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Colorful Geology: Using Crayons to Model the Rock Cycle

Sarah White
Iowa State University

COLORFUL GEOLOGY

Using Crayons to Model the Rock Cycle

by **Sarah White**

ABSTRACT: The activity presented here is appropriate in a unit addressing the rock cycle and related concepts. Many variations of this activity exist, but the version below emphasizes student inquiry and decision-making. In doing so, it encourages mental engagement and promotes a deeper understanding of important geological concepts. *This article promotes National Science Education Content Standards A, B, and D, and Iowa Teaching Standards 1, 2, 3, 4, and 5.*

The cycling of rocks is an interesting phenomenon, but often not perceived as such by middle school students. Their reaction is understandable given the abstract nature of the concept, and the way the topic is often taught. Effectively teaching the rock cycle is challenging because beginning instruction with a concrete experience is difficult. And yet learning is promoted when concrete experiences precede and occur alongside verbal explanations.

The following activity makes use of crayons to illustrate the rock cycle. But rather than using the crayons for drawing, they will be the material for modeling the rock cycle. Students find this activity interesting and memorable, and it provides a valuable concrete experience to draw upon when introducing the rock cycle and whenever useful throughout the course. The activity requires two to three 40-50 minute class periods, and is well suited for the beginning of the school year to help students become familiar with inquiry and decision-making.

Activating Students' Prior Knowledge and Generating Experience

Begin by asking students what a “cycle” is and have them contribute some examples of processes that cycle. Write these on the board as “proposed examples of processes that cycle”. Using the words “proposed examples” is important as students sometimes provide incorrect examples. Place them on the board anyway as this is a brainstorming session. Later, when students have a better grasp of what is meant by “cyclical processes”, return to the list and have students critique the originally proposed examples.

Tell students that they will be using crayons to model a cycle that occurs in nature. At this point don't tell them that it's the rock cycle. Ask students, “What is a model?” Be prepared to wait at least 3-4 seconds after students respond to encourage other ideas and elaboration of ideas (Rowe, 1986). When you are certain that students' ideas are exhausted, ask them for some examples of models. Follow this with “What is the value of creating models?” and “What might be some limitations of models?” The purpose of this discussion is to activate students' thinking and help the teacher understand students' preconceptions. Return to this discussion at the end of the activity.

Required materials and safety concerns for this activity appear in Table 1. Students should be encouraged to ask for additional materials. When they do, ask them “How will you use this material, and how will it help you achieve the desired end?” Depending on the material requested and the rationale given, decide whether to approve the request.

Begin this activity by assigning students to work in pairs. Give each student in the pair a different colored crayon for them to observe. Ensure that students make careful observations and write detailed notes. However, rather than have them thoughtlessly follow directions, ask questions such as, “What is the value of making careful observations and writing detailed notes?” If need be ask

Table 1. Required materials and safety guidelines

Required materials include a variety of crayons with the paper removed, hand lens, cheese grater, craft sticks, butter knifes, aluminum foil, and zip-top bags. A heat source is needed and may be derived from hot plates, alcohol lamps, hair dryer, or heat lamps.

Safety issues include cutting utensils and heat sources. When students modify their crayons into shavings and small pieces, care must be taken to avoid injury. The same goes for when the students are heating their wax to melt it. First ask students to tell you what safety precautions are necessary, and reteach relevant safety rules if necessary. Always ask students to consider the reasons for the safety precautions so that they understand and apply them in future situations in and out of school.

questions such as, “How will you remember all the information and be able to share it with your colleagues?” The key is to help students learn to make careful and detailed observations, and keep copious notes without being told to do so. If students must repeatedly be told to do this during the school year, then they have not learned the importance of these behaviors. So rather than tell students to make particular observations, ask questions that encourage them to make many observations before moving on to the next stage.

When students are observing their crayons, they often ask if they can break them and look inside. When you feel students have made sufficient observations, have them begin breaking their crayons into small pieces. Ask them what tools would be useful for doing this, and follow students' suggestions with a question addressing the pros and cons of the various suggested methods. This is also a fine time to ask students what they have thus far observed. Among their responses, students will likely note that the crayon is a wax-like substance. Use this observation in asking them what sorts of tools would work best to create small pieces of crayons. If you have already introduced the concept of weathering, as students are cutting/shaving their crayons, ask them what process in the natural world they are modeling. If you have not yet introduced the concept of weathering, this activity provides an opportunity to do so.

Once pairs have their two crayons sufficiently broken up/shaved, again direct them to make careful observations. Students often notice that the crayon shavings are lighter in color than the whole crayon or that they crumble apart. They may also notice the bigger pieces are still similar in color, and that the crayon breaks in random shapes. When they are finished observing the broken up crayon bits, have them take some of each color of crayon and place into their zip-top bag. Tell your students to press and squish the crayon pieces together into a new crayon. Students will have troubles getting all the pieces to stick together and that is fine. Ask questions like “What problems are you encountering?,” “What is the value of a zip-top bag to squish the bits of crayons together?,” and “What might make it easier to squeeze the crayon bits together?” This will encourage students to think about what they are doing and analyze the pros and cons of the process. Some students may even suggest or ask if they can use different materials to get the crayons to stick better. Use your discretion to decide what to allow.

Often students suggest that heating the pieces would make melding them easier. Acknowledge the idea, but tell them that heating must wait until other approaches have been tried. This is a deliberate decision as using heat now would misportray the formation of sedimentary rocks and could lead to misconceptions. You will also want to be careful about using heavy objects to press the crayon pieces together as extreme pressure may not provide the necessary result to clearly model sedimentary rock. If heavy books, wooden blocks, table legs, and hammers are suggested by students, ask them why trying both heavy and light objects might result in more interesting or complete data? You may want to have students use a variety of these methods or consider the pros and cons of each and decide on one method. Having students use small books or pressing the baggie with the crayons inside against a desk typically yields desired results.

Walk around observing what students do and what they are saying to one another. When you see that a group's crayon pieces are sticking together, instruct students to open the bag and remove the clump. Ask questions such as, “What do you notice about the newly formed clump?,” “How is it similar to the original full size crayons?,” and “How is it different than the original full size crayons?” Students may say that their new crayon doesn't look anything like a real crayon, since they won't be able to easily shape the pieces back into the shape of a normal crayon. This is fine; students don't need to get the pieces to look like a normal crayon. Students quickly note that the clump has a different shape, but can still be used to write. They also state that the clump is made of different colored pieces and falls apart easily, an important observation that will later be linked to the rock cycle.

Now is the time to remind students of their previous idea that heating the crayons might result in a more cohesive clump of crayon. Ask students questions such as, “How might slight heating affect joining the crayons?,” “What might happen if we melt the crayons completely?,” And “How can we test the affect of different amounts of melting?” Asking questions that encourage students to vary the extent that the crayon bits are melted is deliberate because completely melting the crayons more accurately models generation of new rock, while partial melting models generation of metamorphic rock. Students often suggest using hair dryers, a warm window ledge, a light bulb, or holding it in their hands for awhile. Respond by asking a question such as, “While using these heat sources, how will you ensure that you achieve different levels of melting?” Questions like this help students realize that to observe slight melting they must carefully and slowly warm their crayon bits and periodically observe them to determine when they have become soft. Also, as students try to combine their warm crayon pieces, ask them how different amounts of pressure might affect their results. Encourage students to try different ways of squishing crayon pieces together once they are warm.

When students discuss melting the crayons, ask what materials would be useful to fully melt their crayon pieces. Some students suggest simply continuing the heating process for a longer period of time. Others want to use a stronger heat source, but understand that the zip-top bags must be replaced with another material. For those not making this connection, ask “What procedural and safety issues need to be considered before you use a strong heat source?” Have groups share their ideas with the class and at the end of the sharing ask “What are the pros and cons each suggestion?” Continue asking questions that help students make an appropriate decision. The container in which the wax is melted must be considered in light of the heat source. If the heat source is a flame or hot plate, provide aluminum foil to students and show them how to make small bowls. The melted wax will solidify on the foil, but easily peels off. The foil is inexpensive and with care the bowls can be used repeatedly.

Before beginning, ask students to state precautions that must be followed when working with heat sources such as alcohol lamps, hot plates, etc. Ask further questions to ensure they understand: 1) that the crayon bits should be slowly heated to melting; (2) how to work with the melted crayon so that it does not get on them or make a mess; and (3) what to do after the crayon bits are fully melted. Again, accomplishing this through questioning is important so that students are mentally engaged and provide evidence they understand what to do and the reason for that behavior.

Students are typically excited to heat and increase the pressure on the crayons. Constant observation of students' work is important to quickly determine if they are safely heating the crayon bits to soften and melt them. When you note that groups have formed a more solid/stuck together crayon, have them make careful observations of the resulting product. Ask questions such as, “What do you notice now about your newly formed crayon?”, “What are the differences and similarities between this crayon and the one you made without heat?” “How does heating the crayon bits alter the effect of pressure on the crayon bits?” If students have slightly heated and applied pressure to the crayon bits, they will notice that the heated crayon bits were far easier to squish together. Their final crayon should be held together much better, but may still fall apart. When students have completely melted crayon bits for mixing, draw their attention to how the consistency and color compares to the other methods of melding crayons. Table 2 summarizes the overarching observations made at the different stages in this activity.

Table 2. Observations made at several stages in the crayon activity
A. Initial observation of original whole crayon
B. Observation of crayon bits made from breaking/shaving original whole crayon
C. Observation of crayon clump formed from squishing together crayon bits
D. Observation of crayon clump formed by warming and applying pressure to crayon bits
E. Observation of crayon clump formed by melting and applying pressure to crayon bits

Scaffolding from the Activity to the Rock Cycle

The post-lab discussion is crucial for helping students use the prior days' experiences to understand the rock cycle. Begin by asking students to share what they observed during the prior two days. The multiple responses they provide raise the issue of how to portray all the data in a coherent fashion. Ask students, “How might we organize the data so it is easily understood?” Students often suggest making a chart and you should then ask students how the chart should be organized. You might have students work in pairs and create a chart on white boards to share, have them address the pros and cons of suggested tables, and then have them reach consensus on which organizational chart to use on the class board. This may take some time early in the school year, but students learn the pros and cons of different approaches to sharing data. As the school year proceeds, they make these decisions quickly and appropriately indicating that they have learned an important lesson about conveying information. Collect observations from each group, and have some crayons on hand in case disagreements ensue and further observations are required to resolve discrepancies.

Next, begin tying their experiences in the activity to the concept of the rock cycle. Some suggested questions for this discussion include:

- What does 'cycle' mean?
- Think about the different stages of the activity. At which stages was the crayon material most similar? Even though those stages were similar, what were some differences?”
- At which stages was the crayon material most different? Even though those stages were different, what similarities did they show?

Students may say the crayon material produced from squishing (Observation C) is the same as that produced by warming and pressure (Observation D). If they do, ask them to compare how fragile the resulting crayon was from each process. With effective questioning that plays off students' ideas, students will come to see that the crayon they started with (Observation A) is the most similar, but not identical, to the crayon material they ended with after complete melting and application of pressure (Observation E). After they make this connection, ask them, “How do you think the original crayon was made?” Share with students that the material was melted and then placed in a mold, much like what they did prior to observation E. Follow this with, “How did this activity illustrate a cycle?” and have students work with a partner to draw on their white boards the path the crayons took from beginning to end. Have students draw it as a cycle and label each stage. Walk around observing students' work, listening to their discussions, and ask questions where appropriate. When students are done, have them share their drawings and explain them to the class. When finished, have students collaborate to create a final cycle drawing on the board for the whole class. Interject questions when necessary to address any discrepancies or issues that arise.

Further discussion should focus on tying this activity to rocks and the rock cycle. Ask students to again tell you what purpose a model serves, and its limitations. Ask students what happens to rocks over long periods of time as wind, rain, floods and other daily wear and tear occurs. Have them state which stage of the activity modeled this. Here is where you should introduce or reinforce the concept of weathering and ask students to consider how the activity accurately and inaccurately modeled that phenomenon. To introduce the formation of sedimentary rocks ask, “Based on what you observed with the crayons, what might happen to pieces of rock that result from weathering if they are exposed to extreme amounts of pressure?” To introduce igneous rocks you might ask, “What connections can you make to volcanoes/lava and the melting of crayons?” For metamorphic rocks, “Based on what you observed using crayons, what might happen to sedimentary rocks under extreme heat as well as pressure?” Finally, students' attention can be drawn to the rock cycle by asking, “How might rocks undergo a cycle similar to what you created for the crayons?” These questions are only starting points for developing understanding of the different kinds of rocks and the rock cycle, but importantly tie new concepts to the students' concrete observations of the crayons.

If you have already discussed the different kinds of rocks and the rock cycle, you might reinforce what you have previously addressed. For instance, you can ask questions such as the following:

- Which crayons were like igneous rocks? Sedimentary? Metamorphic?
- How did the different colored crayons help model the different types of rocks?
- How does this crayon activity accurately and inaccurately model the rock cycle?

This lab is intended to provide a concrete representation of the rock cycle, but it does not address all the interconnections between rocks in nature. However, referring back to these concrete experiences will assist students in understanding the geology content as it is introduced. The success of this activity depends on how the teacher uses questions to help students make desired links. The questions provided throughout this article are examples of questions that Penick et. al. (1996) suggest will help students make important observations and connections.

Conclusion

Learning through inquiry is important for mentally engaging students and achieving the many goals teachers have for them (Clough, 2006). However, students often initially struggle with inquiry activities. Often students are used to being lead step by step through activities and the new found freedom can leave students feeling frustrated and unwilling to cooperate (Moscovici & Nelson, 1998). Implementing activities such as the one provided here assists both students and teachers in moving toward inquiry. Moving progressively to learning experiences that demand students to think more deeply and make key decisions helps reduce the frustration they often feel when first faced with these responsibilities.

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Sarah White has taught sciences at Pocahontas Middle and High School and at Saydel High School. Her areas of emphasis have included both Earth Science and Physical Science. Sarah is currently pursuing a Masters in Science Education Research at Iowa State University. She can be contacted at dolphea@iastate.edu.