Integrating Chemistry & Earth Science

URBAN HEAT ISLAND MODULE

LESSON 3:

Plate Tectonics

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

BALTIMORE CITY PUBLIC SCHOOLS

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Cary Institute of Ecosystem Studies

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ICE Leadership Team

- Alan R. Berkowitz, Head of Education, Cary Institute
- Joshua Gabrielse, Director of Science, City Schools
- Kevin Garner, Coordinator of Science, City Schools
- Kia Boose, Secondary Science Specialist, City Schools
- Vonceil Anderson, Curriculum Writer, City Schools
- Jonathon Grooms, Assistant Professor of Curriculum and Pedagogy, George Washington University
- Kevin Fleming, Graduate Research Assistant, George Washington University
- Mary Ellen Wolfinger, Doctoral Student, George Washington University
- Bess Caplan, Ecology Education Program Leader, Baltimore Ecosystem Study
- Tanaira Cullens, Education Assistant, Baltimore Ecosystem Study
- Chelsea McClure, Education Assistant, Baltimore Ecosystem Study
- Martin Schmidt, Upper School Science, McDonogh School

The following lesson and associated materials are part of the Integrating Chemistry and Earth science (ICE) Urban Heat Island Module. The Module brings together important concepts from Earth science and chemistry to help students build an understanding of why urban areas have higher temperatures both during the day and at night, than their rural counterparts.

ICE Partners

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Lesson 3: Plate Tectonics

Driving Question: *How does convection affect the surface of the Earth?*

Summary: Students will examine global earthquake and volcano data to develop an understanding that convection within the Earth's mantle is the mechanism behind plate tectonics, earthquakes, and volcano formation.

Activity Description:

- **Opening Activity:** Engage students' interest in earthquakes by playing music.
  - Play the audio from Carol King - I Feel the Earth Move (YouTube 3:09).
- **Modeling the Cycling of Matter Inside Earth:** Connect convection currents to plate motion using a demonstration with Rheoscopic fluid.
  - Use Rheoscopic fluid model of the earth showing plate movement to model convection inside earth (YouTube 2:31) .
  - Relate the video to the lab activity from lesson 2 on convection currents. Point out the motion of the sawdust/pepper on the surface of the water compared to the bits of paper in the video.
- **Global Earthquake Data:** Students will explore the locations of plate boundaries based on the locations of earthquakes and volcanoes.
  - Show students one of the following videos to help them better visualize how convection currents within earth cause plate tectonics. They should see in the video that earthquakes and volcanoes are more likely at tectonic plate boundaries. Please note that the Earth's mantle is "predominantly solid but in geological time it behaves as a viscous fluid."
    - Plate Tectonics (BBC-1:08) is a narrated video that shows convection currents moving tectonic plates and resulting volcanic eruptions. However, the crust appears too mushy.
    - Spreading in the South Atlantic is a 11s animation showing how, over 130 million years, convection currents in the mantle moved South America away from Africa to form the South Atlantic Ocean.
    - Ocean-Content Subduction is a 13s un-narrated animation that doesn't show the complete convection current but accurately depicts a volcano.
  - *Global Earthquake, Volcano, and Tectonic Plate worksheet*
    - Students look at a map of global earthquakes and volcanoes and draw likely tectonic plate boundaries on a blank map.
    - Discussion Prompt: What patterns do you observe in the data presented on the map?
    - After students have completed their map show them the map of tectonic plate boundaries. Have them compare the tectonic plate boundaries they drew to the ones on the map and make corrections/modification to their map.

- **Teacher Notes:**
  - It is important to note that volcanism is a form of advective heat transfer, moving heat by buoyancy and pressure with the physical upward (or lateral) movement of molten rock (lava, magma).
  - Volcanoes are also a release point of heat from the inner earth as new crust is formed.
  - Additional Teacher Resources: What drives the movement of tectonic plates? This resource gives additional information on other forces that move tectonic plates.

- **Click & Learn online activity:** Students use the interactive site to develop a more complete understanding of the process of plate tectonics.
  - Students will work through the Dynamic Earth Interactive.
    - Have students take notes as they work through the activity
    - Requires devices with Adobe Flash installed.
  - Teacher Resource video: Plate Tectonics & Large-Scale System Interactions (Bozeman Science 6:12) provides a nice concept summary for teachers, including what students should have learned previously.
- **Global Heat Model:** Students update their models from Lesson 2's homework .
  - Ask student to edit/modify their models as needed, based on the material they learned today.
- **Homework:** Complete Currents in the Earth System Reading Activity

Global Earthquakes, Volcanoes and Tectonic Plates

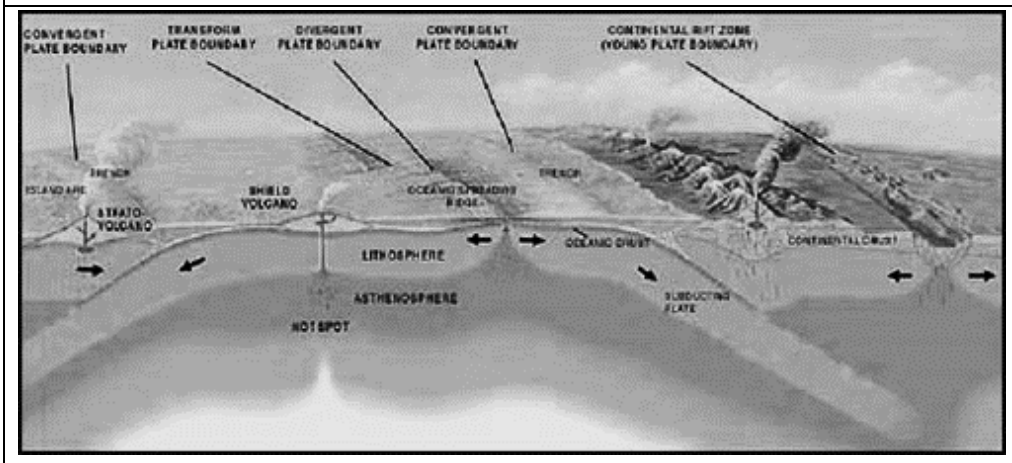
- Go to Global Earthquakes and Volcanoes Map
- Turn on layers for earthquakes and volcanoes
- Sketch on the map where you predict the tectonic plates are located.

Web Link: https://pbslm-contrib.s3.amazonaws.com/WGBH/buac17/buac17-int-quakevolmapint/index.html c

Convection Currents: Currents in the Earth's System

Excerpt from Earth a Dynamic Structure

Read, annotate and answer the questions.

Convection currents occur within: • the geosphere – plate tectonics • the atmosphere - wind • the hydrosphere - ocean currents	What three areas of the planet experience Convection Currents?
 Convection currents in the magma drive plate tectonics. Heat generated from the radioactive decay of elements deep in the interior of the Earth creates magma (molten rock) in the aesthenosphere.	Focus Question: What is the source of energy for convection currents in the geosphere?
The aesthenosphere (70 ~ 250 km) is part of the mantle, the middle sphere of the Earth that extends to 2900 km. It contrasts with the more rigid lithosphere, the outer shell of the Earth (0 ~ 70 km) that contains the continental crust (made up of less dense granitic rocks) and the oceanic crust (more dense basaltic rocks) that are broken up into more than a dozen rigid plates.	Define: Aesthenosphere Define: Lithosphere

Large convection currents in the aesthenosphere transfer heat to the surface, where plumes of less dense magma break apart the plates at the spreading centers, creating divergent plate boundaries. As the plates move away from the spreading centers, they cool, and the higher density basalt rocks that make up ocean crust get consumed at the ocean trenches/subduction zones. The crust is recycled back into the aesthenosphere.	Describe the convection current process that happens in the Mantle. What is a subduction zone?