South Florida Geological Site Guide series
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No 02

Perrine Wayside Park

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Location and access

The park is located on the east side of US 1 (S. Dixie Highway) at roughly SW 164th St, north of where US1 divides.

What there is to see

Miami oolite and its sedimentary structures, including the post-depositional modification by burrowing organisms. Aclosed karst depression, now filled with water.

Background

The oolitic facies of the Miami Formation is exposed in a small bluff on the south side of the roughly circular pond

Fig. 1 Looking toward the SE across the pond to the bluffs on the SE side

Rock type(s)

The rock is a white to cream-colored rock composed mainly of spherical grains and shell fragments. It effervesces when acid is applied, indicating that the grains are composed of calcite (calcium carbonate – $CaCO_3$), and therefore the rock is a limestone. This particular type of limestone, composed of grains cemented together, is referred to by sedimentologists as a *grainstone*. The majority of fragments are nearly spherical sand grains called *ooid s*. A grainstone composed predominantly of ooids is termed an *oolite*. Microscopic examination shows that these sand grains are made up of concentric layers around a small central nucleus of either shell fragments or small quartz grains.

Fossil studies and uranium-lead dating indicated that the limestones of the Miami Formation were produced in the Pleistocene epoch, about 125,000 years ago – very young by geological standards.

Mapping of the oolite shows that it makes up a continuous *oolite bank* that forms the Atlantic Coastal Ridge which is in the eastern parts of Miami-Dade and the southern part of Broward county.

Interpretation
Oolitic sand banks are forming at the present time in the shallow waters of the Bahama Banks. Calcite is more soluble in cold water than warm water, so the warm conditions in tropical to sub-tropical seas encourages the precipitation of calcite from dissolved calcium bicarbonate in seawater. The reaction is:

$$Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$$

It is also possible that this reaction is not entirely inorganic and algae may play an important role in the precipitation of calcite in ooids. The agitation caused by the Atlantic oceanic swell rolls the grains around during calcite precipitation producing the concentric pattern observed in the ooids.

Thus, the Miami Formation is considered to have formed in conditions very similar to the present day Bahamas. If this is the case, then sea level at the time of the deposition of the Miami Formation would have been about 10m (~30 ft.) higher relative to the land than a present. As Florida is tectonically very stable it is more likely that this higher level was the result of global sea level rise rather than uplift of South Florida. This view is supported by many other studies that indicate that the Miami Formation was deposited in the last interglacial stage (Sangamon) when sea level was indeed about 10m above the present sea level.

Sedimentary structures

Observations
At the lower part of the outcrop laminations can be seen, which dip about 25^0 to the E. In the upper bed, these laminations disappear and are replaced by an unstratified, honeycombed-appearing rock. On close inspection this structure can be seen to be composed of a series of tubes, both horizontal and vertical. This rock is sometimes referred to as the "mottled facies: of the Miami Formation.

Fig 2 The bluffs on the SE side of the pond. The upper part, underneath the trees shows the bioturbated, "mottled" facies. The lower part is compose of largely undisturbed cross beds.

Interpretation
The laminations are the remains of cross bedding observed at other localities in the Miami Formation. Cross bedding has been shown to result from deposition by horizontally moving water or air. The cross laminations dip in the direction of the movement of the currents. In this case, this suggests that the majority of the currents were roughly perpendicular to the trend of the oolite bank and the ancient coastline.

The mottled facies is an example of biorturbation, which is the disruption of the original sediment by burrowing organisms. The oolite banks would have had numerous organisms living in burrows beneath them, as do similar oolite banks in the Bahamas today. The burrowing disrupted the previous cross bedding and produced the "mottled" appearance of the outcrops. It has been discovered that many of the more spectacular burrows are due to the burrowing shrimp, *Callianassa*,. Note how the bioturbation completely has destroyed the cross bedding in the upper part of the outcrop. The *Callianassa* can only burrow down about 1-2 m, so at the bottom of the outcrop the cross bedding is still visible.

Landform Development (geomorphology)

Observations
The main feature of the park is the roughly circular pond. There are several circular depressions in Miami-Dade county, some of which are deep enough to penetrate the water table of the Biscayne aquifer, and so form a pond.

Interpretation
The depression in which the pond sits is said to be closed in the sense that there is no way for water to drain out of it on the surface. After the formation of the oolite banks at about 125,000 years, seal level was stable until about 75,000 years ago, after which the climate became colder as the Earth entered into another glacial period. At the glacial maximum, 18,000 years ago, seal level was some 100m (~300ft) below present sea level, so easterm Miami formed a series of low hills reaching up to 330ft above sea level.

The rock was therefore exposed to rainfall which is very slightly acidic and slowly dissolves limestone, a process known as *karstification*. The rainwater trickles down through the rocks, eventually dissolving away vertical conduits or caves. At the surface these vertical caves open up and form a closed conical depression called a "doline". [Sometimes these depressions will be called "sinkholes" a term which is avoided here because it is too general and also because it is confused with rapidly opening catastrophic collapse sinkholes which are a hazard in central Florida, but not in South Florida]. As the Earth emerged from the glacial maximum, both seal level and South Florida's water table rose. Eventually the lower part of the doline flooded to form todays circular pond.

Below the water table, solution tends to form horizontal caves. This karstification process continues to the present day. In fact, the *karstification* of the Miami and Ft. Thompson Formations in the Late Pleistocene has resulted in a high permeability and porosity in the Biscayne Aquifer, which makes it one of the most productive aquifers in the U.S. You owe every glass of water and every shower to the Late Pleistocene drop in sea level!

References and further reading

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