Every Pebble Tells a Story [1]

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Objectives:

Make inferences about the geological history of a pebble by observing its characteristics and by utilizing geological principles and concepts. The Every Pebble Tells a Story* activity is an excellent follow-up to the study of mineral and rock identification. However, extensive experience with mineral and rock identification is not required. This activity provides practice in observing and critical thinking and opportunities for sketching and creative writing. Because students select, analyze and write about their own pebble, we have found that the activity is very engaging for students. Additional materials (http://web.ics.purdue.edu/~braile/edumod/pebble/pebbleAM.htm) that accompany this activity include resources for the teacher, for helping the student with the interpretation of their rock sample, and for mineral and rock identification.

* MS Word and PDF versions of this document are located at:
http://web.ics.purdue.edu/~braile/edumod/pebble/pebble.doc, and
http://web.ics.purdue.edu/~braile/edumod/pebble/pebble.pdf.
A PowerPoint file consisting of much of the information contained here and in the pebble additional materials file is located at: http://web.ics.purdue.edu/~braile/edumod/pebble/pebble.ppt.

Materials:

1. At least one rock (pebble to cobble sized* - a few centimeters in diameter) for each student. (Rocks that are selected should have distinctive texture, crystal structure, layering or shape that can be interpreted in a logical geological history. Such rocks are relatively easy to find in the gravel found in creeks and rivers and in gravel pits or quarries. Gravel used in landscaping usually contains many interesting pebbles. Rounded rocks are often good samples because if there is interior layering, it is usually visible on the smooth surface, and because the rounding provides another "event" in the pebble's geologic history.) Examples of rock samples are shown in Figures 1 and 2.

   *In geology, rock fragments or sedimentary particles are classified and named according to size. For more details, see the Simplified Sediment Size and Names table in the Additional Materials section (http://web.ics.purdue.edu/~braile/edumod/pebble/pebbleAM.htm).

2. "Everybody Needs a Rock" book by Byrd Baylor (optional).

3. Hand lenses or magnifying lenses.

4. Mineral and rock identification materials: nail, penny, streak plate. Acid to test for limestone (optional); vinegar can be used instead of weak acid if the sample is scratched with a steel nail to produce a small amount of powdered rock..

5. Rock and mineral books for reference.

6. Water to wet the pebbles.

7. Metric ruler to measure size of rock features.

Additional Materials:

Additional materials (Rock Cycle diagram; mineral and rock identification flowcharts and tables; illustrations of geology principles; and a sample rubric) to accompany this activity can be found at: http://web.ics.purdue.edu/~braile/edumod/pebble/pebbleAM.htm. These materials can be used as a teacher resource. Some of the materials can also be provided to students to help them complete the activity.

Preparatory Lessons:

This activity should normally be preceded by lessons or activities related to rocks and rock identification and classification. It would also be useful to discuss the rock cycle, and geologic principles of "Original Horizontality", "Superposition", and "Cross-cutting relationships" (see Additional Materials section, above). Reading the book "Everybody Needs a Rock", by Byrd Baylor (Aladdin Paperbacks, Simon and Schuster), and looking at the pictures in this book, is a good introduction to this activity and a good connection to literature.

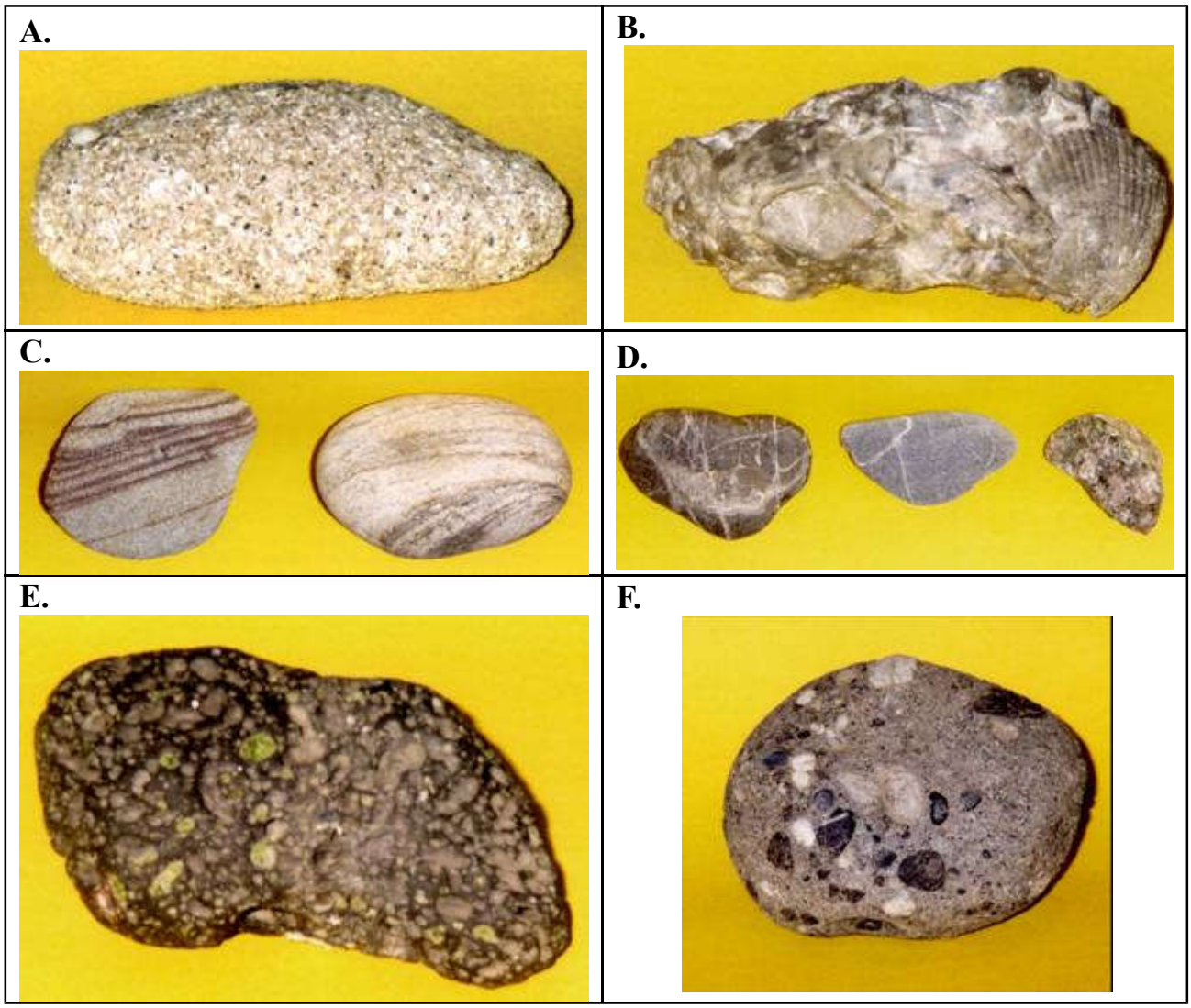

Figure 1. Examples of rock samples used for the Every Pebble Tells a Story activity. A. Sandstone (sedimentary). B. Limestone (sedimentary; note fossil clam). C. Quartzites (metamorphic, note cross-bedding in the sandstone layers which have been metamorphosed). D. Pebbles showing crosscutting veins (left two samples) and visible crystals (right sample). E. Vesicular (holes caused by gas bubbles as lava cooled) basalt (igneous, volcanic); olive green crystals are the mineral olivine. F. Conglomerate (sedimentary).

Figure 2. Pebbles selected for the Every Pebble Tells a Story activity.

Sample Reporting Pages:

An example of several of these steps for a particular rock sample is shown below:

1. Observations and description (size, shape, smoothness, texture, layering, colors, crystals or rock fragments visible, etc.) of your rock sample (pebble):

   - elongated, approximately oval shape; ~14 cm x 6cm x 3.5 cm
   - has dark and light alternating layers, ~2 mm thick
   - medium grain size (individual grains or crystals are visible)
   - layers are slightly wavy (foliation)
   - hardness of minerals is ~5 or greater
   - surface is rounded and smooth
   - white veins that cut across the layers are present
   - some small cracks are visible
   - a small piece was fractured off after the rounding

2. Sketch of your sample (annotate your sketch by pointing out distinctive features or characteristics):

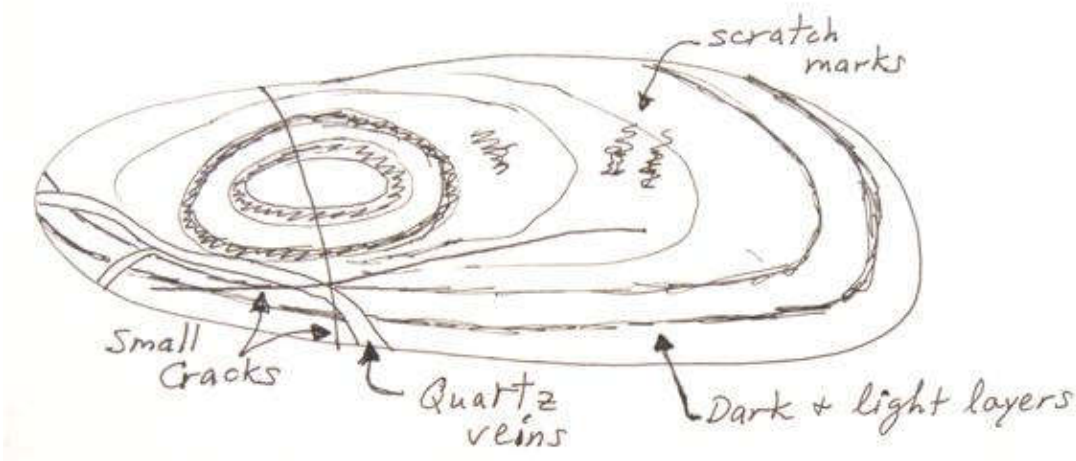

Photo of rock sample (optional; for comparison with sketch in sample).

3. Rock type or classification (igneous, sedimentary or metamorphic; include evidence, rationale and observations which justify your classification) and rock name (if possible; such as granite, basalt, sandstone, limestone, gneiss, etc.):

- metamorphic; grains have re-crystallized and are interlocking with virtually no pore spaces and foliation visible
- rock is a gneiss

4. Inferred geologic history of your sample (oldest to youngest):

Oldest Sediments accumulate in layers

Rock forms by burial and lithification

Deeper burial and high temperature and pressure cause metamorphism

Heating and pressure cause foliation

Rock fractures and veins are injected

Rock unit is uplifted or brought to surface

Rock breaks (erodes) into small fragment

Rounding occurs - probably by river transport

Small piece of rock breaks off during transport

Youngest A few scratch marks occur on upper surface

5. Additional information that you would need to verify classification (step 3) or inferences you have made in the geologic history (step 4):

6. The story of your rock. (Write a creative story of the "lifetime", “history”, or "adventures" of your rock. Use opposite side of paper or additional sheets of paper to continue your story):

Gneiss Rock

Hello! My name is Gneiss Rock. I’m a metamorphic rock. I didn’t start out that way. No. I began as part of a very large accumulation of sediments millions of years ago somewhere beneath the ocean. There were sand and shale deposits and the sediments just kept accumulating until I was buried very deeply and compacted into part of a thick sequence of layers of sedimentary rocks. I really don’t know what happened next except that I began to feel hot and feel increased pressure from the rock around me. Something must have been pushing on the sedimentary rock layers. The heat and pressure kept increasing until I noticed that my sand and silt particles were changing into larger mineral crystals. Also, the flat boundaries separating the different sedimentary materials were now more wavy layers. Later, some cracks formed in me and they were quickly filled with a hot fluid that became solid and formed white veins that cut though some of my layers. It had taken a long time, but I had become a metamorphic rock.

After enduring many millions of years of heat an pressure, suddenly, I felt movement – I was moving upwards. And the temperature and pressure were decreasing. Eventually, I reached the surface and much of the rock around me was slowly worn away by the constant erosion of wind and water. Then one day, I broke off from rocks around me and rolled down a hillside. There were many pieces of rock that looked similar to me in the rock pile. In the next heavy rain, several of us were washed down the hill and into the river. We were tossed and turned, and we bumped into each other and into other rocks that were already in the river. I could feel that I was wearing away on my outside but also becoming smooth. Once while I was being carried by the current of the river, I bumped into a huge rock and a piece of me was chipped off. Shortly after that, I came to rest in a calm area of the river and I sat there for a long time before someone picked me up and took me to a classroom. I no am no longer being bounced around or worn away – just picked up and stared at, and occasionally scratched by people who are trying to find out who I am and where I came from. They should just ask me; I could tell them the story of my life!

Notes to teacher:

Rock samples for the Every Pebble Tells a Story activity can usually be found adjacent to streams and rivers and in rocks used for landscaping. The majority of these rocks are common rock types that are relatively resistant to erosion such as quartzite, granite, gneiss, chert and volcanic rocks. These rock samples are also commonly rounded because of erosion and transport by stream and rivers or along beaches. Layered rocks are desirable as the layers can be interpreted in terms of time or processes that result in two rock types that are in contact. Rock samples that display rounding or differential erosion, are broken, scratched or chipped, have crosscutting faults, jointing or veins, or are stained are desirable as these features add additional stages in the geologic history of the rock sample that is to be interpreted by the student as part of the activity and should be reflected in the creative story written by the student that describes the rock's history.

Making a drawing of the rock samples encourages careful study and observation of the rock which increases the probability of correctly interpreting the rock type and inferring an accurate time sequence that summarizes the geologic history of the rock sample.

Connections to National Science Education Standards (National Research Council, 1996, http://www.nap.edu/readingroom/books/nses/html/): *Teaching Standards:* inquiry-based (A,B); opportunity for assessment (C). *Professional Development Standards:* opportunity for learning new Earth science content (A,C); suggestions for effective teaching strategies (B). *Assessment Standards:* authentic assessment (C). *Content Standards: Science as Inquiry* – practice inquiry and fundamental science skills (grades 5-8 and 9-12, A); *Earth and Space Science* – structure of the Earth system (grades 5-8, D), geochemical cycles, origin and evolution of the Earth system (grades 9-12, D).

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Procedure (use this "Procedure" section and the "Observations and Story Pages", below, as a handout):

1. Select a rock sample for observation. Carefully observe (Figure 3) the features (shape, surface roughness, layering, minerals, types of crystals, texture, presence of fossils, etc.) and briefly describe these characteristics on the **Observations and Story Pages**. It may be useful to put your sample in water to moisten the surface and make certain features, colors and contrasts more visible. A hand lens or a magnifier may also be useful to more closely observe the details of the rock's grains, minerals and layering. Be sure to take advantage of the third dimension – the fact that you can observe all "sides" of the rock and see if layers continue to the other side, etc.


.Figure 5. Students making observations of rock samples.

2. Make a sketch of your rock; annotate the sketch noting the most significant features.

3. Identify the rock type. Where does your rock fit on the **Rock Cycle**? Is your rock igneous, sedimentary or metamorphic? Can you further classify your rock by name (such as granite, basalt, sandstone, limestone, gneiss, etc.)? Note the rock type or classification of your sample on your **Observations and Story Pages**. Explain why you think it is this type (what observations support your conclusion?).

4. Describe the geological history of your rock sample. Start with the earliest stage of development that you can interpret from the characteristics of your rock and its classification and list the further stages that have produced your rock sample. Try to account for all important stages, events or processes. Don't forget the most recent events that have affected your rock – how it came to have the shape that you observe. It may not be possible to determine the precise history of the rock, but your sequence should represent a logical and possible history.

5. What information about your sample, or testing that could be performed on your sample, might be useful in resolving questions that you might have about the inferences that you made in step 4?

6. Write a creative story about the "lifetime", "history", or "adventures" of your rock.

7. Select a partner and share your pebble's observations, history and story. In this way, you will each help evaluate the inferences made and learn about an additional rock sample.

EVERY PEBBLE TELLS A STORY

Observations and Story Pages

Name _____ Date _____

1. Observations and description (size, shape, smoothness, texture, layering, colors, crystals or rock fragments visible, etc.) of your rock sample (pebble):

2. Sketch of your sample (annotate your sketch by pointing out distinctive features or characteristics):

3. Rock type or classification (igneous, sedimentary or metamorphic; include evidence, rationale and observations which justify your classification) and rock name (if possible; such as granite, basalt, sandstone, limestone, gneiss, etc.):

4. Inferred geologic history of your sample (oldest to youngest):

5. Additional information that you would need to verify classification (step 3) or inferences you have made in the geologic history (step 4):

6. The story of your rock. (Write a creative story of the "lifetime", “history”, or "adventures" of your rock. Use opposite side of paper or additional sheets of paper to continue your story):

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The web page for this document is:
http://web.ics.purdue.edu/~braile/edumod/pebble/pebble.htm
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