated in deep pockets off our coasts. The concluding seven essays deal with the physics, chemistry, and exploitation of minerals, and also with the Mining Academies of Saxony and Hungary and the Mining Establishment of France. The authors are Hunt, Playfair and Warington Smyth.

Volume ii, pt. 1 by John Phillips, with assistance from Salter, monographs the stratigraphy and palaeontology of the Malvern Hills, compared with the Paleozoic Districts of Abberley, Woolhope, Mayhill, Tortworth and Usk; and is a fine district memoir in every respect.

Volume ii, pt. 2, starts with three essays by Hooker. The first is of a semi-popular nature comparing the vegetation of the Carboniferous Period with that of the present day. Its author explains that it is based on the first impression received by a naturalist, who, having been almost exclusively occupied with an existing Flora, is called upon to contrast it with the fragmentary remains of another Flora, whose species are, without an exception, different from those now living.' Then follow two essays on Asteriadæ and Cystideæ, by Forbes, and a long First Report on the Coals suited to the Steam Navy, pp. 530-630, by De la Beche and Playfair. This last, an early example of fuel research, necessitated the setting up of boilers and the execution of many thermal, chemical and other tests. The experiments were carried out by skilled operators temporarily engaged for the purpose at the expense of the Admiralty. In the end this First Report furnished the Navy with important practical data in a field hitherto scarcely entered except in America ; but it wisely refrained from giving positive advice, since the suitability under discussion depends upon a number of totally independent qualities, the relative importance of which must be assessed by the users. (Two further Reports were supplied to the Admiralty, but were not published between Geological Survey covers.) Four of the remaining six essays deal with metalliferous ores, mainly of lead. Of these, two concern the mining district of Cardiganshire and Montgomeryshire, pp. 635-684, and are by Hunt and Smyth ; and two are particularly noteworthy as initiating a long series of Mineral Statistics extracted by Hunt from voluntary returns made to the Mining Record Office.

In 1844 De la Beche introduced a new series of publications, Figures and Descriptions Illustrative of British Organic Remains. Each issue contains to plates and is called a Decade, an old fashioned use of the word. The first four Decades were by Forbes. The last, No. 13, by three other specialists, including T. H. Huxley, appeared in 1872.

Unofficial publication

Meanwhile, in 1848, a most important precedent was established. Jukes and Selwyn, followed by Ramsay and Ave-line, read papers before the Geological Society on certain results obtained during the official survey of Wales. De la Beche had been hesitant about such outside publication, but eventually agreed, so long as intended communications were submitted for his approval in advance. This procedure has been of great value to the institution. Perfect adjustment of what is best put out to learned or technical societies and what is best retained for the Survey itself will never be attained ; but on the whole, with ups and downs, a reasonable working practice has prevailed during most of the subsequent years.

Glaciation and drift

Geological readers may have wondered that the 1840 meeting of the British Association at Glasgow should have been cited in connexion with Ramsay's introduction to the Survey without any mention

of Agassiz's announcement there of his Etudes sur les Glaciers de la Suisse, in which he sketched a hypothesis of a former glaciation of Northern Europe. As a matter of fact for some years to come the announcement meant very little to the Geological Survey.

Let us go back behind 1840. Critics of uniformitarianism in its early days had a strong card to play when they pointed to the dispersal of enormous erratic blocks, characteristic of Switzerland and Northern Europe. A million successive pushes will not transport a boulder, if each push in itself is too small to produce any displacement at all. Hutton realised the strength of the argument, and to this we owe the first suggestion that glaciers in the past may have had a much greater extension than today. His remarks applied to Switzerland, where his task was to account for de Saussure's record of the distribution of Mont Blanc granite boulders, without invoking the assistance of a deluge. He pictured a condition with the Alps higher than at present, when ' there would have been immense valleys of ice sliding down in all directions towards the lower country, and carrying blocks of granite to a great distance, where they would be variously deposited, and many of them remain an object of admiration to after ages, conjecturing from whence or how they came.' From the termination of the glaciers to the passes of the Jura, Hutton proposed to conduct the boulders, ice-rafted, down river courses which existed before the present-day hollow of. Lake Geneva was eroded.

After Waterloo, Playfair, 67 years old, realised his ambition to examine the evidence of some of his master's interpretations affecting the continent of Europe. In 1815 we find him standing among great boulders on the slopes of the -Jura. He saw one monster, 2,520 tons in weight, which had performed a journey of fully 70 miles and still remained rough and angular. He did not flinch ; but decided that ' a glacier which fills up valleys in its course,• and which conveys the rocks on its surface free of attrition, is the only agent we now see capable of transporting them to such a distance, without destroying that sharpness of the angles so distinctive of these masses.'

Passing on, we find it recorded that Professor Jameson taught his Edinburgh classes, as early at any rate as 1827, that the erratic phenomena of Scotland might point to the past existence of glaciers. Other pioneers include Esmark of Oslo, 1827, and Goethe in the 1829 edition of his Wilhelm Meister.

Before long there followed much more intensive studies in the Alps by Venetz and Charpentier, presently joined by Louis Agassiz. In 1838 the latter explained to Buckland on the south-east slopes of the Jura mountains, various well characterised glacial phenomena. Buckland did not allow himself to be convinced until he had crossed the Swiss plain to examine for himself glaciers still at work in the Alps. Then he returned and told Agassiz that he had similar evidences in Scotland and England (which Agassiz knew quite well), but had hitherto grouped them with his other Reliquia Diluviance (the title of a book on Noah's flood which he had published 1823). As a consequence he persuaded Agassiz to come to the Glasgow meeting of the British Association, where he would be sure to see fossil fishes even if the evidence for vanished glaciers melted away on closer examination.

Buckland had started a tour of glacial investigation before joining Agassiz at Glasgow ; and after the Association meeting the two roamed far and wide through Scotland, England and Ireland. An epitome of their results was communicated to the Geological Society in November and December of 1840. It is easy to find fault with important details, but the evidence which they gave of land glaciation of Britain by ice-sheets comparable with that existing today in Greenland has held its own triumphantly. To read merely the Proceedings of the Society, especially remembering that Buckland spoke as its President and that Lyell joined in the chorus with a paper On the Geological Evidence of the former existence of Glaciers in Forfarshire, might lead one to imagine that the fight had been won at the first charge. Moreover, one knows that the defences of probable opponents had been weakened in advance. On the one hand, the yachting naturalist, James Smith, of Jordan Hill, had already in 1839 started publication regarding arctic shells in the post-boulderclay, uplifted, marine deposits of the Clyde valley, while similar evidence had come from Canada and Sweden ; and on the

other, uniformitarian Lyell had already in 1836 begun to account for distribution of erratics by invoking floating ice. Accordingly the new glacial theory was addressed to an audience familiar with the idea of an arctic climate and of transport of boulders by ice of a kind. Fortunately for our understanding of the case we can turn from the Society's Proceedings to a contemporaneous report of the discussions which took place following the delivery of the papers. This invaluable account is reproduced in H. B. Woodward's History of the Geological Society of London. One of the discussions continued until midnight, and on the whole the opinions expressed were extremely damnatory.

In his succeeding Presidential Address, February, 1841, Buckland reviewed the situation in a very conciliatory style. The contest between the adherents of land ice and sea ice he thinks, ' will probably be settled, as in most cases of extreme opinions and exclusive theories, by a compromise ; the glacialist will probably abandon his universal covering of ice and snow, and will be content with glaciers on the elevated regions of more southern latitudes than now allow of their formation ; the diluvialist, retaining his floating icebergs as the most efficient agents in the transport of drift and erratic blocks to regions distant from their place of origin, may also allow to glaciers their due share in the formation of moraines and striated surfaces, in latitudes and elevations that are no longer within the zones of perpetual congelation.' It is true that important features of Agassiz's conception deserved to be jettisoned, but Buckland retreated much too close to the mountains as a result of the rough handling he had received from his critics. He was not alone in his timidity, since for a long time most British geologists accepted the boulder clay of the lowlands as a product of ice floes carried by marine currents.

It has been said above that the announcement of the glacial theory at first meant little to the Geological Survey. This is well exemplified in an entry Ramsay made in his diary for the 16th April, 1845. He had been to the Geological Society to hear A. F. Macintosh read a paper On the Supposed Evidences of the former Existence of Glaciers in North Wales. Ramsay's jotting is: Jolly night at the Geological. Buckland's glaciers smashed.' This comes amusingly, in retrospect, from one who was destined to become an international figure in glaciology. His conversion seems to date from 1848, when Robert Chambers, who had come south to compare Welsh glaciers with Scottish, gave him a valuable lesson in the Pass of Llanberis. Next year at the Royal Institution Ramsay delivered a discourse on the Geological Phenomena that have produced or modified the Scenery of North Wales, in which he assigned great importance to glacial action. He has recorded that the praise he got from Herschel, De la Beche and others was almost too much to be good for him. Faraday ran up to him at the close and shook him by both hands, asking: ' Where did you learn to lecture ?' Ramsay had now reached the compromise position anticipated by Buckland. He still attributed the general smooth mantle of drift up to 2,300 ft. to glacial marine deposit.

Interest in glaciation has provided a very effective incentive towards the production of drift maps, that is of maps showing the nature of the post-Tertiary superficial accumulations. Such maps are keenly desired by agriculturists and town planners. Unfortunately they are relatively difficult to produce since the distribution of drift is much less methodical than that of the underlying so-called solid formations. Very little could be achieved in the way of drift mapping so long as field work was carried out on the scale of one inch to the mile. Still, a start was actually made, covering a large part of Norfolk, by Joshua Trimmer, 1844-46. His results are given in the Journal of the Agricultural Society for 1847, and of the Geological Society, 1851. Trimmer's interest in diluvial phenomena was of old standing, for in 1831 he had announced the discovery of marine shells in gravel well over 1,000 ft. on Moel Tryfan, Snowdonia. In 1846 he joined the Survey, continuing till 1854, always keen on superficial deposits.

Consummation of De La Beche's hopes

The quarters at Craig's Court soon proved too cramped for the staff and exhibits marshalled by De la Beche. Moreover, in 1839 the Treasury had sanctioned a proposal for lectures on the practical applications of geology, and Craig's Court failed to afford opportunities to make even a start in this direction. De la Beche had been greatly impressed by the achievements of the Mining Academy at Freiberg and of its virtual offspring, the Ecoles des Mines, established in Paris in 1783 and reestablished, despite political turmoil, in 1794 ; and accordingly he attached great importance to personal teaching as supplementary to research and publication. He was a persistent planner, and his ambitions were of such a kind as appealed very strongly to the Prince Consort. The year 1851 brought to both these great men the consummation of their dearest hopes: to De la Beche, the opening of his new Museum of Practical Geology at 28, Jermyn Street, off Piccadilly, with accommodation not only for the Geological Survey and Mining Record Office, but also for a Government School of Mines and of Science applied to the Arts ; and to the Prince, the triumphantly successful Great Exhibition of the Industry of all Nations.

His Royal Highness opened the Museum on the 12th of May, 1851, in the presence of a brilliant gathering. After receiving an address from Sir Henry De la Beche, he spoke as follows:—

> In thanking you for the address which you have just read to me, I would 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 great 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 scence, 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.

At the time of the opening of the School of Mines and Science in Jermyn Street the following were professors or lecturers under the presidency of De la Beche: Chemistry, Playfair ; Geology, Ramsay ;

Mechanical Science, Hunt; Metallurgy, John Percy ; Mining and Mineralogy, Waring-ton Smyth ; Natural History, Forbes. Four out of the six were already Fellows of the Royal Society.

Next year saw the initiation of a new series of publications for the Museum of Practical Geology and Geological Survey, entitled: Records of the School of Mines and of Science applied to the Arts. Vol. i, pt. 1 preserves for us the Inaugural and Introductory Lectures to the Courses for the Session 1851-2, delivered by De la Beche and his six professors. De la Beche's own discourse is particularly delightful, free from all the parenthetical complexity we have noticed in his writings of earlier date. Its author glows with quiet enthusiasm and confidence. He explains that the exhibits in the Museum are intended to illustrate the lectures of the School, though also open to the general public. He communicates to the reader some of his own feeling for the building stones, pottery, glass, ores and metals, which he has gathered together, in large measure as presentations from generous donors. He tells how such matters as the working of coal and the ventilation of mines receive ample attention. He emphasises the value of the fossil collection, ' the most perfect of its kind,' and of the rock collection too —showing that new features of first class importance have been introduced as a result of transfer from overcrowded Craig's Court. He has evidently been subjected to criticism from carpers who prefer practice to science ; but he feels that this criticism is already losing ground: ' Those whose duties or inclinations take them among our industrial population can scarcely fail to observe how much the term practical is becoming appreciated in its true sense. . . . Science and practice are not antagonistic, they are mutual aids.' For himself he has chosen for his new building the proud title of Museum of Practical Geology.

The theme of fruitful co-operation between science and practice is developed in succession by the specialist professors, each giving a most interesting account of the achievements of applied science in his own field. It is characteristic that Percy declares himself no believer in useless metals,' and foretells a future for tungsten, at that time thrown away as waste at the Cornish tin mines.

A syllabus is provided of the courses of instruction in lecture hall, laboratory and field, leading up to a diploma, and of the corresponding fees. This must be taken in conjunction with a passage in De la Beche's discourse, which reminds us that: ' The history of the greatest discoveries teaches us, that it is not only by the rich that mankind has been advanced. As far as may be in our power, we propose to explain by evening lectures to the working men of London, those really engaged in business, and whose characters can be vouched for by their employers, such part of our collections as may be thought usefully interesting to them. Some slight payment may be required, sufficient to prove that those attending desire to do so. At the time when our collections are open gratuitously to the public the working man is usually engaged in his occupation, and yet we have much to show—much that may be important to him in his calling.' De la Beche's solicitude for the working man is distinctly reminiscent of Count Rumford's. All the lecturers participated in the evening course, which proved a most attractive perennial feature of the school's curriculum.

At the opening of Parliament in 1852 Queen Victoria announced that a comprehensive scheme was in preparation to ensure the advancement of practical science and the fine arts. Thus the Department of Science and Art was established under the Board of Trade, and on its recommendation the Royal School of Chemistry was absorbed in 1853 into De la Beche's School, which now assumed the title of Metropolitan School of Mines, and of Science applied to the Arts. Hofmann, largely concerned with distillation products of coal, remained Professor of Chemistry ; while Playfair resigned to become Secretary for Science in the new Department. Playfair's transfer was not surprising, for in 1850 he had acted as one of the Commissioners organising the Great Exhibition ; nor can one wonder that next year, 1854, De la Beche found himself, with his Survey, Museum, Records Office and School, following Playfair from the Office of Woods and Forests into the Department of Science and Art.

Playfair's zeal to employ the profits of the Great Exhibition in the advancement of science held the seeds of eventual dismemberment of De la Beche's creation ; but the prestige of the creator and of his immediate successor, coupled with the expenses of the Crimean war, 1854-56, and the untimely death of the Prince Consort, 1861, delayed the operation until 1871.

Reference has already been made to the death of the first Curator of the Museum, Richard Phillips, the day before the new building was opened. His place was taken by Trenham Reeks, who had been Assistant Curator since the beginning in 1839.

Start in Scotland

The general awakening in the country after the Great Exhibition led among other things to an agitation in Scotland for a share in the benefits of the Geological Survey. Extension to the northern kingdom had already been voted in Parliament, but so far had had to wait upon the progress of the Ordnance Survey. Now six inch to the mile maps began to be issued, and Ramsay, who had been commissioned by De la Beche to examine the situation, decided if possible to take advantage of their facilities. Accordingly he crossed to Ireland to learn from Jukes and his men the technique of six-inch field work. Thus it was that in the autumn of 1854 the geological survey of Scotland was started by Ramsay himself, and, most fortunately, on the six-inch scale.

Thomas H. Huxley

Another great event in Survey annals dates from 1854. Thomas H. Huxley, born 1825, had returned in 1850 from a long voyage in H.M.S. Rattlesnake, during which he had investigated with outstanding success marine life near the Great Barrier Reef of Australia. Till 1854 the Admiralty had allowed him to work up results at home, but had then countered an application for money to secure full publication with an order to report for duty as an ordinary ship's doctor. Huxley resigned, and consented to take over Forbes' position as Professor of Biology at the School of Mines—Forbes was leaving for an Edinburgh chair which he scarcely lived to occupy. Huxley in addition was appointed Naturalist to the Survey. He refused ' point blank' De la Beche's offer of employment as Paleontologist, as he did not care for fossils and intended to give up natural history for physiology. Actually he held his Survey post for thirty-one years, and a large part of his life-work was paleontological.

Progress To 1855

Now let us take a glance at the progress made in field work generally by the end of 1855 (Fig. 8). The western half of that part of England and Wales which lies south of the latitude of Liverpool, including the whole of the principality, had been covered by geological one-inch sheets actually published. In Ireland a definite start of map publication had been made, mainly in Wicklow ; though progress had been delayed through non-appearance of Ordnance one-inch maps required for reduction purposes. In Scotland there was no publication, but field work had begun in East Lothian.

The field staff at the beginning of the year numbered six under Ramsay in Great Britain ; and seven under Jukes in Ireland.

Of memoirs not already mentioned we may list parts 2-4 of vol. i of the Records of the School of Mines, all issued in 1853. Part 2 consists almost wholly of an account by Jukes of the Geology of the South Staffordshire Coalfield. It may be taken as a good first example of a long succession of coalfield memoirs continued to this day and of pre-eminent economic importance. Parts 3 and 4 relate to Mines of Wicklow and Wexford and Mineral Statistics, 1848-1852. Part 4 marks the end of

the Records; but not of Mineral Statistics, for Hunt continued their separate publication under the regis of the Survey until 1880 had been covered.

Close of De la Beche's reign

De la Beche began to fail from partial paralysis in 1853, although still able to undertake an inspection tour in Ireland the following year. ' Up to the very end,' says Sir Archibald Geikie, Sir Henry came to the Museum, even though he could not leave the chair in which he was wheeled into the building, and his loud voice and hearty laugh could be heard all over the place. He had still his joke for each member of the staff, and his kindly word of inquiry and encouragement for the attendants and cleaners.' He appeared for the last time two days before his death, which occurred on the 13th April, 1855.

In February of the same year De la Beche had been awarded the Wollaston Medal of the Geological Society. He was too ill to attend, so that Sir Roderick Murchison in accepting the medal for transmission was able to speak of his friend's field work and also of his ' successful completion of a great National Establishment, ...which to the imperishable credit of its author, stands as the first Palace ever raised from the ground in Britain, which is entirely devoted to the Advancement of Science Sir John Flett, in writing The First Hundred Years of the Geological Survey of Great Britain, was able to add: ' Nothing that he [De la Beche] did has failed and with the progess of the years all his projected enterprises have expanded and developed.'

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