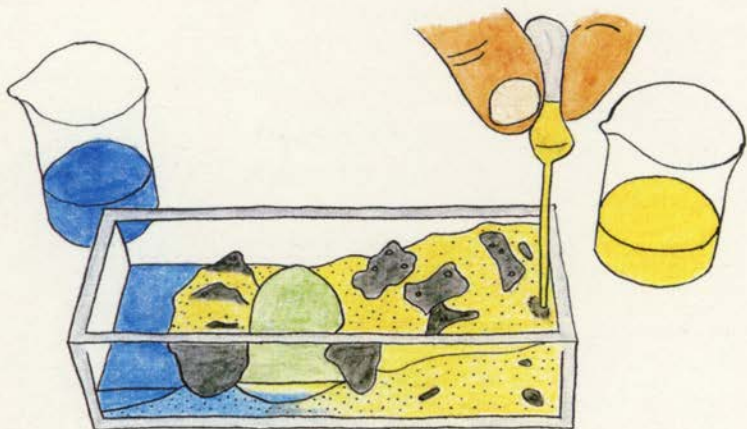




Anchialine Pools



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Anchialine Pools

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Anchialine Pool Models

THE ground beneath our feet looks different in different parts of the country. In cities, a thin layer of concrete or asphalt covers a layer of soil. Below the soil is bedrock. Soil layers are thicker in flat, moist regions and thinner in arid regions, on steep slopes, or young lava. Bedrock could consist of igneous, metamorphic, or sedimentary rock. Some common sedimentary rocks such as conglomerate and sandstone can allow water to soak through the large pores. Siltstone, limestone, and igneous and metamorphic rocks have much smaller pore space that limits the rate at which water can flow through. Using sand, we can make a simple model that behaves like our local ground. The Hawaiian islands have unique groundwater features called **anchialine pools**. These pools are windows to the groundwater system and important indicators of the health of the entire system. Let's make a model of them to learn how they work!

Step 1

Fill one of the 50 ml beakers with blue colored water. Add 3 spoonfuls of rock salt and stir until the salt dissolves. This will represent **seawater**.

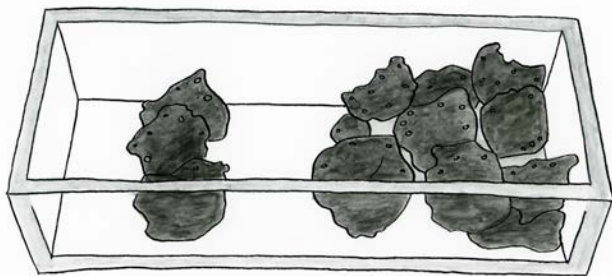


Step 2

Fill the other 50 ml beaker with yellow colored water. This will represent **freshwater** (no salt needed).

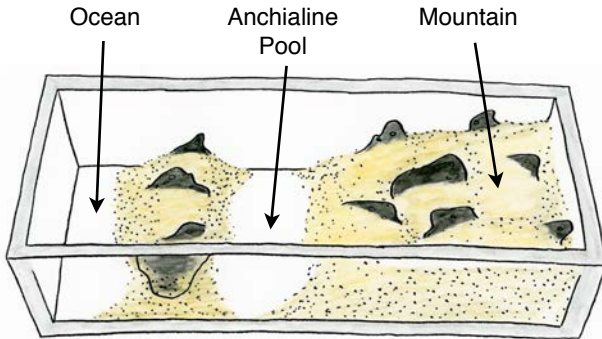
Step 3

Arrange the pieces of lava in the wide plastic box as shown here.



Step 4

Use the 100 ml beaker to add sand to the model to fill in the spaces between the rocks as shown here. We are using the sand to slow down the flow of water in our model. You have to imagine that the spaces between the sand grains are representing small cracks in lava.



Step 5

Put a short pipette in each beaker of colored water. Try not to mix up the pipettes. Add a dropper full of yellow freshwater to the right mountain (mauka) side of the model. Then add a dropper full of blue seawater to the left ocean (makai) side. Alternate back and forth between the two colors slowly, observing what happens in the an-

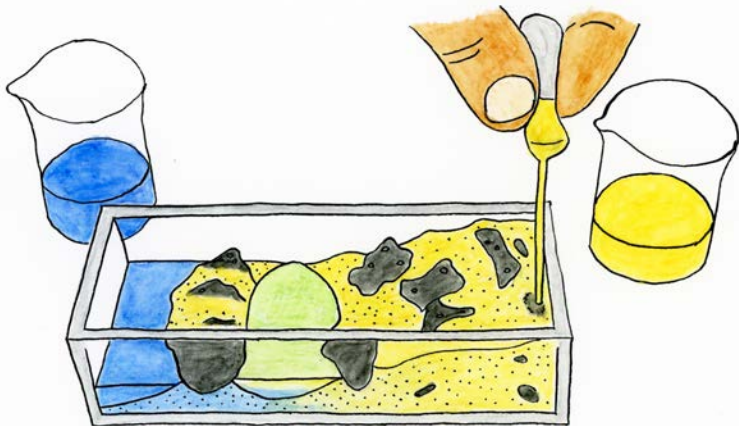
chialine pool section as you go. Stop when your anchialine pool is almost full.

Science Notebook

Record your observations in your science notebook. Be sure to draw detailed pictures of your setup. What color is the water in the anchialine pool?

Step 6

Now you will use your yellow pipette in reverse, as a pump. Squeeze the bulb, insert it deep into the mountain and release. You should see yellow water being sucked up into the bulb.



Empty the pipette into your yellow beaker. Whenever you remove one pipette full from the freshwater side, add another dropper full of blue water to the ocean side. Repeat.

Science Notebook

What do you notice happening to the anchialine pool? Record your observations in your science notebook.

Step 7

Try it in the opposite direction. Pump out the ocean water and add freshwater to the mountain.

Science Notebook

What do you notice about the water in the pool? Can you use the pipette to sample the water from different depths of the pool?

Clean up

Dump the wet sand into the sand recycling bin at the front of the classroom. Rinse off the plastic model and lava and return the lava to your cloth bag.



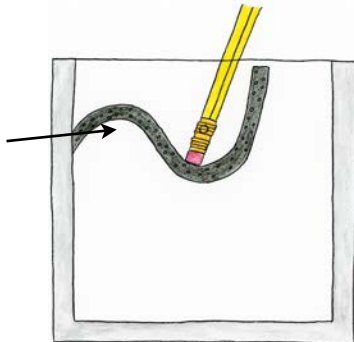
A Closer Look at Groundwater

GROUNDWATER is what keeps us alive. It is vitally important to not only humans, but also the plants and animals that inhabit our environment. But since groundwater is hidden out of sight underground, few of us understand how much there is, where it is, and how and where it moves.

Step 1

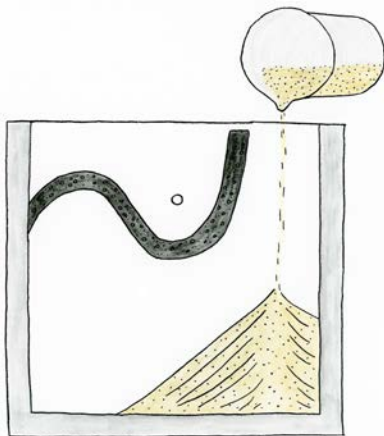
Start by using the eraser end of a pencil to carefully position the black foam in the tall skinny plastic box. Be careful not to rip the foam.

This hump should be at the same level as the hole in the box.



Step 2

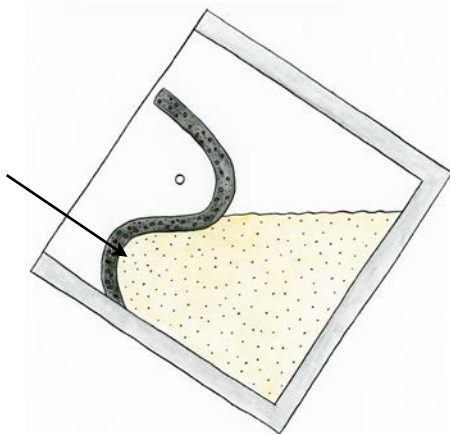
Then use the 100 ml beaker to add dry sand to the model.



Step 3

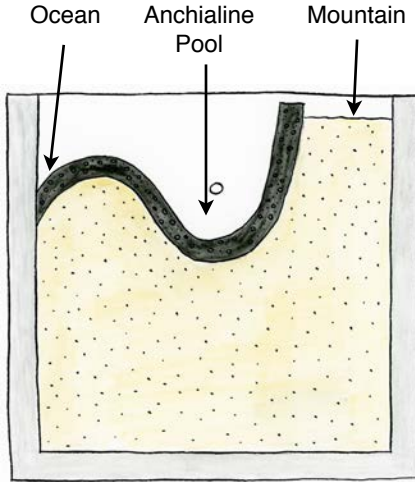
Tip the model to get the sand to fill the hump. Be sure that the sand is tightly packed into the raised hump.

Make sure there is no gap here.



Step 4

Top off your model and tap lightly on table to get the sand to settle.



Step 5

Place the model into the empty wide plastic model that you used for the first experiment. This will catch any drips of water seeping out of the hole in this model. Use the long pipettes to add blue saltwater to the left ocean side of the model. Use the other pipette to add yellow freshwater (groundwater) to the right mountain side of the model. Alternate between the two types of water until the anchialine pool begins to fill.

Science Notebook

Draw and label a detailed picture of what is going on in your science notebook.

Step 6

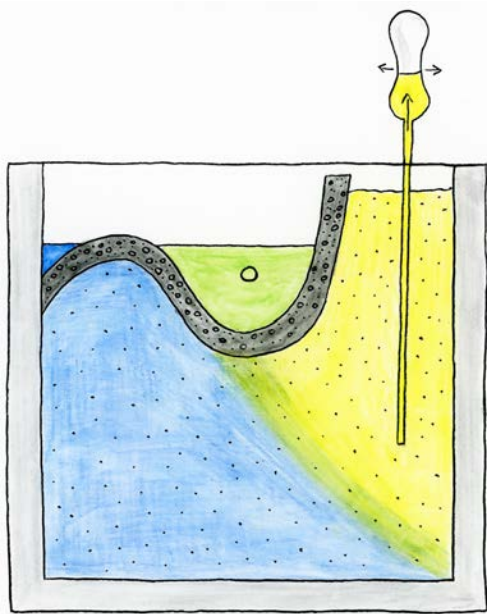
Continue to add water until the hole in the middle of the anchialine pool begins to leak. Add a few more droppers of each type of water.

Science Notebook

Draw and label a detailed picture of what is going on in your science notebook.

Step 7

Next, use the long yellow pipette as a pumped well. Squeeze the bulb, insert it into the sand as seen on the diagram on the next page. This may take two hands and two people! Don't let go of the bulb until you have it inserted to the depth shown on the diagram. Now let go. The bulb will suck up the groundwater just like a real groundwater well. Have your partner keep the ocean at a constant level.



Science Notebook

How does the freshwater interact with the saltwater? What happens when you pump the ocean water and add freshwater? How could the new development mauka affect the anchialine pools makai?

Clean up

Dump the sand into the sand recycling bin. Rinse and dry off your materials.



Where Can You See Anchialine Pools?

AT Kaloko-Honokōhau National Historical Park, there are many **anchialine pools**. They provide a window into the groundwater system that lies under Kaloko-Honokōhau. In fact, the surface of these pools is the surface of what is known as the **water table**. However, in most places the groundwater exists only in narrow cracks. The height of the water table here fluctuates with the tides telling us that the pools are connected to the ocean through cracks and lava tubes. The water is not as salty as the ocean water, which tells us that rain water and fresh groundwater coming from the forest uphill mix with the ocean water in these pools forming **brackish water**.

These pools are the home of ‘ōpae ‘ula shrimp and are native to Hawai‘i. They are a type of brine shrimp and are a favorite meal for fish and shore birds. They can move from pool to pool through

tiny fractures and lava tubes. If you are lucky, you may also see **pinao 'ula** the black-orange damselfly which is an endangered species.



Pinao 'ula



'Ōpae 'ula

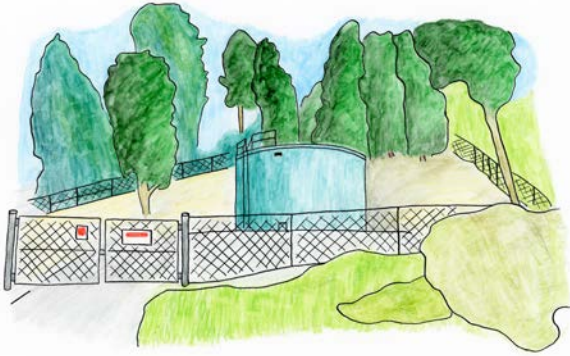
Science Notebook

Many anchialine pools on the island are polluted. What do you think happens to the life that relies on these pools when they get polluted?

Cold freshwater wells up in springs in anchialine pools and in the surf zone. The mixing of the fresh and salt waters creates a blurry texture to the water called a **halocline**. This makes it difficult to see clearly when you are snorkeling. Ancient Hawaiians swam down to these upwellings to catch the freshwater in an inverted gourd. Anecdotal stories indicate that upwelling zones were more plentiful just a couple of decades ago.

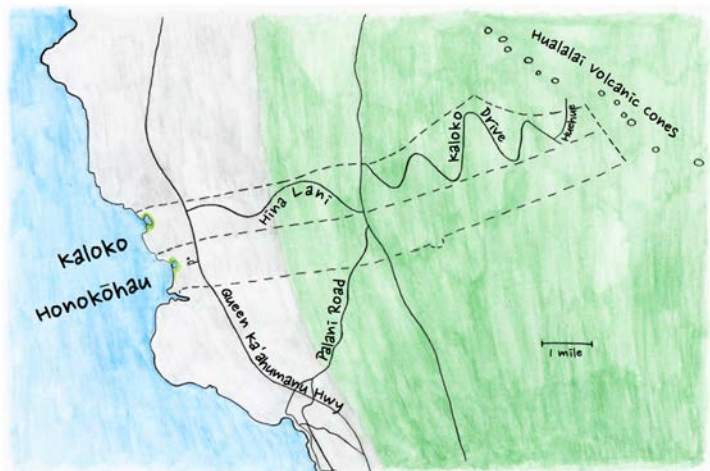
Science Notebook

What would happen to the saltiness of the anchialine pools if the amount of freshwater reaching the ocean decreases?



One of many groundwater pumping station in the Kaloko ahupua'a.

The ancient Hawaiian community grew to hundreds of thousands and lived sustainably for hundreds of years. They developed systems that were sensitive to the environment. Their system for dividing the land was one such system. Kaloko-Honokōhau National Historical Park straddles the coastal portion of four **ahupua'a** land divisions, Kaloko and Honokōhau are the two main ones. Ahupua'a are swaths of land that extend from the sea to near the mountain top.



The native Hawaiians divided the land this way because they realized that the mountain was connected to the sea by water flowing below the surface in these regions through cracks and lava tubes.

As clouds are forced to rise as they blow over the tops of mountains, they cool. Since cold air cannot hold as much moisture as warm air, the clouds begin to precipitate. The heavy wet clouds that form over the Pacific Ocean come from the northeast and drop most of their water on the eastern slopes of the island. The west side of the island is much less wet, but precipitation still oc-

curs. Clouds linger on the west side of the mountains forming what is called a **cloud forest**. Moisture from the clouds bathes the leaves of



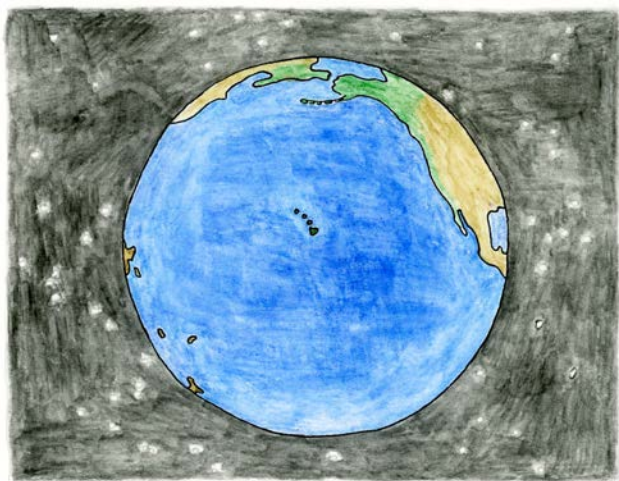
trees in dew that drips on and **infiltrates** into the soils and rocks below. The ahupua'a relied on water supplied by clouds covering a relatively small patch of forest.

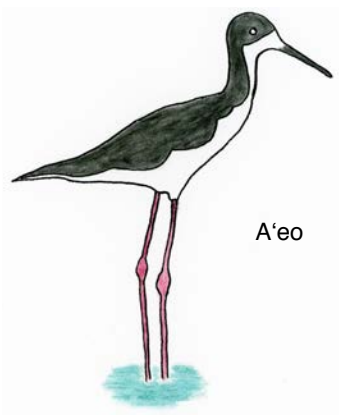
This small amount of water input was enough to meet the freshwater needs of animals and people who used only what they needed to sustain their lives.

Today, the freshwater springs of Kaloko-Honokōhau are no longer drinkable because their flow rates have diminished to the point where saltwater from the ocean mixes with the freshwater too quickly. People now have the ability to pipe good drinking water from place to place, but unfortunately, wildlife do not have this luxury. If the pools of water along the coast become too salty or polluted, the native plants and animals will disappear. Many Hawaiian elders tell stories of abundant and diverse plants and animals of their youth that were central to their local culture. This is a loss that we are only just beginning to understand.

The ahupua‘a model sustained large populations for hundreds of years, so we cannot simply blame current trends on population growth. Our modern standard of living and approaches to land management are altering the land in profound ways. Perhaps the ancient Hawaiian culture’s greatest contribution to the world is their demonstration that large populations of people can live sustainably on an isolated island if they are sensitive to the environmental conditions of the Earth and sky. This is a message that the world

needs to hear in this age of globalization. After all, the blue marble is just an island floating in the sea of space.







Uncle Fred Cachola

What did you tell the US Congress in 1978 that helped establish Kaloko-Honokōhau National Historical Park?

We said, take a good look at this place, keep this environment pure as possible. Try to create protective zones, buffer zones around the park because we saw this tsunami of urban and commercial development coming in and we had to protect this place from that. We said it loud and clear. Watch out for the water! It was known, our ancestors knew, you mess around with the water mauka (in the uplands), you're going to hurt these fish ponds down here. We don't have to be hydrologists to know that. So we got the park established in 1978 and it was a great day, it really was.

Why was your report to congress was called the *Spirit of Kaloko-Honokōhau*?

We put into that report a lot of the physical realm and significance of the ponds and the walls, the salt pans, the heiau and all of that. But what we tried desperately, and we found it very difficult, was the spiritual significance. What it meant for Hawaiians when you go there and you just feel the difference. You look. You touch. And you're right there with your ancestor. You know, he put that rock there. Why did he put it here? Why wasn't it there? You know that he ate from this pond. They didn't like the word "culture" because we talked about the spirit; they can't handle spirits! They can't handle feelings. They can't handle that. They can handle petroglyphs, they can handle fish ponds, they can handle water, they can handle all that. The physical is no problem. They can see it, but when we start talking about connecting with the spiritual, they have a hard time. I think they still do.

What are the biggest challenges that the park faces today?

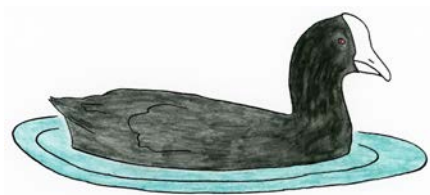
We are battling, battling, battling with people who look at all the lands around it as opportunity for

business, for residential, commercial, boat harbors, tourism... and that little island, I call it a kīpuka. Kīpuka are those precious parts of a mountain or a flatland where lava flows and for whatever reason it flows around an area and it leaves it intact; biologists love it! The native birds love it! The insects, the plants too because here is a kīpuka surrounded, and the rest of it is all devastated by lava. And that's how I see the park. The lava flows are coming, My god! Look at this. Here it comes. Cars, development, two thousand residents! Here comes Costco. Here comes, what's that? Home Depot. What we have is a kīpuka of Hawaiian culture surrounded by chaos. And they need water. Pumping it out. Using it and dumping the waste sewage into holes that are connected to the aquifer! We all know where that wastewater is going. We're battling.

Why are the anchialine pools so important?

You know, water is not just a human need; it's a need for the environment. And when you consider you and that environment are part of the same person, you're all together, you know, and so you hurt one part of that environment, you're hurting yourself. I think they're finally beginning to get

the message. That it is feasible and possible to protect special environments that enrich the soul. And we need that just as much as we need food and water.



‘Alae kea

Materials Needed

2 Clear Plastic Boxes
Cloth bag with 20 pieces of lava
100 ml beaker
2 50 ml beakers
2 short pipettes
2 long pipettes
Metal scoop
Jar of rock salt
Black spongy foam
Sand (Sieved to 0.4 - 1.0 mm)
Blue colored water
Yellow colored water
Colored pencils
Science Notebook

For more information, visit:

www.cns-eoc.colostate.edu/anchialinepools.html



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