Erosion and Weathering Observational Activity

Standard 7.2.1: Develop a model of the rock cycle to describe the relationship between energy flow and matter cycling that create igneous, sedimentary, and metamorphic rocks. Emphasize the processes of melting, crystallization, weathering, deposition, sedimentation, and deformation, which act together to form minerals and rocks. (ESS1.C, ESS2.A).

Standard 7.2.2: Construct an explanation based on evidence for how processes have changed Earth's surface at varying time and spatial scales. Examples of processes that occur at varying time scales could include slow plate motions or rapid landslides. Examples of processes that occur at varying spatial scales could include uplift of a mountain range or deposition of fine sediments. (ESS2.A, ESS2.C).

Background: The goal of this activity is to give participants an opportunity to observe and describe erosional and weathering features firsthand, improving their understanding of the processes that lead to outcrops of igneous, metamorphic, and sedimentary rocks to become sediments and soils at varying time scales.

The process of **weathering** can be divided into two categories: *mechanical weathering and chemical weathering.* Put simply, mechanical weathering is the physical breakdown of rocks into smaller fragments, and chemical weathering is the chemical change of minerals within the rock. These processes can be further categorized in the following ways:

Mechanical Weathering:

- **Frost Wedging/Freeze Thaw:** Freezing and thawing of water in cracks in the rock.
- **Exfoliation:** Decrease in pressure that results from removal of overlying rock and/or uplift.
- **Salt Weathering:** Formation of salt crystals within the rock that push grains apart.
- **Biotic Weathering:** Such as cracking from plant roots.

Chemical Weathering:

- **Hydrolysis:** An example is acid rain dissolving limestone or reacting with plagioclase feldspar to form kaolinite. This can also be caused by respiring plants.
- **Oxidation:** An example is oxygen and water on the surface reacting with pyrite to form dissolved iron ions and sulphuric acid.

Erosion is the removal material on the Earth's surface from one location to another. It is different from weathering because erosion implies motion, while weathering is stationary.

Like weathering, erosion can be broadly classified into *mechanical erosion and chemical erosion*. Examples of mechanical weathering being caused by water, wind, glaciers, plants, animals, and humans. Chemical erosion is closely related to chemical weathering, where chemical weathering is the process where material is broken down *in place* into solutes and chemical erosion is the process of carrying those solutes away. For example, the formation of karst topography results from ground water dissolving soluble rocks, such as limestone, and then carrying the solutes off.

Materials: For the observational part of this activity the participants will need access to an area outside that is exposed to weathering, ideally an area with multiple types of rocks. Some good locations include parks, graveyards, sculpture gardens, fields, and riverbeds. Ideally, whatever site is chosen should be scouted first to make sure that multiple examples of mechanical and chemical weathering are present.

While all that is really needed are something to write on and something to write with, some useful items to bring along could be:

- Magnifying glasses
- Rulers or other things to measure with
- Cameras to take pictures to look at later
- Bags/Vials to collect soil and/or sediment
- A shovel (where light digging would be permitted)

Directions: The primary goal is to give the participants an opportunity to explore, observe, and describe weathering features, so this activity is mostly self-driven. Whenever you and the participants arrive at your chosen location, it has been helpful to find a feature and then to go through the motions of describing it with them, to help them recognize what is important and ways they can systematically go about describing a feature.

Before you set them loose around your chosen area, make sure to set clear boundaries of where people can go explore, especially if you are near private property. Give them time expectations on how long they will have to look and around and describe what they find. It could be helpful to call everyone together about halfway through to discuss what people have already found and to describe it to one another, giving them a chance to not only see and listen to how other people are recording observations, but also a chance for them to share their findings.

How many features you want to be described could vary based on time allowed, class dynamics, the location, or the weather, but two or three is usually a good number. This activity could also be done on the participant's own time, if they live in a place that has easy access to natural features. Included alongside the observation sheets are some synthesis questions that could be done alongside the observational activity or afterwards.

Online Resource: A useful resource is a free online textbook, *Physical Geology,* by Stephen Earle.

https://opentextbc.ca/physicalgeology2ed/

Name: _____

Weathering and Erosion Observation

Field Site Name: _____

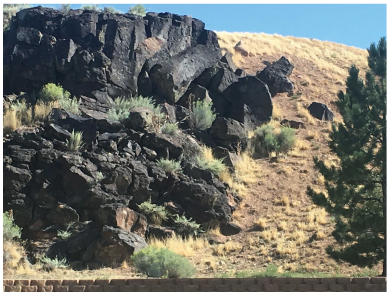
What colors do you see?	
What patterns do you notice?	
Are there shiny, dull, or sparkly surfaces?	
What does it feel like?	
What rock types are present here?	
Describe two other features of what you see:	- -
What surface processes are affecting this outcrop? (Be specific)	
Is this an example of mechanical weathering or chemical weathering (or both)?	
Hypothesize what this outcrop may look like in 100 years if the weathering continues the way it has been (say why you think so)	

Name: _____

In the space below draw a simple sketch of the outcrop. Be sure to point out the features you described in your observations:

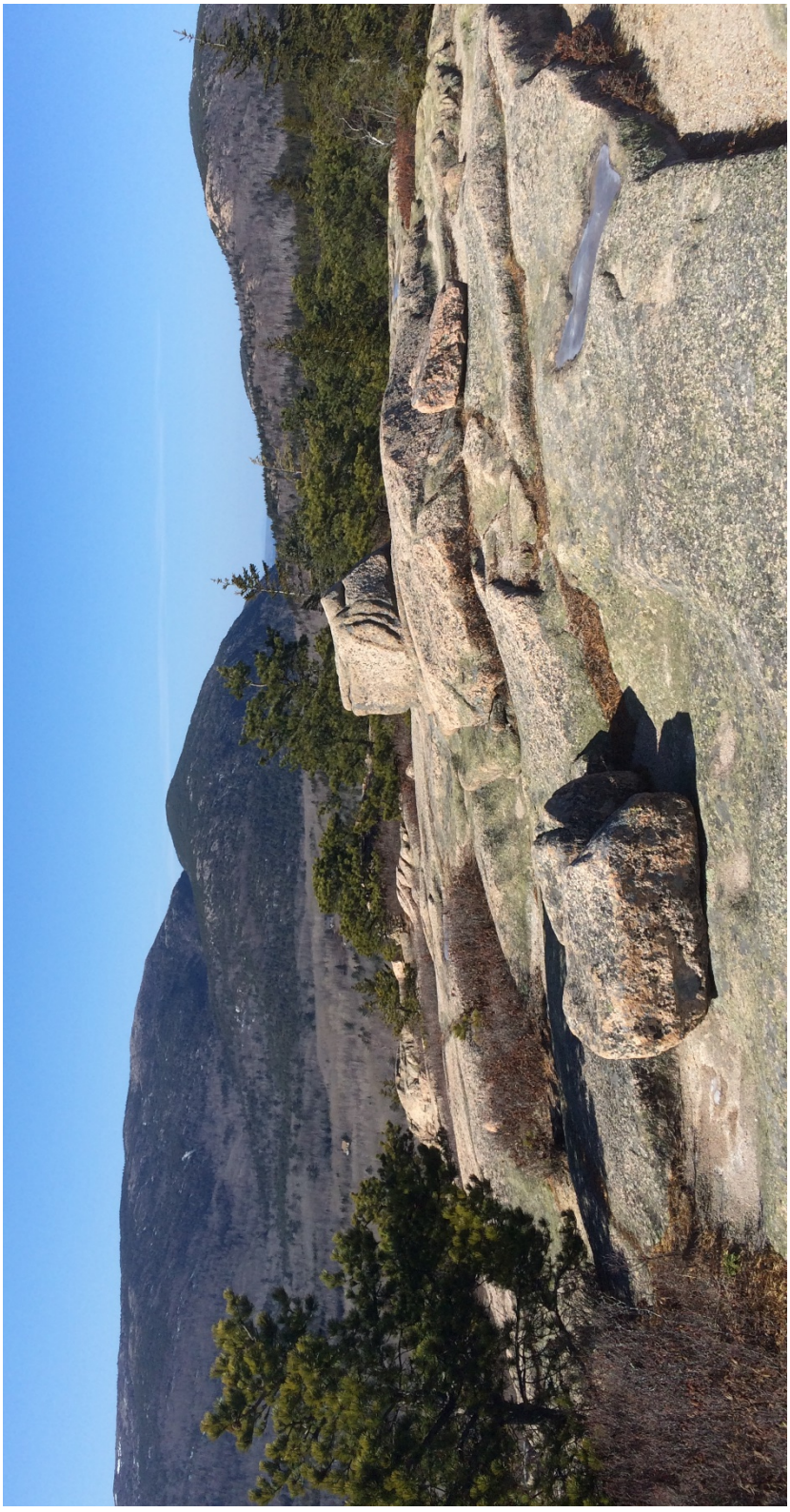
Name: _____

Match the sediments with the outcrops that they most likely weathered from.



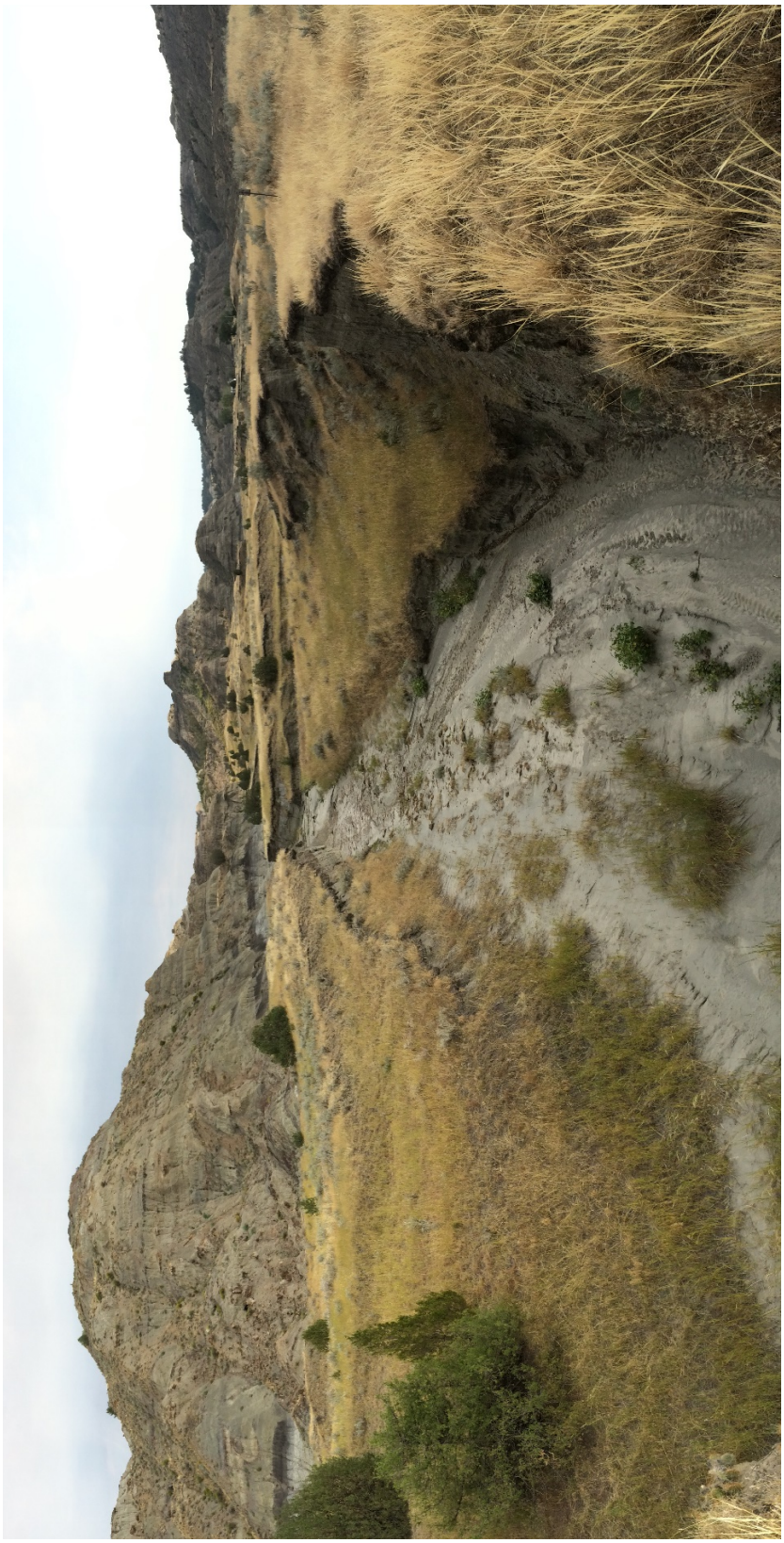
Name: _____

In the following pictures identify any two examples of weathering or erosion.



(Acadia National Park, Maine)

Name: _____

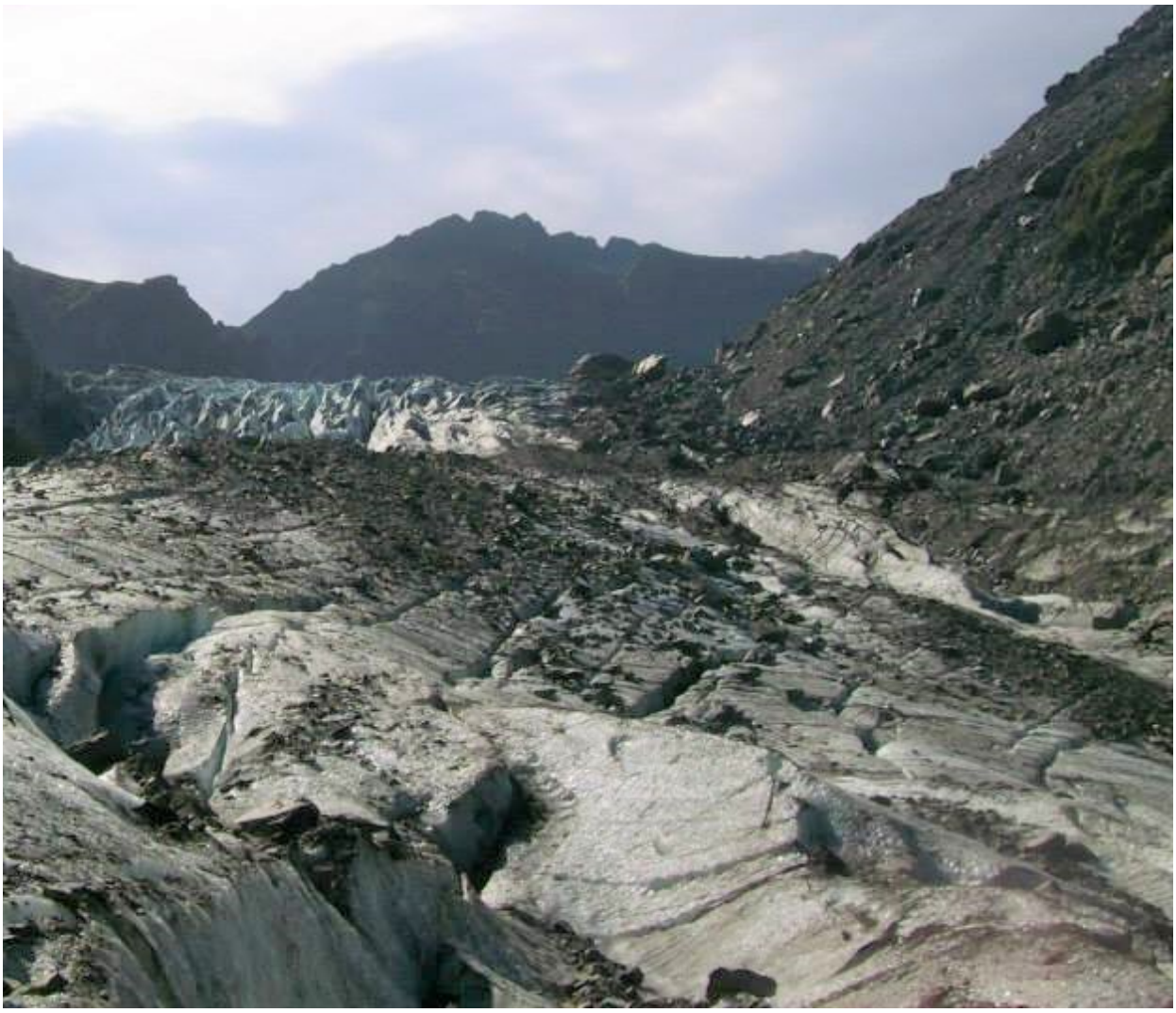


(Makoshika State Park, Montana)

Name: _____

(Yellow Stone National Park, Wyoming)

Name: _____



(Fox Glacier, New Zealand)

Name: _____

What weathering and erosional forces will a sandstone slab in a hot and windy desert experience? What about a granite slab in a cold and wet forest? Which do you think will break down faster?

The sandstone slab will experience primarily wind erosion, while also being impacted by exfoliation and the occasional rainstorms. The granite slab will experience freeze thaw, exfoliation, mechanical weathering from tree roots and other plants. Which will break down faster is a complicated question and is dependent on many factors, so having good reasoning is more important than a strictly correct answer.

Why do you think the mineral quartz is the most abundant grain of sand?

The two primary reasons are that quartz is one of the most abundant minerals on earth and that it is very stable on Earth's surface. So not only is there more of it than many other minerals, it is more likely not to react and form new minerals before being deposited as angular to rounded sand.

How does plate tectonics play a role in weathering and erosion?

This question is very broad and open ended. One of the major examples, however, is that mountain building and uplift expose many rocks to the surface.

Billions of years ago the atmosphere on Earth had much less oxygen than it does today, how do you think this might have impacted weathering and erosion?

This is another broad question, but some examples are that oxidation processes would have been much less impactful. If the atmosphere was much higher in CO_2, chemical weathering from acid rain would have been more pronounced.

In what ways can plants increase rates of weathering and erosion and in what ways can they decrease rates of weathering and erosion?

Plant roots can break and expose rocks causing weathering and can produce carbonic acid also causing weathering. At the same time, plant roots can consolidate material and reduce erosion (you can see this in the Makoshika photo).