Appendix 1

Cycling Materials of Planet Earth

For the investigation of soils, rocks, and minerals

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1 HOW CAN WE CHARACTERIZE ROCKS?

The Earth's crust is composed of matter known as rocks.

In this activity, we identify and characterize rocks based on their properties.

A: Characterization of rocks

1. To gain experience with the characterization of rocks, practice by playing the following "game":
   In front of you are ten different types of rocks. Take a few minutes to look over the rocks, and pick one rock without letting your team members know which one you chose.
   Take turns, describing a characteristic of your chosen rock to your classmates. The winner is the one who uses the largest number of characteristics to describe the chosen rock.
   (**Hint:** Start the description with properties that represent the largest number of rocks, rather than the most prominent property of the chosen rock).

2. In the left column of the following table (ignore the right column for now), write down the properties you used that helped you describe the rocks. (For example, if your description is a statement like: "I chose the rock that is the smallest of the rocks," then the property would be "size").

Properties that were helpful	Type of Property (permanent / not permanent)
a.	
b.	
c.	
d.	
e.	
f.	

Permanent and non-permanent properties used to characterize rocks

There are some properties which can be used to describe a rock in any situation. These properties are related to the internal characteristics of the rock, and are therefore also valid when the shape or size of the rock changes as a result of weathering or erosion. For example, the property of hardness is a permanent property. If we break a rock, each of its fragments have the same hardness as the original, and therefore may be used to identify it based on this property.

In contrast with permanent properties, there are some non-permanent properties that are not related to the internal characteristics of the rock. If the rock undergoes external changes, these properties change. For example, the property "size" is not permanent. If we break the rock, each fragment will have different sizes, compared to the original, however the properties of all the fragments will remain the same, because they are all still the same material! Therefore, the property "size" is not a helpful property with which to characterize rocks.

3. Now, fill in the second column in the table above ("Type of Property"). Decide whether each property you listed is permanent or not.

Permanent properties are used to identify rocks in geology[1].

When we want to identify rocks, we use only the permanent properties, which deal with the internal characteristics of the rock, and do not change regardless of the sample used. Therefore, the list of properties that a geologist uses to identify rocks in the field include:

- ★ **Color**
- ★ **Malleability**
- ★ **Friability**
- ★ **Hardness**
- ★ **Reaction to dilute hydrochloric acid**

The following sections will help you classify the rocks according to the properties mentioned above.

1. The field of Earth Sciences that deals with the world of rocks is known as Geology (Geo – Earth, -logy – study of) and the researchers in this field are known as geologists.

B: Classification of rocks according to their properties

How can we examine the color property of rocks?

The colors of an exposed surface of rock can vary due to contact with air and water. Therefore, it is important to examine the properties of color in a piece of rock that shows a recently cut "fresh" surface.

1. Classify the rocks in front of you according to the color property. Detail the type of test, the category according to which each rock was classified, and the number of rocks that were in each group. Record your observations in the table.

Property	Type of Test	Classification Group (Categories)	Number of Rocks in the Group
		1. White 2. Yellowish 3. Greenish 4. Red 5. Brown 6. Black 7. Other:_____	_____ _____ _____ _____ _____ _____ _____

How can we examine the property of malleability in rocks?

To examine whether a rock is malleable, you need to put a drop of water on it, and rub the wet area with a finger. If you can mold a piece of the rock between your fingers, like kneading clay, it is a sign that the material that makes up the rock reacts with the water, and becomes malleable.

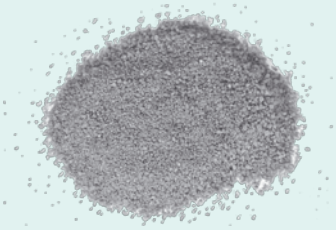
2. Classify the rocks in front of you according to the property of malleability. Detail the type of test, the category according to which each rock was classified, and the number of rocks that were in each group. Record your observations in the table.

Property	Type of Test	Classification Group (Categories)	Number of Rocks in the Group
Malleability	We placed a drop of water on the rock and examined whether it was possible to mold a piece of the rock between our fingers.	1. Not malleable 2. Slightly malleable 3. Very malleable	_____ _____ _____

How to examine the property of friability of rocks?

The friable rocks are those that can be broken up using your finger, into sand-sized grains.

Pay attention! A rock that disintegrates into a fine powder should also be classified as a friable rock!



3. Classify the rocks in front of you according to the property of friability. Detail the type of test, the category according to which each rock was classified, and the number of rocks that were in each group. Record your observations in the table.

For the next task, you will need the rocks that were categorized as friable. Place those separately on a tray.

Property	Type of Test	Classification Group (Categories)	Number of Rocks in the Group
Friability		1._____ 2._____	_____ _____

How do we examine the property of hardness of rocks?

The test for hardness of a friable rock will be different from those that are not friable (as explained below). Start with the hardness tests of rocks that are **not friable**.

Hardness test in rocks that are not friable:

In non-friable rocks, you can examine the property of hardness by scraping rocks with easily accessible instruments that have different degrees of hardness.

To examine the hardness of a non-friable rock, you can try to scratch the rock with a metal tool, such as a nail or hammer. If the metal tool leaves a mark or scratch, we can infer that the hardness of the rock is high.

It is important to note that sometimes the rock shows a scratch-like mark, but in fact, this is not due to an actual scratch. This line can be "erased" easily, by cleaning the area with a little water. This is evidence of the **high degree of hardness** of the rock.

If the rock is scratched by a metal instrument, try to scratch it with your fingernail. If the rock is scratched with a metal instrument, but cannot be scratched by your fingernail, we conclude that the rock has a **medium degree of hardness**.
If the rock is scratched by a metal tool, and your fingernail, we can conclude that the rock has a **low degree of hardness**.

4. Select the rocks belonging to the group "non-friable" according to the classification carried out in the previous activity, and determine their hardness using the scratch test. Record your observations in the table.

Property	Type of Test	Classification Group (Categories)	Number of Rocks in the Group
Scratch test to determine hardness		1. Is scratched with a fingernail 2. Not scratched with fingernail, but scratched by metal. 3. Not scratched by metal.	_____ _____ _____

Hypothesis

5. Why can't you examine the hardness of friable rocks by scratching them?
Can you think of an alternative method for determining the hardness of brittle rocks?

_____

_____

Examination of the hardness of friable/brittle rocks:

When we try to scratch crumbly rocks, the rock breaks apart into particles or grains. Because the small grains that make up the crumbly rock cannot be scratched with a nail, geologists examine the property of hardness of friable rock particles by grinding them in their teeth.

How to examine the hardness of a friable rock by grinding?

Break apart the rock into small pieces, place several pieces between your front teeth, and try to crush them..

If the granules are ground between the teeth, we can conclude that they have a low degree of hardness.

If the granules are not ground between the teeth, we can conclude that they have a high degree of hardness.

(Remember the last time you ate a sandwich on the beach. Certainly, you've experienced the sound and feeling when granules are not crushed...)

6. Select the rocks that were classified as "friable" in your previous classification, and determine their hardness by grinding.

Property	Type of Test	Classification Group (Categories)	Number of Rocks in the Group
Hardness determined by grinding (only in friable rock) Note: Only for sandstone and gravel.		1. _____ 2. _____	_____ _____

How can we examine the property in which rocks react with dilute hydrochloric acid?

To examine the reaction of rocks with dilute hydrochloric acid, you will place a drop of acid on the rock to clean it, and then squeeze another drop on the clean area. If gas bubbles are released in response to the acid contacting the rock, then this means that the rock is composed of a material that reacts with dilute hydrochloric acid. The reaction is known as effervescence.

7. Classify the rocks in front of you according to whether they react with dilute hydrochloric acid. Record the details of the test, and the category to which you classify each of the rocks. Record your observations in the table.

Property	Type of Test	Classification Group (Categories)	Number of Rocks in the Group
Reaction to dilute hydrochloric acid		1._____ 2._____ 3._____	_____ _____ _____

Where do we go from here?

In this activity, we learned that rocks can be classified in different ways, based on various properties. In the next activity, we will see how the rocks can be identified based on a specific set of properties that you've determined in advance.

2 HOW CAN WE IDENTIFY THE ROCKS?

In front of you are ten rocks that you classified in the previous activity, along with ten identification cards that go along with these rocks. Try to classify the rocks according to the ID cards.

How can we identify a rock described by an ID card?

To identify a rock, you will need to classify the rock several times, each time according to another property described on the card. In each separate classification round, only the rocks that match the chosen card will be selected, which will reduce the number of initial rocks. In other words, at each stage, you will classify only those rocks that correspond to the card in the previous stages.

Detailed instructions for identifying the rocks are below.

Instructions for the identification of rocks by ID cards:

a. Pick a card and read the first property described.
   Note: The cards include terms that you may not know yet, and so you will not be familiar with the properties.

b. Sort all the rocks according to the first property listed on the card, and form two piles: one pile of rocks that match, and another pile of rocks that do not match this property. (For example: if the first property on the card is "white, yellow, or red", then all the rocks should be classified according to color. Therefore, you will form a pile of the white, yellow, and red rocks, and another pile with the rest of the rocks).

c. Next, classify the rocks that correspond just to the first property, according to the second property indicated on the card. In this way, you can determine which rocks correspond to both the first and second properties. (For example, if the second property on the card is "high malleability", sort from the pile of white, yellow, and red rocks only those that are also highly malleable).

d. Continue sorting in this way until you have found the rock that has all the properties listed on the card. The name of the rock is listed at the bottom of the card!

e. Place each rock next to the appropriate ID card so your teacher can be sure they've been identified correctly.

Pay attention!
When considering the hardness of a rock, remember the two methods from the previous activity:
If the rock is friable, examine the hardness by grinding the grains between your teeth (in this case, you cannot examine the hardness by scratching), and if the rock is not friable, examine the hardness by scratching (in this case, you cannot examine the hardness by grinding).

Table of properties of the examined rocks:

Name of Rock	Prominent properties to help identify the rock in the future
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

3 THE LINK BETWEEN THE PROPERTIES OF ROCK AND ITS COMPOSITION

In the previous activity, you identified rocks based on a group of properties that characterize them. The question is: Where did the properties of each rock originate?
In the next two activities, you will try to answer this question.

A: Property of Taste

1. In the previous activity you worked with ten rocks and three minerals.

What are minerals?
At this stage, we will refer to the mineral as the building block of rocks: minerals are the materials that make up rocks. There are rocks that are composed of a single mineral, and there are rocks that are composed of several minerals. In the following activity, we will try to determine what minerals and rocks are, based on their chemistry.

Observations

Examine the taste property in the three minerals in front of you. Which of the minerals is the saltiest?

How do I examine the taste property?

Find the mineral that has the saltier taste.

It is possible that the mineral has a salty dust due to friction with other minerals in the box, and therefore, the minerals will all taste a bit salty. Therefore, as a first step, wash the minerals with a little water.

Conclusion

Name of mineral (use the ID cards to help you): _____

Complete the table below, which will help you identify this mineral in the future.

Name of mineral	Relevant properties that will help me identify the mineral in the future

Hypothesis

2. There is a rock that is composed entirely of the newly identified mineral.
   Which property do you think will characterize this rock? _____

Conclusion

3. Examine the rocks found on the tray. Which rock is composed of the mineral you just identified?

Additional Information

To answer this question, assume that the mineral is the only one identified that tastes salty in the collection of soils, rocks, and minerals. This assumption is based on the fact that the other minerals rarely taste salty, and the possibility of finding one is slim.

Use the ID cards to find the **name of the rock**: _____.

Property of Malleability

Observations

1. Examine the minerals on the tray with respect to the property of malleability. Which mineral becomes highly malleable when it comes in contact with water?
   Name of mineral (Use the ID cards to help you): _____.

Complete the table below, which will help you identify this mineral in the future.

Name of mineral	Relevant properties that will help me identify the mineral in the future

Hypothesis

2. There is a rock that is composed entirely of the newly identified mineral.
   Which property do you think will characterize this rock? _____

Conclusion

3. Examine the rocks found on the tray. Which rock is composed of the mineral you just identified?

Additional Information

To answer this question, assume that only the rocks that contain this mineral are malleable when the rock comes in contact with water.

Use the ID cards to find the **names of the rocks:**

_____, _____.

Hypothesis

4. Both rocks contain the mineral found to be malleable when it comes in contact with water, but the two rocks are different from each other. What is the reason for this difference? Try to make a hypothesis:

The effervescence property due to contact with dilute hydrochloric acid

Observations

1. Examine the minerals on the tray with respect to the property of effervescence with dilute acid. Which mineral reacts when it comes in contact with dilute hydrochloric acid?
   Name of mineral (Use the ID cards to help you): _____.

Complete the table below, which will help you identify this mineral in the future.

Name of mineral	Relevant properties that will help me identify the mineral in the future

Hypothesis

2. There is a rock that is composed entirely of the newly identified mineral.
   Which property do you think will characterize this rock? _____

Conclusion

3. Examine the rocks found on the tray. Which rock is composed of the mineral you just identified?

Additional Information

To answer this question, assume that the mineral is the only one identified that effervesces when it comes in contact with dilute hydrochloric acid. This assumption is based on the fact that other minerals rarely react with dilute acid, and the possibility of finding one is slim.

Use the ID cards to find the **name of the rock**: _____.

Combination of properties in rocks

Observations

1. Which rock has these two properties: malleability and reaction with dilute hydrochloric acid?

   Name of the rock (use the ID cards to help you): _____.

Conclusion

2. What can you determine about the mineral composition of this rock? (In other words, which minerals make up this rock?) _____ and _____.

Conclusion

3. Is this rock made up of one mineral or several minerals? _____.

Conclusion

4. We have now made enough observations to try to answer the question from the beginning of the activities: Where did the properties of each rock originate? _____.

Observations

5. Look at the rock with your naked eye, and with the help of a magnifying glass. Can you distinguish between the particles of the minerals that are malleable and those that react with acid? If the answer is no, explain the reason.

In the previous sections, you examined a rock that was made up of tiny particles of different minerals. We could not distinguish between the malleable minerals and the minerals that react to dilute hydrochloric acid.
In the following section, we will examine a rock with larger particles of different minerals, which can be distinguished quickly.

E: Examination of the components of granite

Instructions for the activity

Work with your peers to identify the granite rock using the identification cards.

Now, go back to the rest of the rocks and minerals, and select the three minerals that make up the granite rock.

Observations

1. In contrast to the limestone, which has very small particles, the particles that make up granite are large, and you can see the minerals that make up the granite with your naked eye (each mineral has a different color).
   How many minerals can you distinguish in the granite? _____.

Conclusion

2. Is the granite rock made of one mineral or several minerals? _____.

Conclusion

3. There are three main minerals in granite rock, which you can distinguish with the help of the color property. Write down the colors of the different minerals, and use the ID cards to record their names:

Instructions for identifying minerals:
The mineral biotite is fragile, and comes apart easily into very thin pieces. In the sample, the biotite crystals are attached to a crystal of the mineral orthoclase, and are not separated.

	Color of the mineral	Name of the mineral
Mineral 1		
Mineral 2		
Mineral 3		

CARDS FOR THE IDENTIFICATION OF ROCKS AND SOILS

Color: green or gray or red of yellowish-red

Malleability: very malleable

Hardness: is scratched with a finger-nail

Reaction to dilute HCl acid: no effervescence

Name of the rock: clay stone

Color: gray or yellow or brown

Malleability: not malleable

Crumbly: crumbles

Reaction to dilute HCl acid: effervescence

Name of the rock: calcareous sandstone

Color: white or gray or yellowish

Malleability: not malleable

Hardness: not scratched with a finger-nail, scratched with nail

Reaction to dilute HCl acid: effervescence

Name of the rock: limestone

Color: there are 3 options:
-gray or white
-black
-red or pink

Malleability: not malleable

Hardness: not scratched with a nail

Reaction to dilute HCl acid: no effervescence

Name of the rock: granite

Color: white or gray or clear

Malleability: not malleable

Hardness: not scratched with a finger-nail, scratched with nail

Reaction to dilute HCl acid: no effervescence

Taste: salty

Name of the rock: salt (halite)

Color: gray or brown or white or black

Malleability: not malleable

Hardness: not scratched with a nail

Reaction to dilute HCl acid: no effervescence

Name of the rock: chert

Color: gray or yellow or red or reddish or purple

Malleability: not malleable

Hardness: crumbles

Reaction to dilute HCl acid: no effervescence

Name of the rock: quartz sandstone

Color: brown - red

Malleability: malleable

Reaction to dilute HCl acid: no effervescence

Attention: there are sometimes small fragments in limestone that effervesce strongly with acid

Name of the soil: red soil

Color: red

Malleability: not malleable, slightly malleable

Reaction to dilute HCl acid: no effervescence

Name of the soil: silty soil

Color: yellow or light brown

Malleability: not malleable

Reaction to dilute HCl acid: no effervescence

Name of the soil: sandy soil