The Evolution of the T2L Science Curriculum

Over the last four years, the Teach to Learn program created 20 NGSS-aligned science units in grades K-5 during our summer sessions. True to our plan, we piloted the units in North Adams Public Schools, and asked and received feedback from our science fellows and our participating teachers. This feedback served as a starting point for our revisions of the units. During year 2 (Summer of 2015), we revised units from year 1 (Summer/Fall 2014) and created new units to pilot. In year 3, we revised units from years 1 and 2 and created new units of curricula, using the same model for year 4. Our understanding of how to create rich and robust science curriculum grew, so by the summer of 2018, our final summer of curriculum development, we had created five exemplar units and established an exemplar unit template which is available in the T2L Toolkit.

We made a concerted effort to upgrade all the existing units with exemplar components. We were able to do much, but not all. So, as you explore different units, you will notice that some contain all elements of our exemplar units, while others contain only some. The fully realized exemplar units are noted on the cover page. We did revise all 20 units and brought them to a baseline of "exemplar" by including the Lessons-At-A-Glance and Science Talk elements.

Grade 4

Earth's Surface

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A T2L Exemplar Unit

MCLA NAPS Williams

Teach To Learn

A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

T2L Curriculum Unit

The Earth's Surface

Earth Science/Grade 4

In this unit, students investigate the processes of erosion and weathering through hands-on investigations. They will see how these processes affect the formation of landforms. Students will analyze different types of maps to look for patterns and will design a solution to mitigate the effects of an earthquake.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Unit Creation and Revision History

Authors

Tiffinie Alvarez, Secondary Education major, English major, Massachusetts College of Liberal Arts (Summer ’18)
Kathy Atwood, Grade 3 Teacher, North Adams Public Schools (Summer ‘14)
Jean Bacon, Administrator for Teaching and Learning, North Adams Public Schools (Summer ‘14)
Amina Diop, Astrophysics major, Mathematics major, Williams College (Summer ‘18)
Lauren Mangiardi, Elementary Education Major, English Literature, Massachusetts College of Liberal Arts (Summer ‘18)
Priscilla Mercado, Computer science major, English major, Williams College (Summer ‘18)
Stephanie Nguyen, Elementary Education major, Interdisciplinary Studies major, Massachusetts College of Liberal Arts (Summer ‘18)
Lindsay Osterhoudt, Science Coordinator, North Adams Public Schools (Summer ‘14)
Matthew Roychowdhury, Physics major, Williams College (Summer ‘18)
Troy Segala, Business Administration Management major, Massachusetts College of Liberal Arts (Summer ‘14)

Revisions, Summer 2015

Jessica L. Wojcik, Interdisciplinary Studies major, Education major, Social Work minor, Massachusetts College of Liberal Arts
Grace Sullivan, English and Women’s Studies major, Williams College

Revisions, Summer 2016

Diego Garcia, Computer Science major, Williams College
Annie Gagnon, Biology major, Massachusetts College of Liberal Arts

Project Manager: Leslie Rule, Teach to Learn, Massachusetts College of Liberal Arts

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Lessons at a Glance

Independent online student research | Technology integration | YouTube Video

Outdoor education | Movement | Lab work

Lesson	Core Activities	Extensions	Aspects of Lesson
1. What is a Physical Map?	• Types of Maps • Treasure Maps • Map Features Review • Landform Review • Word Warm-Up • Physical Map Investigation • Online Maps • Daily Planet Earth Newspaper		
2. Mohs' Hardness Scale	• Physical Properties of Minerals • Describing Minerals • Mohs Hardness Scale • Mineral Observation Stations • Mineral Identification • The Mystery Rock Experiment • Mineral Ad		

3.What is Erosion?	• Weathering and Erosion PowerPoint • Erosion and Abrasion Stations • Washing Away Landforms • Berkshire Landforms • Mt. Greylock Article	• Paired Passages	
4. What is a Soil? Is All Soil the Same?	• Soil Exploration • IMOWA Chart • Soil Discovery • Soil Recipe • Soil Drainage Test	• Connections to Mount Greylock	
5. Fossils	• Make your own fossil • Fossilization Game • Fossil Map • Write about your fossil	• Trip to Berkshire Museum	
6. Earthquakes and Fault Lines	• Volcano Demonstration • Ring of Fire Activity • Graham Cracker Plate Tectonics		
7. Protecting Against Natural Disasters	• Geo Squad Stops Fred the Flood Video • Floods PowerPoint • "Safe Houses" reading • Disaster Preparedness Game • Dinosaur Extinction Debate • Disaster Survival Comic	• Flood Activity	

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Unit Plan

Stage 1 Desired Results		
Grade Level Standards	***Meaning***	
(4-ESS1-1) Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. [Clarification Statement: Examples of evidence from patterns could include rock layers with marine 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**	**UNDERSTANDINGS** ***Students will understand that…*** • Physical maps show the locations of physical features on land, such as mountains, rivers, and elevation. • Local, regional, and global patterns of rock formations reveal changes over time due to forces such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. • The development, weathering (how it is broken down into smaller pieces), and eroding (particles are transported elsewhere) of landforms can help people infer the history of the current landscape. • Rainfall helps to shape the land and impact the living things found in a region. • Liquid and solid water, wind, and living organisms break rocks, soil, and sediments into smaller particles and move them around.	**ESSENTIAL QUESTIONS** 1. How can we protect against natural disasters? **2.** What can rocks tell us about the past? **3.** How can maps model Earth's features?

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.] **(4-ESS3-2) Generate and compare multiple solutions to reduce the**	• The location of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans.	
	Student Learning Targets	
	"I can" statements 1. I can identify a physical map and its components. 2. I can read maps that depict mountain ranges, trenches, active volcanoes, and earthquakes. 3. I can perform appropriate tests to determine the hardness, color, luster, cleavage, and streak of different minerals. 4. I can note differences between rocks and minerals. 5. I can use previously recorded data to identify different minerals. 6. I can observe and describe examples of weathering through frost wedging, abrasion and tree root wedging. 7. I can observe and describe examples of erosion through wind, water, and ice. 8. I can explain the difference between "weathering", "erosion", and "deposition". 9. I can explain how soil is formed through decomposition and weathering. 10. I can illustrate the connection between soil formation (e.g. ratios of organic matter to minerals) and its color and texture. 11. I can identify and describe the differences between soil, loam, and clay. 12. I can write a story about the history of my fossil. 13. I can explain the differences between types of fossils. 14. I can explain how plate tectonics create earthquakes and mountains. 15. I can discuss how volcanoes are formed and the effects of their eruptions on land.	

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.*]	16. I can model how earthquakes, mountains, and volcanoes are created. 17. I can discuss three types of natural disasters including volcanic eruptions, earthquakes, and floods. 18. I can discuss the impacts of natural disasters and how to protect against or lessen the effects of these natural disasters.

Stage 2 – Evidence

Evaluative Criteria	Assessment Evidence
Science Journals Class Discussions Group presentations Participation	Planet Earth Newspaper Journal entries Class discussions Practice MCAS questions

Stage 3 – Learning Plan

Lesson 1: In this lesson, students will review landforms. They will then be introduced to physical maps, both online and on paper.

Lesson 2: Students will learn about the three main categories of rocks and that rocks are made from combinations of minerals. They will perform Mohs' hardness test to identify various minerals, including a mystery mineral.

Lesson 3: Students will learn about weathering and erosion through a PowerPoint and various activities. They will analyze pictures of Berkshire county landforms and theorize as to how they were formed.

Lesson 4: Students will learn about the components and characteristics of soil. Then, they will write a soil recipe for their newspaper project and do a soil drainage test with different types of soil.

Lesson 5: Students will engage in games and activities to learn about fossils. They will make their own fossils and then write a story about the fossil they made.

Lesson 6: In this lesson, students will learn about volcanoes and earthquakes. They will build a volcano and model earthquakes using graham crackers and cool-whip. They will then map earthquakes and volcanoes on the Ring of Fire to explore the connection between the two phenomena.

Lesson 7: In the final lesson of the unit, students will learn about the things they need to survive from natural disasters, including ones mentioned previously such as volcanic eruptions and earthquakes. Then they will have a debate about the extinction of the dinosaurs.

Adapted from Massachusetts Department of Elementary and Secondary Education's Model Curriculum Unit Template. Originally based on Understanding by Design 2.0 © 2011 Grant Wiggins and Jay McTighe. Used with Permission July 2012

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Lesson Feature Key

Lessons in this unit include several features to help instructors. It is a quick guide to help identify and understand the key features.

Icons

Talk science icon: Look for this icon to let you know when to use some of the talk science strategies (found in the unit resources of this unit)

Anchor phenomenon icon: Indicates a time when an anchoring scientific phenomenon is introduced or when an activity connects back to this important idea**.**

Text Formatting:
[SP#: ....] Any time you see a set of brackets like this, it indicates that students should be engaged in a specific science or engineering practice.

Underlined text in the lesson: This formatting indicates important connections back to the central scientific concepts and is useful to note these connections as an instructor, as well as for students.

Callouts

Teaching Tip
In these call-out boxes, you'll find tips for teaching strategies or background information on the topic.

Student Thinking Alert
Look out for common student answers, ways in which students may think about a phenomenon, or typical misconceptions.

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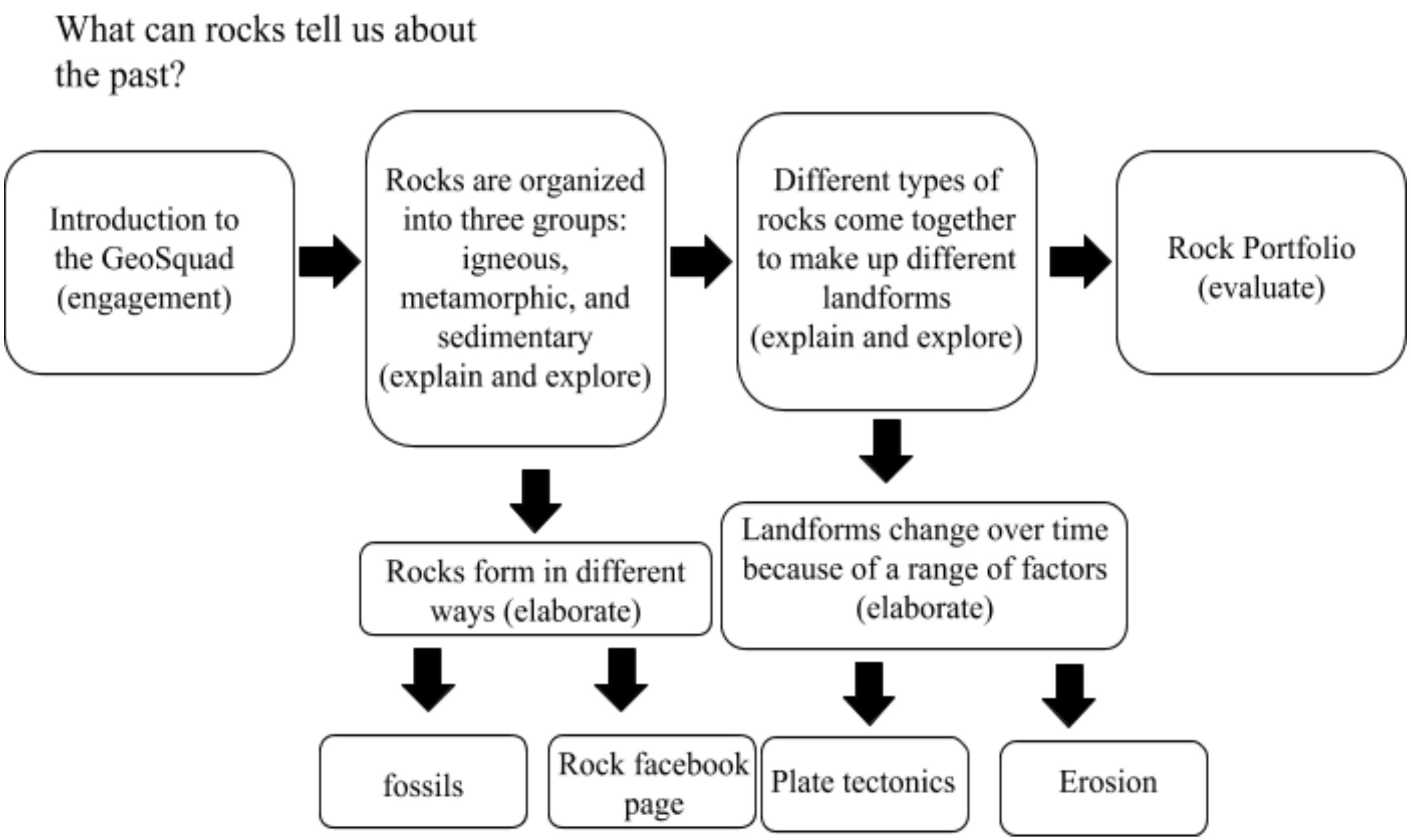
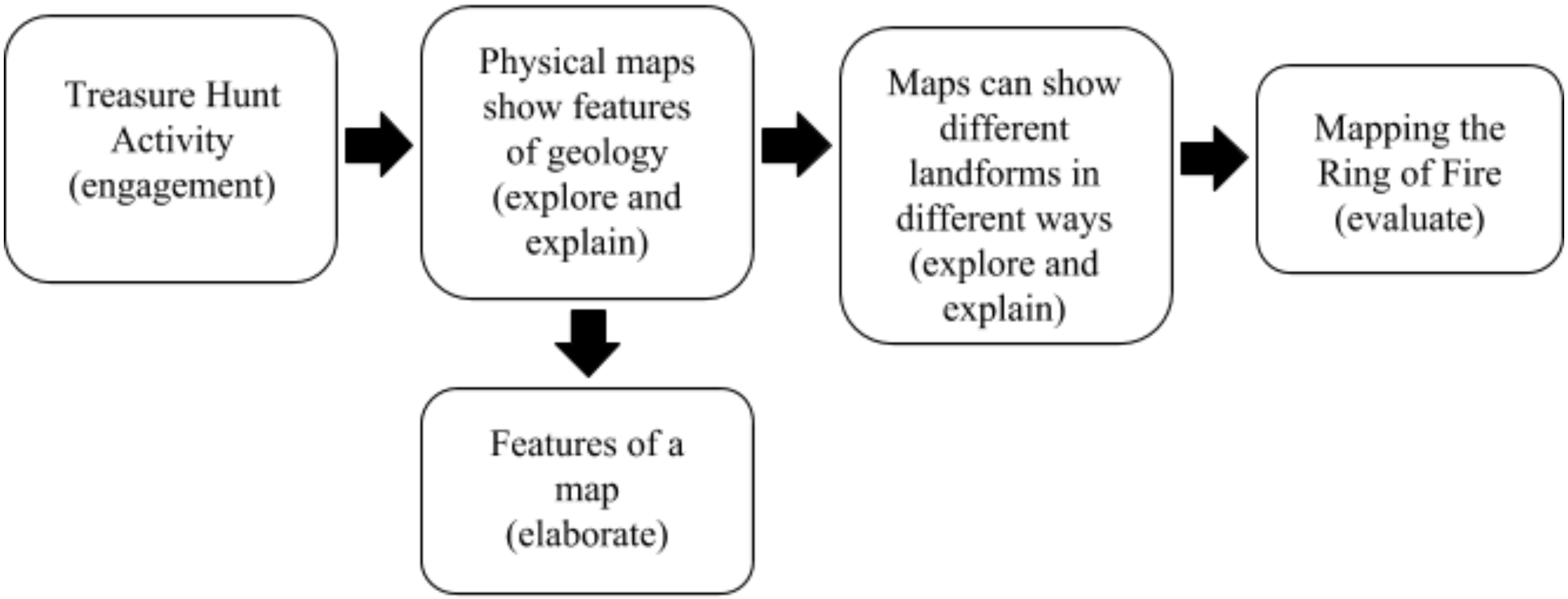
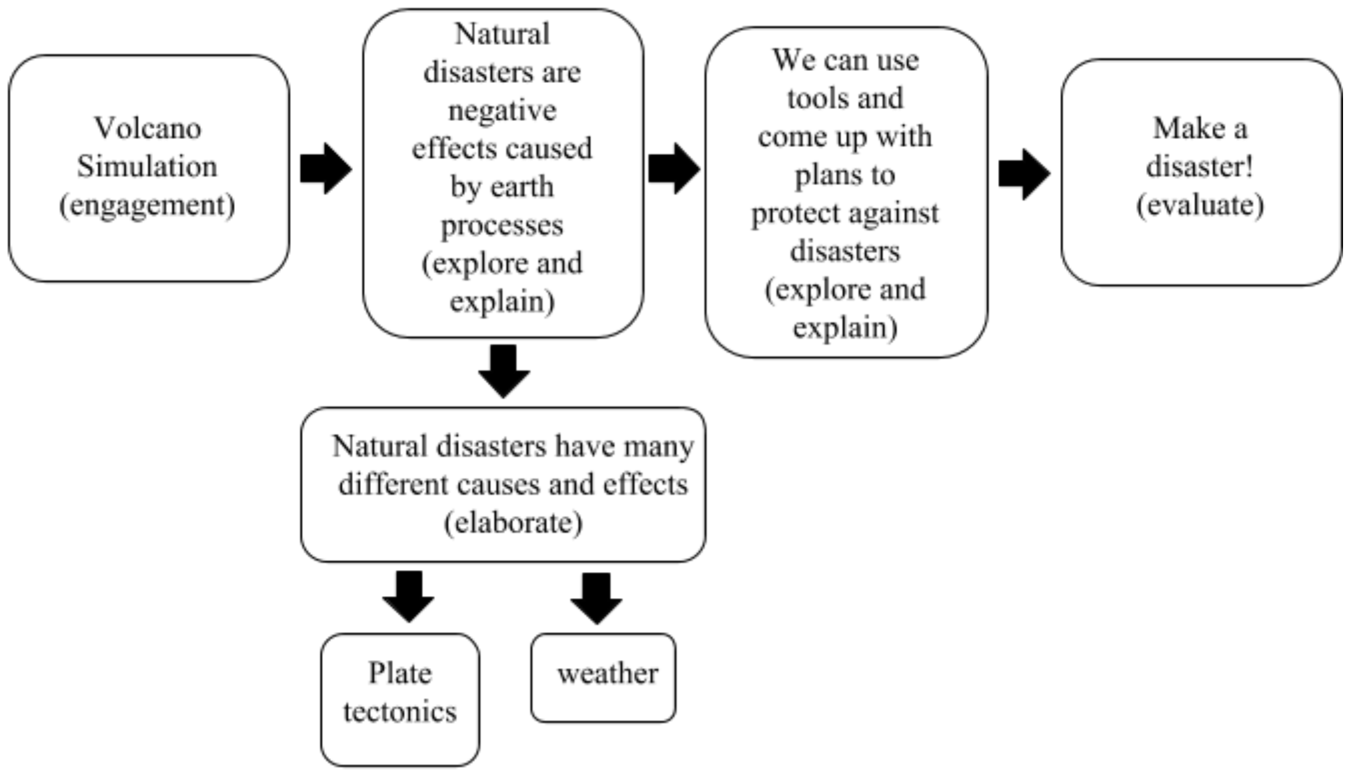
Essential Question Concept Maps



How can maps model earth's features?



How can we protect against natural disasters?



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Tiered Vocabulary List

Tier 1	Tier 2	Tier 3
Color	Hardness	Sedimentary
Soil	Streak	Igneous
Clay	Texture	Metamorphic
Loam	Decomposition	Mineral
Sand	Decaying	Crystal
Continents	Landforms	Luster
	Particles	Cleavage
	Scale	Frost wedging
	Boundaries	Tree root wedging
	Prehistoric	Weathering
	Earthquake	Trenches
	Fossil	Compass Rose

	Erosion Flood Redirect Contain Withstand Barrier	Fault Lines Tectonic Plates Organic Inorganic Jurassic Abrasion Legend Prevention Extinction

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Science Content Background

Please read through the explanation provided in the next few pages and jot down questions or uncertainties. Consult internet resources to answer your questions, ask colleagues, and work together as a team to grow your own understanding of the science content and the central phenomena in this unit. This knowledge primes you to better listen and respond to student ideas in productive ways. Please feel free to revisit this explanation throughout the unit to revise and improve your own understanding of the science content.

Essential Questions

1. ***What can rocks tell us about the past?***
   Rocks are an essential gateway into the past for scientists. They contain information such as the dates of the rock and the types of organisms that may be living around or inside of them (preserved as fossils). The Earth's crust layers can tell us about the different time periods that organisms lived in and the types of activity that occurred.

2. ***How can we protect against natural disasters?***
   There are many ways that living organisms help protect against natural disasters. First, we must determine how natural disasters occur to construct plans for protecting living organisms. There are many protection methods against disasters such as barriers, fallout plans, and shelters. However, the protection method you implement depends on the type of disaster.

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3. ***How can maps model Earth's features?***
   There are many types of maps such as topographic maps, physical maps, political maps, etc. Each type of map focuses on different aspects of the Earth's surface to model different features. In this unit, students will primarily use physical maps which show the physical features of the Earth. Students will learn to identify Earth's features on the map and how features can be represented in several different ways. In addition, students will learn that since maps are representations of the world, they are not able to represent everything. For this reason, mapmakers utilize symbols to indicate Earth's features.

Rationale for Order of Content

Since this unit focuses on the Earth's surface, we begin this unit with a review of the mapping aspects found in the second-grade unit, Land and Water. Similar to the second-grade unit, mapping will serve as a tool to help students learn about the Earth's features. From a variety of maps such as topographical maps, students will see how Earth's surface is composed of many components such as landforms. Once the students gain an understanding of the Earth's surface features, students will learn about the fundamental building blocks of the Earth's surface, minerals and rocks.

The GeoSquad, a group of animated rocks, will guide students through Mohs' Hardness Scale and the study of rocks and minerals. By learning about the formation of different types of rocks, students will learn how landforms they saw in the first lesson, *What is a Physical Map?*, were created. Furthermore, with this knowledge, specifically about sedimentary rocks, students will develop their understanding that the planet's surface is shaped over time by natural forces. Then, in the third lesson, *What is Erosion?*, students will learn about erosion as they discover the ways rocks and minerals are broken down. This lesson will expand upon students' understanding of how natural forces such as weathering shape Earth's surface. Besides this, erosion will teach students that rocks vary with age, so students can correct any misconception that rocks are all the same age.

In this way, students will learn that the Earth's crust is composed of multiple layers and the topmost layers are newer in comparison to the bottom layers. This idea, along with the process of creating Earth's layers, will be covered in lesson four. In this lesson, students will apply knowledge of erosion to learn how rocks and minerals are broken down to create soil.

In the second half of this unit, the anchoring phenomenon involving fossils and dinosaurs, will be more obvious to students. In the fifth lesson, students will learn about fossils in more depth. Since students learned about soil components in the fourth lesson, they will use this knowledge to learn how sometimes the decaying organic matter in soil is compressed under layers of soil, turning them into stone or fossils. This lesson will also connect back to the dinosaur anchoring phenomenon because dinosaur fossils were also created in this way. From this lesson, students will understand why archaeologists must dig deep to find dinosaur fossils, since it takes years of erosion to create the layers of soil to bury the dinosaur carcasses and turn them into stone. Next, students will learn about the outer layer of the Earth's surface, the crust, in the sixth lesson. Specifically, students will be taught that the crust is composed of tectonic plates that are constantly moving.

Due to the movement of tectonic plates, natural disasters such as earthquakes and volcanic eruptions occur. Based on this information about tectonic plates, students will be able to conclude that the plate movements that create volcanoes could have caused the dinosaurs' extinction. In addition to natural disasters, students will use their knowledge of metamorphic rock formation to learn how landforms such as mountains were formed in this lesson. Finally, students will cover several ways to lessen the effects of natural disasters. In the last lesson, students will learn that solutions for natural disasters vary depending on the type of natural disaster. For instance, flood chutes can contain flood waters, but they cannot contain the damage caused by earthquakes.

Anchoring Phenomenon

The lessons in this unit, especially the last three, are tied together by the story of dinosaurs and the mystery of their extinction. In lessons 3 and 5, the students learn about how dinosaurs' remains form fossils. In lesson 6, the students are introduced to disasters such as volcanoes and earthquakes and the disasters' possible role in wiping out the dinosaurs. In lesson 7, they will be presented with evidence of the dinosaurs' extinction and have the opportunity to debate possible theories.

There are still some mysteries surrounding the extinction of the dinosaurs, but for this unit, we chose the most widely agreed-on theory as the answer to the anchoring phenomenon. We know that near the end of the Mesozoic period, volcanoes in the Deccan Traps started exploding. Consequently, the air was filled with ash and greenhouse gases. Then, many dinosaurs began to go extinct, causing the number of dinosaur species to decline. A quarter million years later, a 6-mile wide asteroid slammed into the Yucatan peninsula, forming the Chicxulub Crater. It created 300-foot-wide tsunami waves and 10.0-magnitude earthquakes across the Gulf of Mexico, covering the area in rocks. The explosion created an enormous cloud of dust that enveloped the earth. The dust then cooled into pieces of burning glass that rained down from the sky and heated up the atmosphere, causing forests to burst into flame. The ripples the asteroid sent through the Earth may have even pushed magma to the surface and caused volcanoes to explode even faster for the next 500,000 years.

The smoke from the Deccan volcanoes, the asteroid, and the burning forests blackened the world's skies for years, throwing the planet into twilight. Without the Sun's rays shining on the earth, plants died off and the world's temperature dropped dramatically. By the time the ash cleared up, the atmosphere was filled with greenhouse gases, causing the Earth to experience dramatic climate change due to global warming. All these natural disasters were more than enough to kill off large animals on land and sea, but small animals like birds, reptiles, and mammals managed to survive.

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Key Science Ideas

- Mapping has 4 components: title, key, compass rose, scale.
- There are a variety of maps such as topographical maps, physical maps, etc.
- The physical properties of minerals include hardness, color, luster, cleavage, and streak.
- Rocks can be composed of one or many minerals.
- **Mohs' Hardness Scale** can be used to identify different minerals.
- Soil is the upper layer of the Earth's surface and it has **five** components: **I**norganic matter, **M**icroorganisms, **O**rganic matter, **W**ater and **A**ir (IMOWA).
- Some **inorganic matter** comes from natural processes such as weathering, and others such as coins and bottles come from pollution created by humans.
- **Microorganisms** are small living beings that live in the soil.
- **Organic matter** represents living beings, dead animals, and plants and matter coming from living organisms.
- **Water** and **air** are found in the space between soil particles.
- **Decomposition** is a biological and physical breakdown of organic matter such as leaves, dead animals, and plants into simpler organic matter.
- Soil is formed through the process of **erosion** and **weathering**.
- **Erosion** is a geological process through which rocks are worn away and carried to another location by natural forces such as **wind** and **water**.
- **Weathering** is a process by which rocks break down into smaller pieces.
- There are **three** types of weathering: **physical** weathering, **biological** weathering, and **chemical** weathering.
- All soils are not the same because they have different **colors**, **texture,** and **water retention capacities**.
- There are three different forms of fossils in this unit: **body fossils, trace fossils, and mold fossils.**

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- Fossils are found in **sedimentary** rock. This is because sedimentary rock is the softest form of rock; it allows the fossil to sit in the rock and harden over many years without being crushed by the weight.
- **Erosion** is a major reason that fossils can form and that we are able to discover them. **Water** is fundamental to fossils forming, as it seeps into the fossil and helps turn it to stone over millions of years.
- The outermost layer of the Earth is called the **crust,** and the crust is broken into pieces called **tectonic plates**.
- **Earthquakes** occur when two tectonic plates collide or slide against each other, and energy is released.
- When two plates collide and the land shifts upward, **mountains** are created.
- When plates collide, and a piece of an oceanic plate breaks off, magma rises to the surface and hardens, creating a **volcano**.

Explanation

Minerals and Rocks

- A mineral is an inorganic solid with a definite chemical composition and a crystalline structure formed by geological and naturally occurring processes. A rock is a combination of one or more minerals. They may also include organic remains and mineraloids while others are predominantly composed of just one mineral. There are three types of rocks: igneous, metamorphic, and sedimentary. Sedimentary rocks are formed from particles called sediment, which includes sand, shells, pebbles, and other fragments of material. The sediment accumulates in layers and over a long period of time hardens into rock. Sedimentary rock is typically soft and may break apart/crumble easily. Sedimentary rocks are usually the only type that contains fossils. Metamorphic rocks are formed under the surface of the Earth from the change that occurs due to intense heat and pressure. Igneous rocks are formed when magma cools and hardens.

The Mohs Hardness Scale

- The Mohs Hardness Test is used to identify a mineral type. This test compares the resistance of a mineral to being scratched by ten reference minerals known as the Mohs Hardness Scale. The test is useful because most specimens of a given mineral are very close to the same hardness, which makes hardness a reliable diagnostic property. The scale goes from 1-10, with 1 being the softest mineral. The scale is as follows: Talc, gypsum, calcite, fluorite, apatite, orthoclase, quartz, topaz, corundum, diamond.

Soil, Erosion and Weathering

- **Soil Formation**: Soil is formed through the process of **erosion** and **weathering. Erosion** is a geological process through which rocks are worn away and carried to another location by natural forces such as wind and water. Erosion can also carry soil and sediments. **Weathering** is a geological process by which rocks break down into smaller pieces. The difference between weathering and erosion is that erosion involves displacement. There are three different types of weathering:
    - ➢ **Physical or Mechanical weathering** is due to physical forces acting on rocks. **Sometimes rainwater will soak into rock and then freeze,** expanding as it does. With enough cycles of freezing and melting, the water will create large cracks in the rock and cause pieces to break off. It also occurs when moving water rubs rocks against each other, also causing tiny pieces to break off. The rubbing the rocks experience is very gentle and slow-paced, however, so they often look more like they've been sanded down than broken apart.
    - ➢ **Biological weathering** is due to the presence of living organisms such as plants, bacteria and animals. For example, trees are always sending out roots to find nutrients and increase their hold on the ground; sometimes those roots can even pass over bare rock. If the roots do end up finding soil after stretching over a rock, they will grow thicker and thicker, eventually squeezing the rock like a boa constrictor. Under that pressure the rock will

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crack.

- ➢ **Chemical weathering** is due to chemical processes such as oxidation and acidification. For example, **water can dissolve certain types of soft rock**. In caves, water will drip from the ceiling, bringing with it pieces of dissolved rock. Over time these residual pieces of rock add up and form stalactites on the ceiling and stalagmites on the floor.

- **Erosion** is mainly due to wind and water. In liquid form, **water** can carry away pieces of rock while moving in a river, flood, or wave. In solid form, water moves dirt and rock as a glacier. **Glaciers are large sheets of ice** that flow down mountainsides in the same manner as rivers, only much more slowly. Glaciers are often a great deal larger than rivers, and as a result they can carve out huge pieces of rock and large quantities of gravel from the mountains they roll over. Consequently, in the process, glaciers decrease the mountains' height and carve out large valleys. Berkshire valley is one of the greatest examples of glacial erosion. The entire valley was carved by glaciers. Balance Rock in the Berkshires is a piece of a mountain that was left behind by a melted glacier.
- **Wind** often plays an important role in the landscapes of dry areas. **Winds carry large quantities of sand and dust for thousands of kilometers.** Sometimes the winds can blow away fertile soil, making the area drier and harder to farm. The sands that winds carry can blast against rocks as they travel in the air, scarring their surfaces with lines and wearing them away.
- **Soil** is formed when rocks break down through the process of weathering and the smaller rock pieces are carried away by air, wind, and gravity and accumulate in a region. Also, when rocks break down, they release minerals which make the soil rich. Then, the soil accumulates air and water which then leads to the development of microorganisms, plants and animals. When some of the living beings die, they are decomposed and turned into simpler organic matter that enriches the soil. To note: this process of soil formation takes a very long time to occur.

Components of Soil

- Soil is the upper layer of the Earth's surface, made up of five different elements: **I**norganic, **M**icroorganisms, **O**rganic, **W**ater and **A**ir (**IMOWA**). Generally, "ideal" soil is made up of 45% inorganic matter, 25% air, 25% water and 5% of organic matter and microorganisms.
- **Inorganic matter** is a soil element that does not come from any living matter. This is usually the product of rock weathering and often referred to as dirt. Some inorganic materials include sand, clay, silt and loam. Sand particles have a diameter size between 0.05 to 2 mm, clay has particles whose diameter size is between 0.002 and 0.05 mm and finally silt particles have a diameter size less than 0.002 mm. Loam is a mixture of sand, clay and silt. Usually, loam contains an equal proportion of sand and silt and a small quantity of clay. Additionally, there are some other types of inorganic materials that do not originate from natural processes. These materials include coins, bottles, plastic bags. They find their way into the soil due to pollution by humans, which ultimately can harm the soil.
- **Microorganisms** are extremely small living organisms that can be very hard to see with the naked eye. Soil is their habitat and some of the microorganisms contribute to the process of **decomposition,** which is a biological and physical breakdown of organic matter such as leaves, dead animals and plants into simpler organic matter.
- **Organic matter** is made up of elements that are living organisms or come from living organisms. Organic matter includes plants, dead animals at various stages of decompositions, and microorganisms.
- **Water** and **Air** are the remaining components of soil and they are necessary for the survival of living organisms. They are found in the space between soil particles.
- All soils are not the same and these differences can be explained by the soil composition. We can see the differences between soils by looking at their **texture**, **color** and **water retention capacity**.
- **Texture and Water retention capacity:** Soil texture depends on the size of the particles that make up the soil. The size of the particles also affects the ability of the soil to retain water. For instance, since sand has large particles that cannot be packed together perfectly, water moves very easily between the gaps. Clay has very fine particles packed together

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which makes it hard for water to move, hence clay retains water very well.

- **Color:** The color of the soil depends on the proportion of its five constituents. For instance, a black-colored soil indicates a high content in organic matter whereas a yellow or red soil indicates a high content in iron or oxidized materials.
- Soil is important because it is a **habitat** for several animals, plants and microorganisms, a **storage** of nutrients for living beings, and an **anchor** for plants.

Fossils

- Fossils take millions of years to form. There are a few factors that must be present to make a fossil. First, the organism must be buried quickly after death. Some of the most common places to find fossils are riverbeds or ocean floors because the movement of the water helps bury the organism in the bottom of its depths where the fossilization process can begin; fossils are largely found in sedimentary rock. Once underground the fossil takes in water and minerals from the Earth, slowly replacing the tissue of the organism with minerals. Again, this takes a very long time to happen. Compression from the weight of the ground above helps this process. Erosion is a large part of why fossils exist as well as why they are found. If it weren't for erosion, fossils wouldn't have been buried to become what they are, and they wouldn't have been unburied to be discovered by human beings.
- There are diverse types of existing fossils in the world. For this unit we will specifically focusing on three main versions: body fossils, trace fossils, and mold fossils. These are the types of fossils archeologists work with the most in their profession.
  - ➢ ***Body fossils*** are the remains of a dead animal or plant and are the most common found fossils in the world. These are dinosaur bones, petrified trunks, shells, etc. During the process of fossilization hard tissue such as bone and bark are far more likely to become fossils because of the nature of their makeup. Soft tissue tends to wear away; whether that be from erosion, water, wind, or other organisms such as fungi or algae that eat them. Organisms that do not wear away must then be buried in sediment. Crustaceans and shells that live on the ocean floor are

much more readily fossilized because they are already in a sediment.

- ➢ ***Trace fossils*** are structures preserved in sediment that represents the organism's biological anatomy. These are things like footprints or burrows. A seashell rolling along the ocean floor is not an example of a trace fossil because it tells nothing of the organism's anatomy. The bodily structure and function of the animal is the key aspect of a trace fossil. They are very seldom found with a body fossil, and they are hard to match back to an animal, therefore they are classified by the activity they are performing rather than the animal they refer to.
- ➢ ***Mold fossils*** are exactly what they sound like, a mold of an organism. This means that a lifeform had been lying in the sediment long enough for the surrounding rock to harden, leaving an impression of the organism, and the organism wears away, leaving only the mold of its body. Examples include impressions of shells or leaves imprinted on a rock.

- Here is a link to more information about these as well as other types of fossils:

http://www.fossilmuseum.net/fossilrecord/fossilization/fossilization.htm

Earthquakes, Fault lines, and Volcanoes

- To begin, teachers must understand that the Earth is made of many layers, the outermost layer of which is called the **crust**. The crust is broken up into pieces that are called **tectonic plates.** This lesson covers two types of boundaries that occur when tectonic plates interact with each other. These boundaries are called transform boundaries and convergent boundaries. A **transform boundary** occurs when two tectonic plates rub together. As the pressure builds between the plates, they slip releasing the energy that we perceive as an **earthquake.** A **convergent boundary** occurs when two tectonic plates collide with each other. As the two plates collide they form **mountains** between them as the land shifts upward. This lesson also covers the creation of volcanoes which occurs at a **subduction zone.** A subduction zone occurs when a denser oceanic plate is thrust underneath a less dense continental plate. A piece of the oceanic plate breaks off and melts allowing for magma to come to the surface. This magma hardens and forms what we know as a **volcano.**

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Protecting Against Disasters

- Natural disasters are any Earth processes that harm and destroy living creatures and the things they need to survive. Natural disasters can happen very slowly, such as major droughts, or very quickly, such as earthquakes. The priority in dealing with natural disasters is **to find out whether we can prevent them from happening**.
- The key to preventing disasters is to figure out what makes them happen. For example, floods occur when there is more water in an area than the ground can absorb. We can sometimes prevent the ground from being overloaded with water by growing plants or setting up rain catchers or flood chutes.
- Humans can't prevent *every* flood from happening, and there are some types of natural disasters we can't prevent at all. Some disasters like, earthquakes, and volcanic eruptions will happen no matter what humans do. That's **why it's useful to be able to figure out when natural disasters are most like to happen,** so that we can start moving people and valuable objects out of harm's way while we still have enough time. Of course, **no one can fully predict natural disasters; just like a weather forecast, the best we can do is figure out when there is a good chance that a natural disaster will happen.**
- Meteorologists can oftentimes forecast blizzards, hurricanes and tornadoes and figure out the paths they are going to take once they form. Volcanologists, who study volcanoes, also have tools at their disposal. Eruptions often start when magma is released from deep within the Earth by shifting plates. These plates also set off small earthquakes. By listening carefully to these earthquakes, volcanologists sometimes realize that it sounds like enough magma has risen to trigger an eruption. The bubbling magma also releases gases such as carbon dioxide and sulfur dioxide that are different from the gases that the volcano releases when it isn't going to erupt. By measuring these gases, volcanologists can tell when a volcano's magma is rising. Lastly, as volcanoes fill up with gas and magma they often start to bulge a bit like an inflating balloon. By placing sensors on the volcano, volcanologists can measure this bulge.
- Volcanologists saw warning signs like these on Mt. Pinatubo and Mt. St. Helens weeks before they erupted, and both

times warned people in the surrounding areas to evacuate. Some estimate that these evacuations saved tens of thousands of lives.

- By far, earthquakes are the worst understood and the hardest to predict of Earth-based natural disasters. The best we can do is look at the history of certain fault lines to see if the earthquakes in that area follow a pattern. Seismologists (earthquake scientists) are also able to calculate if a fault is "wound up" enough to trigger a big earthquake, but that only tells us that an earthquake *could* happen, not that it will happen.
- Lastly, there are cases where we can't prevent or predict natural disasters or might not be able to move everyone and everything to safety. In that case, **we can either redirect the disaster, contain it, or withstand it.**
- The flood chutes in North Adams **redirect** flood waters in the Hoosic River from spilling onto the streets in the town. Redirecting lava flows is complicated and dangerous, but it has been done, especially on slow-moving lava. In 1982, people redirected the lava coming out of Mt. Etna, in Sicily, by building huge Earth walls with bulldozers as the lava came in. They even carved out channels from the thicker (but still very hot!) lava and deepened them by setting off explosives inside them.
- Reservoirs can **contain** floodwaters by trapping them, so they don't get to sensitive areas. The city of Houston has large, low-lying areas filled with trees and grass that are dry most of the time, but fill up with water during floods. In 1971 in Iceland, people were even able to contain lava by constantly spraying it with cold seawater. The lava hardened into a thick wall that kept the newer, molten lava behind it from coming any closer.
- Lastly, we can build the structures we want to protect so that they can **withstand** disasters. Dikes and seawalls withstand storms and floods and protect everything behind them. People who live in earthquake-prone areas can firmly attach heavy objects of furniture in their homes to the walls and ground, so they won't tip over; they can also reinforce the walls of their houses with plastic mesh, bamboo, and shatter-proof glass windows so they are harder to break.

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Sometimes the best way to withstand an earthquake is not to stay still but to go with the flow; the most modern earthquake-resistant skyscrapers are built on springs and ball bearings so that they sway with an earthquake, instead of getting torn apart by the shaking.

Mapping

- In this lesson, students will review map features and how to read a map. In the later lessons of this unit, maps will be used to communicate information about the placement of fossils on the Earth's surface. In addition, students will use maps as tools to learn how the placement of tectonic plates can predict natural disasters, such as in the ring of fire. Therefore, to learn about natural disasters and fossils, students must first learn about map reading. Although mapping is not integral to the science taught in this lesson, it is a tool and model used for learning. Thus, teachers need to teach mapping as another method for learning.

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Lesson 1: What is a Physical Map?

LESSON BACKGROUND

In this lesson, students will review map features and how to read a map. In the later lessons, maps will be used to communicate information about the placement of fossils on the Earth's surface. In addition, students will use maps as tools to learn about the placement of tectonic plates and how that can cause natural disasters. To learn about natural disasters and fossils, students must first learn about map reading. Although mapping is not integral to the science taught in this lesson, it is a tool and model used for learning. Thus, teachers need to teach mapping as another method for learning.

Science Content Background

Since maps are essential in this unit, teachers should understand the different types of maps. Specifically, physical maps and topographic maps. Unlike political maps which depict state boundaries, physical maps depict landforms such as mountains and deserts. Similarly, topographic maps show landforms and ocean bodies. However, unlike physical maps which show landforms as flat, topographic maps use relief to show the elevations of the land. For instance, mountain ranges on topographic maps are shown with concentric lines that show the elevation gain. Furthermore, teachers should understand that since maps are representations of the land, they only focus on certain aspects of the land. To help make reading a map easier, symbols are also used. For this reason, teachers need to keep in mind that maps do not show everything in an area.

Overview of the Lesson

Students will review map features and landforms by looking at a variety of maps and doing a treasure hunt. Then, they will investigate distinct types of maps to note similarities and differences between the maps. Students will also use Google Earth to explore online mapping options. Finally, for their Daily Planet Earth Newspaper, students will create a physical map of Massachusetts.

Focus and Spiral Standard(s)

Focus Standard: 4-ESS2-2. Analyze and interpret maps of Earth's mountain ranges, deep ocean trenches, volcanoes, and earthquake epicenters to describe patterns of these features and their locations relative to boundaries between continents and oceans.

Spiral Standard: 2-ESS2-2. Map the shapes and types of landforms and bodies of water in an area.
Clarification Statements:

- Examples of types of landforms can include hills, valleys, river banks, and dunes.
- Examples of water bodies can include streams, ponds, bays, and rivers.
- Quantitative scaling in models or contour mapping is not expected.

Spiral Standard: 6.MS-ESS2-3. Analyze and interpret maps showing the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence that Earth's plates have moved great distances, collided, and spread apart.
Clarification Statement:

- Maps may show similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches), similar to Wegener's visuals.

State Assessment Boundary:

- Mechanisms for plate motion or paleomagnetic anomalies in oceanic and continental crust are not expected in state assessment.

Spiral Standard: 7.MS-ESS2-2. Construct an explanation based on evidence for how Earth's surface has changed over scales that range from local to global size.
Clarification Statements:

- Examples of processes occurring over large spatial scales include plate motion, formation of mountains and ocean basins, and ice ages.
- Examples of changes occurring over small, local spatial scales include earthquakes and seasoning weathering and erosion.

Spiral Standard: 8.MS-ESS2-1. Use a model to illustrate that energy from Earth's interior drives convections that cycles Earth's crust, leading to melting, crystallization, weathering, and deformation of large rock formations, including generation of ocean seafloor at ridges, submergence of ocean sea floor at trenches, mountain building, and active volcanic chains.
Clarification Statement:

- The emphasis is on large-scale cycling resulting from plate tectonics.

W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
SP 2: Developing and using models SP 4: Analyzing and interpreting data	**ESS2.B: Plate Tectonics and Large-Scale System Interactions** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and	**Patterns:** Patterns can be used as evidence to support an explanation. (4-ESS2-2)

	volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)	

Learning Targets
I can identify a physical map and its components.
I can read maps that depict mountain ranges, trenches, active volcanoes, and earthquakes.

Assessment
Students will create a physical map of Massachusetts for their Daily Planet Earth Newspaper.

WIDA Language Objectives
(Dependent on the needs of your ELL students)

Targeted Academic Language/ Key Vocabulary
Tier 1: Continents
Tier 2: Scale, Boundaries
Tier 3: Legend, Trenches, Compass rose

RESOURCES AND MATERIALS

Quantity	Item	Source
1 map	**Political map**	**Bin**
1 map	**Road map**	**Bin**
1 map	**Attraction map**	**Bin**
1 map	**Topographical map**	**Bin**
1 map	**Physical map**	**Bin**
1 map	**Weather map**	**Bin**
1 per student	Laptop/iPad	Classroom Teacher
1 per student	Map Features Worksheet	CMC Website
1 per student	Google Earth Worksheet	CMC Website
1 per student	Blank Template of Massachusetts	CMC Website

****Items in bold should be returned for use next year****

LESSON DETAILS

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Lesson Opening/ Activator

1. **Types of Maps:** Before the students come into the classroom, display the different types of maps available on tables around the classroom. Then, ask the students to go around the room to note the similarities and differences between maps. Next, have the students return to their seats for a class discussion. They should recognize that not all maps are the same. Different maps are needed to represent different things. Ask the students to determine what is unique about each map and what makes some of the maps similar. The teacher should write these similarities and differences on the board. Also, ask the students to look for patterns on the maps. **(SP 4: Analyzing and interpreting data)**

2. **Treasure Hunt:** The teachers should be sure to hide the "treasure" before the start of this activity. The teacher can decide what to hide as "treasure". Then take the students outside and split them up into groups of three or four. The number of students in your class will determine the number of treasures you must hide. Teachers should search create a simple map of the playground/ outdoor area the students will be exploring for this activity. The students will then be given maps and told that there is treasure on the playground that they must find using the map. Give them 10-15 minutes to try and achieve this task. Ask the students to count their paces as they go from location to location on the playground, with someone recording the numbers as they go; this will give students a grasp of scale when it is discussed. This is a great formative assessment to see if the students remember how to read a map from their second-grade mapping skills. If the teacher deems it necessary, assign roles to students for the activity: have someone direct the group based on the map, someone can be the digger for the treasure, someone can count out paces, etc. The teacher or science fellow may help if the students are having difficulty reading the map. **(SP 2: Developing and using models)**

During the Lesson

1. **Map Features Review:** Students will review the features of a map using the "map features" worksheet. The features are key, title, scale, and compass. Each picture contains a map feature highlighted in a red box. Students need to match the highlighted feature with the appropriate word. To note: students did not learn about scale in second grade. Therefore, the teacher or science fellow should use the treasure hunt to explain the concept of scale.

2. Now, ask the students how they measured the distances between locations on their treasure maps. The answer should be the number of paces they took. Tell the students that the number of paces they recorded on the treasure hunt is the scale used on the treasure map. Scale allows individuals to measure the distance between two locations. Then, ask a few groups of students to share the number of paces they wrote down on their maps. When students notice that the number of paces varied with each group, ask them why they think this is. Be sure to explain how real maps measure scale in meters or other units for the sake of accuracy and consistency.

3. **Landform Review:** Tell the students that a map can represent various components of the world; some of these components include landforms. Since students studied landforms in grade 2, the teacher should be sure to review the various types of landforms. The teacher can ask students about any types of landforms they remember and some of their characteristics. Then, watch the video "What are Landforms?" After the students watch the video, the teacher can ask the students to complete the list on the board, using the information provided in the video. Here is a link to the video:
    a. https://www.youtube.com/watch?v=v48SV4zU9Ak The video can be stopped at 2:00 since the rest of it is a quiz.

4. **Physical Map Investigation**
    a. Present a flat map and a topographical map to the students

b. Ask them to respond to the question "What do both maps have in common (landforms, bodies of water)?
c. Then, divide the students into groups and let the groups observe the two maps and note the differences between them. Ask them to record their findings in their science journals by making a Venn diagram.
d. Then, gather the students and ask them to share their findings with the class. The teacher should make a giant Venn diagram on the board so that students can see the differences and similarities between the maps.

5. **Online Maps**: Give each student a device and have them explore Google Earth so they can look at pictures of the Earth, starting in North Adams, then have them complete the Google Earth worksheet.

6. For this lesson, students will create a physical map of Massachusetts. A blank template of Massachusetts will be provided for the classroom teacher to copy and hand out to students. **(SP 2: Developing and using models)**
    a. There are several items that a basic map includes. Talk to the students about what a map has, including a title, a legend, a compass rose, boundaries, color, labels etc. All these items should be included in the maps the students create.

    b. Students should create a legend for their maps. The legend may include colors and shapes. For example, the Appalachian Mountains run through the western part of Massachusetts. The students may want to draw a triangle to indicate a mountain in their legend. Then, draw a few triangles along the left side of Massachusetts to represent the mountain range. The students may opt to draw a triangle that is a different color and size then the rest to represent Mt. Greylock, the tallest mountain in Massachusetts. On the right side of Massachusetts, the students may want to color the border blue to represent the Atlantic Ocean.

Student Thinking Alert
Students might think physical maps are maps people can physically hold. However, it is actually a map which depicts landforms of an area such as deserts, mountains, plains, etc.

Assessment
Students will create a physical map of Massachusetts.

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Lesson 2: Mohs' Hardness Scale

LESSON BACKGROUND

This lesson is meant to be an introduction to the composition of the Earth's surface. The topics introduced in this lesson include minerals, rocks, and the Mohs Hardness Scale. This lesson is meant to lay the foundation for the topics of erosion and weathering, which are important to understand how the Earth's surface changes.

Science Content Background

Minerals and Rocks

A mineral is an inorganic solid with a definite chemical composition and a crystalline structure formed by geological and naturally occurring processes. A rock is a combination of one or more minerals but may also include organic remains and mineraloids. Some rocks are predominantly composed of just one mineral. There are three types of rocks: igneous, metamorphic, and sedimentary. Sedimentary rocks are formed from particles called sediment, which include sand, shells, pebbles, and other fragments of material. The sediment accumulates in layers and over a long period of time solidifies into rock. Sedimentary rock is typically soft and may break apart/crumble easily. Sedimentary rocks are usually the only type that contains fossils. Metamorphic rocks are formed under the surface of the Earth from the change (metamorphosis) that occurs due to intense heat and pressure. The rocks that result from these processes may have shiny crystals, formed by minerals growing slowly over time. Igneous rocks are formed when magma cools and hardens. Magma is composed of molten rock and is stored in the Earth's crust. Lava is magma that reaches the surface of our planet through a volcano vent. When lava cools very quickly, no crystals form and the rock looks shiny and glasslike. Sometimes gas bubbles are trapped in the rock, leaving the appearance of tiny holes/spaces in the rock.

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The Mohs Hardness Scale

The Mohs Hardness Test is used to identify a mineral. The test is useful because most specimens of a given mineral are very close to the same hardness, which makes hardness a reliable diagnostic property. The scale goes from 1-10, with 1 being the softest mineral (talc). From softest to hardest, the scale is as follows: Talc, gypsum, calcite, fluorite, apatite, orthoclase, quartz, topaz, corundum, diamond.

Overview of the Lesson

Students will use the Mohs Hardness Scale to perform tests on a collection of minerals. The teacher should carefully read over the lesson before teaching this lesson in order to gain a better understanding of the concepts they will need to explain to the students. Students will be creating a chart about the mystery minerals and design an ad for their Daily Planet Earth Newspaper project.

Focus and Spiral Standards

Focus Standard: 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Clarification Statement:

- Examples of evidence from patterns could include rock layers with marine 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.

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State 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.

Spiral Standard: 3-LS4-1. Use fossils to describe types of organisms and their environments that existed long ago and compare those to living organisms and their environments. Recognize that most kinds of plants and animals that once lived on Earth are no longer found anywhere.

Clarification Statement:

- Comparisons should focus on physical or observable features.

State Assessment Boundary:

- Identification of specific fossils or specific present-day plants and animals, dynamic processes, or genetics are not expected in state assessment.

Spiral Standard: 6-MS-ESS1-4. Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations that result from processes occurring over long periods of time.

Clarification Statements:

- Analysis includes laws of superposition and crosscutting relationships limited to minor displacement faults that offset layers.
- Processes that occur over long periods of time include changes in rock types through weathering, erosion, heat, and pressure.

State Assessment Boundary:

- Strata sequences that have been reordered or overturned, names of specific periods or epochs and events within them, or the identification and naming of minerals or rock types are not expected in state assessment.

Spiral Standard: 6-MS-ESS2-3. Analyze and interpret maps showing the distribution of fossils and rocks, continental shapes,

and seafloor structures to provide evidence that Earth's plates have moved great distances, collided, and spread apart.
Clarification Statement:

- Maps may show similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and wedges), similar to Wegener's visuals.
- State Assessment Boundary: Mechanisms for plate motion or paleomagnetic anomalies in oceanic and continental crust are not expected in state assessment.

Learning Targets

I can perform appropriate tests to determine the hardness, color, luster, cleavage, and streak of different minerals.
I can note differences between rocks and minerals.
I can use previously recorded data to identify different minerals.

Assessments

- Students will create a chart of their observations of different minerals.
- Students will use a list of characteristics given to them to identify the mystery minerals quartz and limestone.
- As part of the portfolio newspaper project, students will become an expert on one of the minerals they observed and create an advertisement for this mineral.

Targeted Academic Vocabulary

Tier 1: color
Tier 2: organic, hardness, streak
Tier 3: mineral, crystal, luster, cleavage, igneous rocks, sedimentary rocks, metamorphic rocks

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RESOURCES AND MATERIALS

Quantity	Item	Source
1 per student	**Hand Lens**	**Bin**
5 White and 5 Black plates (1 per group)	**Streak plates**	**Bin**
5 per group	**Penny**	**Bin**
5 per group	**Nail**	**Bin**
1 box per class	**Mineral Kit - Includes 15 mineral samples**	**Bin**
1 per pair/group	**Limestone sample**	**Bin**
1 per pair/group	**Quartz sample**	**Bin**
1 per student	Science Journal	Classroom Teacher
	Rock Cleavage Video https://www.youtube.com/watch?v=zAOTfSWjw0Q&list=PLsAWD8mKKE95eF864ryLNK8SXJfJ-EsWh&index=1	CMC Website

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1 piece	Chart Paper	Classroom Teacher
1	**“How to Describe Luster” Board**	**Bin**
1 per student	Rocks and Minerals Comparison Chart	Binder
1 per student	Mineral Observation Chart	Binder
1 per student	MCAS question	Binder
1	Minerals and Rocks PowerPoint	CMC Website
1 per student	GeoSquad Comic	Binder
1 per student	Daily Planet Earth Mineral Advertisement Template	CMC Website

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/Activator

1. The Earth is made up of many different types of minerals; some are more common than others. Today, we’re going to go on a mystery mineral hunt to learn more about what minerals are and how to identify them. Be sure to explain the difference between rocks and minerals. Rocks are groups of different minerals that form together. Therefore, minerals make up rocks.
2. Present the Minerals and Rocks PowerPoint and then show the Mighty Minerals Animation (included in the PowerPoint). This is meant to be an introduction to the GeoSquad characters: Izzy, Maggie, and Spencer. Then, show the GeoSquad comic to students (this is also included in the PowerPoint) have the students follow along. **Note:** The teacher

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will need to make copies of the GeoSquad comic so that the students can read along.

3. Below is a chart that compares minerals and rocks. The classroom teacher should make copies of this to hand out to students to paste in their science journals.

During the Lesson

1. **Physical Properties of Minerals:** Below are the physical properties of a mineral:
    a. Describe the following terms, while using part 2 of the PowerPoint as a visual.
    b. **Color** is simply what color the mineral is. Students will identify this through observation.
    c. **Luster** is how shiny or dull something is and can be classified using those words. Luster can also be described as pearly, greasy/oily, earthy/dull, or waxy. Students test luster by observing the rocks and describing the way it appears in the light. Examples of luster are provided on the board that says "How to Describe Luster" which is included in the bin.
    d. **Cleavage** is how the mineral breaks into pieces. Some minerals break up into chunks or small cubes while others break up into small thin sheets. Cleavage can be observed by looking at the number of flat/curved sides on a mineral and the angle between them. Be sure to take time to explain this concept, it might be helpful to show the following video https://www.youtube.com/watch?v=zAOTfSWjw0Q&list=PLsAWD8mKKE95eF864ryLNK8SXJfJ-EsWh&index=1
    e. **Streak** is the color of powder when dragged across a non-weathered surface. In this test, students scrape the mineral across a black streak plate and a white streak plate to see if any color is left on the plate. For example, when we write with a pencil, we're creating a streak from the graphite.
2. **Describing Minerals:** Before the hands-on activity, the teacher should talk to the students about each method of describing a mineral. Use examples or explain that hardness is the ability to scratch the surface of the mineral.
    a. Hardness can be tested with your fingernail, a penny, and a steel nail.
    b. If the fingernail can scratch it, that means it has a hardness less than 2.
    c. If you can scratch the mineral with a penny but not a fingernail it's most likely a 3.
    d. If you can scratch it with a steel nail but not a penny it most likely will be between 3 and 5.
3. **Mohs Hardness Scale:** Talk about the Mohs Hardness Scale and how to read the scale. The Mohs Hardness Scale was

developed to compare the hardness of certain minerals. The scale goes from 1 to 10 where 1 is the softest mineral (or very easy to scratch) and 10 is the hardest (or very difficult to scratch). An example of a 1 would be graphite. An example of a 9 and 10 would be rubies and diamonds. Understanding the hardness of a mineral is important because it helps people determine what that mineral could be used for whether it be jewelry, carving, storage, etc. It's also very helpful when identifying minerals.

   a. Use the sample MCAS question to show students how they should interpret the Mohs Scale. Note: Memorizing the numbers and minerals is not important, rather the kids should understand how to interpret the scale and what the numbers mean.
      i. The correct answer is **A.** apatite because it is between the fluorite (4) and quartz (7). If the mineral scratches fluorite than it is at least a 4 or higher. If it does not scratch quartz than it cannot be above a 7. The only mineral from the list of options that is between 4 and 7 is apatite.

4. **Mineral Observation Stations:** Divide students into five groups and give each student a mineral observation chart to record information at each station. At each of the five stations set up three minerals (from the mineral kit) along with streak plates, a nail, and a penny. Give the students time to observe one mineral at each of the stations. **[Scientific Practice 4 Analyzing and Interpreting Data]** Once the students have made and recorded their observations, come back together as a class and discuss what they saw. Ask the students: What did you find? Were there some tests that were easier to perform than others? What was difficult about this experiment?
   ****If there is a time constraint the lesson can be divided into two parts beginning here. ****
5. **The Mystery Rock Experiment**: This activity can be done with a partner or in groups. Give the students a sample of quartz and limestone without telling them what they are. Have the students identify which mineral is which by performing the tests. After this activity is complete and the students have identified the minerals provide some background about each mineral, descriptions are given below:
   a. **Quartz** is the most abundant mineral on Earth. It is often a hard (hardness = 7 on Mohs), white or colorless mineral that is made of silicon dioxide. Although it is most often white or colorless, quartz can also be found in a variety of environments and colors. It is found in igneous, metamorphic, and sedimentary rocks. Typically, quartz is used as gemstones in jewelry because it is hard and colorful.
   b. **Limestone** is a sedimentary rock composed of calcium carbonate. Limestone is impacted due to pressure. It is

very hard, and the texture can be very smooth or coarse. The most common use of limestone is for construction and architecture. The pyramids of Giza are made of limestone. It may also be used as countertops and for building fireplaces.

6. **Mineral Ad:** Students will now create ads on the computers that will be added to their "Daily Planet Earth" newspapers. The ads will be based on one mineral they observed from the lesson. Remind the students that the purpose of the advertisement is to make the mineral appealing, so that the readers will want to buy it. Each advertisement should explicitly state the mineral type and include some of the mineral's qualities. Furthermore, students should include at least one image of their mineral. Some qualities that students can include in their ads are:
    - Luster
    - Color
    - Hardness
    - Shape
    - Size
    - Uses
    - Crystal structure

***Students will create their advertisements and copy and paste their images into the newspaper template.

Assessments

- Students will create a chart of their observations of different minerals.
- Students will use a list of characteristics given to them to identify the mystery minerals quartz and limestone.
- As part of the portfolio newspaper project, students will become an expert on one of the minerals they observed and create an advertisement for this mineral.

Lesson 3: What is Erosion?

BACKGROUND

This lesson introduces the concepts of weathering and erosion in preparation for lessons 4 and 5. Students will learn about how rocks are broken down and moved until they turn into soil, and will have a brief introduction to fossils.

Science Content Background

Weathering and erosion are important processes that gradually wear down dirt and lead to the production of soil. **Weathering breaks rocks into smaller and smaller pieces but leaves them in place, whereas erosion breaks down rocks by carrying them away from their original locations**. Weathering and erosion can work together to make rocks disappear; for example, many rocks are weathered into small chunks, and then those chunks are eroded away and broken into even smaller pieces as they are being moved. **Water and living things like plants and microorganisms are the main drivers of weathering. The main drivers of erosion are water and wind.** Water is the main cause of erosion on Earth, whether it's in liquid or solid form.

In liquid form, water can carry away pieces of rock while moving in a river, flood, or wave. In solid form, it moves dirt and rock as a glacier. Weathering and erosion turn rocks, as well as entire landforms made from rocks, into gravel, and sandy and clay-like dirt. Plants, microorganisms, and animals like worms use this dirt and change it into dark, fertile soil; in other words, they act as a decomposer in their soil habitat. Because all the soil, sand, and gravel in the world was at one time a part of a rock, dirt types are different based on which minerals were in the rocks they came from.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Focus and Spiral Standard(s)

Focus Standard: 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Clarification Statement:

- Examples of evidence from patterns could include rock layers with marine 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.

Spiral Standard: 3-LS4-1. Use fossils to describe types of organisms and their environments that existed long ago and compare those to living organisms and their environments. Recognize that most kinds of plants and animals that once lived on Earth are no longer found anywhere.

Clarification Statement:

- Comparisons should focus on physical or observable features.

State Assessment Boundary:

- Identification of specific fossils or specific present-day plants and animals, dynamic processes, or genetics are not expected in state assessment.

Spiral Standard: 6.MS-ESS1-4. Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations that result from processes occurring over long periods of time.

Clarification Statements:

- Analysis includes laws of superposition and crosscutting relationships limited to minor displacement faults that offset layers.
- Processes that occur over long periods of time include changes in rock types through weathering, erosion, heat, and pressure.

State Assessment Boundary:

- Strata sequences that have been reordered or overturned, names of specific periods or epochs and events within them, or the identification and naming of minerals or rock types are not expected in state assessment.

Spiral Standard: 6.MS-ESS2-3. Analyze and interpret maps showing the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence that Earth's plates have moved great distances, collided, and spread apart.
Clarification Statement:

- Maps may show similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches), similar to Wegener's visuals.

State Assessment Boundary:

- Mechanisms for plate motion or paleomagnetic anomalies in oceanic and continental crust are not expected in state assessment.

Focus Standard: 4-ESS2-1. Make observations and collect data to provide evidence that rocks, soils, and sediments are broken into smaller pieces through mechanical weathering and moved around through erosion.
Clarification Statements:

- Mechanical weathering processes can include frost wedging, abrasion, and tree root wedging. Erosion can include movement by blowing wind, flowing water, and moving ice.

State Assessment Boundary:

- Chemical processes are not expected in state assessment.

Spiral Standard: 2-ESS2-4. Observe how blowing wind and flowing water can move Earth materials from one place to another and change the shape of a landform.
Clarification Statement:

- Examples of types of landforms can include hills, valleys, river banks, and dunes.

Spiral Standard: 7.MS-ESS2-2. Construct an explanation based on evidence for how Earth's surface has changed over scales that range from local to global in size.
Clarification Statements:

- Examples of processes occurring over large spatial scales include plate motion, formation of mountains and ocean basins, and ice ages.
- Examples of processes occurring over small, local spatial scales include earthquakes and seasoning weathering and erosion.

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
• Planning and Carrying Out Investigations • Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and/or measurements to produce data to	**ESS2.A: Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1) **ESS2.E: Biogeology** Living things affect the physical characteristics of their regions. (4-ESS2-1)	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1) , (4-ESS1-1)

serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1)		

Learning Targets

1. I can observe and describe examples of weathering through frost wedging, abrasion and tree root wedging.
2. I can observe and describe examples of erosion through wind, water, and ice.
3. I can explain the difference between "weathering", "erosion", and "deposition".

Assessment

Students will create an article about erosion on Mt. Greylock for their "Daily Planet Earth Newspaper." Students will type up their articles and include images of the effects of erosion on Mt. Greylock. In their articles, students should first describe Mt. Greylock, specifically, the minerals/rocks which make up Mt. Greylock (they learned in lesson 2 that it is composed of quartz and limestone) The students should also write about the erosion process based on what they learned in the lesson. Students will type their articles and copy and paste their information into the newspaper template.

WIDA Language Objectives

(Dependent on the needs of your ELL students)

Targeted Academic Language/ Key Vocabulary

Tier 3: frost wedging, abrasion, tree root wedging, erosion, weathering, deposition

RESOURCES AND MATERIALS

Quantity	Item	Source
1 per classroom	Computer + projector	Classroom Teacher
1 per classroom	Weathering & Erosion PowerPoint	CMC Website
1 per classroom	Activity Station Setup (Rock & Roll, and Swept Away: Hands on Nature p. 253-254 (each of these stations require numerous materials, be sure to use cornmeal for the swept away station rather than rice)	Binder
	What's Strong Enough to Make a Canyon? https://tinyurl.com/ybzlhu2g)	CMC Website
1 per group	Sticky tack	Bin
2 (1 per Splash station; 1 per Swept station)	**Baking pan**	**Bin**
1 per Splash station	**Tablespoon**	**Bin**
2 per student	3 oz. Dixie cups	Bin
1 per student	Spoon	Bin

1 per group	Paper plate and plastic plate	Bin
As needed	**Cinnamon**	**Bin**
As needed	**Salt**	**Bin**
1 per group	**2 binder clips**	**Bin**
1 per group	**2 plastic cups**	**Bin**
1 per group	**1 plastic condiment container**	**Bin**
1 per group	Ruler	Classroom Teacher
1 set per classroom	**Laminated Images of Berkshire Landforms**	**Bin**
As needed	Water	Classroom Teacher
2 per Rock station	**Clean, sealable plastic container**	**Bin**
3 handfuls (2 per Rock station; 1 per Swept station)	**Stones**	**Bin**
1 per classroom	Small bag of cornmeal	Bin
1 handful per Swept station	**Blocks of wood**	**Bin**

1 per student	Straws	Bin
1 per student	"Preparing for Disaster" reading	Binder
1 per student	"Watch for Steady Rocks" reading	Binder
1 per student	Paired Text Questions Worksheet	Binder
10	**Small plastic dinosaurs**	**Bin**

****Items in bold should be returned for use next year****

Lesson Prep

The night before, place pieces of sand and gravel in an ice tray, fill it with water, and freeze the "gravel ice cubes" for the glacier demo. Gather the materials used in the Rock & Roll activity and the Blown Away activity and review the Canyon activity (available at https://tinyurl.com/ybzlhu2g) and put together the dripsticks.

LESSON DETAILS

Lesson Opening/Activator

Use the Weathering and Erosion PowerPoint to guide this discussion.

1. Show the first image in the PowerPoint (root wedging) and ask for volunteers to guess what is happening in the picture. To guide the students, ask probing questions: Why are the objects in this picture where they are? Do you think anything is being moved, pushed, or changed in some way, even if it is happening slowly? What is doing the moving and changing in this picture? What do you think this image looked like in the past? What do you think it will look like in the future if the same action keeps happening?
2. At the end of the PowerPoint, take some time to clarify the difference between

Student Thinking Alert
Students should understand that actual weathering and erosion often takes far longer than it does in models, which is why it is not always easy to notice in everyday life.

weathering, erosion and deposition. (Weathering breaks rocks into smaller pieces but leaves them in place; erosion moves these small pieces, as well as soil, away from one place; deposition piles up those pieces in a different location.) The PowerPoint also asks about the end results of weathering and erosion; the students should understand that when rocks get broken up into small enough pieces and carried away, they become soil, sand, and dirt.

During the Lesson

1. **Erosion and Abrasion Stations**
    a. The following two stations should be set up outside, if possible. Break the class into two groups. Using "Hands on Nature," set up two activity stations: Rock & Roll (weathering by abrasion) and Swept Away (erosion by wind). In Swept Away, substitute dry cornmeal for the rice. The instructions can be found on pages 253-254 of "Hands on Nature." **[SP2: Using Models].** It would be ideal to have one adult at each station. Divide the students into groups and have them spend around 10-15 minutes at each station.

2. **Washing Away Landforms**
    a. Set up the materials for the: "What's Strong enough to Make a Canyon?" lesson, available at https://tinyurl.com/ybzlhu2g, using 6 or 8 cups of cornmeal instead of 4. However, instead of placing a dripstick over the cornmeal land, the teacher will place a gravel cube on the cornmeal. As the ice cube melts, it will slide down the cornmeal, creating a tiny "valley" and leaving behind little pieces of gravel. Have the students watch the ice cube for a little while and ask them if this model reminds them of any type of erosion they have learned. Guide the students into understanding that this model resembles the movement of glaciers.
    b. Break each of the groups of two or three and complete the cornmeal activity. Instead of having every group make a flat piece of land, however, assign some groups to sculpt a mountain, some groups to build a valley, some groups to make a crater, and some groups to make a flat plain as specified by the activity. The teacher and Science Fellow can go around helping the students as needed in sculpting their landforms using spoons and cups. Find three groups and ask them to hide one plastic dinosaur in their cornmeal land.

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c. (Let the students voice and share their ideas using the A/B talking protocol). At the end of the activity, have each group visit a station that had a different landform from their own. As a class, discuss how similarities and differences in the way different landforms eroded. Ask the students if any of them noticed the dinosaurs inside the land. Tell them that these represent the fossils, which are the ancient bones of the dinosaurs that have been buried over time. Ask the students if they think erosion helps us learn about the past and how.

Student Thinking Alert
Students might not realize that the earth did not always look the way it is now. Teachers can reference the activities in this lesson to explain how the earth has changed, or even briefly visit the website http://dinosaurpictures.org/ancient-earth#0 to show students what Earth looked like in the past.

3. **Berkshire Landforms**
   a. Split the students into groups and pass out the images of Berkshire landforms. Have them look over the images and make notes in their science journals of where they see erosion in the pictures. The students should exchange cards with another group once they've had a few minutes to look over the images.

Lesson Closing

Tell each group to turn over their image and figure out whether their landform was metamorphic or sedimentary. Then, make a chart on the board dividing the rocks into "Maggie" rocks and "Spencer" rocks, and have students add their landforms to the chart. Remind the students that sedimentary rocks often come from the ocean floor, and metamorphic rocks often come from mountains.

Optional Extension

1. **Paired Passages Activity**
   a. This is an optional activity that may be completed when the Science Fellows are not present.

b. In this exercise, students will read two passages and then compare and contrast the texts. After reading the texts, the students will then complete the Paired Text Questions worksheet, which tests for comprehension. The texts for this lesson are "Watch for Steady Rocks" and "Preparing for a Disaster" (located in the binder).

Assessment

Students will create an article about erosion on Mt. Greylock for their "Daily Planet Earth Newspaper." Students will type up their articles and include images of the effects of erosion on Mt. Greylock. In their articles, students should first describe Mt. Greylock, specifically, the minerals/rocks which make up Mt. Greylock (they learned in lesson 2 that it is composed of quartz and limestone) The students should also write about the erosion process based on what they learned in the lesson. Students will type their articles and copy and paste their information into the newspaper template.

Lesson 4: What is a Soil? Is All Soil the Same?

Lesson Background

This lesson is focused on the types of soil, soil composition and the characteristics of soil. It is critical for the students to understand that soil is an important component of the surface of the Earth. Learning more about soil will allow students to deepen their understanding of the processes of erosion, weathering and deposition since soil is formed through those processes.

Science Content Background

Soil is the upper layer of the Earth surface made up of five different elements: **I**norganic, **M**icroorganisms, **O**rganic, **W**ater and **A**ir (**IMOWA**). Generally, "ideal" soil is made up of 45% inorganic matter, 25% air, 25% water and 5% organic matter and microorganisms.

Overview of the Lesson

The students will learn the components of soil by first observing soil outside. Students will participate in a discussion about soil composition and will use the IMOWA chart to guide this discussion. The students will learn the characteristics of soil and will explore them using the soil drainage test. For the Daily Planet Earth newspaper, students will be creating a recipe for soil.

Focus and Spiral Standards

Focus Standard: 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Clarification Statement:

- Examples of evidence from patterns could include rock layers with marine 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

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walls and a river in the bottom, indicating that over time a river cut through the rock.

State 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.

Spiral Standard: 3-LS4-1. Use fossils to describe types of organisms and their environments that existed long ago and compare those to living organisms and their environments. Recognize that most kinds of plants and animals that once lived on Earth are no longer found anywhere.

Clarification Statement:

- Comparisons should focus on physical or observable features.

State Assessment Boundary:

- Identification of specific fossils or specific present-day plants and animals, dynamic processes, or genetics are not expected in state assessment.

Spiral Standard: 6.MS-ESS1-4. Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations that result from processes occurring over long periods of time.

Clarification Statements:

- Analysis includes laws of superposition and crosscutting relationships limited to minor displacement faults that offset layers.
- Processes that occur over long periods of time include changes in rock types through weathering, erosion, heat, and pressure.

State Assessment Boundary:

- Strata sequences that have been reordered or overturned, names of specific periods or epochs and events within them, or the identification and naming of minerals or rock types are not expected in state assessment.

Spiral Standard: 6.MS-ESS2-3. Analyze and interpret maps showing the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence that Earth's plates have moved great distances, collided, and spread apart.

Clarification Statement:

- Maps may show similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches), similar to Wegener's visuals.

State Assessment Boundary:

- Mechanisms for plate motion or paleomagnetic anomalies in oceanic and continental crust are not expected in state assessment.

Learning Targets

I can explain how soil is formed through decomposition and weathering.

I can illustrate the connection between soil formation (e.g. ratios of organic matter to minerals) and its color and texture.

I can identify and describe the differences between soil, loam, and clay.

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
Planning and Carrying out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control	**ESS2.E: Biogeology** Living things affect the physical characteristics of their regions. (4-ESS2-1)	Patterns can be used as evidence to support an explanation. (4-ESS1-1), (4-ESS2-2)

variables and provide evidence to support explanations or design solutions. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1)		

Assessment

- Students will be assessed on their knowledge of how soil is formed through the "soil recipe" activity.
- To assess their knowledge of organic and inorganic material as well as its connection to soil formation, review science journals. Students should be creating an "IMOWA" chart and writing a sentence or two about their observations of the soil sample that they are exploring.

WIDA Language Objectives

(Dependent on the needs of your ELL students)

Targeted Academic Language/ Key Vocabulary

Tier 1: soil, clay, loam, sand
Tier 2: texture, particles
Tier 3: decomposition, decaying, organic, inorganic

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RESOURCES AND MATERIALS

Quantity	Item	Source
2 cups per student	Soil from Decaying Matter	Bin
1 per student	Wooden skewers	Bin
As needed to cover desks	Newspaper	Classroom Teacher
1 per student	**Hand Lens**	**Bin**
2 per class	**Sieve**	**Bin**
1 per student	Science Journal	Classroom Teacher
1 piece	Chart paper	Classroom Teacher
15 (3 per group)	**Soda Bottles (funnel, planter, screen)**	**Bin**
15 cups (3 cups per group)	**Sand**	**Bin**
15 cups (3 cups	Potting soil	Bin

per group)		
15 cups (3 cups per group)	Clay	Bin
As needed	Water	Classroom Teacher
5 (1 per group)	**Measuring cup**	**Bin**
1	Spencer PowerPoint	CMC Website
1	Daily Planet Earth Soil Recipe Template	CMC Website
1	IMOWA Chart	Binder

****Items in bold should be returned for use next year****

Teaching Tip
Tell the students that the normal inorganic component of soil is "dirt". However, coins, bottles, plastic bags find their way into the soil because of pollution and they may harm the soil and the organisms living in it.

LESSON DETAILS

Lesson Opening/Activator

1. **Soil Exploration:** Divide the students in small groups and share with them that they will be studying the composition of the soil out on the playground. Tell them that they need to record the different elements they see in the soil. Give the students 10-20 minutes to explore soil out on and around the playground and then, bring the students back to the class and ask them share their findings with the class. Remind the students that the surface of the Earth holds lots of soil and that Spencer the sedimentary rock from the

GeoSquad will be telling them more about soil today. Go through the Spencer Sedimentary PowerPoint on soil with the students.

During the Lesson

IMOWA Chart

> **Student Thinking Alert**
> Students might think that the term "dirt" means all types of dirt. Let them know that in this context, "dirt" is used to refer to the inorganic content of the soil.

2. After the soil exploration, introduce the students to the IMOWA chart. Before you begin, distribute the IMOWA worksheet. Be sure to clarify the meaning of organic, inorganic, microorganism and decomposition with the class.
    a. Inorganic materials are found in soil and often account for about half of the soil's makeup. Most of the time this inorganic material takes the form of sand, silt, or clay. We sometimes refer to this part as the soil "dirt." Inorganic refers to something that does not come from living matter, such as a mineral. Explain to the students that sometimes we find other inorganic materials in soil such as coins, trash, paper wrappers from food, etc. These are NOT essential items for creating soil (and shouldn't even be in the soil) but sometimes these things find their way into soil. These are still inorganic materials because they do not come from living matter. Tell the students that coins, bottles, plastic bags find their way into the soil because of pollution and they may harm the soil and the organisms living in it. Most of the inorganic matter comes from the weathering and erosion of rocks. Some weathering may occur right where the soil forms, some of the inorganic matter may come from weathering of other rock locations nearby.

    b. Organic material comes from living matter. This is the other half of the soil's makeup. Many times, the organic material is in the form of plant and animal residue (for example, manure, leaves that fell off trees, or animals that have died). Explain that the more organic material in the soil, the "richer" the soil is (and the better it is for farming because organic matter stores lots of nutrients). To determine the richness of soil, we will observe the

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color and texture of the material. Is the soil dark in color and soft/smooth to the touch? If yes, then this soil has more organic material than inorganic material. If the soil is lighter in color, drier, and rough then it is not as rich and probably has less organic material.

c. Tiny living things called microorganisms are found in the soil. Most of the time, you won't be able to see the microorganisms, which are typically in the form of fungus or bacteria.

d. **Optional:** Ask students to classify the elements they found in the soil during the soil exploration activity using the IMOWA chart. Then, ask a few of them to share their classification.

3. Decomposition refers to the process of decaying or rotting. As organic material is mixed into soil over time, those materials begin to decay or rot. After a long time, the materials are broken down so finely that you do not notice them in the soil.

4. Explain to the students that there are different types of soil and these differences can be due to the soil texture, color and water retention capacity. Some examples of soil are: sand, loam, clay and silt.
   a. **Soil color**: The types of rock and organic matter that are broken down result in different soil colors
   .
   b. **Soil texture:** The original material and the extent to which the original material has broken down. Sand is made up of small rock bits; clay is made up of finer rock bits; loam is made up of larger bits of rock and organic material.

   c. **Water retention:** Because sand has larger rock particles, it cannot be packed together tightly and there is lots of space in between grains of sand; water is able to drain through these spaces. Clay is made up of fine particles

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that fit together tightly, with little air space; therefore, it retains water well. Loam has a little space in between particles; it is able to retain water, but not as much as clay.

5. (Class discussion) **Soil Discovery**

Note: Teachers need to compose soil for the students to observe and sort through, it is important to get a good variety of materials in the soil so that students are able to generate a lot of items on their "IMOWA" charts. It may be helpful to add inorganic human-produced materials as well such as rubber bands, pencils, pennies or other objects that you may have in the classroom, so kids are able to note the difference between organic and inorganic material. You could also add naturally-forming organic materials such as rocks and minerals.

   a. Lay out a newspaper or tarp and get students to record their prediction about what they think is going to be in the soil, have them write their ideas in their science journal. After they record a few thoughts, pour a sample of soil onto the newspaper for the students to look. Students will use skewers to move particles around and try to separate the soil into piles of similar particles. Students will use the lenses to examine finer pieces of the soil. A sieve could be used to separate sand from finer soil for students to inspect. Have the students feel the soil between their fingers so they are able to examine texture. Students will record what they discovered in the soil sample with a few sentences in their science journals. The students should separate their findings into a new "IMOWA" chart so they can grasp the differences between the four types of materials. Ask students if they can make a claim as to whether there is more inorganic or organic material and ask them to provide reasoning and evidence for their claim. **[SP 7 Engaging in argument from evidence]**

6. **Soil Recipe for Newspaper Project:** Students will now write a soil recipe for their "Daily Planet Earth" Newspaper. First, students should fill in the ingredients' column which should include sand, small rocks, dead leaves, or other items

students observed in their soil sample. Students may also include bacteria, microorganisms, and macroorganisms like worms in their ingredients' list, but it's not required. Next, students will write the soil recipe's steps.

7. The recipe steps are:
    a. Break down rocks into pieces.
    b. Then, break down other organic material (dead leaves, flowers, bugs, etc.)
    c. Next, mix the ingredients for a long period of time to mimic the process of weathering and erosion. (The amount of stirring time can be decided by the student.)

***Students will type their recipes and copy and paste their images into the newspaper template.

4. **Soil Drainage Test** (this can be done in small groups or as a class) **[SP3- carrying out an investigation]**
    a. In this activity, students will explore the characteristics of three types of soil i.e. color, texture and water retention capacity.

    b. In the bin, there are three soda bottles, cut in two pieces: one is funnel-shaped, the other looks like a planter. Cover the tip with the screen (tighten with a rubber band) and place the funnel tip-down into the planter. (It may help to do this experiment over newspaper for easy cleanup.)

    c. Fill one funnel with dry sand, one with loam (potting soil), and one with clay. Take time to observe and describe each type of soil, paying special attention to color and texture. Ask the students to draw a diagram of the apparatus in their science journals and write down which soil they think will hold the most water

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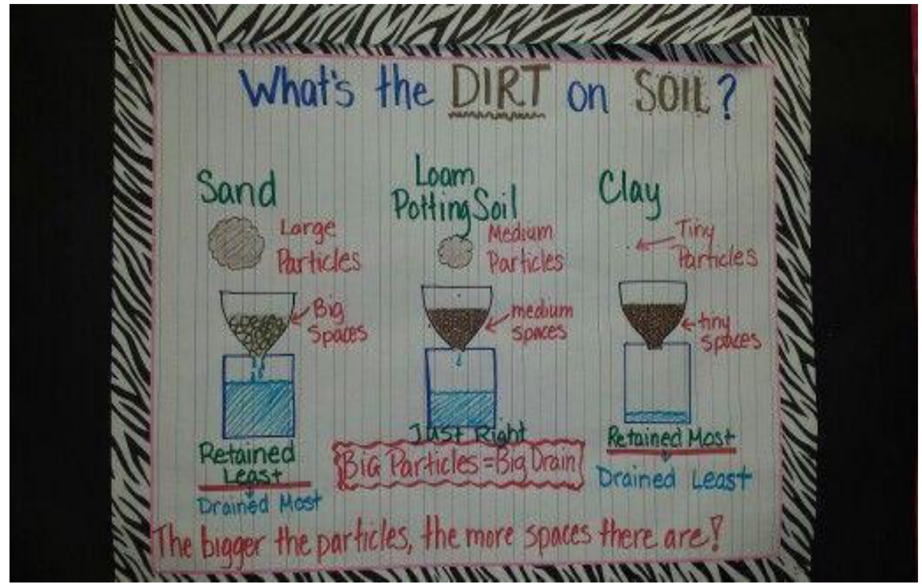
d. Students may share their hypothesis with the class.

e. Slowly pour 1 cup of water into each funnel. Watch as the water filters through the soil and into the bottom of the planter.

f. Next have students draw a diagram with the results of the experiment. An example of what the entry should include is below.

g. Ask which soil would be best for plants. Why?



Assessment

- Students will be assessed on their knowledge of how soil is formed through the "soil recipe" activity.
- To assess their knowledge of organic and inorganic material as well as its connection to soil formation, review science journals. Students should be creating an "IMOWA" chart and writing a sentence or two about their observations of the soil sample that they are exploring.

Extension

Connections to Mount Greylock

Ask the students, how weathering and erosion impact the soil on Mt. Greylock? How does the soil move from the top of the mountain to the bottom? Does the soil change or look different over time due to weathering and erosion?

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Lesson 5: Fooling with Fossils

LESSON BACKGROUND

Students must first learn what a fossil is. Fossils provide a valuable record of plant and animal life as well as environmental conditions from millions, even billions of years ago. Remains and traces of ancient life are preserved in rocks as fossils. The fossil record is a natural documentation of the evolution and history of life on Earth. It is important to note that there are many different types of fossils, but for this unit we are focusing on body fossils, trace fossils, and mold fossils.

Science Content Background

Fossils take millions of years to form as they are embedded into the sedimentary rock that is formed in the crust of the earth. There are three types of fossils that we will be learning about: body fossils, trace fossils, and mold fossils. **Body fossils** are fossils of the actual organisms themselves found in the earth; these are organisms such as dinosaur bones or petrified wood. **Trace fossils** are impressions of fossils that represent to anatomy of the organism. It is NOT a cast of the organism itself, but instead relates to how it lived its life; these are findings such as footprints, burrows, or egg nests. They show how the organism moved and went about daily life. A **mold fossil** is a fossil that is an impression or mold of the organism itself. The organism lay in the sediment for long enough that the rock around it hardened, creating an impression of the organism. The organism was then impacted by another factor such as erosion and weathering, or another organism that ate it away, so that all that is left is a mold of the original living being. These are the three main types of fossils that archeologists work with in their work and what we will be looking at today.

Overview of the Lesson

Students will be making their own fossils after learning about the three different types of fossils. Finally, students will be adding to their newspaper portfolios with an article about the fossil that they made during class.

NGSS Alignment Table

Science/Engineering Practice(SEP)	Disciplinary Core Ideas (DCI)	Cross Cutting Concepts (CCC)
(4-ESS2-1) Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Analyze and interpret data to make sense of phenomena using logical reasoning.	**ESS1.C: The History of Planet Earth** 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.	Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1), (4-ESS3-2)

Focus and Spiral Standards:

Focus Standard: 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Clarification Statement:

- Examples of evidence from patterns could include rock layers with marine 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.

Spiral Standard: 3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.

Clarification Statement:

- Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.

Assessment Boundary:

- Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.

Spiral Standard: 6.MS-ESS1-4. Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations that result from processes occurring over long periods of time.

Clarification Statements:

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- Analysis includes laws of superposition and crosscutting relationships limited to minor displacement faults that offset layers.
- Processes that occur over long periods of time include changes in rock types through weathering, erosion, heat, and pressure.

State Assessment Boundary:

- Strata sequences that have been reordered or overturned, names of specific periods or epochs and events within them, or the identification and naming of minerals or rock types are not expected in state assessment.

Spiral Standard: 6.MS-ESS2-3. Analyze and interpret maps showing the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence that Earth's plates have moved great distances, collided, and spread apart.
Clarification Statement:

- Maps may show similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches), similar to Wegener's visuals.

State Assessment Boundary:

- Mechanisms for plate motion or paleomagnetic anomalies in oceanic and continental crust are not expected in state assessment.

Learning Targets:

I can write a story about the history of my fossil.
I can explain the differences between types of fossils.

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Assessment

Students will write a story about the fossil they made in class today. The story should include facts about the fossil such as what type of fossil, where it came from, and what time period it formed. Encourage the students to tell the story of their fossil.

Target Academic Language:

Tier 2: Prehistoric

Tier 3: Jurassic, Fossil

RESOURCES AND MATERIALS

Quantity	Items	Source
6 (two of each type)	**Different types of fossils**	**Bin**
1 bag	Whole Wheat Flour	Bin
2 containers	Salt	Bin
1	**Measuring cup (that can measure at least 1 cup)**	**Bin**
	Various items to press into salt dough to make fossils	Classroom Teacher/Outdoors

1 per student	Fossil Handout	Binder (teacher to make copies)
	Fossil PowerPoint	CMC Website
	Daily Planet Earth Fossil Article Template	CMC Website
	Laptops/iPads	Classroom Teacher

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

Students will be looking at molds of model fossils that the teacher will pass around. The students are encouraged to touch and feel these models, guessing what they are as they pass them around. The teacher will lead a discussion about what they are touching and reveal that they are fossils from millions of years ago. Then they will go over the fossil PowerPoint about the three different types of fossils found in this unit.

Student Thinking Alert

Not just dinosaurs become fossils. Many different things such as plants and insects have been preserved as fossils as well. Dinosaurs are a great way to get kids introduced to the concept of fossils, but they must understand that the term fossil does not predominantly refer to a dinosaur.

During the Lesson:

1. **Make your own fossil:** Students will be making their own fossils today from salt dough. **This will need to be made in advance by the teacher, the directions can be found here:** https://www.makelifelovely.com/diy-dinosaur-fossils-with-salt-dough/ Give each student a ball of salt dough. Then have the students go outside and search for various natural items they can press into their salt dough to make a fossil.
2. **Fossil Map:** Students will now be looking at a map with the teacher of fossils found all over the world but should focus specifically on the United States and it regions. The teacher should demonstrate how to use the website, so students can explore it on their own in small groups. Point out different regions of the country and then divide the groups up to look at each. This will coincide with their social studies work. *This will take preparation with understanding and familiarizing yourself with the website.*
    a. *https://paleobiodb.org/navigator/*
3. **Fossil Story:** Students will now write a story about the fossil that they have made. They will be pretend they are archaeologists telling the world about the amazing fossil that they have just discovered. Their article should include what their fossil is and what type, where they found it, how old they think it is, what time period it's from, and how it formed. This will be included as an article in their newspaper portfolio.

Extension: Take a field trip to the Berkshire museum! In the Museum students can dig for dinosaur bones and look at real fossils in the prehistoric exhibits.

Student Thinking Alert

Make sure that students understand that scientists don't know everything about the past, there are new discoveries all the time. Fossils are found every year all around the world, so the map they are seeing will change as new discoveries are made. This also means that the information that scientists have changes as well; they may believe one year that the T-Rex was the apex predator and come to find out that it was really a new dinosaur that hasn't been discovered yet! Just as we believed the sun revolved around the earth, information changes through time and discovery.

Other Resource: Here is a website that lists all the states and the famous fossils that have been found in them: https://www.fossilera.com/pages/state-fossils

Lesson Closing

Students who want to present their fossil should be given the opportunity to do so. The teacher should do a final review of the types of fossils.

Assessment

Students will write a story about the fossil they made in class today. The story should include facts about the fossil such as what type of fossil, where it came from, and what time period it formed. Encourage the students to tell the story of their fossil.

Lesson 6: Earthquakes and Fault Lines

LESSON BACKGROUND

This lesson covers the effects of tectonic plate movement including the creation of volcanoes and mountains. Major activities in this lesson includes a hands-on investigation of plate movement as well as a research project on the ring of fire.

Science Content Background

This lesson is grounded heavily in plate tectonics and the effects of plate movement, so teachers will need to understand and demonstrate these effects. To begin, teachers must understand that the Earth is made of many layers, the outermost layer of the Earth is called the **crust**. The crust is broken up into pieces that are called **tectonic plates.** This lesson covers two types of boundaries that occur when tectonic plates interact with each other. These boundaries are called transform boundaries and convergent boundaries. A **transform boundary** occurs when two tectonic plates rub together. As the pressure builds between the plates, they slip releasing the energy that we perceive as an **earthquake.** A **convergent boundary** occurs when two tectonic plates collide with each other. As the two plates collide they form **mountains** between them as the land shifts upward. This lesson also covers the creation of volcanoes which occurs at a **subduction zone.** A subduction zone occurs when a denser oceanic plate is thrust underneath a less dense continental plate. A piece of the oceanic plate breaks off and melts allowing for magma to come to the surface. This magma hardens and forms what we know as a **volcano.**

Overview of the Lesson

Students will learn about the formation of volcanoes, mountains, and earthquakes by participating in a series of experiments that demonstrate the effects of plate tectonics. For the Daily Planet Earth project, students will be creating a news article about a natural disaster that they research.

Focus and Spiral Standards

Focus Standard: 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.

Spiral Standard: 2-ESS2-2. Map the shapes and types of landforms and bodies of water in an area.

Clarification Statements:

- Examples of types of landforms can include hills, valleys, river banks, and dunes.
- Examples of water bodies can include streams, ponds, bays, and rivers.
- Quantitative scaling in models or contour mapping is not expected.

Spiral Standard: 6.MS-ESS2-3. Analyze and interpret maps showing the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence that Earth's plates have moved great distances, collided, and spread apart.

Clarification Statement:

- Maps may show similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches), similar to Wegener's visuals.

State Assessment Boundary:

- Mechanisms for plate motion or paleomagnetic anomalies in oceanic and continental crust are not expected in state assessment.

Spiral Standard: 7.MS-ESS2-2. Construct an explanation based on evidence for how Earth's surface has changed over scales that range from local to global in size.

Clarification Statements:

- Examples of processes occurring over large spatial scales include plate motion, formation of mountains and ocean basins, and ice ages.
- Examples of changes occurring over small, local spatial scales include earthquakes and seasonal weathering and erosion.

Spiral Standard: 8.MS-ESS2-1. Use a model to illustrate that energy from Earth's interior drives conventions that cycles Earth's crust, leading to melting, crystallization, weathering, and deformation of large rock formations, including generation of ocean seafloor at ridges, submergence of ocean seafloor at trenches, mountain building, and active volcanic chains.

Clarification Statement:

- The emphasis is on large-scale cycling resulting from plate tectonics.

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Analyze and interpret data to make sense of phenomena using logical reasoning. (4-ESS2-2)	**ESS2.B: Plate Tectonics and Large-Scale System Interactions** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)	**Patterns** Patterns can be used as evidence to support an explanation. (4-ESS1-1), (4-ESS2-2)

Learning Targets

1. I can explain how plate tectonics create earthquakes and mountains.
2. I can discuss how volcanoes are formed and the effects of their eruptions on land.
3. I can model how earthquakes, mountains, and volcanoes are created.

Assessment

Students will create a "Natural Disaster" news article for their Planet Earth Newspaper

WIDA Language Objectives

(Dependent on the needs of your ELL students)

Targeted Academic Language/ Key Vocabulary

Tier 2: Earthquake

Tier 3: Tectonic Plates, Fault line

RESOURCES AND MATERIALS

Quantity	Item	Source
4 packages	**Modeling clay / Play Doh**	**Bin**
1	**Small plastic cup**	**Bin**
1 tablespoon	Flour	Bin
2 tablespoons	Baking soda	Bin
⅓ cup	**Vinegar**	**Bin**
1 4" square	Tissue Paper	Bin
1 roll	Paper towels (for cleanup)	Classroom Teacher
1 per student	Scissors	Classroom Teacher

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1	**Large rectangular plastic bin**	**Bin**
1 per student	Science Journal	Classroom Teacher
1 per student	Laptop/iPad	Classroom Teacher
	Projector	Classroom Teacher
1 per student	Plastic plates	Bin
2 boxes	Graham Crackers	Bin
3-4 containers	Cool Whip	Contact Sue Beauchamp
2	**Plastic Bowls**	**Bin**
	Daily Planet Earth Natural Disaster Article Template	CMC Website
	Izzy and Maggie Geosquad Comic	Binder (teacher to make copies for students)
	How to Draw the Geosquad Instructions	CMC Website

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/Activator

Have the teacher project an image of a volcano and ask the students what they already know about volcanoes and earthquakes. Explain that they will be learning about volcanoes and earthquakes today.

During the Lesson

1. **Volcano Simulation**
   - **a.** In order to learn about natural disasters and how to create a plan to lessen their effects, we need to know what happens during natural disasters. One type of natural disaster is a volcanic eruption. There are many volcanoes, and one of the most famous is Mount St. Helens in Washington State which last erupted in 2008. Today, we are going to simulate a volcano erupting. The Science Fellows or classroom teacher should guide this experiment in front of the class. Before beginning the experiment, have students draw a "before" diagram of what the volcano looks like. Once the experiment is complete, ask the students to draw an "after" diagram of the volcano and have the students write a sentence or two about what happened during the experiment. **[SP: Patterns]**

b. The Science Fellow or classroom teacher will need to make a model of a volcano out of modeling clay and place it in the plastic bin that is provided. The bin will help prevent a mess. To create the volcano, shape the clay around the plastic cup into a cone with the point as the top. The mouth of the cup should be at the top of the volcano.

c. Once the model volcano is complete the Science Fellow will need to pour 2 tablespoons of baking soda and 1 tablespoon of flour into the center of a 4-inch square piece of tissue paper. Wrap the tissue paper around the baking soda and flour and twist both ends. It should look a Tootsie roll wrapped up when it is finished.

d. Place the mixture in the cup in the volcano model.

e. To make the volcano "erupt," pour in half of the required amount of vinegar (this is about ⅙ of a cup). Make sure to step back a little, so the mixture does not get in your eyes or on your clothes. When the foaming stops, add the remaining amount of vinegar (about ⅙ of a cup).

f. Talk to the students and ask them what happened. When volcanoes erupt and the lava cools down, it builds the mountain up. Ask the students what kind of rocks are formed from the cooling magma. The students should answer igneous rocks based on what they learned in previous lessons.

g. There are many volcanoes all over the world, especially located in the ring of fire. The ring of fire is an area in the Pacific Ocean where there is a continuous series of ocean trenches, volcanoes, and tectonic plate movements.

Not only are there volcanic eruptions but also there are several earthquakes that occur here due to tectonic plate movement.

2. **Ring of Fire Mapping Activity:**
   a. Assign each student to look up either a volcano or a major earthquake from the Ring of Fire and find its location on the map and one interesting fact about the phenomena. Interesting facts can include: How many times has the volcano erupted? When is the last time it erupted? How tall is it? In the case of earthquakes, how far away was the earthquake felt? The teacher may want to write these prompts on the board. The Smithsonian Institute's website (https://volcano.si.edu/search_volcano.cfm) is the best website to go to for those researching volcanoes, but students can also look them up on google maps to figure out their location.

   b. Volcanoes:
      i. Mt. Erebus
      ii. Mt. Taranaki
      iii. White Island
      iv. West Mata
      v. Mt. Merapi
      vi. Mt. Pinatubo
      vii. Mt. Fuji
      viii. Sarychev Peak
      ix. Makushin

x. Mt. Edziza

xi. Mt. St. Helens

xii. Volcan de Fuego

xiii. Sangay

xiv. Llaima

xv. Mt. Hudson

c. Earthquakes:

i. 1960 Valdivia earthquake

ii. 1906 San Francisco earthquake

iii. 2011 Tohoku earthquake

iv. 1999 Ambrym earthquake

v. 2010 Christchurch earthquake

3. Have the teacher project a world map at the front of the classroom (with a white board or chalkboard behind the projection if possible) and ask the students to come up and point to the location of their earthquake/volcano (if possible have them make a dot on the board of where their earthquake/volcano is located). Once the dots have been made on the board, ask the students if the collection of volcanoes and earthquakes forms any particular shape. If students are having a hard time visualizing the shape, the teacher should guide them to the conclusion that the collection of dots should form a ring, which is called the Ring of Fire.

Fun Fact: The ring of fire has 452 volcanoes and includes 75% of all of the world's volcanoes, as well as most of the world's earthquakes!

a. Ask the students to think about why so many volcanoes and earthquakes are clustered along this ring. Have the students do a think-pair-share. You may ask probing questions to guide their thinking: What do all the spots along the Ring of Fire have in common? Why might earthquakes and volcanoes occur in similar places?

b. After the students have offered their ideas, have the students read the comic about plate subduction with Izzy and Maggie and engage in a discussion about what they learned from the comic.

4. **Graham Cracker Plate Tectonics/Earthquake Activity:** Explain to the students that the earth's surface is made up of layers and the crust of the Earth is made up of tectonic plates. As the plates move and collide with each other they can cause mountains to form or earthquakes to occur. Hand out three graham crackers to each student as well as a plate with cool whip. Students should break all the graham crackers in half in order to conduct their explorations. Tell the students they will be using the graham crackers to learn about how different boundaries can affect the Earth in different ways.

5. **Earthquake Creation:** Explain to students that an earthquake occurs when two tectonic plates grind past each other. Have the students take two cracker halves and gently slide their edges against one another. Ask the students to pay attention to how the crackers feel and the sounds they make. Have the students do this a few times. Explain that earthquakes are caused when the plates collide and scratch together. As the pressure between the plates builds, the

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plates slip releasing energy that we feel as an earthquake.

6. **Mountain Creation:** Explain to students that a mountain is created when two plates move towards each other. When two plates move toward each other they can collide and form mountains. Ask the students take two cracker halves and to dip one end of each graham cracker in water, the adults can carry around a bowl of water so the students can dip their crackers from their seat. Have students place the crackers with the soggy sides facing each other and ask them to gently push the crackers together. The crackers should fold on top of each other, forming mountains.

7. **Volcano Creation:** Explain to students that a volcano is created when a denser oceanic plate is thrust under a less dense continental plate. As the oceanic plate breaks away, hot magma oozes up and hardens creating volcanic mountains. Students will demonstrate the creation of volcanoes using a graham cracker (broken in half) and a plate with dollop of cool whip. The students should rest the two halves of the graham cracker on top of the cool whip and slide one half over the other. As they apply pressure, part of one cracker should break off and the cool whip (the magma) below the cracker should come up onto the surface, forming the volcanoes.

Assessment

Students will create a “Natural Disaster” news article for their Planet Earth Newspaper

Lesson 7: Protecting Against Natural Disasters

LESSON BACKGROUND

This lesson ties together everything students have been learning about different Earth processes.

Science Content Background

Natural disasters are any Earth processes that harm and destroy living creatures and the things they need to survive. Natural disasters can happen very slowly, such as major droughts, or very quickly, such as earthquakes. The first priority in dealing with natural disasters is to find out whether we can prevent them from happening. The key to preventing disasters is to figure out what makes them happen. For example, floods occur when the ground cannot absorb enough water. We can sometimes prevent the ground from being overloaded with water by growing plants or setting up rain catchers.

We can't prevent *all* natural disasters, so it's useful to be able to figure out when natural disasters are most likely to happen, so that we can start moving people and valuable objects out of harms way while we still have enough time. Of course, no one can actually predict natural disasters; just like a weather forecast, the best we can do is figure out when there is a good chance that a natural disaster will happen. Lastly, there are cases where we can't prevent or predict natural disasters or might not be able to move everyone and everything to safety. In that case, we can either redirect the disaster, contain it, or withstand it.

Overview of the Lesson

In this lesson, students will learn about natural disasters. They will think about potential ways to protect themselves against natural disasters or ways to lessen the effects by experimenting with volcanoes, earthquakes, and floods. For the Daily Planet

Earth newspaper portfolio project students will be creating a “How to Survive a [natural disaster]” guide and comic.

Focus and Spiral Standards

Focus Standard: 4-ESS3-2. Evaluate different solutions to reduce the impacts of a natural event such as an earthquake, blizzard, or flood on humans. *

Clarification Statement:

- Examples of solutions could include an earthquake-resistant building or a constructed wetland to mitigate flooding.

Spiral Standard: 3-ESS3-1. Evaluate the merit of a design solution that reduces the impacts of a weather-related hazard.

Clarification Statement:

- Examples of design solutions to a weather-related hazard could include a barrier to prevent flooding, a wind-resistant roof and a lightning rod.

Spiral Standard: 7.MS-ESS3-2. Obtain and communicate information on how data from past geologic events are analyzed for patterns and used to forecast the location and likelihood of future catastrophic events.

Clarification Statements:

- Geologic events include earthquakes, volcanic eruptions, floods, and landslides.
- Examples of data typically analyzed can include the locations, magnitudes, and frequencies of natural hazards.

State Assessment Boundary:

- Active analysis of data or forecasting is not expected in state assessment.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Identify the evidence that supports particular points in an explanation. (4-ESS1-1) ● Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2)	**ESS3.B: Natural Hazards** A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) *(Note: This Disciplinary Core Idea can also be found in 3.WC.)* **ETS1.B: Designing Solutions to Engineering Problems** Testing a solution involves investigating how well it performs under a range of likely conditions. *(secondary to 4-ESS3-2)*	**Influence of Engineering, Technology, and Science on Society and the Natural World** Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2)

Learning Targets

I can discuss three types of natural disasters including volcanic eruptions, earthquakes, and floods.

I can discuss the impacts of natural disasters and how to protect against or lessen the effects of these natural disasters.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Assessment

Create a "How to Survive a [natural disaster]" article for Planet Earth Newspaper. Each student will choose one natural disaster (flood, volcano, or earthquake) to write about.

WIDA Language Objectives

(Dependent on the needs of your ELL students)

Targeted Academic Language/ Key Vocabulary

Tier 2: Flood, Redirect, Contain, Withstand, Barrier
Tier 3: Prevention, Extinction

RESOURCES AND MATERIALS

Quantity	Item	Source
1 per student	"Safe Houses" Article (2 pages)	Binder
4 packages	**Modeling clay / Play Doh**	**Bin**
1 roll	Paper towels (for cleanup)	Classroom Teacher
1 per student	Scissors	Classroom Teacher
1	**Large bin or bucket**	**Bin**

1 per student	Science journal	Classroom Teacher
1	Floods in North Adams PowerPoint	CMC Website
1	Dinosaur Extinction Powerpoint	CMC Website
1 per student	Laptop/iPad	Classroom Teacher
	Projector	Classroom Teacher
1 container	**Legos**	**Bin**
6	**Aluminum Pans**	**Bin**
12 boxes	Jello Mix	Bin
30 per student	Mini marshmallows	Bin
30 per student	Toothpicks	Bin
2 boxes	Popsicle sticks	Bin
As needed	Building blocks	Classroom Teacher
As needed	Tape	Classroom Teacher
1 roll	**String**	**Bin**
2 boxes	**Plastic spoons**	**Bin**

1 per group	Paper plate	Bin
1 per group	Brass Fastener	Bin
1 per group	Paper clip	Bin
2 per group	**Cups**	**Bin**
As needed	Glue	Classroom Teacher
1 per student	Geosquad Flood Comic	Binder
1 per student	Blank Comic Templates	CMC Website
1 per student	Daily Planet Earth How to Survive a Natural Disaster Article Template	CMC Website
	Geosquad Flood Video	CMC Website

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/Activator

Show students the GeoSquad Flood Video. After the video, explain to students that Earth processes can harm and damage life, including people and the structures they build, are called natural disasters. Ask students to think about the Earth processes they've learned about this unit, and whether any of them could be considered natural disasters. As students to share their and create a list on the board.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Teach To Learn
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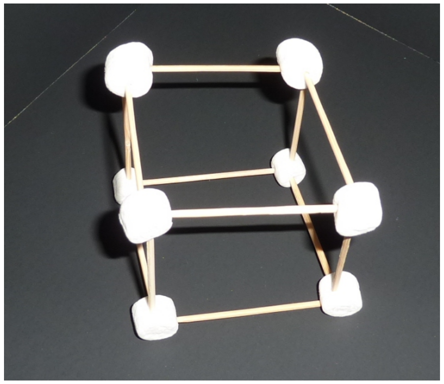
During the Lesson

1. Share with the students that there are three main ways to protect against a natural disaster: redirecting the danger, containing it, or withstanding it. Divide the board into three sections, one labeled “Redirect”, one “Contain” and one “Withstand”. The teacher should go over the vocabulary words (redirect, contain, withstand) with the students by first asking them to think of their own definitions and share them with the class. Here are definitions for the words:
    a. **Redirect:** to change or guide an object or force to another area.
    b. **Contain:** to hold a substance or object
    c. **Withstand:** to hold out against, resist, or endure
2. **Floods:** Explain that North Adams has a history of floods, project the Floods in North Adams PowerPoint on the board.
    a. **Building a Town:** Build a small town and then simulate a flood. Have the students come to the front table of the classroom. Using soil or clay, create a base for the town in a large bin or bucket. If there is enough soil, build a mountain in the corner of the bin to represent Mount Greylock. Have pairs of students each create a small building, person, or plant to put in the town using Legos. Once the town is assembled, get a gallon ot so of water and pour it into the bin. Pour the water starting at the top of the mountain.
    b. Ask the students to talk describe what they see. Be sure to introduce the concept of flooding and explain that is what they are watching happen now.
    c. Ask students to think-pair-share ideas for how to prevent floods. As the students share out their ideas, have the class organize the ideas based on whether their plans would involve redirection, containment, or withstanding.
2. **“Safe Houses”**: Hand out the *National Geographic* article “Safe Houses” by Chris Carroll. Call on a student to read the title and introductory paragraph. Explain that this article will be about earthquake-proof buildings and homes. Call on a different student to read each paragraph, pausing between each to summarize concepts and define vocabulary. At the

end of the article, ask students what type of prevention method was mentioned in the article. The answer should be withstanding. **[SP8: obtaining information]**

*****This lesson can be broken up at this point if there are time limitations*****

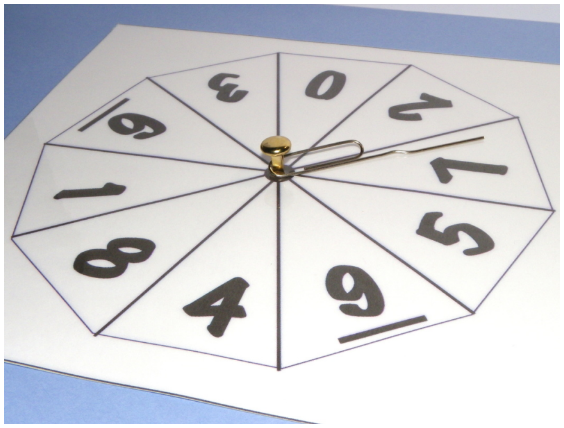
3. **Disaster Preparedness Game:** This activity is adapted from: https://www.teachengineering.org/activities/view/cub_natdis_lesson03_activity1
   a. This activity will need to be prepared a day in advance. The teacher will have to make jello to fill 6 aluminum pans the day before. In this lesson, the class will be split up into small groups of 3-4 students. Since class sizes change, the teacher may have to increase or decrease the number of aluminum pans. For each aluminum pan full of jello, the teacher will have to also make a house beforehand. To create these houses, the teacher should connect 12 toothpicks with 8 marshmallows to make a cube shaped house. Please see the image below for an example.



   b. For this activity, tell the students that they will be like the GeoSquad because they will save their town from natural disasters. The students will save the town by using the tools from their tool boxes. Tell the students that the toothpick-marshmallow house in the aluminum pan will represent all the buildings in the town.
   c. Before beginning the activity, divide the students into groups and give each group a paper plate, a brass fastener, and a paperclip to create their spinners. For the tool box (items the students can use in this activity), students will be given a basket full of materials such as popsicle sticks, toothpicks, plastic spoons, building blocks, marshmallows, string, tape, cardboard, etc. It is a good idea to lay out an assortment of items on tables around the room so that each group has their own materials to work with. The teacher can add additional items from the classroom if they'd like to.

Each group will also be given two plastic cups. The first cup will be filled with water and be labeled as flood waters. The other cup will be filled with glue and be labeled as lava. Finally, each group will be given a tray of jello with a house resting on top of the jello.

d. To begin the activity, the teacher should ask the students to name the natural disasters they learned about in this unit. (The answer should be floods, volcano eruptions, and earthquakes). The teacher should write these disasters on the whiteboard. Then, the teacher should tell the students to draw lines on their paper plates to divide their spinners into 3 equal sections (triangular shaped). One section should say floods, the next should say volcanic eruptions and the last should say earthquakes. Then, the students should insert the brass fastener in the middle of the paper plate. Next, the students should put one end of the paper clip around the brass fastener. Finally, the students should fold back the ends of their brass fastener to ensure it stays attached to the paper plate. Look at the picture below for an example of what the spinner should look like.



1. To play the game, the students should spin the spinner to land on a natural disaster.

2. Once students land on a natural disaster, they must decide whether to redirect, contain, or withstand this natural disaster, using the tools from their tool box. The teacher should tell the students to refer to the whiteboard with examples of prevention methods and the article they read if they need help.
3. The students should create their solutions and then test it out by executing the natural disaster. Below is a brief description of what the activity will look like:
    a. For floods, there are many options for students. They can use the plastic spoons to dig flood chutes (redirect the flood) or reservoirs (contain the floods). They can also build levees or other types of barriers with popsicle sticks or other materials to redirect the flood waters. Then, the students will pour the cup of water to test whether or not their house will be flooded.
    b. For volcanic eruptions, the students can use the plastic spoons to dig channels to redirect the lava. They can also build trenches to contain the lava. Then, students will test whether or not their house is burned down by pouring the liquid glue (it represents lava) on their aluminum tray.
    c. For earthquakes, the students should use the materials from the toolbox to reinforce their house. Then, the students should test the house's sturdiness by shaking the tray of jello. The instability of the jello mimics the movement of the land during earthquakes.
    d. After each disaster, the students should write about it in their science journals.
        i. Type of disaster (flood, volcano eruption, or earthquake):
        ii. Prevention method (redirect, contain, or withstand):
        iii. Description of prevention method (materials used and how they built it):
        iv. Did the solution work (yes or no)?
        v. Ways to improve their solution:
    e. The students should continue spinning the spinner until they complete all 3 disasters.

Lesson Closing

1. Ask students to brainstorm ideas about the extinction of the dinosaurs. Then project the Dinosaur Extinction PowerPoint on the board, allowing student volunteers to read each slide out loud.
2. Then ask students to choose a theory from the powerpoint that resonates with them. Create groups based on what the students choose and give them ipads to further research the theory they choose (you should have four groups). Instruct the students to look for facts about their theory, encourage them to use the links provided on the powerpoint.
3. Once all the students have finished their research (this should take no more than 10-20 minutes), tell the students they are going to have a debate. If possible, the debate should take place outdoors. Pick a student volunteer stand in front of the class and give one reason the others should believe their theory. Then, pick a student volunteer from a different group to respond. Allow the debate to carry on with each group making a statement and allow the other groups to respond.

Assessment

For this assessment, the students will have two options. The students can either write a "How to Survive [a natural disaster]" article for their "Daily Planet Earth" Newspaper and make a comic, or just make a comic strip. Each student will choose one natural disaster (flood, volcano, or earthquake) to write about. The article "Safe Houses" is also a great resource for ideas.
Note: Comic templates should be printed beforehand. There will be three different templates available. Please print out enough copies of each template.
Tell students that today they will be comic strip writers and explain that comic books are made up of comic strips. They will be writing a short scene depicting a natural disaster and how to prevent it. Students can work independently or in pairs. The comic strip must contain:

- At least one character that will lead the readers through the plot.

- One of the following natural disasters, and an explanation of the disaster that demonstrates the students' understanding:
  - ➢ Earthquake
  - ➢ Volcano
  - ➢ Floods
- One way to prevent the disaster or mitigate damage to the surrounding area

Curriculum Embedded Performance Assessment

Standard(s) Covered by this Assessment:

[2016] 4-ESS1-1. Use evidence from a given landscape that includes simple landforms and rock layers to support a claim about the role of erosion or deposition in the formation of the landscape over long periods of time. [Clarification Statements: Examples of evidence and claims could include rock layers with shell fossils above rock layers with plant fossils and no shells, indicating a change from deposition on land to deposition in water over time; and a canyon with rock layers in the walls and a river in the bottom, indicating that a river eroded the rock over time. Examples of simple landforms can include valleys, hills, mountains, plains, and canyons. Focus should be on relative time.] [State Assessment Boundary: Specific details of the mechanisms of rock formation or specific rock formations and layers are not expected in state assessment.]

[2016] 4-ESS2-2. Analyze and interpret maps of Earth's mountain ranges, deep ocean trenches, volcanoes, and earthquake epicenters to describe patterns of these features and their locations relative to boundaries between continents and oceans.

Student Learning Targets

1. Identify what a physical map is and what it consists of.
2. Read scientific maps of mountain ranges, trenches, active volcanoes, and earthquakes. (Topographical maps not required.)
3. Design and test an erosion prevention solution.
4. Read scientific maps of mountain ranges, trenches, active volcanoes, and earthquakes, climate and weather.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

RESOURCES AND MATERIALS

Quantity	Item	Source
3 (1 per group)	**Geographic map of Mt. Greylock**	**Bin**
3 (1 per group)	**Rectangular clear plastic container**	**Bin**
15 cups (5 cups per group)	**Topsoil**	**Bin**
As needed	Rocks (small to medium in size)	Classroom Teacher
As needed	Straws (cut down the middle)	Bin
As needed	Popsicle sticks	Bin
1 per group	**Clean ketchup bottle**	**Bin**
As needed	Water (to fill ketchup bottles with)	Classroom Teacher
1 per student	Science journal	Classroom Teacher

****Items in bold should be returned for use next year****

Assessment

- Design an erosion prevention system for a site that is prone to water erosion on Mt. Greylock. Use different barriers such as trees, rocks, and drainage pipes to create a situation that prevents the least amount of soil from washing away.

- Groups should come up with an oral presentation which touches on the following questions: Why did you build your erosion prevention system this way? Did it work well?

Procedure: Explain to students that they are going to build an erosion system to protect a part of Mount Greylock that could be impacted by water erosion. Let the students know that the people in the surrounding towns cannot let the soil from the mountain wash down onto their house so it's up to them to plan a way to prevent it from happening.

1. Review erosion and water erosion and how it affects a landscape. Feel free to reference the experiment done in Lesson 3. Talk about how different things, such as trees and rocks prevent soil loss as well as how water travels and can be funneled (drainage).

2. Set up three workstations covered with newspaper to make for an easy clean up. Pile soil to form a slope inside each clear plastic container. The slope will be different depending on the container but should be steep enough to promote water flow. On each desk lay a small pile of rocks, straws cut down the middle, and popsicle sticks.

3. Hand out a geographic map of Mt. Greylock and have students review them. The students should position their models according to the map's depiction of the mountain site.

4. Describe how we use models to imitate what might happen on a larger scale. Explain to the students that we will pour water at the top of the mountain to simulate rainfall. Their job will be to work together in groups to place rocks, trees (popsicle sticks), and drainage pipes (straws) on Mt. Greylock to prevent soil erosion. Give students 15-30 minutes to design their erosion prevention system and then call for their attention.

5. As they finish designing their systems, gather all the students to come over to one of the groups models. Have students explain how their layout may succeed or fail and get all the students to make a prediction what will happen. Pour water slowly on the top of the model for 5 seconds and notice how much soil was taken away. Repeat this process for the other groups models

6. Have students write a paragraph about how item placement affected erosion prevention, as well as how different items worked better than others. Ask the students to describe three ways how erosion might have affected Mt. Greylock over time.

5E Instructional Model Background

This instructional model exists as a set of phases for science instruction that starts with students' prior knowledge in order to reconstruct a new knowledge with deeper understanding. The *Engagement* phase is first, in which teachers and students begin to mull over questions, prior knowledge and understanding, and potential frustrations they might have with a topic. This phase is meant to be informal – this is the start of the lesson. The second step involves *Exploring* phenomena, which acts as an introduction to the larger concepts that engages students in a hands-on approach. After exploration, *Explanation* of scientific concepts begins. To further student understanding, *Elaboration* is next, in which students are presented with even more challenging activities and problems. Following the learning process comes *Evaluation*, as deemed necessary by learning goals and defined achievements. The model is based on scientific research about how children learn and is meant to be followed chronologically, although some steps may be repeated.

Science Talk and Oracy in T2L Units

Science talk is much more than talking about science. In line with the science and engineering practices, students are expected to make a claim that can be supported by scientific evidence. The MA STE Standards (and the NGSS) value the importance of engaging in an argument from evidence. NGSS defines how this practice takes form in the real world: *"In science, reasoning and argument are essential for identifying the strengths and weaknesses of a line of reasoning and for finding the best explanation for a natural phenomenon. Scientists must defend their explanations, formulate evidence based on a solid foundation of data, examine their own understanding in light of the evidence and comments offered by others, and collaborate with peers in searching for the best explanation for the phenomenon being investigated."*

Students are asked to participate in articulate and sensible conversations in which they are able to communicate their ideas effectively, listen to others to understand, clarify and elaborate ideas, and reflect upon their understanding. These forms of talk can be developed using scaffolds such as the A/B Talk protocol (below) and strategies for class discussions (from the Talk Science Primer, link below). Oracy is developed in the physical, linguistic, cognitive, and social-emotional realms; each of these realms can be expanded upon over time in order to develop a thoughtful speaker. Being able to display appropriate body language, use proper tone and grammar, be thoughtful and considerate thinkers, and allow space for other thoughts and opinions are all important facets of oracy to work on and through with students. Incorporating the appropriate scaffolding is an important aspect of fostering these skills. Techniques for teaching effective science talk often include modeling, discussion guidelines, sentence-starters, and generating roles, while gradually putting more responsibility on students to own their thinking and learning.

Part of creating a safe school environment for students is allowing them a space that is comfortable enough for them to express ideas and ask questions, while being validated for their thoughts and questions; students should be feel comfortable and confident when speaking and listening for understanding. Effective talk is an important part of being an active, intelligent member of a community and society. Successful development in oracy is important for future employability and general well-being of adults.
The following resources should be helpful examples of how to employ effective use of progressive oracy and science talk in your classrooms.

- Oracy in the Classroom: https://www.edutopia.org/practice/oracy-classroom-strategies-effective-talk
- Science Talk Primer: https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

• A/B Talk Protocol

Adapted from https://ambitiousscienceteaching.org/ab-partner-talk-protocol/

 1. Share your ideas **Partner A** • I think ______ happened because… • Evidence that supports my idea is… • The activity we did with ______ helps me know more about ______ because… • One thing I'm wondering about is…	2. Listen to Understand **Partner B**  • I heard you say ______. What makes you think that? • I heard you say ______. What if ______? • Can you explain the part about ______ again? • What do you mean when you say ______?
3. Clarify and elaborate **Partner A**  Answer partner's questions or ask for clarification in order to understand a question.	4. Repeat steps 2 & 3 until all questions are answered  
5. Switch roles and repeat steps 1-4  	6. Reflect on your understanding in writing • My idea about ______ changed when my partner said ______. • I will add ______ to my idea about ______ because… • I still have questions about… • I may be able to answer my question(s) if I could investigate ______.

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Teach To Learn
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Unit Activity Planner

Activity	Learning Targets	Science Connection to Phenomena	MA Standards
Lesson 1 **Activity 1:** Online Maps **Activity 2:** Daily Planet Earth Newspaper	• I can identify a physical map and its components. • I can read maps that depict mountain ranges, trenches, active volcanoes, and earthquakes.	Students will use maps to note patterns in the earth's surface. Specifically, how earthquake prone areas have volcanoes and mountains. Maps will help students learn that landforms are not randomly formed.	**Focus Standard: [2016] 4-ESS2-2.** Analyze and interpret maps of Earth's mountain ranges, deep ocean trenches, volcanoes, and earthquake epicenters to describe patterns of these features and their locations relative to boundaries between continents and oceans.
Lesson 2 **Activity 1:** Physical Properties of Minerals **Activity 2:** Mohs Hardness Scale **Activity 3:** Mineral Observation Stations **Activity 4:** Mineral	• I can perform appropriate tests to determine the hardness, color, luster, cleavage, and streak of different minerals. • I can note differences between rocks and minerals. • I can use previously	Students will learn about the formation of rocks which make up the earth's surface. For instance, from volcanic eruptions, igneous rocks form. In addition, the pressure and heat from the shifting of tectonic plates during	**Focus Standard: (4-ESS1-1) Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.** Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change

Identification **Activity 5:** The Mystery Rock Experiment **Activity 6:** Mineral Ad	recorded data to identify different minerals.	earthquakes form metamorphic rocks. Other rocks such as sedimentary rocks take a while to form, since it takes years of erosion to create the layers of particles which compose these rocks.	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.*]
Lesson 3 **Activity 1:** Weathering and Erosion **Activity 2:** Erosion and Abrasion Stations **Activity 3:** Washing Away Landforms **Activity 4:** Berkshire Landforms **Activity 5:** Mt. Greylock Article	• I can observe and describe examples of weathering through frost wedging, abrasion and tree root wedging. • I can observe and describe examples of erosion through wind, water, and ice. • I can explain the difference between “weathering” and “erosion”.	Students will learn how natural phenomenon such as the melting of glaciers, wind, floods, and other types of erosion and weathering create landforms such as sand dunes and valleys.	**(4-ESS1-1) Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.** [Clarification Statement: Examples of evidence from patterns could include rock layers with marine 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.] **4-ESS2-1**. Make observations and collect data to provide evidence that rocks, soils, and sediments are broken into smaller pieces through mechanical weathering and moved around through erosion. [Clarification Statements: Mechanical weathering processes can include frost wedging, abrasion, and tree root wedging. Erosion can include movement by blowing wind, flowing water, and moving ice.] [State Assessment Boundary: Chemical processes are not expected in state assessment.]
Lesson 4 **Activity 1:** Soil Exploration **Activity 2:** IMOWA Chart **Activity 3:** Soil Discovery	• I can explain how soil is formed through decomposition and weathering. • I can illustrate the connection between soil formation (e.g. ratios of organic matter to minerals) and its color and texture.	In this lesson, students will learn the effects of weathering and erosion. Specifically, how weathering and erosion break down rocks into smaller particles to create soil. Students will also learn how natural	

Activity 4: Soil Recipe **Activity 5:** Soil Drainage Test	• I can identify and describe the differences between soil, loam, and clay.	processes such as the decomposition of plant and animal matter create soil. In this way, students will learn how soil type plays a huge factor in natural disasters. Soil such as sand cannot hold a lot of water, so it is more susceptible to flooding.	
Lesson 5 **Activity 1:** Make your own fossil **Activity 2:** Fossilization Game **Activity 3:** Fossil Map **Activity 4:** Write about your fossil	• I can make write a story about my fossil and the life that it lived. • I can explain the differences between types of fossils.	Students will learn about what happened to the remains of the dinosaurs. The dinosaurs became fossils after years of erosion. As a result, they were buried in the sedimentary rock which makes up the earth's crust. In this way, students learn how fossils are embedded in the earth's surface.	**(4-ESS1-1) Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.** [Clarification Statement: Examples of evidence from patterns could include rock layers with marine 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

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			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.*]
Lesson 6 **Activity 1:** Volcano Simulation **Activity 2:** Ring of Fire Mapping **Activity 3:** Graham Cracker Plate Tectonics/Earthquake	• I can explain how plate tectonics create earthquakes and mountains. • I can discuss how volcanoes are formed and the effects of their eruptions on land. • I can model how earthquakes, mountains, and volcanoes are created.	In this lesson, students will learn how plate movements cause natural disasters such as earthquakes and volcanic eruptions. The tectonic plates also form landforms such as mountains.	**4-ESS2-2. (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.

Lesson 7 **Activity 1:** Floods **Activity 2:** "Safe Houses" **Activity 3:** Disaster Preparedness Game	• I can discuss three types of natural disasters including volcanic eruptions, earthquakes, and floods. • I can discuss the impacts of natural disasters and how to protect against or lessen the effects of these natural disasters.	Students will learn about the damages caused by natural disasters and prevention methods.	**[2016] 4-ESS3-2.** Evaluate different solutions to reduce the impacts of a natural event such as an earthquake, blizzard, or flood on humans. * [Clarification Statement: Examples of solutions could include an earthquake-resistant building or a constructed wetland to mitigate flooding.]

NGSS Alignment Table

Students who demonstrate understanding can:

(4-ESS1-1) Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. [Clarification Statement: Examples of evidence from patterns could include rock layers with marine 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.]

(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.*]

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	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations	**ESS1.C: The History of Planet Earth** Local, regional, and global patterns of rock formations reveal changes over time due	**Patterns :** Patterns can be used as evidence to support an explanation. (4-ESS1-1), (4- ESS2-2)

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1) **Analyzing and Interpreting Data** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Analyze and interpret data to make sense of phenomena using logical reasoning. (4-ESS2-2) **Constructing Explanations and Designing Solutions**	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) **ESS2.A: Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2) **ESS2.E: Biogeology** Living things affect the physical characteristics of their regions. (4- ESS2-1)	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1), (4-ESS3-2) --- **Connections to Engineering, Technology, and Applications of Science** <u>Influence of Engineering, Technology, and Science on Society and the Natural World</u> Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2) **Connections to Nature of Science** Scientific Knowledge Assumes an Order and Consistency in Natural Systems Science assumes consistent patterns in natural systems. (4-ESS1-1)

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Constructing explanations and designing solutions in 3– 5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Identify the evidence that supports particular points in an explanation. (4-ESS1-1) Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2)	**ESS3.B: Natural Hazards** A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.) **ETS1.B: Designing Solutions to Engineering Problems** Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2	

Connections to other DCIs in third grade: 4. ETS1.C (4-ESS3-2)

Articulation of DCIs across grade-levels:
: K.ETS1.A (4-ESS3-2); 2.ESS1.C (4-ESS1-1),(4-ESS2-1); 2.ESS2.A (4-ESS2-1); 2.ESS2.B (4-ESS2-2); 2.ESS2.C (4-ESS2-2); 2.ETS1.B (4-ESS3-2); 2.ETS1.C (4-ESS3-2); 3.LS4.A (4-ESS1-1); 5.ESS2.A (4-ESS2-1); 5.ESS2.C (4-ESS2-2); MS.LS4.A (4-ESS1-1); MS.ESS1.C (4-ESS1-1),(4-ESS2-2); MS.ESS2.A (4-ESS1- 1),(4-ESS2-2),(4-ESS3-2); MS.ESS2.B (4-ESS1-1),(4-ESS2-2); MS.ESS3.B (4-ESS3-2); MS.ETS1.B (4-ESS3-2)

Common Core State Standards Connections:
ELA/Literacy —

RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-ESS3-2)
RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. (4-ESS2-2)
RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-ESS3-2)
W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS1-1), (4-ESS2-1)
W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information and provide a list of sources. (4-ESS1-1), (4-ESS2-1)
W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-ESS1-1)

Mathematics –
MP.2 Reason abstractly and quantitatively. (4-ESS1-1), (4-ESS2-1), (4-ESS3-2)
MP.4 Model with mathematics. (4-ESS1-1), (4-ESS2-1), (4-ESS3-2)
MP.5 Use appropriate tools strategically. (4-ESS2-1)
4.MD.A.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS1-1), (4-ESS2-1)
4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale. (4-ESS2-1), (4-ESS2-2)

List of Unit Resources

Lesson 1

Quantity	Item	Source
1 map	**Political map**	**Bin**
1 map	**Road map**	**Bin**
1 map	**Attraction map**	**Bin**
1 map	**Topographical map**	**Bin**
1 map	**Physical map**	**Bin**
1 map	**Weather map**	**Bin**
1 per student	Laptop/iPad	Classroom Teacher
1 per student	Map Features Worksheet	CMC Website
1 per student	Google Earth Worksheet	CMC Website
1 per student	Blank Template of Massachusetts	CMC Website

Lesson 2

Quantity	Item	Source
1 per student	**Hand Lens**	**Bin**
5 White and 5 Black plates (1 per group)	**Streak plates**	**Bin**
5 per group	**Penny**	**Bin**
5 per group	**Nail**	**Bin**
1 box per class	**Mineral Kit - Includes 15 mineral samples**	**Bin**
1 per pair/group	**Limestone sample**	**Bin**
1 per pair/group	**Quartz sample**	**Bin**
1 per student	Science Journal	Classroom Teacher
	Rock Cleavage Video https://www.youtube.com/watch?v=zAOTfSWjw0Q&list=PLsAWD8mKKE95eF864ryLNK8SXJfJ-EsWh&index=1	CMC Website
1 piece	Chart Paper	Classroom Teacher
1	**“How to Describe Luster” Board**	**Bin**

1 per student	Rocks and Minerals Comparison Chart	Binder
1 per student	Mineral Observation Chart	Binder
1 per student	MCAS question	Binder
1	Minerals and Rocks PowerPoint	CMC Website
1 per student	GeoSquad Comic	Binder
1 per student	Daily Planet Earth Mineral Advertisement Template	CMC Website

Lesson 3

Quantity	Item	Source
1 per classroom	Computer + projector	Classroom Teacher
1 per classroom	Weathering & Erosion PowerPoint	CMC Website
1 per classroom	Activity Station Setup (Rock & Roll, and Swept Away: Hands on Nature p. 253-254 (each of these stations require numerous materials, be sure to use cornmeal for the swept away station rather than rice)	Binder

	What's Strong Enough to Make a Canyon? https://tinyurl.com/ybzlhu2g)	CMC Website
1 per group	Sticky tack	Bin
2 (1 per Splash station; 1 per Swept station)	**Baking pan**	**Bin**
1 per Splash station	**Tablespoon**	**Bin**
2 per student	3 oz. Dixie cups	Bin
1 per student	Spoon	Bin
1 per group	Paper plate and plastic plate	Bin
As needed	**Cinnamon**	**Bin**
As needed	**Salt**	**Bin**
1 per group	**2 binder clips**	**Bin**
1 per group	**2 plastic cups**	**Bin**
1 per group	**1 plastic condiment container**	**Bin**
1 per group	Ruler	Classroom Teacher
1 set per classroom	**Laminated Images of Berkshire Landforms**	**Bin**

As needed	Water	Classroom Teacher
2 per Rock station	**Clean, sealable plastic container**	**Bin**
3 handfuls (2 per Rock station; 1 per Swept station)	**Stones**	**Bin**
1 per classroom	Small bag of cornmeal	Bin
1 handful per Swept station	**Blocks of wood**	**Bin**
1 per student	Straws	Bin
1 per student	"Preparing for Disaster" reading	Binder
1 per student	"Watch for Steady Rocks" reading	Binder
1 per student	Paired Text Questions Worksheet	Binder
10	**Small plastic dinosaurs**	**Bin**

Lesson 4

Quantity	Item	Source
2 cups per student	Soil from Decaying Matter	Bin
1 per student	Wooden skewers	Bin
As needed to cover desks	Newspaper	Classroom Teacher
1 per student	**Hand Lens**	**Bin**
2 per class	**Sieve**	**Bin**
1 per student	Science Journal	Classroom Teacher
1 piece	Chart paper	Classroom Teacher
15 (3 per group)	**Soda Bottles (funnel, planter, screen)**	**Bin**
15 cups (3 cups per group)	**Sand**	**Bin**
15 cups (3 cups per group)	Potting soil	Bin

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15 cups (3 cups per group)	Clay	Bin
As needed	Water	Classroom Teacher
5 (1 per group)	**Measuring cup**	**Bin**
1	Spencer PowerPoint	CMC Website
1	Daily Planet Earth Soil Recipe Template	CMC Website
1	IMOWA Chart	Binder

Lesson 5

Quantity	Items	Source
6 (two of each type)	**Different types of fossils**	**Bin**
1 bag	Whole Wheat Flour	Bin
2 containers	Salt	Bin
1	**Measuring cup (that can measure at least 1 cup)**	**Bin**

	Various items to press into salt dough to make fossils	Classroom Teacher/Outdoors
1 per student	Fossil Handout	Binder (teacher to make copies)
	Fossil PowerPoint	CMC Website
	Daily Planet Earth Fossil Article Template	CMC Website
	Laptops/iPads	Classroom Teacher

Lesson 6

Quantity	Item	Source
4 packages	**Modeling clay / Play Doh**	**Bin**
1	**Small plastic cup**	**Bin**
1 tablespoon	Flour	Bin
2 tablespoons	Baking soda	Bin

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⅓ cup	**Vinegar**	**Bin**
1 4” square	Tissue Paper	Bin
1 roll	Paper towels (for cleanup)	Classroom Teacher
1 per student	Scissors	Classroom Teacher
1	**Large rectangular plastic bin**	**Bin**
1 per student	Science Journal	Classroom Teacher
1 per student	Laptop/iPad	Classroom Teacher
	Projector	Classroom Teacher
1 per student	Plastic plates	Bin
2 boxes	Graham Crackers	Bin
3-4 containers	Cool Whip	Contact Sue Beauchamp

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2	**Plastic Bowls**	**Bin**
	Daily Planet Earth Natural Disaster Article Template	CMC Website
	Izzy and Maggie Geosquad Comic	Binder (teacher to make copies for students)
	How to Draw the Geosquad Instructions	CMC Website

Lesson 7

Quantity	Item	Source
1 per student	"Safe Houses" Article (2 pages)	Binder
4 packages	**Modeling clay / Play Doh**	**Bin**
1 roll	Paper towels (for cleanup)	Classroom Teacher
1 per student	Scissors	Classroom Teacher
1	**Large bin or bucket**	**Bin**
1 per student	Science journal	Classroom Teacher
1	Floods in North Adams PowerPoint	CMC Website

1	Dinosaur Extinction Powerpoint	CMC Website
1 per student	Laptop/iPad	Classroom Teacher
	Projector	Classroom Teacher
1 container	**Legos**	**Bin**
6	**Aluminum Pans**	**Bin**
12 boxes	Jello Mix	Bin
30 per student	Mini marshmallows	Bin
30 per student	Toothpicks	Bin
2 boxes	Popsicle sticks	Bin
As needed	Building blocks	Classroom Teacher
As needed	Tape	Classroom Teacher
1 roll	**String**	**Bin**
2 boxes	**Plastic spoons**	**Bin**
1 per group	Paper plate	Bin
1 per group	Brass Fastener	Bin

1 per group	Paper clip	Bin
2 per group	**Cups**	**Bin**
As needed	Glue	Classroom Teacher
1 per student	Geosquad Flood Comic	Binder
1 per student	Blank Comic Templates	CMC Website
1 per student	Daily Planet Earth How to Survive a Natural Disaster Article Template	CMC Website
	Geosquad Flood Video	CMC Website

CEPA

Quantity	**Item**	**Source**
3 (1 per group)	**Geographic map of Mt. Greylock**	**Bin**
3 (1 per group)	**Rectangular clear plastic container**	**Bin**
15 cups (5 cups per group)	**Topsoil**	**Bin**
As needed	Rocks (small to medium in size)	Classroom Teacher

As needed	Straws (cut down the middle)	Bin
As needed	Popsicle sticks	Bin
1 per group	**Clean ketchup bottle**	**Bin**
As needed	Water (to fill ketchup bottles with)	Classroom Teacher
1 per student	Science journal	Classroom Teacher

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