Weathering and Clast Production – Geol 113

Goals: To understand the production of clasts from the weathering of rocks.

Materials: rock and sediment samples from the two localities, sediment grain size chart, 10x magnifying lenses, binocular microscope, streak plates, glass plates.

Types of Chemical Weathering

Acid/Base – chemical alteration of minerals brought about by changes in acidity or alkalinity.
Hydration/Dehydration – incorporation or removal of water in the chemical structure of a mineral.
Hydrolysis – chemical reaction between silicate minerals and surface or ground water to produce clay minerals and dissolved ions.
Redox – chemical alteration of minerals brought about by changes oxidation and/or reduction. Oxidation of metal ions by oxygen is the most common form of this kind of process.

Table One: Chemical formulas and environments of formation of some rock-forming minerals.

Mineral	**Chemical Formula**	**Environments of Formation**
quartz	SiO_2	igneous, metamorphic, sedimentary
plagioclase	$(Na,Ca)AlSi_{2\text{-}3}O_8$	igneous, metamorphic
K-feldspar	$KAlSi_3O_8$	igneous, metamorphic
muscovite	$K_2Al_4(Si_6Al_2O_{22})(OH,F)$	igneous, metamorphic
biotite	$K_2(Mg,Fe)_{6\text{-}4}(Si_6Al_2O_{20})(OH,F)$	igneous, metamorphic
hornblende	$(Na,K,Ca)_{0\text{-}2}(Mg,Fe,Al)_5(Si_6Al_2O_{22})(OH,F)_2$	igneous, metamorphic
kaolinite	$Al_4(Si_4O_{10})(OH)_8$	sedimentary
limonite	$FeO{*}OH{*}nH_2O$	sedimentary

Exercise One: Forty-Acre Rock

Examine the specimens from Forty-Acre Rock, Lancaster County near Pageland, South Carolina. The outcrop was a large expanse of horizontally-exposed rock (i.e., you can walk on it), and the entire exposed surface was subject to both *physical* and *chemical* weathering. *Biological* processes also weathered the outcrop (note that some of the samples contain abundant plant and fungal material, some of which is still attached to the rock fragments). The samples were all collected from the surface of the outcrop.

1. Examine the small, “fresh” (not weathered) igneous rock sample, and identify the igneous rock:

2. Identify the three main minerals contained in the fresh igneous rock (see Table one for a list of possible minerals):

Arrange the specimens (slabs and bags) in order from least weathered to most weathered (ignore the plant debris). Compare the fresher samples to the more weathered samples and complete the following table:

	Fresh **Highly Weathered**
Color(s)	
Grain size(s)	
Grain shapes	
Grain sorting	

3. There is an obvious color difference between the fresh and weathered samples. What is the rust-colored mineral coating the weathered sample? According to Table One, what is the chemical formula of the rust-colored mineral?

4. According to your answer to question #2 and the information in Table One, which of the three *original* minerals was the only one that could produce the rust-colored mineral when weathered?

5. What element(s) do the minerals in #3 and #4 have in common that the other minerals *lack*?

6. Which *two* of the four major chemical weathering processes (see definitions on first page of exercise) were responsible for the formation of the rust-colored mineral from weathering of the original mineral?

7. Which of the three minerals was least altered by weathering in these samples? What observation of the samples allowed you to determine this?

8. If chemical and physical weathering continued, what would be the mineralogy of the clasts produced?

9. Which abundant mineral(s) in the original rock would not be present in the heavily weathered clasts?

10. What would happen to those mineral(s) crystals?

Exercise Two: Saprolite

Examine the sample of South Carolina saprolite. Unlike Forty-Acre Rock, this material was weathered while buried (i.e., not exposed on the surface), and thus much more subject to *chemical weathering* than physical weathering.

1. Identify the four minerals in the saprolite sample:

   Chalky, white mineral: ______________________________
   Silvery, flaky mineral: ______________________________
   Glassy mineral ______________________________
   Brownish-black, blocky mineral ______________________________

2. Based on the mineralogy, what kind of igneous rock was the original source rock? **Hint**: one of the four minerals was *not* present in the source rock.

3. The capped vial contains saprolite and water. Vigorously mix it up and place it on the table. What color is the suspended sediment when it is first mixed up?

4. Observe the vial for a minute or so. What is the grain size of the sediment that settles on the bottom first?

5. Continue to observe the sediment settling. After several minutes, two separate layers of suspended sediment should form in the water. What color is the top layer?

6. Which mineral in the *saprolite* is the same color as the sediment in the top layer? Are the clasts of this mineral larger or smaller than the clasts of the other three minerals?

7. Larger grains settle out more quickly in a shaken vial than smaller grains. Use the following general rules to determine the grain size of the various layers:

   - Sand-sized grains settle out within a minute
   - Silt-sized grains settle out over the next 10 minutes or so
   - Clay-sized grains remain suspended for hours to days

Based on all of your observations of the sediment in the vial, complete the following diagram:

Suspended Sediment

Grain size _______________ Mineral(s) _____________

Settled Sediment

Top: Grain size _______________ Mineral(s) _______________________

Middle: Grain size _______________ Mineral(s) _______________________

Bottom: Grain size _______________ Mineral(s) _______________________

8. If the saprolite was exposed at the surface and physically weathered, what would happen to the different kinds of clasts?

9. If chemical weathering also continued, which minerals in the saprolite would remain in the eventual deposits?

10. Will all of the clasts be transported the same distance by a stream?