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Iowa Geological Survey

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AN UNUSUAL WELL RECORD IN NORTHWESTERN
IOWA¹

JAMES H. LEES

THE HOLSTEIN WELL

In the autumn of 1920 the town of Holstein, in Ida county, began the drilling of a second deep well for its public water supply, the work being done by Thorpe Brothers of Des Moines. On March 29 of the present year (1923) Mr. George Thorpe called the office of the Geological Survey by 'phone from Holstein and told me that they were "up against a hard proposition," that they were able to drill only a few inches a day, and he asked me to go up there and advise them what to do. I went to Holstein the next day and examined the drillings from the bottom of the well. My inspection showed very quickly that the rock was a granite, for not only were the clear limpid grains of quartz in evidence but fragments of light pink feldspar were equally abundant and some fragments of dark ferromagnesian minerals also were present. The drill foreman gave me a chip about an inch square which he said had come from the bottom of the well and this corroborated the evidence of the cuttings. It is a light pinkish gray granite of very distinctive appearance. The drill had penetrated this granite for thirty feet. No wonder they were "up against a hard proposition"! The City Council was advised to stop drilling at once. It is, perhaps, needless to say that no water had been found in the granite.

A full set of samples had been saved and while not all of these were examined some of those from the lower part of the well were studied somewhat carefully. These showed some decided anomalies as compared with the familiar section farther east in the state. A series of samples of sandstone which came from 600 to 700 feet probably represents the Des Moines series of the Pennsylvanian, although, of course, it may belong to the Dakota sandstone. The St. Peter sandstone exhibits its normal facies and it is of about its average thickness. It extends from 1435 feet to 1490 feet. Below it to 1800 feet the rock is chiefly limestone and belongs to the Prairie du Chien stage. Thus far the section is about

what might be expected but below this horizon the variation is decided. The succession may be outlined briefly as follows.

1800 to 1880 feet, shale.

1880 to 1890 feet, sandstone, brownish, of white quartz and other types of grains derived from igneous rocks.

1890 to 1950 feet, shale, greenish, very fine textured, except for a few brownish angular grains, but not very smooth feel; noncalcareous.

1950 to 1970 feet, shale, grayish, otherwise similar to above.

1970 to 2000 feet, sandstone, grains very fine to one-eighth inch in diameter, some very round and smooth; some fragments of larger grains dark colored and quartzitic. Much iron oxide is present as a red coating.

2000 to 2010 feet, sandstone, dull pinkish; grains of quartz small, rounded, clear; much fine powder which gives the color to the entire mass.

2010 to 2020 feet, grains of clear quartz, pink feldspar and a little ferromagnesian mineral, subangular to rounded; has appearance of being a gradation from sample above to that below but probably represents a pink fine-grained granite.

2020 to 2040 feet, quartz, feldspar and ferromagnesian minerals in small subangular to angular grains with some powder. The chip mentioned above came from the bottom of this part and some other smaller fragments which are present in the drillings are gray granite, rather soft, perhaps weathered. The driller stated that the rock drilled increasingly harder from about 2010 feet to the bottom and that through the last six or seven feet he could drill only about a foot a day.

The following is offered as a possible correlation of the strata herein discussed, with the concurrent judgment of Doctor W. H. Norton.

1435 to 1490 feet, sandstone, St. Peter.

1490 to 1800 feet, limestone, chiefly, Prairie du Chien.

1800 to 1880 feet, shale.

1880 to 1890 feet, sandstone } Cambrian.

1890 to 1970 feet, shale }

1970 to 2010 feet, sandstone and quartzite, Sioux quartzite (Huronian).

2010 to 2040 feet, granite, Archean.

If this correlation is correct, the Cambrian is represented almost entirely by shale, instead of by the predominating sandstones of the eastern section, and likewise is much thinner than it is farther east. It is possible that the three divisions correspond to those

found along the Mississippi bluffs, although on the other hand the sandstone may be adventitious and bear no genetic relation whatever to the St. Lawrence beds.

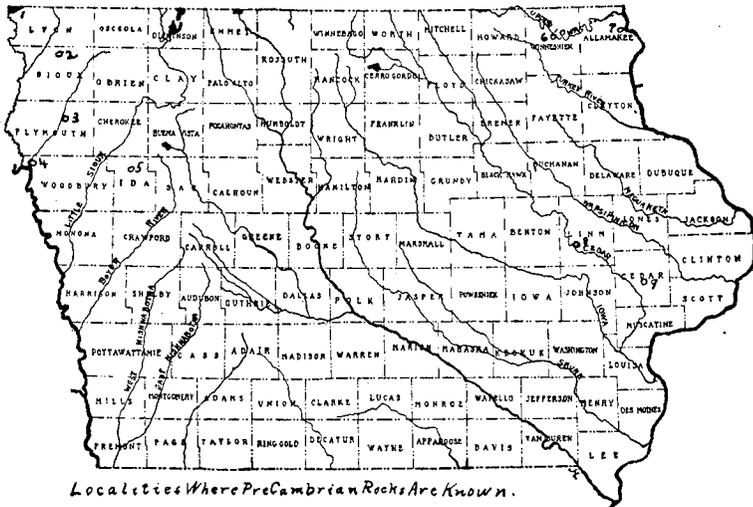
Another striking feature is the thinness of the beds here assigned to the Huronian. This contrasts strongly with the thickness reported from Hull and elsewhere in the state as described below. It may be that the relative softness of these beds is due to their being somewhat weathered through their entire thickness. Professor Thomas and the writer found a quartzitic conglomerate boulder north of Stuart which was so friable as to be readily broken with a light sledge hammer. Is it possible that these beds belong to the Red Clastic Series of Norton² and that the true Sioux quartzite is absent? The character of the cuttings would indicate that the rock here discussed is Sioux quartzite rather than the overlying Red Clastics. The presence of the quartzite at this depth is quite surprising as the samples from the first well, only a few feet from this one, gave no indication of the pre-Cambrian strata having been reached or even approached.

The most surprising feature of the record, however, is the presence of granite in the lower thirty feet. While the universal presence of granite or of metamorphic rocks beneath the Sioux quartzite has been accepted as axiomatic it has not heretofore been suspected that they would be found at such a relatively shallow depth, when all the factors are considered. The granite is here assigned to the Archean (Archeozoic) to agree with the section given by Doctor Norton in the reference already cited, keeping in mind the possibility that it may be Proterozoic and of similar age as the igneous rocks found in the Hull well. There is no indication that this rock is at all foliated, and it is worthy of note that this is the first case in which true granite has been authentically reported from an Iowa well. Again, the granite may be an intruded sill or dyke or one of several flows and may be interleaved with clastic beds or it may be a part of the great fundamental granitic mass of the earth's crust. The fact that the upper few feet is weathered would not seem to be a factor in deciding its nature.

OTHER WELLS IN PRECAMBRIAN STRATA

The record of this well is especially valuable in the additional insight it affords as to the character of the foundation rocks underlying the Paleozoic strata of this part of the Mississippi valley. A very few wells in Iowa have reached the pre-Cambrian rocks and only three have been known heretofore to reach the rocks which

² Iowa Geol. Surv., Vol. XXI, p. 70.



1, Northwestern Lyon County; 2, Hull; 3, Le Mars; 4, Sioux City; 5, Holstein; 6, Decorah; 7, Lansing; 8, Cedar Rapids; 9, Tipton.

normally lie beneath the Huronian quartzites. These were: a well at Sioux City, one at Le Mars, and an oil prospect recently drilled at Decorah. Other wells which reached the pre-Cambrian are that at Hull in northwestern Iowa and those at Lansing, Cedar Rapids and Tipton in the eastern part of the state.³ Of course the Sioux quartzite is known to outcrop in the extreme northwest corner of Iowa and it is known also to be intruded by igneous rocks near Sioux Falls and farther north. The altitude of the outcrops is about 1300 feet. The next locality from which the pre-Cambrian is known is Hull, in Sioux county. Here intercalated sandstones and quartz porphyries extend from a depth of 755 feet to the bottom of the well at 1263 feet. The curb is 1433 feet above sea, which would place the top of the pre-Cambrian beds at 678 feet above sea level. At Le Mars, in Plymouth county, a well whose curb is 1275 feet above sea reached crystalline rock, "gneiss (?)," at 1060 feet and penetrated gneiss (?) and schist to the bottom at 1560 feet. A sandstone at 960 feet may be pre-Cambrian. This would place the pre-Paleozoic floor at 315 feet above sea, or possibly higher. Norton assigns the gneiss (?) and schist to the Archean and its surface is 215 feet above sea level.

The Holstein wells have a curb altitude of 1439 feet and according to the correlation suggested here the pre-Cambrian surface is

³ The wells here mentioned are described in Iowa Geol. Surv., Vol. XXI, as follows: Sioux City, p. 1097; Le Mars, p. 1076; Hull, p. 1092; Holstein, p. 1048; Lansing, p. 285; Cedar Rapids, p. 540; Tipton, p. 449; Fort Dodge, p. 918; Boone, p. 816; Des Moines, p. 893; Stuart, Vol. XXVII, p. 159.

531 feet below sea level, while the granite floor is forty feet lower. These four localities are fairly well in line with each other and indicate the slope of the pre-Paleozoic floor toward the southeast.

The other well in western Iowa which penetrates the Paleozoic strata is the deep waterworks well at Sioux City. This starts from an altitude of 1125 feet, reaches the bottom of the Cambrian sandstones at a depth of 1260 feet, or 135 feet below sea level, and passes thence directly into schists, which it pierces for 751 feet, to the bottom of the well at 2011 feet. The Sioux quartzite seems to be entirely absent, and the base of the Paleozoic rocks is nearly four hundred feet higher here than at Holstein. As an interesting bit of negative evidence it may be stated that the well at Fort Dodge, which is directly east of Sioux City and Holstein, starting from an elevation of 1011 feet above sea level, had penetrated the Cambrian sandstone only fifty-nine feet when drilling was stopped at 1817½ feet. The top of the Jordan here is 757 feet below sea level. At Boone the Cambrian beds were pierced for nearly five hundred feet without being entirely penetrated; so it is evident that at Fort Dodge the pre-Cambrian floor should be far below the bottom of the well.

No wells in central Iowa reach the Sioux quartzite as the Boone and Des Moines wells, each 3000 feet deep, failed to penetrate the Cambrian strata and the Stuart well, 3021 feet deep, stopped in the New Richmond sandstone of the Prairie du Chien stage.

Other wells, then, which reach the base of the Cambrian beds are found only in eastern counties. The deepest of these, but the one about which least is known, is the recent oil prospect drilling near Decorah, Winneshiek county. This was begun in Ordovician strata, at an altitude of about 875 feet. It is not known at what depth the base of the Cambrian strata was reached but schist is said to have been struck at about 1800 feet and to have been present till the prospect was abandoned at 3200 feet.

The city well at Lansing, in Allamakee county, starts in the Cambrian strata at an altitude of 640 feet above sea level and was said to reach "hard crystalline rock," assumed to be Huronian quartzite, at 751 feet or 111 feet below sea level. The first city well at Cedar Rapids, Linn county, starts from an altitude of 733 feet and reaches Huronian (?) quartzite at a depth of 2150 feet or 1417 feet below sea level. It extends seventy-five feet into this quartzite. The city well at Tipton, Cedar county, starts from an altitude of 810 feet and reaches the pre-Cambrian floor at 1435 feet below sea level. Here red sandstones were reached and were

penetrated for 431 feet. These are classed as Algonkian (?) (Huronian) by Norton and are called by him the Red Clastic Series.

The thickness of the Cambrian sandstones of eastern Iowa is in strong contrast with that of western Iowa so far as these are revealed by wells. At Lansing they are a thousand feet thick, at Cedar Rapids 750 feet and at Tipton 783 feet thick. Nothing is known of the strata in the Hull well above the pre-Cambrian, and there are only two samples, from 860 and 960 feet, to account for six hundred feet of strata above the Archean gneiss (?) of the Le Mars well. Norton assigns only the sample at 960 feet to the pre-Cambrian. In the case of the Sioux City well he assigns to the Cambrian the strata from 840 to 1260 feet on the basis of somewhat scattered samples. The correlation of the Holstein well given in this paper allows only 170 feet to the Cambrian. In the vicinity of the "Sioux Island" of course the Cambrian is entirely absent.

SUMMARY

The Holstein well is of interest: because it is one of very few in Iowa which penetrate the entire thickness of the Paleozoic strata; because it shows a decided anomaly in the character and thickness of the Cambrian strata; because of the unexpected thinness of the Huronian quartzite; because of the unique presence in it of a true unmetamorphosed granite.

Other localities at which sandstone or quartzite assignable to the Huronian has been found are Hull, where the rock is interbedded with quartz porphyry, Le Mars, Lansing, Cedar Rapids, Tipton, and perhaps Decorah. Schists and gneisses of Archeozoic age have been found at Sioux City and Le Mars, and probably at Decorah.

The Cambrian strata seem to be thinner in the western counties than in the eastern counties.

The few records available show a decided southeastward slope along the pre-Cambrian floor in northwestern Iowa and an equally strong slope southward in eastern Iowa. This floor is much lower in the eastern part of the state than in the western part—a hundred feet below sea level at Lansing, thirteen hundred above sea level in the northwest corner.

A more complete record of the Holstein well will be published by the Geological Survey.

IOWA GEOLOGICAL SURVEY.