Formative Assessment Exemplar - 7.2.2

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

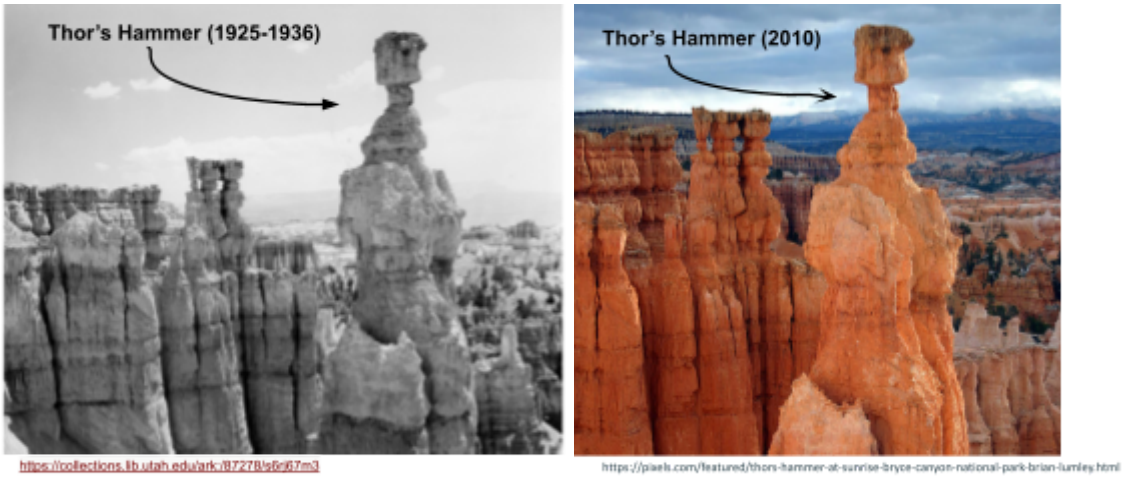
References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Teacher Facing Information

Standard: 7.2.2

Assessment Format: Printable or Online Format (Does not require students to have online access)

Phenomenon	
Thor's hammer is one be the best-known hoodoos in Bryce's Canyon National Park. The look of Thor's Hammer continues to change as shown in Figure 1.	Proficient Student Explanation of Phenomenon:
Cluster Task Statement	
(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed) In the questions that follow, you will using pictures and other resources, construct an explanation for how rock processes have changed the landscape of Bryce Canyon National Park over time.	
Supporting Information	
Figure 1 - Thor's Hammer 1936 - 2010  https://collections.lib.utah.edu/ark:/87278/s6nj67m3 https://pixels.com/featured/thors-hammer-at-sunrise-bryce-canyon-national-park-brian-lumley.html This figure shows the changes that have occurred to Thor's Hammer from 1936 until 2010. Figure 2 - Formation of Hoodoos	

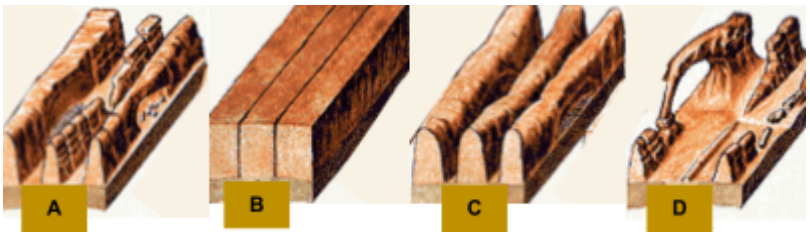
This figure shows how a hood forms from a plateau (1) then as rocks break it forms walls (2), windows (3), and then individual hoodoos(4). *Brian Roanhorse/NPS* https://www.nps.gov/brca/learn/nature/hoodoos.htm

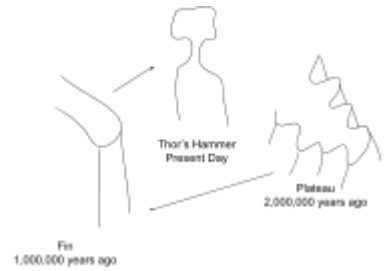
Table 1 (below) defines some different rock processes that play a role in changing the Earth's Surface.

Table 1 - Information about Different Rock Processes

Rock Processes	Abrasion	Dissolving	Ice Wedging	Plant Root Growth
Description	Rocks can be worn down by friction, as they rub past one another. This can happen as rocks tumble down against another rock.	As rainwater mixes with carbon dioxide it creates an acid that dissolves rock.	Rainwater fills small cracks in a rock. As water freezes, it expands, which causes the cracks to widen and split the rock apart.	When plants grow in the cracks of rocks, their roots can wedge open cracks.

Cluster Questions	
Gather: Cluster Question #___1___ Question Type: Multi Select Addresses: __X__ DCI: (ESS2.A) _____ SEP __X__ CCC (Cause and Effect) Answer: a. weathering d. Erosion e.Abrasion f.freezing - ice wedging G. dissolving	Question 1: Based on the diagram in Figure 1, choose the three following rock processes contribute to the formation of Thor's Hammer in Bryce Canyon National Park? Choose the three that apply. a. Weathering b. Melting c. Plant Growth d. Erosion e. Abrasion f. Ice Wedging g. Dissolving h. Deformation
Reason: Cluster Question #___2___ Question Type: Multiple Choice Addresses:	Question 2: Compare the pictures of Thor's hammer taken about 80 years apart in Figure 1. Using what you understand about these processes and the pictures provided, which statement best describes the scale of

__X__ DCI (ESS2.A) _____ SEP __X__ CCC (Scale) Answer: C. Slow changes happened to the rock formation over thousands of years and continue happening each year	change that has taken place? A. Rapid changes are occurring each year causing significant changes to the rock formation B. Rapid changes happened in the past but the rock formation currently isn't experiencing any additional changes C. Slow changes happened to the rock formation over thousands of years and continue happening each year D. Slow changes only happened in the distant past to the rock formation causing it to look the exact same for the past 80 years
Cluster Question #___4___ Question Type: Matching Addresses: __X__ DCI (ESS2.A) __X__ SEP (Construct an Explanation) __X__ CCC (Scale) Answer: A: 3 million years ago B: 2 million years ago C: 1 million years ago D: Present Time	Question 3: The picture above shows four stages of formation for natural arches, which has a similar formation process to the hoodoos in Bryce Canyon. The stages are not in sequential order. Match each stage of formation with a possible age to put them in their correct sequence.  Time Options: Present Time 100 years ago 500 years ago 1,000 years ago 1 million years ago 2 million years ago 3 million years ago A:_____ B:_____ C:_____ D:_____
Communicate: Cluster Question #___4___ Question Type: Model Addresses:	Question 4: Create a model to explain how the hoodoo "Thor's Hammer" may have been created. Draw at least 3 stages of the creation process and label an approximate time each of the stages occurred.

__X__ DCI (ESS2.A) __X__ SEP (Construct an Explanation) __X__ CCC (Scale) Answer:  Other possible answers similar to diagrams in the supporting information.	
Communicate: Cluster Question #___5___ Question Type: Short Answer Addresses: __X__ DCI (ESS2.A) __X__ SEP (Construct an Explanation) __x__ CCC (Scale) Answer: It will experience a little more erosion, but will still mostly look the same	Question 5: Explain how the hoodoo "Thor's Hammer" might look 100 years from now.
Communicate: Cluster Question #___6___ Question Type: Short Answer Addresses: __X__ DCI (ESS2.A) __X__ SEP (Construct an Explanation) __X__ CCC (Scale) Answer: It will have eroded a lot and may not even be standing anymore.	Question 6: Explain how the hoodoo "Thor's Hammer" might look 1 million years from now.
Proficiency Scale	
Proficient Student Explanation: The changes that are happening to Thor's Hammer are occuring gradually over long periods of time	

due to the different rates of erosion from wind and water runoff and ice wedging

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending
SEP: Does not meet the minimum standard to receive a 2.	**SEP:** Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard). Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. Identify the evidence that supports particular points in an explanation.	**SEP:** Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. Construct an explanation using models or representations. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real	**SEP:** Extends beyond proficient in any way.

		world phenomena, examples, or events. Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.	
CCC: Does not meet the minimum standard to receive a 2.	**CCC:** Recognizes natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. Uses Standard units to measure and describe physical quantities such as weight, time, temperature, and volume.	**CCC:** Observes time, space, and energy phenomena at various scales using models to study systems that are too large or too small. Recognizes that the observed function of natural and designed systems may change with scale and that proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. Recognizes scientific relationships can be represented through the use of algebraic expressions and equations. Observes phenomena	**CCC:** Extends beyond proficient in any way.

		at one scale may not be observable at another scale.	
DCI: Does not meet the minimum standard to receive a 2.	**DCI:** 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. Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. ESS2.C The Roles of Water in Earth's Surface Processes Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in	**DCI:** ESS2.A Earth Materials and Systems All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. ESS2.C The Roles of Water in Earth's Surface Processes Water's movements—both on the land and underground—cause weathering and	**DCI:** Extends beyond proficient in any way.

	streams, lakes, wetlands, and the atmosphere.	erosion, which change the land's surface features and create underground formations.	

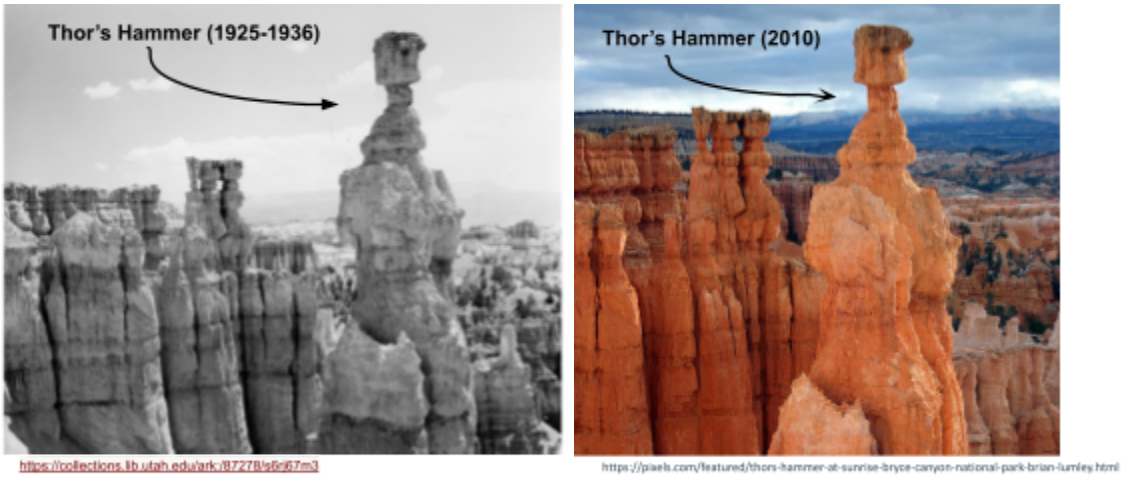
(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

Thor's hammer is one be the best-known hoodoos in Bryce's Canyon National Park. The look of Thor's Hammer continues to change as shown in Figure 1.

Figure 1 - Thor's Hammer 1936 - 2010



This figure shows the changes that have occurred to Thor's Hammer from 1936 until 2010.

Figure 2 - Formation of Hoodoos

This figure shows how a hood forms from a plateau (1) then as rocks break it forms walls (2), windows (3), and then individual hoodoos(4). *Brian Roanhorse/NPS https://www.nps.gov/brca/learn/nature/hoodoos.htm*

Table 1 (below) defines some different rock processes that play a role in changing the Earth's Surface.

Table 1 - Information about Different Rock Processes

Rock Processes	Abrasion	Dissolving	Ice Wedging	Plant Root Growth
Description	Rocks can be worn down by friction, as they rub past one another. This can happen as rocks tumble down against another rock.	As rainwater mixes with carbon dioxide it creates an acid that dissolves rock.	Rainwater fills small cracks in a rock. As water freezes, it expands, which causes the cracks to widen and split the rock apart.	When plants grow in the cracks of rocks, their roots can wedge open cracks.

Your Task

In the questions that follow, you will using pictures and other resources, construct an explanation for how rock processes have changed the landscape of Bryce Canyon National Park over time.

Question 1

Based on the diagram in Figure 1 and information in Table 1, choose the three following rock processes contribute to the formation of Thor's Hammer in Bryce Canyon National Park? Choose the five that apply.

a. Weathering
b. Melting
c. Plant Growth
d. Erosion
e. Abrasion
f. Ice Wedging
g. Dissolving
h. Deformation

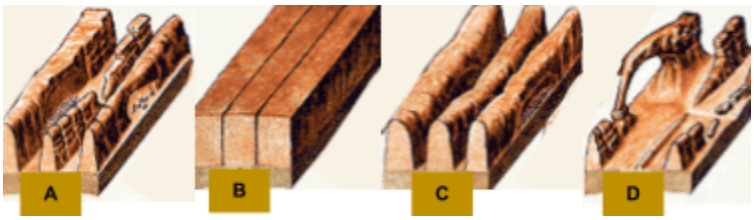
Question 2

Compare the pictures of Thor's hammer taken about 80 years apart in Figure 1. Using what you understand about these processes and the pictures provided, which statement best describes the scale of change that has taken place?

a. Rapid changes are occurring each year causing significant changes to the rock formation.
b. Rapid changes happened in the past but the rock formation currently isn't experiencing any additional changes.
c. Slow changes happened to the rock formation over thousands of years and continue happening each year.
d. Slow changes only happened in the distant past to the rock formation causing it to look the exact same for the past 80 years.

Question 3

The picture above shows four stages of formation for natural arches, which has a similar formation process to the hoodoos in Bryce Canyon. The stages are not in sequential order. Match each stage of formation with a possible age to put them in their correct sequence.



Time Options:
Present Time - 100 years ago - 1,000 years ago - 1 million years ago - 2 million years ago - 3 million years ago

A:_____
B:_____
C:_____
D:_____

Question 4

Create a model to explain how the hoodoo “Thor’s Hammer” may have been created. Draw at least 3 stages of the creation process and label an approximate time each of the stages occurred.

Question 5

Explain how the hoodoo “Thor’s Hammer” might look 100 years from now.

_____

_____

_____

_____

_____

Question 6

Explain how the hoodoo “Thor’s Hammer” might look 1 million years from now.

_____

_____

_____

_____

_____