What are "Stromatolites"?

Stromatolites are living examples of earth's earliest reefs.

Stromatolites form an unusual and special type of reef. Unlike most present-day reefs, which are composed of coral, stromatolites are formed by microorganisms. These micro-organisms trap and bind sand grains together and/or precipitate calcium carbonate to form laminated mounds of limestone. The layered internal structure of these reefs is a characterisitc feature and, indeed, the name 'stromatolite' in Greek means 'layered rock'.

Stromatolites are rare in today's oceans. However, they can be found in several localities along the margins of Exuma Sound. The Bahamian stromatolites are living examples of Earth's earliest reefs.

Living stromatolite reef complex, Stocking Island

Earth 3 billion years ago (Smithsonian Mural)

Stromatolites and Earth History

Stromatolites are the oldest known macrofossils, dating back over 3 billion years (Earth is ~4.5 billion years old). Dominating the fossil record for 80% of our planet's history, stromatolites formed massive reefs in Earth's primitive oceans.

Scientists believe that the photosynthetic activity of cyanobacteria, the most important group of stromatolite-forming microorganisms, generated the oxygen in our atmosphere. An oxygen-rich environment was critical to the development of higher forms of life on Earth.

After a long global dominance, stromatolites suffered a dramatic decline in abundance starting ~700 million years ago. This decline, which led to the near disappearance of stromatolites, has been attributed to various factors, ranging from the evolution of competing organisms (plants and animals) to changes in ocean chemistry.

Living Stromatolites

For years, living stromatolites were thought to be extinct. The only information about stromatolites came from fossils in the rock record. Then, in the 1960's, modern stromatolites were found in Shark Bay, Australia, where the seawater is too salty for most animals and plants to survive. These harsh environmental conditions allow stromatolite-building microorganisms to become the dominant community.

Bahamian Stromatolites

In the 1980's, stromatolites were discovered in Schooner Cays, Bahamas, growing in an open marine environment. Living stromatolites have since been found in several localities along the margins of Exuma Sound, including Lee Stocking Is., Stocking Is., Highborne Cay, and Exuma Land & Sea Park. At all of these sites, stromatolites are frequently buried by shifting sand, which excludes growth of advanced reef organisms, that would otherwise overgrow or disrupt the stromatolites.

Bahamian stromatolites typically grow as mounds or columns. The stromatolite surface is a living microbial mat. Carbon isotope dates indicate that stromatolites in the Stocking Island reef complex began forming 1000-2000 years ago.

Fossil and living stromatolites are an important source of information on the early development of life on earth and possibly other planets.

Stromatolites viewed underwater (A) and in vertical cut section (B,C); C is microscope image of surface mat.

RIBS

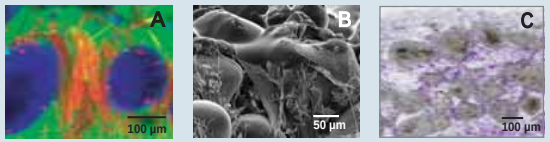
A major goal of RIBS is to understand fundamental processes and biological-geological interactions in the three billion year-old stromatolite ecosystem. Researchers adopt multidisciplinary approaches. Microbiological, geochemical and sedimentological analyses based on a variety of novel and innovative techniques are integrated in field and lab-based studies. The results will have significant implications for understanding such fundamental issues as the evolution of life, the dynamics of sedimentation, and the flow of energy and matter through the Biosphere.

The Research Initiative on Bahamian Stromatolites (RIBS) is conducting an active research program. The RIBS team includes sedimentologists, microbiologists, geochemists, and biological oceanographers from several US institutions, including University of Miami, U. Connecticut, U. South Carolina, Duquesne, U. of Maryland, U. North Carolina, U.C. Davis, Smithsonian Institution, and NASA Ames as well as European institutions from Switzerland, Scotland and the Netherlands.

Why Study Stromatolites?

Living stromatolites are an ideal model system for studying biological-geological interactions.

Stromatolites form a compact ecosystem that is elegant in simplicity. Three distinct microbial communities are responsible for the growth of these layered reefs. Initially, hair-like filamentous cyanobacteria trap and bind sediment (A). Subsequently, the surface becomes colonized with a slimy coating (biofilm), which precipitates a thin crust of limestone (B). Finally, coccoid (spherical) cyanobacteria colonize the surface immediately below the thin limestone crust (C). These coccoid cyanobacteria bore into the sand grains, and alter them into a hard-cemented layer. Eventually, filamentous cyanobacteria re-colonize the surface and the cycle begins again. The subsurface, layered portion of the stromatolite is 'fossilized', non-living rock, with each layer representing a former surface mat. Studies of this simple system provide models for biogeochemical cycling, population dynamics, and mineral formation in modern and ancient environments.



Microscopic images of the three microbial communities forming Exuma stromatolites.

Highborne Cay Research Station

To conduct field studies, the Research Initiative on Bahamian Stromatolites operates a research station on Highborne Cay. From here, resident scientists observe stromatolite development on a continuing basis.

Instruments in the water measure wave energy and sea surface temperature. A weather station provides data on wind speed, wind direction, air temperature, and light. Stromatolite surfaces are marked to correlate growth with environmental conditions.

The laboratory provides space to process samples, calibrate equipment, and perform data analysis. Microscopes are used for field identification of microbial assemblages; microsensors provide data on geochemical gradients.