ART. XIV.—*Notes on the Geology of Parts of the Seminole, Creek, Cherokee and Osage Nations*; by CHARLES NEWTON GOULD.

DURING the month of August, 1900, while engaged in the Oklahoma Geological Survey, I was enabled to make a brief reconnaissance of the northwestern part of the Indian Territory and the Osage nation, Oklahoma. The trip was made by wagon and occupied in all about two weeks. I was accompanied by Mr. Paul J. White, botanist to the survey, and Mr. Roy Hadsell, general assistant. The route lay through Cleveland and Pottawotamie counties, Oklahoma, and the Seminole, Creek, Cherokee and Osage nations. The chief towns through which we passed were Shawnee, Keokuk Falls, Okmulgee, Sapulpa, Tulsa and Pawhuska.

The object of the trip was primarily to ascertain the general geological features of the region, and particularly to locate the eastern extremity of the Red-beds. Incidentally it was intended to locate the position of the heavy ledges of limestone which were supposed to extend southward from the Flint hills of southern Kansas into the western part of the Creek nation.

As is well known, the Flint hills or Permian mountains extend north and south across Kansas, reaching their culmination in Cowley, Butler, Chautanqua, Elk and Greenwood counties in the southeastern part of the State. For the most part these hills are composed of massive ledges of limestone containing great quantities of flint in the form of nodular concretions. Besides the limestones there are beds of green, blue and reddish shales of considerable thickness. The entire series is fossiliferous. The fossils of the lower part of the hills indicate that the rocks are of Upper Carboniferous age, while those from the summit are Permian. The Cottonwood Falls limestone, which lies near the point of division of these groups, is located near the top of the Flint hills.

Few ledges of sandstone are found except in the extreme southern part of the State. In the vicinity of Dexter, Cowley County, Kansas, a bed of arenaceous shale immediately beneath the Strong flint (Prosser) changes into a ledge of light brown sandstone. This ledge may be traced south past Maple City to the State line, and thence down Beaver creek to the vicinity of the Kaw agency. By this time, however, several other ledges of sandstone have come in. The section of a hill at the mouth of Beaver reveals the presence of six ledges of sandstone each from five to fifteen feet thick, alternating with limestone and shale.

This is intended to show that while the Flint hills in Kansas consist almost entirely of limestones and shales, still on the

southern line of the State sandstones have already begun to appear. To the south these conditions obtain more and more until the limestone is entirely replaced by sandstone. Even in Kansas the rock east of the Flint hills is sandstone and shale. To the west the limestones gradually thin out and give place to shales (the Marion and Wellington formations) which farther west are succeeded by the Red-beds. South of the State line the sandstones from the east and the Red-beds from the west begin to approach each other, while the limestone ledges become thinner and thinner and the flint less pronounced.

In Pawnee County, Oklahoma, there are still some heavy ledges of limestone, although even here sandstones greatly predominate. In eastern Payne County, fifty miles south of the Kansas line, the conditions have changed still more. The following section taken at Ingalls will illustrate the succession of the various rocks:

<i>Section at Ingalls, Oklahoma.</i>		
No.		Feet.
13.	Red clay and sandstone.....	20
12.	Red sandstone	2
11.	Red clay shale.....	20
10.	Two ledges of hard, flinty, fossiliferous limestone, 1 to 2 feet thick, separated by 1 foot of greenish clay...	5
9.	Red clay shale.....	50
8.	Sandstone	5
7.	Red and green shale.....	10
6.	Limestone	1
5.	Shales	10
4.	Limestone	1
3.	Greenish shale	5
2.	Limestone	1
1.	Shales.....	20
Total.....		150

No. 10 forms the cap of the noted Twin Mounds, seven miles east of Ingalls, as well as the tops of numerous bluffs and escarpments in the vicinity. It is the most pronounced ledge in the region and is the one that gives tone to the erosion forms. It will be observed, however, that of the 150 feet of strata represented but eight feet are limestones, the remainder being either sandstone or shale, with the latter predominating. Above the rocks represented in this section only shales and sandstones of the Red-beds are to be found. The gradation from the underlying Permian or Carboniferous to the superjacent Red-beds is so slow that when on the spot it is not easy to tell just where the one leaves off and the other begins. At

Ingalls, as shown above, there is a fifty foot ledge of red clay which may not be distinguished from typical Red-beds clay, below the thickest limestone ledge in the region. On the State line there are several hundred feet of blue and green shales between the upper limestone and the base of the Red-beds.

In general, however, it may be observed that in going eastward from a Red-beds region toward the Carboniferous the sandstones and shales, which have been of a deep brick-red color, become more and more brownish and grayish, and finally lose entirely their characteristic hue and take on that of the older formations. The lithology changes also, but so gradually that it is impracticable if not impossible to fix any but an arbitrary line of separation between the two groups.

With these facts in mind the reconnaissance was undertaken. In the absence of evidence to the contrary it was assumed that the limestones forming the southern extension of the Flint hills extended as far south as the Seminole nation. The plan, then, was to go east from Norman, Oklahoma, until these limestone ledges were encountered and then to follow them northward to the Kansas line. This object was not accomplished for the reason that on the eastern trip no limestones were found. As will be shown later, the only time when the party encountered the Flint hills was in the Osage nation, on the road from Pawhuska to Winfield. While the trip extended much farther east than had been planned, still this fact need not be regarded as an unmixed evil inasmuch as it enabled us to visit a region the geology of which has not been well understood.

From Norman to Shawnee the rock is prevailingly red. About the west line of the Seminole country the sandstones begin to lose their red color and are usually brown or even light gray. These ledges are frequently quite pronounced and in many localities form prominent escarpments or even hills of considerable size. Keokuk Falls of the North Canadian, on the north line of the Seminole reservation, is formed by one of these ledges. From Keokuk Falls to Okmulgee, a distance of fifty miles, only sandstones and shales appear. The sandstone ledges are often many feet thick and dip slightly to the west or southwest. The peculiar "stair-step arrangement" so noticeable in the Carboniferous of Kansas is observed throughout the region. Prominent ledges appear to the east as the escarpment of a bluff or hill. To the west these dip lower and lower and finally disappear beneath the bed of a stream, while they are succeeded above by other ledges.

These sandstones are not barren of fossils; the more common Carboniferous types being abundant in certain localities. Beds of coal are reported from the vicinity of Okmulgee. At Henry-

ville, a few miles south of Okmulgee, extensive beds have been located and are now being worked.

From Okmulgee to Sapulpa, thirty-five miles north, the same geological conditions obtain. Massive ledges of sandstone continue to give tone to the erosion forms. Two isolated buttes a few miles east of the "Frisco" railroad are so prominent as to have received the name of "Twin Hills." In the vicinity of these buttes the only ledge of limestone seen on the trip, except that in the Osage nation, was observed. The ledge is not to exceed two feet thick and is cut in a remarkable manner by joints running nearly at right angles. These joints are from twelve to twenty inches apart and in many cases extend the entire thickness of the ledge. As a result the limestone is cut into regular cubical blocks. In a number of places where the ledge is exposed in the bed of a stream these blocks have been pried out and used for foundations or stone walls. This rock requires very little dressing and will doubtless prove a source of considerable income.

In the region around Sapulpa and between that place and the Arkansas river at Tulsa, the sandstone ledges continue. Buttes and narrow ridges bordered by high and steep bluffs are frequent. Tanaha mound, five miles east of Sapulpa, is perhaps the most typical of these. It is situated on the high prairie with its base 100 feet or more above the level of the Arkansas river at Tulsa. The sides of the hill are grass-covered and do not reveal the strata except the more prominent ledges of sandstone. The following section taken along the east slope illustrates the general rock structure of the country:

Tanaha Mound Section.

No.		Feet.
10.	Sandstone forming cap of mound ----	10
9.	Slope	15
8.	Sandstone forming prominent terraces	5
7.	Slope	40
6.	Sandstone forming terraces	10
5.	Slope	30
4.	Sandstone forming a broad terrace...	5
3.	Slope	20
2.	Sandstone	10
1.	Slope from level of prairie 100 feet above the level of the Arkansas...	50
Total		195

Of this 195 feet of strata 40 feet consist of sandstone. The remainder, or 155 feet, is chiefly arenaceous shale. From the top of the mound a magnificent view of the surrounding country may be obtained. To the south especially is the scene

of particular geological interest. The dip of the sandstone ledges to the west is distinctly noticeable, and no fewer than five "stair steps" may be noticed from this point. Coal is found in several places in the vicinity. From what I was able to learn it occurs in at least two beds. On Coal creek, five miles east of the mound, a vein three feet thick is reported. Oil is also said to be present, although this can scarcely be authenticated as yet.

The most eastern point reached on the trip, and the lowest geologically, was the Dawson coal field in the west-southwest corner of the Cherokee nation. In the vicinity of Dawson the country is gently rolling. The coal is obtained by stripping. At present it is taken from a depth of from ten to fifteen feet. The rock dips quite strongly to the southwest. The following section shows the location of the vein:

Dawson Coal Field Section.

No.		Feet.
4.	Evenly laminated light brown shales with regular cleavage lines and some concretions.....	10
3.	Coal	2½
2.	Shales like No.4, grading upward from No.1	8
1.	Massive gray or yellowish sandstone, becoming shaly above and grading into No. 2.....	15
Total.....		35½

Other exposures of the same vein are found for several miles both north and south of Dawson. Outcrops are reported from numerous points along Bird creek all the way to Skiatook, a distance of more than twenty miles. This promises to become one of the most productive coal fields in the territory.

From Dawson to Pawhuska, a distance of 45 miles, the road lay up the valley of Bird creek. The hills are often steep and rugged and the bluffs are capped by ledges of massive or cross-bedded sandstone. Although no opportunity afforded to secure complete sections of the rocks of the region, the following (p. 190) is believed to present a fairly accurate provisional section from Skiatook to the top of the hill west of Pawhuska, or, in other words, from the upper coal beds to the base of the Flint hills. The dip of the rock continues to be to the west and southwest.

The three most noticeable features of the section are: 1st. The great predominance of sandstones and sandy shales. Of the entire section less than fifty feet consist of limestone. The three ledges of limestone are located near the center of the section and are well exposed on the bluffs below Lewis

Bird Creek Section.

No.		Feet.
9.	Massive sandstones and arenaceous shales extending from Lewis Rogers' place, thirty miles southwest of Pawhuska, to the top of the hill five miles west of Pawhuska	600
8.	Fossiliferous limestone	10
7.	Fossiliferous sandstone and shale	50
6.	Limestones with fossil shells and crinoids	5
5.	Sandstones and shales	100
4.	Massive fossiliferous limestone	20
3.	Arenaceous shales with ledges of sandstone	200
2.	Two thin ledges of limestone containing great quantities of fossil corals " <i>Camptophyllum torquium</i> " in ledges of sandy shale	25
1.	Sandstones and shales from Skiatook	100
Total		1110

Rogers'. 2d. The strong and uniform dip of all the rocks to the west. This dip will average perhaps ten to fifteen feet per mile. 3d. The entire series is fossiliferous. This is the best fossil field in the territory that has come to my knowledge, and should be thoroughly studied. The ledges numbered 6, 7 and 8 particularly will reward investigation. All of these ledges are well exposed on the bluff back of Ben. Avant's farm, thirty-five miles southeast of Pawhuska.

From near Pawhuska to Winfield, Kansas, our route lay across the Flint hills. Massive ledges of limestone with flinty concretions, alternating with beds of calcareous shale, composed practically all the rock seen. The only sandstone noticed was on Beaver creek and near Maple City, spoken of above. The Flint hills have been too often described to require more than a passing mention in this place.

The results of this trip may be summarized as follows:

1. The Flint hills do not extend as far south as the Seminole country.

2. The sandstone, which is well developed in the eastern part of Chautauqua County, Kansas, continues uninterruptedly southward east of the Flint hills, beyond the North Canadian river.

3. The eastern limit of the Red-beds in southern Oklahoma is not far from the western part of the Seminole country.

4. A line of coal beds extends north and south near Bartlesville, Skiatook, Dawson, Tulsa, Okmulgee and Henryville. These beds vary much in thickness.

5. There is no reason to doubt that gas and oil will eventually be found near these coal beds.