GEOS 602 – Geophysical Fields
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Problem Set #8 Due Thu April 8

1. Basalt flows from a submarine fissure erupting along the Reykjanes Ridge at 60°N, 30°W crystallize on the ocean floor. As the temperature descends through the Curie point, some thermoremanent magnetism (TRM) is induced by the Earth's magnetic field. Assuming the dipole approximation (degree 1 terms), what will be the inclination and declination of the TRM?

   For reference:

g_0^1 = -29,775	
g_1^1 = -1851	h_1^1 = 5411

2. Derive the expression for the magnetic anomaly caused by a two-dimensional horizontal ribbon infinitely extended in the *y*-direction. Use the expression for the gravitational attraction of the same ribbon with surface density σ, where the edges of the ribbon are located at (r_1, θ_1) and (r_2, θ_2) relative to the observation point:

   $$\mathbf{g} = 2G\sigma\left[\hat{\mathbf{i}}\log\frac{r_1}{r_2} + \hat{\mathbf{k}}(\theta_1 - \theta_2)\right]$$

   Note that the magnetization used in the expression you derive here will have units of magnetic moment per unit area.

3. We model marine magnetic anomalies using a series of 2D horizontal ribbons spaced at appropriate separations, to explain the normal and reversed TRM in the oceanic crust. We often use the *thin-sheet approximation*, in which a horizontal sheet of thickness *T* is at a depth *z*, with $T << z$. In this approximation, we assume that *r* and θ do not change over the thickness of the body, and the anomaly is then proportional to the thickness. This way we can use the same expression derived in problem 2 with the magnetization being the magnetic moment per unit volume multiplied by *T*. In practice, magnetic anomalies are modeled by taking the magnetic moment of reversely magnetized blocks of crust to be zero, and that of normally magnetized blocks of crust to be 2**M**. Because a uniformly magnetized infinite sheet produces no field, this is equivalent to using -**M** and +**M** for the two types of crust.

   (a) Consider a point on a mid-ocean ridge, between two oceanic plates with only one reversal (treat the oceanic crust as an infinite sheet and the magnetic anomalies as 2D). The ridge crest is located between two reversal boundaries, a distance L from each one, on normally magnetized crust. Calculate the horizontal and vertical components of the magnetic field at this point.

   (b) Now consider a point directly above one of the reversals, given the same situation as above. Calculate the horizontal and vertical components of the magnetic field.