

PROCEEDINGS OF THE NINTH SUMMER MEETING, HELD AT DETROIT, MICHIGAN, AUGUST 10, 1897

HERMAN LE ROY FAIRCHILD, *Secretary*

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SESSION OF TUESDAY, AUGUST 10

The Society was called to order at 10.45 o'clock a m (local time) in room 211 of the Central High School building, the President, Professor Edward Orton, in the chair. By a mutual understanding between the Society and the American Association for the Advancement of Science, the Geological Section (Section E) of the Association had temporarily suspended its sessions and yielded the use of its room and time to this meeting of the Society.

ELECTION OF FELLOWS

The Secretary announced that the nine candidates for fellowship had received a nearly unanimous vote of the ballots transmitted, and that they were elected, as follows:

Fellows Elected

RICHARD ELWOOD DODGE, A. B., A. M., Teachers' College, West 120th street, New York, N. Y. Professor of Geography in the Teachers' College.

CHARLES REDWAY DRYER, A. B., M. A., M. D., Terre Haute, Indiana. Professor of Geography, Indiana State Normal School.

WILBUR C. KNIGHT, B. S., A. M., Laramie, Wyoming. Professor of Mining and Geology in the University of Wyoming.

CYRUS FLETCHER MARBUT, A. B., A. M., State University, Columbia, Missouri. Instructor in Geology, and Assistant on Missouri Geological Survey.

HENRY FAIRCHILD OSBORN, Sc. D., Columbia University, New York, N. Y. Professor of Zoology in Columbia University, and Curator in Vertebrate Paleontology, American Museum of Natural History.

EDMUND CHASE QUEREAU, Ph. B., Ph. D., Syracuse, New York. Professor of Geology, Syracuse University.

GEORGE OTIS SMITH, A. B., Ph. D., Washington, D. C. Assistant Geologist, U. S. Geological Survey.

WILLIAM GEORGE TIGHT, B. S., M. S., Granville, Ohio. Professor of Geology and Biology, Denison University. Engaged in glacial geology.

JOHAN AUGUST UDDEN, A. B., A. M., Rock Island, Illinois. Professor of Geology and Natural History in Augustana College.

After some announcements the President declared the reading of papers in order, under the customary rules. The first paper was—

GRANITE MOUNTAIN AREA OF BURNET COUNTY, TEXAS

BY FREDERIC W. SIMONDS

The second paper was entitled :

STRATIGRAPHY AND STRUCTURE OF THE PUGET GROUP, WASHINGTON

BY BAILEY WILLIS

[Abstract]

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INTRODUCTION

The article of which the following pages form an abstract is the result of field work conducted in the years 1881 to 1884 for the Northern Transcontinental Survey, and in 1895 and 1896 for the U. S. Geological Survey. The district particularly described is that which lies east of the southern portion of Puget sound, extending from the vicinity of Seattle to the foothills of mount Rainier. Most of the localities are comprised within the area of the Tacoma quadrangle of the atlas of the United States.

PHYSIOGRAPHY

The water bodies of Puget sound occupy deep and steep-sided channels in an elevated expanse of gravelly deposits, which is further divided by valleys that were formerly arms of the sound, but which are now filled with alluvium. The escarpments of the gravelly plateaus rise from 200 to 300 feet above the waters of the Sound and the alluvial plains of its former branches. The surfaces of the plateaus present a great variety of smooth and hummocky levels, supporting occasional rounded hills a hundred feet or more in height. All the aspects of the district are characteristic of forms modeled by extensive glaciers, and the individual features

developed either on stagnant ice-sheets or in front of glaciers as morainic ridges or beneath ice of whose lower surface they present the casts.

In the vicinity of the Sound these gravel deposits are deep, extending below sea-level probably several hundred feet, and even at distances of 20 to 30 miles eastward along the foothills of the Cascade range covering the older rocks locally to depths from 300 to 400 feet. They thus determine the topographic aspects of a wide area, almost obliterating the configuration of the solid rock surface upon which they rest.

From the bluffs about the Sound the plateaus rise toward the mountains by terraces, which are often disposed irregularly with reference to existing streams, but in a general way extend above the higher tracts between the rivers. Within these higher areas the deposit of gravel is thin or locally wanting above the older rocks. The canyons cut by the principal rivers flowing from the Cascades and mount Rainier also expose the underlying strata, and they may be seen in occasional isolated outcrops in the gravelly expanse nearer the sound. The topographic aspects are not markedly influenced by these outcrops, over which, as over the plateaus, extends the prevailing forest.

The gravels occur at considerable heights on the Cascades, but their general surface probably does not extend to much more than 1,000 feet above sea. From it the mountains rise up boldly, sometimes with precipitous fronts. Between these bold foothills on the east and the all-concealing gravels on the west is the zone, 10 to 20 miles wide, of terraces and transverse canyons throughout which the coal-bearing strata may be traced. It is worthy of note that the known productive coal fields all lie in the lower basin of Puget sound and not upon the higher western slopes of the Cascade range.

Valleys, canyons, and hills older than the present ones lie buried beneath the gravel deposits. They are so concealed that no clear conception can be formed of their distribution, but their relatively bold character is indicated by a few facts. In the vicinity of Renton, and between that town and Seattle, sharply defined hills of hard rock rise like islands from the alluvium of the Duwamish valley. The former canyon, now filled almost to the summits of buttes along its course, is inferred to have been deep and steep-sided. At Burnett, 20 miles from tidewater and 335 feet above it, a gangway driven on a coal vein 200 feet below the outcrops passed into a channel filled with gravel and tree roots. The slope from the nearest outcrop to the point where the buried channel was struck descends at an angle of not less than 35 degrees. At Wilkeson a similar buried channel was encountered in a water-level gangway 2,250 feet from the entrance and 250 feet below the level of the overlying gravel terrace. This preglacial topography is of much interest as a phase of the history of the Sound Basin, and it is economically important as a factor which modifies the amount of coal available above any given level. It sometimes introduces difficulties in mining. The topographic surface of the gravel deposits bears no definite relation to that of the Coal Measures.

STRATIGRAPHY

The coal-bearing rocks of the Puget Sound basin have been designated the Puget formation.* They are prevaillingly sandstones of variable composition, texture, and color, thinly interbedded, and frequently cross stratified. Their composition varies from that of a typical arkose, consisting of slightly washed granitic minerals, to silicious clays. Beds of concentrated quartz sands or conglomerates have

* C. A. White, Bull. U. S. Geological Survey, no. 51, 1889, pp. 49-63.

not been observed. Carbonaceous materials are generally present as fragments of plants, as vegetal ooze in greater or less proportion to the other constituents, and as distinct coal beds. Carbonate of iron is frequently an integral constituent of the rocks.

In color they are, when fresh, generally bluish gray, shading to brownish black. They weather to buff tints, which are usually dull. The coarser and more massive varieties form beds 20 to 100 feet thick, in which bedding planes are not distinguishable. The finer deposits are thinly laminated and carry abundant leaf impressions, which occasionally interlap with one another so as to form a mass of leaf fragments.

The weathered forms assumed by these rocks rarely present sharp profiles. The more massive beds develop rounded bosses by spheroidal disintegration due to oxidation of the iron carbonate. The thinly bedded strata break down readily, either as a clay mud or in thin scaly fragments, or in angular bits which are externally indurated by a cement of iron oxide.

In many of the sandstones silvery white mica has developed as a secondary mineral, but they exhibit no other indication of metamorphism. The coals, on the contrary, being chemically more sensitive, have undergone metamorphism to a greater or less extent through loss of combined water and concentration of fixed carbon. They vary, therefore, from lignites, whose representative analyses have the range—

| | <i>Per cent.</i> |
|----------------------------|------------------|
| Moisture..... | 8 to 12 |
| Volatile hydrocarbons..... | 35 to 45 |
| Fixed carbon | 30 to 45 |

to bituminous lignites or steam coals, in which the moisture is reduced to 5 per cent or less, and the fixed carbon ranges from 40 to 50 per cent, or to bituminous coking coals, which are fairly represented by the figures:

| | <i>Per cent.</i> |
|----------------------------|------------------|
| Moisture | 1 to 3 |
| Volatile hydrocarbons..... | 25 to 35 |
| Fixed carbon..... | 50 to 60 |

The variations from lignite to bituminous coking coal are of regional extent—that is to say, where lignites are found they may be expected to maintain a uniform composition over a relatively wide area, and bituminous varieties are equally constant in their character within the fields in which they occur. There are, however, occurrences of more condensed coals, ranging into anthracite, which are, so far as is definitely known, of local distribution only.

The cause of variation in quality among these coals may be sought in pressure and movement which they have suffered. The lignites retain the compact structure originally assumed by the peaty deposit under the load of overlying strata. Their beds have been tilted, but internally not much disturbed. They have therefore undergone comparatively moderate chemical change. The Green River steam coals have assumed a more or less cubical structure, due to shearing under pressures which caused movement within the vein. The resulting chemical effect was to expel 5 to 8 per cent of water. Beyond the area of this mechanical influence the coal changes into lignite by transition within a single bed. The coking coals of the Wilkeson field and those of the extreme eastern portion of the Green River field have been rolled out between their walls and crushed. Their softness and their concentrated condition have resulted from this mechanical disturbance. The

further transformation of the coal to anthracite and coke occurs in the vicinity of igneous rocks, to whose influence it is wholly due.

The stratigraphic relations of the Puget series are not determinable within the area under discussion, since the strata nowhere come in contact with older sedimentary rocks. Sixty miles northward, on the Skagit river, is a contact between similar coal-bearing strata and older metamorphic schists, described in an earlier report* as possibly a surface of deposition or of faulting. Examination of this locality in 1895 led to the discovery of small pebbles of the schist forming a basal conglomerate in the sandstone beds next the contact, which was therefore a surface of deposition during a transgression. Fossils found in limestone under the schists are stems of crinoids of Carboniferous or Triassic age, whereas the coal-bearing sandstones of this locality are assigned by Knowlton to the Eocene on the evidence of numerous leaf impressions.

The age of the Puget formation has been in doubt because of the obscurity of stratigraphic relations, the general absence of marine fauna, and the indeterminate character of the flora. Collections made for Newberry prior to 1884 represented various stratigraphic horizons which were not distinguished. Most of the species were new. Newberry correlated the plants with the Laramie (Cretaceous) flora, and the series has been dated late Cretaceous or early Eocene. A more definite correlation with the Tejon formation of California has been suggested by C. A. White.

The latest evidence on this still debatable question is that of collections made in 1895 and 1896 from definitely determined stratigraphic horizons on Green river, above Burnett on South Prairie creek, and on Carbon river near Carbonado. A preliminary examination of the fossil plants enables Knowlton to report that the lower beds of the series are Eocene, whereas the upper beds may be of Miocene age. The floras from horizons several thousand feet apart in stratigraphic range are so distinct as to afford means of correlating separate strata of the Puget formation. Further collections and detailed studies must be made before we can determine how closely coal beds may be identified by their fossil plants and to what extent the fossils will aid in working out the complex, obscure relations of distinct parts of the coal fields.

Most prominent among the rocks associated with the Puget group are eruptives of Tertiary or later age. They occur as dikes and flows in various forms of intruded and extruded igneous rocks.

Thus the Puget series is related to four other groups of rocks, which may be named in order of their age, as follows: (1) Metamorphic schists and limestones of Carboniferous or Juratrias date, upon which the Eocene strata were deposited unconformably, at least in the Skagit district; (2) the marine Miocene, or Tejon, with which the Puget series is stratigraphically continuous; (3) the Tertiary eruptives, which are younger than the Puget group, and date down almost to the present time; (4) the Glacial gravel deposits of Pleistocene age.

The measured sections of the Puget series exhibit total thicknesses of 5,800 feet on Green river, 5,500 feet on South Prairie creek, and 5,480 feet in Carbon River canyon. None of these measures is complete. In each instance the lowest stratum is of the Eocene outcropping on an anticline, and the highest is the limit of exposure where the rocks pass under later formations. These sections probably overlap, and there are also higher beds exposed on South Prairie creek above the limit of

* Reports of Tenth Census, vol. xv, p. 760.

the measured sections. These considerations justify the inference that the thickness of the Puget series may probably be 9,000 feet or more.

STRUCTURE

The strata of the Puget series were deposited upon the slowly subsiding bottom of the geosyncline between the axes of the present Cascade and Olympic ranges. As strata of similar composition and age are involved in the mass of the Cascade range, and probably also of the Olympics, the uplift of these mountains was to a greater or less extent accomplished after the Puget epoch. From a section observed immediately east of Renton, in which the highest strata of the Puget formation are in overthrust contact with conglomerates derived from the Puget rocks, it is inferred that the effort of compression took place in Miocene time. As a result of this effort the Puget strata were more or less extensively folded, a process to which they readily yielded in consequence of the frequent interbedding of soft coal beds. The resulting folds differ in character in the several productive districts, being in the northern or Gilman field simply monoclinical; in the Green River field broadly flexed, and in the Wilkeson field closely appressed with extensive overthrust faults. The details of these structures are further complicated by normal faulting of later date and the intrusion of the igneous rocks of post-Miocene age.

In general the axes of these folds trend north and south, parallel to the axis of the antecedent geosyncline, but there are evidences in local structures which show that the forces of compression were exerted also at right angles to the greater pressure. In general terms, the structure may be described as that of the Appalachian type modified by the local peculiarities of stratigraphy which give it the specific characteristics of the anthracite coal fields.

The detailed evidence on which these generalizations are based will be presented in the descriptions and maps in the article in the Eighteenth Annual Report of the United States Geological Survey.

Remarks upon the matter of Mr Willis' paper were made by E. W. Claypole.

The paper will be printed in full in the Eighteenth Annual Report of the United States Geological Survey.

The next paper was read by Mr Frank Leverett in the absence of the author.

LOESS AS A LAND DEPOSIT

BY J. A. UDDEN

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OBJECTIONS TO AQUEOUS HYPOTHESIS

A study of the work of the wind as a geological agent leads me to discuss the bearing this study appears to have on the deposition of the American loess. This

I am led to do since serious objections to the hypothesis of aqueous deposition are being urged. It should be understood that some aqueous deposition is recognized to be necessary. I only wish to show that it fails to cover the whole series of phenomena, and that the wind has been very important and perhaps more potent and far-reaching in influence than water deposition.

It is scarcely necessary to speak of the objections to aqueous deposition based upon topographic relations of the loess. As is well known, this deposit not only borders valleys, but blankets interfluvial tracts as well, often resting on an eroded surface like a mantle of snow, being found on the highest as well as the lowest parts of the previously eroded tracts. It is not rare to find it occurring at elevations differing several hundred feet within a distance of but a few miles. Another objection to aqueous deposition, based upon absence of shorelines, has recently been made. The occurrence of terrestrial shells in the loess I also merely mention as a feature out of harmony with the theory of aqueous deposition, especially of deposition in a large body of water.

ADEQUACY OF WIND AS SHOWN IN THE MISSISSIPPI VALLEY

That the wind is adequate to produce such a deposit seems to be certain from the fact that materials of the same kind are constantly carried by the air. The question then also arises whether the conditions in the Mississippi valley are or may have been such that wind sediments may have accumulated in the territory now covered by the loess. I wish to call your attention to these points. They may be very briefly stated as follows:

1. *The universal presence of mineral dust in the atmosphere, and its constant settling, necessitates its accumulation in places where erosion is at a standstill or where it does not exceed the rate of atmospheric sedimentation.*

It seems possible that the conditions prevailing at the present time in some places in the Mississippi valley permit a secular accumulation of atmospheric dust. Observations which I have made in this direction indicate, however, that the quantity of atmospheric sediments now laid down is too small to give support to the view that there is any general accumulation of this kind going on over the loess region at the present time; but the same observations also indicate that the quantity of dust carried in the air is subject to extreme variations with rather moderate changes in meteoric conditions. The atmospheric sedimentation of the present time is hence no certain quantitative index for the past, and it seems quite possible that conditions may at some time have been more favorable to its effectiveness than they seem to be at present.

2. *Erosion of the flat loess-covered uplands is at the present time exceedingly slow as compared with the average rate of denudation of the whole Mississippi valley.*

This is a circumstance of importance in considering the possibility of an accumulation of wind sediments, for if extreme differences occur in the rate of surface denudation, it follows that by a very small addition of sediments in one place, where erosion is least rapid, the land may be built up, while it is being levelled down in other places where surface erosion is more rapid.

From the topography of the Mississippi valley it is quite evident that denudation progresses at a very unequal rate for different parts of the land surface. Owing to the greater slope of the land in the peripheral regions of the valley, erosion there is much more rapid than in the central region. On the west slope this difference

is at present so great that there is a zone running north and south over the plains, where the western tributaries are leaving a part of their load and building up the land. Again, the comparatively slow denudation east of this zone is itself distributed unequally, being largely confined to the drainage channels and only to a very small extent, as sheet erosion, affecting the flat surface of uplands away from creeks and gullies. The lateral slopes of the smallest as well as of the largest drainage channels in the loess region soon merge into the nearly horizontal upland plain. Erosion decreases with the slope and practically ceases with it. Rain water on a level surface appears to soak into the ground as rapidly as it falls, even in the heaviest rains. This is especially the case where the surface is covered by vegetation. By far the greater part of the land area in the region of the loess consists of such flat land. It is believed that the greater part of the sediments of the Mississippi are taken from its own bed and bluffs and from the beds and immediate slopes of its tributaries, large and small. These constitute mere narrow belts, which dissect the much more extensive plains, and they occupy only a small part of the entire land surface. The greater part of the land denudation in the central region of the Mississippi valley is hence confined to a comparatively limited area, from which the greater part of the river's load is taken. The removal of only a small quantity of materials from the much more extensive level uplands must make their planing down by sheet erosion exceedingly slow. Evidently this rate would be still further reduced if the drainage were more sluggish. It might be so slow as not to equal the secular accumulation of atmospheric dust on the land surface, in which case this would of course accumulate.

SIMILARITY OF COMPOSITION OF DUST AND LOESS

In their mechanical composition fine wind sediments and loess are largely identical. The bulk of each consists of particles from one-sixteenth to one-sixty-fourth of a millimeter in diameter, with two nearly symmetrically decreasing series of admixtures above and below these sizes. An aqueous deposit, spread over hundreds of miles of a broken topography and reaching a thickness of a hundred feet, could not very well be as uniform in its mechanical composition as the loess is. It would more frequently contain coarser materials. In particular it seems improbable that a water deposit as fine as the loess should be without thin seams of fine silt, such as are generally to be observed in aqueous sediments. These are more or less conspicuously laminated. In a wind sediment, on the other hand, such a sorting and lamination is impossible, owing to the smallness of each sorted load, to the less constancy of the depositing current, and to disturbing agencies which are at work thoroughly mingling successive deposits on the surface of the land.

OTHER FEATURES SUSTAINING EOLIAN HYPOTHESIS

There are other features of the loess which appear easy to explain if it be regarded as a terrestrial deposit. One such feature is the relation which has been shown to exist between the border of the Iowan drift and the loess. At the time of the deposition of these two terranes there was a low drainage gradient. The land to the south of the ice was probably a low swampy plain, where surface erosion was nearly at a standstill except along the water-courses, and where, as a consequence, atmospheric dust may have accumulated. Such accumulations may have reached up over the margin of the ice fields and may thus have caused oc-

casional overlapping of the loess on the Iowan till. The gradual transitions from underlying terranes which often merge, as it were, into the base of the loess, would naturally be formed as the conditions for the accumulation of the loess slowly set in. Thus we should expect to find under the loess here and there the oxidized surface of the older till, old soils, forest beds, peat, overwash aprons, dunes sand, etcetera. The loess itself ought to be heaviest and coarsest along the larger drainage channels, where the topography has aided in producing local wind eddies and where the rivers have helped to expose materials to wind action. The water of these rivers may have added a part of the material in some places along their courses. This is indicated by occasional stratified phases of the loess in such localities. The multiple age of the loess is also easily accounted for, as with the many climatic changes attendant upon the periods of the ice age, conditions may readily at different times so far have favored the work of the wind as to have allowed the accumulation and the preservation of its sediments.

The paper was discussed by J. W. Spencer, G. F. Wright, E. W. Claypole, G. K. Gilbert, and Frank Leverett.

Following the discussion of Mr Udden's paper, at 12.15 o'clock the Society adjourned for the noon recess.

At 2.15 o'clock p m the Society was again called to order, and in the absence of President Orton Mr G. K. Gilbert was elected temporary chairman.

The following paper was read :

ANALOGY BETWEEN DECLIVITIES OF LAND AND SUBMARINE VALLEYS

BY J. W. SPENCER

At the conclusion of the reading President Orton resumed the chair.

The next paper was by the same author:

GREAT CHANGES OF LEVEL IN MEXICO AND THE INTEROCEANIC CONNECTIONS

BY J. W. SPENCER

The paper is printed in full in this volume.

The two papers by Mr Spencer were discussed together, and remarks were made by E. W. Claypole, W. N. Rice, and G. K. Gilbert.

The following paper was read :

ORIGIN OF THE GORGE OF THE WHIRLPOOL RAPIDS AT NIAGARA

BY F. B. TAYLOR

The paper is printed in full in this volume.

Remarks were made by G. K. Gilbert, J. W. Spencer, G. F. Wright, E. W. Claypole, and the President.

A second paper by the same author was

GLACIAL DRAINAGE OF THE SIMCOE AREA IN ONTARIO

BY F. B. TAYLOR

Remarks were made by J. W. Spencer.

The following paper was then read:

LIMESTONES OF SOUTHEASTERN MICHIGAN, WITH THEIR ASSOCIATED SANDSTONE, SALT, AND GYPSUM

BY W. H. SHERZER

[Abstract]

Passing in a northeast and southwest direction across the southeastern corner of Michigan is a low anticline, which crosses Monroe county and enters Wayne county south of Detroit. It is on this anticlinal ridge that most of the natural outcrops and quarries occur in this portion of the state. The oldest rocks exposed belong to the Waterlime division of the Lower Helderberg, and extend downward, as determined by deep borings, into the Salina, which reaches a possible thickness at Detroit of 2,000 feet. The Waterlime beds are exposed in the streams and quarries about Monroe, and southwestward towards Sylvania, Ohio. These beds consist of a drab or brown dolomite, in places brecciated, and characterized by the absence of large corals and fish remains. In general fossils are not abundant, and those that are found are in the form of moulds and casts. Calcium carbonate comprises from 54 to 55 per cent of the rock and magnesium carbonate from 42 to 43 per cent. These rocks are used locally for building, road-work, and lime.

A bed of dolomitic oölite may be traced from Stony Point, on the lake Erie shore, southwestward to near the state line. On Plum creek, south of Monroe, this bed is 2 feet thick. The granules here are well rounded, but southwestward they become in places singularly elongated and almost vermiculate, passing into compact dolomite.

A bed of remarkably pure white sand rock, known by the Ohio survey as the Sylvania sandstone, passes northeastward from Sylvania, crosses the Raisin river near Grape, outcrops at a point seven miles northwest of Monroe, and curves eastward to the south of Gibraltar. This sand rock is of interest because of its economic value in glass manufacture, because of the secondary enlargement of its grains, and because it has been regarded as the equivalent of the Oriskany in this region. In Monroe county its thickness seems to range from 20 to 30 feet, but it thickens and broadens correspondingly as it passes northward. What seems to be the same bed is found at Trenton at a depth of 230 feet; at Wyandotte, 280 feet, and at Detroit at 475 feet, it now having attained a thickness of over 100 feet. That this bed cannot be regarded as the equivalent of the Oriskany is shown by the fact that it is overlain by beds of Waterlime, consisting of a silicious dolomite, a brown sandstone, and a light porous dolomite, exposed at Ottawa lake, Raisinville, Maybee, Flat Rock, Gibraltar, and Grosse Isle. With the exception of a few unidenti-

fiable fragments secured by Dr C. Rominger, the bed has never yielded fossils until during the past season's work of the State survey.

The Waterlime beds are much fissured and broken in places, furnishing numerous localities with underground drainage. Several large and small "sinks" occur in the southwestern part of Monroe county, Ottawa lake being the largest. These fill up in the spring and then are drained into subterranean channels. At three different points live fish are reported to have been pumped from wells, a creditable witness assuring me that he saw three mullet-like forms swimming in a pail, having greatly enlarged pectoral fins and being entirely without eyes.

Calcite and celestite occur in the cavities in the beds at various places, and at Maybee these minerals are associated with native sulphur in considerable quantity.

Above this group of beds lies the Corniferous division of the Upper Helderberg, outcropping and artificially exposed at Dundee and Trenton. Just north of the latter place the Sibley Quarry Company has opened more than 40 acres to a maximum depth of 33 to 35 feet. The main dip of the rocks is west 5 degrees south, and equals 2.5 degrees to 3 degrees. Ten beds of limestone, varying in thickness from 2 to 9 feet, are exposed, and two of chert, 14 and 24 inches respectively. The rock is light colored and remarkably rich in lime carbonate, some samples yielding 98 to 99 per cent. Two drill cores have been taken out, and show that the rock becomes more magnesian as it descends. Fossils are very abundant, particularly corals, bryozoa, brachiopods, gasteropods, and lamellibranchs. Fish teeth and spines are occasionally found. In the lower strata the rocks are well bedded and furnish excellent building stone. The quarry refuse is run through a crusher and converted into road material. Burning produces a strong quality of lime, but the chief use of the purer beds is in the manufacture of soda ash and caustic soda.

At Dundee the same beds are exposed, but are thinner. The rock possesses much the same character as at Trenton, contains the same assemblage of fossils, but is more highly impregnated with oil. These rocks, known by the present State survey as the "Dundee limestone," attain a thickness from 100 to 150 feet. Beneath the city of Detroit deep borings reveal the presence of three valuable veins of rock-salt, struck at depths of about 900, 1,200, and 2,000 feet, the combined thickness of which cannot be far from 500 feet. Toward the south these veins approach the surface and become thinner, while northward they deepen and thicken. The highest of the three veins at Wyandotte gives 50 feet of rock-salt, rapidly thins southward to 8 feet, and probably gives out completely at Monguagon creek, being replaced by gypsum in the wells of Church and Company just north of Trenton. At the latter place the second vein in the most northern well shows 33 feet of salt and none in the most southern well, so that here seems to be the southern limit of the rock-salt along the river, with a possible southwestward extension into Monroe county. At both Wyandotte and Trenton the lowest vein is replaced by gypsum and shale, and the Niagara limestone entered at a depth of from 1,250 to 1,400 feet. In the well of the Eureka Iron and Steel Works at Wyandotte what was believed to be the Trenton was reached at 2,610 feet.

The occurrence of such deposits of solid salt in close association with lime carbonate of as high a grade as that of the Sibley quarry at Trenton is of the greatest economic importance to this section of the state. Within less than a decade ten millions of outside capital, employing thousands of workmen, have been attracted thereby to the banks of the Detroit river.

Remarks upon the paper were made by E. W. Claypole.

The following papers were read by title :

NOTES ON THE GEOLOGY OF THE LOWER PENINSULA OF MICHIGAN

BY ALFRED C. LANE

NOMENCLATURE OF THE CARBONIFEROUS FORMATIONS OF TEXAS

BY ROBERT T. HILL

ICE-TRANSPORTED BOULDERS IN COAL SEAMS

BY EDWARD ORTON

CLAY-VEINS VERTICALLY INTERSECTING COAL MEASURES

BY W. S. GRESLEY

This paper is published in full in this volume.

Upon motion of Mr G. K. Gilbert, the thanks of the Society were voted to the Local Committee and to the Geological Section of the American Association for the Advancement of Science.

The President declared the meeting adjourned.

REGISTER OF THE DETROIT MEETING, 1897

The following Fellows attended the session of the Society :

| | |
|------------------|------------------|
| G. H. ASHLEY. | W. H. SHERZER. |
| E. W. CLAYPOLE. | F. W. SIMONDS. |
| H. L. FAIRCHILD. | C. H. SMYTH, JR. |
| G. K. GILBERT. | J. W. SPENCER. |
| C. H. GORDON. | F. B. TAYLOR. |
| FRANK LEVERETT. | A. W. VOGDES. |
| EDWARD ORTON. | BAILEY WILLIS. |
| W. N. RICE. | G. F. WRIGHT. |

Present at the meeting of the Society, 16.

The following Fellows were in attendance upon the meeting of the American Association for the Advancement of Science :

| | |
|-------------------|------------------|
| T. C. CHAMBERLIN. | R. D. SALISBURY. |
| W J MCGEE. | R. P. WHITFIELD. |
| R. S. WOODWARD. | |

Total attendance, 21.