

## GEOLOGY 101

### OUTSIDE CLASS PROJECT #1: WEATHERING EXPERIMENTS

Maximum points: 70,000,000

A common analogy for weathering is doing the dishes. I am presenting to you the opportunity to test that analogy. I want you to do a small amount of research about different weathering types, and then perform an experiment on some really nasty dishes in your house to determine the best methods of chemical and physical weathering in your kitchen. Then you will calculate the weathering rate for food and compare it to weathering rates for rock. The point of this exercise is for you to have fun while doing science!

Here is how you should approach this experiment:

- 1) **Research.** Do some research about the major types of weathering, both physical and chemical. Write up a short explanation of at least four type of weathering (two physical, two chemical). Each should be a paragraph long and include a description of the process, the results (softer rock? Smaller rocks? Angular fragments?), and common environments in which each process occurs.
- 2) **The experiment.** You will try to clean some really nasty dishes using three different processes. Each of the processes should be analogies of the one of the weathering processes you researched (note: even though you researched four processes, you will be simulating only three). Also, you will need to dirty **four (4) dishes**, and use one dish as a control (in other words, you won't do weathering to this plate)
  - a. **Dirty the dishes.** Make all four dishes as difficult to clean as possible by burning/baking/sticking/ the hardest food to clean you can think of. All dishes must be equally dirty (the food must cover the same area on each plate). Take notes on what food was used, how much of each plate is covered with food (50%, 80%, 100%, etc – it should be roughly the same for each plate), and measure the thickness of the food on the plates (it should be at least 5 mm thick).
  - b. **Determine your methods.** Set one plate aside as the control plate (you won't do any weathering action to it). For each of the remaining plates (at least three, but hopefully more), come up with a way to represent three of the four weathering techniques you researched. Each technique should either soften the food or weaken the bonds between the food and the plate. You're on your own to devise your methods, but be sure to consider what the geologic analog would be. Be creative!
    - i. **Reflect on what you're trying to do.** Setting up a good experiment is sometimes the hardest part. Double check that your experimental technique is a reasonable analogy for the geologic process you're trying to replicate. If you're uncertain, please feel free to ask me about it.
  - c. **Do the dishes!** Apply your methods to the dishes. Keep careful notes about what materials are involved, how much time is allowed for the process to take place (5 minutes of sandblasting, 2 hours of soaking, 30 sec of spraying with acid, etc). Also, consider what other factors you didn't include in your experiment that might affect the results.

- d. **Determine the winner.** Once all the weathering has been completed, determine how effective each technique has been. To do this, turn the control plate each plate upside down on a clean counter or towel. Gently tap on the bottom to shake free any loose material. Turn the plate over and estimate the percentage of food remaining on the plate (in other words, estimate the amount of material lost when no weathering was done). Next, repeat this process for each of the experimental plates. Take careful notes on how much material was removed during each experiment. Compare these results to the results for the control plate. For example, if the control plate lost 5% of the food and your freeze-thaw experiment lost 30%, then the freeze-thaw experiment was 25% effective ( $30\% - 5\% = 25\%$ ).
- e. **Calculate the rate.** Determine the rate of weathering for your most effective experiment. To do this, take the thickness of the food you measured in step 1 and divide this number by the time needed to weather this material (in minutes, hours, or days, whatever is appropriate). The resulting number (in units of mm/min or something similar) is the weathering rate.
- 3) **Write-up.** Finally, you need to write up your experiments. Write-ups should include the following elements (these are minimum requirements, please add more):
- Your weathering techniques research
  - Description of your experimental procedure, including which experimental techniques relate to which geologic process
  - Results of each experiment
  - Rank each experiment in order of effectiveness (include your numerical analysis)
  - A discussion about *geologic time* (some calculations and a paragraph).
    - Using the weathering rate you calculated for your most efficient experiment, calculate the time it would take to weather a mound of food the size of the Environmental Studies Building. To do this, divide the distance from the edge of the mound to the center (about 50 meters) by the rate of weathering. Present your answer in reasonable units of time.
    - Next, calculate how long it would take to weather out the depth of the Grand Canyon (1,600 meters). Present your answer in years.
    - Consider actual weathering rates for rocks. Weathering of marble tombstones in a cemetery in Boston occurs at a rate of 0.17 mm/year. Assume the Environmental Studies Building is a solid block of marble – how long would it take to weather? Do the same calculations for the Grand Canyon. Present both answers in years.
    - Do your calculations make sense? Is this a reasonable amount of time to form the Grand Canyon? Write a short paragraph that describes any problems with our line of reasoning, including how weathering of marble in Boston might be different from weathering in Bellingham or Arizona, or if the Grand Canyon actually formed through the process you developed. How you would change the experiment to better estimate how long it took for the Grand Canyon to form?
    - How might this experiment relate to the concept of Uniformitarianism? Include in your write up a short discussion of weathering, erosion, and Uniformitarianism.

Write-ups should be between 2 and 4 pages of **double spaced text**, (photos, graphs, etc, or captions for these do **NOT** count as text).

**Grades** will be based on the following:

- Completeness
- Scientific approach and experimental design
- Calculations (show all your work!)
- Interpretation of results (including how your experiment relates to geology)
- Basic grammar and writing skills.

If you have access to a digital camera, please include a photo of each person involved in your study, especially if they are in class. **IMPORTANT:** You may work in groups, but each person must submit their own write-up (this means each person writes something different – if two people turn in the same write up, this is considered plagiarism and both people will be considered academically dishonest. See the student handbook about what this means and the consequences).

Feel free to come to me with questions or comments. The point of this assignment is to have fun while thinking about science! Go for it!