SECTION E, GEOLOGY AND GEOGRAPHY.

ABSTRACTS of papers read before the Section on August 26–29, 1901, are as follows:

'Some Problems of the Dakota Artesian System': JAMES E. TODD.

This paper presents some of the unsolved problems found in several years' study of the artesian wells of South Dakota. The artesian system shows four or five aquifers, or water-bearing strata, more or less completely separated from one another. Our first problem is, how is this separation accomplished? By sheets of clay wholly, or in part by mutual precipitates between two kinds of water? Again, artesian waters may be divided into soft and hard, and both kinds are found in the same aquifer in different localities. This presents the question, what decides the mineral content of the water at any place? Is it what is brought from its original source, or the composition of the rock in which it is found? The latter seems most accordant with the facts. Again, though from the hydraulic gradient the flow seems to be uniformly towards the southeast, the soft waters in each aquifer are found toward the northwest, and the hard to the southeast. Therefore, another problem is, how can we explain the lime and less soluble salts replacing the soda and more soluble salts in the same stream? Again, a prominent content of the water about Pierre, and extending westward indefinitely, is natural gas, and this gas has been identified with the water itself and not with any carbonaceous stratum above. What then is the origin of the gas? The high temperature with which it is associated, 92° to 102° F., and its intimate mixture with the water, suggest a chemical origin, but nothing in that line, which has been hinted by any chemist, can be conceived to occur in this region. There is no trace of volcanic or crustal disturbance, but from geological relations there is strong ground for believing that extensive carbonaceous deposits may have been formed in the Carboniferous period a little west of Pierre, the eastern edge of which the Dakota formation, which bears the water, directly overlaps. Subterranean heat may distill the gas into the overlying water stratum, carrying the higher temperature from below, and perhaps adding to it by condensation. But, perhaps more strange, a few miles east of Pierre the gas disappears and the temperature of the water declines 20 degrees or more. We have, therefore, another very obscure and difficult problem. What becomes of the gas? This problem in some respects resembles the disappearance of soda ingredients in the water, mentioned above. Perhaps the readiest suggestion is that the gas escapes from the water to the surface, by its greater penetrating power, but no gas springs have been found, and only a little at higher levels, which has been discovered in shallow wells. We have already alluded to the phenomenally high temperature of some wells. This has been well discussed by Darton in the 18th Annual Report U. S. G. S. The oxidation of pyrites he considers inadequate, yet as the higher temperatures are connected with the presence of sodium chloride and gas, so far as we know, it is strongly impressed upon us that some chemical reactions yet undiscovered have something to do with the high temperature, origin of gas, and disappearance of sodium salts in the great eastward-flowing streams of artesian waters.

'Interpretation of Some Drainage Changes in Southeastern Ohio': W. G. TIGHT.

This paper traces some old river valleys and indicates the sequence of events during the changes and the time of the inauguration of the changes.

'Moraines and Maximum Diurnal Temperature': JAMES E. TODD.

It has been noted that the moraines in the James River valley are frequently wider and rougher on the west side of the valley than on the eastern. This is particularly true of those later than the first, for they are formed on a quite smooth plain. The first is much influenced by preglacial topography. Moreover the western sides of the loops are apt to be at lower altitudes. In seeking for an explanation for this, we find nothing more satisfactory than the fact that the maximum diurnal temperature is uniformly considerably higher after noon, hence the western half of an ice lobe will receive more heat and consequently be more active, *i. e.*, move faster, bring more débris, melt more rapidly, be more apt to detach and bury more ice blocks. The lower altitude may result from the melting back of the ice farther on a concave surface, such as is apt to be left by the former ice sheet. A corollary of this general proposition is that in the northern hemisphere the southern side of an east- or west-flowing glacier will tend to exhibit similar phenomena for a similar reason, viz., because of the southern position of the sun. Instead of curving such glaciers toward the north, as argued several years ago in one of our prominent scientific journals, it will rather tend to quicken the motion in the ice toward the south, though at the same time, because of greater melting, it may not widen the ice, but the contrary. If the débris transported is abundant it may turn the course of the glacier northward, somewhat as the deposition of sediment in a delta or an alluvial fan may divert the stream which forms it. Of course the influence here recognized is not all-powerful, but may be counteracted in certain cases by other conditions.

'On *Campodus*, *Edestus*, *Helicoprion*, *Acanthodes*, and other Permo-Carboniferous Sharks': C. R. EASTMAN.

The genus *Campodus*, known only by fragmentary remains from the Coal Measures, was shown by St. John and Worthen, and later by Max Lohest, to have possessed a typical Cestraciont dentition. The researches of these authors were based upon a unique example of the left ramus of the lower jaw, from which the anterior and posterior extremities were missing. Two specimens are now known, belonging respectively to the Museum of Comparative Zoology at Cambridge and the State University of Nebraska, which exhibit the symphysial series of teeth and incidentally throw new light on the relations of *Edestus*, *Helicoprion* and the like. In one jaw of *Campodus*, presumably the lower, there was one arcuate, median azygous series of symphysial teeth, opposed to which in (presumably) the upper jaw were two corresponding series separated by a slight interval. As successional teeth were developed the functional ones became coiled in a regular arc like *Edestus*, with the coronal buttresses directed inward (posteriorly). The complete whorls of *Helicoprion* are believed to represent a more advanced stage of an entirely homologous dental structure. A new and very large species of *Acanthodes*, represented by a pectoral fin, numerous spines and shagreen, was reported from the Coal Measures of Mazon Creek, Illinois, and reference made to the occurrence of *Phoebodus* in the Keokuk Limestone of Iowa and Permian of Nebraska. The large variety of *Ctenacanthus* spines occurring in the Kinderhook Limestone of Iowa fall into two principal categories, one long and slender and gradually tapering, the other short and blunt. These are probably to be correlated with the first and second dorsal fins of the same individual, instead of being regarded as distinct species.

'Note on Certain Copper Minerals': ALEXANDER N. WINCHELL.

Chalcopyrite has been found more than once as an accidental product in metallurgical operations, but bornite has never been described as formed in the same way, nor as produced artificially by sublimation.

Both these minerals form at the smelter of the Butte and Boston Consolidated Mining Co., at Butte, Montana. They form slowly, attaining their maximum thickness of about four inches in the course of six months to a year. They form in the Allen-O'Harra calciner along the rails in the bed of the furnace. In fact, they not only form beneath the flanges of the rails, but also slowly replace the rails themselves. When the rails are taken out they have only a thin upper surface layer of iron remaining; all the rest has been transformed into chalcopyrite and bornite, with the exception of that portion of the rails completely embedded in the brick bed of the furnace. An examination of these sulphides shows that, while they are somewhat impure from mechanically admixed quartz and perhaps some other foreign matter, they exhibit the true characters and chemical composition of chalcopyrite, coated in places with films of bornite. Both minerals have been formed by sublimation, and not by fusion, since the temperature of the furnace never rises high enough to fuse the ores present. Since these minerals replace and destroy the iron rails of the calciner, their formation leads to the necessity of removing and replacing the rails with new ones once every ten or twelve months.

'Note on the Minerals Associated with Copper in Parts of Arizona and New Mexico': GEO. H. STONE.

In the mountain ranges of southeastern Arizona and southwestern New Mexico are numerous copper-bearing veins in limestones and shaley limestones of Carboniferous age. In respect to the kinds of copper compounds and the occurrence of quartz and hydrous gangue minerals, these veins are not very different from the copper-bearing veins of Colorado and the States northward. Fluorspar is rare, and the sulphates scanty. It is in respect to the kind and quantity of their anhydrous silicates that they are notable. One of the common gangue minerals is pyroxene. Occasionally it occurs as distinct and easily recognizable four-sided needles. Generally it forms small columnar or stellate crystallizations that are scattered through the decomposed and partially replaced lime rock, or it may be enclosed in quartz. Sometimes it forms slabs of asbestos up to two inches in thickness having their fibers parallel and at right angles to the surface of the slab. In a few cases I noticed these slabs having their fibers interlaced in all directions, and then they are very tough and elastic. The pyroxene occurs both in limestones and in porphyry dikes that penetrate the limestones. Asbestos occurs as a gangue mineral at Ward, Boulder County, Colorado, and in some others of the mountain districts, but I have never seen it so abundant as in the Chiricahua range in Cochise County, Arizona. Another common mineral in the veins in question is epidote. It occurs filling small cavities both in limestones and porphyries, and is very common as a product of contact metamorphism. But now and then it occurs in large quantities as gangue material proper. Thus in the California Mining District in the Chiricahua mountains there is a copper-bearing vein which for nearly a mile is composed of a solid mass of epidote wherever it has been opened by cuts and shafts. It is of various widths up to 5 feet. By far the most abundant of the anhydrous silicates in these veins is garnet. It is generally green, but occasionally brownish or yellowish green, and sometimes carmine or rose red. The copper is sometimes found impregnating the garnet mass, but more often occurs in porous quartz alongside of the larger garnet bodies. The garnets occur in irregular masses in the limestone, and often line drusy cavities. They are plainly a replacement of the limestone due to vein metamorphism of the country rock. In parts of the Chiricahua mountains the copper veins are marked by belts of limestone more or less charged with garnet up to fifty or more feet in breadth.

In the region in question during the upheaval of the mountains, we find that where the strains were relieved by faulting and the uptilting of monoclinal blocks, the limestones retain their fossils and original amorphous condition. But where anticlines were formed there was much lateral (horizontal) pressure, the limestones are re-crystallized to a semi-marble, and the fossils are obliterated. This may be termed regional metamorphism. The same sort of recrystallization has taken place in the lime rock along the copper-bearing veins, and we may term it vein metamorphism.

'The Minerals and Mineral Localities of Texas': FREDERIC W. SIMONDS.

There has been, so far as the author is aware, no attempt to list in a complete form themineral species occurring in Texas. In the 'Mineral Resources of the United States,' for 1882 (Washington, 1883), Professor John C. Smock, of the Geological Survey of New Jersey, who was charged with the preparation of the material illustrative of the 'Eastern Division,' published two tables for the purpose of showing the mineral resources of Texas. The first included 'Ores, Minerals and Mineral Substances of industrial importance and known occurrence, which are at present mined'; and the second, 'Ores, Minerals and Mineral Substances of industrial importance and known occurrence, but which at present are not mined.' Of the former, eight are mentioned; of the latter, 32. In the 'Mineral Resources' for 1887 (Washington, 1888), the same tables, with slight modification, mainly in the matter of additional localities, are repeated. In the First Annual Report of the Geological Survey of Texas (Austin, 1890), Mr. W. von Streeruwitz published a list of minerals, 63 in number, observed in the Trans Pecos region, but the details of occurrence and localities were, unfortunately, not given (pp. 225–226). In the same volume, Dr. Theo. B. Comstock records 111 minerals collected in the 'Central Mineral Region'—the Llano country. This 'includes only those which occur as crystals or in special or rare situations,' and is regarded by him not as complete, but as affording a 'preliminary list of localities' (pp. 379–391). A list of those minerals and rocks of Trans Pecos Texas which, up to this time, could be classified by their appearance, blow-pipe tests and laboratory work, constitutes Chapter IV. of a 'Report on the Geology and Mineral Resources of Trans Pecos Texas,' by W. H. von Streeruwitz (Second Annual Report of the Geological Survey of Texas, pp. 710–713, 1890). It is, as the writer states, "far from being complete, but it comprises a number of the more important and valuable minerals, building stones and ores of west Texas, giving the localities where they were found." Unfortunately, the State does not possess a collection containing all minerals which I have thus far been able to list; and, as a consequence, the information concerning this occurrence has been derived from many sources, viz.: from a careful examination of the various reports relating to the geology of the State and its resources, keeping in mind at all times the value, as far as it could be estimated, of the observer as an authority. On the same basis, the various scientific journals have been gone over, and the 'transactions' of the different learned societies. Thus far, I have recorded as occurring in Texas one hundred and fifty minerals, varieties, and mineral substances, exclusive of rocks, of which eight are at present of economic importance, viz.: petroleum, coal, lignite, limonite, salt, gold and silver. Of localities the number has, even within the last few months, been enormously increased.

'Note on the Extinct Glaciers of New Mexico and Arizona': GEO. H. STONE.

In southwestern Colorado there were once extensive glaciers on the La Plata and San Juan mountains. The largest of these was 70 miles long and filled the valley of the Las Animas river. It deposited a terminal moraine just north of Durango, Colo., but appears not to have reached so far south as the 37th parallel of latitude. In New Mexico east of the Rio Grande the only extinct glaciers that I have been able to trace were along the high range that forms the southern extension of the Sangre dė Christo range of Colorado. Each lateral valley of this range contained its glacier both in Colorado and as far south in New Mexico as a point not far north of Santa Fe. In the region south of the Galisteo are the Ortiz, San Pedro, San Dias, Pedernal, Gallina and Jicarilla mountains. I have visited all these mountains and found no proof of the former existence of glaciers. South of White Oaks is a lofty north and south range—the Sierra Blanca. It is the highest range in that part of New Mexico, probably rising to near 11,000. It is a place of great snowfall, as its name signifies. In valleys of northern exposure I found large masses of snow late in June. I was not able to find moraines. West of the Rio Grande the main southeast spur of the San Juan mountains passes into New Mexico as the Conejos range. This range falls rapidly toward the south and was glaciated for not more than 30 to 50 miles south of the Colorado-New Mexico line. South of this there are no mountains in western New Mexico so high that we could expect to find traces of glaciers on them until we reach the lofty Mogollons. They have a heavy snowfall. They are rather inaccessible and I have not visited them. I have explored the higher mountain ranges that lie south of the Gila river in New Mexico and Arizona, but no moraine or other sign of a glacier was I able to find. The farthest south and west I have found traces of extinct glaciers is at Prescott, Arizona. Around Prescott are numerous moraines. The highest part of the névé of this glacier could not have been much above 9,000 feet. The central part of the glacier is approximately in N. Lat. 34° 30′. The occurrence of an ancient glacier so far south as this was probably due to a very great snowfall owing to the proximity of the ocean. It is doubtful if there was any mountain range high enough to have had its glaciers in glacial time between Prescott and the Sierra Nevada. Probably there were then small glaciers in some of the cirques of northern exposure among the mountains directly southeast of Prescott. We may yet find that the glaciers reached their southern limit in the Mogollon mountains of New Mexico and Arizona.

'The Pre-glacial Surface Deposits of Lower Michigan': A. C. LANE.

Some years ago in working out the general system of drainage of the basin of the Great Lakes, before it was disarranged by the ice from the north, Professor J. W. Spencer drew a sketch map indicating the great streams flowing down to Lake Michigan and Saginaw Bay and joining the Laurentian River, which flows off across Canada. In this scheme of drainage he has been followed by most of the writers since, and his work has been somewhat elaborated by Mr. E. H. Mudge in an article in the *American Journal of Science*, Volume 4, 1897, page 383. There were, however, certain arguments against the idea that the center of lower Michigan drained through the Saginaw Bay. Directly in the mouth of the bay is a group of islands, the Charity Islands, which are composed of cherty, sub-Carboniferous limestone, of about the age of the Upper St. Louis. On both sides of the bay occur outcrops of the same limestone. The mouth of the bay is shallow, and the ledges of limestone can almost be traced continuously across it not far below the lake surface, and as the elevation of the bed rock surface around in Bay County is, as Spencer and others have remarked, considerably below the present lake surface, it seems hard to assume that any river used to flow northeast out of the Bay. The results of my studies of the rock surface topography of Huron County, published in Volume 7 of our reports, based on the extensive lists of borings catalogued there, showed clearly a river system flowing southeast, gathering strength. Again when I came to discuss the general subject in Water Supply Paper No. 30, it became evident that the Saginaw lobe of ice did not advance as far, proportionately, as Michigan or the Huron-Erie, being retarded, apparently, by this limestone ridge. And, moreover, the result of borings for coal, oil, gas and salt throughout the Saginaw valley made it pretty clear that, before the ice age this valley did not drain as at present, but to the west and northwest. The evidence which I presented on this point, in Water Supply Paper No. 30, was very candidly accepted by Mr. Mudge, who at the same time pointed out some emendations in detail. Since, however, authors are still following Spencer, it may not be inappropriate to call attention to the subject once more and to present some of the elevations above tide which make it reasonably certain that the drainage of lower Michigan was to the northwest. The coal basin of Michigan is surrounded by a series of ramparts of which the sub-Carboniferous limestone, Marshall sandstone, Devonian limestone and Niagara limestone are the most important. It is probable that in the neighborhood of Saginaw Bay all these ramparts were broken down by pre-glacial rivers, except the innermost, curved to the right and left, so that finally when the ice overrode this the lobe extended in the general direction of the ice motion, that of Saginaw Bay. The shore of Saginaw Bay has now been so completely lined with borings that it is not conceivable that any valley of the first order 300 feet below lake level can go out that way, while it is only a few miles south, in Saginaw County and west of it, that we find bed rock elevations of only 300 and 400 feet below tide. The west part of the State is so heavily covered with drift that our information regarding the bed rock surface is much more scanty, but we know that in the northwest part, bed rock surface is below sea level. The great group of lakes resembling somewhat the Finger Lakes of New York, and the bays which are associated, Great and Little Traverse Bays, require special explanation, and seem to find it in some large pre-glacial valley that had irregular pre-glacial topography, such as would be found where the escarpments of the middle and lower Devonian limestone come close to master valleys. It seems to me possible that before the last ice age the main streams connecting the valley of Lake Michigan with that of Lake Huron may have passed from just north of Petoskey to somewhere near Cheboygan; at any rate, there was a considerable stream there. So far as the present indications of levels are concerned, it would seem as though the *streams were flowing to the south rather than to the north*, but before we can settle this question, we must hear from the geologists of other States.

The following papers were also read before the American Geological Society and the Section.

1. 'Account of the Colorado Excursion': C. R. VAN HISE.

2. 'Junction of the Lake Superior Sandstone and the Keweenawan Traps in Wisconsin': U. S. GRANT.

3. 'Hydrographic History of South Dakota': J. E. TODD.

4. 'The Still Rivers of Western Connecticut': W. H. HOBBS.

5. 'Geology of the Northeast Coast of Brazil': JOHN C. BRANNER.

6. 'Classification of the Geological Formations of Tennessee': JAMES M. SAFFORD.

7. 'Horizons of Phosphate Rock in Tennessee': JAMES M. SAFFORD.

8. 'The Oscillations of the Coast Ranges of California': A. C. LAWSON.

9. 'Some Features of the Geology of Golden, Colorado' (a paper preparatory to the excursions in Morrison and Golden on Tuesday and Wednesday): H. B. PATTON.

10. 'The Geological Occurrence of Oil in Colorado': A. LAKES.

11. 'Report on Some Studies Relative to Primal Questions in Geology': T. C. CHAMBERLIN.

12. 'A Plea for Greater Simplicity in the Language of Science': T. A. RICKARD.

13. 'Sandstone Intrusions near Santa Cruz, California' (lantern illustrations): J. F. NEWSOME and J. C. BRANNER.

14. 'On the Pleistocene Deposits of Iowa' (lantern illustrations): SAMUEL CALVIN.

15. 'Problems of the Quaternary Deposits of the South Platte Valley': GEORGE L. CANNON.

16. 'Physiography of the Boston Mountains, Arkansas': A. H. PERDUE.

17. 'A Quantitative Study of Variation in the Fossil Brachiopod *Platystrophia biforta*, Schl.': E. R. CUMINGS and A. V. MAUCK.

MEMBERSHIP OF THE AMERICAN ASSOCIATION.

THE following have completed their membership in the American Association for the Advancement of Science during the month of October:

Hendery Allison, M.D., 149 Richmond Terrace, Port Richmond, N. Y.

Jacob H. Arnold, Teacher of Natural Science, Redfield College, Redfield, South Dakota.

Samuel M. Bain, Professor of Botany, Univ. of Tenn., Knoxville, Tenn.

Dr. Philip P. Calvert, Professor of Zoology, Biological Hall, Univ. of Pa., Philadelphia, Pa.

John J. Davis, Attorney-at-law, Clarksburg, W. Va.

Miss Anna M. Deens, Botany and Zoology, 216 North Ave., W., Allegheny, Pa.

Miss Abigail C. Dimon, Zoology, Radnor Hall, Bryn Mawr, Pa.

Manuel V. Domenech, Civil Engineer and Architect, Lock Box 151, Ponce, Porto Rico.

Fred. N. Duncan, Chemist, Georgetown, Texas.

Gano S. Dunn, Electrical Engineer, Crocker-Wheeler Co., Ampere, N. J.

Edward M. Ehrhorn, County Entomologist, Santa Clara Co., Mountain View, Cal.

Sumner B. Ely, Mechanical Engineer, Vandergrift Building, Pittsburg, Pa.

Robert Gauss, Editor *Denver Republican*, Denver, Colo.

Professor Chas. B. Gilbert, Educator, 106 Brunswick St., Rochester, N. Y.

Charles P. Greenough, Attorney-at-law, 39 Court St., Boston, Mass.

Mrs. Margaret L. Griffin, Botany and Geology, Keene, N. H.

Wm. C. A. Hammel, Department of Physics, State Normal School, Baltimore, Md.

Judge Lynde Harrison, Lawyer, 52 Hillhouse Ave., New Haven, Conn.

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Ray V. Hennen, Civil Engineer, care of Carter Oil Co., Sistersville, Tyler Co., W. Va.

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Dudley S. Reynolds, M.D., Louisville, Ky.

James F. Rhodes, Author and Historian, 392 Beacon St., Boston, Mass.

Maurice Ricker, Zoology, High School, Burlington, Iowa.

Milnor Roberts, Professor Mining and Metallurgy, Univ. of Washington, Seattle, Wash.

Sanford Robinson, Civil and Mining Engineer, Steeple Rock, Grant Co., New Mexico.