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A PRELIMINARY EVALUATION OF DUBIOFOSSILS FROM THE POTSDAM SANDSTONE

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ABSTRACT

Preliminary results of study of a meter-long block of Potsdam Sandstone (Cambrian) from Malone, New York, indicate that the contained structures are not body fossils although the sub-cylindrical and sub-triangular morphologies of the 22-24 cm - long dubiofossils are very suggestive of once-living structures. Wall structure included four layered units, two of which are known only from the void that remains after their dissolution(?). The medial layer is of clay and silt whereas the outer layer is of medium and coarse quartz sand grains. All structures are curved and preserved in the stable, concave down position. It appears that the structures are mud curls, or clay rolls - "tonrollen," that have included two thin algal layers in their fabric. The algal layers were likely responsible for the quality of preservation of these unusual specimens.

INTRODUCTION

In 1992, during excavation at a residence in Malone, New York, a boulder of Potsdam Sandstone was brought to the surface and dropped, whereupon it parted on a bedding plane revealing remarkable structures of uncertain origin. Appearance of the boulder, and its proximity to another, coupled with local geomorphic setting, suggest that Potsdam Sandstone bedrock lies close by and that the boulder has not been glacially transported.

Local residents recognized the unique character of the specimen and alerted members of the St. Lawrence Geology Department. The owners subsequently permitted removal of the slabs to the laboratory in Canton for study. They have since been returned to the owner in Malone (Figure 1).

THE BOULDER

The boulder is a meter-long, trapezohedral slab of Potsdam Sandstone with length determined by joint or fracture plane and thickness by parting on parallel bedding planes

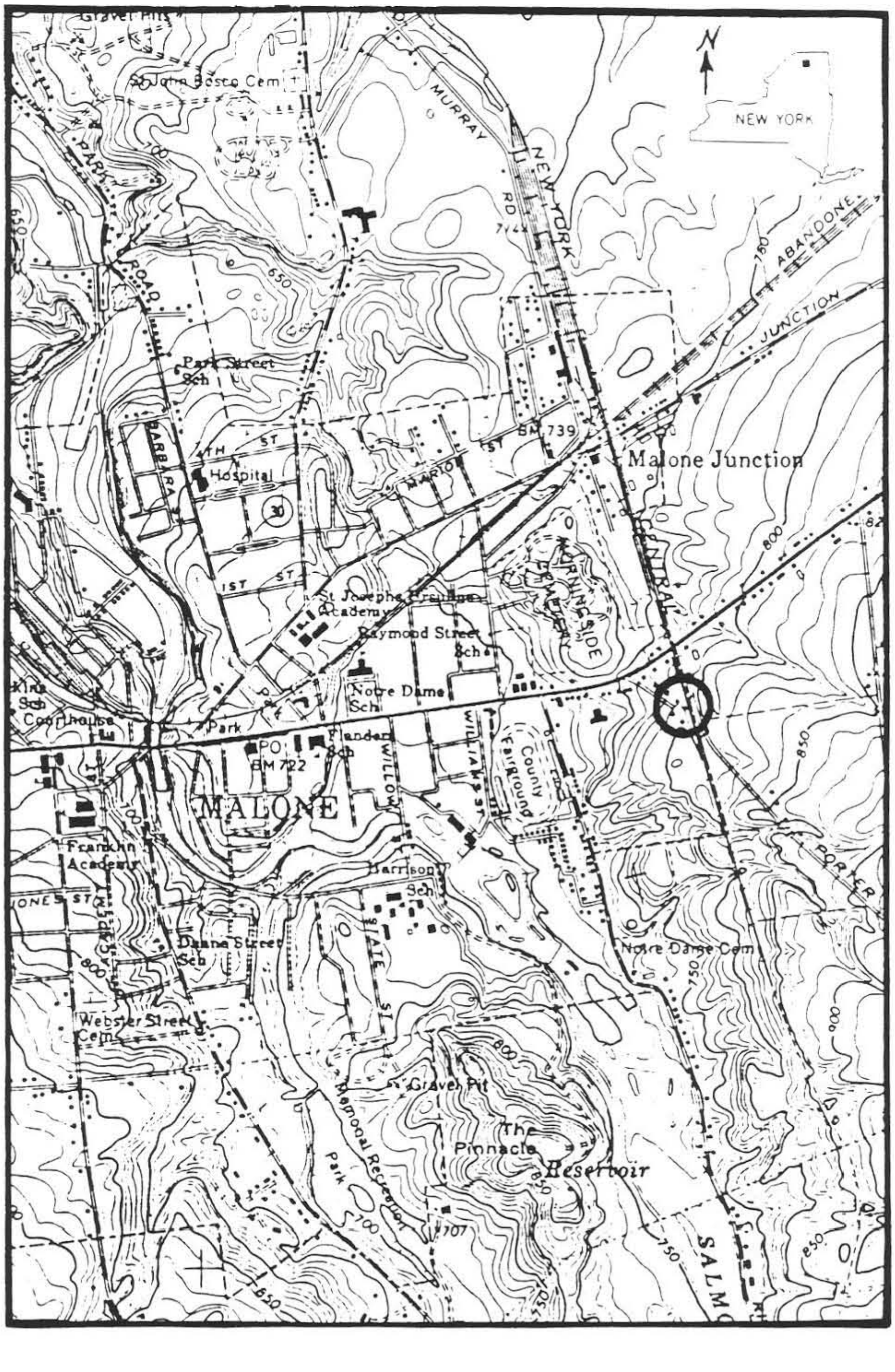

Figure 1: Portion of the U.S.G.S. Malone 71/2 minute topographic quadrangle indication the approximate location of discovery of the unusual Potsdam Sandstone specimen.

Figure 2: Lower parting surface of Potsdam Sandstone slab exposing enigmatic structures which occur as raised elements (or convex epireliefs) on this surface. Knife is 9.0 cm long.

Figure 3: Upper parting surface preserving structures as concave hyporeliefs in Potsdam Sandstone. Knife is 9.0 cm long.

approximately 45 cm apart. Edges are gently-rounded angles. It is composed of fine- and medium-grained quartz sandstone that is plane-laminated on a millimeter scale. Some laminae are colored by dark maroon hues presumed to result from hematite coatings on grains. The principal cement is silica.

Examination of cross-sectional surfaces indicates no cross-stratification present. Stratigraphic up is suggested only by some very tentative channeling that seems to cut out a few laminations. There are no trace fossils present. If correctly interpreted, the rock split on a bedding plane lying approximately 7.5 cm from the stratigraphic top of the slab when it was dropped. It parted to expose 35 concave, curved, sub-cylindrical to sub-triangular, dark maroon features on the lower surface (Figure 2). The counterpart, on the upper surface of the bedding plane, exposed the convex replica of the same features (Figure 3) with a few exceptions due to differences of parting fracture. All seem to have lain concave down.

THE STRUCTURES

The structures themselves show as much as 2.5 cm of relief when seen in cross-section on sides of the slab. Curved relief of approximately 1 cm is common for most bedding surface elements. They are gently curved throughout or relatively flat centrally with curved margins. Among the 35 individual elements no two are precisely the same, however, there are two or three general shapes that recur. Most obvious is the sub-triangular form (Figure 4) and varieties of it that seem to result from bending or breaking of triangular structures during deposition as seen in Figure 5. Elongate, sub-cylindrical forms (Figures 2 & 3) occur in several lengths and widths and some, likely incomplete, are nearly equidimensional. Forms are evenly distributed across the bedding plane and obviously extended beyond the confines of the slab at hand. Greatest length for both forms is consistantly between 22 and 24 cm. "Width" of sub-triangular types is between 12 and 15 cm based upon three specimens, one of which was a reconstruction.

Each individual displays, on part and counter part, a smooth, maroon-colored clay(?) surface, patterned with transverse grooves, or channels, that are presently filled with white, very fine-to-fine-grained sandstone matrix. Grooves are arrayed perpendicular to the long axis of each specimen and occur at rather regular intervals of 1.5 to 2 cm. On the sub-triangular forms these are intersected centrally by an axial pattern as well. Margins are smooth and all termini are rounded. There are no angular features excepting those that can be assigned to breakage during transport or burial.

Encasing walls, if wall is an appropriate term to apply to a feature that separates two deposits, do not close upon themselves, although some nearly meet and in one instance a wall rolls "inside" itself. The nature of the wall structure itself is of interest. When the parts were separated the wall material was lost. Consequently the features preserved are molds in most instances. On some specimens it appears the wall structure was missing on burial so that matrix adheres to matrix with no wall between.

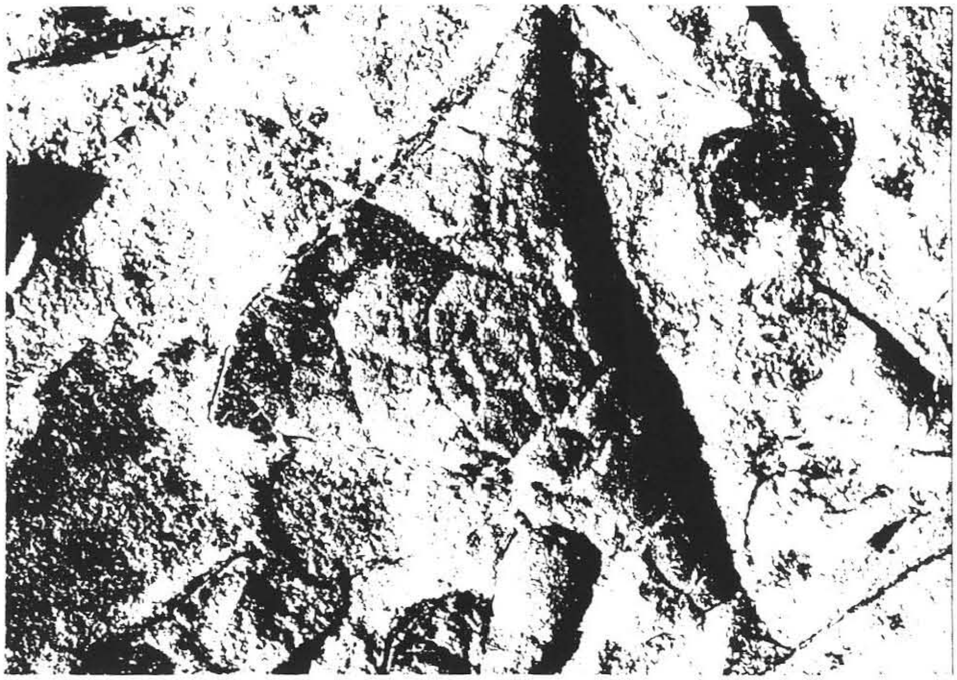

Figure 4: Sub-triangular element preserved as convex epirelief. Longest edge is 22 cm long. Note rounded tips and pattern of matrix-filled grooves resembling mudcracks.

Figure 5: Sub-triangular structure that has been centrally crushed and bent during deposition. Length of straightest margin, tip to bend, is 14 cm. Note spaces where wall layers were not preserved on this and adjacent structures.

THE WALL

Although not present over the surface, wall material is available where the structures are embedded in the sandstone. Specimens shown in Figure 5 display many of the pertinent relationships. Walls were approximately 1.5 mm thick and layered as indicated in Figure 6. Preservation shows the walls to have been three-layered, more probably four-layered, units, two of which are not preserved but appear

as voids (Fig. 5, 6). Between the missing layers was a layer of silt in a clay matrix (Figures 7 and 8). The outer surface of the structures seems to have been a layer of medium and coarse quartz sand one or two grains in thickness. These grains are embedded in a clay matrix and seem to show pressure solution on the portion of the grain directed toward the outer wall (Figure 9).

Perhaps the most puzzling, and potentially important, observation is that two layers have not been preserved. Each was approximately 0.5 mm thick, perhaps greater when fresh, and they seem to have been uniformly distributed over the surfaces of all forms because they are found universally around all intact margins. Complete coverage is, obviously, an inference. Voids imply the absence of layers due to non-preservation. Dissolution after induration is the probable cause because there seems to have been no collapse of matrix into the voids. What was the composition of these lost wall layers? SEM examination of surfaces of the preserved midwall did not reveal any structure or surface texture that might shed light on the nature of this missing material. Might it have been organic in composition?

COMPARISONS

The aspect of these structures makes them likely candidates for interpretation as arthropod exuvia. Discussions with Dr. Ellis Yochelson (oral communication, 1992), and Dr. Hans Hofmann (written communication, 1992) have pointed out that similar objects have been described as arthropod carapace fragments Tillyard (1936), "fossil-like" objects (Elston and Scott, 1972), and mud curls, or clay rolls (Voigt, 1972). Both Cloud (1973) and Hofmann (1971) have warned of similar structures that may easily be confused for fossils, but should be regarded as pseudofossils or dubiofossils (Hofmann, 1972) because they preserve no biogenic structure.

Preliminary comparisons with the literature show that pseudofossils from the Precambrian Troy Quartzite of Arizona illustrated on the cover of Geotimes by Elston and Scott (1972) are quite similar in form. These are re-illustrated in a discussion of pseudofossils in Häntzschel (1975, p. W169). No triangular elements are defined in that specimen, but sub-cylindrical forms are quite similar to those on the Malone specimen.

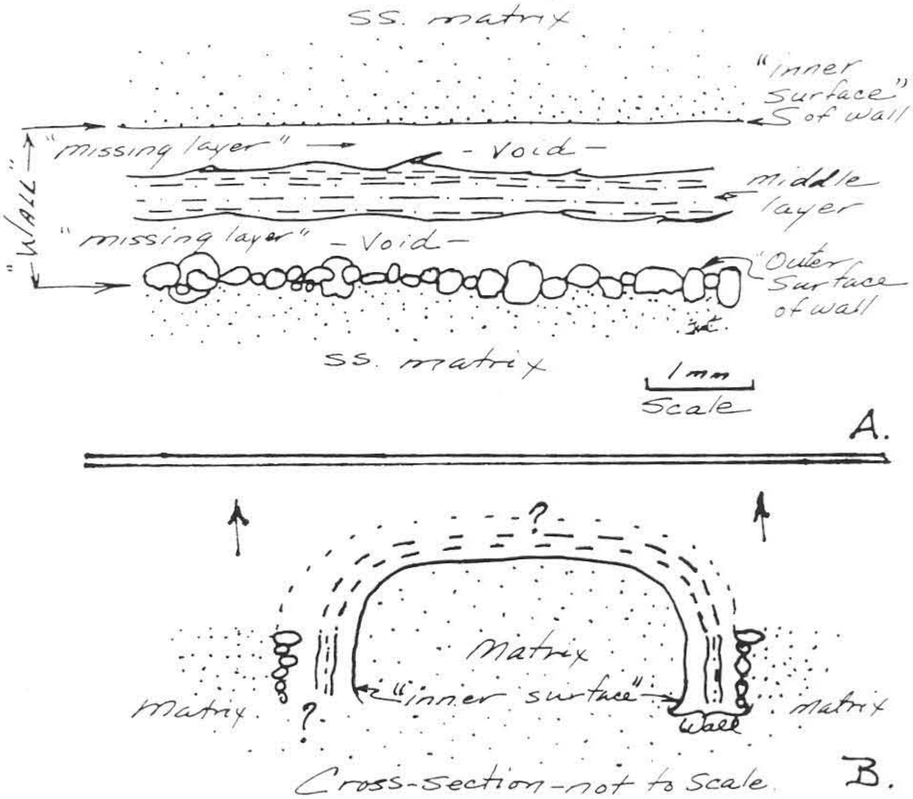

Figure 6: Sketch of wall structure (A) and relationships of wall layers with reference to stratigraphic up (arrows) on a cross-section of Malone dubiofossil specimens (B). "Depositional up" of the proto-wall mud layers was likely coarse-layer down.

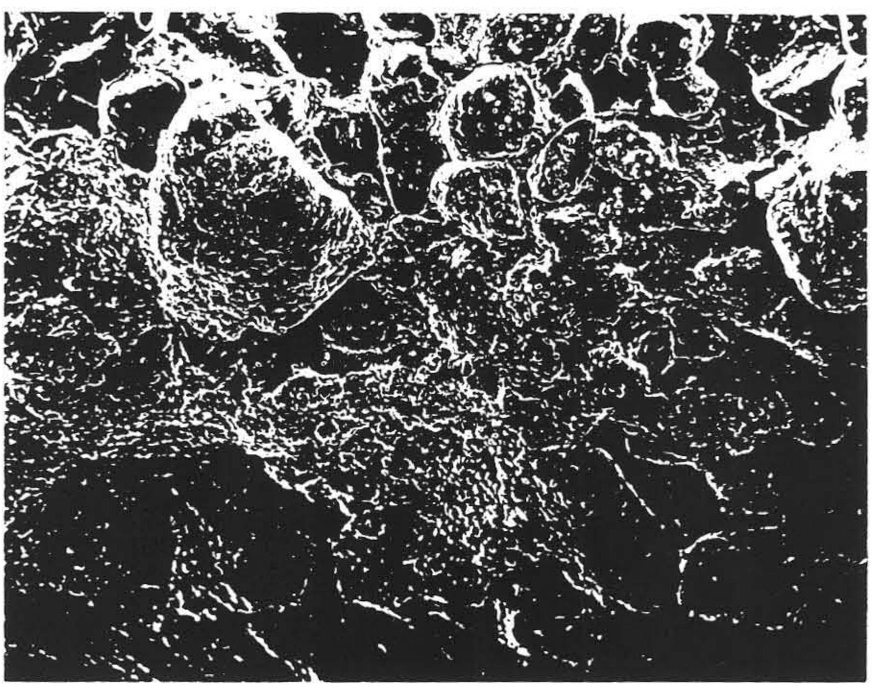

Figure 7: SEM photomicrograph of the outer (depositionally upper) surface of the middle layer of clay-covered silt grains. Magnification 470X.

Figure 8: SEM photomicrograph of clay from the inner surface of the middle layer. Magnification approximately 7,500X.

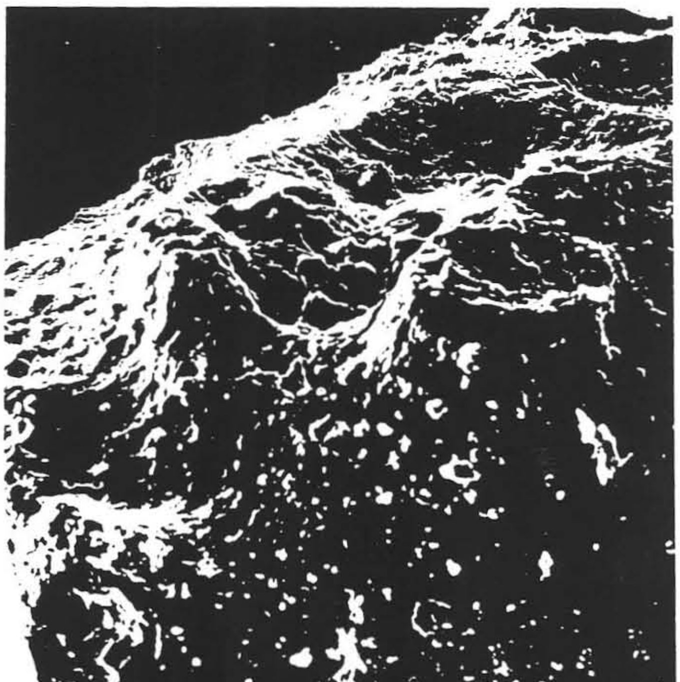

Figure 9: SEM photomicrograph of portion of the surface of a single grain of coarse quartz sand plucked from the outer edge of the wall. Note elongations and grooves. Although interpreted as a pressure solution surface, this may represent secondary silica cement coating the grain. Magnification approximately 1,300X.

INTERPRETATIONS

Repetition of general forms, rugosity and continuity of surfaces, even the degree of separation on the bedding plane, all contribute to the impression that these structures are organic remains. Their study was approached as a test of the hypothesis of an organic origin. Observations were made as if an investigation of skeletal elements and organismal morphology were being conducted.

No morphological features assignable to mesozoan or metazoan invertebrates were recognized. Specific shapes were not repeated, although general shapes recur as noted above. Wall structure preserves only inorganic materials and structures. A medial clay layer seems to verify that clay rolls, or "tonrollen", are the objects in question. It appears that a multi-layered clay drape was desiccated on a Potsdam Sandstone tidal plain. An incoming tide, or some similar rising water event such as a storm surge, brought water to gently mobilize portions of a clay layer that had rolled as it dried.

In Spring of 1993, Yochelson and I performed a simple experiment using exact morphological replicas of individual specimens from the Malone slab in a recirculating flume. Aluminum foil replicas were picked up and carried easily when concave up, but were forced onto the bottom by the current when they rolled into the concave-down position. In this position they were very stable and were readily covered by migrating ripples. It appears that the specimens occur in the rock in the stable position which is in accord with earlier observations about orientation of the boulder. Their interpretation as clay rolls seems a possibility.

Presently, the best interpretation is that they are interesting, non-biogenic structures. This is not to say that further examination, or better yet an alternate interpretation, may provide other insights in the future. Certainly, some questions remain unanswered. Why were two layers of the curls missing? What has been lost from those layers of the specimen? Why are there no desiccation cracks in the termini of any specimens? How far have they been moved before deposition?

Elston (1975, *in* Häntzschel) apparently noted a relationship between algae and the rolled specimens in the Arizona samples. It seems very likely that algae actively bound the layers together in the Malone specimen as well. After close examination it appears that the two layers missing from the framework of the wall were biogenic. These layers were probably made of closely "woven" algal mats. Such structures aided the clay to be flexible yet sturdy and thus to withstand transport more readily. Precise paleoenvironment of origin and deposition have not been determined as yet.

Presence of similar structures in Late Precambrian and Cambrian rocks in several parts of the world implies that similar conditions existed in those regions. One may wonder why no occurrences of these inorganic(?) structures are described from younger rocks? Could it be that conditions for forming these structures were constrained temporally? Perhaps bioturbation has been responsible for not permitting algal mats to be preserved extensively, and perhaps bioturbating organisms destroy algal mats by either eating them, or simply by breaking them up a great deal so they are destroyed by current action. Has such biologic action kept these dubiofossils from appearing in the rock record after the Cambrian? Might their absence from post-Cambrian rocks hold information about the evolution of, or developments in, feeding styles?

More discoveries of these unique structures will have to be made in other units before their exact relationships become understood. Presently, they must be considered curled algal mats with interlayered mud built up on a bed of sand lamina. Hofmann's (1972) term "dubiofossil" is an appropriate assignment.

ACKNOWLEDGMENTS

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