R.E.V.E.A.L THE GEOSCIENCES

(RESEARCH EXPERIENCES AND VIRTUAL EXPLORATION FOR ACCELERATED LEARNING IN THE GEOSCIENCES)

DAREN T. NELSON (DAREN.NELSON@UNCP.EDU), AMY GROSS (AMY.GROSS@UNCP.EDU), DEPARTMENT OF GEOLOGY AND GEOGRAPHY AT UNIVERSITY OF NORTH CAROLINA AT PEMBROKE

INTRODUCTION

"Graduating geologists who have trained without the benefit of extensive geological fieldwork is like training doctors without ever allowing them to dissect a cadaver" (Mark Cooper - Encana, 2007).

The main goal of the project is to "reveal" geological awe of the world and career potential of the geosciences to our students by accelerating the learning process through both onsite and offsite research experiences and virtual exploration. Onsite research opportunities will provide mentored research for our majors in order to "reveal" needed skills that they will utilize in their career and enhance their understanding of the topics. The students will then aid in "revealing" the geological concepts they learn in their research experiences by developing virtual field guides and labs that will be explored by others. The hope is that the virtual field guides/labs will successfully enable the our department to "reveal" the field to students who do not have the opportunity or physical capability to go into the field, increase interest in the geosciences, and ultimately aid in the recruitment of additional students into the geosciences.

Because of our university's physical location within the physiographical province of the Coastal Plain it is especially difficult to take our students to geologically diverse field localities. In order for us to see diverse geological localities, such as within the Appalachian Mountains or Piedmont, we would have to travel long distances that limit us by time, legal, and financial constraints. Even though field experiences can be expensive, time consuming, and risky, most geoscientists agree that the experiences they had as an undergraduate were necessary for their professional development.

Virtual Geology Field Trips are a means of bringing the "field" to the ordinary student. This Virtual Geology Field Trip can be broken into shorter segments for specific lessons. Online classes can benefit from such virtual experiences, as they won't even see hand samples due to the distance ed. nature of such classes. More virtual field trip experiences are being planned and filmed at this time These virtual experiences have been used within fully online, face-to-face, and hybrid courses with some success.

METHODS

To accomplish the project goals, mentors and undergraduate researchers have focused on the geological history of select outcrops and regions that will enhance student understanding of both basic and advanced geological concepts. These mentored students use various multimedia sources such as video, Gigapan, 3D modeling, drones, etc… to obtain high resolution panoramas of outcrops/landscapes and incorporate 3D modeling of rock samples into these field guides/labs. To increase the interaction and depth of the experience, the mentored students can also generate a range of data (i.e. collect rock samples, produce thin sections, photographs, GPS readings, rock orientations, GPR transects….) at the field sites that can be then incorporated with the multimedia.

We have collected and photographed samples from all of the United States but have focused our local field trips to Hanging Rock, Pilot Mountain, Raven Rock, Morrow Mountain, and Stony Mountain Vineyards (NC). Students helped develop these field experiences and are a great source of documenting students' excitement regarding field work.

Filming was done with a Panasonic AV/AG 90A professional video camera and highlights from these trips were edited using Adobe Premier. A YouTube channel, a SketchFab page, GigaMacro page, Gigapan page, and ArcGIS Online Storymap have also been created to link to these virtual experiences.

Gigapan of the University of North Carolina at Pembroke Old Main Building. Students can practice creating images and other multimedia on campus prior to going in the field.

VIRTUAL FIELD TRIP CASE STUDY: MORROW MOUNTAIN STATE PARK, NC

1 At Morrow Mountain State Park, the meta-argillite was quarried by the Civilian Conservation Corps (CCC) in the 1930's for use in the construction of buildings, bridges, and retaining walls throughout the park (Stewart & Roberson, 2007). A rock sample from the quarry was collected with permission from the state park and can be see in this 3D model. The meta-argillite is a meta-mudstone from the Ordovician to Late Cambrian period (630 to 550 million years ago). This material has a smooth, layered texture making it easy to split into flat stone sheets.

Grain Size and Layering (1)

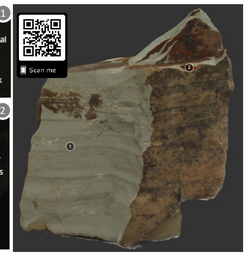
Look at the size of the individual grains and the layering within the rock. What can you determine about the depositional setting of the rock based on these obervations?

Color variations (2)

Look at the color of the fresh surface of the rock and the color of the weathered regions.

Why is one surface red whereas the fresh surface grey-green?

Does the color give you any indication of some of the elements in the rock and possible source materials for the sedimentary grains.



Aphanitic texture (1)

What can you determine from the aphanitic igneous texture of the rock?

Also what does the color of the igneous rock infer?

Color variation (2)

This side of the rock was exposed wheras the lighter gray surfaces are fresh broken surfaces that show the interior of the rock. Why do you have different colors? What processes are at work?

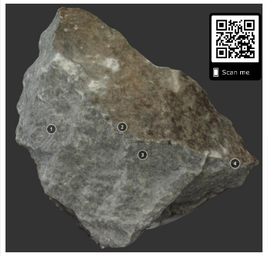
Green tones (3)

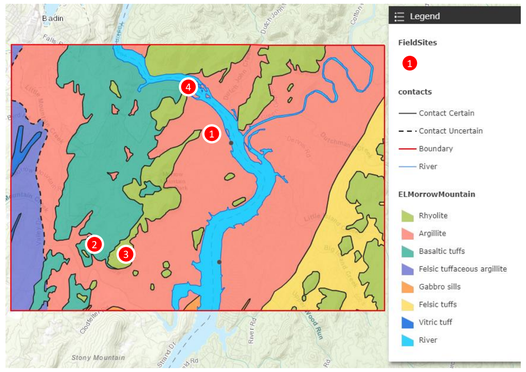
This rock has been slightly metamorphosed and has some faint green tones to it. When basalt is metamorphosed the high magnesium minerals often are altered to form minerals such as chlorite or epidote (minerals that have a greenish hue). Due to this hue the metamorphosed basalt are often called greenstone. Can you find other localities in the sample that also have this faint green hue?

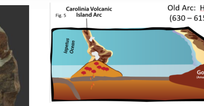
Summary (4)

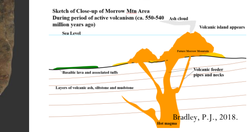
Based on your own observations and the observations discussed in the other annotations can you explain the history of the rock and therefore the basic geological history of the Morrow Mountain region?

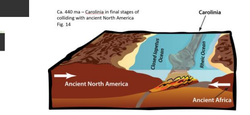
2 Video still from virtual field trip. Boulder field at the base of Morrow Mountain. Slightly metamorphosed basalt (greenstone) of Morrow Mountain State Park, NC. The basalt erupted ~550 Ma as part of an island arc prior to colliding with Laurentia as part of the Carolina Terrane.

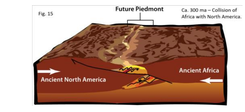


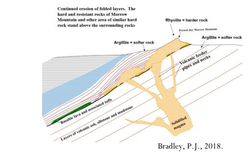




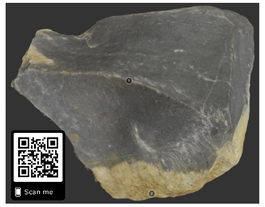








3 The Native Americans made use of the mountain for quarrying the rock called meta-rhyodacite which was used for making arrowheads and spear points. The rapid cooling of the lava and the low-grade metamporphism of the region produced the good-to-excellent conchoidal fracture of the stone.



Concholdial Fracture (1)

The dense framework of the minerals cause the minerals to break in a conchoidal fracture (much like glass). This fracturing pattern causes the mineral to have sharp edges and points that were ideal for native americans to use the stone in their tools (i.e. arrowheads, scapers, axes…)

Weathered rind (2)

When exposed to the elements (rain and oxygen) the mineral undergoes chemical weathering processes to create a weathered surface on the edges that were exposed. The reddish hue suggests oxidation of iron from the mineral and the tanish color orginates from the hydrolosis of the mineral into clays such as smectite and kaolinite.

This type is a homogeneous dark gray, aphanitic, aphyric rhyolite that commonly exhibits flow banding, especially on slightly weathered surfaces. However, on recently flaked rhyolite, the flow lines are difficult to see. When present, flow lines are thin, only a few millimeters. Extremely old and weathered debris exhibit a chalky grayish-white exterior (Daniel & Butler 1996).

4 Meta-rhyodacite, as it is termed at Morrow Mountain state park, is a slightly metamorphosed mixture of rhyolite and dacite. The feldspar inclusions in the material make it unsuitable for tool making (Stewart & Roberson, 2007).

This outcrop of dense and hard rock is why the dam is at this locale. The river could not cut through this section of the river quickly and falls and rapids formed in this region. The sample collected in this activity was collected from the opposite side of the river but should be characteristic of this outcrop.

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Morrow Mountain State Park is located where the Yadkin and Uwharrie rivers meet to form the Pee Dee River just east of Albemarle.. Upstream from the park are dams that form Badin Lake and downstream is a dam that forms Lake Tillery

Feldspar Inclusion (1)

What is the composition of feldspar?

What does that tell us about the rock?

Weathered Rind (2)

This rock has been exposed to the surface in its past; therefore the outside rind of the rock has been altered by chemical weathering.

Weathered out feldspar (3)

Why would the feldspar weather faster that the rest of the rock mass?

What is this called when one rock weathers differently than another?

What factors would influence the rate of weathering in a rock?

Concholdial fracture (4)

This rock was found near Morrow Mountain State Park here in NC. The dense framework of the rock enabled Native Americans in our region to use this rock for weapons and tools due to its concholdial fracture. The feldspar inclusions make it hard for these samples to fracture properly, therefore, natives would only collect samples that did not include these inclusions.

Color, Texture, and Origin (5)

What does the color of the rock suggest about it's chemical composition?

The feldspar inclusions should also give you a hint.

How big are the individual crystal grains?

What does the size of these crystal grains suggest about the rock's cooling history?

If this is a volcanic (extrusive) rock what kind of volcano could this igneous rock be a characteristic sample?

If this is a plutonic (intrusive) rock what kind of igneous feature could this sample be characteristic?

NC VIRTUAL GEOLOGY FIELD TRIP VIDEO STILLS

Hanging Rock State Park, part of the Sauratown Mountains anticlinorium, metamorphosed sedimentary rocks.

Fractures and an overhang in the quartzite and gneiss at Raven Rock State Park. This is along the Fall Line, and was part of Gondwana (Carolina Terrane).

Pilot Mountain State Park, view of Big Pinnacle from Small Pinnacle.

Exposed tree roots along the Cape Fear River at Raven Rock State Park. Gneiss and Quartzite outcrop here, as this is along the Fall Line, where we grade from the Piedmont into the Coastal Plain

Meta-basalt boulder field at Morrow Mountain. The rock at Morrow formed as Rodinia was being assembled.

Preserved bedding in the metamorphosed sandstone of Pilot Mountain. The sands of the Iapetus Ocean were metamorphosed as Laurasia and Gondwana collided to form Pangaea.

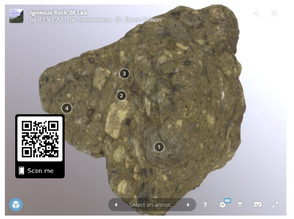
Vertical fracture in the Pilot Mountain Quartzite.

Stony Mountain Gabbro, part of the Albemarle Arc, island arc subduction.

ONLINE ROCK IDENTIFICATION

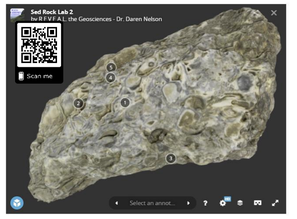
Igneous Rock 08 Investigation

Students were to make observations interpret the type of igneous rock, identify if it was intrusive or extrusive, and then if extrusive determine what kind of volcano it could have erupted from.



Sample extracted from Hyalite Canyon near Bozeman, MT. Sample is from the Eocene (~56-34 Ma) Absaroka Volcanic rocks

Sedimentary Rock 7 Investigation

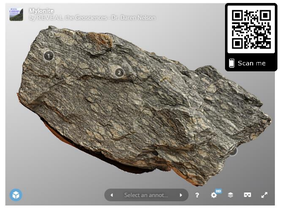


Students were to make observations interpret the type of sedimentary rock, if it clastic or chemical in origin, and then give a potential depositional environment for the sample

Sample extracted from Snows Cut outside of Kure Beach, NC. - Eocene age deposit. – Castle Hayne Limeston

Metamorphic Rock 06 Investigation

Students were to make observations interpret the type of metamorphic rock, if it is foliated or non-foliated, and then give a potential metamorphic environment for the sample



Proterozoic age - Falls Lake Mylonite, NC

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