GEOPHYSICAL INVERSION   ASSIGNMENT 7(SILL)

The file bergheim.dat is the Bouguer gravity anomaly (mgal) along the Bergheim Road. The first column is easting in m, the second column is Bouguer gravity in mgal. The station spacing is 50 m and 100m.

The expression for gravity over a thick horizontal sill, with a vertical edge, is

$$2\pi G\rho t\left[\frac{1}{2} + (1+\frac{d}{t})Tan^{-1}\frac{x}{d+t} - \frac{d}{t}Tan^{-1}\frac{x}{d} + \frac{x}{2t}ln(\frac{(d+t)^2+x^2}{d^2+x^2})\right]$$

No pi in this formula; 1/2 is not needed, but a regional constant is needed to fit the data

where x is position along a profile, ρ is the density contrast of the sill with the host rock, t is the thickness of the sill, and d is the depth to the top of the sill. This formula can also be used to model a contact between two media, whose densities differ by ρ, if you let the thickness become infinite. The edge of the sill is at $x = 0$, if it is at x_o then substitue $x - x_o$ for x everywhere. The profile is also orthogonal to the strike of the edge, if it is not, then substitute $(x - x_o)sin\alpha$ for x everywhere.

1) Assuming the profile in Bergheim is due to a contact that strikes at right angle to the profile, invert for the position of the edge, the density contrast, and the depth, using the simplex algorith *FMINSEARCH*. The depth you recover will actually be a maximum depth, because you do not know if the contact is vertical, or if the strike is orthogonal to the profile. Use thickness t = 100 m.
Prior to inversion, make several trials to select a reasonable starting model, in which d would be about 1000 m and x0 near 0

2) If the profile has some strike to the contact, the anomaly will look wider. It will also look wider if the depth to the contact is greater, but the details of the curvature will be different. Repeat the inversion, this time with a strike included. You will probably find that the strike and depth are correlated, as are depth and thickness, so map the joint error space.

3) Assume that the thickness of the sill is 50 m, and solve again.

For fminsearch, It also seems useful to have final values of all model parameters NOT EQUAL 0. Thus, it is better to change all coordinates so that the center of the profile becomes, for example, 5000 m