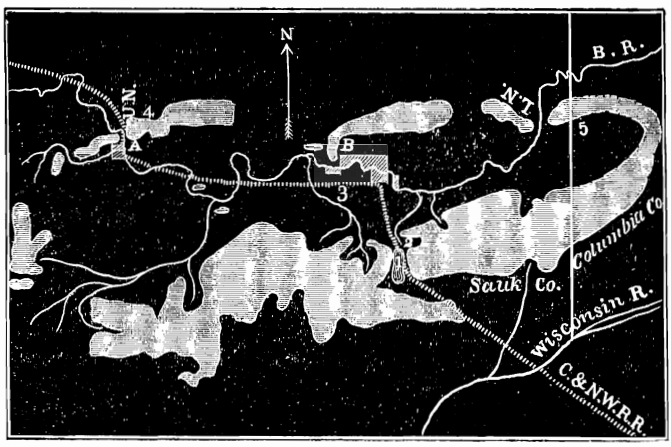
ART. XLVII.—*On the relations of the Sandstone, Conglomerates and Limestone of Sauk County, Wisconsin to each other and to the Azoic;* by Prof. JAMES H. EATON.

THE age of the quartzite hills and ridges of Sauk County has been satisfactorily determined by Mr. Roland Irving* to be Pre-silurian. Mr. James Hall † in his report of the State Survey calls them Huronian. On Dr. Lapham's map a small region on the Eau Claire River, adjacent to the great central area of granitic rocks, is colored as quartzite. An examination of this locality, to determine whether the latter rest unconformably upon the former, would perhaps determine their age. For the present we can say that these rocks differ lithologically.

The accompanying map is by Mr. Wm. H. Canfield, of Baraboo, who for many years has been the officialy surveor

1.



A, Abelman; B, Baraboo; B R, Baraboo River; L N, Lower Narrows; U N, Upper Narrows. 1, Devil's Lake; 2, 3, Potsdam Sandstone; 4, Section; 5, Limestone. Scale, three-twentieths of an inch equal to a mile.

for Sauk County, and it is taken from surveys made by him with the especial purpose of marking the quartzite outcrop. It has been completed for Columbia County by Mr. T. C. Chamberlain, of Whitewater. The dotted line east of the Upper Narrows was also added by Mr. Chamberlain. It is believed that this map shows the entire outcrop of Azoic rocks in the region of the Baraboo River.

We have thus represented a group of islands which existed in the Potsdam sea, with their common trend east and west, or at right angles to the dip of the rocks.

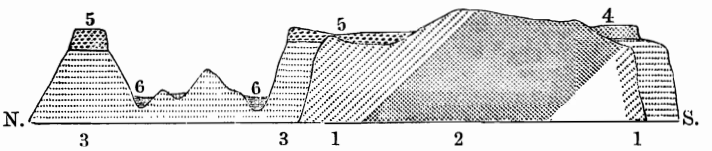
* This Journ., Feb., 1872. † Survey of Wis., p. 11.

The following localities were visited by myself in the fall of 1872:

The point marked (2) on the map is the locality from which the fossils were obtained, which were described by Mr. Alexander Winchell* in 1864. In a short time a large number of fossils were obtained from loose pieces of sandstone. I was assured that there is a quarry of the rock in a place near by, but the time did not suffice to find it. The fossils were *Scolithus linearis* Hall, *Orthis Barabuensis* Winchell, *Straparollus primordialis* Winchell, *Dicellocephalus Minnesotensis* Owen.

At the locality marked (4), however, is a section (fig. 2) which is truly magnificent in its exposure, of all the rocks which belong to this region, in their stratigraphical relations, except the limestone. It is at the railroad station, Abelman. The Baraboo River, in forming the Upper Narrows, has left upon the

2.—Section at Upper Narrows, Baraboo River.



1, Quartzite. 2, Metamorphic Conglomerate, 3, Potsdam Sandstone- 4, 5, Conglomerates. 6, Drift.

east side a nearly vertical section, about half a mile long and 300 hundred feet high at the highest point. This section is of a core of tilted rock, flanked on *both* sides by horizontal Potsdam sandstone and conglomerates. No doubt can therefore remain that the tilted rock is Pre-silurian.

The dip of the entire section of Azoic rock is to the north or slightly west of north. Its face is cut by numerous vertical joints in the same manner as the cliffs at Devil's Lake. At the extreme southern end the rock varies from a compact dark-colored homogeneous quartzite, to a much less compact and lighter quartzite. One large detached block of the hard, dark quartzite was seen beautifully covered with ripple-marks.

Passing along the face of the cliff toward the north it becomes covered with large blocks of quartzite, sandstone and conglomerate, which have fallen from above.

Coming to the exposed rock again, it changes to a metamorphic conglomerate. This makes up more than half the section. It consists of *angular* pieces of the compact Sauk quartzite, firmly imbedded in a cement of white crystalline quartz. The former vary in size from small fragments to

* This Journ. II, vol. xxxvii, p. 226.

masses several tons in weight. Numerous cavities are lined with quartz crystals. The dip here is from 75–80° N.

The remainder of the section consists of the homogeneous, dark, compact quartzite, bedded in the same manner. We have then indications of three successive sets of circumstances in Azoic times; those in which were formed respectively the underlying quartzite, the conglomerate and the overlying quartzite. The lower quartzite must have been already hardened from the moving sands before it was broken into fragments for the conglomerate. And then its cement was crystallized. Finally, layers of sand spread over this were hardened.

As has been said, upon the southern flank of this Azoic core, horizontal beds of Potsdam sandstone lie unconformably. They extend a short distance over the edges of the upturned beds of quartzite.

The relation of this sandstone to the underlying quartzite shows most unmistakably the effects of shore action. The quartzite is generally in place, but the large blocks, formed by the crossing of the planes of bedding and the joints, are somewhat isolated, as if they had formed crags on an old coast, where the wearing of the waves had enlarged the cracks. Into these fissures and crevices the sand is forced. There are also blocks of quartzite, that have been displaced somewhat, which are enveloped in sandstone. In the sandstone itself is an occasional rounded pebble of quartzite. The sandstone which rests upon the northern flank is irregularly bedded, having the ebb and flow structure. Farther north are three isolated hills of sandstone.

Resting on the sandstone at the south, and stretching also over the quartzite, is a conglomerate made up of a friable sandstone, like that below, containing numerous rounded pebbles of the quartzite of various sizes. The cement makes up a considerable part of the rock. This conglomerate, as I have assured myself by careful examination, is exactly like that mentioned by Mr. Irving as occurring on the quartzite just northeast of Devil's Lake, and containing Potsdam fossils. The finding of this conglomerate, therefore, in its true relation, verifies Mr. Irving's supposition in opposition to Mr. Winchell, that neither the conglomerate nor the quartzite is the *base* of the Potsdam system, for here the true base comes in between, as sandstone. In the same manner there is a conglomerate at the north resting conformably on the sandstone and unconformably on the quartzite. One of the isolated hills of sandstone is also capped by the same. As nearly as could be determined, the level is the same as that of the conglomerate at the south. But its character is different. It is made up almost entirely of small rounded pebbles of quartzite of a pretty uniform size. The cement is quite hard, but true sandstone.

This section then represents an old Azoic reef of tilted rock, running east and west, washed upon either side by the waves of the Potsdam sea. On the south the action appears to have been gentler than on the north, for while at the south the quartzite has been triturated to a fine sand, containing, to be sure, larger or smaller pieces of quartzite, well rounded, the northern shore must have been exposed to the breakers which washed out the fine sand and left pebbles of a uniform size. It may be that within the circle of these islands was a sheltered bay. Mr. Chamberlain has observed at a little distance back from the edge of the cliff, sandstone again covering the conglomerate and, in fact, the entire length of the quartzite, indicating a subsequent subsidence of the entire reef below the water.

At the point marked (5) on the map is a limestone quarry. It is horizontally bedded. All points of junction with the underlying rock are concealed, but it is plainly, at least, 100 feet below the Potsdam sandstone in place. Whether it is a local deposit in the Potsdam sandstone or is the Lower Magnesian limestone, I have not yet determined. The latter supposition requires an enormous erosion between the putting down of the Potsdam sandstone and the Lower Magnesian limestone. A number of fossils were secured, several cephalic shields of a trilobite, a *Pleurotomaria?* and others still more indefinitely known.

Another feature of interest in this region is the evidence of glacial action aside from the drift. At the point (3) on the map is an isolated hill of sandstone. On my visit the earth had just been removed from a large surface in order to quarry the rock. It was entirely smoothed and covered with glacial striæ. Their direction was N. 66° E. On the surface of the limestone previously mentioned, the polishing is even more perfect, and the striæ have the same direction. The only way I can explain this deflection from the usual direction is, that it was caused by the trend of the ridges. At the Glacial epoch, the erosion of the Baraboo Valley must have been as great as at present.

Mr. Canfield writes me: "The polished surface of quartzite that I especially mentioned to you, * * * showing probable glacial rubbing, was three-fourths of the way up the bluff in section 27. I also stated to you my convictions that the evidences of that character could be found all over the tops of the bluffs, within the glacial limit, which is east of the 'Lake of the Bluffs.' There is certainly a great deal of granitic debris piled upon the top of the bluffs."

Beloit, Wisconsin, Feb. 14, 1873.