

# 1920 Flett succeeds to Directorship - Geological Survey of Great Britain (by E.B. Bailey)

From Earthwise

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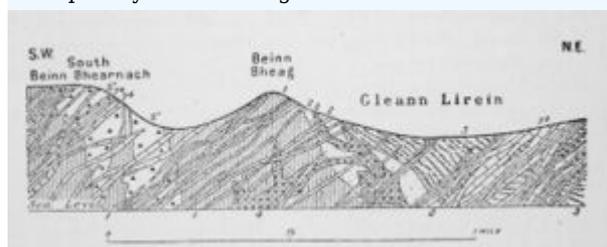


Figure 33 Flank of Loch Spelve anticline, Mull. 1, Moine Gneiss; 2, Mesozoic Sediments ; 3, Tertiary Basalt Lavas ; 4, Gabbro ; 5', Vent Agglomerate; 7a and b, Acid and Basic Cone-Sheets. (Quoted from Bailey, Mull Mem., 1924, p. 237).

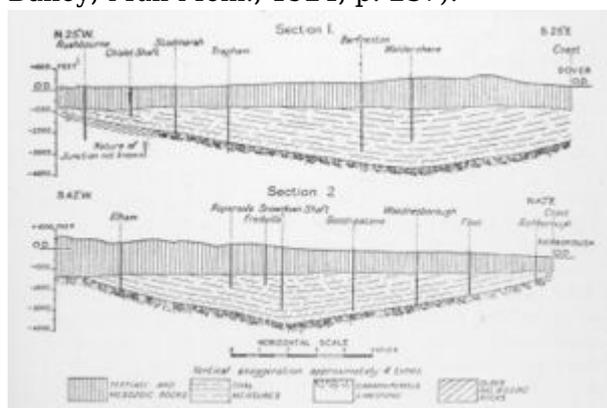


Figure 34 Horizontal sections across the Kent Coalfield. (Quoted from Dines, Sum. Prog. for 1932, pt 2 p. 22.)

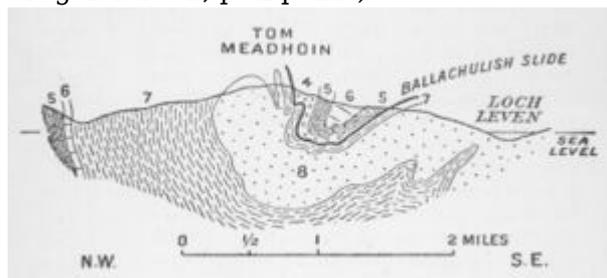


Figure 35 Section showing relation of Ballachulish Slide to Tom Meadhoin Fold. The Dalradian Schist formations are now

known to be increasingly old from 4 to 8.  
 (Quoted from Bailey, Ben Nevis and Glen  
 Coe Mem., 1916, p. 42.)

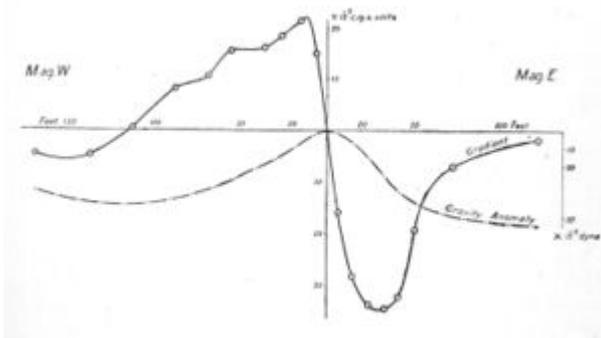


Figure 36 Components of corrected gravity gradients parallel to line of traverse across Swynnerton basalt dyke. (Qoted from McIntock and Phemister, Sum, Prog. for 1927, pt.2 p.7



Plate 4. Museum of Practical Geology. Top: Jermyn Street, main floor with two galleries above Lecture Hall. Bottom: South Kensington, ready to receive exhibits.

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## 1920 Flett succeeds to Directorship

John Smith Flett took over from Strahan in the second year of peace, 21st July, 1920. Howe at the same time followed Lamplugh as Assistant Director for England and Wales, since the latter, like Strahan, had passed the 60 year limit. The vacancy left by Flett in Scotland was filled by Gibson.

As a result of the representations of the Geological Survey Board the scientific establishment was now increased by sixteen fieldsmen to meet pressing coalfield and other economic needs. There should have been corresponding additions to the indoor staff, paleontological and petrological. Subsequent calls for help from the fieldsmen have in their multitude proved very difficult to answer, even with the assistance of outside experts. Still, the progress made as a result of the post-war influx has been very satisfactory.

By 1922 there were twelve officers of District Geologist rank: T. C. Cantrill, R. G. Carruthers, B. Smith, H. Dewey, W. B. Wright, C. E. N. Bromehead (in England and Wales) ; E. B. Bailey, M. Macgregor, C. H. Dinham (in Scotland) ; H. H. Thomas (Petrographer), F. L. Kitchin (Paleontologist) and W. F. P. McLintock (Curator and Librarian). Under these there served 38 Senior Geologists and Geologists (including an Assistant Curator). In addition, there were Technical and General Assistants, Draughtsmen, labourers, warders, messengers, cleaners, carpenters and charwomen.

McLintock, whose appointment is listed above, originally joined the Survey as Assistant Curator in 1907 ; but in 1921 he transferred to the Royal Scottish Museum where, since Goodchild's death in 1906, the care of the geological gallery had ceased to be a Survey appointment. His return was opportune, for he was destined to play a distinguished part in the transfer of Survey Headquarters from Jermyn Street to South• Kensington, an operation which, as we shall see, presently became Flett's outstanding contribution to Survey life. McLintock in later years followed Smith and Bailey as Director.

We may further anticipate by cataloguing the changes that occurred on the Assistant Director and District Geologist levels before Flett retired in 1935:

*Assistant Directors:* 1925, Gibson retired ; Macgregor promoted (Scot.); 1931, Howe retired ; Smith promoted (Eng.).

*District Geologists:* 1925, J. E. Richey promoted (Scot.) ; 1927, Cantrill retired ; Dinham transferred to England ; 1928, G. V. Wilson promoted (Scot.) ; 1929, Bailey resigned (Scot.) ; 1930, T. Eastwood promoted (Eng-) ; 1934, Kitchin died (Paleontologist) ; J. Pringle promoted, 1935 ; Thomas died (Petrographer) ; J. Phemister promoted.

It will be noted that after Bernard Smith's promotion in 1931 there was an unfilled vacancy among District Geologists.

The rapid post-war recruitment did not introduce all the difficulties that would have attended such a move in normal times. There were in the post-war demobilisation pool several candidates who had already graduated in Geology, or could do so within a short period. The Geological Survey Board as one of its first moves had laid down that, in general, candidates for the Survey should have completed a ' University course for a Degree in Science with Honours in Geology.' It has been very exceptional for any but a first class honours graduate to be accepted since.

Quasi-simultaneous bulk enlistment did, however, lead to unevenness of promotion in after years. This applied even in regard to advancement to the grade of Senior Geologist, which was now firmly established, though, unfortunately, with an unsympathetic limit as to numbers. On the other hand, pay and allowances were improved, to bring conditions into line with those of other branches of the Civil Service.

The change was greater than was required to counterbalance increased cost of living, and helped to introduce early marriage and a desire for settled winter quarters.

## District offices

The increase of staff could not be accommodated in the two existing Headquarters. It was decided to institute branch offices in certain coalfields, each in charge of a District Geologist. Soon the following dispositions were made:\* Newcastle under Carruthers to serve Northumberland and Durham.

- Whitehaven under Smith to serve Cumberland.
- York under Bromehead to serve Yorkshire. Manchester under Wright to serve Lancashire.
- Newcastle was placed under the Assistant Director for Scotland ; the remainder, under the corresponding officer for England.

Opinions differ as to the balance of advantages that have accrued under this District Office arrangement. The gains are the more obvious, but the losses may be the more important. The former include all-the-year-round contact with the coalfield concerned. This does not help in field-work, but it is an important matter in watching bores, consulting mining plans and making underground examinations—and perhaps, above all, in maintaining personal relations with colliery staffs. The difficulties can be listed under two headings:

1. *Instability.*—A field unit, given a special task to overtake, generally moves on after a comparatively few years. Thus the Whitehaven office was closed in 1927, and the York office in 1938. Since then the staffs of these two units, with new objectives, have been based on the London office, enlarged in 1935.
2. *Isolation.*—It is not good training for a small group of young Geologists to be isolated, with their attention concentrated upon one branch of geological research, and with deficient library, laboratory and personal aids. In his early years a Geologist should be given a variety of experience with transfer from one District Geologist to another. This is easy if the District Geologists concerned share headquarters, since the indoor work of the transferee can be regulated by arrangement ; but any general attempt to carry out such a policy with a multitude of headquarters is bound to fail. Cognate with this trouble is the reluctance a Director must on occasion feel when faced with the proposition of moving an experienced Geologist of special aptitude from one district to another. The move may be desirable from the Survey point of view, and yet it may involve uprooting a household and upsetting the education of a young family. Accordingly, in practice, a newly enlisted Geologist is likely to be sent by accident to fill a vacancy in some outlying branch office, and there remain until, if he deserves it, he is promoted to be District Geologist and goes elsewhere. Not only is his experience very limited,

but the staff he is eventually called upon to lead probably regard him as an intruder with much less knowledge than they themselves possess.

The correct answer to the winter quarter problem lies, I am convinced, midway between over-centralisation and over-dispersal. Scotland is properly accommodated. England and Wales should have at least two, likely three, headquarters. Each of these should cater for a group of District units, with adequate library and other ancillary support, and with a varied menu of geological interests. In Scotland, since 1902, almost every Geologist has had two very different areas in hand, highland and coalfield, according to the season ; and experience has shown that the result is good.

## **District organisation disregarded**

From 1926 to 1929 and again during 1933 and 1934 Flett, on a small scale, threw District organisation overboard. His object was twofold. He wanted to accelerate mapping in the north of Scotland, including part of Sutherland, the Orkney Isles and the neighbourhood of Mallaig in Inverness-shire, and also to widen the experience of some of his coalfield Geologists of the North of England. Accordingly he sent picked men from York, Manchester and Newcastle to do part-time summer work with their Scottish colleagues. The result was a nightmare for the District Geologists concerned north of the Border. Team-work of a district unit, both in the field and in publication, depends in large measure upon day to day exchange of ideas *during the winter*. Such consultation was of course impossible for members of a team dispersed between two, three and sometimes four winter quarters.

As regards Orkney, where the geology is very simple, the result was successful. The maps appeared in 1932, and the inclusive memoir in 1935. This was largely due to Flett's personal knowledge of the district. He supplied the petrographical chapter of the memoir, as well as a considerable measure of coherence and driving power throughout. As for the Sutherland rush, it attempted to clean up mapping which had been started and dropped on many previous occasions. We can at any rate say that it provided some of the material with which H. H. Read had to cope in producing a memoir that, as we shall presently see, appeared in 1931. The Mallaig effort was a *de novo* operation, faced with splendid opportunities coupled with normal Highland difficulties. Its completion, entangled in the Second World War, has not yet been accomplished.

## **Speeding publication**

Criticism has just been offered of Flett's readiness to disregard the requirements of team-work organised under District Geologists. It is pleasant to recall other experiments, more or less on lines laid down by Teall, which, though unpopular with his staff at the time, have since won gratitude.

The staff almost always resents publication of a colour-printed edition of a one-inch map, unless preceded by special revision to bring the mapping up to the most recent standard of excellence. It is apt to forget that the public should not be kept waiting longer than necessary for information already in hand. A case in point is afforded by the one-inch maps of the Scottish Southern Uplands. Between 1923 and 1933 Flett arranged for colour-printing of nine one-inch maps of this region, carrying the results of the famous revision made by Peach and Horne some 45 years earlier. Only three of these sheets, dated 1889-93, were as yet available (hand-painted) in revised form ; while the remainder, dated 1871-79, were in the old style. Admittedly the 1889-93 maps were much the most important of the lot, and were supplemented by a 10 mile to the inch map in the 1899 Silurian memoir ; but it is a great thing that Flett released the remainder, while directing his staff to country which was either unmapped or much more in need of revision than the area concerned.

Similarly between 1921 and 1933 Flett somewhat eased the situation in the South of England by issuing a dozen colour-printed sheets based on partial revision. The favoured districts include Ramsgate, Brighton, Shaftesbury, Marlborough, Cirencester and Ipswich. Corresponding sheet memoirs were supplied by outside experts, Osborne White, L. Richardson and P. G. H. Boswell. In 1929 he also published a colour-printed map of Stonehaven on the east coast of Scotland. The land area covered by this sheet is very small, but geologically very interesting. It had been revised in detail by Robert Campbell, of Edinburgh University.

Perhaps we should have pointed out before now that the Ordnance Survey restarted colour-printing for the Geological Survey in 1919, and the following year produced a colour-printed geological map of Anglesey as a whole. A two-volume memoir had already appeared in 1919. This Anglesey map and memoir were the work of E. Greenly, who had been a member of the Geological Survey under Peach in the North-West Highlands from 1889 till his resignation in 1895. Thereafter he devoted himself to an unofficial six-inch geological survey of Anglesey. His work was gladly accepted by Teall and Strahan for Geological Survey publication. It is of a very high standard, though, as is usual in relation to an area of schistose rocks, it has raised as many problems as it has solved.

## Field work and publication

At the start of Flett's directorate not much less than half the energy of the Survey was devoted to finishing Strahan's *Special Reports on Economic Resources*, and most of the remainder to coalfield revision. Work on the former soon dwindled, while that on the latter increased. Four English coalfields have already been specially mentioned as the sites of the new District offices. In addition broad areas were under revision in the Midlands of England under Cantrill and in Lowland Scotland under Bailey and Macgregor. The only English unit working with very minor coalfield attachment was that engaged on London and South-East England under Dewey. Even this made the first official survey of the concealed coalfield of Kent.

In Scotland, during 1919, Read alone was engaged in the Highlands. He had been invalided out of the Army in 1917 after combatant duty in Gallipoli ; and had been sent next year by Flett to revise, on the six-inch scale, two one-inch sheets covering parts of the shires of Banff and Aberdeen—originally mapped in the bad early eighties on the one-inch scale. His welcome new maps with an inclusive memoir appeared in 1923. Meanwhile, in 1920, having finished part of the field work connected with this task, Read was placed in a unit stationed in Sutherland, at first under Macgregor, later, in 1926, under Richey. Its task of cleaning up, to which allusion has already been made, involved three one-inch sheets. One of these had been published hand-coloured in 1896 without a memoir ; while the other two, started in the '80s, had never been completed. The resultant maps and memoirs appeared in 1925 and 1931, with Read as main author. They furnish a very valuable account of his views on the age and metamorphism of the Moine sediments, and on granitisation, a subject never more discussed than at the present time.

While the work was proceeding in Sutherland during the summers of 1920-23, another Scottish unit under Bailey finished the parts of Mull falling outside the main one-inch sheet already completed. It also surveyed neighbouring islands and the western part of Ardnamurchan. In the latter a Mull-like centre of Tertiary igneous rocks was mapped by Richey.

In 1924 and 1925 the Highlands were given a complete rest, so far as field work was concerned. This did not mean abandonment of Highland geology, for writing up of pre-war results, supplemented by what had since been accomplished, occupied much time indoors.

There was of course a glut of delayed publication to be dealt with, both in London and Edinburgh, the maps and memoirs of South Wales were completed, except for new editions, by 1921. The

corresponding publications for North Wales started to appear in 1923, and continued until 1929. There were also non-economic memoirs to finish and produce. Among these the most important dealt with the volcanic history of Mull. Team work in this island had been carried on from 1907 to 1914 by nine fieldsmen, most of them only very minor participants, supported by Thomas as Petrographer ; and it had revealed a truly fascinating story. Flett's opinion of it may be gathered from the following quotation taken from his *First Hundred Years of the Geological Survey of Great Britain*:

No part of Britain has proved more complicated than Central Mull, and the intricacy of the structure was often too great to be represented even on the six-inch maps. The history of the Mull volcanoes, and of the various stages through which their activity passed, makes one of the most wonderful chapters of the geology of Britain. Not only was the sequence of lava eruptions and of intrusions exceedingly difficult to decipher, but the tectonics also were of types not previously recognised. When the geological work on Mull was completed and the maps and memoirs issued, it was universally admitted that new lustre had been added to the records of the Geological Survey of Scotland. For originality and thoroughness the work carried out by Clough and Bailey in Mull is fit to stand comparison with the work done under Horne and Peach in unravelling the history and structure of the North-West Highlands. It was also an appropriate sequel to Harker's notable achievement in the survey of the southern part of Skye.

Before joining up in 1915 I had prepared a skeleton memoir on Mull. On my return in 1918 this skeleton had to be filled in with the help of my colleagues ; and the map, which on account of its detail is regarded by the Ordnance Survey as their prize production in colour-print, had to be seen through its various stages. The map appeared in 1923, and the main Tertiary and Post-Tertiary memoir in 1924, followed by a Pre-Tertiary memoir in 1925. Flett played an important part in securing proper time for the field and indoor work, mostly carried out while he was either Assistant Director or Director. He had the further satisfaction of helping forward Survey publication of memoirs on two other great Scottish centres of Tertiary igneous activity, Arran, 1928, and Ardnamurchan, 1930. The former was entrusted to G. W. Tyrell, of Glasgow University, and may be regarded as a second edition of Gunn's North Arran memoir of 1903. The latter was prepared by Richey with petrological collaboration by Thomas. These last two authors in their private time also gave excellent accounts of the Mourne Mountains and Slieve Gullion, corresponding Irish centres. Richey thus became our foremost investigator in the field of British Tertiary igneous activity. As for Thomas, his services to Petrology have been great indeed among the Tertiary volcanoes of both Scotland and Ireland and their Early Paleozoic forerunners in Wales ; but our first thought of him always conjures up the sacred circles of Stonehenge. In 1920, on the invitation of the Royal Society of Antiquaries, he undertook an examination of the so-called 'foreign' stones, long a subject of inquiry; and he recognised them as transported from the far away Prescelly Mountains of Pembrokeshire, a truly enduring monument to human skill and devotion.

There is space for little more concerning the rich harvest of publication characteristic of Flett's regime. The survey of the completely concealed coalfield of Kent, which was started in 1930, is specially noteworthy since it broke new ground, so far as official investigation was concerned. Its results are clearly set out in Part ii of the Geological Survey's *Summary of Progress* for 1932. (The practice of publishing selected scientific papers gathered together in separately issued *Parts* of the *Summary*, and not merely as *Appendices*, began in 1927.) Here H. G. Dines deals with sequence and structure, while R. Crookall and C. J. Stubblefield respectively cover fossil plants and animals.

Coal had first been raised in Kent in economic quantities in 1913, but the establishment of the coalfield may be said to date from the early 1920'S. Previous to the passing of the Mining Industry Act of 1926 there had been great difficulty, in 'obtaining accurate information regarding the circumstances of the field. The Survey had, it is true, been able to publish two very important

memoirs, in 1911 and 1923, dealing with the Mesozoic cover as revealed by boring ; but it could produce nothing regarding the Coal Measures themselves beyond copies of such records as had already appeared in print. Most of its 1932 report is based upon information previously withheld, but now voluntarily placed at its disposal.

A memoir on another and more important concealed coalfield, the eastern continuation of the exposed coalfield of Yorkshire and Nottinghamshire, reached a second edition in 1926, written by G. V. Wilson. The first edition, 1913, had been by Gibson ; and a great deal of exploration had occurred in the interval.

Speaking generally of the coalfield revision of the Survey, one may say that it has been done without the hurry of former days. The original surveyors had aimed at obtaining as much information as could speedily be issued in maps and memoirs, and they had in many parts of England and Wales to work on one-inch maps. It is true that they filed a number of bore records additional to those intended for publication ; but it was physically impossible for them to aim at anything approaching completeness. During Teall's time till today, the surveyors have striven more and more after completeness. They have also in many cases maintained contact with colliery manageffients after satisfying the immediate publication programme. Moreover, since the passing of the Mining Industry Act, two Assistants, one in Scotland, where coal boring is particularly prevalent, the other in England, were appointed to watch bores put down in ground not currently allocated to a particular Geologist. They were, in my young days, nicknamed Boa-constrictors, and have proved invaluable. I have seen, as the years passed, coalfield after coalfield rescued from the Survey's half-forgotten past ; and I believe that the time is at hand when the decennial revision of active coalfields, asked for by the Coal Conservation Committee of 1906-7, will be more than achieved. Indeed, I think that, if individual Geologists were entrusted with the supervision of highly skilled Assistants, not merely decennial, but perennial, revision might be successfully attempted.

Hand in hand with more meticulous co-ordination of mining information has gone unhurried examination of field exposures and increasing attention to fossil evidence. This has proved particularly valuable to the mining community, which left to itself has seldom the specialist training for such studies, though increasingly conscious of their value, particularly in the interpretation of deep expensive bores. Outside experts, such as Kidston among plants, Bisat among goniatites, and Trueman among non-marine lamellibranchs, have given every assistance to the Survey in their daily work, besides blazing the trail. Gibson, as we have already seen, did more in his English days than any other Survey contemporary to bring home to the mining fraternity the value of fossils and fossil experts. In later years all Field Units, perhaps especially those engaged in Lancashire and Yorkshire, have had conspicuous success in their employment of palxontological guides. In this connection Wright will long be remembered as a leader.

Kidston has been mentioned repeatedly in these pages. He was for many years unofficial Palobotanist to the Survey.

He undertook the naming of current collections, thus securing for himself much additional knowledge. He also started a great Survey memoir on *The Fossil Plants of the Carboniferous Rocks of Great Britain*, of which the first parts appeared in 1923. He died suddenly in 1924 while gathering further material in South Wales. He had been so impressed with the value of the Survey as a home of research that he bequeathed to it his own magnificent collection of plant impressions along with much supporting material. The whole constituted, according to Flett, ' the greatest single acquisition which the Survey's collections have ever received,' high praise indeed ! It is still being worked over by Crookall, the Survey's official Palxobotanist, appointed largely to complete Kidston's great monograph.

It must not be supposed from anything which has been said above (when District offices came under criticism) that a Survey Unit engaged on a coalfield is likely to be confined to Coal Measures. As a rule it completes each one-inch sheet that it enters, and thus obtains an invigorating and healthy variety of experience. Then there are the ubiquitous problems bequeathed by the Quaternary. The Cumberland Unit found these particularly interesting. It had a relatively small coalfield to cover ; and presently part of the staff moved on to tackle the famous hematite field in adjacent Carboniferous Limestone—already described in considerable detail by their District Geologist, Bernard Smith, in a *Special Report*, 1920. Others of the unit made a long migration to the coalfield of the Forest of Dean, near the borders of South Wales.

The Southern Unit in the main dealt with the Cretaceous and Tertiaries of South-East England ; but Dines from 1925 spent some of his time in the metalliferous field of Cornwall. He has already been mentioned for his work on the Kent coalfield.

In 1923, a novel publication was entrusted to this Southern Unit, to cover London with colour-printed six-inch maps. The London County Council proved extremely co-operative, and by 1935, the year of Flett's retirement, is out of a projected total of 42 quarter sheets had appeared.

## **A problem of scientific liberty**

Here perhaps I may be permitted to return to a subject already introduced in connection with Horne's administration as Assistant Director for Scotland. Flett, when he succeeded to Horne's position and later when he held the Directorship in London, claimed that all scientific writings of the staff, which were intended for unofficial publication, should be submitted in advance for official permission. He sought, in fact, to abrogate the previous custom that scientific writings dealing with districts not on the official publication programme were free of this restriction ; and I refused to give way.

I want it to be clear that no question was raised of my having at any time unfairly anticipated official publication, or stolen a march on a colleague, or indulged in unseemly criticism. My two faults came under two headings

1. In certain interpretations of the Highland Schists my work was, in Flett's judgment, mistaken.
2. I publicly reinterpreted districts already covered by the Survey and not as yet included in its official programme for revision.

In both these directions Flett considered that I brought discredit upon the Survey.

Flett thought that I was a useful officer in coalfields and among igneous rocks; and I have no complaint that from 1924 to 1929 I and my unit were not sent to the Highlands. Admittedly it may seem strange to outsiders that Flett during this time could think that he would get better understanding (if the Devil may so quote scripture) from babes and sucklings<reference>My reference to babes and sucklings must be read in its context. The men selected were among the best the Survey has ever been fortunate to possess.</reference> brought from the North of England to work under conditions that precluded adequate training or supervision ; but the reason is simple. Flett had noticed that several workers (myself the latest example), who had spent a considerable time in the Highlands, had produced theories upon which no agreement could be reached. He concluded that we had lost perspective through close contact with local difficulties, and that the stratigraphical and tectonic problems we conjured up were in essence imaginary. To him, looking on from a distance, the main issues seemed perfectly straightforward ; and he considered that the best results might be expected from temporary employment of Geologists who had not become infected with the malaise of the district.

It is only fair to add that Flett partly inherited his distrust of my Highland interpretations from Horne ; but Horne had frankly said he was too old to test them himself, and, after getting Clough and Maufe to check them in the field, he had acquiesced even to official publication. Furthermore, from time to time, I made important mistakes, for instance, the one already mentioned in regard to the stratigraphy of the Loch Leven area on the borders of Argyll and Invernessshire. I remember asking Carruthers, to whom I am especially grateful for correction in this matter, whether his reinterpretation of Loch Leven led him to doubt my interpretation of Ballachulish, the key area of the district as a whole. His reply was: ' Certainly not ! Any damned fool could have worked out that country.' This was reassuring. Still, the fact remained that I had made mistakes; a fact that necessarily influenced onlookers.

Much more difficult to understand was Flett's announcement to me, soon after my return from the War, that Read's researches under his guidance in the East Highlands during the past two seasons had shown that my reading of Ballachulish and Fort William in the West was wrong ! I marvelled at this feat of television, but obtained permission for Read to accompany me to Fort William—where, to Flett's regretful surprise, he reported that he saw the local geology exactly as I and others had seen it in the past.

During my official separation from the Highlands, whilst busily pushing forward the mapping and description of the Ayrshire coalfields, I was still able year by year to spend a fortnight of my holidays revising chosen localities. Careful preparatory study of field maps made by past members of staff allowed of wonderfully profitable concentration on critical exposures. To stop this an order was issued that, while Survey field maps were open to inspection by the general public, they were only to be shown to a member of staff after permission had been granted by the Director. It was obvious that I must look elsewhere for scientific opportunity. I applied for the Chair of Geology at Glasgow University, left vacant by Prof. J. W. Gregory's retirement, and was accepted, starting work 1st January, 1930. Though in the next seven years I often found it extremely hard work attempting to do justice alike to my duties as teacher and researcher, I felt continually grateful, for my scientific life had been saved.

I recognise the difficulty attaching to the subject which has just been outlined in relation to a particular case. I believe that most readers will hold that Flett correctly interpreted his duty and that a Civil Servant should surrender all right to independent publication. I hope not, for, as I have said already, if this comes to be the acknowledged rule, the chance of tempting a true scientist into the Civil Service will vanish, except in wartime.

## **Underground water**

Three special aspects of Flett's directorate, concerned with Water, Agriculture and Geophysics, remain to be considered before we turn to his creation of a new Museum and Offices.

Flett soon reinvigorated publication of Water Survey memoirs, which had slackened during the War. At first he was able to rely upon a continuation of outside help from Whitaker ; but after the latter's death in 1925 he turned to an entirely non-Survey expert, L. Richardson. These two authors, Whitaker and Richardson, supplied five each of the twelve memoirs produced. A regrettable feature is that rainfall now received little or no attention. This falling away was probably connected with Mill's famous ' gift of British weather' to the nation, which dated from 1919. Previously, as a private individual, Mill had organised a vast unpaid British Rainfall Organisation, which from 1860 onwards published annual reports. In 1919, however, Mill stepped down, feeling the weight of years, and his organisation was gratefully taken over by the Meteorological Office of the Air Ministry.

Whitaker's last two memoirs, on Wiltshire, 1925, and Dorset, 1926, were posthumous, and appeared

as joint-publications with Survey authors, F. H. Edmunds and W. Edwards, respectively. The two junior authors were sent for a considerable time to the field and told drastically to edit and condense Whitaker's compilations. This was in part determined by a desire to reduce the price of the finished article in view of high post-war printing charges. It was also in part due to an increasing realisation that unchecked records of wells that have been sunk through ill-defined strata are apt to be misleading, if presented verbatim to an innocent reader who may think that he should believe everything he sees in print. The restraint and selection exhibited in these two memoirs were maintained in their successors of the Flett period. Another valuable feature was the introduction in every case of a helpful geological map.

It will be remembered how from 1874 to 1895, that is during most of Ramsay and Geikie's director-generalships, a committee of the British Association, with Hull in the Chair and De Rance as Secretary, had investigated circulation of underground water. There is little doubt that its activities materially helped such members of the Survey staff as sought to foster official publication of data bearing on the subject. A milestone along this path is, of course, Geikie's 1899 inception of *County Water Supply* memoirs, which, as we have seen, prospered greatly under his successors. Concurrently there were several public inquiries into various aspects of water, mostly surface water, involving, for instance, salmon, sewage and power.

Following its York meeting in 1932, the British Association appointed a further committee, including Bernard Smith, recently promoted Assistant Director of the Geological Survey for England and Wales. Its function was to inquire into the position and prospects of an Inland Water Survey of Britain. It came to the conclusion that a central organisation was desirable, controlled perhaps by the 'Department of Scientific and Industrial Research. The appositeness of the inquiry, we may interpose, was emphasised by severe drought during 1933 and 1934.

In the latter year a joint deputation of the British Association and the Institute of Civil Engineers put the case before the Minister of Health. As a result, the Government decided on an Inland Water Survey Committee, which was appointed in 1935 by the Minister of Health for England and the Secretary of State for Scotland. Its object, as explained to Parliament, was to collect and correlate reliable records dealing with rivers and underground waters. The rivers were to be cared for by the two Ministers mentioned above, but as regards underground water the Committee thought:

The work of examining and securing the amplification of the information on this subject could best be done by the Geological Survey who have on their staff persons with the necessary knowledge and experience. We [the I.W.S. Committee] are therefore glad to report that the Committee of the Privy Council for Scientific and Industrial Research have agreed that the Geological Survey should assist in the work.

This statement appears in the First Annual Report of the Inland Water Survey Committee, of which Sir Henry Lyons was Chairman, and was published in 1936, the year after Flett retired. It shows the position reached at the end of his reign.

Public acknowledgment of the Geological Survey as keeper of the national records of underground water gave both additional responsibility and additional strength. Edmunds, Who was already author or joint author of two Water Supply memoirs, was entrusted with the work that resulted from the Geological Survey's association with the Inland Water Survey Committee.

# Agriculture

An intimate relation between soil and underlying material, whether solid rock or drift, is often self-evident ; so much so, that it seems incredible to a British geologist that a useful soil map of any considerable stretch of our country will ever be made by a worker unversed in the principles of Geology. In some cases the connection is crystal clear, as in the district covered by A. D. Hall and E. J. Russell in their delightful *Report on the Agriculture and Soils of Kent, Surrey and Sussex*. This, after completion at Rothamsted, was published in 1911 by the Board of Agriculture. Its authors found the Geological Survey map all that could be desired as a basis for their descriptions.

In other districts, however, the connection may be very elusive. For instance, the distribution of under-soil material may be complicated, in which case a geologist tends to generalise, and to include several lithological types in one of his mapped divisions ; or, again, trouble may arise through a geologist entirely neglecting what is for him a mere surface film, whereas for a soil expert it may be the very stuff that matters. Moreover, much material may be introduced into a developing soil, by wind, water, or organisms (including farmers), which is not derived at all from the underlying formation—although the latter may be mistakenly credited with the role of a parent ; and, equally, much may be selectively removed.

It is often thought by optimistic agriculturists that the Geological Survey could make soil maps in its spare time ; but geological surveyors know that to prepare a creditable soil map of the country as a whole, even when geological maps of solid and drift are everywhere available on the six-inch scale, will be a most formidable task. It will require skill in field and laboratory techniques, and a knowledge of living creatures, of a quite non-geological character.

.Some Survey geologists of pre-Flett times, for instance Kilroe and Woodward, and further back, but above all, Trimmer, felt particularly strongly the natural appeal of soil. Flett did much to foster this sentiment in his staff. He was himself stimulated by Sir Thomas Middleton, who from 1920-43 represented agriculture on the Geological Survey Board. The net result of several years of sympathetic effort may not seem very impressive ; but probably it has been exactly what was needed and should prove very helpful in the future. Here we can do nothing more than list a few organisational steps, in all of which the Geological Survey participated, often represented by H. G. Dines and J. B. Simpson.

1925. Middleton presided over a conference of soil men. Small field parties of agriculturists and geologists tried cooperative mapping in seven counties. Foreign experts gave valuable assistance.

1926. A series of annual Soil Survey Field Meetings was instituted—' the main purpose is to examine, map and compare the results reached by small groups of surveyors into which those members attending the meetings are divided up, with the object of gaining experience and ascertaining the degree of uniformity that can be reached by separate groups working on a common method.' One result of prolonged discussion this particular year was the provisional adoption of two models of field-auger.

1929. Great advantage was obtained from air photographs.

1930. Middleton attended the fifth Soil Survey Field Meeting. He records that previous sharp differences of opinion as to principles and methods have now given place to general agreement (see below under 1931). A Soils Survey Correlation Committee was established under the chairmanship of Prof. G. W. Robinson, of Bangor.

1931. Various agricultural centres at which soil mapping was in progress were visited by the Soils

Survey Correlation Committee. As regards agreement, we learn that parent material offers the most suitable basis for primary classification of British soils; and as regards previous differences of opinion, we read that 'grouping by climatic regions, such as is being done on the Continent, has not been satisfactorily applied in this country.'

1934. The Soils Survey Correlation Committee was superseded by a Soil Surveyors' Conference. This was furnished with a standing Executive Committee with Robinson again in the Chair. At the request of the Ministry of Agriculture it was agreed that the Geological Survey should continue to be represented.

As a further contribution to agriculture the Geological Survey published two one-inch soil texture maps of Ayrshire, prepared by the West of Scotland College of Agriculture who worked in close touch with the Geologists responsible for the revision of the solid and drift of the area. Cooperation with the Forestry Commission was also arranged in their assessment of soil characters that influence the growth of timber.

Perhaps I may add that in after years I was consulted, as Director of the Geological Survey, on the institution of a Soil Survey. I was very sympathetic to the proposal, and advised that the two Surveys might be expected to give the best results if they operated as independent organisations, linked closely, I hoped, by friendly consultation.

## Geophysics

Flett made a brave start in exploring the possibilities of geophysics from the Geological Survey's point of view. In this he had the enthusiastic support of Sir Francis Ogilvie, during the latter's chairmanship of the Geological Survey Board from 1920 to 1930. In the Board's Report for 1924 we read that consideration had been given at different times to 'the various methods that have been suggested for detection of underground deposits by accoustical, electrical, or gravitational means'; and that of these 'the gravitational method seems the most promising.'

The Anglo-Persian (Iranian) Oil Company, whose Chairman at the time sat on the Geological Survey Board, was anxious for unbiased discussion, and very willingly explained the Company's employment of the Eotvos torsion balance. This is a wonderful instrument devised by an Austrian scientist. It determines the rate of change of gravity from place to place, which, of course, after integration, allows of the mapping of gravity contours. The Company also offered a demonstration under working conditions. Accordingly McLintock and Phemister were sent in 1926 to Persia, where they critically examined and verified observations and deductions of the Company's geophysical staff. On their return they did good service in expounding the theory and practice of the Eotvos balance in the Survey's *Summary of Progress* and from several other convenient housetops.

The next step was to secure a balance for the Geological Survey and to experiment with it on home problems. The work was assigned to the same two skilful operators. The exercises chosen were as follows:—

1927. Basalt dyke cutting Trias marl, Swynnerton, Staffordshire. Result: A traverse across an expected, but concealed, position of the dyke got a clear indication of the d.yke's presence, and a strong suggestion of its inclination.

1927-28. Drift-filled channel aligned with the Kelvin river, N.W. of Glasgow. Result: A rock barrier seems to block what had previously been taken as a buried channel of the Clyde. This result is probably trustworthy and, if so, is of great scientific interest.

1928-29. Pentland Fault, S.W. of Edinburgh. Result: An exact sub-drift position of the fault was suggested, and also certain structural accompaniments. Most of the gravity anomalies detected were ascribed to the presence of the Arthur's Seat volcanic rocks.

1930. Thrussington, Melton Mowbray district (following a magnetic survey, 1929, see below). Result: Gravity anomalies suggested an uneven sub-Trias floor of Precambrian rocks. Precambrian intrusions had been invoked in 1929 to account for magnetic readings, but, if present, could not, by gravity, be distinguished from associated Precambrian sediments. A known fault gave a clear signal.

Partly concurrently with the above gravity surveys, a series of magnetic surveys was undertaken with modern equipment. All except one (1930, an investigation of the Lornty dyke by McLintock and Phemister) were entrusted to A. F. Hallimond:

1929. Swynnerton Dyke (see gravity series, 1927). Result: Sixteen traverses located the dyke again and again under cover, and showed its width and branching and, less certainly, its depth of cover.

1929. Melton Mowbray (it will be remembered that the Geological Survey co-operated in an examination of the already known magnetic anomaly of this district in 1917—see also gravity series, 1930). Result: The position and depth of intrusions, 'possibly granite,' were deduced. These intrusions were considered to belong to the Precambrian floor of the district and to be directly overlain by Trias. The associated Precambrian sediments suggested later (1930) by gravity readings could not, magnetically, be separated from overlying Trias.

1930. Lornty Dyke, near Blairgowrie. Result: This basic dyke could easily be located under shallow cover, and the character of the anomalies suggested an unexpected, and most interesting, distribution of permanent magnetism since confirmed in the laboratory.

1930. Pentland Fault (see gravity series, 1928-29). Result: Rather vague support 'was obtained for some of the deductions of the gravity survey. Lack of detailed agreement is understandable since only parts of the Arthur's Seat volcanics are notably magnetic.

1930. Pipewell, Northamptonshire. Result: The Northampton Ironstone proved to be too weak a magnetic subject significantly to affect the local field.

In 1931 further geophysical exploration by the Geological Survey was suspended. This was partly due to pressure of work in relation to the impending transfer of the Offices and Museum of the Survey to South Kensington ; and partly, I imagine, to misgivings of the new Chairman of the Geological Survey Board. The instruments were accordingly lent for teaching purposes to the Imperial College of Science.

Flett's geophysical venture as a whole has proved of permanent value in that it brought the Geological Survey into contact with a great community of oil and water borers who seek aid from geophysical techniques. It is true that the gravitational work, carried out with the instruments available at the date, but since fortunately superseded, proved expensive both in time and money ; and it is undeniable that similar effort directed to orthodox geological survey in other directions would have given a better harvest of results. Still it was important at the time to have a demonstration in our country by an independent body that geophysical survey is a genuine operation and not mere quackery (there are of course charlatans in the trade). The main criticism that can be offered is, I think, that money ought to have been set aside in advance to check by boring some of the geological deductions that were bound to follow. Comparatively little boring would have added enormously to the educational value of the experiment, for members of staff no less than for outsiders.

Some, perhaps, may think that problems of obvious economic value should have been selected for investigation. It would, however, have been difficult in such cases to have avoided all appearance of favouritism among conflicting interests of private enterprise.

## To South Kensington

In April, 1923, it was found that the roof of De la Beche's Museum of Practical Geology in Jermyn Street required repair. The damage was due to settlement of the foundations. It is quite possible that the trouble started with a German bomb, dropped near at hand in Piccadilly on the 19th October, 1917. Had not some plaster fallen from the roof, it might have escaped notice for some years to come. As it was, to quote from Flett's *First Hundred Years of the Geological Survey*: 'The Museum was at once closed to the public as dangerous, but the staff continued to work in it as usual.'

The Geological Survey Board, in view of all the circumstances, revived a recommendation that had been made by a Departmental Committee in 1912, and pressed for transfer of Survey Headquarters to South Kensington, where a site was available on land purchased from the proceeds of the 1851 Exhibition. Next year, 1924, the Government decided, at least in principle, to adopt this procedure.

As a temporary measure elaborate timber supports were erected in the Museum, and thin sheets of wood were inserted to replace glass in its one-time transparent roof. At last, on the 4th of August, 1925, the building was reopened to the public. To quote again from Flett 'The interior now presented a spectacle such as no other museum in the world could furnish.'

Meanwhile, plans were made for removal, in so far as this matter lay in the hands of the Survey. In 1925 Flett, accompanied by McLintock, visited museums at Copenhagen, Oslo, Stockholm, Berlin, Dresden, Prague, Vienna, BudaPesth, Munich, Frankfurt on the Maine, Strasbourg, Brussels and Paris. They found that those which had been built as museums showed a progressive and advantageous development of plan. They were particularly impressed with the design and furniture of the Riksmuseum at Stockholm and the Deutsches Museum at Munich ; and generally speaking they learnt much of value regarding display, labelling, and illustration of exhibition material, and storage of reference specimens. All the recent museums had abundant ancillary accommodation for storage and research, including laboratories and libraries.

Financial stringency prevented the Office of Works from making any provision in their estimates for 1926-27, and again 1927-28, for the building of the proposed new Offices and Museum. It even came to be questioned whether the Survey required a museum of its own, since paleontology and mineralogy are principal features of the British Museum (Natural History) already at South Kensington. However, in July, 1927, a Royal Commission was appointed to consider and report on the condition and organisation of national museums in London and 'Edinburgh ; and in November it took evidence from Flett, who put forward the Survey case in cogent terms.

After this there was little delay. On the 22nd December the Under Secretary of State for the Home Office announced in the douse of Commons that the Royal Commission had advised the transfer of the Geological Museum to South Kensington at the earliest convenient moment, and that the Chancellor of the Exchequer hoped to give effect to this recommendation as soon as financial circumstances permitted. One last quotation from Flett: 'The period of suspense was over.'

Fortunately the financial difficulties of transferring the Survey from Jermyn Street to South Kensington, when properly faced, proved of much the same obliging character as those which have helped Columbia University in a succession of migrations from the centre of New York. The Government leased the Jermyn Street-Piccadilly site for , 'II,000 a year, which more than recoups it for the , '245,000 expended on new buildings and furniture at South Kensington, on a site, it will be

remembered, inherited from the 1851 Exhibition.

This site, situated on Exhibition Road, in what might fitly be called Princeconsortland, adjoins the British Museum (Natural History) on the west, and the Science Museum on the north ; while to the east it faces the Victoria and Albert Museum, north of which stand the Huxley Buildings, the first to be occupied of a great series housing the Imperial College of Science.

Plans for the new buildings were prepared by Sir Richard Allison and Mr. J. H. Markam, of H.M. Office of Works, and the furniture was designed by other officers of the same department. There was, of course, constant consultation, in which Flett and McLintock played a very prominent part, assisted by Grant Ogilvie. The latter had been successively Director of the Royal Scottish (Edinburgh) and Science (S. Kensington) Museums, before becoming Principal Assistant Secretary of the Department of Scientific and Industrial Research, and, concurrently until 1930, Chairman of the Geological Survey Board.

A start was made at actual building in 1929• By 1931 progress was such that several members of the field staff were diverted to co-operate with their museum colleagues in developing the exhibitional detail of the master plan, since successfully put into operation. According to this, the basement of the new Museum is devoted to workshops and storage; the main floor and two galleries to the display of exhibits (main floor to illustrate principles, first gallery, regions, and second gallery, economic resources); while the top floor, with a superficial area of 16,000 square feet, houses ' reserve and study collections,' and is furnished with tables for the benefit of research workers. Alongside, and with easy communications, stand the library, laboratories, and staff working rooms.

Flett arranged that the regional displays of the second gallery should be made the subject of eighteen *Regional Guides* illustrating the geology of the whole United Kingdom. The preparation of these *Guides* proved very stimulating to their selected authors; and their appearance has been welcomed by a wide public, much wider than that which has easy access to the Museum. The *Guides* rank, in fact, among the Survey's best-sellers.

Building proceeded so satisfactorily that the *Summary of Progress* for 1932 foretold a transfer to be completed in stages during 1933. The prophecy seemed safe, since it was penned in the early months of 1933. Suddenly, however, the Government installed an International Monetary and Economic Congress, thus delaying the entry of the Survey until the beginning of 1934.

On the 3rd of July, 1935, the new Museum of Practical Geology was opened to the public by a great-grandson of the Prince Consort, no less a person than H.R.H. the Duke of York, since crowned George VI. The ceremony was attended by over 1,200 guests.

In the evening of the same day the Geological Society held a reception of delegates and guests in its rooms at Burlington House in Piccadilly. The occasion was particularly happy, for the opening of the new Museum coincided with the Centenary of the Geological Survey. Next day this latter event provided the subject of a special assembly in the lecture theatre of the Royal Geographical Society at Kensington Gore. Lord Rutherford presided, as Chairman of the Advisory Council of the Department of Scientific and Industrial Research. He pointed to the large and representative gathering of scientists drawn from all parts of the world (some 130 from overseas); and found in it a striking testimony to widespread respect and admiration surrounding the British Geological Survey. He might, perhaps, have added affection, for the Survey, with all its faults, still occupies a warm corner in the heart of international Geology.

Flett entered into the spirit of the harvest thanksgiving, and furnished an appropriate *resume* of the long day's work. He was followed by speakers from abroad. Other festivities came later in the day.

After that, Museum and indoor functions were deserted in favour of the field. Three well attended excursions spent a week visiting South Wales, the Isle of Wight and Edinburgh, as the case might be.

Mention of Edinburgh recalls that Flett, in spite of his London preoccupations, succeeded in securing greatly improved Headquarters for Scotland in the form of a mansion in Grange Terrace, Edinburgh, which was occupied in 1927.

## Flett retires

For my own part I never enter the extraordinarily successful new Museum of Practical Geology without a feeling of gratitude to Flett, to whom above all, with the whole-hearted support of his colleagues, the nation owes this great achievement. Very fittingly, having reached the goal of his latter years, he retired on the 30th September, 1935. He had already been knighted ten years previously.

Flett's next concern was to see through the Press an official volume, entitled *The First Hundred Years of the Geological Survey of Great Britain*, which is in no way superseded by the present booklet. He then settled down to produce a new edition of his old favourite, the Lizard memoir. The original edition, published in 1912, had been a joint work with Hill, who died in 1927. Meanwhile, in 1925, Miss E. M. Lind Hendriks had begun an intensive search for fossils, to be richly rewarded by debris of Devonian plants from some of Hill's presumed pre-Devonian formations. The result was specially welcome, since it cleared up part of the uncertainty that attended, and still attends, the dating of wide tracts of De la Beche's killas. Flett checked Miss Hendrik's discoveries during a month spent on the ground in 1932, and produced a most helpful account in the corresponding *Summary of Progress*. A new edition of the map appeared in 1934 ; but a new edition of the memoir had to wait until his retirement gave Flett, during 1937 and 1938, the requisite time for its preparation. Then came a further postponement owing to the paper famine of the Second World War ; so that the date of actual publication was 1946.

Flett also represented the Royal Society at the Jubilee celebrations in Canberra of the Australian and New Zealand Association for the Advancement of Science. 'He had scarcely returned from this antipodean venture when war was declared. He died in January, 1947, after having seen his country once more victorious, though again sadly mutilated.

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