Water's Influence on CNY Geology & Plate Tectonics

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Introduction

Take a look around Central New York and you will see a unique geological landscape. In our part of the world, we take water for granted; it completely surrounds us.

From the shallow warm seas of more than 350 million years ago to the erosion of today's waterways, water has had a major impact on our geological history. Within a one hour drive of Syracuse evidence of its impact can be easily found.

Rock from the Jamesville Quarry contains fossils from coral and sea life hundreds of millions years old. Travel along Interstate-81 to Tully and you can see the end moraine from the last glaciation. Drumlins located throughout northern Cayuga and Wayne counties are still further evidence of the glacier. Green Lake rests in what remains of the plunge pool of a waterfall, one created by the retreat of that same glacier. Geologists estimate the historic waterfall contained a greater volume of water than the current American side of Niagara Falls.

Think water's impact is ancient history? Consider the 1993 mudslide at Bare Mountain in Tully where the road was covered with several feet of mud or how the (almost) annual flooding of the Seneca River has eroded the shore-line, or how global warming may cause rising sea levels.

Plate Tectonics: Moving Currents

Plate tectonics is the recognized theory of how Earth's crust and its plates move. This idea, originally proposed in the early 1900s, has led to advances in all areas of geology. Many of the general processes considered to drive plate movement, such as **convection currents** in the **mantle** and **subduction zones**, are understood.

Although much has been learned in the last century, questions about mechanism remain. For example, what role does the interactionbetween Earth's core and mantle have on the rate of **continental drifting**? What causes super-continents to break apart?

The outer parts of Earth's interior are divided into **lithosphere** and **asthenosphere**. The lithosphere is cooler, more rigid and contains both crust and mantle. The key principle of plate tectonics is that the lithosphere is separated into separate and distinct plates that ride on the plastic-like asthenosphere. The plates are around 60 miles thick and are comprised of lithospheric mantle covered by either continental or oceanic crust.

A plate typically has both oceanic crust and continental crust. Where two plates meet is called a **plate boundary**. Plate boundaries are usually associated with earthquakes and the creation of mountains, volcanoes and oceanic trenches. The Pacific Plate's Ring of Fire is where most of the world's most active and widely known volcanoes can be found.

MOST*

VOCABULARY

- Asthenosphere
- Continental Drift
- Convection Currents
- Lithosphere
- Mantle
- Mid-ocean ridge
- Moraine
- Plate tectonics
- Subduction zone

HELPFUL TERMS

- Convergent plate boundary
- Curie point
- Divergent plate boundary
- Pangaea

Inside This Packet

New York State Standards

Middle School Activity

Standard 1: Analysis, Inquiry and Design
Science: S1.1, S1.2, S1.3, S2.1d, S2.2a, S3.1T1.3a
Technology: T1.3a, T1.5b

Standard 4: Physical Setting
Key Idea 2.1c, 2.1d, 2.2a, 2.2d, 2.2e, 2.2f

Skills: Presenting Results

Plate Tectonics: Plate Boundaries

Plate Tectonics: Moving Continents

Up through the 1990s, the prevailing explanations of what drives plate tectonics highlighted the idea of convection currents within the mantle.

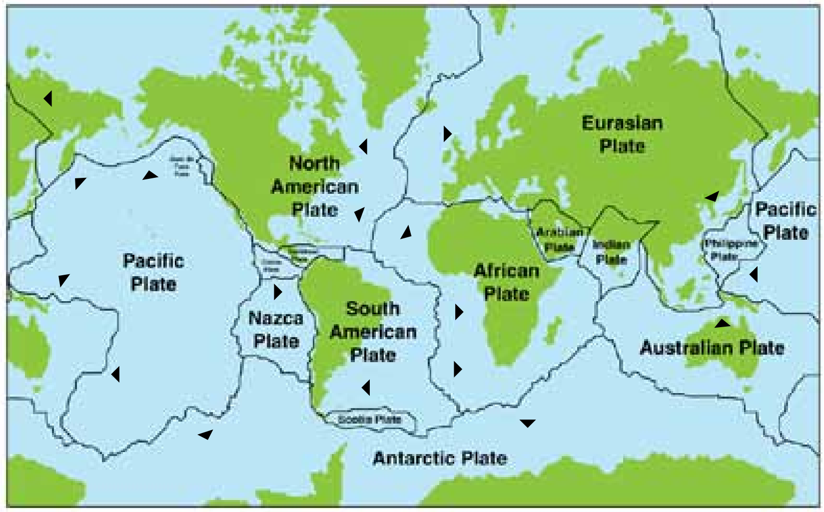
Hotter, lighter (less dense) material slowly rises from the heated lower regions of the mantle to the upper, cooler regions of the mantle and spreads outwards, much like hot air rises in a room then spreads across the ceiling. The hotter material cools, becoming more dense and sinking back to the lower regions of the mantle.

This rising and falling of material creates currents that are thought to drive plate motion. Most scientists now favor the idea that the forces associated with subduction are more important than sea floor spreading.

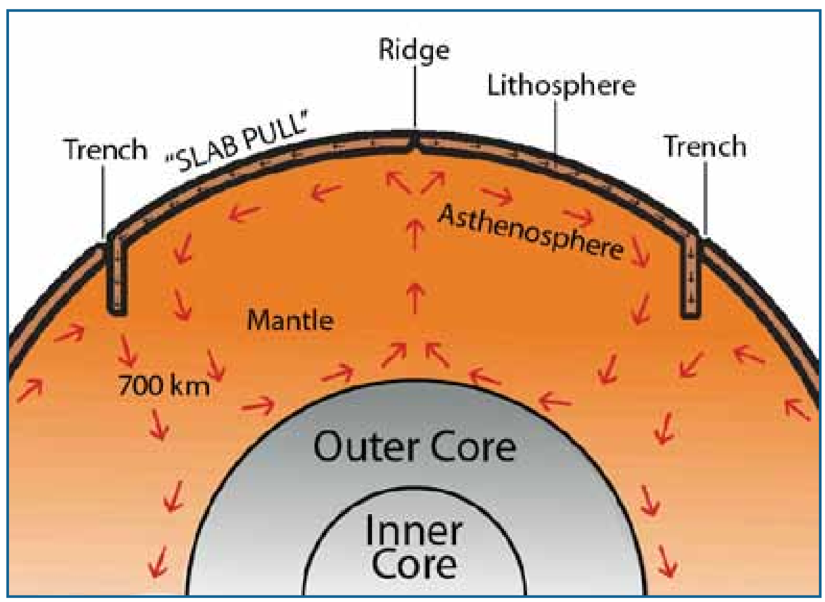
Subduction is where two tectonic plates move toward each other with one sliding underneath the other and moving into the mantle. An oceanic plate ordinarily slides under a continental plate or another oceanic plate and the material of this older, colder oceanic crust is pulled into the mantle by gravity to be recycled.

Currently, no one proposed mechanism can completely explain all the components of plate tectonics. Since these forces are buried deep within the earth, no mechanism can be directly tested to prove it beyond reasonable doubt. However, there is a strong correlation between directional motion and velocity with plates containing subduction components. Therefore, slab pull is currently considered to be the main driving force.

Tectonic Plate Map



Underneath Earth's Crust



Demonstration/Activity: Convection Currents

MATERIALS NEEDED

Large clear jar or beaker

Food coloring
(blue and yellow)

Rubber band

Sharp pencil

Water

Non-latex glove

Students should be able to:

Explain the theory of plate tectonics

Explain the convection cell theory

Describe how density differences drive convection cell theory

Relate heating and colling cycles to density changes

Define a subduction zone

Define a divergence zone

Point out the location of the Mid-Atlantic Ridge

List 4 types of evidence that support the plate tectonics theory

One of the theories behind plate movement is convection currents.

Here's how scientists think it works: Hot molecules move around faster than cool ones. This fast movement causes the molecules to spread further apart and be less densely packed than cooler molecules. When a liquid is heated, it is less dense (lighter) than when it is cool. Lighter, less dense objects tend to float on top of heavier, denser materials. The very hot core of Earth is constantly heating up the material in the mantle closest to the core. This hot liquid rock, being less dense, rises very slowly through the mantle towards the crust. As the liquid rock rises through the mantle, it cools and becomes heavier causing it to slowly sink. This rising and sinking motion creates currents that are said to be one of the factors that slowly move the tectonic plates, what works out to a few inches a year.

What to do:

1. Fill non-latex glove with HOT water. Place yellow food coloring in the glove. Make sure the glove is quite full and rubber band the top to secure. Be very careful and place the glove in the large jar or beaker.

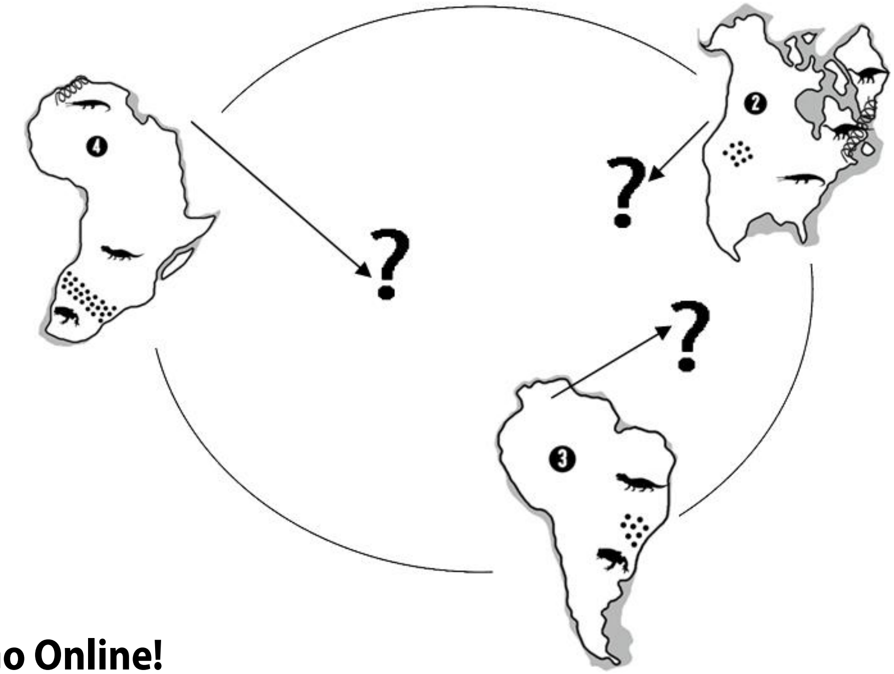
2. Fill the jar with COLD water so that water covers the glove and comes nearly to the top of the jar. Add blue food coloring to the COLD water.

3. Carefully poke a hole in the plastic glove with the pencil. What happens?

What is happening?

The hot yellow water, being less dense, rises through the cooler blue water leaving a green trail as it moves. As the hot water (green trail) reaches the surface of the water it begins to spread. As the hot water cools, it becomes more dense causing it to sink. A convection cell is generated that is visible by the green trail.

Activity: A Plate Tectonic Puzzle



Go Online!

To print this activity, please visit:
http://amnh.org/education/resources/rfl/pdf/dinos_plate_tectonics.pdf

Once you print the activity, cut out the land masses and try to find the right spot to put them on the globe. Examples can be seen above.

After completing the puzzle have student teams share with another team their results and explain their findings.

Solve the puzzle to discover what the Earth looked like 220 million years ago.

1. What's the code?
Use a legend to identify the symbols on each island or continent.

2. Puzzle me this.
Look at the shapes of continents and islands. What landmasses seem to fit together?

3. Let's rock!
Examine the evidence and try to match up landmass boundaries that show similar rock strata, fossilized desert belts, and dinosaur fossils.

4. Hold that Pose.
Look over the arrangement of the continents and islands and decide if the position of any of them should change. When you are satisfied with your map of Pangaea, tape or glue it down on the world map.

This activity is provided by the American Museum of Natural History, New York City.