HOMEWORK 6 - due March 10

1) Turcotte and Schubert, problems 6-4 and 6-12.

2) By assuming the lithosphere responds as thin elastic plate when it is subjected to topographic loads, one can calculate a linear relationship between gravity anomaly and topography in the Fourier transform domain.

$$Q(|k|) = 2\pi G\,(\rho_c - \rho_w)\,e^{-2\pi|k|s}\left|1 - e^{-2\pi|k|d}\left\{1 + \frac{D\,|2\pi k|^4}{g\,(\rho_m - \rho_c)}\right\}^{-1}\right|$$

The flexural rigidity D is

$$D = \frac{E\,h^3}{12\,(1 - \nu^2)}$$

G	-	gravitational constant	6.67×10^{-11} m^3 kg^{-1} s^{-2}
g	-	acceleration of gravity	9.82 m s^{-2}
ρ_w	-	seawater density	1025 kg m^{-3}
ρ_c	-	crustal density	2800 kg m^{-3}
ρ_m	-	mantle density	3330 kg m^{-3}
s	-	mean water depth	(average of topography, must be positive)
d	-	crustal thickness	6000 m
h	-	elastic plate thickness	(0 - 50,000 m)
E	-	Young's modulus	6.5×10^{10} N m^{-2}
ν	-	Poisson's ratio	0.25

Plot this transfer function for wave numbers k ranging from 0 to 10^{-4} m^{-1}. Use elastic thicknesses of 0 m and 30000 m. Why does the transfer function approach zero at high wave numbers? Why does it approach zero at low wave numbers?

Explain what happens when the elastic thickness is zero. For zero elastic thickness, what is the relationship between topography (above the base level) and the total crustal thickness?

Using this transfer function Q(|k|), and the topography given in the computer file (ftp tope x.ucsd.edu pub/class/hw5), calculate a model gravity anomaly profile for h=0. The basic procedure is to take the Fourier transform of the topography, multiply by the transfer function Q(|k|) and inverse Fourier transform the result.

Compare this model gravity profile with the observed gravity profile. Increase the elastic thickness until the model gravity profile matches the observed gravity profile. How does this value of elastic thickness compare with the value found by Watts, JGR, v. 83, 5989-6004, 1978? How old was the lithosphere when this seamount formed?