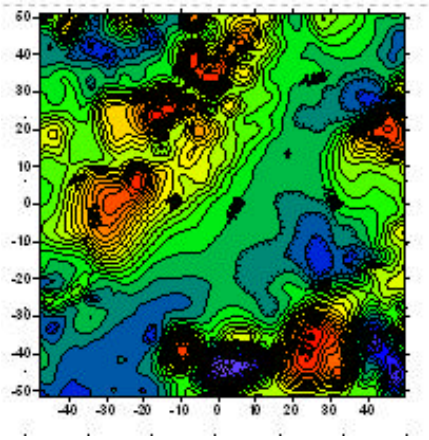
Edge Detection – step by step with the USGS DOS Software (Phillips, 1997)



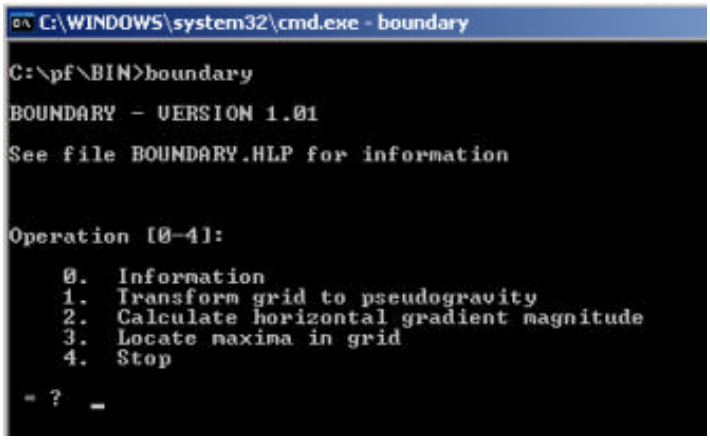
- Work in a subdirectory with a fairly short path length. The USGS DOS programs don't handle long paths. Thus, C:/something works well but you can go a little longer than that, e.g., :/Steve/pf….

- The USGS potential field software should be in C;\PF\BIN for easiest use. In C:\PF\Help you'll find a help file for each of the program in the software suite. You can read those help files with Window's Notepad. If you don't install in C:\PF, you will have to alter path names in a few of their .bat and .prm files. In general, I'll give the directions below as if you have copied the appropriate USGS files into the C:\PF\BIN subdirectory.

- Start by removing the regional (IGRF) background magnetic field from you magnetic data. For surveys of limited size, the easiest approach is just to subtract the mean value from the data.

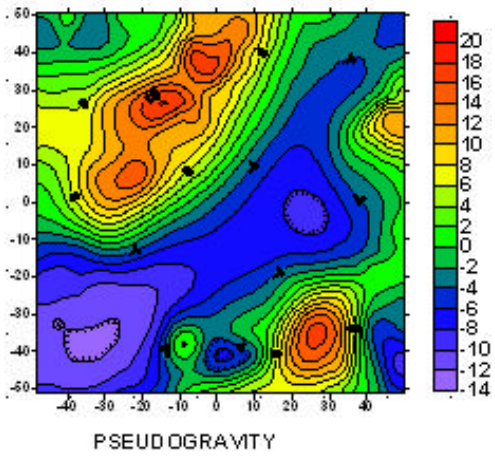
- Decimate those data to 64 x 64 by using Surfer's Grid Node Editor, storing the data as an ASCII.dat file, and then gridding it at 64 x 64 (probably with kriging). Make sure to save it as a GS binary grid, not a Surfer 7 grid, otherwise PFDRIVER08 will gag. Remember, the file names for USGS software have to be 8 characters or less.

- Use PFDRIVER08 to convert the resulting Surfer grid to a USGS grid.



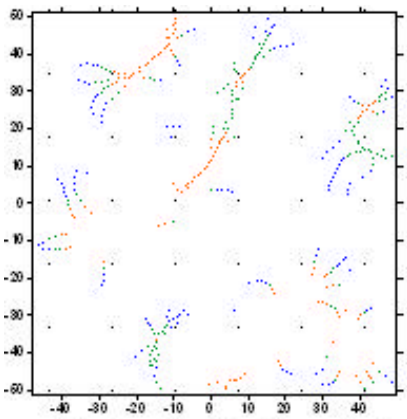
Horizontal Gradient Method

The horizontal gradient method (HGM) is that of Blakely and Simpson (1986) as implemented in the USGS software. Your data have to be transformed to pseudogravity, or reduced to pole (RTP), to use this method. If you intend to use them for depth estimates and you are looking for edges of thin horizontal sheets (say in a thrusted terrane) use HGM on the pseudogravity transformation. If you are looking for edges of vertical contacts with large depth extent, use RTP. Either way, HGM is good for horizontal locations of edges. Assuming that your USGS magnetic grid is called GS_MAG.GRD and in the subdirectory with the USGS DOS.EXE programs:



- Open a DOS command window (Start/Run/CMD) and change directories to the one with the USGS binaries (cd C:\pf\bin)

- Run BOUNDARY at the command line. BOUNDARY is interactive and then gives you 5 choices; pseudogravity is #1. You provide the input file name (remember – 8 characters or less): GS_mag.grd, and then tell it you want automatic augmentation; this helps reduce the Gibbs effect. You then provide the field's inclination and declination and that of the magnetization for the area; thus, the same numbers if it is all induced magnetization. Follow that with the grid azimuth and units as requested, the 8-character output file name and any optional grid id.



Maxima in horizontal gradient

- BOUNDARY is now back at its original menu. You follow through and create a grid of horizontal gradient magnitudes. Use PFDRIVER to make a Surfer version of the grid.
- Back at BOUNDARY's original menu, pick option #3 and create a USGS .xyz file of the X-Y locations of the maxima in that grid. I typically use option #1 in creating the .xyz binary file and keep all values greater than one standard deviation below the mean value. PFDRIVER08 will convert the USGS.xyz file to an ASCII.DAT file that Surfer can read.

Analytic Signal Method

The analytic signal (Roest et al. 1992) is implemented with the USGS DOS batch (.bat) file AS.BAT.batch files run at the command line just like .EXE's. You can run this directly on your total field anomaly; those data do not need to be reduced to pole or made into pseudogravity. The analytic signal depends on a 2nd order derivative in the vertical of the magnetic field so is thus more susceptible to noise than the horizontal gradient method.

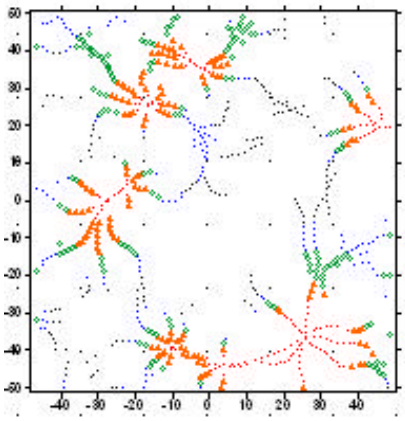
A problem you can run into with this is if you do the first install of the USGS DOS software from their web site. BEWARE: they assume that you have an "i:" drive and they refer to it in a couple of the required .PRM files – you'll have to change that to "C:". Also, if you did not install in C:\PF you will need to fix a couple other lines in batch files that default to that path. Error statements when things don't run make this apparent.

- At the DOS command line: AS GS_MAG GRD 72 72 would be the command line for a file with name: gs_mag.grd and original rows, columns equal to 64 x 64. That is, you provide:

  AS file_ prefix file_suffix augmented_rows augmented_columns

  CKDIMS.EXE will give you the next step up in rows x columns that the FFT expects.

  AS.BAT produces grids of the x-gradient, y-gradient, z-gradient, and a USGS grid of the Analytic Signal, GS_MAG.AS. PFDRIVER will convert that to a Surfer grid

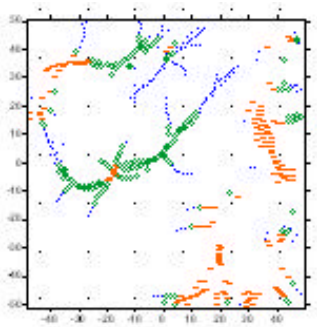


Analytic Signal

- Now use BOUNDARY again with option #3 to extract the maxima of the analytic signal grid and then PFDRIVER to make a .dat file for Surfer's Post Map option as above. You can also use PFDRIVER to make a Surfer grid of the analytic signal grid and take at look at it that way as well.

Local Wavenumber Method

Thurston and Smith (1997) invented the local wavenumber method. Phillips (1997) implements it in the USGS DOS software with LOCAL.BAT. Like the analytic signal, this can be applied directly to the total field anomaly. Also like the analytic signal, the local wavenumber method has high order derivatives of the anomalous field (second derivative in the vertical) so is susceptible to noise.



At the command line:

- LOCAL grid_prefix grid_suffix
- Local.bat produces a number of grids, al explained in the help file. The USGS grid with the local wavenumber is PHASE.H.
- Follow through with BOUNDARY and PFDRIVER to create a contour of the local wavenumber grid and a post map of maxima from that grid.

References:

Blakely, R. J., and Simpson, R. W., 1986, Approximating edges of source bodies from magnetic or gravity anomalies. Geophysics 51, 1494–1498.

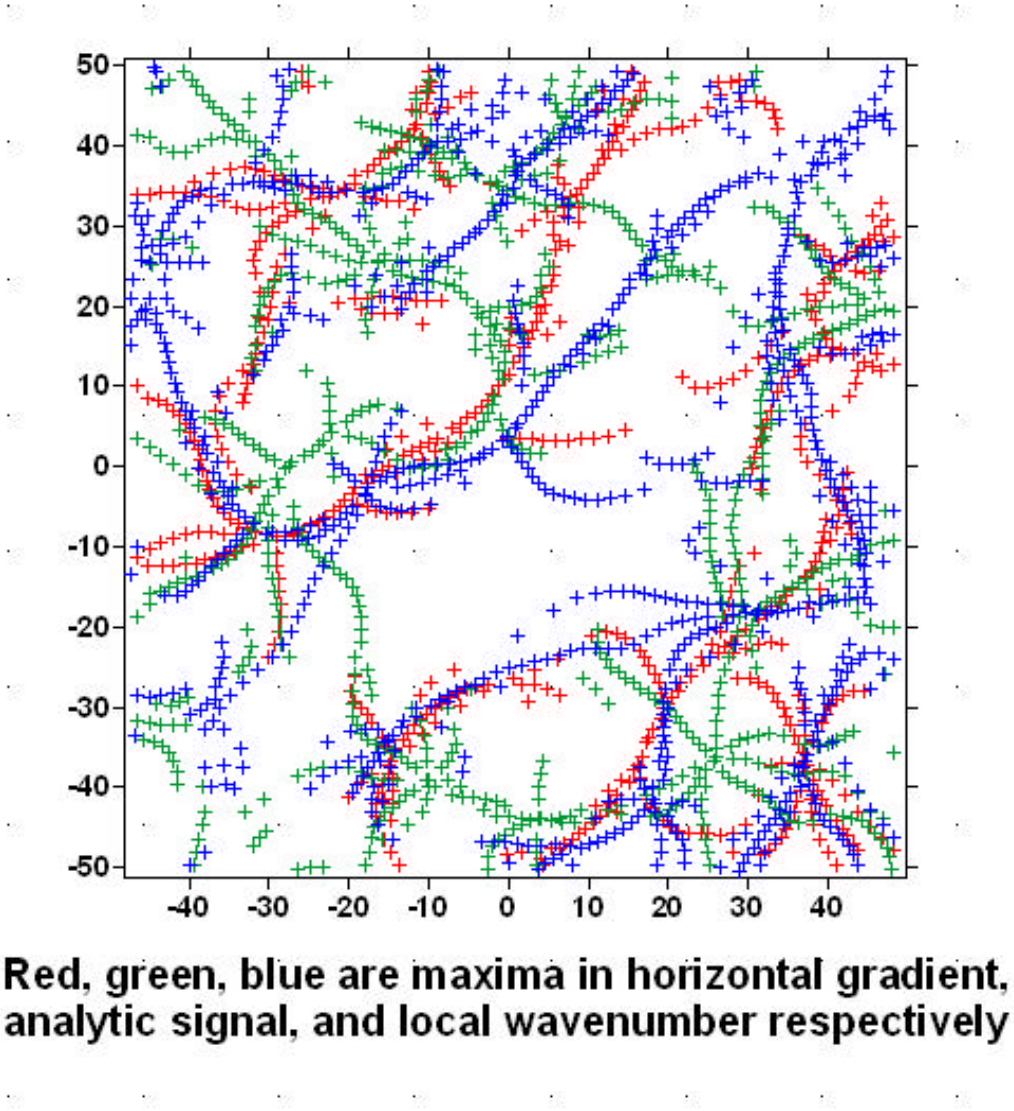
Phillips, J.D., 1997, Potential-field geophysical software for the PC, version 2.2: U.S. Geological Survey Open-File Report 97-725, 34p. (online at ftp://greenwood.cr.usgs.gov/pub/openfile-reports/ofr-97-0725/pfofr.htm).

Phillips, J.D., 1998, Processing and Interpretation of Aeromagnetic Data for the Santa Cruz Basin—Patagonia Mountains Area, South-Central Arizona, USGS Open File Report 02-98. Available online at: http://geopubs.wr.usgs.gov/open-file/of02-98/

Phillips, J. D., 2000, Locating magnetic contacts: a comparison of the horizontal gradient, analytic signal, and local wavenumber methods: Society of Exploration Geophysicists, Expanded Abstracts, 2000 Technical Program, 1, 402–405. Online: ftp://ftpext.usgs.gov/pub/cr/co/denver/musette/pub/outside_pubs/jeff/Phillips_SEG2000.pdf

Roest, W. R., Verhoef, J., and Pilkington, M., 1992, Magnetic interpretation using the 3-D analytic signal: Geophysics 57, 116–125.

Thurston, J.B., and Smith, R.S., 1997, Automatic conversion of magnetic data to depth, dip, and susceptibility contrast using the SPI (TM) method: Geophysics, v.62, no.3, p.807-813.



Red, green, blue are maxima in horizontal gradient, analytic signal, and local wavenumber respectively