

GASTROLITHS FROM MINNESOTA.*

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ABSTRACT. The Dakota formation is represented by conglomerates, sandstones and shales extending eastward into southern Minnesota. Some portions of these contain smooth and highly polished pebbles that are believed to be gastroliths. They seem to suggest the presence of dinosaurs on this part of the continent during the Cretaceous.

INTRODUCTION.

DURING the late Paleozoic and early Mesozoic much or all of Minnesota appears to have been a land area that was undergoing erosion, deep weathering, or extensive leaching and solution of its limestone areas. The deeply weathered Precambrian, and the old residual iron deposits now found on top of the Paleozoics, may have been formed largely during that long interval of emergence from the late Paleozoic and early Mesozoic seas. With the beginning of the Cretaceous, however, sedimentation began over parts of what is now the state and a more detailed recording of major events was restored once more. During this time the land areas probably were suited to terrestrial inhabitants and undoubtedly such forms roamed over the Minnesota region.

THE DAKOTA FORMATION.

Sandstones and shales representing the Dakota formation extend into Minnesota and have been identified by their well preserved flora. A meager molluscan fauna also suggests the same age for these deposits. Eastward the Dakota wedges out against older rocks of the central and eastern parts of the state. At New Ulm the formation is chiefly a sandstone but it contains conglomerates, shales and even thin streaks of lignite. Still farther to the east the conglomerates become somewhat coarser and constitute a larger proportion of the formation. In Olmsted, Mower and Fillmore counties some of the pebbles are quite large and many of them are chunks of rock of cobblestone size or larger. Most of these latter are flint or chert nodules that have weathered out of the underlying rocks, hence have not been carried very far. In fact

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many of them are not even marked by erosion and their surfaces still show well preserved fossils of the formations (chiefly Devonian) from which they were derived.

THE OSTRANDER MEMBER.

The old gravels, lying below the loess and the drift of the southeastern region, are yellow to brown from the great quantity of iron oxide associated with them and the thin film of the same oxide that partly covers the pebbles, but the pebbles themselves are white to pink quartz with flint and chert running a close third. Most of this iron within the conglomerate and associated with the pebbles or forming the cement, may have been derived from the residual iron of the old weathered surface below. In the southeastern region, particularly in Mower and Fillmore counties, these poorly cemented conglomerates or gravels take on much importance and have been widely used for surfacing secondary roads. Gravel pits in the formation are numerous and these beds have been named the Ostrander member¹ of the Dakota formation, from the pits near the town of that name in southern Fillmore county. These yellow conglomerates or gravels should not be confused with the yellow glacial gravels, carrying numerous igneous pebbles, occurring in the same region and that have materials in part derived from the Ostrander.

GASTROLITHS.

The pebbles in the gravels or conglomerates of the Ostrander member are well worn and some are smoothed or even polished by water action. Scattered among the common pebbles of the gravels, however, are larger ones, mostly chert, that are highly polished and at once suggest a somewhat different origin from that of the more usual ones. These highly polished pebbles are angular to subangular and rounded forms weighing up to four or more ounces. The polish is uniform over the whole surface and tends to extend into the pitted areas as well. The origin of these larger and highly polished pebbles is a problem quite aside from that of the residual chunks mentioned, or the origin of the water-worn quartz and flint pebbles that constitute the major part of the conglomerate. In most gravel pits opened

¹ Stauffer, Clinton R., and Thiel, George A.: 1941, Minnesota Geological Survey, Bull. 29, 103.

in this poorly cemented Ostrander member these objects are not very common but in the pits and road cuts on the low ridge south of Bear Creek, near Racine, Mower county, they are fairly abundant. At least it is a place where one might be reasonably sure to find a few. Careful search, however, will reveal them in nearly every pit where the Ostrander gravels are actively worked.

The transportation or agitation of small pebbles and sand grains in water may produce smooth surfaces, which, in the case of sand and small quartz pebbles, may approach a polish. That appears to be the cause of the smoothness of many of the ordinary pebbles of the Ostrander but it does not seem to apply to the high polish of the larger ones. The idea of dust polishing suggested itself as a possible explanation of the smooth surfaces of these pebbles. Ventrifacts are often well polished on the exposed surfaces and since it is easily shown that under certain conditions the pebble frequently may be turned completely over, such polish may cover the entire surface. Wind wear and polish may produce the characteristic unikanter or einkanter and the dreikanter shapes so well known in dry or arid regions. The polished surfaces of such ventrifacts are likely to be "distinguished by their well-smoothed, fine matte surface and shallow irregular pitting,"² but none of these attributes seem to apply to the smoothed and polished Ostrander pebbles of southeastern Minnesota.

The first of these pebbles was found by Mrs. Stauffer while we were working along a hillside adjacent to Highway No. 63 some four or five miles southwest of Lake City, Wabasha county, during the summer of 1937. Later they were found from Goodhue and Bellechester on the north to Etna and Cherry Grove on the south and in nearly every exposure of the Ostrander gravels. Always they are the hard flint, or quartz pebbles with an occasional stray that may be a banded jasper. Many of them may be located stratigraphically by their petrographic composition. Thus the first one found, or the one from a point near Lake City, is a piece of oölitic chert from the Shakopee formation. It is very highly polished and beautifully preserved. Others carry Devonian fossils and their horizon is thus determined.

² Smith, H. T. U.: 1940, State Geological Survey of Kansas, Bull. 34, pl. 10.

See also Baker, A. A., Dane, C. H., and Reeside Jr., J. B.: 1936, United States Geological Survey, Professional Paper 183, 6, pls. 13 and 14.

The suggestion that these highly polished pebbles are gastroliths or gizzard stones of dinosaurs was one of the first conceived. A representative selection of the polished pebbles from a dozen or more Minnesota localities was compared with a handfull of gastroliths from the Trinity beds of Texas and another from the Morrison beds of Wyoming and still another handfull from the Morrison beds of Utah with most interesting results (Plates 1 and 2). Every feature shown by the pebbles from the plains and mountain states are present in the specimens from the Ostrander beds of Minnesota. In fact when they were placed side by side it was impossible to distinguish any of them from the others. A dozen or more of the Ostrander pebbles were taken to a recent meeting and were exhibited to various members of the Paleontological Society. Everybody who saw them pronounced them gastroliths, although there was some hesitancy when told the specimens came from Minnesota. The fact is no finer collection of gastroliths can be made anywhere than in southeastern Minnesota. There is no intention to attack or discuss the interpretation of gastroliths as the gizzard stones of ancient reptiles. The point is that here on the prairie in the Mississippi Valley, almost adjacent to the river, there are pebbles in an outer edge member of the Dakota formation that answer to the description of gastroliths and match those from widely separated regions. They are probably as truly gizzard stones as any found anywhere in the United States.

To date no skeletal remains of dinosaurs have been found in the state, but the life conditions that are suggested by the Ostrander deposits are quite similar to those that must have prevailed farther to the west during the Morrison, and the land area now Minnesota doubtless was then a suitable habitat for the dinosaur and hence it probably was inhabited by the reptilian hordes which we know were then roaming other parts of the continent. The Cretaceous sea that spread over other parts of the state a little later (Benton) had its marine reptiles and they have scattered their remains over the Mesabi district. Probably then too the adjacent shores teemed with reptilian life, although no certain evidence has been identified. Unfortunately in the north the glaciers did a rather thorough job of erasing the Mesozoic, and the drift has all but completed the task of burying the remnants too deeply for easy access.

CONCLUSION.

The highly polished pebbles of Dakota age in southeastern Minnesota are probably gastroliths. If gastroliths are gizzard stones and mean the presence of dinosaurs, it seems certain that Minnesota was a part of their range during the Ostrander stage at least. Hence one may expect that sooner or later reptilian remains will be found in the remnants of the Dakota formation in Minnesota.

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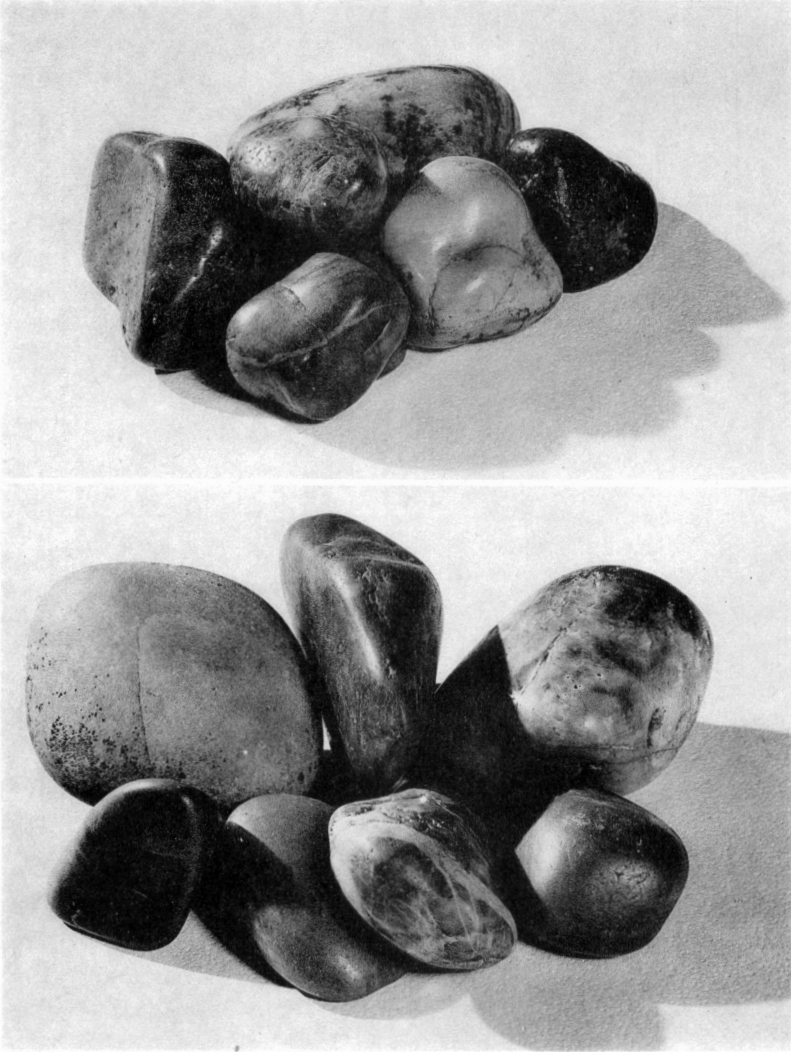


Fig. 1 or upper ($\frac{1}{2}$ natural size).

Gastroliths from the Morrison beds at Kane, Big Horn Basin, Wyoming.

Fig. 2 ($\frac{1}{2}$ natural size).

Gastroliths from the Trinity sand at Cross Cut, near Cross Plains, Texas.

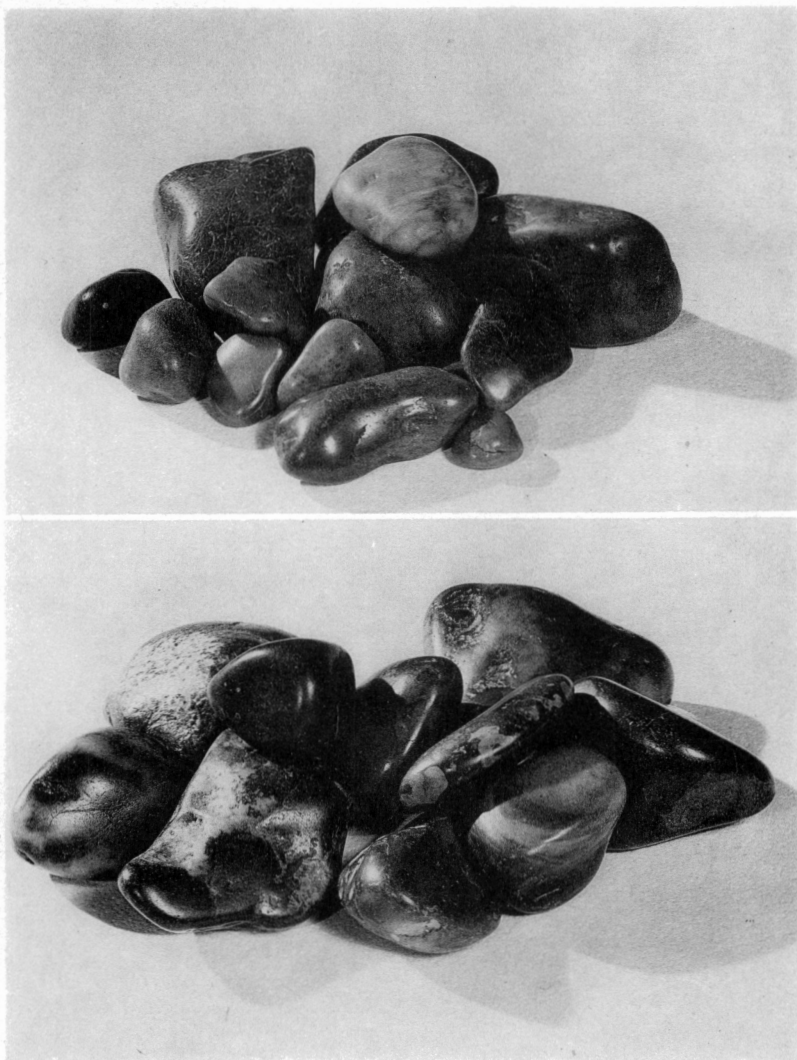


Fig. 1 or upper ($\frac{1}{2}$ natural size).

Gastroliths from the Morrison beds, Cleveland, Utah.

Fig. 2 ($\frac{1}{2}$ natural size).

Gastroliths from the Ostrander beds along Bear Creek, two miles south of Racine, Mower County, Minnesota.