Natural History: Geology

Geology of Montezuma Castle

The Verde Valley geology is quite a bit different from that of the rest of northern Arizona. The biggest difference can be seen in the Verde limestone. This is the pale to white stone that you see at Montezuma Castle. In a cave in the Verde limestone is where the Sinagua built Montezuma Castle. The Sinaguans lived in these dwellings from about A.D. 1125 to 1425, about 875 to 575 years ago.

There are three basic types of rocks: igneous, sedimentary, and metamorphic.

1. Igneous rock is formed either when magma cools below the ground surface or when magma forces its way to the surface (as lava) and then cools to form rocks. One example of an igneous rock is granite.

2. Sedimentary rock is the type of rock that you see all around you at Montezuma Castle. Sedimentary rock is formed by the wearing away and removal of other rocks. The eroded rock gets transported by water or wind to lakes and oceans; this rock debris and other organic debris from plants settle to the bottom of the lakes and oceans and eventually turn into a rock layer.

3. Metamorphic rocks form far under the earth's surface. These rocks are created when other rocks get buried under a lot of other layers of rock. Eventually, the rock that got buried is changed into a different type of rock. This is because the more material that builds up over the buried rock, the more heat and pressure there is to squish and change the buried rock into something new. Remember, metamorphosis means "to change or alter form."

The white Verde limestone that forms the cliffs you see at Montezuma Castle is a sedimentary rock. It started to form about eight million years ago. That was when a volcanic eruption dammed the Verde River at the southern part of the Verde Valley, where it left the valley. For the next six million years, the Verde River was backed up, and because the water had nowhere to go, numerous swamps and lakes formed. (Compare that to the desert you see today!) Rivers were coming in from northern Arizona to keep the lakes filled. These rivers were full of debris from other rocks up north; this debris and other plant debris settled to the bottom of the lakes. About two million years ago, the natural lava dam finally broke because the lake had gotten so big and had eroded so much of the dam that it was not strong enough to hold back all that water anymore. The lakebeds eventually dried out, and all the debris turned into sedimentary rock. Today we call that rock the Verde limestone, the same rock that the Sinagua built their homes in.

Geology of Montezuma Well

Montezuma Well is another place in the Verde Valley where the Sinagua lived. The same white Verde limestone

that is found at the Castle is also found at the Well. When you climb up to the main overlook at Montezuma Well, make sure you look to your left. You will see a cave in the Verde limestone where the Sinagua built their homes.

The Well is a limestone sinkhole that was formed in the Verde limestone. It was created about 10,000 years ago when the roof of a large underground cavern collapsed. There is a natural spring underneath the lake that brings 1.5 million gallons of water into the Well everyday. If so much water is coming into the Well, then why doesn't it fill up and spill over with water? The answer is that there is a hole in the Well. If you follow the trail down into the Well, you will come to a big cave. By this cave the water goes underground and escapes from the Well. Incredibly, the amount of water coming into the Well and the water leaving the Well are just about equal. Therefore, the level of the Well always stays the same.

Red Rock Country

The northern part of the Verde Valley is often referred to as "Red Rock Country" because as you look around the landscape, most of the rocks are red. The red rocks have been sculpted by millions of years of erosion, which is the wearing away and movement of rocks by wind and water. They now stand as spectacular rock formation: the mesas, buttes, and pinnacles of the Sedona area. Why are the rocks red? These rocks are red because they were formed in an environment similar to seashores in a desert. There was lots of water, and that means lots of oxygen. There were also other rocks in the area that contained the metal iron. When you mix together the iron and the oxygen, you get a metal that scientists call hematite. When enough hematite is present in the soil, it turns the rocks red. Have you ever seen what rust looks like? It's the same idea. When you leave things that have iron in them outside in the rain for a long time, the oxygen in the water reacts with the iron and turns the metal red, or "rusts" it.

The people who built Montezuma Castle and other Southwestern cultures used the mineral hematite as a pigment. When you crush hematite you get a reddish powder that can be mixed into paint. Prehistoric people used this paint to color objects like baskets and pottery. More recent groups have also used it as body paint or for other skin decoration.

Educator's Outline for

IS IT LIMESTONE?

OBJECTIVES

After completing this exercise the student will be able to

1. determine if a rock is limestone by discovering the presence of calcium carbonate.
2. learn how limestone is formed in a natural environment.

GRADES: 5 TO 8

AZ CURRICULUM STANDARDS:
Science Standard 1 – Science as inquiry
Science Standard 6 – Earth and space science
Language Arts Standard 3 – Listening and speaking

GROUP SIZE: 5 to 30

DURATION: 1 hour

SETTING: classroom

MATERIALS: household vinegar, eye-dropper, samples of limestone and basalt

PROCEDURE:

1. Divide students into small groups. Have enough vinegar, eye-droppers, and rock samples for each group.
2. Have one student in the group dip the eyedropper into the vinegar, and then drop a small amount on the limestone rock. Have the students watch carefully and record any observations. Now have another student drop a small amount of vinegar on a basalt rock, while the others watch and record their observations.
3. Ask the students to discuss with their groups the results of each test. Why did the vinegar bubble on one of the rocks and not the other?

Limestone is deposited by water — in this case by an ancient lake in the Verde Valley.

Through photosynthetic activity of plants, carbon dioxide was removed from the water, causing the precipitation of lime, (calcium carbonate) which deposited on the bottom of the lake. The sedimentary material became limestone. When an acid is placed on the surface of a rock that contains calcium carbonate, the carbonate gas is released and can been seen as bubbles on the rock. Limestone is a very common rock in the Verde Valley.

Montezuma Castle was built in an alcove carved by weathering in the Verde limestone. Montezuma Well was made when a cavern in a limestone mound collapsed, forming a sinkhole around a natural spring. The many pockets and holes in the limestone were weathered out by slightly acidic water. When atmospheric carbon dioxide and organic material are diluted in water, it creates a weak acid called carbonic acid. This acid dissolves the limestone and carries the lime in solution. It is re-deposited farther downstream along the irrigation ditches, resembling concrete.

OBJECTIVES

After completing this exercise the student will be able to

1. understand what an evaporate is and how it is produced
2. appreciate the importance of salt as a trade item.

GRADES: 5 TO 8

AZ CURRICULUM STANDARDS:
Science Standard 1 – Science as inquiry
Science Standard 5 – Physical Science
Science Standard 6 – Earth and space science

GROUP SIZE: 5 to 30

DURATION: 1 hour

SETTING: classroom

MATERIALS: salt, water, clear dish

Educator's Outline for

EVAPORATES

PROCEDURE:

1. Divide the students into small groups. Each group should be supplied with a clear dish, warm water, and table or Epsom salt.

2. First, have the students add the salt to the warm water. What happens to the salt? Next, pour the salty water into a clear, shallow dish. Set the dish in a sunny place until all the water evaporates. What does the dish look like? What is left in the dish?

Salt has been mined in the Verde Valley near Camp Verde both prehistorically and historically. Mineral salts are left behind when a body of water without an outlet evaporates. There are many basins in the West that contain very salty water or dried beds of mineral salts called playas. The Sinagua mined salt. They traded it, possibly for pottery or shells. Salt has been an important trade item for many cultures around the world.