The photographs obtained by employing the above-mentioned instrument and method were, as a rule, of 0·30 metres diameter, but for special purposes diameters of 0·50 and 0·70 have been used. Some of these pictures have been beautifully reproduced in the volume before us, and surpass any others that have been obtained both in clearness and fineness of detail.

A minute examination of such photographs has greatly enlightened us on many points regarding the surface movement and appearance of the photosphere, and in the near future we shall have series of photographs taken very quickly one after another, which will help us to follow the motions, invisible even to the unaided eye, most closely.

Further, it has been shown that the forms, dimensions, and distribution of the granulations are not in accordance

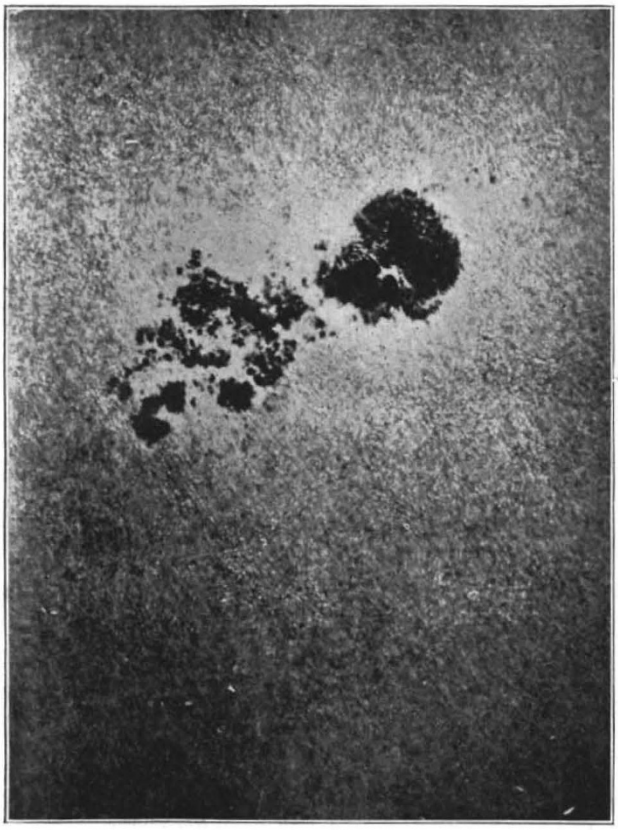

FIG. 2.—A portion of the solar surface, showing a sunspot and a mean *réseau* (June 22, 1885).

with the ideas formed of these elements of the photosphere as seen through telescopes. The photographic images do not confirm the notion that the photosphere is built up of elements, the forms of which are constant, and resemble rice grains, &c. The granulations, according to M. Janssen, assume different shapes under different circumstances, and vary very much in size.

The discovery of the photospheric *réseau* is another outcome of the Meudon photographs. A close study of the photographs showed that the photosphere was not uniformly constituted in every part, but that it was divided into series of figures more or less separate from one another, and exhibiting a peculiar structure. The sizes of these figures were found to vary, and their contours were more or less rounded, sometimes rectilinear, and very often polygonal. These different types of *réseaux* are clearly seen on the photographs in the volume, and one of these, illustrating a mean type of *réseau*, is given in the reproduction accompanying this article (Fig. 2).

The picture, here considerably reduced, was taken on June 22, 1885, the diameter of the disc being 0·888 metres, and gives a good idea of what is meant by a mean *réseau*. The photograph shows, further, a large spot, the principal nucleus of which measured nearly two minutes of arc in diameter. The faculæ and striæ of the penumbra of the spot illustrate very clearly that these parts were formed of granulations like the rest of the solar surface.

A special inquiry as to the distribution of this granulation over the entire solar surface brought out the fact that even at the poles it was quite distinguishable; it thus differs from the spots, which are limited to two narrow belts on each side of the solar equator.

The last sections of the volume are devoted to several other uses of solar photography, as, for instance, the questions of the presence of a lunar atmosphere, or of small bodies passing between the earth and the sun. Both of these have been investigated at Meudon, and in each case a negative answer was the outcome of the research.

In bringing this notice to a conclusion, we may remark that this, the first volume of the "Annals," is worthy of the institution from which it hails, besides being a valuable contribution to astronomy. It is, perhaps, the most handsome volume of any "Annals" which it has been our lot to notice, and the numerous reproductions of photographs are models of what can be accomplished in this line of work.

The French Government is to be congratulated on being the means by which such fine work in astronomical science can be accomplished, and is, we have no doubt, proud of the able director to whose energy and skill such important advances are due.

WILLIAM J. S. LOCKYER.

RECENT WORK OF THE UNITED STATES GEOLOGICAL SURVEY.

THE Fifteenth Annual Report of the United States Geological Survey opens with a few words of farewell spoken by the Director, Major Powell, on his retirement. Modestly and briefly he reviews some of the work done by himself and his colleagues, which has been expressed in not less than a thousand maps and two hundred volumes. The last Report issued by him is a worthy successor of the earlier ones in material and in illustrations; many of the latter are exceptionally fine, and show what can be done by the artistic printing on high-class paper of blocks processed from good photographs. When will English officialdom learn that the thousands of pounds spent in promoting research lose nine-tenths of their effect on account of the slovenly and imperfect presentation of the results to the public?

One of the most interesting memoirs in this volume, on the Granites of Central Maryland, is prefaced by a short but very able chapter from the pen of Prof. G. H. Williams, whose promising life has been cut off in its prime. Here we see evidence of a firm grasp of his subject, with knowledge and experience amongst the class of rocks with which he deals, and the ability not only to acquire and assimilate the work of other observers, but to show clearly that towards the end attained not only himself but a host of other workers have contributed.

Evidence from apophyses, chilled margins, contact metamorphism, and inclusions, as well as from the ultimate chemical and mineralogical constitution of the rocks, is all effectually used to demonstrate that these rocks are igneous products; the close association of a wide range of petrographic types is evidence pointing to the same conclusion. The pegmatites are studied in detail, and a conclusion arrived at that in this district

segregative and intrusive types are mixed together. This preliminary study is followed up by Prof. Williams' student, Mr. C. R. Keyes, in a detailed description of the binary or true granites, granitites, and hornblende-granites of Maryland. This writer insists that both primary and secondary muscovite occur in the granites, and that the intimate intergrowths of allanite and orthite are original and not secondary products. The bed-like or "sheeted" and spheroidal joints are described and illustrated, and it is made quite clear that the rocks are of igneous origin, locally affected by shearing, so as to pass into gneissose and schistose rocks.

Mr. Lawson's paper on the Geology of the San Francisco Peninsula is deserving of attention at the present time, when cherts and other radiolarian rocks are being so much studied in Britain. Mesozoic rocks, the Franciscan series, rest unconformably on the Montara granite, which, in its turn, is intrusive into crystalline limestone. The Franciscan series consists of sandstones, in the interstital matter of which important reconstruction has occurred, foraminiferal limestones, radiolarian cherts, and volcanic rocks, partly intrusive and partly interbedded, and often exhibiting characters similar to the "pillow lavas" which occur in Britain in association with cherts. The latter rocks, which range from holocrystalline aggregates of quartz granules to masses of isotropic silica, are well banded and associated with what the author calls shales, although "the highest powers of the microscope fail to reveal any clastic material" in them, and he is driven to admit that it is only the interbedding of the cherts with common sandstone which checks the supposition that they are deep-sea deposits. He inclines to the view that the silica has been mainly derived from submarine, siliceous springs. The rocks of this series, where associated with intrusive peridotites, pass into micaceous, chloritic, and amphibolic schists. An excerpt from some notes of Dr. Hinde shows that he has compared the radiolaria with forms from Jurassic and Cretaceous rocks in Switzerland and Hungary. A short account of the serpentines, the later bedded rocks, the diastrophic record, and geomorphy concludes the memoir.

The preliminary report on the Marquette iron-bearing district of Michigan, while illustrating the use of local names in accurately defining particular terranes, certainly makes one wish that such of the terms as are likely to become of larger importance were less cacophonous. The Wewe slate, the Ajibik quartzite, the Bijiki and Kitchi schist, of this paper, the Rappahannock and Aquia Creek series of another paper, suggest a large field of work for the International Congress in the special effort at simplification of nomenclature which it is making at St. Petersburg. The basement series of granites and gneisses is separated by an unconformity from the lower Marquette, and that by another from the upper Marquette series, all these systems being folded together in a complicated fashion which has not yet been unravelled. The two Marquette series are correlated with the upper and lower Huronian systems. The bulk of the iron ores, which consist of specular iron and magnetite, occur in the Negaunee formation of the lower series, and below the Goodrich quartzite; but they frequently extend above and much more often below, into the numerous beds overlapped by quartzite. They have been formed by the concentration of iron ore in a cherty carbonate of iron, governed by the folding of the rocks and the position of intrusive diorite dykes.

Mr. Lester F. Ward contributes a memoir on the Potomac formation to the fifteenth report, and a correlation paper on its analogies to the lower Cretaceous rocks of Europe to the sixteenth report. The general order of succession is studied, and the floras dealt with in detail by the help of tables, plates, and descriptions of new species. The tables lead the author to conclude that the floras compare with the Kome and Atane beds of Greenland, and comprise the interval between these two. The correlation paper is accompanied by beautiful colour-printed geological maps of of South-east England and the Isle of Wight, the author considering that the Potomac formation is about equivalent to the Wealden series. Further comparison is instituted with Cretaceous floras in Italy, and Cretaceous and Jurassic floras in Portugal.

Under Mr. Walcott's direction the publications of the Survey at once become more specialised. One large volume is devoted to purely scientific work, two parts of another to mineral statistics and related papers, and a third to memoirs mainly of an economical character. This has led to a development in the character of the papers. Those of an economic character tend to become more useful to the agriculturist, the miner, and the road-master, while the rest are written in such a way as to be not only of value to the scientific man and popular for the public, but to have an educational character, being evidently written with a view of placing new ideas and methods of work before both official geologists and amateurs. As an example of the latter, we may cite the pre-Cambrian paper, by Mr. Van Hise; of the former, those on road-stones, by Prof. Shaler, and the mining papers in the economic volume.

In dealing with road-metal, Prof. Shaler shows that the tests of crushing strength usually made in Britain and elsewhere, while of great value for building stones, do not express all that is required with regard to material for roads. Bits of stone are placed in a drum, which is overturned at the rate of 33⅓ revolutions per minute, and the powder is collected and weighed. The binding power of the dust is further tested by making briquettes, which are broken and then crushed, moulded, and broken again as often as necessary. This gives a fair idea of the staying power of any particular stone for different kinds of traffic, and enables the geologist, after further petrographical examination, to express a pretty decisive opinion on the merits of different metalling stones. Study of sections of roads shows that great attention ought to be paid to the gradual building up of metal, and that in many cases it would be advisable to mix softer binding stone with tougher metals on which the steam-roller has little crushing effect. An account of road metals and paving clays in Massachusetts is given in the sixteenth report, and of the United States generally in the fifteenth.

A very valuable report on the Cripple Creek mining district is given by Mr. Whitman Cross and Mr. Penrose, the former dealing with the general geology, the latter with the mining geology. Through a platform of granites and schists a volcano opened in Tertiary times, and ejected at first andesites and then phonolites, basalts, and rhyolites in an order which cannot be precisely ascertained, owing to the removal of lava streams by denudation leaving only dyke rocks behind. A sentence in the introduction shows that scientific terms taken into ordinary use suffer an even worse fate than ordinary terms which have been adopted for scientific use. In England the term granite, and in Ireland diorite, are used as almost synonymous with road-metal, the former being applied to everything from basalts to greywackes, and from porphyroids to hard sandstones. Similarly the word porphyry, originally meaning a purple rock, was first applied to a purple rock with "porphyritic" crystals in it, then to a ground mass like that embedding the crystals, whether the latter were present or not. Now, Mr. Van Hise quotes a miner's definition that "porphyry—well, porphyry generally runs three or four dollars" of gold to the ton.

The phonolites, which are intimately connected with gold deposits, are fully described; they contain abundance of felspar, nepheline, sodalite, ægirine, and a blue

amphibole. Nepheline- and augite-syenite, nepheline-basalt, and tuffs and breccias also occur. The acid and intermediate rocks are rich in alkalies, and the latter eruptions were of strongly-contrasted acid and basic magmas, conforming to the complementary types of Brögger. In the mining portion of the memoir Mr. Penrose shows that gold occurs deep down as a telluride which has been decomposed near the surface to form native gold. The ore deposits occur in fissures, blending into the country rock, and generally associated very definitely with dykes, because fissures have followed pre-existing dykes. Detailed descriptions of the country, with maps and sections, follow.

Mr. Eldridge's geological reconnaissance across Idaho gives a brief description of Archæan and Algonkian rocks, which are overlain by Palæozoic rocks whose exact age is unknown, but apparently ranging from Cambrian upwards, and including sub-Carboniferous rocks. Cainozoic rocks follow, and igneous rocks of all ages from Archæan to Tertiary are present. Several mining districts, yielding gold and silver, are described, and a little coal occurs in the Tertiary rocks.

The Mercur mining district in Utah, described by Mr. Spurr, with an introduction by Mr. S. F. Emmons, yields both gold and silver, the latter chiefly at the contact of limestone with porphyry, where both rocks are altered and decomposed, the former where the Eagle Hill porphyry has produced a silicification of the limestone with which it is in contact. The ores are associated with sulphides, or else have become oxidized near the surface, and the gold probably occurred originally as a telluride.

The economic volume closes with two papers, one on the public lands and their water supply, by Mr. F. H. Newell, and the other on the water resources of the great plains, by Mr. R. Hay. The first paper indicates the rate of progress in disposal of public lands, their general agricultural character, and chief sources of water supply from streams, wells, and reservoirs. The second shows that, although the deep supply of water is limited, quite sufficient for probable requirements may be obtained from the Tertiary grit, which is met with at depths ranging from 100 to over 300 feet.

The two parts of vol. iii. of the Sixteenth Annual Report are entirely devoted to mineral statistics and papers germane to the mining industries. These statistics, previously published as ordinary octavo, are now issued in royal octavo, and form a part of the Annual Report. The production of minerals is represented not only by tables, but by curves and diagrams, so that their meaning can be rapidly grasped, and with them are published not only accounts of the various mining industries of the United States, but notices showing the history and present phase of the same industries all over the world. Mode of occurrence of the various classes of ores, methods of winning them, details of quarrying and mining operations, and prices of products are all treated in detail. Improved methods, whether adopted at home or abroad, are described in full, and every effort is made to bring all the industries abreast, or to keep them ahead, of what is done elsewhere. Many of the papers are compact summaries of particular classes of deposits, which will be extremely useful for those who require to become rapidly acquainted with particular products and industries. As examples of this, the articles on bauxite and fertilisers may be noticed. The article on iron contains a very useful set of maps, showing the localities of iron ore deposits throughout the world. Many of the other articles contain series of analyses, and bibliographies are annexed to some of the papers.

The scientific volume (Part i.) of the Sixteenth Annual Report opens with a short and, to some extent, popular paper on the dinosaurs of North America, by Prof. O. C. Marsh, illustrated by eighty-five plates, indicating the principal structural characters of these reptiles, and giving restorations where they are warranted by the number of bones preserved. The plates were prepared for a series of monographs now in preparation, and they are here published in advance. Questions of classification are relegated to a subordinate position, and the author confines himself almost entirely to a short account of the principal bones found, laying stress on the points which justify the restorations adopted. A useful table showing the horizons of vertebrate fossils in America is given, and in this the beds are classified according to their dominant vertebrate fossils, which, in the Mesozoic rocks, are chiefly reptiles. It is shown that the so-called "bird tracks" of Connecticut River are due to dinosaurian reptiles, and not to birds.

On comparing European with American Sauropoda, Prof. Marsh notes the absence of the gigantic Atlantosauridæ and the Diplodocidæ from Europe, while the Cardiodontidæ are abundant there. Restorations of four European forms—*Compsognathus*, *Scelidosaurus*, *Hypsilophodon*, and *Iguanodon*—are published, and, in conclusion, the affinities and classification of the dinosaurs are discussed.

Prof. H. F. Reid contributes a short memoir on Glacier Bay and its glaciers, like those named after Muir, Rendu, and Cushing, illustrated by an admirable series of photographs and profiles of the ends of the ice streams. After dealing with the "hard" geology, the stratified gravels are considered; these rest on blue clay formed of stream and moraine mud, covered with the tree stumps of a forest which appears to have been living within a few centuries until destroyed by floods and gravel. Certain smooth holes in the ice are thought to be the result of the closing of crevasses containing water by the ice-movement. An esker of sand and gravel, projecting one hundred yards from the moraine of Dent Glacier, has a winding course, and appears to have been produced by a stream flowing in a channel through the ice.

Part i. of the Sixteenth Annual Report closes with three very important papers by Nelson Dale, Van Hise, and Hoskins, dealing with a group of cognate subjects. Mr. Dale gives a series of examples of various structural phenomena which are well illustrated in the Green Mountain region and in eastern New York. Different types of folds, false-bedding, single, double and triple cleavage, and evidences of stretching and brecciation. This short paper is illustrated by drawings and photographs of sections and specimens, many of which are referred to by Van Hise in the communication which follows.

Mr. Van Hise, in his "Principles of North American pre-Cambrian Geology," gives, first of all, a set of principles to guide field-work in these rocks, weaving together the results of his own rich experience with the work of other observers, such as Heim, Lapworth, Rogers, Gilbert, Dana, Geikie, Harker, and a host of others. This is followed by an application of the principles to the different areas where pre-Cambrian rocks may be studied in America.

At a greater depth than 10,000 to 12,000 metres cavities could not exist, even in the strongest rocks, and all fissures and cracks would be closed and welded by flowage of the rock material under the stress existing there. Near the surface deformation of rocks by fracture would be possible, and between the two zones there would exist an area of combined fracture and flowage, the strong rocks yielding by the former, and the weaker by the latter process. Folds are simple or composite if in two dimensions, complex if in three; and it is pointed out that the true succession can only be made out in a complex district by unravelling the cross sets of folds, or, what is the same thing, ascertaining the "pitch" of the axes of the minor folds. The structures hitherto considered under the name of cleavage are separated

into two types; that formed in the zone of flowage at right angles to the stress, and due to the growth of new particles and the orientation of old ones in this direction, thus giving rise to a grain in the rock, receives the name of *cleavage* proper; that which is due to definite planes of parting, formed along surfaces of shear, and originating in the zone of fracture, is called *fissility*. Those rocks, which on coming to the surface from the lower zone pass through the upper while under sufficient pressure to produce fissility, have this structure produced in the planes of true cleavage, while in other rocks it arises independently of any other structures. In deep-lying rocks fissility parallel to the bedding may be produced when the vertical weight is sufficient. Cracking and deposit of minerals may cause banded structures in imitation of bedding, and the imitation may be strengthened by further movement in the banded rock and by metamorphism.

The origin of joints and faults is somewhat lightly discussed. It is shown that both structures may result from pressure or tension, and Daubrée's explanation of joints by torsion is shown to be but another statement of their origin by complex folding. A very important point is made in linking these structures together and showing their relation to fissility, and it is insisted that "there is every gradation between faulting and fissility, and probably every gradation between faulting and cleavage."

Autoclastic rocks, crush-conglomerates and breccias, are next discussed, and it is pointed out how essential it is to discriminate between them and basement conglomerates. Metamorphism, in a wide sense, is next dealt with under the heads of consolidation, welding, cementation, injection, metasomatism, and mashing (dynamic metamorphism). The origin of the chief metamorphic rocks, both sedimentary and igneous, is fully discussed. In dealing with the most ancient sedimentary rocks, unconformities are of the greatest value, in spite of the undeniable difficulty of finding them; other tests of age are dates of intrusion and of movement, and number of movements undergone by different members of a succession. It must here be noted, however, that as the brain of a crow is unable to count more than three men with guns, so the brain of the geologist is inadequate to count more than three directions of movement, if so many. In igneous rocks the order of injection is still to be regarded as the great clue.

The pre-Cambrian rocks are divided into two great groups—the basement complex, or Archæan group, and the pre-Cambrian sediments, or Algonkian group. The different views held as to the origin of the first group are fully and fairly discussed, and after rejection of the theories that they are altered sediments, intrusive rocks, and primitive earth-crust, the view is provisionally adopted that, while little is probably left of the primitive earth-crust on which the Algonkian rocks were formed, it having been destroyed by erosion, the Archæan rocks represent the plutonic rocks solidifying beneath it, their formation in the upper part beginning in Archæan times and continuing steadfastly downwards to the present day. All the intrusions of those later-formed rocks, which have made their way to the surface through the upper (Archæan) layer, must be separated from it and considered as of later date. In dealing with the Algonkian rocks, a useful reference is given to all the fossils hitherto found in these rocks below the *Olenellus* zone, which is taken as the base of the Cambrian. The later part of Mr. Van Hise's paper will be found to be a most useful summary of the present state of knowledge of the American pre-Cambrian rocks.

The appendix to this paper contains a mathematical discussion of the depth of the zone of flowage, and the function of stress and strain on the rocks in producing cleavage and fissility.

NOTES.

THE following despatch from the Government of India t Lord George Hamilton is published in the latest number of the *Kew Bulletin*:—"We are informed by our Director of the Botanical Survey of India that the 'Flora of British India," which was begun by Sir Joseph Hooker some twenty-five years ago, has just been brought by him to completion. The value of the work as a contribution to pure science has already been appreciated and acknowledged by others who are more competent to speak in such a matter than ourselves. But we desire to express our hearty recognition of the service to India which Sir Joseph Hooker has rendered by his monumental undertaking. He has for the first time brought the botany of the Empire into a collective form and placed it upon a firm and lasting basis, thus completing the work which he began nearly half a century ago in the Himalayas. We would ask your lordship to convey to Sir Joseph Hooker our high appreciation of his labours, and of their value and importance as systematising and adding to our knowledge of the vegetable productions of India, and our hearty congratulations upon having brought to a satisfactory conclusion a work to which he has devoted so many years of his life." In transmitting a copy of this letter to Sir Joseph Hooker, Sir Arthur Godley writes:—"Lord George Hamilton desires heartily to associate himself with the Government of India in their acknowledgment of the valuable services you have done to India by this great work, and by your labour in the field of Indian botany, since you first visited that country nearly fifty years ago."

WITH reference to the foregoing note, we learn from the *Kew Bulletin* that Sir J. D. Hooker's literary activity has not ceased with the completion of the "Flora of British India," which has occupied him for a quarter of a century. The veteran botanist has offered to undertake the preparation of the two remaining volumes of the "Handbook to the Flora of Ceylon," left unwritten by the untimely death of Dr. Trimen. The necessary materials and specimens have already been received at Kew from the Royal Botanic Garden, Peradeniya.

THE St. John's correspondent of the *Times* states that Lieut. Peary, the Arctic explorer, has returned from Greenland, bringing the Cape York meteorite, weighing forty-five tons, the largest in the world, and also six Arctic Eskimos, who are going polewards with him next summer. All the members of the expedition are well.

THE Commission du Musée d'Histoire naturelle at Geneva has formed itself into a committee having for its object the erection of a monument to the memory of François Jules Pictet-de la Rive. A site for the monument has been granted in front of the museum. Old students of the eminent investigator, and all who are interested in the work which he accomplished, are invited to send subscriptions for the memorial fund to MM. Lombard, Odier & Cie, Genève.

DR. T. W. ENGELMANN, professor of physiology in the University of Utrecht, has been appointed successor to the late Prof. Du Bois-Reymond in the chair of Physiology at Berlin.

PROF. WIESNER, of Vienna, has undertaken during the past summer a journey to Spitsbergen to complete his observations, previously made in the Tropics, as to the effect of light and other external conditions on the growth of plants.

AN International Ornithological Congress will be opened at Aix on November 9.

IT is reported that earthquake shocks were felt at Tashkent on Saturday last, September 18. The disturbance was noticeable