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Volcano is a planetarium program designed to teach your students about some of the basic large-scale geologic history and workings of our planet Earth. The students will learn about different types of volcanoes, how they work, and their association with earthquakes and continental drift. Then we will venture beyond Earth into the Solar System, investigating volcanism on the Moon, Venus, Mars, Io and Triton.

This Teacher's Guide is designed to help you, the teacher, better prepare your students for their upcoming presentation of ***Volcano*** when the Northern Stars Planetarium visits your school. This guide contains background information for you and a few worksheets for you to copy and distribute to your students.

PROGRAM OUTLINE

I. Our Changing Planet: Continental Drift
   A. How the world used to look
   B. How the continents moved to where they are today.
   C. All Dome World Map showing all plates & faults & volcano sites

II. Problems with continental drifting
   A. Earthquakes
   B. Friction – causing heat build-up – volcanoes

III. The different types of Volcanoes
   A. Composite type (explosive). Example – Mount St. Helens
   B. Shield type (quiet). Example – Hawaiian volcanoes
   C. Why? Pent-up gases!

IV. Lava
   A. Pahoehoe type flows
   B. Aa type flows
   C. The ash, bombs, cinders, and types of rocks

V. Volcanoes on the Moon?

VI. Volcanoes on Venus?

VII. Olympus Mons – a Giant Volcano on Mars

VIII. Io – the first actively erupting volcanoes found beyond Earth

IX. Triton – an ice volcano?

VOCABULARY

Ash Fine particles blown from volcanoes by explosive gas expansions that pulverize the frothing lava and solid rock into a fine dust.

Basalt The type of rock that comprises nearly all lava.

Caldera What we call volcanic craters over two kilometers in diameter.

Composite Volcano An explosive type of volcano. These volcanoes characteristically have thick lava with a large amount of dissolved gases. The release of these gases creates great explosions. The primary gases are carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen, hydrogen sulfide and steam. Most volcanoes in the world are composite. Mount St. Helens is a good example. They typically have a cone shape.

Core The center region of the Earth. It is composed primarily of very hot and heavy metals, mostly iron and nickel. It is twice as dense as the mantle. It is the main source of heat that causes the convection currents in the mantle. The outer core is molten and the inner core is solid. From the mantle to the center of the core is 2,100 miles.

Earthquake The shaking, rumbling, and physical breaking and displacing of rock and soil due to the release of pressures within the crust.

Fault line The line between two tectonic plates. These often mark areas of earthquakes and volcanoes. For example: The San Andreas Fault in California marks the boundary between the "Pacific Plate" and the "North American Plate." Sometimes plates are separating, sometimes colliding, and sometimes they are sliding beside each other. Volcanoes tend to be explosive "Composite" volcanoes where plates *collide* and quieter "Shield" volcanoes where plates *separate.*

Geyser Geysers are formed when groundwater is heated by an underlying body of hot magma. As the temperature increases in the water, pressure builds until the geyser blows. Geysers can be found near "hot spots" like Yellowstone or along "fault lines" like in Iceland.

Hot Spot A place where a narrow plume of hot magma rises up through the mantle and the extra heat often creates a volcano or at least hot geo-thermal activities such as hot springs and geysers. Examples are Hawaii and Yellowstone Park. Volcanoes found here tend to be quiet "Shield" volcanoes.

Igneous Rocks All volcanic rocks are igneous, but not all igneous rocks are volcanic. Igneous simply means that the rock formed from a liquid magma. Granite is igneous but not volcanic because it formed underground. Basalt, obsidian and pumice are igneous and volcanic – they all formed above ground after emerging from a volcano.

Lava The liquid or molten rock that comes from a volcano. When it flows, it takes one of two different forms of texture, though the composition remains the same. The two types are

Aa A course, rough, crumbly type of lava. The aa oozes out of the flow on all sides, hardening to a very coarse basalt rock. The term "aa" is derived from the Hawaiians.

Pahoehoe A smooth, billowy, wrinkled type of solidified lava. It is the most fluid form of lava. When a river of pahoehoe flows, it quickly hardens on top but continues to flow underneath; when the lava drains out from beneath the crust, it leaves a tunnel or "lava tube" behind. The term "pahoehoe" is derived from the Hawaiians.

Lava Tube A tunnel that is left behind from a lava flow. They form from pahoehoe flows where the lava solidified on top but keeps flowing underneath. When the flow runs out, the lava tube is left empty.

Mantle A thicker and denser part of Earth below the crust. The mantle slowly moves due to convection currents of heat working up from the core below. This convection is what makes the crustal plates slowly move about. The mantle is about 1800 miles thick.

Obsidian A glassy rock formed from rapidly cooled, thick lava.

Pele The Hawaiian goddess of volcanoes and fire.

Plate Tectonics The idea that Earth's crust is made of large continent-sized plates that float about on convection currents in the mantle. Therefore, our planet did not always look the way it does today, nor will it in the future because the continents are moving.

Pneumonoultramicroscopicsilicovolcanoconiosis This is not only the longest word in the English language (45 letters), it also is the name of a lung desease caused by breathing in fine particles from a volcanic eruption. It is pronounced: pneu-mo-no-ul-tra-mi-cro-scop-ic-sili-co-vol-ca-no-coni-o-sis! *Whew!*

Pumice A glassy, volcanic rock, similar to obsidian, but so full of gas bubbles that it will float on water. It forms from the rapid cooling of frothing, thick lava.

Ring of Fire The series of faults that surround the Pacific Plate. It is collectively so named because of the large number of volcanoes found along it.

Shield Volcano A less-explosive type of volcano. These volcanoes characteristically have a lower gas content and more liquid lava. The volcanoes of Hawaii are typical. The name is derived from their resemblance to a large shield laying on the ground.

Tsunami A tidal wave caused by volcanic eruption or earthquake.

Volcanology The scientific study of volcanoes and the reasons they erupt.

STUDY QUESTIONS

1. Explain the difference between "Composite" and "Shield" types of volcanoes. (Composites are explosive, Shields are quiet.)

2. What's the difference between an active volcano and an extinct volcano? (Any volcano that has erupted within historic times – the last 5-10 thousand years – is considered active. This may be a long time in human terms, but not in geologic terms.)

3. The largest volcano on Earth, Mauna Kea in Hawaii, from base to summit is over 33,000 feet tall, while Mt. Everest from base to summit is only 29,000 feet tall. Why then do we say Mt. Everest is the world's tallest mountain when Mauna Kea is over 4,000 feet higher? (Because the base of the two mountains are located at different levels. Mauna Kea's base is on the ocean floor, while Mt. Everest's base is measured from sea level. If we measure Mauna Kea's height from sea level, it is only 14,000 feet tall.)

4. Are there any remains of volcanoes in the State of Maine? (Yes) Where? (Traveller Mountain in Baxter State Park, Quoggy Joe Mountain in Presque Isle, and Haystack Mountain in Mapleton. Mt. Kineo in Moosehead Lake. Mt. Katahdin is <u>not</u> volcanic.)

TRUE OR FALSE

1. The Earth is the only planet in our Solar System to have volcanoes. (F)

2. The Hawaiian volcano of Kilauea has thrown lava nearly 2,000 feet into the air. (T)

3. There are over one thousand active volcanoes on Earth. (F – only 600)

4. There are between ten and thirty volcanic eruptions each year. (T)

5. When Mount St. Helens erupted in 1980, it was the largest volcanic eruption in the last two hundred years. (F)

6. Mount St. Helens exploded with such force that it threw ash over twelve miles high into the air. (T)

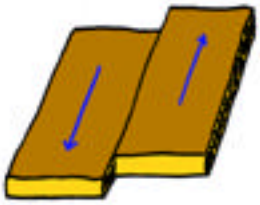
7. When the volcano named Krakatoa erupted in 1883 in the South Pacific, it was so loud it could be heard 3,000 miles away. (T)

8. Tsunamis can travel faster than the average jet plane. (T – over 600 m.p.h.)

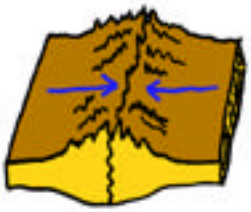
9. Molten lava has a temperature of 4,000 degrees Fahrenheit. (F – the hottest measure temperature was 2,200 degrees F, which is 12 times hotter than boiling water.)

10. Pumice is a type of volcanic rock that can float on water. (T – as a matter of fact, large rafts of pumice floating in the ocean were once reported as "floating islands.")

FAULT LINES AND HOT SPOTS



Sliding Plates Sometimes two plates will slide past each other horizontally. This is a powerful source for earthquakes. An example would be the San Andreas Fault in California.



Colliding Plates Sometimes two plates will collide head-on, crumbling the front edges and creating large mountains. An example would be the Himalayas, which formed when India collided with Asia.

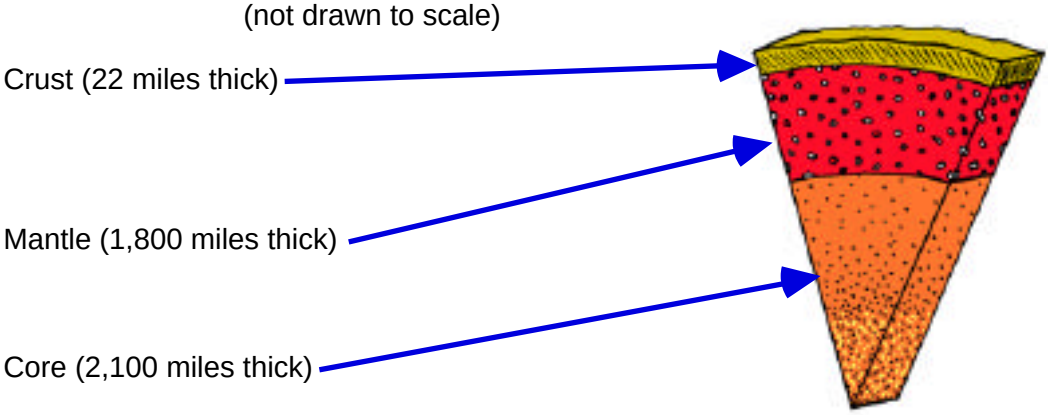
Separating Plates When two plates move apart, it allows hot magma to ooze up from the crack. It then hardens and makes new crust. Shield volcanoes usually form here. An example is the Mid-Atlantic Ridge that is separating, slowing making the Atlantic Ocean wider, as well as forming some islands, such as Iceland.

Subducting Plates Sometimes when one plate collides with another, one will "subduct" or go under the other. When it goes underneath, the heat and friction melt the crust that is going underneath. This usually creates composite volcanoes. Mount St. Helens is a good example.

Hot Spot Sometimes a narrow plume of magma rises up through the mantle, making a "hot spot" underneath a plate. It if is close enough to the crust, it can create shield volcanoes, like in Hawaii. If it is deeper, it can make geysers and geo-thermal heat, as we find in Yellowstone Park.

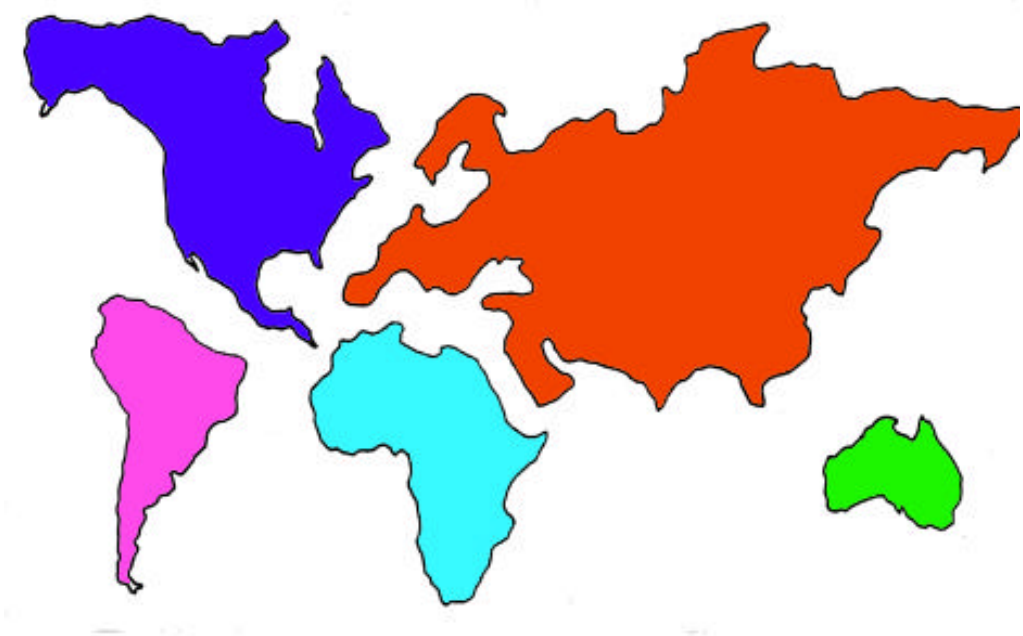
THE EARTH'S INTERIOR

(not drawn to scale)



UNDERSTANDING TECTONIC PROJECT

1. **Plate Tectonics:** After your students have gained a basic understanding of how Earth's crust is divided into plates roughly equivalent to the continents, give your students a copy of the world map below. Explain to them that at one time, all the continents were crammed together into one giant continent that scientists call Pangea. Have they *cut the continents out* and try to imagine how they might have once fitted together. (For a correct view of Pangea, see next page.) Then, using the map on the next page showing the directions the continents are moving, have your students predict how the world will one day look in the future.



THE ANCIENT CONTINENT OF PANGEA

Earth:
200 Million Years Ago!

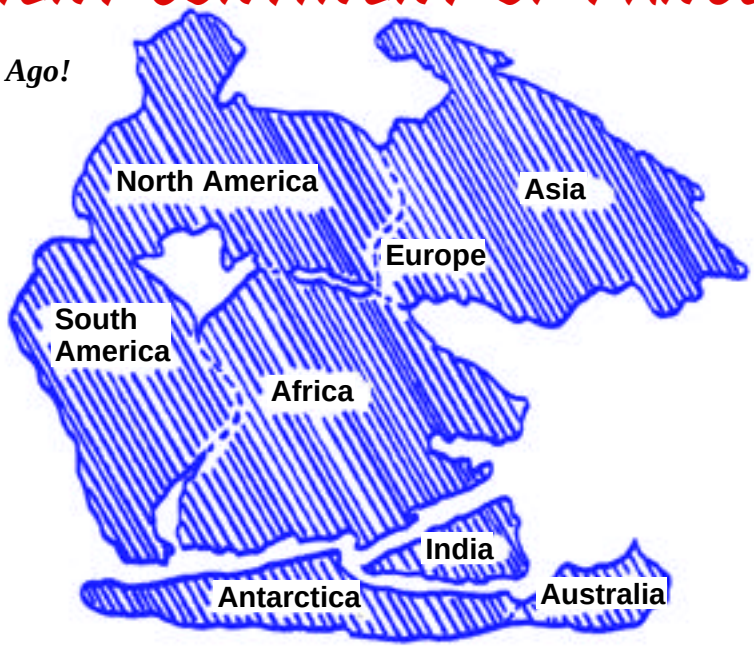
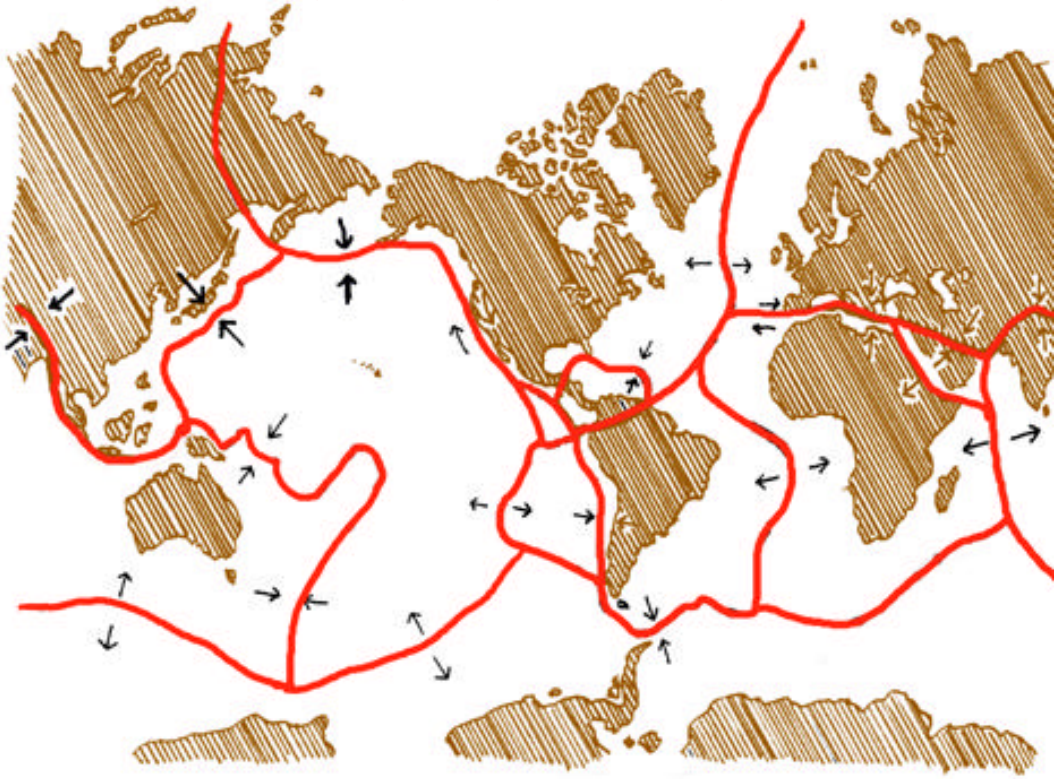


PLATE TECTONICS TODAY

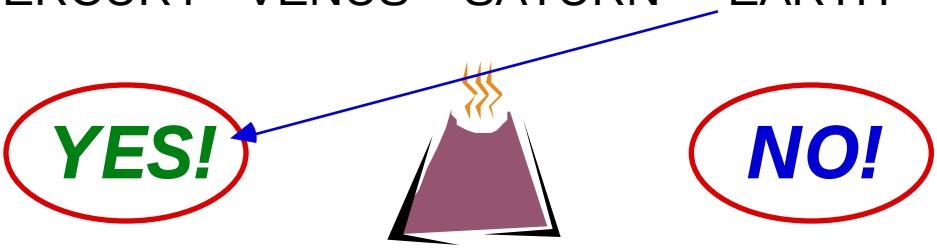


VOLCANOES IN THE SOLAR SYSTEM

Earth is not the only planet in the Solar System to have volcanoes. Use this work sheet to learn more about extra-terrestrial volcanic activities.

Do these planets and moons have volcanoes or not? Draw lines to the correct answer.

SUN MERCURY VENUS SATURN EARTH MOON



IO MARS JUPITER URANUS TRITON NEPTUNE

TRUE OR FALSE

1. _____ The largest volcano in the Solar System is Mauna Kea in Hawaii.
2. _____ Triton, a moon of Neptune, has volcanoes that erupt ice rather than lava.
3. _____ The Great Red Spot on Jupiter is a huge volcano.
4. _____ Olympus Mons, the largest volcano on Mars, it also the largest mountain in the Solar System.
5. _____ The Sun is so very hot because of constant volcanic eruptions.
6. _____ Mars is believed to have active volcanoes today.
7. _____ Io, a moon of Jupiter, has active volcanoes today.
8. _____ The dark areas you see on the moon at night are really ancient lava flows.

Answers on page 11.

PET ROCK

How well do you know your rock?

Your rock's name is: _____

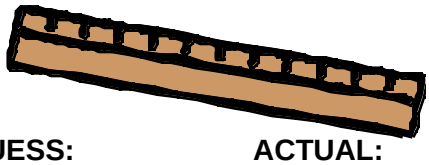
Where did you find your rock? _____

Any birthmarks? (Lines, spots, crystals, etc.) _____

_____

What color or colors is your rock? _____

DRAW A PICTURE OF YOUR ROCK



How well do you really know your rock? Let's find out.

CHARACTERISTICS:	**YOUR GUESS:**	**ACTUAL:**
Length of your rock?	_____	_____
Width of your rock?	_____	_____
Mass?	_____	_____
Will it chip easily?	_____	_____
Can you scratch it?	_____	_____

WRITE A CAREFUL DESCRIPTION OF YOUR ROCK:

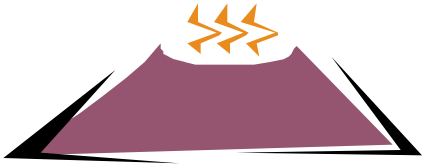
_____

_____

_____

_____

Now everyone should put their rocks into one bag. Mix them up and then see if you can find your pet rock. ***Good luck!***



Volcano! Word Search

F	**I**	**R**	**E**	**S**	**G**	**T**	**C**	**P**	**E**	**X**	**C**	**M**
T	**B**	**R**	**D**	**H**	**P**	**R**	**H**	**O**	**A**	**J**	**O**	**O**
S	**A**	**V**	**H**	**I**	**E**	**I**	**M**	**A**	**R**	**S**	**M**	**U**
U	**S**	**V**	**O**	**E**	**L**	**T**	**G**	**H**	**T**	**E**	**P**	**N**
N	**A**	**K**	**T**	**L**	**E**	**O**	**J**	**W**	**H**	**X**	**O**	**T**
A	**L**	**M**	**S**	**D**	**C**	**N**	**Z**	**X**	**Q**	**P**	**S**	**S**
M	**T**	**Q**	**P**	**V**	**R**	**A**	**S**	**H**	**U**	**L**	**I**	**T**
I	**X**	**I**	**O**	**Z**	**U**	**Z**	**N**	**P**	**A**	**O**	**T**	**H**
P	**L**	**A**	**T**	**E**	**S**	**B**	**M**	**O**	**K**	**S**	**E**	**E**
F	**A**	**U**	**L**	**T**	**T**	**R**	**J**	**O**	**E**	**I**	**J**	**L**
X	**V**	**A**	**O**	**M**	**R**	**Q**	**S**	**I**	**O**	**O**	**X**	**E**
M	**A**	**N**	**T**	**L**	**E**	**R**	**X**	**P**	**Z**	**N**	**G**	**N**
P	**U**	**M**	**I**	**C**	**E**	**Z**	**M**	**A**	**G**	**M**	**A**	**S**

Find these words horizontally, vertically, and diagonally:

ASH
BASALT
COMPOSITE
CORE
CRUST
EARTHQUAKE
EXPLOSION
FAULT
FIRE
HOT SPOT
IO
LAVA
MAGMA
MANTLE
MARS
MOON
MOUNT ST HELENS
PELE
PLATES
PUMICE
SHIELD
TRITON
TSUNAMI
VOLCANO

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Decker & Decker, ***Volcano Watching.*** Honolulu: Hawaii Natural History Association, 1984. (An excellent resource on volcanoes)

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Answers for page 8:
YES: Mercury, Venus, Earth, Moon, Mars, Io, Triton
NO: Sun, Saturn, Jupiter, Uranus, Neptune
1. False 2. True 3. False 4. True 5. False 6. False 7. True 8. True

Volcano Show Evaluation

After the Northern Stars Planetarium has visited your class, please take a moment to fill out this evaluation. Your suggestions are very valuable to us!

Mail the completed evaluation to :.....Northern Stars Planetarium
15 Western Ave.
Fairfield, Maine 04937
Or Email To :.....info@northern-stars.com

1. Show Name: _____

2. Group grade/age level:_____

3. Was the material presented at an appropriate level for your class? _____

_____

4. Was the amount of material discussed: Enough Overwhelming Not Enough

5. Should any parts of the presentation be developed further? _____. If so, which parts?

6. Was there sufficient time for questions and answers? Yes No

7. Were you studying astronomy or another related subject at the time of the planetarium's visit?

Yes No

If so, was the planetarium visit helpful?_____

8. Was the Teacher's Guide helpful in preparing your class for the planetarium visit?

Yes No

Which parts were most helpful? _____

Which parts were least helpful? _____

9. Did the presenter present the material in a clear and understandable fashion? _____

10. How would you rate the overall program given to your class in the planetarium?

11. (Optional) Your name & school:_____

Thank you for your time! Your Comments Make a Difference!