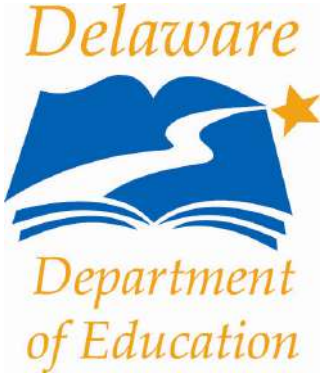
Delaware Science Coalition

Grade 6 Earth History Unit Template



Preface: This unit has been created as a model for teachers in their designing or redesigning of course curricula. It is by no means intended to be inclusive; rather it is meant to be a springboard for teacher thought and creativity. The information we have included represents one possibility for developing a unit based on the Delaware Science Content Standards, the Delaware Science Coalition units, and the Understanding by Design framework and philosophy.

Unit Summary:

The study of Earth's history enables people to use observations of present processes to infer past history of the Earth. The Grand Canyon's undisturbed horizontal sedimentary rock layers allow for these inferences through the study of individual rock types, formations, sequences, and use of index fossils. The Grand Canyon allows us to use the relative geologic time scale to understand vast amounts of time and the changes that have taken place in Earth's history.

Stage 1: Desired Results
Delaware Science Content Standards

This course focuses on the Delaware Science Content Standards and Grade Level Expectations in Standards 1 and 5 found on the following web site: http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml

Standard One: The Nature and Application of Science and Technology

Understandings and Abilities of Scientific Inquiry:
Students should be able to:

1. Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.
2. Design and conduct investigations with controlled variables to test hypotheses.
3. Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.
4. Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation.
5. Communicate scientific procedures, data, and explanations to enable the replication of results. Use computer technology to assist in

communicating these results. Critical review is important in the analysis of these results.

6. Use mathematics, reading, writing, and technology when conducting scientific inquiries.

Science Technology and Society:

Students should know that:

1. Advances in technology can expand the body of scientific knowledge. Technological tools allow people to observe objects and phenomena that otherwise would not be possible. Technology enhances the quality, accuracy, speed and analysis of data gathered.

2. Science and technology in society are driven by the following factors: economical, political, cultural, social, and environmental. Increased scientific knowledge and technology create changes that can be beneficial or detrimental to individuals or society through impact on human health and the environment.

History and Context of Science:

Students should know that:

1. Over the course of human history, contributions to science have been made by different people from different cultures. Studying some of these contributions and how they came about provides insight into the expansion of scientific knowledge.

Standard 5: Earth's Dynamic Systems

Components of the Earth:

Students should know that:

3. The formation of sediment and soil requires a long period of time as rocks are weathered, eroded and deposited.

Students should be able to:

- Use appropriate instruments and tools to identify the sedimentary rocks: limestone, shale, and sandstone. Infer the environmental conditions in which these rocks formed.
- Examine sedimentary rock formations. Use relative dating and fossil evidence to correlate sedimentary rock sequences. Infer the succession of environmental events that occurred from one rock sequence to another (transgression or regression of the seas). Use the correlated sedimentary rock sequences to support Earth's geologic time scale.

Interactions Throughout Earth's Systems:

Students should know that:

4. Constructive processes that build up the land and the destructive processes of weathering and erosion shape and reshape the land surface. The height of Earth landforms is a result of the difference between the rate of uplift and the rate of erosion at a particular location.

Students should be able to:

- Investigate and describe how factors such as abrasion, frost/ice wedging, temperature changes, and plant growth cause physical weathering of rocks. Infer the environment in which the sedimentary particles were formed based on the results of weathering.
- Investigate how weathered materials are transported (i.e., mass movement and wind, water, and ice processes) in the process of

erosion. Explain how erosion shapes rock particles.
- Describe the process by which eroded materials can form horizontal layers of sedimentary rock.
- Explain how sedimentary rocks are formed through the processes of weathering, erosion, and deposition.

Students should know that:

11. Past geological events and environments can be reconstructed by interpreting fossilized remains and successive layering of sedimentary rocks.

Students should be able to:

- Recognize that fossils indicate that many organisms that lived long ago are extinct. Use index fossils to determine the relative age of rock sequences, and environmental conditions at the time of formation. Recognize, through fossil evidence, that some species can be traced back in geologic time. (Standard 7)

Students should know that:

12. The fit of continental coastlines, the similarity of rock types and fossilized remains provide evidence that today's continents were once a single land mass. The continents moved to their current positions on plates driven by energy from Earth's interior.

Students should be able to:

- Cite three lines of evidence such as the fit of coastlines, the similarity of rock type and contiguousness of bedding areas, and similarity of fossilized remains that indicate that the continents were once a large land mass.

Big Ideas

- Observations of present processes (weathering, erosion, and deposition) and evidence of these processes (ex., grain size and shape, landforms, layering).
- Using present observations and evidence to make inferences.
- Change over time of Earth's crust.
- Processes that shape the Earth.
- The Earth as interacting systems.
- Cycling of rock material.
- Using a model to understand events of the past.
- Using patterns to infer changes over geologic time.

Unit Enduring Understandings

Enduring Understanding: Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying the explanation.
Enduring Understanding: The development of technology and advancement in science influence and drive each other forward.

Enduring Understanding: Understanding past processes and contributions is essential in building scientific knowledge.

Enduring Understanding: Earth's systems can be broken down into individual components which have observable measurable properties.

Enduring Understanding: Earth's components form systems. These systems continually interact at different rates of time, affecting the Earth locally and globally.

Unit Essential Question(s)

How are observations and inferences essential in understanding Earth's history today and in the past?

How can observations of sedimentary rocks lead to inferences about the environment in which the sediments were deposited? How do these observations lead to inferences on how present processes of weathering and erosion will affect the sedimentary rocks?

How is Earth's timeline similar and different than your own personal timeline?

Can index fossils provide a complete picture of Earth's history?

Are the continents in fixed positions? How do you know?

Knowledge & Skills

Knowledge:

- Observations are evidence gathered using the senses
- Inferences are conclusions based on observations and personal experiences.
- John Wesley Powell used observations of the Grand Canyon to make inferences on the history of the area.
- Rock layers are made of vertical sequences of rocks that extend over a horizontal area.
- The properties of sedimentary rocks determine how they will weather and erode.
- Larger rocks physically and chemically weather into smaller sediments. The sediments are eroded and transported by wind, water, or ice. The sediments are deposited in new locations where they may combine to form sedimentary rocks.
- Sandstone forms from sand particles which are deposited on or near a beach and that are compacted and cemented together.
- Shale forms from clay-sized particles which are deposited in shallow, still water and that are compacted together.
- Limestone forms from either the remains of marine organisms or from the carbon dioxide exhaled by marine organisms that combines with seawater to form calcium carbonate.
- The Earth is 4.5 billion years old. Compared to this, humans have only recently been on earth. We know about Earth's past not because

people saw what occurred but because we make observations and inferences using knowledge on processes that occur today and apply this to the past.

- Index fossils indicate the relative age of sedimentary rock layers and are used to correlate layers vertically and horizontally.
- Earth's continents are moving. There is evidence to support the theory that they were once together as a super continent and have been moving apart since then.
- Igneous rocks form from molten rock that cools on or below the surface.
- Metamorphic rocks form when heat and pressure changes rocks.
- The rock cycle explains the cycling of one rock type to another over time.
- The surface of the Earth is constantly changing as rocks weather, erode, and deposit and become new rocks.

Skills:

- Making observations
- Generating evidence
- Communicating results
- Conducting a critical review
- Comparing observations
- Conducting tests for calcium carbonate
- Identify sandstone, shale, and limestone
- Correlate rock layers horizontally across location
- Explain how differential erosion changes a landscape
- Explain how physical and chemical weathering act on rocks to form sediments.
- Identify the sediments that form sandstone, shale, and limestone.
- Model the formation of sandstone, shale, and limestone.
- Create a geologic timeline of Earth's history.
- Use index fossils to correlate rock layers.
- Identify evidence that supports the theory that the continents were once together and have moved to their present positions.
- Describe the rock cycle.

Describe how the surface of the Earth is constantly changing through the processes of weathering, erosion, and deposition.

Stage 2: Assessment Evidence

Assessment: The summative assessment consists of 12 questions. These questions are meant to flow conceptually while spanning different cognitive levels. In this way, the assessment becomes diagnostic in knowing the student's cognitive level of understanding which

then leads to instructional changes.

Transfer Key Ideas:

- Compared to the age of the Earth, humans have only been present for a very short period of time. Therefore, geologists make inferences based on their observations to understand Earth's history. Evidence from rocks and fossils can help scientist make inferences about the past.
- Rock layers form on top of each other; therefore, the oldest rocks are generally found on the bottom and the youngest are generally found on the top.
- The Earth's surface is constantly changing because of the processes of weathering, erosion, and deposition.
- Rocks are weathered into sediments. These sediments may be eroded and deposited in other locations.
- Energy from Earth's interior drives the movement of continents. Evidence for the movement can be found in the fit of the continental coastlines, similarity of rock types and fossil remains.

Expectations of Students:

- Students are expected to make a table and record color, texture, fossil evidence, and reaction to acid for each of three sedimentary rock samples. Students are then expected to use the data they gathered to identify sandstone, shale, and limestone.
- Students are expected to explain that sedimentary rocks provide evidence about the past environments (dry land, still water, deep ocean), when layers were deposited (oldest on the bottom in an undisturbed unit), and how the environment changed over time (shale overlain by limestone means the water was getting deeper).
- Students are expected to explain that sediments are deposited on top of each other. If no forces have acted on the layers, then the oldest are on the bottom and the youngest on the top.
- Students are expected to explain that sandstone forms from sand-sized particles carried water and deposited near the water's edge. Students are expected to explain that shale forms from fine particles. Because of the small size and mass of the particles, the particles are carried far by water and do not settle out until the water is still.
- Students are expected to infer that an area was under water when limestone formed, was quiet water when the shale particles were deposited, then was dry land (beach) when the sandstone formed.
- Students are expected to use the processes of weathering, erosion, and deposition correctly to tell the story of given pictures.
- Students are expected know that humans have been present on the Earth for a relatively short time period compared to the age of the Earth. Students are expected to use knowledge on the fit of coastlines, fossil evidence, or matching rock types to support the theory. Students are expected to know that energy in the Earth derives the movement of plates. At 6th grade, they are not expected to know how this occurs on that it does.

Formative assessment is found in each investigation and embedded throughout. Quick writes are used to determine what the students know prior to starting an investigation. These are scored using a check system. Informal notes of students are also used formatively during the investigation. Teacher observations, student lab sheets, and student journals, response sheets, and student self-assessments are also used.

Earth's History assessment can be found at http://www.doe.k12.de.us/programs/sci_assess/default.shtml

Rubrics/checklists for Performance Tasks

Earth's History assessment rubrics can be found at http://www.doe.k12.de.us/programs/sci_assess/default.shtml

Other Evidence
(This could include tests, quizzes, prompts, student work samples, and observations used to collect diverse evidence of student understanding.)

1. Differentiating between an observation and an inference: from the FOSS Earth History unit, Mid-Summative Exam 1. Teacher manual p. 415.
2. Evidence of generating testable questions: Investigation 2, part 4: Sorting Grand Canyon Questions. Students refine and sort questions into categories.
3. Evidence of correlating rock columns and differentiating sedimentary rock types: Earth History unit, Mid Summative Exam 3, p. 417
4. Evidence of understanding processes that shape rock layers: FOSS Earth History unit, Mid Summative Exam 4, p. 418
5. Evidence of making inferences about the origin of a rock: FOSS Earth History unit, Mid Summative Exam 5, p. 419
6. Evidence of understanding geologic time and the use of time lines: FOSS Earth History, Mid Summative Exam 6, p. 420-421
7. Evidence of understanding of the use of index fossils: FOSS Earth History unit, Mid Summative Exam 7, p. 422-423
8. Evidence of transfer of knowledge of rock layers and characteristics: FOSS Earth History unit, Mid Summative Exam 8, p. 424-425
9. Evidence of knowledge of unit concepts: FOSS Earth History unit, Final Summative Exam p. 426-432

Stage 3: Learning Plan
(Design Learning Activities To Align with Goals and Assessments)

Key learning events needed to achieve unit goals

The FOSS Earth History unit is used to meet the learning goals. The unit is divided into 8 investigations. In addition to this, a separate activity on Plate Tectonics has been added by the Delaware Science Coalition.

Investigation 1: Pushing the Envelope. In this investigation, students learn the difference between an observation and an inference through investigating a cancelled envelope.

Investigation 2: Into the Grand Canyon. Students learn how the body of scientific knowledge grows through the use of observations and inferences. This is learned through studying the work of John Wesley Powell as he made observations of the Grand Canyon and inferred the history of the area.

Investigation 3: Grand Canyon Rocks. As John Wesley Powell did many years ago, students make observations of the Grand Canyon rocks, learning to identify sandstone, shale, and limestone. Using their evidence, they infer changes to the landscape due to differential erosion.

Investigation 4: My Sediments Exactly. Students observe sand and shale and model the processes through which they form. Using this knowledge, they infer the type of environment in which sandstone and shale form.

Investigation 5: Limestone. Students observe limestone and model the processes through which limestone forms. Using this knowledge, students infer the type of environment in which limestone forms.

Investigation 6: It's About time. Like a personal timeline, the Earth also has a timeline. Students learn about the 4.5 billion years of Earth's geological time through creation of a scale model. Through this, they learn that humans have been on Earth for a relatively short period of time as compared to the length of time in which the Earth has existed.

Investigation 7: Fossils and Time. Students learn to use index fossils to relatively date sedimentary rock layers. Using these same index fossils as one piece of evidence, students learn that the Earth's continents were once connected and have moved to their present positions.

Investigation 8: One Rock to Another. Students conclude this unit with a study of the rock cycle. Having learned about sediments and sandstone, igneous and metamorphic rocks are introduced.

Potential Misunderstandings:

1. Students often use the terms "rock" and "mineral" as the same thing. Minerals are naturally occurring inorganic solids (not coal, not pearly, not glass). Rocks are made of minerals and other things.
2. Students think that the property of color is a good way to identify rocks and minerals when, in fact, it is a poor way to do this. Limestone occurs in many different colors depending on minerals that are included within the rock. There are many colors of the same rock type or kind of mineral so color should be the last property used for identification.
3. Students often have difficulty connecting sediments to sedimentary rocks. Furthermore, they often have the misconception that heat is involved in sedimentary rock formation and have this confused with metamorphic rocks (Happs, 1982).
4. Students do not recognize the geologic way or sorting sediments by their sizes and the term boulder, gravel, sand, and clay referring to the size of sediments. For example, clay to students is the colorful modeling clay found in art stores. (Happs, 1982).
5. Students have the misconception that a religious idea on the age of the Earth is scientifically based. Scientists use evidence to develop theories. A theory is not just a "guess" but a scientific theory is a well developed idea accepted by the scientific community and based on a great deal of evidence. Theories do change over time as new evidence is brought forth. Religious ideas are not based in scientific evidence but rather in beliefs. Student beliefs should be valued but students need to understand the major scientific theories agreed upon by scientists as well.
6. Students have the misconception that scientific studies in the past are irrelevant. Students need to understand how the body of scientific knowledge grows as evidence is collected over time. The work of John Wesley Powell was instrumental in understanding the formation of the Colorado plateau and Grand Canyon. Other scientists have built upon this work and expanded what we now know.
7. Students have the misconception that a rock is just a rock and that it provides no other information. We an infer form rock layers and formation the environment at the time of sediment deposition as well as the processes that have acted on the rock over time.
8. Students have the misconception that fossils are the actual organism that lived long ago. In reality, fossils can be imprints of organism's exterior parts (cast) or a mold of the interior. Fossils can also be things like footprints, a burrow, dung, or the actual remains that have been preserved.

This unit is meant to be taught in a 9-10 week format. Here is a suggested timeframe based on a regular 40-55 minute class period.

Monday	Tuesday	Wednesday	Thursday	Friday
Investigation 1, part 1	Investigation 1, part 1	Investigation 1, part 2	Fossil footprint and mid-summative exam	Investigation 2, part 1
Investigation 2, part 1	Investigation 2, part 2	Investigation 2, part 3	Investigation 2, part 4	Mid-summative exam and wrap-up
Investigation 3: Part 1	Investigation 3: Part 1	Investigation 3: Part 1	Investigation 3: Part 2	Investigation 3: Part 3

Investigation 3: Part 4	Investigation 3: Mid-summative exam and wrap-up	Investigation 4: Part 1	Investigation 4: Part 2	Investigation 4: Part 3
Investigation 4: Part 3	Investigation 4: Part 4	Investigation 4: Part 5	Investigation 4: Part 6	Investigation 4: Part 6
Investigation 4: Mid-summative exam and wrap-up	Investigation 5 Part 1	Investigation 5 Part 2	Investigation 5 Part 3	Investigation 5 Part 3
Investigation 5 Part 4	Investigation 5 Mid-summative exam and wrap-up	Investigation 6 Part 1	Investigation 6 Part 1	Investigation 6 Part 2
Investigation 6 Part 3	Investigation 6 Part 4	Investigation 6 Mid-summative exam and wrap-up	Investigation 7 Part 1	Investigation 7 Part 2
Investigation 7 Mid-summative exam and wrap-up	Plate tectonic Activity	Investigation 8 (Optional) Part 1	Investigation 8 (Optional) Part 2	Investigation 8 (Optional) Part 3
Investigation 8 (Optional) Part 4	Investigation 8 (Optional) Mid-summative exam and wrap-up	Unit Conclusion		

Resources & Teaching Tips

Resources:

Books and Web sites:

1. FOSS Earth History. 2001. The Regents of the University of California.

2. United Streaming- Weathering, Erosion, Deposition. http://www.unitedstreaming.com/

3. Bill Nye. Disney Educational Productions. Erosion, Rocks, and Soil.

4. Anderson, Michael. Along the Rim. A Guide to the Grand Canyon's South Rim From Hermits rest to Desert View.

5. Whitney, Stephen R. A Field Guide to the Grand Canyon.

6. Google Earth. This site provides a bird's eye view of the earth at any location. Download from this site: http://www.google.com/intl/en/options/

- **Erosion: http://dep.disney.go.com/educational/billnye_experiment?id=77A42VL00**
- **Rocks and Soil. http://dep.disney.go.com/educational/billnye_experiment?id=77A18VL00**

Field trips

1. Iron Hill Museum. Field trip on rocks and minerals and the changing earth. http://www.ironhillmuseum.org/programs/rocks-are-weird.html

2. University of Delaware's Mineralogical Museum. Penny Hall, Newark Campus. http://www.museums.udel.edu/mineral/mineral_site/

3. Brandywine State Park, Greenville, DE. Field trip to explore the blue rocks in Delaware. http://www.destateparks.com/bcsp/bcsp.asp

4. Delaware Nature Society's Abbott's Mill. Field trip for grades 6-8 entitled *Rock Hounds*. http://www.delawarenaturesociety.org/edu/abbotts_programs.html