

Prepared in cooperation with the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office under Interagency Agreement number IAG DE-AI52-12NA30865/DE-NA0001654

# **PDEPTH—A Computer Program for the Geophysical Interpretation of Magnetic and Gravity Profiles Through Fourier Filtering, Source-Depth Analysis, and Forward Modeling**

Chapter 17 of  
Section C, Computer Programs  
**Book 7, Automated Data Processing and Computations**

Techniques and Methods 7–C17



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By Jeffrey D. Phillips

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Techniques and Methods 7–C17

**U.S. Department of the Interior**  
**U.S. Geological Survey**

**U.S. Department of the Interior**

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**U.S. Geological Survey**

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U.S. Geological Survey, Reston, Virginia: 2018

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## Conversion Factors

International System of Units to U.S. customary units

<b>Multiply</b>	<b>By</b>	<b>To obtain</b>
<b>Length</b>		
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
meter (m)	1.094	yard (yd)
<b>Mass</b>		
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)
<b>Density</b>		
kilogram per cubic meter (kg/m <sup>3</sup> )	0.06242	pound per cubic foot (lb/ft <sup>3</sup> )
gram per cubic centimeter (g/cm <sup>3</sup> )	62.4220	pound per cubic foot (lb/ft <sup>3</sup> )
<b>Acceleration</b>		
milligal (mGal)	$3.281 \times 10^{-5}$	feet per squared second (ft/s <sup>2</sup> )

Standard International [SI] System of Units to centimeter-gram-second [cgs] units

<b>Multiply</b>	<b>By</b>	<b>To obtain</b>
<b>Length</b>		
meter (m)	100.0	centimeter (cm)
<b>Mass</b>		
kilogram (kg)	1000.0	gram (g)
<b>Acceleration</b>		
meters per squared second (m/s <sup>2</sup> )	$1.000 \times 10^5$	milligal (mGal)
<b>Density</b>		
kilogram per cubic meter (kg/m <sup>3</sup> )	0.001	gram per cubic centimeter (g/cm <sup>3</sup> )
<b>Magnetic susceptibility (dimensionless)</b>		
magnetic susceptibility (in Standard International [SI] units)	$1/(4\pi)=0.079577$	magnetic susceptibility (in centimeter-gram-second [cgs] units)
<b>Magnetic field strength</b>		
tesla (T)	$1.000 \times 10^{-4}$	Gauss (G)
nanotesla (nT)	1.000	gamma
<b>Magnetization</b>		
ampere/meter (A/m)	$1.000 \times 10^{-3}$	electromagnetic unit per cubic centimeter (emu/cm <sup>3</sup> )

## Abbreviations

2D	two-dimensional
2.5D	two-and-a-half-dimensional
3D	three-dimensional
cgs	centimeter-gram-second
HGM	horizontal gradient magnitude
mGal	milligals
nT	nanotesla
SI	Standard International (meter-kilogram-second) units
Tcl/Tk	Tool Command Language/Toolkit

# PDEPTH—A Computer Program for the Geophysical Interpretation of Magnetic and Gravity Profiles Through Fourier Filtering, Source-Depth Analysis, and Forward Modeling

By Jeffrey D. Phillips

## Abstract

PDEPTH is an interactive, graphical computer program used to construct interpreted geological source models for observed potential-field geophysical profile data. The current version of PDEPTH has been adapted to the Windows platform from an earlier DOS-based version. The input total-field magnetic anomaly and vertical gravity anomaly profiles can be filtered to produce derivative products such as reduced-to-pole magnetic profiles, pseudogravity profiles, pseudomagnetic profiles, and upward-or-downward-continued profiles. A variety of source-location methods can be applied to the original and filtered profiles to estimate (and display on a cross section) the locations and physical properties of contacts, sheet edges, horizontal line sources, point sources, and interface surfaces. Two-and-a-half-dimensional source bodies having polygonal cross sections can be constructed using a mouse and keyboard. These bodies can then be adjusted until the calculated gravity and magnetic fields of the source bodies are close to the observed profiles. Auxiliary information such as the topographic surface, bathymetric surface, seismic basement, and geologic contact locations can be displayed on the cross section using optional input files. Test data files, used to demonstrate the source location methods in the report, and several utility programs are included.

## Introduction

This report describes PDEPTH, a computer program used to interpret magnetic and gravity profile data through Fourier filtering, depth analysis, and two-and-a-half-dimensional (2.5D) forward modeling. The program currently runs on a Windows platform, but it could be adapted to run on other platforms that support Tool Command Language (Tcl), Toolkit

(Tk) graphics, and the public domain C and Fortran compilers, gcc and g77 or gfortran. The program interacts with the user through a graphical interface and uses ASCII text files for data input and data output.

PDEPTH is based on, and constructed from, parts of many previous U.S. Geological Survey computer programs. These programs are referenced in appropriate sections of the report. A previous, DOS-based version of PDEPTH was released as part of the U.S. Geological Survey Potential-Field Software Package for the PC (Phillips, 1997). The current Windows version uses a Tcl/Tk graphical user interface that communicates with the Fortran source code through C-interface routines.

## Background

Measurements of magnetic and gravity fields are noninvasive and among the least expensive of geophysical measurements for studying subsurface geology and infrastructure. Magnetic and gravity profile data can be collected on the ground, from aircraft, or from satellites, or extracted from geophysical data grids. Although it is relatively easy to make these measurements, their interpretation can be difficult, in part because of the mathematical nonuniqueness of source inversions from potential field measurements (Blakely, 1995).

## Magnetic Anomalies

Although the magnetic field of the Earth is a vector quantity, it is dominated by the Earth's core field, which does not change direction significantly over areas the size of typical magnetic surveys. As a result, most modern magnetometers measure only the scalar intensity of the magnetic field, which is called the total magnetic field or the total magnetic intensity.

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The fixed local direction of the magnetic field vector for each survey is calculated from a geomagnetic field model that predicts the direction and intensity of the core field of the Earth as a function of time and location.

The target of most magnetic surveys is the anomalous magnetic field produced by the local geology and local man-made sources. To calculate the anomalous magnetic field, the measured total magnetic intensity must be corrected by subtracting both the predicted intensity of the core field and the intensity of the time-varying magnetic field produced by currents in the Earth's upper atmosphere, as measured by a nearby base station magnetometer. The resulting scalar quantity is called the total field anomaly, and it is assumed to represent the intensity of a magnetic field vector in the local direction of the core field.

Magnetic anomalies are measured in units of nanoteslas (nT). At mid-latitudes, the core field of the Earth has an intensity on the order of 50,000 nT. Amplitudes of typical magnetic anomalies range from a few nanoteslas up to several hundred nanoteslas. Anomaly amplitudes of 1,000 nT or more are possible, especially near power lines and steel objects, such as cars.

Magnetic anomalies of geologic origin are produced by variations in the magnetic mineral content, or "magnetization," of the local geologic units. The primary magnetic mineral is magnetite. Magnetite can occur as large, multi-domain grains in rocks that cooled slowly, such as granite, or as small single-domain grains in rocks that cooled rapidly, such as volcanic flows. Sedimentary and metasedimentary rocks can contain mixtures of grain sizes depending on the source rocks.

Rocks containing large, multi-domain magnetite grains generate magnetic fields that result from induced magnetization in the direction of the local core field. The ratio of the intensity of the induced field to the intensity of the inducing field is called the magnetic susceptibility, and is a dimensionless physical property of the rock unit. PDEPTH uses centimeter-gram-second (cgs) units for magnetic susceptibility. Magnetic susceptibilities measured in Standard International (SI) units (meter-kilogram-second units) are a factor of  $4\pi$  larger than susceptibilities measured in cgs units. Average magnetic susceptibilities for sedimentary rocks range from less than  $1 \times 10^{-5}$  cgs ( $1.26 \times 10^{-4}$  SI) up to  $5 \times 10^{-5}$  cgs ( $6.28 \times 10^{-4}$  SI), with some atypical sedimentary rocks having susceptibilities above 0.001 cgs (0.0126 SI). Metamorphic rocks have magnetic susceptibilities ranging from 0 to 0.006 cgs (0.0754 SI), with an average of 0.00035 cgs (0.00440 SI). Igneous rocks can have magnetic susceptibilities as high as 0.01 cgs (0.126 SI), with averages of 0.00065 cgs (0.00817 SI) for silicic igneous rocks and 0.0026 cgs (0.0327 SI) for mafic igneous rocks (Dobrin, 1960).

Volcanic rocks and some metamorphic rocks containing small, single-domain grains of magnetite acquire their magnetic properties at the time of cooling or of chemical alteration. These rocks have remanent magnetization directions corresponding to that of the core field at the time of cooling or alteration. Remanent magnetizations

can be "normal," acquired in the direction of the current core field, or "reversed," acquired when the core field had the opposite polarity. Although PDEPTH allows for remanent magnetizations, it is often easier to treat remanent magnetizations as susceptibilities, positive for normal magnetizations and negative for reversed magnetizations. Most magnetic rocks contain some combination of remanent and induced magnetization.

Magnetic anomalies of human origin are produced by (1) excavation, heating, or replacement of geologic materials; (2) iron-bearing materials such as steel; or (3) electrical fields along power lines, electrified railways, and cathodically protected pipelines. These cultural sources are usually small compared to most geologic sources, but nearby steel and electrical sources can produce large magnetic anomalies in ground magnetic profiles and significant short-wavelength anomalies in aeromagnetic profiles.

Survey height can have a large effect on magnetic anomaly amplitudes. Magnetic anomalies produced by three-dimensional (3D) sources decay in amplitude as 1 over the cube of the distance away from the sources. Those produced by two-dimensional (2D) sources decay in amplitude as 1 over the square of the distance away from the sources.

### Gravity Anomalies

The gravity field near the surface of the Earth is another vector quantity. However, because the measured vector is always directed vertically downward, the gravity field can be treated as a scalar quantity. Raw gravimeter measurements must undergo a series of corrections before they become useful as gravity anomaly measurements. The corrections include factors such as the meter constant, the meter drift, Earth tides, the station latitude, and the station elevation. Additional corrections may include a correction for the mass between the station elevation and sea level (Bouguer correction), a correction for the effects of local terrain variations (complete Bouguer correction), and a correction for variations in the thickness of the crust (isostatic correction). Ideally, the corrected measurement should represent the vertical gravity at the measurement station produced by the density variations in the local geologic units of interest.

Gravity anomalies are measured in units of milligals (mGal). Typical gravity anomalies have amplitudes ranging from a few milligals up to 100 mGal or more. High-precision gravity surveys can measure anomalies with amplitudes below 1 mGal. In PDEPTH, densities are specified in cgs units of gram per cubic centimeter ( $\text{g}/\text{cm}^3$ ). Densities measured in SI units of kilogram per cubic meter are 1,000 times larger than densities measured in cgs units. Note that gravity fields calculated by PDEPTH using densities in  $\text{g}/\text{cm}^3$  units will only be accurate if distance units of kilometers are also used. If the distance units are other than kilometers, the density values must be adjusted to correct the calculated gravity anomaly amplitudes. For example, if distance units of meters are used

in PDEPTH, the cgs unit densities must be divided by 1,000 to produce the correct gravity anomaly amplitudes. In contrast, the amplitudes of calculated magnetic anomalies are always independent of the distance units.

Some absolute densities of geologic materials include  $0 \text{ g/cm}^3$  for air and  $1 \text{ g/cm}^3$  for water. Recent alluvium can have densities ranging from  $1.55 \text{ g/cm}^3$  (dry) to  $1.95 \text{ g/cm}^3$  (wet). Some average densities in  $\text{g/cm}^3$  units include 2.1 for older alluvium, 2.2 for rock salt and gypsum, 2.32 for sandstone, 2.42 for shale, 2.54 for limestone, 2.61 for granite, 2.70 for dolomite, 2.74 for metamorphic rocks, and 2.79 for basalt (Dobrin, 1960). The average density of the Earth's crust is often specified as  $2.67 \text{ g/cm}^3$ , which is also a good value for crystalline basement rocks in general.

More important than the absolute density values are the density contrasts at each geologic interface. In areas of moderate relief, the topographic interface between air and alluvium, with a density contrast of  $1.1 \text{ g/cm}^3$ , will produce a much larger gravity anomaly than an interface of the same relief between sandstone and shale (density contrast of  $0.1 \text{ g/cm}^3$ ) or between shale and granite (density contrast of  $0.2 \text{ g/cm}^3$ ).

Gravity anomaly amplitudes decay with distance away from the sources, but at a lower rate than magnetic anomaly amplitudes. Gravity anomalies produced by 3D sources decay in amplitude as 1 over the square of the distance away from the sources. Those produced by 2D sources decay in amplitude as 1 over the distance away from the sources.

## Fourier Filters

Fourier-domain filtering is the standard approach used to generate derivative products from digital gravity and magnetic profiles. Examples of derivative products users can generate from within PDEPTH include reduced-to-pole magnetic profiles, pseudogravity profiles, pseudomagnetic profiles, and upward- or downward-continued profiles. Internally, PDEPTH uses Fourier filters to generate complex analytic signals and vertical derivatives.

The use of Fourier filters implies certain assumptions about the profile data. All the profile filters mentioned above assume that the anomalies and the sources are 2D, generally extending perpendicular to the plane of the profile. Filtering of profiles that cross 3D or 2.5D sources can lead to distortion in the results. All the filters also assume that the profiles are measured on a level surface. This assumption is routinely violated, and can lead to distortion in the results. Reduced-to-pole and pseudogravity filters are based on the assumption that all magnetization vectors are parallel or anti-parallel to the core field direction. So, while induced magnetization is allowed, most remanent magnetizations will distort the results. These filters also fail at low magnetic latitudes.

PDEPTH provides an ideal platform for investigating the level of distortion introduced by Fourier filters. This is because filtered results from a model can be compared to calculated results from the same model.

## Source Location Methods

PDEPTH offers a variety of methods for estimating source locations from gravity and magnetic profile data. Each method is based on a unique set of assumptions, derivative products, and parameters. No two methods will give the same results. Even within a single method, different sets of parameters will yield different results. Some methods provide only estimates of source location; other methods also provide estimates of dip, magnetic susceptibility contrast, and source type. Most methods look for single isolated sources such as contacts (equivalent to body corners), the edges of thin sheets (equivalent to small steps in thick layers), or horizontal line sources (equivalent to horizontal cylinders or small steps in thin layers). One method looks for multiple contacts or sheet edges. Another method looks at the spectral characteristics of the data through the autocorrelation function and tries to estimate depth to a basement surface containing white-noise magnetization.

Profile-source location methods all involve one general assumption—that the sources are 2D and extend perpendicular to the plane of the profile. If the sources are 2D and strike at some angle  $\alpha$  away from the perpendicular, the source locations will be too deep by a factor of  $1/\cos(\alpha)$ .

Another factor affecting the source depth is the assumed structural index. The structural index is a number corresponding to the source type, and it is related to both the dimensionality of the source and the behavior of the field produced by the source. Most isolated sources have some infinite dimensions and some infinitesimal dimensions. For an isolated magnetic source, the structural index is equivalent to the number of infinitesimal dimensions, and also to the rate of decay of the magnetic field away from the source. A magnetic dipole, with a structural index of 3.0, has three infinitesimal dimensions, and its field decays as 1 over the distance cubed. A magnetic line source, with a structural index of 2.0, has two infinitesimal dimensions and its field decays as 1 over the distance squared. A magnetic sheet source, with a structural index of 1.0, has one infinitesimal dimension, and its field decays as 1 over the distance. A magnetic contact, with a structural index of zero, has no infinitesimal dimensions. The decay rate argument breaks down for a magnetic contact.

Gravity sources have structural indices that are 1 less than the number of infinitesimal dimensions. The field of a point mass decays as 1 over the distance squared, thus a point mass has a structural index of 2.0. Similarly, a line of mass has a structural index of 1.0, the edge of a density sheet has a structural index of 0.0, and a density contact has a structural index of  $-1.0$ .

Integer structural indices indicate ideal sources like those described above. The structural index of an ideal source should not change with observation level. Noninteger structural indices are produced by combinations of ideal sources, and will vary with observation level. For example, consider a magnetic dike of finite thickness. The dike can be modeled using two nearby contact sources. Just above one edge of the

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dike, the magnetic field appears to be that of a contact, and the structural index is near zero. At a great distance above the dike, the field appears to be that of a magnetic sheet source, and the structural index will approach 1. At intermediate distances, the structural index will have intermediate values.

Most source location methods assume a structural index, then solve for the source locations. In general, assumed contact sources will produce the shallowest depths, assumed sheet sources will produce greater depths, assumed line sources will produce even greater depths, and assumed point sources will produce the greatest depths. Clearly for these methods, the source depth cannot be estimated independently of the structural index.

PDEPTH has a unique capacity to check for reliability of the estimated source locations, dips, and other parameters. If source locations estimated from an observed profile are used to construct a model, and the parameters of the model are adjusted to fit the observed profile, then the calculated profile from the model can be swapped with the observed profile. This allows the same source location method to be applied to the field of the model. If the solutions are consistent with the model and similar to the solutions for the observed profile, then you can have some confidence in your result. If the solutions are not consistent with the model, then you may need to find some other source location method that gives better results on the model and apply it to the observed data.

### Forward Modeling

The gravity field of the model is calculated using the algorithm of Talwani and others (1959) for 2D sources and the algorithm of Rasmussen and Pedersen (1979) for 2.5D sources. The magnetic field of the model is calculated using

the algorithm of Shuey and Pasquale (1973). Subroutines for performing these forward calculations are taken from the program SAKI (Webring, 1985).

## Program Description

### Installation

Follow the instructions in the “readme.txt” file included with the software distribution (<ftp://ftpext.usgs.gov/pub/cr/co/denver/musette/pub/techniques-and-methods/tm7C17>).

### Startup

PDEPTH can be started in one of two ways: from the command line, or from a menu program such as the supplied PFGraphicsMenu program. (See the “Auxiliary Programs” section of this report for a description of the PFGraphicsMenu program.)

If pdepth.exe is located in a directory specified in the PATH environmental variable, then PDEPTH can be invoked from the command line in a command window. For example, the command line C:\> pdepth will start PDEPTH in the current directory.

The PDEPTH startup dialog (fig. 1) allows the user to specify an optional command file, the graphics resolution, and the background color (black or white). Graphics resolution is specified by an iplotr code, such as 10 for 640×480 pixels. Other iplotr codes are 11=800×600, 12=1,024×768, 13=1,152×864, 14=1,280×960, and 15=1,600×1,200 pixels.

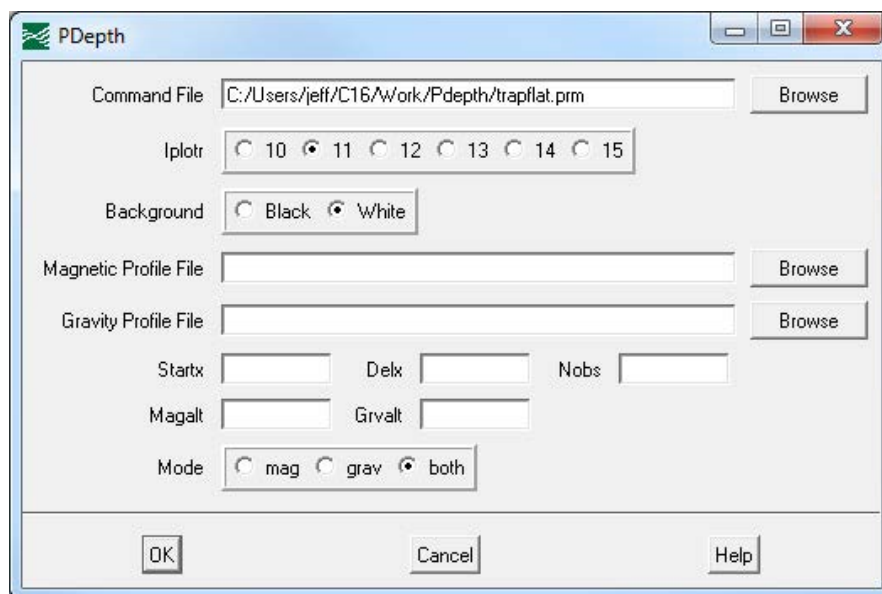


Figure 1. The PDEPTH startup dialog.

## Input Files

In simple-forward modeling mode, PDEPTH does not require any input files. This mode is only useful for constructing simple models and calculating magnetic and gravity fields on flat surfaces. To run in this mode, the following fields must be filled out in the PDEPTH startup dialog:

- Startx, Delx, and Nobs—The leftmost distance coordinate, the distance increment, and the number of observations, respectively.
- Magalt, Grvalt, or both—The fixed altitude(s) of the calculated profiles (negative upward).
- mag, grav, or both—The type of field(s) to be calculated.

All other modes require input files. At the very least, a file containing an input gravity or magnetic profile is required. Profile files, command files, and model files are based on formats used in the program SAKI (Webring, 1985).

## Profile Files

A profile file contains either three columns or five columns of data, with each column separated by white space. The first column contains the distance coordinate along the profile, ordered from low to high; the low value does not need be zero. The distance coordinates do not need to be equally spaced, but they should not repeat or backtrack. The second column contains the elevation (negative upward) of each observation in the same units as the distance. The third column contains the observed magnetic- or gravity-anomaly value. The optional fourth and fifth columns contain the easting and northing coordinates of the observation. Profiles longer than 4,096 points are subsampled during input to PDEPTH. If one or two profile files are specified in the PDEPTH startup dialog, no other distance or altitude parameters are required. By default, PDEPTH recognizes the following filename suffixes for profile files: .pro, .mag, .grv, .sak, and .txt.

## Command File

The simplest way to enter data into PDEPTH is through a namelist command file. This file can be used to specify the names of the input profile files, and all parameters needed to begin modeling. Here is an example of a simple command file:

```
$parms
hfile='GML1.2.mag'
efield=50000.
einc=63.1
edec=14.5
azimuth=20.42001561
$
```

Parameters permitted in a command file include:

- hfile—The name of the magnetic profile file (in single quotes).
- gfile—The name of the gravity profile file (in single quotes).
- mfile—The name of the model file (in single quotes).
- azimuth—The azimuth of the profile (degrees east of north).
- vex—The vertical exaggeration to be used in displaying the cross section (default is 1.0).
- iave—Enables floating datum for gravity calculations (0=off; 1=on).
- jave—Enables floating datum for magnetic calculations (0=off; 1=on).  
(By default, iave and jave are on. You should turn iave and jave off if you believe the regional fields have been completely removed from your profile data or if you want to build consistent models along several profiles extracted from the same dataset.)
- efield—The intensity of the core field at the site (in nT units).
- einc—The inclination of the core field at the site (degrees down from horizontal).
- edec—The declination of the core field at the site (degrees east of north).  
(The three parameters efield, einc, and edec can be calculated using a geomagnetic field model.)

If a command file is specified in the PDEPTH startup dialog, the only other dialog parameters required are the `iplotr` code and the background color. By default, PDEPTH recognizes the following filename suffixes for command files: .prm, .cmd, and .txt.

## Model File

The model file is usually constructed within PDEPTH and written out when PDEPTH closes. However, model files can be constructed or edited outside of PDEPTH. The model file consists of a first part listing x,z pairs of body vertex coordinates, and a second part containing the physical property parameters and vertex indices for each body. In the first part of the model file, it is best to list a single vertex pair on each line. That way, the line number corresponds to the index of the vertex. The x-value is a distance coordinate along the profile, the z-value is a negative elevation. The number of vertices must not exceed 712. The list of vertices is terminated by a line starting with '>>'.  
>>

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In the second part of the model file, each body is defined by a single line containing seven physical property values:

1. Density in  $\text{g/cm}^3$  units if distances and elevations are in kilometers.
2. Magnetic susceptibility in cgs units.
3. and 4. Prism lengths in distance units for 2.5D bodies (that is, 20, -20). The first number is the near side (positive) and the second is the far side (negative). Values of zero indicate a true 2D body having infinite extent. These lengths can be different and will move the prism off axis for gravity calculations. And remember that all distance units should be in kilometers for gravity calculations.
5. Remanent magnetization intensity in electromagnetic unit per cubic centimeter ( $1 \text{ ampere/meter} = 1 \times 10^{-3}$  electromagnetic unit per cubic centimeter).

6. Remanent magnetization inclination in degrees.
7. Remanent magnetization declination in degrees. The total magnetization used in the forward calculation is a vector sum of the induced and remanent magnetization or  $J_i + J_r$ , where  $J_i$  = susceptibility (in cgs units)  $\times$  Earth field strength (in nT units) and  $J_r$  = remanence (in electromagnetic unit per cubic centimeter)  $\times 1 \times 10^5$ .

Following this physical property line are one or more lines containing the indices of vertex coordinates in clockwise order; the first index is not repeated. The last line of vertex coordinates for each body is terminated with '>' or '<'. The physical property line may also be terminated with '>' or '<'. The number of bodies must not exceed 50. Here is an example model file as output by PDEPTH:

```

-106.526    -5669.56
 429.314    -5669.56
 483.861    -5711.27
 628.249    -5682.39
 718.090    -5675.97
 830.392    -5692.02
 942.694    -5685.60
 961.946    -5682.39
 990.824    -5679.18
1109.54     -5759.40
1148.05     -5708.06
1340.56     -5714.48
1555.54     -5717.69
1703.14     -5682.39
2161.97     -5082.38
 669.961    -5387.20
 756.594    -5550.84
-109.735    -5586.13
 2142.72    -5531.59
>> BODY SPECS
0.000  4.000E-03  0.00  0.00  0.00  0.0  0.0 >P 1
 1  2  3  4  5  6  7  8  9 10
11 12 13 14 19 15 16 17 18 >B 1

```

By default, PDEPTH recognizes the following filename suffixes for model files: mod, asc, and txt.

### Geology File

This is an optional file containing the locations of geologic contacts and faults, geologic unit labels, and physical property values to be plotted as a function of the distance coordinate along the profile. Each line in this file must have the following format:

- Five characters specifying the geologic unit symbol, blanks, or a feature name such as “fault” for a fault, “bend” for a bend in the profile, or “lineA” for an intersection with line A.
- Five characters containing the density, density contrast, or blanks.
- Five characters containing the magnetic susceptibility or blanks.
- Ten characters containing the horizontal location of the left contact of the unit or the location of the fault or feature.



- Ten characters containing the horizontal location of the right contact of the unit or the location of the fault or feature.

PDEPTH will display geologic contacts and features as thin vertical gray lines, feature names or unit symbols in white (or black), densities in cyan, and magnetic susceptibilities in red. By default, PDEPTH recognizes the following filename suffixes for geology files: .geo, .asc, and .txt.

## Section File

This optional file contains lines to be drawn on the depth section. Each record in this file consists of a distance-coordinate, a depth-coordinate (negative elevation), and a flag number. The flag number is an arbitrary constant for all the records in a given line; it changes at the first coordinate of a new line. PDEPTH will display the lines in gray. By default, PDEPTH recognizes the following filename suffixes for section files: .sec, .asc, and .txt.

## Output Files

### Model File

Newly created or modified model files can be written out at any time using the “EditMod” or “New Mod” buttons under the EDITMOD MENU. On exit, PDEPTH will optionally output the current model file if it was created or modified during the session. In both cases, the user must agree to output the file and overwrite any existing file of the same name.

### Calculated Profile Files

On exit from PDEPTH, the user can write out the last calculated magnetic and gravity profiles (if any) to the files hcalc.out and gcalc.out, and the last calculated pseudogravity, pseudomagnetic, and reduced-to-pole profiles (if any) to the files pgcalt.out, pmcalc.out, and rcalc.out, respectively. If these files exist, the user will be asked if they can be overwritten.

### Depth Files

Each time a depth estimation method is applied to a profile, PDEPTH writes the results to a new file called pdepth.tmp. If the “Save” button under the DEPTH MENU is pressed, several things happen. First, an index number which counts the number of “Save” button presses is incremented. Then the index number is written to the file pdepth.log, followed by records describing the depth estimation method, the input profile, and the parameters used. Then the depth estimation results in the file pdepth.tmp are appended to the file pdepth.

dep. Each record written to pdepth.dep contains the new index number. Through this unique index number, each new set of depth estimates in the file pdepth.dep can be related to the actual parameters used for the depth estimation, which appear in the file pdepth.log. The first record in file pdepth.dep is a header record with the names of the columns. These column names are described below.

- X—The easting of the depth estimate, if available from the profile file, otherwise the distance coordinate.
- Y—The northing of the depth estimate, if available from the profile file, otherwise zero.
- elev—The elevation of the source relative to sea level (in distance units).
- depth—The (negative) depth of the source below the observation surface (in distance units).
- function—Contains the peak amplitude of the horizontal gradient magnitude (HGM), the analytic signal amplitude, or the local wavenumber; the number of clustered solutions in the Werner and multi-source Werner solutions; the solution tolerance for the Euler solutions; the depth convergence for Autocorrelation solutions; or the average percentage depth error for the clustered Extended Euler solutions.
- OMstrike—The assumed strike of the solution, perpendicular to the profile azimuth, for plotting in Oasis montaj.
- OMdip—The estimated dip of the solution for plotting in Oasis montaj.
- GMSdip—The estimated dip of the solution for plotting in GM-SYS.
- physprop—The estimated magnetic susceptibility (in cgs units) or density contrast (in g/cm<sup>3</sup> units) of the solution, if available.
- si—The structural index assumed or estimated for the source.
- index—The unique index relating this set of depth solutions to information in the file pdepth.log. This can be used to define symbols in GM-SYS.
- method—The short name of the depth estimation method.
- source—The short name of the source profile.
- target—The type of source targeted or identified.

The file pdepth.log relates the record index in file pdepth .dep to the specific parameters used in the depth analysis, and contains records such as these:

```

index = 1
analytic signal depths - continued field
window = 31
index = 2
multi-source werner depths - continued field
window = 87 radius = 15.0% minimum# = 3 #sources = 3
index = 3
horizontal gradient depths - pseudogravity
window = 21

```

## User Interface

Once the PDEPTH startup dialog is filled out to the extent needed, and the “OK” button is pressed, a window containing the PDEPTH user interface (fig. 2) will open at the graphics resolution specified in the startup dialog. The user interface consists of a profile window at the top, a geologic cross-section window at the bottom, and a series of menu buttons along the right side. The profile window will display the gravity (in cyan) and magnetic (in orange) profiles, as specified in the startup dialog or the command file. The vertical scale will only be correct for one of the profiles, as indicated by the color of the label. The other profile is scaled to fit within the profile window. The cross-section window

will display only the elevations (negative upward) of the observation points for the profiles in corresponding colors. Vertical exaggeration of the cross-section window will either be as specified in the command file or 1:1 if left unspecified. The name of the input command file, if any, is displayed in the title bar.

Linework in PDEPTH is either permanent, semipermanent, or temporary. Permanent lines, such as the input magnetic and gravity profiles, are never erased (although they can be replaced by calculated profiles). Semipermanent lines, such as most derivative profiles and the model, can only be erased by special actions. Temporary lines, such as depth estimates and terraced profiles, are always erased whenever the screen is cleared or windowed.

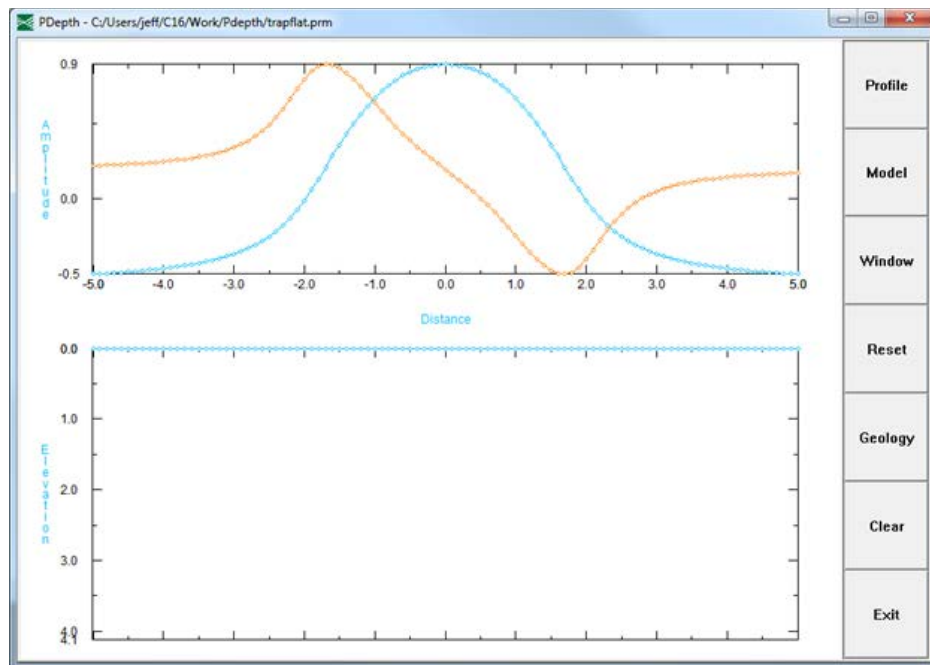


Figure 2. The PDEPTH user interface.

## OPENING MENU

The OPENING MENU along the right side of the interface contains the following option boxes, which can be selected by clicking on them with the mouse:

- Profile—Displays the PROFILE MENU, which contains some options for modifying the contents of the profile window.
- Model—Displays the MODEL MENU, which contains options for modifying the contents of the model window and some additional options for modifying the contents of the profile window.
- Window—Zooms in on an area of the cross-section window and the corresponding portion of the profile window. The zoom rectangle is selected by the mouse. Temporary linework will be erased.
- Reset—Unzooms the display and erases temporary linework.
- Geology—Prompts for the names of two text files that contain geologic overlays (figs. 3, 4, and 5). These are the Geology File and the Section File defined in the “Geology File” and “Section File” sections of this report. To erase the displayed geologic contacts and cross-section lines, select the “Geology” menu button with the mouse, clear the file names with the <Enter> key, then select the “Clear” menu button with the mouse.
- Clear—Refreshes the display, erasing temporary linework.
- Exit—Exits the program. To protect against accidental exits, a dialog asks users if they really want to exit. If the model file may have been changed, a second dialog will ask users if they want to save the changes. If profiles have been calculated, a third dialog will ask users if they want to output the calculated profiles. This third dialog allows the user to write out the last calculated magnetic and gravity profiles (if any) to the files hcalc.out and gcalc.out, and the last calculated pseudogravity, pseudomagnetic, reduced-to-pole profiles (if any) to pggcalc.out, pmcalc.out, and rcalc.out, respectively. If any of these files exist, the user is asked if they can be overwritten.

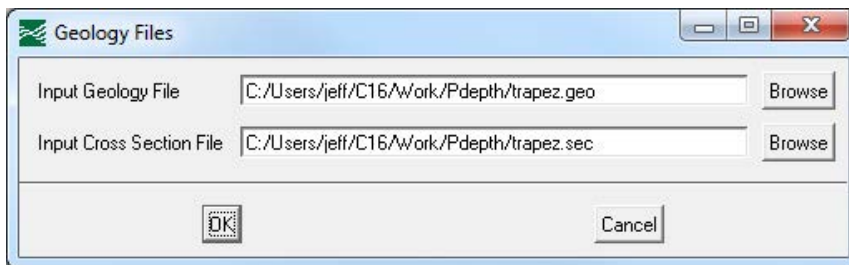


Figure 3. The Geology dialog.

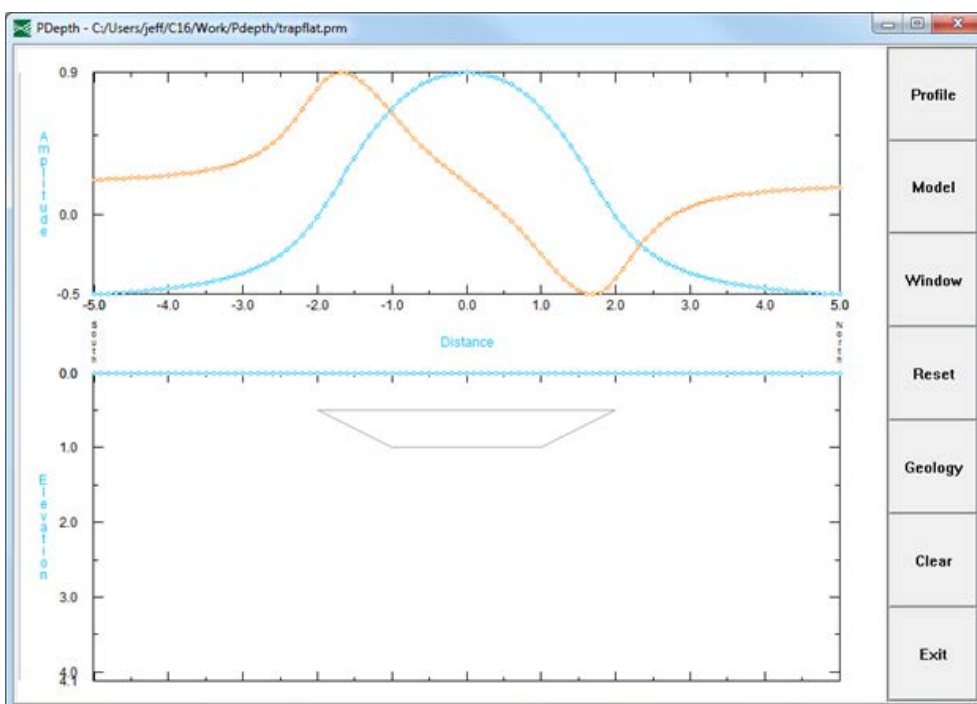
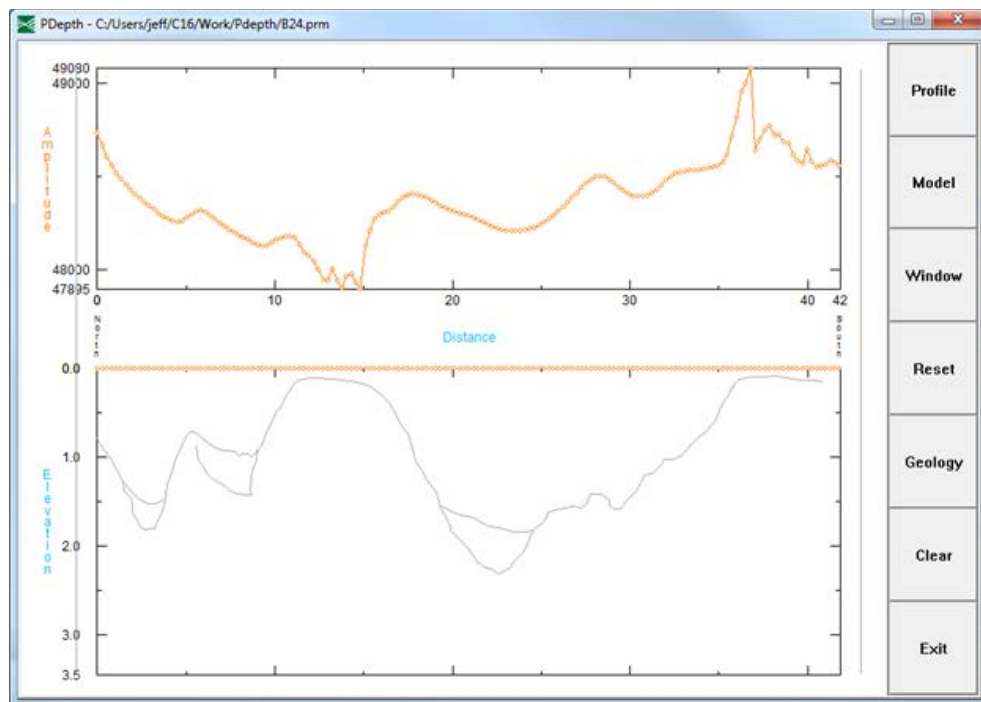


Figure 4. Source body and compass directions plotted using the Geology dialog.



**Figure 5.** Seismic bathymetry and compass directions plotted using the Geology dialog.

## PROFILE SELECTION MENU

The PROFILE SELECTION MENU is a secondary menu used by some of the options in the PROFILE MENU, the MODEL MENU, and the DEPTH MENU to select a particular profile for processing. The colors of the menu box labels correspond to colors of profiles that may be displayed in the profile window. Only profiles displayed in the profile window can be selected for processing. The PROFILE SELECTION MENU contains the following option boxes, which can be selected by clicking on them with the mouse:

- Mag—Selects the magnetic profile, displayed in orange, for processing.
- Grav—Selects the gravity profile, displayed in cyan, for processing.
- RedPol—Selects the reduced-to-pole magnetic profile, displayed in red, for processing.
- PsdoMag—Selects the pseudomagnetic profile, displayed in light orange, for processing.
- PsdoGrv—Selects the pseudogravity profile, displayed in purple, for processing.
- Upcont—Selects the upward continued profile, displayed in green, for processing.
- None—Cancels the selection process and returns to the previous menu.

## PROFILE MENU

The PROFILE MENU contains the following option boxes, which can be selected by clicking on them with the mouse. The colors of the calculated profiles correspond to the colors of the menu box labels, unless the labels are black.

- Terrace—Plots a terraced version of a selected profile using the method of Cordell and McCafferty (1989). Normally, terracing is used to estimate physical property boundaries from gravity or pseudogravity data. Terracing can also be applied to reduced-to-pole magnetic or pseudomagnetic data as long as it is understood that side lobes produced by thin bodies can result in false physical property boundaries. The profile to be terraced is selected by the mouse from the PROFILE SELECTION MENU. The linework of the terraced profile is temporary.
- RedPol—Plots a reduced-to-pole magnetic profile in red as calculated from the input magnetic profile. If not previously specified, the inclination and declination of the regional magnetic field and the profile azimuth must be entered in a dialog. The linework of the profile is semipermanent. Reduced-to-pole is a phase transformation designed to move the magnetic anomalies directly over their sources. It rotates both the induced magnetization vector and the core field vector to the downward vertical. A reduced-to-pole profile is required for locating vertical magnetic contacts using the horizontal gradient depth analysis method.

- PsdoMag—Plots a pseudomagnetic profile in light orange, as calculated from the gravity profile. The desired inclination and declination of the regional magnetic field are entered in a dialog. If not previously specified, the profile azimuth must also be entered in the dialog. Select Field Incl=90 and Field Decl=0 to plot a reduced-to-pole pseudomagnetic profile. The linework of the pseudomagnetic profile is semipermanent. The pseudomagnetic operator is equivalent to a vertical derivative operator followed by an optional reduction-FROM-the-pole operator. It is intended to transform the gravity field into an equivalent magnetic field that would be produced by the same sources. The pseudomagnetic transformation can be used to apply magnetic depth analysis methods to gravity data, and to identify sources producing coincident gravity and magnetic anomalies.
- PsdoGrv—Plots a pseudogravity profile in purple, as calculated from the input magnetic profile. If not previously specified, the inclination and declination of the regional magnetic field and the profile azimuth must be entered in a dialog. The linework of the profile is semipermanent. The pseudogravity operator is equivalent to a reduced-to-pole operator followed by a vertical integral operator. It is intended to transform the magnetic field into an equivalent gravity field that would be produced by the same sources. The pseudogravity transformation can be used to apply gravity analysis methods to magnetic data, and to identify sources producing coincident gravity and magnetic anomalies. A pseudogravity profile is required for locating horizontal magnetic sheet edges using the horizontal gradient depth analysis method.
- Spline—Resamples profiles with uneven data spacing to a constant sample interval. The number of points in each profile is unchanged. The new sample interval is displayed in the title bar. Evenly sampled profiles are required for most of the operations available in the PROFILE and DEPTH MENUS.
- ClrProf—Refreshes the entire display, erasing all temporary linework and all semipermanent linework within the profile window.
- Clear—Refreshes the entire display, erasing temporary linework.
- Return—Returns to the OPENING MENU.

## MODEL MENU

The MODEL MENU contains the following option boxes, which can be selected by clicking on them with the mouse:

- Depth—Displays the DEPTH MENU containing options for estimating source depths and locations from the displayed profile data.
- EditMod—Displays the EDITMOD MENU containing options for creating or editing SAKI models.
- Upcont—Plots a profile, in green, that has been upward (or downward) continued for a specified distance. The profile to be continued is chosen from the PROFILE SELECTION MENU. Upward continued profiles can be used to estimate depths or physical property boundaries of deeper sources. The altitude of the upward continued profile is plotted in green above or within the model window. In the case of downward continuation, the user is prompted for two lowpass filter parameters, the starting wavenumber of the taper (between 1 and 3.14) and the exponential decay factor (greater than 0). Some trial and error will be required to optimize these parameters. The green linework is semipermanent.
- Itgrav—Uses the iterative forward gravity modeling technique of Cordell and Henderson (1968) to estimate depth to an interface between materials with different densities. The PROFILE SELECTION MENU menu allows the user to choose either the gravity profile or the pseudogravity profile as input. The user is prompted for the number of iterations and “epsilon.” Normally five iterations and an epsilon of 0.1 will suffice. The user must specify a density contrast, a reference plane depth (actually a negative elevation, which is approximate because the reference plane will always be parallel to the observation surface), and either a ridge or basin model. A ridge model builds upward from the reference plane and a basin model builds downward. Only those parts of the profile having the same sign as the density contrast are used in the modeling. For this reason, the zero level of the profile can be changed by a specified constant. The resulting interface is plotted in the model window using a color specified by the user. At locations where the calculated gravity (or pseudogravity) field from the interface is within 1 mGal of the observed gravity (or pseudogravity), a “#” symbol is used. Otherwise a “.” symbol is used. The linework is temporary.

- **Swap**—Exchanges the observed and calculated magnetic and gravity profiles. The calculated profiles will replace the observed profiles in the display, and thereby become available for filtering or source-depth analysis. The user is required to verify the exchange by selecting the “Swap” button a second time. Once the swap has been completed, the original observed profiles are stored in the buffer formerly used by the calculated profiles. Thus, as long as new calculated profiles have not been generated, the original observed profiles can be restored to the display by “swapping” a second time. Once new calculated profiles have been generated, the original observed profiles are lost to the program. The “Swap” menu button does not affect the output of calculated profiles on exit from the program. The last calculated profiles will be written out to files regardless of whether they are in the observed or calculated buffers.
- **Clear**—Refreshes the display, erasing temporary linework.
- **Return**—Returns to the OPENING MENU.

## DEPTH MENU

The DEPTH MENU is used to estimate the locations, dips, physical property contrasts, and structural indices of magnetic and density sources using a variety of different methods. The displayed source locations (also called depth estimates) can be helpful in constructing or revising models using the EDITMOD MENU. All methods that estimate dip and susceptibility contrasts of magnetic sources do so by assuming induced magnetization. Some of the source location methods available in the DEPTH MENU require specifying multiple parameters. Results on calculated fields from model files can be used to choose the optimum parameters for a particular method. Linework used for depth estimates is temporary. The “Save” menu button appends the most recently computed, currently displayed results to the file pdepth.dep

in text format, and also writes additional information about the current results to the file pdepth.log. The DEPTH MENU contains the following option boxes, which can be selected by clicking on them with the mouse.

- **MSW**—Estimates source locations and dips using multi-source Werner deconvolution (Hansen and Simmonds, 1993). The PROFILE SELECTION MENU is used to choose the profile to be analyzed. A dialog (fig. 6) prompts the user for required parameters, including:
  1. The window length (all running windows contain 22 data values; longer windows skip data points thereby focusing on deeper sources).
  2. The clustering radius as a percent of depth. This is the maximum distance the program will search in order to find all depth solutions in a cluster. Larger values will result in more individual solutions in each cluster, but fewer clusters.
  3. The minimum number of solutions in a cluster. Increase this number in order to limit display of minor depth clusters.
  4. The number of edges to search for within the window. The specified number of edges will be sought within the moving window, and identified clusters will be plotted (fig. 7) as a white (or black) number (2–9) or letter (A–Z) indicating the number (2–9 or 10–36+) of solutions in the cluster, along with a dip line in orange for magnetic sheet solutions, red for magnetic contact solutions, and blue for density sheet solutions. Dip lines are not plotted for density line solutions.
  5. The type of solutions (density line, magnetic sheet, density sheet, or magnetic contact) desired.
  6. If individual solutions are to be plotted (in gray).

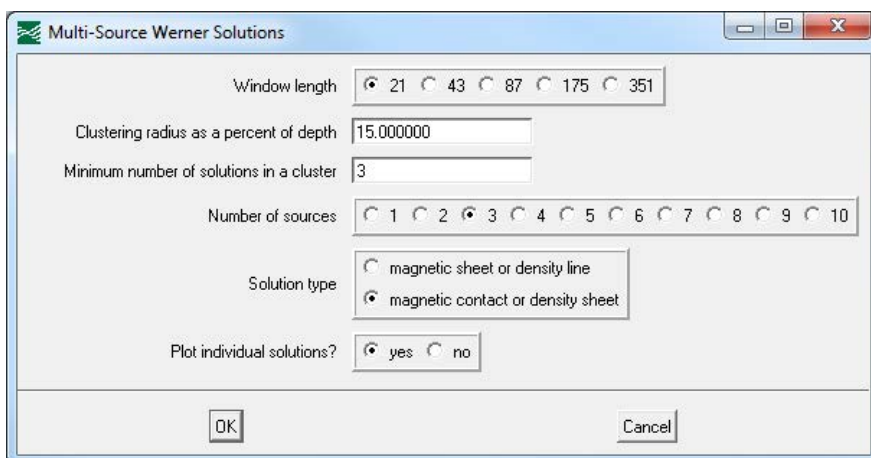
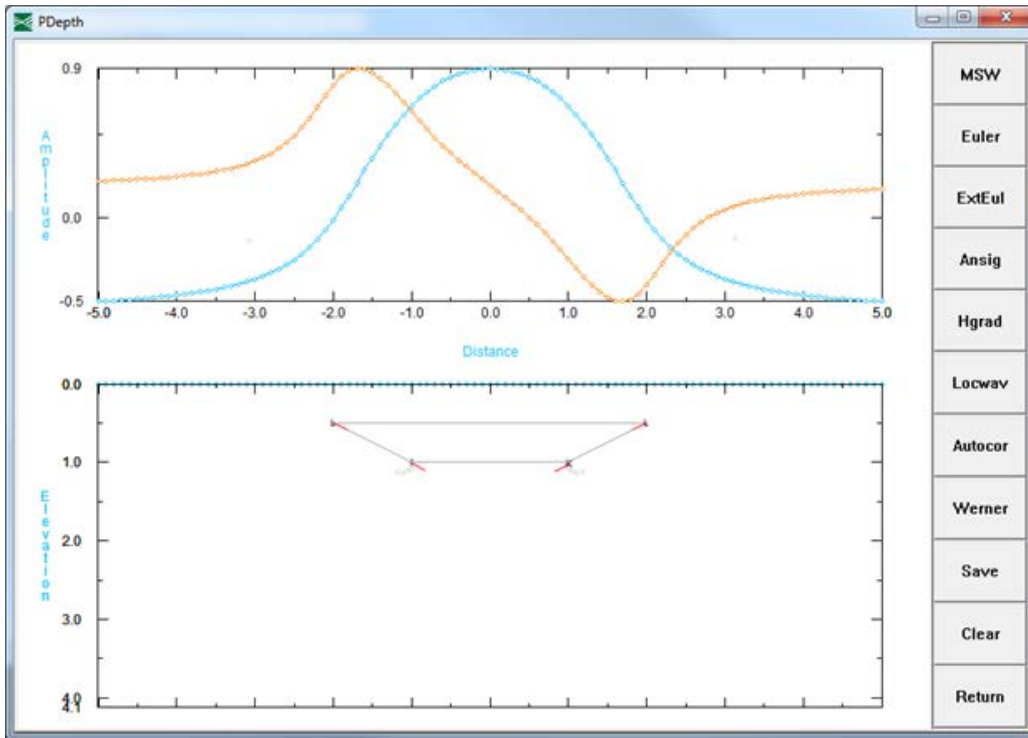


Figure 6. The multi-source Werner dialog.

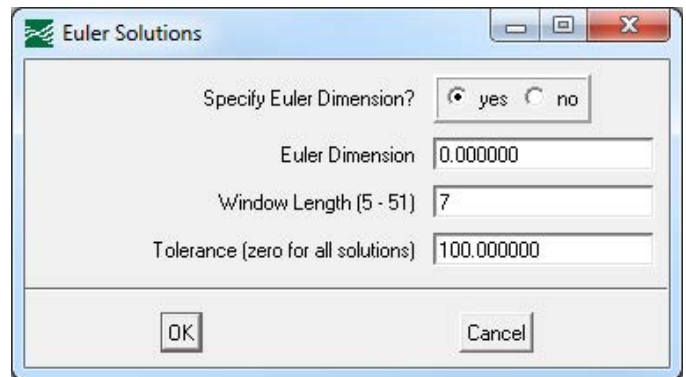


**Figure 7.** Multi-source Werner contact solutions from the magnetic profile.

- Euler—Estimates source locations using Euler deconvolution (Thompson, 1982). The PROFILE SELECTION MENU is used to choose the profile to be analyzed. A dialog (fig. 8) asks users if they want to specify a fixed Euler dimension and its value. For best results, the Euler dimension should be specified as follows: -1 for a density contact, 0 for a magnetic contact or density sheet, 1 for a magnetic sheet or density line, 2 for a magnetic line or point mass, and 3 for a magnetic dipole. Noninteger values may be used. If the user chooses not to specify a fixed Euler dimension, the program will solve for a Euler dimension at each source location, but the source locations will be less reliable. The dialog also asks the user for the window length and the tolerance. A tolerance of zero will plot all solutions. A tolerance greater than zero will plot those solutions that satisfy

$$\text{depth/error} > \text{tolerance}$$

where “error” is the estimated standard error of the depth. Solutions are plotted as colored symbols (fig. 9) which represent the Euler dimension (table 1).



**Figure 8.** The Euler dialog.

**Table 1.** Euler dimension symbols.

[<, less than; d, dimension]

Symbol	Meaning	Magnetic dimension	Density dimension
c	Contact	0.0<d<0.5	-1.0<d<-0.5
s	Sheet	0.5<d<1.5	-0.5<d<0.5
p	Line	1.5<d<2.5	0.5<d<1.5
o	Point	2.5<d<3.0	1.5<d<2.0

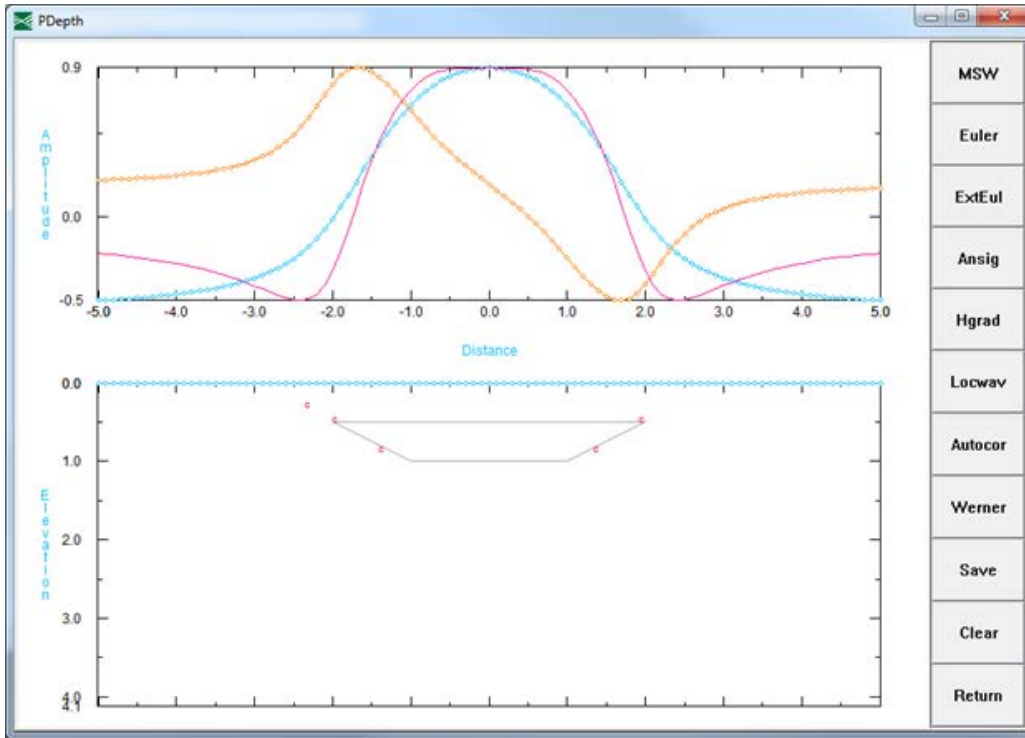


Figure 9. Euler contact solutions from the reduced-to-pole magnetic profile.

- ExtEul—Estimates source locations and dips using extended Euler deconvolution (Mushayandebvu and others, 2001). The PROFILE SELECTION MENU is used to choose the profile to be analyzed. A dialog (fig. 10) then asks the user to specify the solution type, the window length, the maximum error in depth as a percentage, the clustering radius, the minimum number of solutions in a cluster, and whether or not to plot the individual solutions (as gray diamonds). Clustered solutions are plotted (fig. 11) as colored symbols (C for contact, S for sheet, and P for line) with colored dip lines.
- Ansig—Estimates source locations and dips using the analytic signal method of Nabighian (1972, 1974). The PROFILE SELECTION MENU is used to choose the profile to be analyzed. A dialog (fig. 12) asks users if they want to plot the analytic signal curves. If selected, the curves calculated from the input profile are plotted (fig. 13) as dashed lines using the profile color for the magnetic sheet or density line solutions and a related color for the magnetic contact or density sheet solutions. Higher amplitude peaks on the curves indicate stronger or shallower sources. Broader peaks indicate deeper sources. The dialog also asks the user to specify the source type(s), the window length, and the minimum peak amplitude required for a solution.

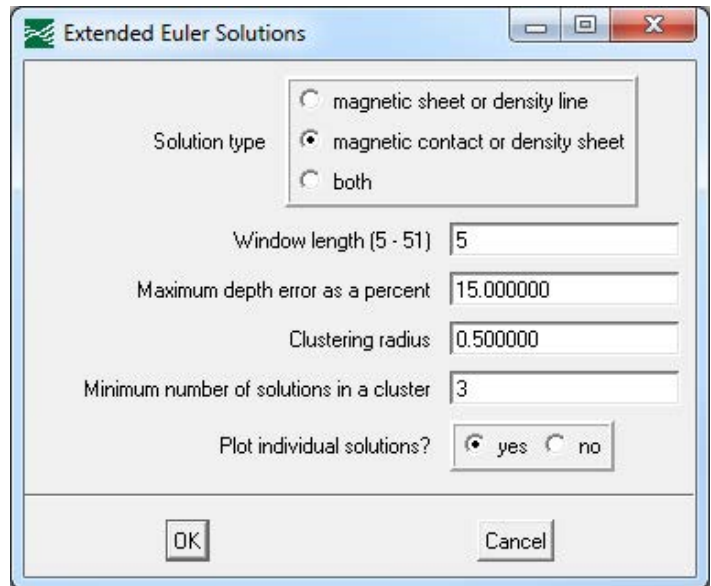


Figure 10. The Extended Euler dialog.



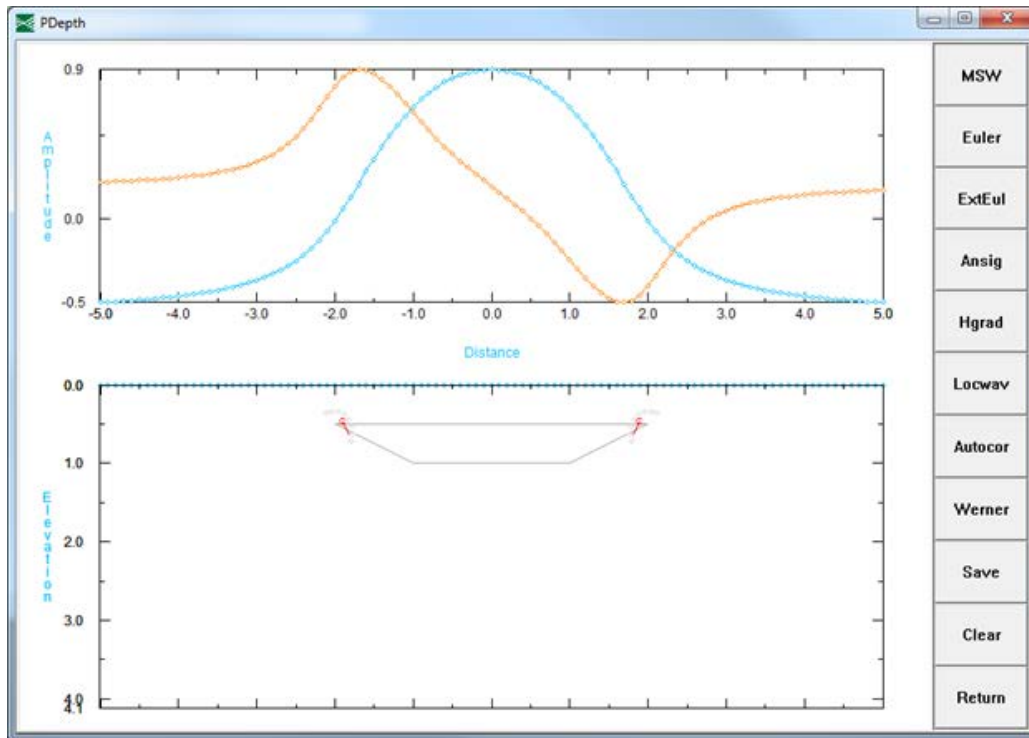


Figure 11. Extended Euler contact solutions from the magnetic profile.

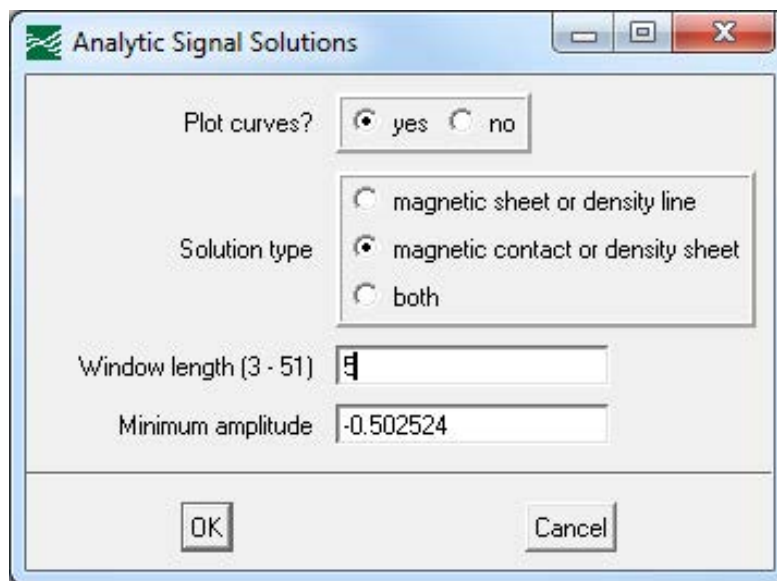
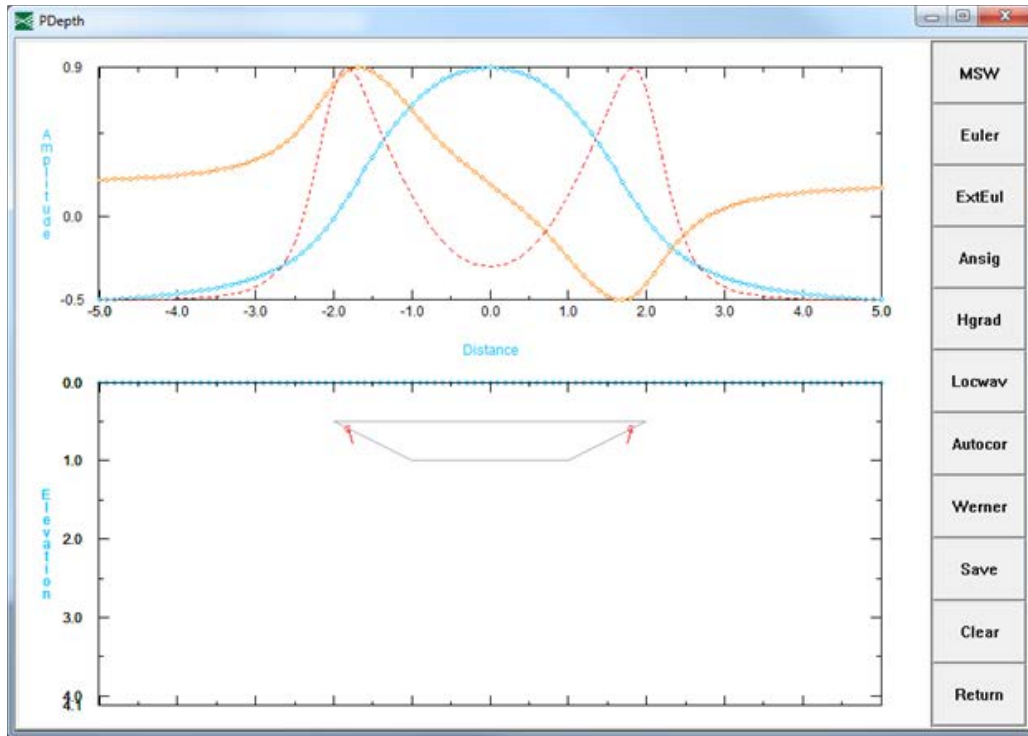


Figure 12. The Analytic Signal dialog.

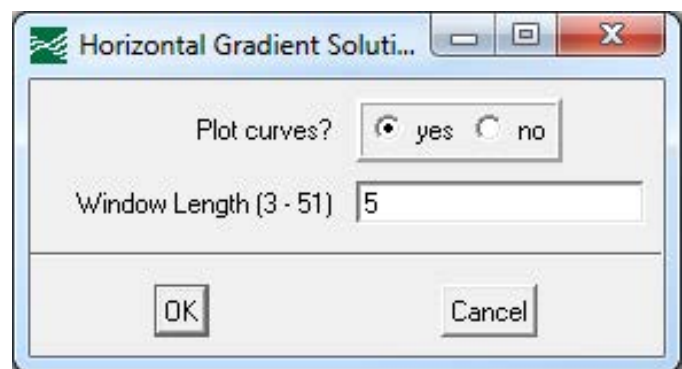


**Figure 13.** Analytic Signal contact solutions from the magnetic profile.

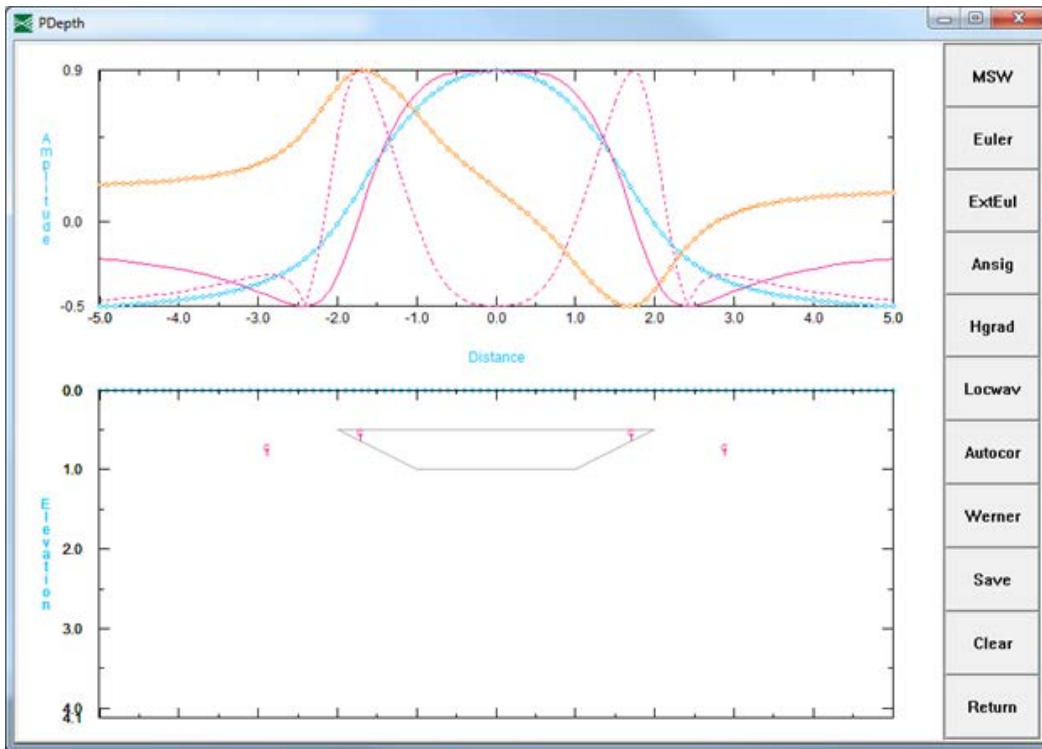
A depth estimate is plotted (fig. 13) under each peak in the dashed curve(s) in a color corresponding to the curve. Sheet solutions are indicated by “S” symbols, contact solutions are indicated by “C” symbols, and line solutions are indicated by “P” symbols. Dip lines are plotted for each sheet and contact solution. The user will be prompted for the magnetic field magnitude, inclination, declination, and profile azimuth if they are required and have not been previously assigned. The analytic signal curve is computed from the first horizontal and vertical derivatives of the profile, and is moderately susceptible to contamination by noise.

- Hgrad—Estimates source locations using the horizontal gradient method (Roest and Pilkington, 1993). This method can estimate the locations of vertical contacts from the HGM of the reduced-to-pole magnetic or pseudomagnetic profile, and can also estimate the locations of horizontal sheet edges from the HGM of the gravity or pseudogravity profile. The PROFILE SELECTION MENU is used to choose the profile to be analyzed. A dialog (fig. 14) asks users if they want to plot the HGM curve and also asks for the window length. Solutions are plotted (fig. 15) as colored “C”

symbols with vertical dip lines for vertical contacts and colored “S” symbols with horizontal dip lines for horizontal sheet edges. Solutions will be mislocated in the down-dip direction for nonvertical interfaces, and side lobes in the HGM curves will produce false solutions for bodies having finite thickness. The HGM curve is computed from the first horizontal derivatives of the profile, and is relatively robust in the presence of noise.

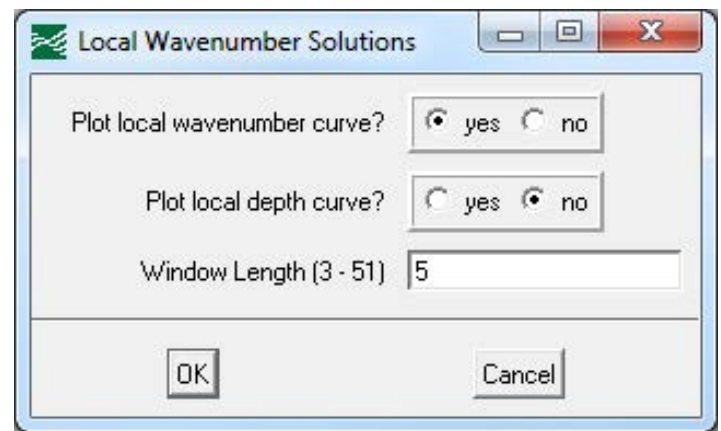


**Figure 14.** The Horizontal Gradient dialog.



**Figure 15.** Horizontal Gradient vertical contact solutions from the reduced-to-pole magnetic profile.

- Locwav—Estimates source locations, dips, and structural indices using the local wavenumber method (Thurston and Smith, 1997; Smith and others, 1998). The PROFILE SELECTION MENU is used to choose the profile to be analyzed. A dialog (fig. 16) asks users if they want to plot the local wavenumber curve as a dashed line in the profile window and (or) the local depth curve as a dashed line in the cross-section window. Sources should lie under peaks of the local wavenumber curve. For contact solutions, the peak amplitude of the local wavenumber curve is the reciprocal of the depth. Thus, the local depth curve is simply the reciprocal of the local wavenumber curve. The dialog box also asks for the window length. Local wavenumber solutions are plotted (fig. 17) as white (or black), two-character numbers indicating the structural index of the source and colored dip lines. A two-character number of -9 would indicate a structural index of -0.9, 01 would indicate a structural index of 0.1, 29 would indicate a structural index of 2.9, and so on. The local wavenumber curve is computed from first and second derivatives of the profile, and thus is likely to be contaminated by noise.



**Figure 16.** The Local Wavenumber dialog.

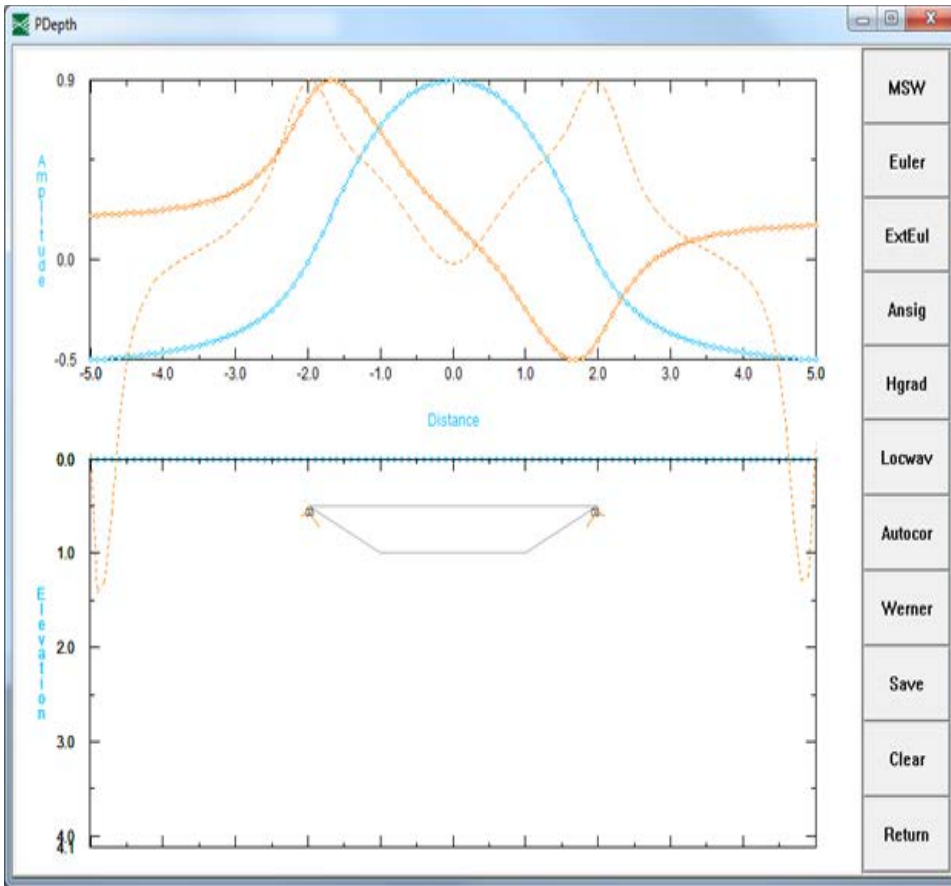


Figure 17. Local Wavenumber solutions from the magnetic profile.

- Autocor—Estimates source depths using the autocorrelation method of Phillips (1979). The PROFILE SELECTION MENU is used to choose the profile to be analyzed. A dialog (fig. 18) asks the user for a range of window lengths (of between 7 and 29 points), convergence values for primary and secondary solutions, a subsampling (decimation) factor, and includes an option to plot the depth curves. Depth estimates for a range of window lengths should be examined. Shorter windows pick up depth changes more quickly and provide depth estimates closer to the ends of the profile. Longer windows yield smoother, possibly more stable solutions. The program will process all pairs of odd-valued window lengths between the specified minimum and maximum. Depth curves are calculated wherever several lags of the autocorrelation function yield depths within the specified convergence value. A depth estimate is plotted (fig. 19) wherever depth curves calculated using two different window lengths intersect.

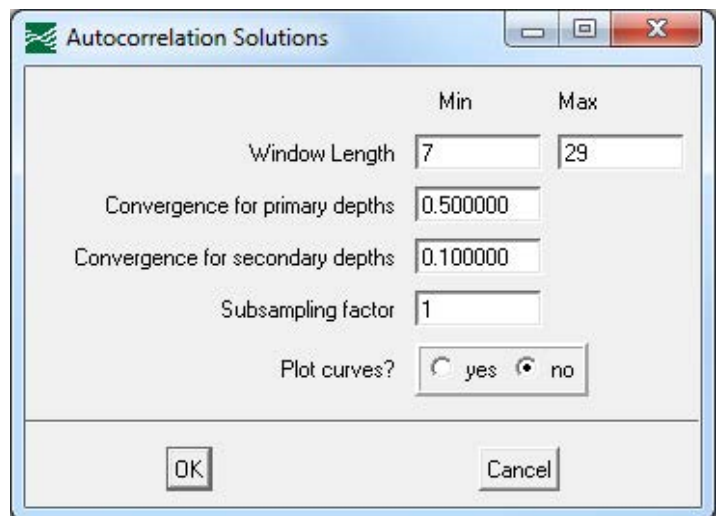
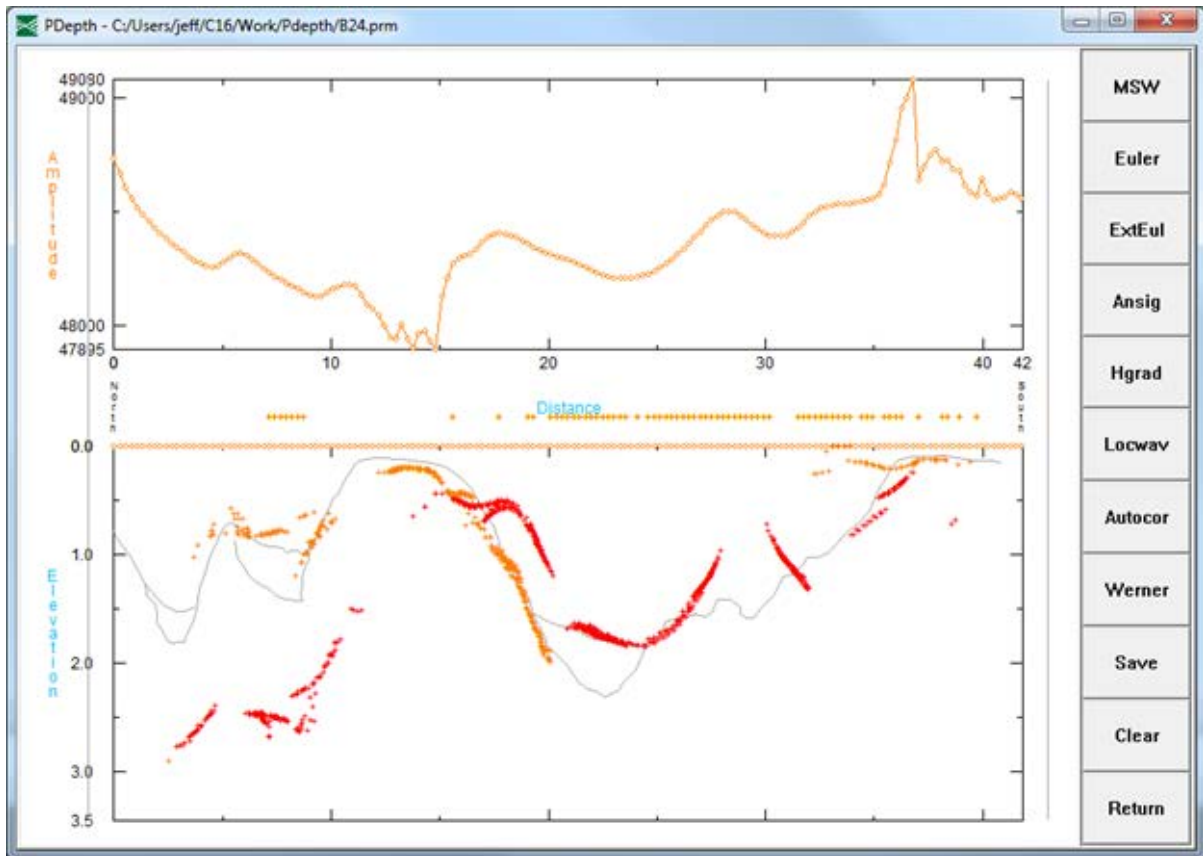


Figure 18. The Autocorrelation dialog.



**Figure 19.** Autocorrelation solutions from the magnetic profile.

Primary solutions are based on a comparison of the zero autocorrelation lag with higher lags, and secondary solutions are based on a comparison of two successive autocorrelation lags. Both solutions are based on an assumption of random (white noise) magnetization emplaced in a variable-depth, 2D basement striking perpendicular to the profile. Regions along the profile that exceed convergence thresholds and exhibit 3D source behavior that could lead to depth estimates that are too shallow are flagged by plus signs plotted above the observation surface. Convergence values chosen for primary solutions will normally be larger than the values chosen for the secondary solutions. Secondary solutions are plotted in the profile color. Primary solutions are plotted in a related color. Convergence values and window lengths can be varied until a consistent picture of basement depth emerges. Convergence of depth estimates, both as a function of lag and as a function of window length, is the best indication of a valid solution.

- Werner—Estimates source locations using Werner deconvolution (Werner, 1953; Hartman and others,

1971). The PROFILE SELECTION MENU is used to choose the profile to be analyzed. The input profile is assumed to be a magnetic profile, so results on gravity profiles should be viewed with suspicion. A dialog (fig. 20) asks the user for the degree of the interference polynomial; a value of 2 is usually recommended. The dialog also asks for the clustering radius as a percentage of depth and whether or not to plot the individual solutions (in gray). The depth estimates are plotted (fig. 21) as asterisks for interface (contact) solutions and dashes for sheet solutions. Clustered solutions are plotted in color. Clustering of depth estimates is used to indicate a valid solution.

- Save—Writes the last set of depth estimates to the file pdepth.dep. The depth estimates are appended to the file. Also writes information about the method and parameters used to the file pdepth.log.
- Clear—Refreshes the display, erasing temporary linework.
- Return—Returns to the MODEL MENU.

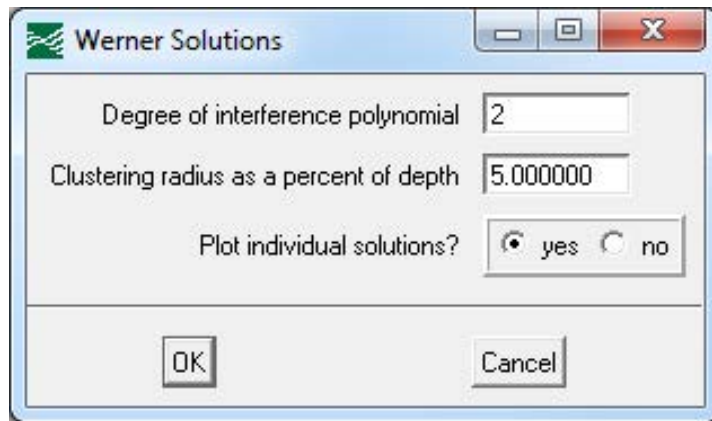


Figure 20. The Werner dialog.

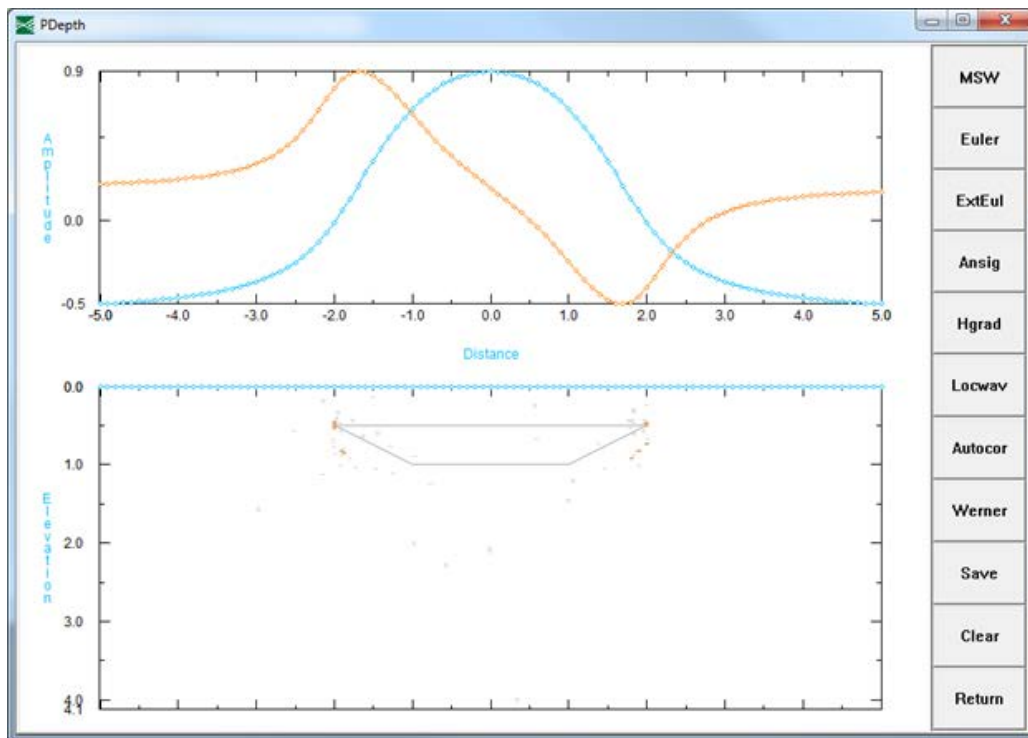


Figure 21. Werner contact (\*) and sheet (-) solutions from the magnetic profile.

## EDITMOD MENU

The EDITMOD MENU contains the following option boxes, which can be selected by clicking on them with the mouse. Model linework is semipermanent. To erase the model, select the “New Mod” or “EditMod” button, and respond to the file name prompt with the <Enter> key. Calculated profiles are displayed using temporary linework. Use the “Swap” button described in the “MODEL MENU” section of this report to make them permanent.

- New Mod—Creates a new SAKI model file. The user will be prompted for the file name. If the file exists, the user will be asked if it can be overwritten. Once a model file is opened, it will remain open until either the “New Mod” or “EditMod” menu buttons are selected, or until the program is exited. If a model file is open at the time the “New Mod” or “EditMod” menu button is selected, the user will be asked to click on the button a second time in order to write out and erase the current model. A mouse click on any other part of the screen will cancel the New Mod or EditMod request.
- EditMod—Edits an existing SAKI model file. The user will be prompted for the input file name. For a description of the format of the model file see the “Input Files” section of this report.
- New Bod—Creates a new body by clicking clockwise on corner locations with the mouse. The body will remain open until the polygon is closed by clicking on the “New Bod” button a second time. Physical properties of the body should be set or reset using the “Prop” menu button.
- Del Bod—Deletes a body. The body to delete is selected by the mouse, highlighted, then selected by the mouse again to verify. The corners of the body are not deleted.
- New Cor—Creates a new corner in the middle of a polygon line segment by selecting the endpoints of the line segment with the mouse.
- Del Cor—Deletes a corner. The corner to delete is selected by the mouse, highlighted, then selected again by the mouse to verify.
- Mov Cor—Moves a corner. The corner to move is selected by the mouse, highlighted, then moved to a new position that is also selected by the mouse.
- Prop—Enters basic physical properties for a body selected by the mouse. Current values of the density contrast, the magnetic susceptibility, the body extents, and the remanent magnetization parameters are displayed, and new values may be entered.
- Calc—Uses SAKI subroutines (Webring, 1985) to calculate gravity and magnetic fields based on the current model. The first time the “Calc” menu button is selected for a model, the user may be prompted for the regional magnetic field intensity, inclination and declination, and the profile azimuth. Calculated fields are displayed without symbols.
- Return—Returns to the MODEL MENU.

## Auxiliary Programs

### PfGraphicsMenu

PfGraphicsMenu is a small graphical user interface-based utility program written in Tcl/Tk that simplifies access to graphics programs such as PDEPTH. The PFGraphicsMenu program can be started from a shortcut on the desktop or from the command line in a command window once the PATH environmental variable is set up correctly. It consists of a small window with a single button labeled “Start” (fig. 22). Clicking on the “Start” button opens a drop-down menu. The first item on the menu is Setup. Before running PDEPTH for the first time, you must run Setup to define the working directory and graphics screen resolution. The dialog box for Setup (fig. 23) contains a “Browse” button used to search the directory tree for the working directory and a row of radio buttons used to select the graphics screen resolution. Due to limitations of Tcl/Tk, in order to select a working directory using the “Browse” button, you must actually select a file within the working directory. Any file will do. As a reminder, a message indicating this requirement appears in the title bar of the dialog box.

After running Setup, select “ASCII Profiles” then “Pdepth” from the PFMENU drop-down menu. This will open the PDEPTH startup dialog.



Figure 22. The PfGraphicsMenu “Start” button.

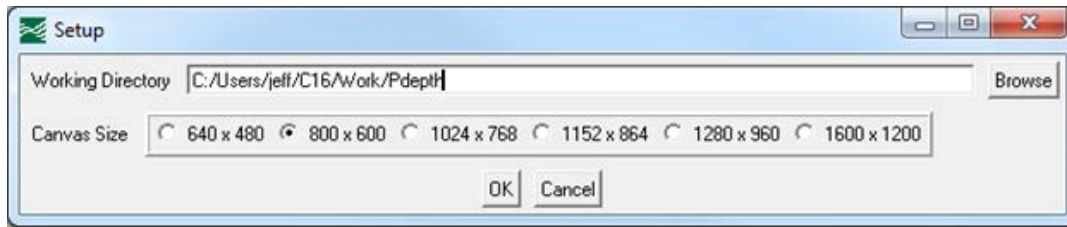


Figure 23. The PfGraphicsMenu Setup dialog.

## Usgs\_pdepth.gx

Usgs\_pdepth.gx is a plug-in Geosoft eXecutable module for Geosoft Oasis-montaj that extracts information from a Geosoft database and generates ASCII input files for program PDEPTH. The Geosoft database must be organized into lines, and can contain flight-line data, ground profile data, or data from the rows or columns of a grid. The database must contain a distance channel, an observation elevation channel, a magnetic (or gravity) anomaly channel, and X (easting) and Y (northing) location channels. Optional channels include the topographic elevation, elevations for up to five geologic horizons, and a five-character geologic unit code defining the surface geology at each location. The other required parameter is a prefix for the output file name, which can be 1 to 25 characters. Other parameters that can be specified include the geomagnetic field strength, inclination, and declination; a vertical exaggeration factor for display within PDEPTH; and an along-line decimation factor between 0 and 20. The Geosoft eXecutable module determines the profile azimuth.

Output files for each line are named using the specified file-name prefix followed by the Geosoft line number, and include a namelist (.prm) file, a profile (.mag) file, a geology (.geo) file, and a section (.sec) file. The geology and section files may be empty if the corresponding optional channels were not assigned. The Geosoft eXecutable module assumes that the Geosoft database contains magnetic anomaly data. If it contains gravity anomaly data instead, then additional steps involving renaming of the .mag files to .grv files and editing of the .prm files may be necessary.

Source code and current compiled versions of usgs\_pdepth.gx are maintained and distributed through U.S. Geological Survey Open-File Report 2007-1355 (Phillips, 2007).

## Pdep2xyz

Pdep2xyz is a command-line utility program that reformats and appends information from file pdepth.dep to an ASCII XYZ file for import into a Geosoft Oasis-montaj database. Pdep2xyz is intended to provide a path for moving source location estimates from multiple runs of PDEPTH into

Oasis-montaj so they can be displayed on a map, displayed in 3D, edited, or gridded. Pdep2xyz should be started from the command line after running a PDEPTH depth analysis method on the first profile of interest, saving the result using the “Save” menu button, and exiting PDEPTH. Pdep2xyz will check for the resulting pdepth.dep file, and if it is found, will ask for the name of the output Geosoft XYZ file. If the XYZ file exists, pdep2xyz will append the information in pdepth.dep to the end of the file, otherwise a new XYZ file will be created. The user must specify a positive line number for the profile before the information is written to the XYZ file. Specifying a negative line number will close the program.

Pdep2xyz can be left running during multiple runs of PDEPTH. Each time PDEPTH is closed and a new pdepth.dep file is created, the information in that file can be appended to the XYZ file by entering a positive line number at the prompt.

Information contained in the output XYZ file includes the specified line number for each profile, and columns containing X, Y, elev, depth, function, OMstrike, OMdip, GMSdip, physprop, si, index, method, source, and target. See the “Depth Files” section of this report for more information on these channels.

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