LAB 11: ISOSTASY

The following lab will introduce you to the basic calculations involving isostatic adjustments. Key to this is drawing neat columns that show the geologic layers. These do not need to be to scale, but if they are sloppy, you could get confused and make mistakes.

**Part I: Isostasy**

For all problems in this section, you must make a neat and well labeled sketch of your two columns using a straight edge. The columns do not need to be drawn to scale, but they do need to be neat. You should indicate where you are balancing each column to receive full credit.

1) During the last ice age there was a 3 km thick ice sheet over the Hudson Bay region. This ice sheet is now gone and the region is isostatically rebounding. Assuming that the region was in isostatic equilibrium when the 3 km thick ice sheet was present, how much will the surface of the earth rebound due to the removal of the ice sheet once the region reaches isostatic equilibrium? Use the stratigraphic column below for your data.

The next page has been left blank for you to setup and solve this problem. Please make sure to fill in your final answer at the bottom of the page.
1) Total isostatic rebound after removal of glacier = ____________________ km
2) A typical continent has a 40 km thick layer of crust with density 2.7 g/cm$^3$, underlain by 70 km of lithospheric mantle with a density of 3.1 g/cm$^3$. Oceanic lithosphere has 2 km of water on top (assume 1.0 g/cm$^3$), then 6 km of basalt (2.9 g/cm$^3$) and also 70 km of lithospheric mantle at 3.1 g/cm$^3$. Below both the oceanic and crustal sections is asthenosphere with a density of 3.2 g/cm$^3$. Assume that the continental crust is at some unknown elevation above sea level.

Given these parameters, how much higher is the top of the continental crust than the top of the oceanic crust?
3) Mount Rogers is Virginia’s highest point and has an elevation of 1.75 km (5729 feet). Assuming that Mt. Rogers is in isostatic equilibrium, calculate the thickness, in km, of the crustal root (i.e. just the extra crustal thickness below Mt Rogers). Assume that the density of the crust is 2.6 g/cm$^3$, the density of the mantle is 3.3 g/cm$^3$, and that the normal crust is at sea level. This is not a trick question. You do have enough information to solve this problem. The key will be to set up two columns where some of the unknown parameters cancel out. Hint: The Mt. Rogers block should only contain crust, which can be subdivided to cancel out parts of the non-mountain or normal crustal block.
4) The picture below shows the complete Bouguer anomaly for the state of Colorado (Courtesy of the USGS). The Colorado border is marked by the thin black lines.

![Bouguer anomaly map of Colorado](image)

a. What does the large negative anomaly over the Rocky Mountains suggest about the subsurface geology? Why?

b. Based solely on the figure above, are the Rocky Mountains in isostatic equilibrium? What is needed to determine this?

c. Based on your answers in part a and b, would you expect the free-air anomaly over the Rocky Mountains to be positive, negative, or zero? Why?