Water for Life

Place-based science learning resources

Module 1:

What is Angaur made of?

Version date: September 8, 2016

Introduction

The purpose of this module is to plan and implement an engaging and locally relevant informal place-based science education activity. Its goal is to support youth and community learning about fundamental science concepts related to water resource issues within the context of the local environment and using local examples.

This module was developed in collaboration with municipal leadership, the national utility company, community members, and local educators. It incorporates western science content as well as indigenous environmental knowledge. This emphasizes participants' application of science-based and traditional knowledge to better understand and appreciate the complexity of their own island environment.

Improving informal youth and community education about their specific water resource and environmental issues will enable them to make better and more informed decisions on resource management and sustainable use. This module is best used by government and non-government agencies, specifically their community outreach and education specialists, in their informal education efforts with youth and community members.

Acknowledgments

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This document was created by Danko Taboroši (iREi) and Destin Penland (PREL), with support by Ethan Allen (PREL). We would like to thank iREi, PREL, Water for Life network, Angaur State Government, Palau Public Utilities Corporation, Palau Ministry of Education, Angaur Elementary School, the Pacific islands Climate Education Partnership and, most importantly, the people of Angaur island.

Time and Materials

SUGGESTED TIMING OF THIS ACTIVITY
This activity can be done at any part of the year. The timing should be chosen during low tide, and if possible on a day when the ocean is calm.

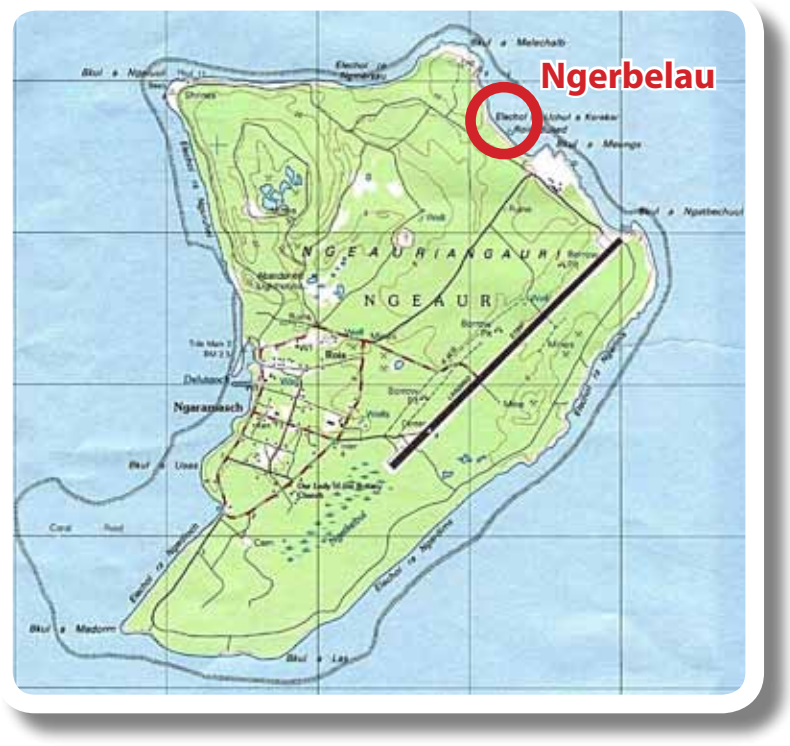
SUGGESTED TIME USE
90 minutes

SUGGESTED GROUP SIZE
No more than 25 persons

SUGGESTED ADULT TO YOUTH RATIO
1 adult for every 4 youths

MATERIALS AND RESOURCES NEEDED
- Basket to collect rock samples (one per participant)
- Small container to collect sand (one per participant)
- Transportation for guides (facilitators) and participants
- Drinking water for guides (facilitators) and participants

LOCATION OF INSTRUCTIONAL SITE



Step 1

The group assembles at ***Ngerbelau***, the beach on the northeastern coast of Angaur. On arrival, the guide asks the participants: "What is this beach -- where we stand now -- made of?". If the participants answer "rocks, sand" the guide can rephrase the question as "What are the rocks and sand on this beach made of?".

The participants may know that these are made of the remains of living things from the ocean. The guide points at the ocean, and asks the participants to name some of the living things found in the sea around Angaur.

Participants will say things like fish, coral, crabs, sea urchins, etc. The guide will then ask how these animals are classified in groups. Together, they will come up with the list of key phyla:

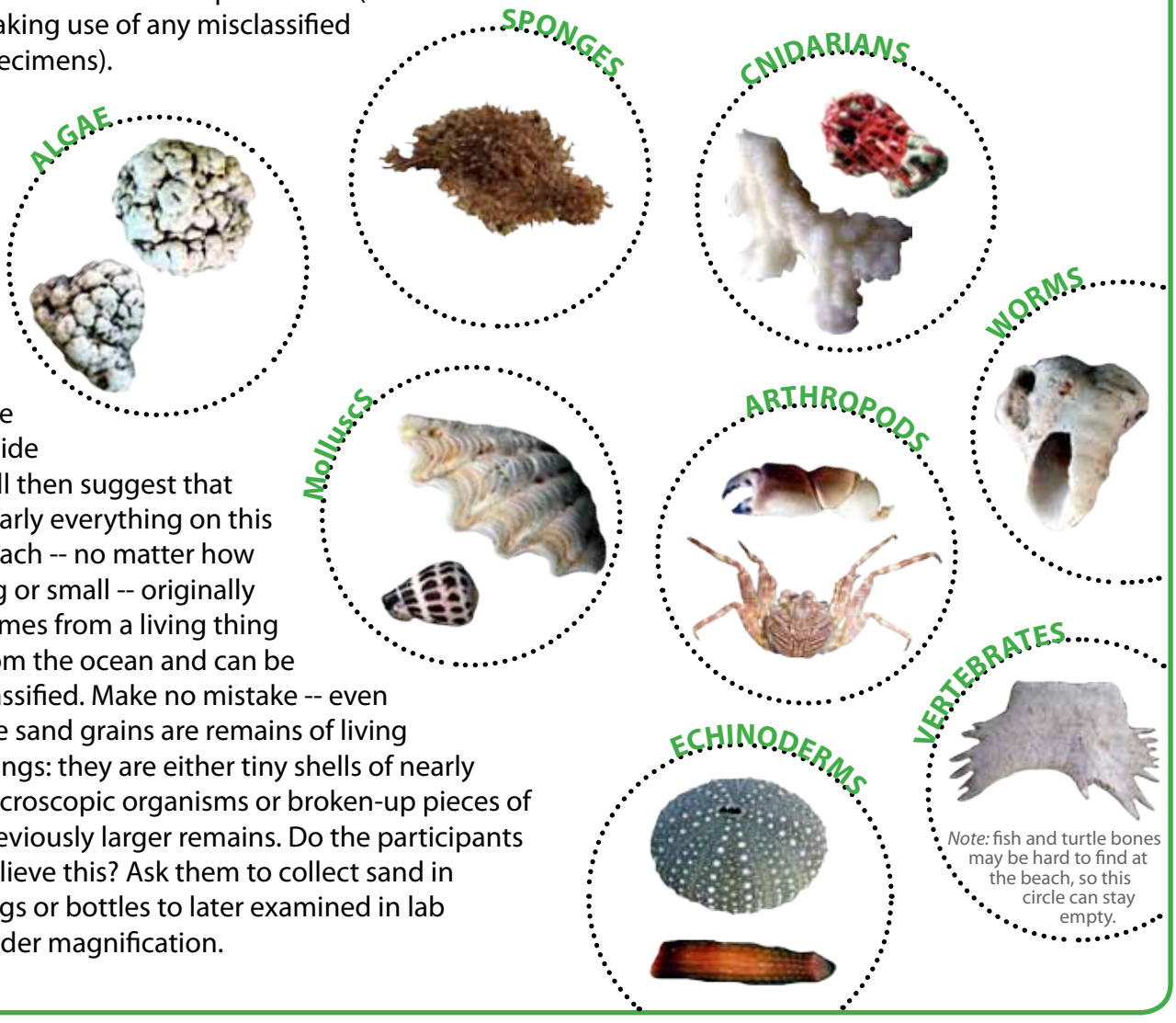
- **Sponges**
- **Cnidarians** (corals, soft corals, jellyfish)
- **Worms**
- **Molluscs** (clams, snails, squid, octopus)
- **Arthropods** (crabs, shrimp, lobsters)
- **Echinoderms** (sea urchins, sea stars, sea cucumbers)
- **Vertebrates** (fish, turtles, mammals)

VIEW OF THE BEACH AT *NGERBELAU*

Step 2

The group will draw circles in the sand and label them with the names of phyla: sponges, cnidarians, worms, etc. The guide will then ask the participants to explore around the beach and find and bring remains of each of the key phyla (try to find at least one from each phylum). The participants bring rocks and put them in appropriate circles in the sand. The guide reviews and may correct the participants' classifications, finding new specimens for any circles that may have been left empty. At this point, the guide should add an additional circle labelled "algae" and find material to place there (also making use of any misclassified specimens).

PARTICIPANTS CLASSIFY THEIR FINDS



The guide will then suggest that nearly everything on this beach -- no matter how big or small -- originally comes from a living thing from the ocean and can be classified. Make no mistake -- even the sand grains are remains of living things: they are either tiny shells of nearly microscopic organisms or broken-up pieces of previously larger remains. Do the participants believe this? Ask them to collect sand in bags or bottles to later examined in lab under magnification.

Step 3

Let us talk about the specific remains that the participants collected. Look at them in some detail. Ask the participants to compare and contrast them, get an idea how to identify them, recognize sponge vs. coral vs. clam or snail shell vs. sea urchin spine, etc. Ask the participants to explain to each other how some of the trickier remains are best recognized.

Pick up a clam shell and ask where the body was when the clam was alive. The participants will answer that the body was inside the shell. Remind the participant of the proper term for the skeleton that protects the body from the outside: **exoskeleton**. This is quite unlike the bones of fish, birds, people, etc., which are on the inside of bodies and known by the term **endoskeleton**.

Ask participants to identify examples of both skeleton types from among the material that was collected. (Note that most things on the beach are remains of exoskeletons, only fish bones are endoskeletons).

EXOSKELETON

ENDOSKELETON

ROCK-LIKE

NOT ROCK-LIKE

The other key difference is that some of the remains are rock-hard (coral, clam, worm tube) and others are not (sponge, crab, fish). That is because different organisms make their hard parts from different materials.

Coral, clam, and snail shells are hard like rock, durable, resistant. Crab, sponge, and fish remains are fragile, less durable, break down easily, they are hard like rocks.

Ask participants to classify all the collected material into two groups: those that are like rock and those that are not like rock.

Step 4

Now we know what the beach is made of, but still have the main question: "What is Angaur island made of?" Point to the nearby rocky ridge and ask the participants what they think that bedrock was made of. The participants should go and examine the rock surface, touch it and look at it very closely. Is it one solid rock that is the same throughout (homogeneneous) or are there different parts in it (for example, different textures, different color shades, fossils, etc.)?

If participants did not identify some fossils by themselves, help them find some. Ask them what organism it belonged to and where does that type of organism live. They will reply that it lives in the ocean. Ask a follow-up question "How did this skeleton of an ocean creature get embedded in this bedrock, here on dry land?".

Let the participants explore possibilities. Depending on what they say, assist the participants to come to the conclusion that the bedrock was originally formed underwater and became exposed as dry land when the sea level became lower. When the sea level became lower, an ancient coral reef was turned into dry land. All the organisms that lived within that reef died and their skeletons became the land. Over time, they changed so much that it is often difficult to recognize what they once were. We no longer call them corals, algae, molluscs, etc. -- we call them rocks. Specifically, they are the type of **sedimentary rock** called **limestone**. Limestone is created from old reefs and also from broken pieces of reefs and skeletons of marine organisms (such as those seen on the beach and in shallow water) when they became squeezed and stuck together. (Participants can examine this process in a lab activity where previously loose sand grains naturally gets cemented together).

ROCK RIDGE AT THE BEACH

CLOSE-UP VIEW OF THE ABOVE ROCKS

Step 5

Now that we know that Angaur was made of remains of marine organisms from an ancient reef, let's look again at the remains that make up the beach. Ask the participants to describe the colors of skeletons that they collected. The skeletons are mostly white or pale grey. Then ask the participants to look at the island and say what colors do they see? There will be greens, browns, etc.

Why do we see those colors on land if the skeletons that make up the rocks are white and pale grey? The participants are going to say that there are trees and other plants and soil.

Why is our island not covered only with these pioneer plants? Why are there other plants? Ask participants questions of this type: what came to Angaur first: a small coastal scrub or a large tree? Use different examples and Palauan plant names as needed. When participants respond which came first, ask them what it is that made the survival of those latter plants possible? What enabled their growth?

A HANDFUL OF ANGAUR SOIL

Step 6

The guide will then ask the participants how did the plants and soil get here? The participants will answer that some seeds floated over the ocean or drifted in air or were carried by birds. Some of those plants are very hardy and can survive in tough places, including bare areas, near seawater, and with no or very little soil. They are the **pioneer plants**. They are the first to start growing on new land.

Ask the participants to look at the plants around them and point out those that could have been pioneer plants that grew on an ancient Angaur when it was still mostly bare. As you stand on the beach and look inland, the pioneer plants will be those that are closest to the ocean (especially those that you often see growing on bare rock). The little island just off the beach and also *Berandang* (the rocky area behind the powerplant) are excellent visual examples of pioneer plant communities.

PIONEER PLANTS GROWING ON LIMESTONE

The participants should come to the conclusion that over long periods of time, the pioneer plants grew, died, decayed, and contributed to the development of soil. Remind the participants that soil is a mixture of broken up rock and organic material (which comes from breakdown of plants and animals). As more soil formed, more and a greater diversity of plants could grow. Eventually, land animals come too (by drifting, swimming, or flying...).

Lab Activity 1

- **Identify the sea organisms shown on the photos**
- **Connect names and photos as in the example**

PLANTS

- Algae
- Seagrass
- Mangroves

ANIMALS

- Sponges
- Cnidarians
- Worms
- Molluscs
- Arthropods
- Echinoderms
- Vertebrates










Lab Activity 2

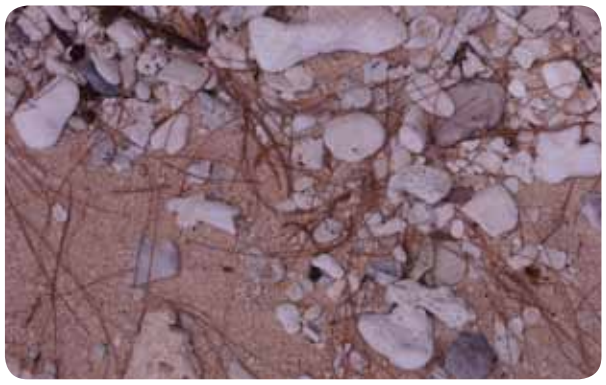
- **Identify the illustrated material, found on a beach**

(Next to each item, write AL for algae, S for sponges, C for cnidarians, W for worms, M for mollusks, A for arthropods, E for echinoderms, and V for vertebrates. One chindarian and one mollusc have been identified. Helpful hint: There is only one item each for algae, sponges, and vertebrates).

Lab Activity 3

- **Collect samples of sand from different beaches**
- **Label each sample with beach name and date**
- **Examine the samples under magnification**
- **Describe, compare, and contrast different sands**

SAND FROM ONE OF ANGAUR'S BEACHES



A CLOSER LOOK...

UNDER MAGNIFICATION

You know that nearly all rocks found on Angaur's beaches are pieces of skeletons of corals, algae, molluscs, and other marine organisms.

But what about sand?
Where do you think the sand comes from?
What is it made of?

To answer these questions, let's get down on our hands and feet and take a close look at the sand. Can you recognize any sand grains and tell where they come from? In general, it is difficult to recognize the origin of sand grains by looking at them with the naked eye. They are too small. Let's grab some sand and take it to school, where we can examine it under magnification. Try to get sand from several different beaches.

Under magnification, we can take a very good look at individual grains of sand.

- Are the sand grains all the same or different?
- What colors do you see?
- What shapes do you see?
- Can you identify the origin of some grains?
- Are there differences in sand from different beaches?

Just like rocks, sand on Angaur also comes from broken skeletons of coral, algae, molluscs, and other organisms. There are countless kinds! Imagine -- there are even sand grains made by single-celled organisms! Those grains are shaped as brownish balls of more or less the same size. They come from tiny organisms called *foraminifera*. They live in the sea and when they die, their shells pile up as sand on the beaches.

Lab Activity 4

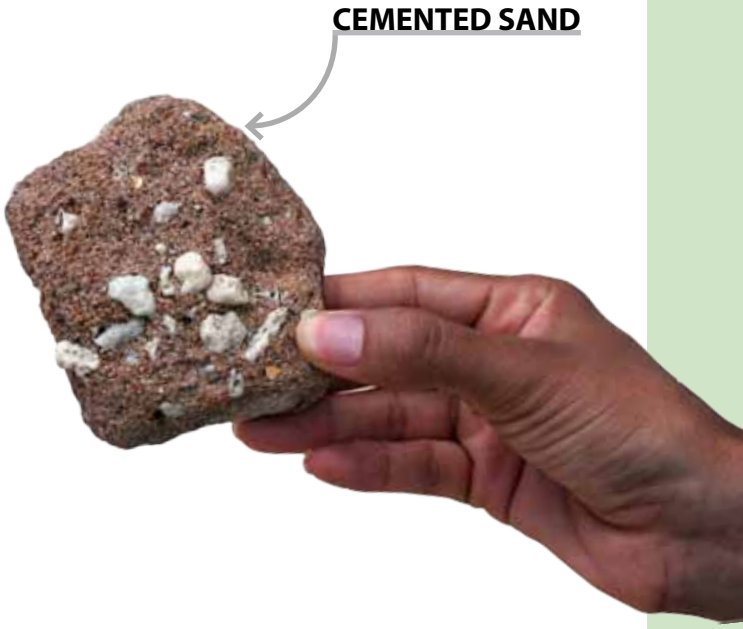
- **Look for evidence of sand turning into rock.**
- **Try to naturally "cement" a pile of sand.**

As you have learned during the outdoor activity, most of our island is an ancient coral reef that became limestone when the sea level changed. Parts of it may have originally been beaches, lagoon floors, and other sandy areas, but are now solid rock. How is that possible? Can sand turn into rock?

Take a walk around some of the beaches in Angaur to look for rocks that used to be loose sand. On the picture to the right is one such rock we found on a beach. Most of the beach is made of loose sand, but in some places, the sand became cemented into rocks. This is a natural process.

On Angaur, you can see some very large rocks that were made by the natural cementation. The long, dark-colored slabs of rock that stick out from the sand on the beach just south of the port are a great example of this. If you break off a small piece, you will see that the inside of this rock is made of sand grains that were cemented together.

You can even try an experiment. Bring sand from a beach and make a large pile outdoors, somewhere where it won't be in anyone's way. To see how loose the sand is on day 1, use a plastic spoons scoop some of it up. Let days go by. The sand pile will be rained on, dried by the sun, and rained on again, many times over. After several weeks or even months, try to scoop the sand using a plastic spoon. Is it still loose as it was originally, or is it harder than before? Did the grains begin to stick to each other?



Culminating Activity

- **Participants will write a 1-page response to the module core question:**
  - **> What is the island of Angaur made of?**

- **Participants will develop a display or model that**
  - **> demonstrates their answer, or**
  - **> illustrates their interest**

This document was developed by **Danko Taboroši** (Island Research & Education Initiative - **iREi**) and **Destin Penland** (Pacific Resources for Education and Learning - **PREL**) in close collaboration with Governemnt of Angaur State, Palau Public Utilities Corporation, and educators at Angaur Elementary School. The project was funded by **National Science Foundation** under **Water for Life** grant to PREL (award 1224185). For more information, or to suggest corrections/ modifications to this document and its updated versions, please contact us at irei@islandresearch.org.