

ART. XLIV.—*Note on the Fox Hills Group of Colorado*; by J. J. STEVENSON, Professor of Geology in the University of New York.

NOT far from thirty miles below (north) Denver, St. Vrain's Creek enters the South Platte River from the west. The Thompson enters from the same side several miles above Evans, or about forty-five miles below Denver; and the Cache La Poudre, in like manner, enters somewhat more than fifty miles from Denver. The towns of Evans and Greeley lie close together, the former being on the South Platte River almost fifty miles from Denver.

In 1873, I visited this region and made some observations, which were published shortly afterward. As the conclusions, which I then reached, were called in question, I took occasion before entering the field in 1878 to revisit the locality.

A line of bluffs begins on the west side of the South Platte River at a little way below the mouth of St. Vrain's Creek, and continues until within a mile or two of Thompson Creek. This bluff is more or less distinct on the north side of the St. Vrain for nearly four miles from its mouth. Similar bluffs are conspicuous along the northerly bank of Thompson for several miles, and can be traced thence to near the Cache La Poudre without any difficulty.

A low bluff-like ridge, lying at from one to three miles from the river, begins at Platteville on the east side of the stream, and is easily followed to a considerable distance northeastward from the town of Evans.

In the bluffs lying on the west side of the Platte, the rocks dip gently northward. On the opposite side the dip is insignificant; a very gentle anticlinal was observed at Platteville, and the rocks are almost horizontal or possibly dipping slightly toward the north at four miles southeast from Evans.

On the West side of the South Platte River.—Following the grade of the Colorado Central Railroad on the west side of the river, one finds, somewhat more than four miles above Evans, an outcrop of bright yellow, very friable sandstone, forming a broad band on the bluff. Fragmentary outcroppings of the same rock were observed farther down the river, but here for the first time the exposure is satisfactory.

On the Thompson, the exposure ends with the curving bluff at probably five miles from the river, and the dip along the stream is insignificant.

As already stated, the bluff begins again on the south side of the Thompson probably two miles from that stream, and is continuous thence to within a short distance of the St. Vrain.

Here again is a fine exposure of the sandstone which shows a gentle east-northeast dip. The section up to the St. Vrain is as follows, the thicknesses being estimated :

1. Yellow sandstone	450 feet.
2. Blue sandstone	200 “
3. Concealed	200 “
4. Yellow sandstone	100 “
5. Gray to blue sandstone	50 “
Total	1,000 “

No. 1, the sandstone already referred to as occurring in the bluffs both north and south from the Thompson, is bright yellow and for the most part extremely friable, weathering easily and breaking down into loose sand. But, at irregular intervals, vertically, it shows thin layers of darker sandstone, some of which are quite compact, while others are flaggy, though they all resist the action of the weather. The unequal resistance to the weather is so marked that south from the Thompson the bluffs are known as the Monument Bluffs. The features are exactly the same as those shown in Monument Park, north from Colorado Springs, and the peculiar forms exhibited in photographs, taken by Mr. Jackson in that Park, are accurately reproduced here. So closely do the rocks on the Platte and St. Vrain resemble those in Monument Park, that one might well be tempted to imagine that they are parts of one series, and that the series is continuous along the whole face of the mountain.

This locality was visited by me in 1873,* in company with Mr. J. A. P. Kelley of Evans. and in 1878 with Dr. J. Innes and Mr. S. A. Stevenson of Evans, and Mr. A. J. McClure of Bellefonte, Penn. For the greater portion, the soft, yellow sandstones are devoid of fossils, but here and there *Halymenites major* Lesqx. occurs, and occasionally one stumbles on a little nest of *Ostrea*. The harder layers are quite different, many of the more compact being crowded with the *Halymenites*, while most of the flaggy layers contain Fox Hills fossils, among which are *Ammonites lobatus*, *Nucula cancellata*, *Maetra Warrenana*, and numerous other species. Other layers are crowded with fragments of carbonized wood, and frequently one finds in such layers oblong cavities, six inches long, filled with carbonaceous matter in oolite grains and closely resembling the roe of a large fish. In 1873, Mr. Kelley discovered a thin layer containing impressions of dicotyledonous leaves. But the leaf specimens, with nearly all the other specimens obtained during that visit,

* Notes on the observations made in 1873 were published in the Proc. Lyc. Nat. Hist. of N. Y. for Jan., 1874; in the Proc. Amer. Phil. Soc. for 1875; and in the report to Lt. Wheeler, published in 1876.

were destroyed by an accident to the building where they were stored in Evans. During my last visit the leaf bed could not be found.

These fossils can be procured between the Thompson and St. Vrain from a high knob near the Stone House, but localities are numerous both north and south from the Thompson, specimens having been obtained by me from both sides of that stream, and from the north side by persons connected with the Geological Survey of the Territories.

The blue sandstone appears first above the Stone House, and physically differs little from the overlying yellow sandstone. It contains, however, no inconsiderable proportion of shale, while shaly layers are few in the other rock.

The interval, No. 3, as given in the section is too small, but no direct means of determining the thickness was at my disposal, and the calculation was made roughly by depending on the rate of dip at the southern termination of the bluffs at St. Vrain. The sandstones at the base of the section are exposed on the St. Vrain at nearly three miles from the river. They resemble the higher sandstones in structure, and as far as examined proved to be non-fossiliferous.

The relation of this enormous mass of sandstone to the coal beds mined by the St. Vrain Company could not be made out directly, as there is no way of connecting the exposures; but a barometric line carried over to the mines seems to indicate that the coal at those works lies not far from the horizon of the concealed interval. There is no evidence that any faults exist in this vicinity. Coaly material was obtained in borings, begun on the north side of St. Vrain in the sandstone at the base of the section.

On the East side of the South Platte River.—In 1874, Dr. J. Innes made several borings in search of coal at about five miles southeast from Evans. No. 1 was begun in dull, yellow sandstone, moderately coarse, containing small ferruginous nodules with *Halymenites major* and shells; but only fragments of the latter were seen, sufficient, however, to show that they belong to characteristic species of the Fox Hills group. This boring was carried 268 feet and gave the following section:

1. Sandstone	52 feet.
2. Carbonaceous shale	4 “
3. Yellow sandstone	10 “
4. Light shale	50 “
5. White sandstone	40 “
6. Blue shale	10 “
7. Blue sandstone	10 “
8. Alternations of sandstone and shale....	92 “
Total	268 “

Certainly very different from anything exposed on the western side of the river. The rocks here are almost horizontal, but there seems to be a very slight dip toward the north. Accompanied by Dr. Innes, and Messrs. Miller and Stevenson of Evans, I followed up the gulch from this boring to No. 2, which is but a short distance from the last and only a few feet higher. Between the two is a blossom of *coal* or carbonaceous shale. Almost immediately north from the gulch and at barely 100 feet above No. 1, a third boring was put down, in which the following section was obtained:

1. Dirt	10 feet.
2. Sandstone	10 "
3. Fire clay	2 "
4. Sandstone	14 "
5. <i>Black shale</i>	16 "
6. Sandstone	21 "
7. Fire clay	1 foot.
8. <i>Coal</i> with a little shale	2 feet 10 inches.
9. Interval	28 " 3 "
10. <i>Coal</i>	0 " 2 "
Total	105 " 3 "

The black shale, No. 5, is very carbonaceous throughout, and No. 10 is in close proximity to the dark shale or *coal* seen between borings No. 1 and No. 2, which rests almost directly on the sandstone at the top of the section in No. 1.

At fourteen feet above the curb of this boring, a shaft was begun in order to reach the *coal bed*, No. 8 of the section; but after it had been sunk to a depth of twenty-eight feet, Dr. Innes made a boring to determine the character of the coal once more. In this, the upper portion of the shale, No. 5 was found to be a *coal bed* two feet seven inches thick; the *coal bed*, No. 8, was unchanged in thickness, while the little bed at the bottom of the third boring had swelled to six inches. But of the three beds only the middle one showed good coal, that from the others being very soft and of not merchantable quality.

The shaft shows 10 feet of debris resting on eighteen feet of sandstone. The latter contains several fine-grained, somewhat ferruginous layers, which are crowded with remains of Fox Hills species, of which many weathered specimens still lie round the dump. The best specimens obtained were carried away as the work advanced, but a box of them was selected by Dr. Innes, and sent to me in 1874 by Mr. J. A. P. Kelley of Evans. This contained the following species: *Ammonites lobatus*, *Cardium speciosum*, *Nucula cancellata*, *Mactra alta*, *Mactra Warrenana*, *Lunatia Moreauensis* and undetermined species of *Anchura*. Fragments of these were seen on the dump, and some good specimens of the univalves were obtained.

At a little distance from this shaft another boring was made, which shows eleven beds of coal in the same interval, which vary in thickness from two to thirty-one inches.

One cannot join the exposures on the east, with those on the west side of the river, as the terraced plains of the Platte are very broad from Platteville to far below Evans. At the same time, the fucoids and the mollusks are fully characteristic of the Fox Hills group, and show that the rocks on both sides of the river are of the same age. Those on the east side have been regarded as without doubt belonging to the Laramie, not to the Fox Hills Group.

The bluffs on the west side between the Thompson and the St. Vrain have been colored as *Laramie* on Dr. Hayden's map. These bluffs show Fox Hills fossils to the top; they contain no coal; no leaf-impressions were found by Dr. Hayden's corps. It is difficult to understand, therefore, why the richly fossiliferous sandstones of the bluffs should be colored as Laramie, while the underlying sandstones, without characteristic features, should be colored as Fox Hills. The bluffs along the Platte, both north and south from the Thompson and those on both sides of the Thompson, are *Fox Hills* and *Fox Hills* only. No higher rocks are exposed between Thompson and St. Vrain within five miles west from the Platte.