The Green Giant

Once you find the geocache, click "Found It" on the Geocaching.com app and then read and answer the questions below. Make sure to return the cache to exactly the same place you found it for the next geocacher to find!

Most of the naturally occurring rocks in the Clemson area are gneiss, schist or pegmatite (a rock associated with an igneous intrusion) This makes finding a rock like the Green Giant, that is not one of these three rock types, particularly interesting. Finding rocks that are unusual to an area can help you figure out a more detailed geologic history.

Warning: It has been noted that some people do not have good cell phone reception in this area.

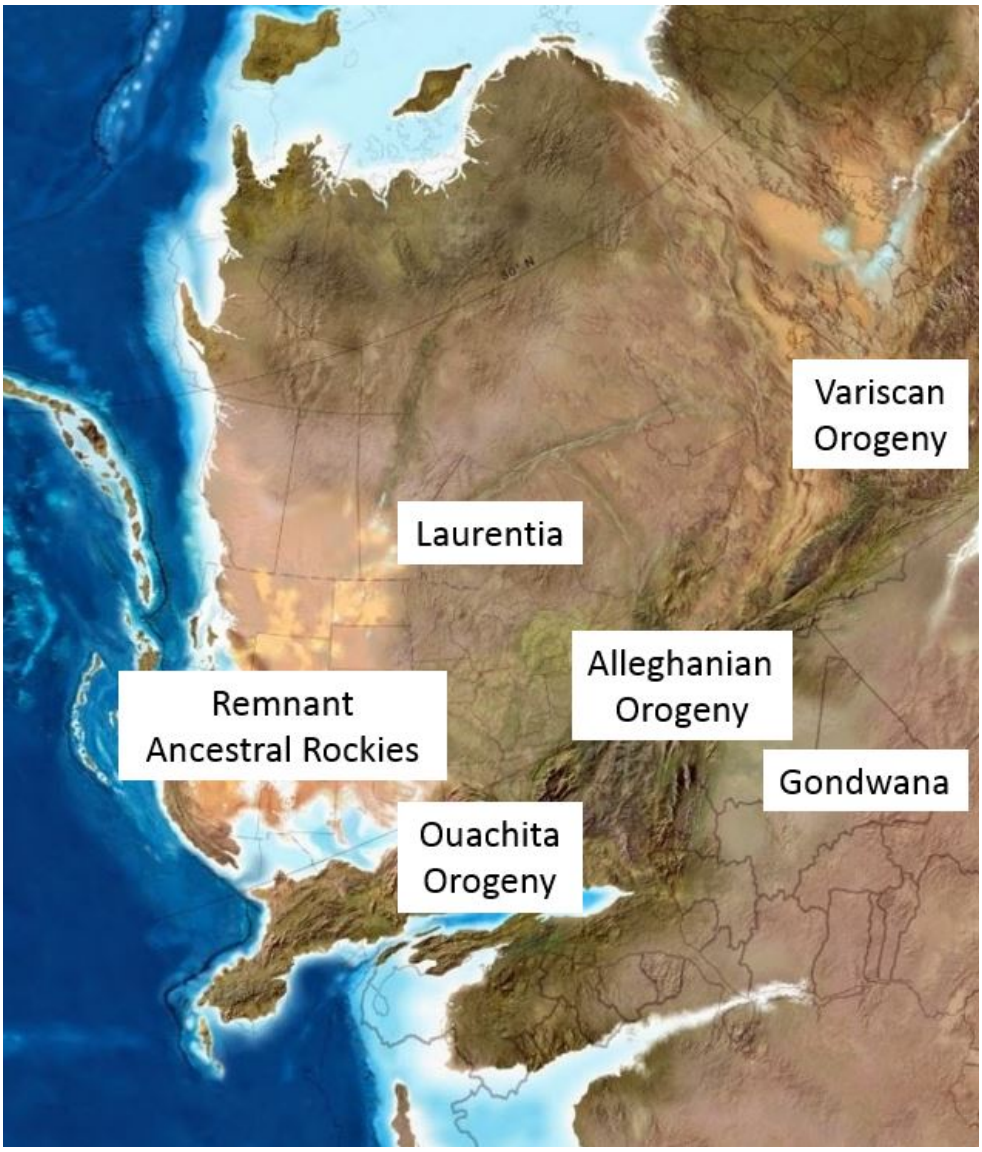
Your email address (**clemsongeopaths@g.clemson.edu**) will be recorded when you submit this form. Not **clemsongeopaths**? Sign out
* Required

1. **Last Name, First Name** *

Building the Appalachians

The Green Giant is an ultramafic rock. An ultramafic rock is a rock that contains less than forty-five percent silica, the crusts most abundant element. Why is an ultramafic rock in the Experimental Forest a big deal? Not only is it different from most other rocks surrounding it, but could possibly represent the tectonic collision between the African continent and North American continent. However, more than 300 million years ago (almost 100 million years before the appearance of dinosaurs!), the continents of Africa and North America did not exist as we know them today. Africa was part of the supercontinent Gondwana, while North America was part of the large supercontinent Laurentia. The collision of these two continents formed several mountain ranges, including the Atlas Mountains of Morocco and our nearby Appalachian Mountains. The image below is a paleogeographic relief map (a reconstruction of ancient history) illustrating the elevation of the area after this collision between these two supercontinents, along with the associated mountain building events (called orogenies). The mountain building event that created the Appalachian Mountains is called the Alleghanian Orogeny.

Collision of Laurentia and Gondwana



2. **The Appalachian and the Rockies are the two longest mountain ranges on the North American continent. Which mountain range has a higher elevation (on average)?** *
Mark only one oval.

- The Appalachians
- The Rockies

Appalachians vs. Rockies

If you said the Rockies, you are correct! The Rockies are considerably higher in elevation than the Appalachians. The highest 100 peaks of the Rockies are all greater than 12,290 feet, while the highest point in the Appalachians is Mount Mitchell, North Carolina at only 6,684 feet - approximately half the elevation of the western mountain range. However, when the Appalachians were first formed, they reached these same elevations.

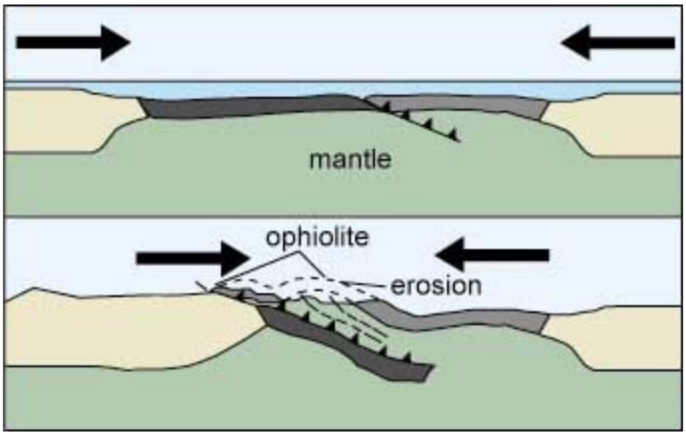
So what happened? Simply put, the Appalachians are much older than the Rockies, and have been systematically eroded over millions of years. In fact, much of the sediment blanketing the eastern United States is eroded material from this large, ancient mountain range.

Is the Green Giant part of this eroded material?

Yes and no. The giant boulder is clearly an eroded piece of a larger outcrop, however must eroded boulders in this area are still of a common rock type - typically schist, gneiss, or pegmatite. This ultramafic rock is actually what is called an ophiolite. An ophiolite represents a section of the earth's oceanic crust that has moved on top of continental crust.

So how do these rocks get from the bottom of the ocean to the foothills of Clemson? The collision that would have formed this ophiolite also would have helped form the Appalachian Mountains. A diagram that illustrates how this might happen is shown below. The two gray rock bodies represent old oceanic crust that is colliding at a convergent plate boundary, similar to the collision between Laurentia and Gondwana. As the collision continues, the lighter gray crust is forced up and on to the adjacent continental crust on the other side of the plate boundary. This oceanic crust found on top of continental crust is what we consider an ophiolite.

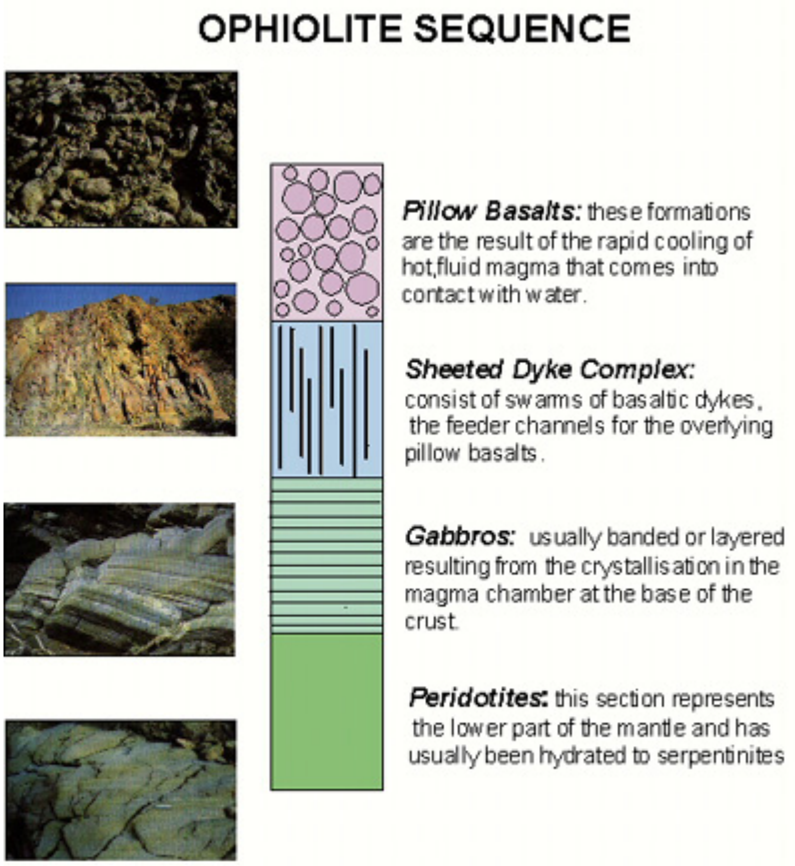
Ophiolite Emplacement onto Continent



An Ophiolite Sequence

An ophiolite is a general term; more specifically the process of moving oceanic crust on top of continental creates an ophiolite sequence. An ophiolite sequence is a series of rocks occurring in a defined order that represents a specific series of tectonic events. An ophiolite sequence is shown below. Notice that the from top to bottom of this sequence, the chemical composition changes from basalts to gabbros to peridotite.

Simplified Ophiolite Sequence



The diagram illustrates a typical ophiolite sequence based on the ophiolites from Oman, which is where the accompanying photographs were taken. (photos from: "The Mid-Oceanic Ridges: Mountains below the sea", A. Nicolas)

3. **An ophiolite sequence, from bottom to top (peridotite to basalt), shows a change in rock chemistry in what direction and indicates what about rock composition?**
   Mark only one oval.

   - The rocks in the sequence become more mafic and therefore contain more silica (quartz).
   - The rocks in the sequence become more mafic and therefore contain less silica (quartz).
   - The rocks in the sequence become less mafic and therefore contain more silica (quartz).
   - The rocks in the sequence become less mafic and therefore contain less silica (quartz).

4. **The Green Giant represents what section of the ophiolite sequence?** *
   Mark only one oval.

   - Pillow Basalts
   - Sheeted Dyke Complex
   - Gabbros
   - Peridotites

An Ultramafic Ophiolite

Ultramafic rocks are typically rare and contain less than 45% silica; most other rocks in the Clemson area contain a much higher percentage of silica. A common mineral that is associated with ultramafic rocks is olivine. A lot of ultramafic rocks like this one tend to be a dark greenish to blackish color because of the high olivine content. There are not very common because ultramafic rocks form from deep within the earth, where there is less silica.

5. **Which process best explains why the 'Green Giant' has such a low silica content?** *

Mark only one oval.

- Rock originally formed from a low--silica oceanic crust.
- Metamorphism during orogeny squeezed out most of the silica.
- Weathering and erosion dissolved out most of the silica.
- Most silica melted out of the rock during high temperature emplacement.

Activity Evaluation

6. **I enjoyed this activity.** *

Mark only one oval.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

7. **I learned something from this activity.** *

Mark only one oval.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

8. **This activity made we want to learn more about this subject.** *

Mark only one oval.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

9. **Comments? (optional)**

Don't forget your geoselfie!

Take a picture of yourself with the Green Giant in the background and submit it via the link that follows after submission of this form.
