Chemical and Physical Weathering Field and Lab Experiment: Development and Testing of Hypotheses

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Exercise A: Physical and Differential Weathering

Physical weathering processes are fundamentally important to the formation of many clastic rocks. Therefore an understanding of these processes will give you valuable insight into the provenance and environmental conditions that led to the formation of ancient sedimentary sequences. The goal of this lab is to explore the relationships between bedrock, weathering, and the creation of sediment. You will design this lab experiment as a group. The purpose of this lab is to observe and quantify the effects of physical weathering on several different rock and sediment samples you collect in the field. You have 2 weeks to conduct your experiment.

Step 1: Identify field collection sites (streams, creeks, and rivers) on regional geologic and topographic maps and note any identifiable features on the map that might dictate characteristics of sediment samples or rocks from outcrops you will collect at each site.

> **Questions to Ponder:** How might the sediment samples you collect in the various streams/creeks/rivers vary and why? How will the geologic setting, bedrock, size, gradient, or shape of a stream affect the sediment characteristics of each sample? What role will differential weathering play in determining the sediment characteristics at each site? How can you measure all the above quantitatively and qualitatively in a scientifically meaningful way?

Step 2: Before you start designing an experiment to address the questions above you need to make multiple meaningful (and testable) hypotheses about what you expect to find in your samples.

> **Questions to Ponder:** What differences do you expect to see in your sediment samples (size, shape, composition, etc.) and why? Will all your hand specimens and sediment samples contain the same ratio of major mineral constituents? Why or why not? Will clasts, when present, be the same size, shape, etc. at each location? If not, how and why should your samples differ?

Step 3: Design a field collection and laboratory experiment to test these hypotheses. You will be provided with the following materials to design your lab:

geologic and topographic maps of your study area		a balance	spatula
rock and sediment samples	sieve set	graduated cylinders	markers
sediment sample containers	label tape	stereomicroscopes	glass jars
dilute hydrochloric acid	hand lenses	rock hammer	weigh paper
low temp oven	beakers		

You may (and should) use any other materials that are practically available.

When designing your lab, think about the following questions:

- How can we measure how much physical weathering is taking place?
- Are replicates necessary to accurately test our hypotheses?
- If so, how many replicates should we test?
- How can we standardize our sample populations to make meaningful observations about different specimens?
- How can we quantify sediment characteristics?
- Can we determine anything about physical weathering by looking at a hand specimen?
- How should we divide tasks to avoid qualitative sample error (difference in individual perception of sediment characteristics)?

Step 4: Collect and process your samples.

Remember, organization is key to most scientific experiments so label each sample in detail. **Save all samples for possible use in another experiment.* You should all be equally involved in the experimental design and maintenance. However, you may agree to split up tasks once the project is underway.

Step 5: Your final individual report (less than 5 pages at 1.5 spacing) should consist of:
Introduction (including initial hypotheses), methods, results (this might include graphs or tables), discussion, and conclusion (which might also include what you would do differently next time)
Remember that your results are simply what the data show. Your discussion involves interpretation of those results.

Please address at least a few of the following in your paper:

- Which samples (or components of samples) indicated the highest degree of physical weathering and how does your data support this conclusion?
- Which sample (or component) was a product of the least weathering and how do you explain this result?
- What properties of each sample affected their resistance to physical weathering and which properties seemed most significant?
- Can you separate the effects of chemical and physical weathering in your dataset? Why or why not?
- How does bedrock type affect weathering rate?
- How do stream morphology, flow, or other characteristics affect weathering rate?
- How might this information help you interpret ancient sedimentary sequences?
- Do your results reflect what you learned from your textbook?

Step 6: Share your results with the Chemical weathering groups via an in class PowerPoint presentation. The presentation should be approximately 15 minutes long.

Have Fun!!

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Exercise B: Chemical Weathering

Chemical weathering rates and processes can be hard to envision (how long does it really take for a limestone to dissolve?) but extremely important to the formation of some sedimentary rocks. The goal of this lab is to better understand the processes and effects of chemical weathering. You will design this lab experiment as a group. The purpose of this lab is to observe and quantify the effects of chemical weathering on several different rock and sediment samples you collected in the field. You have 2 weeks to conduct your experiment.

Step 1: Identify field collection sites (streams, creeks, and rivers) on regional geologic and topographic maps and note any identifiable features on the map that might dictate characteristics of sediment samples or rocks from outcrops you will collect at each site.

> **Questions to Ponder:** How might samples from various areas on the map differ in their susceptibility to chemical weathering processes? What environmental conditions might contribute to the chemical weathering of rocks at these sites? What rock types will offer the most contrast in degree of chemical weathering? How can you recognize the effects of chemical weathering in rock and sediment samples from these sites?

Step 2: Before you start designing an experiment to address the questions above you need to make multiple meaningful (and testable) hypotheses about what you expect to find in your samples.

> **Questions to Ponder:** Which samples from the field sites will likely be the most susceptible to chemical weathering? How would you expect exposure to a weak acid to change the surface, volume, or mass of each specimen? Does weathering rate change as weathering progresses? With the above in mind, how should samples from various sites 'weather' differently? How can you measure chemical weathering quantitatively and qualitatively in a scientifically meaningful way?

Step 3: Design a field collection and laboratory experiment to test these hypotheses. You will be provided with the following materials to design your lab:

geologic and topographic maps of your study area		a balance	spatula
rock and sediment samples	sieve set	graduated cylinders	markers
sediment sample containers	label tape	stereomicroscopes	glass jars
dilute hydrochloric acid	hand lenses	rock hammer	weigh paper
low temp oven	beakers		

You may (and should) use any other materials that are practically available.
When designing your lab, think about the following questions:

- How can we measure how much chemical weathering is taking place?
- Are replicates necessary to accurately test weathering of each rock or sediment sample?
- If so, how many replicates should we test?
- At what intervals should we test our samples to get high resolution data on weathering?
- How can we standardize our sample populations to make meaningful observations about different specimens?
- How might chemical weathering processes change the surface or mass of each specimen?
- Can you determine anything about weathering rate or susceptibility by looking at a hand specimen?
- Do we need control specimens?
- Will acid strength or 'freshness' affect our experiment?
- What acid strengths are realistic in the real world and what strengths are appropriate for your experiment?

Step 4: Collect and process your samples.

Remember, organization is key to most scientific experiments so label each sample in detail. **Save all samples for possible use in another experiment.* You should all be equally involved in the experimental design and maintenance. However, you may agree to split up tasks once the project is underway.

Step 5: Your final individual report (less than 5 pages at 1.5 spacing) should consist of:
Introduction (including initial hypotheses), methods, results (this might include graphs or tables), discussion, and conclusion (which might also include what you would do differently next time)
Remember that your results are simply what the data show. Your discussion involves interpretation of those results.

Please address at least a few of the following in your discussion:

- Which sample weathered the most and how does your data support this conclusion?
- Which sample weathered the least and how do you explain this result?
- What properties of each sample affected their resistance to chemical weathering and which properties seemed most significant?
- Does weathering occur at a linear or non-linear pace? Why or why not?
- Did the rate of weathering change for any sample during the experiment? If so, what may have caused this to happen?
- In the real world, what factors may influence the rate at which a given rock weathers chemically?

Step 6: Share your results with the Physical weathering groups via an in class PowerPoint presentation. The presentation should be approximately 15 minutes long.

Have Fun!!