Lesson Title	Earth's Formation and Structure
Length of Lesson	1 class period (50 min)
Created By	Charles Vaughan
Subject	General Science
Grade Level	8
State Standards	4a, 4b
DOK Level	DOK 2
DOK Application	Infer, Predict, Relate
National Standards	5-8: D: Earth and Space Science
Graduate Research Element	Understanding the history and formation of the Earth within our solar system is vital to understanding how comets formed as well. In fact, there are theories stating that comets are responsible for much of the water present on Earth today. My research, which entails knowing the composition of comets, would definitely aid in understanding how much water contribution comets really had on the early Earth.

Student Learning Goal:

MS 8th Grade:

4a: Compare and contrast the lithosphere and the asthenosphere.

4b: Describe the cause and effect relationship between the composition of and movement within the Earth's lithosphere.

National Standards for Grades 5-8:

D: Earth and Space Science: Structure of the Earth System:

- The solid earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core.
- Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.

D: Earth and Space Science: Earth's History:

- The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.

Materials Needed (supplies, hand-outs, resources):
This lesson is primarily a presentation, but a few additional materials are used to explain the asthenospheric plasticity on Earth. These materials include: plastic cups (enough for every student), popsicle sticks, and a cornstarch and water mixture. It is recommended that the cornstarch and water be prepared early in a large batch. Enough should be made for every student to have a small cup filled with the mixture.

Other materials include a PowerPoint presentation (file name: INSPIRE_Vaughan_09_01_12_Powerpoint.ppt) and a note-taking sheet (file name: INSPIRE_Vaughan_09_01_12_NoteSheet.doc) which will aid in teaching the lesson. Several videos are linked within the presentation, so the computer/projector also should allow for sound output.

Lesson Performance Task/Assessment:
Students will be given broad information on the formation of the early Earth as well as its current composition as a result of its early stages. The lesson should start with the theoretical formation of the planets from the solar system accretion disk. Students should understand that gravity pulled matter together, eventually forming the planets under this theory. They should also be able to explain how layers in the Earth developed due to density distribution during the early molten phase. As the Earth cooled, the outer crust and upper mantle became solid, yet thermal activity still in the core of the Earth contributes to movements in the crust. Students should be able to identify these major layers, as well as some of the sub-layers (e.g., lithosphere, asthenosphere, outer core, inner core).

A critical element of the presentation needs to be an explanation of the lithosphere and asthenosphere, which are layers of Earth's upper mantle and crust. The corn starch mixture is a short yet effective aid to demonstrate the plasticity in the asthenosphere that allows for movement on the lithosphere above.

Lesson Relevance to Performance Task and Students:
Understanding the geological processes we see today will explain why scientists have developed theories about how the early Earth was formed.

Anticipatory Set/Capture Interest:
The toughest questions we've ever been asked involve how we are here in the first place. What signs in Earth geology can lead us backwards into figuring out how the early Earth was formed? Do the modern theories about Earth's creation in the solar system explain the current phenomenon we see now?

Guided Practice:
Much of this lesson is guided through instruction, although inquiry should definitely be allowed. When using the PowerPoint, please note that text was very limited on the slides themselves (which is intentional). The instructor should add any pertinent vocabulary/examples as needed.

Emphasize that the early Earth was assumed to be very hot and mostly molten. This liquid-like state in the early Earth is the reason for Earth's composition in layers today (i.e., dense metallic core, rocky mantle, and thin crust of lighter elements). Students should be asked questions throughout the presentation regarding what they think happened as a result of the early Earth's formation (e.g., If the Earth was a large ball of molten liquid long ago, how do you think materials distributed themselves due to their densities?). The heat that still remains in the Earth is responsible for movement in the lithosphere.

Another topic that should be introduced involves Earth's water content. Although most of the surface of Earth is covered with water, it compromises only a small amount of the total material present. Scientists believe some water was present on Earth in the early developing stages, but much may have been added due to comet collisions. This is an important tie to my own personal research since I study the composition of comets, and knowing this composition can help us understand how much of our water was given to Earth by comets.

Independent Practice:
The corn starch mixture, although liquid, shows solid-like properties when put under high stress. The students should be encouraged to swirl the mixture in the cup, noting how it behaves like an ordinary thick liquid. Then, by prodding or pushing the mixture with popsicle sticks, the students can see how it cracks and resists like a solid.

When mixing the water with corn starch powder, use a ratio of about 1 part water with 3 parts corn starch. As one can expect, if the mixture is too soupy, it needs more powder, and if the mixture is too chalky, it needs more water. Have enough water and powder available so that students can adjust their mixtures as needed. It is recommended that the students use at least one tablespoon of powder to start.

Remediation and/or Enrichment:
Remediation – IEP

For more advanced classes (and experienced teachers), the lesson can be taught in reverse, starting with the Earth today and ending with the early molten Earth or accretion disk in the solar system.

Check(s) for Understanding:
Students should be able to explain how the Earth possibly formed from asteroid collision in the early solar system. They should also be able to explain how continental drift occurs, and why scientists think the Earth has a dense metal core.

Closure:
Are the continents still moving? If so, how do we know?
What do you think could happen next in Earth's geological history?
If the Earth was not hot and molten to begin, how would that change its structure now?

Possible Alternate Subject Integrations:
Physical Science, Astronomy

Teacher Notes:
Do not rely solely upon the PowerPoint. Integrate questions and props as needed.