

Article XXIX.—THE CHARACTER OF THE WICHITA AND CLEAR FORK DIVISIONS OF THE PERMIAN RED BEDS OF TEXAS.

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The Red Beds commonly reckoned as Permian in Texas are separable into three main divisions, the Wichita, Clear Fork, and the Double Mountain. The lower two of these, only, carry any vertebrate remains and pretty closely within the limits of Wichita, Baylor, Archer and Willbarger Counties, though there have been bones found north in the vicinity of the Wichita Mountains and along the north line of Oklahoma.

During the summers of 1896, 1903, and 1906 the author worked in these beds collecting vertebrate fossils and gave considerable attention to an attempt to unravel the stratigraphy of the region in order to more definitely locate the horizons of the animals discovered. This matter proved to be of very great complexity because of the discontinuity of the layers and their rapid change in character; but the observations of three years make it possible to offer a tentative arrangement of the strata. It is very evident that this region, like the Lower Permian of Africa and India, the Ecca and Talchir formations, is largely river-deposited material in some old delta or on some shallow tidal coast. The source of the material was pretty certainly the elevation to the north now represented by the Wichita Mountains.

The bulk of the beds in all three divisions is a fine red clay, but this is interspersed with beds of sandstone, conglomerate and impure limestone. The lowermost, the Wichita division, is

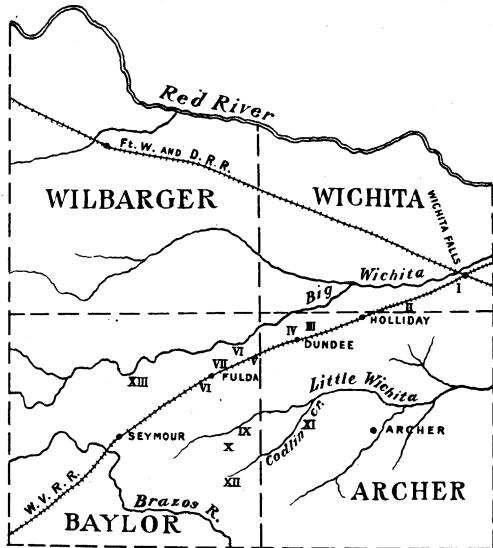


Fig. 1. Sketch map of the portion of Texas where the Permian beds occur, showing the location of the sections given in Fig. 2.

largely clay, but the Clear Fork has a much more varied character. The Clear Fork plainly represents a period when the seas were more shallow than in the preceding and the deposits were made on wide flats, in relatively confined channels with swift currents or in wide lagoons. There is a total absence of invertebrate fossils from the sandstone and clay in this division, the few shells that have been found coming from the thin layers of impure limestone; a few ferns have been collected from the layers of fine sandstone. As in the other divisions the Clear Fork is largely made up of thick beds of bright red clay, which is commonly filled with nodules and concretions but at times is very pure and free from any foreign matter. Running through the beds of red clay, however, are thin layers of sandstone which appear and disappear, thin out and change to a conglomerate or a clay in a most confusing manner; these layers are of small extent and thickness; they exhibit crossbedding to a remarkable degree and are frequently much bent; it is evident that they are the work of local currents intruding without any regularity into the deposits of clay. The red clay itself changes in color and composition in a most surprisingly sudden manner, all shades of blue, gray, buff and yellow following each other, and the changes take place almost as rapidly horizontally as vertically. The thickness of the layers of clay is also subject to most sudden and surprising changes, ranging from a few feet to twenty or thirty. It is only by the closest observation that it is possible to determine whether one of these beds of sandstone is but a small bit deposited by a local current or a portion of one of the more persistent layers which may be traced over the region.

The lower divisions in Wichita and Archer Counties are more nearly horizontal, but in Willbarger County they dip decidedly to the south and west. The presence of locally harder layers which have weathered out into shelves and flat-topped hills make this very apparent.

Among the numerous beds of sandstone which are dispersed among the clays there are a few which seem to be fairly persistent through the region. The upper one of these, separating thick layers of red clay which lie above and below it, is a sandstone varying from a few inches in thickness to many feet, and ranging in color from a bright blue through all the shades of brown, yellow and buff to a brilliant red. In some places it is very massive and even weathers out into rounded concretionary masses from five to twenty feet in diameter, but this may change in a few rods to a thin and shaly condition with pronounced crossbedding. From its prominent development near the little station of Fulda on the Wichita Valley railroad this layer of sandstone may be called the Fulda sandstone. Near this place it is quite massive and nearly twenty feet thick in places; it lies directly upon the clay beneath and disappears from the surface beneath the over-

lying layers a few miles east of the town of Seymour in Baylor County. In the valley of Godlin Creek and the portions of the valley of the Little Wichita near the mouth of Godlin Creek this sandstone terminates below in a layer of conglomerate which separates it from the clay beneath. This conglomerate is composed of small pebbles not larger than a bean and presents a uniform appearance wherever it occurs. The sandstone above is almost entirely devoid of fossils, hardly a fragment having been found in it, but the conglomerate is frequently so filled with bones that it forms veritable bone beds, and in many places isolated bones and water worn fragments may be literally shoveled up from the surface.

Below the Fulda sandstone is a considerable thickness of clay, commonly red above and gray below, but frequently showing the most brilliant and variegated shadings. Running through the clay at irregular intervals are thin layers of shaly sandstone; these are always strongly crossbedded and are frequently sharply bent. They are separated in many cases by decided unconformities from the clay above and below, but this seems rather due to the action of a pretty swift current which eroded a channel in the clay in which the sandstone was later deposited than to represent any considerable time interval between the two deposits. Frequently the clay is interrupted by beds of pebbly conglomerate formed of small iron and clay-iron concretions about the size of a bean or smaller. The position of this layer is very indefinite and it varies widely in thickness; in some places it is far below the base of the Fulda sandstone and in others it rises much nearer to it. Near the mouth of Godlin Creek this layer becomes several feet in thickness and rises until it comes in contact with the conglomerate at the base of the Fulda sandstone. These ill defined layers of uncertain extent lying in the clay evidently represent the position of transitory currents in an ordinarily quiet lagoon or over the tidal flats of a wide delta. As additional evidence of the later fact it may be stated that it is almost exclusively upon or in these thin layers of sandstone and conglomerate that the vertebrate remains are found below the level of the Fulda sandstone and conglomerate; fossils of an exceptional degree of preservation are sometimes found in the clay but their occurrence is so rare that not more than one or two specimens will be found in a summer's search. The remains which are found on or in the sand layers were evidently washed there by currents from a distant shore and they are generally more or less imperfect, having been dispersed by the action of the current or by predatory animals, while those found in the clay were evidently animals which mired down on wide mud flats or were drifted out on the surface of the stagnant lagoons.

Above the Fulda sandstone there is a considerable thickness of clay which is in many places bright red but on the south side of Godlin Creek is

bright blue with many inclusions of sulphur yellow clay stone; this shades into a red above and is capped by a layer of limestone which covers the hills over a good many square miles. This limestone, from its uniform thickness, is called in my notes, the "six inch" limestone. Just south of Fulda the stone is dark brown in color and filled with colonies of worm casts; it is very hard and has determined the level of a broad shelf which borders the valley of the stream and lies in blocks on the top and slopes of this shelf like an artificial pavement. Further to the west and north this stone becomes more shaly and changes through buff to pure white. It finally disappears beneath a red and gray clay dipping a few degrees to the west and south. Locally this stone changes into a conglomerate bearing invertebrate and even a few vertebrate remains; in one place, just south of Fulda there is a bed of limestone very similar to this but at a lower level and of small extent; it is only a couple of inches thick and contains an enormous number of small amphibian bones.

Further north, on the south side of the Big Wichita, this limestone is pure white and is represented by several layers separated by a few inches of gray clay. At one point examined, a few miles back from the river and a couple of miles east of the Seymour-Vernon road, there is a thin layer of limestone not over a couple of inches thick, which broke up into nearly perfect cubes so that, as it lies washed clean on the surface, it presents the appearance of a perfect mosaic; below this are a few inches of gray limey clay and then the main bed of limestone, which here, as further east, is uniformly about six inches thick and lies like a pavement on the slopes of the hills. A third layer of limestone presents at this point a most beautiful series of mud cracks. This limestone forms the floor of the ford where the Seymour-Vernon road crosses the Big Wichita River.

Going west from this locality the limestone disappears beneath a bed of gray and red clay filled with concretions which reaches a thickness of 20 to 30 feet. At the upper limits of the clay lies one of the most persistent layers of the region; this is a bed of hard, pebbly conglomerate from six inches to a foot in thickness and varying in color from a dark to light but having through most of its extent a deep purplish red color, which is very characteristic. This is one of the most readily determined levels of the region and may be called the Wichita conglomerate. Above the conglomerate lies a great bed of massive sandstone reaching in some places a thickness of a hundred feet; the color is in general red but it changes locally to brilliant shades of orange, yellow and blue. This bed of massive sandstone produces a very marked change in the topography; to the east of the Seymour-Vernon road the hills are low with broad shelves on the sides but to the west, where the sandstone appears, the hills are high and steep-sided, standing out in isolated mesas.

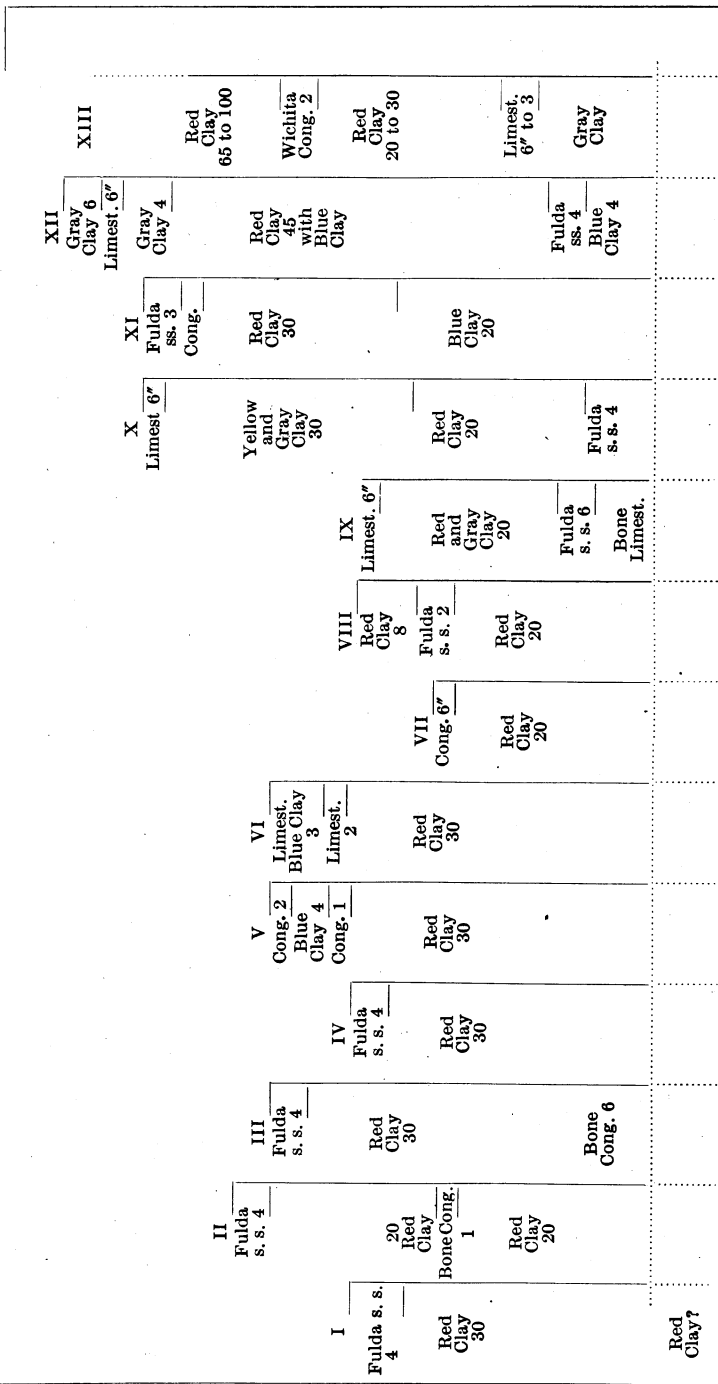


Fig 2 Sections showing the different layers at localities marked on the map (Fig. 1, p. 657). Numbers refer to thickness in feet.

To the north of the Big Wichita River the sandstone becomes thinner in places and is sharply crossbedded; it even gives place to clays locally. The tops of the high hills are marked by a thin layer of white shaly limestone which is perhaps the lowest member of the next higher group, the Double Mountain.

No invertebrates have been discovered in the upper beds, and the position of the vertebrate remains is much less easily determined but, as further east, they seem to occur on or in layers of shaly sandstone or conglomerate lying at irregular places in the clay. The Wichita conglomerate seems to be completely barren, as is the massive sandstone above, except where the sandstone exhibits local phases of a conglomeritic character. Some few bones have been found in the gray clay just above the six-inch limestone.

The whole formation seems to be very clearly the result of river deposition, either in the form of a wide delta or in very shallow water. With little doubt the material was derived from the degradation of the Ouchita Mountain mass, which was uplifted at the end of the Carboniferous and, perhaps more specifically, from the Wichita Mountains which lie directly north of the region.