ART. LIV.—*Transition from the Copper-bearing Series to the Potsdam;* by L. C. WOOSTER.

DURING the summer of 1883, some facts throwing light upon the relationship existing between these formations along the St. Croix River, Wisconsin, fell under my observation, and, though not new in kind,* they may be of interest to those who are endeavoring to find in the East a correlative of the Wisconsin Potsdam.

In northwestern Wisconsin the Potsdam sandstone has a total thickness, from the Laurentian granite below to the Lower Magnesian limestone above, of about one thousand feet. There are two horizons in which fossiliferous remains are especially

* See vols. i, and iii, Wisconsin Geological Reports.

abundant, viz: (1) the middle of the formation, and (2) the middle of the upper third.

At Osceola Mills, about four miles from the southernmost outcrop of the Copper-bearing or Keweenawan Series, the second of these two horizons is found at an elevation of about 100 feet above the level of St. Croix River, and presents a somewhat peculiar though characteristic fauna. Some of these layers are exceedingly porous and friable, and yet they contain casts of *Holopea Sweeti* and a Bellerophon in great abundance. Were it not for the Potsdam trilobites and brachiopods in these same layers, one might well imagine that he was gazing upon a *Trenton* sandstone. But, a few feet below these layers all evidence of life ceases and one looks in vain for a fossil down to the water's edge. While closely examining these lower layers at Osceola, I was greatly interested in the discovery of several pebbles in the sandstone evidently derived from the Keweenawan series at the northward. The sandstone here became variable in color and hardness, being on the whole darker and in certain places exceedingly compact, or as Capt. Knapp expressed it, baked. But no fusion or evidence of heat from steam-holes was present.

The government force engaged in building dams on the St. Croix under the supervision of Capt. Knapp had, the previous winter, dug into a most curious deposit on the Minnesota side of the river, about four miles north of Osceola and near the outlying outcrops of Copper-bearing rock. Under the guidance of Capt. Knapp, the locality was visited late one afternoon, and the "most curious deposit" was found to consist of "trap" conglomerate. The conglomerate composed a ridge which stretched to the westward from the river bank to the bordering ledge of sandstone one-fourth of a mile back. The river end of the ridge is about fifty feet in height and one hundred feet in breadth at its base. The component bowlders, bowlderets and pebbles of the conglomerate varied in size from those at the base of the exposure thirty inches in diameter to the finely comminuted material at the top where the rock might with propriety be called sandstone. All the bowlders were highly altered, so that Capt. Knapp could see little resemblance between them and the hard, resistant and apparently unchanging "trap" bowlders and ledges with which he was familiar. But after much search a bowlder was found near the base of the exposure with an *unchanged* center of "trap." The matrix of this conglomerate consisted of the same material as the imbedded bowlders. Here and there in all parts of the exposure this matrix contained fragments of linguloid shells, apparently *Lingulepis pinniformis*. Many cavities in the matrix and in the bowlders were lined with quartz crystals. Not the slightest evidence of

heat was discovered, all the alterations being evidently the work of infiltrating waters continued through countless ages.

Conclusions: 1. The material of this conglomerate, all being more or less rounded, and the shells, being without exception fragmental, must have been subjected to violent wave action along cliffs of Copper-bearing rock at this exposed point of the ancient (not to say Archæan) island. 2. There was some evidence to show that this fifty feet in depth of conglomerate not only graduates into sandstone above, but also on each side. Hence the ridge may mark the mouth of a primordial mountain torrent. 3. The age of the deposit seen must be late Potsdam since it graduates into sandstone of that age.

4. This conglomerate is not exceptional, since the Potsdam is conglomeritic along its shore margin in Wisconsin, and on the St. Lawrence River in New York (as seen by the writer). This conglomerate is well shown in the vicinity of Laurentian granite at Chippewa Falls and Eau Claire, Wisconsin, and near Oak Point eighteen miles above Ogdensburg, New York. Hence the Keweenawan or Copper-bearing rocks were subjected to the same erosive and denuding agency, whatever that may have been, which broke off and transported to the sea-shore portions of Laurentian and Huronian ledges. In Wisconsin, only the lower layers of the Potsdam may, at the present time, be seen in contact with the Laurentian and Huronian rocks, except around the islands of quartzite and quartz-porphyry in southeastern Wisconsin. Here the conglomerate is uniformly present and presents phenomena analogous to that just described on the St. Croix above Osceola. 5. The Keweenawan series is older than, unconformable with, and has supplied much of the material for, the Potsdam sandstone.

These conglomerates bordering the Laurentian, Huronian and Keweenawan areas must have supplied a large part of the bowlders of the drift deposits of the Northern States.