PEAC
PRIVATE EDUCATION ASSISTANCE COMMITTEE
Trustee of the Fund for Assistance to Private Education

DepED
DEPARTMENT OF EDUCATION

2017

LEARNING MODULE

Science G10| Q1

Plate Tectonics:
The Science of Plate Tectonics and Disaster Preparedness

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NOTICE TO THE SCHOOLS

This learning module (LM) was developed by the Private Education Assistance Committee under the GASTPE Program of the Department of Education. The learning modules were written by the PEAC Junior High School (JHS) Trainers and were used as exemplars either as a sample for presentation or for workshop purposes in the JHS In-Service Training (INSET) program for teachers in private schools.

The LM is designed for online learning and can also be used for blended learning and remote learning modalities. The year indicated on the cover of this LM refers to the year when the LM was used as an exemplar in the JHS INSET and the year it was written or revised. For instance, 2017 means the LM was written in SY 2016-2017 and was used in the 2017 Summer JHS INSET. The quarter indicated on the cover refers to the quarter of the current curriculum guide at the time the LM was written. The most recently revised LMs were in 2018 and 2019.

The LM is also designed such that it encourages independent and self-regulated learning among the students and develops their 21st century skills. It is written in such a way that the teacher is communicating directly to the learner. Participants in the JHS INSET are trained how to unpack the standards and competencies from the K-12 curriculum guides to identify desired results and design standards-based assessment and instruction. Hence, the teachers are trained how to write their own standards-based learning plan.

The parts or stages of this LM include Explore, Firm Up, Deepen and Transfer. It is possible that some links or online resources in some parts of this LM may no longer be available, thus, teachers are urged to provide alternative learning resources or reading materials they deem fit for their students which are aligned with the standards and competencies. Teachers are encouraged to write their own standards-based learning plan or learning module with respect to attainment of their school's vision and mission.

The learning modules developed by PEAC are aligned with the K to 12 Basic Education Curriculum of the Department of Education. Public school teachers may also download and use the learning modules.

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SCIENCE 10

MODULE 1: PLATE TECTONICS: The Science of Plate Tectonics and Disaster Preparedness

INTRODUCTION AND FOCUS QUESTION(S):

Humans have explored the sky, the outer space and the deep blue sea. But has anyone been to, or drilled down into the deepest part of the crust, or to the innermost part of the earth? You have probably seen photos and videos of the stars and planets, including Earth, taken from outer space as well as the bottom of a sea, but have you seen an actual photo of the earth's interior?

You studied earthquakes and tsunamis in the 8th grade, and volcanoes in the 9th grade. Have you ever wondered how these geological wonders of the earth are related? Have you ever asked why some mountains erupt, while others don't? Does the Earth's crust move during, before, or after an earthquake, and when a volcano erupts? How should we prepare for disasters of this magnitude? What is plate tectonics? In this module, we will put together everything you've learned in the past two years. Also, we will approach the study of these geological processes at a more global scale, and, at the same time, still be able to use and apply your learning in the Philippine setting.

Remember to search for the answer to the following questions:
How should we prepare for disasters that include volcanic eruptions, earthquakes and tsunamis?
How do Earth's plate movements affect humans?

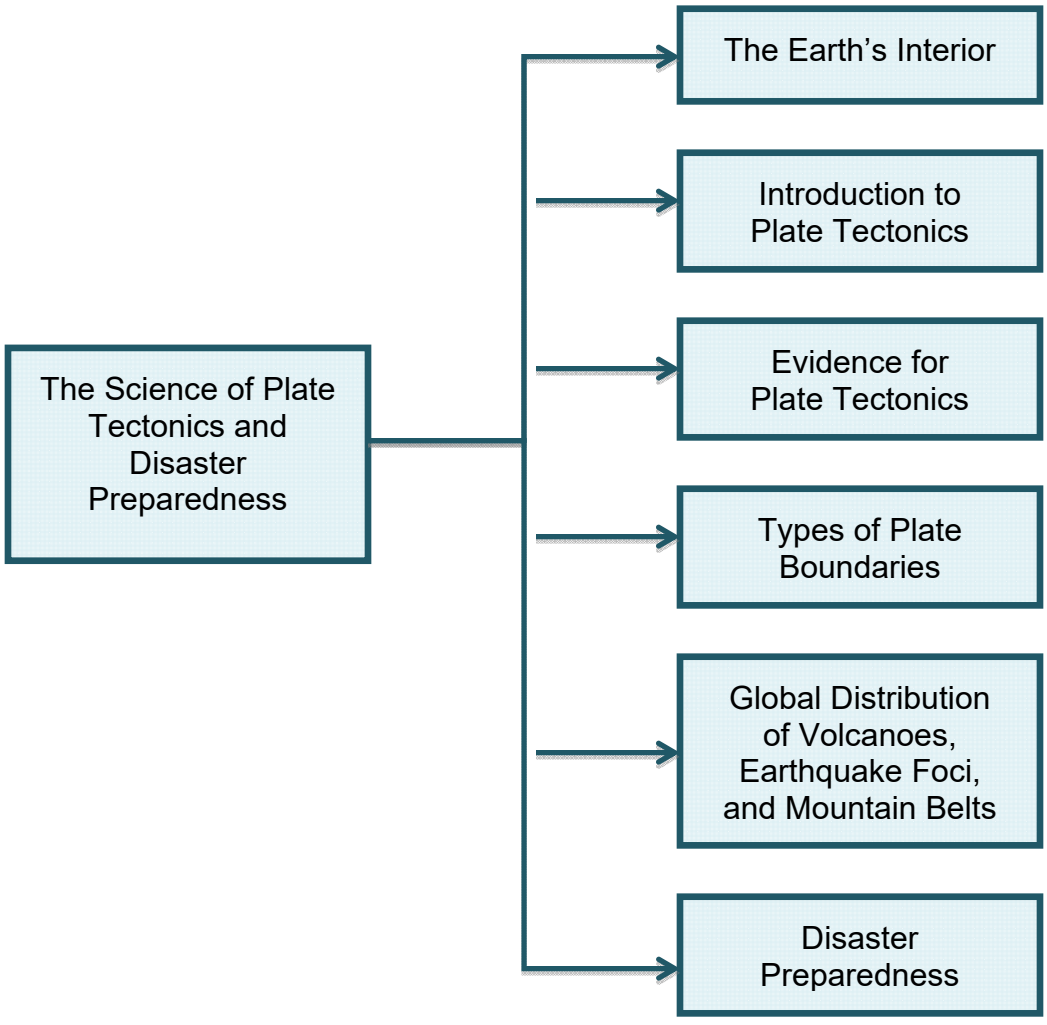
LESSONS AND COVERAGE:
In this module, you will examine these questions when you take the following lesson:
Lesson 1 – The Science of Plate Tectonics and Disaster Preparedness

In this lesson, you will learn the following:

Lesson 1	• Describe the distribution of active volcanoes, earthquake epicenters, and major mountain belts. • Describe the different types of plate boundaries. • Explain the different processes that occur along the plate boundaries. • Describe the internal structure of the Earth. • Describe the possible causes of plate movement.

	• Enumerate the lines of evidence that support plate movement. • Infer patterns and relationship among the locations of volcanoes, earthquake epicenters, and mountain ranges. • Justify one's predictions or conclusions with available evidence.

MODULE MAP:
Here is a simple map of the above lesson you will cover:



EXPECTED SKILLS:

To do well in this module, you need to remember and do the following:

1. Read everything carefully and thoroughly.
2. Always follow the instructions.
3. Finish each activity and submit worksheets before proceeding to the next.
4. Take down notes in your computer or in a notebook. Process questions will always be asked to check your understanding.
5. Use a dictionary to look up the meaning of unfamiliar words.
6. Maximize the features of your computer (desktop/laptop/tablet) and its software to help you work more efficiently and to enhance your learning. These include taking screen shots, screen recording, downloading videos, taking photos, posting stickies, using a notepad, recording an audio or video, saving a web page as PDF or exporting as PDF, using the search engine and many more.
7. Use the rubric to guide you in the preparation and evaluation of the expected outputs.
8. Consult your teacher if you need to clarify or verify something about an activity.
9. Follow the schedule of the activities, remind yourself of deadlines. Read in advance when necessary.
10. Find time to relax and take a break. Have fun learning.

PRE-ASSESSMENT:

Let's find out how much you already know about this module. Click on the letter that you think best answers the question. Please answer all items. After taking this short test, you will see your score. Take note of the items that you were not able to correctly answer and look for the right answer as you go through this module.

(A) 1. Based on data provided by seismic waves, which statement is true about the internal structure of the earth?
   A. The core is solid, and the mantle is both solid and liquid.
   B. The crust and core are both solid, and the mantle is liquid.
   C. The crust is solid, the mantle is semisolid, the outer core is liquid and the inner core is solid.
   D. The crust is solid, the mantle is semisolid, the outer core is solid, while the inner core is liquid.

(A) 2. Which description is the best match for convergent plate boundaries?
   A. Two plates move away from each other.
   B. Two plates move towards each other.
   C. Two plates slip past each other.
   D. One plate moves in, the other moves out.

(A) 3. Which evidence does not support Wegener's concept of continental drift?
   A. Seas and oceans in different parts of the world have the same pH and salt content with their coasts containing the same type of sand
   B. Matching plant fossils in South America, Africa, India, Australia, and Antarctica
   C. Matching early mammal fossils found in South America and Africa
   D. Evidence of glaciers is present in regions with warm, dry climates

(A) 4. Earthquakes, volcanism, and mountain building are three of the most spectacular earth processes related to tectonic activity. Which statement justifies the occurrence of a number of volcanoes in the Pacific Ring of Fire?
   A. The magma is most active in the peripheral areas of the Pacific Ocean Basin.
   B. The peripheral areas of the Pacific Ocean Basin contain the boundaries of several plates where subduction takes place.
   C. Earthquakes and tsunamis occurred when these volcanoes were formed, thus, changing the landscape.
   D. The plate beneath the Pacific Ocean is constantly moving, thus, forming more volcanoes.

(A) 5. Earthquake epicenters are randomly distributed on earth. Is this true or false?

A. True. Earthquakes can happen anywhere across the globe because the plates are moving.
B. True. Earthquakes are random events because earth is a geologically active planet.
C. False. Earthquake epicenters are found exclusively along the periphery of the Pacific Ocean Basin.
D. False. Earthquake epicenters are much more common at the ocean ridges and beside trenches, just as volcanoes are.

(A) 6. Which phrase would best describe the process of subduction?
A. Sinking process
B. Rising process
C. Colliding process
D. Sliding process

(A) 7. Does Earth become smaller or bigger when plates move?
A. Bigger. New ocean floor is continuously being formed at the Mid-Atlantic Ridge which means that the Atlantic Ocean is expanding.
B. Bigger. Iceland is located at the boundary between the North American plate, which moves to the west and the Eurasian plate which moves to the east. This opposing movement increases the width of Iceland approximately two centimeters every year, about one centimeter to the right and one centimeter to the left.
C. Smaller. Because subduction continuously takes place and some plates keep colliding. These form new volcanoes and mountains in the Andes and the Himalayas.
D. Neither. When new crust is created at the Mid-Atlantic Ridge, which is a divergent plate boundary, the same amount of crust is absorbed into the earth during subduction at convergent plate boundaries like the Nazca Plate subducting beneath the South American Plate responsible for the formation of the Andes Mountains, which are actively growing.

(A) 8. Why do tectonic plates move?
A. Due to active volcanism and earthquakes
B. Due to thermal convection in the mantle
C. Due to earth's gravitational force
D. Due to earth's rotation

(M) 9. If you were given the following choices of permanent residence when you become an adult, which place would be less prone to natural disasters?
A. Los Angeles, California, USA
B. Puerto Princesa, Palawan, Philippines
C. Singapore, Republic of Singapore
D. Sicily, Italy

(M) 10. Why is an emergency disaster kit necessary at home if you live in the Philippines?
A. Because it is a highly vulnerable country
B. Because it is prone to typhoons
C. Because its geographic location puts it at high risk to natural disasters
D. Because it is at high risk to the effects of climate change

(M) 11. Japan and the United States are developed countries. Japan and the west coast of the USA are located along the Pacific Ring of Fire. Are these two countries vulnerable to the effects of earthquakes?
A. They are not at risk because they have the latest technology.
B. They are at risk because of their geographical location.
C. They are at high risk, however the extent of damage that may be caused by an earthquake may depend on its magnitude, their level of preparedness and the kind of technology they used to lessen damage.
D. They are at high risk even if they are rich countries because the Pacific Ring of Fire lies along plate boundaries where active volcanism and most major earthquakes occur.

(M) 12. Mr. and Mrs. Villanueva bought a house and lot in Zambales in January 1988, though they have an apartment in Manila where they spend most of their time. The husband's work sometimes requires him to spend time in Zambales wherein they have to stay there three times a year in a span of about 4-5 months. Five years later, their home in Zambales lost its value due to some damage. They decided to sell the land in Zambales at a lower value due to nature's wrath, and they didn't want to spend money to repair the house. Which among the following could have been the biggest factor in terms of natural hazards that influenced the couple's decision?
A. The 7.8-magnitude earthquake in northern and central Luzon in July 1990
B. The eruption of Mount Pinatubo in June 1991
C. Typhoon Pablo
D. Typhoon Milenyo

(M) 13. On 26 December 2004, a tsunami occurred in the Indian Ocean. It was the result of the Indio-Australian Plate subducting below the Eurasian Plate. It was caused by an earthquake measuring more than magnitude 9. The earthquake caused the seafloor to uplift, displacing the seawater above. This was the cause of the tsunami in Thailand. The following are some of the significant post-tsunami impacts except:
A. The mortality rate of the Thai people increased in the next 5 years.
B. An early warning system between countries surrounding the Indian Ocean has been set up.

C. The confidence of European tourists in travelling to places such as Phuket, Thailand took some time to recover.
D. The fishing industry has been damaged by the extensive destruction of fishing boats and tackle which individual fishing families couldn't afford to replace.

(M) 14. Which evidence in recent history suggests that plates move?
A. Earthquake and tsunami in Japan in 2011
B. Eruption of Mayon volcano in Albay
C. All of the above
D. None of the above

(T) 15. Michael lives in an area very close to an active fault. What should his earthquake emergency survival kit contain?
A. money, important legal documents, radio, backpack
B. water, non-perishable food, whistle, flashlight with batteries
C. food, medicine, identification, toiletries, clothes
D. water, toiletries, flashlight, cash

(T) 16. You are the president of your grade 10 class. You have studied earthquakes in the past but this school year is almost over and the school has not conducted an earthquake drill yet. What should you do?
A. Educate your classmates about earthquakes.
B. Educate your adviser about earthquake hazards.
C. Conduct an earthquake drill with your classmates during homeroom period.
D. Consult with your adviser and principal and suggest an earthquake drill for the school.

(T) 17. In Albay, people still live within the permanent danger zone around Mayon volcano. What would you suggest to the governor of Albay to solve issues on evacuating residents from the permanent danger zone when the volcano shows signs of eruption, even if the province has a very good record of having zero casualty?
A. Build a permanent evacuation center for the people of Albay.
B. Educate the residents on the dangers of living near a volcano.
C. Provide financial assistance to build their homes away from the volcano and means of livelihood.
D. Conduct a seminar on the benefits of living far away from the permanent danger zone of the volcano.

(T) 18. Your family recently migrated to Japan due to your father's job. You have watched videos of the tsunami in Japan a few years ago. Which among the following is not a good practice during a tsunami?
A. Watch the tsunami and try to see if it will even reach you before evacuating.

B. Get out of the water and move away from the water's edge.
C. Go to a higher ground.
D. Take your emergency preparedness kit and evacuate.

(T) 19. Why should a tsunami warning system be established in coastal areas?
A. To warn people during an earthquake
B. For immediate evacuation
C. All of the above
D. None of the above

(T) 20. Your father just got a promotion and his already high salary was even doubled. However, your family had to move to Camiguin Island several kilometers away from Mount Hibok-Hibok, which is an active volcano. Having known that you live near an active volcano, what information should you know and preparations should you take in case the volcano will show signs of an eruption?
A. Check out the website of PHIVOLCS and read on the past eruption history of Mt. Hibok-Hibok from your local library.
B. Interview local community folks in the island about the past eruptions of this volcano and asked what they did.
C. Be prepared for a possible volcanic eruption by keeping and regularly maintaining a bag of clothes, footwear, non-perishable goods, bottled water, toiletries, flashlight, batteries, and cash which is always ready to carry anytime.
D. Search the internet or other resources for pertinent data about Mt. Hibok-Hibok, talk to long-time residents or officials in the area, and discuss with your family a possible volcanic disaster preparedness plan.

EXPLORE

Let's begin this module by gathering your ideas about plate tectonics.

ACTIVITY NO. 1: PUT ON THE MAP

Look at the world map shown below. Where do you think earthquakes are most likely to happen? Where can you find volcanoes? Where are the major mountain belts of the world located? Where are tsunamis most likely to occur?

Source: http://geology.com/world/world-map.shtml

Write your answer to these questions by filling in the "Put on the Map" worksheet below. Alternatively, you can download a copy of the map, then crop, label, and paste parts of it or the whole map under the "Where in the world?" column. Then write your reason or explanation under the "Why here?" column.

Put On The Map Worksheet		
	Where in the world?	Why here?
Earthquakes		
Volcanoes		
Mountain Belts		
Tsunamis		

PROCESS QUESTIONS:

1. What was your basis for identifying these locations in the world map?
2. Do earthquakes and tsunamis occur randomly on Earth? Are volcanoes and mountain belts found in every country or continent? Why? Why not?

ACTIVITY NO. 2: PROMPT MY BRAIN

In the previous activity, you pointed out the location of earthquakes, volcanoes, mountain belts, and tsunamis using a world map. Are you currently located in one of those places? If you are, **how should we prepare for disasters that include volcanic eruptions, earthquakes and tsunamis?** Moreover, **how do Earth's plate movements affect humans?**

Sum up your answers to these questions by filling in the **Initial** column of the IRF Chart.

How should we prepare for disasters that include volcanic eruptions, earthquakes and tsunamis? **How do Earth's plate movements affect humans?**		
INITIAL	REVISED	FINAL

End of EXPLORE:

You just tried finding out where disasters like earthquakes, tsunamis and volcanic eruptions occur in the world, how we should prepare for these disasters, and how plate movements can affect us.

Let's now find out what the answer is by doing the next part. What you will learn in the next sections will also enable you to do the final project, which involves suggesting and demonstrating ways to ensure disaster preparedness.

We will start by doing the next activity.

FIRM-UP

Your goal in this section is to learn and understand key concepts about plate tectonics. The competencies that you should be able to accomplish are listed below. Monitor your progress in this module using this checklist of competencies.

CHECKLIST OF COMPETENCIES

Competencies	Crystal Clear	Somewhat Clear	Not Fully Understood
1. Describe the distribution of active volcanoes, earthquake epicenters, and major mountain belts			
2. Describe the different types of plate boundaries			
3. Explain the different processes that occur along the plate boundaries			
4. Describe the internal structure of the Earth			

5. Describe the possible causes of plate movement			
6. Enumerate the lines of evidence that support plate movement			
7. Infer patterns and relationship among the locations of volcanoes, earthquake epicenters, and mountain ranges			
8. Justify one's predictions or conclusions with available evidence			

ACTIVITY NO. 3: LET'S REVIEW

When you were in the 8th grade, you were asked to explain how earthquake waves provide information about the interior of the earth. Let's review the internal structure of the earth by watching this video. Click on the link.

https://www.youtube.com/watch?v=aY6SG7GPAlo Earth's Interior - Seismic Evidence Explanation, By Chris Merkert (14.31 minutes)

PROCESS QUESTIONS:

1. What is the earth's interior made of?
2. How will you describe its internal structure?
3. How did scientists deduce which layer of the earth is solid, liquid or semisolid?

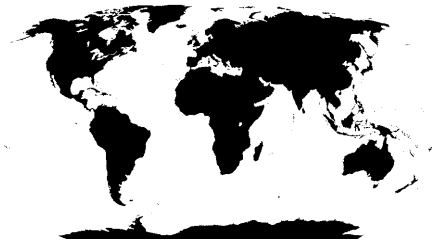
ACTIVITY NO. 4: SURF THE NET

You are now about to learn more about plate tectonics. As you explore this concept, do remember the various study skills and strategies that were mentioned initially in this module such as downloading videos, exporting a web page to PDF, taking screen shots, screen recording, taking down notes, posting stickies, using a dictionary, among others.

Part 1: Draw and Tell

Before you start learning about plate tectonics, answer the questions in the worksheet below and draw what is required. Write and draw your response in the second column or "My Response Before Surfing the Net". You may use Paint or

Photoshop to make your drawing and save a JPEG file of the image. Alternatively, you can replicate the Draw & Tell worksheet in a paper, then scan or take a photo of your output, and upload it in the submission bin. Make sure to keep both the hard and soft copies. File name should be Last Name_Draw&Tell. Should you need assistance or if you require further clarification, feel free to ask or email your teacher.

DRAW & TELL WORKSHEET		
Question	My Response Before Surfing the Net	My Response After Surfing the Net
Look at this map of the world. Do you see that the west coast of Africa and the east coast of South America look like they might fit together like a jigsaw puzzle? Do you think there is a reason for that? Why?  Source: http://www.u-tt.com/images/worldmap_bg.gif		
What happens when Earth's plates move?		
What drives the plates to move? Draw a cross section of the Earth to further illustrate your answer.		
What happens at a plate boundary where two plates are moving away from each other? Draw a picture (a side view) to show your answer.		

What happens at a plate boundary where two plates are moving towards each other? Draw a picture (a side view) to show your answer.		

How did you come up with your drawing? Let's see how others would answer those questions and find out if you have the same illustration by moving on to the next section.

Part 2: A Quick Tour of Plate Tectonics

For an introduction of plate tectonics, click on this link to watch the video. https://www.youtube.com/watch?v=JmC-vjQGSNM Plate Tectonics, By Bozeman Science (9.21 minutes)

In addition, use the link below to get more information about plate tectonics. Save it as or export as PDF in your computer. This will be most helpful in the event of a slow internet connection or sudden loss of electricity. Read pages 157-159 and 164-165. As you encounter the highlighted key words and the vocabulary, review and repeat these key words to yourself by saying them out loud. You may also keep writing down these key words and their meaning until you remember them. http://www.tclauset.org/20_ESbk/ch08.pdf Chapter 8 Plate Tectonics in PDF

PROCESS QUESTIONS:

1. What is continental drift?
2. Why did scientists reject Wegener's idea of continental drift?
3. What is plate tectonics?
4. What is the source of energy that drives the movement of the lithospheric plates? Why do you think this is the source?

Part 3: Uncovering the Evidence

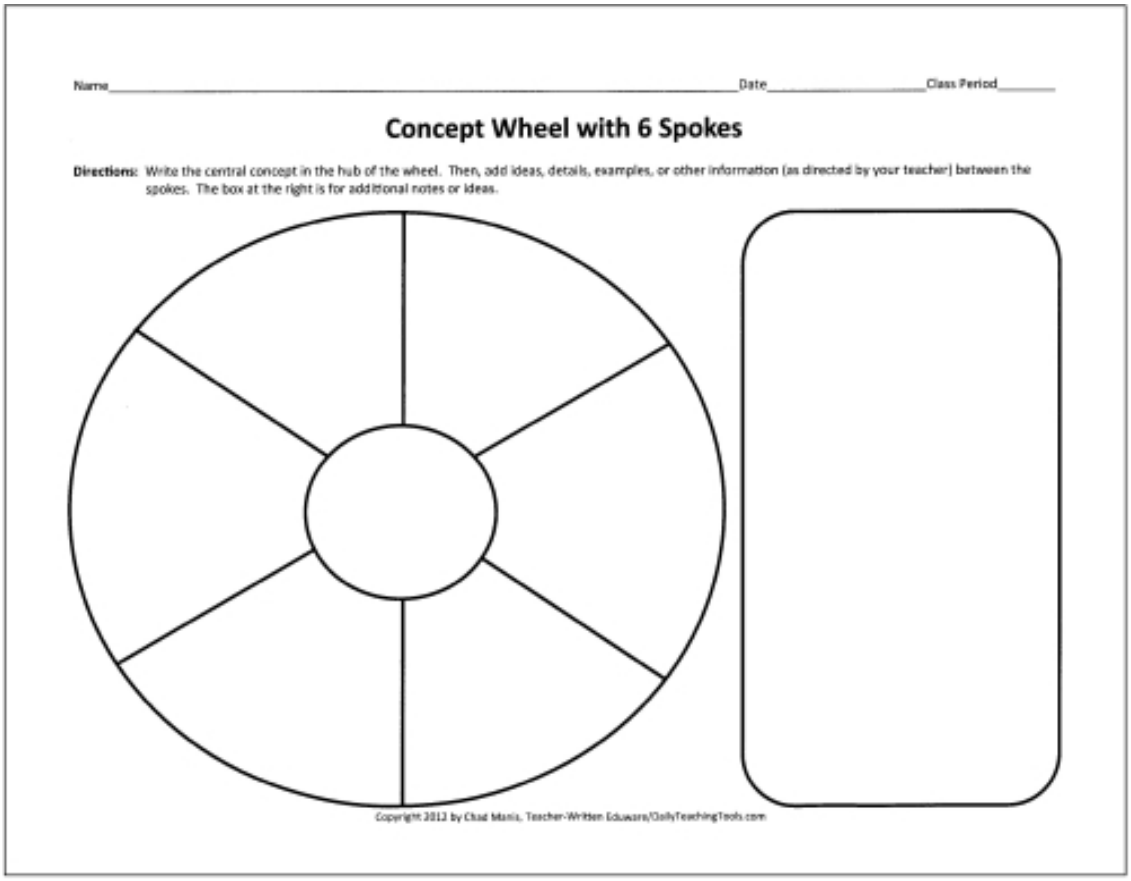
Previously, you watched the video "Plate Tectonics" by Bozeman Science. Can you recall any evidence mentioned by Mr. Anderson? In this section, you will examine further the lines of evidence that support plate movement.

Click the link below to know more.
http://www.geolsoc.org.uk/Plate-Tectonics/Chap1-Pioneers-of-Plate-Tectonics/Alfred-Wegener Wegener supported his Continental Drift idea with 5 lines of evidence

Read also pages 159 and 161-163 of Chapter 8 Plate Tectonics in PDF that you've just downloaded in Part 2. Keep in mind that as you encounter the highlighted key words and the vocabulary, review and repeat these key words to yourself by saying

them out loud. You may also keep writing down these key words and their meaning until you remember them.

After reading, accomplish the Concept Wheel with 6 Spokes graphic organizer. Write the evidence within each spoke with a short description. Use the box at the right for additional information or ideas. Then submit your work.



Source: http://www.dailyteachingtools.com/images/ConceptWheel6.jpg

PROCESS QUESTIONS:

1. What evidence have you gathered that support the theory of plate tectonics? Discuss.
2. Can you identify and describe at least 2 fossil evidence that support plate movement? Cite and support your ideas.
3. What do glacial deposits suggest about plate movement?
4. Why are magnetic patterns important evidence for plate tectonics?

Part 4: Push the Boundaries

In this section, you will learn in detail how movement at the boundaries of lithospheric plates affects Earth's surface.

Do take down notes and be prepared to answer three (3) worksheets after exploring the websites.

Explore the different types of plate boundaries by watching this video. Click on the link.
https://www.youtube.com/watch?v=GeDcnFUvBdw Plate boundaries, By Chris Merkert (20.28 minutes)

Refer to the PDF copy of "Chapter 8 Plate Tectonics" which you previously downloaded from http://www.tclauset.org/20_ESbk/ch08.pdf. Read pages 167-171. Remember to say the key words aloud or write them down.

Furthermore, use the following links to enhance your learning:

- http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_subduction.html Subduction animation with key points
- http://www.iris.edu/hq/files/programs/education_and_outreach/aotm/11/AOTM_09_01_Convergent_480.mov Animation of Convergent Boundary with explanation
- http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_hawaii.html Animation of the Hotspot volcanic chain
- http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_convection2.html Animation of Convection and Origin of Hawaiian-Emperor Seamount Chain
- https://www.youtube.com/watch?v=uSKzdbEVsI8 Divergent Boundary Animation with explanation, By IRIS EPO
- http://www.iris.edu/hq/inclass/animation/fault_transform Animation of Transform Fault with explanation

Now, complete the three Frayer Model graphic organizers.

- Identify the three types of plate boundaries and write the name of each type inside the oval at the middle of each Frayer Model organizer.
- Fill in the required information in each window/box for each of the three Frayer Model organizers.

PLATE BOUNDARY NO. 1

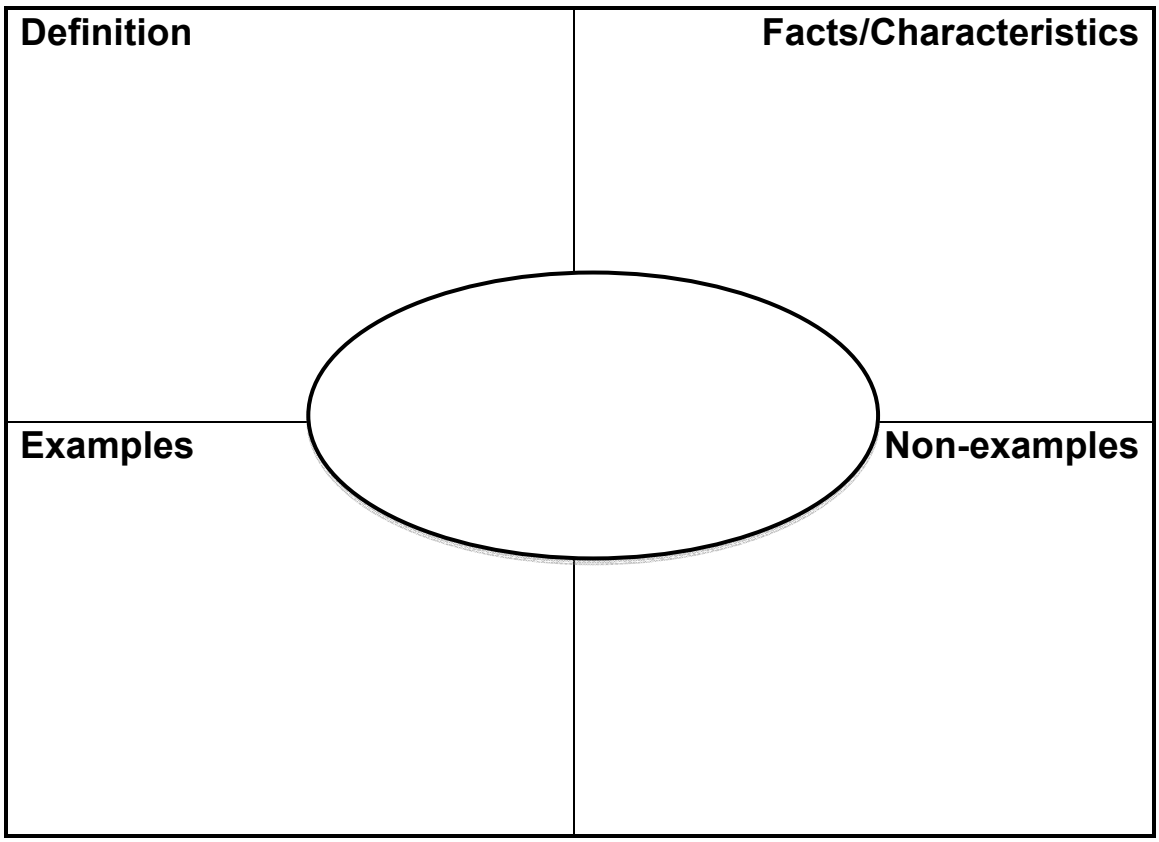


PLATE BOUNDARY NO. 2

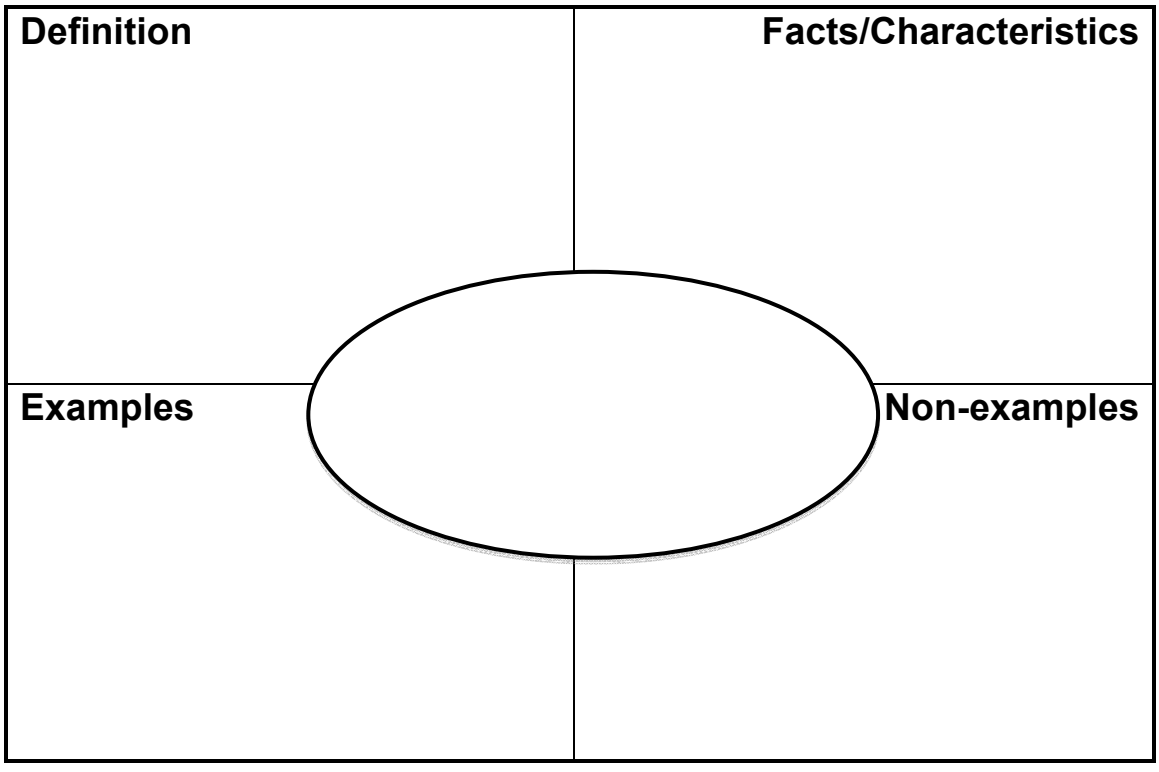
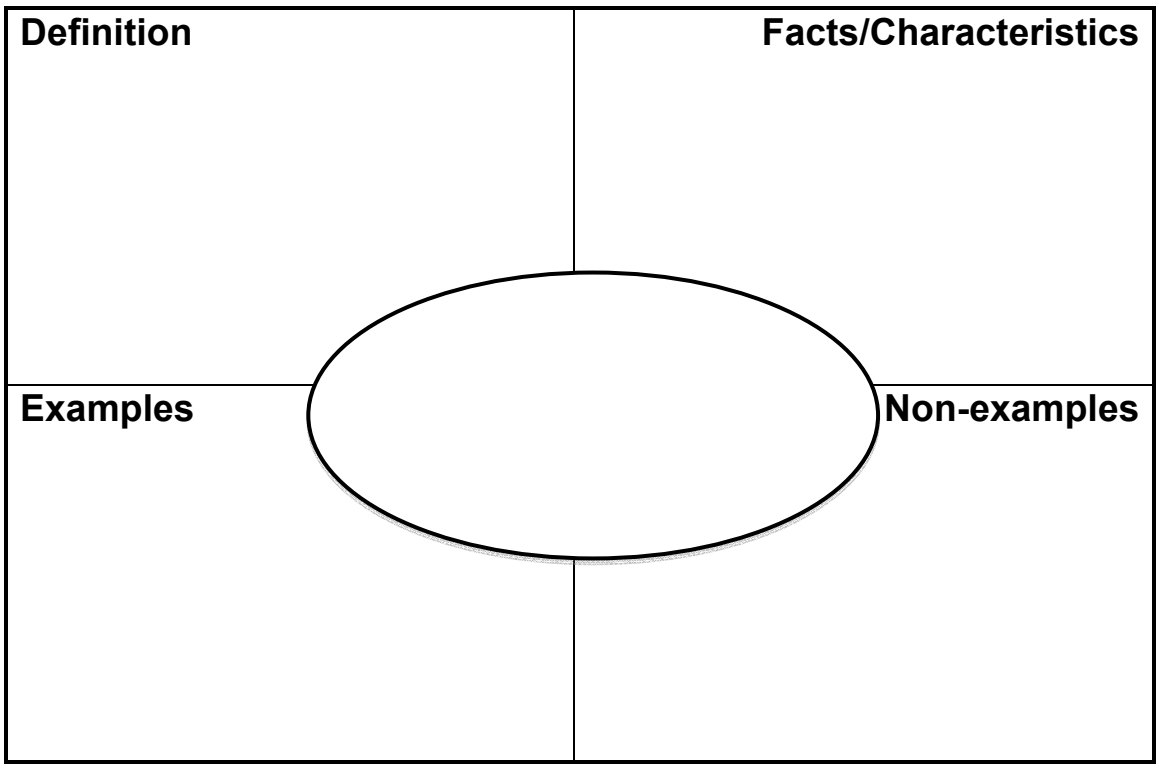


PLATE BOUNDARY NO. 3



PROCESS QUESTIONS:

1. How did you classify the three types of plate boundaries? What was your basis?
2. What processes occur along each type of plate boundaries?
3. What made you say that the items you listed under the "Non-examples" window are such? How did you classify these as non-examples?

Part 5: Colliding Continents

Let's relax a bit for now and watch a documentary film about plate tectonics. Click on the link to watch "Colliding Continents". You do have the option to download it first. It would help if you take down notes as well.

https://www.youtube.com/watch?v=KCSJNBMOjJs National Geographic Colliding Continents (50.04 minutes), By King Ashur

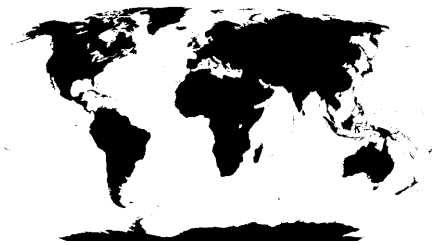
PROCESS QUESTIONS:

1. How would you describe the geological features of the Earth more than 250 million years ago?
2. What powers plate tectonics?
3. What is Pangaea?
4. How did geologists plot the relative positions of continents?

5. Does the Earth go through a cyclic phase? How does this happen?
6. How will you describe the geological features of the Earth 250 million years in the future? What do you call the next supercontinent? How will it affect life on Earth?
7. Does plate tectonics make Earth become smaller or bigger? Does the Earth's surface area change at all? Explain your answer.
8. **How do Earth's plate movements affect humans?**

Part 6: Draw and Tell Me Again

Retrieve the Draw & Tell Worksheet you initially accomplished in Part 1. Alternatively, you may go back to the hard copy if you used one. Fill in the third column or "My Response After Surfing the Net" column. Then submit your final worksheet showing both your response before and after.

DRAW & TELL WORKSHEET		
Question	My Response Before Surfing the Net	My Response After Surfing the Net
Look at this map of the world. Do you see that the west coast of Africa and the east coast of South America look like they might fit together like a jigsaw puzzle? Do you think there is a reason for that? Why?  Source: http://www.u-tt.com/images/worldmap_bg.gif		
What happens when Earth's plates move?		

What drives the plates to move? Draw a cross section of the Earth to further illustrate your answer.		
What happens at a plate boundary where two plates are moving away from each other? Draw a picture (a side view) to show your answer.		
What happens at a plate boundary where two plates are moving towards each other? Draw a picture (a side view) to show your answer.		

PROCESS QUESTIONS:

1. Are your answers and drawings after surfing the net similar with or different from those before surfing the net?
2. How are they similar or different? Discuss.

ACTIVITY NO. 5: MAY THE FORCE BE WITH YOU

Now that you've learned more information about the science of plate tectonics, let's look further into these forces of nature by simulating them.

Part 1: Move the Earth!

Make the tectonic plates move with your personal choice of crust type then see what happens. Click the link below to download the interactive simulation for plate tectonics. You will need Java version 6 to run this. If you already have the latest version of Java 7, you need to disable Java 7 and re-enable Java 6. You can restore Java 7 later.

https://phet.colorado.edu/en/simulation/plate-tectonics Plate Tectonics Interactive Simulation by PhET

Part 2: Make a Quake!

Now let's see if you can generate a powerful earthquake and prevent buildings from collapsing. Click on the link to make your own temblor with the Earthquake Simulator.

http://www.tlc.com/games-quizzes/earthquake-simulator.htm Make-a-Quake: Earthquake Simulator

PROCESS QUESTIONS:

1. What were the outcomes of your earthquake simulation? How did that make you feel?
2. What variables cause the least damage and what cause the greatest damage?
3. If you were to consult an engineer, what questions should you ask when they put up a building and make it earthquake proof?
4. Consider the case of Ruby Tower's collapse in Manila during the 1968 Casiguran earthquake.
   - http://en.wikipedia.org/wiki/1968_Casiguran_earthquake 1968 Casiguran earthquake
   - http://newsinfo.inquirer.net/inquirerheadlines/nation/view/20061030-29501/Ruby_Tower_earthquake_survivors_visit_hallowed_ground Ruby Tower earthquake survivors visit hallowed ground
5. Based on the earthquake simulation, what caused the extent of building damage in the Ruby Tower?
6. Using the earthquake simulator, which variables should you choose under "Ground" and "Prevention" if you were to rebuild the Ruby Tower and will have minimal damage when another 7.0-magnitude earthquake hits Manila?
7. **How should we prepare for an earthquake?**

Part 3: Build Your Own Volcano and Watch it Erupt!

Now it's time for some explosion! Build your own virtual volcano and discover the power of its eruption. Click the link to simulate a volcanic eruption.

http://www.cosmeo.com/braingames/virutal_volcano/index.cfm?title=Virtual%20Volcano Volcano Explorer: Build your own volcano and watch it erupt

PROCESS QUESTIONS:

1. What types of volcanoes did you build?
2. Which type of volcano did you find most interesting? Why?
3. What variables cause the least explosive and the most explosive eruption?
4. Recall the 1991 eruption of Mount Pinatubo. Which factors from the virtual volcano simulation caused this type of eruption?
5. Using the volcano simulator, which variables would possibly cause an eruption for a volcano like Taal Volcano? What type of eruption will it be? Justify your ideas.
6. **Considering the different types of eruption from the simulation, how should we prepare for a volcanic eruption?**

How was your experience with simulating these forces of nature? What determines the effects or outcome that each of these geological processes will cause?

Share your experience and answer to these questions by creating a short blabber with www.blabberize.com. Submit your blabber by sharing the link in this portal.

ACTIVITY NO. 6: FIND MY LOCATION

Earthquakes, volcanism and mountain building are three of the most spectacular earth processes related to tectonic activity.

In this activity, you will study how plate tectonics explain the relationship among the distribution of active volcanoes, earthquake epicenters, and major mountain belts.

Start by clicking on the links below.

http://www.indiana.edu/~g103/plate/plate2.html Interactive Map of Plate Tectonics and Geologic Processes (Volcanism, Earthquakes and Mountain Building)

http://itc.gsw.edu/faculty/bcarter/physgeol/eq/dist.htm Distribution of Earthquakes and their Foci

https://ees.as.uky.edu/sites/default/files/elearning/module04swf.swf Plate Tectonics Interactive Maps with a superimpose feature

http://www.cms.fu-berlin.de/geo/fb/e-learning/geolearning/en/mountain_building/introduction/mountain_distribution/index.html?TOC=introduction/mountain_distribution/index.html Global Distribution of Mountains

Complete the Find My Location Worksheet to organize and summarize what you read and explored from the 3 links provided.

- Put a check mark under either the “Yes” or “No” column whichever corresponds to your answer.
- Write a short explanation for your answer.
- Provide additional supporting details under the “Back it up” column only if you find it necessary.
- Finally, summarize everything in one concise paragraph in the “Wrap-up” box at the bottom.

FIND MY LOCATION WORKSHEET				
Earth Process/Activity	**Does it occur along plate boundaries?**		**Explain your answer**	**Back it up**
	Yes	**No**		
Earthquakes				
Volcanism				
Hotspots				
Mountain Building				
WRAP-UP:				

PROCESS QUESTIONS:

1. Where do earthquakes often occur?
2. How are earthquakes related to volcanoes?
3. Are volcanoes found on the same location where mountains are built? Why or why not?
4. How will you describe the distribution of hotspots?
5. How does plate tectonics explain the distribution of earthquake epicenters, active volcanoes and major mountain belts?
6. **How do Earth's plate movements affect humans?**

Now, go back to the map analysis you did in Activity No. 1. Retrieve your "Put on the Map" Worksheet by clicking on the Retrieve Map button below. Recheck your answer and compare it with your answer in the "Find My Location" Worksheet. Then fill out "My GPS Check-bric". Answer each question by choosing the appropriate response. Then, you may write your ideas, opinion, feeling, or reflection under the "Recalculating My Thoughts" column.

As you do this, recall the process you went through from the moment you answered the questions in Activity No.1, until you've completed the worksheet in Find My Location activity.

MY GPS CHECK-BRIC			
Question	Yes	No	Recalculating My Thoughts
Did I use my prior knowledge to answer the questions in Activity No.1?			
Did I use deduction to analyze the map in the first activity?			
Did I come up with the same answer in the "Find My Location" worksheet?			
Did I try different outcomes in the simulation?			
Did I detect a pattern that may lead to an explanation of the outcomes?			
Did I look for evidence to prove my ideas?			
Were my answers the result of a systematic investigation?			
Did I discover something new or different?			
Do I need to go back and review the topic?			
Do I need help understanding the topic?			
Am I on the right track?			
	Already	Not Yet	
Did I reach my goal?			
Am I ready to proceed to the next activity?			

ACTIVITY NO. 7: SELF-ASSESSMENT QUIZ

Let's check your knowledge of plate tectonics. Take the Plate Tectonics online quiz by clicking on this link.
http://www.glencoe.com/sec/science/lep_science/earth_science/tutor/quizzes/test11.html 25-item online quiz about plate tectonics

Check and review your answers. How well did you do in the quiz?

ACTIVITY NO. 8: DISASTER PREPAREDNESS AND MITIGATION

Now that you are more familiar with plate tectonics and how it explains the relationship among volcanoes, earthquakes, and resulting effects, like tsunamis, it is time to focus on how to prepare for these disasters. Disaster preparedness is not exactly new to you, since you have encountered this concept when you studied earthquakes and typhoons in Grade 8 and volcanoes in Grade 9.

First, let's review history and analyze two cases of disasters in the past.

Part 1: Case Analysis

For each case, watch the video/s first by clicking on the links. Then read the news article and the article on disaster preparedness that follow.

Case 1

- https://www.youtube.com/watch?v=b9DMiy_DVok Tsunami - Caught On Camera - P1, By John Daniel (10.58 minutes)
- https://www.youtube.com/watch?v=S0p_6G5GIeo Tsunami - Caught On Camera – P2, By John Daniel (10.54 minutes)
- https://www.youtube.com/watch?v=PHpG1P3JwEU Tsunami - Caught On Camera – P3, By John Daniel (10.53 minutes)
- News article: http://edition.cnn.com/2004/WORLD/asiapcf/12/30/asia.quake/ Tsunami death toll tops 118,000
- http://www.pbs.org/wgbh/nova/earth/anatomy-tsunami.html Anatomy of a Tsunami; Interactive Animation of the Indian Ocean Tsunami
- http://www.noaa.gov/features/tsunami/preparedness.html What's Your Tsunami Preparedness?

Case 2

- https://www.youtube.com/watch?v=-H_HZVY1tT4 Mt. St. Helens Eruption May 18, 1980 720p HD, By PLSheffield (6.28 minutes)

- News article: http://news.nationalgeographic.com/news/2004/10/1007_041007_mtsthelens_recap.html Mount St. Helens Volcanic Eruptions: 1980 vs. Now

- http://emergency.cdc.gov/disasters/volcanoes/before.asp Key Facts About Preparing for a Volcanic Eruption

PROCESS QUESTIONS:

1. What caused the Asian tsunami in December 2004?
2. What did you notice about the frequency of the water receding into the sea and the waves approaching the land?
3. Why did thousands of people die?
4. What may have caused Mount St. Helens to erupt in 1980?
5. How will you describe the eruption of Mount St. Helens?
6. What were the significant effects of this eruption?

Discuss and share your thoughts with your classmates about these two cases by answering the questions in the two forums. Before joining these forums, make sure you have watched all the videos and read all the articles.

Forum 1: What struck you most about the Indian Ocean Tsunami of December 2004? Why? **How should we prepare for a tsunami?**

Forum 2: How did the eruption of Mount St. Helens in 1980 impact the way you look at volcanoes? **How do Earth's plate movements affect humans?**

After sharing your ideas in the two forums, read your classmates' contribution and respond to at least one of them.

Part 2: The Hyogo Declaration and Framework for Action

After analyzing the two cases presented previously, we'll put everything together now, and come up with a plan and strategy that is anchored on what is accepted and has been agreed upon by the international community.

To know more about disaster preparedness and mitigation on a global level, click on this link.
http://unesdoc.unesco.org/images/0015/001504/150435e.pdf A brochure on Disaster Preparedness and Mitigation: UNESCO's Role

Save this brochure as or export as PDF in your computer. Read pages 5-18 of the brochure.

Accomplish the 5 Hyogo Commitments Worksheet.

- Write the rationale/principle/basis of UNESCO for adopting the Hyogo Declaration and Framework for Action in the “Rationale” box.
- List down the 5 commitments included in the Framework under the “5 Commitments” column as presented in the brochure.
- Then fill in the details of each commitment under the “What should be done?” column.

The 5 Hyogo Commitments	
Rationale:	
5 Commitments	**What should be done?**
1.	
2.	
3.	
4.	
5.	

PROCESS QUESTIONS:

1. Why is disaster preparedness extremely important?
2. What prompted UNESCO and the different countries involved to come up with the 5 Hyogo Commitments?
3. How will these 5 Hyogo Commitments help us to mitigate disasters like volcanic eruptions, earthquakes and tsunamis?
4. **How should we prepare for disasters that include volcanic eruptions, earthquakes and tsunamis?**

Part 3: Learn From The Expert

You've just read about the Hyogo Declaration and Framework for Action which encompass UNESCO's strategy for dealing with disaster reduction. This includes capacity building in vulnerable nations, research on natural hazards, coordination of early warning systems, the promotion of education and public awareness, and the integration of disaster reduction into development and anti-poverty programmes.

Let's investigate this further by learning from the expert on disaster preparedness.

Click the link below to learn more from the expert on disaster reduction.
http://content.time.com/time/world/article/0,8599,2058390,00.html How Japan Became a Leader in Disaster Preparation

PROCESS QUESTION:

1. Why is Japan known as the world leader in disaster preparedness?
2. What do you think are the three most important strategies that Japan practice which made them the world leader in disaster preparedness?

End of FIRM UP:

In this section, the discussion was about the key concepts of plate tectonics and the relationship among the locations of volcanoes, earthquake epicenters, and mountain ranges. You also learned more about disaster preparedness at the international level.

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision? What new learning goal should you now try to achieve?

This time, write your answers to the questions posted at the beginning of this module by accomplishing the REVISED column of the IRF Chart.

How should we prepare for disasters that include volcanic eruptions, earthquakes and tsunamis? **How do Earth's plate movements affect humans?**		
INITIAL	**REVISED**	FINAL

Moreover, go back to your checklist of competencies and see how much you've accomplished.

CHECKLIST OF COMPETENCIES			
Competencies	**Crystal Clear**	**Somewhat Clear**	**Not Fully Understood**
1. Describe the distribution of active volcanoes, earthquake epicenters, and major mountain belts			
2. Describe the different types of plate boundaries			
3. Explain the different processes that occur along the plate boundaries			
4. Describe the internal structure of the Earth			
5. Describe the possible causes of plate movement			

6. Enumerate the lines of evidence that support plate movement			
7. Infer patterns and relationship among the locations of volcanoes, earthquake epicenters, and mountain ranges			
8. Justify one's predictions or conclusions with available evidence			

Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

Your goal in this section is to take a closer look at some aspects of the topic.

ACTIVITY NO. 9: GET UP TO SPEED WITH PLATE TECTONICS

Though it seems like a very long time ago when plate tectonics was discovered in the 20th century, it is considered a very short time in science years. With all the tectonic-related global events that happened in the past and with the advancement in science and technology, what updates do we now know about plate tectonics?

In this activity, you will read 3 articles related to plate tectonics and how tectonic activities have affected and will affect humans. You will be asked to summarize each article.

Article Reading and Analysis

Article 1: *Satellite Map Reveals Secrets of the Sea Floor*

Click this link to read the first article.
http://www.abc.net.au/science/articles/2014/10/03/4099260.htm Satellite Map Reveals Secrets of the Sea Floor, By Stuart Gary, 3 October 2014

Sum It Up Instructions:

- Read the article and, as you read, list the main idea words on the "Sum It Up" sheet.

- Write a summary of the article using as many words of the main idea words as possible. Put one word in each box under the "Text Summary". Imagine that you have only $2.00 and that each word you use is worth 10 cents.
- Finally, you'll sum it up in 20 words.

Sum It Up!	
Name:	Date:
Title of the Article:	
Main Idea Word Bank	
Text Summary (10 cents per word)	
Sum it up for $2.00	

Submit your Sum It Up sheet.

PROCESS QUESTIONS:

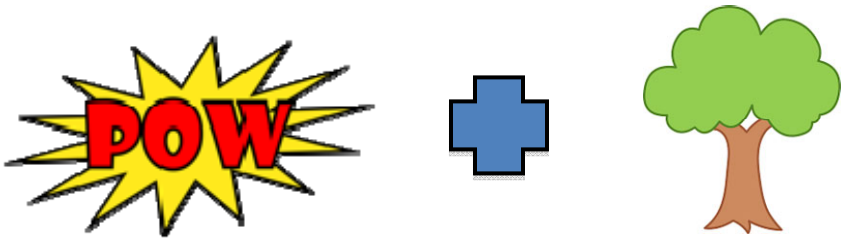
1. What was the most significant discovery about the sea floor using satellite technology?
2. Which recent disaster in the Indian Ocean reminds us that we need to explore further our oceans?
3. How can we benefit from this discovery?
4. **How do Earth's plate movements affect humans?**

Article 2: *Small Islands Amplify Tsunami Flooding*

Click this link to read the second article.
http://www.livescience.com/48638-offshore-islands-boost-tsunami-flooding.html
Small Islands Amplify Tsunami Flooding, By Becky Oskin, 5 November 2014

After reading the article, answer this question: *Should people living in coastal areas rely on offshore islands to help reduce risk of flooding and damage from tsunamis?*

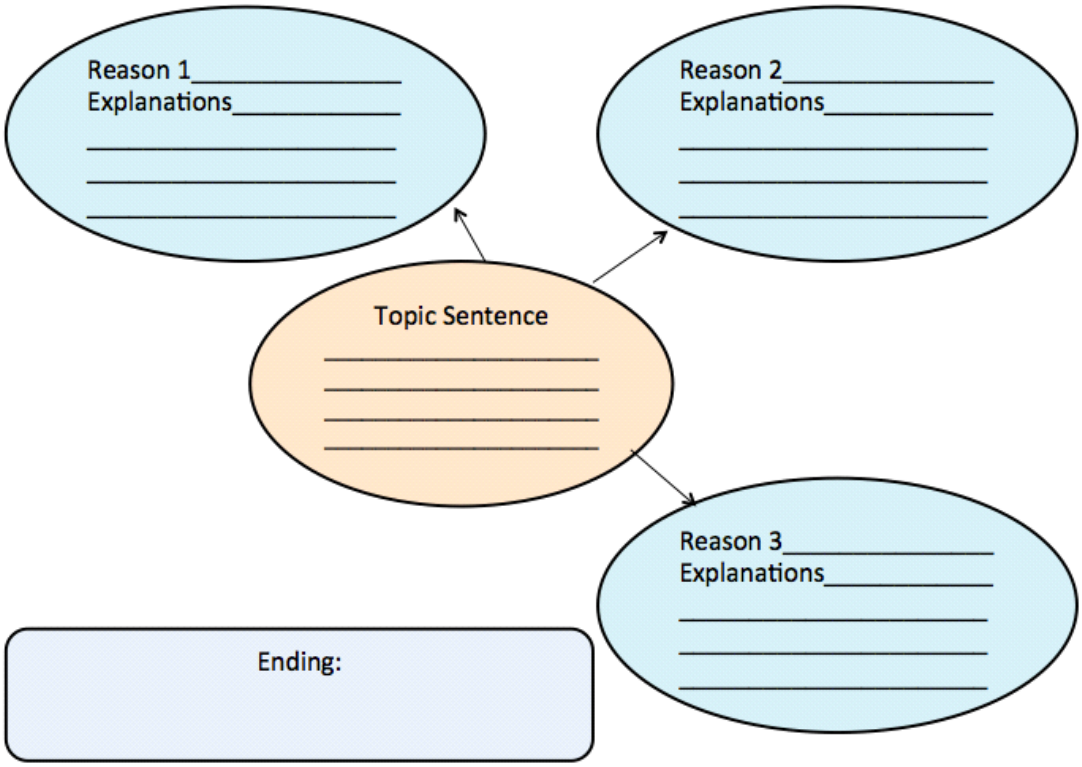
To guide you in answering that question, do the POW + TREE Activity.



Strategy		Activity
Pick an idea or opinion.		Formulate an opinion and state that opinion clearly.
Organize and generate notes and ideas for each part of the TREE.		Organize notes by completing a graphic organizer:
	**T**opic Sentence	Formulate a topic sentence expressing an opinion.
	Reason	Give at least three reasons to support the topic sentence.
	Explanation	Explain your reasons.
	Ending	Formulate a statement to summarize the topic sentence.
Write and say more.		Write a complete paragraph. Follow the plan developed using the TREE strategy.

Source: http://iris.peabody.vanderbilt.edu/module/pow/cresource/how-might-ms-price-provide-help-to-meet-the-individual-needs-of-all-her-students-including-those-with-disabilities/pow_04/

Accomplish the TREE graphic organizer shown below.



Now write your paragraph inside the box below based on the TREE graphic organizer that you have completed.

Submit your work when you're done.

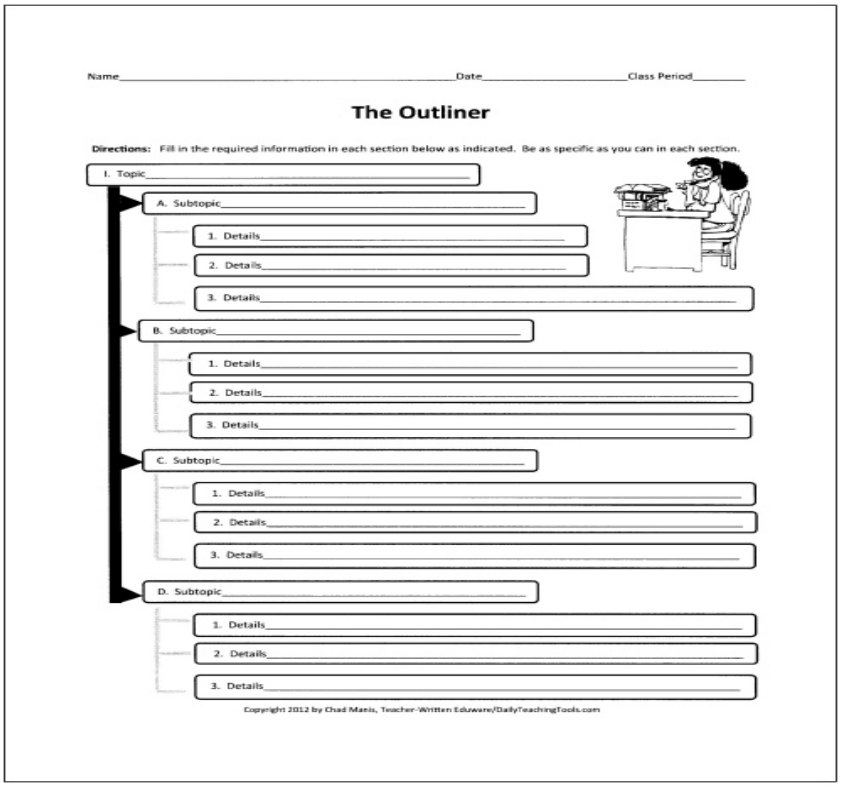
PROCESS QUESTIONS:

1. What is the difference between small and big offshore islands in terms of offering protection against tsunamis?
2. How will the result of this study be of use to the government and to people living near coastal areas?
3. **How should people in tsunami-prone areas prepare for this kind of disaster?**

Article 3: *25 Years After Loma Prieta, Earthquake Science is Transformed*

Click this link to read the third article.
http://www.livescience.com/48332-loma-prieta-earthquake-25th-anniversary.html
25 Years After Loma Prieta, Earthquake Science is Transformed, By Becky Oskin, 17 October 2014

Summarize the article by listing down strategies used by the state of California or the United States to prepare for another earthquake in the future and to mitigate this kind of disaster. As you identify the strategies or action plan, write the details or give a specific example for each strategy. Use the "Outliner" sheet to accomplish this task then submit your work.



Source: http://www.dailyteachingtools.com/images/Outliner.jpg

Compare your list of disaster preparedness and mitigation strategies which you derived from the article with that of UNESCO's 5 Hyogo Commitments.

Moreover, compare the strategies used by the United States with those used by the National Disaster Risk Reduction and Management Council (NDRRMC) of the Philippines. Click the link below to read about the NDRRMC's strategies.

http://www.rappler.com/newsbreak/iq/43819-fast-facts-ndrrmc Fast Facts: The NDRRMC

On top of that, you have the option to search online and compare the disaster preparedness plan or strategies of other disaster-prone countries.

PROCESS QUESTIONS:

1. What were the significant transformations in earthquake science after the Loma Prieta earthquake?
2. Are there similarities or differences from your list with UNESCO's Framework for Action? What are these?
3. Do you see any pattern? Describe.
4. How are the strategies used by the United States similar and different with those of the NDRRMC? Is there a pattern? Explain.
5. **How did the United States prepare for earthquakes?**
6. **How did the Philippines prepare for disasters? Are these sufficient? Explain.**
7. Lastly, recall the article you read in Part 3 of Activity No. 8 (http://content.time.com/time/world/article/0,8599,2058390,00.html How Japan Became a Leader in Disaster Preparation). How do the NDRRMC's strategies compare with those of Japan's?

ACTIVITY NO. 10: SITUATION ANALYSIS: WHEN DISASTER STRIKES

In this activity, you will examine four natural disasters from different parts of the world that are related to plate tectonics. Make sure to read thoroughly or listen carefully to the situations that will be presented. Take down notes, highlight key concepts and use the dictionary to find the meaning of unfamiliar words. Be prepared to answer questions after each situation and make a synthesis after examining all the given situations.

Be guided by the rubric shown below.

RUBRIC FOR UNDERSTANDING

SCORE	DESCRIPTION
3	Generalization is valid, logical, insightful, and makes accurate references to the data presented. Justification is comprehensive, clearly stated, and based on careful analysis of cases given. The way the student defends his/her answer is reflective of strategic thinking and a deep understanding of the topic.
2	Generalization is valid. Justification is correct and shows some analysis of cases given. The way the student defends his/her answer is reflective of an adequate understanding of the topic.
1	Generalization shows little relationship to the data presented. Some statements are correct, but most are inaccurate due to incomplete analysis of cases given. The way the student defends his/her answer is reflective of a superficial understanding of the topic.
0	Generalization is invalid. Justification is incorrect and has no relationship or no reference to the cases given. The student clearly does not understand the topics. The way the student defends his/her answer is coming out from memorization.

Situation 1: *The 1868 Arica Tsunami*

Click this link to read about the tsunami that swept the city of Arica which is located in Chile at present.
http://www.usc.edu/dept/tsunamis/peru/ptsu_1868.html The 1868 Arica Tsunami

PROCESS QUESTIONS:

1. What caused the Arica tsunami in 1868?
2. What were the damaging effects of this tsunami?
3. What do you think were the possible factors that contributed to the loss of thousands of lives and the huge damage to properties in this disaster?
4. **How did plate movement in the area of the Peru-Chile Trench affect the people along the South American coast?**

Situation 2: *Mount Etna Erupts*

Click this link to know more about the 1669 major eruption of Mount Etna in Sicily.
http://www.history.com/this-day-in-history/mount-etna-erupts Mount Etna Erupts

PROCESS QUESTIONS:

1. Why did people live on the slopes of Mount Etna despite the danger of living near an active volcano?
2. Why did the people in the city near the volcano stayed during the eruption instead of fleeing?
3. **How did the residents of the city of Catania handle the eruption of Mount Etna?**

Situation 3: *Iceland Volcano on the Brink of Major Eruption*

Click this link to watch the news video about the past eruption of Mount Hekla and another possible eruption from the same volcano as well as from Mount Katla. https://www.youtube.com/watch?v=AaY3kqzs6uw Euronews Science – Iceland volcano on brink of major eruption

PROCESS QUESTIONS:

1. How did the past eruption of Mount Hekla affect Iceland and Europe?
2. How do the volcanoes of Iceland benefit this country?
3. **How is Iceland preparing for another possible eruption?**

Situation 4: *Remembering the 1990 Luzon Earthquake*

Click this link to read about one of the strongest earthquakes in the Philippines. http://www.rappler.com/newsbreak/iq/63417-remembering-1990-luzon-earthquake Remembering the 1990 Luzon Earthquake

PROCESS QUESTIONS:

1. Why is the Philippines considered as the third most disaster-prone country in the world?
2. What valuable lessons did the 1990 Luzon earthquake leave?
3. The 1990 Luzon earthquake was the result of a horizontal left lateral strike-slip motion along the Philippine and Digdig Faults. **How did this plate movement impact the lives of the Filipino people?**

Synthesis

In the previous section, we looked at different situations involving tectonic-related disasters in different countries. Let's put together in the table below our answers to the essential questions that we asked for each article.

	SITUATION 1	SITUATION 2	SITUATION 3	SITUATION 4
ESSENTIAL QUESTIONS:	**The 1868 Arica Tsunami**	**Mount Etna Erupts**	**Iceland Volcano on the Brink of Major Eruption**	**Remembering the 1990 Luzon Earthquake**
How should we prepare for disasters that include volcanic eruptions, earthquakes and tsunamis?	We should prepare by…	We should prepare by…	We should prepare by…	We should prepare by…
How do Earth's plate movements affect humans?	Earth's plate movements affect humans…	Earth's plate movements affect humans…	Earth's plate movements affect humans…	Earth's plate movements affect humans…

PROCESS QUESTIONS:

1. Look at your answers to the essential questions in the above table. What do all the answers have in common?
2. Are all the strategies the same? How do the answers differ? What are the different significance of earth's plate movements and their impact to humans?
3. Complete the following statement and support your answer with examples from the above articles.

The ways by which humans prepare for disaster to ensure safety and reduce damage are …

_____
_____
_____

The impact of Earth's plate movements to humans is …

_____
_____
_____

Supporting reasons and examples from the above articles:

_____
_____
_____

Organize and present your answers to the essential questions in the table above by creating your own blog using www.edublogs.org. Sign up for a free account. Create your blog, publish it and submit by sharing the URL in the portal.

ACTIVITY NO. 11: I AM STRONG AND COMPLETE!

After doing the tasks in the previous activities, you should now be able to strengthen your new knowledge and understanding of plate tectonics.

It's time for you to complete the IRF Chart by filling out the FINAL column.

How should we prepare for disasters that include volcanic eruptions, earthquakes and tsunamis? **How do Earth's plate movements affect humans?**		
INITIAL	REVISED	**FINAL**

End of DEEPEN:

In this section, the discussion was about various tectonic-related global disasters in the past and some updates about plate tectonics. We also examined disaster preparedness and mitigation in these situations.

What new realizations do you have about the topic? What new connections have you made for yourself? What helped you make these connections?

Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is to apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding.

ACTIVITY NO. 12: DISASTER PREPAREDNESS: THE BEST THING SINCE SLICED BREAD

In previous activities of this module, you've watched, heard and read about several disasters like earthquakes, tsunamis, and volcanic eruptions that are all resulting effects of Earth's plate movements. Due to their damaging effects to humans and properties, it is a must for everyone to always be prepared especially those living in high-risk areas.

In this activity, you will be a given a chance to propose and develop your own disaster preparedness plan with a group.

Before you do that, let's have some fun, and play a disaster simulation game. Click on the link below to play this game. It may take awhile to load.

For the purpose of our lesson, use only the scenarios involving an earthquake and a tsunami when you play the game.

http://www.stopdisastersgame.org/en/playgame.html Stop Disasters! A disaster simulation game from the UN/ISDR

PROCESS QUESTIONS:

1. Did you enjoy the game? Why? Why not?
2. How did you feel while playing the disaster simulation game and after the disaster struck?
3. Did you make any improvement when you advanced from easy to difficult level? Discuss.
4. What strategy did you use to make sure you save lives and accomplish your goal?
5. What characteristics should a disaster preparedness planner or disaster reduction specialist possess?
6. **How should we prepare for disasters like earthquakes and tsunamis?**

Now that you have simulated disaster preparedness, you may want to review the skills you've learned in previous activities and figure out how to come up with a disaster preparedness plan.

Read the details of the 2013 Bohol earthquake shown below.

"The Philippine Institute of Volcanology and Seismology (Phivolcs) said Wednesday that a newly discovered fault may have been the source of the magnitude 7.2 earthquake that rocked Central Visayas Tuesday.

Phivolcs Seismic division officer in charge Ishmael Narag said Phivolcs did not see the new fault line in Bohol earlier despite the occurrence of an earthquake near the new fault line in 1996 because the province's limestone structure made identifying active faults difficult.

'Medyo mahirap makita yung features ng active faults sa Bohol kasi yung province ay predominantly [composed of] limestone. Ang limestone kasi, madaling ma-weather. So nawawala agad yung anumang superficial features that could have suggested the placement of a new fault,' he said.

Narag also said state seismologists already raised the possibility that a strong earthquake might occur in the province when they made the Philippines' comprehensive geohazard maps in 2007."

Source:
http://www.gmanetwork.com/news/story/331158/scitech/science/phivolcs-new-fault-line-may-have-been-source-of-bohol-earthquake

The following are excerpts from a report from the National Disaster Risk Reduction and Management Council on the effects of the earthquake in Sagbayan, Bohol, October 15, 2013. The information reflects conditions as of October 30, 2013, 6:00 a.m., unless otherwise stated.

From the National Disaster Risk Reduction and Management Council

Overview
An earthquake of tectonic origin with a magnitude of 7.2 occurred in Region VII specifically at Tagbilaran City, Bohol and Cebu City at about 8:12 a.m. last October 15, 2013.

As of 6:00 a.m., October 30, 2013, PHIVOLCS recorded 3,066 aftershocks, 84 of which were felt.

Effects

Casualties
222 Dead
797 Injured
8 Missing (all in Bohol)

Affected population

A total of 671,103 families (3,221,248 persons) were affected in 1,527 barangays in 60 municipalities and 6 cities in 6 provinces of Regions VI and VII (these numbers increased from the last situation report, as per validation of DSWD)
In Bohol, 75,140 families (370,836 persons) were displaced.
There are currently 376 evacuation centers in the affected areas.

Damages

A total of P2,203,930,000 worth of damaged roads, bridges, flood control, school buildings, hospitals, and other public buildings was reported in the Provinces of **Cebu (P819,051,000),** Bohol (P1,383,159,000),Negros Oriental (P270,000), and Siquijor (P1,450,000).

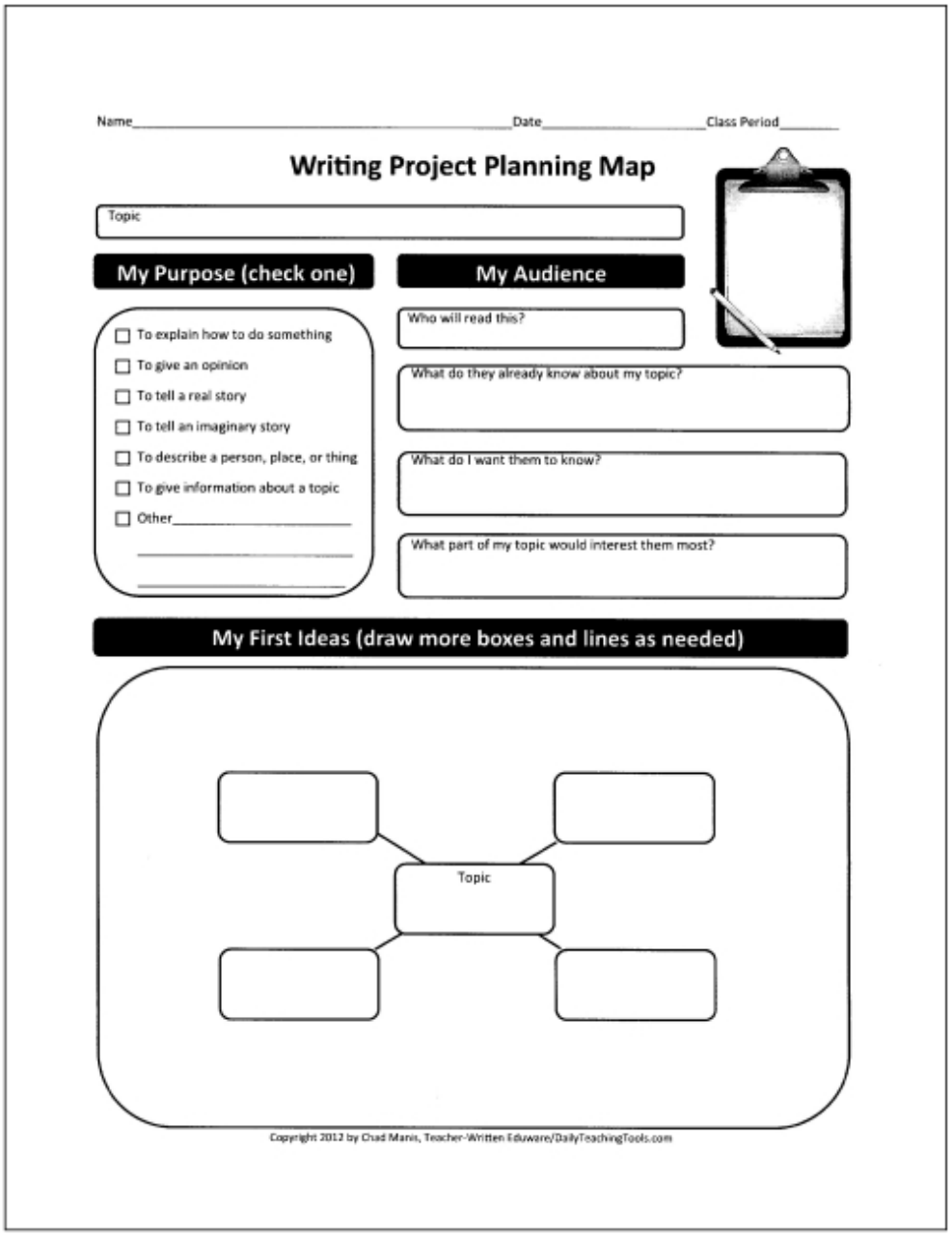
A total of **66,932 houses were damaged (12,238 totally / 53,694 partially)** in Bohol, Cebu, Neg. Occidental, Neg. Oriental, Iloilo, Siquijor, and Guimaras.
41 bridges were affected of which 38 are passable in the Provinces of Bohol, Cebu and Negros Occidental.

Source: http://www.gov.ph/crisis-response/updates-cebu-and-bohol-earthquake/

You can read more from the links provided. There are also other available resources online about this disaster which you may access.

Collaborate with the members of your group, brainstorm, solicit their ideas for this task, and assign roles. Each group should have a coordinator, a researcher, and a multimedia designer. Everyone should be involved in making the plan.

After studying the facts about the 2013 Bohol earthquake, develop a disaster preparedness plan for Bohol that will reduce damage from earthquakes. Use the Writing Project Planning Map to help you organize your ideas.



Source: http://www.dailyteachingtools.com/images/WritingProjectPlanMap.jpg

Then organize and present your disaster preparedness plan using www.canva.com. When your Canva presentation is done, export it as a PDF then upload to www.slideshare.net. Set the privacy settings to public in Slideshare then submit the link in the OHSP portal. You need to create a free account for each app.

PROCESS QUESTIONS:

1. If PHIVOLCS made the Philippines' comprehensive geohazard maps in 2007 and already raised the possibility that a strong earthquake might occur in the province, why were hundreds of lives lost and billions worth of properties damaged in the 2013 Bohol earthquake?
2. What should a good disaster preparedness plan contain?
3. **How should we prepare for disasters that include volcanic eruptions, earthquakes and tsunamis?**
4. **How do Earth's plate movements affect humans?**

ACTIVITY NO. 13: DIFFERENTIATED PERFORMANCE TASK

You're now ready to make the project for this module. You will be given three options for your final product. You only need to choose and make one.

The Philippines, because of its geographical location, is vulnerable to many types of natural disasters. It is located at the western part of the Pacific Ring of Fire, a most active part of the earth characterized by an ocean encircling belt of active volcanoes and earthquake generators.

In response to all these factors and conditions, you are to develop a strategy for disaster preparedness and risk reduction for natural catastrophes that include volcanic eruptions, earthquakes and their resultant effects like tsunamis specifically designed for Filipinos whether in the government and private sectors or common citizens.

Your product will be evaluated based on:

- Content
- Planning and Organization
- Creativity
- Impact

Option 1: LOCAL DRRM (DISASTER RISK REDUCTION AND MANAGEMENT) OFFICER

The West Valley Fault or formerly known as the Marikina Valley Fault System stretches from the Province of Bulacan to the Province of Laguna in the south traversing Metro Manila areas. This fault poses a great danger because it cuts

through all the modern and progressive portions of Manila. The Philippine Institute of Volcanology and Seismology (PHIVOLCS) warned Metro Manila residents of the possible movement of the West Valley Fault that threatens the entire National Capital Region. (Source: http://philnews.ph/2013/10/17/west-valley-fault-earthquake-threatens-metro-manila-video/)

You are the Local DRRM Officer of Muntinlupa City and tasked to ensure disaster preparedness this year among public schools in the city. You are to create any of the following that will be used to educate and train elementary and high school students in preparation for an earthquake so they will know what to do during an earthquake.

- Demonstration video
- PowerPoint presentation
- Presentation using a Web 2.0 tool (e.g., www.emaze.com, www.prezi.com)

Option 2: PHIVOLCS SCIENCE RESEARCH SPECIALIST

Mayon Volcano recently erupted and has always been active. The eruption of Mt. Pinatubo in 1991 caused huge damage to properties and the environment especially in Pampanga, Zambales and Tarlac. Hundreds of people were killed and thousands were left homeless. There are also many other active and dormant volcanoes in the Philippines.

You are the Science Research Specialist of PHIVOLCS and scheduled to be interviewed in a national TV program on the science behind volcanic eruptions and primarily on disaster preparedness and risk reduction.

You will prepare any of the following as your visual aid that will be shown to the viewers during the TV interview.

- Flyer illustrating a Disaster Preparedness Kit
- Animated Video (e.g., Flash, Shockwave or www.powtoon.com)
- Comic Booklet or Digital Cartoon (e.g. www.toondoo.com)

Option 3: EMERGENCY MANAGEMENT SPECIALIST

As an Emergency Management Specialist trained overseas, you were hired by the Philippine government to develop capacity-building activities at the barangay and municipality level to include orientation on earthquake and tsunami concepts, familiarization of tsunami hazard maps and preparation of tsunami evacuation plans.

Your first assignment is to conduct a training in Iloilo City. The participants for the training include LGU members, Barangay Council, Coast Guard, and the Philippine army from coastal municipalities in Western Visayas. You are to design a simple

yet comprehensive and easy-to-understand training tool that focuses on disaster preparedness, risk reduction, response and recovery plan for tsunamis. The training tool may be created using any of the following formats.

- Brochure
- Video presentation of a collection of photos and videos from actual tsunamis that happened in different countries, including pre-tsunami and post-tsunami events and activities
- Infographic in PDF using Canva (www.canva.com)

RUBRIC FOR DIFFERENTIATED PERFORMANCE TASK

CRITERIA	Outstanding 4	Satisfactory 3	Developing 2	Beginning 1
Content	Shows student's deep and thorough understanding of scientific concepts learned; able to apply knowledge to novel and relevant situations	Shows student's correct understanding of concepts learned; able to apply knowledge to relevant situations	Shows student's inadequate understanding of concepts; able to apply knowledge but to an already known situation	Shows student's lack of understanding of concepts; not able to apply knowledge to new situations
Planning & Organization	The material reflects deliberate, careful and thorough planning. It has a strong educational value. The information is presented in an interesting and logical fashion.	The material reflects adequate planning. It is educational and the information is presented in a logical order.	The material reflects minimal planning. It has weak educational value and some information is presented illogically.	The material reflects insufficient planning. It is hard to follow and lacks educational value.

Creativity	Shows originality and innovation in activities and materials done.	Shows resourcefulness in activities and materials done.	Shows resourcefulness in some activities and materials done; A lot of the work is borrowed from other resources.	Shows no originality and lack of creativity in activities and materials. Work is entirely copied without any acknowledgment of the original source.
Impact	Material is highly stimulating and immediately mobilizes the reader or audience to initiate action. Impact is high.	Material provides reader or audience with substantial reason to take action. Impact is sufficient.	Some parts of the material are confusing thus weakening the impact of the message on the reader.	Material is vague about the proper course of action to take. Impact is low.

ACTIVITY NO. 13: MY REFLECTION JOURNAL

Now that you have accomplished your performance task, let's look back and review your learning process in this lesson.

Write your personal reflections in the journal log below by answering the questions.

My Reflection Journal
How did I get started? What were my first thoughts?
Which activity helped me understand the topic better?
Which part of the lesson did I find most challenging? Did I try anything that didn't work? How did I feel about it?

What methods did I follow to establish patterns and relationships?
How did I prove my ideas?
What did I learn from utilizing a systematic investigation?
How well did I do? Did I get the results I expected?
What could I have done differently?
What were my remarkable accomplishments? How did it make me feel?
How might I apply this line of thinking to other problems or situations?

End of TRANSFER:

In this section, your task was to develop a strategy for disaster preparedness and risk reduction for natural catastrophes that include volcanic eruptions, earthquakes, and their resultant effects, like tsunamis.

How did you find the performance task? How did the task help you see the real world use of the topic?

You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment.

POST-ASSESSMENT:

It's now time to evaluate your learning. Click on the letter of the answer that you think best answers the question. Your score will only appear after you answer all items. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

(A) 1. Over what surface do lithospheric plates move?
- A. Lower mantle
- B. Inner core
- C. Outer core
- D. Asthenosphere

(A) 2. Which description is the best match for divergent plate boundaries?
- A. Two plates move away from each other.
- B. Two plates move towards each other.
- C. Two plates slip past each other.
- D. One plate moves in, the other moves out.

(A) 3. Which among the following is not a valid evidence for plate movement?
- A. Distribution of earthquake foci and volcanoes
- B. Jigsaw fit of all the tectonic plates
- C. Fossil remains of the freshwater reptile *Mesosaurus*
- D. Matching magnetic patterns and age of rocks on either side of the mid-ocean ridges

(A) 4. The occurrences of earthquakes and volcanoes around the world gave support to Wegener's ideas. Where do most earthquakes and volcanoes occur?
- A. along hot spots
- B. along tectonic plates
- C. at the boundaries between lithospheric plates
- D. at the boundary between the upper mantle and lower mantle

(A) 5. Why don't earthquakes, volcanic eruptions, and mountain ranges occur randomly on Earth?
- A. Because they are related to each other.
- B. Because their occurrence is a result of geological processes that originated from the movement of lithospheric plates.
- C. Because they are all connected from north to south and from east to west.
- D. Because they are the products of Earth's major geologic processes that began billions of years ago.

(A) 6. How is a trench formed in the ocean?
- A. When two plates collide, a trench is formed.
- B. When oceanic plates collide, one subducts under the other.
- C. When two continental plates collide, a trench is formed.
- D. When two oceanic plates move apart, a valley forms in the ocean.

(A) 7. Where does mountain building generally occur? What evidence can support this?

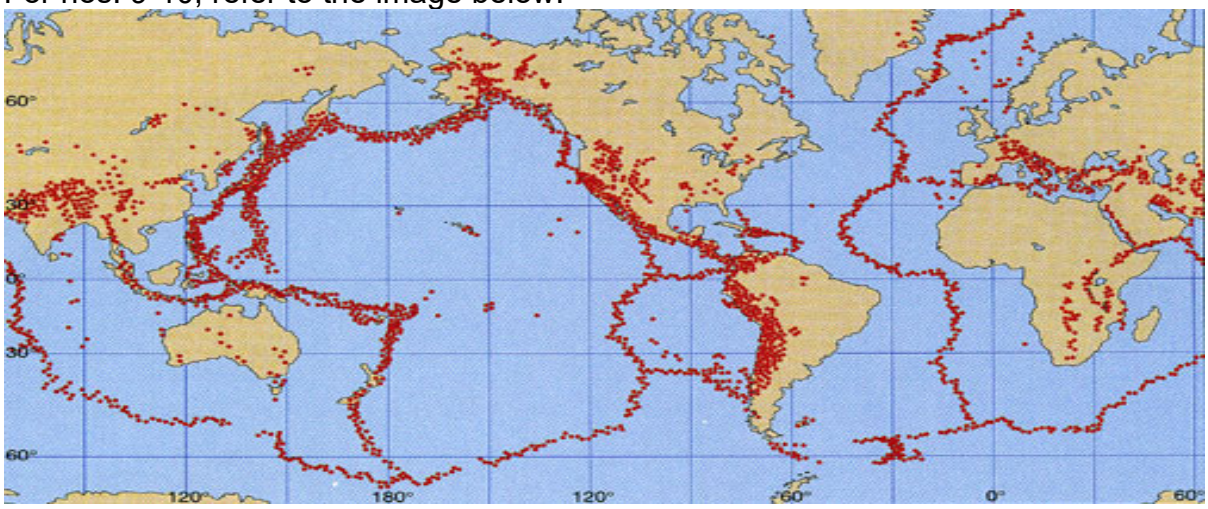
I. Mountain building generally occurs at convergent plate boundaries.
II. Mountain building generally occurs at divergent plate boundaries.
III. The mountainous island chain in Hawaii and the island arc of Japan were formed by lava erupting from volcanoes as a result of two diverging oceanic plates.
IV. Mountain ranges are formed in mid-ocean ridges in the Pacific Ocean.
V. The Himalayas, Andes, and Appalachian mountains are examples of major mountain belts which are the result of colliding lithospheric plates.

A. I and V only
B. II and III only
C. II and IV only
D. I and IV only

(A) 8. Which among the following steps does not accurately describe the process that possibly caused plate movement?

A. The rocks of the lower mantle are hot enough so that they flow very slowly.
B. The core heats the rock material of the lower mantle. As it is heated, it expands, becomes less dense and rises as a convection current.
C. The less dense lower mantle rock material moves up and forms granite that floats on the surface causing the lithoshere to move.
D. The lower mantle rock material rises toward Earth's surface and may divide the lithosphere above and form a mid-ocean ridge.

For nos. 9-10, refer to the image below.



Source:
http://www.geology.illinois.edu/people/hsui/classes/geo350/lectures/earthquakes/GlblEqkC.jpg

(M) 9. The map shows the distribution of earthquake foci on Earth. The earthquake foci are shown in red. Which among the following are at a very high risk for earthquakes?

A. Eastern part of Australia
B. Western coastal area of South America
C. Southern Greenland
D. All of the above

(M) 10. Looking at the same map, which among the following should be practiced by the people living near coastal areas with the red dots?

I. earthquake drill
II. tsunami drill
III. hurricane drill
IV. wildfire drill

A. I only
B. II only
C. I and II
D. III and IV

(M) 11. Japan is known as the leader in disaster preparedness. Which among the following does not support this claim?

A. Perched on the Ring of Fire, Japan is one of the most earthquake-prone countries in the world, but it's also one of the best equipped to handle them.
B. Japan boasts the world's most sophisticated earthquake early-warning system and also has very strict building codes.
C. Japan has a culture of preparedness among its citizens and leaders.
D. Japan leads in the innovation and manufacture of advanced technology like electronics and cars.

(M) 12. Albay's Disaster Risk Reduction Management (DRRM) is an ideal model in building a resilient, safe community during times of disaster events, a research study said. The province of Albay has attained a "Zero Casualty" target for one and half decade which includes the eruptions of Mayon Volcano in 2001, 2006 and 2009. Which among the following may have contributed to Albay's success?

I. Albay understands that it has an active volcano within its province and is aware of the risks of living near a volcano.
II. The province of Albay has made risk reduction a priority.
III. Vulnerable communities in Albay are prepared on how to react by information campaigns that were done.
IV. The province applied the warning and evacuation principle rather than search and rescue. The basic disaster risk reduction strategy is preparedness for the responders and the victims, not preparedness just for the responders (relief and rescue).

A. I and II only
B. III and IV only
C. II, III and IV only
D. I, II, III and IV

(M) 13. How did the Indian Ocean tsunami of December 2004 impact the international community in terms of disaster preparedness and risk reduction?
A. It prompted governments to establish a risk reduction plan.
B. It fostered camaraderie among nations.
C. It prompted governments to adopt the Hyogo Declaration and agree upon a Framework for Action aimed at building the resilience of nations and communities to disasters.
D. It prompted governments from different nations to establish the Millennium Development Goals with the aim of ensuring safety, preparedness and resilience of at risk countries.

(M) 14. If subduction takes place at convergent boundaries, and mountain ranges are built along mid-ocean ridges, what do these plate movements imply about the surface area of the Earth?
A. The subduction of plates means that Earth is becoming smaller.
B. The continual formation of new rocks in the ocean floor means that Earth must be getting larger.
C. The movement of plates means that Earth is rebuilding itself in a cyclic phase and therefore may change in dimensions and magnitude in the future.
D. The Earth has a constant surface area, thus, when new land is created at the ridge between plates, the same amount of land created must be absorbed into the earth at subduction zones.

(T) 15. Based on UNESCO's five Hyogo commitments, which practices must be observed by the Philippines in preparation for an earthquake?
I. The Philippine government should integrate disaster risk reduction into its laws, programmes and plans, and ensure the participation of local communities in planning.
II. The Philippines should apply safety codes to ensure that schools, hospitals, homes and other buildings do not collapse in earthquakes.
III. The Philippines should reduce risks by requiring its lawmakers and government officials to be the first responders during a disaster.
IV. The Philippine government and regional or local authorities should conduct risk assessments, adopt contingency plans, and test preparedness by such measures as evacuation drills.

A. I and II only
B. I, II and III only

C. I, II and IV only
D. I, II, III and IV

(T) 16. How should the Filipino people respond to the laws and programs created by the Philippine national and local government on disaster preparedness and risk reduction?
A. Volunteer to help
B. Be informed, support, participate and take action
C. Coordinate with your city or town mayor and local officials
D. Watch news on TV or read the newspaper and prepare your family

(T) 17. Hekla is a stratovolcano in the south of Iceland with a height of 1,491 meters. Hekla is one of Iceland's most active volcanoes. How should the people in Southern Iceland prepare best for a volcanic eruption?
A. Follow the advice of local authorities, develop an evacuation and sheltering plan for yourself/your family, and be prepared to shelter or evacuate.
B. Prepare an emergency supply kit.
C. Make arrangements with friends or family for transportation.
D. As you evacuate, take only essential items with you including at least a one-week supply of prescription medications. Then close all windows and doors of your home.

(T) 18. Millions of people around the world live in areas at risk for tsunamis, such as Hawaii, Alaska, the U.S. and Canadian coasts, Indonesia, Sri Lanka, Thailand, and India. And millions more visit these places every day. Would you know what to do in the event of a tsunami? Which among the following list can and should be done as part of tsunami preparedness?
I. Check out reliable tsunami websites and read news articles online about any possible forecast for tsunamis before travelling or taking a vacation in a tsunami-prone area.
II. Learn about tsunami risk in your community.
III. Plan an evacuation route and prepare the essentials.
IV. Securely fasten a bell near the ground about 10 meters away from your door so it will wake you up to warn you in case the tsunami occurs at night while you're sleeping.

A. I, II and III only.
B. II, III and IV only
C. II and III only
D. I, II, III and IV

(T) 19. You belong to Region IV A in the Philippines. You've heard about active faults and the Valley Fault System but do not know the details nor its exact location. As part of your earthquake disaster preparedness plan, which source should you check to find out if an active fault traverses Santa Rosa City in Laguna?

A. The Hazard Maps of the Philippine Institute of Volcanology and Seismology (PHIVOLCS) in its website
B. The Hazard Maps of the Department of Science and Technology (DOST)
C. Google Maps
D. Map of the Philippines

(T) 20. UNESCO forms part of a network of UN agencies, inter-governmental groups, and non-governmental or civil society organizations that are teamed together as part of the International Strategy for Disaster Reduction. If you were a disaster reduction specialist working at the international level, which among the following organizations would not be involved or concerned with your cause?

A. International Strategy for Disaster Reduction (ISDR)
B. United Nations Children's Fund (UNICEF)
C. The World Bank Group
D. AIDS United

GLOSSARY OF TERMS USED IN THIS LESSON:

asthenosphere - a portion of the upper mantle just below the lithosphere that is involved in plate tectonic movements and isostatic adjustments

continental drift – the idea that the continents move around on Earth's surface suggested by German climatologist Alfred Wegener

continental plates - thick, less dense lithospheric plates that are made of granite and form the continents

convection - the movement caused within a fluid by the tendency of hotter and therefore less dense material to rise, and colder, denser material to sink under the influence of gravity, which consequently results in transfer of heat

convergent boundary - a lithospheric plate boundary where two plates come together

divergent boundary - a lithospheric plate boundary where two plates move apart

hotspot - a place in the upper mantle of the earth at which hot magma from the lower mantle upwells to melt through the crust usually in the interior of a tectonic plate to form a volcanic feature; hot spot volcanoes cannot be ascribed either to a subduction zone or to seafloor spreading at mid-ocean ridges

lithosphere – the rigid outer part of the earth, consisting of the crust and upper mantle

lithospheric plates - large pieces of Earth's lithosphere that move over the asthenosphere

mantle plume - heated lower mantle rock that rises toward the lithosphere because it is less dense than surrounding mantle rock

mid-ocean ridges - long chains of undersea mountains

oceanic plates - thin, dense lithospheric plates that are made of basalt and form the ocean floor

Pangaea - an ancient, huge landmass composed of earlier forms of today's continents; an ancient supercontinent

plate tectonics - a theory explaining how the pieces of Earth's surface (the plates) move

Ring of Fire - also called Circum-Pacific Belt or Pacific Ring of Fire, long

horseshoe-shaped seismically active belt of earthquake epicentres, volcanoes, and tectonic plate boundaries that fringes the Pacific basin

seafloor spreading - a hypothesis that new sea floor is created at mid-ocean ridges and that in the process the continents are pushed apart from each other

stratovolcano – another name for composite volcano; a steep volcanic cone built by both lava flows and pyroclastic eruptions

subduction - the sideways and downward movement of the edge of a plate of the earth's crust into the mantle beneath another plate; a process that involves a lithospheric plate sinking into the mantle

subduction zone - the zone of convergence of two tectonic plates, one of which usually overrides the other

tectonic plates – also called lithospheric plates

temblor – an earthquake

transform fault boundary - a lithospheric plate boundary where two plates slide by each other

trench - a valley in the ocean created where one lithospheric plate subducts under another

tsunami - a very high, large wave in the ocean that is usually caused by an earthquake under the sea and that can cause great destruction when it reaches land

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https://www.youtube.com/watch?v=uSKzdbEVsI8 Divergent Boundary Animation with explanation, By IRIS EPO

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