9 pl.), is in the main devoted to developing a new system of classification for the group, and to the criticism of Professor Haeckel's monograph, 'Die kalkschwämme.' 30 species were brought in by the Challenger, 23 of which were new. All these are elaborately described, and illustrated by most exquisite plates, chiefly drawn by the author. Mr. Poljaeff expresses the hope, "that the systematic arrangement of the group Calcarea, here proposed, will serve as a sufficiently sure basis for further investigations," — a hope which will be shared by all, but which in the present unsettled state of opinion among specialists in this department, and in view of the scarcity of material for investigation, is perhaps a trifle premature.

Other papers upon the Protozoa are promised, but are mostly far down in the list. The Hexactinellid sponges are assigned to Prof. F. E. Schulze; the Tetractinellidae, to Professor Solles; the Monactinellidae, to Mr. S. O. Ridley. Mr. H. B. Brady's paper on the Foraminifera, and Professor Haeckel's on the Radiolaria, will probably first be printed.

G. BROWN GOODE.

Smithsonian institution.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

RECENT PROGRESS IN PHYSICS.[1]

AFTER referring to what at first appeared a rather startling experiment, the holding of a meeting of the association outside of Great Britain, and to the undoubted pleasure and benefit the members would receive from their visit to Canada, Lord Rayleigh spoke of the loss the association had met in the death of Sir W. Siemens, and gave a brief account of Siemens's scientific work. He called attention to the fact that it is now some years since the presidential chair had been occupied by a physicist, and, while regretting that he should be called on to preside when the association met in a country of so great interest to the naturalists, he proposed to do the best he could by giving a sketch of the progress in late years of physical science.

It is one of the difficulties of the task, that subjects as distinct as mechanics, electricity, heat, optics, and acoustics, to say nothing of astronomy and meteorology, are included under physics. Any one of these may well occupy the lifelong attention of a man of science; and to be thoroughly conversant with all of them is more than can be expected of any one individual, and is probably incompatible with the devotion of much time and energy to the actual advancement of knowledge. Another difficulty incident to the task, which must be faced but cannot be overcome, is that of estimating rightly the value, and even the correctness, of recent work. It is not always that which seems at first the most important that proves in the end to be so. The history of science teems with examples of discoveries which attracted little notice at the time, but afterwards have taken root downwards, and borne much fruit upwards.

One of the most striking advances of recent years is in the production and application of electricity upon a large scale. The dynamo-machine is, indeed, founded upon discoveries of Faraday, now more than half a century old; but it has required the protracted labors of many inventors to bring it to its present high degree of efficiency. Looking back at the matter, it seems strange that progress should have been so slow, not merely in details of design, the elaboration of which must always require the experience of actual work, but with regard to the main features of the problem. It would almost seem as if the difficulty lay in want of faith. Long ago it was recognized that electricity derived from chemical action is (on a large scale) too expensive a source of mechanical power, notwithstanding the fact that (as proved by Joule in 1846) the conversion of electrical into mechanical work can be effected with great economy. From this it is an evident consequence that electricity may advantageously be obtained from mechanical power; and one cannot help thinking, that, if the fact had been borne steadily in mind, the development of the dynamo might have been much more rapid. But discoveries and inventions are apt to appear obvious, when regarded from the stand-point of accomplished fact; and he drew attention to the matter only to point the moral that we do well to push the attack persistently when we can be sure beforehand that the obstacles to be overcome are only difficulties of contrivance, and that we are not vainly fighting unawares against a law of nature.

The present development of electricity on a large scale depends, however, almost as much upon the incandescent lamp as upon the dynamo. The success of these lamps demands a very perfect vacuum, — not more than about one-millionth of the normal quantity of air should remain, — and it is interesting to recall, that, twenty years ago, such vacua were rare even in the laboratory of the physicist. It is pretty safe to say that these wonderful results would never have been accomplished had practical applications alone been in view. The way was prepared by an army of scientific men, whose main object was the advancement of knowledge, and who could scarcely have imagined that the processes which they elaborated would soon be in use on a commercial

[1] Address to the British association for the advancement of science at Montreal, Aug. 27, 1884, by the Right Hon. Lord Rayleigh, M.A., D.C.L., F.R.S., F.R.A.S., F.R.G.S., professor of experimental physics in the University of Cambridge, president of the association.

scale, and intrusted to the hands of ordinary workmen.

The requirements of practice react in the most healthy manner upon scientific electricity. Just as in former days the science received a stimulus from the application to telegraphy, under which every thing relating to measurement on a small scale acquired an importance and development for which we might otherwise have had long to wait, so now the requirements of electric lighting are giving rise to a new development of the art of measurement upon a large scale, which cannot fail to prove of scientific as well as practical importance. Mere change of scale may not at first appear a very important matter, but it is surprising how much modification it entails in the instruments, and in the processes of measurement. For instance: the resistance-coils on which the electrician relies, in dealing with currents whose maximum is a fraction of an ampère, fail altogether when it becomes a question of hundreds, not to say thousands, of ampères.

The powerful currents which are now at command constitute almost a new weapon in the hands of the physicist. Effects which in old days were rare, and difficult of observation, may now be produced at will on the most conspicuous scale. Consider, for a moment, Faraday's great discovery of the 'magnetization of light,' which Tyndall likens to the Weisshorn among mountains, as high, beautiful, and alone. It is even possible that it might have eluded altogether the penetration of Faraday, had he not been provided with a special quality of very heavy glass. At the present day these effects may be produced upon a scale that would have delighted their discoverer, a rotation of the plane of polarization through 180° being perfectly feasible. With the aid of modern appliances, Kundt and Röntgen in Germany, and H. Becquerel in France, have detected the rotation in gases and vapors, where, on account of its extreme smallness, it had previously escaped notice.

Reference was made to the importance the question of the magnetic saturation of iron was assuming in the discussion of the problems arising in connection with the dynamo-machines, and to the work of Rowland and Stoletow on the theory of the behavior of soft iron under varying magnetic conditions.

The introduction of powerful alternate-current machines by Siemens, Gordon, Ferranti, and others, is likely also to have a salutary effect in educating those so-called practical electricians whose ideas do not easily rise above ohms and volts. It has long been known, that, when the changes are sufficiently rapid, the phenomena are governed much more by induction, or electric inertia, than by mere resistance. On this principle, much may be explained that would otherwise seem paradoxical. To take a comparatively simple case, conceive an electro-magnet wound with two contiguous wires, upon which acts a given rapidly periodic electromotive force. If one wire only be used, a certain amount of heat is developed in the circuit. Suppose, now, that the second wire is brought into operation in parallel, — a proceeding equivalent to doubling the section of the original wire. An electrician accustomed only to constant currents would be sure to think that the heating-effect would be doubled by the change, as much heat being developed in each wire separately as was at first in the single wire; but such a conclusion would be entirely erroneous. The total current, being governed practically by the self-induction of the circuit, would not be augmented by the accession of the second wire; and the total heating-effect, so far from being doubled, would, in virtue of the superior conductivity, be halved.

During the last few years, much interest has been felt in the reduction to an absolute standard of measurement of electromotive force, current, resistance, etc.; and to this end many laborious investigations have been undertaken, some of the results being embodied in the resolves of the Conference of electricians assembled at Paris.

For the measurement of current strength, advantage may be taken of Faraday's law, that the quantity of metal decomposed in an electrolytic cell is proportional to the whole quantity of electricity that passes. The best metal for the purpose is silver, deposited from a solution of the nitrate or of the chlorate. The results recently obtained by Professor Kohlrausch and by Lord Rayleigh are in very good agreement; and the conclusion that one ampère, flowing for one hour, decomposes 4.025 grains of silver, can hardly be in error by more than a thousandth part. This number being known, the silver voltameter gives a ready and very accurate method of measuring currents of intensity, varying from a tenth of an ampère to four or five ampères.

The beautiful and mysterious phenomena attending the discharge of electricity in nearly vacuous spaces have been investigated and in some degree explained by De la Rue, Crookes, Schuster, Moulton, and the lamented Spottiswoode, as well as by various able foreign experimenters; and a remarkable observation by Hall of Baltimore, from which it appeared that the flow of electricity in a conducting-sheet was disturbed by magnetic force, has been the subject of much discussion.

Without doubt, the most important achievement of the older generation of scientific men has been the establishment and application of the great laws of thermo-dynamics, or, as it is often called, the mechanical theory of heat. The first law, which asserts that heat and mechanical work can be transformed one into the other at a certain fixed rate, is now well understood by every student of physics; and the number expressing the mechanical equivalent of heat resulting from the experiments of Joule has been confirmed by the researches of others, and especially of Rowland. But the second law, which practically is even more important than the first, is only now beginning to receive the full appreciation due to it. One reason of this may be found in a not unnatural confusion of ideas. Words do not always lend themselves readily to the demands that are made upon them by a growing science; and the almost unavoidable use of the word 'equivalent' in the statement of the first law is partly responsible for the little attention that is given to the second, for the second law so far contradicts the usual statement of the first as to assert that equivalents of heat and work are not of equal value. While work can always be converted into heat, heat can only be converted into work under certain limitations. For every practical purpose, the work is worth the most; and, when we speak of equivalents, we use the word in the same sort of special sense as that in which chemists speak of equivalents of gold and iron. The second law teaches us that the real value of heat, as a source of mechanical power, depends upon the temperature of the body in which it resides: the hotter the body, in relation to its surroundings, the more available the heat.

In order to see the relations which obtain between the first and the second law of thermo-dynamics, it is only necessary for us to glance at the theory of the steam-engine. Not many years ago, calculations were plentiful, demonstrating the inefficiency of the steam-engine, on the basis of a comparison of the work actually got out of the engine with the mechanical equivalent of the heat supplied to the boiler. Such calculations took into account only the first law of thermo-dynamics, which deals with the equivalents of heat and work, and had very little bearing upon the practical question of efficiency, which requires us to have regard, also, to the second law. According to that law, the fraction of the total energy which can be converted into work, depends upon the relative temperatures of the boiler and condenser; and it is therefore manifest, that, as the temperature of the boiler cannot be raised indefinitely, it is impossible to utilize all the energy which, according to the first law of thermo-dynamics, is resident in the coal.

On a sounder view of the matter, the efficiency of the steam-engine is found to be so high that there is no great margin remaining for improvement. The higher initial temperature possible in the gas-engine opens out much wider possibilities; and many good judges look forward to a time when the steam-engine will have to give way to its younger rival.

To return to the theoretical question, we may say, with Sir W. Thomson, that, though energy cannot be destroyed, it ever tends to be dissipated, or to pass from more available to less available forms. No one who has grasped this principle can fail to recognize its immense importance in the system of the universe. Every change — chemical, thermal, or mechanical — which takes place, or can take place, in nature, does so at the cost of a certain amount of available energy. The foundations laid by Thomson now bear an edifice of no mean proportions, thanks to the labors of several physicists, among whom must be especially mentioned Willard Gibbs, and Helmholtz. The former has elaborated a theory of the equilibrium of heterogeneous substances, wide in its principles, and, we cannot doubt, far-reaching in its consequences. In a series of masterly papers, Helmholtz has developed the conception of *free energy*, with very important applications to the theory of the galvanic cell. He points out, that the mere tendency to solution bears, in some cases, no small proportion to the affinities more usually reckoned chemical, and contributes largely to the total electromotive force. Also, in England, Dr. Alder Wright has published some valuable experiments relating to the subject.

From the further study of electrolysis, we may expect to gain improved views as to the nature of the chemical reactions, and of the forces concerned in bringing them about. Lord Rayleigh did not consider himself qualified to speak on recent progress in general chemistry; but if he might, without presumption, venture a word of recommendation, it would be in favor of a more minute study of the simpler chemical phenomena.

Under the head of scientific mechanics, it is principally in relation to fluid motion that advances may be looked for. The important and highly practical work of the late Mr. Froude in relation to the propulsion of ships is, doubtless, known to most. Recognizing the fallacy of views widely held, as to the nature of the resistance to be overcome, he showed, that, in the case of fair-shaped bodies, we have to deal almost entirely with resistance dependent upon skin-friction; and, at high speeds, upon the generation of surface-waves, by which energy is carried off. Although Professor Stokes, and other mathematicians, had previously published calculations pointing to the same conclusion, there can be no doubt that the view generally entertained was very different. Mr. Froude's experiments have set the question at rest in a manner satisfactory to those who had little confidence in theoretical prevision. Although the magnitude of skin-friction varies with the smoothness of the surface, we have no reason to think that it would disappear at any degree of smoothness consistent with an ultimate molecular structure. That it is connected with fluid viscosity is evident enough, but the *modus operandi* is still obscure.

Some important work bearing upon the subject has recently been published by Prof. O. Reynolds, who has investigated the flow of water in tubes as dependent upon the velocity of motion, and upon the size of the bore. The laws of motion in capillary tubes, discovered experimentally by Poiseuille, are in complete harmony with theory. The resistance varies as the velocity, and depends in a direct manner upon the constant of viscosity. But, when we come to the larger pipes and higher velocities with which engineers usually have to deal, the theory which presupposes a regularly stratified motion evidently ceases to be applicable, and the problem becomes essentially identical with that of skin-friction in relation to ship-propulsion. Professor Reynolds has traced with much success the passage from the one state of things to the other, and has proved the applicability, under these complicated conditions, of the general laws of dynamical similarity, as adapted to viscous fluids by Professor Stokes.

As also closely connected with the mechanics of viscous fluids, an important series of experiments upon the friction of oiled surfaces, recently executed by Mr. Tower for the Institution of mechanical engineers, must not be overlooked. When the lubrication is adequate, the friction is found to be nearly independent of the load, and much smaller than is usually supposed, giving a coefficient as low as a thousandth. When the layer of oil is well formed, the pressure between the solid surfaces is really borne by the fluid; and the work lost is spent in shearing, that is, in causing one stratum of the oil to glide over another.

The nature of gaseous viscosity, as due to the diffusion of momentum, has been made clear by the theoretical and experimental researches of Maxwell. A flat disk, moving in its own plane between two parallel solid surfaces, without contact, is impeded by the necessity of shearing the intervening layers of gas; and the hinderance is proportional to the velocity of the motion and to the viscosity of the gas, so that, under similar circumstances, this effect may be taken as a measure, or rather definition, of the viscosity. From the dynamical theory of gases, to the development of which he contributed so much, Maxwell drew the startling conclusion that the viscosity of a gas should be independent of its density; that within wide limits the resistance to the moving disk should be scarcely diminished by pumping out the gas, so as to form a partial vacuum. Experiment fully confirmed this theoretical anticipation, — one of the most remarkable to be found in the whole history of science, — and proved that the swinging disk was retarded by the gas as much when the barometer stood at half an inch as when it stood at thirty inches. It was obvious, of course, that the law must have a limit; that at a certain point of exhaustion the gas must begin to lose its power; and Lord Rayleigh remembers discussing with Maxwell, soon after the publication of his experiments, the whereabouts of the point at which the gas would cease to produce its ordinary effect. His apparatus, however, was quite unsuited for high degrees of exhaustion; and the failure of the law was first observed by Kundt and Warburg, at pressures below one millimetre of mercury. Subsequently the matter has been thoroughly examined by Crookes, who extended his observations to the highest degrees of exhaustion, as measured by MacLeod's gauge. Perhaps the most remarkable results relate to hydrogen. From the atmospheric pressure of seven hundred and sixty millimetres, down to about half a millimetre of mercury, the viscosity is sensibly constant. From this point to the highest vacuum, in which less than a millionth of the original gas remains, the coefficient of viscosity drops down gradually to a small fraction of its original value.

Such an achievement as the prediction of Maxwell's law of viscosity has, of course, drawn increased attention to the dynamical theory of gases. At the same time, the theory presents serious difficulties; and we can but feel, that, while the electrical and optical properties of gases remain out of relation to the theory, no final judgment is possible.

In optics, attention has naturally centred upon the spectrum. By the use of special photographic methods, Abney has mapped out the peculiarities of the invisible rays lying beyond the red with such success that our knowledge of them begins to be comparable with that of those visible to the eye. Equally important work has been done by Langley, using a refined invention of his own, based upon the principle of Siemens's pyrometer. Interesting results have also been obtained by Becquerel, whose method is founded upon a curious action of the ultra-red rays in enfeebling the light emitted by phosphorescent substances. One of the most startling of Langley's conclusions relates to the influence of the atmosphere in modifying the quality of solar light. By the comparison of observations made through varying thicknesses of air, he shows that the atmospheric absorption tells most upon the light of high refrangibility; so that, to an eye situated outside the atmosphere, the sun would present a decidedly bluish tint.

Cornu has made use of the fact that the refrangibility of a ray of light is altered by a motion of the luminous body to or from the observer to determine whether a line is of solar or atmospheric origin. For this purpose a small image of the sun is thrown upon the slit of the spectroscope, and caused to vibrate two or three times a second, in such a manner that the light entering the instrument comes alternately from the advancing and retreating limbs. As the sun is itself in rotation, and thus the position of a solar spectral line is slightly different according as the light comes from the advancing or from the retreating limb, a line due to absorption within the sun appears to tremble, as the result of slight alternately opposite displacements. But, if the seat of the absorption be in the atmosphere, it is a matter of indifference from what part of the sun the light originally proceeds; and the line maintains its position in spite of the oscillation of the image upon the slit of the spectroscope.

The instrumental weapon of investigation, the spectroscope itself, has made important advances. The magnificent gratings of Rowland are a new power in the hands of the spectroscopists, and, as triumphs of mechanical art, seem to be little short of perfection.

The great optical constant, the velocity of light, has been the subject of three distinct investigations by Cornu, Michelson, and Forbes. As may be supposed, the matter is of no ordinary difficulty, and it is therefore not surprising that the agreement should be less decided than could be wished. From their observations, which were made by a modification of Fizeau's method of the toothed wheel, Young and Forbes drew the conclusion that the velocity of light *in vacuo* varies from color to color, to such an extent that the velocity of blue light is nearly two per cent greater than that of red light. Such a variation is quite opposed to existing theoretical notions, and could only be accepted on the strongest evidence. Mr. Michelson, whose method (that of Foucault) is well suited to bring into prominence a variation of velocity with wave-length, has recently repeated his experiments with special reference to the point in question, and has arrived at the conclusion that no variation exists, comparable with that asserted by Young and Forbes. The actual velocity differs little from that found from his first series of experiments, and may be taken to be 299,800 kilometres per second.

It is remarkable how many of the playthings of our childhood give rise to questions of the deepest scientific interest. In spite of the admirable investigations of Plateau, it still remains a mystery why soapy water stands almost alone among fluids as a material for bubbles. The beautiful development of color was long ago ascribed to the interference of light, called into play by the gradual thinning of the film. Some of the phenomena are, however, so curious as to have led excellent observers like Brewster to reject the theory of thin plates, and to assume the secretion of various kinds of coloring-matter.

When the thickness of a film falls below a small fraction of the length of a wave of light, the color disappears, and is replaced by an intense blackness. Professors Reinold and Rücker have recently made the remarkable observation, that the whole of the black region, soon after its formation, is of uniform thickness, the passage from the black to the colored portions being exceedingly abrupt. By two independent methods, they have determined the thickness of the black film to lie between seven and fourteen millionths of a millimetre; so that the thinnest films correspond to about one-seventieth of a wave-length of light. The importance of these results in regard to molecular theory is too obvious to be insisted upon.

In theoretical acoustics, progress has been steadily maintained, and many phenomena which were obscure twenty or thirty years ago, have since received adequate explanation. If some important practical questions remain unsolved, one reason is that they have not yet been definitely stated. Almost every thing in connection with the ordinary use of our senses presents peculiar difficulties to scientific investigation. Some kinds of information with regard to their surroundings are of such paramount importance to successive generations of living beings, that they have learned to interpret indications, which, from a physical point of view, are of the slenderest character. Every day we are in the habit of recognizing, without much difficulty, the quarter from which a sound proceeds; but by what steps we attain that end has not yet been satisfactorily explained. It has been proved, that, when proper precautions are taken, we are unable to distinguish whether a pure tone (as from a vibrating tuning-fork held over a suitable resonator) comes to us from in front, or from behind. This is what might have been expected from an *a priori* point of view; but what would not have been expected is, that with almost any other sort of sound, from a clap of the hands to the clearest vowel-sound, the discrimination is not only possible, but easy and instinctive. In these cases it does not appear how the possession of two ears helps us, though there is some evidence that it does; and, even when sounds come to us from the right or left, the explanation of the ready discrimination which is then possible with pure tones is not so easy as might at first appear. We should be inclined to think that the sound was heard much more loudly with the ear that is turned towards than with the ear that is turned from it, and that in this way the direction was recognized. But, if we try the experiment, we find, that, at any rate with notes near the middle of the musical scale, the difference of loudness is by no means so very great. The wave-lengths of such notes are long enough, in relation to the dimensions of the head, to forbid the formation of any thing like a sound-shadow, in which the averted ear might be sheltered.

In concluding this imperfect survey of recent progress in physics, Lord Rayleigh said emphatically that much of great importance had been passed over altogether. He should have liked to speak of those far-reaching speculations, especially associated with the name of Maxwell, in which light is regarded as a disturbance in an electro-magnetic medium. Indeed, at one time, he had thought of taking the scientific work of Maxwell as the principal theme of his address. But, like most men of genius, Maxwell delighted in questions too obscure and difficult for hasty treatment; and thus, much of his work could hardly be considered upon such an occasion as the present. Maxwell's endeavor was always to keep the facts in the foreground; and to his influence, in conjunction with that of Thomson and Helmholtz, is largely due that elimination of unnecessary hypothesis which is one of the distinguishing characteristics of the science of the present day.

In speaking unfavorably of superfluous hypothesis, Lord Rayleigh did not wish to be misunderstood. Science is nothing without generalizations. Detached and ill-assorted facts are only raw material, and, in the absence of a theoretical solvent, have but little nutritive value. At the present time, and in some departments, the accumulation of material is so rapid that there is danger of indigestion. By a fiction as remarkable as any to be found in law, what has once been published, even though it be in the Russian language, is usually spoken of as 'known;' and it is often forgotten that the rediscovery in the library may be a more difficult and uncertain process than the first discovery in the laboratory. In this matter, we are greatly dependent upon annual reports and abstracts, issued principally in Germany, without which the search for the discoveries of a little-known author would be well-nigh hopeless. Much useful work has been done in this direction in connection with our association. Such critical reports as those upon hydro-dynamics, upon tides, and upon spectroscopy, guide the investigator to the points most requiring attention, and, in discussing past achievements, contribute in no small degree to future progress. But, though good work has been done, much yet remains to do.

In estimating the present position and prospects of experimental science, there is good ground for encouragement. The multiplication of laboratories gives to the younger generation opportunities such as have never existed before, and which excite the envy of those who have had to learn in middle life much that now forms part of an undergraduate course. As to the management of such institutions, there is room for a healthy difference of opinion. For many kinds of original work, especially in connection with accurate measurement, there is need of expensive apparatus; and it is often difficult to persuade a student to do his best with imperfect appliances, when he knows that by other means a better result could be attained with greater facility. Nevertheless, it seems important to discourage too great reliance upon the instrument-maker. Much of the best original work has been done with the homeliest appliances; and the endeavor to turn to the best account the means that may be at hand develops ingenuity and resource more than the most elaborate determinations with ready-made instruments. There is danger, otherwise, that the experimental education of a plodding student should be too mechanical and artificial, so that he is puzzled by small changes of apparatus, much as many school-boys are puzzled by a transposition of the letters in a diagram of Euclid.

In closing, Lord Rayleigh touched on the 'Greek question,' or 'Greek and Latin question,' and tried to ease the fears of the good souls who fear some day to awake and find their souls are no longer their own, but have been made away with by some scientific investigator.

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

U. S. geological survey.

(Work proposed for the ensuing fiscal year.)

THE plans for work to be done during the year ending June 30, 1885, have been matured as follows, subject to the exigencies of the service: —

North Atlantic district. Topography. — The work done during the past year, in this district, by the authority of the secretary of the interior, will be continued under the general direction of Mr. Henry Gannett. Recognizing the value of the work in progress in Massachusetts, the governor recommended and the legislature appropriated a sum of forty thousand dollars, to be expended during three years — ten thousand the first year, and fifteen thousand during two succeeding years — for topographic work, to be done under the general direction of a commission appointed to co-operate with the geological survey. This commission consists of Hon. F. A. Walker, president of the Institute of technology, Prof. N. S. Shaler of Harvard college, and Assistant H. L. Whiting of the coast-survey. Four parties will be put in the field, in charge of Messrs. H. F. Walling, Anton Karl, J. D. Hoffman, and S. H. Bodfish respectively, assisted by Mr. W. G. Newman and others. The topographic work by the state of New Jersey having ceased, and the material having been transferred to the geological survey without expense to the United States, it is proposed that the topographical work be taken up by Mr. C. C. Vermeule, aided by competent assistants, under the general superintendence of Prof. George H. Cook, state geologist, who gives his services gratuitously for that purpose.

General geology. — General geological work will be carried on in New England under the direction of Prof. R. Pumpelly.

South Atlantic district. Topography. — The work begun in 1882 will be continued under the general direction of Mr. Gilbert Thompson. Six topographical parties will enter the field under Messrs. C. M. Yeates, Morris Bien, F. M. Pearson, W. A. Shumway, and one other; there will be also two triangulation parties, one under S. S. Gannett, with general assistants Messrs. Wilson, Blair, McKinney, Oyster, Hackett, Hayes, Wakefield, Niblack, Michler, and Harrison. The area it is proposed to survey includes that portion of the Appalachian region comprised in eastern Kentucky, south-western Virginia, western North Carolina, eastern Tennessee, north-western South Carolina and Georgia, and northern Alabama.

General geology. — This part of the work in this district will be in charge of Mr. G. K. Gilbert, assisted by Messrs. I. C. Russell, Ira Sayles, H. R. Geiger, J. C. White, and W. D. Johnson. The work begun in the District of Columbia will be suspended during the absence of parties in the field, but the geology will be extended by Mr. McGee through parts of Virginia and Maryland.

Southern Mississippi and Rocky Mountain district. Topography. — Excepting in Yellowstone National Park, the general direction of work in this district will be taken by A. H. Thompson. In Arizona two parties, under H. M. Wilson and A. P. Davis, will be assisted by Messrs. Holman, Wallace, Maher, and Chapman. In Texas, Mr. E. M. Douglas will direct the work, as will Mr. R. U. Goode, with Messrs. Hawkins and Ratcliff assisting, in parts of Kansas, Missouri, and Arkansas. Some astronomical work in this district will be executed by Mr. Robert S. Woodward, assisted by Bushrod Washington. In the Yellowstone National Park, Mr. J. H. Renshawe will remain in charge of the work, assisted by Ensigns Chase and Garrett and Mr. S. A. Aplin.

Geology. — Arnold Hague, assisted by Messrs. Iddings, Weed, Wright, and Davis, will carry on the geological survey of the Yellowstone Park.

Northern Mississippi and Rocky Mountain district. Geology. — The survey of the glacial formations in this district will be continued under Prof. T. C. Chamberlin, assisted by Messrs. Salisbury and Todd. General geological work in Michigan, Wisconsin, and Minnesota, will be continued, as heretofore, under the direction of Mr. R. D. Irving, assisted by Messrs. Chauvenet, Daniells, C. W. Hall, Vanhise, and Merriam. Dr. F. V. Hayden will re-enter upon his investigations of the geology of the Upper Missouri, assisted