"What is the relation between tectonic plates and earthquakes?"

The lesson plan was developed according to the Cypriot national curriculum

School level: Primary

Grade, age of students: 6th grade, 11-12 years old

Approx. time needed: 80 minutes

Domain: Geography

Sub-domain: Geology

Classroom organization: Teams of 3-4 students

Concept competences:

- Explain that the Earth's crust consists of a number of tectonic plates
- Conclude from maps that the boundaries of tectonic plates are associated with seismic zones

(Indicative) Skill competences:

- Interpret data from digital globe and maps
- Support their arguments with valid data

Means and materials:

For each student:

- work sheet (you can find an indicative work sheet in the appendix)
- world map that shows the tectonic plates boundaries

For each team:

- computer
- computer programs:
  - google earth
  - google earth KML for:
    - Plate boundaries
    - Earthquakes from 0-2011

You can download google earth from:

https://www.google.com/earth/download/ge/agree.html

You can download google earth KML from:

http://earthquake.usgs.gov/earthquakes/feed/v1.0/kml.php
https://maps.google.com/gallery/search?hl=el&q=earthquakes

Activities description:

Orientation phase

If an earthquake occurred not a while ago, you can ask your students to mention experiences (what they felt, what and how they think it happened) or you can show a news broadcast about an earthquake event. After that you can ask the following questions: "Do you think earthquakes occur only in Cyprus?" "Where do you think, other earthquakes might occur and why?" "Why do you think we have so many earthquakes in Cyprus?" You can have your students map their ideas about earthquakes and present some of them to the other students.

Conceptualization phase

Show a world map that presents the tectonic plate's boundaries and earthquakes occurrence (e.g. http://all-geo.org/highlyallochthonous/wp-content/uploads/2010/07/globalseis.jpg) and also an image that shows the earth layers (e.g. http://www.worldatlas.com/aatlas/infopage/tectonic.gif). You can have the students ask questions based on their observations, or if they are not familiar with the procedure, you can raise some of the questions. For example: "Where do earthquakes occur in relation to the tectonic plates?" "Why? (Observe the earth's layers)" "Do you think the morphology of the places that earthquakes occur (plates boundaries) is the same everywhere?" "What do you think are the differences/similarities and why?" You can have your students add their ideas on their concept map.

Investigation phase

Each team works in a computer using google earth. Each student can use a world map showing the plates boundaries and the work sheet that is provided in the appendix (you should adjust the work sheet according to your students' needs and knowledge about the concept of the lesson and the processes of inquiry). During the investigation, the children observe a specific place on earth (by using google earth and the world map) and they interpret their observations based on the plates' movements, while explaining their reasoning. They follow, more or less, the same procedure for each type of boundary (convergent, divergent and transformed). For more details about the investigation procedure, see the students working sheet in the appendix.

During this phase, the teacher must have a guiding role. You can stop the teams when there is a need to discuss something altogether or you can add specific points to the working sheet so that students will know when they must stop and have a conversation with the whole class or call the teacher for a discussion within the team.

Conclusion phase

Students compare the data they collected during the previous phase with their concept map (initial ideas). They can add/delete/adjust (with a different color) what they have learnt and present it to the classroom (they can also do the same thing after they listen to all the teams or you can have a classroom concept map and teams can add to that).

Useful information for the teacher:

- **The lesson plan was developed according to inquiry – based learning (you can find more about it in the Intellectual Output 1 of the SSE project)**

- **If you are not familiar with the use of google earth** you can find out more in this website: https://support.google.com/earth/answer/176576?hl=en

- **If your students are not familiar with google earth** you can provide them with the information needed for the lesson (e.g. screenshots for showing them the steps they must follow) or you can devote some time before the lesson to get your students familiar with the tool

- **If your students are not familiar with inquiry** you can follow a more structured type (e.g. give specific roles to the students of each team, have more structured activities during the investigation phase: provide them data, words they can use to explain certain things, examples, ways to organize their data)

- **If they are familiar with inquiry and /or the concept** you can choose a more open type of inquiry (e.g. they can organize their data in a form they choose is best)

- **If you want to extend the lesson,** here are some suggestions:
    - *Volcanoes* (if you want you can develop similar activities like those above. You can add to google earth information about the location of volcanoes by using this hyperlink: https://maps.google.com/gallery/search?hl=el&q=volcanoes. You can also enable the appearance of photos [earth gallery/layers/photos] if you want your students to see and study the morphology of the volcanoes:
        - Where do the most volcanoes form? (Convergent, Transformed or Divergent boundaries?). Explain why.
        - What is the relation between volcanoes and earthquakes occurrence?
    - *Creation of Cyprus*
    - *Develop models about a specific earthquake event*

Appendix

Work sheet (investigation phase) – each student also has a world map that shows the tectonic plates boundaries.

1. Zoom in Cyprus

Do you see something strange? What is the ocean's floor morphology there? *Use your world map to make comparisons.*

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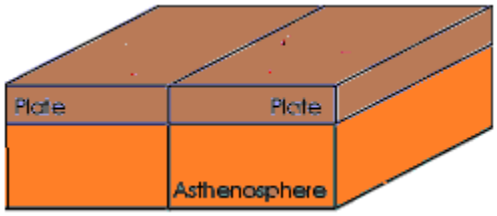
a. Draw arrows to the picture below to show the two tectonic plates (African and Eurasian) move when an earthquake occurs on their boundaries near Cyprus. Explain your reasoning.



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b. Use google earth and draw on your world map with a color where you think similar type of boundaries exists. Explain how you came up with this decision.

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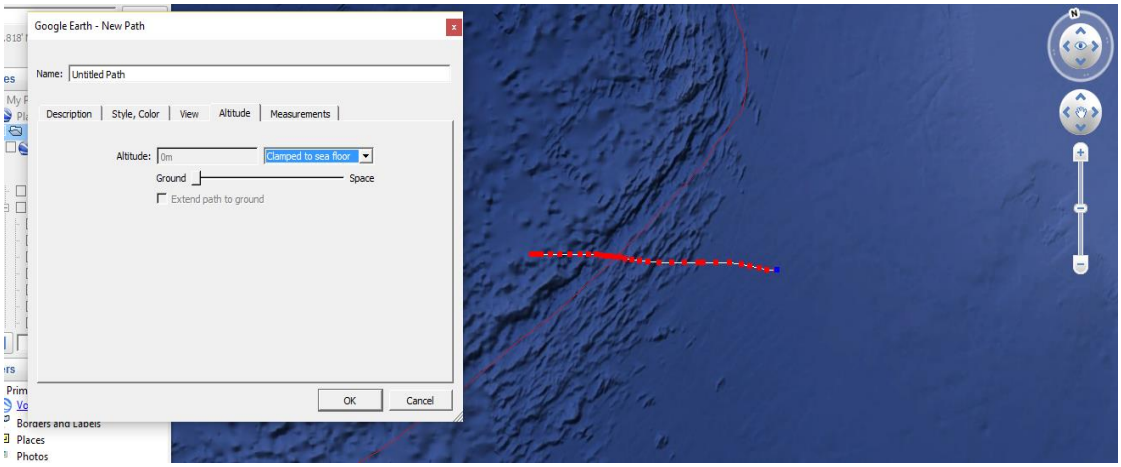
c. Enable the tectonic plates KML (Places - on the left of the screen). Compare your observations with your answers above. You can add and/or adjust the lines you draw on your map.

Add a horizontal path to a place with divergent boundaries of your choosing (see how you can add a path in the screenshot below). Then click Edit/ Show Elevation Profile.



d. What do you observe?

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e. What is the difference between divergent and convergent boundaries? *If you want you can follow the procedure descripted above for the convergent boundaries.* Why do you think there is a difference?

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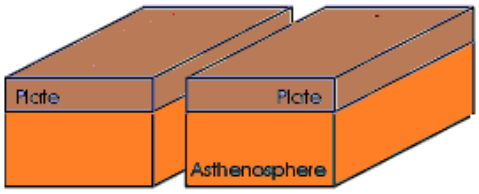
f. Draw arrows to the picture below to show how the two tectonic plates move when an earthquake occurs on the divergent boundaries. Explain your reasoning.



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2. Visit San Andreas Fault, California

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(You can find the place by writing it to the search box on the left of your screen)

a. What is the ground morphology there? (You can disable tectonic plates KML to take a better look)

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Why do you think the ground morphology is that way?

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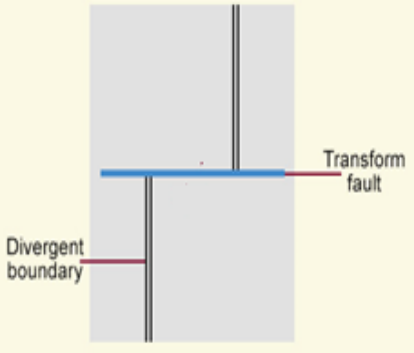

Based on your observations, draw to the picture on the left arrows of how a transform fault moves and explain why you think it moves that way.

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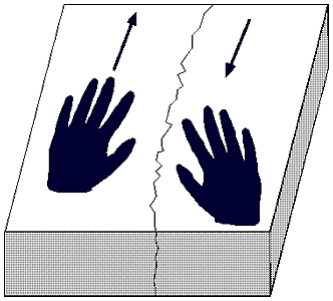
Investigate:



1. Ask your teacher to give you two pieces of foam rubber.

2. Place the pieces on your desk and connect their rough edges together. **Each piece of foam rubber represents a tectonic plate.**

3. Push lightly the two pieces, one towards the desk and the other towards you (like the picture).

What do you observe?

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Soon a little bit of foam rubber along the crack (the fault) will break and the two pieces will suddenly slip past each other. What does this sudden breaking represents?

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Why do earthquakes occur?

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Based on the data you have collected during this investigation:

*Draw on your world map arrows to show the direction of tectonic plates drift.

*Compare all your data with your concept map (add/adjust what you have learnt with a different color)

*Prepare to present your concept map to the rest of the class