5E Integrated STEM Lesson Plan – Template

Lesson Title: Earthquakes and Volcanoes

Author: Mary Driskell (Adapted from Teaching with Fergy Lesson)

Topic:

- Earthquakes- How to measures, read case studies, dangers and how to predict an earthquake.
- Volcanoes- How to measure, read case studies, dangers and how to predict a volcanic eruption.

Targeted Grade Level: *Grades 6-10*

Time Needed: *4-6, 50-minute class periods.*

Subject Integration: The subjects that are integrated in this lesson is science, technology, math mostly in the form of reading and making graphs. Literacy and social studies are also covered in this lesson. The students are asked to do a variety of reading activities along with research. They also have to study about the various locations of earthquakes and volcanoes around the world and their effect on the environment that surrounds them.

Justification: This lesson is a combination of how earthquakes and volcanoes effect the world we live in. Students will learn about the different types of earthquakes and volcanoes, where they are most common and their effect on the world. They will also learn about factors that engineers take when designing buildings in earthquake- prone regions. They will also us Google Earth to summarize data and synthesize the information by relating the physical properties of volcanoes to magma composition and tectonic setting.

Standards:

NGSS Performan

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
Developing and Using Models	ESS2.A: Earth Materials and	Energy and Matter

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-3),(HS-ESS2-6) Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5) Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2)	Systems Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3) ESS2.B: Plate Tectonics and Large-Scale System Interactions The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3)	The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) Energy drives the cycling of matter within and between systems. (HS-ESS2-3) Structure and Function The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7) Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)		

Common Core State Standards: *Use your state standards if Common Core is not applicable in your state. You are encouraged to list the CCSS and your state standards.*

Mathematics - MP.2 Reason abstractly and quantitatively. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6)

MP.4 Model with mathematics. (HS-ESS2-3),(HS-ESS2-6)

HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6)

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-3),(HS-ESS2-6)

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6)

ELA/Literacy -

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS2-2),(HS-ESS2-3)

RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts,

processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2)

WHST.9-12.1 Write arguments focused on discipline-specific content. (HS-ESS2-7)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-3)

ITEEA Standards

Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)
Earth's Systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes
There are internal processes and sources of energy within the geosphere that cause changes in Earth's crustal plates
Describe how the movement of crustal plates can cause earthquakes and volcanic eruptions that can result in mountain building and trench formation

Other Standards

Missouri Standards

6-8.ESS2.A.2

- *Construct an explanation based on evidence for how*

geoscience processes have changed Earth's surface at varying time and

spatial scales.

9-12.ESS2.A.1

- *Develop a model to illustrate how Earth's interior and*

surface processes (constructive and destructive) operate at different

spatial and temporal scales to form continental and ocean-floor features.

Measurable Student Learning Objectives: After this activity students will be able to describe and identify the common volcano types, and relate volcano types with associated volcanic hazards, tectonic settings, and geographic location. The student will be able to describe examples of the types of damage caused by earthquakes. Describe how engineers design buildings to resist earthquakes. Examine what subsurface materials are most and least likely to result in significant damage form earthquakes.

Nature of STEM: *The nature of science is covered in lesson by studying the various aspects of earthquakes and volcanoes, which are phenomena's that happen in the natural world. The nature of technology that is covered in lesson is the student's learning about the tools scientist use to study and learn about earthquakes and volcanoes. The nature of engineering is cover in this lesson when the students learn about the design process of making homes that are earthquake safe and how poor engineering can cause complete devastation. The nature of math is covered in this lesson by students studying the quantities representation on the graphs and charts provided in the lesson.*

Engaging Context/Phenomena: The engaging phenomena for this lesson is to gain an understanding of why volcanoes and earthquakes happen where and learn about how to better prepare for one when it happens and how they help change and form the world we have today.

Data Integration: Students will be looking at many different maps and graphs of tectonic plates and the location of volcano which will help them learn how they all work together.

Differentiation of Instruction: Differentiation for this lesson can easily be achieved, because most of this activity is done in small groups. So, when planning your groups make sure to have a balance in each group so they can help each other out. The activities can also easily be shortened for those students who require less written work. This lesson is also easily adaptable to online learning.

Real-life Connection: *The real-life connection to this lesson is that even though earthquakes and volcanoes to not happen everywhere they can have a devastating effect on the people that do live where they happen. For my students we do have a fault line that runs throw the boot heel of Missouri and by scientists' predictions is long overdue.*

Possible Misconceptions: Possible student misconceptions could be that volcanoes are randomly located across the Earth's surface. Volcanoes are only found on land and

only in hot climates. They may also believe that all volcanoes erupt violently. If a volcano does not erupt for 100 years, it is considered extinct. Earthquakes happen randomly around the world and when they do happen the ground opens up. Students might also believe that scientist can predict when an earthquake will happen.

Lesson Procedure:

5E Model	5E Objectives
Engage *Your students will watch the video* "Bill Nye Plate Tectonics, Volcanoes and Earthquakes" *and discuss the question.*	**Procedure:** Play the video *Bill Nye Plate Tectonics, Volcanoes and Earthquakes.* T video has 4 embedded questions for whole group discussion. *On the worksheet be is a fifth question, about what questions would they still like to find the answer.* **Modifications:** The video is about seven minutes long; you may need to stop the v and re-watch if the students are unable to discuss the questions in enough details. **Standards Addressed:** 6-8.ESS2.A.2- • Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales *9-12.ESS2.A.1* • *Develop a model to illustrate how Earth's interior and surface processes ope at different spatial and temporal scales to form continental and ocean- floor features.* *Missouri Standards* *6-8.ESS2.A.2* • *Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.* *9-12.ESS2.A.1* • *Develop a model to illustrate how Earth's interior and surface processes (constructive and destructive) operate at different spatial and temporal scales to form continental and ocean-floor features.* **Formative/Summative Assessments:** The assessments for the engagement activ

	will be the outcome of the review worksheet from the video. **Resources –** • Bill Nye Plate Tectonics, Volcanoes and Earthquakes https://edpuzzle.com/media/5f10d931bd1fc03f3a2aa181
Explore **The students will receive real experience with the topic using and developing creative thinking skills, by making observations, recording results and making connections.**	**Procedure: P**lace students in groups of 2 or 3, have them complete the 9 Explorati Lab stations writing their answers on their lab passport and turning it in after compl of all the stations. **Modifications:** More time might be needed for some students to complete all the stations and the 2 rest stations can be taken out if you do not think they are needed **Standards Addressed** 6-8.ESS2.A.2- • Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales 9-12.ESS2.A.1 • Develop a model to illustrate how Earth's interior and surface processes ope at different spatial and temporal scales to form continental and ocean- floor feature *Missouri Standards* *6-8.ESS2.A.2* • *Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.* *9-12.ESS2.A.1* • *Develop a model to illustrate how Earth's interior and surface processes (constructive and destructive) operate at different spatial and temporal scales to form continental and ocean-floor features.* **Formative/Summative Assessments:** The assessment for the exploration phase the completion of the stations and the accuracy of the passport.

	Resources: • Can we predict Earthquakes? https://www.youtube.com/watch?v=gFB-qpiKccs • Earthquakes and Volcanoes 5E Lesson by Teach with Fergy
Explain The students will develop and understanding of earthquakes and volcanoes, they will make observations and engage in group discussions.	**Procedure**: Explain the concepts by presenting the material found in this lesson. T lesson is designed to be completed over two days. There are ten videos that go al with the lesson. There is a PowerPoint that can be used with this lesson which has videos embedded in them. One PowerPoint is complete the other has blanks that c be filled in by the students on their worksheet. Have students do a think- pair- share after the videos to discuss what they learned for each. There is also a student note- taking page over the PowerPoint. **Modifications:** This is a long lesson some of it can be removed for time. The vide mostly cover what are on the slides. There are also two choices of PowerPoints to for this lesson. The note-taking page can also be pre-filled out for those students w learn better by just listening and have the paper for a study guide later. **Standards Addressed:** 6-8.ESS2.A.2- • Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales *9-12.ESS2.A.1* • *Develop a model to illustrate how Earth's interior and surface processes op at different spatial and temporal scales to form continental and ocean- floor features.* *Missouri Standards* *6-8.ESS2.A.2* • *Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.*

9-12.ESS2.A.1

- *Develop a model to illustrate how Earth's interior and surface processes (constructive and destructive) operate at different spatial and temporal scales to form continental and ocean-floor features.*

Formative/Summative Assessments: Assessment for this lesson is class and sm
group discussions.

Resources:

- Earthquakes and Volcanoes Lesson.ppt
- Earthquakes and Volcanoes Lesson_stu

- *Are All These Natural Disasters Normal?* *https://www.youtube.com/watch?v=JWXvgvyvKX8&feature=emb_logo*
- *Earthquakes 101 | National Geographic* *https://www.youtube.com/watch?v=VSgB1IWr6O4&feature=emb_logo*
- Faults - https://www.youtube.com/watch?time_continue=1&v=27hGcQGSKpc&feature=emb_logo
- How Does The Richter Scale Work? https://www.youtube.com/watch?time_continue=1&v=NaNw9LHq9dc&feature=emb_logo
- Recalling 1960 Chile Quake- https://www.youtube.com/watch?v=DFLLtVPzwGA&feature=emb_logo
- Tsunami Animation: Valdivia, Chile, 1960 (rotating globe) https://www.youtube.com/watch?time_continue=2&v=RHYbprZAIWo&feature=emb_logo
- Volcanoes 101 | National Geographic https://www.youtube.com/watch?v=yDy28QtdYJY&feature=emb_logo
- Meet the Volcanoes | NOVA https://www.youtube.com/watch?v=HdhARb2PGqA&feature=emb_logo
- The colossal consequences of super volcanoes - Alex Gendler https://www.youtube.com/watch?v=hDNlu7Qf6_E&feature=emb_logo
- Mount Tambora Eruption 1815 https://www.youtube.com/watch?v=mjoXgDvhLxw&feature=emb_logo
- Earthquakes and Volcanoes 5E Lesson by Teach with Fergy

Elaborate The students will use their newly obtained knowledge from watching the videos and slide show to propose solutions and extend their learning to new situations	**Procedure:** The students will complete a Scavenger Hunt. This activity will require students to move beyond what was covered directly in the lesson and allow them to further develop their understanding of earthquakes and volcanoes. The students ca either work in small groups or individually. Students will need at least one device p group. The teacher will facilitate learning and keep the students focused. **Modifications**: Students that need extra help should be pair with a student that can help them be successful during this activity. The number of locations could be shortened for struggling students or the amount of work could be lesson for those students. **Standards Addressed:** 6-8.ESS2.A.2- Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales *9-12.ESS2.A.1 Develop a model to illustrate how Earth's interior and surface proce operate at different spatial and temporal scales to form continental and ocean- floor features.* *Missouri Standards* *6-8.ESS2.A.2* • *Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.* *9-12.ESS2.A.1* • *Develop a model to illustrate how Earth's interior and surface processes (constructive and destructive) operate at different spatial and temporal scales to form continental and ocean-floor features.* **Formative/Summative Assessments:** The students will be completing various activities in this lesson. They will be doing research along with watching videos and answering question.

	Resources: Earthquakes and Volcanoes.docx • Earthquakes and Volcanoes 5E Lesson by Teach with F
Evaluate The students are given the opportunity to demonstrate their understanding and evaluate their own progress about earthquakes and volcanoes.	**Procedure:** The students can choose to do either final lesson on Earthquakes or Volcanoes. The teacher will give the students the needed material to complete the lesson they choose to do and will facilitate and help keep the students focused on t task. **Modifications: The Final lesson can be done in pairs or small groups if neede** **Standards Addressed:** MS-ESS2-2 Earth's Systems • Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales MS-ESS2-3 Earth's Systems • Analyze and interpret data on the distribution of fossils and rocks, continenta shapes, and seafloor structures to provide evidence of the past plate motion HS-ESS2-1. • Develop a model to illustrate how Earth's internal and surface processes ope at different spatial and temporal scales to form continental and ocean-floor features Missouri Standards 6-8.ESS2.A.2 • Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. 9-12.ESS2.A.1 • Develop a model to illustrate how Earth's interior and

	surface processes (constructive and destructive) operate at different spatial and temporal scales to form continental and ocean-floor features. **Formative/Summative Assessments:** The students can either do a project on volcanoes or earthquakes. **Resources**: • Adapted from Tectonic Hazards by Addie Williams • https://dese.mo.gov/sites/default/files/curr-mls-standards-sci-6-12-sboe-201 • https://www.nextgenscience.org/

Teacher Background: Background information that is needed for this lesson is an understanding of earthquakes and volcanoes. The teacher should pre-watch the videos that are linked in this lesson and read the material provided before hand also any earth science textbook is a good source to gain a better understanding of the topic.

Sources

- Bill Nye Plate Tectonics, Volcanoes and Earthquakes https://edpuzzle.com/media/5f10d931bd1fc03f3a2aa181
- *Are All These Natural Disasters Normal? https://www.youtube.com/watch?v=JWXvgvyvKX8&feature=emb_logo*
- *Earthquakes 101 | National Geographic https://www.youtube.com/watch?v=VSgB1IWr6O4&feature=emb_logo*
- Faults - https://www.youtube.com/watch?time_continue=1&v=27hGcQGSKpc&feature=emb_logo
- How Does The Richter Scale Work? https://www.youtube.com/watch?time_continue=1&v=NaNw9LHq9dc&feature=emb_logo
- Recalling 1960 Chile Quake- https://www.youtube.com/watch?v=DFLLtVPzwGA&feature=emb_logo
- Tsunami Animation: Valdivia, Chile, 1960 (rotating globe) https://www.youtube.com/watch?time_continue=2&v=RHYbprZAIWo&feature=emb_logo
- Volcanoes 101 | National Geographic https://www.youtube.com/watch?v=yDy28QtdYJY&feature=emb_logo

- Meet the Volcanoes | NOVA https://www.youtube.com/watch?v=HdhARb2PGqA&feature=emb_logo
- The colossal consequences of super volcanoes - Alex Gendler https://www.youtube.com/watch?v=hDNlu7Qf6_E&feature=emb_logo
- Mount Tambora Eruption 1815 https://www.youtube.com/watch?v=mjoXgDvhLxw&feature=emb_logo

- https://www.livescience.com/37052-types-of-faults.html
- https://www.usgs.gov/faqs/what-a-fault-and-what-are-different-types?qt-news_science_products=0#qt-news_science_products
- https://www.youtube.com/watch?v=gFB-qpiKccs
- Earthquakes and Volcanoes 5E Lesson by Teach with Fergy
- Tectonic Hazards by Addie Williams
- https://dese.mo.gov/sites/default/files/curr-mls-standards-sci-6-12-sboe-2016.pdf
- https://www.nextgenscience.org/

Engagement

Bill Nye

Plate Tectonics, Volcanoes and Earthquake

Your task: Watch the video:
https://edpuzzle.com/media/5f10d931bd1fc03f3a2aa181

Answer the following questions:

1. Discuss with your shoulder partner what cause volcanoes and earthquakes to happen.

2. In your group discuss three facts you learned about Plate Tectonics and share at least one with the class. You will two minutes for your discussion.

3. What are some of the different ways' volcanoes erupt?

4. Analyze how scientist use the Richter Scale when describing the strength of an earthquake.

5. Share with your group what new information you have learned from watching this video and what are some unanswered questions you still have. Write each question on a post-it note and teachers directions.

Exploration

Station 1

Get Hands-On – Draw a diagram of an earthquake **OR** a volcano. Be sure to label your diagram to indicate what is happening at each part of the event, both below the Earth's crust and at the surface.

Station 2

Research – Research the three main types of faults: strike-slip, normal, and thrust/reverse. Give a brief description of each.

- Site you can use or find other reliable sources on your own

https://www.livescience.com/37052-types-of-faults.html

https://www.usgs.gov/faqs/what-a-fault-and-what-are-different-types?qt-news_science_products=0#qt-news_science_products

Station 3

Explain yourself – Write down an opinion to the following question in paragraph form. Do you think we may one day be able to predict earthquakes? If so, what makes you think so and how might it be done? If not, why not?

Station 4

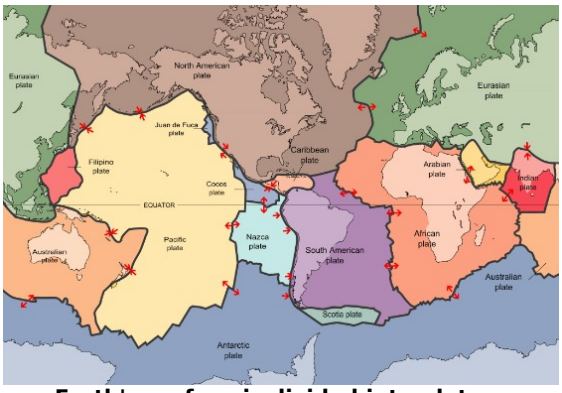
Applicability Reading – Read the following information article and answer the associated questions found below in the *Applicability Reading* section of your passport.

Endeavor STEM Teaching Certificate Project
Mary Driskell
7/20/2020

Applicability Reading – Earthquakes and Volcanoes: Case Studies

Earthquakes and Volcanoes 5E Lesson by Teach with Fergy

Instructions: Read the following information article and answer the associated questions found below in the *Applicability Reading* section of your passport.



Earth's surface is divided into plates.

Earthquakes and **volcanoes** are **natural disasters**, or events caused by natural processes that result in severe property or environmental damage and loss of life. Both are caused by the movement of Earth's tectonic plates. The surface of the Earth is in constant motion, with plates gliding along atop the **magma** (partially-molten rock) beneath the **lithosphere** (Earth's uppermost layer, composed of crust and upper mantle). These plates interact with one another, by pushing into each other, spreading away from one another, or sliding past one another, at **plate boundaries**. Such interactions result in earthquakes and volcanoes. Here, we present a brief overview of earthquakes and volcanoes and the tectonic interactions that cause them before discussing a case study of each: **the largest earthquake of the 21st century** (so far) and **the longest-erupting volcano in the world**.

Earthquakes

During earthquakes, the ground shakes, sometimes severely. They occur when plates slide past each other and their edges get stuck. Plate movement generates a lot of energy, which is stored while the plates are stuck together. Suddenly, the plates slip apart again, releasing that energy in the form of a **seismic wave**.

Earthquakes can destroy buildings.

These waves originate at **faults**, which are cracks in the Earth's crust between masses of rock. The specific point along the fault from which energy is released is called the **focus** and the point on the Earth's surface directly above the focus is called the **epicenter**.

Volcanoes are vents in Earth's crust.

Volcanoes

Volcanoes are vents in the Earth's crust through which molten magma rises to the surface to escape as **lava**. Different types of volcanoes occur at different types of plate boundary. At **subduction zones** (convergent boundary at which one plate slides beneath another and its lithosphere melts), violent eruptions occur. At **divergent plate boundaries** (plates move away from each other), magma rises into the space left behind and emerges less explosively onto the surface. Some volcanoes even form within plates rather than at the boundaries. As a plate moves over a plume of magma, the magma pushes up through the crust, forming a string of volcanoes, called **hotspot volcanoes**.

The Largest Earthquake of the 21st Century

On the morning of Sunday, December 26, 2004, a massive earthquake struck the Indian Ocean off the coast of Sumatra, Indonesia. Measuring between 9.1 and 9.3 on the **Richter scale** (a logarithmic scale of the magnitude of an earthquake, ranging from less than 1 to more than 8), it was the second-largest earthquake ever recorded. Only the Great Chilean Earthquake of 1960, with a recorded magnitude of 9.5, was larger. Prior to the advent of recording equipment, however, there may have been many larger quakes.

The 2004 earthquake and tsunami devastated many parts of

The 2004 tsunami hit Thailand soon after inundating Sumatra.

The plates broke apart across 1500 km (900 mi), the longest fault rupture ever recorded. Plate movement caused some islands to rise farther out of the ocean, increasing their size, while causing others to become submerged. The earthquake lasted for almost 10 minutes and set off

minor quakes in places as distant as Alaska. The movement of the seafloor displaced enormous amounts of water, triggering a **tsunami** that devastated communities all around the Indian Ocean. Across fourteen countries, at least 230,000 people were killed. In Sumatra alone, between 130,000 and 160,000 people were killed by the earthquake and resulting 80 to 100-foot-high tsunami waves. In Thailand, the tsunami claimed 5,000 to 8,000 lives, while the death toll in Sri Lanka was around 35,000 and in India was approximately 15,000. The tsunami traveled all the way to South Africa, 5,000 miles away, claiming two additional lives. Over 1 million people were left homeless. Despite the massive loss of life, the Sumatran earthquake was not the deadliest of the 21st century. That distinction belongs to the 2010 Haiti earthquake, with estimates of up to 316,000 deaths.

The Longest-Erupting Volcano in the World

Mount Kīlauea on Hawaii's Big Island has been erupting since 1983. Kīlauea, and all the islands of Hawaii, is a hotspot volcano. Most of Hawaii's volcanoes are inactive because they have moved away from the column of rising magma. However, lava could still erupt from the Haleakalā Crater on Maui. The Big Island, the youngest of Hawaii's islands, is very much an area of active volcanism. There are two main craters on Kīlauea, **Halema'uma'u** and **Pu'u 'O'o**. Pu'u 'O'o has been discharging lava since 1983, with Halema'uma'u erupting more frequently in recent years.

Pu'u 'O'o is one of the main craters of Kīlauea volcano.

Shield volcanoes are wide with

Kīlauea is a **shield volcano**, a wide, low volcano with gentle slopes that rarely erupts explosively. The eruption of shield volcanoes is **effusive**, an easy flow of lava rather than an explosion. Shield volcanoes tend only to erupt explosively when lava encounters water it generates steam. The shape of shield volcanoes is due to the high fluidity of their lava, which flows easily and thus does not pile up into a steep slope, instead spreading widely along the ground.

As rocks melt, the resulting magma fills a chamber beneath Kīlauea's surface. The magma pushes against the top of the chamber, eventually breaking through at weak spots in the rock and erupting through vents in the surface. There are many documented vents on Kīlauea and the

continuous eruption has led to large swaths of lava, covering homes and roads. Occasional explosive events have showered communities with rock fragments and ash. In 1990, 100 homes, a church, and a store in one community were covered by over 50 feet of lava.

Lava and brush fires – May 5, 2018

Lava flow – May 19, 2018

On May 3, 2018, **fissures** (vents) began opening in the Eastern Rift Zone of the volcano, in the community of Leilani Estates on the east coast of the Big Island. The next day, a 5.4-magnitude earthquake struck, followed by a 6.9-magnitude quake (the strongest on the island since 1975). By mid-May, 18 fissures had opened with another 6 rupturing by the end of the month. As of July 24, 8 vents remain active with one, Fissure 8, the primary eruption site. Fissure 8 is erupting like a fountain, with lava plumes as high as

150 feet. Unlike earthquakes, volcanic events are somewhat predictable. Kīlauea is a heavily monitored volcano and authorities were able to issue evacuation orders with plenty of time for residents to seek safety. However, the current event has displaced over 2,000 people, with no end in sight. Researchers estimate that it could last anywhere from months to years. By late July, over 700 homes have been destroyed. The lava covers over 12 square miles (over 7,000 acres) and has sparked several brush fires that have taken some homes spared by the lava itself. In early June, lava spilled into the island's largest lake, evaporating it. Fissures do not just release lava. Dangerous sulfur dioxide gas and other fumes are issuing from the fissures, making the air dangerous to breathe. In addition, a lava lake at the summit of Kīlauea is sinking. As it edges closer and closer to the water below, the chances of an explosive eruption grow. Already some smaller collapses have resulted in explosions with energy equal to that of 5.3-magnitude earthquakes. Thousands of small earthquakes, some reaching magnitudes of 4.0 and above, continue to shake the island due to the pressure of magma build-up. As the lava reaches the edge of the land and spills into the sea, it creates new land, making the Big Island even bigger. As of late July, nearly 700 acres have been added to the coastline.

Applicability Reading – Questions

1. What are natural disasters?
2. Briefly describe the tectonic events that cause earthquakes.
3. Briefly describe the tectonic events that cause volcanoes.
4. What was (so far) the largest earthquake of the 21st century and how big was it?
5. What were the effects of the earthquake?
6. What is the longest-erupting volcano in the world and how long has it been erupting?
7. Summarize what you learned about the volcanic eruption that started on May 3, 2018 and research the current status of the Kīlauea volcano.

Station 5

Test Your Knowledge – Answer the following 5 multiple-choice questions, then provide a written explanation for how/why you came to your conclusions. For calculation questions, make sure you show all your work.

Test Your Knowledge

Instructions: Choose the correct answer and place it in the *Test Your Knowledge* section of your passport. Follow the answer with an explanation for how/why you chose it.

1. Which of the following is NOT a type of fault?
    a) Strike-slip
    b) Slip-strike
    c) Normal
    d) Reverse

2. _____ cannot be predicted.
    a) Earthquakes
    b) Volcanoes
    c) Faults
    d) All of the above

3. Which of the following is NOT a location of volcanic activity?
    a) Convergent boundary
    b) Divergent boundary
    c) Transverse boundary
    d) Within tectonic plates

4. The 2004 Indian Ocean earthquake triggered _____.
    a) a tsunami
    b) a volcano
    c) sinkholes
    d) a hurricane

5. Mount Kīlauea has been erupting since _____.
    a) 1984
    b) 1990
    c) May 3, 2018
    d) 1983

Test Your Knowledge - Answer Key

1. Which of the following is NOT a type of fault?
    a) Strike-slip
    b) Slip-strike
    c) Normal
    d) Reverse

2. _____ cannot be predicted.
    a) Earthquakes
    b) Volcanoes
    c) Faults
    d) All of the above

3. Which of the following is NOT a location of volcanic activity?
    a) Convergent boundary
    b) Divergent boundary
    c) Transverse boundary
    d) Within tectonic plates

4. The 2004 Indian Ocean earthquake triggered _____.
    a) a tsunami
    b) a volcano
    c) sinkholes
    d) a hurricane

5. Mount Kīlauea has been erupting since _____.
    a) 1984
    b) 1990
    c) May 3, 2018
    d) 1983

Station 6

Learn from the Expert – Using a computer, watch the following video clip and answer the associated questions. You may stop, rewind, and restart as often as you like during the time frame.

Learn from The Expert

Instructions: Go to https://www.youtube.com/watch?v=H0bnaV35Sno and watch the video. While you are watching the video, answer each question and place your answer in the *Learn from The Expert* section of your passport. You may re-watch the video as many times as you like in the allotted time. Furthermore, you may re-watch the video while you are at one of the *workstations,* so make sure you record the URL on your passport.

1. What are the three predominant source regions of Hawaiian earthquakes?

2. How does magma cause earthquakes?

3. What has caused earthquakes in the Ka'ōiki fault zone?

4. What type of faults are those at the Ka'ōiki fault zone and Hilina Pali?

5. Where have the largest earthquakes in Hawaii's history occurred?

6. How do earthquakes in the mantle occur?

Learn From The Expert – ANSWER KEY

1. What are the three predominant source regions of Hawaiian earthquakes? **In volcanoes, along volcano-ocean floor boundary, in the crust and mantle.**
2. How does magma cause earthquakes? **Rises through the crust, breaking rock in the process, changing pressure and mass in the volcano create stress in adjacent areas, producing earthquakes on nearby faults and cracks.**
3. What has caused earthquakes in the Ka'ōiki fault zone? **The movement of the Kīlauea side of the fault relative to the Mauna Loa side of the fault.**
4. What type of faults are those at the Ka'ōiki fault zone and Hilina Pali? **Normal faults.**
5. Where have the largest earthquakes in Hawaii's history occurred? **Along the boundary between the volcano and the ocean floor.**
6. How do earthquakes in the mantle occur? **The Pacific Plate adjusts to changing loads and temperatures from the large volcanoes above.**

Station 7

Rest Station

Use this time wisely. Complete any

station work not yet finalized.

Station 8

Become the Question Master – You must create 2 multiple-choice questions, 2 true/false questions, and 1 short answer question that relates directly to the topic: **Earthquakes and**

Volcanoes. You must also supply the answers and you may not re-use any of the questions you have seen in this lab.

Lab Station Passport – Earthquakes and Volcanoes
Earthquakes and Volcanoes 5E Lesson by Teach with Fergy

Names: _____ & _____ &_____

Station #1 – Get Hands-On

Station #2 – Research

Station #3 – Explain Yourself

Station #4 – Applicability Reading

Once you have read the article, place the answer to the questions below.

1.

2.

3.

4.

5.

6.

7. Answer on another sheet of paper.

Station #5 – Test Your Knowledge
Place your answers to the multiple-choice questions below along with your written explanation for how/why you came to your conclusions. For calculation questions, show all your work.

1.

2.

3.

4.

5.

Station #6 – Learn from The Expert
Place your answers to the video questions below.

1.

2.

3.

4.

5.

6.

Station #8 – Become the Question Master
You must create 2 multiple-choice questions, 2 true/false questions and 1 short answer question in the space below. Your questions must relate directly to the topic: **Earthquakes and Volcanoes**.

Multiple-Choice:
1. Answer:

2. Answer:

True/False:

1. Answer:

2. Answer:

Short Answer:

Answer**:**

Explanation

Complete PowerPoint.

Earthquakes and Volcanoes Lesson.ppt

Student PowerPoint with blanks.

Earthquakes and Volcanoes Lesson_stu

Earthquakes and Volcanoes: Student Notes

Natural Disasters

- Events caused by natural processes
- Severe property or environmental damage
- _____
- 6 categories
  - _____
  - Climatological (climate)
  - _____
  - _____
  - Extraterrestrial (outer space)
  - _____

Geological/Geophysical

- Due to plate tectonics and underground processes
- _____
- _____
- Landslides/avalanches
- Sinkholes

Earthquakes

- _____
- Unpredictable
- Can be severe
- Stages
  - Foreshocks: _____
  - _____: main, largest, earthquake in the sequence
  - Aftershocks: _____
- Recall: _____
  - Comprise the lithosphere: _____
- Plates always moving
  - Slide along on top of magma of asthenosphere
- Tectonic plates slide past each other at plate boundaries
- _____
- While they are stuck together, their kinetic energy is stored
- _____
- Faults exist along plate boundaries
- Fault: _____
- Energy released as a seismic wave
  - _____
  - Radiate out from point of energy release like other waves (e.g., light, sound, water)
- Focus: _____
- Epicenter: _____

    - Earthquakes feel strongest at the epicenter
- Dangers
    - Property damage
    - Personal injury/death
    - _____

Earthquake Measurements

- Seismologists study earthquakes using seismographs
    - _____
    - Magnitude: _____
    - Measured in amplitude (wave size)
    - Logarithmic (base 10)
    - _____
- _____
    - <1-2.9: _____
    - 8 or higher: _____
- _____ (more accurate for large earthquakes)
    - 2.5 or lower: _____
    - 5.5-6.0: _____
    - 8 or higher: _____
- Intensity: _____
    - Usually measured in acceleration and velocity of ground motion
- _____ (North America)
    - I: _____
    - XII: _____
- Scales used in other parts of the world are similar
- Qualitative rather than quantitative

The Great Chilean Earthquake

- World's largest measured earthquake
- _____
- Magnitude _____
- Epicenter: _____
- Thousands of buildings destroyed or damaged
- ~2 million people left homeless
- Foreshocks powerful enough to make people go outside (>magnitude 7.0) – likely saved lives
- Most damage and death due to tsunamis
- _____ people died
    - 15 hrs after quake: _____
    - _____: tsunami hit Japan, destroying >1600 homes and killing >180 people
    - 24 hrs after quake: _____

Volcanoes

- _____
- Molten magma escapes at vents as lava
- Occur at subduction zones, divergent plate boundaries, and within plates
  - Subduction zones: lower plate melts and rises, mixing with gases and exploding through surface
  - _____
    - Magma ascends into space left behind when plates move apart
    - _____
- Occur at subduction zones, divergent plate boundaries, and within plates
  - _____
    - Column of magma ascends from deep within mantle
    - Magma pushes up through crust
    - Plate continues to move, resulting in chain of volcanoes (e.g., Hawaii)

Volcanoes

- Active: _____
  - Currently erupting or showing signs of potential eruption (e.g., minor earthquakes, gas venting)
- Dormant: _____
  - No signs of potential eruption but activity considered possible
- Extinct: _____
  - Hotspot volcanoes that have moved away from the magma column are considered extinct

Types of Volcanoes

- _____
  - Alternate layers of cinder, ash, and lava
  - Cones symmetrical with steep slopes
- _____
  - Wide with flat tops and gentle slopes
- _____
  - Composed of rock debris that erupted from the vent
  - Cone circular or oval
  - Most have bowl-shaped crater at top
- _____
  - Steep slopes
  - Lava too viscous to flow far from vent
- _____
  - Large eruption causes emptying of magma chamber and ground collapse, leaving behind massive crater-like depression
- _____
  - Fractures in surface through which lava escapes

Volcano Dangers

- Explosive eruptions
  - _____
  - _____
  - Ash
  - _____
- _____
- _____
  - Masses of ash, gas, and other materials
  - Hot: 100-700ºC (212-1300ºF)
  - Fast: 160 km (100 mi) per hour
- _____
- Ash accumulation
- _____

Volcano Measurements

- Volcanic Explosivity Index
  - _____
    - Measured as the volume of rock fragments and other particles (tephra) that erupt from a volcano
  - _____
    - Effusive: _____
    - Explosive: _____
  - 0: volume _____(effusive)
  - 4: volume _____(explosive)
  - 8: volume _____(explosive)

Mount Tambora

- Largest volcanic eruption in recorded history
- _____
- Volcanic Explosivity Index: _____
  - _____
  - _____
- Northern Coast of Sumbawa Island, Indonesia
- Forest, grassland, buildings burned
- Caused earthquakes and tsunamis
- 10,000 people on Sumbawa died and 35,000 homes were destroyed
- Debris blocked sunlight from reaching Earth → _____
- In Indonesia, famine and disease killed >80,000 people
  - _____
  - _____
  - _____
- 1816: _____

  - Snow and frost in June, July, and August
  - Crops perished, and people starved
  - Mary Shelley wrote “Frankenstein”
- Explosion decreased mountain’s height by >4000 feet and formed a caldera
- Mount Tambora remains active to this day

Elaborate

Earthquakes and Volcanoes – Scavenger Hunt

Instructions:

1. Pages 2-6 contain the six different stations that should be placed around the room.
2. Pages 7-9 is the Teacher Reference and Answer Key.

Note: It does not matter the order the students access the stations.

Location 1

Scavenger Hunt – Earthquakes and Volcanoes –

Watch A Video:
Watch the video below and answer the following questions.

https://youtu.be/c4fKBGsllZI

1. Earthquakes happen when _____.

2. What causes stress on buildings during earthquakes?

3. What is the goal of building design in earthquake-prone areas?

4. What are the two main ways to design a building that will not collapse on people during an earthquake?

5. What is one way to make a stronger building?

6. What is one of the most effective ways to protect buildings from earthquakes?

7. What does Taiwan use in Taipei 101 to combat earthquakes?

8. How are researchers working to make buildings invisible to shock waves?

Location 2

Scavenger Hunt – Earthquakes and Volcanoes –

Matching:
Match the term with its definition.

1. _____ Fault
2. _____Focus
3. _____Epicenter
4. _____Magnitude
5. _____Intensity
6. _____Pyroclastic flow
7. _____Tephra
8. _____Shield volcano
9. _____Cinder cone volcano
10. _____Caldera

a. Amount of energy released by an earthquake
b. Massive, crater-like depression formed when a large eruption causes the emptying of a magma chamber and ground collapse
c. Crack in Earth's crust between rock masses
d. Wide volcano with a flat top and gently sloping sides
e. Circular or oval-shaped volcano, usually with a bowl-shaped crater at the top, composed of rock debris that erupted from the vent
f. Strength of shaking in an earthquake
g. In an earthquake, the point of energy release within Earth's crust

h. Rock fragments and other particles that erupt from a volcano
i. In an earthquake, the point on Earth's surface directly above the point of energy release
j. Hot, swiftly moving mass of ash, gas, and other materials issuing from a volcano

Location 3

Scavenger Hunt – Earthquakes and Volcanoes –

Correcting a Misconception:
Read the following misconception, then correct it. To correct it fully, you must rewrite the sentence including your reasoning. Your statement should be 2-3 sentences long.

Misconception: Earthquakes are completely unpredictable, and volcanoes are completely predictable.

Location 4

Scavenger Hunt – Earthquakes and Volcanoes –

Famous Scientist Research:
Research Charles Francis Richter and George Julius Poulett Scrope. Who were they and what were their most well-known contributions to seismology and volcanology, respectively? Your answers should be written in correct paragraph format with an introductory sentence at least three supporting facts and a summary sentence.

Location 5

Scavenger Hunt – Earthquakes and Volcanoes –

Seek Out:
Seek out the largest volcano in our solar system. Where is it? What type of volcano is it? How big is it? Locate a picture and upload it below. Your answers should be written in correct paragraph format with an introductory sentence at least three supporting facts and a summary sentence.

Teacher Reference and Answer Key

Station #1 -

Watch a Video: Watch the video and answer the following questions: https://www.youtube.com/watch?v=c4fKBGsllZI

1. Earthquakes happen when _____. **tectonic plates shift**
2. What causes stress on buildings during earthquakes? **The force of seismic waves shaking buildings up and down and side to side.**
3. What is the goal of building design in earthquake-prone areas? **Earthquake-resistance.**
4. What are the two main ways to design a building that won't collapse on people during an earthquake? **So that it is stronger or more flexible.**
5. What is one way to make a stronger building? **Reinforce concrete with steel.**
6. What is one of the most effective ways to protect buildings from earthquakes? **Detaching them from the ground by building them on a separate base instead of directly on the foundation.**
7. What does Taiwan use in Taipei 101 to combat earthquakes? **The tuned mass damper, a 728-ton ball near the top of the building that swings on cables.**
8. How are researchers working to make buildings invisible to shock waves? **An in-ground shield of concrete and plastic buried at least 3 feet (1 meter) down. Waves are deflected by soft layers and pass through hard layers, traveling around the building and dissipating in the gaps between the two halves of the shield.**

Station #2 –

Matching: Match the term with its definition.

1. Fault **c**
2. Focus **g**
3. Epicenter **i**
4. Magnitude **a**

5. Intensity **f**
6. Pyroclastic flow **j**
7. Tephra **h**
8. Shield volcano **d**
9. Cinder cone volcano **e**
10. Caldera **b**

a. Amount of energy released by an earthquake
b. Massive, crater-like depression formed when a large eruption causes the emptying of a magma chamber and ground collapse
c. Crack in Earth's crust between rock masses
d. Wide volcano with a flat top and gently sloping sides
e. Circular or oval-shaped volcano, usually with a bowl-shaped crater at the top, composed of rock debris that erupted from the vent
f. Strength of shaking in an earthquake
g. In an earthquake, the point of energy release within Earth's crust
h. Rock fragments and other particles that erupt from a volcano
i. In an earthquake, the point on Earth's surface directly above the point of energy release
j. Hot, swiftly moving mass of ash, gas, and other materials issuing from a volcano

Station #3 –

Correcting a misconception: Read the following misconception, then correct it. To correct it fully, you must rewrite the sentence including your reasoning. Your statement should be 2-3 sentences long.

Misconception: Earthquakes are completely unpredictable, and volcanoes are completely predictable.

When an earthquake will strike and how severe it will be are unpredictable, but seismologists know where major faults are and thus know where an earthquake will occur at some point in the future. Volcanic eruptions are only somewhat predictable. There are some warning signs of an impending volcanic eruption, but how severe the eruption will be, how much lava will pour out, and how long it will last are unpredictable.

Station #4 –

Famous Scientist Research: Research Charles Francis Richter and George Julius Poulett Scrope. Who were they and what were their most well-known contributions to seismology and volcanology, respectively? Your answers must each be 2 to 3 sentences long.

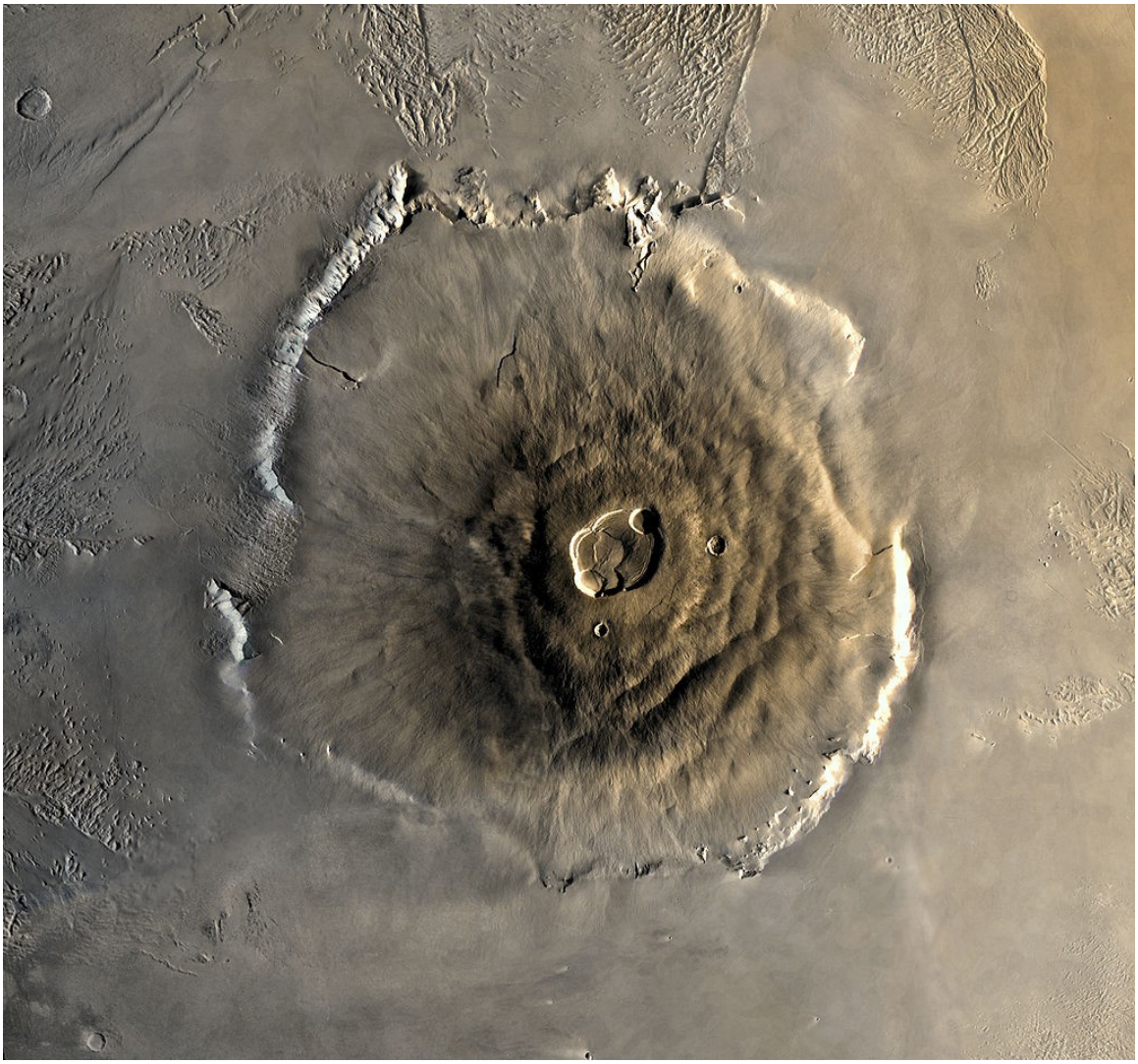
Charles Francis Richter was an American physicist and seismologist. In collaboration with Beno Gutenberg, he developed the Richter magnitude scale, used to quantify the magnitude of earthquakes. (https://www.britannica.com/biography/Charles-F-Richter)

George Julius Pulett Scrope was an English economist and geologist. He wrote what is considered the first systematic written study of volcanology. In it, he showed the role of volcanoes in rock formation, rejecting current academic thought that all rocks were formed via sedimentation from the ocean. (https://www.britannica.com/biography/George-Julius-Poulett-Scrope#ref38174)

Station #5 -

Seek Out: Seek out the largest volcano in our solar system. Where is it? What type of volcano is it? How big is it? Locate a picture, take a screenshot, and upload it below.

Olympus Mons on Mars is a shield volcano 26 km tall (3x the height of Mt. Everest).



(http://www.bbc.co.uk/science/space/solarsystem/solar_system_highlights/olympus_mons)

Evaluate

Tectonic Hazards

As an employee of the local Emergency Task Force you have been asked to develop a present warning the local community about the potential

danger if the volcano/ or earthquake should happen to become active in your area.

Many people in your community are unaware of the potential for an earthquake or a volcanic eruption and are unprepared. Use your expertise and creativity to educate them.

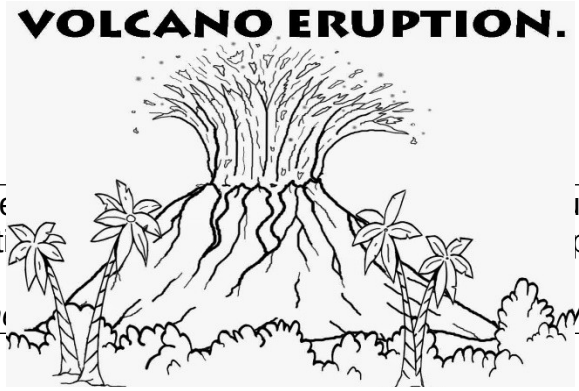
- Your project can be about ONE of the following:
  - New Madrid Seismic Zone
  - Wabash Valley Seismic Zone
  - Cascadia Subduction Zone
  - Hayward Fault
  - Mount Redoubt Volcano
  - Great Sitkin Volcano
  - Gorda Ridge Volcano
  - Mount Shasta Volcano
  - Volcano/Earthquake area of your choice with prior teacher approval.

- Your presentation can be created on PowerPoint, Google Slides, Prezi, Haiku Deck,

- Your presentation **<u>MUST INCLUDE</u>** the following but not limited to:

1. _____Title/Introduction to the topic

2. _____A map showing the location of the fault zone or volcano you chose for your presentation.
3. _____What tectonic plate is involved in your fault zone area or in the creation of your volcano?
4. _____A description of WHY the hazard exists: Why is there a volcano? What is the reason for an earthquake in this area?
5. _____A description of WHAT the hazard is- why is there a danger? What will happen?
6. _____What will the impart of the eruption/earthquake be on the local ecosystem, population and/ or economy?
7. _____A description of what people should do in the event of an eruption/ earthquake
8. _____Explain why volcanoes and earthquakes only happen in certain areas in the world.
9. _____ Share 5 interesting facts about your topic, and what makes them an interesting fact.
10. _____Clearly labeled and appropriate picture
11. **_____Last page or ending should of at least 3 sources listed in correct MLA format.**
12. _____Research notes MUST be handed in with the project along with a list of sources.



Tectonic Hazard Rubric	Does Not Ye Expectati *Needs Som*	ully Meets pectations *Well Done*	Exceeds Expectations *Wow!*

	1 Point	2 Points	3 Points	4 Points
Content	• Information is often inaccurate, incomplete, copied or inappropriate • Did not include all the information required. • Little to no understanding of tectonic process.	• Information is generally relevant and accurate but may be missing details • Only included the basic information. • Basic understanding of tectonic process.	• Information is accurate, complete, and specific. • Good understanding of the basic details. • Good understanding of tectonic process.	• Information is accurate, complete, and specific. • Went well beyond the basic details understand • Excellent understanding of tectonic process.
Presentation & Graphics	• No/poor heading • There is little organization, often loosely related ideas • Poor presentation • The required map and visuals are omitted or inappropriate • No sources listed	• Headings for some sections, but not all. • Organization is weak • Basic presentation • The required map and visuals are included but missing labels/poorly done. • Some sources listed or not in correct format	• All sections have headings. • Good organization • Good presentation • The required map and visuals are clear, complete and labeled. • Minimal Sources listed and correct format.	• Clear and explicit headings. • Well organized • Excellent presentation • The required map and graphics are clear and effectively labeled.
Grammar & Spelling	• Frequent errors in words and sentence structure.	• Noticeable errors in spelling and sentences structure	• Minor errors in spelling and grammar	• Well- edited and written presentation
Points	3/12	6/12	9/12	12/12