GE3040
Midterm #1
2/20/2008

Name ______________________________________

1. For the various geophysical methods listed below give the "operative (dependent)" physical property or properties each method is responding to:

   a. Gravity ____

   b. Magnetics ____

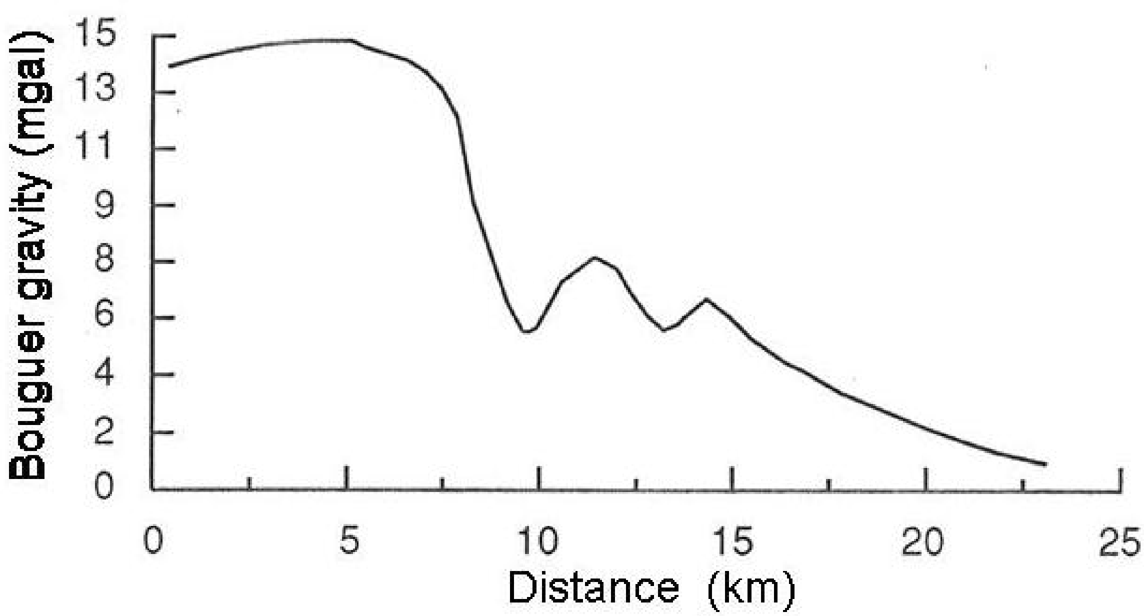
   c. Seismic refraction/reflection ______________________________

   d. Electrical resistivity ______________________________________

   e. Electromagnetics ____

   f. Ground Penetrating Radar __________________________________

2. The observed gravity profile shown below is over alluvial filled valleys (ρ = 2200 kg/m^3) cut into crystalline bedrock (ρ = 2700 kg/m^3). Draw in the regional gravity field and then determine the minimum depth to bedrock in the left-most valley.

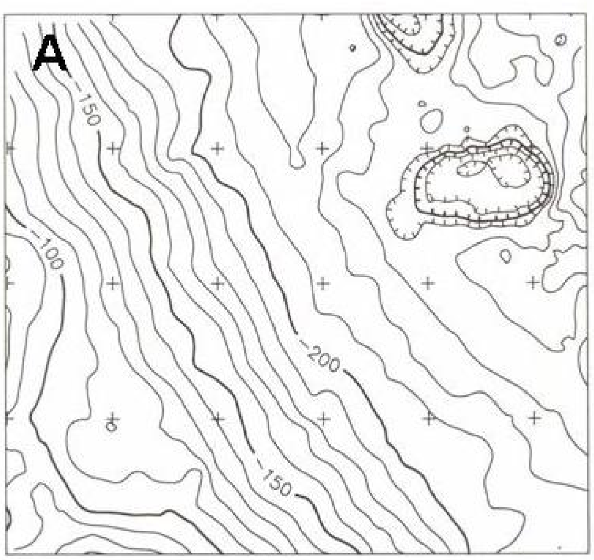


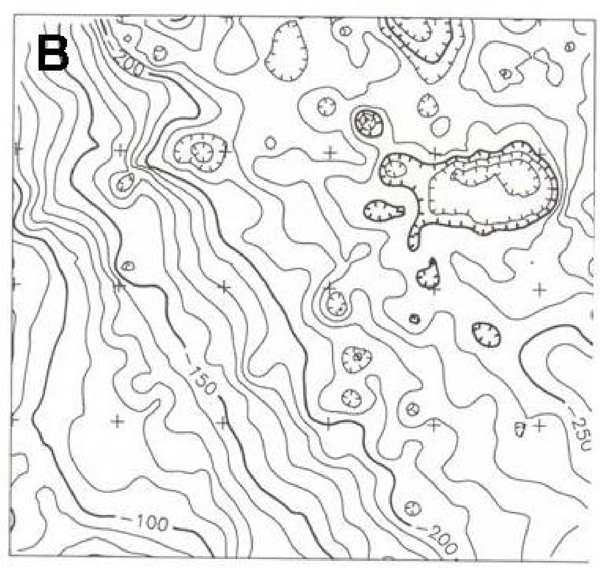
3. The two Bouguer anomaly maps shown below are from the eastern Sierra Nevada Mountains near the Long Valley caldera in California.
    a. Which map shows the complete Bouguer anomaly for this area, i.e. has had terrain corrections made? Why?

    b. Explain why terrain corrections have the same sign for both hills and valleys that surround a gravity station?

    c. In what direction does the crust thicken? What is the cause of this thickening?North is up on the maps.

    d. The prominent anomaly in the NE corner of both maps is caused by a positive or negative density contrast. ______________________





4. Gravity on the reference ellipsoid varies as a function of latitude. What are the different components of this variation and how does each affect the gravity field on the reference ellipsoid.

5. What is the IGSN71?

6. What are the three possible causes of drift in a gravimeter?

7. Geophysical methods can be classified as either active or passive. Briefly describe this classification system.

8. Data Reduction Problem:

Station	Time	Elevation (m)	Reading (du)	Distance (m)
BS	10:00	650	656.0	
101	10:30	780	600.0	150
102	10:45	810	550.0	300
103	11:15	790	570.0	450
BS	11:30	650	645.0	
104	11:45	760	625.0	200
105	12:15	720	675.0	450
BS	13:00	650	627.0	

g_{obs} at BS = 9801019.0 gu
g_{th} at BS = 9800765.0 gu
BS located at 38.95^{o}N
Distances are south of base (BS) for stations 101, 102, 103 and north of the base for stations 104 and 105.
Gravimeter scale constant = 0.0872 gu/du
Bouguer slab reduction density = 2.67 Mg/m^3

(a). What is the drift correction for station 103 with respect to the 10:00 base reading?

(b). What is the drift correction for station 105 with respect to the 10:00 base reading?

(c). What is the observed gravity at station 103?

(d). What is the simple Bouguer anomaly at station 103? Reduction datum is the elevation of the base station and not the geoid.

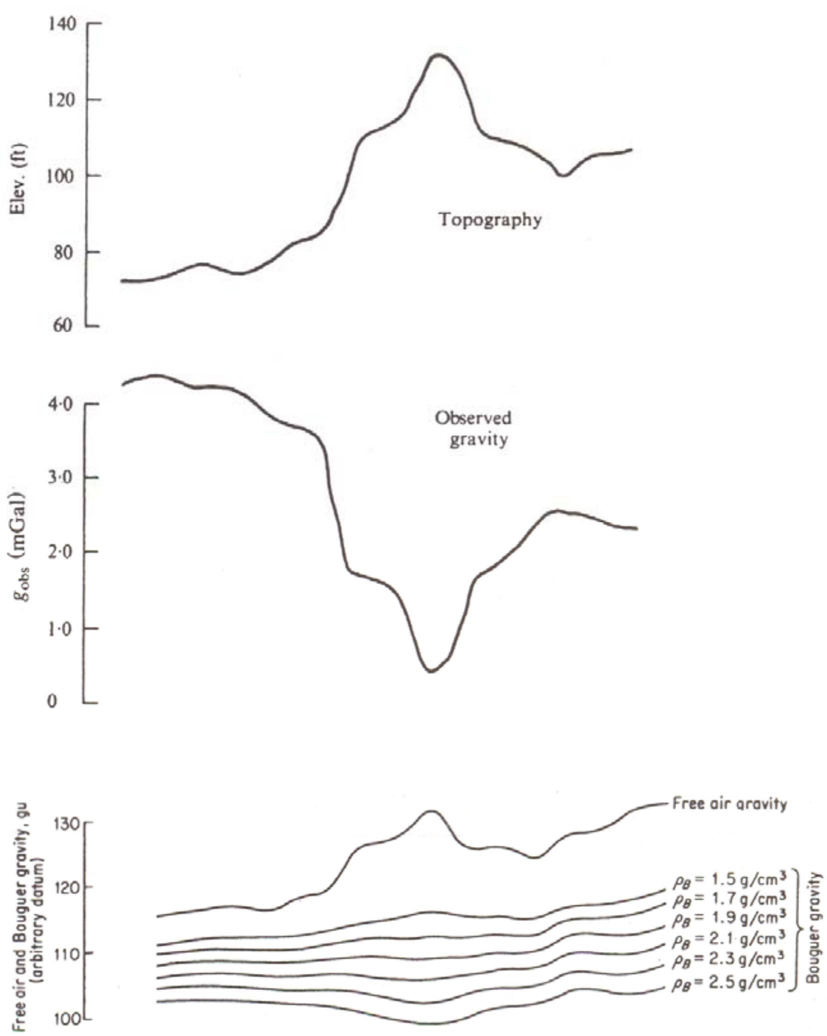
(e). What is the difference in gravity caused by elevation differences between BS and station 105. At which station would gravity be greater due to this effect alone?

(f) What is the difference in gravity between stations 101 and 105 due to latitude. At which station would gravity be greater due to this effect alone?

9. In the diagram below:
    a. Why is there an inverse relationship between observed gravity and topography?

    b. Why is there a direct relationship between the Free Air gravity anomaly and topography (elevation)?

    c. What density is most correct for converting the Free Air gravity values to Bouguer gravity values? Why?



Bonus Question: What is the difference in gravity between a gravity reading taken on the ocean floor (500 m below sea level) and one taken at sea level due to the mass of the sea water only. Assume $\rho = 1.0$ Mg/m^3. Think about this one!

Equation Sheet

$F = Gm_1m_2/r^2$; $g = Gm_1/r^2$;

$G = 6.67 \times 10^{-11}$ m^3/kg-sec^2; $GM = 3.986005 \times 10^{14}$ m^3/sec^2; $\omega = 2\pi/T$

$g_{th} = 9780318.46(1+0.005278895 \sin^2\lambda +0.000023462 \sin^4\lambda)$ gu

Free Air correction: C_{FA} (gu) = 3.086 h (m)

Bouguer slab correction: C_{FA} (gu) = 0.4191ρh (m) where ρ is in Mg/m^3

Theoretical gravity gradient:: Δg_{th} (gu) = $8.11 \times 10^{-3} \sin 2\lambda\ \Delta s$ (m)

Terrain correction: C_T (gu) = $0.4191\ \rho/n\ (r_2 - r_1 + \sqrt{r_1^2 + z^2} + \sqrt{r_2^2 + z^2})$

where C_T = terrain correction of a sector; ρ = Bouguer reduction density (Mg/m^3); n = number of sectors in a zone; r_1 inner radius of zone (m); r_2 = outer radius of zone (m); and z = modulus of elevation difference between observation point and mean elevation of the sector (m).

$g = 4\pi^2 l / T^2$ $g_1T_1^2 = g_2T_2^2$; $g = 2(s_2t_1 - s_1t_2)/t_2t_1$

$R = R_e (1 - f \sin^2\lambda)$; f = 1/298.247; R_e = 6,378,139 m; R_{ave} = 6.371,000 m

$\Delta g_z = (4/3)\pi G\Delta\rho R^3 z/(x^2 + z^2)^{3/2}$ sphere

$\Delta g_z = 2\pi G\Delta\rho R^2 z/(x^2 + z^2)$ horizontal cylinder

$\Delta g_z = 2\pi G\Delta\rho t$ infinite sheet

$\Delta g_z = 2G\Delta\rho t(\pi/2 + \tan^{-1}(x/z))$ step discontinuity

$z = 1.305x_{1/2} = 0.65w_{1/2}$ half-width sphere

$z = x_{1/2} = 0.5w_{1/2}$ half-with horizontal cylinder