sluices which are automatically opened and shut by large floats; and the second consists principally of an arm dragging along on the bottom, and taking various angles according to the depth of the river. Prof. J. B. Johnson's paper on Three problems in river physics was devoted to a discussion of the transportation of sediment, and the formation and removal of sandbars; the flow of water in natural channels; and the relation of levees to great floods, and to the low-water navigation of rivers. Sediment was distinguished as either continuously or discontinuously in suspension, or as rolled along the bottom; and the action of the second sort in the formation of bars was discussed. It was also shown, that the third kind produces sand-reefs on the bottom which move along perhaps ten to thirty feet per day: they are sometimes fifteen feet high, and succeed each other at intervals of some three hundred feet. For the flow of water, the old formulae were shown to be worthless; but the author did not make the mistake of giving new ones. Levees were discussed, and their use discountenanced; waste weirs into side outlets being recommended. This paper will be printed in full. Mr. O. Smith's paper on topography of machines referred to more exact and systematic methods in drawing and speaking of machines and parts thereof, and should have been discussed on Monday. On Thursday, Mr. Arthur Rigg discussed the advantages of trip and eccentric gears, and a somewhat lengthy discussion ensued. It appeared that the American practice of employing simple valve-gearing in small quick-speed engines was approved of, though giving a somewhat inferior card to that of a trip-gear engine. Three other papers — 'The strength of cast iron,' W. J. Millar; 'Experiments on belting,' G. Lanza; 'Steam-engine tests,' C. H. Peabody — were, in the absence of the authors, presented by Professors Wood and Webb; and the session concluded with an interesting talk by vice-president R. H. Thurston, on the development of the philosophy of heat-engines.

PROCEEDINGS OF THE SECTION OF GEOLOGY AND GEOGRAPHY.

IT will be readily admitted by all who were in attendance upon any of its proceedings, that the sessions of section E of the Philadelphia meeting of the American association possessed, both as regards the numbers present and the character of the papers presented, a very unusual interest. As a special feature, might perhaps be mentioned the large amount of attention devoted to those most difficult of geological problems relating to prefossiliferous strata and the origin of the crystalline schists, — questions which not only in the meetings of the association, but in the world generally, seem year by year to be claiming an ever-increasing share of geologists' thought and study.

This tendency was well marked by the opening address of the vice-president of the section, Prof. N. H. Winchell, on the crystalline rocks of the northwest, a paper which needs no notice here, as we have already printed an abstract, and which according to the usages of the section admitted of no discussion.

The real business of the section was commenced on Friday morning, the day succeeding its organization, by the reading of a paper, by Prof. S. G. Williams of Cornell university, on the gypsum deposits of Cayuga county, N.Y. He maintained, on paleontological evidence, that these beds were members of the lower Helderberg formation, instead of belonging, as might have been expected, to the Salina period. A section illustrating their occurrence was discussed, and four distinct reasons given for considering their origin to be due to the action of sulphur-springs on beds of impure limestone.

A paper by Prof. E. Orton of Columbus followed, in which he showed how the remarkable symmetry and order pervading the lower coal measures in western Pennsylvania and Ohio extend across the Ohio River into Kentucky. Sections in both Pennsylvania and Ohio were carefully analyzed, and especial stress laid upon the importance of certain thin limestone beds accompanying the coal measures as reliable geological guides. Credit was given to Professor Crandall for having first shown that the sequence of beds was the same on the Kentucky side of the Ohio River as it was in Ohio. An interesting discussion followed this paper, between Professors Lesley and Orton; the former affirming that no traces can now be found of what were the shores of the original coal basin, and that no elevations or depressions accompanied the deposits of coal-seams, while the latter maintained that the evidences of the old shore-line, especially in Ohio, were very manifest.

Prof. F. D. Chester read an account of the geological survey of the state of Delaware, upon which he has for some time been engaged. He exhibited an unpublished map defining the small areas occupied by Laurentian and Cambro-silurian rocks in the northern part of the state; but naturally devoted most of his attention to the more important clays, sands, and marls, which represent the cretaceous, tertiary, and quaternary formations.

The vice-president of the section, Professor Winchell, followed with a description of a salt-well situated at Humboldt, Minn. The brine, although now to be found principally in rocks of Devonian or Silurian age, he considers to have originated in overlying strata, probably carboniferous.

Professor Orton, in a paper on the distribution of petroleum and inflammable gas in Ohio, showed that while scarcely a formation in the whole state was altogether free from them, their presence in really valuable quantities was confined to the subcarboniferous, and even here to two members of this series, — the Waverly conglomerate and Berea grit. These strata alone satisfy the necessary conditions of productive 'oil sands,' i.e., porous layers of sandstone or conglomerate sealed up between impervious layers of shale. As closely connected with the petroleum deposits of Ohio were mentioned the salt-wells, which yield an abundance of brine derived from the same 'oil sands.' This brine is remarkable for the amount of bromine it contains, the production here — one

pound of bromine for every barrel of salt — being greater than anywhere else in the world. The inflammable, high-pressure gas accompanying the salt brine, especially in the Waverley conglomerate or Logan group, is largely employed as well in forcing the brine to the surface as in evaporating it. A lively discussion regarding the origin of petroleum followed this paper; in the course of which both Professor Newberry and Professor Orton held that it owed its existence to the slow distillation of the organic remains originally contained in the enclosing shales, the 'sands' themselves being remarkably free from organic remains, and acting merely as reservoirs.

No paper presented to the section was greeted with more interest or closer attention than that by Prof. J. E. Hilgard, director of the U. S. coast-survey, on the relative level of the Gulf of Mexico and the Atlantic Ocean, with remarks on the Gulf Stream and deep-sea temperatures. Inasmuch as we hope soon to give this most valuable communication to the readers of *Science*, only its two most essential points need be mentioned here. These are: 1° The discovery by a most careful series of levels, run from Sandy Hook and the mouth of the Mississippi River to St. Louis, that the Atlantic Ocean at the former point is 40 inches lower than the Gulf of Mexico at the latter point; and, 2° That ocean-water at all depths exceeding one thousand fathoms possesses a temperature of nearly 35° F., because this is the temperature consistent with its greatest density. Should the water become either cooler or warmer, it must expand; this it cannot do on account of the superincumbent pressure.

Monday was the day which it was proposed, according to the suggestion of the sectional committee, to set apart for papers and discussions relating to the crystalline rocks; but events seemed to demonstrate the apparent impossibility of especially devoting any fixed time to this or any other subject. It is to be regretted that a more definite topical arrangement of papers cannot be introduced into the programme by the committee, and even more deeply is it to be deplored that what little trace of such an arrangement may appear is entirely obliterated by the failure of authors to respond when their papers are announced. Surely a programme carefully arranged according to subjects, and strictly adhered to, would do much to expedite the discussions and increase the interest of the whole section.

The first paper read was one postponed from Friday by Prof. E. W. Claypole, on some fish remains recently discovered in the Silurian rocks of Pennsylvania. Small fluted spines and oval shields were exhibited closely resembling certain fish remains from the Ludlow rocks of England, which for fifty years past have been recognized as the oldest known traces of vertebrate life on the globe. The studies of Huxley and Lankester were quoted as proving the true ichthyic character of these fossils; and the differences between the European and American specimens, based on a microscopic examination, were noted. The horizon in which the Pennsylvanian specimens were found was considerably below the water-line group (equivalent to the lower Ludlow of England), so that we may safely conclude that these are the oldest vertebrate remains yet discovered.

Prof. A. S. Ewing then presented some calculations regarding the rate of chemical erosion of Appalachian limestones, based on observations in the Nittany valley. These are interesting, but do not, as Mr. Ashburner remarked, seem capable of any general application, since erosion is so very unequal in different areas.

A general discussion upon the subject of maps and map-making was introduced by Prof. George H. Cook's admirable paper on the geological survey of New Jersey. After giving a short account of the work accomplished by the two earlier surveys of the state, the results secured by the existing one, which has been under its present management since its organization in 1864, were recounted. A large geological wall-map of the entire state was produced in 1868, and there were exhibited the three completed sheets of the new and much larger topographical map (scale, a mile to an inch) now in progress. This will finally contain seventeen sheets, and, to judge from what has already appeared, will be a model of accuracy and beauty. The necessity of devoting the small annual appropriation almost exclusively to topographical work has heretofore hindered the study of the geology, but the recent assumption of the former by the U. S. geological survey will now leave this fund free for strictly geological investigations. The practical use of the survey was illustrated in the success of the artesian borings, advised by the state geologist, on the Atlantic coast.

Remarks on the New-Jersey maps were then made by Mr. Trelawney Saunders, Major Powell, and others. A preliminary geological wall-map of the United States, colored as far as reliable data could be obtained, together with another of the states of New York, Pennsylvania, and New Jersey, compiled from the work of Hall, Lesley, and Cook, was exhibited by the U. S. geological survey, and discussed, at the request of Major Powell, especially by those gentlemen present who had aided in their compilation.

Professor Henry S. Williams of Cornell university, in a paper on the influence of geographical and physical conditions in modifying fossil faunas, introduced the exceedingly important subject of the extent to which paleontological evidence is to be regarded as an absolute guide in correlating strata in different regions. This, as is well known, was the subject of the address delivered before the geological section of the British association in Montreal by its president, Professor Blanford, and, as may readily be imagined in view of the many eminent paleontologists present in Philadelphia, excited a lively discussion, the interest in which continued until the final adjournment of the section. Professor Williams explained a series of sections, principally in Chemung and Catskill rocks, taken from a number of localities across New-York state, and deduced from them abundance of proof that faunas in Devonian times, as at present, changed not only geologically in sequence

of time, but also geographically according to the areas of their distribution. The influences which brought about a change in the character of the sediments deposited, also manifested themselves in altering the forms of the organisms inhabiting these sediments.

Mr. Ashburner said that the gradual creeping upward of fossil forms characteristic of one horizon into overlying strata was well borne out in western Pennsylvania. In the oil regions, Chemung forms are often met with in a well-defined Catskill fauna. Professor Claypole considered a gradual transition between two formations as quite the rule, and proposed to call beds of this character between the two horizons especially under discussion, 'Catskill-Chemung.' To such a designation Professor James Hall strongly objected; maintaining that each formation was quite distinct, and that, while there might be an alternation or even commingling of beds belonging to both, no such indiscriminate mixture of typical forms as that described by Professors Williams and Claypole was possible. He would hardly be willing to admit the occurrence side by side at that horizon of Spirifer disjuncta and Spirifer mesostrialis, to which allusion had been made. Two papers by Professor Hall may be mentioned here, since they bear directly on this discussion, although they were not read until two days later. In the first of these, on the intimate relations of the Chemung and Waverley groups in north-west Pennsylvania and south-west New York, it was shown that the apparent commingling of the Chemung and Catskill faunas is due to the fact that the sea-bottom gradually approached the surface, and thus locally gave rise to dry land. The gray Chemung, rocks contain a marine fauna; while the red Catskill beds carry almost altogether land and fresh-water forms, although some Chemung animals survived for a time under the altered conditions. These alternations sometimes extend through three hundred feet. The second of Professor Hall's communications described the recent discovery in considerable numbers of the Eurypteridae, a family especially characteristic of Silurian rocks, in carboniferous beds. These widely separated occurrences are connected by a single known specimen of Eurypterus from the Chemung formation.

The first of a series of papers relating to the crystalline rocks was read by Professor Roland D. Irving of Madison, Wis. It treated of metamorphism in the Huronian of the north-west; although, according to the author, such metamorphism can scarcely be said to exist at all. The terms metamorphism and Huronian were first defined, and then the rocks considered as belonging to this formation in the vicinity of Lake Superior were classified in five categories. These were: 1° quartzites and graywackes; 2° basic massive rocks; 3° acid massive rocks; 4° cherts and limestones; and 5° hornblende, mica, and chlorite-schists. Each of these categories was then considered in succession, and shown not to be metamorphic in the sense of being sedimentary material re-crystallized *in situ*.

Prof. C. H. Hitchcock next presented thirteen sections across the states of Vermont and New Hampshire. These were constructed to show the anticlinal structure of the Vermont gneiss, which their author now considers to be established beyond doubt. The gneiss has the same lithological character as that occurring in the White Mountains, where it is of Laurentian age. As is well known, the structure of Vermont has generally been regarded as synclinal; and if the conclusions of Professor Hitchcock prove correct, they certainly have a most important bearing upon the much-discussed problems of New-England geology. If, as he asserts, the Vermont gneisses underlie the Huronian schists, which extend in a V-shaped area from Canada southward along the border between Vermont and New Hampshire, then they must be the oldest rocks of the region, instead of metamorphosed Silurian or Cambrian sediments, as they are at present more generally considered.

No more important contribution has ever been made to the vexed question of metamorphism and the origin of the crystalline schists than the recently published work of Dr. Johannes Lehmann, now professor in the university of Breslau, entitled 'Untersuchungen über die entstehung der altkrystallinen schiefergesteine,' Bonn, 1884. This elegantly printed book is accompanied by a superb atlas of photographic plates most satisfactorily illustrating rock structures, and was brought to the notice of the association by Dr. George H. Williams of the Johns Hopkins university, who proceeded briefly to review its contents. The most important point brought out by Lehmann is the influence of pressure in the metamorphism of rocks. The great orographic forces which have crumpled the strata have also greatly changed their original form, rendering sediments crystalline and compact, while they developed in homogeneous eruptive masses a schistose or even banded structure. Thus bedding in crystalline rocks is not to be regarded as necessarily a sign of sedimentation, nor is the lithological character of a rock any definite criterion of its age. Professors Carvill Lewis and Hitchcock remarked that these ideas agreed perfectly with what they had observed in the highly crystalline areas which they had particularly studied; and Dr. Williams gave an account of an eruptive mass near Baltimore, in which both changes in mineralogical composition, and the development of a schistose structure, had been accomplished by pressure.

Professor Alexis Julien of New York communicated the results of a very extended study of the Eozoon canadense from nearly all the localities where it has thus far been found, adding other localities of his own discovery. The result of his investigations led him to decide in favor of the inorganic nature of the so-called fossil, although his ideas in regard to the mode of its formation differ considerably from any heretofore advanced. He noticed as universal in all localities, that the calcium and magnesium carbonates were very unequally distributed in the eozoonal limestones; and, that there was a large development of pyroxene where the dolomite was

least abundant. He moreover observed the constant tendency on the part of pyroxene to be arranged in layers alternating with either calcite or apatite, as well as abundant evidence that pyroxene passed by hydration into serpentine, a process which could be seen in every stage at any of the localities visited. From these data it was assumed that siliceous waters, permeating limestones originally evenly dolomitic, would cause the local development of pyroxene by the change of the magnesium carbonate into the corresponding silicate. Were it the case, as so often occurs, that this pyroxene was developed in layers, its subsequent alteration to serpentine or loganite would readily account for all the appearances exhibited by the eozoon, without the necessity of appealing to organic agencies.

The Tuesday afternoon session of the section was almost exclusively devoted to geographical papers and discussions. These had hitherto scarcely received their due share of attention; but now proved, owing to the presence of several distinguished members of the British association, of unusual interest. Sir James Douglass was called to the chair, while Capt. Bedford Pim, R.N., presented a paper on the geographical and commercial advantages of the Nicaragua route across Central America. Capt. Pim is especially fitted to speak upon this subject, on account of long experience and the much careful study which he has devoted to the different plans which have been proposed for inter-oceanic communication. He exhibited a section surveyed under his direction, between the years 1863 and 1867, across Nicaragua, and explained how a canal could be constructed at comparatively small expense, for the transference of ships raised upon pontoons drawing only from four to eight feet of water. The principal objection to Mr. de Lesseps's canal across Panama was not, he thought, the practical difficulties of construction, — although these were very great, — but the almost constant, and long-continued calms prevailing on the Bay of Panama. He himself had once been becalmed there for eleven months. This paper elicited numerous questions and remarks from various members of the section, among them a somewhat extended communication by Rear-admiral Ammen, who had served as a member of the commission appointed by the U.S. government to inquire into the relative merits of the various routes proposed for securing a passage for ships across Central America.

Mr. Ashburner, of the second geological survey of Pennsylvania, then proceeded to give a brief account of the work accomplished during the past ten years, the period of the survey's existence, as well as of its future aims and plans. He was succeeded by Mr. Trelawney Saunders of London, who has been so active in prosecuting the recent survey of Palestine under the auspices of the Palestine exploration fund. His first paper contained an account of a remarkable journey over an entirely unknown portion of Tibet, Mongolia, and the frontiers of India and China, by Kreshna, a native surveyor trained under the trigonometrical survey of India. This was only accomplished after four years of unparalleled hardship, but has made most important additions to the geographical knowledge of Asia. Mr. Saunders's second paper related to the geography of Palestine, in connection with which the great map of the survey was exhibited. Several exceedingly interesting points were explained, where the geographical researches had succeeded in definitely locating sites of biblical events, as well as shed much light upon many heretofore doubtful and difficult allusions in the sacred writings.

The proceedings of Wednesday were introduced by an extended biographical notice of the late Professor Arnold Guyot, by his assistant, Mr. William Libbey, jun., of Princeton. Mr. Libbey's paper will appear in full in the Journal of the American geographical society of New York. Mr. William M. Davis of Cambridge gave some valuable hints as to geographic classification, based upon the study of plains, plateaus, and their derivatives. He traced the history of an area undergoing gradual elevation through a regular course of development, likening it to the successive phases in the life of an organism. His remarks, which laid special stress upon the educational value of such studies, were admirably illustrated by a series of paper models showing different stages of development in the history of a plateau.

Professor H. Carvill Lewis of Philadelphia described a narrow trap dyke, which he had succeeded in tracing continuously across south-eastern Pennsylvania for upwards of ninety miles through Bucks, Montgomery, Delaware, and Chester counties. The dyke, which is generally only visible as a line of bowlders, has been apparently faulted in several places; one great fault of several thousand feet upthrow being coincident with a large lateral displacement of both trap and the adjoining strata. Another important fault in the triassic formation was also mentioned, whereby the entire thickness of this formation is exhibited. The trap dyke is distinct lithologically from other dykes, and does not mark a fault, although passing through the Laurentian, Cambrian and Triassic formations.

Professor Persifor Fraser, from a study of a point in the archean-paleozoic contact-line in south-eastern Pennsylvania near Gulf Mills, concluded that the hydro-mica schists which outcrop there were older than the accompanying limestones, and hence not to be considered as metamorphosed Silurian strata. Professor Carvill Lewis could not agree with these conclusions regarding the structure of this locality; although Professor James Geikie of Scotland, who had recently visited the spot in company with Professor Fraser, expressed himself as entirely convinced of the correctness of the latter's views.

Papers relating to glacial phenomena, which had been so abundant at the Minneapolis meeting, were but scantily represented in Philadelphia. Mr. J. C. Smock spoke of the remains of local glaciers recently examined by him in the Catskill Mountains; and Prof. J. C. Chamberlain, in presenting a paper by Mr. J. E. Todd, exhibited upon a large map the course of the moraines along the upper Missouri River, and explained the effects which these had produced upon the drainage of the region.

Owing to the intense heat which had prevailed throughout the entire meeting, there was but a comparatively small attendance upon the final session of section E on Thursday morning. A large proportion of those down on the programme for papers had already left town; and almost the only communications of real interest which appeared were those of Professors Julien and Bolton, regarding the results of their examination of various sands. Starting some time since with a study of the so-ca led 'musical sands' occurring on the Manchester beach, they have been gradually led to extend their researches to sonorous sands from many other localities, both American and foreign; and finally to include within them a study of all ocean, lake, and river sands, whether sonorous or not. So far from being rarities, as they were considered some years ago, sonorous beach-sands are found to have an exceedingly wide distribution. Already seventy-four American and thirteen foreign localities are known, and the number is constantly increasing. The loudest sound may be produced by suddenly bringing together two divided portions of the sand enclosed in a bag. When suddenly compressed between the hands, musical notes are emitted, the pitch rising as the quantity is diminished. The conditions of sonorousness, Professor Julien considers to be perfect dryness, uniformity of grain ranging from 0.3 to 0.5 mm. in diameter, and freedom from dust. Any sand satisfying these conditions, no matter what be its nature, he thinks may be musical. Sonorous sands, when wet, generally become quicksands. The microscopic study of a large number of sands of all kinds showed that a great variety of minerals participated in their composition. No such thing as a pure quartz sand was discovered.

In place of the regular session Thursday afternoon, the section was treated to an excursion over the Reading railroad, under the guidance of Professor H. Carvill Lewis. Various points where different formations occur were visited, and the complications of the local geology about Philadelphia were explained as far as understood.

NOTES AND NEWS.

THE semi-annual scientific session of the National academy of sciences will be held in the court-house, Newport, R.I., Oct. 14, 1884, at 11 o'clock, A.M.

— An interesting study of the bed of the Delaware River has just been published by the U. S. coast-survey. It is the report of Henry Mitchell on the methods which have been followed, and the results which have been reached, in recent surveys of what is termed 'the estuary of the Delaware,' from Philadelphia to a point fifty-two miles below. He uses the term 'estuary;' because farther down the stream, there is a submerged delta, with numerous channels, 'not unlike the passes of the Mississippi, or more like those of the Ganges after its issue upon the Bay of Bengal.' The laborious character of this survey may be understood by the statement that seven hundred and thirty-four cross-sections have been measured, with widths varying from one to five miles, and including many thousand soundings. Professor Mitchell speaks in terms of high praise of the skill with which this work was performed by Mr. J. A. Sullivan of the coast-survey. The point of greatest physical importance is that of the mean depth of the estuary, the bed of which varies so little that the generalized result is best expressed by a horizontal straight line. The fluctuations are chiefly due to inequalities in the nature of the soil. The grand mean of all the soundings is 18.64 feet. The brief report of Mr. Mitchell includes many interesting comments upon the formation of an estuary, to which we can only make this brief allusion.

— Besides those whose names we previously published, the following gentlemen signed the request to the British and American associations, to consider the formation of an international congress. The list is striking as revealing the great extent of the interest felt in the undertaking. The names referred to are: George J. Brush, James D. Dana, James Hall, J. E. Hilgard, J. S. Newberry, Charles A. Young, Charles E. Bessey, William J. Beal, Edward S. Morse, William A. Rogers, Robert H. Thurston, John Trowbridge, J. Burkitt Webb, N. H. Winchell, De Volson Wood, charles C. Abbott, William Ashburner, W. O. Atwater, ML . Britton, Robert Brown, jun., W. H. Chandler, Alvan G. Clarke, E. W. Claypole, Joseph Cummings, George Davidson, A. E. Dolbear, Louis Elsberg, S. F. Emmons, J. Fletcher, S. A. Forbes, Simon H. Gage, James T. Gardiner, S. A. Goldschmidt, William H. Greene, Horatio Hale, William B. Hazen, Angelo Heilprin, S. W. Holman, Horace C. Hovey, Alexis A. Julien, Joseph Leconte, J. Loudon, N. T. Lupton, George McCloskie, B. Pickman Mann, H. N. Martin, Alfred M. Mayer, T. C. Mendenhall, William H. Niles, James Edward Oliver, Edward Orton, Richard Owen, A. S. Packard, D. P. Penhallow, W. H. Pickering, William H. Pike, Edmund Baynes Reed, Ira Remsen, John D. Runkle, I. C. Russell, William Saunders, B. Silliman, Eugene A. Smith, Francis H. Smith, Q. C. Smith, M. B. Snyder, Ormond Stone, W. Hudson Stephens, Albert H. Tuttle, Warren Upham, Lester F. Ward, M. E. Wadsworth, Charles D. Walcott, Leonard Waldo, Robert B. Warder, Sereno Watson, Charles Whittlesey, Burt G. Wilder, Alexander Winchell, Henry S. Williams, Jacob L. Wortman, Arthur W. Wright, E. L. Youmans, Joseph Zentmayer.

— Dr. Edward Channing received in 1883 the Toppan prize of Harvard university, and the essay which won this distinction has just been printed as one of the Johns Hopkins university studies in history. The theme was the town and county government in the English colonies of North America. The author is led to compare the Massachusetts system of local government with that of Virginia, and to show that both are survivals of the English common-law parish of 1600. The essay concludes with a tabulated statement of local government in England, Massachusetts, and Virginia; by glancing at which, the reader may