

ART. VIII.—*The Age of the Iron Ore in Eastern Wisconsin*; by T. E. SAVAGE and C. S. ROSS.

It has long been known that a bed of oolitic iron ore occurs in several isolated lenses or patches in southeastern Wisconsin, occupying a position immediately above the Maquoketa (Richmond) shale, and below a limestone of Silurian age. This ore bed is best exposed about 4 miles south of Mayville, near the village of Neda, where its maximum thickness is about 30 feet. From this place it continues north towards Mayville and south towards Iron Junction. Another lens is known to be present a few miles farther southeast, in the vicinity of Hartford. North of Mayville an outcrop of the iron ore occurs about 5 miles east of DePere, in Brown County, and still farther north the iron deposit is known in a few places southwest of the town of Sturgeon Bay. The distribution of this iron ore in Wisconsin has been recently described in a paper by F. T. Thwaites,* to which the reader is referred for a detailed description of the distribution of the deposit.

Many years ago this iron ore bed was well described by Chamberlin,† who correlated it with the Clinton iron ore of the Appalachian region as follows:

“As yet there seems no authentic instance of organic remains having been found in this deposit, although I was shown fossils, said, with undoubted truth, to have been taken from the ore, but they were probably found in the disturbed drift ore, as they were Cincinnati species, specimens of which were ascertained to have been driven up by glacial forces into the mixed mass overlying the Mayville ore bed. We are left, then, without the valuable criterion which fossils afford for determining the age of this important formation. But there is, nevertheless, no occasion for doubt on this subject. Its stratigraphic position fixes its age within very narrow limits. The limestone above belongs to a very low horizon in the Niagara group, and, indeed, it has been regarded by some eminent geologists as belonging to the Clinton epoch, and it probably is the approximate equivalent of the upper portion of the Clinton beds of New York, but as will be seen hereafter, there is no good reason for separating this limestone from the great mass of the Niagara group, with which it is intimately connected. There is a sharp line of demarcation between the ore and the limestone at most points, so that there is no reason for assigning the ore a higher position than the Clinton epoch.”

“While, as already stated, the clay below mingles somewhat with the lower layers of the iron deposit, the ore ‘takes on’ layers

* Fredrik T. Thwaites, Bull. No. 540, U. S. Geol. Survey, 1912, pp. 338-342.

† T. C. Chamberlin, *Geology of Wisconsin*, vol. ii, 1877, pp. 327-335.

at the bottom, so that its beds are in a slight degree unconformable to those below, which constitutes a reason for not grouping the iron beds with the Cincinnati series.”

“Within the limits to which stratigraphical evidence thus confines this formation, there can be no hesitancy in referring it, on lithological grounds, to the Clinton epochs, since that epoch is

FIG. 1.

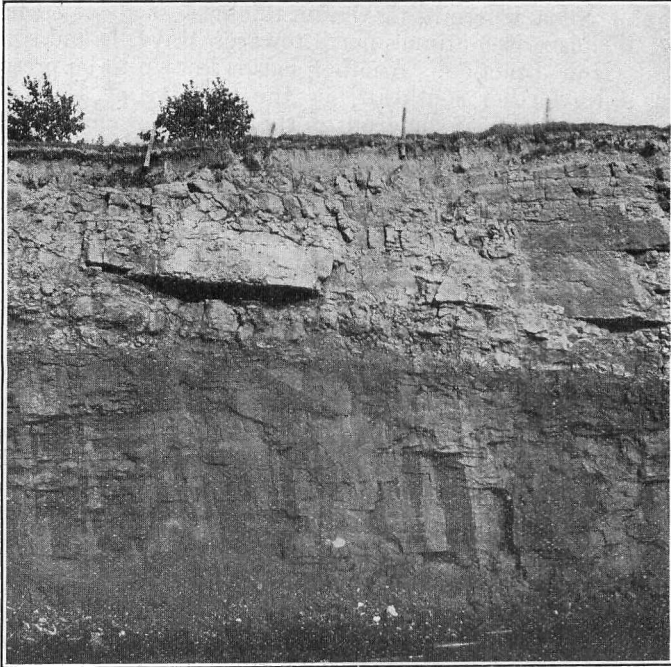


FIG. 1. Iron ore bed unconformably overlain by Mayville (Early Silurian) limestone, in an old iron pit in Iron Ridge, near Neda, Wisconsin.

characterized from Ohio as far eastward as Nova Scotia, and as far southward as Alabama, by a similar deposit of oolitic iron ore.”

Since the above description and correlation of the iron ore in southeastern Wisconsin were made, geologists have generally assumed the Clinton age of the formation, notwithstanding the fact that the definite correlation was based almost entirely upon the peculiar lithology of the deposit, to the exclusion of the suggestive age indicated by the fossils.

In connection with the study of the early Silurian strata in eastern Wisconsin during the summer of 1914, additional information was obtained bearing directly on the age of the iron ore formation in that region. The relations of this bed to the underlying Maquoketa shale, and to the overlying Silurian limestone, so well described by Chamberlin, are well exposed in an abandoned ore pit near the station of Neda, as shown in figure 1. A detailed section of the strata at this place is given below:

Section of strata exposed in an old ore pit near Neda.

Mayville limestone	Feet
4. Dolomite, gray, crystalline, somewhat vesicular, in layers 1 to 4 feet thick	36
A break in deposition.	
Iron ore bed	
3. Iron ore band, hard, non-oolitic	2/3 to 1-1/3
2. Iron ore, oolitic, reddish-brown, in rather even layers, with a thin band of iron coated fragments of shaly material, and iron pebbles near the bottom	25-32
A break in sedimentation.	
Maquoketa shale	
1. Shale, calcareous, bluish-gray, hard, in layers 3 to 8 inches thick; containing shells of <i>Hebertella occidentalis</i> , <i>Platystrophia acutilirata</i> and <i>Rhynchotrema capax</i>	8-10

In the vicinity of Green Bay, about 60 miles north of the locality last described, the iron ore bed is well exposed in the gorge near the foot of Cascade Falls, about 5 miles east of DePere. The succession of strata exposed at this place is shown in fig. 2, and described in the following section:

Section of strata exposed at Cascade Falls.

Mayville limestone	Feet
3. Dolomitic limestone, yellowish-gray, in layers 6 to 18 inches thick	30
A break in sedimentation.	
Iron ore bed	
2. Iron ore, oolitic, in places somewhat conglomeratic in appearance, with a shale band about 10 inches above the base, and much iron pyrites near the top	4-1/2 to 5

A break in sedimentation.

Maquoketa shale	<i>Feet</i>
1. Shale, calcareous, hard, in layers 3 to 8 inches thick, some of which are strongly laminated..	8 to 10

The unconformity between the iron ore and the overlying Silurian limestone is indicated by the uneven plane of contact,

FIG. 2.

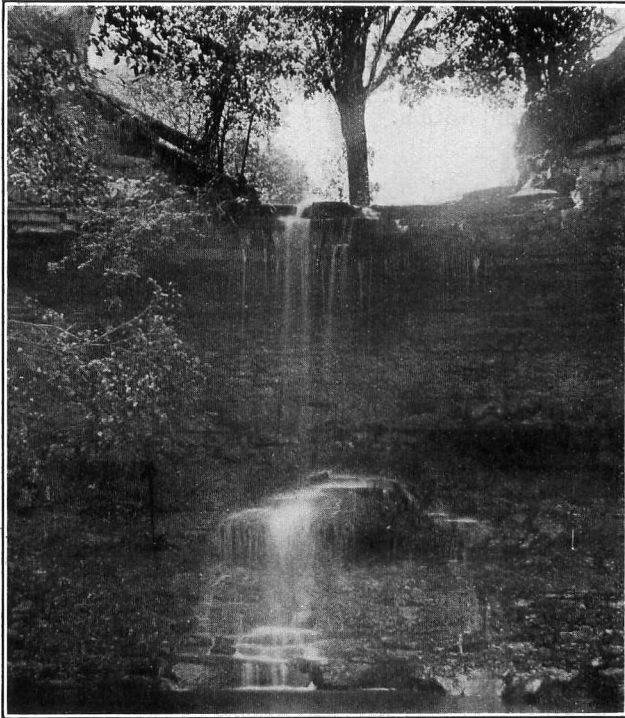


FIG. 2. View showing the bed of iron ore at Cascade Falls, 5 miles east of DePere. The iron bed, included between the arrows in the picture, rests unconformably upon the Maquoketa shale, and is separated from the overlying Mayville (Early Silurian) limestone by a similar unconformity.

and by the residual character of the upper part of the iron ore which contains a much larger percentage of iron pyrites than the average deposit. The relation of the iron ore to the Maquoketa shale is an unconformable one wherever this contact is exposed, the iron ore resting on different levels of the Maquoketa shale.

From the bed of iron ore at Cascade Falls the following fossils were collected :

Cf. *Stenaster* sp.,
Cf. *Eurydictya montifera*,
Lingula cf. *cobourgensis*,
Strophomena wisconsinensis,
Dalmanella tersa,
Byssonychia intermedia,
Byssonychia cf. *radiata*,
Pterinea cf. *demissa*,
Liospira sp.

The fossils listed above, taken from the iron ore bed at Cascade Falls, are *Maquoketa* species. They came from an undisturbed zone one to one and one-half feet above the base of the iron ore bed, where they could neither have been squeezed up from the underlying *Maquoketa* shale, nor have been carried up into the iron ore by the movement of glacier ice. The occurrence of *Maquoketa* fossils in the iron ore is interpreted as indicating the *Maquoketa* age of the bed. A possible alternative interpretation might assume that the fossils were washed by the waves out of the *Maquoketa* shale, and redeposited with the material of the oolite as the sea in which the latter accumulated advanced over the region. The fact that the surface of the shells present in the iron ore show little evidences of wear, and that no fossils of Silurian age are found in the deposit support the former interpretation.

The middle and lower parts of the iron ore bed contain pebbles of shale or slab-like iron ore, which in places form a conglomerate. Many of these pebbles also contain grains of oolitic iron, and are of the nature of iron concretions of irregular shape, the iron not only having replaced the calcareous constituents, but also having been deposited in the spaces between the grains, forming irregular concretionary structures. Another part of the pebbles appear to consist of fragments of *Maquoketa* shale that were worked over and deposited by the waves as the sea in which the oolite accumulated advanced upon the area, and later became thoroughly impregnated with iron. Still another part of the pebbles may have been formed by wave action upon the more clayey portions of the sediments during the progress of deposition of the material, the calcareous portion subsequently having been replaced by iron oxide. The fossil shells present in the iron ore bed were originally calcareous and have all been replaced by iron.

The surface of the pebbles, and also of the grains of oolite, has a shiny, varnished appearance. Grabau* has suggested

* A. W. Grabau, *Principles of Stratigraphy*, p. 57, 1913.

that the shiny character of the surface of the pebble-like concretions in the iron ore bed is due to desert varnish, and assumed that the material of the iron ore bed was transported and deposited in dune-like masses by the winds under arid conditions. The objections to this view are: (1) The iron ore deposit is horizontally and regularly stratified, as may be seen in figure 1, and shows none of the oblique bedding and irregularities of stratification characteristic of wind deposition; (2) The shiny varnished appearance of the pebble-like concretions is due to the iron, which is present not only as a film or rind on the surface of the pebbles, but the larger part of the pebbles and also of the oolite spheres is composed of iron. The surface of the oolite spheres has a varnished or shiny appearance similar to that of the pebbles, and when some of the concentric laminae of the oolite grains are removed, the surface of the inner ones are also seen to have a similar varnished appearance. Concretionary pebbles of iron are found in many places in a zone near the base of the Maquoketa shale, as at Scales Mound, and Kingston, Illinois. The surface of these pebbles in the lower part of the Maquoketa in Illinois has a shiny appearance, similar to that of the pebbles in the iron ore deposit in Wisconsin, yet the same layers in which they occur also contain many shells of marine mollusks, as *Otenodonta fecunda*, *C. obliqua*, *Cleidophorus neglecta* and other species. There seems no stronger reason for doubting the marine origin of the original oolite in Eastern Wisconsin, the calcareous portion of which has subsequently been replaced by the iron, than for considering the lower fossiliferous part of the Maquoketa at Scales Mound and Kingston, Illinois, in which similar iron pebbles occur, as of nonmarine origin.

The senior writer has shown that the lower part of the Mayville limestone of Wisconsin, which immediately overlies the bed of iron ore, corresponds in age to the Edgewood limestone of Illinois and Missouri, which is much older than the Clinton formation in the Appalachian region. Consequently, the iron ore deposit can not be correlated with the Clinton of the east, but is certainly older than the Edgewood formation. The evidence indicates that it represents deposits in local but apparently connected basins (because of the marine fossils) during late Maquoketa (Richmond) time, and after the main portion of the normal marine Maquoketa sea had withdrawn from the greater part of the region farther south in the Mississippi Valley.

The iron ore bed has been referred to by Chamberlin as the "Mayville ore bed," but he applied the name Mayville*

* T. C. Chamberlin: *Geology of Wisconsin*, vol. 2, p. 336, 1877.

more definitely to the limestone formation immediately overlying the ore. Thwaites and others have referred to the deposit as the "Clinton ore," but inasmuch as it has been shown that this formation is much older than the Clinton of New York, this name is no longer appropriate. Since the iron formation is well developed and best exposed in the vicinity of Neda (the present name for the old station of Nye), near which place the ore has been worked most extensively, the name "Neda Iron Ore" is proposed for this formation.

University of Illinois, Urbana, Ill.