with a large photographic spectroscope, deprived of its collimator, for use in Brazil. In this instrument we had two prisms of 60°. The object-glass was a Dallmeyer portrait lens 5D, aperture 3·25 inches, with a focal length of 19 inches. With this he was able to secure a second series of photographs.

The most important results recorded in 1893 may be stated as follows. We not only determined the wave-lengths with considerable accuracy of some 400 lines in the spectra of the chromosphere and prominences, and studied the distribution of the gases and vapour which gave rise to them, but the separation of the spectrum of the corona from that of the chromosphere was made perfectly clear. J. NORMAN LOCKYER.

(*To be continued.*)

WORK AND PROGRESS OF THE GEOLOGICAL SURVEY.[1]

THE first remark that will naturally occur to a geologist into whose hands this Report may come, will probably be one of satisfaction that the account of the work of the Geological Survey for the past year should have been brought out so early, and in a separate form in which the public can purchase it at a low price. But his pleasant surprise will soon be changed into feelings of another kind when he opens the volume and finds it printed, as heretofore, on poor, flimsy paper and in small, close type, so that the perusal of its pages becomes wearisome to the eyes. There could hardly be a stronger contrast to this style of production than that in which the Reports of the United States Geological Survey are issued. These, alike in paper, type and printing, are truly sumptuous publications placed alongside of the miserable efforts of our Stationery Office. Even Canada can afford to present the Reports of its Geological Survey in a form that should make our authorities blush. It is lamentable to see so much excellent scientific work offered to the world in such miserable guise. The Canadian Reports are not only better printed on better paper than ours, but they are actually sold at cheaper rates. Why cannot the mother-country afford to keep up to the level of her transatlantic colony?

The present Annual Report of the Director-General is the longest and most detailed which he has yet issued. It presents a clear picture of the activity of the Geological Survey over all the fields on which the staff is engaged, and enables the public to follow intelligently the progress of the work in the three kingdoms. The volume, or pamphlet of rather more than 100 pages, is divided into three sections, one dealing with the Geological Survey itself, one with the Palæontological Department, and one with the Museum of Practical Geology in Jermyn-street. The section that treats of the Survey consists of two portions, the first of which is devoted to the general statistics and administration of the three branches of the service in England, Scotland, and Ireland. It is interesting to notice in this, as in former Reports, the large extent to which the work of the Geological Survey is made use of for practical purposes. In different ways geology affords valuable information with regard to water-supply, reservoirs, drainage, soils, lines of railway, sites of houses, nature of building materials, and many other questions of daily life. The offices of the Geological Survey have become the recognised headquarters for information of this nature respecting the British Islands. The various Government Departments apply freely for assistance and advice, while the general public continues to make daily inquiries in regard to matters which involve a practical knowledge of geology.

[1] Annual Report of the Director-General of the Geological Survey of the United Kingdom for 1896. London: Printed for her Majesty's Stationery Office, 1897. Price 6*d*.

The scientific results obtained by the Survey during the past year occupy the greater part of the Report, and are full of interest. The narrative of them is arranged in stratigraphical order, beginning with the oldest rocks. We are first taken into the district of Charnwood Forest, and shown the excellent work done there recently by Mr. W. W. Watts. We are then transported into the north-west of Scotland, and watch the labours of Messrs. Peach, Horne, and Clough among the mountains of Assynt and the hills of Skye. The wonderfully complex structure of the country between Cape Wrath and the southern promontory of Skye has now been worked out in detail, most of the maps of that region are published, and we may before long expect a full account of the whole belt of complication from the able band of surveyors who, amidst all the inclemencies of that boisterous climate, and all the physical difficulties of rugged mountain and shaking bog, have so skilfully unravelled the details of one of the most interesting and difficult geological districts in Europe.

In the northern, central and southern Highlands satisfactory progress continues to be made. In the far north Mr. Horne and Mr. Gunn have been at work among the "Moine schists" of Sutherland and Ross-shire. Mr. Barrow and Mr. Cunningham Craig are to be found among the glens and corries of the higher Grampians. Mr. Hinxman is busy among the rocks of Strathspey. On the west side of the country a chain of observers is stationed from the flanks of Ben Nevis to Loch Awe and the hills of Lorne. Mr. Grant Wilson is engaged among the schists and limestones of Loch Linnhe. Mr. Hill has continued his investigation of the metamorphic series around Loch Awe. Mr. Symes has made progress with the volcanic district of western Argyllshire; while Mr. Kynaston has been laying bare the secrets of Ben Cruachan. The work of each of these investigators is succinctly summarised by the Director-General, and attention is called to the more important results obtained in the examination of the younger or Dalradian schists of the Highlands. The mapping is likewise in progress among the metamorphic rocks of the Western Isles, Mr. Wilkinson having now completed the survey of Islay; while Mr. Gunn is prosecuting that of Arran.

One of the most important problems now engaging the attention of the Survey in the Scottish Highlands is connected with the position and relations of a belt of comparatively unaltered strata, wedged in between the schistose rocks and the Old Red Sandstone which has been faulted down against them. These strata, from their lithological characters, their sequence, and their including certain radiolarian cherts, are regarded as probably the equivalents of the closely similar rocks which lie in the Arenig division of the Silurian rocks of the Southern Uplands of Scotland. If such should eventually be proved to be their true age, they will have an important bearing on the age of at least the latest movements to which the Highland rocks owe their contorted and puckered structure. The problem, however, seems to become more difficult the longer it is studied. Last year Mr. Clough, who is engaged on its investigation, has found that no satisfactory line can be drawn between the presumably Lower Silurian strata and the general mass of the rocks of the southern Highlands. If any portion of these rocks should prove to be of Palæozoic age, it would be a notable discovery in British geology. In the meantime we must patiently await the result of the continuation of further research along the Highland border.

The mapping of the Cambrian rocks of the north-west of Scotland has now been completed by the surveys in Skye made last year by Mr. Clough. One of the most singular features of these ancient deposits is the persistence of the same lithological bands for a distance of

100 miles from the mouth of Loch Eriboll into Sleat in Skye. Not only the bands of the Durness limestone, but the "fucoid beds" and the marked subdivisions of the underlying quartzite retain their general characters throughout the whole extent of their outcrop.

The mapping of the Isle of Man has now been completed by Mr. Lamplugh. Much information has been obtained as to the structure of the "Skiddaw Slates" of that island, but no further evidence has been found to fix their true geological age.

The revision of the Silurian formations of the Southern Uplands of Scotland has been brought to a close by Messrs. Peach and Horne, with the assistance of Mr. A. Macconochie. The whole complicated structure of that extensive region has now been unravelled. Among the more interesting recent additions made by these observers to our knowledge of the ground, has been the wide development of volcanic rocks associated with the Lower Silurian sediments. The chief interval of volcanic activity seems to have been the Arenig period; but last year evidence was met with of contemporaneous lavas in the Bala series of Peebleshire. In the Report some valuable details are supplied by Mr. Teall regarding the volcanic series of the Southern Uplands, and also the Galloway granites with their apophyses and attendant metamorphism.

The Silurian areas of Ireland are likewise undergoing revision, with the view of bringing the maps up to the present state of knowledge on the subject. The whole of the country north of Dublin has now been completed by Messrs. Egan and McHenry; while the fossil collector, Mr. Clark, has discovered many new localities for fossils in the Silurian rocks. The revision proceeds upon a careful search for organic remains, and the subdivisions of the Silurian formations are based essentially on the evidence of these remains.

Some important modifications of previously published views were obtained last year by Sir Archibald Geikie and Mr. Kilroe in the west of South Mayo and North Galway. Evidence was gathered which showed that the volcanic rocks of that region, hitherto regarded as of Upper Silurian age, undoubtedly belong to the lower division of the system.

In the Old Red Sandstone, the chief work accomplished by the Survey in 1896 lay in Ross-shire, Arran, and Argyllshire. In the first-named country two hitherto unknown outliers of this formation, capping hills of schist, were found by Mr. Gunn—striking monuments of the denudation of that region. In Lorne considerable progress has been made in the mapping of the interesting volcanic series of the Old Red Sandstone, and some suggestive observations have been made by Mr. Kynaston as to the possible connection of the andesite lavas with the granite of Ben Cruachan.

Among the Carboniferous rocks, the chief task on which the Survey is at present engaged is the revision of the coal-fields on the scale of six inches to a mile. Good progress is reported in the mapping of the great coal-field of South Wales, and a beginning has now been made with the publication of the re-survey. The new maps cannot fail to be of great value in the future development of the mineral resources of this important region. In general, each coal-owner knows only his own ground, and that often very imperfectly. No general acquaintance with the structure and resources of the whole coal-field can be obtained until all the scattered observations at the different mines are correlated and generalised. This, however, is a result which could hardly be effected by private enterprise. It is essentially a national undertaking, and it is this task on which the Geological Survey is now engaged. Mr. Strahan and his colleagues, who are charged with the re-survey, are to be congratulated on the excellent maps which they are producing. Not only are the Coal-measures receiving attention, but the surrounding older formations, the mapping of which is required for the completion of the sheets of the coal-field, are undergoing careful examination, and have already yielded some interesting new results. Thus Mr. Strahan last year discovered that the igneous rocks, which have long been supposed to be intrusive in the Carboniferous Limestone of West Somerset, really include intercalated tuffs, marking the sites of volcanic eruptions during Carboniferous time in the south-west of England.

Strata of Permian age are reported from the northern end of the Isle of Man, where they have been detected in some unsuccessful borings for coal. The younger red sandstones of the Isle of Arran are regarded as not improbably belonging to the same geological system.

Triassic and Rhætic rocks have been mapped over considerable tracts along the southern side of the South Welsh coal-field, and some interesting data have been obtained by Mr. Cantrill regarding the nature and origin of the breccias lying at the local base of these formations.

The most important area of Jurassic rocks examined last year lies in the district of Strath, in Skye, where the ground was mapped by Mr. H. B. Woodward, who has traced the lithological and palæontological subdivisions of the Lower and Middle Lias.

The Cretaceous system over considerable tracts of the south of England was examined during the past year for the purpose of mapping its subdivisions, the clear delineation of which is now found to have so important a bearing in questions of water-supply. Mr. Jukes Browne is engaged on the preparation of a general memoir on the Upper Cretaceous formations, and has had much assistance from Mr. William Hill, whose extensive and accurate knowledge of the subject has been placed at the service of the Survey.

The field-work in the south of England during 1896 lay, for the most part, outside of the areas of the Tertiary formations. Most of the mapping among rocks of that series was carried on in the west of Scotland, where so large and varied a development of Tertiary igneous masses occurs. Mr. Harker continued his investigation of the eruptive rocks of Skye, and contributes some important facts to the Annual Report. Mr. Hinxman noted two remarkable vents in Raasay, while Mr. Gunn was successful in adding a number of previous unknown particulars to our knowledge of the younger igneous rocks of Arran.

The Superficial Deposits, formerly entirely neglected, now receive a large share of the attention of the Geological Survey. As they thickly cover wide tracts of country, they are of paramount importance in regard to agriculture, water-supply, drainage and many other questions of daily life. It is most desirable, therefore, that their nature and limits should be accurately delineated upon maps. This has been done by the Survey over the whole of the northern half of England, and the same investigation is now in progress in the southern half. When the "Drift Survey," as it is called, is completed, the British Isles will be in possession of a map which will serve as an admirable guide to the farmer, well-sinker, engineer, and generally to the whole of that wide public that is practically interested in the relation of the soils and subsoils to all kinds of sanitary questions.

The Survey, while dealing with these applications of its work, does not lose sight of the intensely interesting geological problems presented by the various superficial formations. The present Report, like its predecessors, contains much fresh information on this subject. From the cwms of South Wales to the downs of Kent, the surveyors have been at work among the various drifts, and the more important of their observations are summarised by the Director-General. Of special interest are Mr. Lamplugh's generalisations regarding the successive stages in the history of the glaciation of the Isle

of Man, and Mr. Bennie's discovery of two ancient lake-bottoms near Edinburgh containing an arctic fauna and flora.

The Second Part of the Annual Report is devoted to the work of the Palæontological Department of the service, and contains a summary of the chief changes, additions and rearrangements made during the year in the palæontological galleries under the charge of Messrs. Sharman and Newton.

The general collections in the Museum form the subject of Part iii., wherein Mr. Rudler reports the principal events in the history of the Museum during 1896. It is satisfactory to observe that the collections continue to attract thousands of visitors, and that not only the general public, but schools, natural history societies, students' clubs, and individual students avail themselves of the admirable educational facilities afforded by the collections.

From what has here been said, it will be seen that the Annual Report of the Director-General of the Geological Survey is not a mere piece of dull statistics, but is an interesting and important contribution to science. It is a volume which will obviously be required in the library of every geologist, for it is crowded with observations which he will find nowhere else. Its publication as a separate work now places it within easy reach, and we trust that its sale will encourage Sir Archibald Geikie to continue the issue of as full a record in future years with perhaps, if the Stationery Office can be propitiated, diagrams illustrative of the more important facts described. In the meantime he and his able staff are to be congratulated on the appearance of so excellent a narrative of strenuous and successful labour.

STYLES OF THE CALENDAR.

AT the approach of the end of a century, this subject naturally comes to the front again; but it has lately been somewhat unexpectedly raised to special prominence by the suggested probability of one at least of the Oriental countries of Europe adopting the usage which, on the initiative of Rome in 1582, all the western nations gradually accepted, England (we say advisedly England *not* Britain, because Scotland adopted it before the union even of the crowns) being the last in 1752. America having been colonised by the western Europeans, and the United States having been still British colonies at the date last mentioned, the Gregorian style is universal in that continent. But eastern Europe, including Russia and all the nationalities of the Balkan peninsula, still adheres to the old Julian style; and this chiefly because the Christians of these countries belong to the Greek or Eastern Church, though it is difficult to see why this should restrain them from falling in with a change which has many conveniences, and would bring their dates into uniformity with those of the Latin, Teutonic, and Scandinavian nations—an object of increasing importance, as intercommunication is constantly becoming more frequent.

It is understood that for some time past, as the nineteenth century is drawing to its close, the question of a change has been discussed amongst the officials and astronomers of Russia; and that a plan was proposed to introduce it not by one operation, but gradually. Probably few persons amongst the general public reflect how essentially twofold the Gregorian alteration was; the object of making our calendar years correspond more accurately during the centuries with the tropical years of astronomers, so that the dates used should for all future time correspond with the equinoxes and other solar seasons, by no means implies the necessity of cancelling a number of days from the calendar so that these should correspond with what they were at some definite epoch in the past. The reason for this latter was purely ecclesiastical, the purpose being that, in celebrating Easter, the full moon following the vernal equinox should be governed by one bearing the same date as it did at the time of the Council of Nicæa. This the Eastern Church appears to have thought of less consequence than did the Western; and, indeed, it cannot be proved that on this point the Council did more than decree, in opposition to the so-called Quartodecimans, that Easter Day should always be kept on a Sunday. However that be, when it was noticed that the vernal equinox (which in the time of Julius Cæsar fell on the 25th of March, but in that of the Council A.D. 325, on the 21st), the question was from time to time agitated at Rome of effecting a change in the Julian reckoning. In passing it may be mentioned that Cæsar and Sosigenes the Alexandrian, who assisted him, were quite aware that the true length of the year was somewhat less than $365\frac{1}{4}$ days; the important point of the alteration of the calendar then carried out, was the abolition of the former cumbrous system of the Romans by combining a solar and lunar chronology with intercalary months, which were constantly falling into confusion, and the adoption of one wholly solar, the months being made artificial divisions, and it being thought that (the *exact* length of a year being not known) the regular introduction of an additional day every fourth year (making what we call a leap-year) would be quite sufficient for all practical purposes. Pope Sixtus IV. seriously took in hand the question of improving the Julian system, and in consequence of the great reputation of Regiomontanus (as he is commonly called from his birth-place, though his real name was Müller), who was making observations with his friend Walther at an observatory, the first ever made in Europe, erected by the latter at Nürnberg, sent for him to Rome to assist in this object, but, unfortunately, Müller died shortly after his arrival in 1476, which was about three years after the birth of Copernicus. The scheme was therefore again delayed, and was finally executed under the authority of Gregory XIII. in 1582. A century earlier it would have been adopted throughout western Christendom; as it was, the Protestant countries were slow to follow it, and some of the German States at first endeavoured to make some modifications by using a true instead of a calendar full moon, which did not work well in practice, because the moon is not necessarily full on the same day in different localities. England adopted the Gregorian style in its entirety (already, as we have said, used in Scotland), chiefly at the instance of Lord Chesterfield in 1752; and long before the end of last century the same rule was observed over western Europe, no further alteration having been made since, though it has often been noticed that even the Gregorian year is not absolutely accurate.

A definite proposal is now being made in one of the smaller eastern States for the abandonment of the Julian reckoning still observed by them, and the adoption of the Gregorian style. In the *Times* of the 11th inst., Signor Cesare Tondini de Quarenghi informs English readers that he has drawn up a Bill at the request of the Bulgarian Prime Minister, M. Stoiloff, to be shortly laid before the Sobranye for the purpose of effecting this change in Bulgaria; and he also states that he has been informed that Russia is desirous that this example should be thus set before being carried out in that country. How that may be, we are not in a position to know, but it is surely desirable (though even astronomers are not unanimous on the point) that the year should correspond on the whole, and as far as practicable, with its true length, whilst uniformity of usage throughout Christendom, would undoubtedly be a gain of convenience. We would fain hope that some international agreement might be come to by which, after the dropping of a leap-year in 1900, its regular omission at the end of each period of 128 years should be arranged. This would be a more