ED43E-02

# Teaching and Learning Tectonics with Web GIS

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DR K-12 Award 1118677

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# Curriculum Design Approach for Geospatial Learning

- Curriculum framework
- Design principles
- Multi-step instructional model for the development of inquiry learning activities with spatially-enabled learning technologies
- Educative materials to support teacher enactment

# Education Research Questions

- To what extent does the design model and Web GIS improve middle school learners' understandings of Tectonic concepts and processes?
- How does design model and Web GIS enable spatial and geographical thinking and reasoning skills?
- What factors account for the variance in students' geospatial thinking and reasoning after the curriculum enactment period?
- How can GIT-embedded curriculum materials be effectively designed to support teachers' adoption and pedagogical use of Web GIS?

# 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

# Research Methods

- Pilot testing and field testing in an urban school district (2 schools, 4 teachers,12 classrooms)
- Tectonics content knowledge measures
- Spatial thinking and reasoning measures
- Teacher implementation practice to assess fidelity of implementation and curriculum enactment—adherence to geospatial learning design model
- Classroom observations
- Post-implementation survey to assess pedagogical effectiveness of the educative curriculum materials

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- Instructional Framework
- Instructional Sequence
- Student Resources
- Assessments
- Instructional Resources
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# 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).



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

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## Overview

**Tectonics** is a series of six Web GIS investigations designed to augment a traditional existing middle school Earth science curriculum. The investigations are aligned to Disciplinary Core Ideas: Earth and Space Science from the National Research Council's (2012) *Framework for K-12 Science Education* **ESS2.B: Plate Tectonics and Large Scale System Interactions**. The learning activities are also aligned to tectonics benchmark ideas articulated in the AAAS Project 2061 (2007) *Atlas of Science Literacy*. A Web GIS is also provided for open-ended tectonics investigations for students. Below is a brief overview of the investigations:

**Geohazards and Me: What geologic hazards exist near me? Which plate boundary is closest to me?**
In this investigation, students locate geologic hazards created by tectonic forces near their geographic location. They discover where the most recent earthquake occurred near their geographic location and where the nearest volcano is located. They also investigate how geologic hazards are distributed around the globe and infer how this is related to plate tectonics.

**How do we recognize plate boundaries?**
In this investigation, students use tectonics data to identify the eastern and western boundaries of the North American Plate. They analyze earthquake epicenter and volcano data to determine the boundaries of the North American Plate and analyze the movement of the surrounding plates to determine plate boundary types (divergent, convergent, or transform).

**How does thermal energy move around the Earth?**
In this investigation, students locate areas where heat escapes from the Earth's interior from the hot mantle. They investigate how surface heat flow (loss) is distributed around the Earth and its relationship to plate boundaries. They also explore geologic features on the Earth's surface that are associated with heat loss.

**What happens when plates diverge?**
In this investigation, students locate different divergent boundaries and study their history. They investigate how tectonic strains are accommodated at the plate boundary by examining earthquake and fault data and calculating the half-spreading rate of a plate boundary. They also investigate features of passive margins, areas along divergent boundaries where continental crust joins oceanic crust.

**What happens when plates move sideways past each other?**
In this investigation, students locate oceanic and continental transform boundaries and study their history. They investigate an oceanic transform boundary, the Charlie-Gibbs Fracture zone, using seismic and age of the ocean floor data. They also investigate a continental transform boundary, the San Andreas Fault zone, and the seismic hazards associated with living in this area using earthquake data and historical photographs.

**What happens when plates collide?**
In this investigation, students analyze the distribution of earthquakes and volcanoes to learn about plate collision at an ocean-ocean subduction zone. They determine the slope of subduction along convergent plate boundaries, and discover the relationship between the Aleutian Islands, volcanoes, and subduction zone types. In addition, they learn about the types of landforms created by continents colliding at convergent zones.



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## Instructional Framework

The **Tectonics** investigations use a spatial learning curriculum approach that incorporates a framework, design principles, and instructional model to provide guidance in the development and implementation of the geospatial curriculum materials.

The framework includes:
1. Align materials and assessments with learning goals.
2. Contextualize the learning of key ideas in real-world problems.
3. Engage students in scientific practices that foster the use of key ideas.
4. Use geospatial technology as a tool for learners to explore and investigate problems.
5. Support teachers in adopting and implementing GIT and inquiry-based activities.

[...]

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## Assessments

Tectonics Content Assessment (PDF / MS Word)
Tectonics Content Assessment Key (PDF / MS Word)

Investigation 1: Geohazards and Me: What geologic hazards exist near me? Which plate boundary is closest to me? Assessment (PDF / MS Word)
Investigation 2: How do we recognize plate boundaries? Assessment (PDF / MS Word)
Investigation 3: How does thermal energy move around the Earth? Assessment (PDF / MS Word)
Investigation 4: What happens when plates diverge? Assessment (PDF / MS Word)
Investigation 5: What happens when plates move sideways past each other? Assessment (PDF / MS Word)
Investigation 6: What happens when plates collide? Assessment (PDF / MS Word)

**Tectonics - Student Resources**

**Investigations**
- Investigation 1: Geohazards and Me: What geologic hazards exist near me? Which plate boundary is closest to 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 sideways past each other?
- Investigation 6: What happens when plates collide?
- Open-ended Investigations

**Learn More**
- Reference Frames
- Heat Flow
- Geologic Faults
- Gravity Anomaly
- GPS Geodesy

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## Instructional Resources

Videos | Instructional Handouts | Source GIS Files

[...]

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## Support Materials

Reference Frames
Reference Frames - Print Version (PDF)

Heat Flow
Heat Flow - Print Version (PDF)

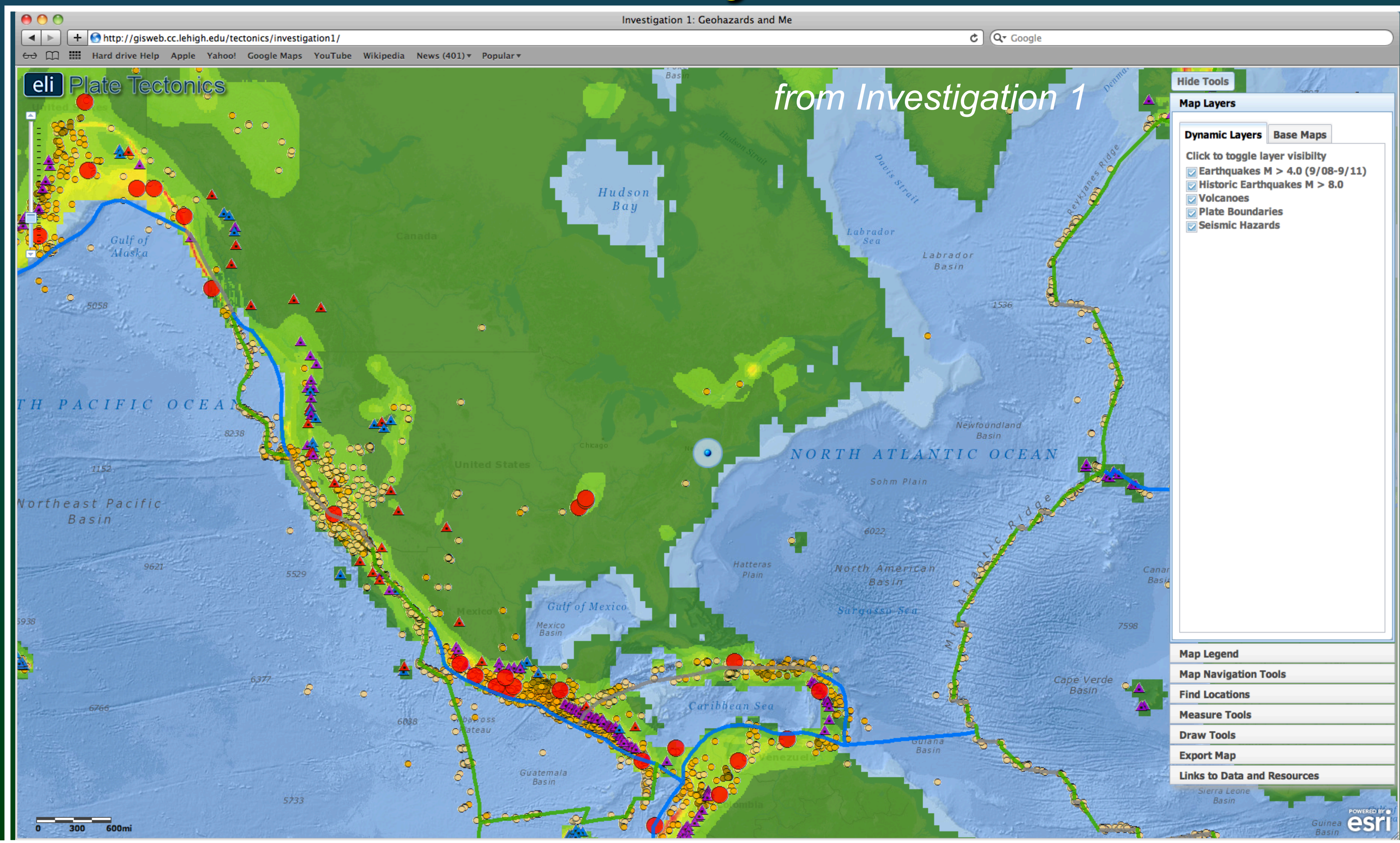
Geologic Faults
Geologic Faults - Print Version (PDF)

Gravity Anomaly
Gravity Anomaly - Print Version (PDF)

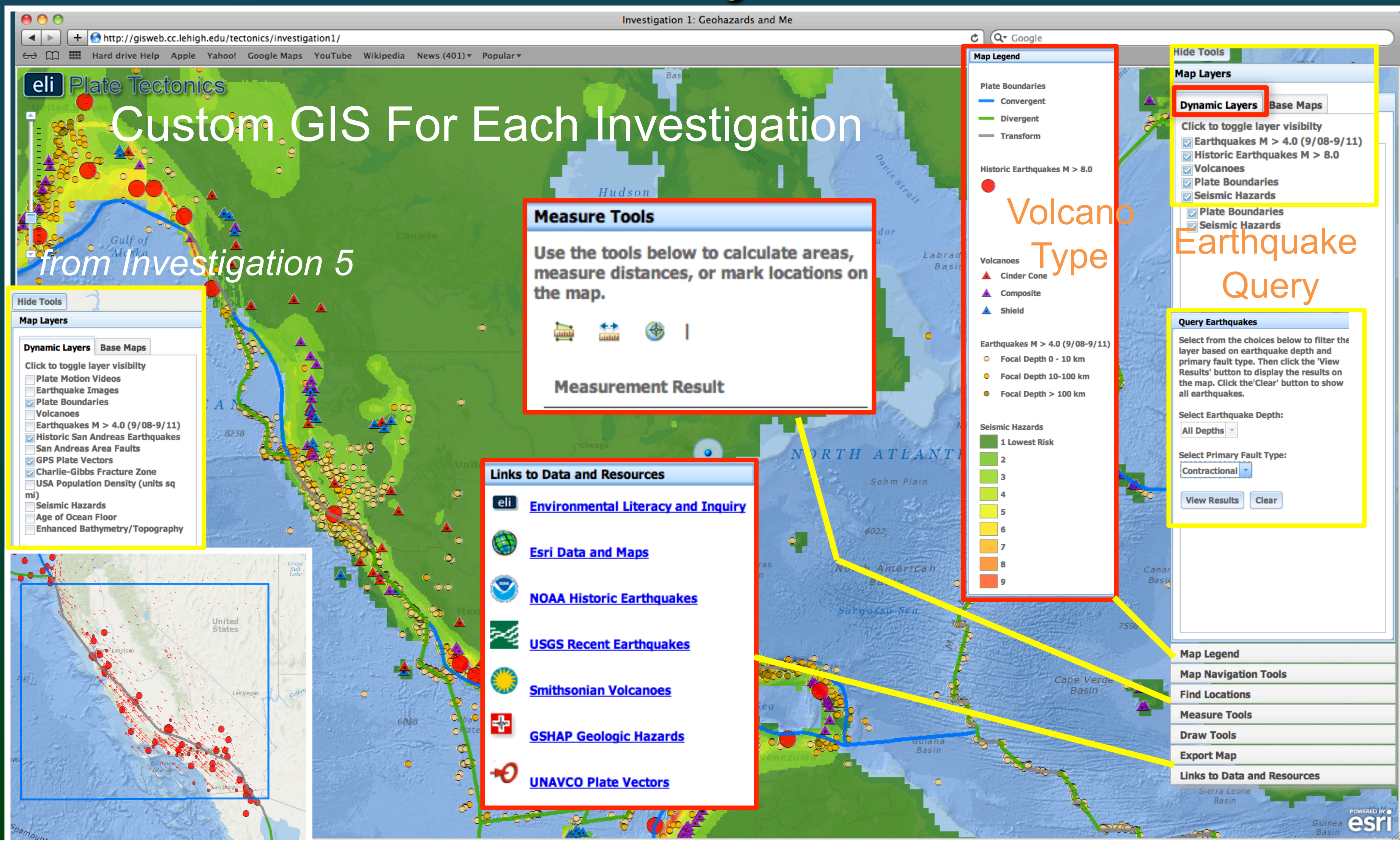
GPS Geodesy
GPS Geodesy - Print Version (PDF)

**To access assessments:**
**Login: eliteacher**
**Password: 87dja92**

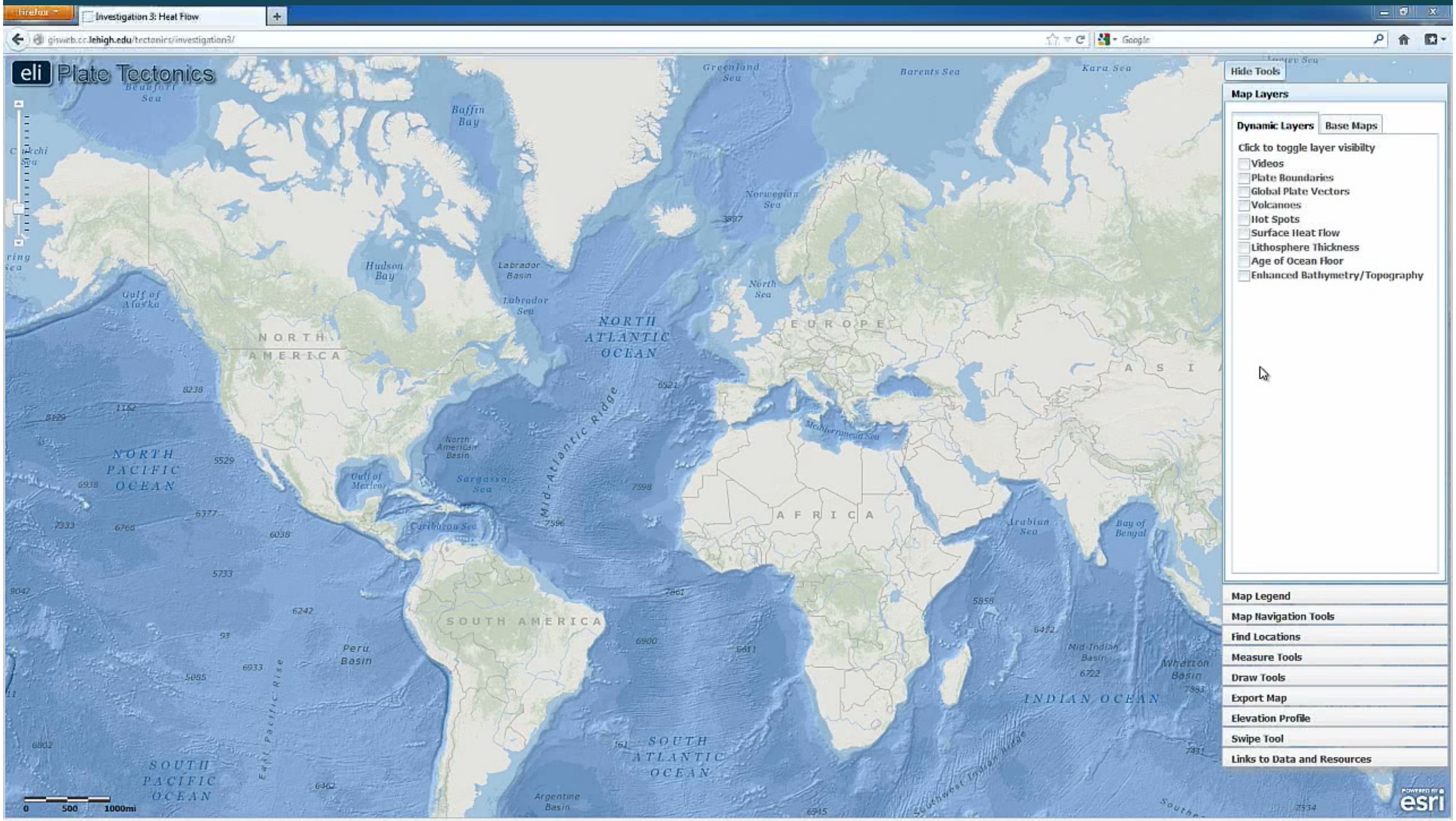
# Where's the nearest hazard to my location?



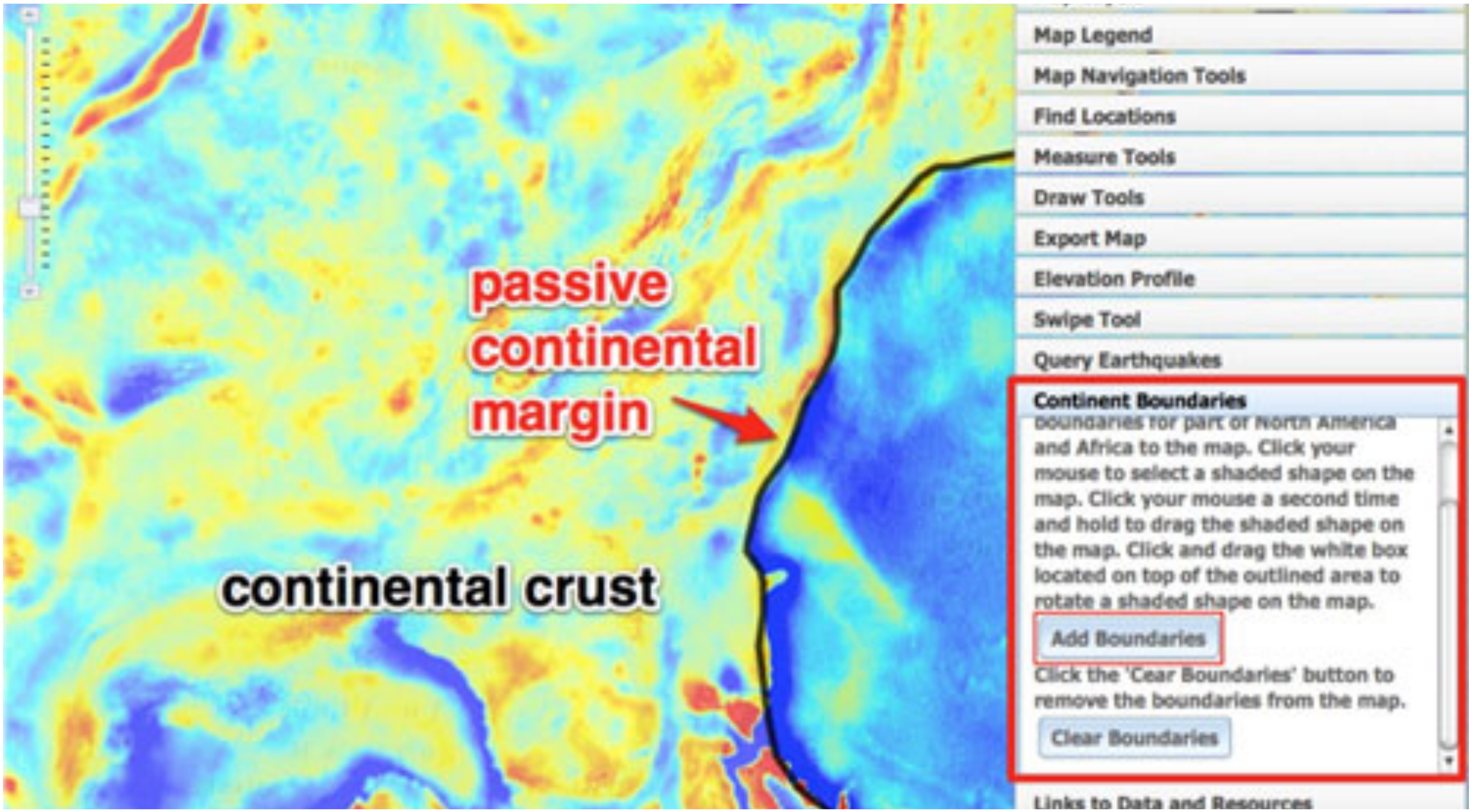
# Where's the nearest hazard to my location?



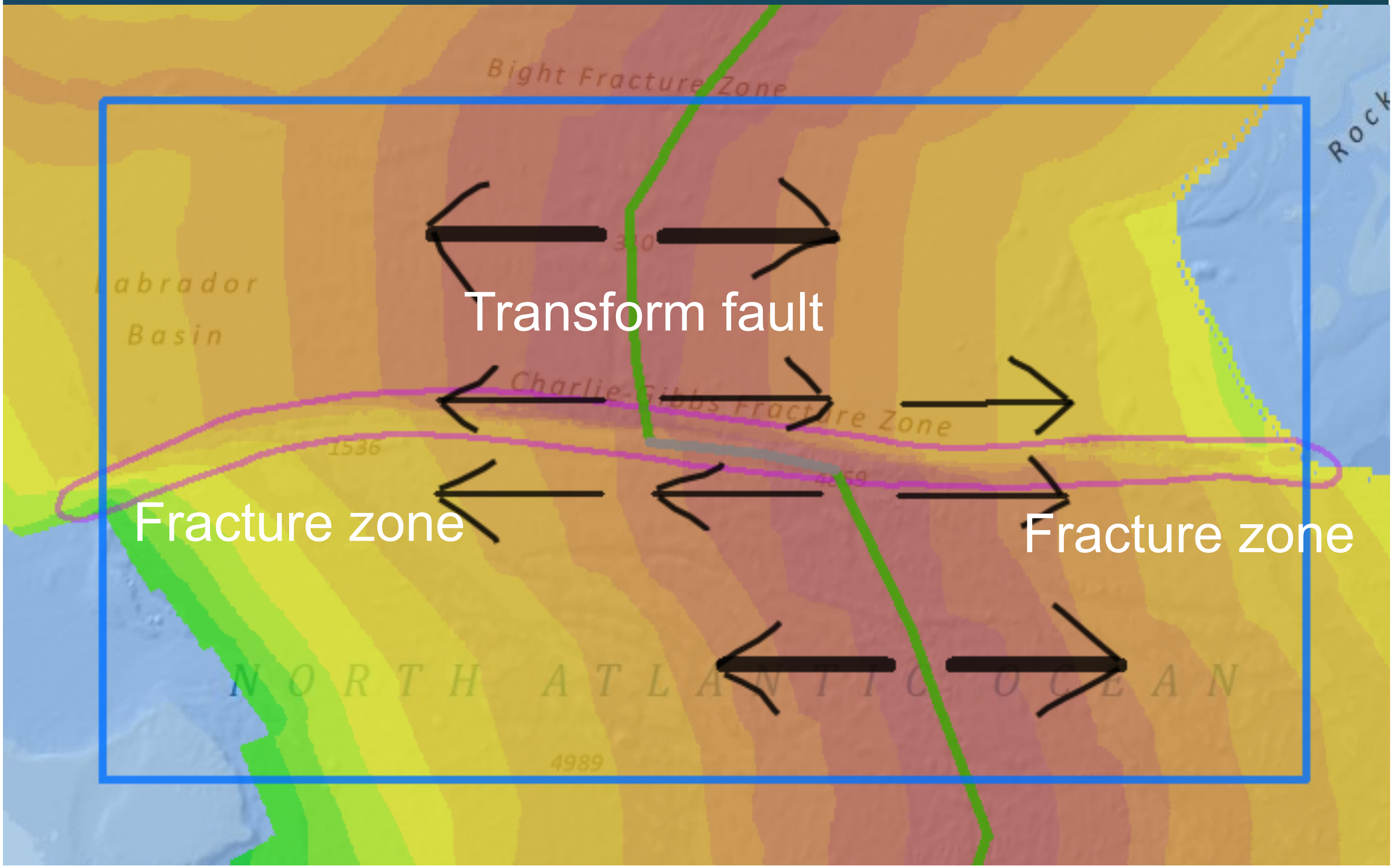
# How does thermal energy move around in the Earth?



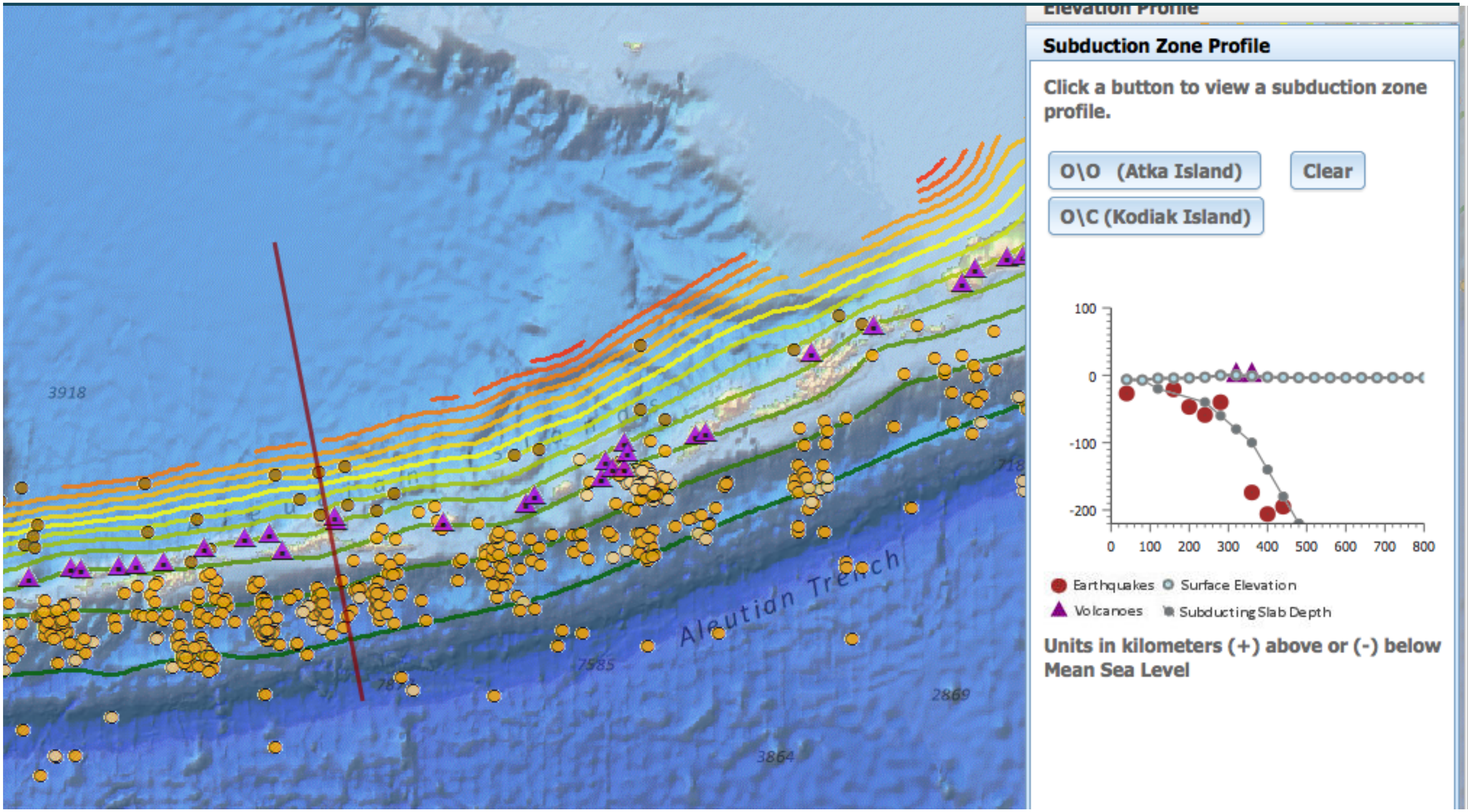
# Continental Boundaries



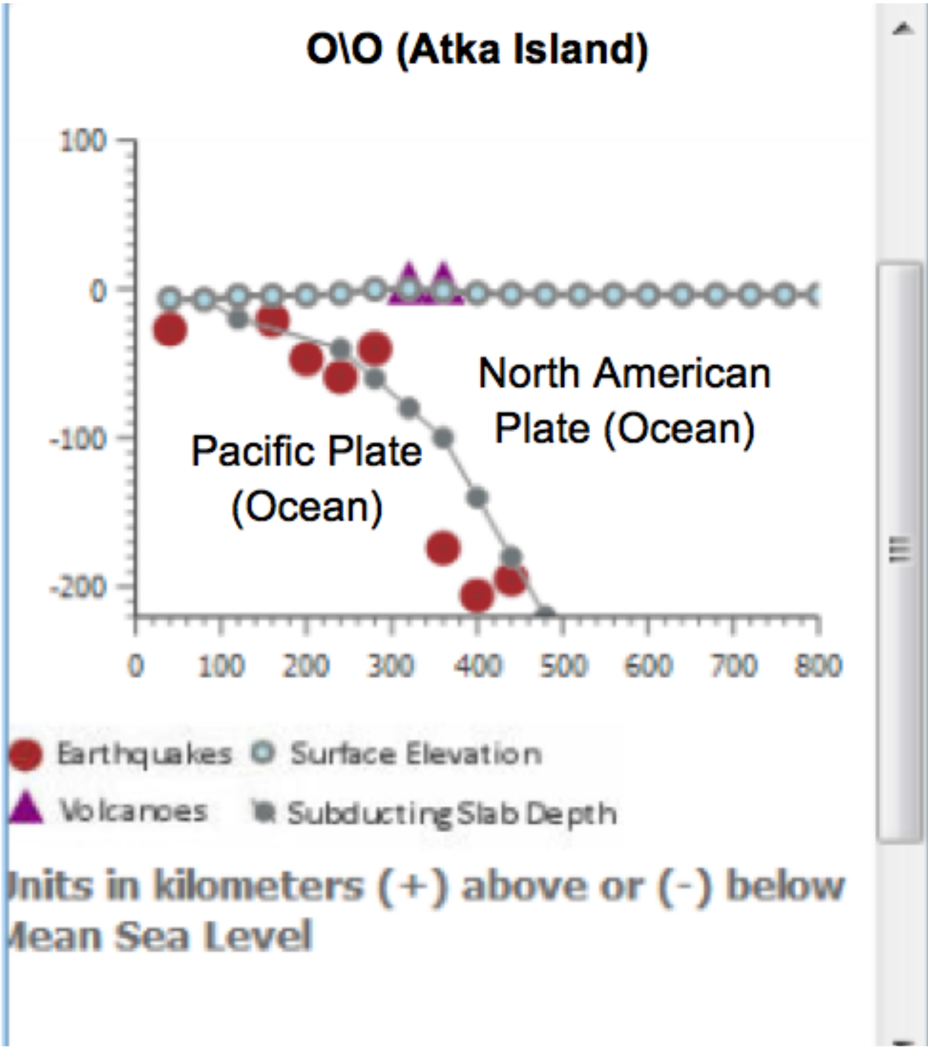
# Ocean Spreading

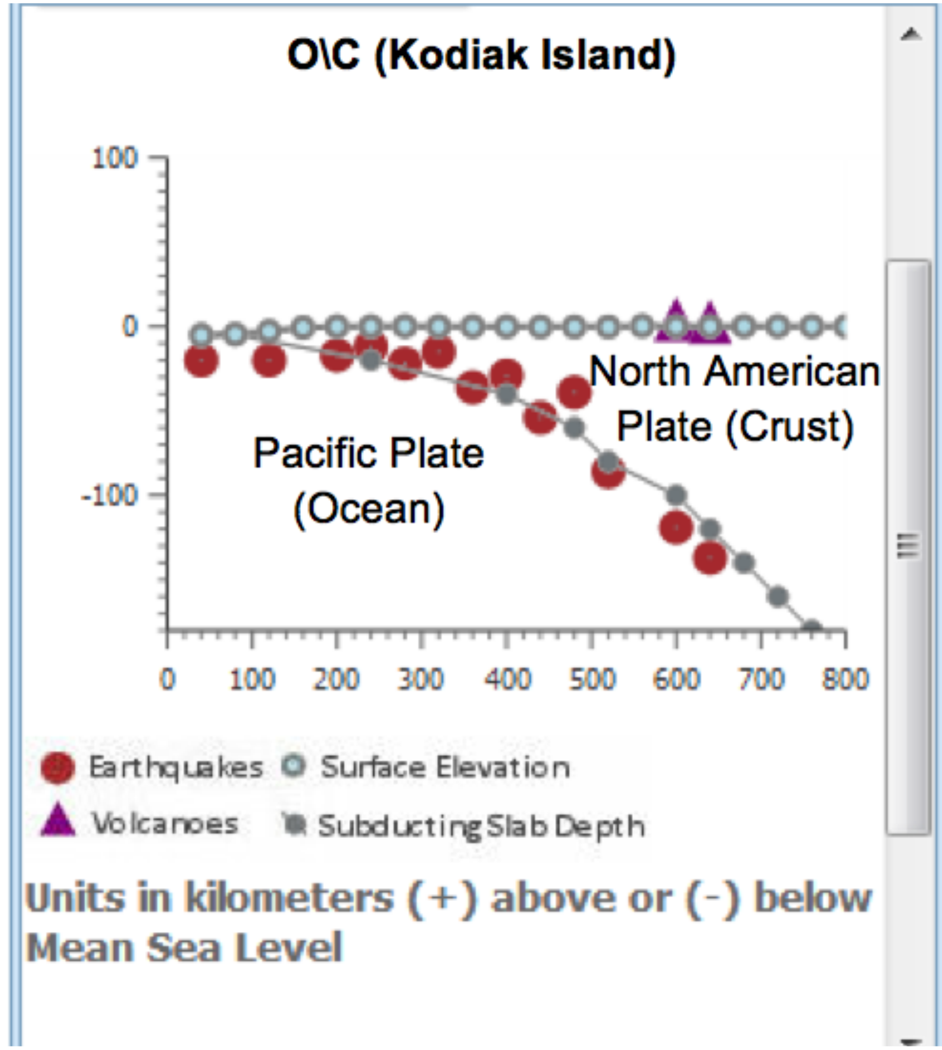


# What happened when plates converge?



# Subduction zone profiles



# Results

- **High fidelity of implementation**
  - **Adherence to the events in the instructional model**
- **High student engagement**
- **Ease of use for urban middle school teachers and students**
- **Assessments are reliable instruments**
- **Significant performance enhancements**
  - **Tectonics content and**
  - **Geospatial thinking and reasoning**

# Questions or Comments?

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# 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.
9. Use icons that portray the real-world concept.

# Spatial Learning Design Model

1. Elicit prior understandings of lesson concepts.
2. Present authentic task.
3. Model task.
4. Provide worked example.
5. Ask learners to perform task.
6. Scaffold task.
7. Ask learners additional questions to elaborate task.
8. Review activity concepts.