GEO 112, Spring 2008   Laboratory exercise #1   Name_____KEY_____

Observations and Measurements in Geology

1. Mass, Volume and Density. On the counter, there are two blocks. For each block, use the ruler to measure the length, width, and thickness (height) in cm. Answers will vary a bit.
A. wooden block   length_23_cm   width_13.5_cm   height_3.9_cm
B. wax block   length_7.7__cm   width_7.7_cm   height_4.5__cm

Calculate the volume of each block. Recall that volume = length x width x height. Be sure to include units. A. wooden block 1211cm3   B. wax block 266.8 cm3

Place the wooden block in the tray full of water. Measure the height of the block that floats above water. Do the same for the wax block.
A. height above water, wooden block __2.0__ cm
B. height above water, wax block ___0.6__cm

Calculate the density of each block. Recall that density = mass / volume. The mass of the wooden block is 590 grams, and the mass of the wax block is 231grams. Be sure to include units. A. wooden block __0.49 g/cm3___   B. wax block _0.87 g/cm3

Compare the densities of the blocks with their respective heights above water. What is the relationship?_height above water decreases with increasing density__

The height that an object will float in a medium depends on the *density* and *thickness* of the object, and the density of the medium, as described by the equation below:

$$\text{Height}_{(\text{above medium})} = [1 - (\text{density}_{(\text{block})}/\text{density}_{(\text{water})})] * \text{Height}_{(\text{block})}$$

This relationship reflects the counteracting forces of gravity and buoyancy. Gravity is pulling the block down, but the relative densities of the materials is pushing the block up.

Use the equation above to calculate the density of tap water (show units):   ~1.0 g/cm3__

Now, think about the bimodal distribution of Earth's crust. The Earth's crust is divided into two main types: 1) continental crust, which is older, thicker and less dense than oceanic crust, and 2) oceanic crust, which is younger, thinner and denser than continental crust. The average density of oceanic crust is 3.1 g/cm^3 and the average density of continental crust is 2.8 g/cm^3. The average thickness of oceanic crust is about 5.0 km and the average thickness of continental crust is about 30.0 km. Finally, the density of the mantle is approximately 3.3 g/cm^3.   Use this information to calculate the average height of each crustal type above the mantle. Show work.

A. average height of oceanic crust above the mantle _0.3 km__
B. average height of continental crust above the mantle _4.6 km__
C. difference (in km) between A and B?_4.3 km__

How does the difference between A and B compare to the actual difference between the average height of continents and average depth of oceans in Figure 1.17C (in your book)?
The 4.3 km difference is close to the actual difference between the average height of the continents and the average depth of the ocean.

Reflect on your work above. Why does the earth have bimodal global topography? What are the two main controlling factors?
Earth has a bimodal global topography because it has two crustal types. The continental crust has a lower density and higher thickness than the oceanic crust. Because of this, the continental crust sits higher in the mantle than the oceanic crust. The two controlling factors are density and thickness of the crust (see above).

If you were able to keep increasing the thickness or the density of the crust, the height of the crust in the mantle would adjust itself until the equation was true again. In geology, the term for this description of reaching a balance (or "equilibrium") between crustal height and relative density is *isostasy*.

2. Rates of change and processes.
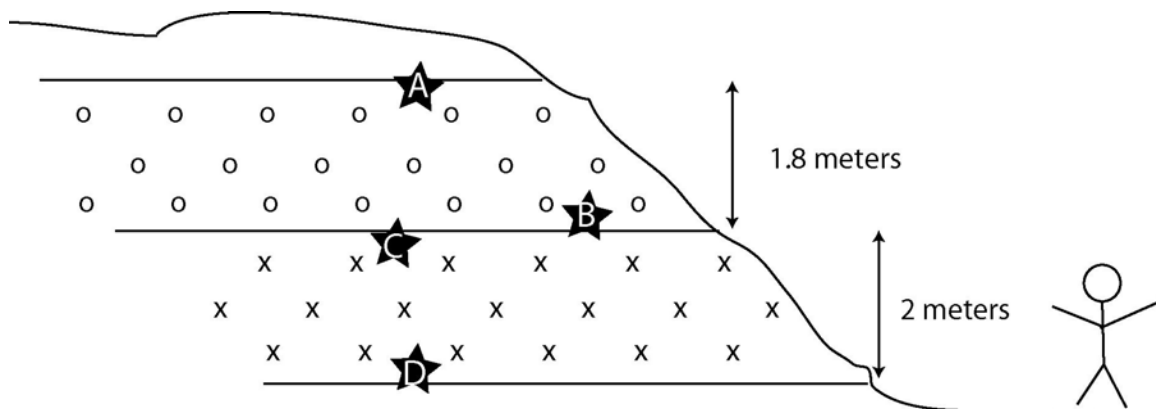
You encounter the rock outcrops above while you are out hiking. You collect rock samples from points A-D and go back and measure their ages in your isotope lab. (A=10.1251 million years old, B=10.1259 million years old, C=10.1262 million years old, D=10.1278 million years old). From detailed analyses of the rock textures and minerals found in the rocks, you determine that all of the rocks were formed from sediments deposited in a floodplain environment.

What is the average rate of sediment deposition for the unit sampled by rocks A and B?
Give units _0.00225 m/year or 2.25 mm/year_

What is the average rate of sediment deposition for the unit sampled by rocks C and D?
Give units _0.00125 m/year or 1.25 mm/year_

What change(s) in the local environment might have caused this change in deposition rate? (several possible correct answers!) _Any answer is fine as long as it is justified.
Less rainfall; drier climate; water diverted to another area somehow; more rainfall (faster floods and less time to deposit sediment).

3. Rates of change and processes, part II. Answer question 15 in Chapter 2 of your lab manual.

See answer key that came with lab manual.

4. Relative dating / geologic history reconstruction.   You have received from NASA the topographic image of the martian surface below.
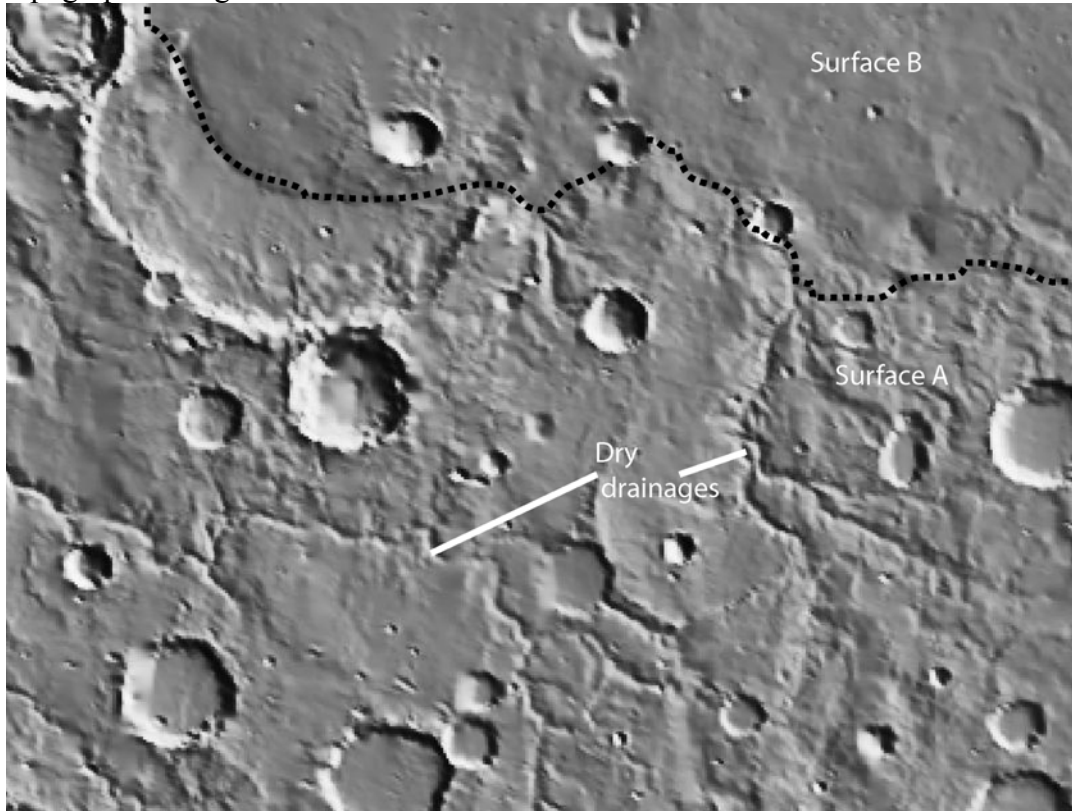
The NASA administrator points out that there appear to be two main units in the area. Surface A is heavily cratered, and contains landforms that look like riverbeds. Surface B is smooth, and lies on top of Surface A. Which unit is older and why?_Surface A because it had to be there first before Surface B could be on top.
Surface B is about 4.1 billion years old, they say. The exact age of Surface A is unknown. When would you say is the last possible time that water flowed across the surface in this area?_4.1 bya___Why?_Because Surface B truncates the channels in Surface A, and therefore water could not have flowed through the channels any later than the age of Surface B. And because no channels are present in Surface B. (any justified answer is fine).

5. Describing features objectively. On the counter, there are two different rock samples. Study the rocks and write at least three descriptive terms or phrases of each rock. Use only *objective* terms (meaning, descriptions that are not a matter of opinion). Anything is fine here. This may prompt discussion about what is an objective term (which is somewhat subjective). Here's what I came up with (again, no right answers):
Rock A _red, smooth, flat, layered, white streaks
Rock B_pink and black, striped, layered, smooth, round
Look at your terms for rock A and rock B. Are any of them on both lists? In my case yes. (smooth)
If so, what does that tell you about the use of that term in distinguishing different rock types (how useful is it)?_not useful—doesn't distinguish well.

(In the coming weeks, we will show you how to distinguish different rock types. You will impress your friends!)

6. Qualitative measurements. Sometimes in science, our measurements are necessarily qualitative (rather than quantitative), yet extremely useful. For example, to identify minerals in the field, one distinguishing parameter we can measure quickly is the mineral's hardness relative to common objects. Test the hardness of the three mineral samples on the counter, by doing the following: a) try to scratch it with your fingernail, b) try to scratch the mineral with a penny, c) try to scratch the mineral with an iron nail, and d) try to scratch glass with the mineral.

These tests are listed in order of increasing hardness. For example, if you can scratch the mineral with your fingernail, it is very soft. If you can make a scratch on glass with the mineral, it is very hard.

Label the minerals in order of increasing hardness:
Mineral A _3__
Mineral B _1__
Mineral C _2___

Next week, we will learn additional tests that are used to identify minerals. You will be a pro at mineral identification in no time.