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Pseudo-organic Structures from the Precambrian Bass Limestone in Arizona

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ABSTRACT

Pseudo-organic structures from the Precambrian Bass Limestone of the Grand Canyon National Park, Arizona are described and illustrated. Certain of these are very similar to the "organic remains" described by Alf (1959) and Glaessner (1969). Although it is difficult to ascertain the true nature of these structures, none can be considered definitely organic.

INTRODUCTION

Alf (1959) described and illustrated supposed organic remains from the Precambrian Bass Limestone of the Grand Canyon National Park in Arizona. These remains he interpreted as jellyfish-like, sponge-like, and worm-like organisms. Cloud (1968) critically reviewed all reported Precambrian organisms of dubious age and nature and dismissed Alf's fossils as inorganic structures. He compared Alf's first jellyfish-like structure to structures produced by gas release from sediments or by compaction of soluble objects. Alf's second jellyfish he believed to be the preservation of Precambrian raindrops. Cloud assumed Alf's sponge-like structure to be a silica nodule and his worm-like structure to be a dubious sedimentary structure.

Glaessner (1966), however, considered that Alf's first jellyfish may be an impression of gelatinous sheaths of colonies of Cyanophyta on bedding planes. Glaessner (1969) refigured Alf's jellyfish and compared it with an illustration of a recent diatomaceous alga. It

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appears that a controversy over the nature of these objects exists, and an addition to the discussion is presented here.

The Bass Limestone of the Grand Canyon is now easily accessible either by rubber rafts or by helicopters, and, therefore, can be restudied in greater detail. In the summer of 1968 certain structures were collected from the Bass Limestone (fig. 1) about 20 miles down the Colorado River from Alf's (1959) site. The present paper is a preliminary notice of certain pseudo-organic structures, none of which, however, are organic, that were collected during a brief field trip to the Grand Canyon area.

STRATIGRAPHIC POSITION

The Proterozoic of the Grand Canyon National Park has been designated Grand Canyon Series by Noble (1914). The Grand Canyon Series is approximately 12,000 ft. thick and consists of two sedimentary groups: the upper—the Chuar Group, and the lower—the Unkar Group. The Unkar Group consists of the following five formations in ascending order: Hotauta Conglomerate, Bass Limestone, Hakatai Shale, Shinumo Quartzite, and Dox Sandstone.

In the Grand Canyon, the Hotauta Conglomerate overlies the Archeozoic Vishnu Schist and varies in thickness but does not exceed 6 ft. It is a highly arkosic conglomerate without any evidence of sorting and remnants of the Vishnu Schist are easily recognized in it.

The Bass Limestone conformably overlies the Hotauta Conglomerate. The type section of the Bass Limestone is in Bass Canyon. The total thickness of the formation exceeds 300 ft. Noble (1914) measured the section and divided it into four units: 1) a basal white limestone, 2) an argillaceous and calcareous red shale and limestone, 3) a white limestone, and 4) a blue slate and white limestone. The thickness of the individual units varies greatly from place to place.

The Hakatai Shale, which conformably overlies the Bass Limestone, represents up to 500 ft. of red shale and sandstones varying from argillaceous to arenaceous. The formation is relatively thin-bedded with abundant ripple marks, mud cracks, "worm burrows" (possibly sedimentary), and other minor sedimentary structures.

LOCALITY

The specimens described in this paper were collected from thin limestone lenses of the basal white limestone member. This is directly below the first major limestone ledge, under the ruins of the

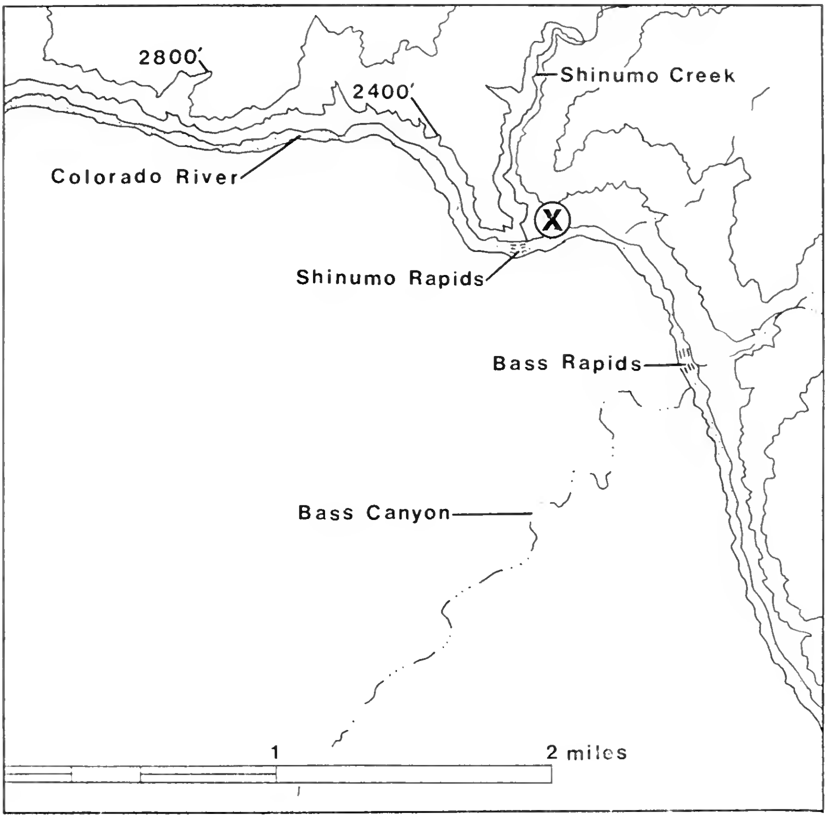

FIG. 1. Map of a portion of Grand Canyon National Park showing the collecting site (X). Only two contour lines, 2,400 and 2,800 ft., are shown on the north side of the Colorado River.

Indian cliff structures. The site is on the north side of the Colorado River between Bass Rapids and Shinumo Rapids, one-tenth of a mile east from Shinumo Creek (fig. 1). It is the first landing spot below the old Bass River crossing cable (mile 108 from Lees Ferry); Havasupai Point Quadrangle, Coconino County, Arizona.

DESCRIPTIONS OF PSEUDO-ORGANIC STRUCTURES

There are a number of distinct structures in the Bass Limestone, but none of these can be considered unquestionably organic. Siliceous nodules are relatively common but carbonate ones also occur. The formation is locally weakly metamorphosed and calcareous

FIG. 2. Three "biscuit" structures from the Bass Limestone. The edge of a larger biscuit is seen on the left.

slates and low degree marbles are present. In addition, the entire Grand Canyon Series is intruded with sills and dikes. Among the great variety of sedimentary and metamorphic bodies there are six kinds of structures that are discussed here: 1) stromatolites, 2) small concretions (fig. 3), 3) large concretions, 4) "biscuits" (fig. 2), 5) microscopic forms, and 6) branching structures (fig. 4).

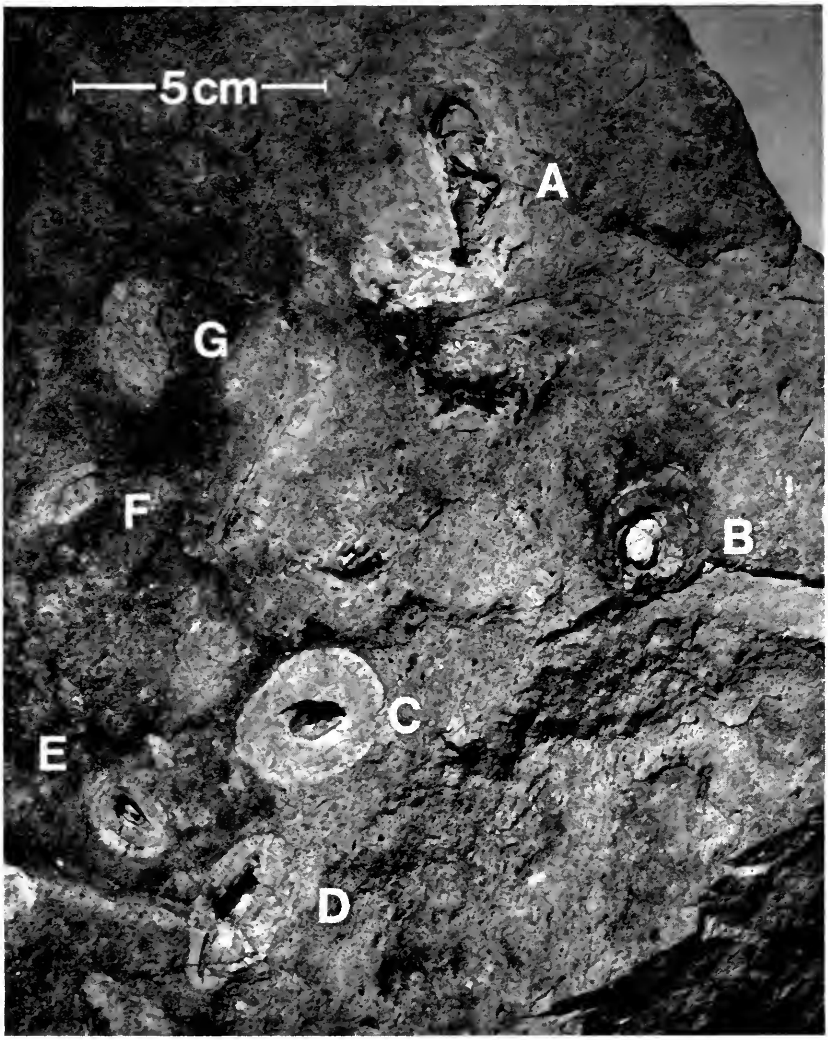

FIG. 3. Small siliceous concretions from the Bass Limestone. A and G: irregular; D, E, and F: ovoid; C: spherical; and B: double-walled.

1. *Stromatolites:* Glaessner (1966) pointed out "that stromatolites are products of organic growth and therefore [are] fossils. They are, however, sedimentary rather than 'organic' . . . structures" (p. 31). The stromatolites in the Bass Limestone are of various sizes; the more frequent sizes are between 3 and 5 cm. across. These

FIG. 4. Branched structures from the Bass Limestone.

are commonly observed on weathered-out blocks of limestone now forming talus slopes and are smaller than stromatolites from the Upper Chuar Group illustrated by Ford et al. (1969, text-fig. 3).

2. *Small concretions:* Many concretionary structures are noted in the Bass Limestone; however, three kinds deserve special attention. These are small concretions (fig. 3), large concretions, and biscuits (fig. 2). Small concretions are either spherical (fig. 3c), ovoid (figs. 3d, e, f), irregular (fig. 3a, g), or double-walled bodies (fig. 3b).

It is very difficult to ascertain the true nature of these concretions. Thin-section analyses do not show any internal structure that would allow them to be considered organic. In certain of these concretions, difficult-to-photograph ghost structures are observed that resemble internal septa or rods. One concretion (fig. 3b) is a distinctly double-walled body with a central core but without any internal structure.

The interpretation of any concretionary body as organic is beset with difficulties. Concretions are here considered as spherical, nodular, or irregular bodies grown by accretion and present in any rocks, but most common in sedimentary rocks. It is possible that many sedimentary concretions are either altered organic matter or by-products of a complicated geobiochemical reaction which occurs when decomposition of organic matter begins (Berner, 1969). Most concretionary bodies, so common in rocks, are certainly not of organic origin. Uniform diffusion produces a concentric pattern away from the center and, if no convection cell sets up, rounded or spherical bodies result. Needless to say, orbicular forms associated with igneous or metamorphic rocks cannot be of organic origin. Clearly, deep mid-oceanic so-called manganese concretions are formed inorganically. Possibly the majority of concretions, so fascinating to paleontologists because of deceptive resemblance to organic structures, are of post-depositional origin.

3. *Large concretions:* Very large—up to several feet in diameter—flat concretionary bodies are observed. These, unlike the other concretions, are carbonate, distinctly discoidal, commonly with the upper side concave as if they were collapsed spheres. It is difficult to interpret these as organic or sedimentary or diagenetic in origin; however, no unmistakably organic details are observed. These concretions weather out of the lower part of the Bass Limestone and accumulate complete or fragmented on the slopes. Large discs have been misidentified as Indian grinding stones, and the central concavity has been misinterpreted for the grinding surfaces. The general shape and the size variation of these concretions are similar to stromatolites, but no distinct stromatolitic banding is observed.

4. *"Biscuits":* These are very interesting ovoid bodies that either stand out partially exposed in the matrix or weather out completely as free biscuit-like structures. They are slightly laminated and superficially similar to stromatolites. They are, however, generally much smaller, and all observed biscuits consist of silica and are not carbonates. Three such structures are shown in Figure 2. Intermediate sizes between large concretions and biscuits are found. The central

core, about half the size of the biscuit, is present. However, no organic morphologic structures are recognized.

5. *Microscopic forms:* When the biscuits are dissolved in hydrofluoric acid, abundant small pollen-like round bodies are observed. These are also present outside the biscuits in the matrix where, however, they are rarer. Whether they are parts of the biscuits cannot be determined. They are small spherical bodies, either complete or fragments. A certain amount of damage and wrinkling is observed. Their color is brown to yellowish and a membrane appears to be present. They are similar to the bodies of the same size from the Chuaria Shale described by Ford et al., 1969, as organic residue.

6. *Branching structures:* These are indeed very interesting structures even if most puzzling. The specimen shown in Figure 4 consists of a branched structure broken off at one end and very suggestive of an alga. The branches are almost leaf-like or sporangia-like, and the shape is reminiscent of a modern brown alga. However, no internal structures are present, nor are there any other indications allowing it to be identified with certainty as a body or trace fossil. It is also difficult to interpret it as a sedimentary or diagenetic structure.

CONCLUSIONS

It appears that Cloud's (1968) conclusions on the nature of Alf's sponges and worms are correct. The second jellyfish figured by Alf appears to be a concretionary structure. Almost identical structures have been collected from 1.4 billion-year-old arkosic sandstone in Johnson Shut-Ins State Park in Missouri. These Missouri structures appear to be almost like organic chambered individuals, however, careful examination shows that they are concretions.

The first jellyfish figured by Alf is similar to the structures referred to in the present paper as "biscuit structures" (fig. 2).

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