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NOTES ON THE GEOLOGY OF NORTHWESTERN IOWA.

BY PROF. J. E. TODD.

I handed in the subject of this paper, intending to throw together various notes which have been accumulating for several years.

I recently took a trip to the region under consideration intending to visit several localities and examine the borings of several wells, which, however, I was prevented from doing for lack of time. Had I been able to procure careful notes from all the wells I should be more decided on several points stated below.

The following is a tabular list of the wells noted with elevations of top and bottom:

LOCALITY.	ALTITUDE OF TOP.	DEPTH.	ALTITUDE OF BOTTOM.
Ponca, Neb.	1175	698	477
Sioux City.....	1160	2071	-911
Le Mars.....	1275	1400	-125
Cherokee.....	1215	960	255
Peterson.....	1260	145	1015
Emmetsburg.....	1230	869	231

Of the Ponca well I had access to notes published by Prof. S. Aughey, who visited a well when it was being bored at that place in 1889, and I also had the opportunity to examine the somewhat complete core taken out by the diamond drill in 1888. A summary of the result is as follows:

Eighty feet—More or less, drift clays.

Forty-five feet—Chalkstone capped with siliceous layers. "Inoceramus beds."

Sixty-five feet—Alternate layers of fine, stratified sand and light and drab clay. A pretty compact stratum of sandstone at the top, with a layer of lignite above, sometimes for a little ways, 6-8 inches thick.

Two hundred and thirty feet—Sand and sandstone. (Dakota.)

Thirty-five feet—Sandy shale and fine light green clay with grains like "green-sand."

Fifty feet—Rusty gray, porous granular limestone above, blotched blue and cream color below, dolomitic, few casts of shells resembling macrocheilus.

Forty-five feet—Limestone, whitish above and capped with a layer more argillaceous, containing fragments of dolomite; below blue, becoming blue carbonaceous clay.

One hundred feet—Compact gray limestone, with portions below darker, vesicular in several strata. A print of a large trilobite near the top.

Fifty feet—Compact limestone with fragments of greenish flint.

The following condensed statement of the Sioux City well is based upon notes kept by the foreman, furnished me by Mr. J. C. C. Hoskins, and interpreted by samples preserved by Mr. D. A. Magee, and submitted to my examination. The mouth of the well is about thirty-eight feet above the top of the sand rock exposed by the river near by.

Sixty-five feet—Soil and gravel.

Twenty-five feet—Gravel.

Fifty-four feet—Shale. (Benton.)

One hundred and ninety-one feet—Sand and sandstone. (Dakota.)

One hundred feet—"Chalk-rock."

One hundred and ten feet—Gray limestone.

One hundred and fifteen feet—Alternation of sand and gray limestones. Water from near top of this rose to within twelve feet of the surface.

One hundred and fifty feet—White and gray limestones.

Four hundred and forty-five feet—Limestones and shales in thick layers, alternating.

Twenty feet—Red mass, five feet underlaid with sand. Water rises strongly to surface from 1,250 feet.

Forty-five feet—Sand and marl.

One hundred and ninety feet—Hard "micaceous limestone and compressed sandstone."

Fifteen feet—Hard, brown rock; Sioux quartzite?

Five hundred and fifty feet—Hard, gray granite, or gneiss, a five foot layer of white limestone at 1,860.

My knowledge of the Le Mars boring has been derived from communications from Mr. Maurice Vincent, for a time resident of the place, and Mr. M. A. Moore, who was largely interested in the enterprise. I have also examined samples from various depths and visited the locality.

Seven feet—Soil.

Thirteen feet—Yellow clay.

Forty-four feet—Blue clay.

Twenty-seven feet—Sand and gravel, hardened above. (Tertiary?)

Eighty-nine feet—"Soapstone and slate. (Niobrara?)

One hundred and thirty-eight feet—Alternating strata of sandstone and clays, some lignites. (Benton?)

One hundred and forty-seven feet—Sandstone with some shale. (Dakota?)

At 1,060 red rock 2-3 feet, from that to 1,400 gray granite with three thin layers of white limestone in the upper part.

What little I know of the Cherokee well was learned from Prof. G. W. Foster, and specimens kindly saved for me by Mr. A. Z. Wellman.

It was bored in the center of the city of Cherokee and being out of the old channel which had furnished a fine flow from moderate depth, a little north, and nearer the Little Sioux, it failed to strike any artesian water.

After penetrating 400 feet of light blue limestone, at 700 feet it passed into blue clay or soapstone, which continued to the bottom, 960 feet from the surface.

The Peterson boring was for coal. Mr. J. A. Kirchner, who had an interest, gave me a record of the boring and specimens showing plant remains similar to those at Sioux City and Ponca were scattered about the mouth of the shaft.

Fifty-seven feet—Bouldery drift clay.

Eighty-eight feet—Sandstone and shaly clay layers alternating with some layers of lignite. The shaft was abandoned because of water. Veins of lignite 3-4 feet thick are said to have been passed through near the bottom of the shaft.

The well at Emmetsburg I find reported by Prof. N. H. Winchell from notes by the borer Mr. Swan, in the Minnesota report for 1879. From it we derive the following:

Two hundred and twenty feet--Drift and cretaceous clays.

One hundred and nine feet--Sand, dark above, gray below. (Dakota.)

Twenty-two feet--Red marl. Jurasso-Triassic.

Thirty-two feet--Broken and sandy limestone.

Four feet--Black shale.

Thirty feet--Limerock.

Fifteen feet--Gray shale.

Two hundred and twenty-four feet--"Magnesian limestone."

Ninety-five feet--Shales gray and blue.

One hundred and seven feet--White sandstone, "St. Croix."

Six feet--"Granite" (quartzite?).

Besides these wells which reveal the depths, much additional light has been derived from numerous exposures along the Big Sioux and Missouri rivers. There are very few elsewhere. The Drift has buried the older rocks almost every where else.

The following generalizations are offered tentatively:

1. There seems to be a slight development of the later Tertiary just below the drift. This is found in the shape of fine sands found in the Le Mars well and more clearly in the high sand pits which are opened 4-6 miles northwest of Sioux City along the bluffs of the Big Sioux, 160-180 feet above the stream. No fossils have been found in them, but the absence of northern erratics and their horizontal stratification indicate their age to be older than the Ice age. Laminate clays and similar sands are found east of Canton, S. D., on the Iowa side of the Big Sioux.

2. The chalky beds of the Cretaceous are usually uppermost through the region. I have not been able to trace a definite horizon very widely but the following summits of exposures determined by barometer from adjacent railway station, may be helpful: Dakota City, Neb., 1251; St. Onge's, Iowa, 1255; Ponca, Neb., 1245; Hartington, Neb., 1324; Yankton, S. D., 1240; Scotland, S. D., 1275; Volin, S. D., 1300; Medicine Knoll, S. D., 1330; Akron, Iowa, 1175; Canton, S. D., 1290; Brandon, S. D., 1315.

The most complete natural section of the rocks, as was pointed out by Dr. White in his report, Vol. 2, p. 196, is at Cedar Bluffs. The thickness of the chalkstone, or "Inoceramus beds," is 45-50 feet. Instead of repeating, I will refer the reader to the sections well given by Prof. St. John in the report just mentioned. The Cretaceous dips to the north so as to drop below the Big Sioux a little above Akron, but it reappears near Canton and is still higher a little above Brandon, S. D., where it may be seen in place only a few feet above the red quartzite.

The Benton clays, or the upper part of the Woodbury shales of the Iowa geologists, are 80-90 feet thick.

3. The Iowa geologists divide the strata differently from Dr. Hayden. The latter seems to make the top of the sandstone at the foot of the bluff at Sioux City the division between the Benton and Dakota, and this horizon passes below the river on the west side at Ponca. There is much shale below this, 24 feet exposed at Cedar Bluffs and estimating from the relations at Sioux City as shown by the well, we may calculate to extend over 120 feet lower, before it comes to the continuous sandstone which the Iowa geologists have called Nishnabotna sandstone. The divisions of the former seem to correspond better with the lithologica characters of the beds.

4. Taking a general view of the formations, there seems to be a slight anti-clinal axis, trending in a northeasterly direction. North of this a broad depression in which, as said before, the firmer cretaceous rocks sink below the Big Sioux. In the vicinity of the red quartzite the cretaceous beds rise again to prominence. In this basin considerable thickness of lignite is reported in the vicinity of Centerville, S. D. Water has prevented an opening of the beds which are said to be 4 or 5 feet thick and within 100 feet of the surface.

5. It is an interesting fact that the cretaceous clays and chalkstone are usually attended by *Mentzolia ornata*, *Shepherdia argentea* and *Schrankia uncinata*. In fact the last has often disclosed to me the cretaceous character of a slope, which otherwise might have passed unnoticed.

EXHIBITION OF VOLCANIC DUST FROM OMAHA, NEBRASKA.

BY PROF. J. E. TODD.

This material was from a stratum of whitish aspect, about 18 inches in thickness, found in the bluffs facing the Missouri river about $7\frac{1}{2}$ miles north of Omaha. It has the same general characteristics as the volcanic dust which has been found in quantity along the Republican, in southern Nebraska, also in Knox, Cumming and Seward counties in the same State. This statement is made on the authority of J. S. Diller of the United States Geological survey, who has examined samples from all these localities microscopically. This differs in being stained with oxide of iron, and the sharp angular grains are coated with carbonate of lime. Like the rest it contains with the finely pulverized glass, a few rounded grains of quartz and angular grains of feldspar less than .02 of a millimeter in diameter. The dust is such as is carried through the air from volcanoes. The sand grains and occasional diatoms indicate its deposition in still water.

The following is a section of the bluff containing the volcanic dust stratum:

Twenty-five to thirty feet—Loess, exposed as much more on slope above.

Seven feet—Stratified yellow clayey loam, with many calcareous concretions.

One and one-half feet—Volcanic dust, stained with iron oxide.

Five feet—Yellow clayey loam, slightly stratified.

One-half foot—Fine gray sand.

Twenty feet—Coarse sand and pebbles obliquely stratified.

Fifteen feet—Unknown, probably in part blue till. Level of the Missouri river.

This locality is the most eastern exposure of the volcanic dust stratum which is found scattered over most of Nebraska. Diligent search has as yet failed to discover it on the Iowa side of the Missouri.