South Florida Geological Site Guide series
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No 02

Alice Wainwright Park

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Location and access

From Bayshore Drive turn east on the road immediately north of Vizcaya. Follow the road around to the left. The entrance to Alice Wainwright Park is a few hundred yards on the right with limited parking on the street. If visiting with a large group, it is better to park buses on the bend of the road and walk the group to the park.

What there is to see

Miami oolite and its sedimentary structures, especially the post-depositional modification by burrowing organisms. Some karstification (solution of the limestone) is also visible

Background

The oolitic facies of the Miami Formation is exposed in a small cliff near the waterfront. The cliff is cut into one of a series of oolite sandbanks that extend from Coconut Grove to Cutler ridge.

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 made 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.

The oolite at this location contains a number of fossils as grains within the rock. A larger than normal fossil of a queen conch (genus *Strombus*: Fig. 1) can be seen on top of the second spur to the north on the outcrop.

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

Figure 1 Fossil Strombus sp on the upper surface of the outcrop

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 SE. These laminations progressively 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 (Fig. 2) . This rock is sometimes refered to as the "mottled facies: of the Miami Fromation.

Figure 2 Tubes produced by *Callianassa* shrimp. The shrimp line the burrows with mucous which enhances the lithification of grains in the walls of the burrow. Later, the weathering of the softer matrix around the burrow produces the tube-like structure.

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 outcrop has the form of a cliff, which in places seems to be undercut near its the base.

At the top of the outcrop, there are small spoon-shaped pits, attributes to solution by rainfall (*solution pits*)

Interpretation

The undercutting of the oolite bank was produced by wave action to produce the cliff and the *wave-cut notch* at its base. 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. As a result, sea level dropped, and at one point stood a little above present sea level. Wave action was strong enough to erode the oolitic sand ridge, and produced the wave cut notch that can be seen at the base of the cliff at Alice Wainwright, and also at Silver Bluff in Coconut Grove.

Sea level continued to fall, and rainfall on the exposed sand banks both dissolved and precipitated calcium carbonate within the banks. The precipitation lithified the sand banks into solid rock, and the solution created cavities of the order of a few centimeters in the formation. 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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