advocated by those who have carefully studied the question, is apparently a necessary step in the suppression of this evil.

3. The utilization of educational institutions in the development of a rational system of forestry.—In this, again, New York is well in advance, although Connecticut has followed in the establishment of a school of forestry at its leading university, and in calling in the services of a trained forester whose work will be carried on in connection with the State experiment station. There can be no doubt that institutions of learning, endowed by public funds, owe to the State the best that they can contribute towards the solution of such problems of public interest, nor is there any doubt that these institutions, permanent in their nature and to a great degree free from political influences, are the best fitted to fulfill a duty in which a consistent policy and continuity of action are indispensable. Both the University and the Agricultural College of Michigan have recognized this duty and have cooperated in rendering such service as they have found practicable. There is still every reason for the continuance of this cooperation and for the enlargement of plans for further work. Should we follow in this the lead of Connecticut, which is similarly situated in the separation of the institutions directly concerned, there would fall to the University the establishment of a department of forestry devoted largely to investigation, while upon the Agricultural College would naturally devolve the care and further development of its experimental forestry stations. Should either or both institutions come into possession of extensive tracts of cut-over lands, with which it has been proposed to entrust them, these new possessions would furnish a series of problems the solution of which is quite as likely to prove of financial value to the State as to themselves. Profits must necessarily be relatively remote, but it is a matter of encouragement that the director of the New York School of Forestry, with but 30,000 acres of land on which to operate and the work barely under way, is confident that hereafter the forestry operations of which he has charge will be self-supporting, and it is the judgment of experienced lumbermen, as well as of scientific foresters, that in Michigan the conditions are such as to insure to the State, or to institutions that can afford to wait, a substantial profit from practical forestry.

V. M. SPALDING.

UNIVERSITY OF MICHIGAN.

GEOLOGY AND GEOGRAPHY AT THE AMERICAN ASSOCIATION.

THE joint session of Section E of the American Association and the American Geological Society was opened on Monday, June 25th, in Schermerhorn Hall, Columbia University, to listen to the address of Vice-President Kemp, of Section E, on the 'Precambrian Sediments in the Adirondack Mountains.' This address, which has already been published in full in SCIENCE, July 20, 1900, was an exceedingly valuable and lucid contribution to the geology of this complicated but interesting region.

The first paper before the regular session of Tuesday morning was also one by Professor J. F. KEMP on the 'Local Geology about the City of New York,' which during the past several years has been studied in considerable detail by Dr. F. J. H. Merrill and others. This paper was given at the request of the 'sectional committee' and was preliminary to the three geological excursions arranged for and participated in by the members of Section E and of the Geological Society on the three following afternoons.

The second paper of the Tuesday morning session was by Mr. E. O. HOVEY, on the 'Geological and Paleontological Collections in the American Museum of Natural His-

tory,'* this paper having been prepared and presented at the request of the sectional committee preliminary to the visit of the members of Section E and of the Association at large to the American Museum on Tuesday evening.

Mr. F. H. NEWELL, in his paper on 'Hydrographic Surveys in New York,' described the objects and methods of this work as now carried on by the United States Geological Survey. One of the primary reasons urged for preserving the forests is the beneficial influence which they have upon the flow of the streams. The belief is widespread that the forest-cover conserves the waters, prevents floods, to a certain extent, and tends to increase summer flow, and that the cutting off of the forests has resulted in an increase of spring floods and in diminished flow during the summer droughts. All admit these influences, yet it has been extremely difficult to define the degree to which they are operative and to obtain convincing data for the support of conclusions.

It is important to know within reasonable limits to what extent the forests and other conditions influence the flow of streams; and the Division of Hydrography of the United States Geological Survey, cooperating with the Division of Forestry of the Department of Agriculture, is endeavoring to bring together facts upon which an answer to this important question can be based. The first step is to learn of the fluctuations of various rivers in different parts of the United States, to ascertain their regimen and to compare this with the cultural conditions of their drainage areas. To obtain these facts it is necessary that careful examinations be carried on through several years, so as to include periods of drought as well as those of excessive precipitation. For this purpose typical streams in various parts of the United States have been selected and stations have been established, at which the flow of the rivers is systematically measured. These river stations in many States, both east and west, cover almost every range of climatic condition from humid to arid. In the State of New York about 20 river stations are now being maintained, most of these being located on streams coming from the Adirondacks to form the upper Hudson, the Mohawk or the Black River. Cooperation in this work is maintained with the State Engineer and Surveyor, and also with the Forest, Fish and Game Commission recently appointed.

Diagrams showing the fluctuations of the streams from day to day throughout the year are prepared from the results of measurements, enabling a person to comprehend at a glance the great variation in volume of the streams under natural conditions. Knowing the changes which follow causes beyond the control of man, it should be possible to ascertain the relative importance of the fluctuations which result from artificial or controllable causes. It may require observations extending over a considerable length of time before we can definitely discriminate between effects produced by changes in the forest conditions; but however long the time or great the expense, it is of the first importance to ascertain these facts.

Mr. W J MCGEE's paper on the 'Occurrence of the Pensauken (?) Formation' within the limits of the city of Washington, brought out the following salient features: The commonly recognized geologic series in Washington and vicinity comprises, in descending order, (1) Later (low level, or fluvial) Columbia; (2) Earlier (high level, or interfluvial) Columbia; (3) Lafayette; (4) Chesapeake; (5) Pamunkey; and (6) Potomac. In a few localities, especially in the deep cutting in the 200-foot terrace at the head of Six-

*Published in SCIENCE.

teenth Street, deposits have been observed which fail to fit into this series. This cutting reveals, unconformably beneath the Earlier Columbia and uncomformably above the Potomac, a heavy deposit of loam and gravel of a structure, composition, texture and material simulating the Earlier Columbia formation in its normal aspect, save that the materials are more extensively disintegrated and decomposed. The resemblance of the deposit to the Earlier Columbia is such that it might readily be classed with that formation if found isolated; but in the Sixteenth Street exposure the two deposits are juxtaposed and separated by a well-defined unconformity—*i. e.*, the stratigraphy shows that the deposit in question is materially older than the earlier Columbia. On comparing the deposit with the Lafayette, as displayed in the nearest exposures of that formation on the west, north and east, it is found to be so different in materials and structure as to demand separation on lithologic grounds; moreover, the deposit is confined to a depression, or amphitheater, which did not exist at the time of Lafayette deposition, but was produced during the period of rapid degradation accompanying the post-Lafayette uplift; so that it must be discriminated from the Lafayette on the basis of homogeny as well as on that of lithology. The interpretation of the deposit is simple: it is evidently a record of an oscillation during the post-Lafayette and pre-Columbia time, which was not of such amplitude and length as to inscribe itself deeply in the local series of formations and land forms. On seeking to correlate the deposit with other elements in the coastal-plain series, difficulty is encountered; no corresponding deposits are known either southward or eastward in Virginia and Maryland; the nearest known deposits of corresponding character and position are a part of those found in southern New Jersey and first grouped by Salisbury under the designation Pensauken, but afterwards divided.

In Dr. JOHN M. CLARKE'S paper on the 'Lenticular Deposits of the Oriskany Formation in New York,' this formation was described as attaining in eastern New York its greatest thickness south of Albany county, where it is highly calcareous and carries its normal fauna. In its extension through central and western New York its deposits are wholly arenaceous and siliceous and they alternately thin and thicken, thus forming a series of lenticular beds which are connected by thin sheets or wholly severed by the actual disappearance of the formation from the rock series. Beginning in Albany county, the formation has a thickness of but one or two feet, thence westward of Schoharie county it slightly thickens, and again thins and actually disappears in southern Herkimer county. Still farther westward at Oriskany Falls, the typical section, it attains a thickness of some 20 feet. At Manlius, Onondaga county, it has decreased to about one foot, and at Jamesville, five miles west, increases to three feet six inches. Four miles west of here, at Brighton, its thickness is one foot six inches, whence westward, at Elmwood, one mile and a half away, it thins to six inches. Again the formation disappears from the rock series, the eastern thinning edge of the next lens appearing first at Split Rock, near Syracuse, thickening towards Marcellus Falls, five miles away, and at Skaneateles Falls, six miles further west, attaining a cross-section of 18 feet; thence suddenly dropping to ten inches at Auburn, six miles still further west. This lenticular mass, designated the *Skaneateles lens*, appears to be the largest of these lenticular deposits west of Albany. From this point westward but two inconsiderable lenses are observable, the deposits being a thin sheet seldom over more than a few inches across.

This evidence is regarded as indicative

of an actual shore line during Oriskany time. No Helderbergian deposits occur in this western section of the State. The transgression of the Oriskany here is in conformity with similar evidence in other regions, of its wide extent beyond the limits of the preceding Helderbergian formation.

A second paper by Dr. J. M. Clarke, on 'The Fauna of the Arenaceous Lower Devonian of Aroostook County, Maine,' brought out the fact that a careful re-study of this fauna indicates that its proposed construction as a Silurian fauna correlating with the Tilestones of Murchison's Silurian section is not justified by the character and affiliation of its species. With such New York Oriskany species as *Anoplia nucleata*, *Cyrtina varia*, etc., it contains a number of species identical with those of Lower Devonian faunas of Western Europe. The faunas of the two localities of the Chapman Plantation, Edmund's Hill and Presque Isle Creek, have very little in common, but both show a close alliance with the arenaceous Lower Devonian faunas.

A paper on 'The Great Chisos Rift along the Canyons of the Rio Grande River,' by Professor R. T. Hill, and embodying the results of a trip by him through the lower portion of this canyon late in 1899, was one of unusual interest, as the region described was entirely new to the scientific world and one which proved to be varied and beautiful in scenery, and rich in geologic and topographic problems. The paper was illustrated by a considerable number of lantern slides prepared from photographs taken by Professor Hill during his journey.

In a short paper, 'Notes on the Geology of Central South Carolina,' Dr. D. S. Martin described the work about Columbia now being carried on by himself and Dr. L. C. Glenn, and the success of the latter in discovering eocene and cretaceous beds separating the 'Potomac' and 'Lafayette' deposits, which in many of the new railway cuts about Columbia are lithologically indistinguishable.

Dr. Alexis A. Julien read a paper on 'The Genesis of the Pegmatite in North Carolina,' in which he called attention to the constant association of vein and of dike phenomena, hitherto without satisfactory explanation in the pegmatite occurrences in the schists of that State and along the Appalachian belt. The several genetic hypotheses were reviewed, based on intrusion of fused magma, vein-infiltration, segregation and pneumatolytic introduction of igneo-aqueous magma. But none of these accounted for important facts observed, *e. g.*, vast pegmatite masses connected with almost capillary fissures, frequent distinct relationship of the material of the pegmatite and adjoining schists, and the almost universal banded structure and evidences of mineral concentration within the pegmatite. In their place he proposed the hypothesis of metasomatic aggregation, by molecular rearrangement of the entire material of portions of the schists in vicinity of fissures, through the action of mineralizers; lateral segregation within the igneo-aqueous magma or emulsion so formed, with production of vein-structure, etc.; crushing and even shearing, by orogenic movements, translation along the fissure-plane, partial obliteration of vein-structure and development of facies of a dike. On such an occurrence of pegmatite, therefore, one looks upon the birth of granite *in loco*, in at least one mode, rather than upon an intrusion of foreign material into cavities of discission or dissolution.

'The Geological Features of the Menominee Iron District of Michigan' were described in a short paper by W. S. Bailey, as occupying an area of about 120 square miles on the north side of the Menominee river, from Waucedah westward to a short distance beyond Iron Mountain. The ore-producing rock constitutes a trough be-

tween rims of basic volcanic rock on the south and granites and gneisses on the north. These are regarded as Archean in age. Between these rims lie two series of Huronian sediments separated by an unconformity. The lower Huronian sediments comprise in ascending order quartzites, dolomites and jasper. The upper Huronian beds are a jasper and ore formation, black slates, a second ore formation and gray slates. Over these unconformably lie horizontal beds of Lake Superior sandstone.

The ore formations consist of alternating beds of jasper, hematite and quartzites. The principal producing horizons are in the upper Huronian. The lower ore-bearing beds are mainly fragmental, and the upper ore-bearing beds are mainly altered crystalline sediments. The ore of the latter has come from iron carbonates, which have been decomposed as in the Marquette district, yielding cherts and hematite.

All of the Huronian rocks are strongly compressed and closely folded. The ores occur in pitching synclines with impervious bottoms. Geologically the Menominee district bears a striking resemblance to the Marquette district. The lower Huronian ore measures, however, which are large producers in the latter district, are scarcely known in the Menominee district, in which district the principal producing mines are in the lower ore formation of the upper Huronian.

In a paper on 'The Still Rivers of Western Connecticut,' Professor WM. H. HOBBS described the general course of the streams of this region as being to the south-southeast down the slope of the Cretaceous plain of erosion. In a few cases, however, large tributary streams are found flowing in nearly the opposite direction. Two notable instances of this sort have been studied, each bearing the name 'Still River'; and attention is thus directed to their exceptionally sluggish currents, due to the barely perceptible slope of their present beds. One of these streams rises near Tarrington, flows north-northeasterly past Winsted, and, after a course of about twelve miles, enters a branch of the Farmington at Robertsville. The other river of the same name, some twenty-five miles distant to the southwest, is a tributary of the Housatonic, having its source in a barrier of drift hills south of Bethel, flowing north northeasterly past Danbury and Brookfield, to enter its trunk stream just where the latter departs from the limestone valley to cut its way through gneiss.

In each case the course of the Still River has been determined by a belt of limestone within harder walls of gneiss and schist. The Still River, tributary to the Farmington, is, furthermore, an instance of reversal of drainage brought about by obstructions of glacial material.

In a paper on 'Drift Erosion, Transportation and Deposition,' by Mr. WARREN UPHAM, the work of the North American ice-sheet is described as threefold. Its erosion of the bed rocks, over the greater part of the glaciated area, is shown to have supplied far more drift than was desired from the preglacial residuary clay and river sand and gravel. Only near the borders of the ice-sheet, or to a distance of two or three hundred miles from it in the interior of this continent, the successive stages of fluctuating glaciation added each its drift deposits without general erosion of the underlying rocks or the earlier formed drift. The transportation of the drift appears to have been chiefly within the lower part of the ice-sheet, reaching in considerable amount at least 1,000 feet above the land surface on the mainly plain-like region of Minnesota and Manitoba. Its deposition for the greater part was directly from the ice, yielding the till and a large proportion of the mass of the moraines. Another

large class of the drift formations shows modification by the waters of the melting ice surface and of rains, and is, therefore, called modified drift. These several phases of action and resulting deposits of the ice-sheet are discussed in the full paper, with illustrations from field observations, and from comparison with now existing glaciers and ice-sheets.

Professor C. W. Hall, in a paper on 'The Chengwatona Series of the Keweenawan' formation, describes this interesting series of volcanic rocks, first identified by Chamberlin as belonging to the Lake Superior copper-bearing formation. These rocks are exposed along the Snake River almost continuously for two miles, with edges 3 to 20 feet above the stream. The succession consists of basic eruptions (lava flows of typical structure) with intercalated conglomerates. The bottom of each flow is of very fine texture and in places apparently devitrified; the middle portion is of coarser yet quite uniform texture, while the top is strongly amygdaloidal with frequent tuffaceous phases. The recognition of the different phases of each flow and the transition from one flow to another can be distinctly seen, as the division planes are sharply drawn. In two or three instances the overlying tuff is thicker than the compact portion of the flow. The diabase is, for the most part, of the characteristic ophitic type, exposed surfaces first mottling and then becoming pitted through unequal decomposition. The amygdaloid carries the minerals characteristic of the Lake Superior basic eruptives with laumonite or some relative the predominant one. Lying interbedded with these diabase flows is a series of conglomerate beds; five were counted. They vary in thickness from 5 feet to 104 feet, and represent a total of more than 200 feet. Pebbles of gabbro, diabase, diabase porphyry, augite syenite and granite conglomerate are recognized, thus suggesting an age even later than tha of the augite syenite around Duluth, in other words, high up in the Keweenawan formation. The number of successive lava flows in the Chengwatona series is its most remarkable feature; not less than 45 were counted, and neither the top nor bottom flow was seen. The total thickness cannot be less than 10,000 feet actually in sight. The attitude of the entire series is uniform, and there is no sign throughout of sufficient displacement to duplicate a single flow. Besides, the conglomerate beds are so unlike in thickness that they cannot by error well be duplicated in the above estimate.

In a paper on 'A Simple Modeling Machine,' Dr. E. B. Mathews described a simple machine, designed by himself, of which many geologists and geographers have long felt a need.

The expense and great amount of time required to make simple relief models of areas studied by the existing methods have prevented geologists from making use of models in the representation of tentative geological interpretations. Moreover, the models made by cross sections, pegs or layer methods take much time and involve a high degree of personal equation in the sculpture. The machine described is a mechanical device for representing with considerable accuracy the territory included within a topographic atlas sheet. Two features are regarded of special importance: in such a machine, there must be rigidity in the horizontal plane in order to avoid distortion, and even greater rigidity in the vertical plane to eliminate vertical exaggeration. It was found possible to obtain the first by the use of a rigid pantograph in which the arms were about an inch and a half broad and three-eighths of an inch thick. The vertical accuracy is obtained by a stylus passing through the end of one arm of the pantograph and held at the desired height by two set screws, the whole resting on a

free-moving support, and this in turn resting on two wooden knife edges. The pantograph is fixed to the top of a table from which a portion of the top has been removed. Below this opening is a depressed shelf on which is placed a tin box containing the plastic clay, which is of a thickness corresponding to the uniform base and the highest point to be represented. Beginning at the topmost contour the stylus traces the limits of that elevation. Outside of the line traced the clay may be removed to the first bench. In the same way all the contours may be followed by one arm of the pantograph and traced in clay by the other. The result is a rough representation of the shape of the county in which the surface is composed of a series of steps. These may be removed by a modeling wire and the whole given artistic life without changing the relative elevation of the different parts. It has been found possible to prepare this first relief model of a quadrangle in a day's time. From this it is possible to make the usual plaster matrices and thence the plaster relief according to the usual methods. The advantage of the machine lies in the speed by which the models may be produced and the elimination of the personal equation in the drawing of the heights.

In a short but interesting paper on 'Certain Late Pleistocene Loams in New Jersey and Adjacent States,' Professor R. D. SALISBURY presented the results of his numerous observations concerning the origin of certain recent loams found widely distributed in that region. These had been examined in hundreds of localities and found to be generally more or less local in character. Sections were exhibited showing its mode of occurrence near Jamesburg, Princeton, Trenton, Philadelphia, etc. The conclusions arrived at from these various examinations were that these loams are of marine origin and represent deposits made during a recent short period of submergence, which submergence in southeastern New Jersey extended to a depth of not less than 200 feet. The work of Professor Salisbury is the more interesting as it has an important bearing on the results of the study of somewhat similar surface loams and sands further south by Hilgard, McGee, Smith and Holmes.

In the paper on 'The Principles of Paleontologic Correlation' by Professor JAMES PERRIN SMITH, paleontologic correlation was described as being of two kinds: (1) Direct, where the faunal regions were closely connected and intermigration of species was easy. An example of this is the correlation of the Cretaceous of the Atlantic and Gulf regions with that of Europe; (2) Indirect, where the faunal regions were separated by land barriers. An example of this is the correlation of the Cretaceous of the west coast with that of the interior and Atlantic regions. These were separated by impassable barriers, but the Atlantic Cretaceous was connected with the European, the European with the Indian, and the Indian closely related to that of the west coast.

Oppel attempted to divide stratigraphic formations into faunal 'zones,' of which he made 30 in the Jura alone, most of which cannot be recognized in outside regions: Buckman divided the Jura into *hemeræ*, of which he found 26 in the Lias alone. These, too, can not be recognized away from the province where they were founded. But, occasionally, the fauna of a certain horizon can be identified in very remote regions, this extension corresponding to periods of unrest, of oscillations of the land and opening up of connections between regions that before were separated. The writer proposes to confine the term *zone* to such widely distributed faunas, which thus become important criteria in interregional correlation. Such zones are that of *Manticoceras intermerceras* in the upper Devonian, of *Agamides rotatorius* in the Kinderhook,

of *Gastrioceras listeri* in the middle coal measures, etc.

The principles governing the migration of marine invertebrates were discussed, and the reality of 'colonies' affirmed. Homotaxis, as defined by Huxley, was discussed, and it was shown that even now similar faunas are living synchronously in widely separated regions, and that the same could have happened, and probably did, in past time. Therefore, correlation is often real, and not merely homotaxial. The strata coming between the interregional zones are, in a sense, only homotaxial, but the zonal faunas themselves often represent synchronous appearances of immigrants in two or more regions from a third unknown point of origin. The substantial agreement of the stratigraphic column in all the continents is the best possible proof of the reality of correlation, for the discrepancies that occur in the periods of endemic development are all corrected in the periods of readjustment, and nature's periodic trial balances bring into harmony the record in the interregional time scale.

The following additional papers were presented before the Section, all except the first two being under the auspices of the Geological Society:

The Ice Age in New Zealand: C. H. Hitchcock. (With lantern slides.)

On a New or hitherto Unrecognized Horizon in the Lower Portion of the Devonian System in Eastern Canada: Henry M. Ami.

Native Copper from Garfield County, Oklahoma: Erasmus Haworth.

Petrographic Studies on the Andesitic Rocks of Silverton, Colorado, with Analyses by W. G. Haldane and E. W. Gebhardt: Frank R. Van Horn.

The Hudson River Beds of the Vicinity of Albany, and their Taxonomic Equivalents: Rudolf Ruedemann. (Introduced by J. M. Clarke.)

Giants' Kettles Eroded by Moulin Torrents: Warren Upham.

Pleistocene Ice and River Erosion in the St. Croix Valley of Minnesota and Wisconsin: Warren Upham.

Evidences of Interglacial Deposits in the Connecticut Valley: Charles H. Hitchcock.

Volcanic Phenomena on Hawaii: Charles H. Hitchcock.

A Theory of the Origin of Systems of nearly Vertical Faults, with Application to the Newark Basin of the Pomperaug River: W. H. Hobbs.

EXCURSIONS.

The following excursions were arranged for and participated in by the members of Section E and of the Geological Society:

Tuesday afternoon.—Under the leadership of Professor Kemp, the crystalline rocks in that portion of New York City east and north of the Columbia University buildings were visited and carefully examined. The interbedded arrangement of the limestones and gneisses indicated clearly the sedimentary origin of these materials.

Wednesday afternoon.—Under the leadership of Professor Kemp, the grounds in the Botanical and Zoological Gardens were visited, and careful attention on the part of the members was given both to the character of the crystalline rocks and to the later surface phenomena, including potholes, the glacial deposits and the new and old Bronx River channels.

Thursday afternoon.—Under the leadership of Dr. A. A. Julien, a visit was made to the Palisades along the west bank of the Hudson for the purpose of studying the geologic and topographic relations there, and for the further purpose of seeing the extent to which the Palisades were being injured by the extensive quarrying now in operation for the purpose of securing road metal.

J. A. Holmes,
Secretary of the Section.