ART. XI.—*Notes on a Reconnaissance of the Ouachita Mountain System in Indian Territory*; by ROBT T. HILL.*

Synopsis.—General topographic features of Indian Territory including Oklahoma. The northern, middle and southern belts. The middle or mountainous belt. 1. The Eastern or Arkansas-Choctaw Division. 2. The Central or Chickasaw Division. 2a. The Wapenucka Sub-division. 2b. The Tishomingo Granite. 2c. The Arbuckle Mountains and Washita Water Gap. 3. The Wichita Division. Partial record of history recorded in the Ouachita System.

LITTLE has been written concerning the geography and geology of Indian Territory, and the writer presents this preliminary paper in hope that it will direct to that interesting region more careful and detailed study.

Topographically Indian Territory, especially its southern half, presents a great diversity of mountain, plain, forest and stream. Within this area is found the extension of nearly every topographic unit from the Missouri-Kansas region on the north to the Texas on the south, from the Great Plains of the west to the forests of Arkansas on the east; there are also many unique characteristic features of the region itself.

The territory may be provisionally divided into three parallel east and west belts, each containing a marked diversity of geologic structure and corresponding topographic expression.

The northern or Cherokee-Oklahoma belt includes the country north of the Canadian; the greater part is prairie with spots of timber decreasing in density toward the west. This belt may be sub-divided into three districts; the eastern or Cherokee, the middle or Oklahoma, the western or Arrapahoe. The Cherokee division, with the exception of a small area of Ozark hills in the northeast corner, is mostly composed of Carboniferous rocks with an undulating topography similar to that of southeast Kansas. The Oklahoma section is a typical red bed region in its western half, with undulating prairies and soft disintegrating structure. The Arrapahoe division is the ragged eastern border of the great plains country, with its characteristic fresh water deposits of sands and grits occupying the flat divides, as originally described in the adjacent west Kansas region by Dr. J. S. Newberry and more recently by Professor Robt. Hay.† These plains are the newest or culminating formation in western Texas, Kansas and Indian Territory; they are now slowly receding westward because of the head water erosion of the streams that indent this eastern border,

* To Mr. James S. Stone, of Newton, Massachusetts, the writer is greatly indebted for his faithful assistance in conducting this investigation. Also to Mr. W. L. Davidson, a student of the University of Texas.

† See Bulletin 57, U. S. Geological Survey.

and in this manner the underlying structure and topography are revealed. The northern belt of Indian Territory distinctly belongs to the Kansas division of the United States and the writer leaves its further description to St. John, Cragin, Hay and Jenney, investigators who possess more facts concerning its geology.

The middle or mountainous belt lies south of the Canadian-Arkansas River. A mountain system traverses it from east to west and marks the great barrier between the upper Mississippi Valley and the Texas-Arkansas regions of the United States.* To a description of these mountains this paper is mostly devoted.

The third and southern belt, the description of which must be left to a future paper, includes the region between the mountainous belt and Red River. It is the northern termination of the Texas region of the United States. It includes many topographic and geologic features which are the result of neozoic sedimentation against the southern border of the mountains.

The Mountain Region of Central Indian Territory.—With the exception of the Ozark hills in the extreme northeastern corner, the mountains of Indian Territory are the direct westward continuation of the Ouachita system of mountains which has been described† as the mountainous area between Hot Springs Arkansas and the Staked Plains of Texas, including the various points known as the Poteau, Seven Devils, San Bois, Shawnees, Jack's Fork, Black Fork, Winding Stair, Sugar Loaf,‡ Cavenal, Stringtown Hills, Limestone Ridge, Potato Hills, Arbuckles, Wichitas, Navajoes and other mountains. These mountains are south of the Arkansas-Canadian drainage and must not be confused with the Ozarks of southwestern Missouri. Dr. J. C. Branner's coming reports will doubtless give us needed light on this relation.

The mountain belt has three distinct sub-divisions: (1) an eastern or Arkansas, (2) a central or Chickasaw, (3a) western or Wichita. Its areal extent may be compared to an arch whose apex is southward, as marked by the course of the Canadian, Arkansas and Red River drainage; its eastern member in Arkansas and the Choctaw nation is a forest area of vertically folded Carboniferous shales and sandstones resembling the Appalachian country; the western member in the Chickasaw and Comanche nations, is a mostly treeless region and consists of low folds of hard white and blue Silurian lime-

* See this Journal, April, 1889.

† Arkansas Geological Survey, 1888, vol. ii. The geology of Southwestern Arkansas, by Robt. T. Hill.

‡ Near Fort Smith, not the Cretaceous butte of the same name east of Caddo.

stones and eruptives; the keystone or central Chickasaw region, consists of an area of granite and Silurian limestones.

1. *The Eastern or Arkansas-Choctaw Division.*—The northern two-thirds of the Choctaw nation and the northeastern Chickasaw country are a direct continuation of the mountains and geologic features of west-central Arkansas. This region consists of numerous timber-covered ridges varying in altitude from 2700 feet along the Arkansas line to 1200 along the Missouri, Kansas and Texas railroad. The ridges are usually elongated, timbered, devoid of sharp peaks and owe their present form to the unequal erosion of the exaggerated structural folds. The general trend of these mountains, corresponding with the strike of the folds, is south of westward, but often, as seen near Stringtown and along the Kiamitia River, it is nearer north and south. The ridges consist of sandstones, clays and shales apparently of the Carboniferous period, but further investigation may reveal older rocks. The rocks occur in numerous parallel, overlapping folds, which are nearly vertical in the southern and central portion of their extent, but become horizontal along their northern outline.

1.

Section north and south across Red Bird Mts., showing relation of Mountain folds to Cretaceous Prairies.

The Saint Louis and San Francisco railroad, from Fort Smith, Arkansas, to Paris, Texas, passes through the heart of the region, and the type structure, as seen along this route, consists of vertical eastward folds dislocated by another and later movement, as seen south of Tushka Homa, the Choctaw capital. This road follows for miles the water gap of the Kiamitia River, which apparently flows in an anticlinal valley. A hundred miles west of this railway, the Missouri, Kansas and Texas road affords another parallel north and south section of the mountain system, but owing to the gradual cessation of timber and decreasing altitude entirely different scenic effects are revealed. The latter road follows the valley prairies between the mountain ridges, which here have the contour and altitude which, in Kentucky, would be called knobs. The railroad follows the strike of the structure from Atoka to Limestone Gap. The differences in elevation are the result of unequal weathering of the crumbling shales and the more resisting sandstones and limestones, the former being treeless valleys while the latter persist as mountainous ridges. (Fig. 3.) Timber grows upon the sandstone outcrops while the

prairies occupy the more compact clays of the valley. Even where the vertical outcrops have been eroded to a level plain, the alternations of sandstones and clays can often be traced for miles by the timber which follows the sandstone outcrops in narrow ribbon-like parallel belts. (See fig. 2.)

The northern half of this area contains coal strata whose extent and known occurrence are indicated on the map. An admirable paper upon the structure of these coal beds has been published by Mr. H. M. Chance.* Mr. Arthur Winslow† has equally well defined them in Arkansas. Mr. J. T. Munson of Denison, Texas, has much unpublished information concerning the formation of this region, and to him the writer is indebted for his invaluable assistance and data.

The coal fields, for which the name Fort Smith-McAllister area is most appropriate, are of great commercial importance, for they are the chief source of fuel supply for the Arkansas-Texas region. These extend along the northern border of the mountains and are terminated on the southwest by the Silurian and granite field of the Tishomingo district which are an apparent barrier between this and the Texas-Ardmore coal

Section north and south through Woodford, showing structure of Prairie and Mountain. Continuation of fig. 1.

field, the fuel of which is of an entirely different character and should not be confused with it‡ geographically, structurally, or economically.

Mr. Chance has published a section of the rocks of the eastern division. He estimates at least 8500 feet of coal-bearing strata, but the total thickness of the Carboniferous and Permo-Carboniferous, as seen in the folds near Ardmore, is greater by the addition of the uppermost or Permo-Carboniferous which here has a thickness of several thousand feet.

The most marked feature of these mountains is the excessive, compressed and vertical folding which the whole region has undergone, and the displacement of these folds by a lateral dislocation which has squeezed them into S-shaped flexures. So excessive is this folding that every stratum in

* *Geology of the Choctaw Coal Fields* by H. M. Chance. Transactions American Institute of Mining Engineers, Feb., 1890.

† *Arkansas Geological Survey, Report for 1888. vol. iii.*

‡ The writer is inclined to believe that the greater excess of ash in the coals of the more horizontal Texas region is due to the calcium carbonate and other impurities deposited in the joints during their long submergence beneath the Cretaceous seas, while the McAllister coals have remained above water.

the mountain region south of the coal fields can be said literally to be standing vertically as shown in the figures. This system of folding is complicated and the writer has not had time for the minute study necessary to interpret it. In general, two great trends or strikes are conspicuous, the first and oldest is about 25° south of west; this is frequently dislocated by an apparently later movement resulting in northeast and

southwest trends, all of which are accompanied by overlapping and lack of continuity.* The direction of the folds has a marked effect on the political features of the region, all lines of transportation and public highways practically following the valleys of erosion in the trend of the folds.

The proof of two great dislocations of the Carboniferous strata is found in the mountains north of Atoka and in Limestone ridge where the vertical folds of the first epoch are deflected by S-shaped dislocations into the southeast course.

Of the many illustrations of this folding one of the finest is found in the peculiar limestone ridge which extends from near Lehigh to Limestone Gap and eastward. This is the principal limestone stratum of the Carboniferous system; it occurs at the base of Mr. Chance's section. It consists of about 200 feet of massive blue limestone and dolomite standing vertically. From near Wapenucka via Lehigh to Limestone Gap, thence eastward to the

Limestone Ridge, showing deflected mountain folds.

St. Louis and San Francisco railroad, it forms a sharp ridge rising 100 feet above the adjacent valleys, a plan and cross section of which are given in the accompanying figure (3).

The Missouri, Kansas and Texas railroad, between Stringtown and Limestone Gap, follows the valley east of this ridge; at the latter place a tributary of the Red river has cut through the ridge which, from this point, trends eastward as shown in

* Dr. John C. Branner, on page 30, vol. i. of his report, has previously expressed an opinion that in Arkansas these folds are of overlapping rather than of continuous strike, as stated by Comstock in the same volume.

Mr. Chance's map. Several sigmoid or S-shaped flexures occur along this section, and, also, in the sandstones of the Coal Measures of eastern Indian Territory and across the Territory to the Arkansas line.

The southern border of this old system has been degraded* by the shore lines of the ancient Cretaceous and Tertiary seas which overlapped it and planed it northward for many miles. The vertical edges of the planed off strata are buried beneath the Cretaceous sediments as shown in my former section along the Arkansas-Texas line, resulting in the complete interment of the Carboniferous system southward, throughout the great central denuded region of Texas where the only exposures of Carboniferous rocks are through erosion of the overlying Cretaceous layers. The structure of these mountains is of the Appalachian type, and Mr. Chance says that "topographically and structurally the Choctaw coal fields represent in miniature the features of the anthracite regions of Pennsylvania."

2. *The Central or Chickasaw Division.*—In the northeastern part of the Chickasaw nation the continuity of the Carboniferous rocks is terminated by an extensive area of Silurian limestones, which, in turn, are succeeded southward by underlying granites whose exact relation to the complicated Coal Measures is not determined, but which are exposed by the erosion of the latter and are unconformable beneath them.

2a. *The Eastern or Wapenucka* portion of this area is interesting, but little explored. It lies west of Boggy station along Delaware Creek at Bill Jackson's ranch, and near the quaint old Chickasaw academy of Wapenucka. There is a series of low limestone hills—apparently remnants of anticlinal folds—along whose strike flows the Delaware creek. In places these limestones resemble the blue Silurian limestone to be described in our discussion of the Arbuckle Mountains, but they are more horizontal in outcrop. In the collection of Mr. J. T. Munson, of Denison, who first called my attention to this interesting region, are fossils apparently Silurian in age *Orthoceras* and *Brachiopoda*, from Bill Jackson's ranch on the Delaware.†

Crinoidal limestones of Carboniferous age are the prevalent rocks and were collected near the academy at the southern border of the district, and the sandstones of apparent Carboniferous age and shales of that age begin there again. A single specimen of *Favosites*, of Silurian age, was collected from one

* Principal Events in North American Cretaceous History as revealed in the Arkansas-Texas Region, by Robt. T. Hill. This Journal, April, 1889.

† Professor Alpheus Hyatt, to whom I sent this specimen, says that he thinks there is little doubt that it is a fragment from the Hudson River group. The *Orthoceras* being closely related to one found at Cincinnati, and the brachiopod being probably *Orthis testudinaria*.

of the Delaware Mountains near the Hudson River limestone. The Delaware Mountains proper are a few long limestone ridges and detached buttes in the beautiful valley of Delaware Creek. Seven miles west of the academy, near Bill Jackson's, they are composed of limestone underlaid by the above mentioned Favosites sandstone—a porous gray quartzite with an occasional patch of limestone. The buttes are peculiarly distorted, their strata being disturbed at a very slight angle in many directions, which may be compared to the uneven curvature of a saddle.

The Delaware mountains were mentioned by Mr. Jules Marcou, who followed the old Fort Smith and Fort Washita trail which passed by them. He referred them to the Sub-Carboniferous or Mountain Limestone.* The scenery in the Valley of the Delaware is exquisite, the contrast between the low rounded hills and the extensive valleys with their peculiar buttes present a restful and varied landscape. The region promises rich scientific treasures to some future student who has time and facilities to work out its structure and history. It was impossible to trace the relation of the Wapenucka district to the Arbuckle Mountains to the westward, owing to dangers of exploration in a country where geologists are not welcome, but there is evidently a close connection if not continuity between them.

Wap

2b. The Tishomingo Granite.—In the heart of the Chickasaw nation south of and underlying the Wapenucka limestone district is an extensive granite area. This is the central division of our mountain region. It is a triangular area of sandy prairie land with low rounded granite hills and undulations, lying between the Santa Fe and M. K. and T. railroad and running east and west from Boggy depot to six miles west of Tishomingo, and northeast to Mill Creek and beyond.

The granite is well displayed two miles southwest of Boggy station; in Pennington Creek; at Tishomingo and other places. At its eastern outcrop it is composed of red feldspar, white and black mica, quartz and hornblende with numerous pegmatitic veins. Its composition and occurrence is nearly identical with the Burnet Texas granite, and it is unlike the igneous rocks of the Wichitas to be described later. In the western part of this area the feldspar is albite. There are numerous dikes of black rock intersecting this granite specimens of which from Pennington Creek have been sent to Professor J. F. Kemp for study. Concerning these he says: "They are a typical diabase. They are mostly idiomorphic plagioclase crystals, doubtless labradorite from the extinction angles, irregular greenish augite and a little magnetite. They show the so-called ophitic

* Geology of North America.

structure of diabase in a very marked degree." The dikes run west 20° S. and are seen at the crossing of Mill Creek road and Pennington Creek.

The northern margin of the granite area is overlaid by hard metamorphosed, sub-horizontal Silurian limestone of the same cherty and flaggy lithologic aspect as the Upper Potsdam rocks of Burnet County, Texas, but I could find no fossils. Carboniferous rocks cover its eastern point at Boggy station. Its southern border was the sea-shore of the ancient Trinity and other Mesozoic and Cenozoic seas and is buried beneath the Trinity sands. The western border is covered by Silurian and Carboniferous rocks.* I saw no evidence that this granite was of later age than the oldest of the Paleozoic rocks which rest upon it.

2c. *The Arbuckle Folds*—West of the Washita River the mountains again present a new and entirely different aspect. An elongated mass of low rounded barren limestone folds stands about 500 feet above the plain and extends east and west, between Wild Horse Creek and the Washita River for about forty miles, forming an almost impassable barrier for wagon travel. They are composed of folds of hard Silurian limestones. The trend of the mountains—north of west—corresponds with strike of the folds, but is opposite in direction to the prevalent trend of the Choctaw-Arkansas division. These folds are the hard persistent core of the structure, the softer and exterior Carboniferous layers having been eroded to the level of the Ardmore prairies. (See figures.)

West of Duncan the limestone hills are buried beneath the red beds for twenty miles, but again appear in the neighborhood of Fort Sill forming a low ridge north of and parallel to the Wichita Mountains, as is explained later.

The Arbuckle Mountains constitute a great and wonderful development of the Silurian system, although this has not been hitherto appreciated, and afford a superb example of folded structure. This folding is beautifully shown in the valley of the Washita which has cut a deep and tortuous water gap through these mountains where, unobscured by forest growth, fold after fold of the stratified limestones and shales appear in startling boldness. Several journeys through this gap only increased the appreciation of the greatness of the task of thoroughly delineating the section, the complexity of which may be inferred from the accompanying figures.

Twenty miles south of the Arbuckle ridges proper, and separated from it by a valley based upon Carboniferous shales and sands, near the crossing of Hickory Creek and the Santa

* The only previous mention of this important granite area of which I am aware was made by Dr. R. H. Loughridge in the 10th Census Report on Cotton Production.

Fe road is a smaller but similar and parallel ridge of folded Silurian rocks extending westward to Healdton (see map). For these mountains there is no local name, and I have called them Red Bird from an adjacent post-office. They serve to prove the great width of the folded belt.

Section across Indian Territory from south to north along Atchison, Topeka and Santa Fe Railway.

The accompanying north and south section and profile from Gainsville, Texas, to Guthrie, Oklahoma, gives at least an idea of the sequence and foldings of the Arbuckle region. Proceeding southward along the line of the Atchison, Topeka and Santa Fe, the typical gypsiferous red beds of Texas, Kansas, Indian Territory and New Mexico—the alleged Triassic*—are seen from Guthrie to Oklahoma City, lying in a disturbed, but comparatively sub-horizontal position, showing greater dips than the Cretaceous, but none of the complicated folding of the Paleozoic strata. South of the Canadian, the Carboniferous clays and sandstones appear with the excessive dips of the Ouachita folds. At Buckhorn Creek, east of Dougherty, the coal-bearing beds of the Carboniferous are seen dipping north at an angle of 65° , and involved in the folds of the adjacent limestone hills. In this vicinity there are terranes at the base of the Carboniferous, the age of which I could not determine, especially a great thickness of soft sandstone, but the succeeding limestones are undoubtedly a part of the Silurian system as determined for me from fossils by Professor Henry S. Williams.

Proceeding southward from Dougherty to Berwin the limestones, shales and sandstones of the pre-Carboniferous succeed each other, but so complicated is the vertical folding, that the writer must confess his utter inability to determine their proper succession, even after considerable study. These rocks occupy in cross-section, almost invariably a sub-perpendicular

* The basal portion of these Red Beds is of Permian age as shown in their Texas continuation by Boll, Cope and White. See American Naturalist, June 1879, September 1880.

position for a distance of twelve miles. From north to south, however, the following distinct sub-divisions are apparent.

Their relation however is indefinite, owing to folds and faults:

1. Massive, hard blue limestones. Strata of 20 feet in thickness alternating with thin flaggy layers. Thickness feet.
(interrupted by a great fault)..... + 280
2. Massive limestones, but in thinner and more flaggy layers. Cherty..... ± 100
3. Thin shaly argillaceous beds, fossiliferous, excessively folded and crumpled. Aggregate thickness including folds..... + 360
4. A massive bed of pure white loosely cemented sandstone, similar to that seen above the Lower Helderberg near Woodford..... 95
5. Thin flags and shales, mostly concealed but seen in contact with 6 at south side of river..... ?
6. A massive, yellow-blue limestone; finer grained than No. 1; rich in fossils (Trilobites, etc.) South bank of Washita at railroad bridge (Trenton)..... + 140
7. Concealed interval.
8. Dark blue shales of great, but undetermined thickness.
9. Carboniferous shales and sandstone, Berwin to Overbrook.

Concerning the age of the pre Carboniferous rocks only a little can be said, but sufficient to confirm the impression that they include Trenton (No. 6), Niagara? (No. 1), Lower Helderberg, (No. 2). Could accurate collections be made, many other terranes would no doubt be shown to exist. The basis for these determinations are as follows. Near Woodford post office, ten miles west of the railroad, I collected from strata which are continuous with and apparently the same as No. 2, the following fossils, kindly determined by Professor H. S. Williams: *Spirifera lamellosa*, *Strophomena rugosa* (= *rhomboidalis*), *Rhynchonella nucleolata*, *Lingula?* *rectilatra*. Concerning these he says: "It is safe to say the horizon is Upper Silurian and probably equivalent to the Lower Helderberg of New York. It is above the Niagara, and this is an interesting feature." Concerning the fossils from No. 6, he says: "They are not very satisfactory but a *Trinucleus concentricus* shows No. 1092a to be of Lower Silurian, probably Trenton age." A fine specimen of *Lituites beckmani* Whitfield, in my possession, I have cause to believe came from this same locality, although I had previously been greatly deceived by its collector as to its locality and horizon.

It is not my desire to attempt any classification of these pre-Carboniferous rocks, but I believe from stratigraphic evidence that the shales at the south end of the gap may prove Devonian. Beneath the Trenton rocks there are exposed still older

terrane, especially in the Red Bird Mountains, which may be Cambrian.

Continuing southward along our section the mountains cease coincident with the limestones, and after a mile of black shales (No. 7) the well-defined Carboniferous sands and shales begin near Berwyn and continue for twenty-nine miles along the railroad to the vicinity of Overbrook. These all occur in vertical folds, apparently coincident with or at least a part of the same system to which the Silurian limestones belong, but which, owing to their disintegrating character, have been leveled down to a low undulating plain. Ten miles south of Ardmore, the Trinity sands, the base of the Comanche series, rest unconformably against the Carboniferous (the Red beds being absent), and upon these in turn to the southward the sub-horizontal beds of the Lower Cretaceous, which I shall make the subject of another paper.*

A parallel north and south section twenty miles west of the Santa Fe road shows the presence of the Red beds and the absence of the Cretaceous, the latter having deflected southward through Texas.

It is not alone in the mountains of the Paleozoic areas, however, that this remarkable vertical structure is seen, but much of the Carboniferous prairie regions east of the Red beds are based upon it. For twenty miles north from the Red Bird to the Arbuckle Mountains the undulating prairies, void of any high relief whatever, except slight rises where the sandstones prevail, are based upon the almost vertical Carboniferous shales and sands, as shown in our diagrams. The wonderful degradation these folds must have undergone exceeds all possibility of description. Yet, as I have shown in my Arkansas report, there are many miles of planed-off folds buried beneath the Cretaceous sediments. This is the only instance in the southwest of a level upland plain underlaid by vertical structure. The great unconformity of sedimentation between the Silurian rocks and the supposed base of the Carboniferous is seen both at Buckhorn on the northern margin of the Silurian and at Hickory Creek near Red Bird on the southern side, as shown by difference of dip, and the presence of conglomerates in contact with the Silurian rocks, especially at the last-named place.

3. *The Wichita Division.*—The Arbuckle folds west of Duncan are buried beneath the Red beds for some thirty miles, but outcrop again some eight miles north of Fort Sill, marking the northern margin of the Wichita Mountains, forming a low foothill which is comparatively inconspicuous, owing to the overshadowing height and sharpness of the adjacent eruptives of the Wichita Mountains proper.

* See vol. ii. pp. 503-528, Bulletin Geological Society of North America.

These mountains rise abruptly above the level of the Red bed prairies, which surround them on every side, and their sharp jagged outlines present striking and exquisite scenery. The ragged peaks of igneous rock present a strong contrast to the stratified ridges of the eastern and central divisions of the system. Although in Arkansas the latter have a similar elevation above the surrounding plain, they have not the rugged peaks and points of the Wichitas, and are covered by forests. Their aspect is Appalachian—the arid Wichitas remind us of the Rockies. The eastern Ouachitas are the eroded remnants of stratified rocks with their characteristic topography, the Wichitas consist of igneous rocks—hard, firm, ragged and barren.

These mountains extend westward from Fort Sill 120 miles to the 100th meridian and were partially mapped out by Marcy and McClelland years ago,* and T. B. Comstock has recently made an interesting reconnaissance of them.† The most prominent of the many peaks are Mt. Scott and Mt. Sheridan; the former is 2400 feet above sea level, 1200 feet above Fort Sill on the plain below, and 1700 feet above Red River fifty miles distant. Though neither high nor extensive, the Wichitas are models of topography and mountain structure. Mt. Scott is a solid mass of red feldspathic granite with little quartz, while neighboring mountains are composed of greenstones, basalts, etc., indicating two widely different types of igneous rocks.

The westward continuation of these mountains is buried beneath the Tertiary sediments of the Staked Plains and with it the history of the relation of the Ouachita system to the Rocky Mountains. At one or two places in No Man's Land and north of Clarendon, Texas, I am told that erosion has cut down to the rocks of this mountain system but I have not been able to find the localities.

The composition of the Wichitas is unlike that of any mountain area of the southwest, and, so far as I could see, presents no structural resemblance either to the basin-surrounded mountains of the Trans-Pecos, or the early Paleozoic buttes and denuded folds of the central Texas region. Their age is not determined. They are certainly Post-Silurian and the Red beds have in part participated in the movements but the eruptives may be Post-Cretaceous or even later. The apparent absence of the Lower and Upper Cretaceous in the composition of the Wichitas is especially noticeable. Their trend and composition plainly places them in the Ouachita system.

* See Exploration of Red River of Louisiana, Marcy.

† See First (Second) Annual Report of the Texas State Geological Survey. Austin, 1889.

Résumé of History recorded in the Ouachita System.

1. There are evidences of a Post-Silurian movement in the Buckhorn and Red Bird unconformities.

2. The great folding and elevation of the system were after the close of the Carboniferous period, probably during the Permian, as shown by the participation of the rocks of the former period in the movement, and Pre-Triassic, if the upper Red Beds are of that age.

3. A second or lateral movement must have taken place after this folding by which the folds were bent into S-shaped flexures. This movement preceded the Red Bed epoch.

4. The marked but not excessive disturbance of the Red Beds indicates movement and displacement after their deposition and previous to the Trinity epoch.

5. The Lower Cretaceous Comanche series—which may be partly Jurassic—was deposited against and not over these mountains, and show in themselves no folding or other disturbance except such faulting as may be attributed to the Post Upper Cretaceous continental movement.

6. The Upper Cretaceous, the Marine Eocene and the Quaternary along the southeastern and eastern border of the system in Arkansas were also deposited against and not entirely over the system, and, like the Comanche series, reveal no participation in adjacent mountain folding, but merely alternations of subsidence and elevation.

7. This system has undergone extensive erosions throughout Post-Carboniferous time, and its sediments have contributed to all later deposits.

8. The western portion of the mountain system was in parts submerged during the Red Bed epoch [Triassic?] and completely degraded or buried beneath the sediments of the great Tertiary lake which constitutes the formation of the Llano Estacado.

9. The relation of this system to the Rocky Mountain movement is to be determined.

The mountains of the Ouachita system, including the eastern or Arkansas-Choctaw division, the central or Wapenucka Limestone district, the Arbuckle division and the Wichitas, should no longer be omitted from our maps, for together they constitute the foundation of all later geologic structure in the Texas region, differentiating it from the Kansas-Missouri region in both present and past geologic times back to the earlier Mesozoic epochs, and influencing all the main river courses of Indian Territory whose great southward bends are an adaptation to the strike of this mountain system, the Washita alone having cut through it.

The mountains are also interesting from their exceedingly diverse structure and composition, and from the fact that, with the exception of the Uintas, they are the only east and west system on our continent.