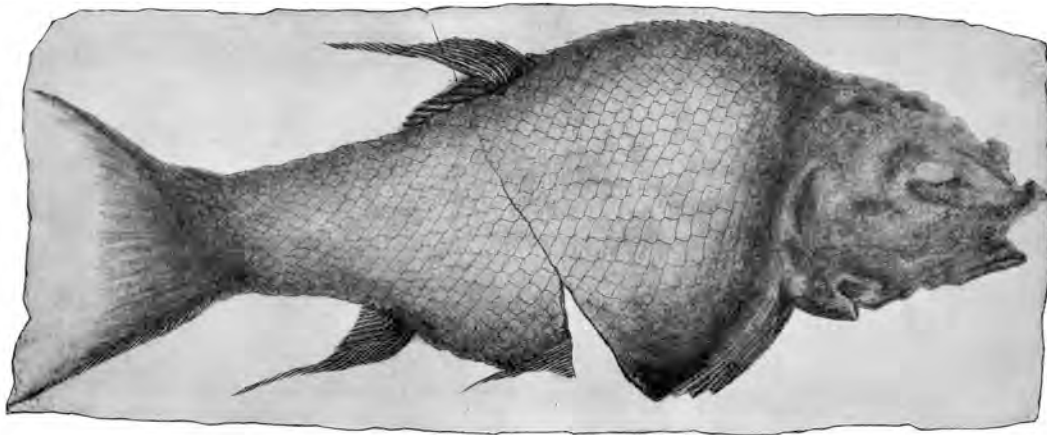


CONTRIBUTIONS TO THE PALEONTOLOGY OF NEW JERSEY (II)

FIELD GUIDE AND PROCEEDINGS

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**GEOLOGICAL ASSOCIATION
OF NEW JERSEY**

**XXIV ANNUAL CONFERENCE AND FIELD TRIP
OCTOBER 12-13, 2007
EAST STROUDSBURG UNIVERSITY,
EAST STROUDSBURG, PENNSYLVANIA**

STOP 5: GINGERBREAD CASTLE STROMATOLITES, HAMBURG, NJ

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***Collecting is not permitted at this outcrop.
Leave hammers in the buses.***

LOCATION

Hamburg 7.5 minute quadrangle.

This spectacular outcrop is on private property; permission to visit must be obtained from Diversified Communities. Hammering is not permitted (and would ruin the outcrop for future visitors).

Use caution on the outcrop; surfaces are steep and may be slippery. Excellent examples of features described may be seen at the base of each slope.

INTRODUCTION

This spectacular outcrop is of stromatolitic Allentown Dolomite (Middle Cambrian – lowermost Ordovician), a shallow water, nearshore carbonate that was periodically subaerially exposed. Dolomitization of the original carbonate preserved many of the original textures (Monteverde 2004). The outcrop consists of ‘whalebacks’ – roche moutonnées carved by glaciers, with the strata dipping to the northwest (Figure 1).



Figure 1. View of outcrop prior to present construction. Ground level is currently slightly lower and the right end of the outcrop has been removed, permitting examination of the outcrop in cross-section.

STROMATOLITES

Stromatolites are ‘discrete, in-place structures with recognizable boundaries that are characterized by “gravity-defying” internal laminae reflecting addition of material to a discrete surface’ (Demico and Hardie, 1994, p. 104). These cyanobacterial three-dimensional laminated structures first appeared ~3.5 Ga, peaking 1.65 – 0.65 Ga; they declined dramatically after the Early Ordovician, coinciding with the increase in epifaunal grazers and burrowers (Demico and Hardie 1994). They are generally classified as 1) laterally linked hemispheroids, 2) discrete vertically stacked hemispheroids or 3) discrete spheroids (Logan *et al.*, 1964). Combinational forms also exist. The term thrombolite (Aitken, 1967) was proposed for structures without discrete laminations. Stromatolites today form in a variety of settings, including shallow subtidal, intertidal and supratidal marine environments or in saline lacustrine environments. In salt ponds these features tend to be flat laminations instead of a more three dimensional feature (Cornee *et al.* 1992).

The stromatolites (Figure 2) observed at this site are of the discrete spheroidal type, which tend to correlate with higher energy environments. The higher energy environment is also reinforced by the many storm layers present throughout the outcrop (Figures 3, 4). These storm layers are rich in ooids .



Figure 2. Close-up of a portion of the uppermost bedding plane in the outcrop. In the center of the picture a collapse breccia is visible (see also Figure 3): material that fell into a cavity following minor dissolution. Immediately overlying this layer are mudcracked carbonates, visible in darker area in lower right portion of photograph; these indicate subaerial exposure at this time. Glacial striations are clearly visible in most of this photograph. Pencil for scale (adjacent to lower left stromatolite).



Figure 3. Oolitic layers; the lower darker-colored layer contains small ooids while the upper layer bears much larger ooids. Dark gray rip-up clasts occur near the interface of the two layers.



Figure 4. Edgewise conglomerate; pebbles are ripped up from underlying layers.



Figure 5. Cross-sectional view of a collapse breccia associated with dissolution of material in-between stromatolite mounds.

Additionally, these mounds appear to be cut by tidal channels and this can cause slumping that is filled by bioclasts and lithoclasts which were originally reworked desiccated tidal flat sediments (Figures 2, 5). Analogous conditions are presented by Wilson (1975) from the Late Cambrian algal mounds of central Texas (Llano Uplift) as well as other areas throughout the edges of the North American craton. The outcrop also includes desiccation cracks (Figure 2), which supposes an intertidal to even supratidal environment. Desiccation cracks are characteristically associated with microbialites in peritidal environments (Burne and Moore, 1987). Both cyanobacterial and algal mats can be responsible for the formation of desiccation cracks in dolomitic sediments in the modern tidal flats of the Bahamas (Mitchell and Horton, 1995).

Diagenetically, the outcrop shows extensive stylolites and fenestral porosity. Stylolites are pressure solution secondary sedimentary structures, while fenestral porosity and bird's eye structures are syndepositional structures mainly found in supratidal algal related mud dominated sediments (Moore, 1989).

PALEOENVIRONMENTAL INTERPRETATION

We interpret this outcrop as having been formed in nearshore to marginal marine conditions (Figure 6). The presence of mudcracks, birds-eye structures, and tidal channels indicate subaerial exposure; the stromatolites and oolitic carbonates would have formed in shallow water. The section records several such fluctuations in base level.

GLACIAL FEATURES

The whaleback outcrops are glacially-carved roche moutonnées. Glacial striations are evident over most of the polished surfaces (Figure 1), and (along with the outcrop orientation) indicate direction of glacial flow. In places, chatter marks are visible.

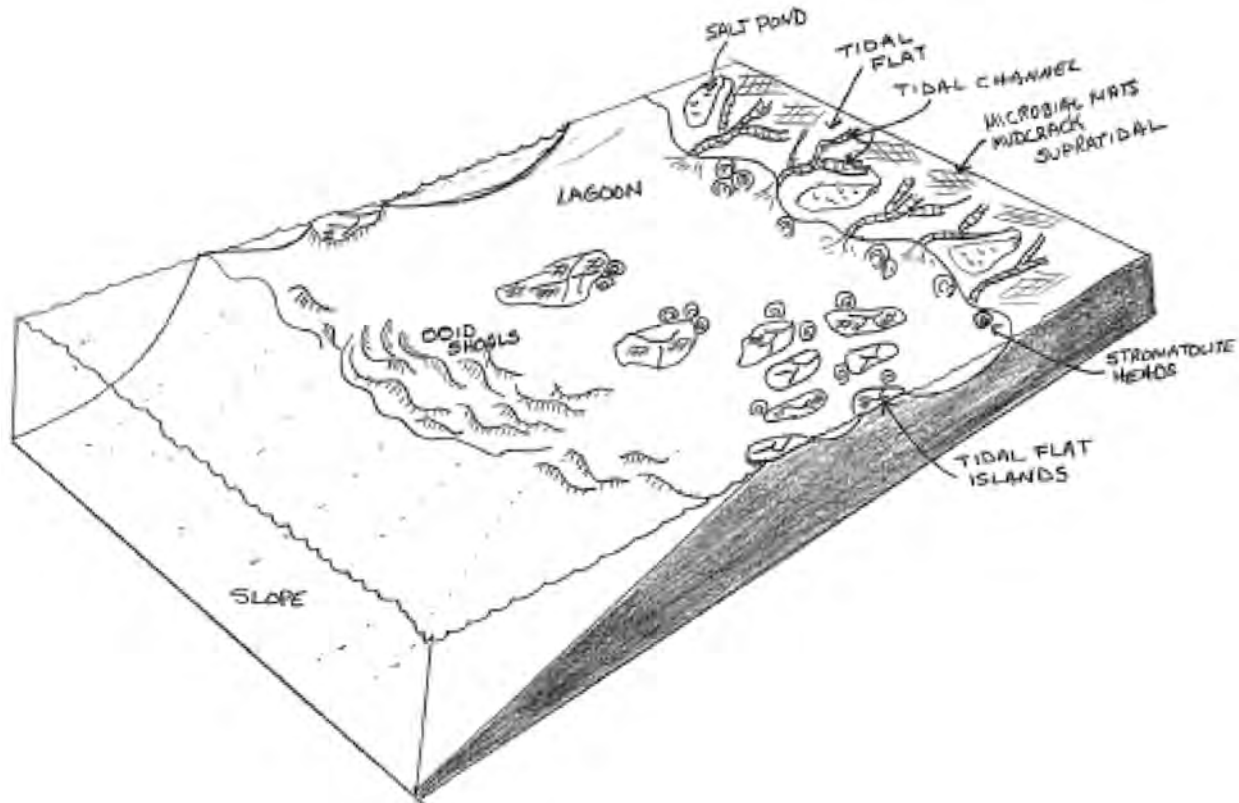


Figure 6. Paleoenvironmental reconstruction of the Gingerbread Castle stromatolite site. (Modified from Pratt et al., 1992.)

HYDROGEOLOGY

A hydrogeological framework study was conducted by the New Jersey Geological Survey at this development as part of a ground-water supply investigation. The well field at the development includes one 8-inch diameter supply well and five 6-inch diameter observation wells in bedrock. The bedrock aquifer is composed of the lower part of the Allentown Dolomite and the upper part of the Leithsville Fm. A profile view (Figure 7) of the hydrogeological framework was constructed based on optical televiewer, fluid-temperature and electrical-conductivity, caliper, heat-pulse flowmeter, and color video (VHS) borehole geophysical logs. Stratigraphic bedding and tectonic fracture orientations were measured using an optical televiewer.

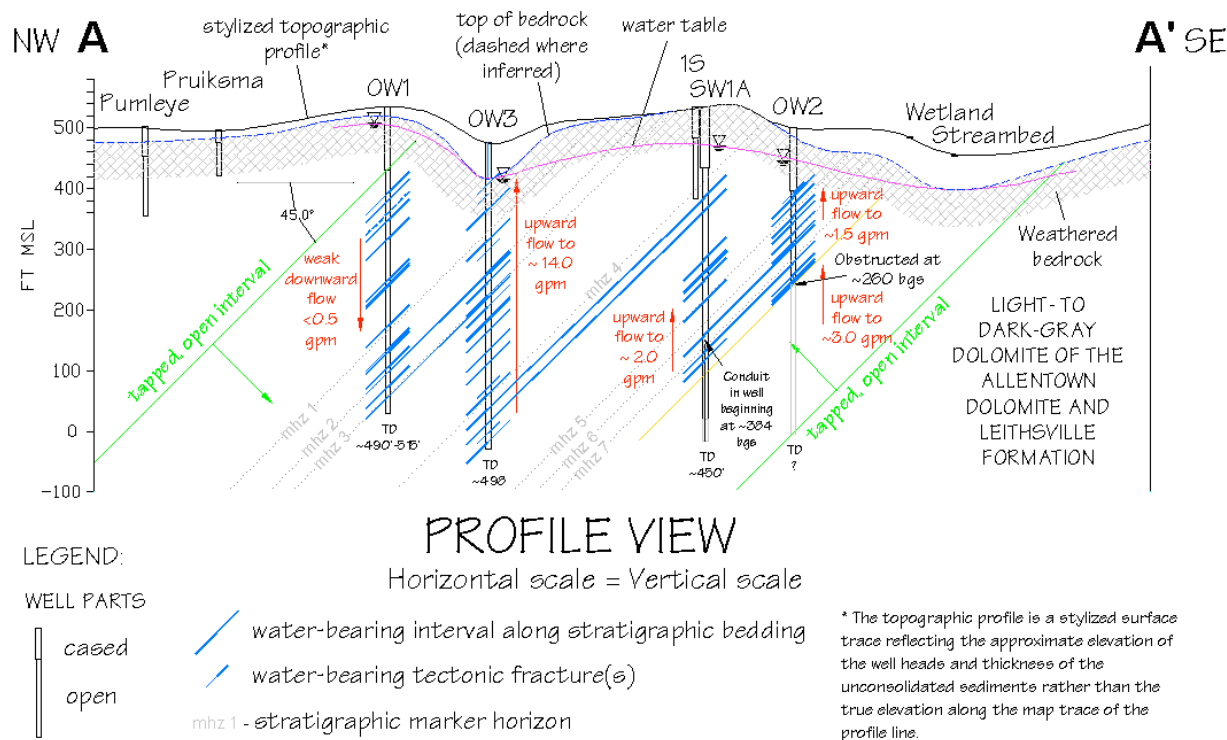


Figure 7. Hydrogeological framework of wellfield.

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