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THE AGE OF THE NEPEAN (POTSDAM) SANDSTONE IN EASTERN ONTARIO

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ABSTRACT. The Nepean sandstone forms the basal formation of the Paleozoic sequence in eastern Ontario and is made up of nearly flat-lying clastic sediments ranging from conglomerate to orthoquartzite. Most workers correlate these rocks with the Potsdam formation of New York State, which is regarded, on faunal evidence from the eastern part of the state, to be Upper Cambrian in age. In Ontario the gradation of the sandstones into the overlying Lower Ordovician (Beekmantown) sediments suggests that the Nepean formation may be of Ordovician age. Using the evidence that the Paleozoic seas invaded eastern Ontario from the southeast, that the fossiliferous formations overlying the sandstones cross the Cambrian-Ordovician time boundary in New York State before reaching Ontario, and that Ordovician fossils have been found in one locality in Ontario in the Nepean sandstone, it is concluded that the formation is of Ordovician (Beekmantown) age in most of the area. East of the area under discussion, in the Province of Quebec, an unconformity separates the sandstone into two units, the lower of which is likely Cambrian in age. The Nepean and Potsdam formations and the sedimentary rocks overlying them show the transgression of a sea from Upper Cambrian to Lower Ordovician time in eastern New York State and eastern Ontario. The sea invaded over rough topography of the Precambrian rocks and, except for an area in the Province of Quebec, there was no break in sedimentation between the Cambrian and the Ordovician.

Geologists have long disputed the age of the Nepean sandstone of eastern Ontario. Most early workers believed the formation to be of Cambrian age and correlated it with the lithologically and stratigraphically similar Potsdam formation of adjoining New York State, which was also thought to be Cambrian in age. However, as pointed out by Wilson (1946, p. 16, 17), the formation is conformable and gradational with the overlying Lower Ordovician rocks and may therefore have been deposited at the beginning of the Ordovician period. A final answer to the question of age of the sandstone can be made only if a good distribution of fossils of known, limited ages can be found in it. Unfortunately, such material is extremely rare in these rocks, so that conclusions must be somewhat tentative.

The Nepean sandstone is a well bedded, nearly flat-lying, cross-bedded and ripple-marked, buff-weathering quartz-grain sandstone, the grains of which are often cemented by silica to yield a remarkably pure orthoquartzite. Calcite-cemented, ferruginous, argillaceous, and feldspathic varieties are also known, and a basal conglomerate is normal. It is defined (Wilson, 1946, p. 10) as that sandstone that underlies the March formation of dolomite and sandy dolomite, of Lower Ordovician (Beekmantown) age. It is widely distributed throughout eastern Ontario and unconformably overlies the igneous and metamorphic rocks of the Precambrian to form the basal member of the Paleozoic sequence in the area. Its basal conglomerate and gradational contact with the overlying, marine March formation, as well as the presence of certain fossils, indicate that the sandstone is for the most part a marine deposit, although there is evidence that some of it was wind-laid. Thicknesses are of the order of 50 to 300 feet, but the formation thins northward and westward to zero near the towns of Arnprior and Perth, Ontario. Exceptional thicknesses have been reported in the vicinity of Montreal and in New York State by Fisher (1956, p. 325: 1500 feet), DeBlois (1959, p. 119: over 1962 feet), Clark (1952, p. 22: 1696 feet), and others. These thicknesses probably represent the filling-in of great depressions in the Precambrian topography, but they may be due to postdepositional

faulting. The top of the Nepean formation is defined as the bottom of the March formation, which begins at the first dolomite bed above the base of the section.

Fossils, except for some problematical ones and the inconclusive *Lingulepis acuminata* Conrad, are extremely rare in the formation, but a few important discoveries have been made. Fisher reports (1956, p. 325, 339) that, in northeastern and central eastern New York State, Upper Cambrian faunas have been found in the Potsdam sandstone and that in the central eastern part of the state it is overlain by the Theresa formation (or its equivalent), also containing Upper Cambrian fossils. These fossils include, in the Theresa (p. 344): *Berkeia saratogensis, Camaraspis* sp., *Elvinia ruedemanni*, and *Foralites* and, in the Potsdam, *Elvinia, Berkeia, Ptychaspis, Prosaukia, Komaspidella, Lonchocephalus, Climachtichnites*, and *Protichnites*, some of which are problematical. Northwestward, the Theresa formation—which is equivalent to the March formation in Ontario—crosses the boundary between the Cambrian and Ordovician periods and contains the Ordovician forms *Ophileta hunterensis, Ecculiomphalus*, and *Sinuopea* (Fisher, p. 344). Farther west the underlying Potsdam sandstone may also cross this boundary, but proof—at least in New York State—is lacking. In Ontario the March, or Theresa, formation is mapped as Lower Ordovician (Wilson, 1946, p. 9; Clark, 1952, p. 13). The observed sequence of sandstone overlain by dolomite is indicative of a transgressing sea, as is the crossing of the Cambrian-Ordovician time boundary by the Theresa rocks. That this boundary was crossed toward the northwest in northern New York State indicates that the transgressing sea moved into eastern Ontario from a southeasterly direction and that the rocks in the northwestern part of the area are younger than lithologically equivalent rocks in the southeast.

Although Lower Ordovician throughout the area, the March beds and the rest of the Beekmantown rocks contain, as might be expected, "older" fauna in the eastern part of the basin than in the western part (A. E. Wilson, personal communication). As it is also known that the underlying sandstone is in gradational contact with the March formation and that the sea transgressed from the southeast, the sandstone must be of Ordovician age, at least in the western part of the area. Proof comes from a fossil find made by M. L. Keith in shaly layers in calcareous sandstone southwest of Brockville, Ontario, which was mapped as Potsdam by early workers (Baker, 1922, map 31c; Wright, 1923, map 1964) and more recently as Nepean by Wilson (1946, map 852A). The fossils, *Raphistomena canadensis* Billings, *Raphistomena calcifera* Billings, and *Eccyliopterus disjunctus* Billings, are all of Beekmantown age (Keith, 1949, p. 8).

One of the more important features of the sandstone is the presence of one or more unconformities or disconformities within it. R. S. Dean (personal communication) describes an unconformity southwest of Montreal. Wright (1923, p. 37) notes one near Brockville, and Cushing and others (1910, p. 62) found one in the Thousand Islands area in New York State. Dean's unconformity is of particular interest because it is near the top of the sandstone sequence, has been mapped over several miles, truncates a considerable thickness of the formation, and has been found in the general area of unusually great thick-

nesses of the sandstone. There is evidence that the sandstone under the unconformity, which Dean correlates with the Potsdam, supplied sand to the overlying sandstone, which he includes with the March formation, and was lithified before the overlying material was deposited. The unconformity is difficult to detect, and it is likely that material both above and below it have elsewhere been mapped as Nepean or Potsdam. In all probability it represents the division between the Cambrian and Orodovician in the area southwest of Montreal, but it is not known if it extends into Ontario or New York State or can be correlated with the unconformities observed by Cushing and Wright.

A tentative history of the area during early Paleozoic time may be made. Drill hole records indicate that the Canadian Shield had fairly rugged topography with relief exceeding 3300 feet at the time the Paleozoic seas invaded it. There is some evidence that it was covered by a deep regolith at that time, although this may have developed much later due to weathering from substratal water after consolidation of the Paleozoic cover. During Upper Cambrian time the sea, which advanced from the area near Lake Champlain, flooded the area southwest of Montreal and northeastern New York State where it deposited sand in deep valleys in Precambrian rocks. This sea may also have left deposits in the Thousand Islands area and near Brockville. Toward the end of Cambrian time the sea withdrew from the eastern Ontario and Montreal areas but appears to have continued to progress in a northwesterly direction across New York State, with no break in sedimentation until Ordovician time. At the beginning of the Ordovician, eastern Ontario was again flooded from the southeast, and much of the Nepean formation was deposited as well as the overlying Beekmantown sediments. These deposits cover the area referred to as the Ottawa-St. Lawrence Lowland, which extends east of the Frontenac Axis and north to nearly 46° latitude. Before the end of Beekmantown time the seas withdrew and did not return until well into the Middle Ordovician (Wilson, 1946, p. 7).

Although considerable geological work has been done in eastern Ontario and New York State, it is hoped that future work will be of sufficiently detailed nature to yield more fossil finds in the Nepean formation that will add to our knowledge of the history of the early Paleozoic in the area.

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