

Using Web GIS to Support Geospatial Thinking and Reasoning

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DR K-12
Award
1118677



Environmental Literacy and Inquiry Group <http://www.ei.lehigh.edu/ei>

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Middle school science teachers



ELI middle school curriculum

- **Energy (40 days)**
- **Climate Change (21 days)**
- **Land Use Change (20 days)**
- **Tectonics (7 Web GIS investigations)**

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Curriculum ▾ Research ▾

- Energy
- Tectonics
- Climate Change
- Land Use Change

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Environmental Literacy and Inquiry (ELI) is an inquiry-based middle school curriculum that uses geospatial information technologies including GIS and Google Earth to investigate environmental issues. The Web site includes curriculum units **Energy**, **Climate Change**, and **Land Use Change**. **Tectonics** is a series of geospatial investigations designed to enhance the middle school Earth science curriculum. Materials best used with the Firefox Web Browser and Google Earth version 5.2 or higher.

ELI is sponsored in part by the Lehigh Environmental Initiative. Supported by the National Science Foundation (DRL -1118677), the Toyota USA Foundation, and the NASA Explorer Schools program. Video production supported in part by the Boeing Company.

NSF TOYOTA USA FOUNDATION Pennsylvania Department of Education pcee.org

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ELI middle school curriculum

- **Geospatial curriculum approach:**
 - Curriculum framework
 - Design principles
 - Instructional model for the development of learning activities with GT
 - Educative materials to support teacher enactment
- **Align instructional materials and assessments with science and environmental literacy learning goals.**
- **Use geospatial technology as a tool for learners to explore and investigate problems.**
- **Iterative stages of development: Prototype, pilot test, and field test with diverse 8th grade urban classrooms.**

Design Principles

1. Design curriculum materials to align with the demand of classroom contexts.
2. Design activities to apply to diverse contexts.
3. Use motivating entry points to engage learners.
4. Provide personally relevant and meaningful examples.
5. Promote spatial thinking skills with easy to use geospatial learning technologies.
6. Design image representations that illustrate visual aspects of scientific knowledge.
7. Develop curriculum materials to better accommodate the learning needs of diverse students.
8. Scaffold students to explain their ideas.


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Curriculum ▾
Research ▾

Energy Home
 Overview
 Instructional Framework
 Instructional Sequence
 Student Resources
 Assessments
 Instructional Resources
 Support Materials

Energy Home

Energy Introduction
 Solar Energy
 Wind Energy
 Tidal Energy
 Hydroelectric Energy
 Nuclear Energy
 Geothermal Energy
 Biofuels/ Biomass
 US Energy Production and Consumption
 Fossil Fuels
 Energy Efficiency and Conservation
 The Isle of Navitas
 Energy Conclusion



Energy is an interdisciplinary technology-supported middle school science inquiry curriculum. This curriculum focuses on the world's energy resources. Students use geospatial information technology (GIT) tools including GIS (My World GIS or Web GIS) and Google Earth, and inquiry-based lab activities to investigate energy sources, production, and consumption. **Energy** is aligned to national science and environmental education standards.

Energy has been field-tested in both urban and non-urban middle schools. Materials best used with the Firefox Web Browser and Google Earth version 5.2 or higher.

ELI is sponsored in part by the Lehigh Environmental Initiative. This material is based upon work supported by the Toyota USA Foundation.

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<http://www.ei.lehigh.edu/eli/energy/>

Where is the best place to locate a new wind

eli Energy Investigations

<http://gisweb.cc.lehigh.edu/energy/> ArcGIS viewer for Flex

“Educative” Support Materials

- Pedagogical and content support for teachers
- Instructional Web GIS handouts: teacher guide, student handout, investigation sheet, assessment information
- WebGIS video tutorials

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Wind Energy

Definition of Wind Energy

Wind energy is energy from moving air.

Air has mass. When it moves, it has kinetic energy. Kinetic energy is the energy of motion.

How does wind form?

Wind forms when the sun heats one part of the atmosphere differently than another part. The heat warms the air causing it to expand. The heated air has less pressure than cooler air. Air always moves from high pressure to lower pressure. The movement of air is wind.

What is wind energy used for?

Wind energy can be converted into mechanical force or used to generate electricity.

Next

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Web GIS Handout

Where is the Best Place to Locate a New Wind Farm?

Wind is moving air and is a locally plentiful source of energy. In this activity, you will use Web GIS to examine wind speed patterns and land use in Pennsylvania to determine the best place to locate a new wind farm. You will

1. Examine wind speed patterns in Pennsylvania.
2. Examine land use patterns in Pennsylvania and in the Lehigh Valley.
3. Determine the best place to locate a new wind farm in the Lehigh Valley and in Pennsylvania.

Read all instructions and answer each question on your investigation sheet.

Step 1: Download data.

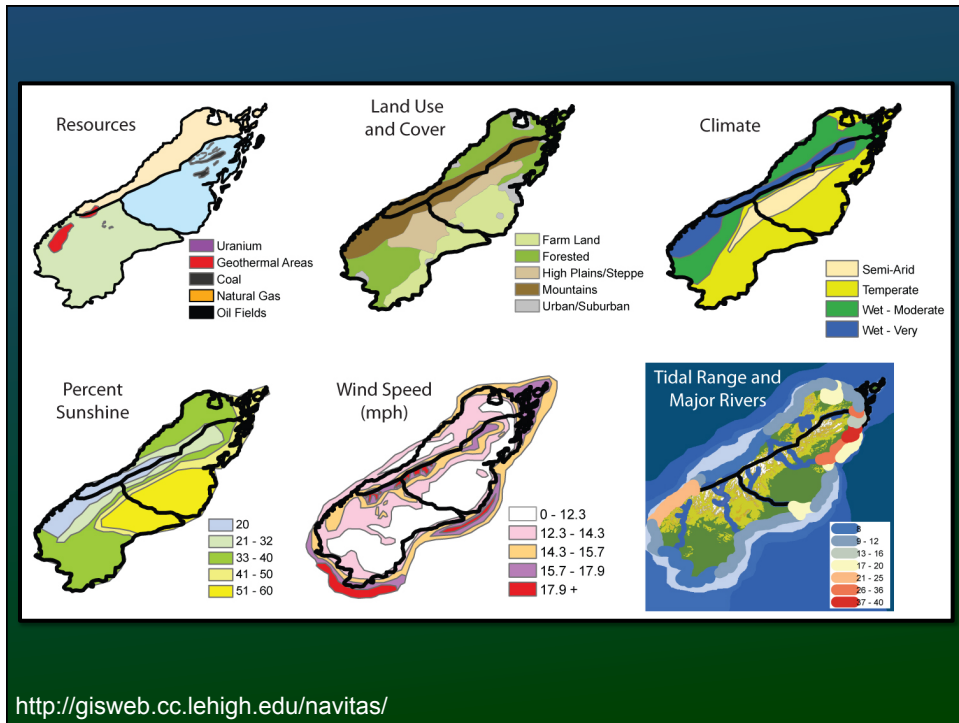
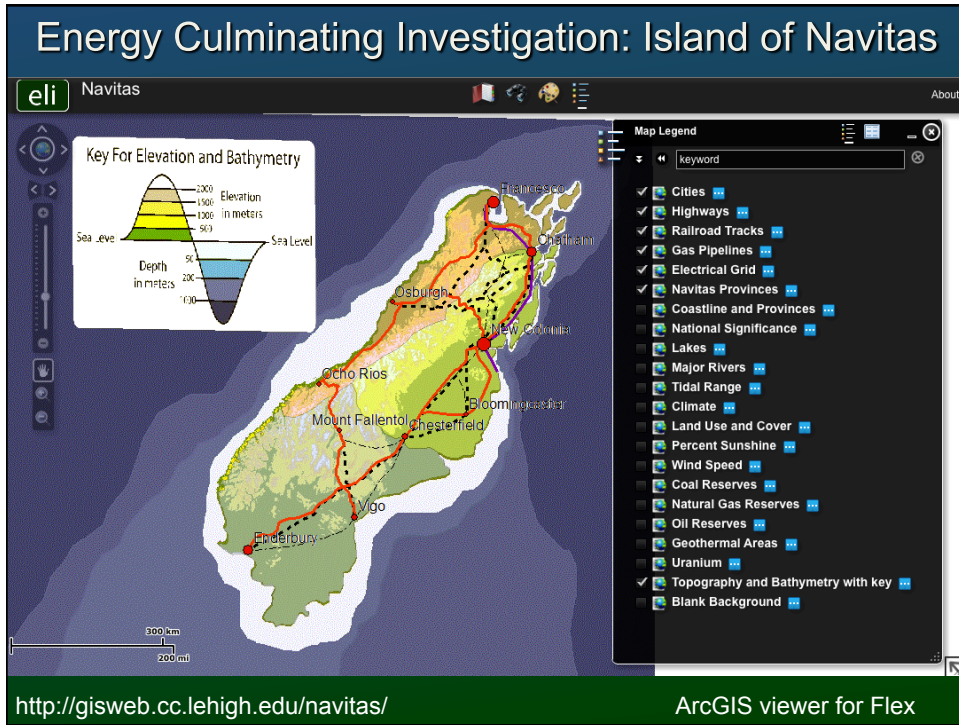
- Open your Web browser. Go to www.el.lehigh.edu/learn/energy/
- Click on **Where is the Best Place to Locate a New Wind Farm with Web GIS?**

Step 2: Basic Features of Web GIS

- Your screen should open to a global view as shown in the picture to the right.
- To navigate in Web GIS you can use the navigation tools (A-F) or the hand (G-H). You can move around the map by selecting different areas or scrolling in them.
- You can zoom in on an area by using the zoom in tool (bottom of I).
- You can find your exact location on the map by viewing the latitude and longitude location in your corner in the bottom left.
- Click on the 'PA' (J).
- You can also get back to the main view by using the **ResetView** icon in the toolbar at the top of the screen (K), or the box that appears, select **Reset View**.
- The data for each activity can be activated using the **Map Legend** tool (L). Click on the **Map Legend** tool. The **Map Legend** window will appear in the Map Legend window, activate a data layer that you want to display by clicking in the checkbox. You can enable or disable a layer by clicking on the globe icon (M) next to each data layer label.
- To remove the legend for a specific data layer, select the globe icon next to that item in the list (N).

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<http://www.ei.lehigh.edu/eli/energy/support>



Where would be the best location to build both a coal and petroleum (crude oil) power plant?

A. Location A
B. Location C
 C. Location E
 D. Location F

What is a **disadvantage** to building a hydroelectric power plant at Location A?

A. A dam at this location could provide recreation opportunities.
 B. Hydroelectric power generation does not create water pollution.
 C. This location could not be used to build a tidal power plant.
 D. Infrastructure is needed to connect to the electrical grid.

Findings

Geospatial technology integrated curriculum increased student's knowledge of Energy concepts and spatial thinking and reasoning skills.

Energy achievement and achievement by subscale for pre/post test.

	Pre-test Mean (SD)	Post-test Mean (SD)	Gain (SD)	Standard Effect
Entire Assessment (n=38)	15.16 (5.10)	22.10 (7.18)	6.94 (6.04)	1.36***
Content Subscale (n=27)	10.80 (3.83)	16.09 (5.48)	5.29 (4.81)	1.38***
Spatial Subscale (n=11)	4.36 (1.97)	6.01 (2.28)	1.65 (2.38)	.84***

*** $p < 0.001$
 N=928

<http://www.ei.lehigh.edu/eli/research/pubs>

Tectonics Project Features

- Tectonics investigations for curriculum enhancement
- Javascript Web GIS to be platform independent (i.e. tablets, laptops, cellphones)
- Interface design and customized data display
- Visualizations and tool features designed to enable spatial thinking
- Content and pedagogical supports for teachers to implement geospatial learning investigations

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Tectonics Home

Overview

Instructional Framework

Instructional Sequence


Student Resources

Assessments

Instructional Resources

Support Materials

Tectonics Home



Tectonics is a series of geospatial investigations designed to augment existing middle school Earth science curriculum. Students use Web GIS to investigate important tectonics concepts. The investigations include scientific practices, crosscutting concepts, and core ideas from the National Research Council (2012) *Framework for K-12 Science Education*.

The materials are best used with the Firefox or Google Chrome Web browser. This material is based upon work supported by the National Science Foundation (DRL -1118677).

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<http://www.ei.lehigh.edu/eli/tectonics>

Menu

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Overview

This is a series of six Web 2.0 investigations designed to support a traditional middle school earth science curriculum. The investigations are aligned to standards for Earth and Space Science from the National Science Foundation (NSF) Framework for 7-12 Earth and Space Science and the Next Generation Science Standards (NGSS) Framework for Earth and Space Science. A Web 2.0 investigation is a Web 2.0 investigation that is designed to be used as a tool for inquiry.

How do we recognize plate boundaries?

In this investigation, students use satellite data to identify the eastern and western boundaries of the North American Plate. They then compare the movement of the plate boundary to determine if it is a transform, divergent, or convergent boundary. They also investigate the relationship between plate boundaries and seismicity.

How does thermal energy move around the Earth?

In this investigation, students look at how heat flows from the Earth's interior to the surface. They investigate how surface heat flow (SHF) is distributed around the Earth and the relationship between SHF and plate boundaries.

What happens when plates diverge?

In this investigation, students look at how different plate boundaries and what they have in common. They investigate an oceanic-oceanic boundary, a continental-continental boundary, and a continental-oceanic boundary. They also investigate the relationship between plate boundaries and seismicity.

What happens when plates move past each other?

In this investigation, students analyze the distribution of earthquakes and volcanoes to learn about plate boundaries. They investigate the relationship between plate boundaries and seismicity.

What happens when plates converge?

In this investigation, students analyze the distribution of earthquakes and volcanoes to learn about plate boundaries. They investigate the relationship between plate boundaries and seismicity.

What happens when plates move past each other?

In this investigation, students analyze the distribution of earthquakes and volcanoes to learn about plate boundaries. They investigate the relationship between plate boundaries and seismicity.

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Instructional Framework

The **Investigations** are a digital learning curriculum approach that incorporates a framework, process, and content to provide students with the engagement and representation in the process of learning.

The framework includes:

1. A series of investigations with learning goals.
2. A series of investigations with learning goals.
3. A series of investigations with learning goals.
4. A series of investigations with learning goals.
5. A series of investigations with learning goals.
6. A series of investigations with learning goals.
7. A series of investigations with learning goals.
8. A series of investigations with learning goals.
9. A series of investigations with learning goals.
10. A series of investigations with learning goals.

The **Investigations** are designed to engage students in the process of learning and to provide them with the engagement and representation in the process of learning.

The **Investigations** are designed to engage students in the process of learning and to provide them with the engagement and representation in the process of learning.

Tectonics - Student Resources

Investigations

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Learn More

- Reference Center
- Web 2.0
- Google Earth
- Google Maps
- Google Scholar
- Google Books
- Google Images
- Google News
- Google Video
- Google Maps
- Google Earth
- Google Scholar
- Google Books
- Google Images
- Google News
- Google Video

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Assessments

Formative Assessments

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Summative Assessments

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Support Materials

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
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- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

To access assessments:
Login: eliteacher
Password: 87dja92

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Support Materials

Reference Center

- Investigation 1: Geohazards and Me
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Web 2.0

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
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- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Google Earth

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
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- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Google Maps

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Google Scholar

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Google Books

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Google Images

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Google News

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Google Video

- Investigation 1: Geohazards and Me
- Investigation 2: How do we recognize plate boundaries?
- Investigation 3: How does thermal energy move around the Earth?
- Investigation 4: What happens when plates diverge?
- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

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Instructional Resources

Investigations

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- Investigation 5: What happens when plates move past each other?
- Investigation 6: What happens when plates converge?

Learn More

- Reference Center
- Web 2.0
- Google Earth
- Google Maps
- Google Scholar
- Google Books
- Google Images
- Google News
- Google Video



Where's the nearest hazard to my location?

Custom GIS For Each Investigation

from Investigation 5

eli Plate Tectonics

Use the tools below to calculate areas, measure distances, or mark locations on the map.

Measurement Result

Links to Data and Resources

- Environmental Literacy and Inquiry
- Erl Data and Maps
- NOAA Historic Earthquakes
- USGS Recent Earthquakes
- Smithsonian Volcanoes
- GSHAP Geologic Hazards
- UNAVCO Plate Vectors

Map Legend

Map Navigation Tools

Find Locations

Measure Tools

Draw Tools

Export Map

Links to Data and Resources

Map Layers

Dynamic Layers

- Base Maps
- Earthquakes M > 4.0 (9/08-9/11)
- Historic Earthquakes M > 8.0
- Volcanoes
- Plate Boundaries
- Seismic Hazards

Query Earthquakes

Select Earthquake Depth:

- All Depths
- 1-10 km
- 10-100 km
- > 100 km

Select Primary Fault Type:

- Contractional

View Results

Clear

How do we recognize plate boundaries?

eli Plate Tectonics

1. Click the button below to prepare the map image to export.

Prepare Map for Export

2. To download your map image...

Macintosh users: Control-click on the image and select "Save Image as..."

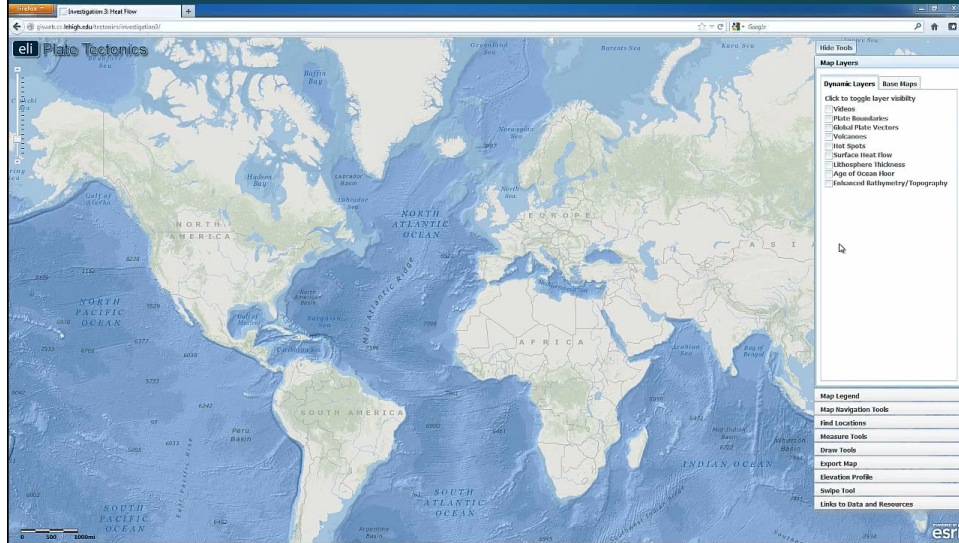
PC users: Right click on the image and select "Save Image as..."

3. Click the button below to return to map navigation.

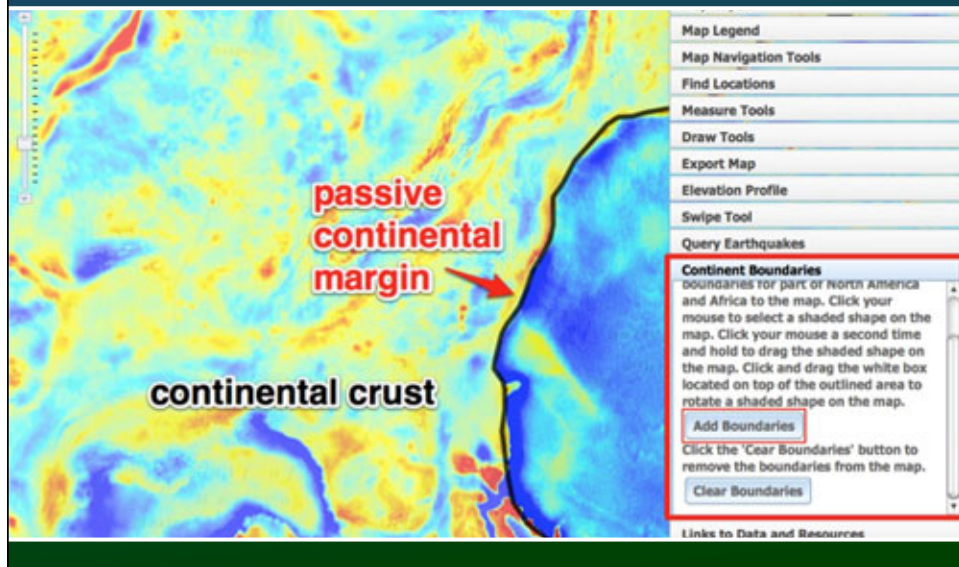
Return to Map Navigation

Links to Data and Resources

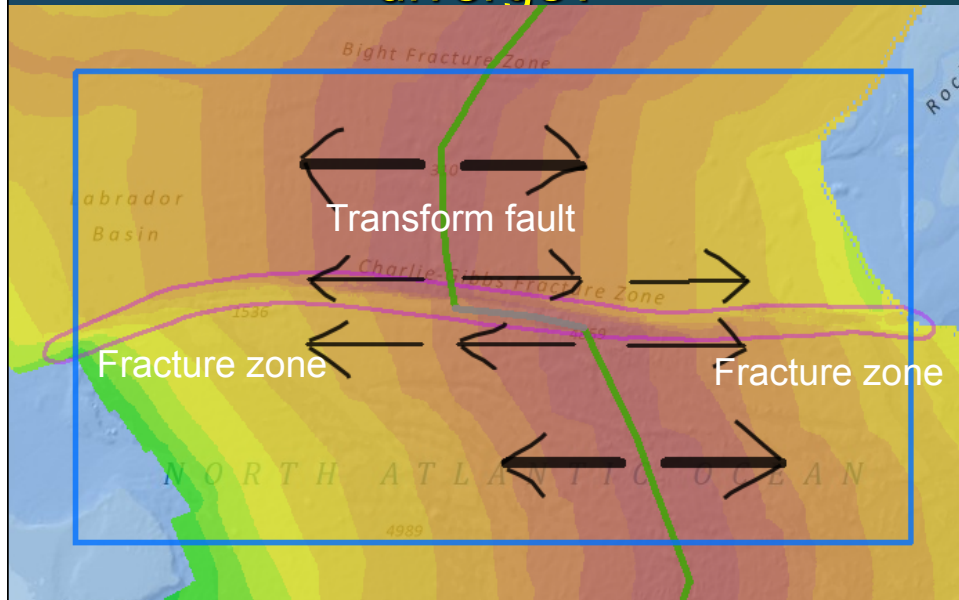
How does thermal energy move around in the Earth?



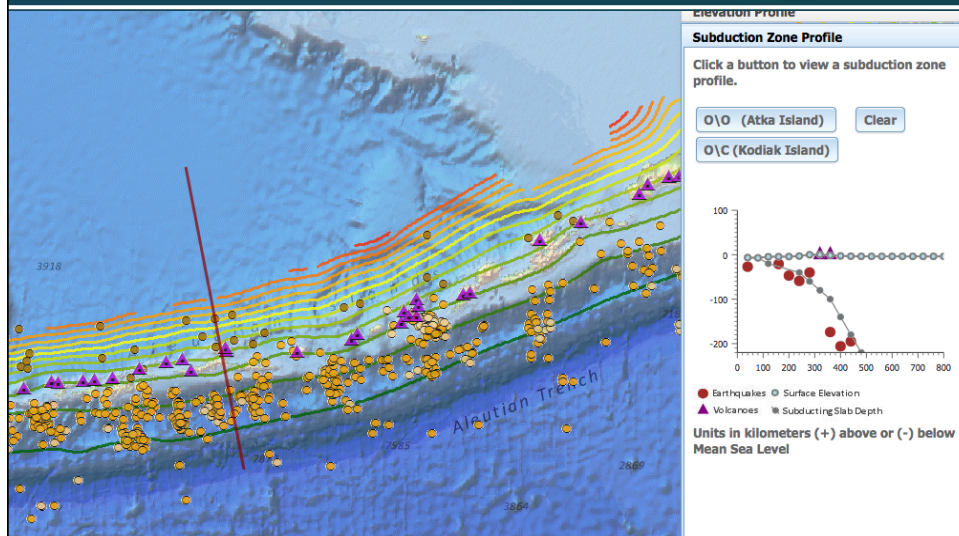
Continental Boundaries



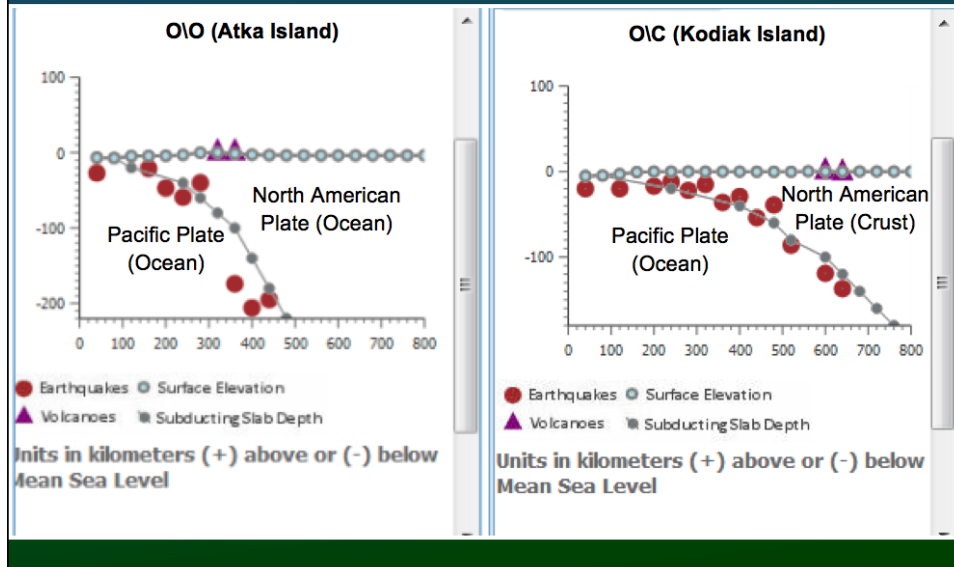
What happens when plates diverge?



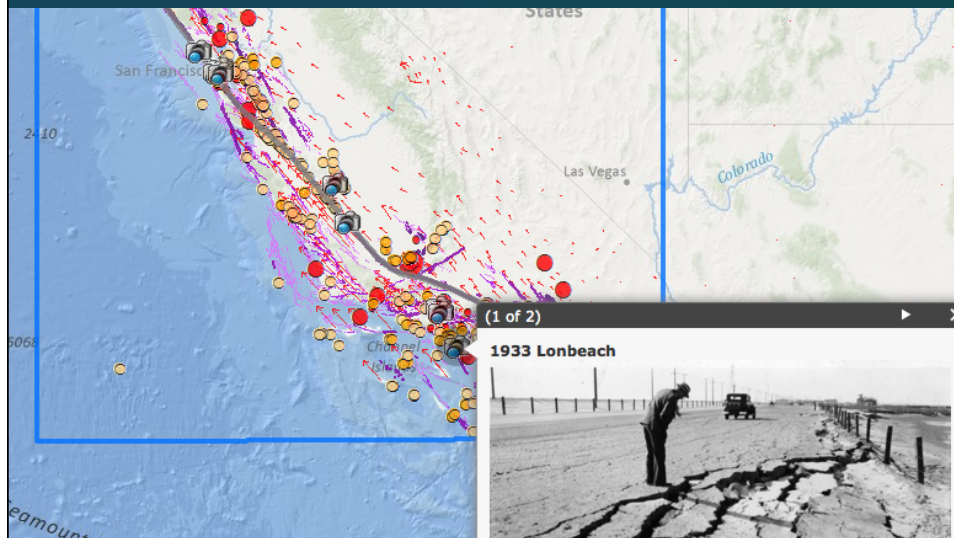
What happened when plates converge?



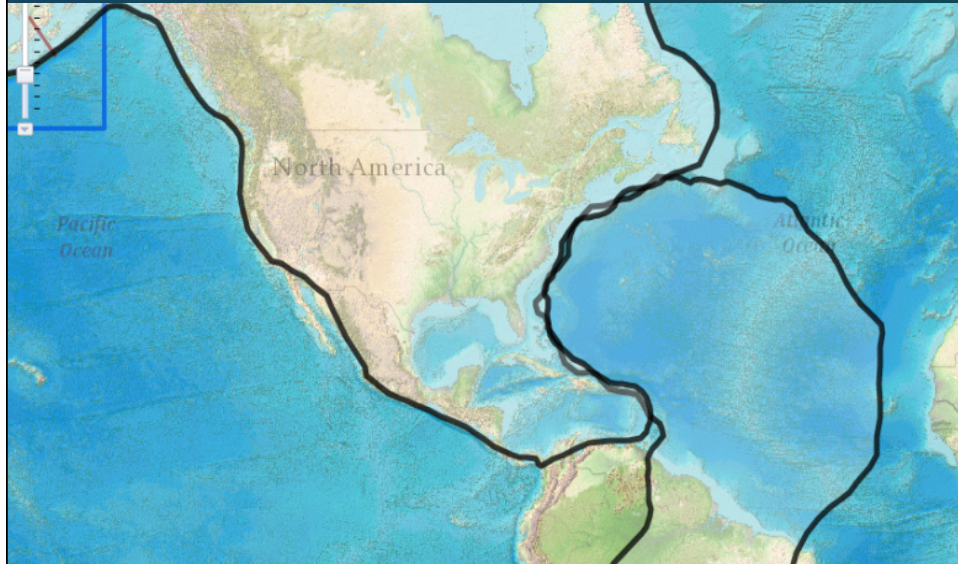
Subduction zone profiles



Investigating the San Andreas Fault Zone



What happens when plates collide?



Findings

Web GIS investigations increased student's knowledge of tectonics concepts and spatial thinking and reasoning skills.

Overall achievement and achievement by subscale for pre/post test.

	Pre-test Mean (SD)	Post-test Mean (SD)	<i>t</i>	Effect Size
Entire Assessment (n=34)	17.57 (5.67)	24.79 (6.03)	49.45***	1.23
Geospatial Subscale (n=19)	9.61 (3.73)	13.71 (3.84)	39.50***	1.08
Tectonics Content Subscale (n=15)	7.96 (2.57)	11.09 (2.65)	40.12***	1.20

*** $p < 0.001$
N=1025

Questions or Comments

<http://www.ei.lehigh.edu/eli>

Presentation available at:
<http://www.ei.lehigh.edu/eli/research/pubs.html>

To access assessments:

Login: eliteacher
Password: 87dja92