HOMEWORK 2 - due October 17

1) Given the rotation pole between the African and South American plates (pole; latitude=62.5°, longitude=320.6°, rate= 5.58 x 10^{-9} radian/yr), calculate the spreading rate at a point on the northern Mid-Atlantic Ridge (lat= 30°, lon= 319°).

2) The vector sum of relative plate velocities around a triple junction is zero.

$$\mathbf{v}_{BA} + \mathbf{v}_{CB} + \mathbf{v}_{AC} = 0$$

Use $\mathbf{v} = \boldsymbol{\omega} \times \mathbf{r}$ to show that the following is also true at the triple junction position, r_o

$$\boldsymbol{\omega}_{BA} + \boldsymbol{\omega}_{CB} + \boldsymbol{\omega}_{AC} = 0$$

where the $\boldsymbol{\omega}$'s are the relative rotation poles.

3) Solve for the temperature T as a function of time t and depth z in a cooling half space.

The differential equation for heat diffusion is

$$\frac{\partial^2 T}{\partial z^2} = \frac{1}{\kappa} \frac{\partial T}{\partial t}$$

and the boundary/initial conditions are

$$T(0,\ t) = T_o; \quad T(\infty,\ t) = T_m; \quad T(z,\ 0) = T_m.$$

Use the following similarity variable η to reduce the partial differential equation to an ordinary differential equation

$$\eta = \frac{z}{2\sqrt{\kappa t}}$$

where κ is the thermal diffusivity, T_o is the surface temperature, and T_m is the initial temperature of the half space. (For help see Turcotte and Schubert page 159.)

3) Depth and time required for Windmanstatten structure (See chapter 3 *in Meteorites and Origins of Planet*s by John Wood http://topex.ucsd.edu/geodynamics/wood_meteorites.pdf.)

The Windmanstatten structure, observed in iron meteorites, is produced by very slow cooling (5°C per million years) of nickel-iron alloy through a temperature of 500°C. Given a large planetesimal, about the size of the Earth's moon (made entirely of Fe-Ni alloy, $\kappa = 1.2 \times 10^{-5}\ m^2/s$), calculate the time and depth when the pattern formed.

Assume that the planetesimal is cooling from a uniform melting temperature T_m of 1400°C at time = 0 and that the surface temperature T_o is 0˚C. Moreover, assume half-space conductive cooling of the planetesimal.