EART162 Homework #4 **Due Tues 29th April 2008**

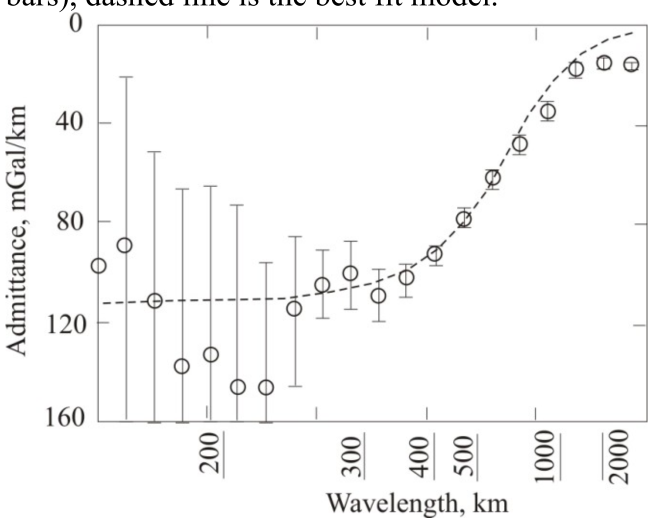
1. The Caloris impact basin on Mercury is about 3 km deep. We are going to make some predictions for what the *Messenger* spacecraft will see once it gets into orbit.

a) If *Messenger* sees no appreciable gravity anomaly over Caloris, what does this imply about the compensation state of the basin, and the lithospheric strength? (2)

b) Let's assume that any gravity anomalies seen are small, and there is no evidence for mantle material at the base of the Caloris basin. Use this information to obtain a *lower limit* on the crustal thickness of Mercury away from Caloris. You may assume crustal and mantle densities of 2900 kg m^{-3} and 3400 kg m^{-3}, respectively. (4)

c) If Caloris was originally 5 km deep, and was then flooded with lavas after the lithosphere cooled and became rigid, how big a gravity anomaly would you see at the surface? At a spacecraft altitude of 300 km, how big would the anomaly be? The basin diameter is 1200 km and the lava density is 2900 kg m^{-3}. (4) (10 total)

2. Here's a plot of admittance as a function of wavelength derived by the *Magellan* spacecraft at Venus. Note that the horizontal scale is non-linear. Dots are data (with error bars), dashed line is the best fit model.

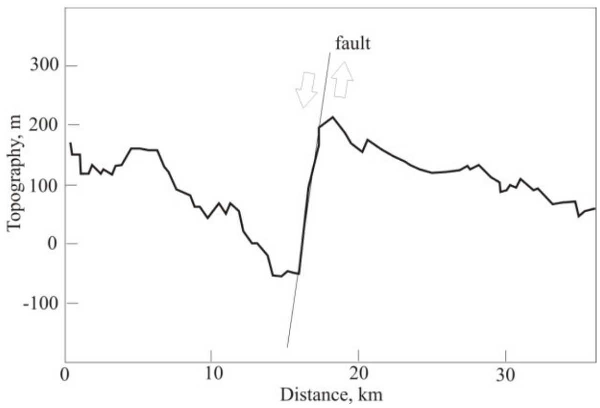


a) Use this plot to determine the crustal density of Venus (2)
b) The degree of compensation *C* is 50% when the admittance is half of the constant value it reaches at short wavelengths. At what wavelength, roughly, does the degree of compensation reach 50%? (1)
c) Using your answer to b), determine the rigidity *D* of the lithosphere of Venus. You may use g=9 ms^{-2}, $\Delta\rho$=500 kg m^{-3}. (3)
d) What is the corresponding elastic thickness of Venus? Use E=100 GPa and Poisson's ratio =0.25. (2)

e) How does this value compare to the elastic thickness for continents on Earth? Why is the T_e value you explain puzzling in view of the high surface temperature of Venus (450°C)? What is one possible resolution of this puzzle? (3)
f) Why do the error bars get bigger at short wavelengths, and what prevents the spacecraft from making better measurements? (3) (14 total)

3. The flexural wavelength is controlled by the flexural parameter α, but what we are more interested in is the elastic thickness T_e.

a) Write down an expression which gives T_e in terms of α (3)



b) The topographic data above show a fault demonstrating evidence of flexure on Europa. Mark one flexural feature and estimate the approximate value of α using this figure (2).

c) Europa (radius=1500 km) has global long-wavelength variations in ice shell thickness. Would you expect these variations to generate large gravity anomalies? Why? (2)

d) Use your answers to a) and b) to derive the elastic thickness. You may assume a surface density of 1 g/cc, g=1.3 ms^{-2}, E=3 GPa and Poisson's ratio = 0.3 (2)

e) Assume that the base of the elastic layer is at a temperature of 190 K and the surface temperature is 100 K. What is the heat flux if the thermal conductivity is 3 Wm^{-1}K^{-1}? (NB look at Turcotte and Schubert chapter 4 if you don't know how to calculate heat flux). (2)

f) How does the value obtained in e) compare with the Earth's present day heat flux? Comment on your answer (3) (14 total)