Red Clay

Students will learn about the formation of red clay that is so common in Virginia's Piedmont. They will discover how rock breaks down to red clay and about the minerals that make up the clay. They will understand how these minerals are related to some of the clay's most obvious properties (why it is so slippery, why it is red and why it stains clothes).

Background

One of the most obvious characteristics of the Piedmont is the red color of its soil. Red clay can be seen almost anywhere that a hole is dug, a field is plowed, or a dirt bank is exposed by erosion or human activity. After a heavy rain, even the rivers and streams take on the red color of the soil. Several circumstances contribute to the formation of red clay soils. First, the bedrock must contain enough iron to produce the reddish iron oxides that color the soil. Second, the climate must be relatively warm and wet. Third, the soil must remain relatively undisturbed so that the slow process of red clay formation can go to completion.

In the mountains, red soils occur but tend to be localized. This is because iron-rich rocks are less common and because erosion tends to be relatively fast on steep slopes, stripping away soil before the clay can form. On the Coastal Plain, soils tend to be enriched in organic material and underlain by iron-poor rocks. Again, red soils tend to be rather localized. In the Piedmont, however, the conditions necessary for the formation of red clay are widespread.

Procedure

Before the trip:

1. Review the physiographic and/or geologic provinces of Virginia. Note the kinds of rocks found in these areas. Most Piedmont rocks are igneous and metamorphic. The Coastal Plain and most of the mountains west of the Blue Ridge are underlain by sedimentary rock. Discuss what kinds of rocks might contain a lot of iron (many igneous rocks and metamorphic rocks derived from igneous rocks, for example amphibolite and greenstone) and those that might be iron-poor (sandstone, mostly quartz and limestone, mostly calcium carbonate).
2. Look at a geologic map and see where some of these rock types are common. If you can, determine what kind of rock lies beneath your school and beneath the park you are going to visit.
3. Talk about where red clay comes from and emphasize how bedrock becomes soil through the process of weathering. Discuss how long this might take (thousands of years).
4. Talk about some properties of red clay. Many students will correctly attribute its color to the presence of iron. Most will be aware that red clay soil stains clothes (this is because iron oxide particles that cause the stain are so small that they "burrow" deep into the threads of the fabric where they are very difficult to remove – the particles are not soluble in water or detergents, which also makes it hard to get rid of them). Red clay is also very slippery mostly because of the clay molecular structure.
5. The discussion of properties leads to a recognition that red clay is really a mixture of two main components: an iron oxide component that gives the clay its color and a clay component that gives the clay its slippery feel.

Grade Levels: 5-10

Objectives

Students will *investigate* the formation of soil and learn about the composition and properties of soil. They will also examine firsthand the processes of weathering and erosion. They will do this by:

- working together in teams to *collect, assemble* and *present* (orally and in written form) scientific information;
- *making* and *recording* field observations, including use of map skills and technology;
- *collecting* samples for classroom study; and,
- *synthesizing* their findings with those of other groups.

Materials

For the class:

- digital camera (potentially useful for all teams, but especially for team 4)
- shovel (for team 4)

For each team:

- notebook
- park or topographic map
- garden trowel
- magnet
- jars and/or bags to collect

For each student:

- pen or pencil, paper
- appropriate clothing
- boots or "wettable" footwear

Where

Most parks. Contact park personnel prior to your visit for locations.

When

Spring or fall.

Time Required

At least two hours.

6. The slippery feel of clay is a result of its molecular structure. This structure can be modeled with a deck of cards. The clay is a sheet structure, with layers stacked one atop another. Like a deck of cards, when pressure is put on the stack, it slips. As an activity, the class can compare the relative difficulty of sliding smooth cards over one another as opposed to sliding sheets of coarse sandpaper past each other.
7. Break the class up into three or four teams in preparation for the park visit. Each team will investigate one aspect of soil formation at the park and record its findings in a team notebook.
   - Team 1 will look for rock that is in the process of turning into soil. This material, saprolite, retains some of the structure of its bedrock source but is crumbly and reddish. This team will collect and describe this material. *Is it easily broken apart? How is it similar to rock (many physical features of the rock may be preserved including granularity and layering)? How is it different (it is crumbly and mostly converted to clay)?*
   - Team 2 will look for samples of fully developed red clay soil. It will begin to determine what minerals are in the soil. *Is any of the soil magnetic? Can you distinguish materials of different sizes in the soil? Is there any organic material? What kind? Are there any pieces of solid rock? What do these look like?*
   - Team 3 will look in streams and ponds for evidence that the same red clay soil has been washed into these bodies of water. *Is the water clear or cloudy? Can you find any water that has a reddish color (this will be hard to do unless it has rained recently)? What color is the bottom sediment in a running stream or a pond? If there is a color difference, how do you explain it? Is the sediment the same color as the soil?*
   - Team 4 will examine soil from a forested area, taking samples from both near the surface and up to a foot beneath. *How does the color of the soil change? What might cause this?* Sketch (or photograph) the layers in the soil.
8. Go over the park rules in detail. You will need to get permission for any digging that you do.

At the park

1. The teams will gather and go to their assigned areas. Make sure that each team has a field notebook, pens or pencils, and a park map.
2. All teams will record observations in the notebook and their sampling/study locations on the park map.
   - Team 1 will go to an area of relatively deep erosion or an area near a bedrock exposure. A road cut along one of the park roads may be a good place to begin looking. If true saprolite cannot be found, collect a sample of bedrock. Even better, if possible, collect both rock and saprolite.
   - Team 2 will look for an area where red soil is exposed at the surface. This could be the edge of a construction area, a ditch at the side of the road or simply an area of unvegetated ground. Collect more than one sample if possible.
   - Team 3 will head for the water. Look for an area where the water is cloudy and red and collect a sample. Then collect a sample of "soil" from the bottom of a running stream and another sample from the bottom of a pond or marsh. Be sure to collect your samples away from swimming beach areas.
   - Team 4 will head for the woods. After confirming you have permission, dig a small hole about a foot deep in an inconspicuous area away from trails or roadways. Make note of any layering (a photograph is a good idea) and take samples from each layer. Carefully refill the hole when you are finished, making sure to replace the topmost layer of soil and organic material in the top of the hole.

Extensions

1. Have students investigate soils from other regions and climates and compare the findings with those from the state park.
2. Using GPS equipment to pinpoint sampling/study locations would be an informative addition to this exercise.

Variations

Younger students:
Students can do a simple study of red clay soil. Running a magnet through the soil will draw out iron oxide particles. These can be tied into explaining the color of the soil. Demonstrate the slipperiness of wet clay and explain in terms of a slipping deck of cards.

For gifted and advanced students:
The students can prepare a presentation on weathering, soil formation, erosion and sediment transport that synthesizes the results obtained by each group.

The students can investigate reactions that lead to the formation of clay from minerals (feldspars, in particular) in rocks.

Credits

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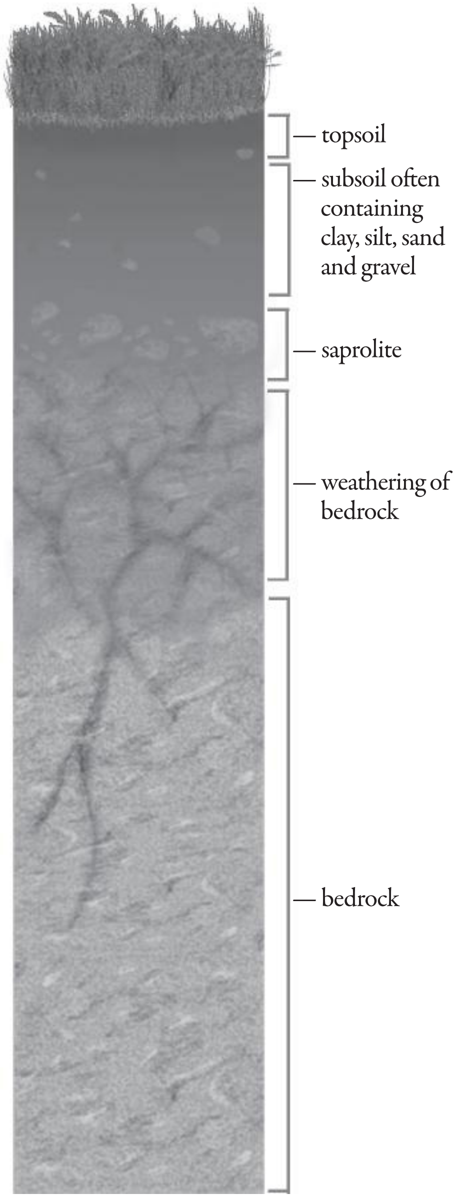
Resources

Soils of the Blue Ridge & Piedmont Regions: http://csmres.jmu.edu/geollab/eaton/web/eaton_files/Publications/sherwood,%20hartshorn,%20eaton.pdf.

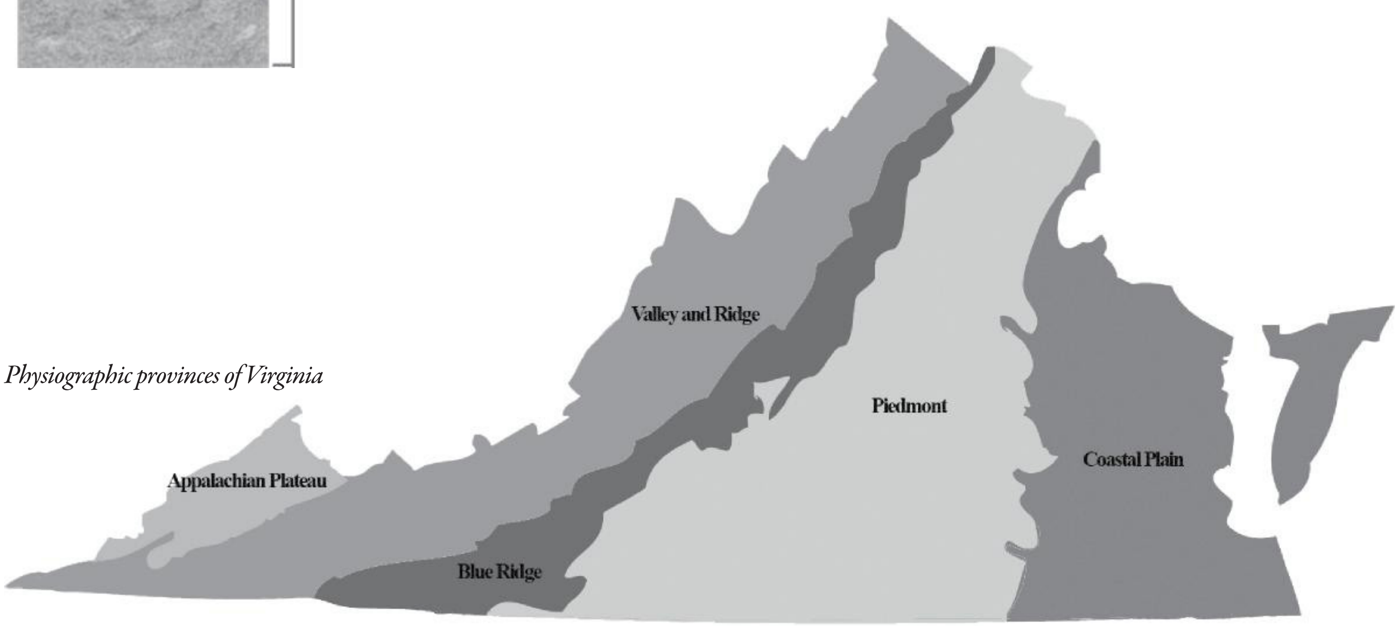
Soils of Virginia: http://pubs.ext.vt.edu/424/424-100/PDF_part6.pdf.



Follow-up

Each team will do a careful examination of the materials they collected and prepare a presentation.

1. Team 1 will emphasize the process of rock turning into soil. Compare saprolite to rock structure and discuss what happens when rock weathers.
2. Team 2 will emphasize the components and minerals found in red clay soil. This will include separating components (magnetic components are iron oxides; small white pebbles are usually quartz; and the part that feels slippery when wet is the clay itself).
   - Teams 1 and 2 should break up some of the soil and saprolite pieces and shake them up in a jar full of water. In comparing results, they may find some similarities (the water will probably turn cloudy and red from suspended material in both cases) and some differences (there will probably be more coarse material in the incompletely weathered saprolite).
3. Team 3 will emphasize erosion of red clay soil and what happens to the soil as it is carried away by streams. Cloudy water is carrying clay in suspension (how does this compare with the sediment jars of teams 1 and 2?). Usually, the "soil" from a lake and, especially, a stream bottom will not be red because the very fine-grained clay has been carried away downstream eventually ending up in the ocean. The stream soil in particular will tend to be sandy (why?); the pond bottom will tend to be organically rich (why?).
4. Team 4 will look at the structure of soil in a vegetated area and discuss how organic and inorganic (e.g. red clay) materials combine to form topsoil. What do the differences in color reflect? What parts of the soil are dominated by organic material? By inorganic material? Why? Ask students to hypothesize about what might happen if the vegetation was removed from the study area.



Physiographic provinces of Virginia

Standards of Learning: K.1, K.2, K.3; 1.1,1.3,1.8; 2.1, 2.2, 2.7; 3.1, 3.7; 4.9; 5.7; ES.4, ES.7, ES.8

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