



**NATIONAL
CONSERVATION
LANDS**

Rocks Rock! Student Workbook

Hit the Trails Learning Education Initiative

Grade 4

Kasha-Katuwe Tent Rocks
National Monument



HIT THE TRAILS LEARNING EDUCATION INITIATIVE

In order to impress the importance of environmental education, natural resource protection, conservation, and restoration, the Bureau of Land Management Kasha-Katuwe Tent Rocks National Monument (Monument) has created an educational initiative called "Hit the Trails Learning." This initiative is aimed at increasing environmental literacy through accessible outdoor educational opportunities for America's youth, veterans, students, seniors, and those with disabilities.

The goal of this initiative is to provide opportunities for schools, universities, and accredited learning institutions to receive formal and informal education on public lands at little to no cost. This is to ensure teachers and students have the opportunity to learn about natural resources in a unique outdoor classroom, while fostering the next generation of land stewards.

An additional goal is to provide accessible educational opportunities for underserved individuals and communities through employment, mentorship, volunteerism, internships, and additional hands-on paid and unpaid employment opportunities. These opportunities are intended to enhance the quality of life for individuals and the livability of the communities we serve.

STEWARDS OF THE MONUMENT

As you go through this workbook before your visit to the Monument, we want to thank you in advance for your thoughtful preparation. It is our pleasure to bring students to the Monument and share what knowledge we have, as Interpretive Guides, about the ecology of the Monument. Aldo Leopold, a conservationist, forester, and founder of the Wilderness Society wrote a series of essays (some of which were turned into books) describing the importance of wilderness and the preservation of native flora for ecological health. From these writings, he formed a land ethic that states, "land is to be loved and respected," as an extension of our ethics. What is your set of ethics?

How do you value the land on which you live? Why is it important to protect the plants, animals, and human histories that form the essence of the Monument? Thank you again for your participation. We hope you will join us in being stewards for the Monument and all public lands.

Welcome to Kasha-Katuwe Tent Rocks National Monument!

In order to safely enjoy and preserve the Monument, we ask that you respectfully observe the following guidelines:

- Bring drinking water, as there is no water available in the Monument.
- Bring seasonal weather protection: sunscreen, hat, and jacket.
- Wear good walking shoes, and pants that protect you when seated on the ground.
- Pack a lunch and/or snacks. Carry out all trash to one of our receptacles.
- Bring all educational materials needed as discussed in your classroom.
- Stay with your assigned group and adult.
- Hike on designated trails only.
- No climbing on any of the geologic formations including the cave.
- Absolutely no carving into the rocks.
- Graffiti and defacing of signs, benches, restrooms, etc. is strictly forbidden.
- Enjoy, photograph, but do not take any natural items, including Apache Tears.
- Please do not disturb or destroy wildlife or plants.

TAKE NOTHING BUT PICTURES

LEAVE NOTHING BUT FOOTPRINTS

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Name: _____

Date: _____

Rock Classification

Listed below are some igneous rocks. Write down whether you think each rock cooled slowly, quickly, or if it is rock from the original source (volcanic material).



Basalt:



Granite:



Pumice:



Obsidian:

Geologists look at a rock's appearance and try to identify what elements make up the rock to help classify it. From the pictures of sedimentary rocks below, can you match which process formed them? Some of the rocks may have more than one process.



This sedimentary rock is formed from compaction of silt and clay/mud.



This sedimentary rock is formed from the bones of sea animals that have been crushed together to make a rock.



This sedimentary rock is composed of sand grains that have been reduced by weathering or transported by moving water.

Let's look at the following sedimentary rocks. Can you tell if each one is fine-grained, conglomerate, or breccia? Try to label each: fine-grained, conglomerate, or breccia.



The following rocks are metamorphic rocks that were formed from heat and pressure.

Metamorphic rocks can be identified by the lines on them. Can you find the lines on each of these rocks? Circle the line on each rock if you can find it.



Gneiss (pronounced nice)

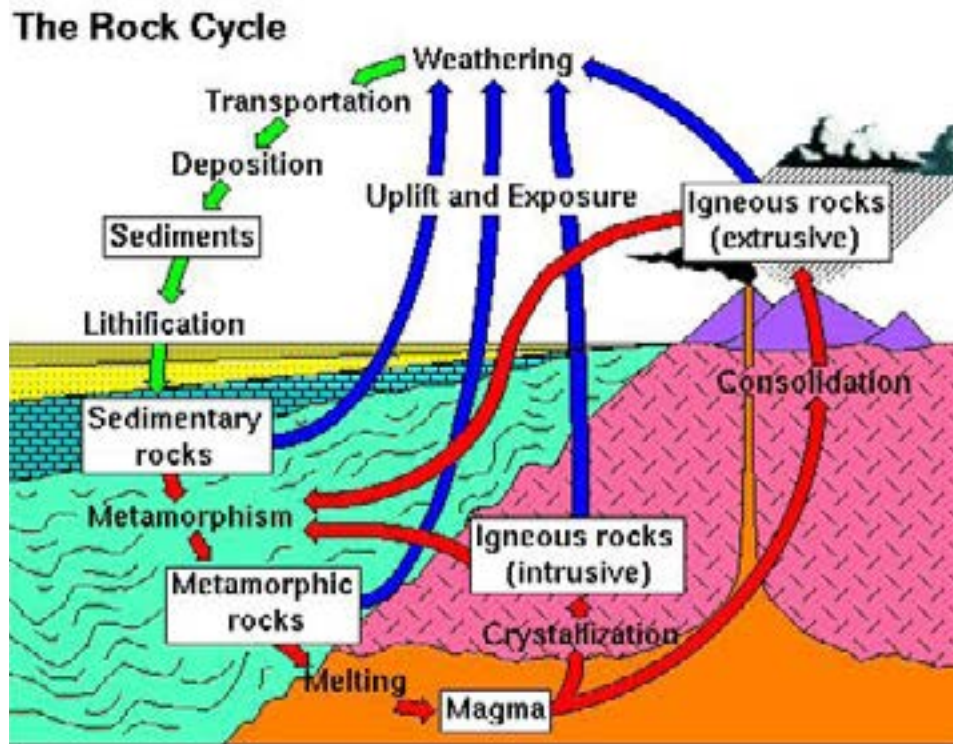


Marble



Slate

Below, observe the intricate process by which rocks are formed: The Rock Cycle!



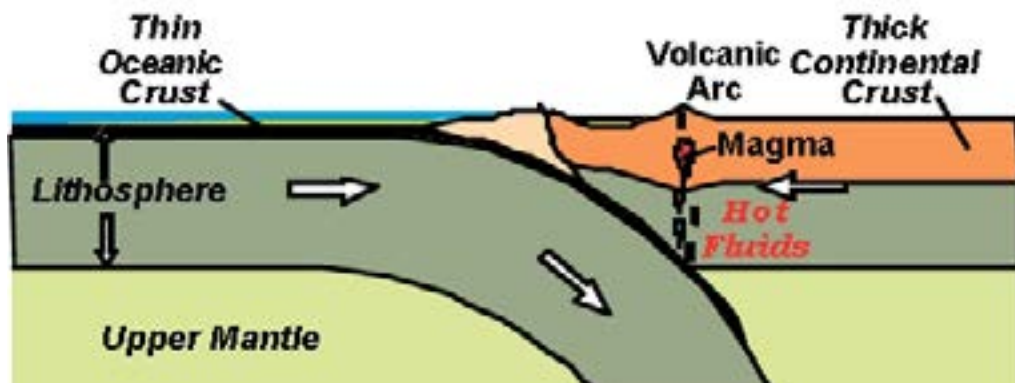
Earth's Changing Surface: Earthquakes

Earthquakes occur in earthquake zones located along the plates underneath the Earth's surface. As the plates smash into each other and form a subduction zone, they create a fault.



Subduction is the process of a plate sliding down and below another. The subduction zone is the area between the plates. This is an example of a subduction zone:

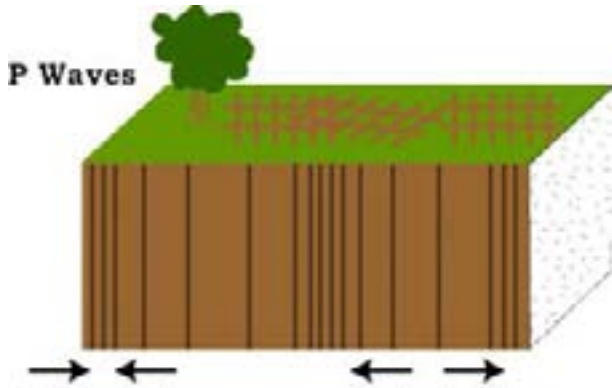
Subduction Zone



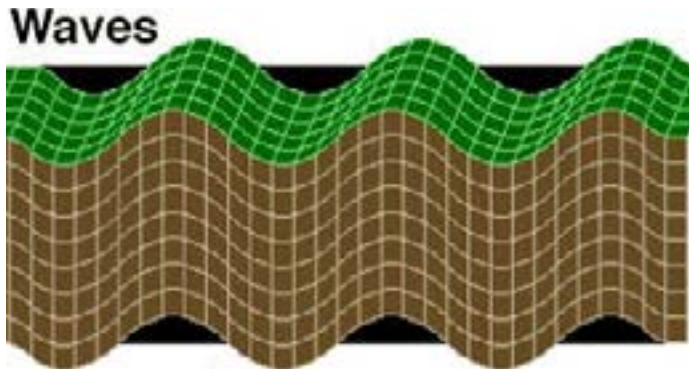
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All earthquakes produce earthquake waves. Some are called Primary Waves or "P Waves." There are also Secondary or "S Waves."



Primary waves can travel through rock and water.

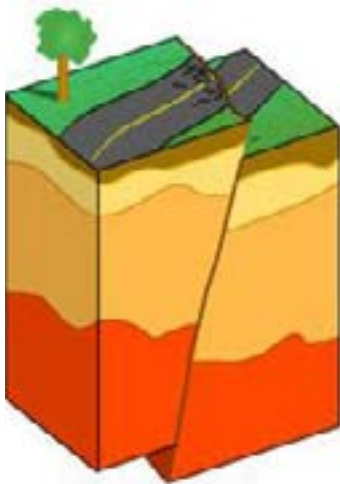


Secondary waves can't travel through rock and water, but can damage buildings or structures.

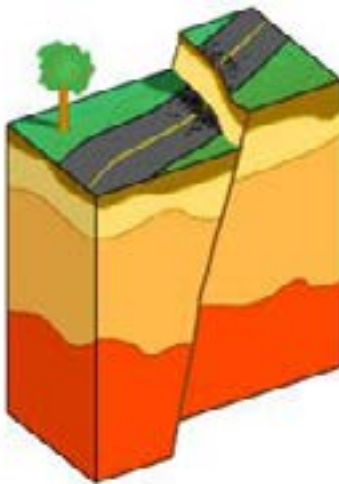
Can you draw a picture below of what an earthquake might look like in your area if it were hit by S waves?

Earthquakes occur when faults shift. When you visit the Monument, you will have the opportunity to look for some of these faults. Three types of faults are: reverse, normal, and strike-slip.

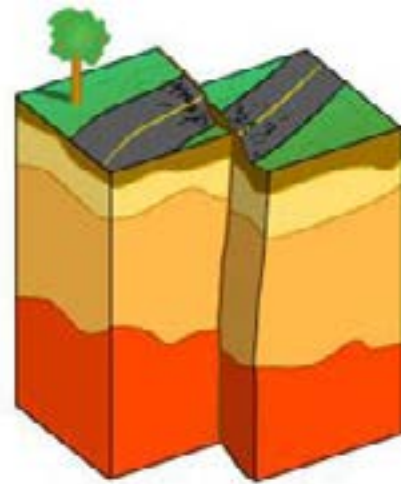
Notice how each fault works. The **reverse fault** pushes up from the bottom; the **normal fault** slides from the top, and the **strike-slip fault** moves equally in opposite directions. Decide which type of fault is being shown in the pictures below.



Reverse fault



Normal fault



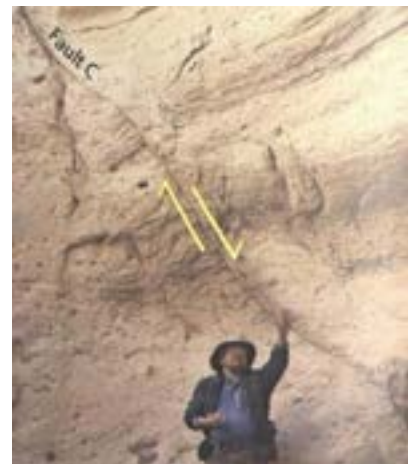
Strike-slip fault



Fault A: _____

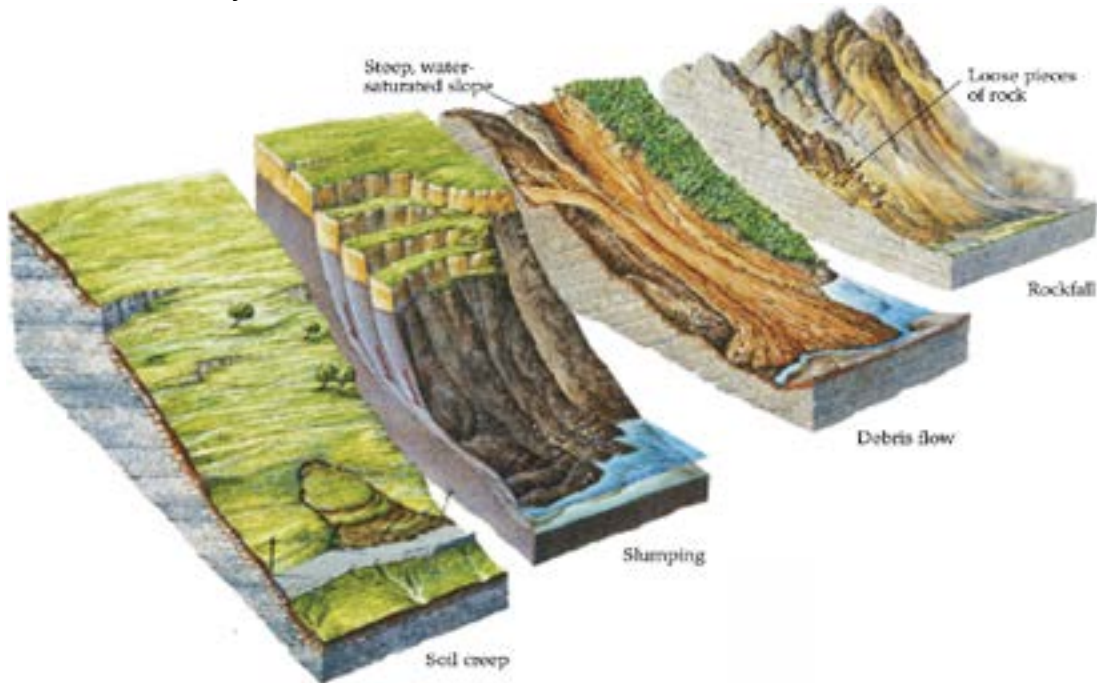


Fault B: _____



Fault C: _____

The following pages contain photos and images of the effects of slope mass movement, whether that be an earthquake, avalanche, landslide, or other form of geologic movement. Below is a diagram displaying some of the types of mass movement commonly seen.



“Types of Slope Mass Movement.” Slope Mass Movements in Adelaide Region. N.p., 04 June 2015. Web. 12 July 2016.



Kyodo, AP. “Major Quake in Tohoku Kills Six | The Japan Times.” Japan Times RSS. The Japan Times Ltd., 15 June 2008. Web. 12 Feb. 2016.



Warford, Jim. Landslides: Riverside Drive, Corner Brook. 2005. Corner Brook. Newfoundland Labrador Dept of Natural Resources. Web. 15 Feb. 2016.



**Dunscombe
Cliff, Devon
County, United
Kingdom**

*Marine and
Coastguard Agency.
"Higher Dunscombe
Cliff, Salcombe
Regis." Dorset
Geologists
Association, 4 Jan.
2006. Web. 12 Feb.
2016.*

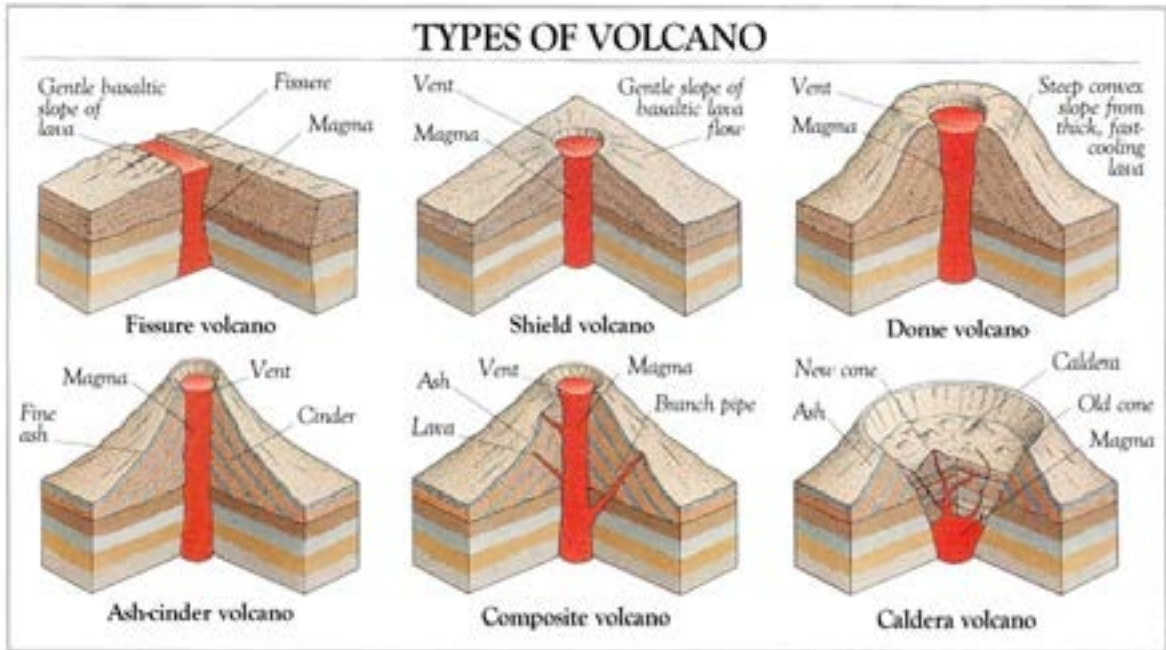
**Whidbey Island,
Washington State**

*Reporter, Daily Mail.
"Insurance Companies WON'T
Cover Devastating Damage
Inflicted by Massive Landslide
as Experts Warn the Ground
Could Continue Moving for
Weeks to Come." Mail Online.
Associated Newspapers, 28
Mar. 2013. Web. 12 Feb. 2016.*



Yosemite National Park

*Hayes, Garry. "A Tale of Two Slides:
Mass Wasting in the Yosemite
Region." Geotripper: News and Views
from the Geologic Realm. N.p., 16
Apr. 2011. Web. 12 July 2016.*

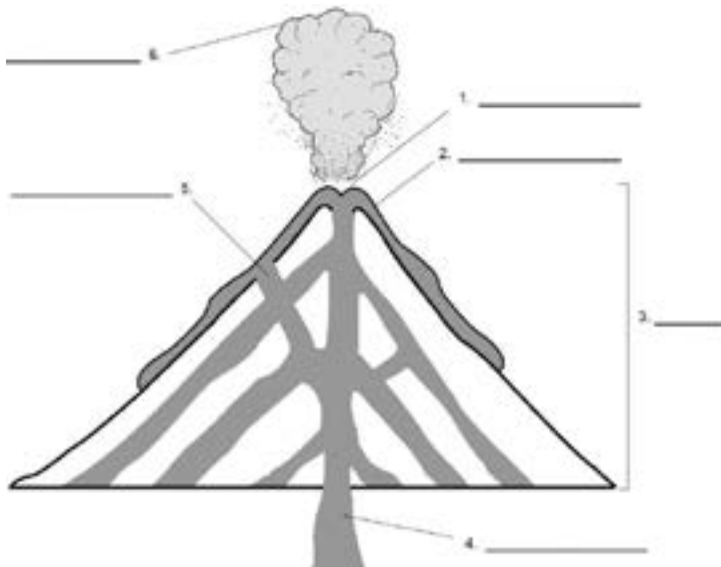


"Vulcanicity and Seismicity." *The British Geographer*. Weebly, n.d. Web. 12 Feb. 2016.

Name: _____
Date: _____

Parts of a Volcano

Use the terms in the word bank to label the parts of a volcano



Word bank:

- MAGMA
- CRATER
- LAVA
- CONE
- VENT
- DUST, ASH, AND ROCK

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Glossary

biotic - the absence of life or living organisms

Breccia - a rock composed of sharp fragments embedded in a fine grained-matrix (as sand or clay)

Conglomerate - a sedimentary rock that contains rounded pebble-size particles. The space between the pebbles is generally filled with smaller particles and/or chemical cement that bind the rock together.

Cementation - the process by which sediment is lithified by precipitation of mineral cement, such as calcite cement, among the grains of the sediment.

Compaction - Tighter packing of sedimentary grains causing weak lithification and a decrease in porosity, usually from the weight of overlying sediment.

Deposition - the settling of materials out of a transporting medium.

Erosion - the act or state of eroding, state of being eroded, the process by which the surface of the earth is worn away by the action of water, glaciers, winds, and waves.

Fault - A break in the continuity of a body of rock or of a vein, with dislocation along the plane of the fracture (fault plane).

Geology - the study of the Earth, the materials of which it is made, the structure of those materials, and the processes acting upon them.

Igneous - rocks formed by the cooling and solidifying of molten materials. Igneous rocks can form beneath the Earth's surface, or at its surface, as lava. Granite, solid volcanic lava, and basalt are examples of igneous rock.

Landslide - the movement of rock, soil, volcanic ash, or other material downslope under the influence of gravity.

Lithification - the processes through which sediments are converted into sedimentary rock, including compaction and cementation.

Magma - molten rock, generally a silicate melt with suspended crystals and dissolved gases.

Melting - to go from a solid state to a liquid state.

Metamorphic - alteration of the minerals, textures, and composition of a rock that is caused by exposure to severe heat, pressure, and chemical actions.

Metamorphism - alteration of the minerals and textures of a rock by changes in temperature and pressure, and/or by a gain or loss of chemical components.

Mineral - any of a class of substances occurring in nature, usually comprising inorganic substances, such as quartz or feldspar, of definite chemical composition and usually of definite crystal structure, but sometimes also including rocks formed by these substances as well as certain natural products of organic origin, such as asphalt or coal.

Normal Fault - A fault with vertical movement and an inclined fault plane. The block above the fault has moved down relative to the block below the fault. The dip angle of the fault plane is between 45 and 90 degrees. Normal faults are the typical structural style of divergent plate boundaries and portions of the crust under extensional stress such as the East Africa Rift.

Pressure - the force per unit of area exerted upon something, such as on a surface.

Pyroclastic flow - a hot, high-velocity mixture of ash, gas, and fragmented rock that flows like a liquid down slopes and over terrain.

Reverse Fault - A fault with vertical movement and an inclined fault plane. The block above the fault has moved upwards relative to the block below the fault. Reverse faults are the typical structural style of convergent plate boundaries and portions of the crust that are under compression. Also known as a "thrust fault."

Sediment - material (such as gravel, sand, mud, and lime) that is transported and deposited by wind, water, ice, or gravity; material that is precipitated from solution; deposits of organic origin (such as coal and coral reefs).

Strike-Slip Fault - A fault with horizontal displacement. Strike-slip faults are typically vertical or near vertical and are typically caused by shear stress. They are the typical fault of transform plate boundaries. The San Andreas Fault is the world's most famous example of a strike-slip fault.

Subduction Zone - an area at a convergent plate boundary where an oceanic plate is being forced down into the mantle beneath another plate.

Transportation - the processes that carry sediment or other materials away from their point of origin. Transporting media include wind, water, and mantle convection currents.

Uplift - A structurally high area in the crust, produced by movements that raise the rocks, as in a broad dome or arch.

Weathering - The processes by which rocks are chemically altered or physically broken into fragments as a result of exposure to atmospheric agents and the pressures and temperatures at or near Earth's surface, with little or no transportation of the loosened or altered materials.

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