ESS1.C: The History of Planet Earth – 1a The Fossil Record and Superposition

**ESS1.C - 1**

[The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)](http://www.nap.edu/openbook.php?record_id=13165&page=177)

**NGSS Evidence Statement:**[MS-ESS1-4](http://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-ESS1-4%20Evidence%20Statements%20June%202015%20asterisks.pdf)

**Framework Text:**

ESS1.C: THE HISTORY OF PLANET EARTH

*How do people reconstruct and date events in Earth’s planetary history?*

Earth scientists use the structure, sequence, and properties of rocks, sediments, and fossils, as well as the locations of current and past ocean basins, lakes, and rivers, to reconstruct events in Earth’s planetary history. For example, rock layers show the sequence of geological events, and the presence and amount of radioactive elements in rocks make it possible to determine their ages.

Analyses of rock formations and the fossil record are used to establish relative ages. In an undisturbed column of rock, the youngest rocks are at the top, and the oldest are at the bottom. Rock layers have sometimes been rearranged by tectonic forces; rearrangements can be seen or inferred, such as from inverted sequences of fossil types. Core samples obtained from drilling reveal that the continents’ rocks (some as old as 4 billion years or more) are much older than rocks on the ocean floor (less than 200 million years), where tectonic processes continually generate new rocks and destroy old ones. The rock record reveals that events on Earth can be catastrophic, occurring over hours to years, or gradual, occurring over thousands to millions of years. Records of fossils and other rocks also show past periods of massive extinctions and extensive volcanic activity. Although active geological processes, such as plate tectonics (link to ESS2.B) and erosion, have destroyed or altered most of the very early rock record on Earth, some other objects in the solar system, such as asteroids and meteorites, have changed little over billions of years. Studying these objects can help scientists deduce the solar system’s age and history, including the formation of planet Earth. Study of other planets and their moons, many of which exhibit such features as volcanism and meteor impacts similar to those found on Earth, also help illuminate aspects of Earth’s history and changes.

The geological time scale organizes Earth’s history into the increasingly long time intervals of eras, periods, and epochs. Major historical events include the formation of mountain chains and ocean basins, volcanic activity, the evolution and extinction of living organisms, periods of massive glaciation, and development of watersheds and rivers. Because many individual plant and animal species existed during known time periods (e.g., dinosaurs), the location of certain types of fossils in the rock record can reveal the age of the rocks and help geologists decipher the history of landforms.

*Excerpt from: A Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas*

**Main Concepts**

* Rock strata are layers of sedimentary and volcanic rock that are deposited on top of each other on Earth’s surface
* The fossil record documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. Fossils are physical evidence for formerly living things (shells, bones, impressions, molds, tracks)
* Principle of Superposition states that younger layers of rock form on top of older layers of rock; thus unless the layers have been disturbed (e.g., folded, faulted), deeper layers are older than those closer to the surface
* Principle of Cross-cutting Relationships states that any rocks or features (like faults) that cut across existing rock strata are younger than the rock strata that they cut across
* Difference between relative age (which layers are older than which) vs. absolute age (age or timespan in millions of years)
* Geologists can determine the relative age of a sedimentary rock formation based on the existence of certain specific fossils (called index fossils) or assemblages (combinations) of fossils that are found in rocks of that age and not in older or younger rocks.
* The present is the key to the past: theories and laws that describe the natural world today, operated the same way in the past; geologic processes that operate today, operated in the same way in the past

**Related Concepts and Applications**

* Geologic time and the geologic time scale
* Biological evolution and evidence for evolution
* Earth history and evidence for Earth history

**Related Crosscutting Concepts**

* **Patterns** the sequence of fossils found from bottom to top in rock strata is consistent from place to place on Earth
* **Scale, Proportion, and Quantity** Rock strata with and without fossils record conditions and processes that occur over millions of years as well as events that occur almost instantaneously
* **Stability and Change**  Earth’s surface changes slowly and quickly over time, but the processes that change Earth’s surface are generally the same today as they were in the past

**Practices of Science and Engineering**

Teachers will impressed if the game teaches students about or, better, involves students in one or more of the following:

* **Planning or Carrying Out Investigations** compare fossils; identify fossils based on descriptions in an identification chart; make observations about fossils and fossil assemblages to infer geologic history (sequence of events)
* **Analyzing and interpreting data** analyze a fossil and the rock it is in to infer what type of organism it was and the environment it lived in; analyze a sequence of fossils or fossil assemblages to identify changes in the environment over time; correlate layers of rock based on fossils and fossil assemblages
* **Constructing Explanations** based on the understanding that the theories and laws that describe the natural world today, operated the same way in the past; geologic processes that operate today, operated in the same way in the past
* **Engaging in argument from evidence** use laws of superposition and cross-cutting relationships to support a claim about a sequence of events

**Grade Bands:**

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| --- | --- | --- | --- |
| **K-2**  You can assume that students already know that  . . . | **3-5**  Students should have learned this, but it is fine to review it . . . | **6-8**  **This is what students need to learn:** | **9-12**  You don’t need to go into this much depth  (but it is ok to go this far if it makes sense to do so . . .) |
| • Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1) | • Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1) | • The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4) | • Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)  • Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history. (HS-ESS1-6) |

**Middle School Level Resources:**

These are examples of what middle schoolers are learning.

Textbook resources:

* Earth Science Textbook from cK-12: <http://www.ck12.org/book/CK-12-Earth-Science-For-Middle-School/>; <http://www.ck12.org/book/CK-12-Life-Science-For-Middle-School>
* Evidence for Earth’s Past: <http://www.ck12.org/book/CK-12-Earth-Science-For-Middle-School/section/11.0/>
* Earth’s History and Geologic Time: <http://www.ck12.org/book/CK-12-Earth-Science-For-Middle-School/section/12.0/>
* History of Life on Earth: <http://www.ck12.org/book/CK-12-Life-Science-For-Middle-School/section/7.4/>
* Evidence for Evolution: <http://www.ck12.org/book/CK-12-Life-Science-For-Middle-School/section/7.2/>

Other Resources: