IS3

Grade Four Instructional Segment 3: Sculpting Landscapes

California's landscape has shaped our history, allowing this unit to be effectively integrated with grade four history–social science standards. Gold was first discovered in California in material eroded away from high in the Sierra Nevada and then deposited in the fertile Central Valley. In grade two, students observed how wind and water change landscapes, noting that some of the changes are slow while others are rapid. In grade four, they focus on the cause and effect relationship and look at exactly what happens when rocks get broken apart, transported, and deposited.

GRADE FOUR INSTRUCTIONAL SEGMENT 3: SCULPTING LANDSCAPES

Guiding Questions

- How do water, ice, wind, and vegetation sculpt landscapes?
- What factors affect how quickly landscapes change?
- How are landscape changes recorded by layers of rocks and fossils?
- How can people minimize the effects of changing landscape on property while still protecting the environment?

Performance Expectations

Students who demonstrate understanding can do the following:

4-ESS3-1. Identify evidence from patterns in rock formations and fossils in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time. [Clarification Statement: Examples of evidence from patterns could include rock layers with shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] [*Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.*]

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [*Assessment Boundary: Assessment is limited to a single form of weathering or erosion.*]

4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features. [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.] (Introduced. Fully assessed in IS4)

GRADE FOUR INSTRUCTIONAL SEGMENT 3: SCULPTING LANDSCAPES

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.* [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [*Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.*] (Introduced. Fully assessed in IS4)

3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3–5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

**The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.*

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Highlighted Science and Engineering Practices	Highlighted Disciplinary Core Ideas	Highlighted Crosscutting Concepts
[SEP-2] Developing and Using Models [SEP-3] Planning and Carrying Out Investigations [SEP-5] Using Mathematics and Computational Thinking [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)	ESS1.C: The History of Planet Earth ESS2.A: Earth Materials and Systems ESS2.E: Biogeology ESS3.B: Natural Hazards ETS1.A: Defining Engineering Problems	[CCC-1] Patterns [CCC-3] Scale, Proportion, and Quantity

Highlighted California Environmental Principles and Concepts:

Principle III Natural systems proceed through cycles that humans depend upon, benefit from and can alter.

Principle V Decisions affecting resources and natural systems are complex and involve many factors.

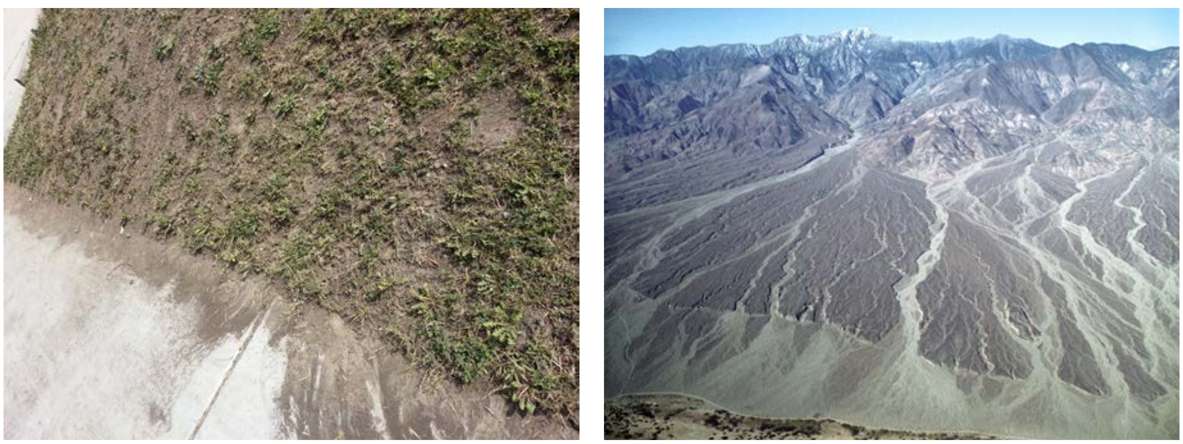
CA CCSS for ELA/Literacy Connections: W.4.3, 4, 7, 8, 10; L.4.1, 2, 5, 6

CA ELD Standards Connections: ELD.PI.4.6, 10.b

Landscapes are constantly changing as forces on Earth's surface sculpt and reshape the rocks. Sometimes these forces act quickly (sudden landslides) while other times they cause more gradual changes. Students will eventually return to the issue of timescales of these processes at a more nuanced level in high school (HS-ESS2-1), but fourth-graders begin by simply observing that there are factors that affect the speed at which landscapes change and that there are systematic patterns that cause these differences in rate.

While erosion of a centimeter of rock might take all year in real life, students can often observe the effects of water, ice, wind, or vegetation on soil in their schoolyard (figure 4.9). These processes have two types of effects on rock and soil: they (1) break material into smaller pieces and (2) transport those pieces (erosion), eventually depositing them in new places. The roots of plants squeeze their way through the soil and slowly wedge pieces apart but do not usually move those pieces very far (weathering only). Other processes often involve both weathering and erosion by the same force. Wind only has enough force to break off and blow away tiny sand and dust particles. By contrast, the force of a moving glacier made of ice was enough to slice off the missing half of Half Dome in Yosemite, literally moving a mountain (or at least half of it). In most parts of California, flowing water is the most important process that breaks apart rocks and moves them. Students should directly investigate at least one of these processes in detail.

Figure 4.9. Erosion and Deposition on the Schoolyard and in Nature



Sources: Mauney 2013; Miller 2008
Long description of Figure 4.9.

One of the most engaging and dramatic investigations of weathering and erosion by water is a **physical model [SEP-2]** of a river called a stream table (a container or tray filled with sand, clay, and/or gravel propped up on one end to represent a sloping mountainside). Because students can try out different scenarios and quickly see the results, stream tables are excellent platforms for students to **plan and carry out investigations [SEP-3]** to examine the effect of water on the rate of erosion. They can make measurements that show how different scenarios such as the type of Earth material, slope of the stream table, rate of water flow, and vegetation all affect the rate of erosion or the rate at which layers accumulate at the bottom (4-ESS2-1; See the "Instructional Strategies Snapshot: Teaching the Nature of Science Explicitly" in chapter 11 for another performance task appropriate for this performance expectation). Each group of students **constructs an explanation [SEP-6]** describing how a change they made in their experimental system **caused [CCC-2]** a change in the speed of weathering, erosion, or deposition.

Students may have used a stream table in grade two to make qualitative observations. By grade four, they can use the same tool but measure the results quantitatively. In grade two, their objective was to distinguish between slow and fast processes, but now they can vary parameters like the slope steepness and notice regular **patterns [CCC-1]** in their data over a range of steepness and describe how much faster or slower (**scale, proportion, quantity [CCC 3]**).

Students can **analyze [SEP-4]** maps of their community and predict places where erosion will happen the fastest (4-ESS2-2). These maps could show topography as different colors where students recognize that the steepest slopes have the most erosion, or simplified geologic maps that indicate the strength of different rocks and therefore their resistance to erosion.

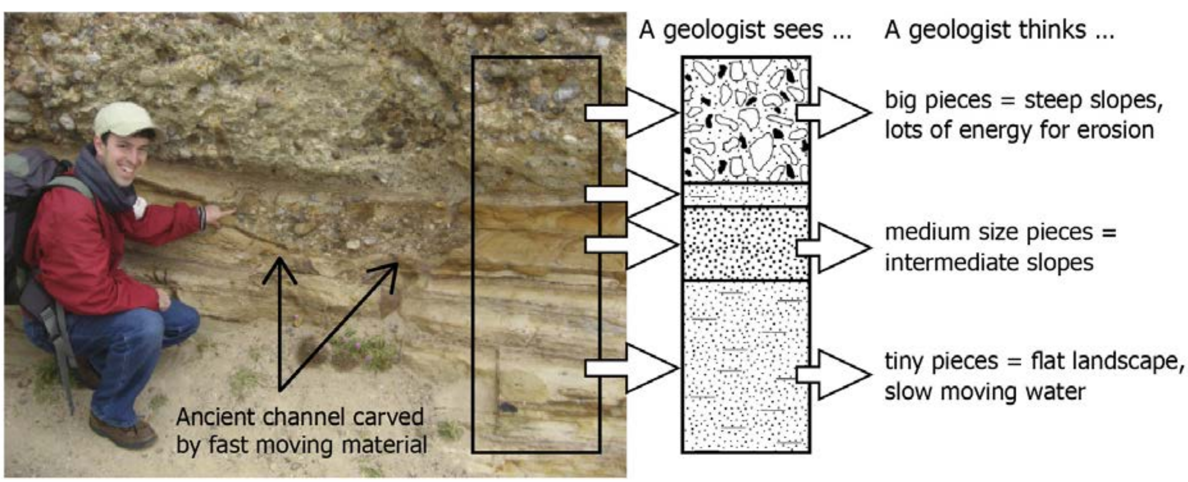
Engineering Connection: Minimize Damage to Property from Erosion

Because flowing water erodes so quickly, most natural rivers erode their banks causing the river to move and flow. Many property boundaries and even the southeastern edge of the State of California at the Colorado River are defined by the location of rivers. As the bank erodes away, people's properties can get smaller and houses can have their foundation eroded away so that they eventually fall down. In a stream table, students can generate and test multiple solutions that prevent the risk of damage to property from this natural hazard (4-ESS3-2; 3–5-ETS1-2; 3–5-ETS1-3). As they reinforce the property, how does the engineering solution affect the natural environment (EP&C III)? When people decide whether or not they will build some sort of protection, they must weigh both the benefits to their property and the damage to their neighbors' properties and to the natural river system (EP&C IV).

Stream tables also allow students to directly investigate how some types of rocks form in layers. When water slows down at the bottom of the stream table, the water no longer pushes the pieces of sand and soil with enough force to move them, so they settle down in a layer. The same thing happens in real life as material eroded from mountains drops out of rivers when the water slows down on the flatter valleys below or when it slows even more as it reaches a slow moving lake or the ocean. Students can place leaves at the bottom of the stream table and watch how they get buried (the first stage in fossil formation). As vegetation and animals in an area change over time, the types of leaves and animal remains that get buried and fossilized also change. The assessment boundary for 4-ESS1-1 states that students do not need "specific knowledge of the mechanisms of rock formation," but understanding how rock layers record changes in landscape does require at least some general understanding of how these layers accumulate. The assessment boundary is designed to signal teachers that students will investigate the processes of rock formation in the middle grades. Material that is often covered in elementary school, such as the classification of rocks into three main types and the rock cycle, are therefore not a part of grade four. Instead, the learning progressions in the California Next Generation Science Standards (CA NGSS) (appendix 1 of this framework) and the performance expectations indicate that grade four focuses on rocks that form at the Earth's surface (primarily sedimentary rocks).

Once students have a basic model for how layers accumulate, they can **interpret data [SEP-4]** from fossils and rock type to infer changes that occurred to the landscape at a particular location (4-ESS1-1). Each layer of rock reveals clues about the environment in which it formed in both the rock material itself (such as the size of the individual pieces that make it up (figure 4.10) and the fossils contained in each layer (building upon LS4.A from grade three about how fossils provide evidence of the environment in which they formed). Students can use observations from famous national parks like the Grand Canyon or more local settings for which geologic studies exist. Ideally, students can take field trips to local exposures of rock layers in their community, but they can also practice interpreting rock layers by examining the different types of concrete and building materials on their own schoolyard (USGS 2015a).

Figure 4.10. Layers of Rock Record Changes in Landscapes



Scientist near Point Reyes Lighthouse in California points out rock formation layers. *Source*: M. d'Alessio
Long description of Figure 4.10.

Opportunities for ELA/ELD Connections

As part of an investigation about rocks, rock formations, and the components in rocks that provide evidence of changes in a landscape over time, students take notes, paraphrase, and categorize information by creating an *I Am a Rock* book. Students can write the information from the point of view of a rock in their investigation, including a description of what it is made of, how it formed, how it provides evidence of changes in the landscape, etc. Students include pictures throughout, as well as a list of sources at the end of the book.

CA CCSS for ELA/Literacy Standards: W.4.3, 4, 7, 8, 10; L.4.1, 2, 5, 6

CA ELD Standards: ELD.PI.4.6, 10.b

IS4

Grade Four Instructional Segment 4: Earthquake Engineering

All regions of California face earthquake hazards. In this unit, students use the phenomenon of earthquakes to introduce the physical science concept of waves. The CA NGSS emphasize waves because electromagnetic waves play a fundamental role in modern technology (communications and medical imaging, among other applications). Grade four students do not yet study abstract electromagnetic waves, but instead **develop models [SEP-2]** of more tangible waves that cause objects to have a repeating **pattern [CCC-1]** of motion.

GRADE FOUR INSTRUCTIONAL SEGMENT 4: EARTHQUAKE ENGINEERING

Guiding Questions

- How have earthquakes shaped California's history?
- How can we describe the amount of shaking in earthquakes?
- How can we minimize the damage from earthquakes?

Performance Expectations

Students who demonstrate understanding can do the following:

4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [*Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*]

4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features. [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]