IX1D v2 Instruction Manual

Version 1.0

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Interpex Limited

P.O. Box 839

Golden, CO 80401

USA

www.interpex.com

Tel: 303 278 9124
Fax: 303 278 4007

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Interpex Limited
P.O. Box 839 - Golden, Colorado 80402
Tel: (303) 278-9124
Fax: (303) 278-4007

ABOUT THIS MANUAL

This manual is a PDF version of the Windows Help file that comes with IX1D v 2. It was created by importing the Windows Help pages into Microsoft Word and importing the pictures separately, with some additional formatting.

Text which is shown in red (such as "Creation of data by spreadsheet entry") indicates an item which is a link in the corresponding Windows Help file. Using the Windows Help file, either alone or from the IX1D v 2 menu, will allow you to click on this link and go to the section of the help file to which it points.

The purpose of this manual is to offer an alternative medium to the Windows Help, and especially one that can be easily printed in its entirety so that it can be read in circumstances where a computer is not relatively available or being used for some other task.

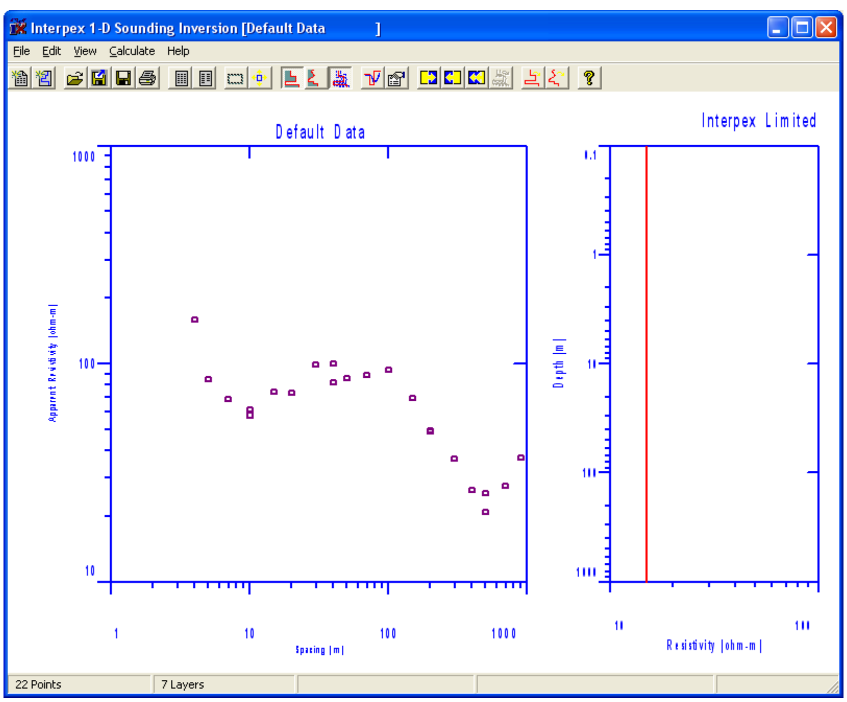
Please contact Interpex Limited by e-mail at info@interpex.com if you have any concerns about possible errors or omissions in this manual.

OVERVIEW

IX1D is a 1-D Direct Current (DC) resistivity, Induced Polarization (IP), Magnetotelluric (MT) and electromagnetic sounding inversion program with the following features:

- Supports Most DC resistivity arrays, including Wenner, Schlumberger, Dipole-dipole, Pole-dipole and Pole-pole arrays.
- Supports Resistivity only or Resistivity with IP measurements in terms of PFE, Chargeability in msec or Phase in mrad.
- Supports Magnetotelluric (MT) sounding inversion with Apparent Resistivity and Impedance Phase..
- Supports Horizontal Coplanar, Vertical Coplanar and Vertical Coaxial Electromagnetic in-phase and quadrature measurements made versus frequency, coil spacing or instrument height.
- Supports TEM data taken with coincident, central or fixed loop configurations.
- supports EM Conductivity data taken at low induction number with Geonics EM-31, -34 or -38 instruments, for example.
- Creation of data by spreadsheet entry
- Import of data or models from flat ASCII files
- Import of Borehole Resistivity Data from flat ASCII files
- Numeric editing of data and models using spreadsheets
- Graphical editing of the model as described below.
- Forward modeling and comparison of synthetic curves to your data
- Inverse modeling to improve the fit to the layered model and your data
- Automatic estimation of a layered model for DC resistivity data
- Automatic estimation of a smooth model
- Equivalence analysis for the layered model
- Printing of graphic and tabulated numeric results
- Export of data, modelL and smooth model to ASCII files with optional addition of random errors.

The standard display shows the data on the left and the model on the right:



Vertical axis is either the TEM voltage, Apparent Resistivity, Apparent Conductivity, Phase, IP value or In-Phase and Quadrature data. This depends on the type of data selected. The horizontal axis is normally the parameter used to create the sounding. This is Electrode Spacing for DC Resistivity and IP, frequency, spacing or height for MaxMin data, frequency for MT data (reversed axis) and Effective Penetration Depth for EM Conductivity data.

The Effective Penetration Depth is calculated from the geometry of the EM Conductivity system and assumes that the frequency is low enough that it does not unduly influence the penetration depth. This is calcuated following McNeill (1980, eq 11-14, fig 6 so that approximately 2/3 of the response comes from above this depth and 1/3 comes from below, similar to the so-called "skin depth". Note that for HMD measurements made with varying height, the Effective Penetration Depth ***increases*** with height, which at first seems counterintuitive. For VMD measurements, it first increases and then decreases with height.

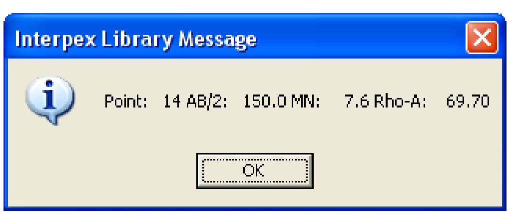
The model is shown on the right side of the display in a sort of Well-Log display. Depth increases downwards and the horizontal axis is the intrinsic resistivity of the layer in Ohm-m (except for EM Conductivity data, which is represented as intrinsic conductivity in mS/m). If DC Resistivity/IP data are used, the second model display is the IP parameter, which could be PFE, Chargeability or phase in mRad. For Resistivity, Resistivity/IP and EM Conductivity data, the model can be displayed on the same axes as the data. In this case, the horizontal axis (Electrode Spacing or Effective Penetration Depth) doubles as model depth.

The status bar shows the number of data points (for MaxMin, IP and MT data, pairs of points), number of layers in the layered model, the RMS fitting error for the layered model, number of layers in the smooth model, the RMS fitting error for the smooth model.

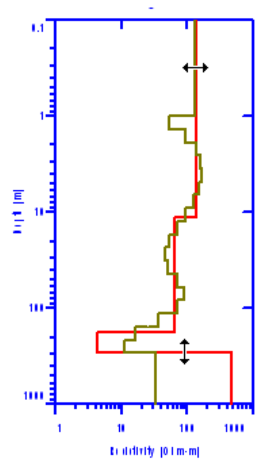
The mouse can be used in two modes, zoom and normal mode. In zoom mode (when View/Zoom is checked and the selection toolbar button is depressed), dragging the mouse with the left button depressed creates a rubber band box which, when the left button is released, zooms the graph containing the zoom box by autoscaling to the box limits. Note that the smallest a log scale can be zoomed to is a single decade. The rescale will normally be somewhat larger than the exact box you zoom to because of rounding of the scales.

When not in zoom mode, the model can be edited by pointing at a layer or layer boundary, depressing the left mouse button and dragging the layer to a new resistivity value or the layer boundary to a new depth.

When the mouse cursor is positioned correctly to edit a resistivity or IP value, the cursor will change from the normal pointer to a horizontal double arrow (vertical double arrow for model plotted on the same display with data):



When the mouse cursor is positioned correctly to edit a depth value, the cursor will change from the normal pointer to a vertical double arrow (horizontal double arrow for model plotted on the same display with data):



Note that for IP data, the depths can only be edited on the resistivity display. Only the IP value of the layer can be edited on the IP display.

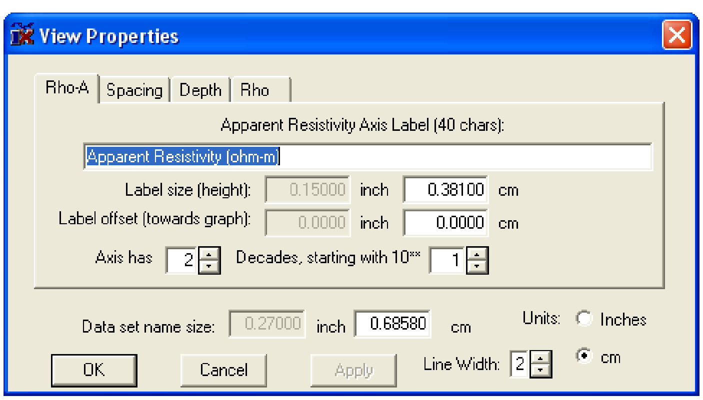
When the left button is released, a new synthetic is calculated and the inversion and equivalence analysis results (if any) are nullified. For Resistivity/IP data, the layer boundaries can only be edited on the resistivity section, not on the IP section display.

You must be inside the graphic display for the resistivity or IP model in order to attach the model for dragging. If the cursor does not change to the double arrow, the values cannot be edited.

For EM Conductivity, the conductivity of the layer is used instead of the resisitivity.

Clicking the mouse while pointing at a data point will display the data for that point in a pop-up box. When you are near enough to a data point for this to happen, the cursor changes to crosshairs. If the cursor does not change to crosshairs, clicking will not show the data for any point.

Right clicking will display the View/Properties dialog box:



IX1D does not have full capabilities unless it is registered or used with keyed demo data files.

There are two ways to register IX1D:

1. The first way is to provide a user name and pay a fee of $499 (price subject to change without notice). Interpex supplies a serial number and using Help Register, you can enter the user name

and password and that activates the software for all but MT data. This method ***licenses the software to a particular user*** and is most useful for situations in which a single user will be using the software and there is ***no*** danger of unauthorized use or copying.

2. The second way is to use Help Register to CPU and pay a fee of $499 (price subject to change without notice). You supply the Program Code as given in the Help Register to CPU dialog and Interpex supplies an Access Key. Using Help Register to CPU, you can enter the access key and that activates the software for all but TEM data, on a particular computer. You must also enter a user name of 11 characters or more but this can be changed from use to use to accommodate different users (for instance in a university laboratory). This method ***licenses the software to a particular computer*** and is most useful for situations in which multiple users will be using the software and there ***is*** danger of unauthorized use or copying.

Installing and Updating IX1D

IX1Dv2 is installed by running the setup file downloaded from the Internet. Usually it is installed into C:\Program files\IX1D. The executable file is called IX1D.exe.

After installing, use Windows Explorer to open the C:\Program files\IX1D directory and drag the IX1D.exe from there to the desktop using the RIGHT mouse button. When released, select "Create shortcut here". Position the shortcut according to your preferences and rename it to IX1D or IX1Dv2.

If you have selected "Hide extensions for known file types" in Tools/folder options/view in the Windows Explorer, the EXE extension will not be shown. It will be the file with the InterpeX "IX" logo and the trace with break on top of it.

Right-click on the shortcut and select properties. Change the "Start in:" field to the location where you will be storing your data files. IX1D remembers which directory you last used and takes you back there, but if it forgets now you will at least start in a reasonable place.

To update IX1D to a new version, download the zip file containing the updates from www.interpex.com and unzip that file into the C:\Program files\IX1D directory. You need WinZip to do this. You can find WinZip at www.winzip.com. If you want to save your present version (just to be safe), rename it to include the version, for instance IX1D211 for version 2.11.

The Help file for IX1D is in the C:\Program files\IX1D directory. You can access it through Help/Contents in IX1D or you can drag it onto the desktop using the RIGHT mouse button and create a shortcut just as you did for the executable.

Originally, the Help file and this manual are installed as dummy versions to save space in the download files. The full manual and the full help file can be downloaded separately. Then, these need to be unzipped and copies into the program directory, normally C:\Program Files\IX1D.

Check the Interpex web site periodically for updates, particularly if you are having problems. Always run the most recent before reporting any problems with the software.

The RMS Fitting Error

The RMS (Root Mean Square) fitting error is used as an indication of the fit between the synthetic data generated from the model and the actual data themselves. The method for calculating this error depends on the type of data being used.

For MaxMin data, the RMS error is the square root of the sum of the squares of the differences divided by the number of data points. The data are already expressed in percent of the primary field and this unit is used also for the RMS error.

For DC resistivity data, the RMS error is calculated by summing the squares of the difference in the log of the apparent resistivities. This result is divided by the number of data points and the square root is taken. The antilog of this result is taken and 1.0 is subtracted from it. Then it is multiplied by 100 to convert to percent. This method of calculating the error is used because of the large dynamic range that can be present in these data; this ensures that high apparent resistivity values do not dominate the calculated error, leaving large errors in the low apparent resistivity values.

REFERENCES

Anderson, W. L., 1989, A hybrid fast Hankel transform algorithm for electromagnetic modeling : Geophysics, Soc. of Expl. Geophys., **54,** 263-266.

Constable, S.C., R.L. Parker, and C.G. Constable, 1987: Occam's Inversion: a practical algorithm for generating smooth models from EM sounding data, **Geophysics, 52**, pp. 289-300.

Davis, P.A., S.A. Greenhalgh, N.P. Merrick, 1980, Resistivity sounding computations with any array using a single digital filter: Bull. Aust. Soc. Explor. Geophys., 11, pp. 54-62.

deGroot-Hedlin, C. and Constable, S., 1990, Occam's inversion to generate smooth two-dimensional models from magnetotelluric data: Geophysics 55, 1613-1624.

Inman, J. R., 1975, Resistivity inversion with ridge regression: Geophysics, 40, pp. 798-817.

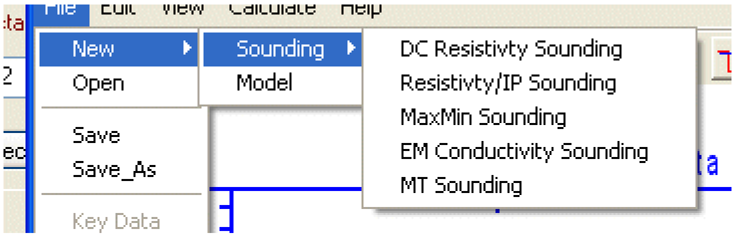
Koefoed, O., 1976, Progress in the direct interpretation of resistivity soundings: an algorithm: Geophys. Prospect., 24, pp. 233-240.

McNeill, J. D., 1980, Electromagnetic terrain conductivity measurement at low induction numbers: Geonics Technical Note TN-6, 15 p.

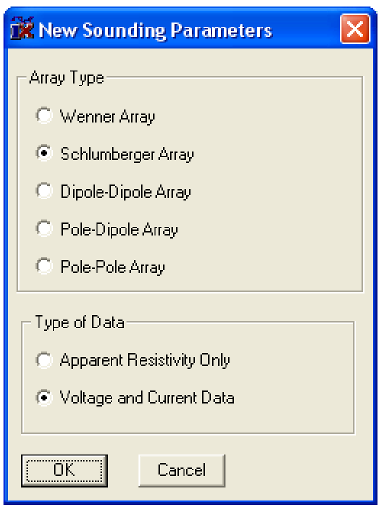
Creating a New Sounding

To create data by entering it into the IX1D spreadsheet, select New from the file menu and select New Sounding.

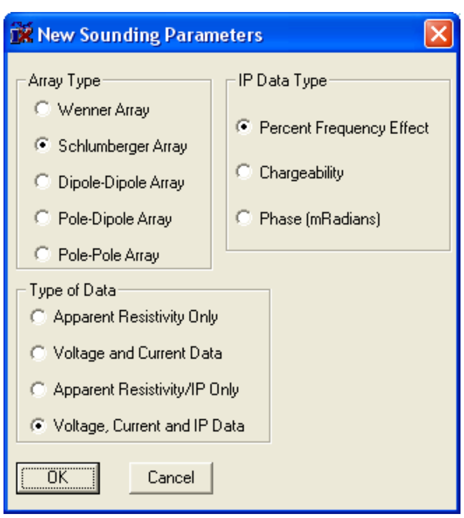
Next select DC Resistivity, Resistivity/IP, MaxMin, EM Conductivity or MT sounding:



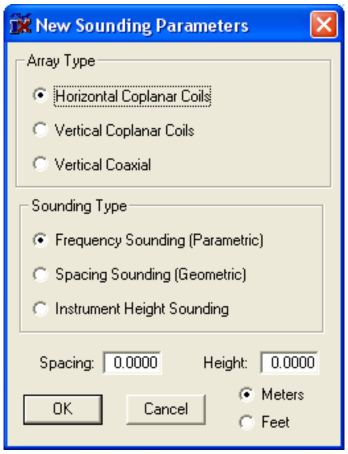
For DC resistivity, select the appropriate array type from the list and select whether you will be entering apparent resistivity or voltage and current data:



For IP data, select array type, IP data type and type of data:



For MaxMin Data, select the appropriate array type and sounding type. Sounding parameters are frequency, coil spacing and height. Most data will be frequency sounding data. Enter the other two (constant) parameters in the dialog box before proceeding (for instance, for frequency sounding, coil spacing and height are constant).



Press OK to continue, or Cancel to cancel the creation of the new sounding.

(For EM Conductivity and MT data, there are no choices to be made and you will proceed directly to the spreadsheet)

Now you will be in the data entry spreadsheet, which will be blank.

Enter a name for the sounding, 24 characters or less. Enter the easting, northing and elevation coordinates and the azimuth of the sounding. Remember 0 degrees is North, 90 degrees is East, and so on.

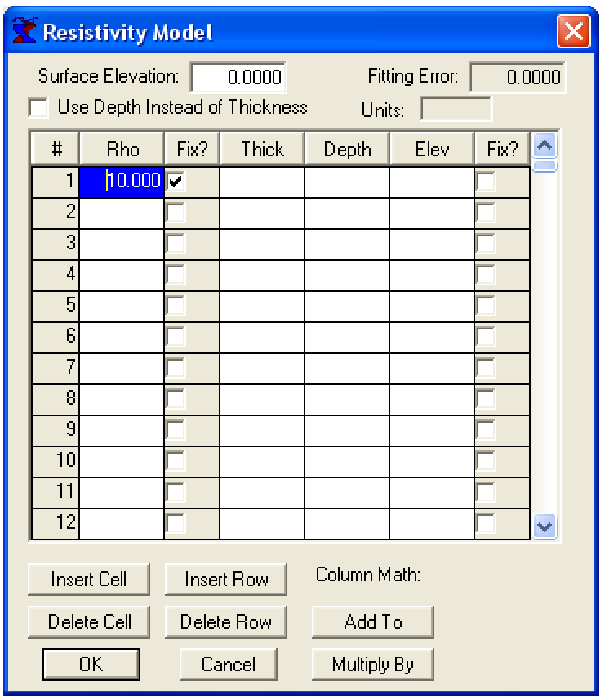
Enter the data values in the spreadsheet and press OK when you are finished entering all the values.

See Edit Data for more explicit instructions on how to use this spreadsheet.

Creating a New Model

Selecting File New>New Model brings up the layered model editor with a blank model. The surface elevation and current fitting error (if any) are shown at the top. There is a check box for using depths instead of thicknesses as parameters.

The model spreadsheet is blank, except for a single entry of first layer resistivity. Enter the resistivities and thicknesses (or depths or elevations) for the model you wish to create. Remember to leave the thickness column one element shorter than the resistivity column.



For EM Conductivity data, the conductivity in mS/m (milliSiemens/meter) replaces resistivity. Convert between the two by dividing into 1000: Rho=1000/S; S=1000/Rho.

See Edit Model for more information on how to use all the features of this tool.

File/Open, Save and Save As

Selecting **File Open** will allow you to open a sounding with its interpretation as previously saved from IX1D using the Save or Save As command.

This file is a binary file which contains the data, the layered and smooth models, the equivalence analysis results and most other information (except program settings) which accompanies the sounding.

The first display is a dialog to select the name of the file to open. Files have the extension IXR.

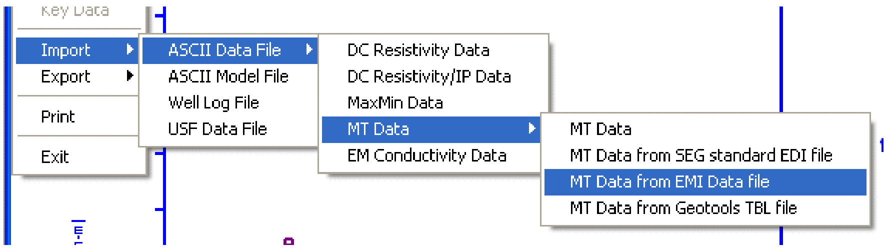
Select a file name from the list and press OK. Use the tools to change directories if the file you wish to open is not in the present directory. Press Cancel if you decide not to open a file.

Using File **Save** will save the current sounding back into the IXR file so it can be retrieved later. If the current data set name is blank, this will perform the same operations as a Save As. Otherwise, the data set name will be appended with the extension .IXR and this will be used as the file name for the saved results.

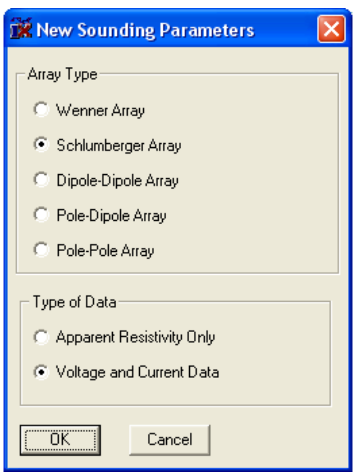
Save As performs the same operations as Save, except you must enter the file name as it does not default to the current data set name. After performing this operation, the data set name is changed to the new name entered and future Saves will use the new file name.

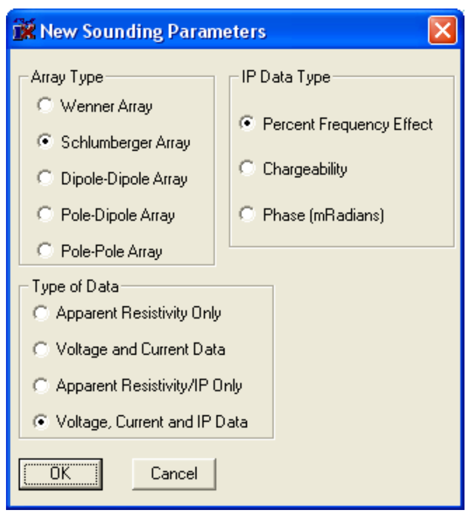
Importing Data

Selecting Import then Import Data and finally DC Resistivity Data, DC Resistivity/IP Data, MaxMin Data, Magnetotelluric Data or EM Conductivity Data from the file menu will allow you to read data from an ASCII file:

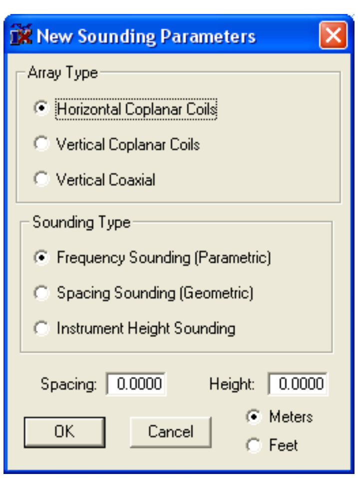


For DC Resistivity data or DC Resistivity/IP Data, first you will need to select the array type and the type of data to be imported:





For MaxMin data, you will need to select the array and sounding type, and will need to edit the constant parameters for the sounding (for instance, if the sounding is a frequency sounding, the coil spacing and height are constant):



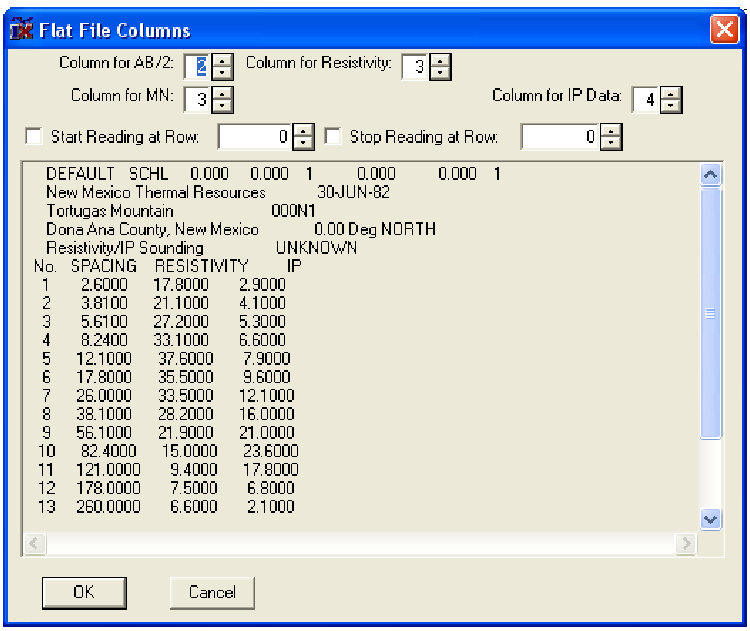
For MT or EM Conductivity data, there are no additional selections to be made. MT data can be imported from SEG standard files (EDI) file, from an EMI generated file or a Geotools generated TBL file.

This is done using the same dialog as New Sounding.

After pressing OK, you will be shown the file selection dialog. Select the appropriate directory and file name to continue importing the data.

After selecting the file name, IX1D will open the file and allow you to edit the column numbers from which the data will be read.

If you are reading Schlumberger data, you will select the columns for AB/2 and MN. For other DC Resitivity data, the Spacing column will be entered. If you are reading voltage and current data, you you will select the columns for voltage and for current. For resistivity data, only one column is used to read the apparent resistivities:



For DC Resistivity/IP Data, there is an additional column for the IP data.

For Dipole-dipole or Pole-dipole data, you will enter the dipole spacing.

For MaxMin data, you will select the columns for the sounding parameter (for instance, frequency) and for the in-phase and quadrature components of the fields.

For MT data, you will select the columns for the frequency, Apparent Resistivity, Phase and for the uncertainties in these data.

A scrolling box shows the contents of the file you have selected for your convenience.

Optionally, you can specify the first row and the last row to read from. Normally, IX1D reads past non-numeric fields and finds the data you are trying to read. However, if your files contain numbers which may be confused with sounding data or if it contains many sets of sounding data, you may want to specify the rows from which IX1D should be reading.

There are 20 lines shown in the file display box. If you click inside this box you can then use the page keys to scroll. Using page keys to scroll the box results in a scroll of 19 lines each time you depress the page key, unless the bottom (or top) of the file has been reached. This can be used to count positions for entering first and last row to read.

Lines which do not contain all columns specified will be skipped. For instance, if you are reading AB/2 from column 2, Resistivity from column 3 and MN from column 4, lines which contain fewer than 4 columns will be skipped. The exception to this is MT data, when there are enough columns to specify the data but insufficient to specify the uncertainties. The uncertainties will be assumed to be zero in this case.

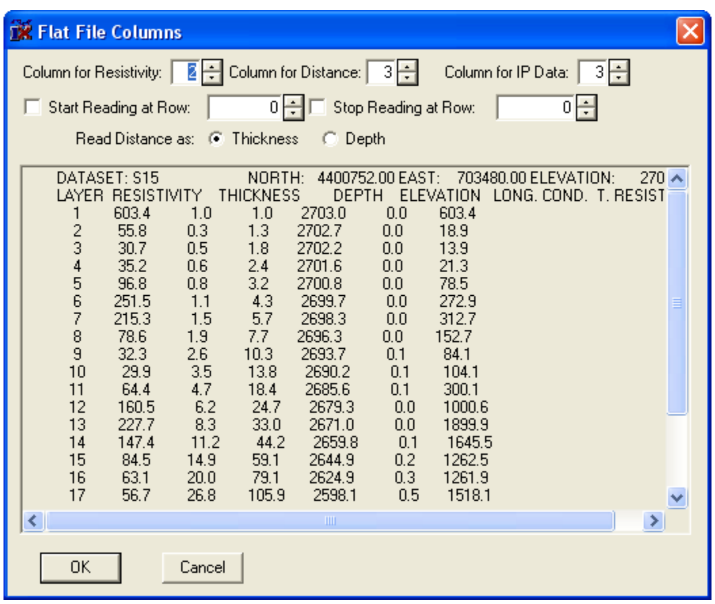
NOTE: If you switch between EM Conductivity data and a resistivity-based data, the model will be converted from conductivity in mS/m to ohm-m and vice versa.

Importing a Model

Selecting Import and then Import Model from the file menu will allow you to read a layered model from an ASCII file.

You will be shown the file selection dialog. Select the appropriate directory and file name to continue importing the model.

After selecting the file name, IX1D will open the file and allow you to edit the column numbers from which the model parameters will be read. You will need to select the column for resistivity and the column for distance. Distance can be selected to be thickness or depth using the radio buttons:



If you have Resistivity/IP data loaded, there will be a selection for the column for the layer IP value. This is in the same units as the apparent IP value.

If you have EM Conductivity data loaded, IX1D will expect Conductivities in mS/m instead of Resistivities in ohm-m.

A scrolling box shows the contents of the file you have selected for your convenience.

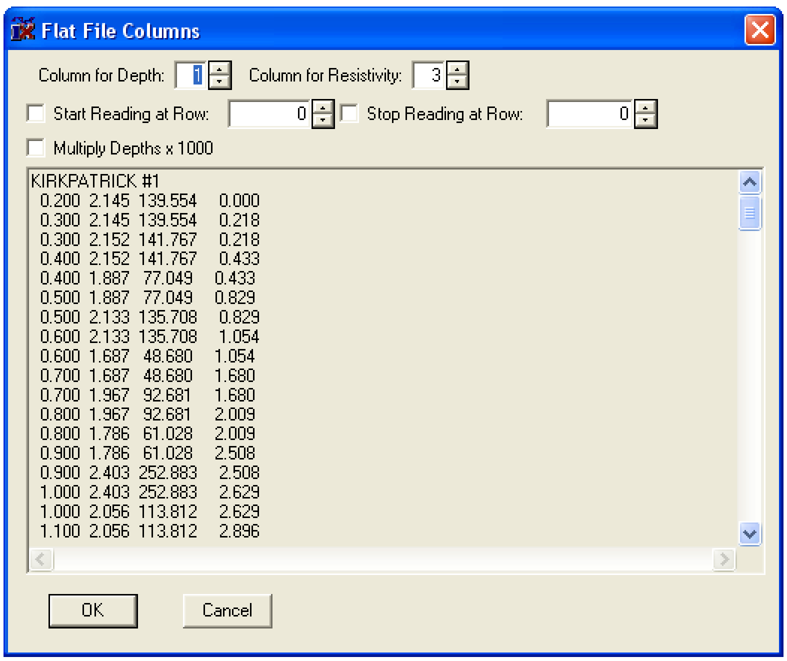
Optionally, you can specify the first row and the last row to read from. Normally, IX1D reads past non-numeric fields and finds the model parameters you are trying to read. However, if your files contain numbers which may be confused with model parameters or if it contains many sets of model parameters, you may want to specify which rows IX1D should be reading from.

Importing Borehole Resistivity Data

Data from a well log (borehole resistivity log) can be imported, processed, printed and the reduced layered model can be copied to the current layered model in the currently loaded data set.

After selecting File/Import/Well Log File, you will be shown the file selection dialog. Select the appropriate directory and file name to continue importing the data. Well logs have the extension LOG, but you can type in any name you like or enter *.EXT to list files with the extension EXT, for instance. Or rename your files so they have the extension LOG.

After selecting the file name, IX1D will open the file and allow you to edit the column numbers from which the data will be read:



Select the column for depth and resistivity.
Depths can be multiplied by 1000 if appropriate.

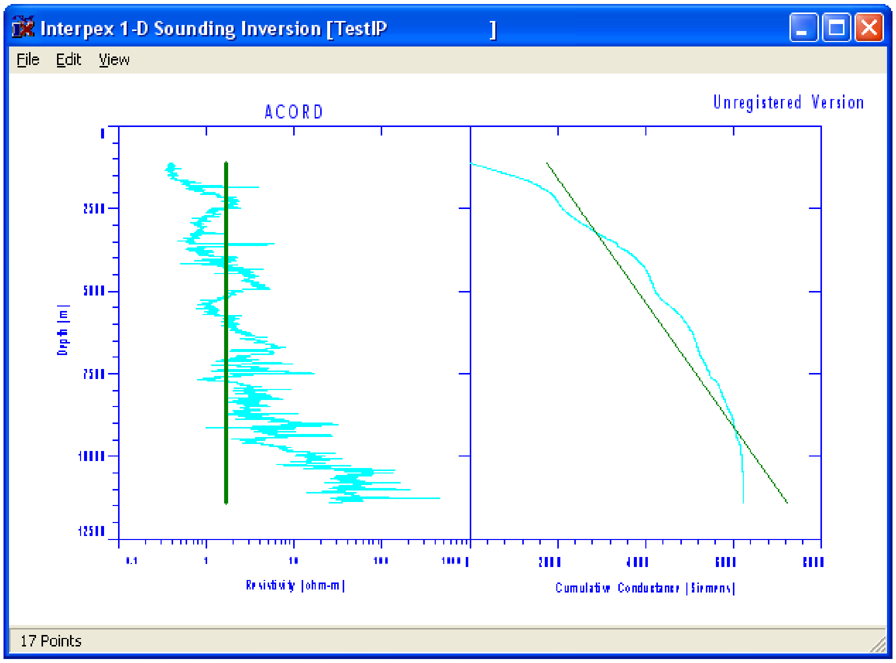
A scrolling box shows the contents of the file you have selected for your convenience.

Optionally, you can specify the first row and the last row to read from. Normally, IX1D reads past non-numeric fields and finds the data you are trying to read. However, if your files contain numbers which may be confused with well log data or if it contains many sets of well log data, you may want to specify the rows from which IX1D should be reading.

IX1D also reads past negative or zero resistivity readings.

There are 20 lines shown in the file display box. If you click inside this box you can then use the page keys to scroll. Using page keys to scroll the box results in a scroll of 19 lines each time you depress the page key, unless the bottom (or top) of the file has been reached. This can be used to count positions for entering first and last row to read.

After import, the well log is shown on the left side of a new window with the cumulative conductance shown on the other side. The cumulative conductance is calculated by summing the conductance of each layer in the log, starting at the first available point. The (longitudinal) conductance is the thickness divided by the resistivity:

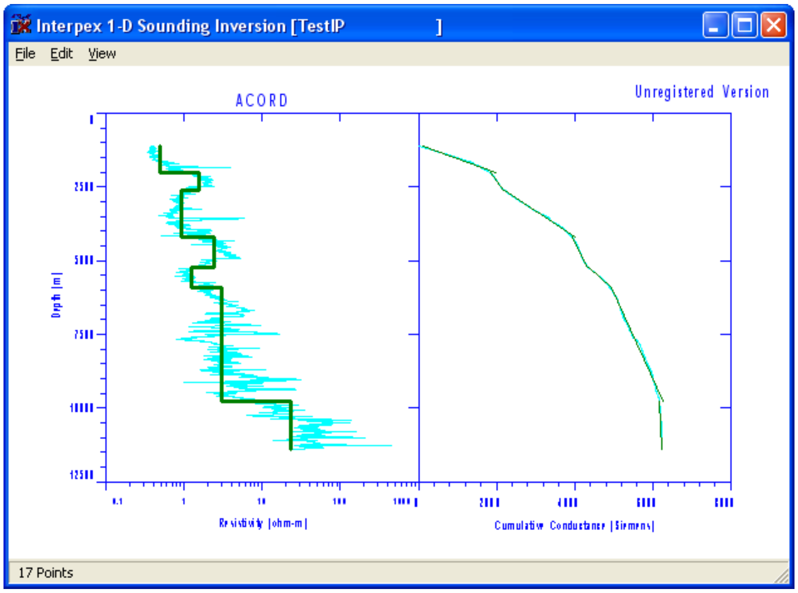


To reduce the log to a reasonable number of layers, you will need to fit the cumulative resistivity curve to a number of straight line segments, with each segment representing a layer. To do this, point and click at the desired depth.

The reduction starts with a single layer for the entire log and the first and last points cannot be removed. To split a segment into two segments, point and click on the depth where you want to split the segment. You can click either in the well log graph or in the cumulative conductance graph. You want to split the segments at every place where the cumulative conductance has a corner or a change in slope. Shallow slopes represent conductive layers and steep slopes represent resistive ones.

To remove a point, point the mouse cursor at the position on the cumulative conductance curve where the point lies and right click the mouse. Remember the first and last points cannot be removed.

As you point and click, the resulting reduced layered model is displayed on top of the well log graph. It is best to use as few layers as possible, while still representing the cumulative conductance curve reasonably well:



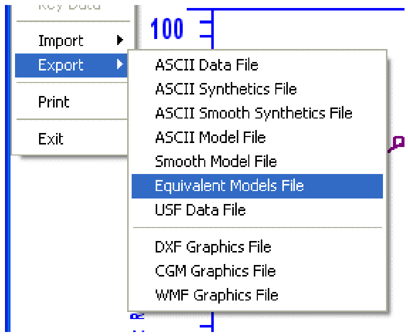
While in this window, you can use File/Set Layered Model to copy the resulting layered model to the layered model for the data set which is currently loaded. You can use Print to print the graphic showing the well log, layered model and the cumulative conductance curve with fits. You can export the layered model to an ASCII file or export the graphic to DXF, CGM or WMF file formats. You can clear the segments you have entered, zoom and unzoom (auto rescale) and select which displays to show.

Major and minor grid lines can also be selected.

EM methods respond only to the conductive part of the model, so reducing a well log in this fashion gives exactly the model which an EM method will see. Galvanic resistivity methods respond mostly to the conductive part but also to the resistive part, so if there is a high degree of anisotropy, the model will not truly represent the section when modeled with DC resistivity methods.

Flat ASCII Data Export

Export Data allows the current data set to be exported to a simple ASCII file. Invoking this command brings up the file selection dialog so that you can select the directory and enter the file name to be used for export.



The file has a default extension of DAT.

The file consists of a header line containing the data set name and the Northing, Easting and Elevation coordinates. The second line contains a header for the data columns and the data follow. Exactly which data are contained depends on the type of data, the sounding array and (for DC Resistivity) the presence of voltage and current data.

For Schlumberger data, the spacings AB/2 and MN and the apparent resistivity values are written. For other DC resistivity data, the spacing and apparent resistivity are written.

For DC resistivity data including voltage and current data, the voltage and current are appended to the other data. Voltage and current data are not available for synthetics.

If IP data are included with DC resistivity data, these are appended to the end of each line.

For MaxMin Data, the frequency, coil spacing, instrument height, in-phase and quadrature are written. The fields are expressed as secondary fields in percent of the primary field.

For EM Conductivity Data, the frequency, coil spacing, instrument height, HMD and VMD apparent conductivities are written.

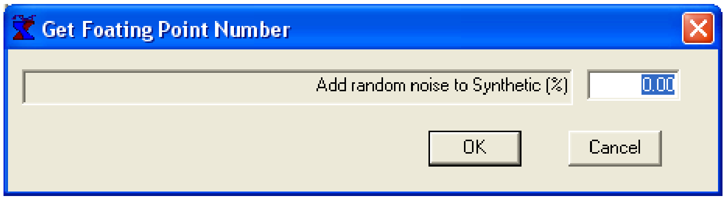
For MT data, the frequency, apparent resistivity, phase and the error bars for these two data are written.

Export (smooth) synthetics works the same as Export Data except that the (smooth) synthetics are exported and that voltage and current data are not exported. This export is preceeded by a dialog which allows you to enter a percentage value for noise. If zero, no noise is added. Otherwise, random noise is added to the data before export.

Data can also be exported in Universal Sounding Format (USF)

The file has a default extension of DAT.

If you export synthetic data, you are given an opportunity to add random noise to the data:



The file consists of a header line containing the data set name and the Northing, Easting and Elevation coordinates. The second line contains a header for the data columns and the data follow. Exactly which data are contained depends on the type of data, the sounding array and (for DC Resistivity) the presence of voltage and current data.

For Schlumberger data, the spacings AB/2 and MN and the apparent resistivity values are written. For other DC resistivity data, the spacing and apparent resistivity are written.

For DC resistivity data including voltage and current data, the voltage and current are appended to the other data. Voltage and current data are not available for synthetics.

If IP data are included with DC resistivity data, these are appended to the end of each line.

For Frequency EM Data, the frequency, coil spacing, instrument height, in-phase and quadrature are written. The fields are expressed as secondary fields in percent or ppm of the primary field.

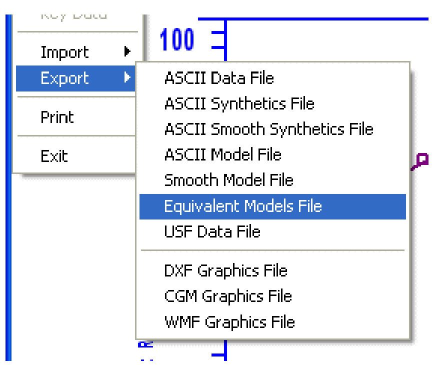
For EM Conductivity Data, the frequency, coil spacing, instrument height, HMD and VMD apparent conductivities are written.

For MT data, the frequency, apparent resistivity, phase and the error bars for these two data are written.

Export (smooth) synthetics works the same as Export Data except that the (smooth) synthetics are exported and that voltage and current data are not exported. This export is preceded by a dialog which allows you to enter a percentage value for noise. If zero, no noise is added. Otherwise, random noise is added to the data before export.

Flat ASCII Model Export

Export Model allows the current model to be exported to a simple ASCII file. Invoking this command brings up the file selection dialog so that you can select the directory and enter the file name to be used for export.



The file has a default extension of MDL.

The file consists of a header line containing the data set name and the Northing, Easting and Elevation coordinates. The second line contains a header for the columns and the data follow. Data written are layer number, resistivity, thickness, depth and elevation. Only layer number and resistivity are written for the last layer which is semi-infinite.

For EM Conductivity measurements, the conductivity in mS/m is written instead of the resistivity in Ohm-m.

Flat ASCII Smooth Model Export

Export Smooth Model allows the smooth model to be exported to a simple ASCII file. Invoking this command brings up the file selection dialog so that you can select the directory and enter the file name to be used for export.

The file has a default extension of MDL.

The file consists of a header line containing the data set name and the Northing, Easting and Elevation coordinates. The second line contains a header for the columns and the data follow. Data written are layer number, resistivity, thickness, depth and elevation. Only layer number and resistivity are written for the last layer which is semi-infinite.

If no smooth model is available, a warning is issued.

Graphics Export

Graphics can be exported in AutoCAD DXF, CGM and WMF formats. Each window has an export option for each of these three kinds of graphics in the File/Export menu.

DXF Graphics Export

Export DXF graphics file allows you to enter a file name for an Autocad DXF interchange file. Then a DXF file is created with the same graphics as is presented in the graphics window on the screen. This menu option is available from all windows and the exported graphic depends on the window from which the option was selected.

CGM Graphics Export

Export CGM graphics file allows you to enter a file name for a CGM interchange file. Then a CGM file is created with the same graphics as is presented in the graphics window on the screen. This menu option is available from all windows and the exported graphic depends on the window from which the option was selected.

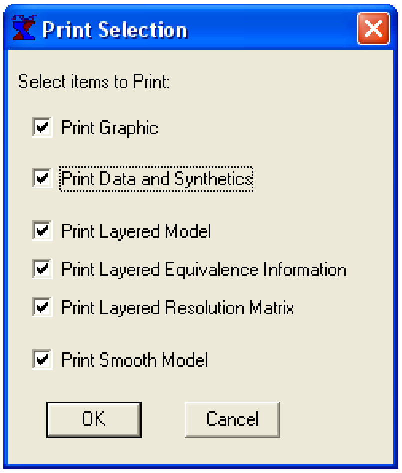
WMF Graphics Export

Export WMF graphics file allows you to enter a file name for a WMF interchange file. Then a WMF file is created with the same graphics as is presented in the graphics window on the screen. This menu option is available from all windows and the exported graphic depends on the window from which the option was selected.

Printing

The File Print command allows you to generate printed output of the displayed graphic for the well log display.

For the sounding display, the File Print command allows you to generate printed output of the data and results for the displayed sounding. When you issue this command you are presented with a dialog of items to be printed. These are in the form of check boxes:



Print Graphic: if checked, the graphic, just as it appears on the screen in the sounding window, is printed. It is automatically sized to fit the paper on which it is printed.

After printing the graphic, a header is printed consisting of the data set name, the array type and the Northing, Easting and Elevation coordinates. This header is not printed if no listings are selected.

Print Data and Synthetics: Prints a listing of the data. for DC Resistivity data, this includes spacings and apparent resistivities, along with the synthetics and differences for both layered and smooth models. Also prints the RMS error in percent. For Frequency EM data, this includes the sounding parameter (normally frequency) and the in-phase and quadrature values for data, layered synthetic and smooth synthetic, as available. For IP data the IP values are shown as well and for MT data, the phase values are shown.

Print Layered Model: Prints a listing of the layered model parameters, including resistivity, thickness, depth, elevation, longitudinal conductance and transverse resistance for each layer. For the last layer, only the resistivity is listed. Intrinsic IP is shown for IP data. Conductivity is shown instead of Resistivity for EM Conductivity data.

Longitudinal Conductance is the thickness divided by the resistivity (thickness times conductivity/1000).
Transverse Resistance is the thickness multiplied by the resistivity (thickness times 1000 divided by conductivity).

Print Layered Equivalence Information: This prints a summary of the results of Equivalence Analysis of the layered model. It consists of the minimum, best fit and maximum values for the layer resistivities (or conductivities), thicknesses and depths.

Print Layered Resolution Matrix. This prints the Resolution Matrix which results from the inversion on the layered model. If this is not available, a note saying current resolution matrix is not available is printed.

Print Smooth Model: This lists the smooth model (if available) in the same way as the layered model is listed.

Editing Data

The Edit Data spreadsheet allows you to edit the data which you have previously entered, which has been imported into IX1D or which read by Opening a previously Saved sounding.

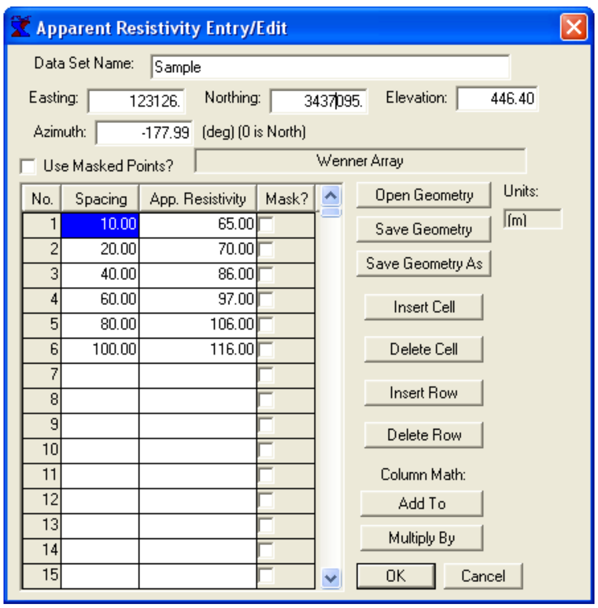
The top section of the dialog shows name for the sounding, 24 characters or less, the easting, northing and elevation coordinates and the azimuth of the sounding. Remember 0 degrees is North, 90 degrees is East, and so on.

It also shows the type of array, which cannot be edited at this point.

There is a checkbox for "Use Masked Points?". If this is checked, the points which are masked (as described later) will be used in spite of the fact that they are masked.

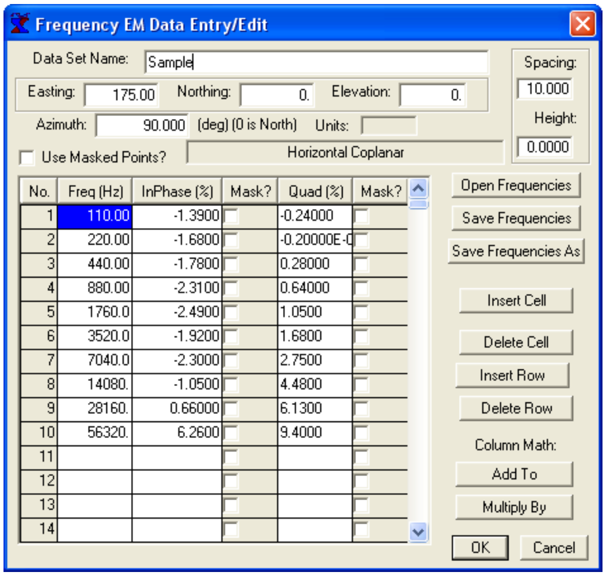
The actual data which appear in the spreadsheet will depend on the type of array used and (for DC Resistivity data) on whether voltage and current or resistivity data only were selected when the data set was created.

For instance, the Wenner spreadsheet is one of the simplest:

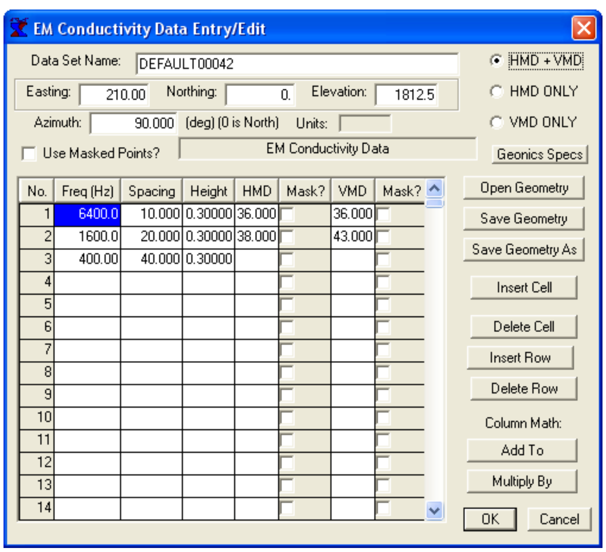


If a Dipole-Dipole or Pole-Dipole sounding is selected, an additional header item, "Dipole Length" will appear. This is the length of the dipole used.

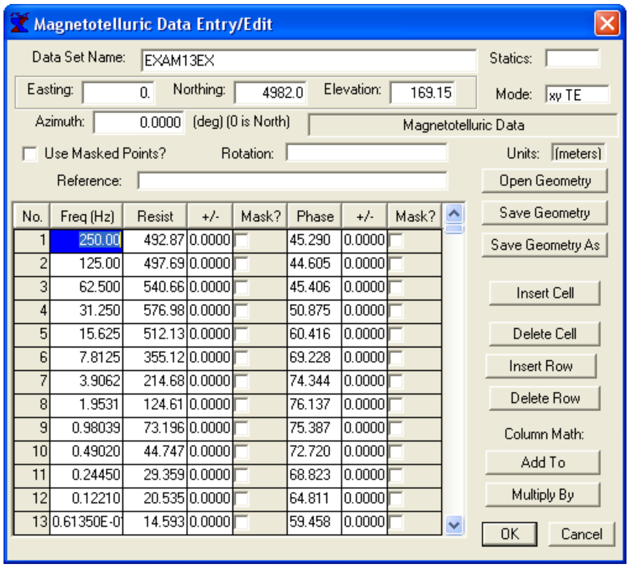
For Frequency EM soundings, the constant parameters will appear in the upper right corner. For instance, if it is a frequency sounding, the coil spacing and height will be displayed for edit:



For EM Conductivity soundings, there is an option in the upper right corner to select HMD and VMD, HMD only or VMD only:



For MT data, character fields are available for Rotation and Reference:



For TEM data, there are Tx loop parameters and a separate spreadsheet for sweep parameters. Please see TEM Data Spreadsheet.

Schlumberger Resistivity Spreadsheet
Schlumberger Voltage/Current Spreadsheet
Resistivity Spreadsheet
Voltage/Current Spreadsheet
Frequency EM Data Spreadsheet
EM Conductivity Data Spreadsheet
MT Data Spreadsheet
TEM Data Spreadsheet

All spreadsheets have similar functions for saving or retrieving geometry, inserting or deleting rows or cells and addition or multiplication column math. The Tab key moves to the next cell to the right. The shift-tab combination moves to the next cell to the left. Using the enter key, with or without shift, moves one cell down. Up/Down arrow keys move one cell up or down, right/left arrow keys move through the characters in the field and ultimately to the next cell, left or right.

The spacing geometry (Frequency (or spacing or height) for Frequency EM data, AB/2 and MN for Schlumberger, Spacings only for all other arrays) can be written to an ASCII file using Save Geometry. Those data can be reread using Open Geometry. Edited versions can be saved under a new name using Save Geometry As.

For EM Conductivity data, the Frequency, Spacing and Height are written to the file and read from it.

For MT data the Frequency data are written to the file and read from it.

For TEM data, the Time data written to the file and read from it, but only for the sweep containing the focus.

Entire rows can be inserted or deleted using Insert Row or Delete Row. The row containing the cursor is the row to be deleted. The current row moves downwards after an insert operation and it is also duplicated at its present position. For TEM data, inserting and deleting rows is applied only to the sweep containing the focus.

Single cells can be inserted or deleted using Insert Cell or Delete Cell. This is especially useful if you have entered data manually and skipped a row somewhere in one of the columns. The insertion or deletion is done at the cell containing the cursor.

Column math can also be carried out using the Add To or Multiply By buttons. Add to adds whatever constant you specify to the contents of the column containing the cursor from the cell containing the cursor downwards. Multiply By multiplies whatever constant you specify times the contents of the column containing the cursor from the cell containing the cursor downwards.

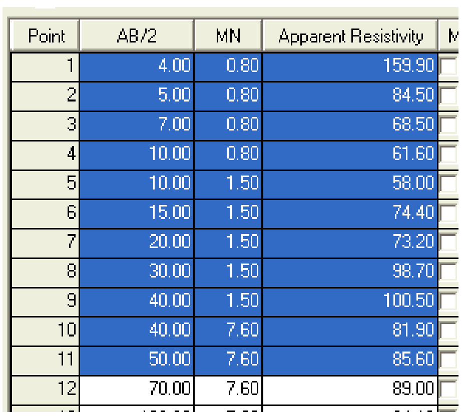
Press OK to save the entered or edited contents and proceed. Press Cancel to abort the entry or editing you have done.

Using Copy/Paste

Data can be copied from other Windows software, for instance Excel, and pasted into fields or spreadsheets in Intepex Software. They can also be copied from Interpex software and pasted into other Windows software. These data go through the Windows clipboard.

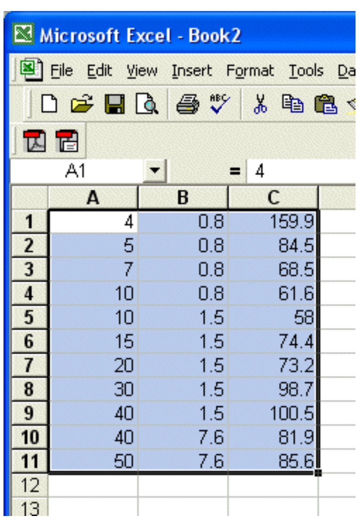
To copy a field in Interpex Software, the data in the field must be selected. To select the data in a field, move into the field using the keyboard (tab, shift-tab, or arrow keys) or double click in the field with the mouse. For instance, a selected field will look like this:

To copy a section of a spreadsheet in Interpex Software, highlight the area by depressing the left mouse button and dragging the mouse, or by depressing the shift key in the first field and moving arrow keys to move into the last field. For example:



Point	AB/2	MN	Apparent Resistivity
1	4.00	0.80	159.90
2	5.00	0.80	84.50
3	7.00	0.80	68.50
4	10.00	0.80	61.60
5	10.00	1.50	58.00
6	15.00	1.50	74.40
7	20.00	1.50	73.20
8	30.00	1.50	98.70
9	40.00	1.50	100.50
10	40.00	7.60	81.90
11	50.00	7.60	85.60
12	70.00	7.60	89.00

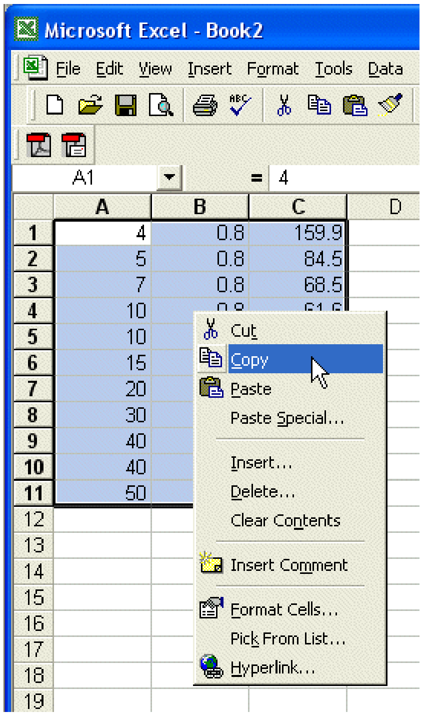
A selected field can be pasted into a word document or another field in another Windows software package and a selected section of a spreadsheet can be pasted into another Windows spreadsheet, like Excel:

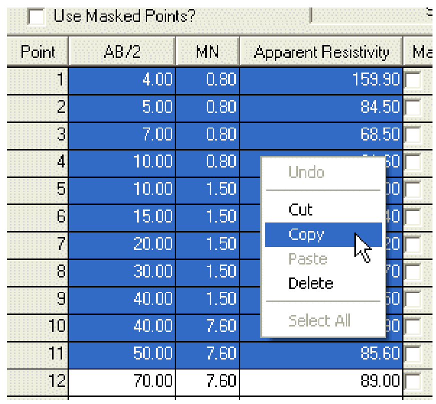


	A	B	C
1	4	0.8	159.9
2	5	0.8	84.5
3	7	0.8	68.5
4	10	0.8	61.6
5	10	1.5	58
6	15	1.5	74.4
7	20	1.5	73.2
8	30	1.5	98.7
9	40	1.5	100.5
10	40	7.6	81.9
11	50	7.6	85.6
12			
13			

Conversely, the fields or selected section of a spreadsheet can be copied from other Windows software and pasted into Interpex software.

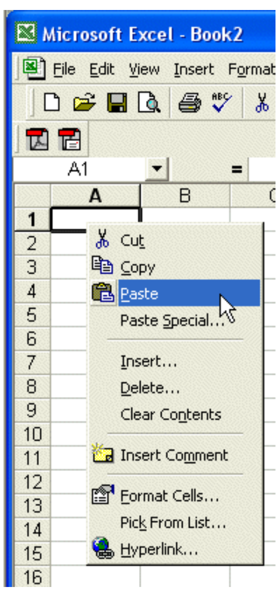
After selecting the field or cells, you can copy by right-clicking and selecting **Copy**:

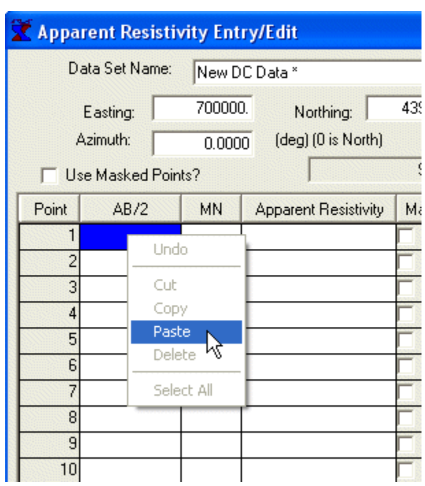




Alternatively, you can just pres **Ctrl-C** to copy.

To paste, select the field or first cell (upper left corner) to paste to, right-click and select Paste:



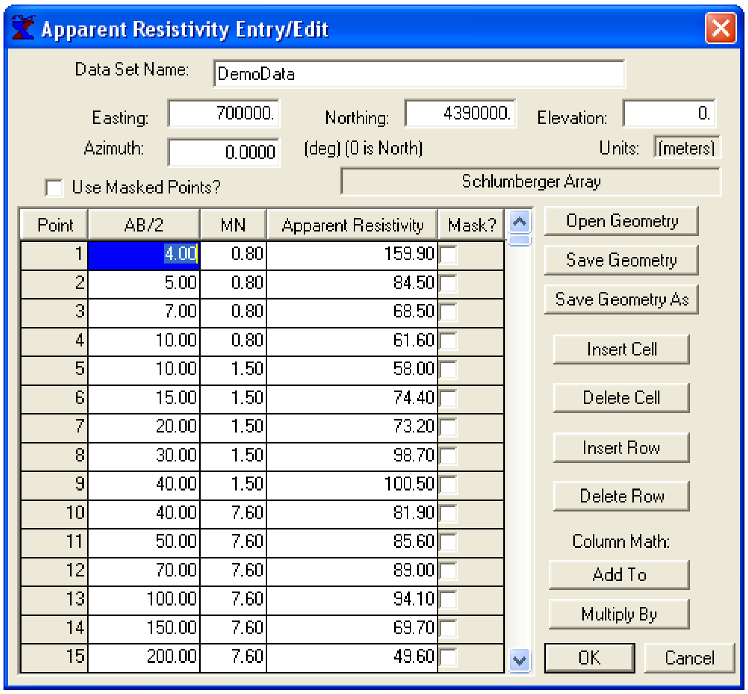


Alternatively, you can select the field or first cell and just press **Ctrl-V** to paste.

Editing Schlumberger Resistivity (IP) Data

The dialog for editing Schlumberger resistivity data contains an entry for the data set name, the Easting, Northing and Elevation coordinates and the azimuth along which the array is laid out (0 is North-South).

The spreadsheet for Schlumberger resistivity only data contains 5 columns (7 columns if IP data) in the data grid. The first is the data index which cannot be edited:



The second is the AB/2 value, which is half the total distance between the (outside) current electrodes.

The third is the MN value, which is the distance between the (inside) potential electrodes.

The fourth is the Apparent Resistivity value.

The fifth is the mask flag. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

If IP data are present, the sixth column is the IP value, expressed in the appropriate units and the seventh is the IP mask flag. Units are PFE for frequency domain data, msec for time-domain data and mrad for phase data.

There is an arbitrary limit of 1000 data points.

Data columns 2 through 4 (and column 6 if IP data) must be of equal length and all data values must be filled in. All values must be positive.

Several buttons on the right side if the dialog allow additional functionality. The **Open Geometry** button will ask for a file name and then read the AB/2 and MN values from a previously stored geometry. **Save Geometry** will save the existing geometry and **Save Geometry As** will save the existing geometry under a new name. Files are named with extensions .GEO.

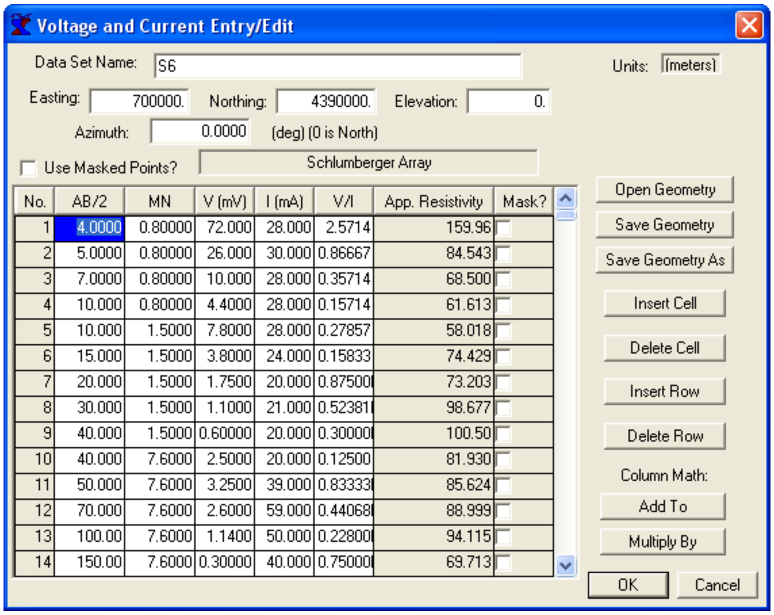
Insert Cell inserts a cell at the current location and shifts other cells down. **Delete Cell** deletes the cell which has the focus and shifts cells up. **Insert Row** inserts a row of cells and **Delete Cell** deletes a row of cells, at the current row that contains the cell which has focus.

Column Math allows for addition (subtraction) or multiplication from the cell containing the focus downwards. **Add To** adds a number to this cell and all others downwards (use a negative number to subtract). **Multiply By** multiplies by a value from the current cell downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Paste for more details.

Editing Schlumberger Voltage/Current (IP) Data

The spreadsheet for Schlumberger voltage and current data contains 8 columns (10 if IP data are present) in the data grid. The first is the data index which cannot be edited:



The second is the AB/2 value, which is half the total distance between the (outside) current electrodes.

The third is the MN value, which is the distance between the (inside) potential electrodes.

The fourth and fifth are the voltage and current values, in mV and mA, respectively.

The sixth is the resistance value, the voltage divided by the current. This is supplied for cases where an instrument gives the resistance (V/I) instead of the voltage and current values, individually. If you are entering resistance values, you must enter the AB/2 and MN values and a current value before entering resistance. When you enter the resistance, the voltage and apparent resistivity will then be calculated. If you do not know the current, enter a reasonable value as it really makes no difference.

In the case where an instrument gives, for example, two-Pi V/I, then this number can be entered into the V/I column, and the Multiply By button can be used to multiply the column by 0.15915 (the same as dividing by two Pi).

The seventh is the Apparent Resistivity value, which cannot be edited and is calculated from the voltage and current (or resistance) values.

The eighth is the mask flag. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

If IP data are present, the ninth column is the IP value, expressed in the appropriate units and the tenth is the IP mask flag. Units are PFE for frequency domain data, msec for time-domain data and mrad for phase data.

There is an arbitrary limit of 1000 data points.

Data columns 2 through 6 (and 9 if IP data are present) must be of equal length and all data values must be filled in. All values must be positive.

If you paste data from another spreadsheet, you may have to use the down arrow to step through all rows to force the apparent resistivity calculation.

Several buttons on the right side if the dialog allow additional functionality. The **Open Geometry** button will ask for a file name and then read the AB/2 and MN values from a previously stored geometry. **Save Geometry** will save the existing geometry and **Save Geometry As** will save the existing geometry under a new name. Files are named with extensions .GEO.

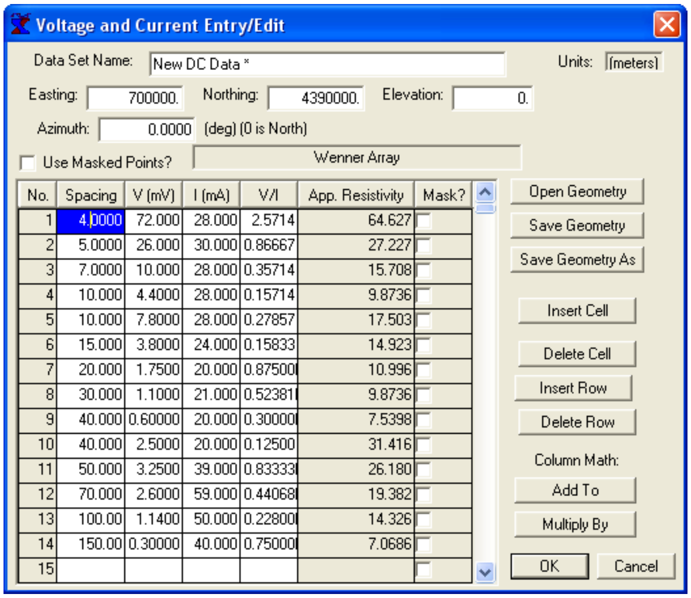
Insert Cell inserts a cell at the current location and shifts other cells down. **Delete Cell** deletes the cell which has the focus and shifts cells up. **Insert Row** inserts a row of cells and **Delete Cell** deletes a row of cells, at the current row that contains the cell which has focus.

Column Math allows for addition (subtraction) or multiplication from the cell containing the focus downwards. **Add To** adds a number to this cell and all others downwards (use a negative number to subtract). **Multiply By** multiplies by a value from the current cell downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Paste for more details.

Editing Voltage/Current (IP) Data

The spreadsheet for voltage and current data contains 7 columns (9 if IP data are present) in the data grid. The first is the data index which cannot be edited:



The second is the Spacing value, which is dependent on the array type. For Wenner, it is the "a" spacing. For Dipole-dipole or Pole-dipole, it is the "n" spacing. This is the distance between the near current and near potential electrodes, divided by the Dipole Length. This does not have to be an integer. For Pole-pole data it is the distance between the poles.

The third and fourth are the voltage and current values, in mV and mA, respectively.

The fifth is the resistance value, the voltage divided by the current. This is supplied for cases where an instrument gives the resistance (V/I) instead of the voltage and current values, individually. If you are entering resistance values, you must enter the AB/2 and MN values and a current value before entering resistance. When you enter the resistance, the voltage and apparent resistivity will then be calculated. If you do not know the current, enter a reasonable value as it really makes no difference.

In the case where an instrument gives, for example, two-Pi V/I, then this number can be entered into the V/I column, and the Multiply By button can be used to multiply the column by 0.15915 (the same as dividing by two Pi).

The sixth is the Apparent Resistivity value, which cannot be edited and is calculated from the voltage and current (or resistance) values.

The seventh is the mask flag. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

If IP data are present, the eighth column is the IP value, expressed in the appropriate units and the ninth is the IP mask flag. Units are PFE for frequency domain data, msec for time-domain data and mrad for phase data.

There is an arbitrary limit of 1000 data points.

Data columns 2 through 5 must be of equal length and all data values must be filled in. All values must be positive.

If you paste data from another spreadsheet, you may have to use the down arrow to step through all rows to force the apparent resistivity calculation.

Several buttons on the right side if the dialog allow additional functionality. The **Open Geometry** button will ask for a file name and then read the spacing values from a previously stored geometry. **Save Geometry** will save the existing geometry and **Save Geometry As** will save the existing geometry under a new name. Files are named with extensions .GEO.

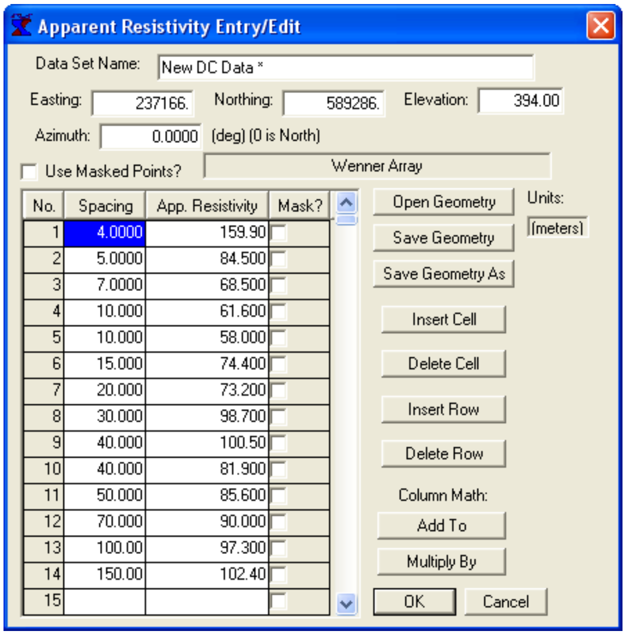
Insert Cell inserts a cell at the current location and shifts other cells down. **Delete Cell** deletes the cell which has the focus and shifts cells up. **Insert Row** inserts a row of cells and **Delete Cell** deletes a row of cells, at the current row that contains the cell which has focus.

Column Math allows for addition (subtraction) or multiplication from the cell containing the focus downwards. **Add To** adds a number to this cell and all others downwards (use a negative number to subtract). **Multiply By** multiplies by a value from the current cell downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Paste for more details.

Editing Resistivity (IP) Data

The spreadsheet for Apparent Resistivity only data contains 4 columns (6 if IP data are present) in the data grid. The first is the data index which cannot be edited:



The second is the Spacing value, which is dependent on the array type. For Wenner, it is the "a" spacing. For Dipole-dipole or Pole-dipole, it is the "n" spacing. This is the distance between the near current and near potential electrodes, divided by the Dipole Length. This does not have to be an integer. For Pole-pole data it is the distance between the poles.

The third is the Apparent Resistivity value.

The fourth is the mask flag. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

If IP data are present, the fifth column is the IP value, expressed in the appropriate units and the sixth is the IP mask flag.

There is an arbitrary limit of 1000 data points.

Data columns 2 and 3 must be of equal length and all data values must be filled in. All values must be positive.

Several buttons on the right side if the dialog allow additional functionality. The **Open Geometry** button will ask for a file name and then read the spacing values from a previously stored geometry. **Save Geometry** will save the existing geometry and **Save Geometry As** will save the existing geometry under a new name. Files are named with extensions .GEO.

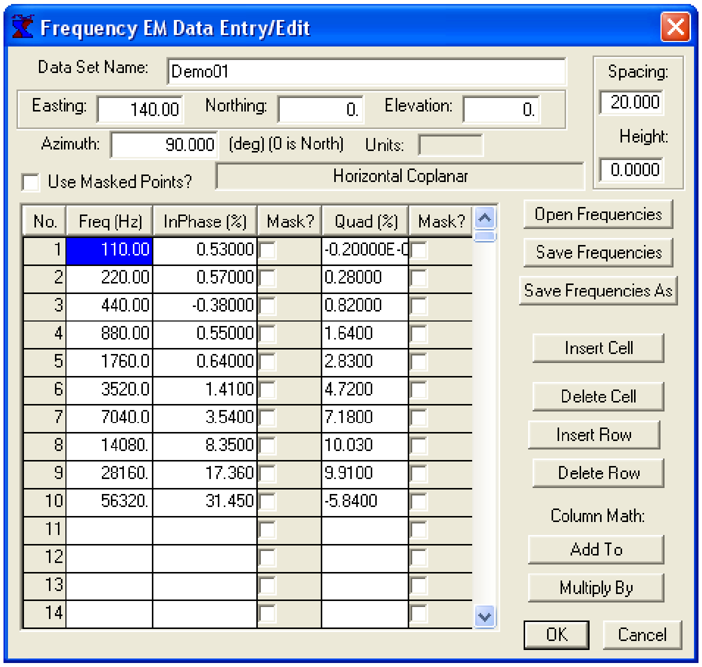
Insert Cell inserts a cell at the current location and shifts other cells down. **Delete Cell** deletes the cell which has the focus and shifts cells up. **Insert Row** inserts a row of cells and **Delete Cell** deletes a row of cells, at the current row that contains the cell which has focus.

Column Math allows for addition (subtraction) or multiplication from the cell containing the focus downwards. **Add To** adds a number to this cell and all others downwards (use a negative number to subtract). **Multiply By** multiplies by a value from the current cell downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Paste for more details.

Editing FEM (MaxMin) Data

The spreadsheet for Frequency EM data contains 6 columns in the data grid. The first is the data index which cannot be edited:



No.	Freq (Hz)	InPhase (%)	Mask?	Quad (%)	Mask?
1	110.00	0.53000		-0.20000E-0	
2	220.00	0.57000		0.28000	
3	440.00	-0.38000		0.82000	
4	880.00	0.55000		1.6400	
5	1760.0	0.64000		2.8300	
6	3520.0	1.4100		4.7200	
7	7040.0	3.5400		7.1800	
8	14080.	8.3500		10.030	
9	28160.	17.360		9.9100	
10	56320.	31.450		-5.8400	
11					
12					
13					
14					

The second is the Sounding Parameter value, which is dependent on the sounding type. Normally this would be Frequency, but it could also be coil spacing or height.

The third is the in-phase value, expressed as a percent (or ppm) of the primary field. This is the secondary field only; the primary field is expected to have been removed by the instrument.

The fourth is the mask flag for in-phase data. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

The fifth is the quadrature value, expressed as a percent (or ppm) of the primary field. This is a secondary field only as the primary field is always in-phase.

The sixth is the mask flag for quadrature data. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

There is an arbitrary limit of 1000 data points.

Soundings are usually parametric (vs. frequency) and in this case there is a single spacing and coil height specified for the entire sounding. In case of a geometric sounding, the second column would be coil spacing and a single frequency and height would be specified for the entire sounding.

Data columns 2, 3 and 5 must be of equal length and all data values must be filled in.

Several buttons on the right side if the dialog allow additional functionality. The **Open Geometry** button will ask for a file name and then read the frequency values from a previously stored geometry. **Save Geometry** will save the existing geometry and **Save Geometry As** will save the existing geometry under a new name. Files are named with extensions .GEO.

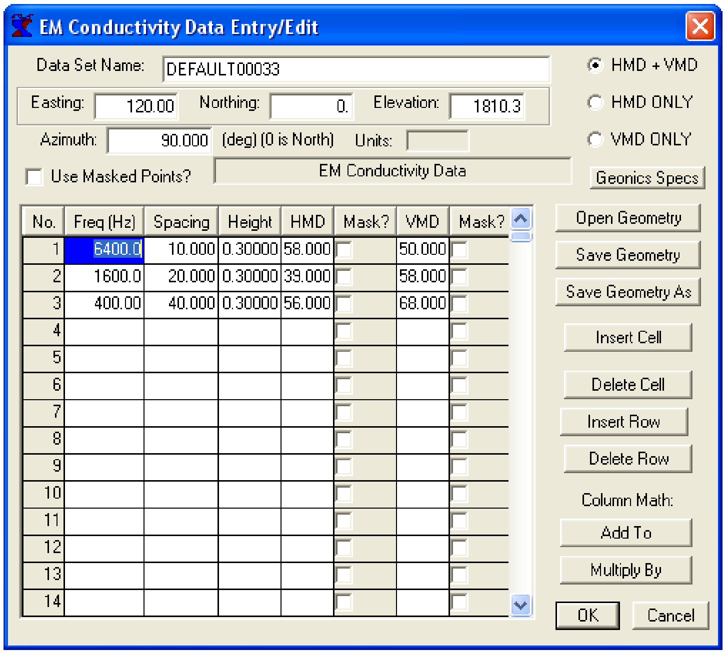
Insert Cell inserts a cell at the current location and shifts other cells down. **Delete Cell** deletes the cell which has the focus and shifts cells up. **Insert Row** inserts a row of cells and **Delete Cell** deletes a row of cells, at the current row that contains the cell which has focus.

Column Math allows for addition (subtraction) or multiplication from the cell containing the focus downwards. **Add To** adds a number to this cell and all others downwards (use a negative number to subtract). **Multiply By** multiplies by a value from the current cell downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Paste for more details.

Editing EM Conductivity Data

The spreadsheet for EM Conductivity data contains 8 columns in the data grid. The first is the data index which cannot be edited:



The second is the Frequency in Hz, the third is the coil spacing and the fourth is the height of the instrument. Note that both coils are assumed to be at the same height above the ground.

The fifth is the value for the HMD (Horizontal Magnetic Dipole or vertical coplanar coils), expressed as an apparent conductivity in mS/m.

The sixth is the mask flag for HMD data. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

The seventh is the value for the VMD (Vertical Magnetic Dipole or horizontal coplanar coils), expressed as an apparent conductivity in mS/m.

The eight is the mask flag for VMD data. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

There is an arbitrary limit of 1000 data points.

Data columns 2, 3, 4, 5 and 7 must be of equal length and all data values must be filled in.

Several buttons on the right side if the dialog allow additional functionality. The **Open Geometry** button will ask for a file name and then read the frequency, spacing and height values from a previously stored geometry. **Save Geometry** will save the existing geometry and **Save Geometry As** will save the existing geometry under a new name. Files are named with extensions .GEO.

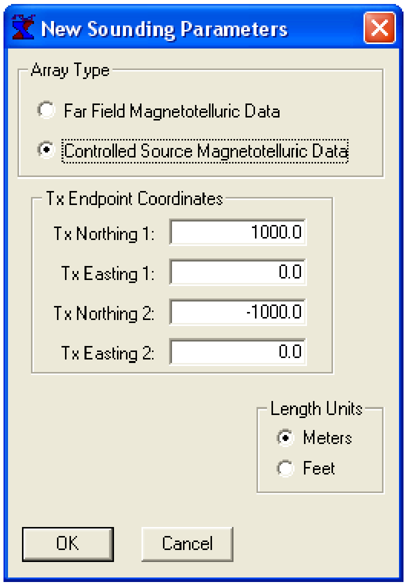
Insert Cell inserts a cell at the current location and shifts other cells down. **Delete Cell** deletes the cell which has the focus and shifts cells up. **Insert Row** inserts a row of cells and **Delete Cell** deletes a row of cells, at the current row that contains the cell which has focus.

Column Math allows for addition (subtraction) or multiplication from the cell containing the focus downwards. **Add To** adds a number to this cell and all others downwards (use a negative number to subtract). **Multiply By** multiplies by a value from the current cell downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Pastel for more details.

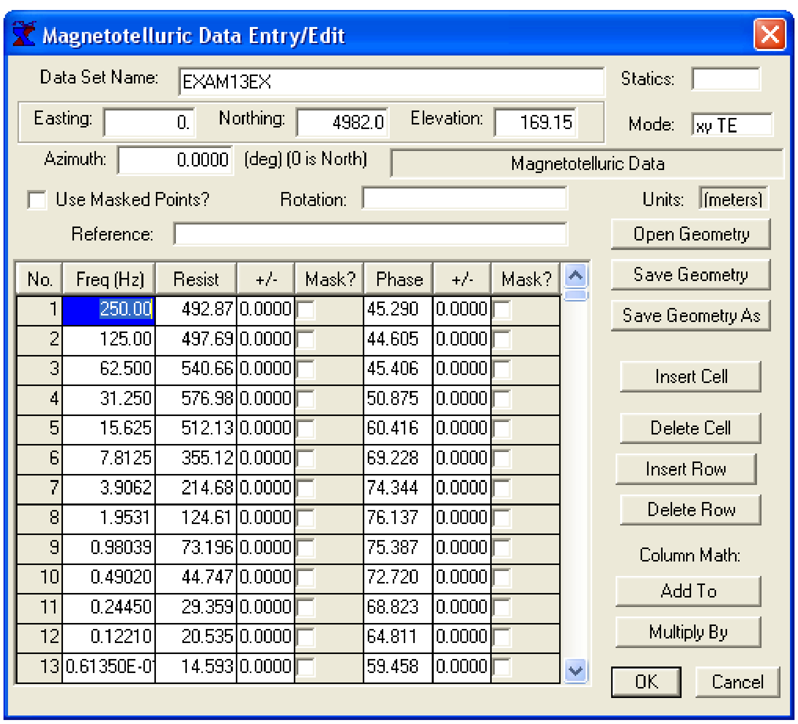
Editing Magnetotelluric Data

Before creating new MT data, there is a dialog which allows you to choose between far field MT and controlled source (CSMT or CSAMT) data:



For CSMT data, the positions of the transmitter electrodes must be specified.

The spreadsheet for Magnetotelluric data contains 8 columns in the data grid. The first is the data index which cannot be edited:



The second is Frequency.

The third is the Apparent Resistivity.

The fourth is the uncertainty in Apparent Resistivity, expressed as a percent of the data value

The fifth is the mask flag for Apparent Resistivity. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

The sixth is the Impedance Phase value, in degrees.

The seventh is the uncertainty in Impedance Phase, in degrees.

The eighth is the mask flag for Phase data. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

Additional fields allow for the statics, mode, azimuth, rotation and reference. These are notational only and do not have any effect on the calculations.

There is an arbitrary limit of 1000 data points.

Data columns 2, 3, 4, 6 and 7 must be of equal length and all data values must be filled in.

Several buttons on the right side if the dialog allow additional functionality. The **Open Geometry** button will ask for a file name and then read the frequency values from a previously stored geometry. **Save Geometry** will save the existing geometry and **Save Geometry As** will save the existing geometry under a new name. Files are named with extensions .GEO.

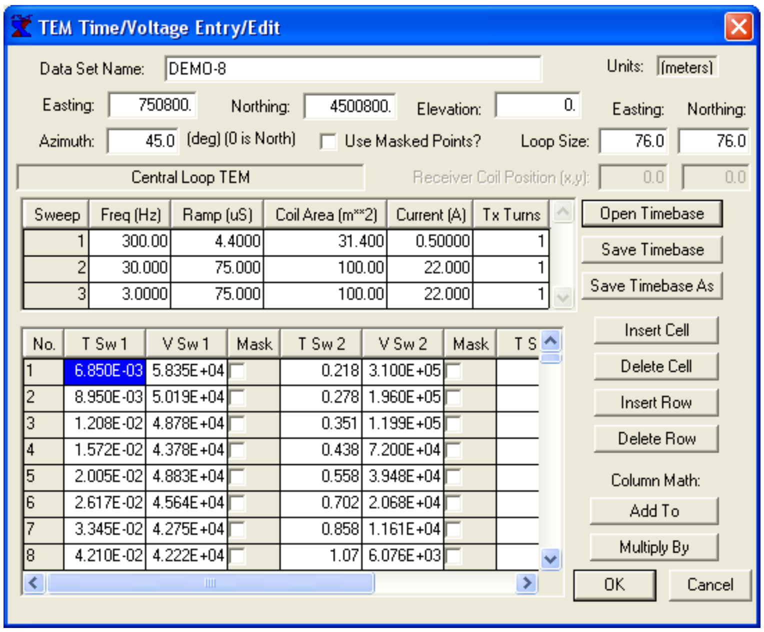
Insert Cell inserts a cell at the current location and shifts other cells down. **Delete Cell** deletes the cell which has the focus and shifts cells up. **Insert Row** inserts a row of cells and **Delete Cell** deletes a row of cells, at the current row that contains the cell which has focus.

Column Math allows for addition (subtraction) or multiplication from the cell containing the focus downwards. **Add To** adds a number to this cell and all others downwards (use a negative number to subtract). **Multiply By** multiplies by a value from the current cell downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Paste for more details.

Editing TEM Data

The data edtor for TEM data is more complex than the other data editors. In addition to the Data Set Name, E, N and Z coordinates and Azimuth, there is a Loop Size and a Receiver Coil Position and an additional spreadsheet for sweep parameters:



The loop size is the size of the TX loop in the selected units (m or ft). For Fixed Loop data, there is also a receiver coil position which is relative to the loop center. Entering 0. for both receiver coil positions in Fixed Loop is the same as selecting Central Loop data.

If the Tx loop contains more than one turn, enter the physical loop size of the Tx loop and multiply the actual current by the number of turns to get the effective current.

The Sweep Parameter Spreadsheet contains 5 columns. The first is the sweep number and cannot be edited.

The second column is the Tx frequency in Hz, the third is the ramp turn-off time in microseconds. The fourth is the effective area of the receiver coil and the fifth is the Tx current in Amps. For a multi-turn receiver coil the effective area is the actual area times the number of turns. This information is normally supplied by the equipment manufacturer.

The data spreadsheet for TEM data contains 4 columns in the data grid for the first sweep and two additional columns for each additional sweep. The first is the data index which cannot be edited.

The second is Time for the first sweep.

The third is the Voltage for the first sweep.

The fourth is the mask flag for Voltage. If the mask flag is set, this data point will not be used in error calculations, in model estimation or inversions unless the checkbox "Use Masked Points?" is set.

The fifth, sixth and seventh columns are the Time, Voltage and Mask Flag for the second sweep, and so on..

There is an arbitrary limit of 1000 data points.

Data columns for each sweep must be of equal length and all data values must be filled in. That is to say that columns 2 and 3 must be the same length, columns 5 and 6 must be the same length, and so on.

Sweep times are saved and retrieved using the **Open Timebase**, **Save Timebase** and **Save Timebase As** buttons. Times are loaded for the sweep which contains the focus. A position in one of the time columns must have focus in order to use this feature. Times are loaded always beginning with the first time position in the sweep.

Insert Cell inserts a cell at the current location and shifts other cells down. **Delete Cell** deletes the cell which has the focus and shifts cells up. **Insert Row** inserts a row of cells and **Delete Cell** deletes a row of cells, at the current row that contains the cell which has focus.

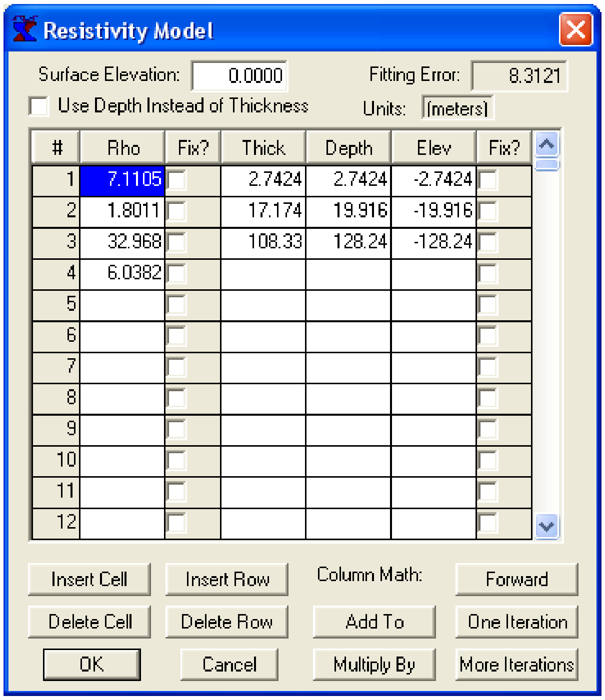
Insert Row and **Delete Row** are performed only on the sweep containing the focus.

Column Math allows for addition (subtraction) or multiplication from the cell containing the focus downwards. **Add To** adds a number to this cell and all others downwards (use a negative number to subtract). **Multiply By** multiplies by a value from the current cell downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Paste for more details.

Editing the Model

The Edit Model spreadsheet is designed to be used as an interactive way of fitting the data to a model. The top section allows for the editing of the surface elevation and the selection of use of Depth, rather than Thickness, as a model parameter:



Selecting the cell to be edited can be done with the mouse or the keyboard. Clicking in the cell positions the cursor inside the numeric string. Double clicking selects the number for replacement with the newly entered number. The Tab key moves to the next cell to the right. The shift-tab combination moves to the next cell to the left. Up/Down arrow keys move one cell up or down, right/left arrow keys move through the characters in the field and ultimately to the next cell, left or right.

Using the enter key executes the Forward function.

Use of depth as a model parameter instead of thickness allow you to fix the depth to the bottom of a layer to match a known depth from a drill hole or other data, without having to fix the thicknesses above it.

The spreadsheet shows seven columns (eight for IP models). The first is the layer number and is not editable.

The second is the layer resistivity. This column should be one element longer than the thickness, depth and elevation columns described below.

The third column is the Fix flag for the resistivity. If a box in this column is checked, the resistivity of the corresponding row will not be changed by the inversion.

If IP data are present, the third is the intrinsic layer IP value and the fourth is the fix flag for IP. If a box in this column is checked, the IP value of the corresponding row will not be changed by the inversion.

The fourth through sixth columns (sixth through eighth if Resistivity/IP data are loaded) show the layer thickness and the depth and elevation to the bottom of the layers. These three columns show the same information in three different forms. Editing one of these values will result in a correction of the other two.

The seventh column (ninth if Resistivity/IP data are loaded) is the Fix flag for the thickness or depth (depending upon the state of the check box at the top). If thickness is selected as the layer parameter, then the thickness of the layer will be held constant, although its depth can change. If depth is selected as the layer parameter, then the depth of the layer will be held constant, although its thickness can change.

Columns four through six (four and six through eight if Resistivity/IP data are loaded) should all be of the same length and one entry shorter than that of the resistivity. This is because the last layer is semi-infinite and has no bottom.

There is an arbitrary limit of 1000 layers in the model.

Entire rows can be inserted or deleted using **Insert Row** or **Delete Row**. The row containing the cursor is the row to be deleted. The current row moves downwards after an insert operation and it is also duplicated at its present position.

Single cells can be inserted or deleted using **Insert Cell** or **Delete Cell**. this is especially useful if you have entered data manually and skipped a row somewhere in one of the columns. The insertion or deletion is done at the cell containing the cursor.

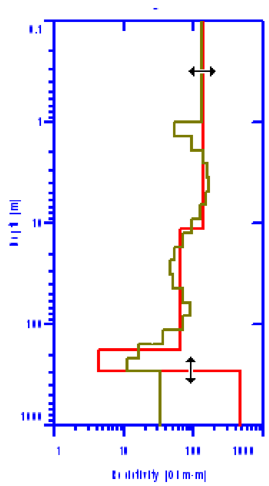
Column math can also be carried out using the **Add To** or **Multiply By** buttons. **Add To** adds whatever constant you specify to the contents of the column containing the cursor from the cell containing the cursor downwards. **Multiply By** multiplies whatever constant you specify times the contents of the column containing the cursor from the cell containing the cursor downwards.

Data can be copy/pasted from elsewhere using the Windows clipboard, either to individual cells, dialog entries or spreadsheet columns or sections. Please see Using Copy/Paste for more details.

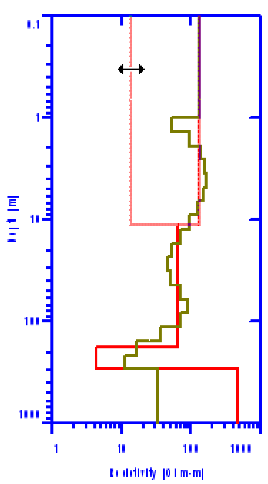
Calculations can also be carried out from within the Edit Model spreadsheet. Buttons are provided for Forward Calculation and for Inversion, using either a single iteration or iteration until convergence.

Graphical Model Editing

The mouse can be used to drag the model in the Sounding window. Position the cursor on a layer resistivity or on a layer boundary, verify that the cursor has changed to a double arrow:



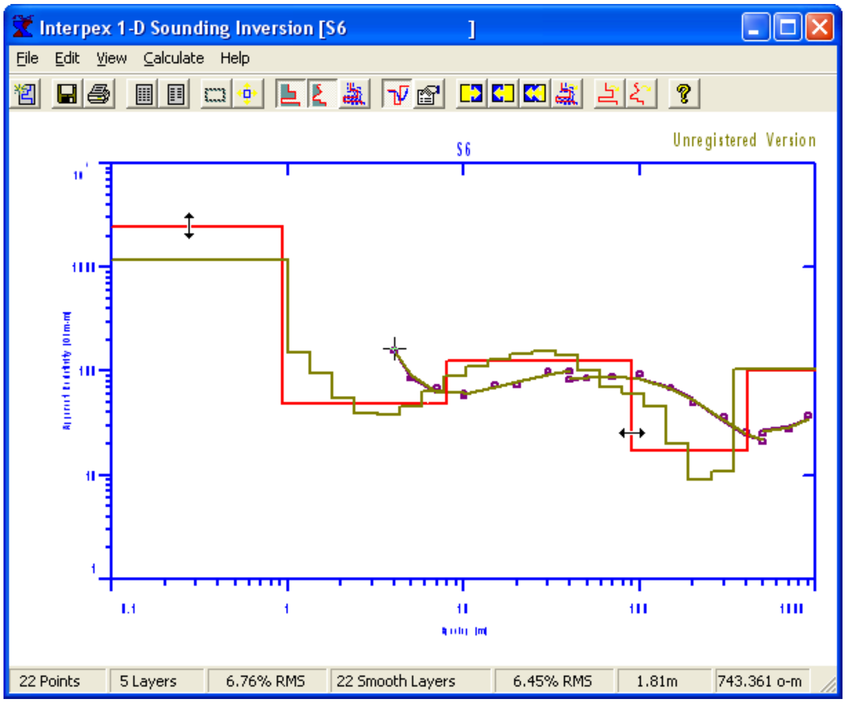
Depress the left button and drag the layer resistivity or layer boundary to a new location:



Doing this will cancel any inversion or equivalence analysis results. When the button is released, the synthetic curve will be automatically updated with a new forward calculation.

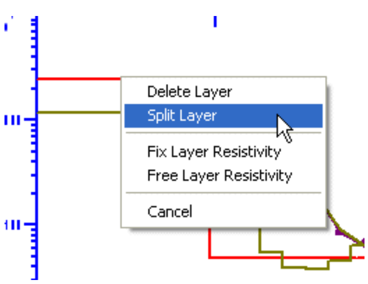
This works regardless of the state of the View/Zoom menu item. To zoom the model, depress the mouse button while the cursor is in the normal arrow mode.

For DC data, the model can be displayed on the same axes with the data. In this case the cursor behavior depends on whether the mouse is pointed at a data point or a model value:



In the Sounding display, when the mouse cursor is positioned correctly to edit a resistivity or IP value, the cursor will change from the normal pointer to a horizontal double arrow (vertical double arrow for model plotted on the same display with data). When the mouse cursor is positioned correctly to edit a depth value, the cursor will change from the normal pointer to a vertical double arrow (horizontal double arrow for model plotted on the same display with data). Note that for IP data, the depths can only be edited on the resistivity display. Only the IP value of the layer can be edited on the IP display.

The mouse can also be used to split layers or delete layers from the model. Position the mouse on the layer resistivity, verify that the cursor has changed to double arrow and click the right button. This brings up a menu offering you the chance to split or delete the selected layer, or to Fix or Free the layer resistivity or thickness at which you are pointing:



Splitting the layer makes what used to be a single layer into a double layer of nearly the same resistivity. Deleting the layer removes the layer and collapses the model if thicknesses are being used. If depths are being used (See Edit Model), the layer boundary is removed but the other boundaries are not adjusted.

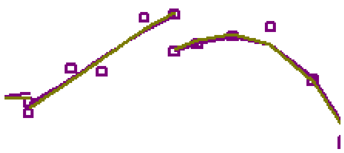
Shifting Data Segments

Shifting of data segments is only available for Schlumberger data.

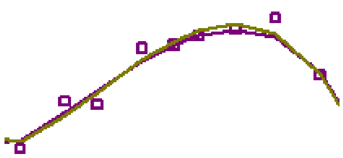
Schlumberger data are almost always taken with overlapping segments. At the shortest spacings, a value of MN is selected and AB is increased until the signal becomes weak. Then MN must be increased in order to continue expanding AB.

Even in a layered earth, there will be some difference in the apparent resistivity derived from two different MN spacings for a single AB spacing. In practice, however, the difference is much greater due to the fact that the near surface, particularly, is not laterally homogeneous.

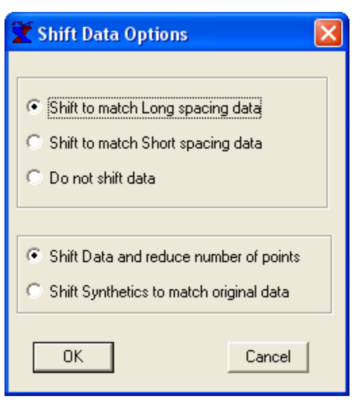
In IX1D, shifting Schlumberger data is not necessary. IX1D detects the shifts in the overlapping segments and introduces this shift into the calculations. This has almost exactly the same effect as shifting the data but preserves the shifts and the original data:



However, if data and model fits are to be shown to persons who are not trained geophysicists, it may be desirable to shift the data to remove the offsets due to changing MN spacings:

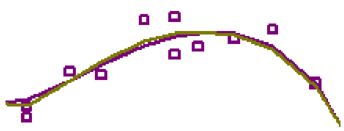


Selecting the menu item Edit Shift Data Segments uses the shifts which have already been determined to shift the data. Overlapping points are combined into a single data point:



Normally it is better to shift the data to match the longer spacings, as they average over more geology than the other spacings, so this is the default. To shift the data, select "Shift Data and reduce number of points".

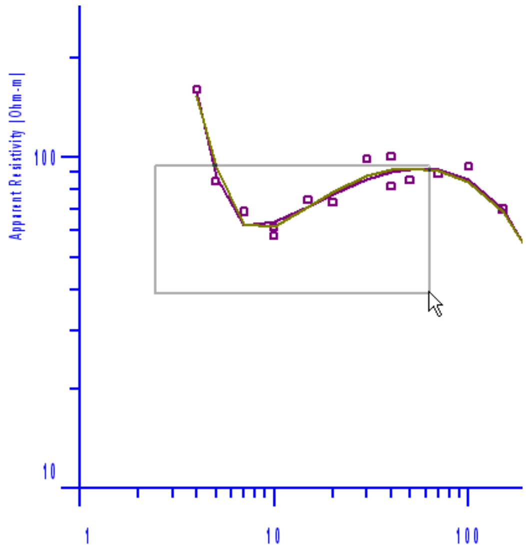
To ignore the shifts, select "Do not shift data" in the upper group and "Shift Synthetics to match original data" in the lower group. Now the shifts will be ignored:



Zooming Displays

Selecting the Zoom menu item toggles its checked state. This sets the zoom state for all displays.

If the Zoom menu item is checked, then the graphical displays can be adjusted using a rubber band box to zoom in or out. Point the mouse cursor at one corner (for example, the upper left) of the desired display area. Press the left button, hold it and drag the mouse to the opposite corner (for example, the lower right) of the desired display area:



Release the button to display.

For the Map window, there is only one graph to zoom. The graph is always scaled so there is no exaggeration of either axis, that is, the scale of both the x- and y-axes (in window units) is the same.

For the Profile window, the horizontal scale is shared by all graphs. The graph in which the mouse button is first depressed is the zoomed display. If the mouse button is depressed outside the graphs, the zoom is applied to the graph which contains the center of the zoom box.

For the Sounding window, this works for either the data or model area(s). In the case of two data or two model graphs, the common axes are scaled together.

For the Well Log window, this works for either the well log or the cumulative conductance graph. Both vertical scales are adjusted together.

For logarithmic graphs, the selected area will be auto-scaled upwards so that all decades which appear in the selected area will be included in the display. The smallest area that can be displayed is a single decade by a single decade. For linear graphs, the axes are scaled upwards to create reasonable axis increments.

Using the View Zoom menu command (or the tool bar button) toggles the state of the zoom. When the Zoom menu item is not checked, dragging the mouse with the left button depressed can be used to create profiles in the Map window or to edit the model graphically in the Sounding window.

Auto-Scaling Displays

Unzoom auto-rescales the graphical displays. If selected from the map window, the map is rescaled and the scales are chosen so there is no exaggeration of one axis over the other.

If selected from the Profile window, all graphical displays are auto-rescaled. Note that the horizontal axis is shared among all displays.

If selected from the well log window, both well log and cumulative conductance are rescaled.

In the case of the sounding window, both data and model displays are rescaled.

For the case of models and data displayed separately, All available data and synthetics are examined and the data plot scales are selected so that all data and synthetics will be displayed. Synthetics which are available but not plotted because of their flags being turned off (unchecked) are not used.

For the case of models and data displayed separately, All available models are examined and the model plot scales are selected so that all models will be displayed. Models which are available but not plotted because of their flags being turned off (unchecked) are not used. For instance, if data have been inverted and equivalence has been analyzed, but the Equivalence menu item is not checked, the equivalent models will not be used to scale the model display.

For the case of models and data being plotted on the same display (Model On Data), All available data and models which are currently selected for display are used to determine the axis range for the combined axis.

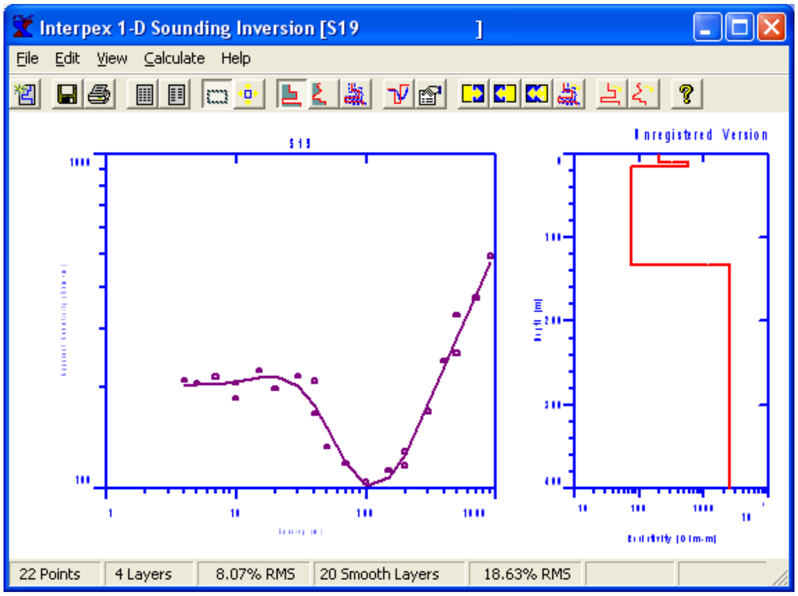
Unzoom is automatically applied when data are imported, entered manually, edited, when the Model On Data flag changes status, and when the smooth model is estimated.

Note that for MT, CSMT and Circular Loop Hz data, the phase display in the sounding window is always auto-scaled to be from 0 to 90 degrees.

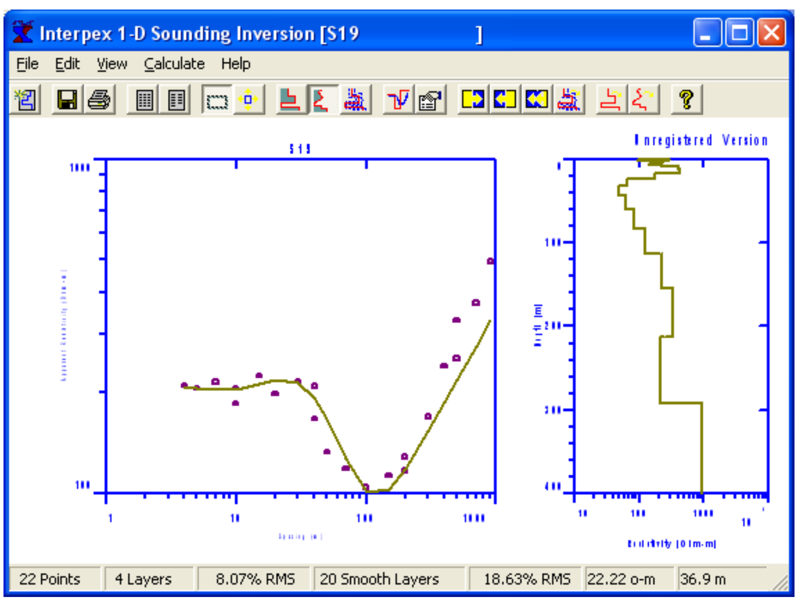
Sounding Display Flags

There are three flags which control the data which are displayed on the graphic display.

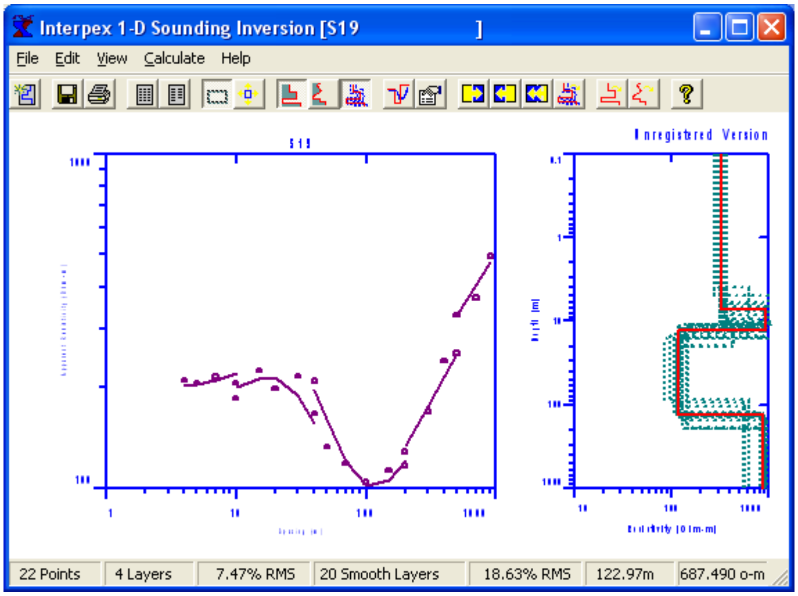
If **Layered** is checked, the layered model will be displayed on the model display and the synthetic, if available, will be displayed on the data display:



If **Smooth** is checked, the Smooth model will be displayed on the model display and the synthetic, if available, will be displayed on the data display.



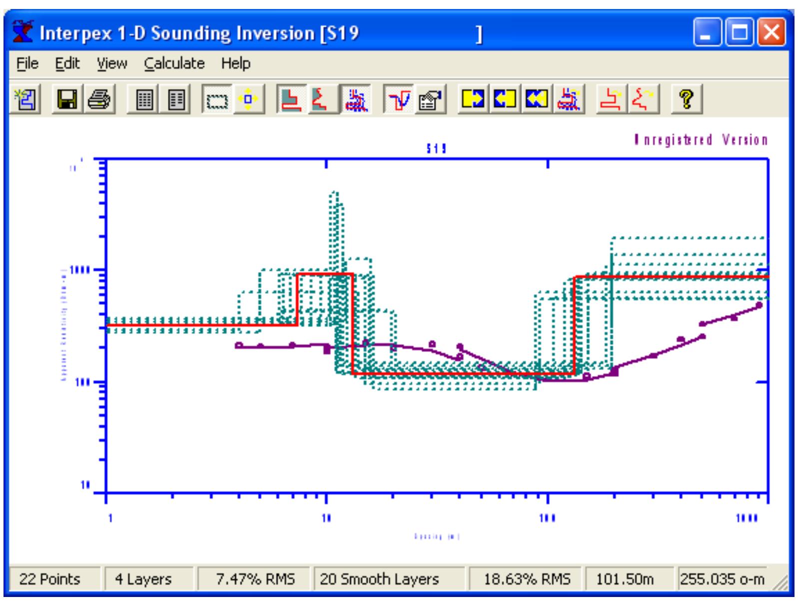
If **Equivalence** is checked, the Equivalent models will be displayed on the model display, provided that **Layered** is checked:



Checking more than one flag will display more than one type of model and synthetic.

Also if these flags are checked and Unzoom is used, the models and available synthetics may affect the axis scaling.

If **Model on Data** is checked, the model will be displayed on the same axis as the data:

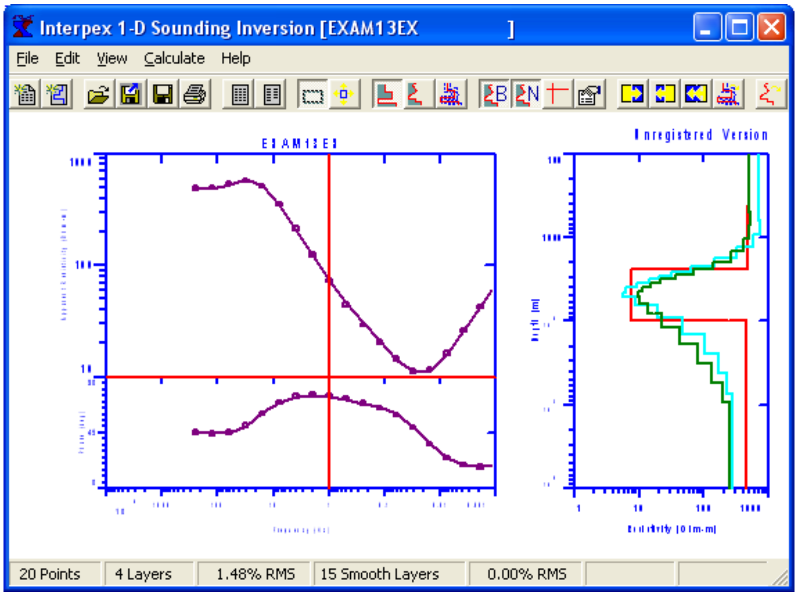


In this case, the Spacing axis is used for depth and Apparent Resistivity doubles as intrinsic resistivity. For Dipole-Dipole arrays where the "n" spacing is used, the depth axis for the model is "n" times the dipole spacing. For EM Conductivity data, the Effective Penetration Depth axis doubles as a true depth axis and the Apparent Conductivity axis doubles as an intrinsic resistivity axis.

This is not available except for DC Resistivity (with IP) and EM Conductivity data.

If **Linear Model** is checked, the model will be displayed in the sounding window with a linear depth axis, instead of the normal logarithmic depth axis. Toggling the state of **Linear Model** will autoscale the model display.

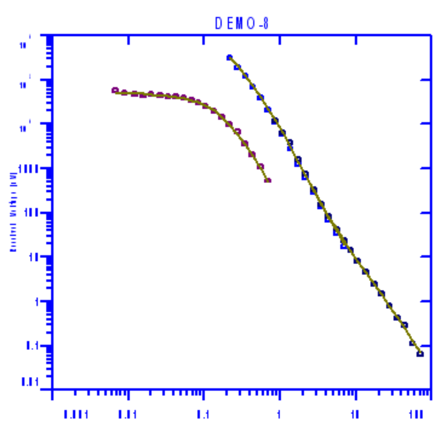
Additional View options for Magnetotelluric data are the **Bostick** (Bostick, 1977) and **Niblett** (Niblett and Wittgenstein, 1960) models and the **Redline 1 Ohm-m, 10 Hz**, which are derived directly from the data:

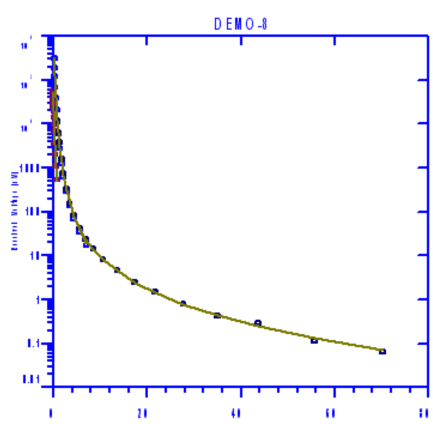


These models do not have a corresponding synthetic curve and can be useful as a guide to editing or creating the layered model.

Additional View options for TEM data are **Voltage** and **Linear Time Scale**. **Voltage** displays voltage, rather than late time apparent resistivity for TEM Data. The voltage can be viewed on a log or linear time scale. Linear time scales are useful to check for exponential decays. Selecting **Linear Time Scale** automatically turns on **Voltage**. Deselecting **Voltage** automatically deselects **Linear Time Scale**.

If different sweeps have different coil areas or currents, they will not merge together. Here is a log time scale plot followed by a linear time scale plot:





The status of these flags is stored in the IX1D.INI file in the program directory.

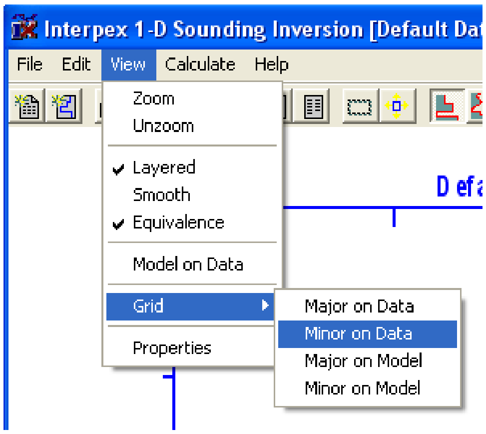
These flags exist also for profiles and they are independent of the flags for soundings. They affect the "Zaborovsky" type sounding and model displays in the same way as for individual soundings. For depth and elevation displays, the Equivalence flag is not used. If the Smooth flag is checked, the smooth models will be displayed, otherwise the layered models are displayed.

Data Pseudosection displays show only the data and these flags have no affect on Pseudosection displays.

Grid Lines on Graphs

Major or Minor Grid lines can be drawn on the Map graph in the main window, on the Data or Model displays in the Profile Window, on the data and/or model graphs in the Sounding window or on the Well Log graph or the cumulative conductance graph in the well log window. These are designed as an aid to determining where data points lie.

Clicking on View -> Grid -> Major on (Map, Log, Conductance, Data or Model) will toggle the state of the major grid line display on the selected plot. In case of displays with log axes, major grid lines are drawn for the full decades of resistivity (or conductivity) and spacing and minor grid lines are drawn on the minor log-spaced ticks:



If Major and Minor grid lines are selected on data and Major on Data is de-selected, the minor grid lines will also be de-selected. If Minor grid lines are selected and Major is de-selected, Major grid lines will also be selected.

If there is more than one data or model display (for instance, with MT resistivity and phase or DC resistivity and IP), the grid lines selected will be drawn on all displays for either the model or data.

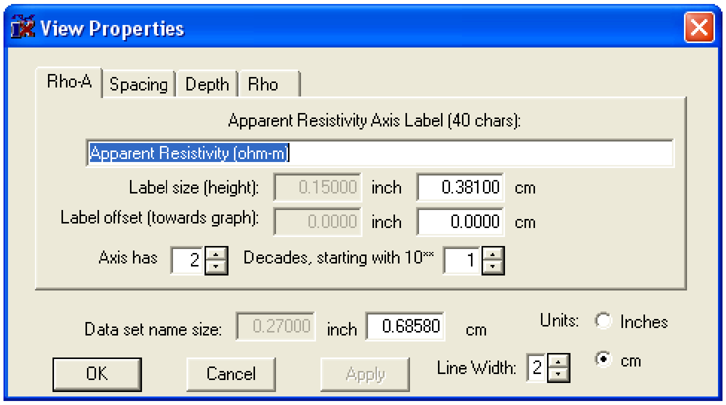
You can use View/Properties to change the number of minor tick marks. Remember, the major grid line is also one of the minor ones, so that the smallest number of minor tick marks available is 1. If you select 5 minor divisions per major division on a linear plot, you will get 4 minor grid lines drawn and one covered by the major one.

Line Colors for Graphs

Invoking View/Colors from any of the windows brings up a dialog allowing the colors to be edited:

View Properties for Graphs

Selecting View -> Properties or right clicking on the graphics display will bring up the View Properties dialog box with four tabs:



For DC Resistivity data, the first two tabs are for the Apparent Resistivity axis (vertical axis on the data plot) and the Spacing axis (horizontal axis on the data plot). Both axes are logarithmic.

For MaxMin data, the first two tabs are for the In-Phase and Quadrature (vertical axis on the data plot) and the Frequency axis (horizontal axis on the data plot). The In-Phase/Quadrature axis is linear, while the Frequency axis is logarithmic.

For EM Conductivity data, the first two tabs are for Apparent Conductivity (vertical axis) and the Effective Penetration Depth (horizontal axis). The Effective Penetration Depth is calculated from the geometry of the system and assumes that the frequency is low enough that it does not unduly influence the penetration depth. This is calculated following McNeill (1980, eq 11-14, fig 6) so that approximately 2/3 of the response comes from above this depth and 1/3 comes from below, similar to the so-called "skin depth".

If IP data are present or in the case of MT data, the third tab is the for the second data axis (IP value or phase, respectively)

For most data, the third and fourth tabs are for the model; the Depth axis (vertical axis on the model plot) and the Resistivity axis (horizontal axis on the model plot). Each tab contains the Axis label, label size and label position in both inches and cm. Labels are centered on the axis but can be moved toward or further away from the axis. For EM Conductivity data, the model shows Conductivity in mS/m rather than Resistivity in Ohm-m. Conversion between the two is by dividing into 1000.

For MT data, these are the fourth and fifth tabs. For IP data, there are two tabs for layer properties, one for Resistivity and a second for IP value. Both the IP and phase axes are linear.

Also shown is the number of decades for the axis and the starting decade.

Other Editing Pointers:

In the lower right corner of the dialog box is a radio button selection for inches or cm. If inches is selected, then only fields in inches can be entered and this will update the cm fields. If cm is selected, then only fields in cm can be entered and this will update the inches fields.

Editing a field in inches or cm and moving the focus to a different field will update the corresponding (cm or inches) field.

The size of the data set name label is shown under the tabbed dialog in both inches and cm. Next to it is the line width. 1 is the thinnest line possible.

Three buttons are available: OK, Cancel and Apply.

Pressing OK takes the data as displayed and makes it permanent, redrawing the display with the current parameters and closes the dialog. Data are drawn from the fields according to the inches/cm radio button selection.

Pressing Cancel leaves the display as is, without changing the parameters to the currently displayed values. However, if Apply has been used, then the present values will be the ones existing at the last use of Apply.

Pressing Apply takes the data as displayed and makes it permanent, redrawing the display with the current parameters, but does not close the dialog. Data are drawn from the fields according to the inches/cm radio button selection.

Forward Modeling

Forward modeling is initiated by invoking the Calculate Forward menu command, by pressing the forward toolbar button or by pressing the Forward button in the Edit Model dialog. It is also used in combination with the inversion and the estimate commands. The synthetic data are displayed on the graph as lines.

Forward modeling is carried out using linear filters in a manner similar to that described by Davis, et al (1980), except that we are using a 283 point adaptive linear filter from Anderson (1979). This takes the spacings which describe the data set and the model specified and generate a synthetic response.

For Schlumberger data, the offsets between different segments is not removed from the data, but is instead introduced into the synthetics. These offsets occur for overlapping segments where several data points are taken with the same AB/2 values but different MN values. The offsets can be partially due to phenomena related to layered media responses but are in many cases more likely caused by variations in the electrical properties of the ground in the near surface where the potential electrodes are planted.

The RMS fitting error shows the degree to which the model fits the data. The error is calculated by first summing the squares of the log errors and dividing by the number of points to get the RMS logarithmic error. This is created to a percent error by taking the antilog, subtracting 1 and multiplying by 100. This manner of calculating the RMS error weights low resistivity values equally as much as it weights high resistivity values, which is important.

Masked points are not used in the calculation of the fitting error. The fitting error is displayed on the window status bar as a percent error.

Inversion Calculations

Inversion is carried out using the Calculate Inverse commands, single iteration or multiple iterations. Inversion is also carried out as part of the smooth model estimation.

Inversion is a least squares fitting of nonlinear parameters. This is done by assuming that the forward problem is locally linear. Thus, the forward problem is replaced by a matrix operation

o = c + A dp

where **c** is the result of forward calculation using the current model, **o** is the set of observed data, **A** is the Jacobian matrix of partial derivatives and **dp** is the desired model improvement which would make the data fit the observations in the ideal case.

A is calculated by perturbing each of the layer parameters in turn and carrying out a forward calculation. Each calculation gives a row of the matrix. Parameters which are fixed are not perturbed and those columns are set to zero.

The inversion is carried out using Ridge Regression in a manner similar to that described by Inman (1975). For each iteration, a model correction is calculated using the best damping factor available for that iteration.

For single iteration commands the process is repeated only once. For multiple iterations, the process is repeated and continued until the reduction in fitting error from the previous step is too small to be of further use.

For Resistivity/IP data, there are two additional options each for single and multiple iterations: Resistivity Only and IP only. The former temporarily fixes all IP model parameters while inverting for resisitivity only and the latter fixes all model resistivity values while inverting for IP only. The original fix/free states of these parametes are restored upon completion.

For smooth modeling, all layer thicknesses are fixed and only the resistivities are adjusted to fit the data. In this case, if the Occam flag is set, Occam's inversion, which minimizes the roughness of the model, is used instead of Ridge Regression.

In the case of Resistivity/IP data, the IP estimates are taken as the average of the data IP values, and these are fixed until three iterations of resistivity inversion have been carried out. Then the IP values are allowed to be adjusted by the inversion.

Automatic Model Estimation

Automatic estimation of a layered model is only available for Resistivity and Resistivity/IP data.

Automatic estimation of a layered model is carried out in a manner similar to that described by Koefoed (1976). In this manner the original data are taken and (in the case of Schlumberger) they are shifted to make one continuous curve. This curve is then extended on both ends and Hankel transformed to the Hankel wavenumber domain where the shape of the curve is more directly related to the layered model.

The curve is then analyzed to determine the number of layers present and the resistivities and thicknesses in the model. Then forward modeling is used to calculate the synthetic curve from the estimated model for comparison with the original data.

This process is also known as Direct Inversion.

Equivalence Analysis

The principle of equivalence states that a model which fits the data is not the only possible model which will fit the data. In a perfect world, where a resistivity curve is sampled continuously over spacings from zero to infinity with no measurement errors, the layered model which perfectly fits these data would be unique. However, resistivity soundings are not sampled continuously, they are sampled over a limited range, and they are subject to both measurement errors and geologic noise.

Other types of data suffer the same undersampling as well, in particular EM Conductivity soundings are notorious for being undersampled.

Equivalence analysis attempts to illustrate the degree to which the model can vary from the best fit model and still provide almost the same fit to the data. It assumes linearity and does not show the complete range of possible models; it is intended only to illustrate the constraints on parameter resolution.

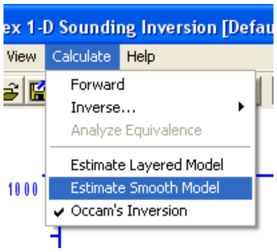
The Resolution Matrix is a by product of the inversion process. This matrix shows the linear combinations of the parameters which are resolved. This matrix is used as a guide in the equivalence analysis process in order to dictate which directions the model can (should be able to) be adjusted without affecting the fitting error. The adjustments are performed incrementally until the fitting error reaches 1.2 times the best fit error. This determines the range for this equivalent parameter. The test is carried out by both increasing and decreasing the parameter, so that for m parameters, 2m equivalent models are generated.

Parameters which are varied by a factor of 100 from their initial values are considered widely variable (not at all constrained) and the process is stopped at this point.

Fixed parameters are not used in the equivalence analysis.

Smooth Model Estimation

There are two ways to carry out the smooth model estimation. In the Calculate menu in the Sounding window, there is an item Calculate/Estimate Starting Smooth Model:



The smooth model inversion is carried out automatically by creating a model with the same number of layers, as there are data points with thicknesses related to the electrode spacings. Initially, all layers are given the same resistivity and this is the average value for all points in the data. All layer thicknesses are fixed.

For MT data, one layer is created for each pair of Apparent Resistivity and Phase pair. For Frequency EM or EM Conductivity data, two layers are created for each pair of In-Phase/Quadrature or HMD/VMD data.

For TEM data and Frequency EM data, several homogeneous earth models are tried as starting models and the best fit homogeneous half-space resistivity is used as a starting point. When executed from the profile window in quick batch mode, the user specifies the starting model, including number of layers, min and max depth and starting value for resistivity/conductivity.

Then, either Ridge Regression or Occam's inversion (Constable, et al, 1987; deGroot-Hedlin and Constable, 1990) is uses to repeatedly improve the model until 9 iterations are used up or until the improvement in fitting error is negligible from one iteration to the next. Occam's inversion is used if **Occam's Inversion** is checked in the calculate menu.

Ridge regression inversion trades off the size of the model improvement and the least squares error predicted from the linearized forward problem. Occam's inversion trades off the roughness of the model improvement and the least squares error predicted from the linearized forward problem. There is also a term which is derived from the roughness of the present model.

Masked values are not used either to estimate the initial resistivity nor in the inversion.

Occam's Inversion

The Occam's inversion flag allows you to switch the smooth model inversion between Ridge Regression and Occam's inversion.

Ridge regression attempts to best fit the data while minimizing the change in the model it must make to do so.

Occam's inversion attempts to best fit the data while minimizing the change in the roughness of the model.

Typically, Occam's inversion produces smoother results in the smooth modeling; however, the Ridge Regression option is offered for comparison or for cases in which the true earth model is not so smooth.

Using this menu command toggles the checked state of this menu item. If it is checked, Occam's inversion is being used, otherwise Ridge Regression is being used. Changing the state of this menu item discards any smooth model which may be present.

The Resolution Matrix

The Resolution Matrix is a by product of the inversion process. This matrix is essentially the inverse of **A** times **A**. Since **A** is normally not square (there are generally more data than parameters) and is ill-conditioned, it does not have a true inverse, but a pseudo inverse. The better the conditioning of **A,** the closer the Resolution Matrix will be to the Identity matrix, **I**.

The Resolution matrix shows the linear combinations of the parameters which are resolved. If the matrix is the Identity matrix, **I**, then all parameters are resolved. If the diagonal element of the matrix corresponding to a particular parameter is 1 and all other elements on that row (or column - the matrix is symmetric) are zero, then that parameter is resolved.

If the diagonal element of the matrix corresponding to a particular parameter is 0.5 and another element on the row or column is 0.5 or -0.5, then these two parameters are interdependent. This occurs most often with thin layers where only the resistance or conductance of the layer is resolved, or where the spacing range used to acquire the data is insufficient to resolve a surface or deep layer.

In the case where a resistivity parameter has a diagonal of 0.5 and the corresponding thickness on that same row shows a value of 0.5, then the product of these two parameters is known, but the resistivity and thickness themselves are not known. This is known as resistance equivalence since the product of the resistivity and thickness is the Transverse Resistance of the layer.

In the case where a resistivity parameter has a diagonal of 0.5 and the corresponding thickness on that same row shows a value of -0.5, then the quotient of these two parameters is known, but the resistivity and thickness themselves are not known. This is known as conductance equivalence since the quotient of the resistivity and thickness is the Longitudinal Conductance of the layer.

Sometimes layers are thin but not thin enough to be exactly equivalent in the manner just described above. In this case, equivalent models may require some adjustment of the overlying and/or underlying layers in order to preserve the goodness of fit.

The surface layer or half-space may not be resolved if the shallow (short spacing, early time, high frequency) or deep (long spacing, late time, low frequency) asymptote is not reached by the data.

The Resolution Matrix is available in the Sounding Window printout.

Help Contents

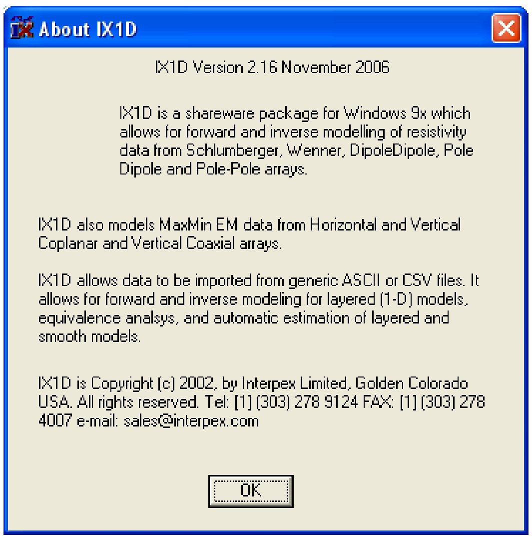
The Help Contents command displays this help file and allows the user to read it using the Microsoft Help System.

If Help is requested from the main map window, the Help Contents is shown, positioned at the very beginning.

If Help is requested from another window, the Help Topic for the section pertaining to that window is shown. However, the entire help file contents is still available by pressing the Help Topics button.

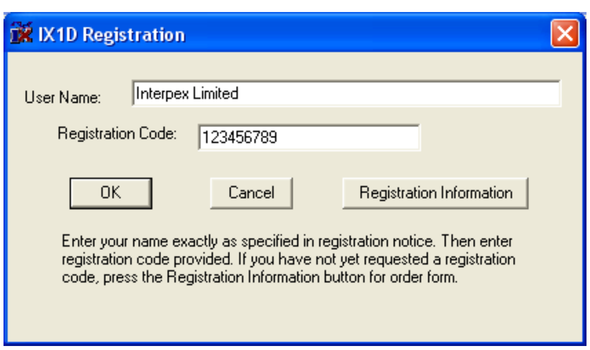
Help About

Help About displays the version and the date of the IX1D software packge, gives some brief description of what it does, displays the copyright notice and gives the phone number, fax number and e-mail address for Interpex:



Help Register

Help Register allows the package by entering a user name and a serial number. The serial number is obtained by furnishing a user name and payment in full of the license fee to Interpex, who will then send a registration code:



Please see also Help CPU RegisterIDD_CPUREGISTER for another method of registering IX1D.

The user name must be entered exactly as specified, including spaces, punctuation and case. The serial number must also be entered exactly as specified.

Entry of a valid username and serial number unlocks the package so it runs at full capability. Unregistered versions will only work with keyed data or with the demo data supplied for evaluation.

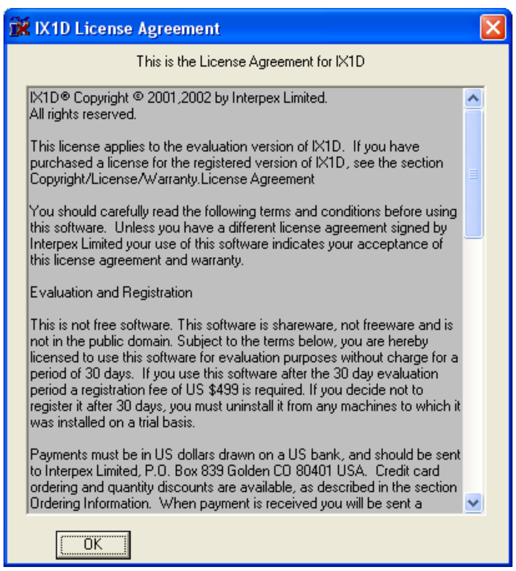
Note that MT data require a dongle for full capability.

Pressing the Registration Information button opens NotePad with the file Order.TXT which contains the order form you need to print out and send in with your payment. Alternatively, the form can be sent by FAX with a credit card number, or you can e-mail it and provide you credit card number by phone.

Do not send a credit card number in an e-mail!

License Agreement

Selecting Help/License Agreement shows the license agreement for IX1D in a scrollable window. By using this software, whether registered or not registered, whether with a dongle or with software key, licensed to a user or to a specific CPU, you are agreeing to and bound by the licence agreement:



Scroll down to read the entire licence agreement: