NATIONAL CONSERVATION LANDS

Rocks Rock! Teachers Guide

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

Rocks Rock!

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Dear Teacher,

Welcome to Hit the Trails Learning: "Rocks Rock" Program. The focus of this program is on the geology that formed Kasha-Katuwe Tent Rocks National Monument (Monument). The students will learn about the three different rock types and how rocks are classified: igneous, metamorphic, and sedimentary through hands on activities as well as in classroom participation. They will also have a better understanding of the different geological phenomenon that form the ever-changing Earth: landslides, earthquakes, volcanic eruptions, and erosion.

The unit is designed for 4th grade students. The activities included provide background information for the students as well as the opportunity to research, learn new vocabulary, and experiment. The worksheets provided engage students in learning about geology. The activities in the field will take place at the Monument during the field trip.

The unit supports the following learning styles:

- *Inquiry-based instruction: Students develop and address questions about how the tent rocks were formed. They will identify different rocks based on texture, form, color, etc.*
- *Social and Emotional Learning: Students participate in small groups in which they will work together to demonstrate the different geological activities such as landslides, earthquakes, volcanic eruptions, and weathering. The students will present a demonstration on each of these geological events.*
- *Each of these activities takes about 45 -60 minute class periods. There are four activities total. These activities will help provide the students with the background knowledge they will need for the field trip to the Monument.*

Common Core Standards

4.P.2.3. Classify rocks as metamorphic, sedimentary, or igneous based on their composition, how they are formed, and the processes that created them.

4.E.2.3. Give examples of how the surface of the Earth changes due to slow processes such as erosion and weathering, and rapid processes such as landslides, volcanic eruptions, and earthquakes.

Table of Contents

Activity 1: Classifying Rocks

FOR THE TEACHER

TIME ESTIMATE: 45 minutes

This activity addresses the following:

- Classifying rocks into igneous, metamorphic, or sedimentary

OVERVIEW

In this activity, students will define igneous, metamorphic, and sedimentary. They will also be able to identify which rocks fall into these categories, inlcuding limestone, basalt, granite, obsidian, pumice, shale, etc. Students will be able to classify the rocks based on texture, mineral deposit, color, and design.

LEARNING OBJECTIVE

Student will be able to define igneous, metamorphic, and sedimentary.

- Student will be able to classify rocks into the categories above by mineral, texture, and composition.

TEACHER PREPARATION

1. Read over background information
2. Make enough copies of the “Rock Classification Worksheet”
3. A glossary is provided

Background Information:

Each rock has its own varying characteristics. The different characteristics are used to classify the rock into one of the following categories: igneous, sedimentary, or metamorphic. For example, a rock with rounded grains cemented together is sedimentary. One with a strong banding and orientation of minerals is metamorphic. The characteristics scientists look for include:

1. The nature of the mineral grains, composition, size, and relationship to surrounding grains; the way the rock occurs;
2. How uniform it is;
3. Its hardness;
4. How it reacts to acid;
5. Its color; and
6. The way in which it breaks. Before trying to identify a rock, break a piece off with a special hammer, called a rock hammer. This will expose a clean, fresh surface.

"When a rock is dirty or covered with lichen or moss, many of its characteristics are obscured preventing you from accurately identifying the rock. Many pebbles are relatively easy to identify without breaking them, but many are extremely difficult, and breaking them usually destroys their interest and charm. As a rule, a pebble catches the eye and is picked up because it is an object, which shows some special effect of color or pattern, often due to layering, veining, or alteration. Such pebbles may be rare and not the common rock types considered here."
http://www.empr.gov.bc.ca/

We will be using two of these techniques to classify rocks: looking at mineral composition and texture. A geologist is a person who studies rocks and how they are formed. When you come out to visit the Monument you study as a geologist does. It can be difficult to look at a picture of a rock and identify it. When you come out to the Monument you will get to see the minerals and deposits up close. For now, let's learn to classify.

Igneous Rocks: Igneous rocks begin as magma (molten rock), which cools and crystalizes into minerals. The rate at whish the rock cools will determine how large or small the minerals/crystals will be. Quick cooling magma will have small crystals that can be seen using a microscope. Slow cooling magma will have larger crystals that can be seen by the naked eye. The second way igneous rocks form is from the original melted rock. These are volcanic rocks. Geologists look at the size of crystals and composition of the rock to classify it.

Metamorphic: Metamorphic rocks also form around volcanoes, but never melt into magma. Instead, metamorphic rocks are put under a lot of pressure and heat which force minerals to be rearranged. Examples of metamorphic rocks are gneiss, marble, and slate.

Sedimentary Rocks: Sedimentary rocks form at the Earth's surface due to accumulation and lithification of sediment. Lithification is a process by which sediments are converted into solid rock by compaction or cementation. Sedimentary rocks are the most common rocks found (www.geology.com). The sediments can consist of smaller rocks, or bone fragments that have been compacted together through chemical processes. For example, bones being compacted form limestone and coal. Other sedimentary rocks are created through weathering. Weathering is the physical disintegration and chemical decomposition of Earth materials at or near the Earth's surface.

http://www.merriam-webster.com

PROCEDURE

Introduce Rock Classification
Discuss the three different areas in which rocks are classified: igneous, metamorphic, and sedimentary. Explain to students that minerals, shape, texture, color, and design can help you classify rocks.

Worksheets
Pass out the Rock Classification worksheet (pg. 3-5 Rocks Rock Workbook or Appendix 1). Have the students try to classify the rocks by the pictures.

Activity
Have students reenact how they think a metamorphic rock is formed by heat and pressure; how a sedimentary rock is formed by weather and smashing bones; and how igneous rocks are formed.

Summarize the worksheets and activity. Check for understanding.

Go online to the www.geology.com webpage and look at different rocks to see if the students can classify them.

ASSESSMENT

Review the worksheets to see if the students correctly identified the different rocks by pictures.

IN THE FIELD

When students are on the field trip, they will have the opportunity to use their rock classification knowledge to identify some of the rocks at the Monument.

"Getting to Know Your Rocks Hike"

This is a guided hike by a BLM Ranger, if one is available. If not, you can request this information in advance.

Activity 2: The Rock Cycle

FOR THE TEACHER

TIME ESTIMATE: 60 minutes

This activity addresses the following:

- What the rock cycle is
- How the rock cycle works

OVERVIEW

In this activity, students will be able to label the rock cycle, and have a better understanding of the rock cycle/how rocks are created.

SUGGESTED MATERIALS

http://www.helpteaching.com/questions/Rocks/Grade_4: This is a free test you can download to assess knowledge about classification and the rock cycle.

http://www.theteachersguide.com/rockcyclelessonplans.htm: This site has excellent information and activities to help build background and understanding on the rock cycle.

Rock Song:
https://www.youtube.com/watch?v=r68iEwYdbh4

LEARNING OBJECTIVE

- Students will be able to label the rock cycle
- Students will have a better understanding of how the rock cycle creates rocks

TEACHER PREPARATION

1. Read over background information
2. Print out free worksheets from the websites listed for suggested materials
3. Utilize Rock Cycle Poster to explain the rock cycle (pg. 6 Rocks Rock workbook or Appendix 2)

Background Information on the Rock Cycle

The rock cycle describes the formation, breakdown, and reformation of a rock as a result of the igneous, sedimentary, and metamorphic processes.

Igneous rocks form from magma or lava cooling and hardening at different rates to create different types of igneous rocks. Weather, erosion, and transportation break up the igneous rock to create soft sediments, mud, and sand. Through compaction and cementation, sedimentary rock is formed from these soft sediments. Sedimentary rocks are rocks composed of pieces of igneous and metamorphic rocks. These sedimentary rocks can also break up back into soft sediment through erosion and transportation. Through heat and pressure, sedimentary rocks can form metamorphic rocks. These metamorphic rocks can be composed of pieces of igneous, sedimentary, and other metamorphic rocks. Metamorphic and sedimentary rocks can be melted into magma through subduction and burial. This magma or lava can cool and harden into igneous rock, thus renewing the cycle. *http://imnh.isu.edu/digitalatlas/geo/basics/diagrams.htm*

PROCEDURE

1. Review Rock Cycle with Students using Rocks Rock Workbook pg. 6 (Appendix 2)

2. Show brief video of the rock song

3. Print and pass out worksheets from suggestions section to give to students

4. Summarize worksheets

ASSESSMENT

Use test from the suggestions of websites listed above to test knowledge on both classification and rock cycle.

IN THE FIELD

When students come to the Monument they will have the opportunity to use their rock classification knowledge to identify rocks. There will be a brief discussion about the rock cycle on this hike as well.

"Getting to Know Your Rocks Hike"

This is a guided hike by a BLM Ranger, if one is available. If not, you can request this information in advance.

Activity 3: Earth's Changing Surfaces - Earthquakes and Landslides

FOR THE TEACHER

This activity addresses the following:

- How earthquakes, landslides, and volcanic eruptions are constantly changing the Earth's surface

OVERVIEW

In this activity, students will learn about the four different types of earthquake waves: P Wave, S Wave, Love Wave, and R Wave. Students will learn about the subduction process and how it relates to earthquakes. Additionally, students will learn about the three different types of landslides: water, seismic, and volcanic.

SUGGESTED MATERIALS

http://www.ringoffirescience.com/basic-earth-science.html: Great activity books for 4th grade science.

TIME ESTIMATE: 60 minutes

LEARNING OBJECTIVE

- Students will be able to list the three different types of landslides
- Students will be able to identify one of the three different types of faults

TEACHER PREPARATION

1. Read over background information
2. Make copies of Earthquake Worksheets (Pg. 7-9 in Rocks Rock Workbook or Appendix 3)
3. Have students complete worksheets
4. Show pictures of landslides included in Pg. 10-12 of Rocks Rock Workbook (Appendix 4)

Background Information: Earthquakes and Landslides

Earthquakes: A sudden movement of the Earth's crust caused by the release of stress accumulated along geologic faults or by volcanic activity. Earthquakes occur when faults shift. When you visit the Monument, you will have the opportunity to look for some of these faults. There are three types of faults: reverse, normal, and strike-slip.

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)

Reverse Fault: A fault with vertical movement and an inclined fault plane

Normal Fault: A fault with vertical movement and an inclined fault plane

Strike-Slip Fault: A fault with horizontal displacement

All earthquakes produce earthquake waves. There are 4 types of earthquake waves: P wave, S wave, Love wave, and R wave. We will be looking at P waves and S waves. 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 one another. A subduction zone is the area between the plates.

P Wave: Primary Waves can travel through solids (granite rock) and liquids (volcanic lava, ocean waves). It moves fast.

S Wave: Secondary Waves travel slower than primary waves. They move in a twisted sideways manner. S Waves can't spring back so it does not move through liquid (lakes, ocean, volcanic lava). It moves rock and solid objects. This wave motion damages buildings and other structures.

Landslides: Landslides take place throughout the United States. There are many types of landslides. The most common are caused by water, seismic activity, erosion, and volcanoes. A landslide is the movement of rock, debris, or earth down a slope driven by the force of gravity. They are also referred to as landslips, slumps, or slope failure. http://www.ga.gov.au

There are three causes of landslides: geology, morphology, and human activity.

Geology: when referring to geology, the rock may be weak, have a fracture, or the layers in the rock may consist of different strengths and stiffness.

Morphology refers the structure of the land, such as vegetation, that holds the soil in place. Fire, flood, wind, and snow all can affect this vegetation causing erosion, which can lead to landslides.

Human activity such as farming, construction, irrigation, deforestation, excavation, and water leakage can all weaken the land's slope giving way to a landslide.

Landslides can involve rocks, soil, water, or a combination of these. A volcano can cause a landslide, which carries ash and lava. Landslides in the mountains may carry large amounts of snow and snow melt. A landslide can move fast or slow depending on the materials being carried. For example, a landslide with a large amount of water will move faster. *http://education.nationalgeographic.org/encyclopedia/landslide*

PROCEDURE

It is recommended to break this section into two teaching classes. In the first class, teach about earthquake waves and faults.

Introduce Earthquakes
Give a brief discussion on the different types of waves: P Waves and S Waves, and how these waves affect the Earth's surface. Discuss faults and where they are located throughout the world. There is a picture on the student's worksheet they can refer to while you are discussing them. When discussing faults you can refer to the pictures on the student worksheets as well. Don't forget to talk about subduction.

Have students complete worksheets on earthquakes/faults

Introduce Landslides
Use the photos from pg. 10-12 Rocks Rock Workbook (Appendix 4). Use the background knowledge you have read over to lead a discussion on landslides. Have students look at photos over a projector and discuss how they think these landslides may have occurred.

ASSESSMENT

Review worksheets students completed on earthquake waves and faults. During Q & A session on landslides check for understanding. Review worksheets to see that the students have understanding.

IN THE FIELD

When students come to the Monument, they will have the opportunity to use their knowledge on earthquakes and landslides by participating in a scavenger hunt for faults, landslides, volcanic materials, weathering, and erosion.

"Exploring Earth's Surface Scavenger Hunt"

This is a guided hike by a BLM Ranger, if one is available. If not, you can request this information in advance.

Activity 4: Earth's Changing Surfaces - Erosion, Weathering, and Volcanoes

FOR THE TEACHER

This activity addresses the following:

- How earthquakes, landslides, and volcanic eruptions are constantly changing the Earth's surface. Continuing the study of Earth's ever-changing surface

OVERVIEW

The students will be learning about the affects erosion and weathering have on the land and how these two processes can change the Earth's surface.

The students will be learning about the different types of volcanoes and how volcanic eruptions can change the Earth's surface.

SUGGESTED MATERIALS

http://www.geography4kids.com/files/land_weathering.html: Great background information on weathering and erosion

http://www.education.com/worksheet/article/weathering-and-erosion: Great free worksheet on weathering and erosion

TIME ESTIMATE: 60 minutes

LEARNING OBJECTIVE

- Students will be able to tell the difference between weathering and erosion
- Students will have a better understanding of how volcanic eruptions can change the Earth's surface
- Use suggested website to print out weather/erosion worksheet

TEACHER PREPARATION

1. Review suggested materials for background on erosion and weathering
2. Print out weathering/erosion worksheet from suggested materials and make copies
3. Make copies of volcano worksheet, pg. 14 (Appendix 5)
4. Print out pg. 13 Rocks Rock Workbook (Appendix 6)

Background Information: Weathering, Erosion, and Volcanos

A volcano is a vent or hole in the Earth's surface through which heat escapes from underground. The heated material underground is the magma, called lava once exposed. Inside the magma there may be rock fragments, ash, or gas (scienceclarified.com). How a volcano affects the Earth's surface can depend on the size of the eruption. Some cause very little damage and have very small eruptions. Larger eruptions can cause landslides, earthquakes, gases in the air, etc.

The pyroclastic flow contains a mix of lava, pumice, ash, and volcanic gases. These flows move very quickly downslope. There are two parts to a pyroclastic flow: the bottom, which consists of fragments that move along the ground, and a cloud of ash that rises above. A pyroclastic flow destroys everything in its path.

There are different ways pyroclastic flows can form. They can form by the collapse of an eruption column, which is when the column ejected upwards into the atmosphere cools and can become too cool and dense to maintain upward momentum. It can also be formed by "boiling over" from the eruptive vent, which is when the material is erupted without forming a high plume and rapidly moves down slope. Finally, a collapse of lava domes or flows are when the front of lava flows/domes become so steep they collapse due to gravitational force (volcanoes.usgs.gov/vhp/pyroclastic_flows.html). When hardened, the lava flow can change the Earth's surface by creating huge grooves, or small canyons. The amount of ash can create new formations the size of hills, mountains, and buttes.

PROCEDURE

Introduce the topic of weathering and erosion Have a brief discussion on the subject. Then have students complete the volcano worksheet (pg. 14 Rocks Rock Workbook, Appendix 5). You can have students refer back to the landslide pictures and discuss how landslides tie into erosion and how this might change the surface of the Earth.

Transition into volcanoes using Appendix 6 (pg. 13) to show the different types of volcanoes. Ask students how they think a volcano might change the Earth's surface. Discuss what pyroclastic flow is and what that means in relationship to changing the Earth's surface. Have students complete the volcano worksheet. There will be more discussion of volcanoes and how the Monument was created.

IN THE FIELD

When students come to the Monument, they will have the opportunity to use their knowledge on volcanoes by participating in a scavenger hunt for faults, landslides, volcanic materials, weathering, and erosion.

"Exploring Earth's Surface Scavenger Hunt"

This is a guided hike by a BLM Ranger, if one is available. If not, you can request this information in advance.

Teacher Answer Sheet

Rock Classification Worksheet

Basalt-slowly
Granite-slowly
Pumice-quickly
Obsidian-quickly

1st rock is limestone and matches the middle definition: The sedimentary rock is formed from the bones of sea animals that have been crushed together to make a rock.

2nd rock is sandstone and matches the third box definition: This sedimentary rock is composed of sand grains that have been reduced by weathering or transported by moving water.

3rd rock is shale and matches the first box definition: This sedimentary rock is formed from the compaction of silt and clay/mud.

Box 1: conglomerate
Box 2: breccia
Box 3: fine-grained

Check to see that the students see the lines on each of the rocks at the end. All have lines in them.

Earth's Changing Surface: Earthquakes Worksheet

Look at student's pictures of earthquakes to see if they have the concept of the S Wave.

Fault A: Reverse Fault
Fault B: Normal Fault
Fault C: Reverse Fault

Parts of a Volcano Worksheet

Volcanoes begin with a crack or a weak spot in the Earth's surface. The crack reaches between 20 and 40 miles inside the Earth to a pocket of melted rock called magma. This hot molten rock is slowly pushed up to the Earth's surface. A volcanic cone and cup-shaped crater form at the top of the volcano. The pressure is released in a volcanic eruption. The magma, now called lava, pours from the crater. Some volcanoes throw out clouds of gas, steam, dust, ash, and rock many miles up into the atmosphere.

1. crater
2. lava
3. cone
4. magma
5. vent
6. dush, ash, and rock

Glossary

Abiotic - 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.

Resources:

http://imnh.isu.edu/
dictionary.reference.com
geology.com
http://www.empr.gov.bc.ca/
http://www.geology.com
http://www.merriam-webster.com
http://education.nationalgeographic.org/encyclopedia/landslide
http://www.ga.gov.au
http://www.scienceclarified.com/
http://volcanoes.usgs.gov/vhp/pyroclastic_flows.html)
http://web.calstatela.edu/faculty/ahamane2/psci183/psci183.activities/psci183.act2.rocks.hand.htm
http://www.windows2universe.org/earth/geology/ig_basalt.html
Gibbons, H. (2009, November). Photo from USGS Scientists Respond to Deadly Samoa Tsunami. Retrieved from USGS Sound waves monthly newspaper: http://soundwaves.usgs.gov/

Appendix 1 Resources:
http://www.pitt.edu/
http://skywalker.cochise.edu
https://www.quia.com
http://www.sandatlas.org
http://www.nature.org/

Appendix 3 Resources:
1st photo: www.decodedscience.org

2nd photo: “subduction zone” volcano.oregonstate.edu

P Waves photo:
https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcRQhhhM8yrlNfakmnFOeMETSJyGlod_5Cfot5XKkKzt6-CfFcNmnQ

S Waves photo:
https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcRr65YPchhNBHGaWHNhV1WlTlkDAqm0wh_-P6d9Ku2WmYVXHvy8P-iTq-A

Fault photo: bubblesdiv1.weebly.com

Photos at Tent Rocks:

Kempter, K. (2009). Kasha-Katuwe Tent Rocks National Monument Trail Map and Geology. Santa Fe , NM: High Desert Feild Guides.

newspaper: http://soundwaves.usgs.gov/

Appendix 5 Resources:

http://www.teachervision.com/