There are many other minor agencies scattered through the Departments which contribute much to the development of the country's resources.

The total appropriations for 1897 to the Departments and Bureaus above described as engaged in promoting science and the development of the country amount to $7,984,559.38.

The total number of employees in the above Departments and Bureaus is, not including the Census, 5,225.

GEOLOGICAL SOCIETY OF AMERICA: NINTH ANNUAL MEETING, WASHINGTON, DECEMBER 29-31, 1896.

THE Geological Society of America was called to order for its ninth annual meeting in the lecture room of the National Museum at 10 a. m., December 29th; President Joseph LeConte, of Berkeley, Cal., in the chair. An address of welcome was delivered by Mr. Charles D. Walcott, Director of the United States Geological Survey, to which a response was given by President LeConte. The local reception committee, through its chairman, Mr. S. F. Emmons, stated the arrangements that had been made for the entertainment of the Society, which included a daily lunch in the museum, a trip through the new Congressional Library with Capt. Green, the Superintendent, and the privileges of the Cosmos club to the fellows and their friends.

The Council presented its printed report, which was laid on the table for one day. Messrs. Hague and Kemp were appointed a committee to audit the accounts of the the Treasurer. The result of the election of officers for the ensuing year was then announced as follows: President, Edward Orton; First Vice-President, J. J. Stevenson; Second Vice-President, B. K. Emerson; Secretary, H. L. Fairchild; Treasurer, I. C. White; Editor, J. Stanley-Brown; Councilors, J. S. Diller, W. B. Scott.

The following fellows were also elected: Rufus Mather Bagg, Assistant in Geology at Johns Hopkins University and on the Maryland Geological Survey; Erwin Hinkley Barbour, Professor of Geology in the University of Nebraska; Samuel Walker Beyer, Assistant Professor of Geology, Iowa Agricultural College, Ames, Ia.; Arthur P. Coleman, Professor of Geology, Toronto University; Henry Stewart Gane, Assistant Geologist, U. S. Geological Survey; John Bonsall Porter, Professor of Mining, McGill University, Montreal; Arthur Coe Spencer, Assistant Geologist, U. S. Geological Survey.

A memorial of Robert Hay was then read by R. T. Hill, and one of Charles Wachsmuth, written by Samuel Calvin, was read by J. Stanley-Brown. A memorial of N. J. Giroux was postponed until the following meeting, as the manuscript was not at the moment available.

The reading of papers was then immediately taken up.

Crater Lake. J. S. DILLER, Washington, D. C.

Crater Lake is deeply set in the summit of the Cascade Range, of Southern Oregon. It is remarkable for its beauty and depth, the grandeur of its encircling cliffs and its geological history. During the glacial period the site of the lake was occupied by a huge volcano comparable in size with Shasta or Rainier. Since then the upper third has disappeared and a pit has formed in its base 4,000 feet deep. The pit is half filled with water forming Crater Lake. The paper was illustrated by lantern slides, and in the course of its presentation the crater lakes of Europe were briefly reviewed and compared with the one in Oregon. The lava flows were described and the peculiar radiating and glaciated valleys that pass out from the cone downwards, but that end in the air upwards. All the phenomena indicated a sinking in, absorption and withdrawal of the cone, leaving the present depression. In discussion President Le

Conte described his own visit to the lake in earlier years with Capt. Dutton, and H. F. Reid inquired as to the amount of erosion visible in the cliffs surrounding the water, to which Mr. Diller replied that there were no beaches to indicate it. On this line Prof. Shaler remarked the great increase in size that had been brought about in the Italian lakes by wave action and the need of caution in estimating the amount of rock that had been engulfed. He also cited the complex character of certain of the Italian ones. Mr. Diller replied that Crater Lake was a unit and gave reasons for thinking that it had not been much enlarged. Mr. Turner cited the vast tuff deposits of the Sierras, which he attributed to mud-flows of tuffs on a grand scale and suggested the applicability of the idea to some of the earlier phenomena in the history of Crater Lake.

The Leucite Hills, Wyoming. J. F. Kemp, New York, N. Y.

After a brief review of the occurrence of leucite the world over and especially in North America, the lantern was used to show the geographical situation and distribution of the Leucite Hills. Three of the outcrops, viz: the Leucite Hills proper, Orenda Butte and Black Rock Butte were described with photographs. Photomicrographs were next used to illustrate the rocks. It was shown that while leucite was as rich in some parts of the southern mesa as described by Zirkel, yet in other places and in the buttes to the north it became more rare and sanidine came in in much greater amount. Hauyne, large augite phenocrysts with rims of biotite and inclusions of limestone and sandstone, were also described. Zirkel's description was quoted in extenso and corroborated for the portions of the flows visited by the geologist of the Fortieth Parallel Survey, but the fuller field work has indicated considerable variability. The cones which look like craters were shown to be solid and were explained as portions which were viscous when intruded so that they remained over the old vents. Pilot Butte, north of Rock Springs, was also described, and the rock was shown to consist of augites and biotite in an isotropic base, regarded as glass. The determination of it as trachyte in Volume II. of the Fortieth Parallel Survey was therefore questioned.

Mr. Cross in discussion spoke of his own visit to the Hills twelve years before, and of the general parallelism of his observations with those of the speaker. Mr. Kemp expressed the hope that Mr. Cross would publish his observations and analyses at the earliest convenient date.

The Solution of Quartz under Atmospheric Conditions. C. Willard Hayes, Washington, D. C.

The projecting portions of quartz pebbles in conglomerates at a number of localities in the South have been found deeply etched, and chalcedonic quartz nodules partially dissolved. The chemical conditions under which the solution may have been effected were considered, and the bearing of the facts observed on the problems of erosion briefly pointed out. The latter point was more fully discussed in Mr. Campbell's paper on 'Erosion at Baselevel,' which followed. Mr. Hayes described the solution of the silica as occurring in a region of heavy forest where fires are frequent. In this way both organic acids and alkaline salts are afforded which effect the solution. Specimens were passed around in illustration which were very significant. Mr. Kemp, in discussion, called attention to the parallel conclusions reached by Dr. A. A. Julien in his study of the talus of the Palisades some years before. Mr. Gilbert cited the recent cementation of sands with silica in the arid regions of the West, and remarked the varying be-

havior of different forms of silica under solvents, some being easily attacked, others very resistant. Prof. Shaler raised the point that it was a reaction taking place on or near the surface and not in depth. Prof. Emerson described his observations on the schists and traps of the Connecticut Valley, where quartz and silicates on the surface were resistant, but where exposed in crevices to the drip of mosses and lichens they were deeply affected. Prof. Stevenson cited the sandstones of central Pennsylvania, where some were greatly corroded on the outcrops, whereas others, such as the White Medina, were very smooth. I. C. White corroborated the last speaker, and cited the change of flint to chalcedony in the lower Carboniferous limestones. M. R. Campbell described the smooth character of the Medina in Virginia at the surface, but its pitting under cliffs where exposed to dripping water. As the following paper was on the same general subject, practically the same discussion continued in connection with it.

Erosion at Baselevel. MARIUS R. CAMPBELL, Washington, D. C.

Many local baselevel plains in the Appalachian coal field show a sharp line of demarcation between the level floor of the basin and the surrounding slopes. Since the streams are too sluggish to mechanically transport the waste of the land, this condition can be explained only by supposing that most, if not all, of the material which is swept in from the surrounding slopes is removed by solution when it reaches the floor of the basin.

Etched quartz pebbles and geodes are evidence that under favorable conditions silica may be dissolved; therefore it remains to determine whether such conditions are liable to be present on a baselevel plain. The solution of the quartz appears to take place only in the presence of decaying vegetation, consequently the swampy character of such a plain would offer almost ideal conditions for the removal of the silica as fast as it is washed in from the surrounding slopes. The alumina is still unaccounted for, but the question was raised that some similar reaction may take place, which removes this compound also.

Mr. Turner; in discussion, emphasized the preeminent insolubility of the quartz that forms the veins of the Sierras, as shown by its occurrence in the prevailing boulders of the local conglomerates. He stated that the pitting of chalcedony may be due to the solution and removal of limestone. Mr. Keith also supported the insolubility of the quartz and cited the baselevel superficial soils and gravels near Washington. The residual pebbles are derived from the quartz veins, whereas the other minerals of the gneisses are only represented by a red clay. Mr. Hayes, in support of Mr. Campbell's position, mentioned the ponds in the plateau of the Coal Measures of the South, which plateau is deeply dissected by streams. He stated that much silica might be removed and yet no pitting result to indicate it. Dr. Wadsworth mentioned his own observations on the Potsdam and St. Peter's sandstones of Wisconsin, made many years ago. An outer shell of hardened rock forms by redeposition of silica, and may even be appreciable within a year's time. He also mentioned the well recognized removal of silica in the formation of the soft hematites of Lake Superior, and emphasized its ready and great solubility under favorable conditions. Professor LeConte laid stress on the solubility of different forms of silica, and Mr. Hayes, in closing the discussion, admitted freely the frequent insolubility of quartz, but still urged the significance of the observations of Mr. Campbell and himself, which, indeed, were unassailable.

The Origin of Certain Topographic Forms. MARIUS R. CAMPBELL, Washington, D. C.

This paper consisted of a study of the various conditions affecting erosion for the purpose of determining the origin of certain exceptional surface features which have not hitherto been satisfactorily explained. The writer reaches the conclusion that local radial movements of the crust of the earth are largely responsible for the exceptional physiographic features.

This theory was then applied to the North Carolina section of the Blue Ridge, and it was shown that the striking features of that region can be explained by supposing a monoclinal uplift to have occurred along the eastern front of the Ridge while the main body of the Piedmont plain remained at sea level. On this assumption the various remnants of peneplains in the Blue Ridge region correspond to halts in the general uplift, and they collectively represent the same, or a portion of the same time interval which is marked by the Piedmont plain to the eastward of the uplift.

Since local uplifts are liable to occur at any time and in any place, the resulting forms may be found in other localities than the Appalachians, and physiographers should learn to distinguish them, for they constitute a record of exceptional conditions.

The paper was illustrated by a large map which brought out the position of the Appalachians south of Roanoke, Va., to which the hypothesis especially applied, but the region of the Black Hills was also cited as a promising place in which to test it.

Mr. Keith, in discussion, spoke in opposition to Mr. Campbell's view and sketched a district on the Nahantahala and Hiwassee rivers in support of his contention. It was later shown that the district, however, was not in the region described by Mr. Campbell and had but limited bearings on his thesis.

Homology of Joints and Artificial Fractures. J. B. Woodworth, Cambridge, Mass.

A synopsis of the structure of the typical joint was given from a previous paper (Proc. Boston Soc. Nat. Hist., Vol. XXXIV, 1896, pp. 163–183). A series of specimens showing the relations between joints and artificially fractured surfaces was exhibited. Obliquity of the biplanes in the margin of fractures is found of value in determining the axis of breaking tension arising from tension, contraction or shearing force. Incidentally, a map symbol for joints was proposed.

The paper was illustrated by an excellent and striking series of lantern slides which made the matter clear.

Physiographic Development of the District of Columbia Region. N. H. Darton, Washington, D. C.

An outline of the physiographic conditions which have characterized each of the earlier stages in the Coastal Plain history of the region and a description of the development of the present topography was presented in a very interesting manner. By means of lantern slides from maps and photographs, the ups and downs of the old shore-lines were shown and the formation of the terraces. In this way the development of the Potomac, Magothy, Severn, Chesapeake, Lafayette and lower and upper Columbia formations were traced.

Dikes in Appalachian Virginia. N. H. Darton, Washington, D. C.

An announcement of further discoveries of diabase dikes and of interesting dikes of acidic eruptives among the Paleozoic rocks of central Appalachian Virginia. When the specimens were passed around, the acidic intrusions, containing, as they did, quartz, feldspar, mica and hornblende phenocrysts in a white ground mass, excited extreme interest, and, as remarked by J. E. Wolff, were very similar to the quartz-mica-porphyrite in the Cortlandt series, near Montrose, N. Y.

On the Changes of Drainage in the Ohio River Basin. FRANK LEVERETT, Denmark, Iowa.

A brief outline of the results of earlier observations on the Ohio and tributaries was followed by a presentation of the results of the writer's studies the past season. The principal topics discussed were as follows: 1. The extent and probable date of deposition of marine deposits found on the lower Ohio, in Indiana, Kentucky and Illinois. 2. Comparison of the probable early drainage systems with the present system. 3. Factors leading to changes of drainage. 4. An interpretation of the relative influence of the several factors in producing the changes of drainage which have occurred in the Ohio River basin. In developing this general plan the writer described, by means of a map, the present drainage systems of western Pennsylvania and their probable discharge, through northerly outlets, now indicated by present streams, into Lake Erie. The former limit of the northerly drainage was probably along the Panhandle of West Virginia. The old drainage lines were detected by following up the remnants of the fluvial plains. Of the three possible causes of change in drainage systems, viz, uplift, stream piracy and glaciation, the last named was regarded as most probable. Prof. G. F. Wright opened the discussion by objecting to some of the proposed northerly outlets as of insufficient size to carry the volume of water. H. P. Cushing later on supported this objection strongly in the case of the Cuyahoga river. Mr. Leverett replied that the gorge was as large as that of the present Ohio below Louisville. M. R. Campbell endeavored, by means of the changes suggested by Mr. Leverett, to account for the puzzling phenomenon of Teazes Valley and its boulders from the New River Basin; but I. C. White, who originally discovered and described Teazes Valley, stated that it could be satisfactorily explained by the Mud and Guyandotte rivers, which now partially traverse it. Prof. Orton remarked the depth of the drift in northwestern Ohio, and the debt that geology owed to the drillers who had shown many buried channels in prospecting for oil. The depth is over 500 feet in some channels. The peculiar relations of the Mercer reservoir and the difficulty of explaining it were also touched on. Prof. Shaler emphasized the stability and lack of change in the drainage lines of Kentucky and his disbelief that ice had ever crossed the Ohio river, on the ground that water would satisfactorily explain the observed phenomena in Kentucky.

The Society then adjourned until the following day at 10 a. m. The fellows were very generally entertained by the resident geologists of Washington during the early evening, and at 8:30 reassembled in the large hall of the Columbian University to listen to the Presidential address of the retiring President, Prof. Le Conte, upon the title, 'The Different Kinds of Earth Crust Movements and Their Causes.'

DECEMBER 30, 1896.

The Council met at 9 a. m., and the Society at 10. The report of the Council as previously printed and distributed was adopted. A memorial of N. J. Giroux, written by Mr. R. W. Ells, was read by Prof. F. D. Adams. The photograph committee then reported through its chairman, Mr. G. P. Merrill. 179 views were received during the year, bringing the total up to 1429. The auditing committee reported favorably regarding the Treasurer's accounts. The Secretary announced that the Council recommended a change in the constitution so as to add the Editor to the Council, and some other verbal changes, all of which will be acted on one year hence. The reading of papers was then resumed.

Notes on the Structure of the Cranberry District in North Carolina. Arthur Keith, Washington, D. C.

The paper opened with a sketch of the topography, drainage and geology of the district. The latter involves seven members below the Siluro-Cambrian limestones. They are in general schists and gneisses and Pre-Cambrian volcanics. A sketch map was used to illustrate the faults of the region. Great folds also intervene. Faults occasionally show breccias and slickensides, but these are not marked. Pressure has caused metamorphism and schistosity. Remarkable cases of sheared conglomerates of quartz porphyry and granite pebbles were exhibited. The phenomena gave accurate data for determining the depths of zones of crushing and flowage. A great shear zone in an east and west line, with a passage of the southern part beyond the northern, was described. The curious behavior of sediments regarding the hard crystallines, and their strange relations to them, if we assume a simple case of compressive stress, transmitted by the sediments, leads the author to believe in the upthrust of the crystallines through and over the sediments.

Note on the Stratigraphy of Certain Homogenous Rocks. C. H. Hitchcock, Hanover, N. H.

The object of the note was to call attention to recent discoveries of obscure planes of stratification cutting the cleavage at large angles, as noted in two formations in the upper Connecticut Valley. These discoveries will make it necessary to question the reliability of many of the observations hitherto made as to the positions of the strata.

The speaker described an argillite and a quartzite at Thetford, near Hanover, whose true bedding he had been unable to discover until lately. Finally the true stratification was identified in many lines nearly at right angles with the cleavage and as indicated by little quartz veins. Quartzite in another locality was also shown to have suffered so much change that its stratification was obliterated. Various examples were further cited to bring out the relations of cleavage and stratification. In discussion, Mr. Lane asked if the observations of Prof. Hitchcock and Mr. Keith carried out Van Hise's rule that cleavages cutting stratification at right angles indicated the presence of synclines and anticlines. Messrs. Hitchcock and Keith replied that so far as their observations went they did.

Unconformities in Martha's Vineyard and Block Island. J. B. Woodworth, Cambridge, Mass.

Beginning below, plant-bearing beds of Cretaceous age appear in both islands without their base being exposed. On Martha's Vineyard marine Cretaceous strata overlie the plant beds; but contact has not been worked out. Above the Cretaceous and on an eroded surface rests the Miocene of Lyell and Dall, composed of (*a*) the osseous conglomerate, (*b*) the green sand, (*c*) the yellowish green sand. There was erosion in the area between (*a*) and (*b*), probably also between (*b*) and (*c*). Fragments of a Pliocene formation have been detected at Gay Head, but little is known regarding it. A marked unconformity now appears on Gay Head and Block Island at the base of the lowest Pleistocene boulder formation. The Miocene has been locally swept away at Gay Head. On Block Island this early Pleistocene rests upon the surface of the Cretaceous white clays, the Miocene being entirely unknown. There was probably some folding of strata at Gay Head before the deposition of this boulder bed. After the deposition of from 25 to 50 feet of compound gravels and sands, more folding took place over Martha's Vineyard and Block Island. The Mohegan Bluff beds on Block Island and the Tisbury beds on Martha's

Vineyard, of glacial origin, were now laid down on eroded surface of folded older strata. In the Vineyard subepoch of erosion the islands were deeply denuded; then followed the last glacial epoch with deposition of moraines and sand plains.

W. B. Clark, in discussion, called attention to the parallelism of the Cretaceous and Miocene on these islands and in New Jersey and Maryland. David White on paleobotanic evidence of age stated that the plant-bearing clays belonged with the Amboy clays. He also commented on the interest attaching to the subdivision of the Tertiary beds. G. K. Gilbert remarked the complexity of the later Pliocene and glacial deposits, involving, as they do, very coarse and fine components, and coinciding with Chamberlin's observations in the West. David White inquired about the correlation of the beds of the Elizabeth Islands with those of the Vineyard. Mr. Woodworth replied that it could at present be but roughly carried out.

The Cementing Materials of the Tertiary Sands and Gravels of Western Kansas. ERASMUS HAWORTH.

In the absence of the author an abstract was given by G. K. Gilbert, who stated that the cementing material proved to be aragonite with subordinate calcite, and sketched the relation of the deposition of the cement to the conditions of aridity in earlier times.

The Work of the United States Geological Survey in the Sierra Nevada. H. W. TURNER.

The speaker had a series of geological atlas sheets of the work in the Sierras and, using these as illustrations, outlined the large features of the geology.

President LeConte remarked the complexity of the geology of the Sierras. In reply to a question of J. E. Wolff regarding the age of the granodiorites, Mr. Turner replied that they were late Jurassic or early Tertiary and that they exhibited remarkable examples of contact metamorphism on the Jurassic slate. Mr. Walcott remarked the completion of the work on the Gold Belt and the plans for the future work of the Survey in the Sierras.

The Cornell Glacier, Greenland. RALPH S. TARR, Ithaca, N. Y.

The speaker outlined the old view of the continuous ice sheet from Greenland to North America, and the later views of Chamberlin and Salisbury regarding the limited and strictly insular character of it. He described the angular topography of the highlands in the interior, and the more rounded, glaciated slopes terminating in cliffs near the coast, interpreting even the jagged mountains as compatible with glaciation. The location of last summer's work was shown and the Cornell glacier was described. The local rocks are gneiss and schists with diabase dikes. The hills are rounded toward the ice, but are angular toward sea. The ice has covered in recent times Wilcox Peninsula and Duck Islands, showing an extension 30 or 40 miles beyond its present position and from 3,000 to over 7,000 feet thick. The ice is now retreating. Reference points were established from which to measure future movements. All the nunataks have been glaciated, though now bare.

G. F. Wright remarked the parallelism between these observations and his own on the edge of the Arctic circle.

Prof. Heilprin also corroborated the conclusions given about the former larger extent of the ice from his own observations in the region and especially on the Island of Disco. The coast was outlined and the character described from Disco to Robertson Bay. The observations of all these speakers, as well as the important paper of Mr. Barton which followed, flatly controverted the views which have recently been expressed regarding the former extent of the ice and certain of its local phenomena.

Shore-lines of Lake Warren, and of a Lower Water-level, in Western Central New York. H. L. Fairchild, Rochester, N. Y.

The beach of the glacial Lake Warren has been traced with practical continuity from Crittenden, N. Y., where long known, eastward to beyond the meridian of Rochester, with an altitude of about 880 feet. A lower beach, with an altitude of 700 feet and of good development, has been detected for a considerable distance, and other evidences of static water at this level extend over a wide area.

The paper was illustrated by a colored map of New York State showing the outlines of Lakes Warren and Iroquois. The speaker sketched the recent views of Lake Warren's restricted area, and of its outlet into the lake formerly in the basin of Lake Michigan, called Lake Chicago. The tracing of another strong beach above Geneva was also shown, and presumably a continuation of the beach at Chittenden followed. The reading of the next paper took place before discussion.

Old Tracks of Erian Drainage in Western New York. G. K. Gilbert, Washington, D. C.

The last stage of Lake Warren was ended by the shifting of the outlet from Michigan to New York. Between that date and the establishment of the Niagara River the discharge from the Erie basin crossed western New York on lines determined by the relations of the shifting ice margin to the topography.

Attention was called to Lake Warren, which stood 500 feet above Lake Iroquois, and to the areal distribution of both. The spillways were described that were scoured out, when, on the removal of the ice barrier that held back Lake Warren, the water fell to the level of Warren. These old lines of drainage were described with their boulder pavements, cataracts and one-sided channels, formed when the ice presented the other side. The speaker showed these at various points, of which those between Rochester and Niagara Falls are of especial interest. Inference about the east and west alignment of the ice front were also drawn.

G. F. Wright inquired about the relations of the lakes with the Horseheads outlet and later remarked the fresh topography of the spillways. R. S. Tarr also asked about the correlation of the beaches with the Cayuga Lake terraces. Mr. Gilbert replied that Horseheads was at that time higher than the water plane and that he had attempted no correlation with the terraces of Cayuga Lake

The Assumed Glaciation of the Atlas Mountains, Africa. Angelo Heilprin, Philadelphia, Pa.

Vast boulder and pebble deposits cover a large part of the region of North Africa, both at sea-level and on the inland plateaus (and mountain slopes) to 3,000 feet elevation and more. These have in places much the appearance of morainic and true drift material, and as such have been described by some geologists and geographers. But their relations are with oceanic and torrential modelling of the land surface and they give no basis for the supposition that ice action was involved in their making. Neither on the highest points of the Atlas Mountains in Algeria nor on their slopes were any evidences of glaciation met with.

The observations were gathered during a trip across the Atlas Mountains the past summer, through Tunis and Morocco into the Sahara. A resumé was given of previous observations on the supposed glaciation of some of these summits. With a sketch map of northern Africa the speaker remarked the general character of the mountains and their Alpine character. He then described the supposed glacial moraines at

various points and interpreted them as formed by water. No striation, polishing or glacial topography were seen. All seemed due to great accumulations in a westward arm of the Mediterranean that set in from Tunis and ran far up into the mountainous country to the westward.

The Relation of an Abandoned River Channel in Eastern Iowa to the Western Edge of the Illinois Icelobe. FRANK LEVERETT, Denmark, Iowa.

The extension of the Illinois icelobe into southeastern Iowa, discussed by the writer at the Philadelphia meeting, is found to have so blocked the drainage along the Mississippi that the line of discharge was temporarily thrown across the plains of eastern Iowa. The several rivers of eastern Iowa that now lead southeastward into the Mississippi entered this temporary line of drainage and followed it southward. A description of the channel formed by this temporary river was given, and the history of the discovery of its several sections was outlined. Inferences were drawn from it concerning the drainage conditions at the time of the culmination of the Illinois icelobe. The paper was illustrated by a sketch map of Iowa.

F. B. Taylor asked about the channel used by the river during its short cut into its present channel between Cedar river and Iowa river. Mr. Leverett replied that it followed the present channel of the Iowa river. Other remarks regarding the ancient gradients of the river were made by Prof. Reid.

Glacial Observations in the Umanak District, Greenland. GEORGE H. BARTON, Boston, Mass.

The result of studies upon the margin of the inland ice for a distance of about fifteen miles from the nearest land was given. And the character of the surface, of the marginal edges of very steep or vertical slope, of the dust holes area, of the billowy area, and of the smooth, level expanse beyond were described. Ice-walled lakes, with small tributary streams, and large streams were met. Studies upon the Great Karajak glacier, its rate of motion, character of surface and margin, movement phenomena as seen along edge, entrance into waters of fiord, its source in the ice cap with crevasses for miles inland, proved of the greatest interest. Smaller glacial tongues along the Karajak fiord, coming from the local ice cap of the Nugsuak peninsula, were described, together with studies upon the glaciers entering Itivdliarsuk fiord and observations on the former greater extension of the ice cap and the distribution of drift and the transportation of material by icebergs. The paper was graphically illustrated by a beautiful and significant series of lantern slides. C. H. Hitchcock asked about marine deposits, such as Champlain clays. Mr. Barton replied that none were met. As Mr. Barton had stated that the survey of the party had indicated a slight movement of the ice up stream near the shore, and down stream at the outer stakes in the glacier, in each case of but a fraction of a foot, Prof. Reid inquired about the accuracy of the instruments, and cited the need of readings closer than a minute. Mr. Barton replied that they had been made with a high-grade surveying transit, but as that part of the work was directed by a colleague he could not give further particulars. A. Heilprin stated the occurrence of marine deposits with shells in northwest Greenland. Mr. Barton's paper was one of the most interesting and important of the meeting and coincided with the observations of Prof. Tarr further north as earlier cited. The British Admiralty charts, for not using which Prof. Wright has been criticised, were found quite unreliable by Mr. Barton and were rejected in favor of Danish maps.

The Nipissing-Mattawa River, the Outlet of the Nipissing Great Lakes. F. B. Taylor, Fort Wayne, Ind.

When the waters of Lakes Superior, Michigan and Huron were making the Nipissing beach, their outlet was eastward over the Nipissing pass at North Bay, Ontario, to the Ottawa valley. This outlet river is called the Nipissing-Mattawa River and the three upper great lakes of that time are called the Nipissing Great Lakes. During the autumn just passed the course of the outlet river was explored. The Nipissing beach is well developed at North Bay at an altitude of about 700 feet above sea-level. On the swampy col between Lake Nipissing and Trout Lake it was a little over a mile wide with a maximum depth of about thirty feet and an average of from ten to fifteen feet. The beach is faintly but clearly marked to the foot of Trout Lake and the shore mark of the river in expanded portions and at some of its rapids was found at several points below. The best evidence of the existence of the ancient river was found where it crosses the course of a bouldery morainic deposit. The boulders in such rapids were scoured by the sand and pebbles moved along by the current into peculiar forms readily recognized. These rapids were located at moraine crossings. Others were less certainly determined. The place of one cataract was also found. In one of its rapids the ancient river was between 600 and 700 feet wide, with an average depth of 35 to 40 feet. This corresponds very closely, in a general way, with the size of the modern St. Clair and Detroit rivers. The remains of the ancient river agree with the Nipissing beach in indicating that this arrangement of the upper Great Lakes endured for a relatively long period of time.

The paper was preceded by a review of the works of previous observers. In discussion G. F. Wright remarked the interest all must feel in the establishment of this thesis and G. K. Gilbert discussed its relations to Niagara Falls as a chronometer. Increasing knowledge brings increasing complexity.

Moraines of Recession and their Significance in Glacial Theory. F. B. Taylor, Fort Wayne, Ind.

A summary of facts presented last summer at Buffalo was first given regarding moraines between Cincinnati and the Straits of Mackinaw, there being 15 in all, whose differences depend on the topography of the land. The oscillations of the ice front and the moraines is so regular in period that ups and downs of the earth's surface cannot be utilized in explaining them. We are forced to refer to astronomical causes and their effects on climate. Precession of the equinoxes, modified by the revolution of the apsides, was cited as the best cause, with intervals of 21,000 years. This time seems long, but it is corroborated by the large amount of clay in the moraines. The effects of the precessions of the equinoxes were analyzed. The oscillation was corroborated by the relations of the boulder belts in three moraines near Fort Wayne, Ind., to the line of drainage apparently taken by the river that drained the glacier.

In discussion G. K. Gilbert emphasized the interest of the ideas and spoke of them as supplying, if true, the clue for the correlation of the moraines in various regions. Frank Leverett spoke of the importance of the estimates of time and significance of the boulder belts. G. F. Wright remarked that moraines of recession with halts, still implied forward movement of the rear ice continually during halts. Mr. Taylor, in reply to the last speaker, described the moraines as having steep outer slopes and gradual slopes inward, which is only explicable by an advance of ice up to a point and then its accelerated retreat. Mr. Heilprin raised

the point that moraines in existing glaciers are steepest toward the ice and that they were the best illustration of what took place in the ice period. Inferences, therefore, regarding the relations of the old moraines to the ice should always be drawn with this in mind.

Variations of Glaciers. HARRY FIELDING REID, Baltimore, Md.

The paper gave a summary of the first annual report of the International Committee on Glaciers. Information received relating to the variations of American glaciers during the past year, as well as of those in other parts of the world, indicated a general recession, although there were some minor exceptions. Illustrations were given and an earnest appeal was made that all geologists and travelers visiting glaciers establish permanent bench marks and directions from which photographs can be taken, as other visitors may reach such regions. Very complete records can thus be made.

The reading of this paper closed the work of the day. At 7:30 p. m. the Society reassembled for the annual dinner at the Hotel Raleigh. All felt great satisfaction to see Prof. Emerson in his familiar place as toastmaster, and the presence of about fifteen ladies, mostly wives of the Fellows of the Society, started an innovation that it is to be hoped will be continued, for it improves greatly the social side of meetings. The banquet was most enjoyable from all points of view, especially in that the Society had an opportunity to extend its congratulations to the retiring President upon the approaching celebration of his golden wedding anniversary.

On Thursday morning at nine o'clock nearly all the visiting Fellows assembled at the office of Captain Green, at the new Congressional Library, and were most courteously conducted over the building. All viewed its magnificant halls and frescoes almost with astonishment, and certainly with great satisfaction that a building so long needed had at last been worthily constructed.

At 10 a. m. the regular sessions were resumed with a slim attendance, which, however, rapidly grew as the members who had been at the Library returned. It was voted that two sections be organized after the reading of the first two papers, inasmuch as it would be otherwise impossible to finish the programme. A letter was also read from Lieut. Peary outlining a plan for another expedition to Greenland next summer, in which it was hoped that various institutions would combine and locate stations for the observation and study of the ice sheet at various points along the coast and in cooperation. The Society gave its approval of the plan in a general way. The reading of papers was then resumed as follows:

Mechanics of Glaciers—Moraines and Stratification. HARRY FIELDING REID, Baltimore, Md.

Observations were made on the Forno Glacier last summer to test the ideas presented to the Society at the Philadelphia meeting. Measures of the movement were begun but not finished. What is usually called the 'ribboned structure' is probably the outcrop of the strata, as Agassiz contended.

Moraines require a new classification into: 1st, those which have their origin below the névé line; and 2d, those which have there their origin above it. The latter present characteristics which have not hitherto been carefully described. It was shown that the débris above the névé line proceeds diagonally downward into the body of the glacier itself as it becomes buried by the successive annual snowfalls that cause the general stratification. The paper was beautifully illustrated by lantern slides. Presi-

dent LeConte inquired about the relations of the phenomena of the dirt bands described by Agassiz years ago. Mr. Reid stated that he was uncertain exactly what was meant by them, but he believed them to be the same as the lines of stratification and to originate as he had described, by the annual burial of fine débris above the névé line.

The Pre-Cambrian Topography of the Eastern Adirondacks. J. F. Kemp, New York, N. Y.

The discovery of outliers of Paleozoic strata, oftentimes of very small area, far within the Archean (perhaps in part Algonkian) complex of the Adirondacks, has made possible the tracing out of some of the Pre-Cambrian topographical features. The recent completion of the topographical sheets of the U. S. Geological Survey has enabled us to illustrate the matter quite fully and with comparisons of present altitudes. It was shown that the early Paleozoic sea apparently set up into narrow embayments in what were doubtless old submerged valleys, which being now indicated by the outliers, reproduce, in a general way, some features of the old topography. The abundance of Potsdam boulders in the drift far in the hills leads to the conclusion that the Potsdam was probably more abundant in the interior before the ice invasion than now.

After a brief introduction which cited the older Cambrian deposits of Vermont and the presumptive evidence that the Adirondack crystallines were a land area, carved by erosion during Cambrian time, slides of topographic maps colored hypsometrically as well as geologically were thrown on the screen and the facts on which the conclusions were based were thus illustrated, due allowance being made for faulting. Crystalline limestones have largely determined the valleys.

In discussion M. R. Campbell inquired if any variety in the basal Potsdam had been noted in different regions, to which the speaker replied that on the east and southeast almost none were apparent. R. S. Tarr remarked the parallel conditions in New Jersey, where, however, folding has supervened. H. P. Cushing described similar phenomena on the north side of the Adirondacks, and especially outliers of crystallines entirely surrounded by Potsdam, and the projection of the latter into the mountains where limestone occurred. F. D. Adams instanced the same relations in Canada around the old Laurentian protaxis, and in particular referred to the observations of Mr. Low in Labrador, showing very strikingly the gradual encroachment of Cambrian and Ordovician sediments into embayments in the old crystallines. A. C. Lane remarked the parallel phenomena in Michigan. H. F. Reid inquired about the amount to which the strata were tilted, to which the speaker replied that the Paleozoics were all notably flat and seldom reached 15 degrees.

The Society then divided into two sections. The one in which the petrographic papers and those dealing with the crystalline rocks were presented assembled in the rooms of Dr. G. P. Merrill of the Museum, the others remaining in the original hall. In the latter the first paper presented was the following, the report for which and the following is based on notes kindly taken by Prof. H. S. Williams and from the abstracts furnished by several authors.

On the Southern Devonian Formations. Henry S. Williams, New Haven, Conn.

The remarkable contrast between the northern and southern Devonian formations was shown. The former consists of a considerable number of separate formations, of differing kinds of sediments, and holding separate and distinct faunas and together

making a series of rocks several thousand feet in thickness, while the southern representations of the Paleozoic series in Tennessee and Alabama is a single formation composed of a single kind of sediment, the Black Shale, and holding, when pure, only one fauna of very few species. It occupies the whole interval between the Silurian and Carboniferous strata. In order to account for the differences the principles of (a) difference of origin for rock: (viz. (1) organic and (2) fragmental), and (b) the sorting power of moving waters were found applicable to most of the cases, but not to account for the origin of the black shales or of the Oriskany.

For the explanation of the Black Shale an origin of the sediments was found in the decay of Lower Silurian limestones composing the surface of the Cincinnati plateau, which occupied the center of the great interior continental basin. The distribution of these black shale muds was accounted for by oceanic currents. Their absence from central Tennessee and neighboring tracts was referred to the scouring of the shallows and to lack of sedimentation; the absence of other faunas to the fatal effects of the fine mud upon marine life. The time of beginning of the sediments was placed at the close of the crisis which brought in the Oriskany sediment; the black color was explained by Sargasso-sea vegetation. The Oriskany formation and its distribution from a center in eastern New York, along the northern shores of the intercontinental basin and along the eastern shores, decreasing in force with extension southward, and its absence west of the Cincinnati plateau, were explained as the result of sinking of the northeast rim of the basin in the Lake Champlain region sufficient to open communication through the St. Lawrence valley, past Montreal, with the eastern sea, and allowing of extensive wash by tidal flows through the estuary or channel, thus bringing into the basin great quantities of coarse sand and the new Oriskany fauna.

In the discussion that followed Mr. Hayes called attention to the thickening of the black shale at its extreme extension southward in Alabama, thus confirming the probability that there was land elevation in that direction during Devonian time.

A Complete Oil Well Record in the McDonald Field between the Pittsburg Coal and the Fifth Oil Sand. I. C. WHITE.

The speaker stated that a new well had been sunk at Pittsburg from the Pittsburg coal seam, 5,800 feet to or below the Carboniferous. Samples had been preserved every five feet, and the well is to go 500–600 feet deeper, making it the deepest well in America and second only to one in Germany.

Structure of the Newark Formation of Western New Jersey. HENRY B. KÜMMEL, Chicago, Ill.

The sedimentary rocks of the Newark formation in western New Jersey are divisible into three subdivisions to which the geographical names Stockton, Lockatong and Brunswick have been given provisionally. The Stockton beds are the lowest and consist of arkose conglomerates and sandstones, freestones and red shales, interbedded and many times repeated. The arkose beds are characteristic of this subdivision. The Lockatong beds are next and consist of hard, black and dark green argillites and shales with some red flagstones. The black argillites are characteristic of this division. The Brunswick beds consist in the main of soft red shales with a few sandy layers. Along the northwest boundary all three divisions lose their type character and grade along the strike into coarse sandstones or massive conglomerates. Two profound faults traverse the formation and repeat the series twice. Faults of a few feet are not uncommon. Although the

monoclinal structure prevails, low folds, particularly in the Brunswick beds, are common. A total thickness of 20,000 feet for the Newark system across New Jersey was given as the nearest estimate of the writer.

The Upper Cretaceous Formations of the Northern Atlantic Coastal Plain. William B. Clark, Baltimore, Md.

This paper was prepared in cooperation with Messrs. R. M. Bagg and George B. Shattuck, who had been Prof. Clark's geological assistants for several years. The areal distribution of the five Post-Potomac Cretaceous formations was represented upon a map on the scale of one mile to the inch, which embraced the area between New York Bay and the Potomac River. The variations in sedimentation and structural relations presented throughout this distance of over two hundred miles were described, as well as the faunal characteristics of the several formations.

The Matawan-Monmouth formations were shown to be equivalent of the Cretaceous Eutaw—Rotten Limestone—Ripley groups of Alabama; and the Pamunkey equivalent of the Eocene Lignitic—Claiborne group of the same area, so that the Rancocas-Manasquan-Shark River formations represent the interval between the Ripley and Lignitic, the first two being of Cretaceous age, the last of Eocene age.

It was also shown that the Upper Cretaceous formations of the Atlantic coast are the approximate equivalents of the Senonian and Danian, of Europe.

Notes on the Stratigraphy and Paleontology of the Laramie and Related Formations in Wyoming. T. W. Stanton and F. H. Knowlton, Washington, D. C.

I. The Ceratops Beds of Converse County. II. The coal-bearing series of the Laramie Plains. III. Localities in Bitter Creek Valley—Block Buttes, Point of Rocks, Rock Springs. IV. Evanston and Hodges Pass. V. Other localities considered—Carbon, Wyo.; Crow Creek, Colo.; Coalville, Utah. VI. Résumé.

(The undersigned (J. F. K.) learned with regret, when it was too late to remedy the matter, that no further abstract of the above paper had been obtained. He had thought it was read by title.)

Geology of Northeastern Washington. I. C. Russell.

The speaker described the remarkable cañon of the Snake River and said it equalled in grandeur the Grand Cañon of the Colorado. There are walls 4,000 feet high and a valley 15 miles across. 4,500–5,000 feet of lavas have been cut through. In the lavas secondary columnar fracturing can be detected radiating from the centers of primary columns and at right angles to the faces of the latter.

A Study of the Nature, Structure and Phylogeny of Dœmonelix. E. H. Barbour, Lincoln, Neb.

The new fossil Dæmonelix is a fresh-water fibrous alga aggregated together into various forms, the chief of which are large regular upright spirals, sometimes with, sometimes without an axis. These fossils occur in every exposure in the Loup Fork Tertiary on Pine Ridge, Sioux County, Neb. They stand invariably upright in fairly coherent sand rock. Area about 500 square miles. Vertical range about 200 feet. Structurally Dæmonelix is cellular but not vascular. It consists of simple parenchymatous tissue without trace of fibro-vascular bundles.

In its phylogenetic relations we can trace apparent development from the simple Dæmonelix 'fibre' in the lowest beds, successively through the Dæmonlix 'cakes,' Dæmonelix 'balls,' Dæmonelix 'cigars' or 'fingers,' and the Dæmonelix 'irregular' to

the Dæmonelix 'regular' of the topmost beds. Though the development is too sudden and startling, nevertheless this is in the order of occurrence.

The paper was illustrated by a superb and demonstrative series of lantern slides and was listened to with the greatest interest. The writer incidentally reviewed the various, more or less absurd, explanations of the 'Devil's corkscrews,' that had been advanced, but in the end he established his own views to the entire satisfaction of those present.

The Society at the conclusion of the paper and after being joined by the other section adjourned until the summer meeting.

The separate section having in hand the papers relating to petrography and crystalline rocks organized with Prof. Emerson as Chairman and Mr. Turner as Secretary. The first paper was the following:

Notes on the Pre-Cambrian Volcanics of the South Mountain District. FLORENCE BASCOM, Bryn Mawr, Pa.

By means of a map of the district and a new and beautifully preserved series of specimens, the textures of the old volcanic rocks, such as spherulites, flow-lines, lithophysæ, etc., were illustrated. In certain sections micropoikilitic textures were found which are secondary as contrasted with the views of Clements and Harker, who, in other localities, regard them as primary. Specimens of lithophysæ were exhibited, charged with piedmontite.

Mr. Lane corroborated the interpretation of the micropoikilitic texture as secondary in many cases on Lake Superior and the micropegmatitic as original. He emphasized the need of care in distinguishing them. Mr. Iddings remarked that some micropoikilitic textures were original and some secondary beyond question, and Mr. Cross, from his study of spherulites, corroborated the same view.

Notes on Rock Weathering. GEORGE P. MERRILL, Washington, D. C.

The paper began with a discussion of the changes, both chemical and physical, which have taken place during the decomposition incidental to the reduction of a gray, micaceous gneiss to the condition of a red, clayey soil. The facts brought out by analysis lead to a discussion of the possible formation of zeolitic minerals during the process of decomposition and their efficacy as conservators of potash, as suggested by Lemberg and Hilgard.

A series of analyses formed the basis of the remarks and showed the great loss in silica, alkalies and alkaline earths which the process had caused, while the alumina and iron oxides had largely remained. Alumina was assumed as the constant member and calculations were based on its permanence. The analyses, when recast on this basis, furnished the ground for very interesting deductions. The speaker had been led by his investigations to question the efficacy of zeolites as conservators of alkalies. A series of specimens in tubes were passed around which had been obtained by washing a sample of a given weight and settling it so as to separate the constituents according to sizes. The chief red coloring ingredient was found in the finest sediment of all. The altered Medford diabase, as well as the rock specially the subject of the paper, were illustrated in this way. The sorting had been done by Prof. Whitney, of the Department of Agriculture. In discussion J. F. Kemp remarked the permanence of iron oxide in process of alteration, which was surprising, as iron is a characteristically restless migrator, and also that phosphoric acid remained constant, whereas in stock piles of Lake Superior hematite, it may be largely leached from the upper portions to the lower in a single season. L. V. Pirsson emphasized the care that is necessary in determining alumina and mag-

nesia, the latter being often weighed with the former. He cited cases of such error, especially in German analyses. Mr. Merrill, in reply, regarding migrating iron oxide, stated that where air has free access, iron is permanent, but that below the surface it is a very restless member. As for phosphoric acid its quantity is small and it is a peculiar ingredient, not always acting the same in different suites of analyses.

Mr. Merrill's paper was a suggestive and important one and has a close bearing on the origin of soils.

The Age of the White Limestone of Sussex Co., N. J. J. E. Wolff, Cambridge, Mass., and A. H. Brooks, Washington, D. C.

After a brief review of previous work and opinions regarding this question, the authors gave the results of their own detailed work which led them to believe that the limestone is of *pre-Cambrian* age. By means of a map the areas throughout Sussex county, N. J., were outlined and the location of crucial sections indicated. These were separately plotted and interpreted as indicating fault lines along which the blue and white crystalline limestones had become mixed up together, affording apparent transitions. The thin bed of quartzite that lies below the blue Cambrian limestone was found extremely serviceable as an aid in stratigraphic work. The outcrop of it that dipped into the white limestone east of the Buckwheat mine had been shown by a recent quarry to run down into the latter, to be tapering off and to contain limestone boulders. It was regarded as produced by the filling of a crevice by the advancing sediments. The ore body was interpreted as interstratified in the limestones because its elongation conformed to the pitch of the foliation of the the metamorphic rocks. Eruptive granites cut all the latter, although not the Cambrian limestone. In discussion J. F. Kemp spoke of the difficulties of the problem and the gratification all must feel to have the relations so well explained. Although the evidence at Mt. Adam and Mt. Eve had seemed to him to favor the metamorphism of the blue limestone there, he had felt able to go no further than probability in the matter. He also commented on the very puzzling nature of the ore bodies and the strong probability that they were replacements.

The section then adjourned for lunch.

When the section reassembled after lunch the first paper read was the following presented by F. D. Adams.

Origin and Relations of the Grenville-Hastings Series in the Canadian Laurentian. F. D. Adams and A. E. Barbour, with an added note by R. W. Ells.

The paper sketched the distribution of the fundamental gneisses in Canada. In the field recently covered in Ontario the rocks were described in detail and as constituting plutonic members of various acid and basic types, now stretched and gneissoid. A map was used to show the areal distribution. The contact of the Grenville series and the fundamental gneiss is an igneous one. The carrying of the work over the intervening belt to the Hastings areas gives ground for thinking that the Grenville consists of portions of the Hastings which have become involved in the fundamental gneiss during the intrusions of the latter. There has been more or less absorption by infusion of the Grenville into the gneissic magma. An added paper by R. W. Ells described an area to the westward where similar conclusions have been reached.

In discussion C. H. Smyth, Jr., remarked the coincidence of the views expressed with his conclusions in the western Adirondacks. J. E. Wolff asked for further particulars regarding the field evidence of the intrusion of the fundamental gneiss into the lime-

stone. He also spoke of the enrichment of metamorphic rocks in the Hoosick region with albite, and therefore with soda, necessitating caution in the interpretation of analysis. Mr. Adams, in reply, described the Grenville series as made up of closely involved limestones and gneisses, the latter exactly like the fundamental ones. He stated that pegmatite dikes cut the limestones in every direction. He also said that his analyses, on which the conclusions regarding the sedimentary origin of certain of the later gneisses were based, had shown such low alkalies and high alumina as to warrant it. There could, therefore, have been no enrichment with soda. Mr. Cross cited, in comparison, the granites and gneisses of the Rocky Mountains. Mr. Iddings questioned the fact of the fundamental gneisses being the original crust. Dr. Adams replied urging its world-wide extent and fairly uniform acid character despite some more basic members. Prof. Emerson remarked on the distinction that was made between intruded fundamental gneiss, regarded as older than the limestones and intruded lavas that would be called later. He raised the point that both were practically the same and that if an intruded lava were called a later rock, although it had existed in the interior, perhaps from very early time, then gneisses now found intruded should also be regarded as later. Dr. Adams, in reply, urged the conception of the original crust, and insisted that, even if after the Grenville-Hastings series had been laid down on it the great batholite softened and penetrated them, it was still to be considered older. The section evidently held diverging views on this point.

The Crystalline and Metamorphic Rocks of Northwest Georgia. C. WILLARD HAYES and ALFRED H. BROOKS, Washington, D. C.

The region discussed in the paper extends southward one hundred miles from the Tennessee line and westward twenty to eighty miles from the Atlanta meridian. It embraces about 4,000 square miles, forming a belt to the east and south of the Georgia-Alabama Paleozoic area. The rocks described consist of (1) the slates and conglomerates of the Ocoee series, (2) the granites, gneiss and crystalline schists of the Piedmont basal complex, and (3) a series of intrusives including granite, diorite, gabbro.

By means of maps colored to show the distribution of the rocks, their areal relations were outlined and many interesting points were adduced, not the least of which were those connected with the intrusive granites, so prominent east of Atlanta at Stone Mountain.

Dr. A. C. Lane asked about the intruded rocks and if there were contact zones. Mr. Brooks replied that there were zones of ottrelite and andalusite schist around both granites and diorites. Mr. Keith also inquired about certain stratigraphical relations.

The Grain of Rocks. ALFRED C. LANE, Houghton, Mich.

The grain of rocks is dependent on the chemical composition and the causes that produce solidification, cooling, gas diffusion, etc., the general law being, the more rapid the action the finer the grain. The paper discussed the grain from the threefold standpoint of theory, observation upon the Keweenawan rocks and experiment.

In regard to chemical composition, the augite of the melaphyres shows plainly the empirical law that the less there is of it the finer is the grain, other things being equal.

The mathematical laws of cooling were applied to an indefinite sheet and the following laws deduced and tested:

(a) The case where we consider the adjacent rock symmetrically heated by the

sheet can be solved by aid of a solution for the case wherein the walls are kept at a fixed temperature. For the temperature at any point of the affected zone is the same as an average temperature obtained from two points as follows: If we imagine a hypothetical dike of the same breadth as the zone affected in the original sheet, and conceive of its walls being kept at a constant temperature, and if we imagine the two points situated at the same distance from the walls of the dike as was the original point whose temperature was sought in the original sheet, the average of the temperatures of the two points will be the value sought. The sum will be used when the original point lies within the hypothetical dike, and the difference if it lies without. We need, therefore, to consider in detail only the case where the sides of the sheet are kept at a fixed temperature.

(b) Taking therefore this case of a sheet originally of a uniform temperature we can divide the cooling into three periods:

1. Before the center has cooled appreciably. During this time the time of cooling is as the square of the distance of the margin, and is otherwise independent of the sheet.

The augite of the Keweenawan ophites follows in its grain this law, the average area of cross sections being proportional to the square of the distance from the margin and independent of the size of flow. Consolidation in this period may be expected to be especially characteristic of effusive rocks.

2. While the center is cooling down one-fourth of original difference in temperature between sheet and margin. This period is about four times as long as the first.

3. Thereafter the rate of cooling when a given temperature is reached will be independent of the position of a point. Hence the grain will be uniform and the same for all parts of the sheet that consolidate in this period. The solidification will tend to to fall into this period for high initial temperatures of the magma and hot walls, compared with the temperature of solidification and broad contact zones. Hence solidification in this period may be taken as typical for abyssal rocks.

Dikes of the Keweenawan in the Huronian show a marginal zone where the grain appears to have been formed in the first period of solidification, and a central belt where the solidification appears to have been in the third period. Throughout, the augite follows the theoretical laws most sharply, while porphyritically formed components are less tractable.

In illustration the speaker showed the results of experiments with sulphur and with candy, and found that they corresponded to his propositions. Slides were passed around, made from luster-mottled melaphyrs to bring the points out. (The abstract of Dr. Lane's paper is somewhat obscurely worded under (a), and it is possible that the undersigned has not accurately expressed it. The direct application lies in this: If we can measure in a diabasic dike or sheet the distance of the zone of even grain from the walls, then, knowing as we do the fusing point of augite, we can calculate the initial temperature of the dike or sheet at time of intrusion.)

In the concluding paper of the session Prof. Emerson described some peculiar phenomena that he had observed in the trap sheets of the Connecticut Valley. In certain flows, mud in streams and chunks had become so involved that it had made the trap a mass of glass and sediments. Steam, supposed to have been evolved from wet rocks under the lava flow by its heat, had boiled up through the lava and made other curious mixtures. These and the alterations resulting were described and illustrated by thin sections.

The Section then adjourned and joined the rest of the Society.

The following titles were also announced, but were not read, chiefly because of the absence of their authors. In several instances they were read by title:

Evidences of Northeasterly Differential Rising of the Land along Bell River. ROBERT BELL, Ottawa, Canada.

Surface Tension of Water as a Cause of Geological Phenomena. GEORGE E. LADD.

Geomorphy of Jamaica as Evidence of Changes of Level. J. W. SPENCER, Washington, D. C. (By title.)

Preliminary Note on the Pleistocene History of Puget Sound. BAILEY WILLIS, Washington, D. C.

Modified Drift in St. Paul, Minn. WARREN UPHAM, St. Paul, Minn.

Note on Plasticity of Glacial Ice. I. C. RUSSELL.

Physical Basis for General Geological Correlation. CHARLES R. KEYES, Jefferson City, Mo.

Notes on the Potsdam and Lower Magnesian Formations of Wisconsin and Minnesota. JOSEPH F. JAMES, Hingham, Mass.

The Age of the Lower Coals of Henry County, Missouri. DAVID WHITE.

New Evidence on the Origin of Some Trap Sheets of New Jersey. HENRY B. KUMMEL, Chicago, Ill.

The Origin and Age of the Gypsum Deposits of Kansas. G. PERRY GRIMSLEY, Topeka, Kansas. Read by title.

On the whole the meeting was a most enjoyable one, and the 75 to 100 Fellows who were in attendance returned to their homes with appreciative and grateful feelings to the geologists of Washington, by whom they had been so hospitably entertained.

J. F. KEMP.

AMERICAN MATHEMATICAL SOCIETY.

THE annual meeting of the American Mathematical Society was held in Hamilton Hall, Columbia University, on Wednesday afternoon, December 30, 1896. The President, Dr. George W. Hill, occupied the chair, and there were twenty-four members in attendance. Profs. T. W. Edmondson and J. L. Patterson were elected to membership. The Secretary's report showed a total membership of 279, being a net gain of 12 for the year. Reports were also received from the Librarian and the Treasurer. The *Bulletin* of the Society has appeared regularly through the year, being at present in the sixth annual volume. The last complete volume is a substantial octavo of 354 pages.

The annual election was held at this meeting, the following ticket being adopted: President, Prof. Simon Newcomb; Vice-President, Prof. R. S. Woodward; Secretary, Prof. F. N. Cole; Treasurer, Prof. Harold Jacoby; Librarian, Prof. Pomeroy Ladue; Committee of Publication, Prof. T. S. Fiske, Prof. Alexander Ziwet, Prof. Frank Morley; Members of the Council to serve until December, 1899, Prof. Alfred Baker, Dr. George W. Hill, Dr. Emory McClintock.

Three papers were presented, abstracts of which are given below.

Prof. Morley, of Haverford College, read a paper on the construction of a single point covariant with five given points. Taking the five points 1, 2, 3, 4, 5 on a conic, U, and taking Gundelfinger's conic for any four, let the intersection of the polars of the fifth point with respect to the two conics be found; the 5 points so obtained lie on a line which strikes U at the zeros of a quadratic covariant, Salmon's S. By taking the polar of the five points with regard to this covariant pair, counted thrice, we obtain a covariant point, readily identified as the second of Salmon's list. For