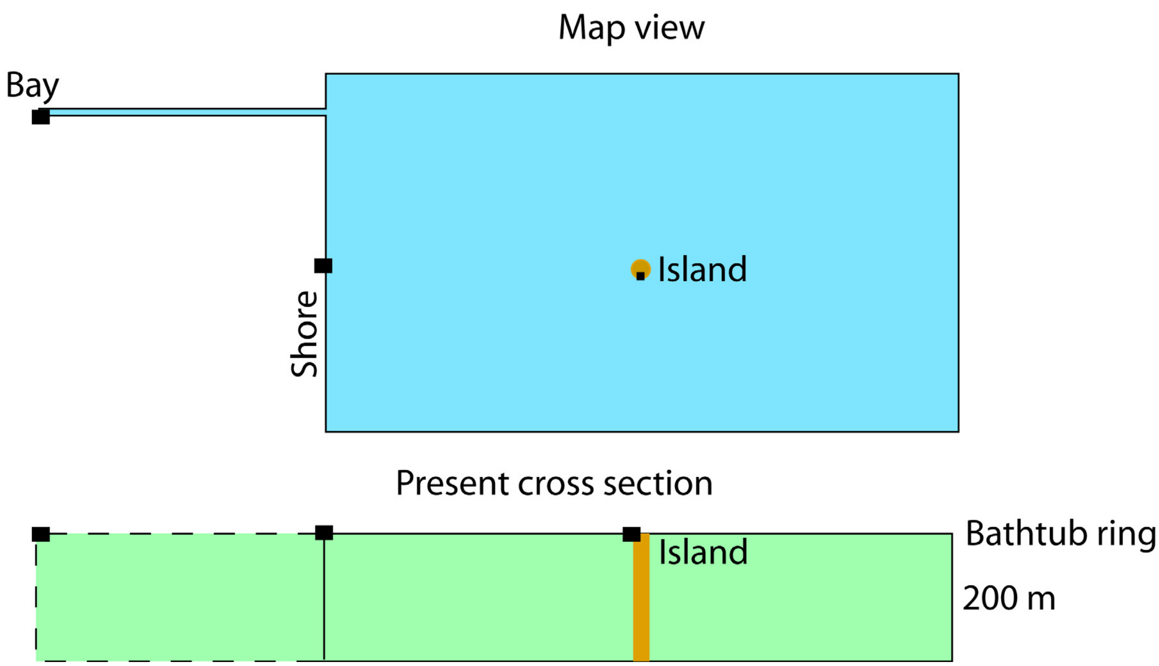
Geophysics 150: Homework 5

(Due March 3 2005)

$G = 6.67\times10^{-11}$ nt m^2 kg^{-2} and $2\pi G = 42$ mgal km^{-1} (gm/cc)$^{-1}$.

1. You are studying a lakebed in the Basin and Range. A geologist tells you that the lake was about 200 m deep with water density 1 gm/cc. Assume that the density of the mantle is 3.4 gm/cc. There was a small island in the middle of the lake, a straight shore and a shallow bay that went far from the lake. The lake had a flat bottom and deep sides for simplicity. That is, treat the bottom as locally flat at each place.



a. The island was small enough that we can treat it as a stadia rod or dipstick that does not affect the load. The small bay lakeshore is now 200 m higher than the lakeshore near the old island. Compute how deep the lake was near the island when it was full.

b. Along the old straight shore there was water only on one side. We thus equivalently have half the load in the center of the lake or a distributed load of 0.5 gm/cc. How deep the lake just offshore.

c. Assume instead that the lower crust is fluid with a density of 2.7 gm/cc. It acts as a compensating layer for the water load rather than the mantle. Repeat parts (a) and (b).

2. Use the map of the Michigan Basin. There is a prominent circular gravity anomaly on the northwest part of the map. We are trying to get an idea of the depth to the body and a taste of real data.

a. Estimate the difference between the peak of the anomaly and the surroundings. $g_{\max}$.

b. Estimate the maximum lateral change of the anomaly on its flanks $(\partial g / \partial r)_{\max}$.

c. A depth estimate is the ratio from equation 4.75 in the book.

$$\left(\frac{g_{\max}}{(\partial g/\partial r)_{\max}}\right)\left(\frac{3^{3/2}}{8}\right)$$

Find this quantity.

d. Make a profile of gravity across the anomaly. Compare it with a sphere at the depth you just computed. What mass difference did you need for your sphere?

e. Use the method on Figure 4.23 to compute a second derivative map around the anomaly. 25 points should be plenty. Obtain a profile and model with equation 4.79 using the depth that you got in part c. Compute the mass difference.

3. Use the magnetic map.

   a. Compare the center of the magnetic anomaly with the center of the gravity anomaly. The magnetic declination is true north here. You are about at 44°N. Compute the expected inclination of a dipole.

   b. These are total component anomalies. Sketch lines of force. Is the maximum offset in the expected direction from the gravity anomaly?