Geology 141
Laboratory Exercise 1
Distance and Time Scales

All of your work should be shown neatly and clearly. You may use the back of the page or another attached sheet. Any explanations or discussions should be written as complete, coherent sentences with correct spelling and grammar.

Part 1: The size of the Earth

In order to gain an understanding of the relative sizes of several important Earth features, you will scale down the Earth to a radius of 20 cm, as follows.

a) On a white sheet of paper, construct a column 20 cm tall. Leave a margin of a few cm above the top of your column. Let the height of this column represent the radius of the Earth (6371 km), with the bottom representing the center and the top representing the surface, which we will assume to be mean sea level. On your column, mark, to the best of your ability, the following features:

(i) The depth of the deepest drill hole = 12 km below the Earth's surface;
(ii) The bottom of the continental crust = 30 km below the surface;
(iii) The base of the continental lithosphere = 150 km below the surface;
(iv) The depth from which the deepest samples of mantle rocks come to the surface: **xenoliths** brought up by volcanic eruptions = 400 km;
(v) The core-mantle boundary = 2885 km down;
(vi) The summit of Mt. Everest = 8.8 km above sea level;
(vii) The typical flight altitude of a commercial jet = 11 km above sea level;
(viii) The typical orbital altitude of the Space Shuttle = 300 km above sea level.

b) For any features that you were unable to accurately show on your figure, explain your difficulties.

c) Could you see any topographic features on the Earth's surface (e.g., mountain ranges, canyons, deep sea trenches) at the scale of your drawing? Explain

d) What volume and what percentage of the Earth do the following layers comprise:

i) The continental crust (neglect the oceanic crust for this question)?
ii) The mantle?
iii) The core?

e) What percentage of the Earth's volume can be studied only be indirect means (i.e., without the benefit of rock samples)? Discuss how this figure compares to any expectations that you might have had before signing up for this course concerning what we know about the Earth and how we know it.

Part 2: Isostacy, crust, and topography

This part of the lab will guide you toward an understanding of the relationship between the composition of oceanic crust (broadly basaltic), the composition of continental crust (broadly granitic), and the topography of the planet. This will also serve as a segue into our discussion of plate tectonics.

a) Complete questions 20-23 in your laboratory manual. For 22(a) and (b), you are asked to use an isostacy equation you would have calculated for question 18. Substitute the following equation:

$H_{above} = H_{crust} - [(\rho_{crust}/\rho_{mantle})H_{crust}]$

Where H_{above} is the height above the mantleline (think of it like a water line on an iceberg) that the crust floats, H_{crust} is the total height, or thickness, of the relevant crust, and ρ is the density of the relevant crust.

Instead of answering question 24, expand with the following question.

b) A mountain is a portion of continental crust thickened by plate movements and collisions (which we'll cover soon). Based on the above questions and the iceberg analogy, explain what happens to a rock formed near the bottom of such a thickened section of crust as the mountain is eroded down over time? Draw a diagram to help explain.