

Geological Survey under Sir Andrew Crombie Ramsay, 1871-1881

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SIR ANDREW CROMBIE RAMSAY

Sir Andrew Crombie Ramsay (From an old engraving.) Plate III

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IV The Geological Survey under Sir Andrew Crombie Ramsay

The death of Murchison, however, initiated a period of rapid change. After a few months it was announced that the new Director-General of the Geological Survey was Andrew Ramsay. The choice was inevitable. Ramsay had earned his promotion by his magnificent record. He was probably the best field geologist of his day and for many years the management of the field work in England and Scotland had been in his hands. His qualities as an administrator had passed the severest tests, and he was universally respected and popular.

The Museum of Practical Geology and the Mining Records Office seem also to have been assigned to Ramsay. At any rate, in a year or two we find him signing the Annual Reports for them as well as for the Geological Survey, though this was not the case in the 1871 Report. The School of Mines, however, was never under Ramsay's direction. For a time it was governed by a Council of the Professors, of which Warrington Smyth was the first Chairman.

Although the School of Mines was no longer integrally connected with the Geological Survey, the actual separation did not take place at once. The Science and Art Department had continued to maintain pressure for the establishment of Science Schools at South Kensington. In 1870 another Royal Commission sat under the presidency of the Duke of Devonshire, and, after pointing out the deficiencies both in regard to curriculum and accommodation that hampered the existing School of Mines, it recommended that the School and also the College of Chemistry should be transferred to the new buildings at South Kensington, where there was ample room both for lectures and for laboratories. No change was made immediately, possibly because of the attitude of Sir Roderick Murchison, and matters were left in their former state for a time. It became clear also that the professors of the School of Mines were not agreed on the advisability of the transfer, for Warrington Smyth, Percy and Ramsay drew up a memorial advancing certain objections to the proposal. We are at liberty to infer that the other professors, Huxley, Frankland and Tyndall were either in favour or neutral. In 1872, however, after Murchison's death, the Council of Professors recommended that Chemistry, Physics and Natural History should be immediately transferred to South Kensington, and this was accordingly done. The College of Chemistry went also in accordance with the recommendation of the Royal Commission of 1870. The change, in fact, was highly desirable, as the accommodation at Jermyn Street was lamentably insufficient. Huxley had no laboratory, no classroom for practical teaching, and for years he worked in a room not more than eight feet square. The chemical laboratories also were crowded, and many applicants could not obtain places. There was no physical laboratory and no instruction in mathematics. Application had been made on several occasions for the acquisition of additional houses in Jermyn Street, but this had never been granted on a sufficient scale. The development of the ground at South Kensington, which had been acquired by the Commissioners of the 1851 Exhibition, and was public property, specially intended for the advancement of scientific education and research, offered a splendid opportunity to remedy these ills.

At this stage, however, the transference was not completed. Mining, Metallurgy and Geology remained at Jermyn Street. The space vacated by the other professors was used to expand the laboratories and working rooms of the School of Mines and the Geological Survey. On account of the increase of staff, the Survey had been very much hampered for lack of room for several years, and Murchison had pointed this out very emphatically in his last Report. The Science and Art Department represented that this state of matters was unsatisfactory and urged the completion of the transfer of the Royal School of Mines, but Lord Frederick Cavendish, on behalf of the Treasury, did not see his way to consent.

The further history of the Royal School of Mines and its connexion with the Museum of Practical

Geology may be briefly outlined. Ramsay continued to give the lectures on Geology till 1876, when he resigned and was succeeded by Judd, who had been at one time a geologist on the Survey. Judd signified his willingness to take up his quarters at South Kensington, where he was provided with classrooms and laboratories in the Western Galleries. At the same time most of the teaching collections of specimens and diagrams were taken to South Kensington and subsequently on several occasions he received donations of duplicate specimens suitable for the illustration of his lectures.

Warrington Smyth and Percy insisted on remaining at Jermyn Street, where there were large and very instructive collections that had been brought together by them to illustrate economic mineralogy, geology and metallurgy. Till his death in 1890 Warrington Smyth continued to lecture at Jermyn Street, but his successor, Le Neve Foster, took up his duties at South Kensington. This finally severed the connexion between the School of Mines and the Museum of Practical Geology.

Percy also had strongly opposed the change; his laboratories were cramped and congested, and space was available at South Kensington. In 1880 the authorities decided that the transfer was necessary, but Percy refused to go. He offered to provide a new laboratory at his own expense at Jermyn Street, but this offer was declined, and Percy, not without protest, sent in his resignation. His successor, Roberts-Austen, took up his duties in the new buildings at South Kensington. Of all the distinguished professors whose names appear on the roll of the School of Mines, none did more than John Percy to establish the world-wide reputation of that famous School.

Huxley remained on the staff of the Geological Survey for several years, though his professorial activities were transacted at South Kensington. His position as Naturalist to the Survey entailed the superintendence of the collection of fossils exhibited in the Museum. Every year he put in a large amount of work and rearranged, labelled and incorporated in the collections large numbers of specimens. In this work he had several assistants, the Newtons, Rhind, Sharman and others. He also wrote monographs on fossil fishes and reptiles which were published by the Geological Survey. Elaborate catalogues of the fossils exhibited in the Museum were compiled under his direction. But apparently he did not visit the field, and the duty of naming fossils sent in by the field geologists devolved on Salter, and after his resignation, on Etheridge and Sharman. Huxley also took a full share in the lectures to working men which were given in the theatre of the Museum. His activity at this period of his life was tremendous and no doubt was a contributing cause to the ultimate breakdown of his health. His last appearance as an officer of the Geological Survey was in the Annual Report for 1881. In that year Robert Etheridge, who had been acting as Palaeontologist, was transferred to the British Museum, and in 1882 Sharman and E. T. Newton were appointed Palaeontologists to both Survey and Museum.

Survey work and publications

Ramsay's qualifications for the post of Director General of the Survey were indisputable. For a good many years, in fact, he had borne the main burden of work and responsibility for all the Survey's activities in England and in Scotland. When Murchison secured a large addition to the field staff in 1867 and 1868 Ramsay's troubles were greatly increased. As has been said before, Murchison does not appear to have taken a close interest in the field work and it is doubtful whether he could have trained young and ignorant geologists to do their surveys in a proper manner. This task fell to Ramsay as Local Director and to the more experienced geologists such as Aveline, Bristow, Hull, Howell and Whitaker. It was not really pleasant work and involved a good deal of responsibility and loss of time. Great pressure was exerted to maintain the area reported each year as having been surveyed and there was a danger that the standard of the work would be relaxed. Ramsay spent a considerable time every year visiting the field parties and inspecting the mapping. No one was more competent for these duties than he was, and, though of a kindly and generous nature, he was a

severe and relentless critic. Ramsay had suffered from ill health in 1862; it took the form of a partial breakdown, undoubtedly caused by overwork, and he was long in making a complete recovery; he felt the weight of his official duties very much more after that period of ill health, and neither in the field nor in the office did he display his former tireless energy and perseverance. He continued, however, to give his lectures in the School of Mines till 1876 and lectured also frequently to working men, to the Royal Institution, the British Association and other scientific bodies. He also continued his literary work. The edition of the North Wales memoir which was published in 1866 was sold out in a few years. A new edition was called for and Ramsay was well aware that many alterations and improvements were inevitable. In addition to his inspection tours in Britain and in Ireland he put in a good deal of field work in North Wales in correcting and amplifying his description of the geology. Three editions of his 'Physical Geology and Scenery of Great Britain' were passed through the press, each of them showing a considerable expansion when compared with the preceding edition. He contributed numerous papers to the Geological Society and to periodicals. These were written in an easy and attractive style, for he was a matter of clear, simple, elegant English. He was also an excellent lecturer, and, although the eminent professors of the School of Mines included such famous lecturers as Tyndall, Huxley and Frankland, it was generally admitted that Ramsay was not inferior to the others.

We shall not err if we ascribe to Ramsay, more than to anyone else, the development of the methods of survey and of publication that even at this day are characteristic of the Geological Survey of Great Britain, although, of course, his more experienced geologists played a great part in this work, and they in turn trained the younger men. Six-inch mapping was now the rule except in some of the eastern and southern counties of England, where still only one-inch maps were available for field work. The survey of the Drifts also was now regarded as essential. On the one-inch map it was hardly possible to do justice to the Drifts, but the six-inch maps were eminently suitable for this class of work, allowing opportunity for the insertion of far more detail. In some parts of the country, such as the Yorkshire moors, there was very little Drift. In others, like the Fen country, there were great stretches of alluvium, where the solid rocks were hardly ever seen. In the south-eastern counties of England the Drifts were mostly gravels, river terraces and recent alluvia. But in Lancashire and the North of England generally, as also in the south and centre of Scotland, the Drifts were both varied and widespread, and much attention had to be given to the mapping of them. Although much had still to be learned regarding their nature and origin, there had been great progress, and this chapter of geological history was being better understood every day.

About the year 1871, when Ramsay succeeded Murchison, the rate of progress both in surveying and in publication was very satisfactory. The number of one-inch Sheets issued every year was not much greater, probably because the area surveyed was not increased in proportion to the increase of staff. But six-inch work and publication were advancing rapidly, because much of the activity of the staff was directed to coalfield surveys during the years between 1861 and 1881. In 1875, for example, 35 whole Sheets of the six-inch survey were reported as published, representing parts of the coalfields of Yorkshire, Lancashire, Northumberland and Durham. In 1878, 34 six-inch Sheets came from the press representing coalfield areas in Northumberland, Yorkshire and Cumberland. In addition to these one whole Sheet and 24 Quarter-sheets of the one-inch map were in the hands of the engravers and 74 six-inch Sheets of the northern counties were being engraved. In 1881, 60 six-inch maps were sent to the engraver, of which 30 were 'Solid with Drift' and 30 were Solid Maps previously published to which the Drift had been added; but in that year, for reasons not stated in the Director's Report, the Department issued instructions by which the engraving of six-inch maps was to a large extent suspended. It was evidently desired to secure more rapid publication of the one-inch maps. The issue of Horizontal and Vertical Sections had on the whole kept pace with the six-inch maps. The following table shows the numbers of maps and sections of each kind, on sale, at various dates:

Published to	1862	1871	1881
One-inch, Whole Sheets	35	41	43S (+1D)
One-inch, Quarter-sheets	91	124S(+3D)	153S(+24D)
Six-inch	15	87	217
Six-inch revised	0	0	4
Horizontal Sections	55	80	119
Horizontal Sections revised	3	13	15
Vertical Sections	27	40	66

This insistence on six-inch coalfield publication was possibly due to the influence of the Coal Commission which sat from 1866 to 1871. The delay in publishing one-inch Sheets may be explained by the fact that in coalfields they are of little importance as compared with six-inch Sheets and also because, if the country is to be published on both six-inch and one-inch scales, and has been mapped on the six-inch scale, it is usually practical to finish the six-inch maps and then reduce to the one-inch scale as much of the geology as can be represented on the one-inch map.

Scotland

In Scotland also there were years of rapid progress in work and publication; up to 1862 little work had been done in the northern kingdom. In 1854 Ramsay was the only geologist in Scotland; Geikie and Howell were at work in 1855. Howell then returned to England. James Geikie and John Young were assisting Archibald Geikie in 1861. Peach joined in 1862 and Horne, Jack and Skae were added to the staff in 1867. In 1866 Young was appointed Professor in Glasgow 'and in 1873 Irvine and Craik were the junior members of the Scottish staff. In 1873 Craik had retired, and Jack went to Queensland in 1877 to found the Geological Survey of that colony, but James S. Grant Wilson and James Linn had now been added to the staff, which consisted of one Director (A. Geikie) and seven geologists.

Published to	1862	1871	1881
Scotland:			
One-inch Sheets	3	13	24
Six-inch Sheets	11	69	124
Horizontal Sections	1	5	9
Vertical Sections	—	2	6

Ramsay was now too busy to take any part in the field work in Scotland though he continued to pay occasional visits of inspection. Archibald Geikie had been made Director for Scotland in 1867, and after that date, with the responsibility for an increased field staff on his shoulders, he also seems to have done little mapping in the field. In November 1871 he began his work as first occupant of the Chair of Geology that had been founded in Edinburgh University by Sir Roderick Murchison. The ordinary course of lectures lasted for five months in the winter, and he had also to lead excursions of his students to places of geological interest.

During the years of Ramsay's Directorship work in Scotland had rapidly advanced. Prime attention was given to the coalfields, and, starting in Midlothian, the survey was gradually carried into Fifeshire, Ayrshire, Lanarkshire, Dumbartonshire and Renfrewshire. In 1871 most of the Old Series maps of Central Scotland, on the one-inch scale, had been issued from the press, to the number of thirteen. One hundred and twenty-four six-inch Sheets of Scotland had been published by 1878, completing the coalfield areas. The only Scottish memoirs which had yet appeared were those on

Midlothian, Eastern Berwickshire and East Lothian, but it was stated that others were in preparation on Ayrshire, Fifeshire and Peeblesshire. These latter were never issued, however, probably because so much pressure was exerted in order to complete the publication of the coalfields that the surveyors had no time to prepare a description of the maps.

On the eastern side of the country, in the Lothians and Fife, the work was principally done by A. Geikie and Howell, though Ramsay started it in Haddingtonshire. On the western side in Ayrshire and Lanarkshire the first mapping was carried out by A. Geikie, James Geikie and John Young. Then James Geikie, Hull, Peach and Jack, after Ayrshire was practically finished, were busy for several years in Lanarkshire, Renfrewshire and Dumbartonshire. When the coalfield area was fairly completely mapped, work was pushed forward in the Southern Uplands, and the principal part in that work was taken by Young, James Geikie, Horne, Jack and Irvine. It took a long time, however, to get these maps finished, and the south of Scotland as a whole was not published till 1893. One reason for this delay was the necessity for mapping the Drifts, which in that country were found to be complicated and of irregular distribution. The solid geology of the Silurian country was not really understood at that time and the original maps show little detail. About the year 1876, when the survey of the Southern Uplands was approaching completion, the work was being actively pushed forward on the north side of the Central Valley in Perthshire, Stirlingshire and Forfarshire. As yet no ground north of the Highland border-line had been surveyed. In 1878, however, work was in progress near Elgin, Inverness, Peterhead and Stonehaven, and by 1881 one Sheet was published (Fraserburgh) and twelve others were being surveyed. At that time the Scottish geologists were J. Geikie, Peach, Horne, Skae, Irvine, Grant Wilson and Linn.

Northern England

In Cumberland, Westmorland and the North-west of England generally work was begun about 1865 and was in progress for about 20 years till the original six-inch survey was completed. From the first it was in charge of Aveline, who was a first-class field geologist and whose maps bear the marks of accuracy and thoroughness. He was ably supported by Clifton Ward, who mapped a large area of the northern part of the Lake District. This was very complicated ground and though Clifton Ward was one of the first British geologists to make use of micropetrological methods, his work necessarily suffered from limited knowledge of fine-grained igneous rocks that were both weathered and metamorphosed, such as the Borrowdale Volcanic Series. Holmes mapped much of the New Red in the Carlisle Basin and Russell took a large share in the survey of the Whitehaven coalfield. This is very difficult and intricate ground. Russell's six-inch maps of that coalfield were never fully published and his one-inch map met with criticism. Some revision was done by Aubrey Strahan about 1890, but this was partial and was never fully published on the six-inch scale. The complicated structure of this coalfield was not clearly understood till the ground was fully revised by Bernard Smith and his staff after 1923. Goodchild was especially interested in the glacial phenomena of the Vale of Eden, on which he wrote some valuable papers.

The work was gradually extended eastwards into the Northern Pennines and northwards to the Scottish border, but these areas were still incomplete in 1882. In addition to the geologists mentioned above, Burns, Hebert and Colvin were engaged on these maps. They surveyed the various limestones of the Carboniferous with great care, and as the ground is often fairly clear of Drift it was possible to make out the structure in considerable detail. Six-inch maps were available for that work from the beginning and a large number were published, even though they indicated few deposits of economic value. At first not much attention was paid to the Drifts, but after 1875 they were mapped and shown both on the six-inch maps and on a special series of one-inch Drift maps.

In Northumberland and Durham the work was under the charge of Henry Howell. As assistants he had Clough, Miller, Gunn, Cameron, and also Topley for a time. The structure of this ground is

comparatively simple both in the coalfield and in the underlying Carboniferous. Work in this district was started about 1865 around Durham and Newcastle-on-Tyne and was barely half completed in 1882. Six-inch maps were published (mostly showing Drift) of the Northumberland and Durham coalfield between 1867 and 1890. Memoirs appeared on certain of the northern Sheets (Cheviots, etc.), but no memoir was written on the Durham coalfield.

Yorkshire

In Yorkshire A. H. Green was District Surveyor till he was appointed Professor of Geology in the Yorkshire College, Leeds, in 1874. His assistants were Tiddeman, Fox-Strangways, Dakyns, Dalton, Clough and Barrow. In 1874 work was in progress in the district around Leeds and Sheffield, and by 1882 most of the exposed coalfield in Yorkshire and Derbyshire had been surveyed and published. Between 1871 and 1880 many six-inch maps of the Yorkshire coalfield came from the press, accompanied by a full series of Horizontal and Vertical Sections, and in 1878 the great memoir on that field was published. The authors were Green, Russell, Dakyns, Ward, Fox-Strangways, Dalton and Holmes, but Green was editor and principal contributor, and Russell gave him much assistance. The work done in the Yorkshire field, both Drift and Solid mapping, was of a high standard and the memoir was far the most complete and satisfactory description of a coalfield that had been published by the Geological Survey up to that time.

As the mapping of the Yorkshire coalfield progressed, work was carried forward into East Yorkshire and Lincolnshire. In the former district six-inch maps were available, and the geologists employed were Fox-Strangways, Barrow, Dakyns and Clement Reid. Drift was mapped in full and much of that work was of a high standard. Further south, in Lincolnshire, much of the ground was surveyed by Jukes-Browne on the one-inch scale, but as most of the rocks were Secondary the mapping is still of considerable value.

London and East Anglia and around The Wash

In the London district the original survey was completed in 1873 and published on a large one-inch Sheet. A special series of Drift maps of the London area was published in 1871 and 1872. The officers employed on this work were Bristow, Whitaker, Woodward, Bennett, Ussher, Blake, Hawkins, Dawkins and Penning. In 1873 a large model showing the geology of London on the six-inch scale was made for exhibition in the Museum of Practical Geology under the superintendence of Whitaker.

Before 1877 all the south-east of England, including the district known as the Weald, had been published on the one-inch maps, and the Drifts, which in that district are not of great importance, had been mapped, though not fully. By 1884 Drift maps of London and of a large part of the south-east of England were on sale. In that region the principal surveyors were Aveline, Topley and Whitaker, with Drew, Dawkins, Polwhele, Bristow, Gould and Le Neve Foster.

There remained the areas of Secondary and Tertiary rocks in East Anglia and around the Wash. These were not completed till 1883. The geologists responsible for these maps were Woodward, Blake, Hawkins, Whitaker, Clement Reid and Barrow.

England summary: 1871 to 1881

It will be seen from this summary account that the years 1871 to 1881 were a period of great activity in England. The area surveyed was very large and the number of maps published was extraordinary. The organization of the Survey had been much improved. In each of the important districts a group of geologists was at work under the superintendence of a senior officer of great experience. The

mapping, especially where six-inch maps were used as a basis, was often exceedingly good. Many of these maps are still current and are very useful. In the coalfields very careful work was being done, especially in Yorkshire, but coalfield maps soon go out of date as the progress of mining brings forward much new evidence every year and on account of the great accuracy which must be attained if the maps are to be of real use to the mining industry. In the Secondary and Tertiary rocks of the east and south-east of England the Old Series maps, with comparatively few alterations, are still the principal authorities for the regional geology. Recent revisions have been made of some of them and show that in certain details, such as the subdivisions of the Cretaceous and the classification of the Drifts, there is room for much improvement, but taken as a whole they have well served the needs of their time. By 1881 only small areas of comparatively simple ground remained to be done in East Anglia, Lincolnshire and in the high fells of Cumberland, Northumberland and Yorkshire. In addition to the Solid maps, Drift maps were being published in all the areas in which surveying was actually in progress, though as yet not more than twenty Drift Sheets were on sale.

It is evident, however, that attention was concentrated on the field work, and the preparation of descriptive memoirs was regarded as less urgent. This, of course, was necessary, as till the maps were issued the memoirs were not required. Few Sheet memoirs had yet appeared on the northern and eastern counties. Accounts of the Lancashire coalfield (1860-64), and those of Derby, Notts, Leicester, Warwickshire and Staffordshire had been issued at an early date (1864 onwards). On the other hand, many memoirs were in preparation and among the more important were those on Rutland by Judd (1875), London by Whitaker (1889), the Weald by Topley (1875), and the Yorkshire Coalfield by Green and others (1878).

Ireland

In Ireland steady progress was being made with the original survey. The death of Jukes in July 1869 was an almost irreparable loss. He was not only a geologist of outstanding merit, and a man of charming personality, but he was also an excellent Director, keeping his sometimes unruly staff well in hand and maintaining a high level of output and a good standard of mapping. He had directed the Irish Survey since 1850, when Oldham went to India, and its regular progress was due more to him than to any other person. The survey of Ireland was about two-thirds completed when Jukes died. Starting in the south-east, it had gradually spread westwards into Kerry and Limerick and was then carried northwards along a wide front. In 1869 work was in hand in Roscommon, Louth and Galway, while all the ground to the south was finished and most of it published. Work was already started on the east coast of County Down and Antrim, and some of these maps had been published. The Irish Survey from the first had had the advantage of using the six-inch 'County maps' which were sufficient for their purposes; in fact, publication had been held up for nearly ten years because the one-inch maps were not yet ready. The one-inch maps showed the Solid rocks by colour and also the distribution of peat and alluvium. The Drift was represented by a fine stipple of black dots. The Irish Drifts were consequently more fully mapped and more clearly shown than on many English maps of the same period. Short descriptive memoirs on the Irish Sheets were generally issued with laudable promptitude.

Some of these were very brief, but others ran to sixty pages and they were very useful. In this respect also Ireland during the Directorship of Jukes was much better served than England or Scotland. Numerous Horizontal Sections were also published to illustrate the structure of the country. Many of these hand-coloured maps are still on sale, and have never been replaced by a revised survey. In some parts of the country, however, a certain amount of revision was done, especially in the Silurian and older rocks, which were being more carefully studied and classified as the knowledge of the Lower Palaeozoic gradually increased.

In 1869, after the death of Jukes, the Directorship of the Irish Survey was entrusted to Edward Hull.

He had been on the English staff since 1850 and had taken part in many arduous campaigns with Ramsay, Aveline, Bristow, Howell and Salter. He had assisted in the preparation of the first maps of the Midland Coalfields and in the periodical and partial revisions of these maps. Some of the short memoirs on these coalfields had been written wholly or in part by Hull. For a season or two he had also mapped in Scotland, but in 1860 he was at work in Lancashire, where he was apparently the first of the English geologists to use and to publish the six-inch maps on coalfield survey. Hull had consequently great experience of exactly those kinds of geology that were likely to be involved in the survey of Ireland, though with metamorphic rocks he had as yet little acquaintance. He was a man of great tact and suavity and a steady worker. A well-known book on the 'Coalfields of Great Britain' had appeared from his pen, and he was much interested in the study of scenery and physiography. Among his able lieutenants in Ireland were Hardman, Kinahan, Symes, and O'Kelly. Kinahan became District Surveyor under Jukes, and Baily, who had been transferred from the English staff, acted as Palaeontologist. The Irish Survey had their headquarters in Dublin and had no very close connexion with the British Survey except that the Director General visited them several times a year and inspected the field work. After 1867 and 1868 there was an increase in the Irish staff, and in 1875 it comprised a Director, District Surveyor, four geologists, nine assistant geologists and two fossil collectors. In the galleries of the Royal College of Science the Irish Survey exhibited a large collection of rocks and fossils to illustrate the geology of Ireland and these were constantly being added to as the field work progressed.

Very wisely Hull made no radical alteration in the methods of mapping and publication that had been employed by Jukes. They were, in fact, as satisfactory as any that could be devised in the circumstances and as good as, or better than, those followed at the same time in England and Scotland. The work went forward efficiently and at an even pace, usually four or five of the small Irish maps being published each year. The descriptive memoirs followed after short intervals. By 1881 only 30 of the 205 maps which represent Ireland on the one-inch scale remained to be published (mostly Donegal and Londonderry).

Review of achievements

In 1881 Ramsay retired at the age of 65 ; on his retirement he was knighted. For some years he had been less vigorous both physically and mentally than in the early days when he worked with such energy in North Wales. The second edition of his North Wales memoir involved a great deal of work. It was finished and published in 1881 and marks the end of his official labours.

Ramsay was a great field geologist and as he became older he was especially interested in the development of scenery, in physiography and in glaciation. He took little interest in petrology, regarding it as futile 'to study mountains through a microscope.' In palaeontology also he was never versed, but he knew how to make a map and how it should appear when it was published. To Ramsay more than anyone is due the great excellence of the Old Series map of England and Wales. Compared with the most recent maps they no doubt appear sketchy and incomplete, but we must remember that in their day they were admitted to be the best geological maps of any country that had been published up to that time. They set a standard which other Surveys strove to attain or to excel, and even to-day many of them are exceedingly useful. Some of the most recent revised issues show no very great improvements except in the coalfields and in the classification of the Drifts. They were accompanied by a magnificent series of Horizontal and Vertical Sections which are models of drawing and colouring that have never been surpassed.

Ramsay was no doubt very fortunate in his assistants. Such men as Jukes, Aveline, Howell, Bristow, Woodward, Whitaker, Geikie, Green, Peach and Horne were geologists endowed with natural gifts of the highest order. Ramsay made the fullest use of them and both by example and precept he trained

them and stimulated them to produce work of the best quality. The standard of work was always getting better and better. This was partly the natural consequence of the increase of knowledge and experience which the surveyors obtained year by year. It was also due to the general advance in the study of British geology, petrology and palaeontology. Better maps were being called for and were being produced. The teaching of geology in the Universities was advancing rapidly, and Ramsay made frequent journeys on the Continent and kept in touch with geological colleagues in other lands. The Geological Survey was a great school for training geologists. At various times the Professors of Geology in Oxford, Cambridge, Manchester, Edinburgh, Glasgow, Dublin, Newcastle-on-Tyne, Leeds and London had previously been members of the Geological Survey staff under Ramsay. Other surveys had been established by or had received additions of seasoned geologists from the British Survey. In India, Canada, Victoria, Queensland and Kashmir men who had served under Ramsay and Jukes were filling important posts as Directors of Geological Surveys. The loss of highly trained and most capable assistants was one of the difficulties which Ramsay, like his predecessors, had constantly to face, and at the same time it caused delay to the progress of the maps by the necessity for training the young recruits. A better class of men, however, was now being obtained from the Universities and the probation period was considerably shortened.

The Museum of Practical Geology in Jermyn Street was in its higher state of efficiency about the time when Ramsay retired. Up to the year 1877 Huxley had continued to attend to the exhibits of British fossils, adding sometimes two thousand specimens to those displayed in the cases, while his assistants, Etheridge and Newton, did most of the determination of the fossils. The economic mineralogy, ores, veinstones and mining models were under the curation of Warrington Smyth and were as complete and satisfactory as the space permitted. Building stones, British rocks and geological maps were adequately represented, and Ramsay himself took much interest in this work. He had prepared three editions of the 'Catalogue of Rocks,' adding explanatory notes on most of the specimens. In this work he had the assistance of Bristow, Bauerman and Geikie. The third edition appeared in 1862. Till 1880, when he resigned, Percy had charge of the exhibits illustrative of Metallurgy.

The most notable addition to the collections that are contained in the Museum of Practical Geology by the generosity of private donors is the Ludlam Collection. It was bequeathed by Mr. Henry Ludlam in 1880 and transferred to the Museum in that year. Mr. Ludlam was in business as a hosier at No. 174 Piccadilly. A bachelor, he had spent large sums of money in the purchase of minerals, British and foreign, which were preserved in ornamental cabinets in the house which he occupied above his shop. For many years he had been the principal private purchaser of mineral specimens in Great Britain and was in constant communication with the officers of the Museum of Practical Geology, especially with Mr. F.W. Rudler, the Curator. In 1872 he had purchased the collection of Mr. William Nevill, of Godalming, including a series of meteorites. He had also acquired the collection of Mr. Charles Hampden Turner, of Godstone, Surrey. Catalogues had been made of the Nevill and Turner collections, and had been printed, but at the time of Mr. Ludlam's death there was no catalogue of the Ludlam collection. The specimens included in the bequest are about 20,000 in number and many of them are exceedingly fine. In particular there are beautiful specimens of Cornish and other British minerals obtained at a period when the tin, lead and copper mines of Britain were in a state of great activity; as most of these mines have been shut down long ago, specimens of this character are now rare and precious. As soon as possible Rudler arranged that selected suites of specimens from the Ludlam Collection should be displayed in special cases in the Museum of Practical Geology, where they made one of the most attractive features of the exhibits and received much attention from the public and from scientific mineralogists.

Twenty years afterwards, when Rudler retired in 1901, he spent many months in preparing a great series of British Minerals from the Ludlam Collection and wrote a handbook on the exhibits, a labour

of love which only the exacting nature of his official duties had prevented him from performing at an earlier date. This series, in a modified form, is on exhibit in the new Museum.

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