

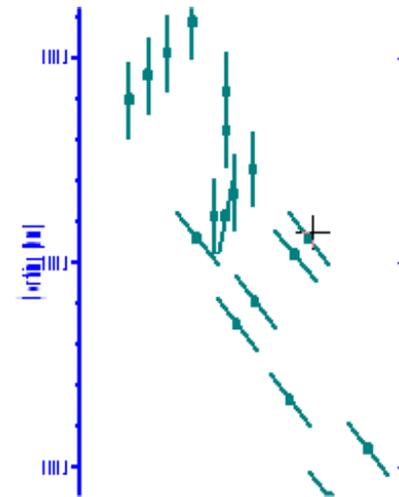
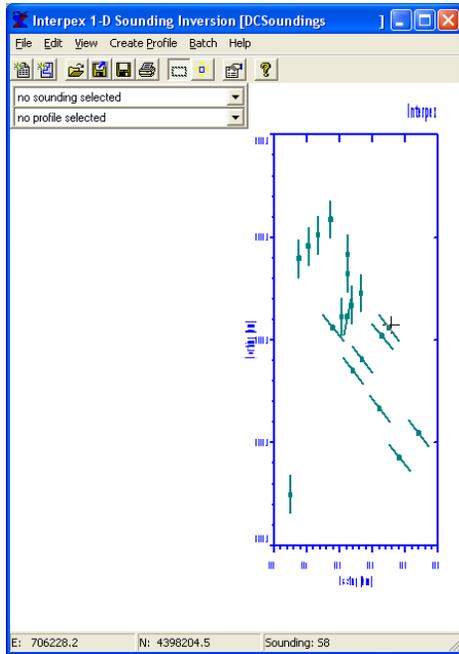
Interpreting Data in IX1D v 3 – A Tutorial

Version 1.0

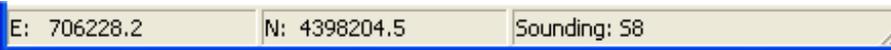
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Select a Sounding from the Map Display using the Mouse

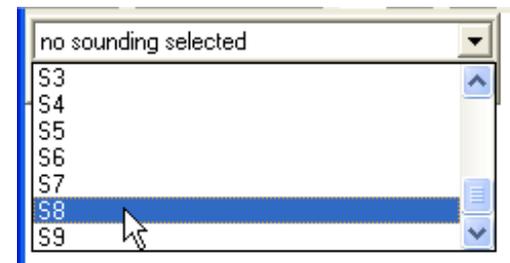
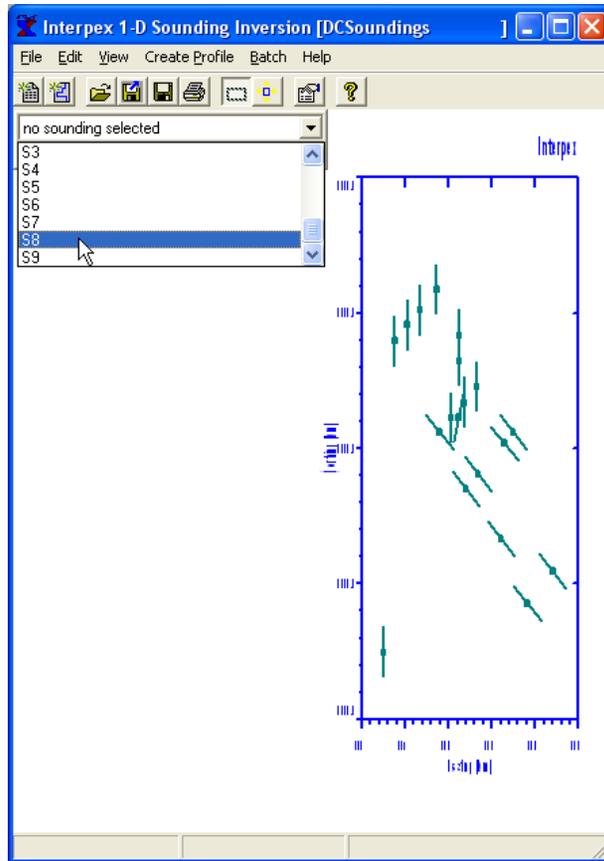


If you right-click on the sounding, there are more options given in the pop-up menu.



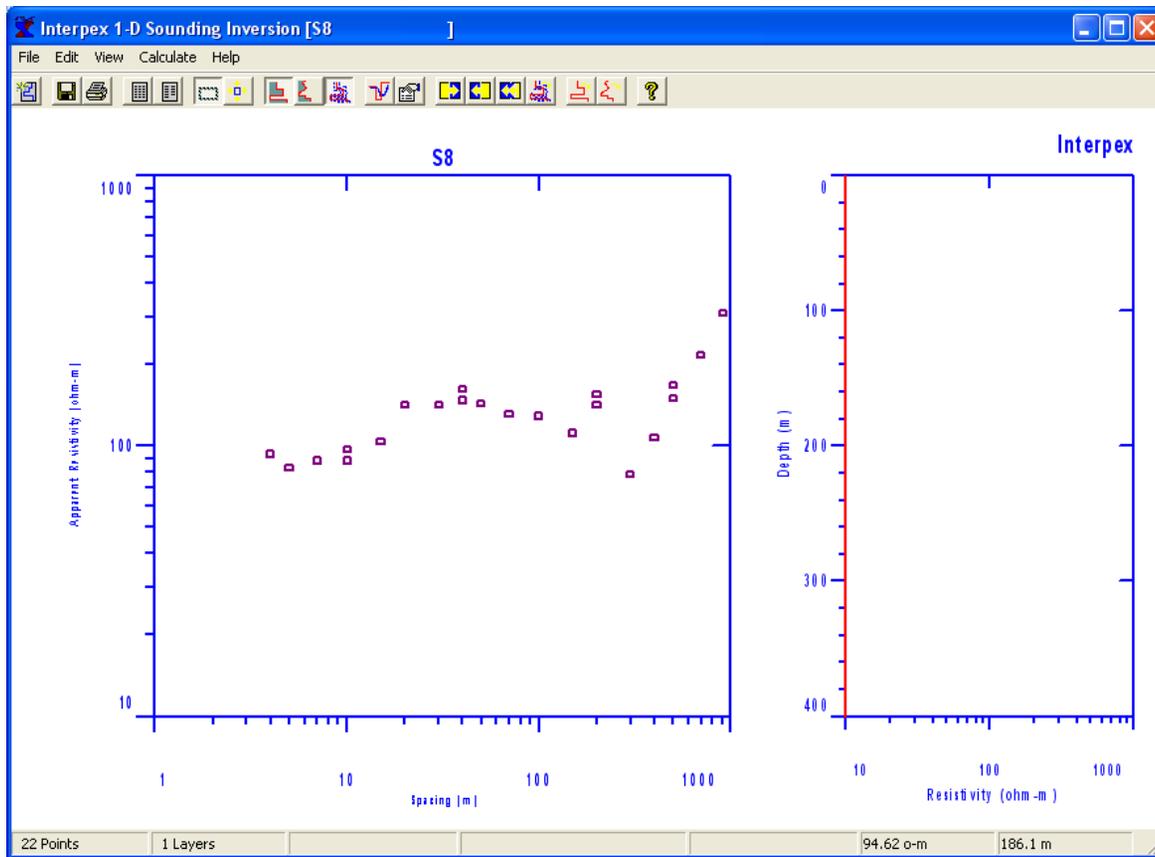
Point at the sounding you wish to interpret. The mouse cursor will turn into a crosshair and the status bar will show the Easting and Northing position as well as the sounding name. Click the mouse to display the data in the sounding window.

Select a Sounding from the Map Display using the Drop-Down Menu Box



Click on the down arrow on the right of the sounding menu box to open the list. Scroll down to point at the sounding you want and click the mouse to display the data in the sounding window.

The Sounding Data are Displayed on the Left with the Model Displayed on the Right



The toolbar buttons can be used to perform various functions. You can do a forward calculation for the model shown on the display (10- Ohm-m half space in this case.

Or a single iteration of inversion

Or multiple iterations



Edit the Model Using the Spreadsheet

The screenshot shows a dialog box titled "Resistivity Model" with a close button (X) in the top right corner. At the top, there are two input fields: "Surface Elevation:" with the value "2694.0" and "Fitting Error:" with the value "0.0000". Below these is a checkbox labeled "Use Depth Instead of Thickness" which is currently unchecked, and a "Units:" field containing "[meters]".

#	Rho	Fix?	Thick	Depth	Elev	Fix?
1	10.000	<input type="checkbox"/>				<input type="checkbox"/>
2		<input type="checkbox"/>				<input type="checkbox"/>
3		<input type="checkbox"/>				<input type="checkbox"/>
4		<input type="checkbox"/>				<input type="checkbox"/>
5		<input type="checkbox"/>				<input type="checkbox"/>
6		<input type="checkbox"/>				<input type="checkbox"/>
7		<input type="checkbox"/>				<input type="checkbox"/>
8		<input type="checkbox"/>				<input type="checkbox"/>
9		<input type="checkbox"/>				<input type="checkbox"/>
10		<input type="checkbox"/>				<input type="checkbox"/>
11		<input type="checkbox"/>				<input type="checkbox"/>
12		<input type="checkbox"/>				<input type="checkbox"/>

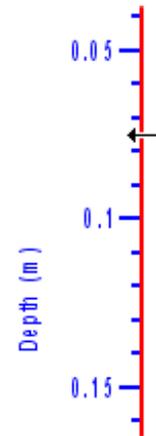
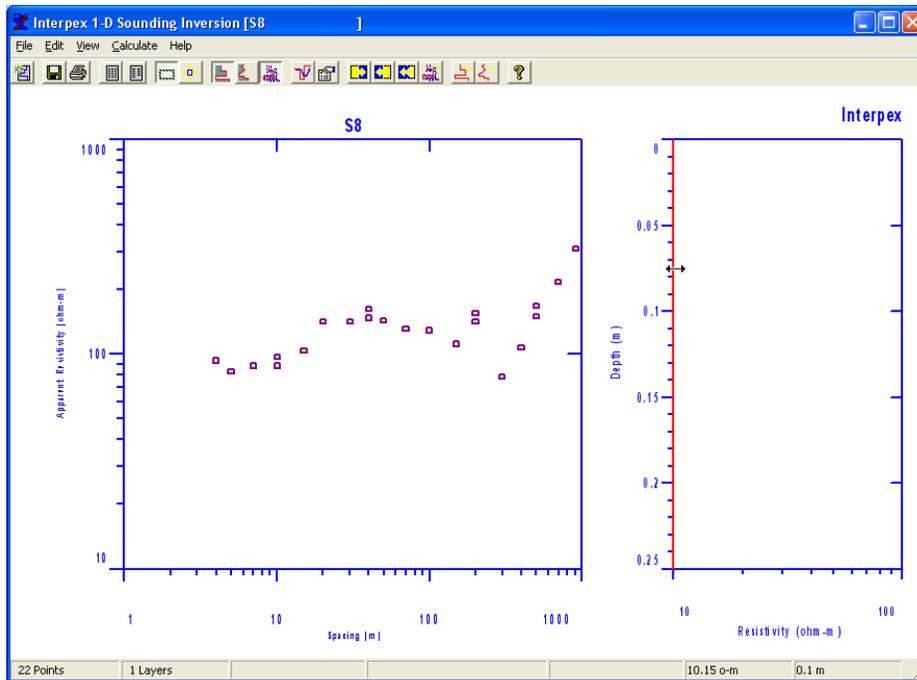
At the bottom of the dialog box, there are several buttons: "Insert Cell", "Insert Row", "Delete Cell", "Delete Row", "OK", and "Cancel". To the right of these is a "Column Math:" section with a dropdown menu currently set to "Forward". Below the dropdown are four buttons: "Forward", "One Iteration", "Multiply By", and "More Iterations".

Use Edit/Model or press  to open the model spreadsheet. You can now enter a starting model as resistivity and thickness or resistivity and depth. Buttons are provided for manipulating the model and carrying out forward and inverse calculations.

The sounding window will be updated as you change the model and perform forward and inverse operations.

Be sure to make the Rho column one position longer than the other columns.

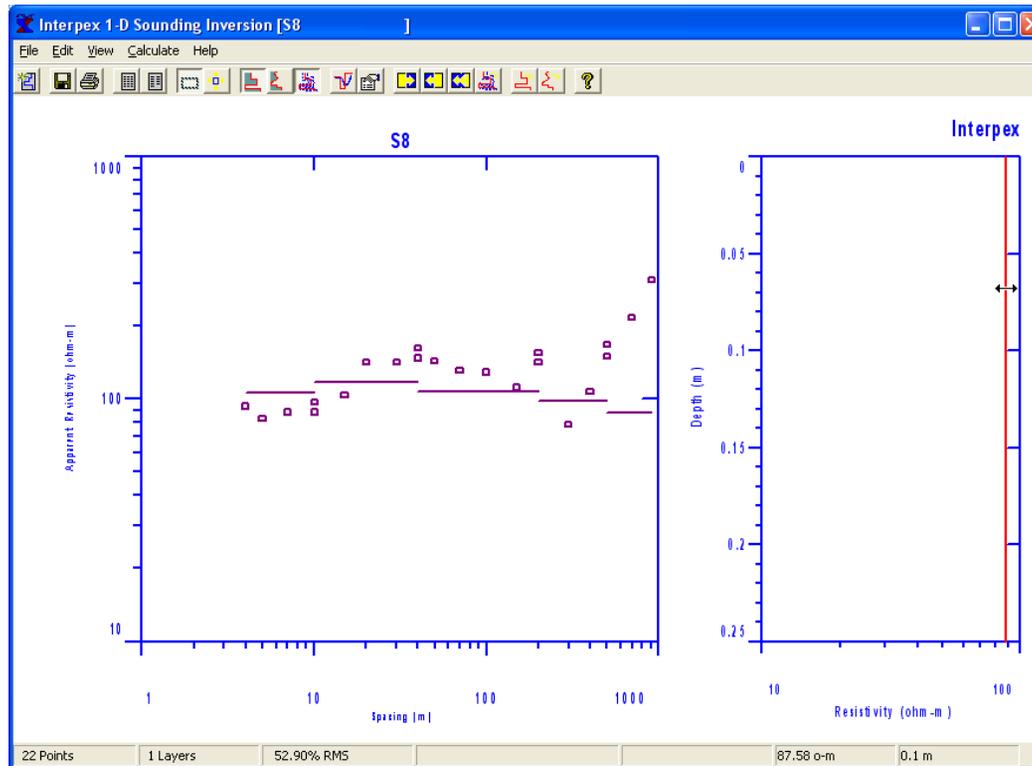
Edit the Model Using the Mouse



Move the mouse near to the red line displaying the model. The mouse cursor will turn into an E-W arrow. If you depress the left button, you can drag the resistivity value inside the graph.

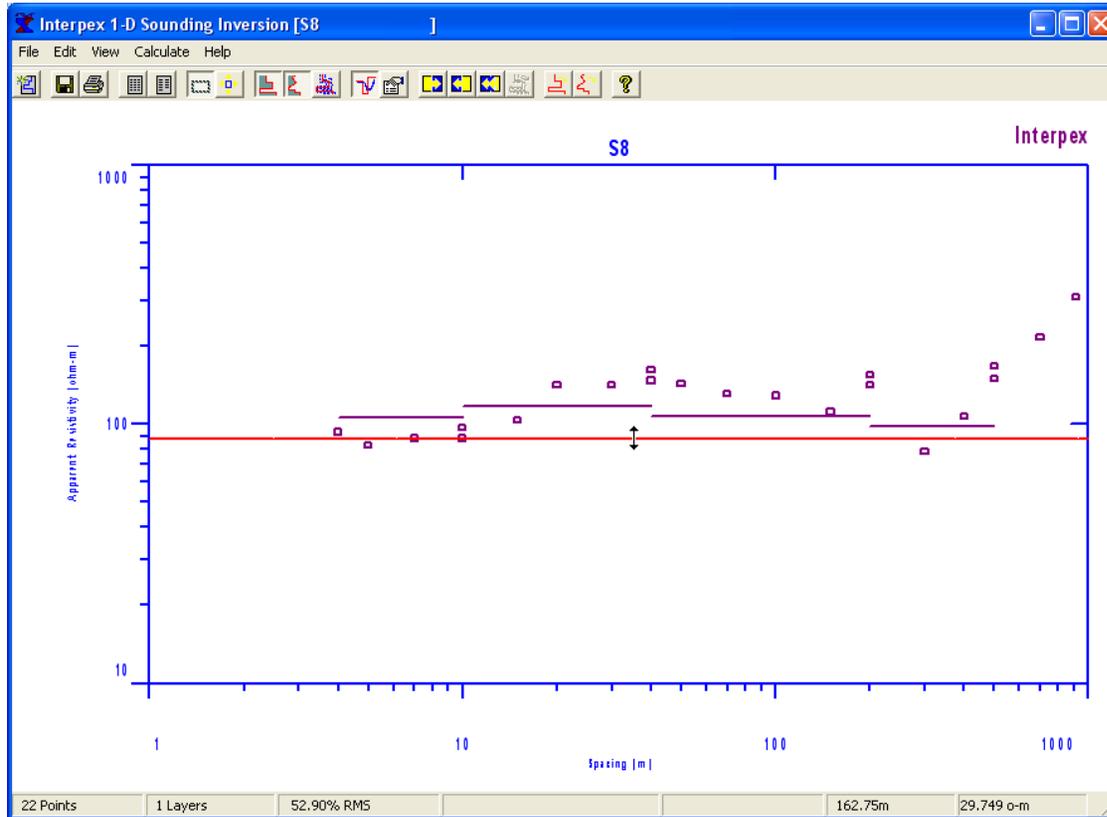
If you right-click the mouse you will see a pop-up menu with options.

Edit the Model Using the Mouse



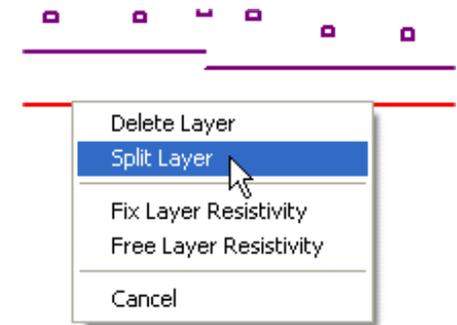
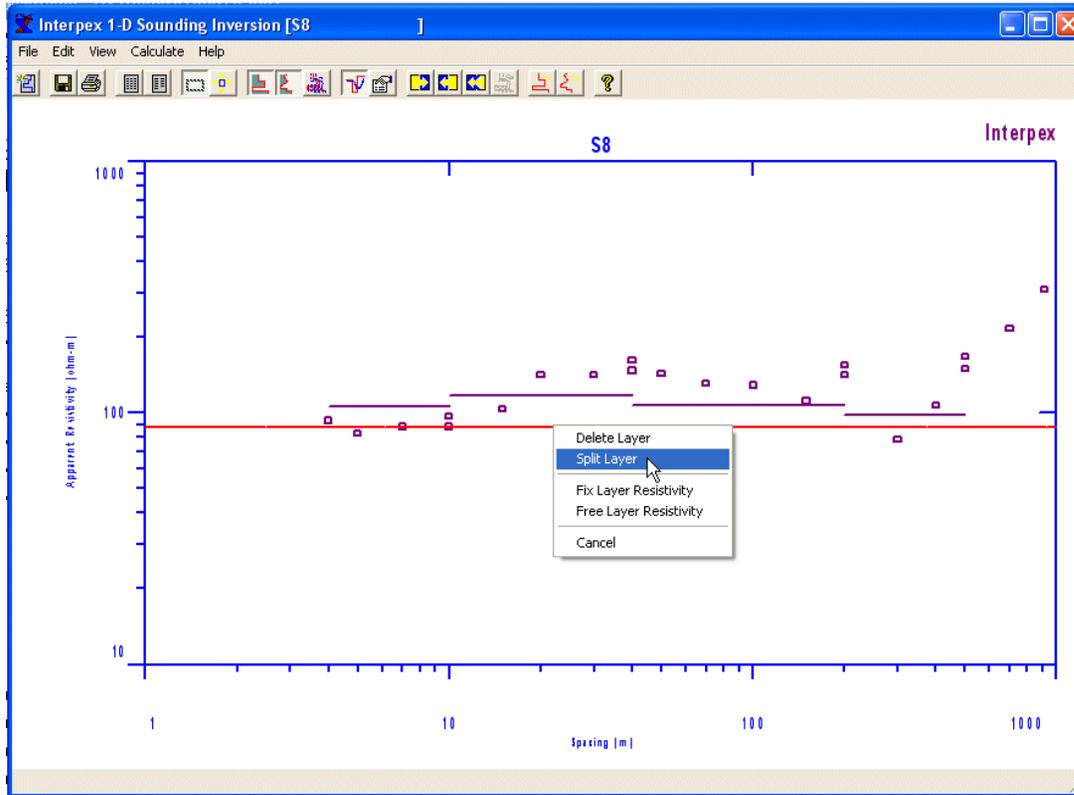
Drag the resistivity from 10-Ohm-m to about 90 Ohm-m and release the button. The synthetic curve for 90 ohm-m will appear on the data display.

Edit the Model Using the Mouse



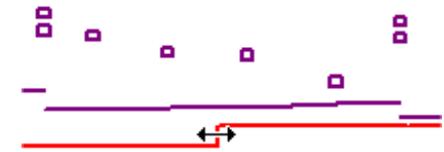
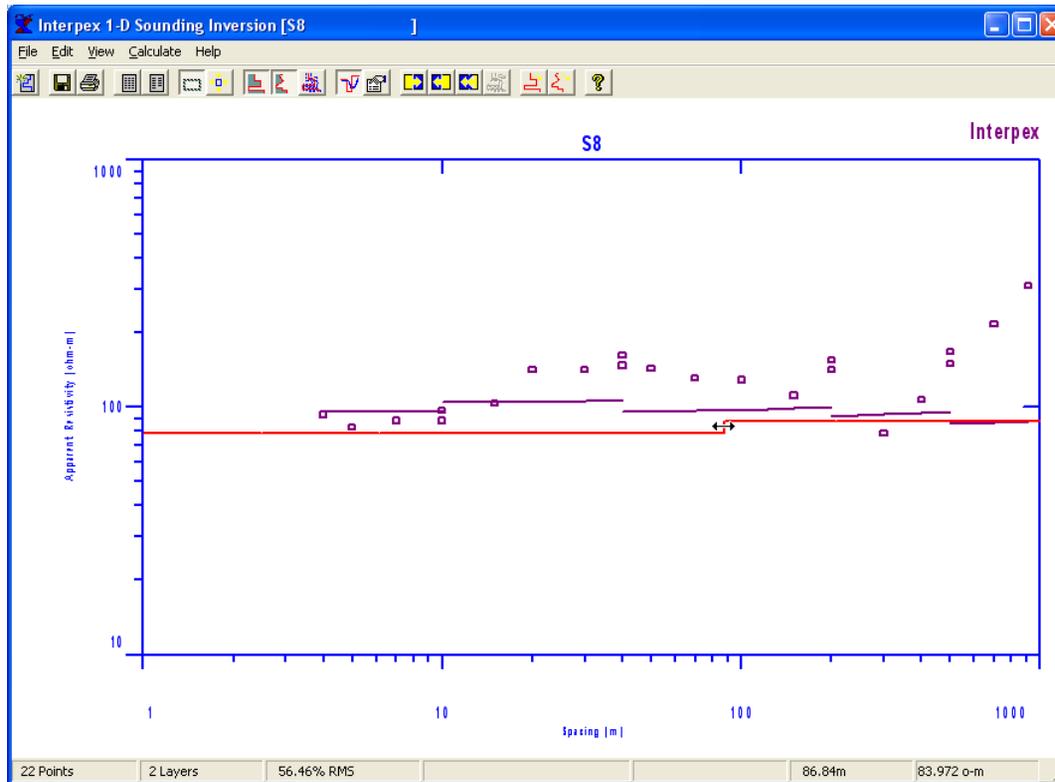
For resistivity data, the model can be displayed on the same axis as the data. Use View/Model on Data or press  Now the cursor turns into a N_S arrow when positioned over the red model line.

Edit the Model Using the Mouse



Right Click on the model while the N-S cursor is displayed to bring up pop-up menu. You can delete the layer (not if there is only one), split the layer or change the Fix/Free status of the layer. Select Split Layer.

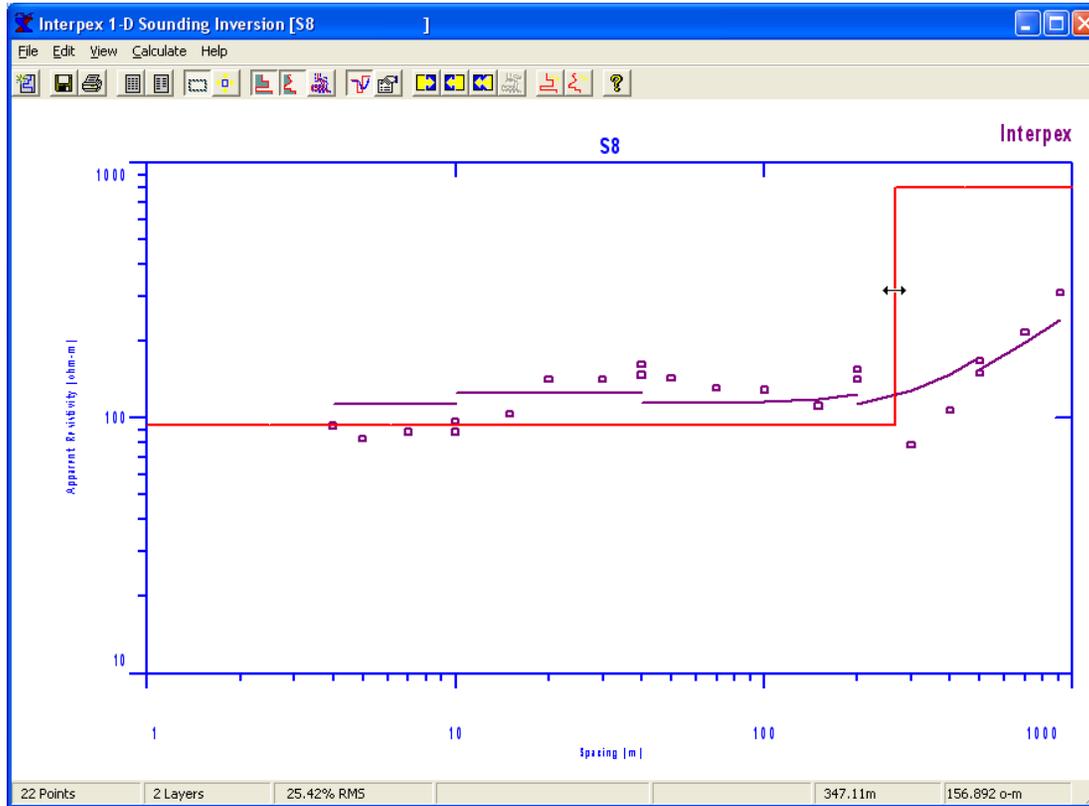
Edit the Model Using the Mouse



Notice there are now two layers and moving the mouse over the split changes the cursor to E-W arrow.

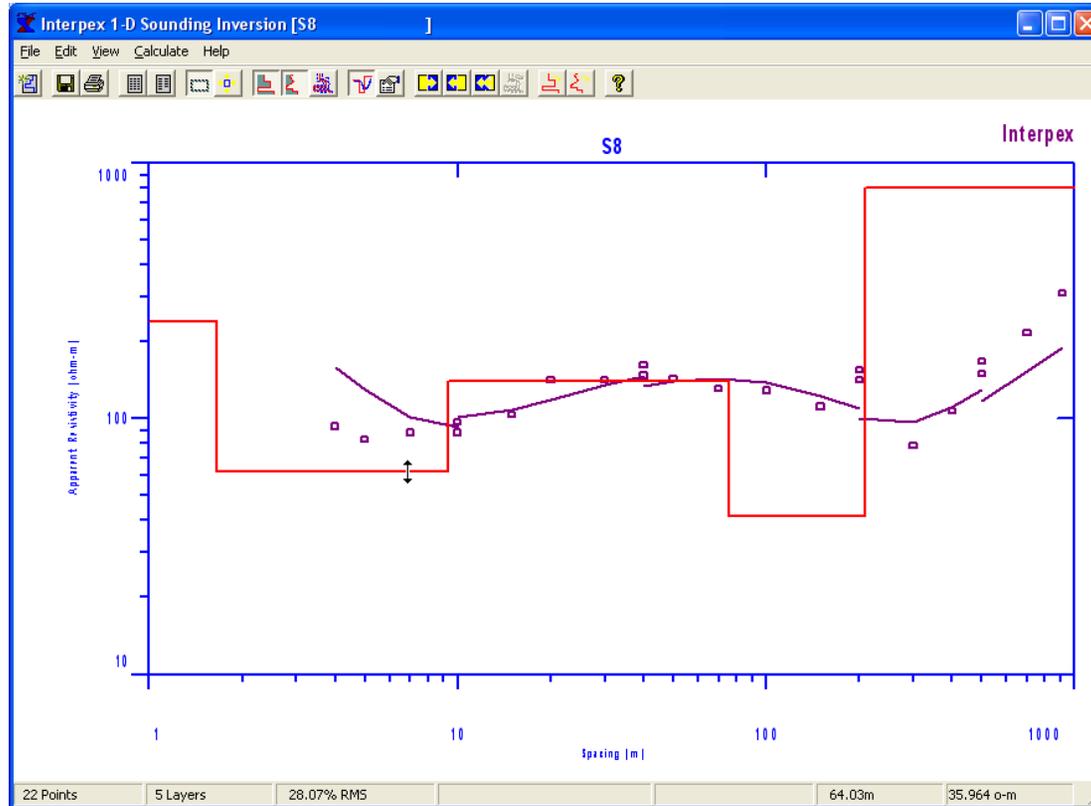
Use the mouse to drag the model around to fit the last layer. Each time you release the left button, the curve will be automatically recalculated.

Edit the Model Using the Mouse



Now use the mouse to split the upper layer several more times until there are enough layers to provide a reasonable (but not too good) fit to the model.

Edit the Model Using the Mouse



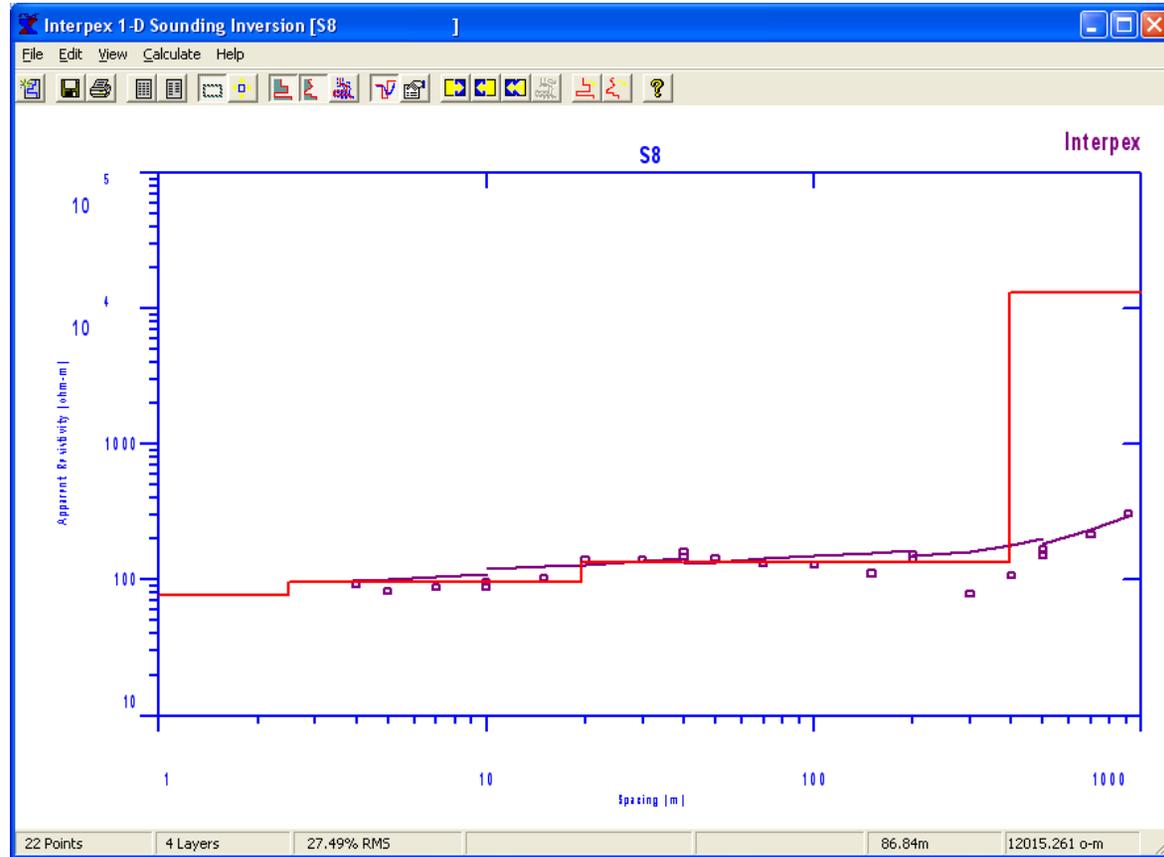
Now we have a suitable starting model for the inversion. Use  or Calculate/Inverse/Multiple Iterations to perform the inversion. You can do this several times if you like.

Edit the Model Using the Mouse



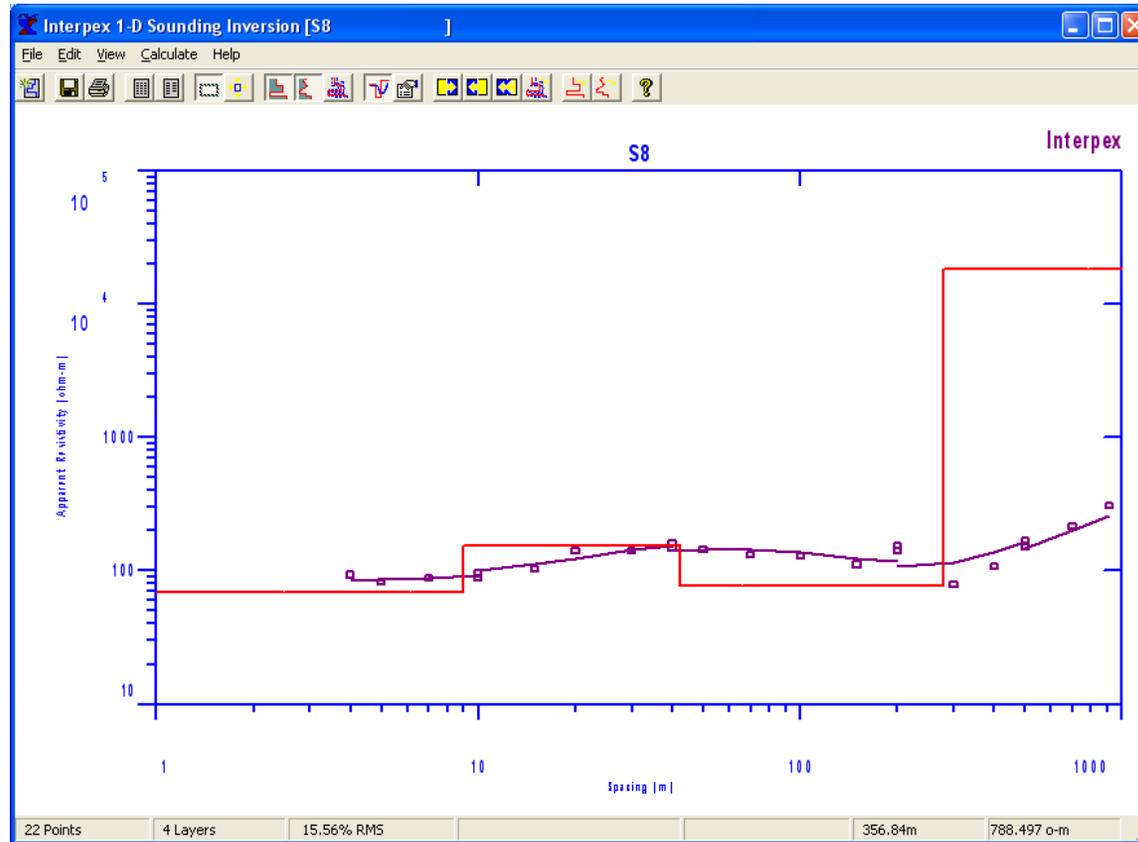
Now we have converged on a final model. You can use the mouse to adjust the model manually and then use the inversion to improve the fit as you like.

For Resistivity, Estimate Layered Model



For Resistivity data (with or without IP), you can have IX1D estimate the layered model using Calculate/Estimate Layered Model or press .

For Resistivity, Estimate Layered Model



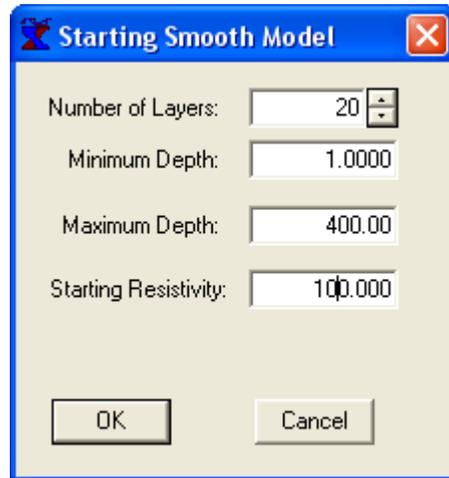
Then use Calculate/Inverse/Multiple Iterations to improve the fit to the estimated model!

Perform Equivalence Analysis



Finally, you can get an indication of the range of models which will fit these data by using **Calculate/Analyze Equivalence** or press 

Estimate Smooth Model

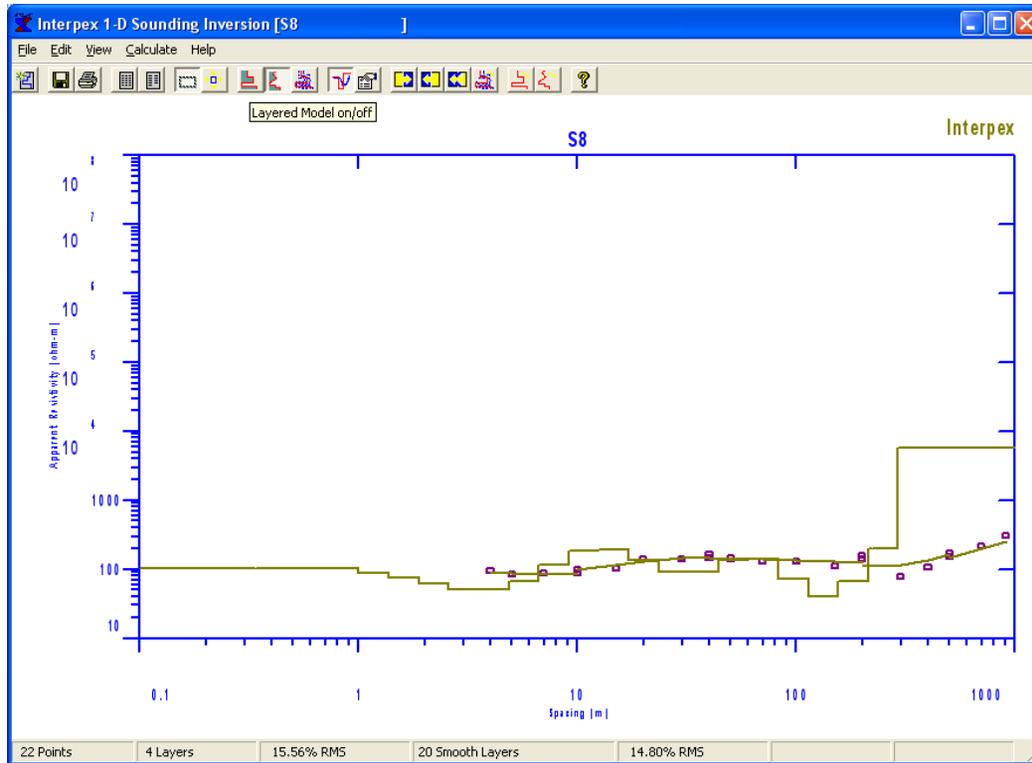


The min and max depth should be selected based on the data. For DC Resistivity, choose a value less than one-half the smallest spacing and more than one-half the longest spacing.

For other types of data, choose values based on the geometry, times or frequencies in the data, taking the resistivity into account.

Use Calculate/Estimate Smooth Model to estimate a model with many layers. Typically, the number of layers should be about the same as the number of data points, but it can be more or less. Choose a min and max depth that will span the range of the data and a resistivity which is within the ball-park of the data. Experiment until you get a good fit and a model that looks good.

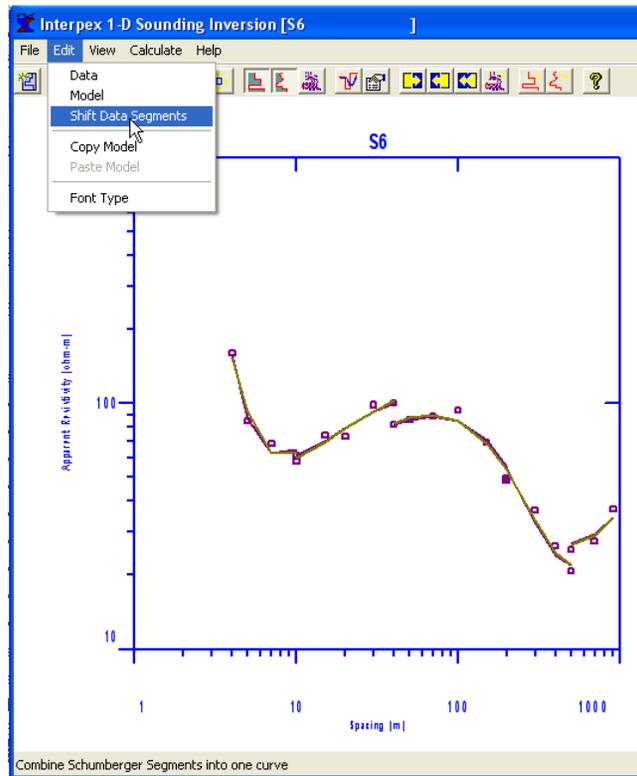
Estimate Smooth Model



The smooth model can also be used as a guide for making the layered model. Estimate the smooth model first, then use the mouse to split layers and drag the model into the appropriate positions.

With Smooth and Layered models, and Equivalent models too, the display can become quite cluttered. Use the View/Layered, Smooth or Equivalence to toggle the displays of these various models. Here we see only the Smooth model. The toolbar buttons can be used as well, as shown on the picture.

Schlumberger Data Segments

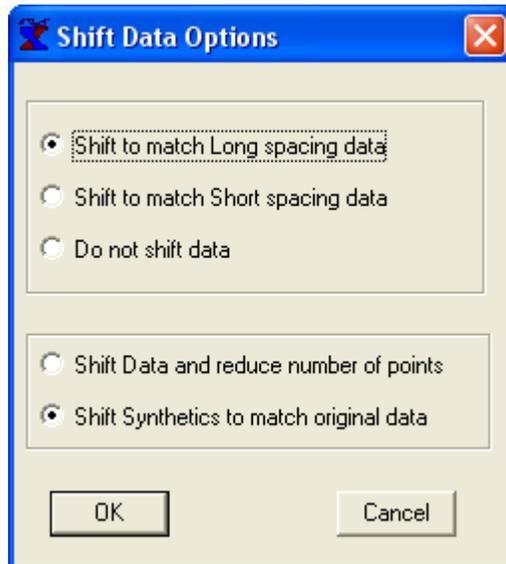


By default, IX1D finds the offsets from one segment to the other and introduces these offsets into the synthetic curves calculated for the Layered and Smooth models.

However, there is a command, **Edit/Shift Data Segments**, which can be used to either ignore the shifts or to shift the data and thereby remove the offsets.

Schlumberger data are normally taken in overlapping segments. Each time the signal becomes weak, the MN spacing is enlarged and two values for the same $AB/2$ are measured, one for the short and one for the long MN. Sometimes 2 or 3 overlapping points are taken for each increase in MN, for different $AB/2$ values.

Schlumberger Data Segments



Using Edit/Shift Data Segments brings up a dialog of options.

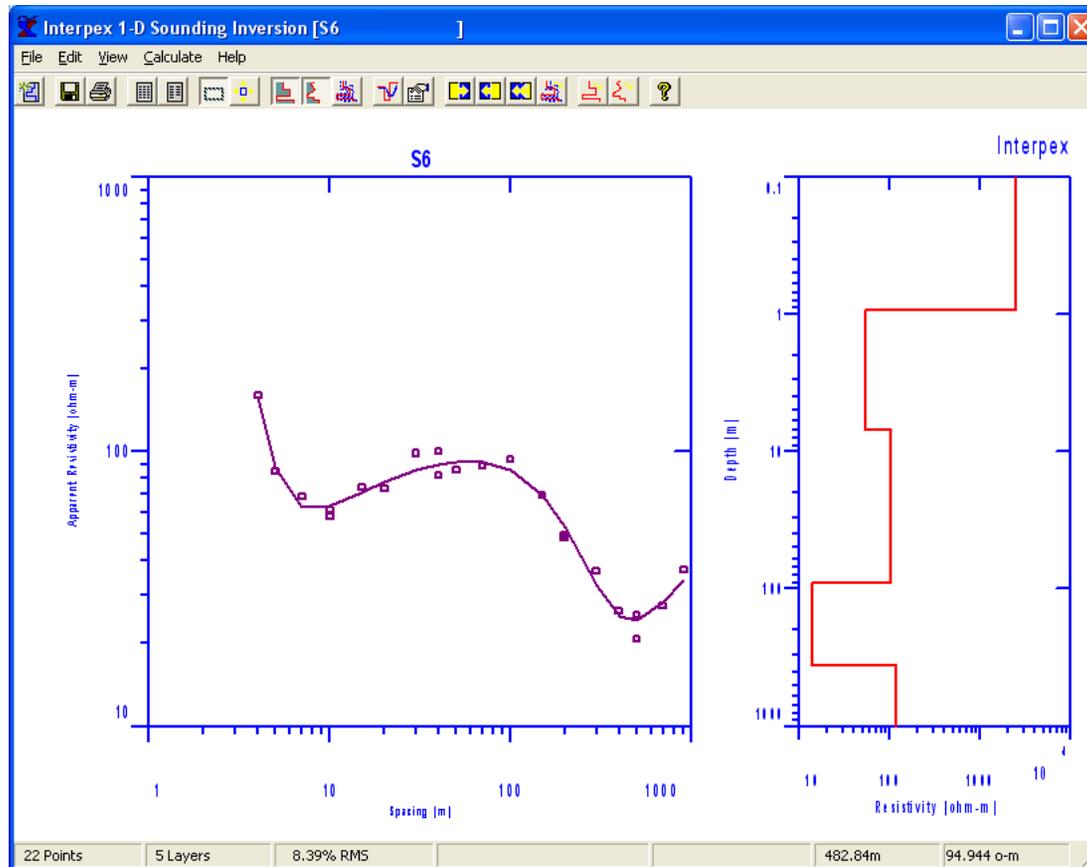
Data are normally shifted to match the long spacing data. The reasoning is that long spacings provide a better average over geology.

In some cases, it may be desirable to match the short spacing data or not shift at all.

Shifting the data will remove the shifts and permanently change the data values.

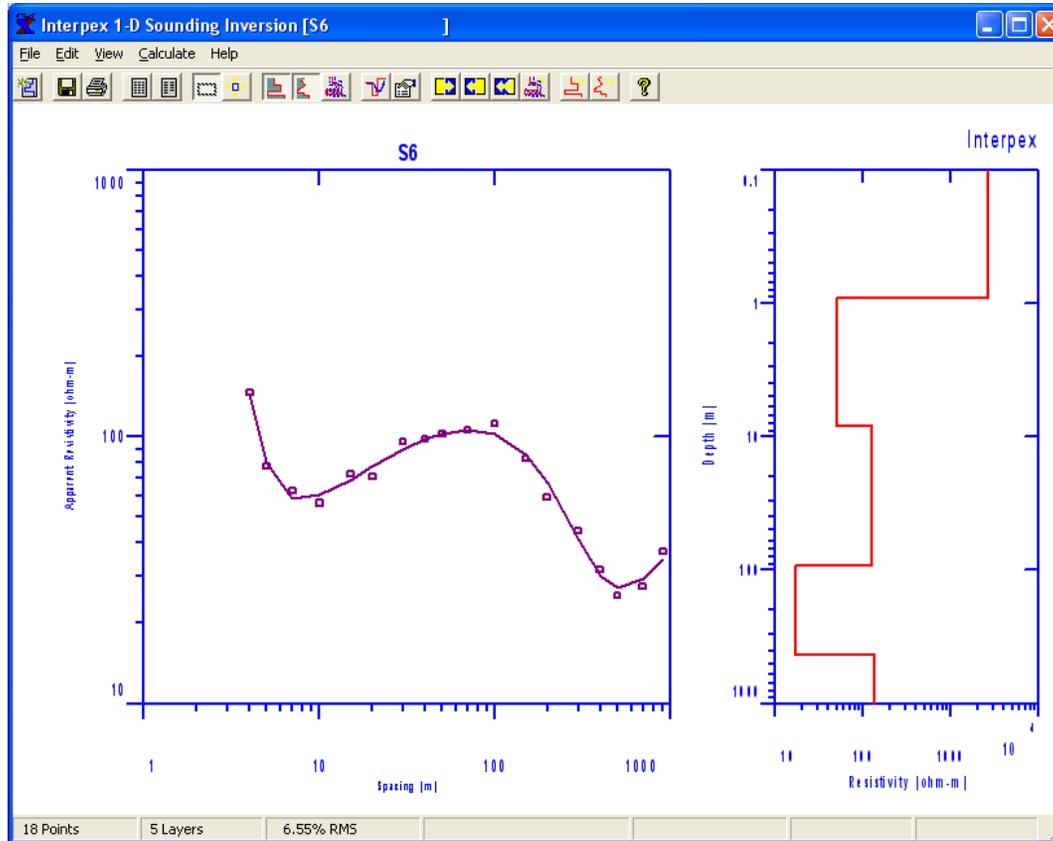
Schlumberger data segments can be shifted to remove the shifts, the shifts can be ignored or the shifts can be introduced into the synthetics, thereby preserving the original data values.

Schlumberger Data Segments



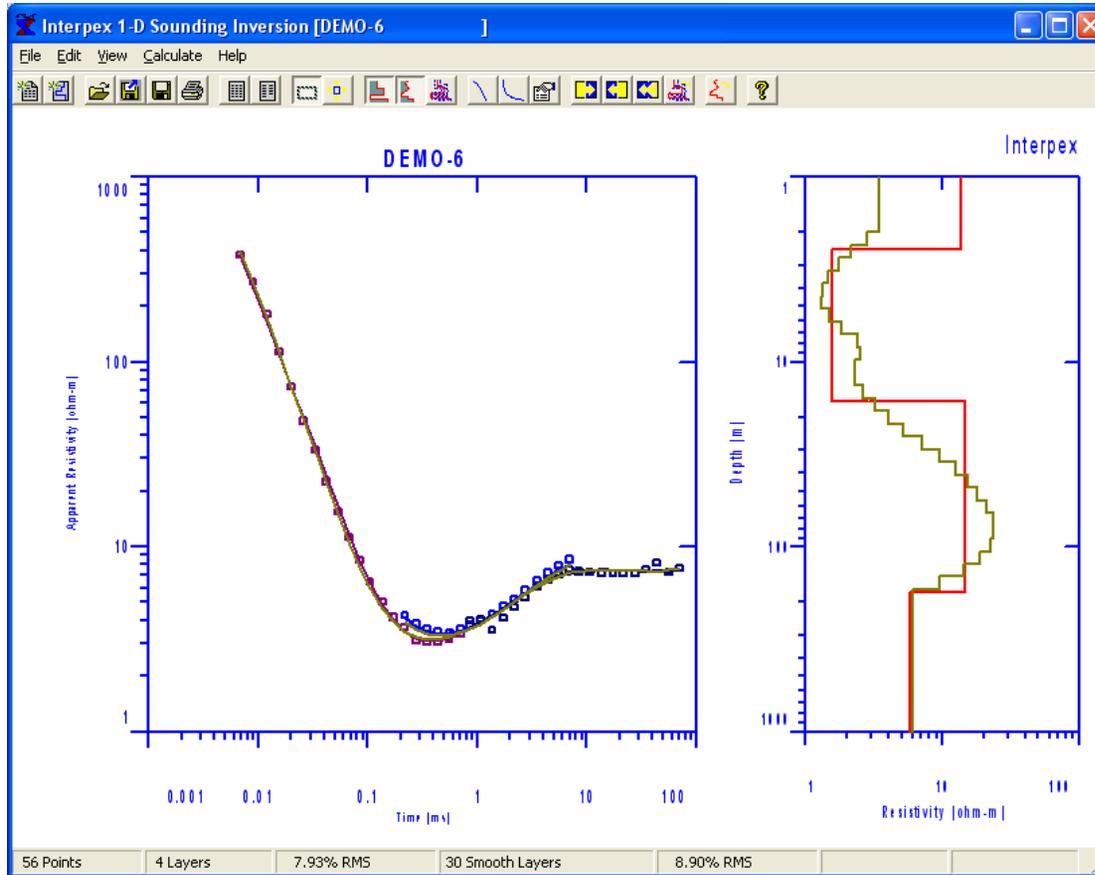
Selecting 'Do not shift data' basically ignores the shifts. The model derived by inverting these data are now different than the model when the shifts were used.

Schlumberger Data Segments



Selecting ‘Shift data and reduce number of points’ shifts each segment to match the next one, preserving either the longest or shortest shift values. Overlapping points are averaged as needed so that only one point for each $AB/2$ is left.

TEM Data Segments (Sweeps)



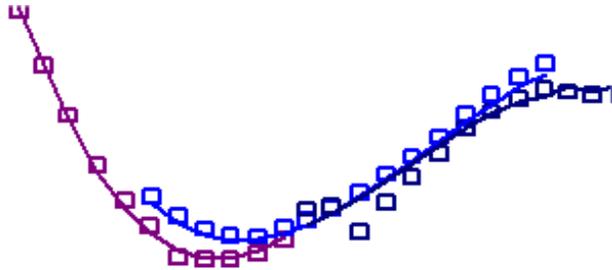
TEM data can be taken at different currents, repetition frequencies and with different ramp times.

This affects the shape of the curves: ramp time changes the early section while repetition frequency affects the late section. Current can affect ramp time.

TEM data can have segments as well and these are called “sweeps”. They are most common for Geonics data but could be derived from other instruments.

IX1D calculates curves for the same ramp and frequency as the data.

TEM Data Segments (Sweeps)

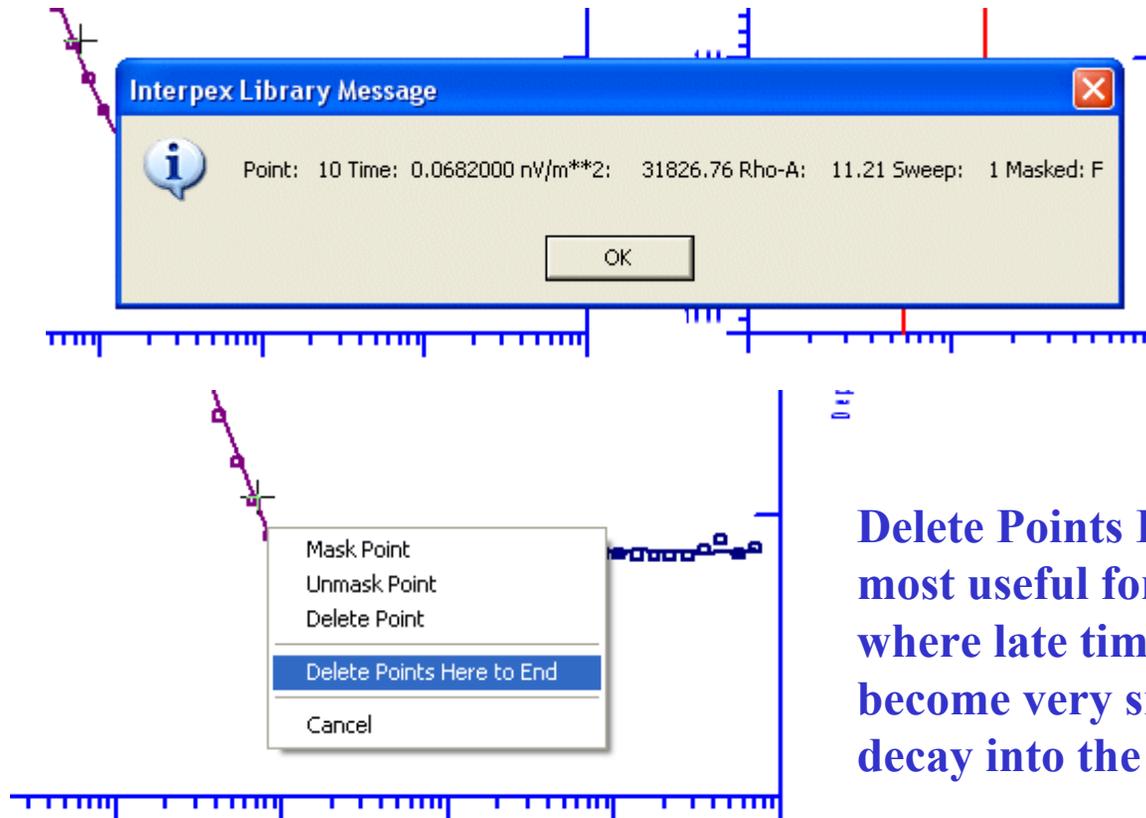


The fact that the transmitter waveform is repeated causes an effect known as “runon”. This means that there are previous pulses in the wave train that affect the curve. The higher the transmitter frequency, the more the effect.

This is most pronounced when a conductive layer underlies a thick resistive one.

Note the separation of both data and synthetic for the blue and magenta curves in the area of overlap. This is due to a combination of ramp time affecting the blue curve while runon affects the magenta curve taken at higher frequency. Here the magenta curve is taken at 300 Hz and 4.2 μ Sec, Blue at 30 Hz and 75 μ Sec.

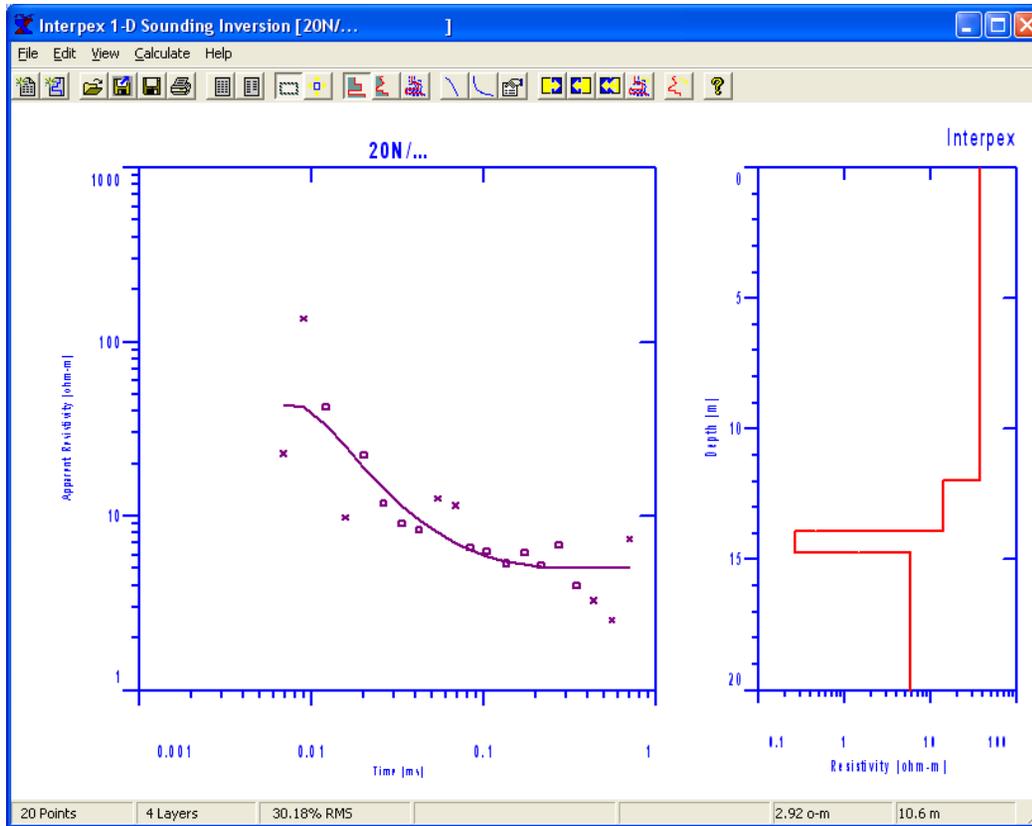
Accessing the Data Graphically with the Mouse



Delete Points Here to End is most useful for TEM data where late time voltages become very small and decay into the noise.

Moving the mouse cursor close to a data point changes the cursor into a crosshair. Clicking the mouse will pop up a window showing the data values and mask state. Right-clicking brings up a menu, allowing you to mask, unmask or delete.

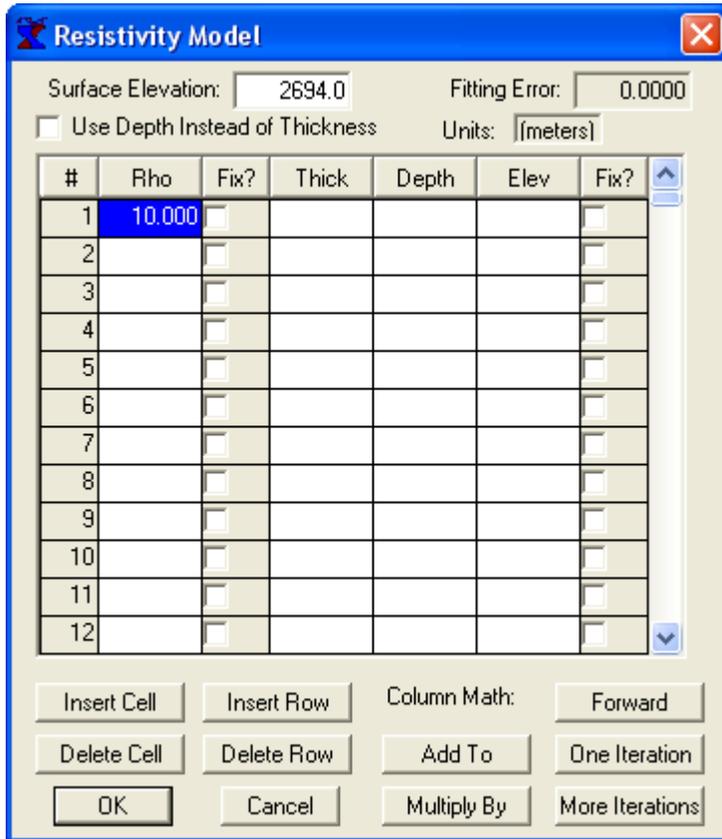
Masking Data



Masked data are displayed with an “x”, rather than a box. Although synthetic values are calculated for these points, they are not used in the inversion calculations or for calculating the RMS error between data and synthetic values. They are for display only.

Masking data is useful when some data points are noisy but the user does not want to discard the points entirely. Masking can be done graphically (see previous slide) or in the data editor by checking the mask box.

Fixing Model Parameters



The image shows a software dialog box titled "Resistivity Model". At the top, it has a blue title bar with a close button. Below the title bar, there are two input fields: "Surface Elevation:" with the value "2694.0" and "Fitting Error:" with the value "0.0000". Below these is a checkbox labeled "Use Depth Instead of Thickness" which is currently unchecked, and a "Units:" dropdown menu set to "[meters]".

#	Rho	Fix?	Thick	Depth	Elev	Fix?
1	10.000	<input type="checkbox"/>				<input type="checkbox"/>
2		<input type="checkbox"/>				<input type="checkbox"/>
3		<input type="checkbox"/>				<input type="checkbox"/>
4		<input type="checkbox"/>				<input type="checkbox"/>
5		<input type="checkbox"/>				<input type="checkbox"/>
6		<input type="checkbox"/>				<input type="checkbox"/>
7		<input type="checkbox"/>				<input type="checkbox"/>
8		<input type="checkbox"/>				<input type="checkbox"/>
9		<input type="checkbox"/>				<input type="checkbox"/>
10		<input type="checkbox"/>				<input type="checkbox"/>
11		<input type="checkbox"/>				<input type="checkbox"/>
12		<input type="checkbox"/>				<input type="checkbox"/>

At the bottom of the dialog box, there are several buttons: "Insert Cell", "Insert Row", "Delete Cell", "Delete Row", "OK", and "Cancel". On the right side, there are four buttons: "Column Math:" (with a dropdown arrow), "Forward", "Add To", and "One Iteration". At the very bottom right, there are two more buttons: "Multiply By" and "More Iterations".

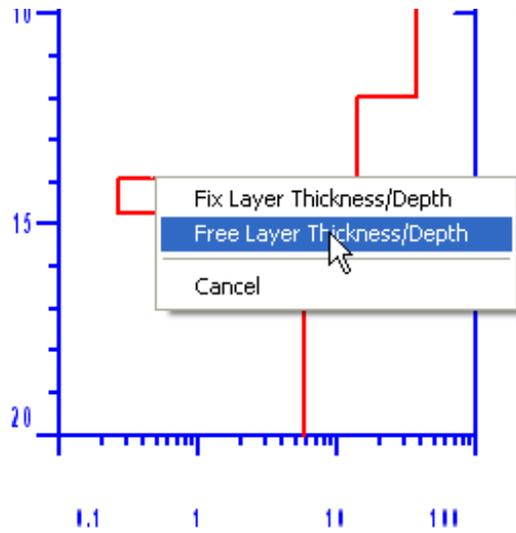
Use Edit/Model or press  to open the model spreadsheet. You can select to Use Depth Instead of Thickness by checking the box near the top left of the dialog.

If the Fix? column just to the right of Rho is checked, that resistivity will be fixed (else free).

If the Fix? column on the far right is checked, that depth or thickness value will be fixed.

Fixed parameters are not varied in the inverse calculations.

Fixing Model Parameters

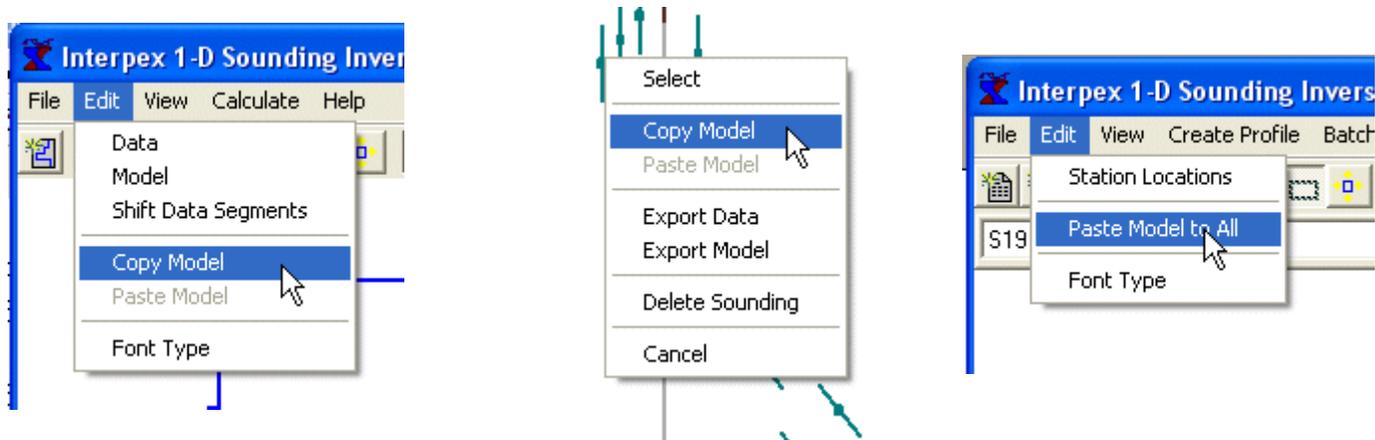


Pointing at a layer resistivity or depth/thickness boundary changes the cursor to a crosshair.

Right clicking brings up a menu allowing you to fix or free that parameter.

If Depth instead of Thickness is selected, that boundary will remain fixed while the other boundaries can move (provided they are free). Otherwise, the distance from that boundary to the next boundary above it (or the surface) remains fixed while the position of the boundary itself will move (except for first layer – the surface never moves).

Copying and Pasting Models



Layered models can be copied from one sounding and pasted into another. You can use Edit/Copy Model from the menu in the sounding window or you can right-click on the sounding in the map window and select Copy Model from the pop-up menu.

This can be used to build a starting model, copy that model to the model clipboard and then paste that model to another sounding by right-clicking on the sounding or by using Edit/Paste model with that sounding open in the sounding window.

You can paste the model to all soundings in the database by using Edit/Paste Model to All in the map window. Now all soundings have a consistent starting model.

Of course, you must use Copy Model before you can use Paste Model.