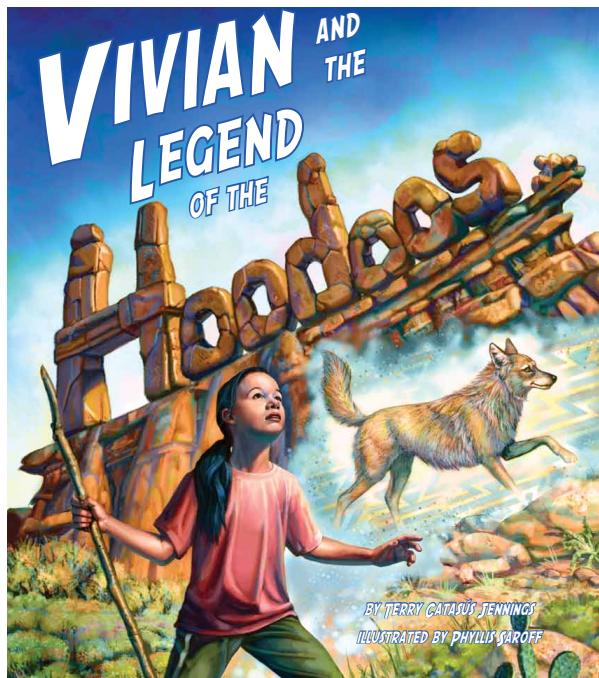


Vivian and The Legend of the Hoodoos

BY TERRY CATASÚS JENNINGS

Erosion Teacher Guide



Long ago, the Old Ones drank all the water, ate all the pine nuts and left nothing for the other creatures. Sinawav the coyote punished them by turning them into rocky hoodoos. Now their spirits shimmer like shadows at the base of their stone columns. When children are bad, the hoodoos are there. Vivian has heard the stories, but this year she has something more important on her mind: basketball tryouts! When Grandma takes her up on the mesa to pick pine nuts, Vivian is too impatient for the old traditions and would rather practice her basketball shots than respect the trees. Will she listen to Grandma when she teaches her about her Paiute ancestors?

This is one of two teacher's guides: Native Culture and Erosion. Native Culture Teacher Guide may be obtained at: <http://www.terrycjennings.com/Teacher-Resources---Erosion.html>

For core standards to which *Vivian* is aligned, please visit: <http://www.arbordalepublishing.com/Standards.php>

For publisher's teacher guides and activities on sound, please visit: http://arbordalepublishing.com/documents/TeachingActivities/VivianLegend_TA

For additional downloadable activities from author, please visit: <http://www.terrycjennings.com/Teacher-Resources---Erosion.html>

Pre-Reading Discussion

Ask students to share what they know about geology, weathering and erosion. Choose several states: Southwestern Utah where *Vivian* takes place as well as say, Florida or Texas, Washington or Oregon, Virginia or North Carolina. How is the geology of these areas different? What similarities do they see, what differences?

How does the geology of the earth change over time? Is it a slow process, or a fast process? What causes these changes. Discuss how long native people have inhabited the Americas and in the United States in particular. As far as we know today, humankind originated in Africa. How did humans end up in the Americas?

Lastly, ask students about hoodoos. How could such a geologic formation be created?

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Discussion



Geology is the study of rocks and the processes that make and change the surface of the earth. There are three kinds of rock: **igneous** which is formed by fire like

volcanoes, or by cooling magma which rises to the surface of the earth; **sedimentary** which is rock made from little pieces of other rocks which have fallen and been carried to the sea where the pressure of the other sediments over millions of years changes the lower sediments to stone; and **metamorphic** which is rock that has changed under heat and pressure under the surface of the earth. Both igneous and sedimentary rocks can be changed by heat and pressure. The particles that make up the rocks change and a new rock is formed. So both igneous and metamorphic rocks can become metamorphic. Basalt, an igneous rock, under heat and pressure will become granite, a metamorphic rock. Limestone, a sedimentary rock, under heat and pressure, will become marble a metamorphic rock. These changes take place under the surface of the earth.

Tectonic forces move the rocks that make up the surface of the earth. They move continents, raise mountains, split plains. Tectonic movements cause volcanoes to erupt and earthquakes to shake the earth. They change the landscape of the land. Sometimes slowly. Others swiftly and violently.

But there is another set of geologic processes which change the landscape of the earth. Weathering and erosion are the twins that work slowly and gradually most of the time, but sometimes they work abruptly and with overwhelming force. Weathering and erosion create the beautiful features of our landscape. Many of the features we visit at national parks. They create the hoodoos of Vivian's legend.

Weathering and Erosion Water, wind, ice, and changes in temperature, wear rocks down. They split pieces off the mother rock. Pieces as large as house size boulders and as tiny as a grain of sand. We call this weathering. Weathering can be mechanical—caused by wind, ice and temperature changes—or chemical. Chemical weathering

is caused when water, carbon dioxide and oxygen act with the minerals in the rock and turn the rock softer, easier for mechanical weathering to take place. Erosion is what happens after weathering takes place. Water and wind carry the particles away from the mother rock. Weathering and erosion make the beautiful formations that call our attention like arches and windows and HOODOOS!!!



The Legend of the Hoodoos is a Paiute legend. It tells how coyote, angry at the greedy behavior of the Ancient Ones, turned them into rocky columns. This legend originated because, in Paiute lands, hoodoos are plentiful. And they are plentiful because sandstone is plentiful. The sandstone in the area where Southern Paiutes live is called Navajo sandstone, because it is primarily red. The iron particles that made up the rock give it color. Oxidized iron, like rust, comes in many colors and makes the rock many shades from red, to yellow, lavender, pink and even white. Like the colors of the Ancient Ones in the legend.

All types of rock erode--igneous, metamorphic and sedimentary. Hoodoos can be formed from all types of rocks. But sedimentary rock is the softest. It's the easiest to erode. That's why most hoodoos are formed in areas where sandstone is plentiful. At Bryce National Park, a basin of hoodoos is the centerpiece of the park. Hoodoos occur all along the areas inhabited by the Paiutes. It's easy to see how the Legend of the Hoodoos might have come about as a means of teaching the next generation about their responsibility to the land and to others.



How Hoodoos Form Hoodoos are formed when rushing water carves canyons on sandstone. When canyons are parallel, they form fins—free standing rock walls between the canyons. Water collects in cracks (joints) across the fins. When temperature goes down and the water freezes, the joints get bigger and deeper.. After millions of years of cycles of freezing and thawing (ice wedging), the cracks become deep enough that columns separate. These are hoodoos. Hoodoos will continue to erode and eventually become sand.

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Erosion by many other names (see accompanying Power Point with examples)

Rushing water over millions of years opens canyons. Skinny canyons and grand canyons. It can undercut rock and create ledges. Enough undercut, the ledge can fall. Rushing water can smooth out swirls in the rock.



Dropping water digs out ponds and pools wherever it falls. Ponds and pools in sand or mud, may be erased when the water's gone. Ponds and pools dug into rock remain and refill with rain and snowmelt, over the years.

Streams and rivulets which flow gently over the same rock slice channels wherever they flow.

Rushing water and gentle flows erode, but so does seeping water. Water seeping through a crack on top of a large rock follow channels within the rock. When the water droplets find rock which is softer than the surrounding rock, they weather and erode it, making holes. The holes grow into pockets and then expand into caves.



Erosion swift and violent:

The force of flood water caused by torrential rains and hurricanes is swift and destructive. Erosion associated with flood waters carries away soil, rocks and structures that may stand in its way. Slow erosion is seldom dangerous except in instances when large boulders are separated from a mother rock and fall on a place which causes loss of life.

Swift eruption caused by floods can be very dangerous. The force of the water is compounded by the mass of eroded soil and structures it carries away.



Seeping water creates alcoves (arches which still have a back to them) in the same way that it makes holes, and pockets and caves in rock.

Alcoves can eventually break through into windows



and arches

Water is not the only element that erodes. Wind, aided by water, chisels sandstone to razor sharp fins. Wind-borne grains of sand scour the sides of the fins, sculpting them into fanciful shapes.



The Cycle Never Ends

Weathering and erosion wear down and reduce rocks and hoodoos and arches to grains of sand which are carried by rivers and streams to the ocean where sediments collect and eventually through the pressure of accumulated weight the sediments turn to rock and wait to be thrust up by tectonic forces to begin the erosion cycle again.

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Interesting Facts



Hoodoos occur everywhere, formed from all kinds of rocks. Hoodoo is a scientific geologic term. Hoodoos are also known as goblins, tent rocks, columns and chimneys

- Ice wedging which is responsible for creating hoodoos can also separate gigantic boulders from mother rocks (over millions of years).
- Sandstone in the area where Paiutes live is primarily red in color. That's why it's called Navajo Sandstone. Why isn't it called Paiute Sandstone? There are several tribes that live in the area. In addition to the Paiute, the Navajo and the Hopi also live in the area. Utes are nearby. There are more Navajo than there are Paiutes.
- The red in Navajo Sandstone is caused by iron within the rock. The colors can fade to yellow, lavender, pink and even white. These colors result from the oxidation of the iron within the stone. Different stages of oxidation (rust) create different colors. Sandstone which is totally white has been leached of its iron by water.



- One of the rules of geology is that all sediments are laid horizontally. That should mean that when you see layers on a rock on the side of the road, all the layers should be horizontal. But they're not! When you see diagonal or vertical layers on rocks, that means that tectonic forces lifted that rock into that position. When layered rocks are not horizontal, they can erode faster because water can seep in between channels between the layers

- As water runs through channels in sandstone, it carries iron with it. The iron can pool in pockets inside the rock. Pockets that range in size from smaller than a pea to bigger than a golf ball. The iron mixes with other minerals in the rock and forms solids called concretions. The concretions grow until they fill the pocket or cavity. Now erosion takes over. As the outer rock weathers and erodes, the concretions are exposed. Made from a concrete of iron and other minerals, the concretions are much harder than



the surrounding stone. As the stone erodes, the concretions are set free. The hard little balls often litter the feet of sandstone or lay on flat surfaces.



- The Hopi believe that if they keep the small balls in their homes, the spirits of their ancestors feel welcome to return to their homes. While some call the concretions Moqui Marbles, Moqui is a derogatory word to Hopi Indians. It is the term for death, but also for trash or refuse pile.
- Mars explorers found concretions in the red planet. Scientists called them blueberries. They are evidence that there was once water on Mars.
- A petrified tree trunk about four feet wide which rested for millions of years across a fault was cut into two pieces when tectonic forces lifted one side of the fault.
- One element of the proof that the Theory of Plate Tectonics was correct was the matching of rock layers and their positions in different continents

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QUESTIONS TO PONDER:

- If you see a hoodoo at a National Park when you are eight. How do you think it will look if you return at age eighty?
- What could be more damaging to human beings, slow erosion of rock, or swift and violent erosion of soil due to floods?
- Why are many of the beautiful geologic structures of the United States in National Parks?
- Why is it important to preserve geologic formations in National Parks?

WRITING ACTIVITIES - POETRY

Combine writing and science by having students write poetry—free verse or rhyming—about a geologic structure or processes. Students can choose a picture of a geologic formation from the Power Point Presentation included in the Teacher Activities or from pictures of National Parks.

SCIENCE ACTIVITY - CAUSES OF EROSION

Match pictures of erosion with the cause of erosion—rushing water, seeping water, flood water, gentle water, dropping water, wind. (Handout provided)

Visit <http://www.terrycjennings.com/Teacher-Resources---Erosion.html> for detailed lesson plans for other activities, and power point presentation of Paiute artifacts as well as handouts and research materials for this teacher guide.

RESOURCES

For core standards to which *Vivian* is aligned, please visit: <http://www.arbordalepublishing.com/Standards.php>

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For Erosion Power Point visit: <http://www.terrycjennings.com/Teacher-Resources---Erosion.html> and click on Erosion Power Point button to download the presentation.

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