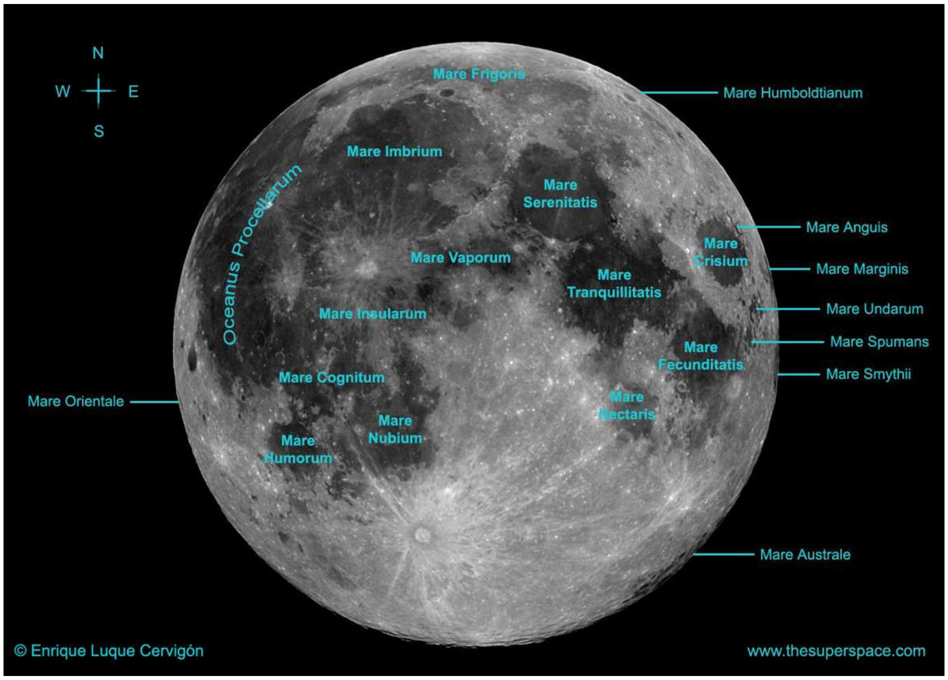
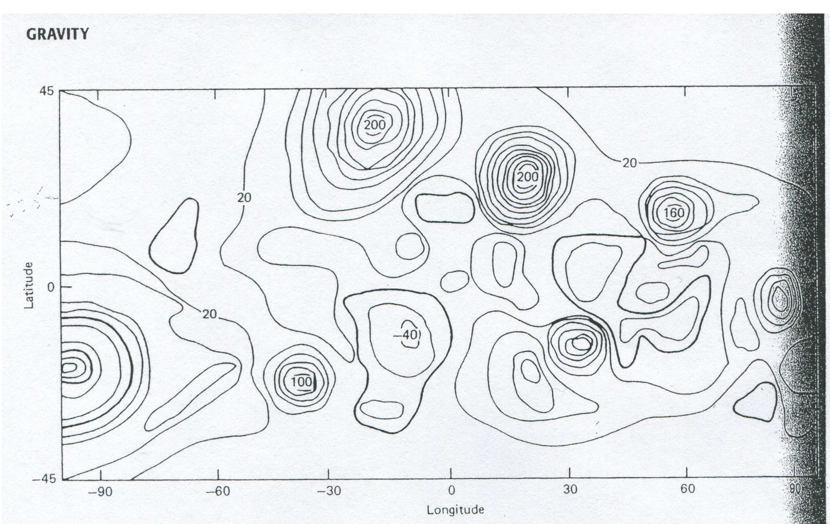
 Name:

Surface Gravity Anomalies



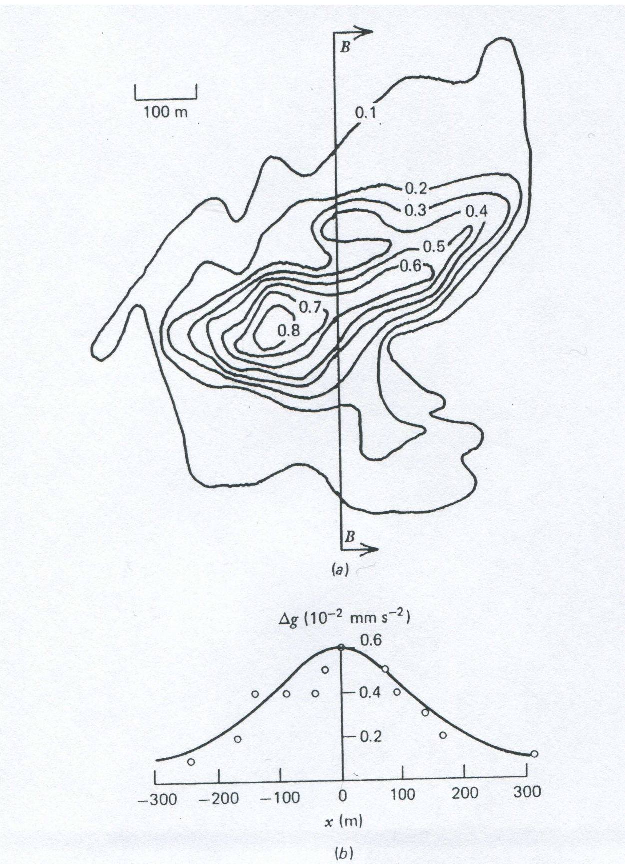
1. The lunar gravity field has been determined by the tracking of orbiting spacecraft. The figure below shows a contour map of the gravity anomalies on the near side of the Moon. The most noticeable features are the positive anomalies coincident with the circular mare basins. **Determine the density of the anomalous mass associated with Mare Serenitatis** centered at about 30°N, 17°E assuming it is at about 2 km depth below your measurement point. You may want to use the equation for calculating the Bouguer gravity anomaly (Δg_b) from your class notes.



5-13 Lunar gravity anomalies at an altitude of 100 km (Sjogren, 1977). The values are in 10^{-2} mm s^{-2} and the contour interval is 0.2 mm s^{-2}

2. A gravity profile across the Pyramid No. 1 ore body near Pine Point, Northwest Territories, Canada, is shown in figure 1. A reasonable fit with equation (1) for a buried sphere (see class notes) is obtained by taking b = 200 m (depth) and $4\pi G R^3 \Delta\rho / 3b^2 = 0.0005 mm/s^2$. Assume that the gravity anomaly is caused by lead-zinc ore with a density of 3650 kg/m^3 and that the country rock has a density of 2650 kg/m^3. **Estimate the tonnage of lead-zinc ore, assuming a spherical body.**

$$\Delta g = \frac{4\pi G R^3 \Delta\rho}{3} \frac{b}{(x^2 + b^2)^{3/2}} \tag{1}$$



5–10 (*a*) Contour map (10^{-2} mm s^{-2} contours) of the surface gravity anomaly over the Pyramid No. 1 ore body (Seigel et al., 1968). (*b*) Gravity measurements on section *BB* from (*a*) compared with a theoretical fit based on Equation (5–102).

Sea ice on the Hudson Bay breaks up and slowly recedes as the warmer temperatures of spring and summer make their way north into Quebec Province in eastern Canada, shown here in this true-color Terra MODIS image from May 21, 2005. Hudson Bay. The Hudson Bay occupies the southernmost portion a depression in the land that was created by the weight of a continental ice sheet in the Pleistocene epoch (between 1.8 million and 11,000 years ago). As the ice sheet retreated, the depression was filled with sea water and sediments. With the weight of the ice sheet now gone, the floor of the compressed Bay is slowly rising, and both the Hudson Bay and James Bay are gradually becoming shallower.

3. The ice sheet over Hudson Bay, Canada, had an estimated thickness of 2 km. At the present time, there is a negative free-air gravity anomaly in this region of $0.3mm/s^2$.

3a. Assuming the ice (density of 1000 kg/m^3) was in isostatic equilibrium and displaced mantle rock with a density of 3300 kg/m^3, determine the depression of the land surface, h_o. (*Hint: the term "isostatic equilibrium" should remind you about isostacy and using columns of equal mass. Draw a sketch of the problem and include columns of equal mass to design your calculation.*)

3b. Assuming the negative free-air gravity anomaly is due to incomplete rebound, determine h at the present time. You can use the free-air gravity correction (Δg_f) below, where $g_o = 9.78 m/s^2$, and the radius of the earth (or elevation) at your location is $r_o = 6378$ plus the local elevation above sealevel (120 m).

$$\Delta g_f = \frac{2hg_o}{r_o}. \tag{2}$$

3c. Using the observation of post-glacial rebound for the receding Hudson Bay ice sheet, determine the mantle viscosity beneath this region. Assume that the ice sheet melted 10,000 yrs ago and that the ice sheet wavelength was about 5 times what we see today.

3d. In class you estimated the viscosity of the mantle beneath the Scandinavian ice sheet which had a wavelength was 2000 km. Discuss the difference between the viscosity obtained in #3c for the Hudson Bay ice sheet with the result obtained for Scandinavia.