Homework 3: Gravity Surveying and Reduction

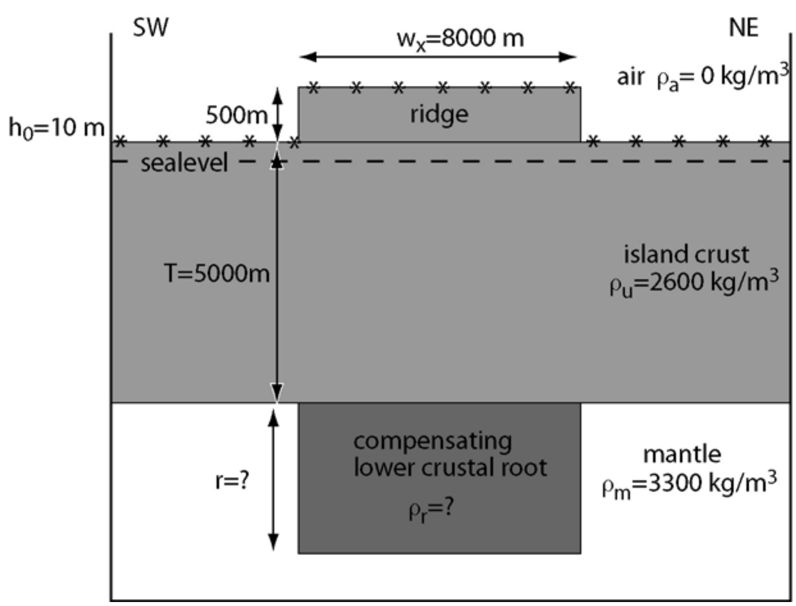
Read *Robinson & Coruh*, Chapter 8

Due Thu. 1/28

1. You are on the Hawaii research vessel R/V Kilo Moana doing a marine geophysical survey.
   (a) Your sonar system reveals that you are passing over a seamount. Does your gravimeter record an increase or a decrease in the pull of gravity as you move over the seamount? Explain.
   (b) The ship crosses the seamount going east and then once again going north. On which crossing does the gravimeter measure a stronger (raw) gravitational pull?
   (c) Extra Credit: The Eötvös correction, E_c, accounts for the centrifugal acceleration away from the Earth associated with the ships motion. Equation 8-14 gives the magnitude (in mGal) of E in terms of latitude ϕ, and the magnitude V (in knots) and azimuth β of the ship's velocity. Compute how much higher/lower the gravity reading is on the east- compared to the north-going crossing. The ship is moving at $V = 10$ knots.

You do a gravity survey over a ridge on a Pacific island much like the Nu`uanu Pali on Oahu. To keep things simple, this ridge is more like a plateau with steep sides as illustrated below. Your measurement points are shown schematically as asterisks (diagram is not drawn to scale).

The file "data.hw3.txt" contains the data collected. Column 1 is horizontal position from the center of the ridge (x, in m), column 2 is the altitude above sea level of your measurements (h, also in m), and column 3 contains your gravity data (absolute gravity in units of mGal). Typing "load data.hw3.txt" in Matlab will create an n x 3 matrix called "data", with the same content as the file. Typing "x=data(:,1)", in which "(:,1)" means use all the rows in column 1, will generate a column matrix of positions. "h=data(:,2)" will give you a vector of altitudes, etc.



2) First plot the observed gravity versus distance (using "subplot(411)") and then plot elevation (h) versus distance on a separate plot below gravity ("subplot(414)"). Why is the observed gravity high where topography is low and why is the gravity low were topography is high?

3) A free-air gravity anomaly Δg_{FA} (see Eq. 8-4a) is the observed gravity minus the Earth normal gravity, g_N, and corrected for the effects of elevation above sea level. Using Matlab, compute free-air gravity anomaly for each of your measurement points, and then in "subplot(412)", plot your results as a function of distance x. The latitude of your survey is 21.5°N. Make sure the units of each term in your correction are in mGal (Δg_{FA} should be much smaller than 9.8 x 10^5 mGal). Why is Δg_F high over the topographic high and low over the topographic low?

4) Next let's produce a *simple Bouguer gravity anomaly*. From the free-air gravity anomaly, remove the effects of the crust between the observation point and sea level by apply the "Bouguer plate correction" (Eq. 8-6a). Plot the resulting "simple Bouguer gravity anomaly" Δg_B below your plot of free-air anomaly ("subplot(413)").