HS.ESS-HE History of Earth

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Students who demonstrate understanding can:

a. Analyze determined or hypothetical isotope ratios within Earth materials to make valid and reliable scientific claims about the planet's age, the ages of Earth events and rocks, and the overall time scale of Earth's history. [Assessment Boundary: Radiometric dating techniques using complex methods such as multiple isotope ratios are not included.]

b. Construct an explanation, using plate tectonic theory, for the general trends of the ages of continental and oceanic crust and the patterns of topographic features. [Clarification Statement: Trends of crustal ages involve the youngest seafloor rocks located at mid-ocean ridges and the oldest ocean rocks often located near continental boundaries, with age bands of rocks parallel across mid-ocean ridges. Major topographic features are ocean ridges, trenches, and hot spot islands.]

c. Construct explanations about changes that occurred to Earth during the Hadean Eon based on data from Earth materials, planetary surfaces, and meteorites. [Clarification Statement: Dynamic Earth processes have destroyed most of Earth's very early rock record; however, lunar rocks, asteroids, and meteorites have remained relatively unchanged and provide evidence for conditions during Earth's earliest time periods.]

d. Construct scientific arguments to support the claim that dynamic causes, effects, and feedbacks among Earth's systems result in a continual coevolution of Earth and the life that exists on it. [Assessment Boundary: Students examine examples of feedbacks between Earth's different systems to understand how life has coevolved with Earth's surface (e.g., the atmosphere and biosphere affect the conditions for life, which in turn affects the composition of the atmosphere.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution. (a)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.

- Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review. (b),(c)

Engaging in Argument from Evidence
Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world. Arguments may also come from current scientific or historical episodes in science.

- Evaluate the claims, evidence, and reasoning of currently accepted explanations or solutions as a basis for the merits of the arguments. (d)

Disciplinary Core Ideas

ESS1.C: The History of Planet Earth

- Radioactive-decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geologic time. (a)
- 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. (b)
- 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. (c)

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (b)
- Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (b)

ESS2.E Biogeology

- The many dynamic and delicate feedbacks among the biosphere, geosphere, hydrosphere, and atmosphere cause a continual co-evolution of Earth's surface and the life that exists on it. (d)

Crosscutting Concepts

Scale, Proportion, and Quantity
Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g. linear growth vs. exponential growth). (a)

Stability and Change
Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. (b),(c),(d)

Connections to other DCIs in this grade-level: **HS.LS-IVT, HS.LS-NSE, HS.LS-MEOE, HS.LS-IRE, HS.PS-SPM, HS.PS-NP, HS.PS-CR, HS.PS-E**

Articulation to DCIs across grade-levels: **K.OTE, 2.IOS, 2.ECS, 4.PSE, MS.ESS-HE**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA –

W.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
WHST.9-10.1	Write arguments focused on discipline-specific content.
W.9-10.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
W.11-12.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
WHST.11-12.1	Write arguments focused on discipline-specific content.
W.11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
SL.11-12.2	Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

Mathematics –

MP.2	Reason abstractly and quantitatively
MP.3	Construct viable arguments and critique the reasoning of others.
MP.5	Use appropriate tools strategically
S.ID	Summarize, represent, and interpret data on a single count or measurement variable; Summarize, represent, and interpret data on two categorical and quantitative variables
S.IC	Make inferences and justify conclusions from sample surveys, experiments, and observational studies