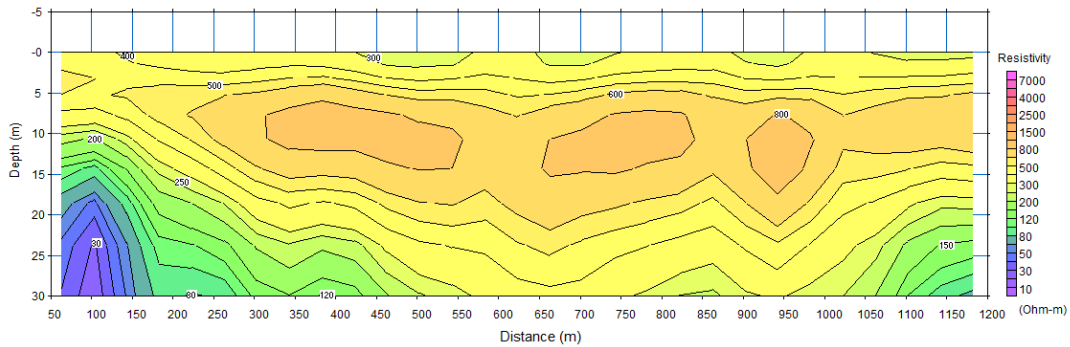
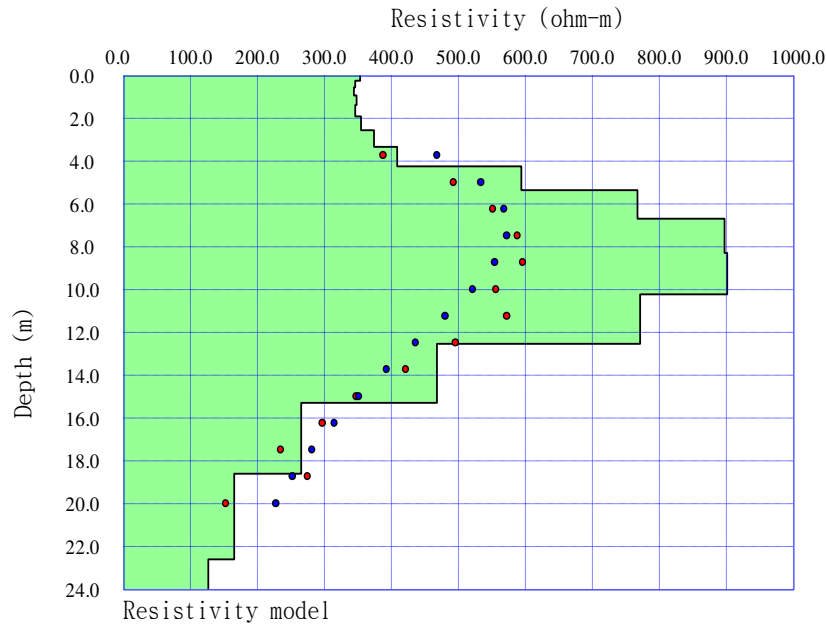




Software for Data Analysis of the OhmMapper

OhmImager Manual



Version 1.1



GEOMETRICS
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Contents

	Page
1. Outline -----	1
1.1 Main features -----	1
1.2 Limitations -----	1
2. Outline of figures shown in the OhmImager -----	7
2.1 OhmMapper lines -----	9
2.2 2D apparent resistivity section (measured data) -----	12
2.3 2D apparent resistivity section (gridded data) -----	13
2.4 1D resistivity data -----	14
2.5 2D resistivity model -----	15
2.6 2D resistivity model (shown by GeoPlot) -----	16
2.7 GPS map -----	17
3. Processing flow -----	18
3.1 Processing flow using Windows PC and OhmLog for data acquisition -----	21
① Launch OhmImager -----	21
② Read OhmLog file (.sto) -----	22
③ Edit Lines and Markers -----	23
④ Remove noise -----	29
⑤ Gridding apparent resistivity data -----	37
⑥ Initial model -----	41
⑦ Show resistivity model by GeoPlot -----	44
⑧ Smooth resistivity model -----	45
⑨ Inversion -----	48
⑩ Save apparent resistivity and resistivity model -----	51
3.2 Analysis with GPS location -----	52
⑪ Show GPS locations -----	52
⑫ Set flags -----	54
⑬ Set distance -----	56
3.3 Data acquisition using a console (G858) -----	57
⑭ Connect a console (G858) to a Windows PC -----	57
⑮ Setting OhmImager for data transfer -----	57

⑩ Data transfer	-----60
3.4 Data processing with MagMap	-----62
⑪ Open RES2D file (.dat)	-----62
4. The OhmImager functions	-----66
4.1 File menu	-----66
4.2 View menu	-----69
4.3 Edit menu	-----72
4.4 GPS menu	-----76
4.5 Resistivity analysis menu	-----77
4.6 Option menu	-----82
4.7 Help menu	-----82
5. File format	-----83
5.1 Plotrefafile (.ovs)	-----83
5.2 RES2DINV file (.dat)	-----84
5.3 Conversing process of inversion (rms.txt)	-----85

1. Outline

The OhmImager software edits apparent resistivity data obtained by the OhmMapper and analyzes resistivity model using a non-linear least squares method and a one-dimensional linear filter method. Analysis is very quick and it is the best for analyzing relatively long survey lines performed at simple resistivity structure. Two-dimensional inversion is not done and complex 2D structure cannot be analyzed. Use other software, such as RES2DINV, to perform 2D inversion. Data file for RES2DINV can be exported after editing. OhmImager can analyze dipole-dipole method used in the OhmMapper as well as other configuration of DC resistivity methods using 4 electrodes, such as Wenner or Schlumberger methods. The 1D inversion is successively applied to the OhmMapper data and pseudo 2D resistivity section can be obtained.

Data acquisition of the OhmMapper can be done by two methods, Console (G858) and Windows PC. OhmLog is used as data acquisition software when the Windows PC is used for data acquisition.

Processing flow depends on which method is used for data acquisition. Figure 1.1 shows the processing flow using Windows PC and the OhmLog for data acquisition. Figure 1.2 and 1.3 show the processing flow using the Console (G858). Figure 1.4 shows summary of the OhmImager and SeisImager suites. The SeisImager suite is seismic processing packages for a refraction method (SeisImager/2D), a surface wave method (SeisImager/SW1D, SW2D) and a downhole seismic (SeisImager/DH).

Refer to *OhmMapper TR1 Operation Manual* for general data acquisition of the OhmMapper and processing using Magmap2000, *OhmLog Manual* for data acquisition using Windows PC and *GeoPlot Manual* for visualization using the GeoPlot.

1.1 Main features

- Long survey line can be analyzed quickly by applying 1D inversion.
- Quality control and editing of data can be effectively and quickly done by using visualization functions.

1.2 Limitations

- Only 1D analysis can be used and accurate resistivity models may not be determined where resistivity strongly changes in horizontal direction. Use other software such as RES2DINV that can apply 2D or 3D inversion for more accurate analysis.

- Inversion assumes flat topography and analysis results may not be accurate where topography is steep. Use other software such as RES2DINV that can apply 2D or 3D inversion.

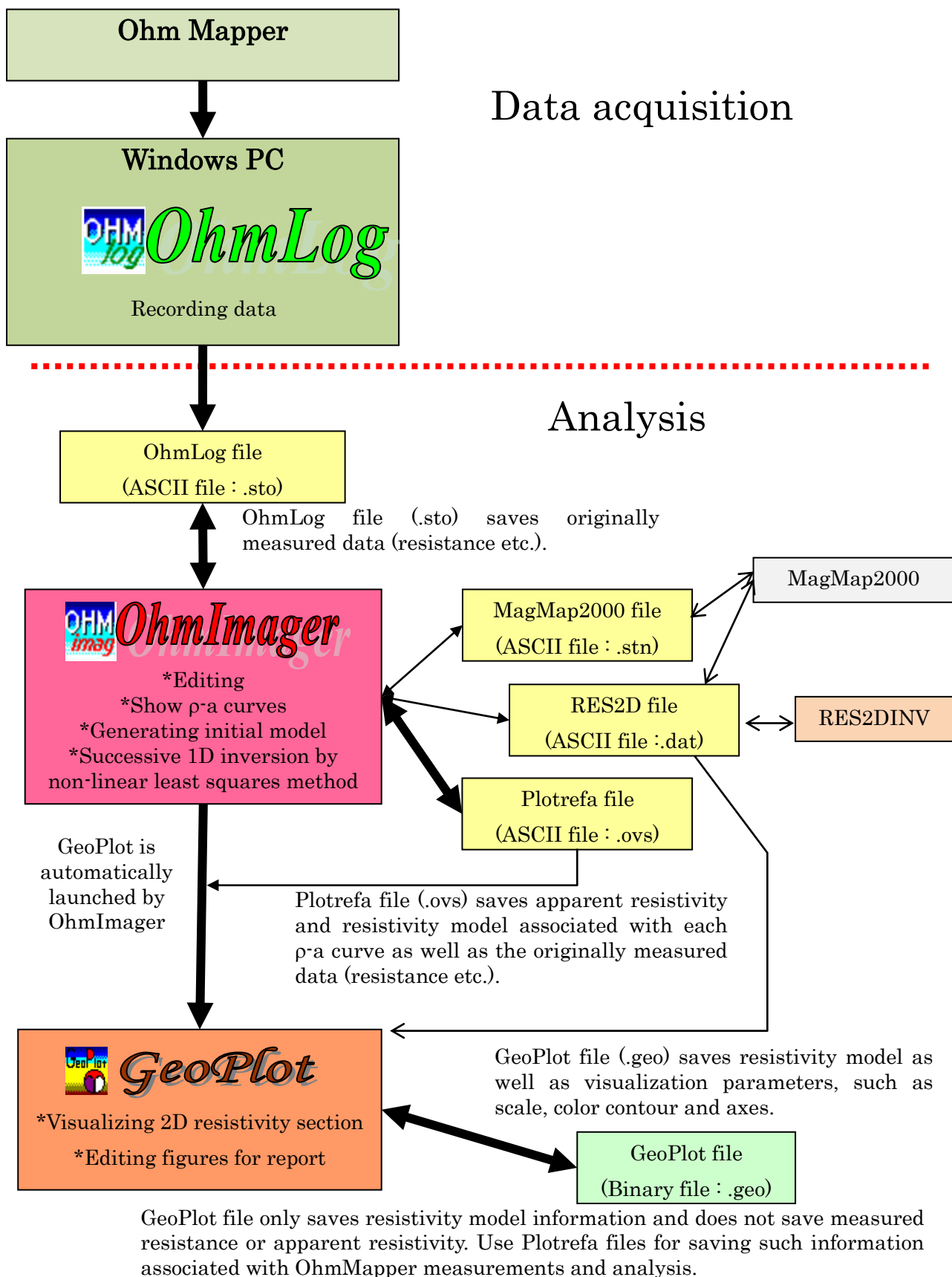
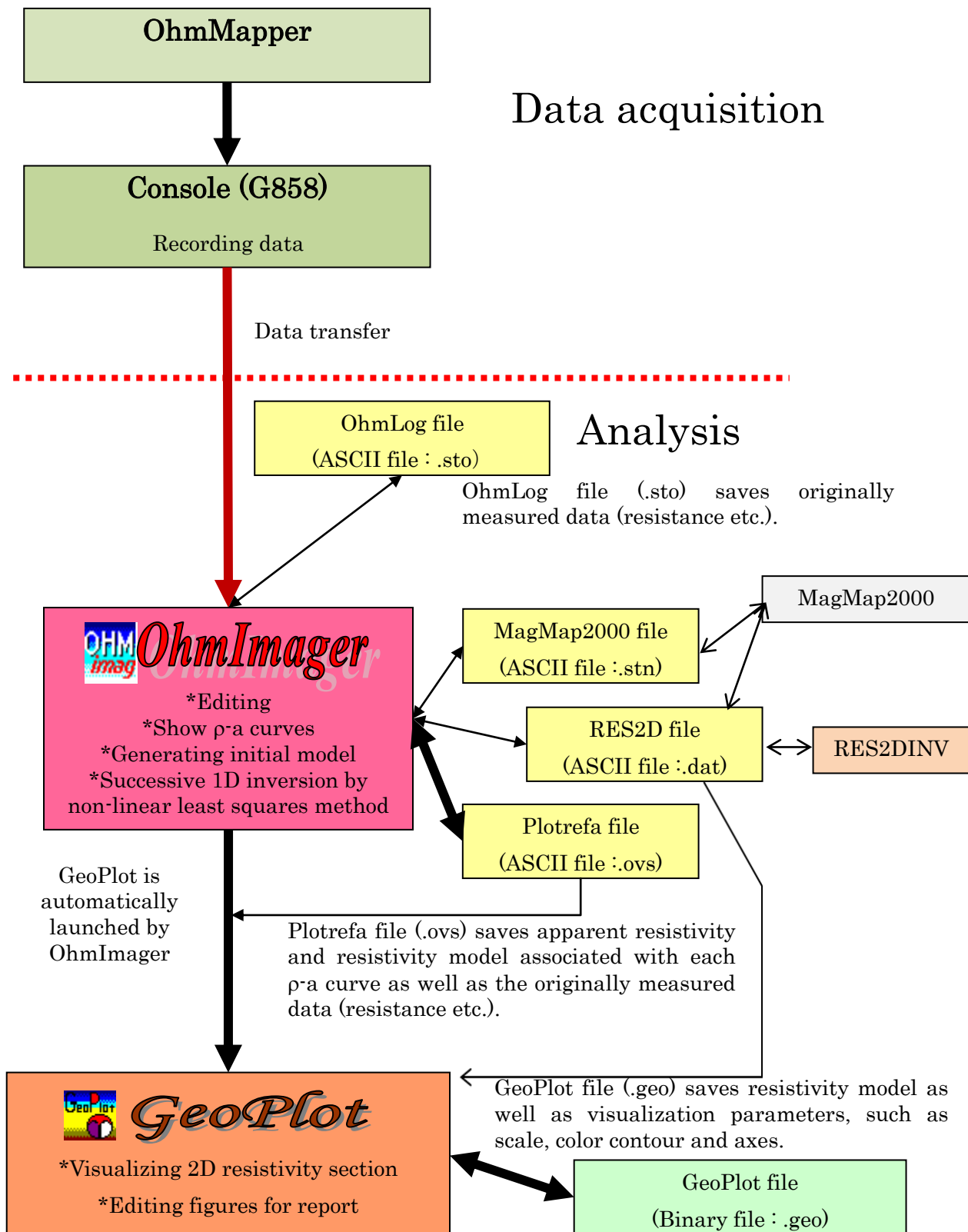


Figure 1.1 Processing flow using Windows PC and the OhmLog for data acquisition.



GeoPlot file only saves resistivity model information and does not save measured resistance or apparent resistivity. Use Plotrefa files for saving such information associated with OhmMapper measurements and analysis.

Figure 1.2 Processing flow using the Console (G858) for data acquisition.

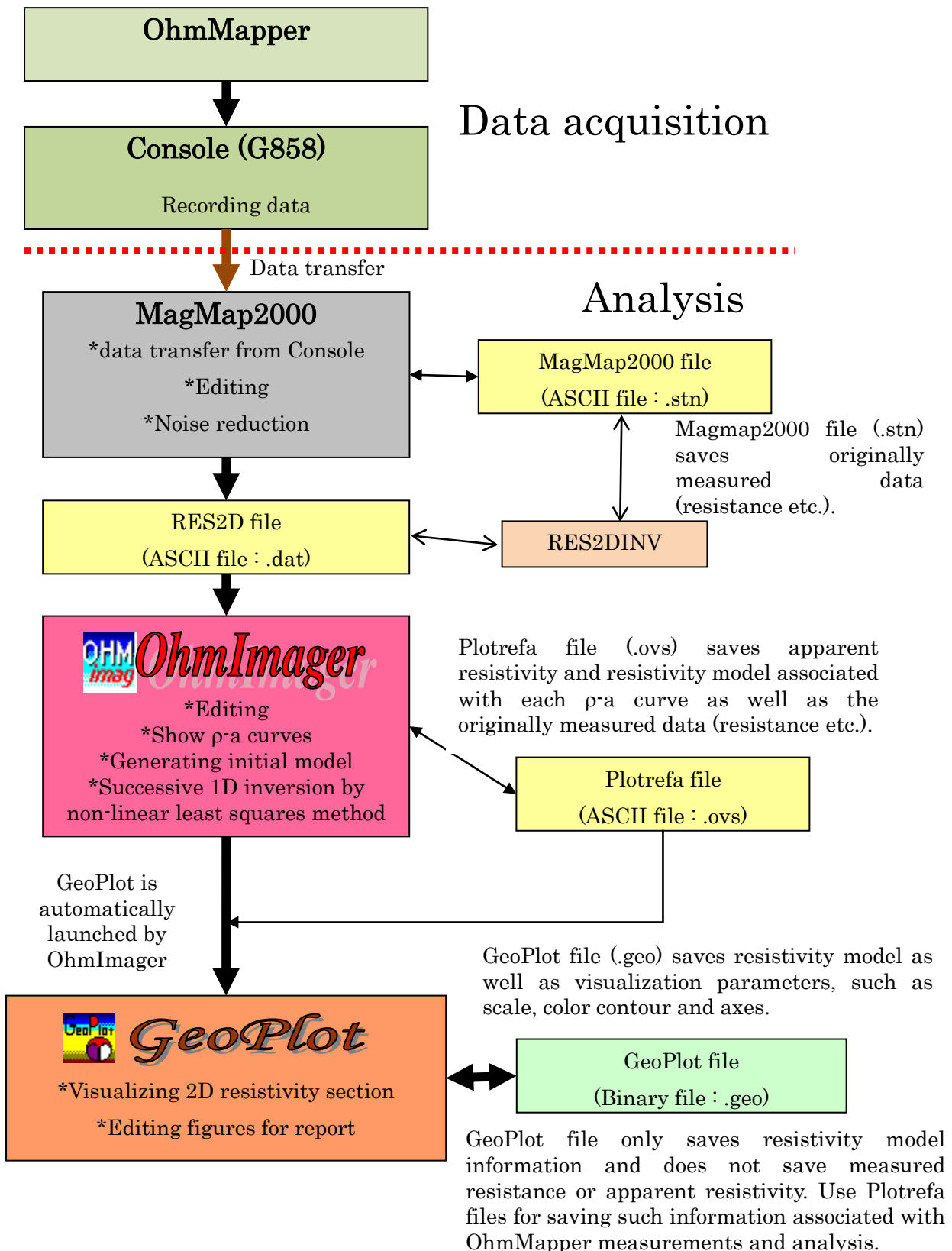


Figure 1.3 Processing flow using the Console (G858) and MagMap2000.

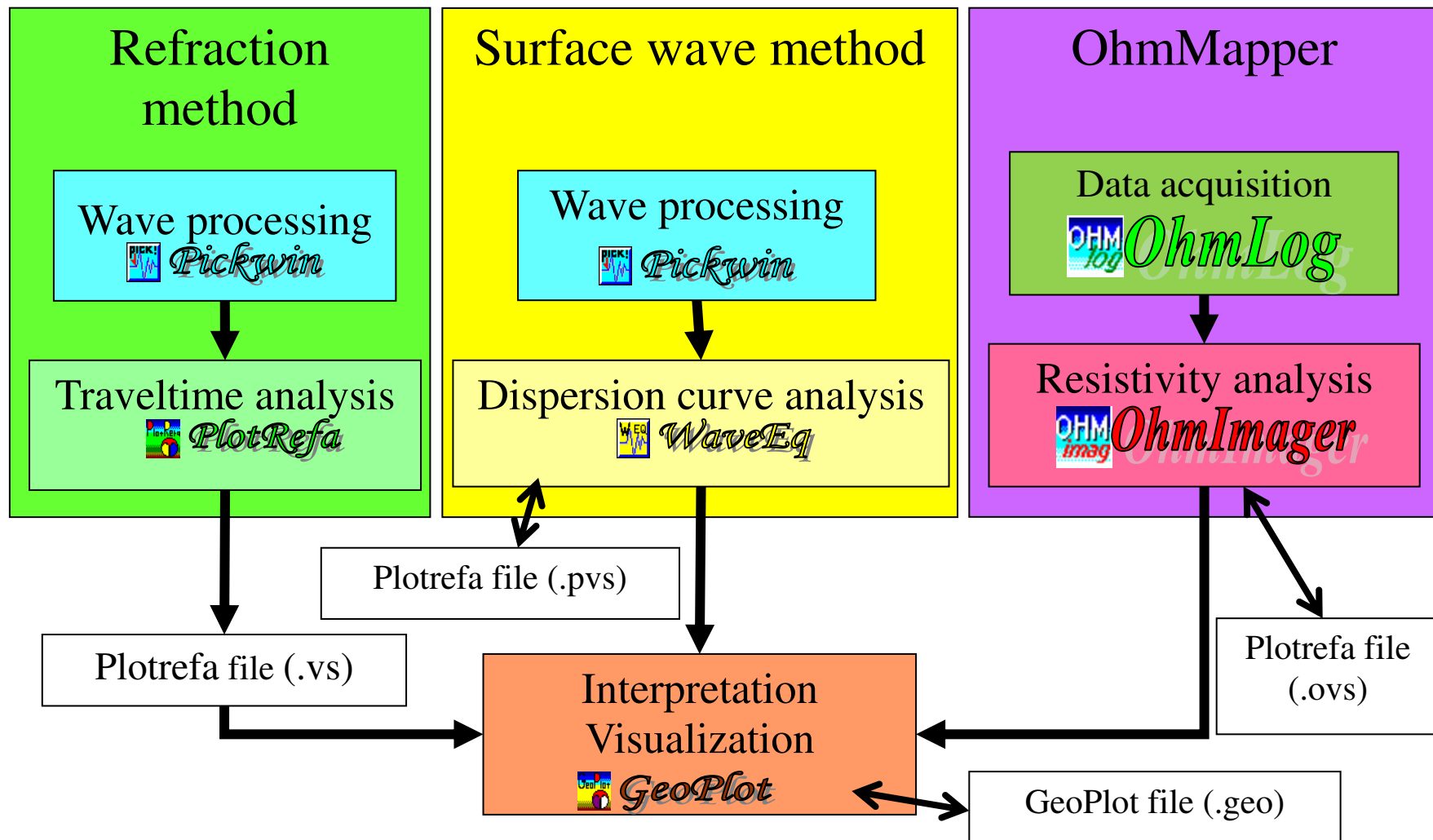


Figure 1.4 Summary of the OhmImager and SeisImager suites.

2. Outline of figures shown in the OhmImager

This section introduces main figures used for editing and analysis of data in OhmImager. Figures can be shown are summarized as follows.

1) OhmMapper Lines

In the OhmMapper measurements and analysis, a *Line* is a series of measurements bracketed by *START* and *STOP* marks. The *Lines* must be continuous measurement and geometry of transmitter and receiver cannot be changed in each line. One survey profile consists of several *Lines*. The OhmImager shows measured resistance or apparent resistivity as a function of distance calculated by markers or GPS locations.

2) 2D apparent resistivity section (measured data)

Measured apparent resistivity data are shown in a section of distance calculated by markers or GPS locations and apparent depth calculated by geometry. Apparent resistivity is expressed by different colors.

3) 2D apparent resistivity section (gridded data)

Measured apparent resistivity data are horizontally averaged with constant spacing and gridded in horizontal direction. 1D inversion is applied to each gridded data. The gridded data are shown in a section of distance and depth. Apparent resistivity is expressed by different colors.

4) 1D resistivity data

Horizontally gridded apparent resistivity data are shown as a function of depth. This figure is called ρ -a curve. Resistivity models (initial model or inverted result) and theoretical resistivity for the resistivity model can be shown as well.

5) 2D resistivity model

Successive 1D resistivity models (initial model or inverted result) made from gridded apparent resistivity data are shown as a 2D resistivity section.

6) 2D resistivity model (shown by GeoPlot)


Successive 1D resistivity models (initial model or inverted result) can be shown as a 2D resistivity model by GeoPlot. Topographic data can be incorporate in GeoPlot.


7) GPS map





GPS locations recorded together with the OhmMapper data can be shown in a map with UTM coordinate.

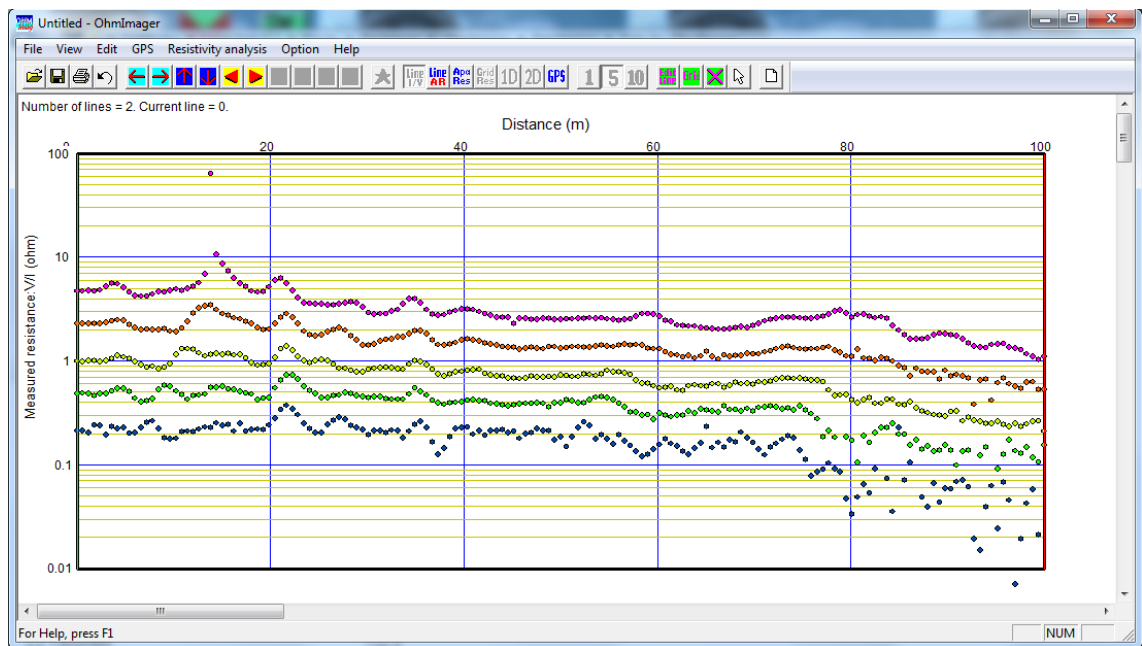
2.1 OhmMapper Lines



In the OhmMapper measurements and analysis, a *Line* is a series of measurements bracketed by *START* and *STOP* marks. The *Lines* must be continuous measurement and geometry of transmitter and receiver cannot be changed in each line. One survey profile consists of several *Lines*. Originally measured OhmMapper Line's data (measured resistance or apparent resistivity) are shown as a function of distance calculated by markers or GPS locations. Select *Show OhmMapper line (measured*

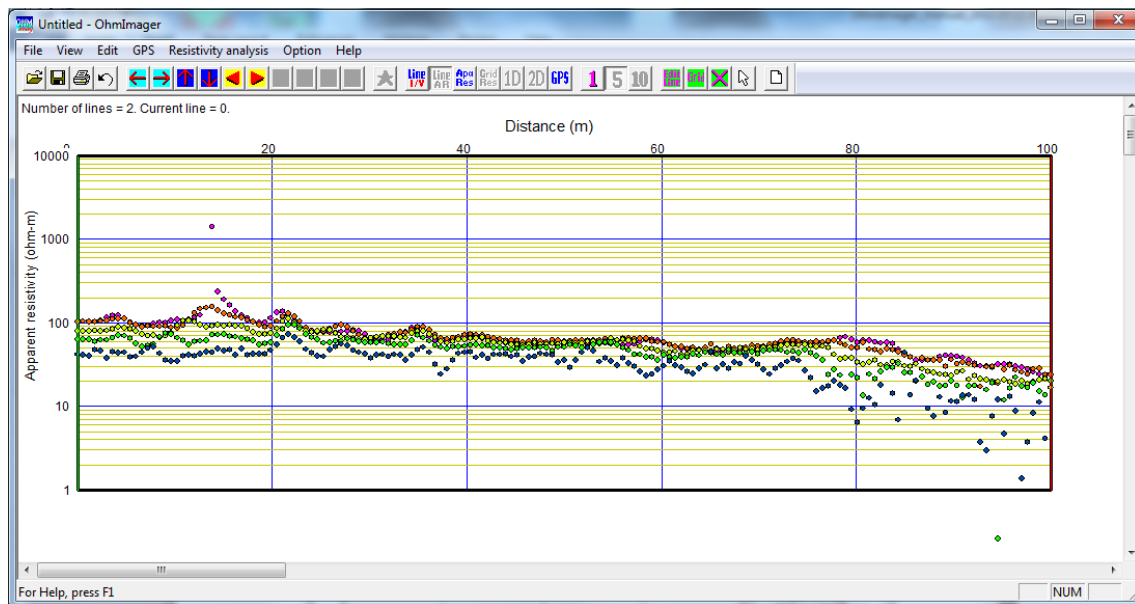
resistance : V/I) in the *View* menu or click the  button on a tool bar to show measured resistance (V/I) and select *Show OhmMapper line (apparent resistivity)* or



click the  button to show apparent resistivity. If more than 2 receivers were used in measurements, you can select whether showing each receiver or all receivers to click the

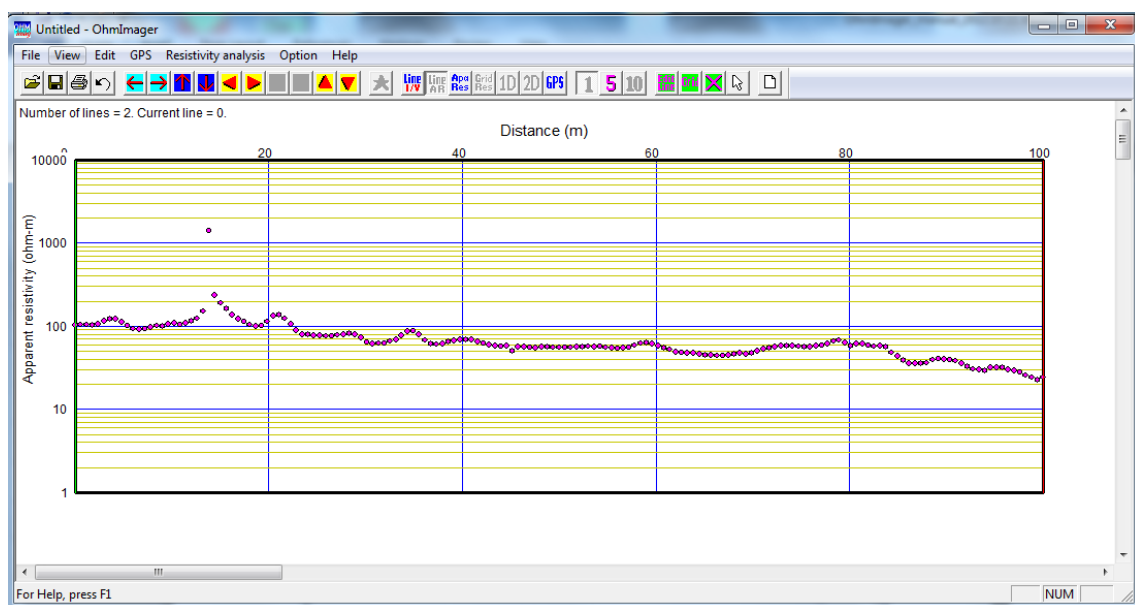
 or  buttons. Use the   buttons to scroll a receiver to be shown when one receiver is shown. Distance in the figure corresponds to the place of an operator.







Measured resistance of 5 receivers ( and  buttons).




Apparent resistivity of 5 receivers ( and  buttons)





Apparent resistivity of single receivers ( and  buttons).


Use the   buttons to scroll a receiver to be shown.


Each receiver is shown as colors shown below. The colors are same as OhmLog.

 : First receiver (closest to a transmitter and farthest to an operator)

 : Second receiver



 : Third receiver

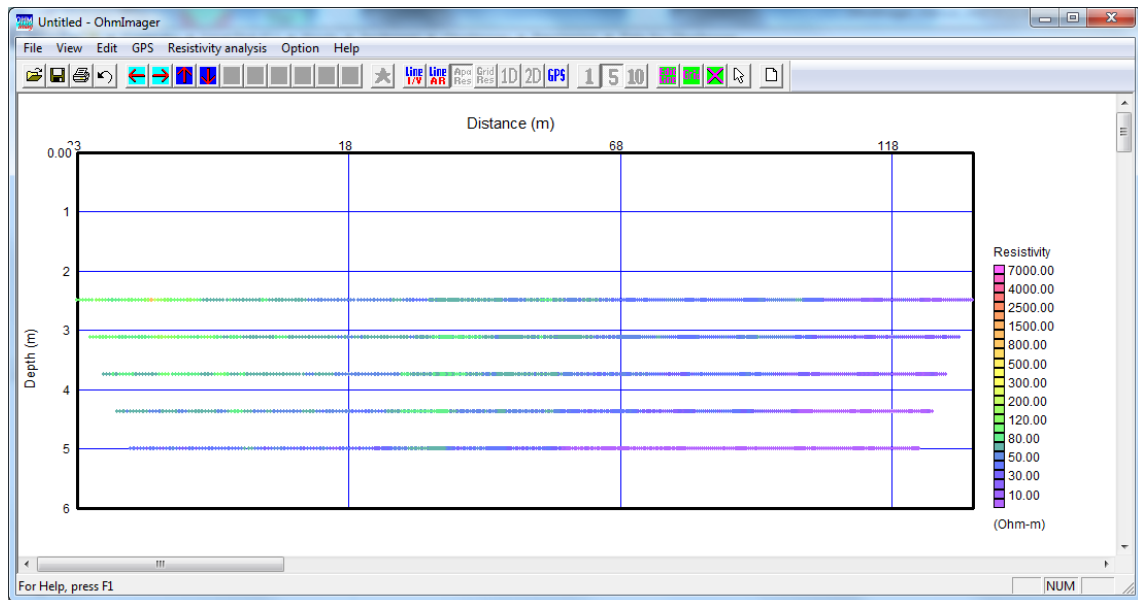
 : Fourth receiver

 : Fifth receiver (closest to an operator)

2.2 2D apparent resistivity section (measured data)


Measured apparent resistivity data are shown in a section of distance calculated by markers or GPS locations and apparent depth calculated by geometry. Apparent resistivity is expressed by different colors and low resistivity data are shown with blue to green and high resistivity data are shown with yellow to red.


Select *Show 2D apparent resistivity data (original)* in the *View* menu or click the  button. If more than 2 receivers were used in measurements, all receiver data are shown normally. Use *Edit lines* in *Edit* menu or click the  button to select receivers to be shown. Distance of each data corresponds to the middle of a transmitter and a receiver.

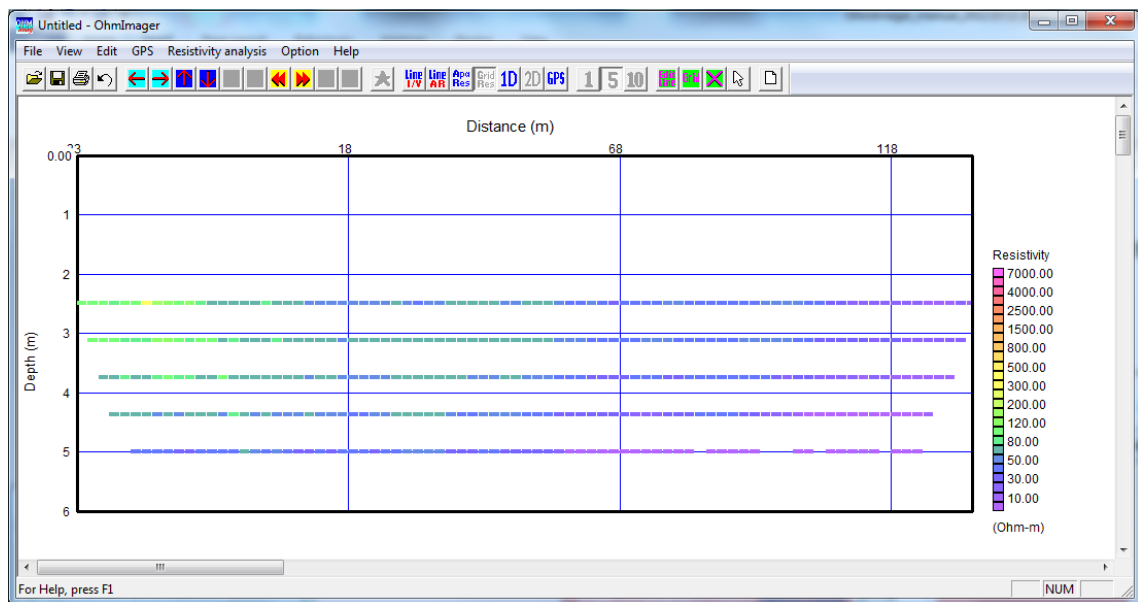


2.3 2D apparent resistivity section (gridded data)

Measured apparent resistivity data are horizontally averaged with constant spacing and gridded in horizontal direction. This operation is called *Gridding* in this manual. 1D inversion is applied to each gridded data.

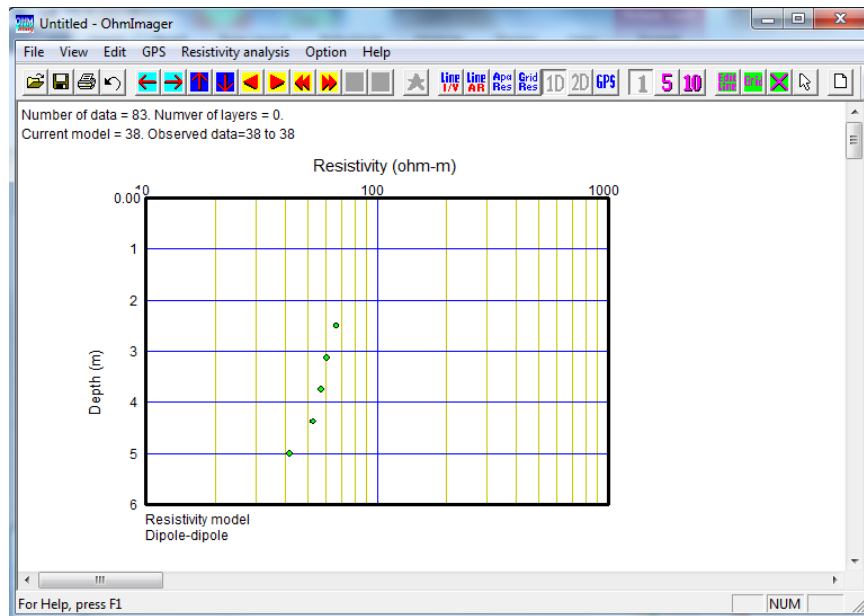
Select *Convert to grid data* in the *Resistivity analysis* menu or click the  button to grid apparent resistivity data.

The gridded data are shown in a section of distance and depth. Apparent resistivity is expressed by different colors. Select *Show 2D apparent resistivity data (gridded data)* or click the  button to show gridded apparent resistivity data.

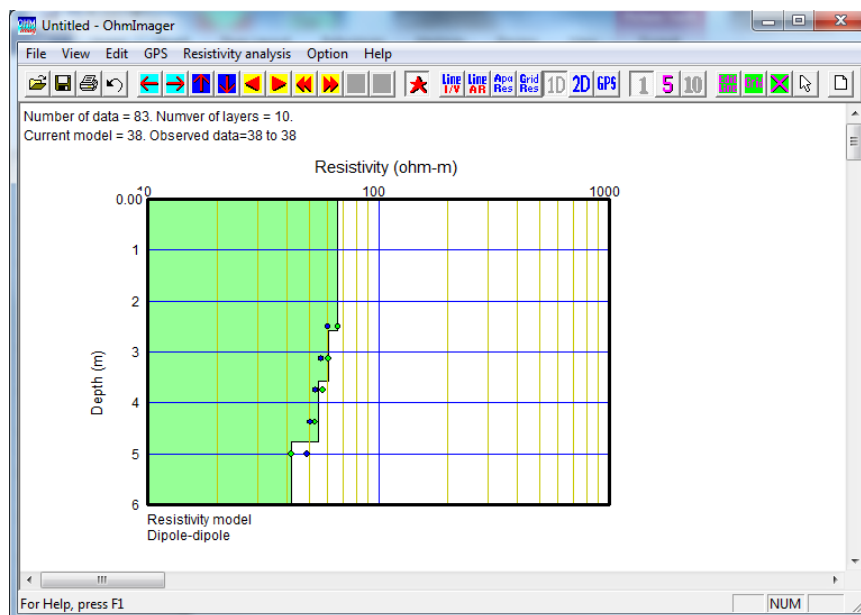


2.4 1D resistivity data

Horizontally gridded apparent resistivity data are shown as a function of depth. This figure is called as ρ - a curve. Select *Show 1D resistivity model* in the *View* menu or click the **1D** button to show 1D resistivity data. Resistivity models (initial model or inverted result) and theoretical resistivity for the resistivity model can be shown as well.




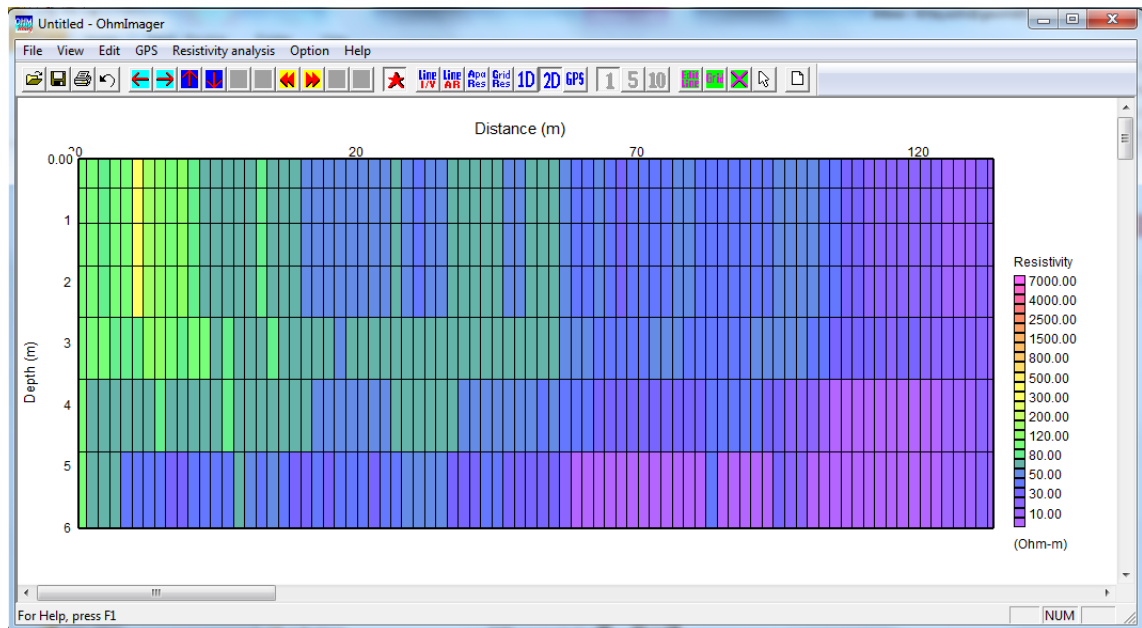
Only gridded apparent resistivity data are shown.



Resistivity model and theoretical apparent resistivity are shown as well.

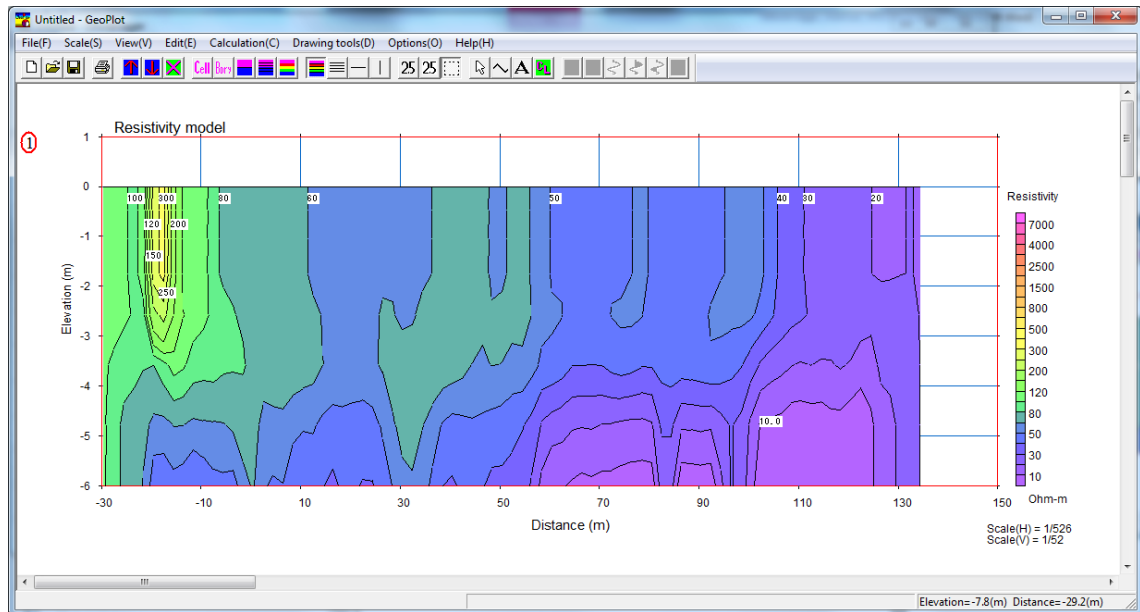
2.5 2D resistivity model

Successive 1D resistivity models (initial model or inverted result) made from gridded apparent resistivity data are shown as a 2D resistivity section. Select *Show 2D resistivity model* in the *View* menu or click the  button to show the 2D resistivity model.




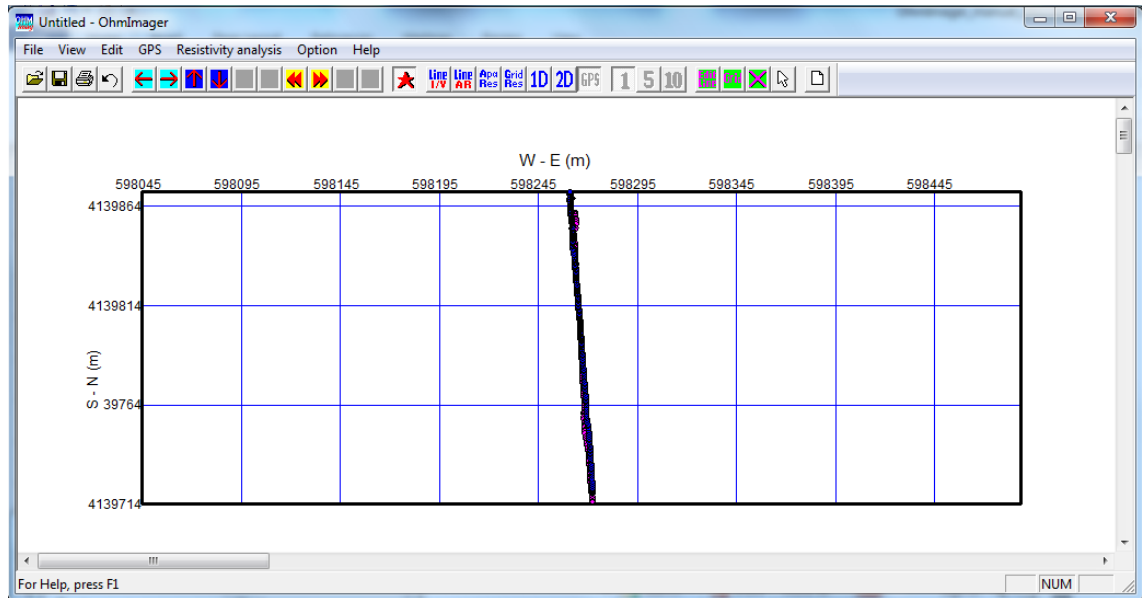
2.6 2D resistivity model (shown by GeoPlot)

Successive 1D resistivity models (initial model or inverted result) can be shown as a 2D resistivity model by GeoPlot. Select *Show 2D resistivity model* <launches GeoPlot> in the *View* menu to show the 2D resistivity model by GeoPlot. Using GeoPlot, detailed visualization parameters, such as contour color or axis configuration can be set up. Topographic data can be incorporate in GeoPlot too.



2.7 GPS map

GPS locations recorded together with the OhmMapper data can be shown in a map with UTM coordinate. Select *Show GPS map* in the *View* menu or click the  button to show the GPS map. A survey line can be defined by mouse along a trajectory of GPS data using this view.



3. Processing flow

Figure 3.1 shows a processing flow using a Windows PC and *OhmLog* for data acquisition. Figure 3.2 shows a processing flow using a console (G858) for data acquisition and *MagMap2000* for preliminary processing. Section 3.1 describes the processing flow of the former one. The latter one is partially described in Section 3.4. Refer *Magmap2000 User Guide* for detailed instruction of *MagMap2000*. Section 3.2 describes a processing with GPS data and Section 3.3 describes a processing flow data acquisition using the console (G858).

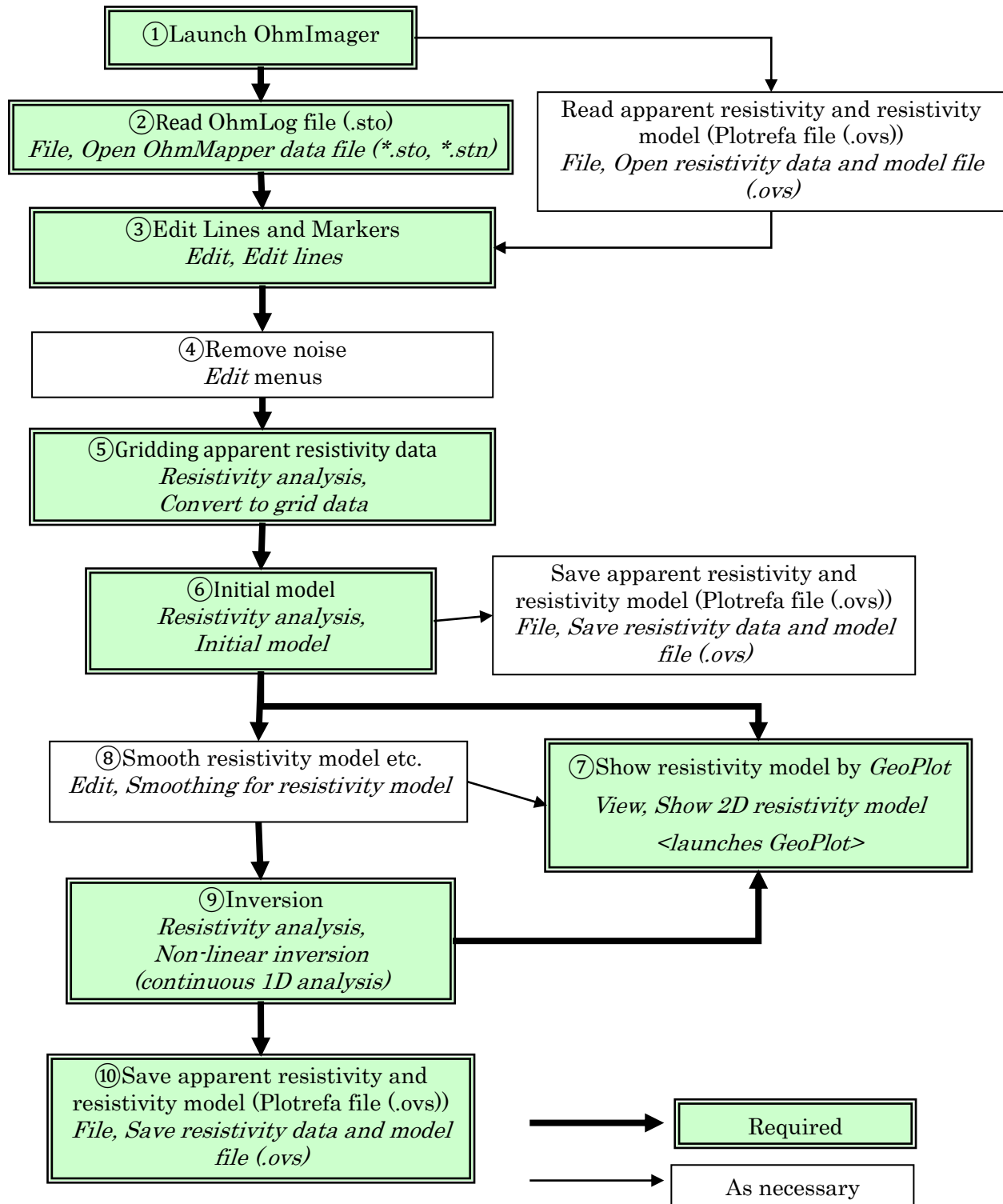


Figure 3.1 Processing flow using a Windows PC and *OhmLog* for data acquisition.

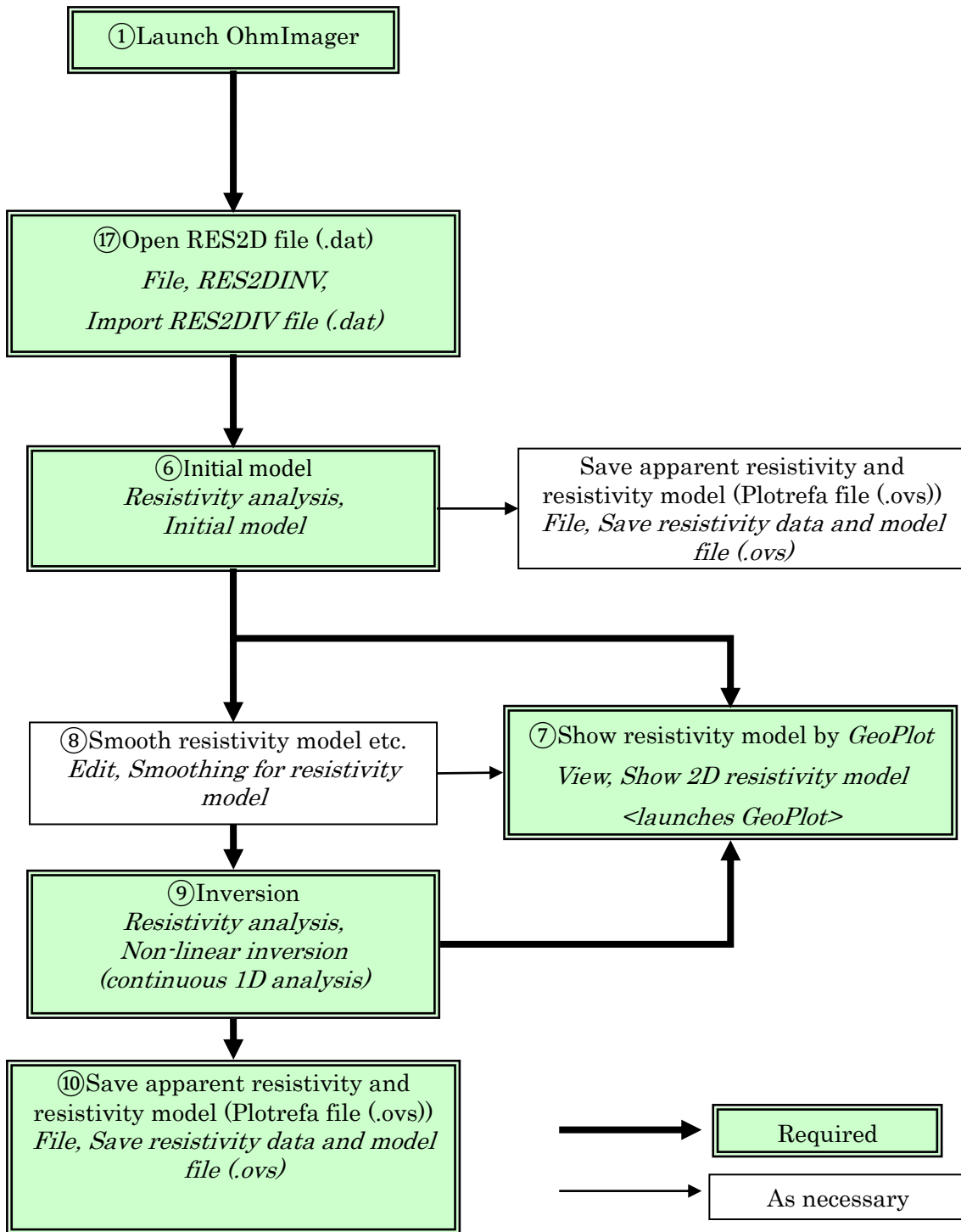
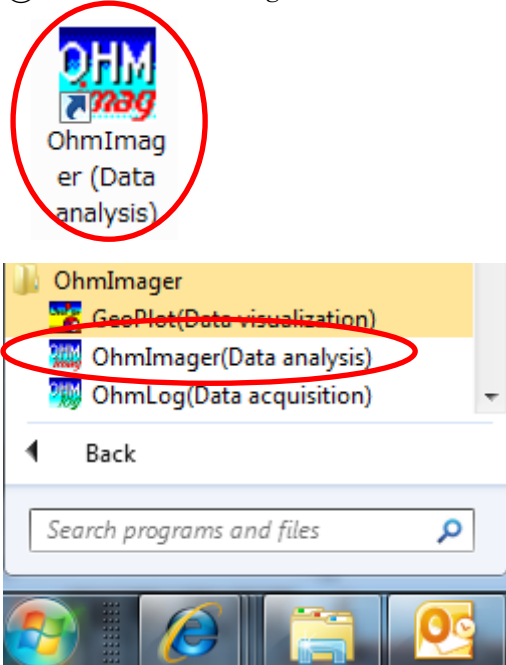


Figure 3.2 Processing flow using a console (G858) for data acquisition and *MagMap2000* for preliminary processing.

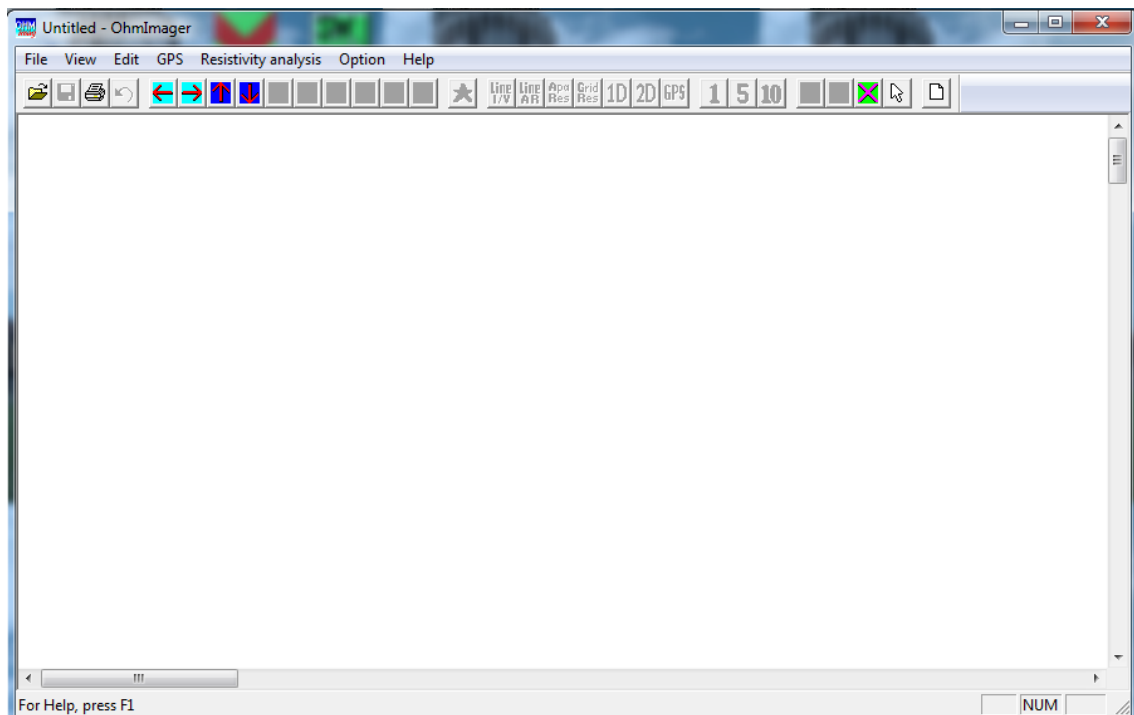
3.1 Processing flow using a Windows PC and *OhmLog* for data acquisition

① Launch OhmImager



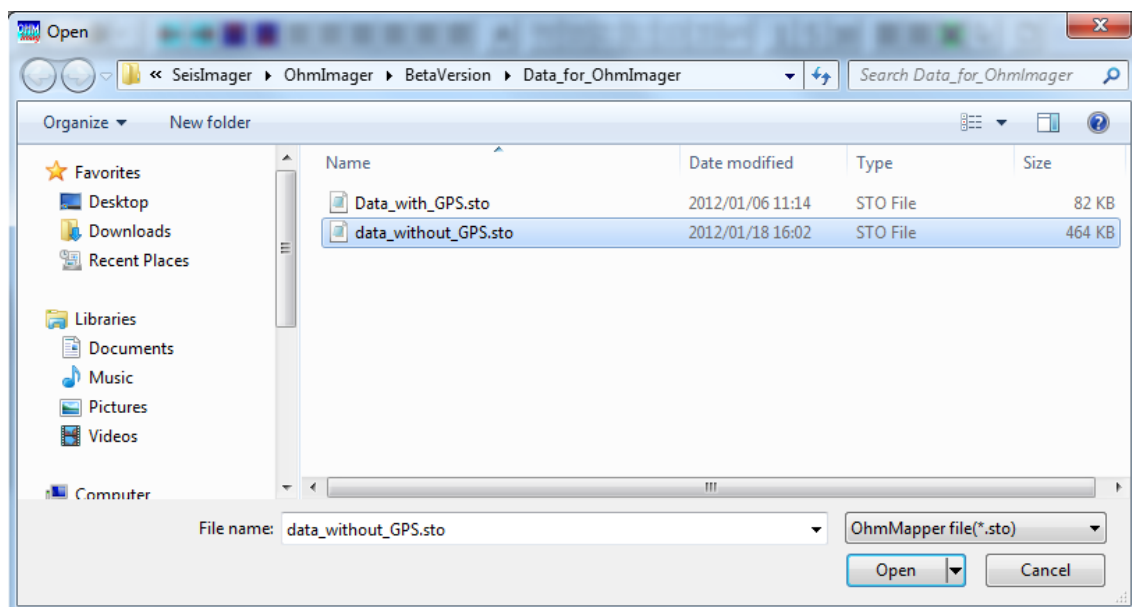
Double click the short cut of *OhmImager* on disk top of PC or select *OhmImager* in *OhmImager* in the Windows' start menu to launce the *OhmImager*.

A window of the *OhmImager* is as shown below.

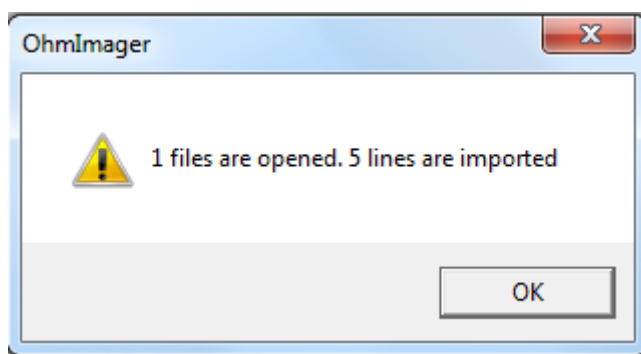


② Read OhmLog file (.sto)

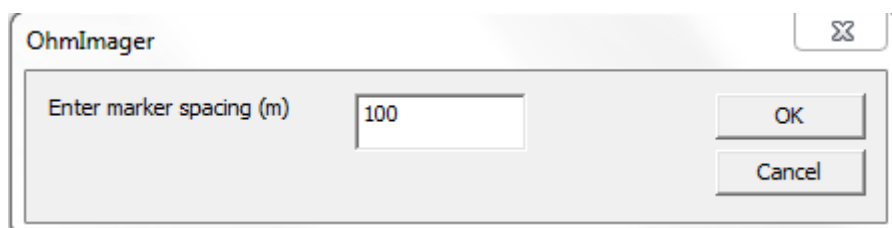
Select *Open OhmMapper data file (*.sto, *.stn)* in the *File* menu to open OhmMapper data files (*.sto) that saved by the *OhmLog*. Data files (*.stn) saved by MagMap2000 can be also read. Several files can be read at once.




Number of files and Lines are shown. Confirm them.



Enter standard Marker spacing. Individual Marker distance can be edited in later. This dialog box is not shown when *.stn files are read.



③ Edit Lines and Markers

After reading OhmMapper data files (*.sto, *.stn), a window shown below appears for editing Lines and Markers. Select Edit lines in the Edit menu or click the  button to show the edit window when data are already read.

Index	Active	Number of marker	Start (m)	End (m)	Number of data	Dipole size(m)	Rope length(m)	Number of receivers	Direction	Delete	Edit
0	<input checked="" type="checkbox"/>	2	0	100	0	5	5	0	Forward	Delete	Edit
1	<input checked="" type="checkbox"/>	21	2000	0	1493	5	2.5	4	Reverse	Delete	Edit
2	<input checked="" type="checkbox"/>	20	0	1900	1436	5	12.5	4	Forward	Delete	Edit
3	<input checked="" type="checkbox"/>	21	2000	0	1528	10	5	4	Reverse	Delete	Edit
4	<input checked="" type="checkbox"/>	21	0	2000	1450	10	25	4	Forward	Delete	Edit

- * Markers are set with the standard spacing entered at the step ② at first time.
- * Direction of measurement was assumed to go back and forth.
- * Number of Markers, number of data and OhmMapper geometry are shown. Confirm them.

a) Delete Lines

Click the *Delete* buttons to delete unnecessary lines.

Number of lines: 5

Index	Active	Number of marker	Start (m)	End (m)	Number of data	Dipole size(m)	Rope length(m)	Number of receivers	Direction	Delete	Edit
0	<input checked="" type="checkbox"/>	2	0	100	0	5	5	0	Forward	Delete	Edit
1	<input checked="" type="checkbox"/>	21	2000	0	1493	5	2.5	4	Reverse	Delete	Edit
2	<input checked="" type="checkbox"/>	20	0	1900	1436	5	12.5	4	Forward	Delete	Edit
3	<input checked="" type="checkbox"/>	21	2000	0	1528	10	5	4	Reverse	Delete	Edit
4	<input checked="" type="checkbox"/>	21	0	2000	1450	10	25	4	Forward	Delete	Edit

Distance (m) plot showing 5 lines (0 to 4) with markers at various distances.

Confirmation message is shown.

OhmImager

Are you sure you want to delete a line?

OK Cancel

Click the *OK* button to delete a Line.

Number of lines: 4

Index	Active	Number of marker	Start (m)	End (m)	Number of data	Dipole size(m)	Rope length(m)	Number of receivers	Direction	Delete	Edit
0	<input checked="" type="checkbox"/>	21	2000	0	1493	5	2.5	4	Reverse	Delete	Edit
1	<input checked="" type="checkbox"/>	20	0	1900	1436	5	12.5	4	Forward	Delete	Edit
2	<input checked="" type="checkbox"/>	21	2000	0	1528	10	5	4	Reverse	Delete	Edit
3	<input checked="" type="checkbox"/>	21	0	2000	1450	10	25	4	Forward	Delete	Edit

Distance (m) plot showing 4 lines (0 to 3) with markers at various distances.

b) Reverse Lines

To reverse a direction of measurement in each Line, click the *Forward* or *Reverse* buttons.

Number of lines: 4

Next Back

Index	Active	Number of marker	Start (m)	End (m)	Number of data	Dipole size (m)	Rope length (m)	Number of receivers	Direction	Delete	Edit
0	<input checked="" type="checkbox"/>	21	2000	0	1493	5	2.5	4	Reverse	Delete	Edit
1	<input checked="" type="checkbox"/>	20	0	1900	1436	5	12.5	4	Forward	Delete	Edit
2	<input checked="" type="checkbox"/>	21	2000	0	1528	10	5	4	Reverse	Delete	Edit
3	<input checked="" type="checkbox"/>	21	0	2000	1450	10	25	4	Forward	Delete	Edit

Line and marker Geometry Apparent depth N-space

Distance (m)

0 150 300 450 600 750 900 1100 1250 1400 1550 1700 1850 2000

0 1 2 3

The direction of clicked Line is reversed.

Number of lines: 4

Next Back

Index	Active	Number of marker	Start (m)	End (m)	Number of data	Dipole size (m)	Rope length (m)	Number of receivers	Direction	Delete	Edit
0	<input checked="" type="checkbox"/>	21	0	2000	1493	5	2.5	4	Forward	Delete	Edit
1	<input checked="" type="checkbox"/>	20	0	1900	1436	5	12.5	4	Forward	Delete	Edit
2	<input checked="" type="checkbox"/>	21	2000	0	1528	10	5	4	Reverse	Delete	Edit
3	<input checked="" type="checkbox"/>	21	0	2000	1450	10	25	4	Forward	Delete	Edit

Line and marker Geometry Apparent depth N-space

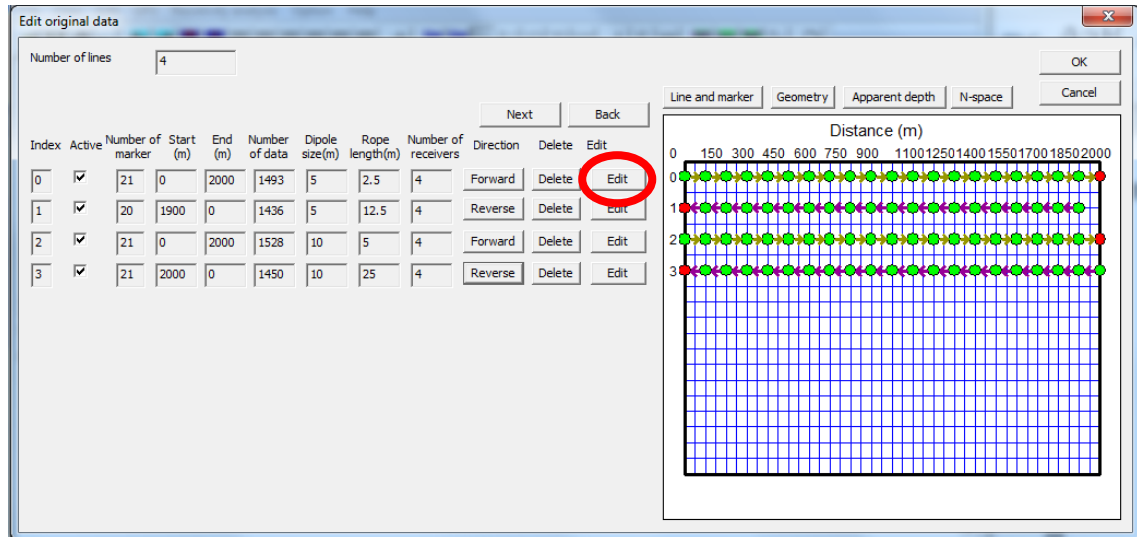
Distance (m)

0 150 300 450 600 750 900 1100 1250 1400 1550 1700 1850 2000

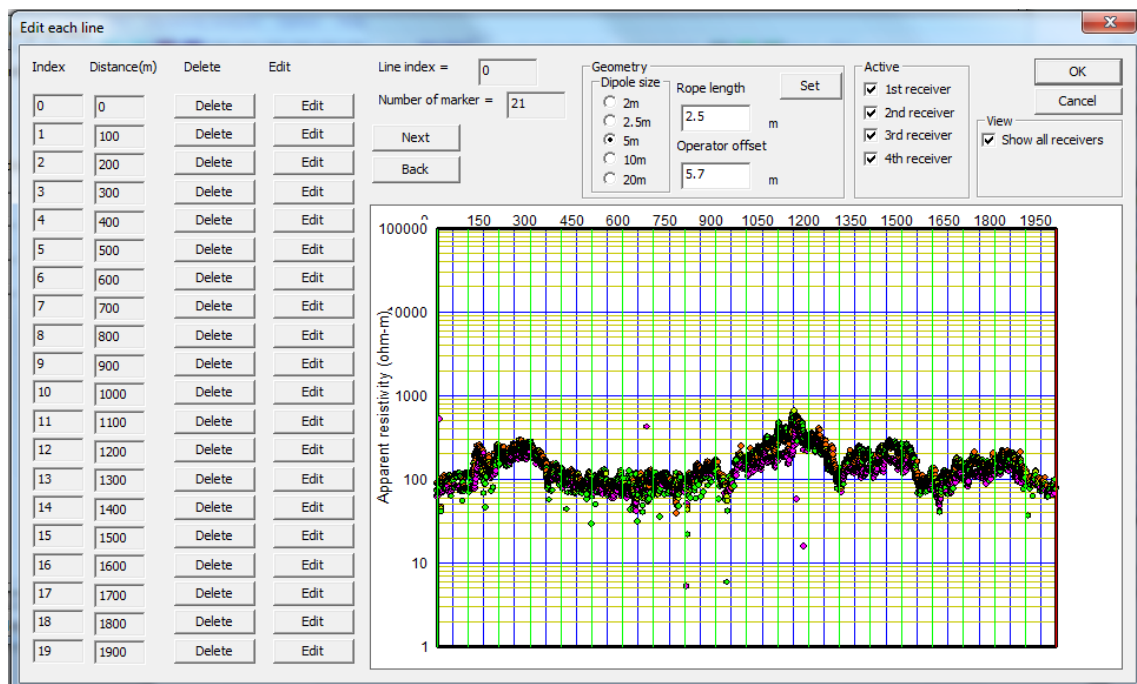
0 1 2 3

c) Edit each Line

To edit Markers in each line, click the *Edit* button.

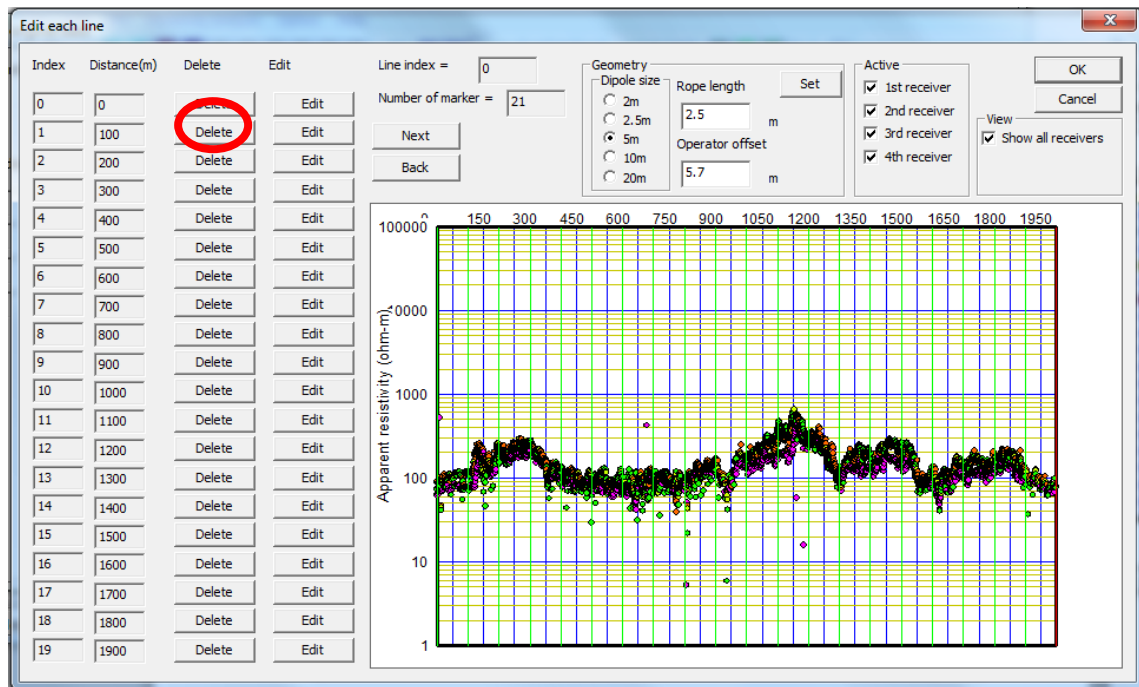


A window for editing markers in each Line appears.

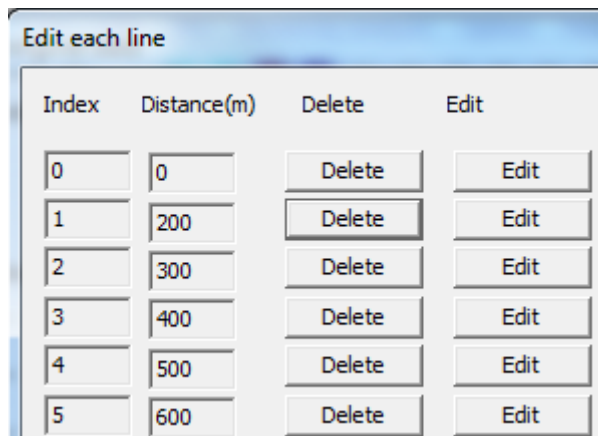


d) Delete Markers

Click the *Delete* button to delete Markers.

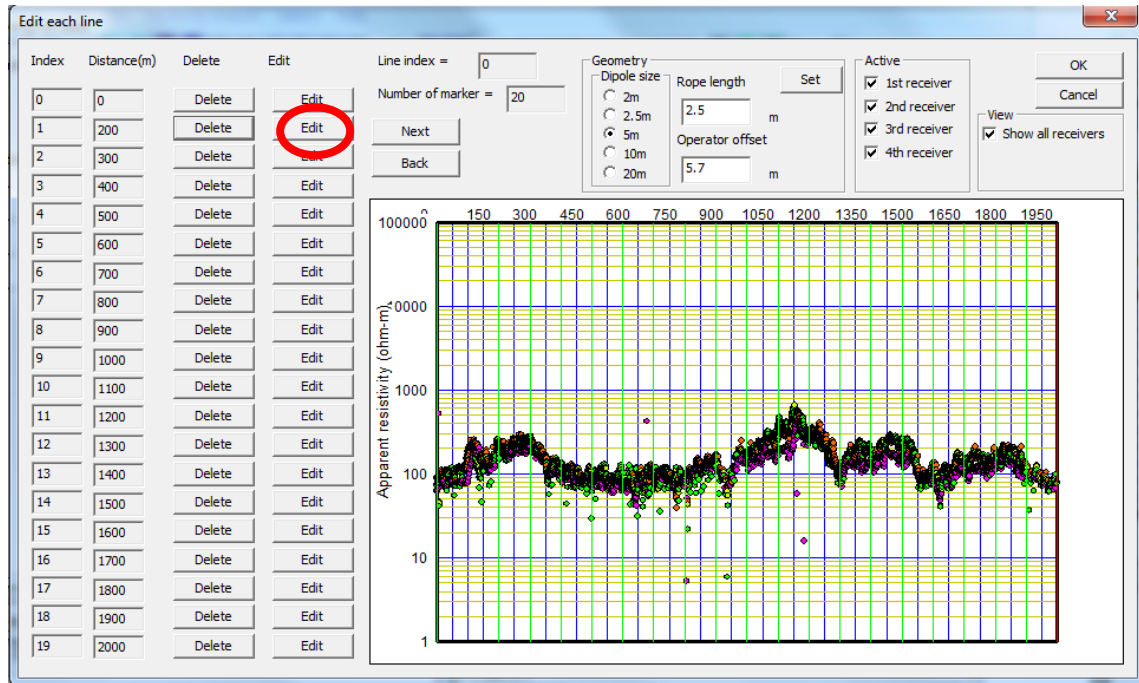


A marker is deleted.



e) Edit Marker distance



Click the *Edit* button to edit distance of individual Markers.

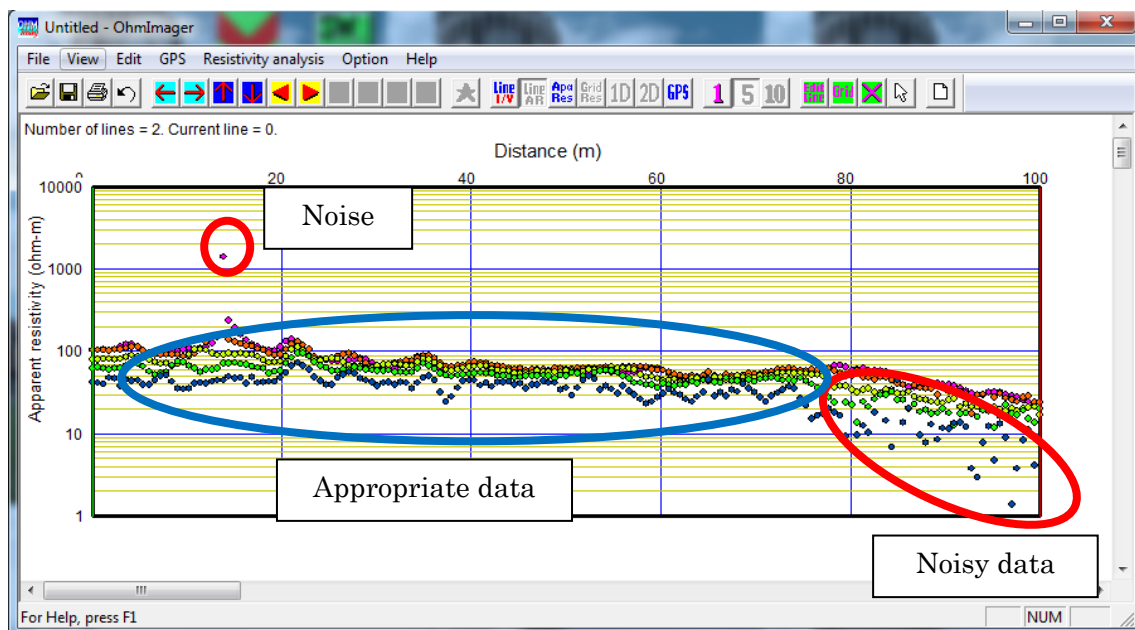



Distance can be edited with a dialog box. Check the *Shift following marker distance* to shift following marker distance too.

④ Remove noise


OhmMapper Line data are normally to be smooth as shown below. Inappropriate data (noise) must be removed before following processing if Lines are not smooth. Select

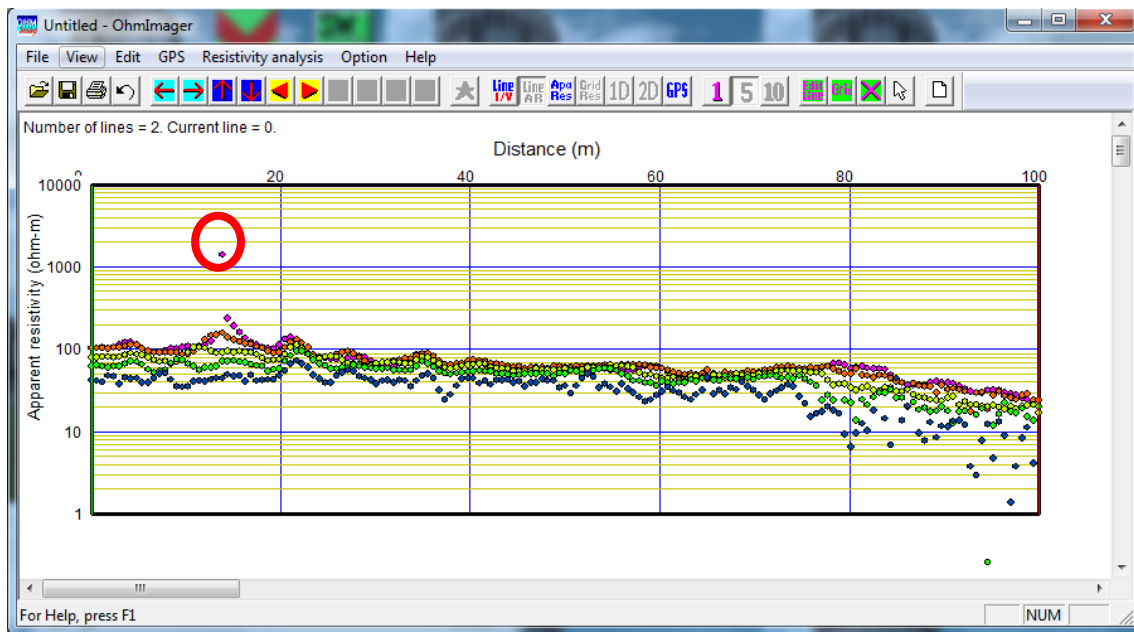
Show OhmMapper line (measured resistance : V/I) in the *View* menu or click the  button or Select *Show OhmMapper line (apparent resistivity)* in the *View* menu or click the  button to show Lines and remove noise.



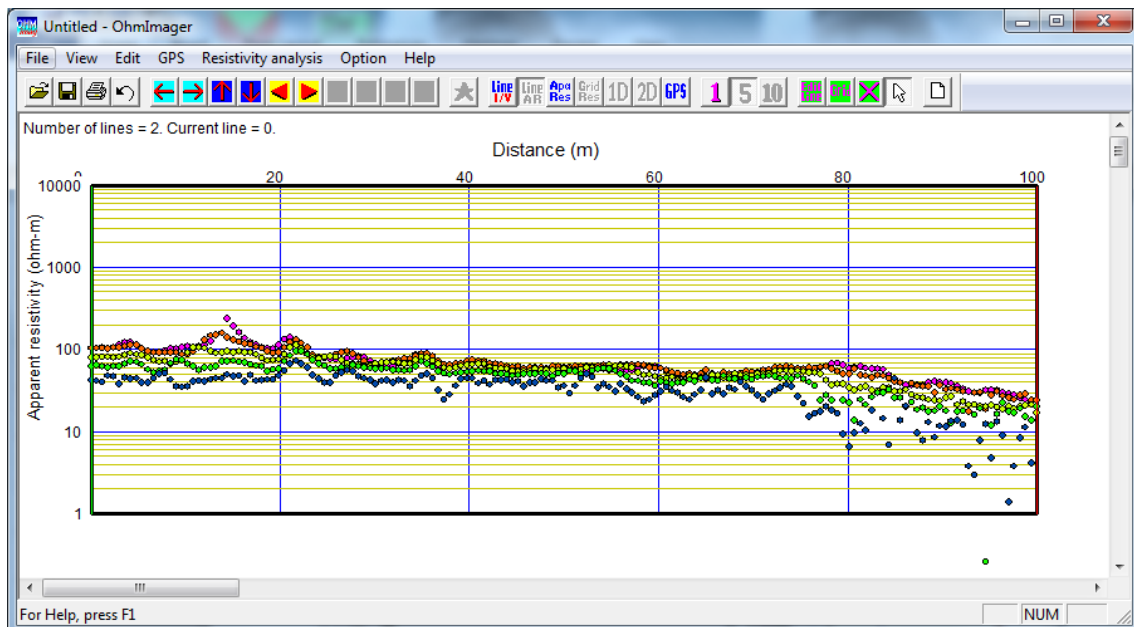
Noise removal can be done by following three methods. A wrong operation can be undone by selecting *Undo* in the *Edit* menu, press the *Ctrl+Z* or click the  button to undo.

a) Remove individual data

Individual data can be selected and deleted by a mouse. To select individual data, click the  button. Selected data are shown as red circles. Multiple data can be selected.

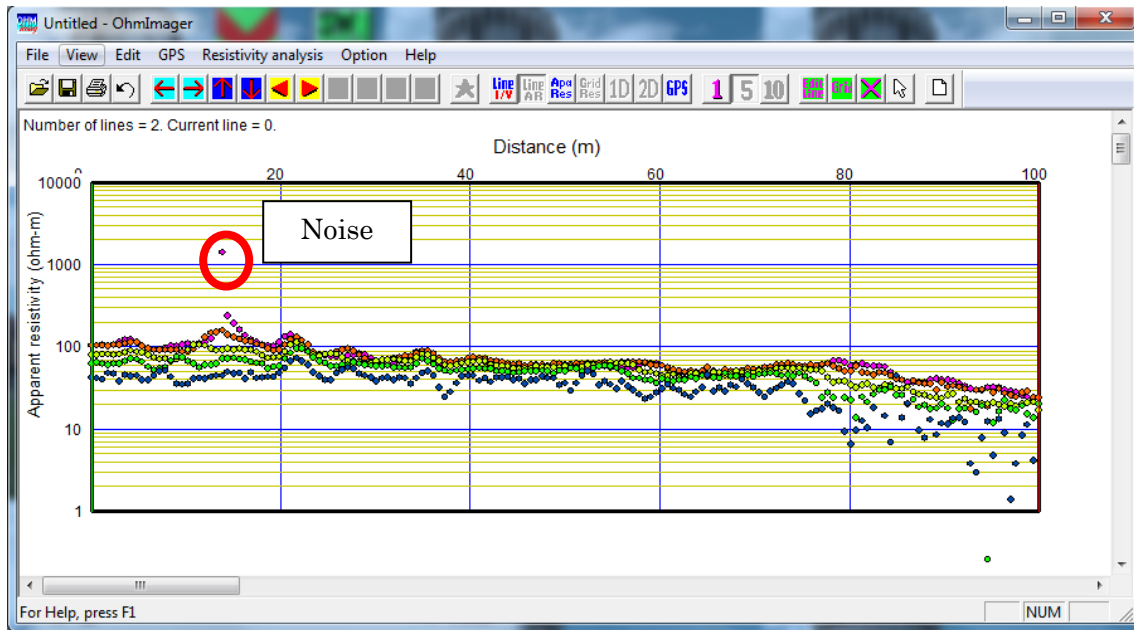


Press the *Delete* to delete data when data are selected. Selected data are deleted.

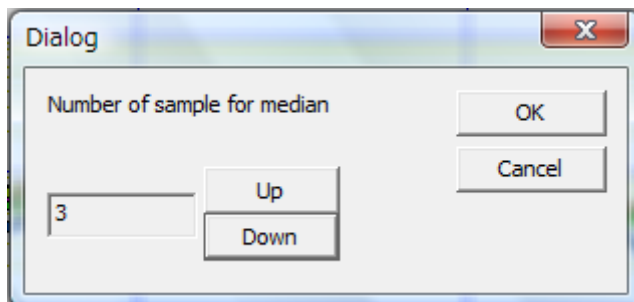


b) Delete isolated data (spike noise)

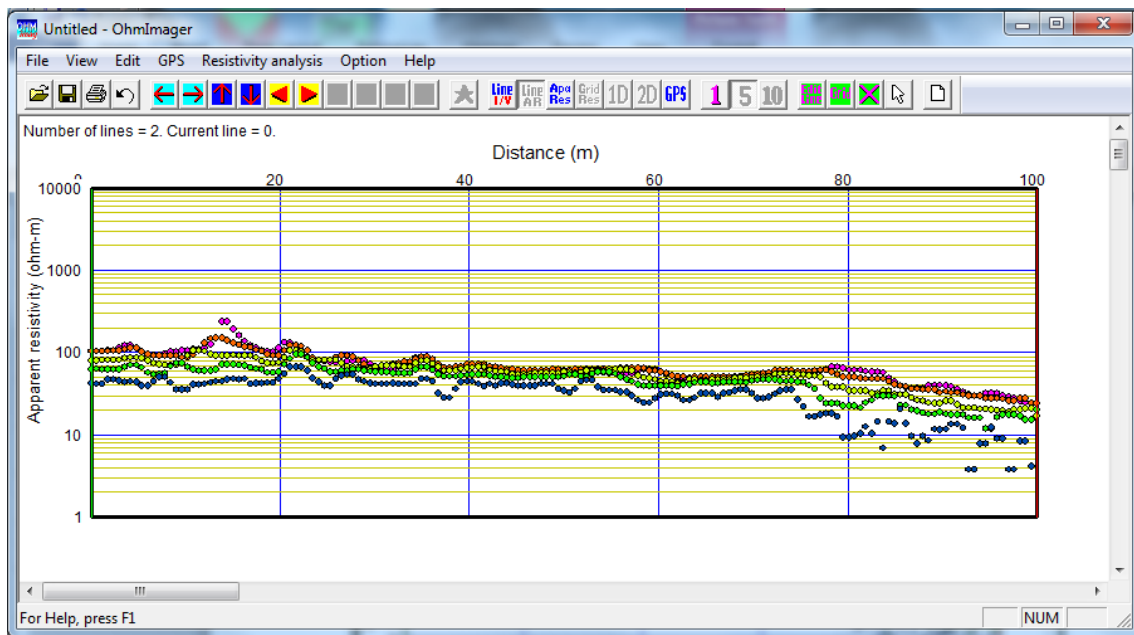
A median filter is efficient to delete isolated data (spike noise) as shown below.



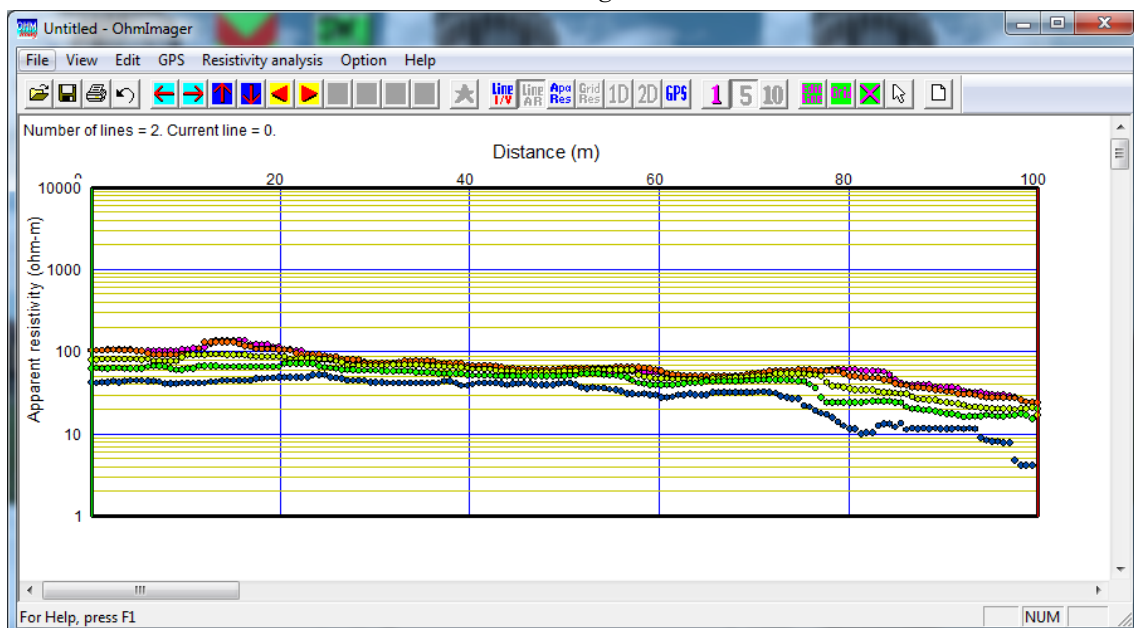
Select *Median filter (de-spike)* in the Edit menu to apply median filter. Set a filter length of the median filter at a dialog box. Odd numbers from 3 to 11 can be set as the filter length. Data become smoother as the filter length gets longer.



Examples of median filtered data with the filter length of 3 and 11 are shown below.



Filter length=3




Filter length=11

The median filter can be applied to each receiver. Show each receiver data by clicking the **1** button to apply the median filter to each receiver. The median filter is only applied to the receiver shown at that time.

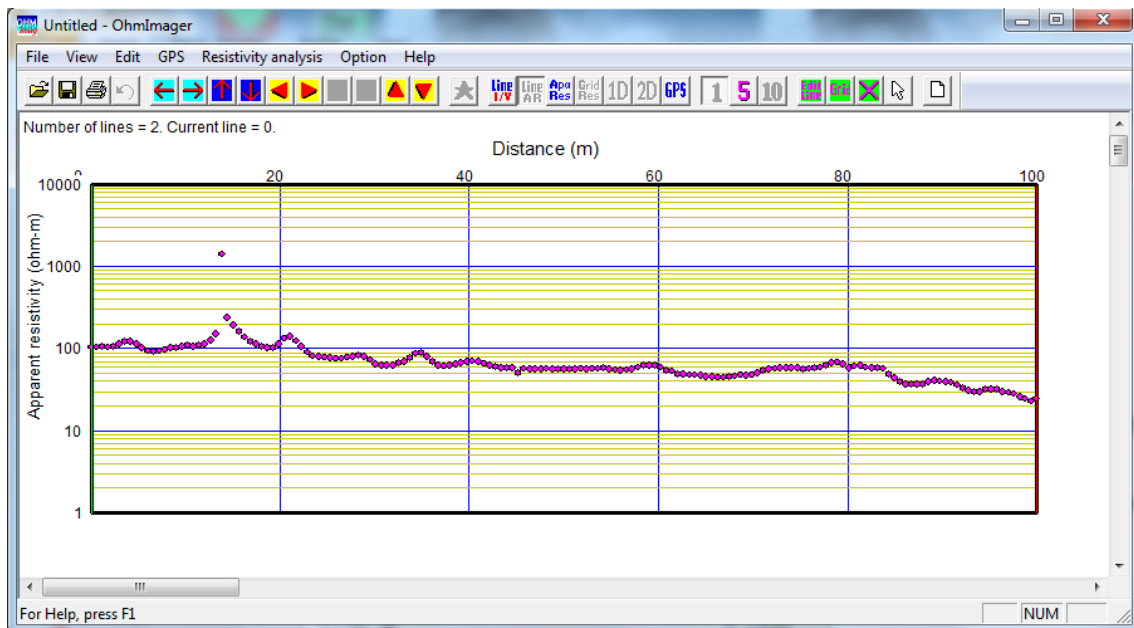
c) Delete data between gate

Data between gate can be deleted. The operation can be applied to all receivers or

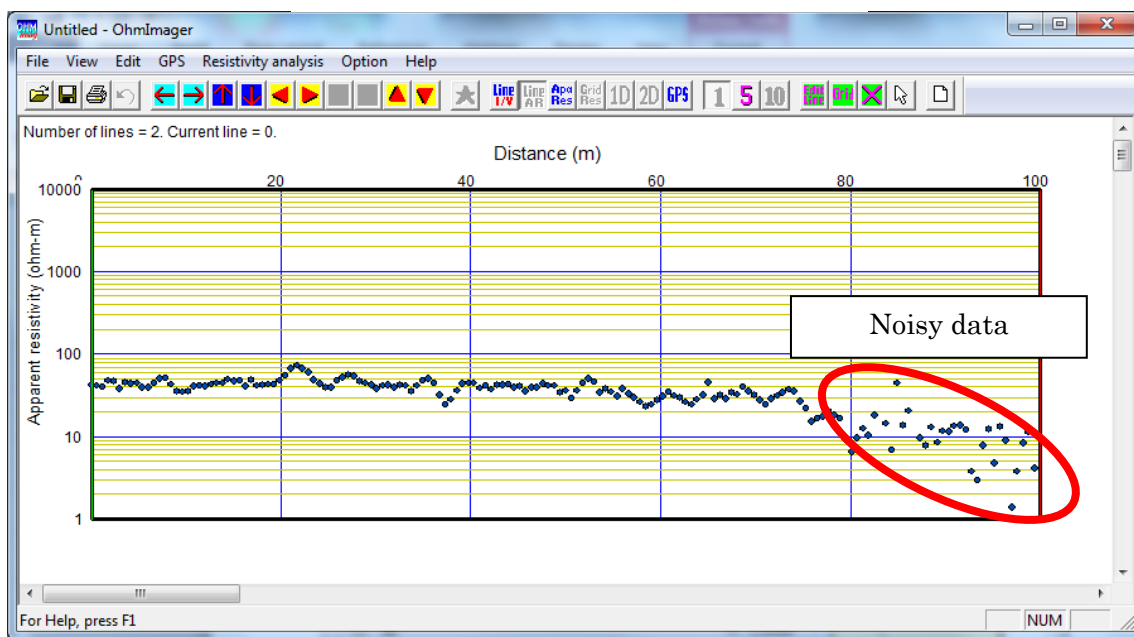
each receiver. To delete each receiver data, click the  button and show each

receiver. A receiver to be shown can be scrolled by the   buttons. In the example

shown below, 1st and 5th receivers are shown respectively.

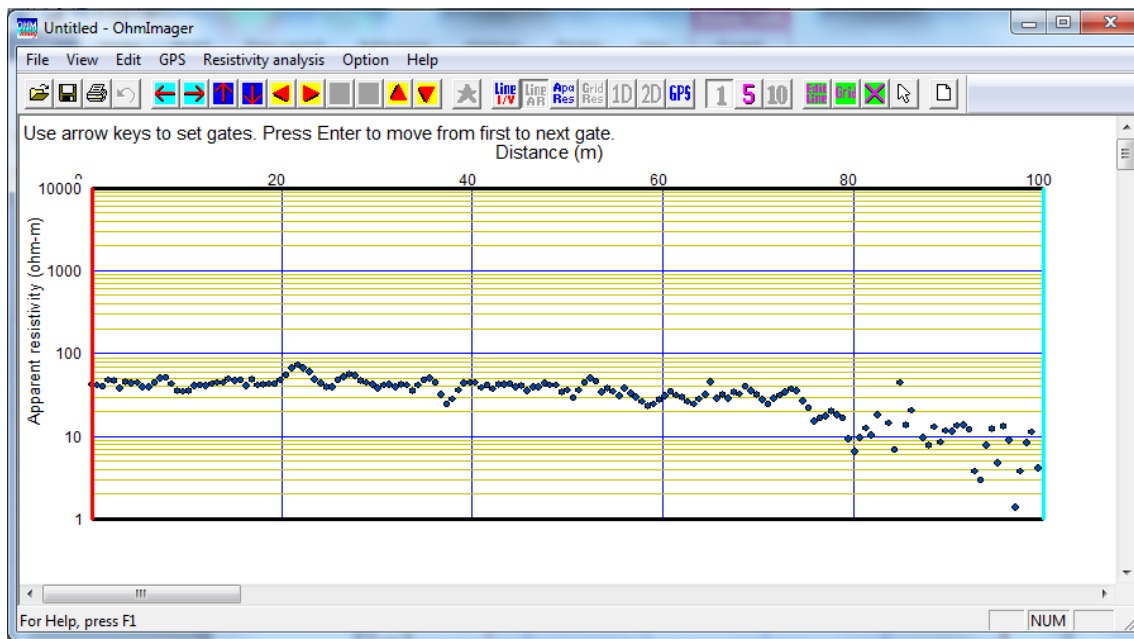


1st receiver (closest to a transmitter)

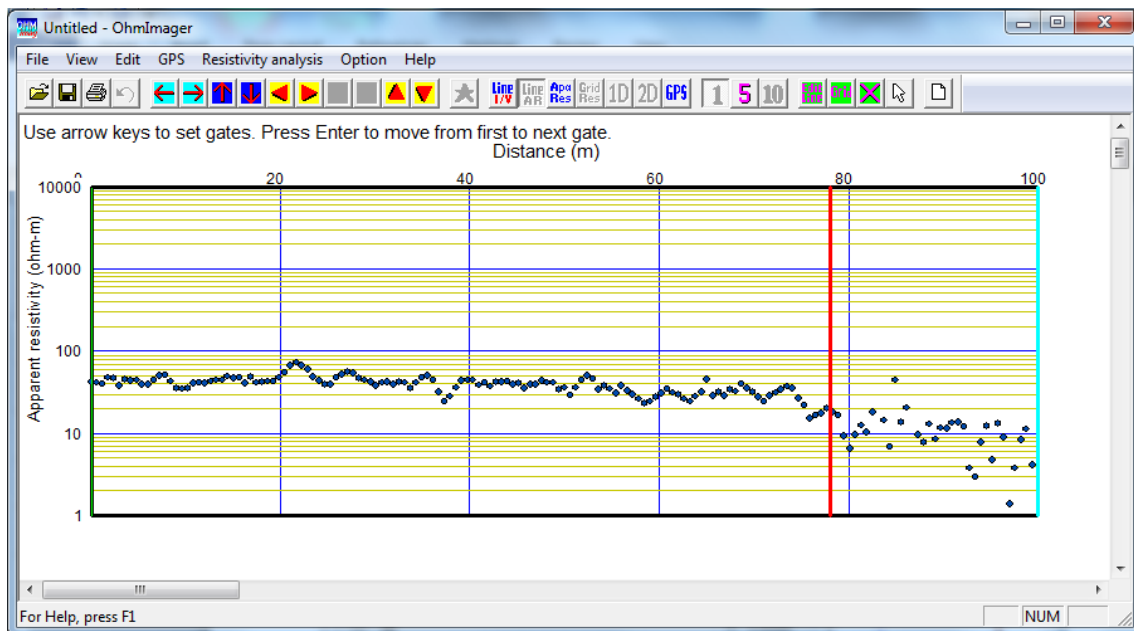


5th receiver (closest to an operator)

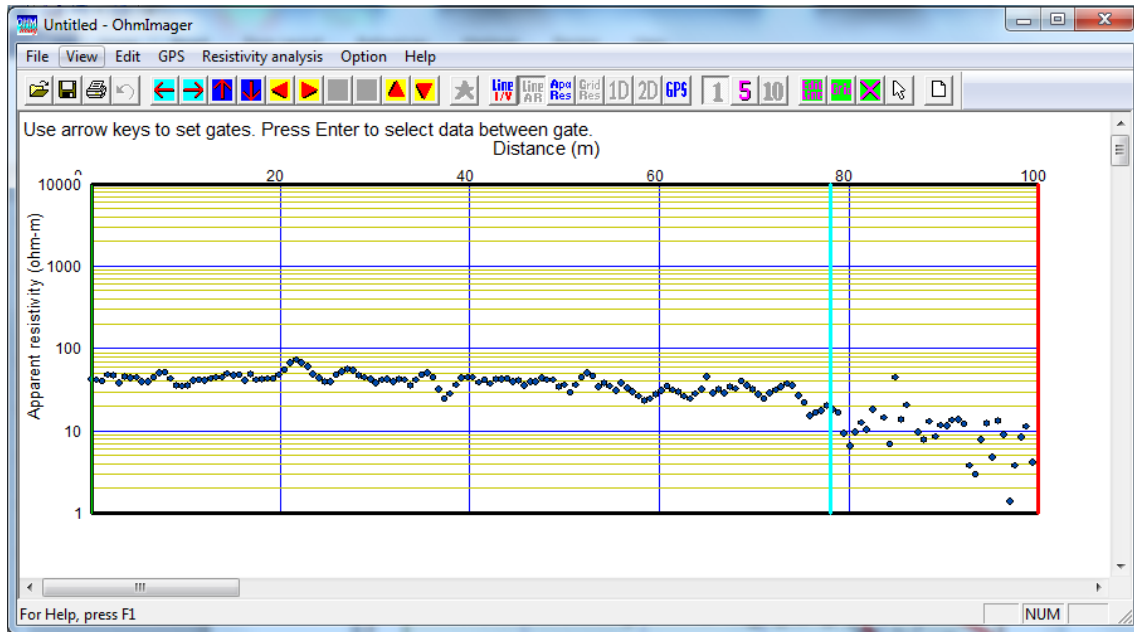
For example, the 5th receiver data from a distance of 80 to 100m will be deleted in a following procedure. Select *Select data between gate* in the *Edit* menu or press the *Ctrl+B*.



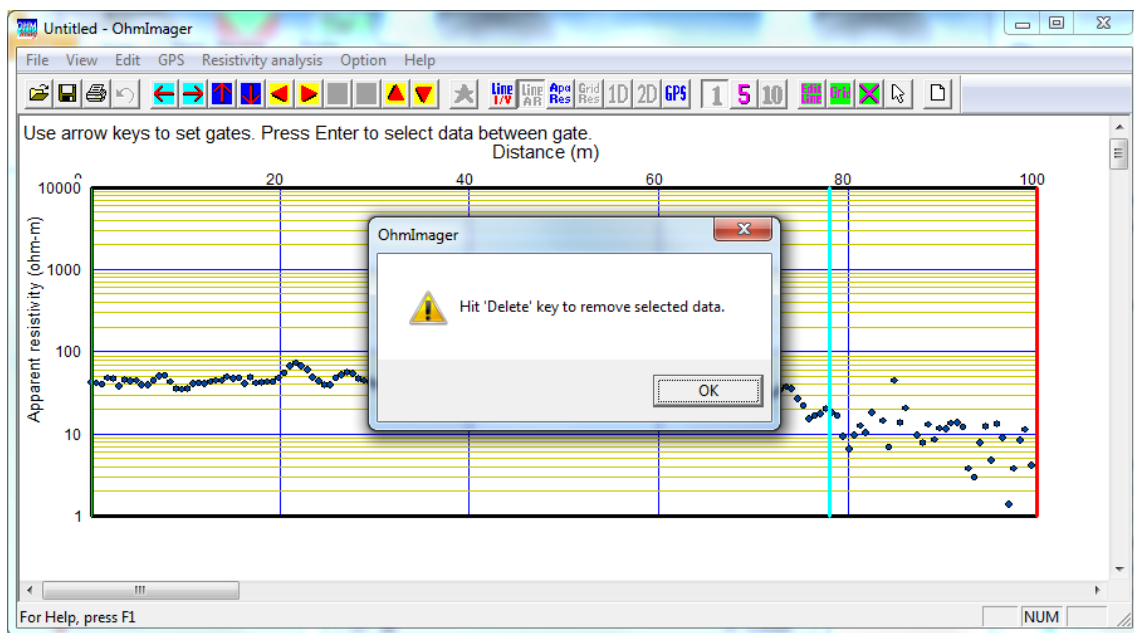
Use the <- or -> keys to move a left side gate (minimum distance) of selection.



Press the Enter key to set the left side gate and the next gate will become active. Use the <- or -> keys to move a right side gate (maximum distance) of selection.

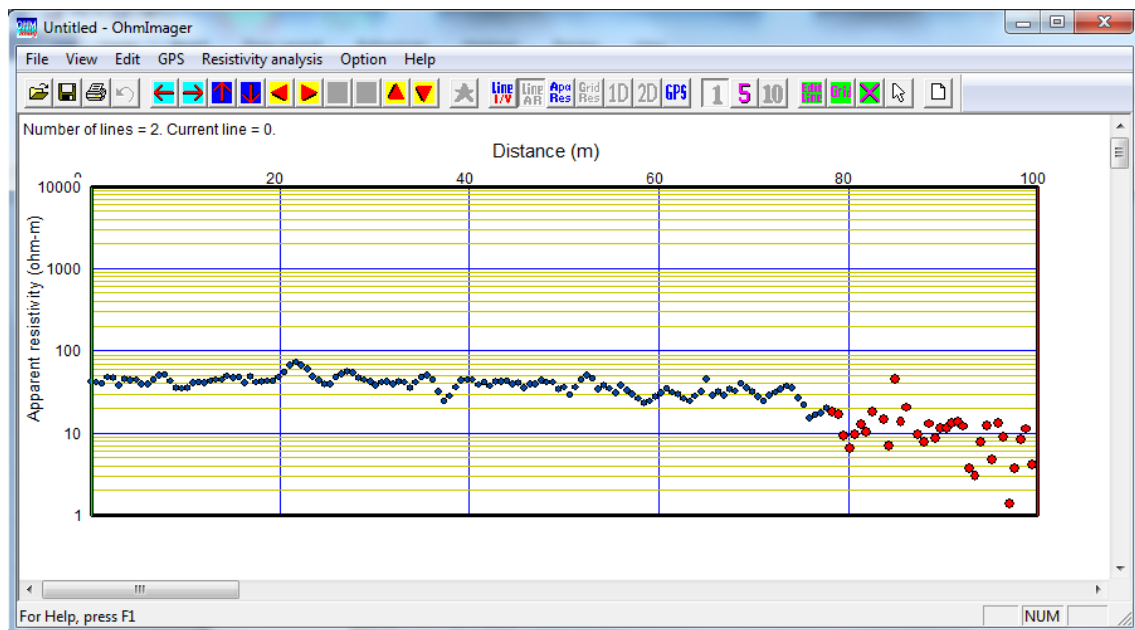


Press the Enter key to set the right side gate.

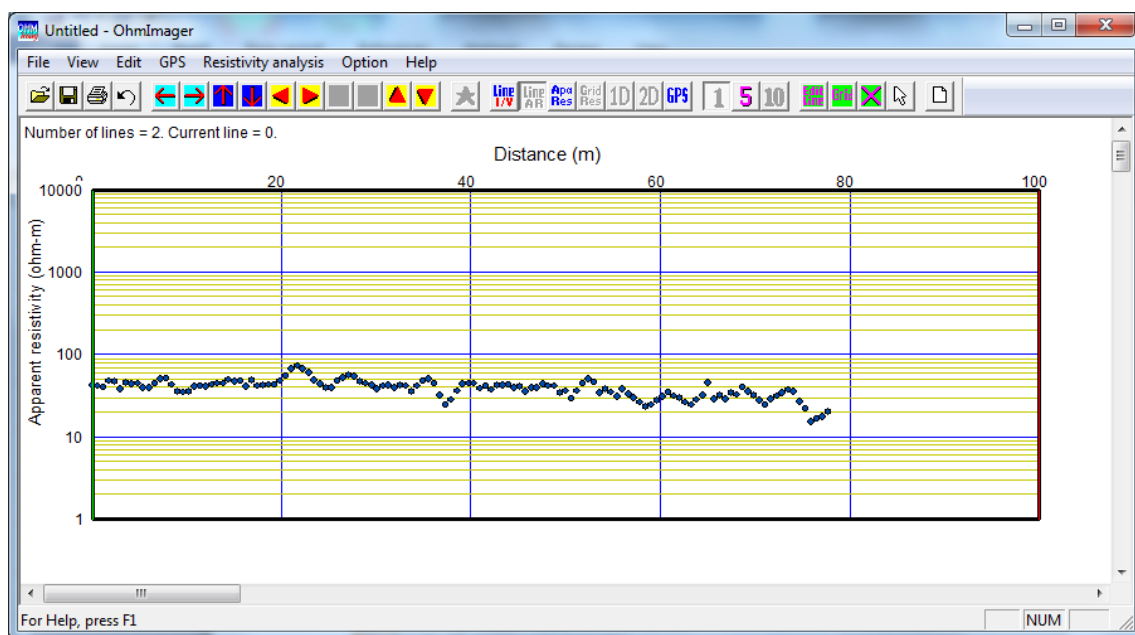


Click the *OK* button and the data between gate are selected and shown as red circles.

Above mentioned operation can be applied to all receivers at once. To apply the operation to all receivers, show all receivers by clicking the **5** button before setting the gate.




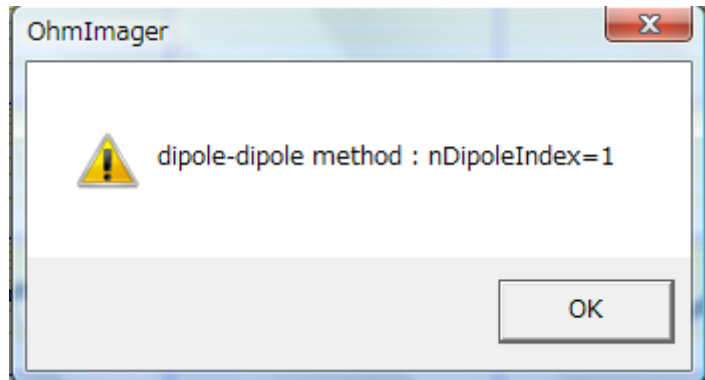
Hit the *Delete* key to delete the selected data.



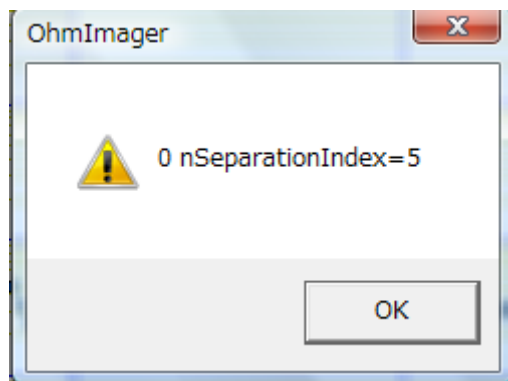
⑤ Gridding apparent resistivity data

OhmMapper can continuously measure resistance (V/I) of ground at very small sample spacings. Considering special sensitivity and horizontal resolution of a resistivity method, however, analyzing individual data is meaningless. Therefore, the OhmImager horizontally averages measured resistance or apparent resistivity with appropriate spacing and applies one dimensional inversion to each averaged data (ρ -a curve) to obtain resistivity models. This horizontal averaging is called as *Gridding*.

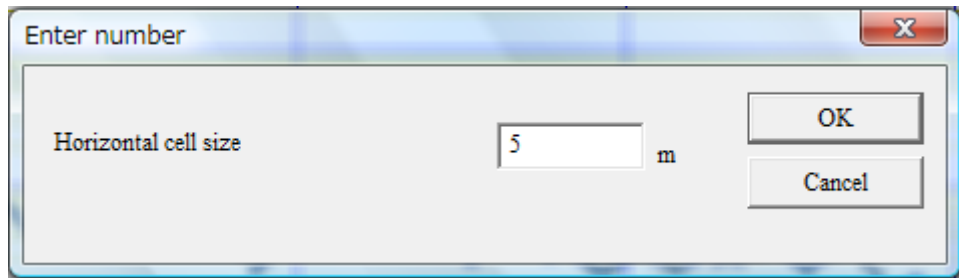
Select *Convert to grid data* in the *Resistivity analysis* menu or click the  button to convert original apparent resistivity data to grid data. A dialog box shown below will appear.



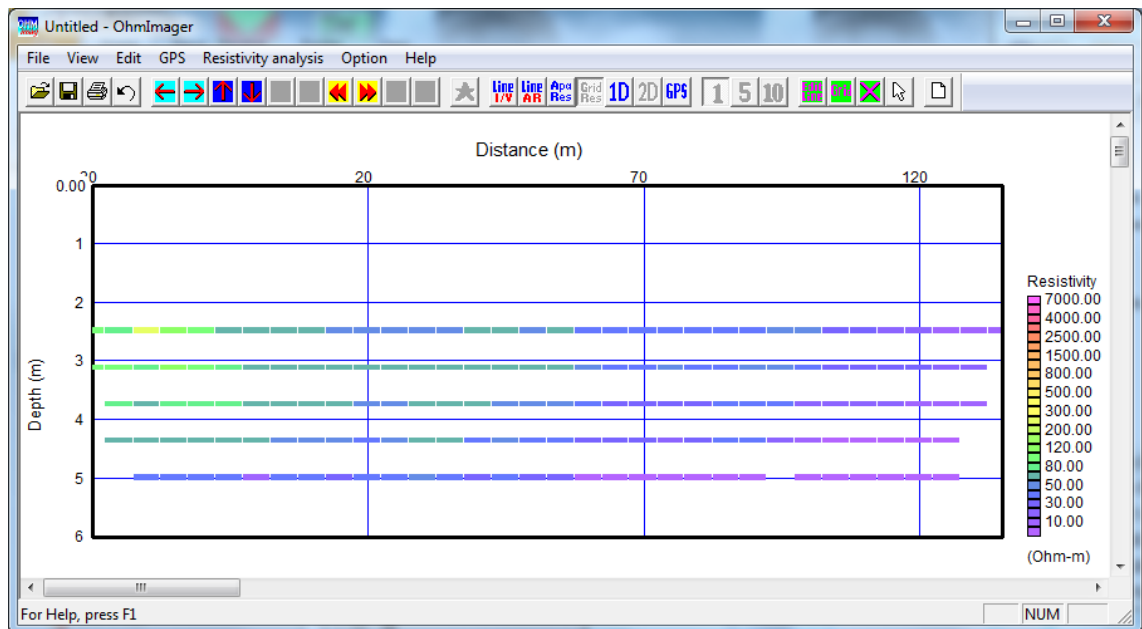
Number of dipole sizes (nDipoleIndex) is shown. For example, number must be 2 when two kinds of dipole cables, 2.5m and 5m length cable (dipole size of 5m and 10m), are used in a measurement.



Numbers of transmitter-receiver separation (N-space) are shown for each dipole size.




Set horizontal cell size (grid spacing). Apparent resistivity data is horizontally averaged with this spacing. For example, if cell size is set as 5m, apparent resistivity data that have same dipole sizes and N-spaces are averaged every 5m. One dimensional inversion is applied every 5m and resistivity models are obtained every 5m. Choose appropriate cell size (grid spacing) considering measuring speed and purpose of investigation.




Click the OK button and gridded data are shown.

After gridding data, each gridded data (cell) can be shown as an apparent resistivity – apparent depth graph (ρ -a curve) by selecting *Show 1D resistivity model* in the *View*

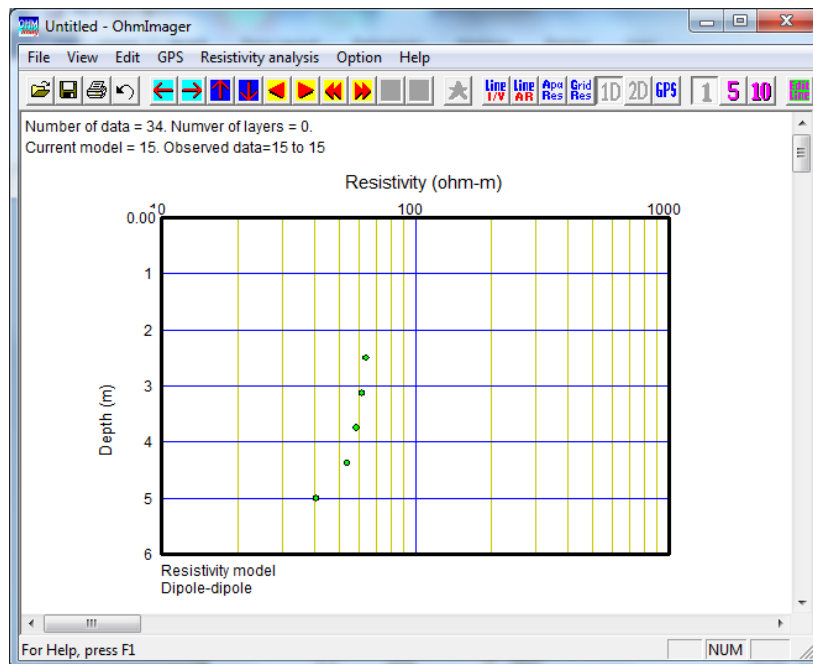
menu or click the  button.

 : change horizontal (resistivity) scale

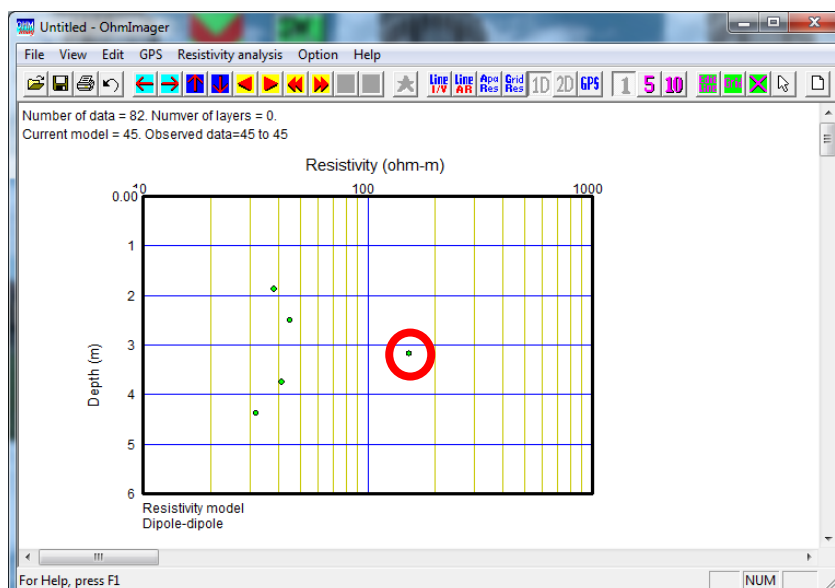
 : change vertical (depth) scale

 : scroll ρ -a curves

ρ_a curves are normally to be smooth. If the curves are not smooth as shown below, check apparent resistivity data.



Normal data

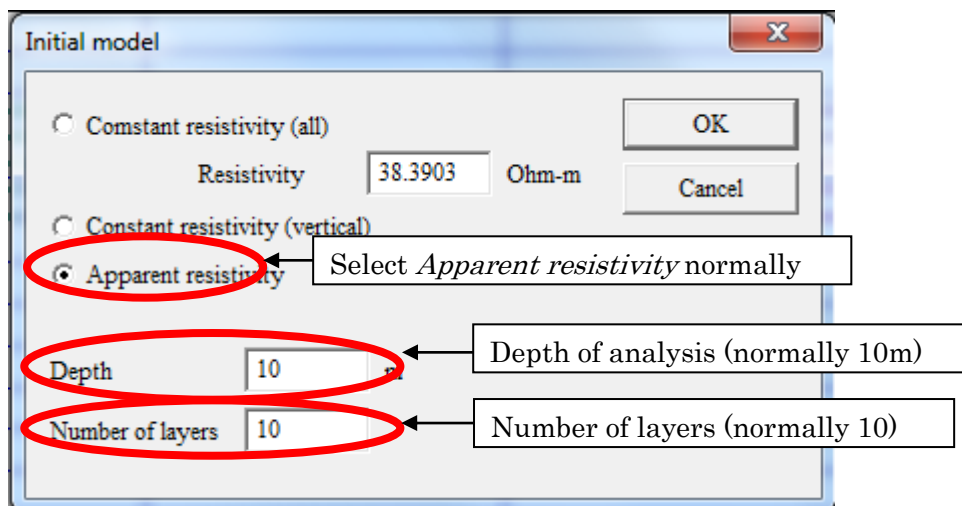


Noisy data

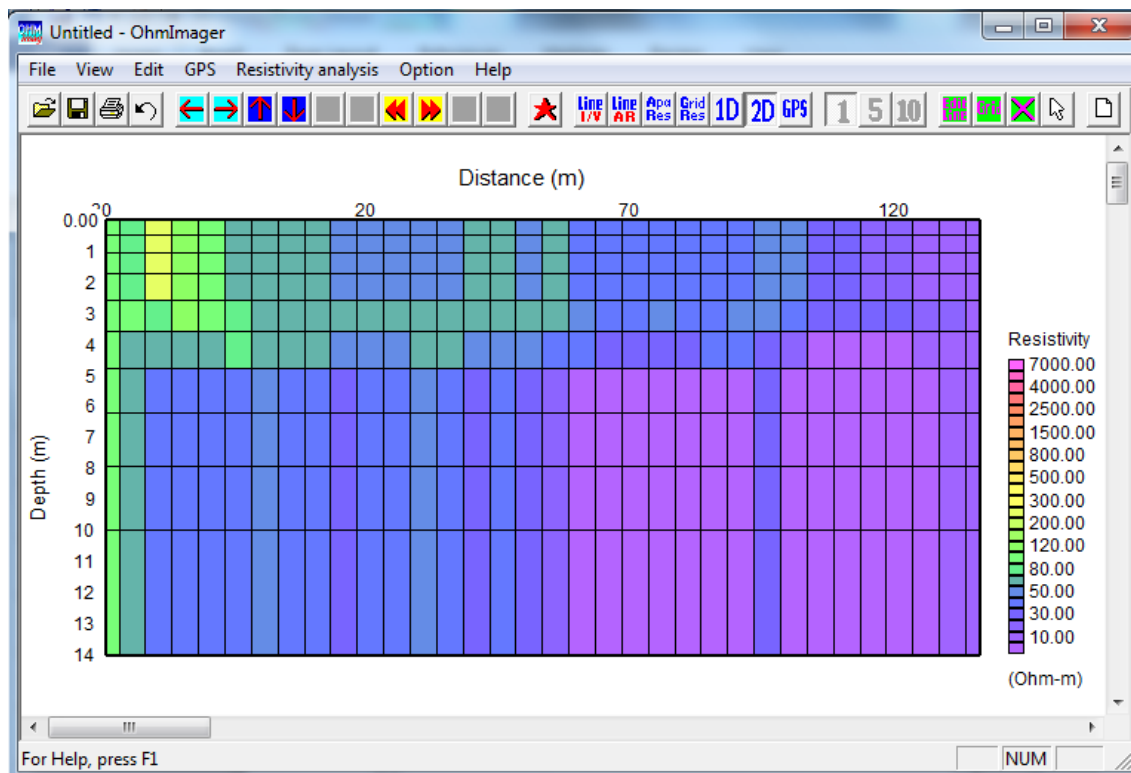
⑥ Initial model

Resistivity models are estimated by inversion in terms of a non-linear least squares method. In the non-linear least squares method, an initial model is created at first and the initial model is iteratively corrected. To create the initial model, select *Initial model* in the *Resistivity analysis* menu.


Set up parameters for an initial model in a dialog box shown below.

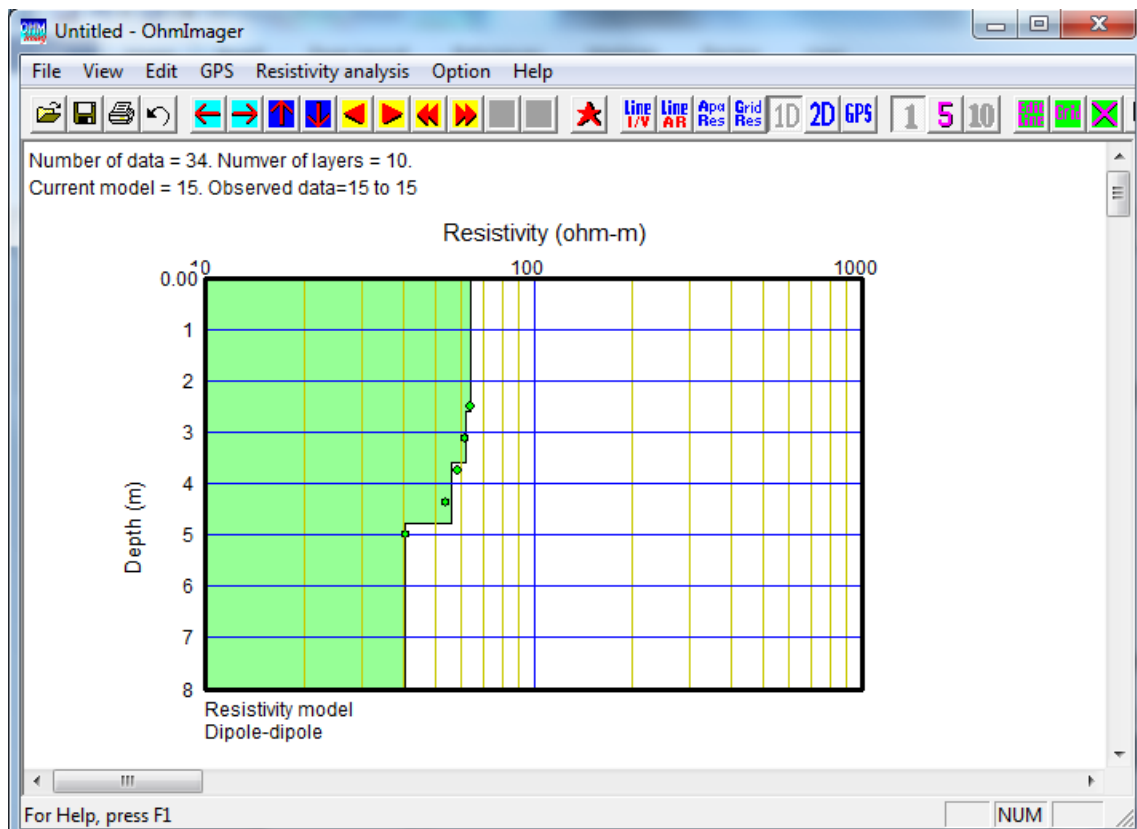


An initial model is shown as a 2D resistivity models.




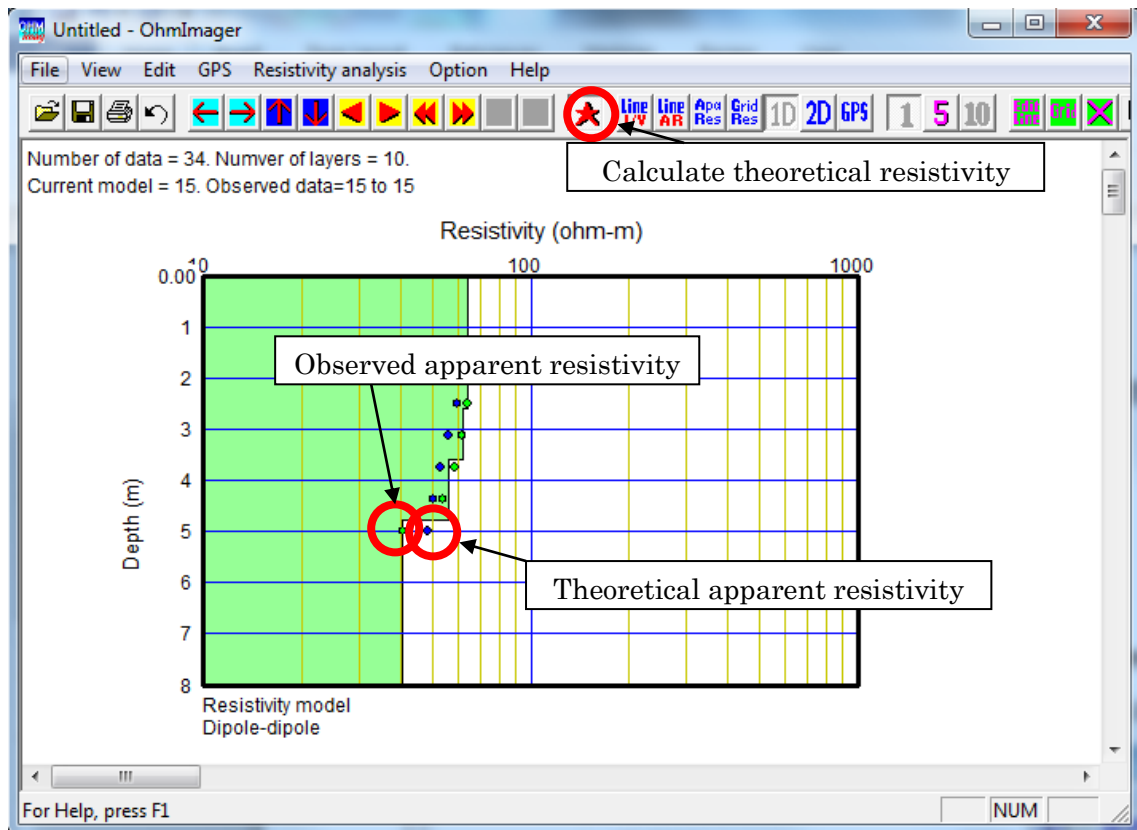
Inverted results may depend on the initial model. Appropriate initial models are very important for appropriate analysis and interpretation. To make sure the initial model is appropriate, check resistivity structure of initial models. The resistivity model can be as a 2D section as well as 1D models as shown below.

To show 1D resistivity models (and gridded apparent resistivity data), select *Show 1D resistivity model* in the *View* menu or click the **1D** button. Use the  buttons to scroll 1D models.



*Comparison of observed and theoretical apparent resistivity data

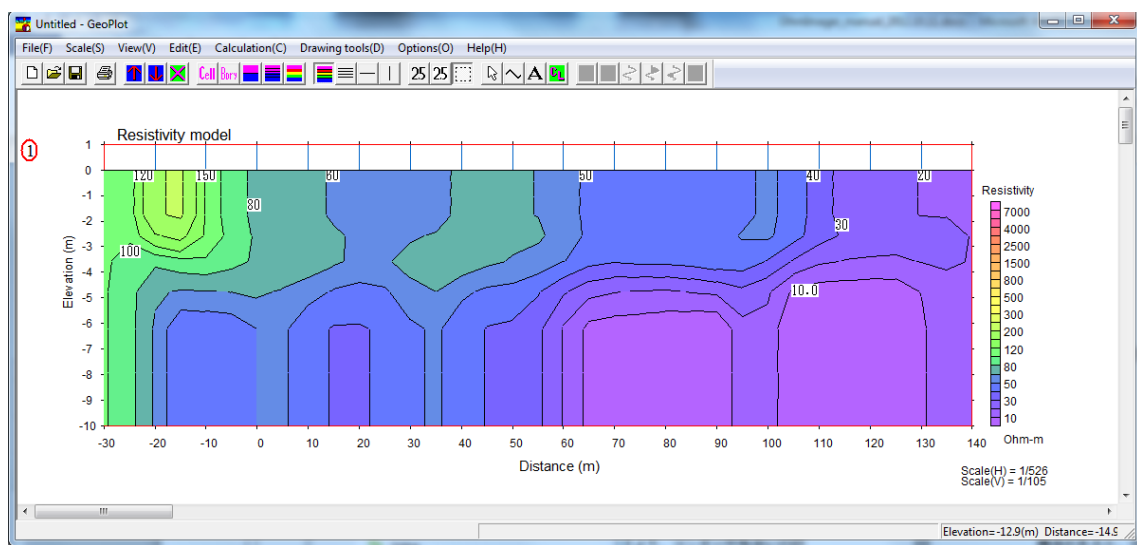
Click the  button and theoretical apparent resistivity for a 1D resistivity model is calculated and shown in comparison with observed data. Theoretical data are shown as blue circle (●) and observed data are shown as green circles (●).



⑦ Show resistivity model by GeoPlot

Successive 1D resistivity models (initial model or inverted result) can be shown as a 2D resistivity model by *GeoPlot*. The *GeoPlot* is general drawing software in SeisImager suites. It can be used not only for resistivity analysis but also seismic refraction or surface wave method too.

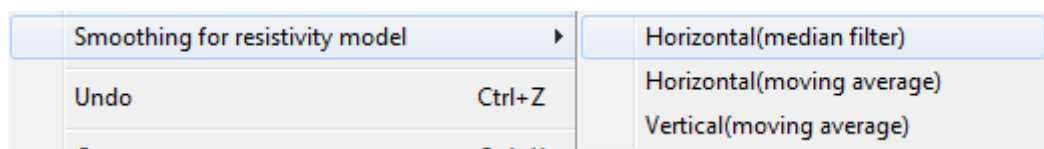
Select *Show 2D resistivity model* <launches *GeoPlot*> in the *View* menu to show the 2D resistivity model by the *GeoPlot*. Using the *GeoPlot*, detailed visualization parameters, such as contour color or axis configuration can be set up. Topographic data can be incorporate in the *GeoPlot* too.



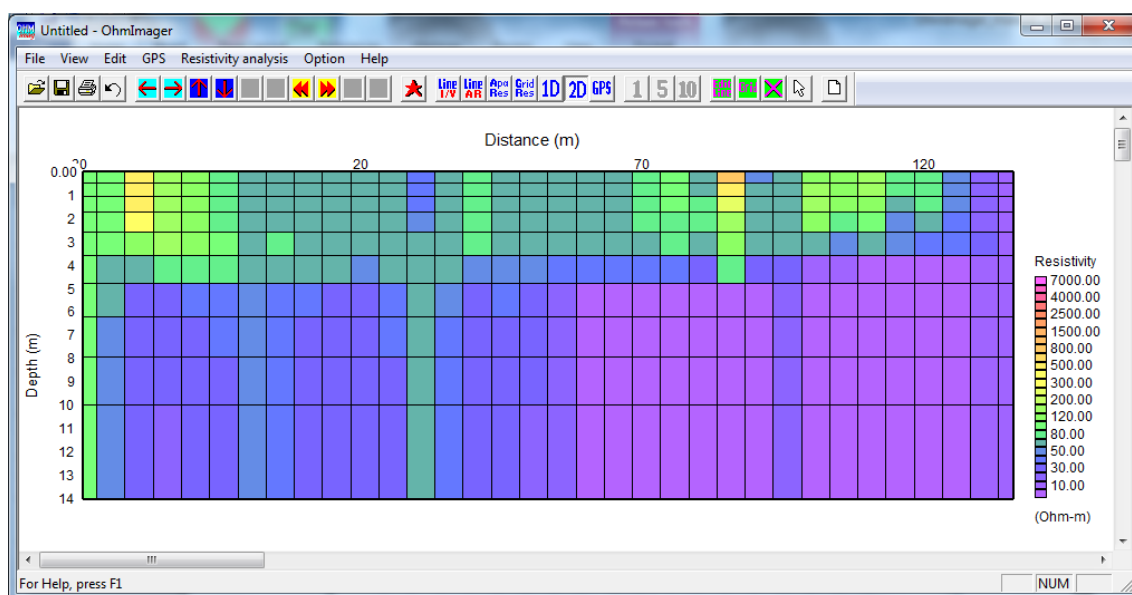
*Refer *GeoPlot Manual* for visualization using the *GeoPlot*.

⑧ Smooth resistivity model

As mentioned before, inverted results may depend on the initial model. If there are some irregular structures in initial models, such irregular structures may remain in inverted results too. To avoid this problem, use smooth resistivity structure as initial models in general. Resistivity models can be smoothed by *Smoothing for resistivity model* menu in the *Edit* menu. This menu includes following three sub menus.

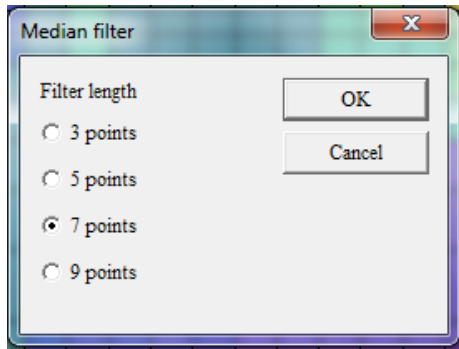


An original resistivity model is shown below. The results of smoothing are shown as follows.



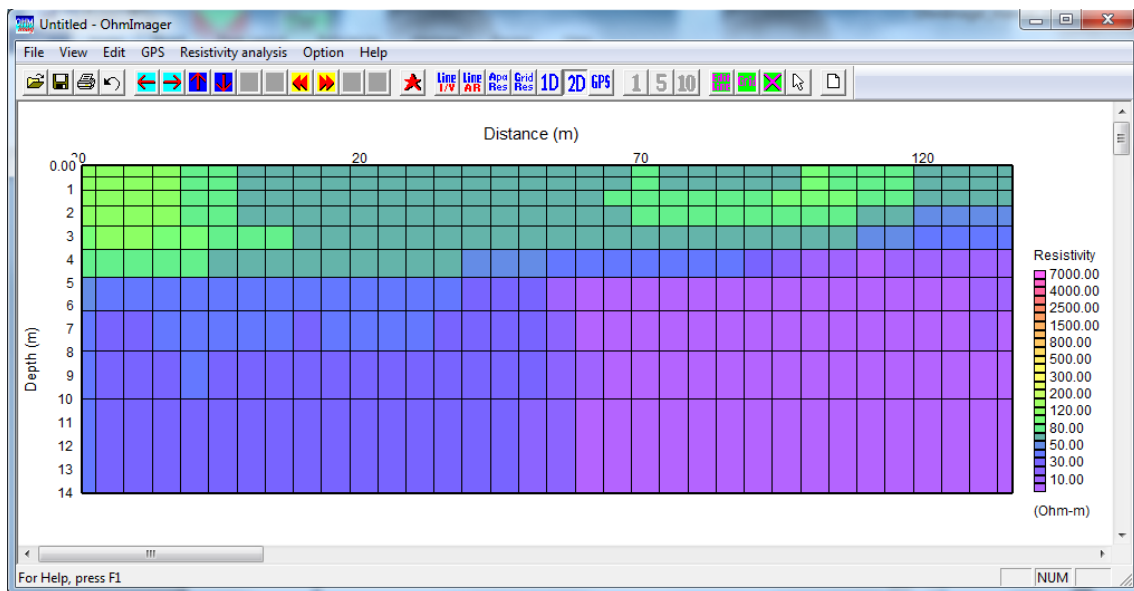
*Horizontal (median filter)

A median filter is effective to remove isolated noise as spike noise. Select *Horizontal(median filter)* and a dialog box appears.



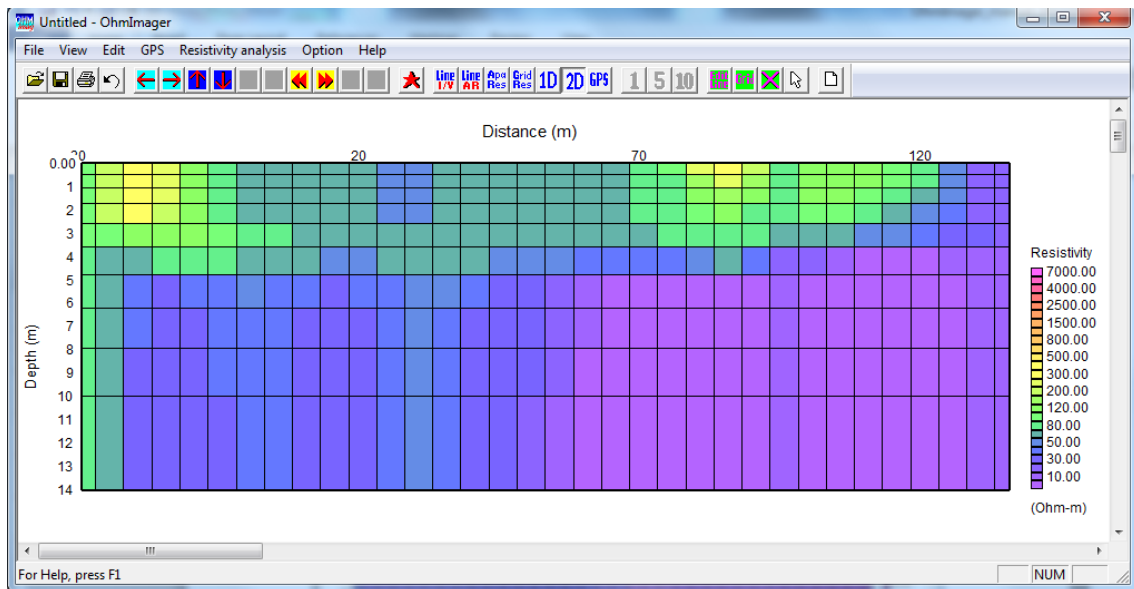
Select a filter length. Longer filter yields smoother result.

A result of 7 points filter is shown below.



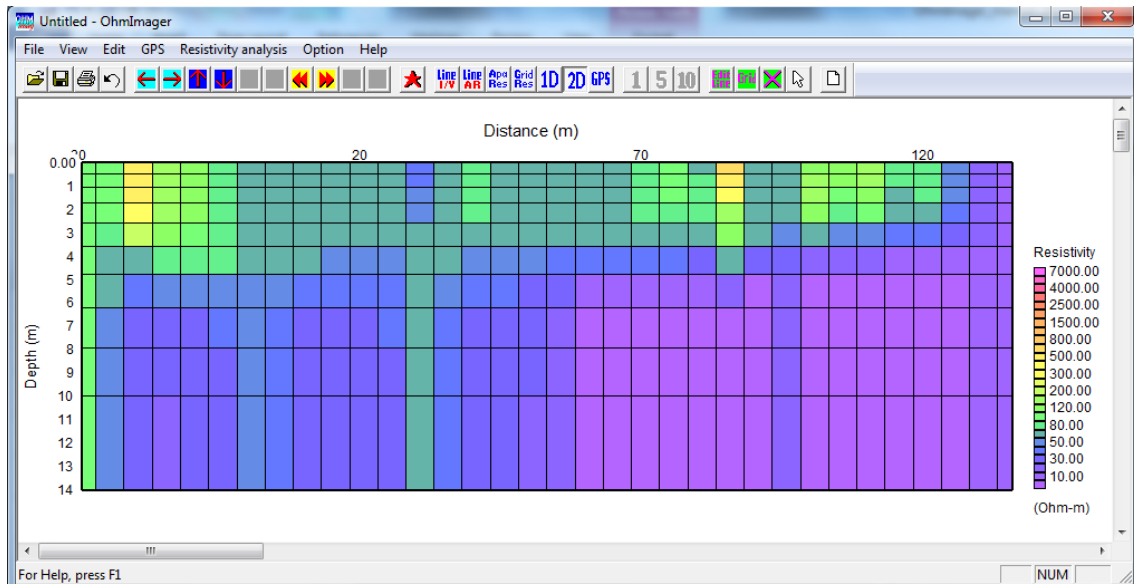
*Horizontal (moving average)

A horizontal smoothing with a moving average is applied. Resistivity models are smoothed in horizontal direction.



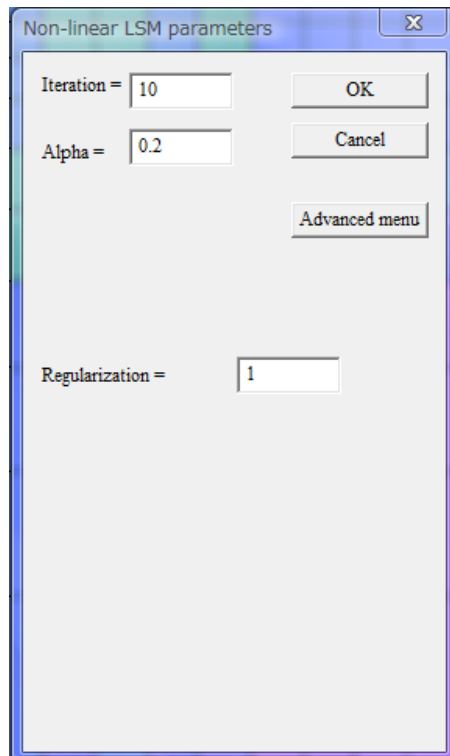
*Vertical (moving average)

A horizontal smoothing with a moving average is applied. Resistivity models are smoothed in horizontal direction.

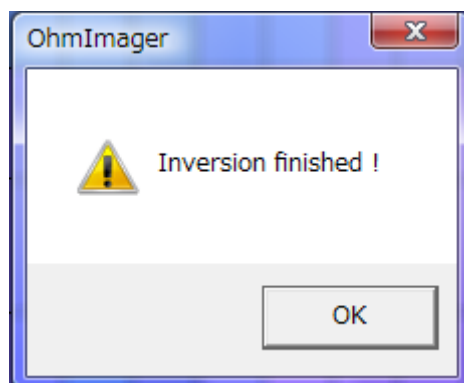


⑨ Inversion

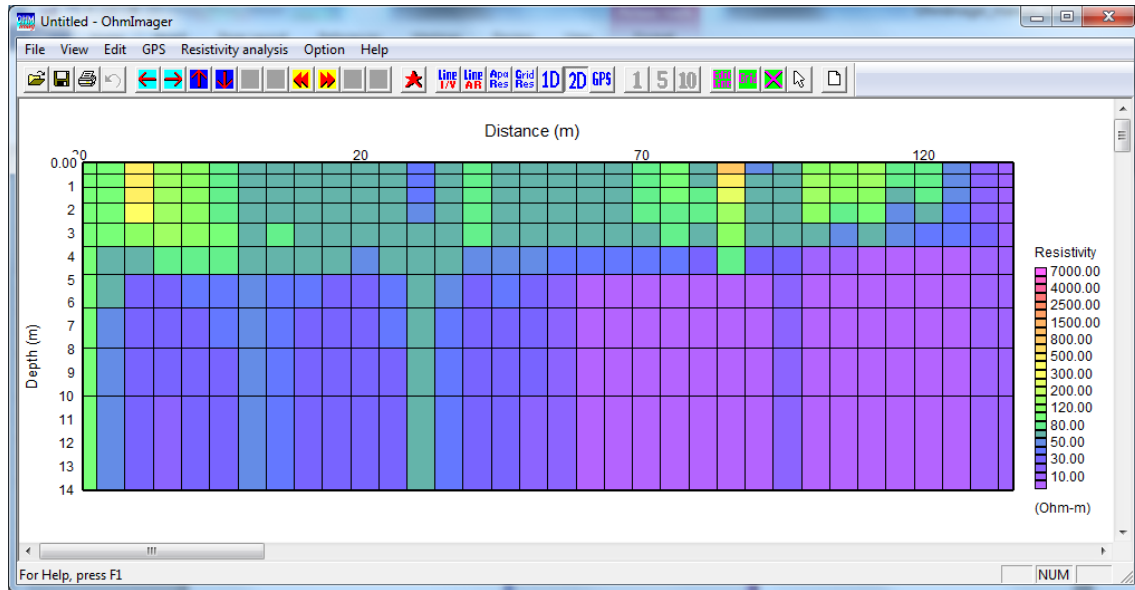
Select *Non-linear inversion (continuous 1D analysis)* in the *Resistivity analysis* menu. Set up inversion parameters in a dialog box appeared. The parameters do not need to be changed in general.



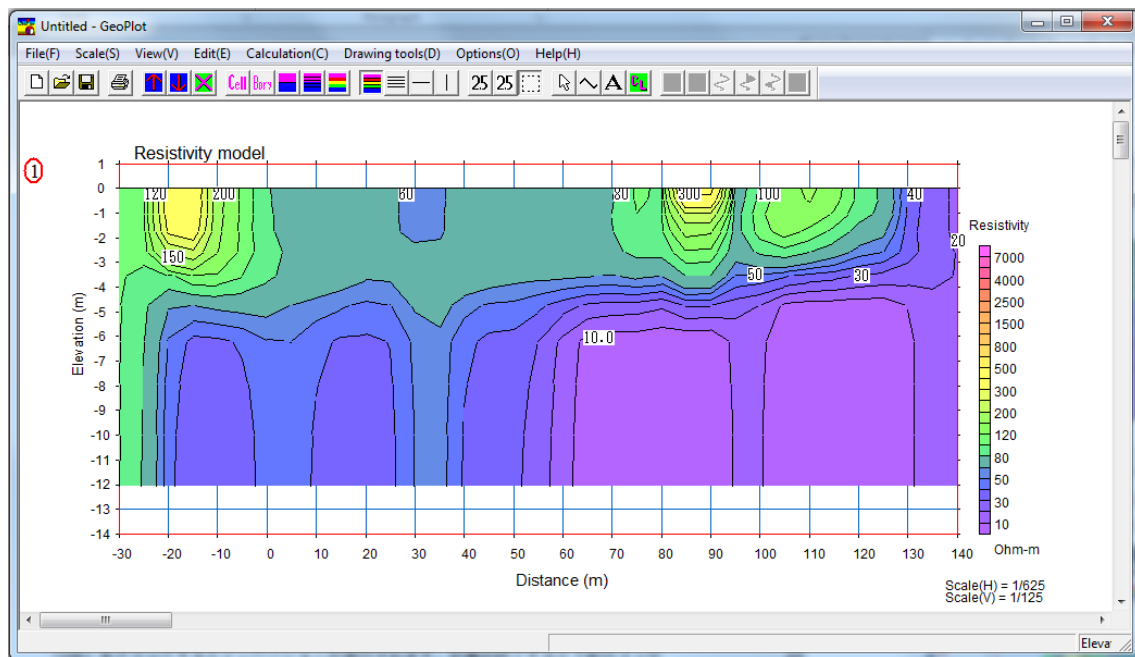
Click the OK button and the inversion starts. Following message is shown when the inversion is finished. Converting process of error between observed and theoretical data is automatically saved in a file named as *rms.txt*.




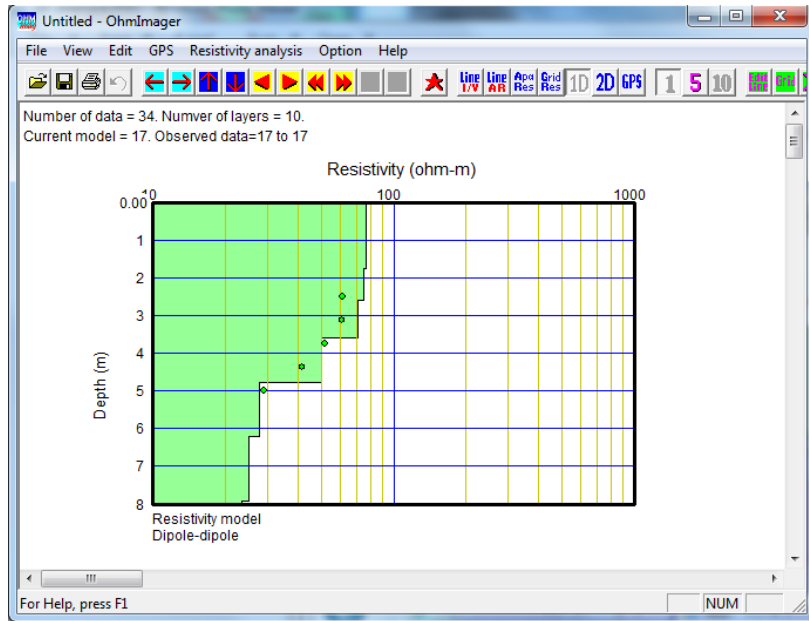
Click the *OK* button and a resultant inverted resistivity model is shown.




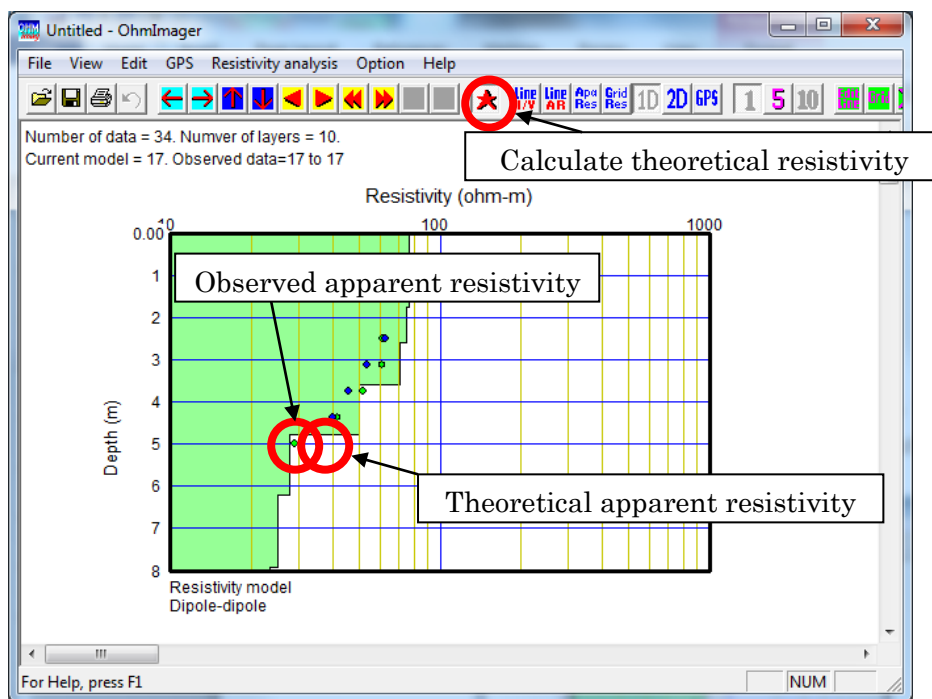
The resultant inverted resistivity model can be shown using GeoPlot by selecting *Show 2D resistivity model* <launches GeoPlot> in the *View* menu as same as initial model.



Select *Show 1D resistivity model* in the *View* menu or click the **1D** button to show inverted 1D resistivity models (and gridded apparent resistivity data) as same as initial models. Use the  buttons to scroll 1D models.




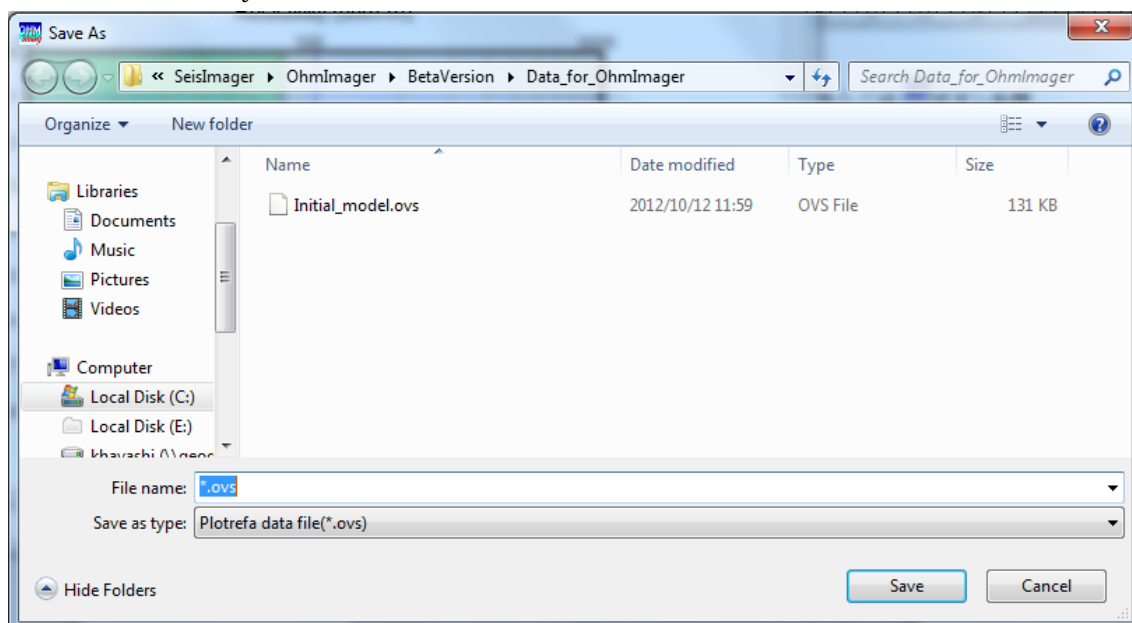
Click the  button and theoretical apparent resistivity for a 1D resistivity model calculated and shown in comparison with observed data. Theoretical data are shown as blue circles (●) and observed data are shown as green circles (●).




⑩ Save apparent resistivity and resistivity model (Plotrefa file (.ovs))

Measured data (resistance), GPS locations, gridded apparent resistivity and resistivity models (initial or inverted) can be saved in one ASCII file called Plotrefa file (.ovs). Use the Plotrefa files to save measured data and analysis results in OhmMapper data processing in general. GeoPlot file (.geo) saved by GeoPlot can only save resistivity model and do not save measured data etc.

Select *Save resistivity data and model file* in the *File* menu or click the  button to save a Plotrefa file. Put a file name in the displayed dialog box and save the file. Use .ovs as extension. Saved Plotrefa file can be directly opened by GeoPlot if the file contains resistivity model.



In the processing using OhmImager, all data and information during processing can be saved in the Plotrefa file (.ovs). The saved Plotrefa file can be opened by selecting

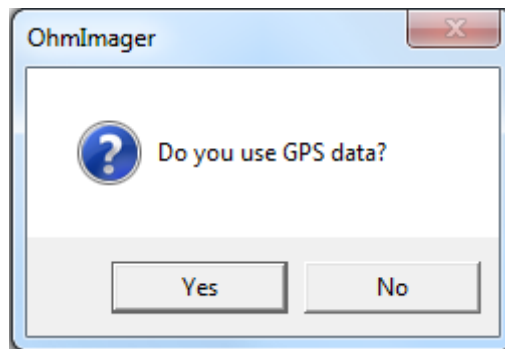
Open resistivity data and model file in the *File* menu or click the  button. Processing can be restarted from the step when data was saved in the Plotrefa file during the processing.

3.2 Analysis with GPS location

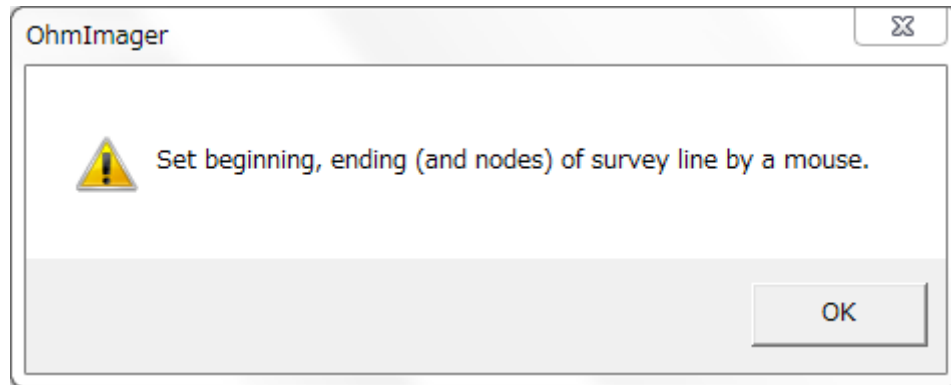
Survey line distance can be set from GPS locations without the Marker.

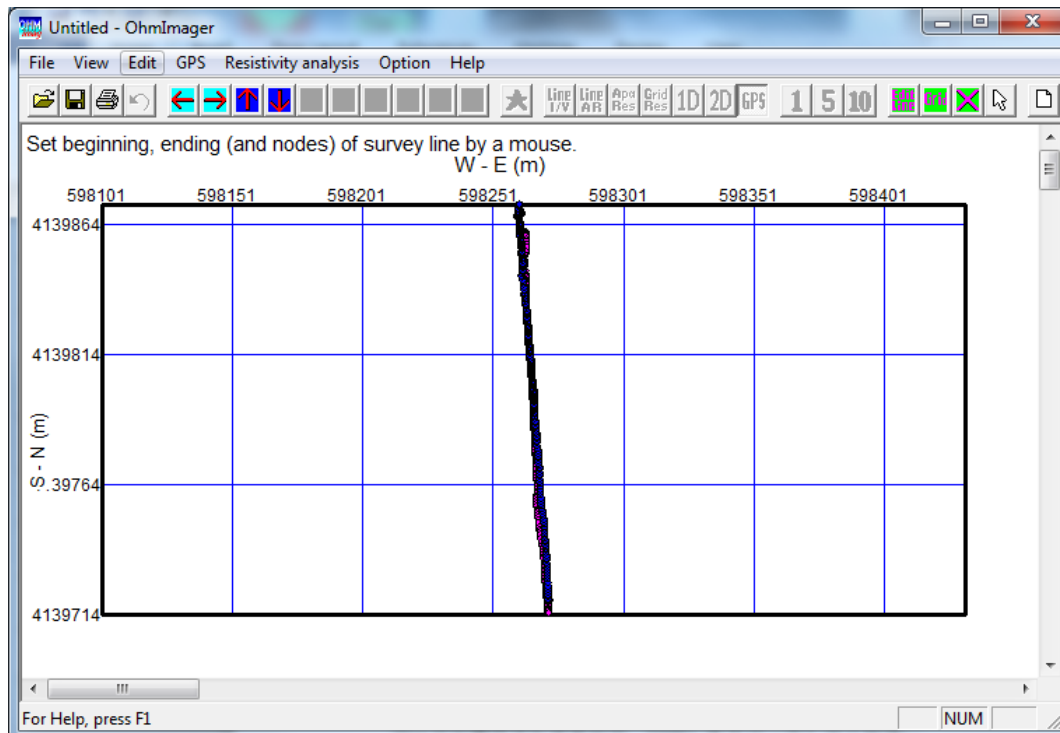
⑪ Show GPS locations

GPS locations are shown with UTM coordinate. Following dialog box is shown when an OhmMapper data file (.sto or .stn) is opened if the file contains GPS locations.




Click the *Yes* button to use GPS locations for setting up distance using GPS locations (click the *No* button to use the Markers). Click the *Yes* button and following dialog is shown. Click the *OK* button.



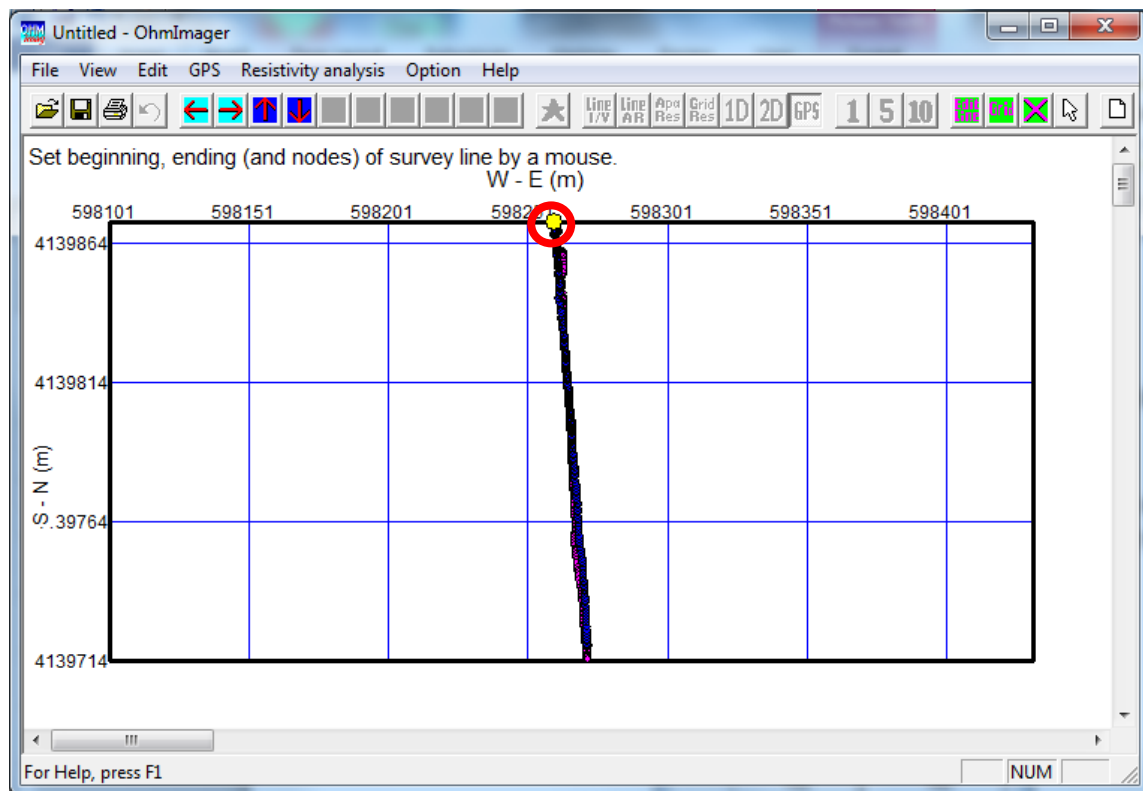


GPS locations of all lines included in the file are shown. Above example show two lines. Different lines are shown with different colors.

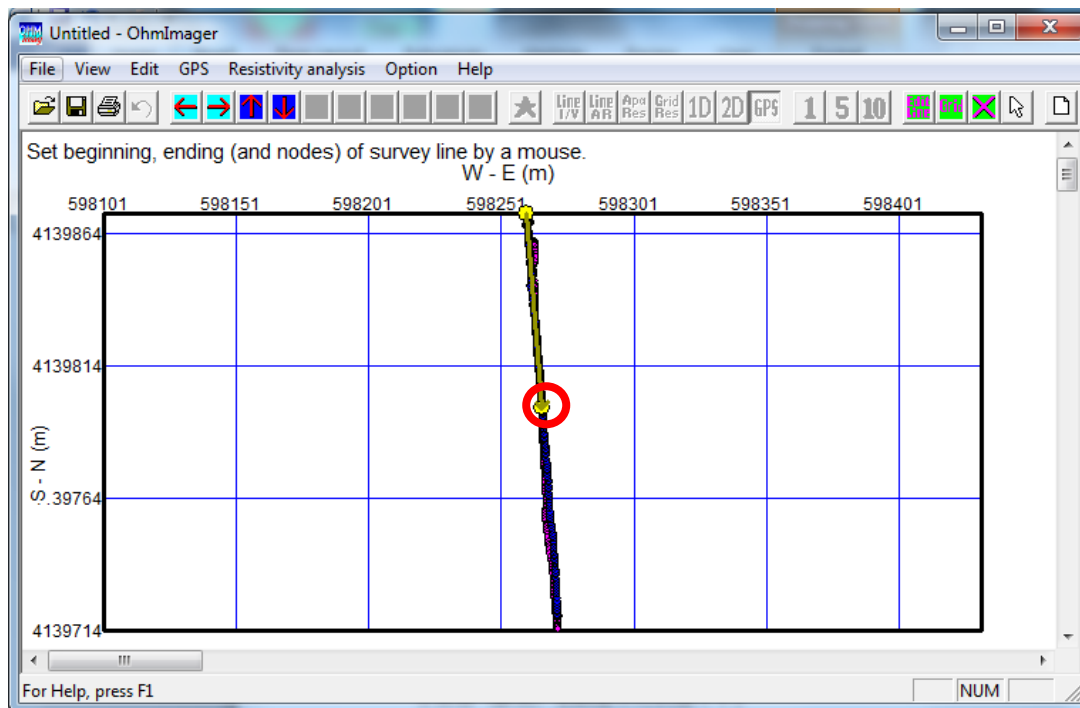
Select *Show GPS map* in the *View* menu or click the  button to show GPS locations when OhmMapper and GPS data have already been opened.

⑫ Set flags

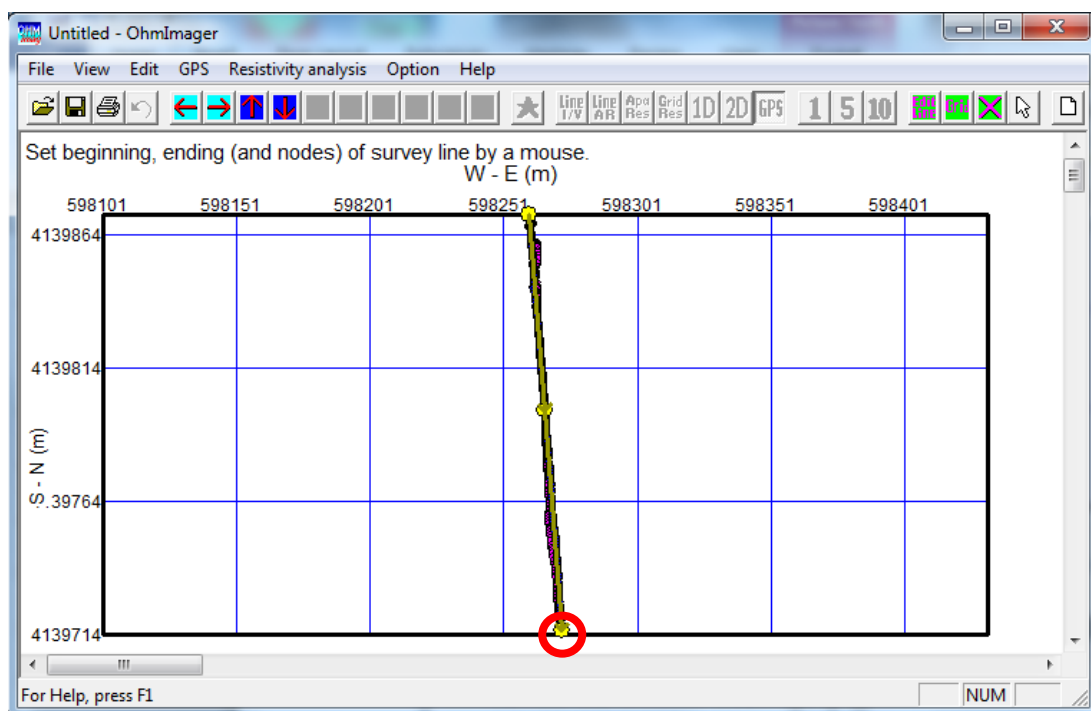
Set a survey line along a trajectory GPS data at first to set up the distance along the survey line. The survey line is defined as a polyline that connects at least two flags. Set flags from beginning to ending in order using a mouse when the message *Set beginning, ending (and nodes) of survey line by a mouse* is shown at top left corner of window. Select *Set flags* in the *GPS* menu when OhmMapper and GPS data have already been opened.




After setting the first flag (top) as the beginning of the survey line. Click ending or nodes by a mouse in order.



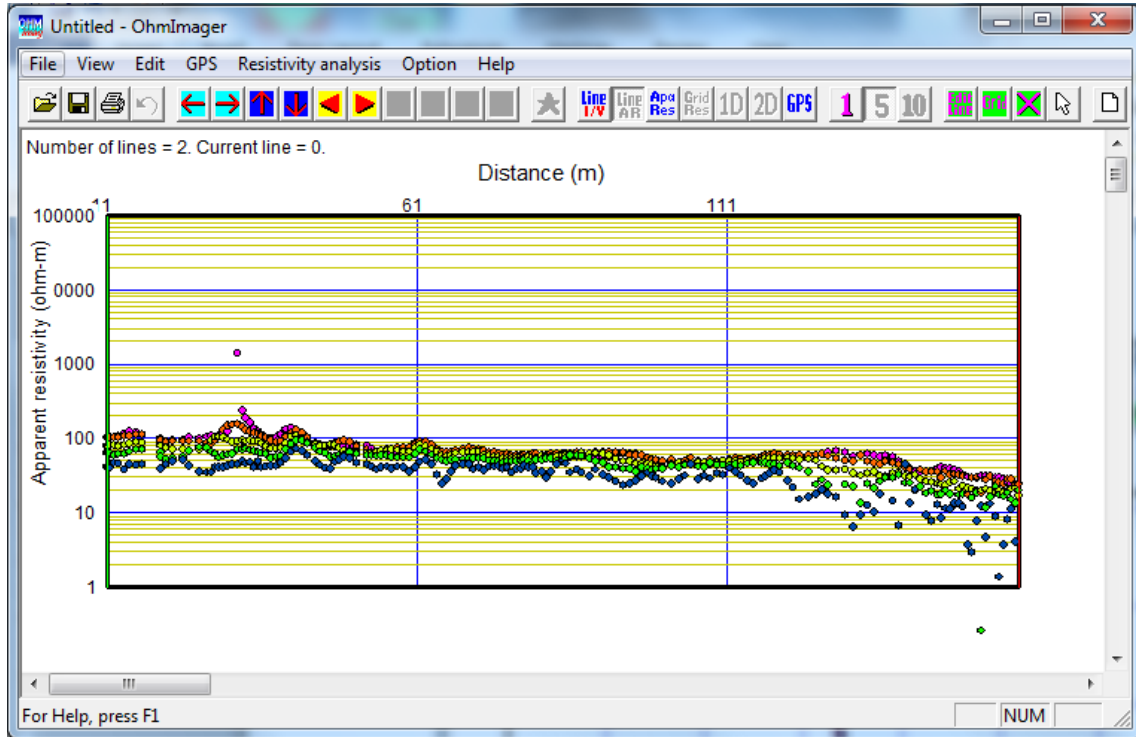
After setting the second flag as node on the survey line.



After setting the third flags as ending of the survey line. Press the *Esc* key or click the  button to complete setting. Select *Clear all flags* in the *GPS* menu to clear all flags and restart the setting.

⑬ Set distance

After completion of flag setting, each OhmMapper data (recorded resistance at each receiver) is projected to the survey line and distance is given to each data. Select *Set distance* in the *Flag* menu to set distance to OhmMapper data.



OhmMapper data in each line is shown as the function of distance. After the setting of distance, processing can be continued from in the step ④ of section 3.1.

3.3 Data acquisition using a console (G858)

There are two methods to analyze OhmMapper data recorded by a console G858; transferring data from the console (G858) to Windows PC using OhmImager and using MagMap2000 for data processing. The former method is described in this section. Refer *MagMap2000 User Guide* and section 3.4 for the latter one.

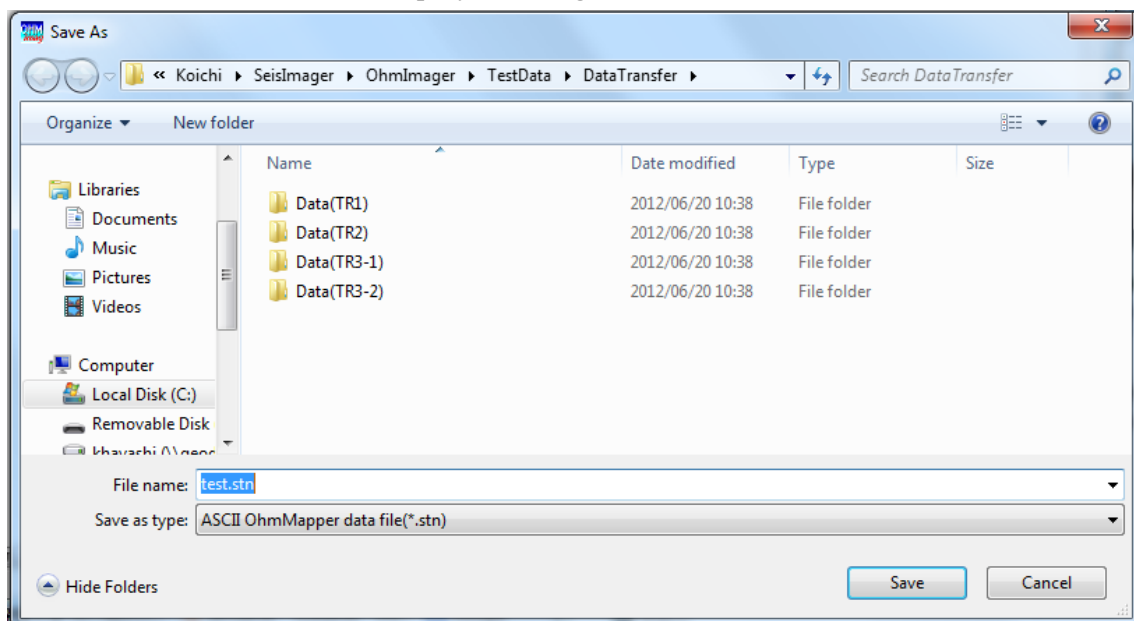
⑭ Connect a console (G858) to a Windows PC

Connect a console (G858) to a serial port of Windows PC using a serial cable associated with the console (G858).

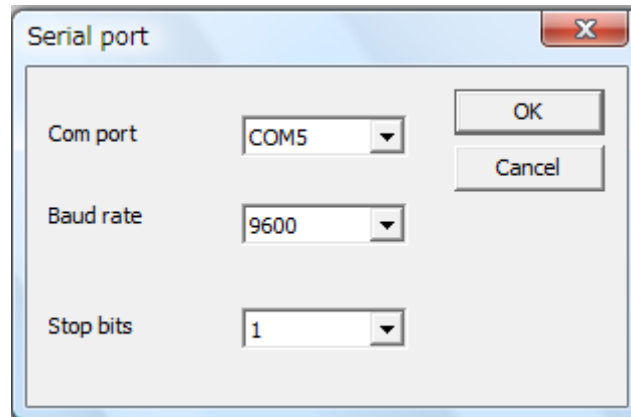
⑮ Setting OhmImager for data transfer

Launch OhmImager and select *Import G858 data by manual transfer* in the *G858* menu in the *File* menu.

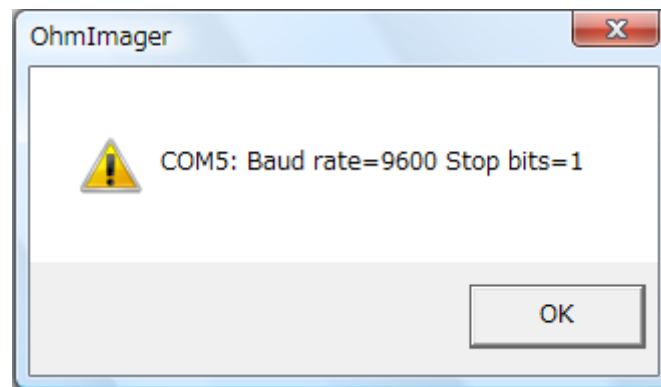
Put destination file name in displayed dialog box. Click the *Save* button.



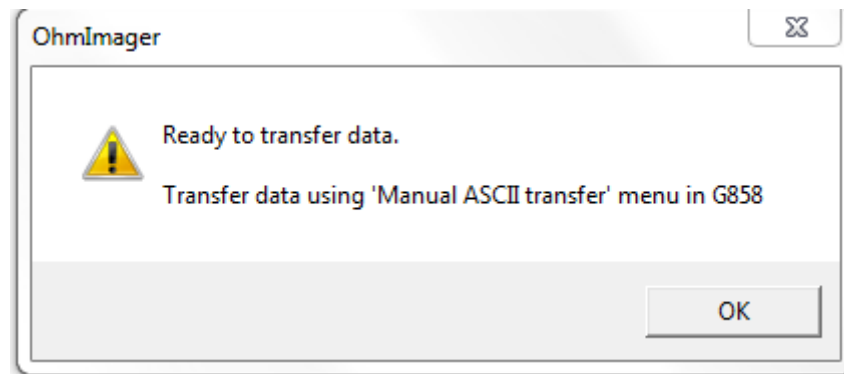
The following dialog box appears with set up parameters for data transfer.



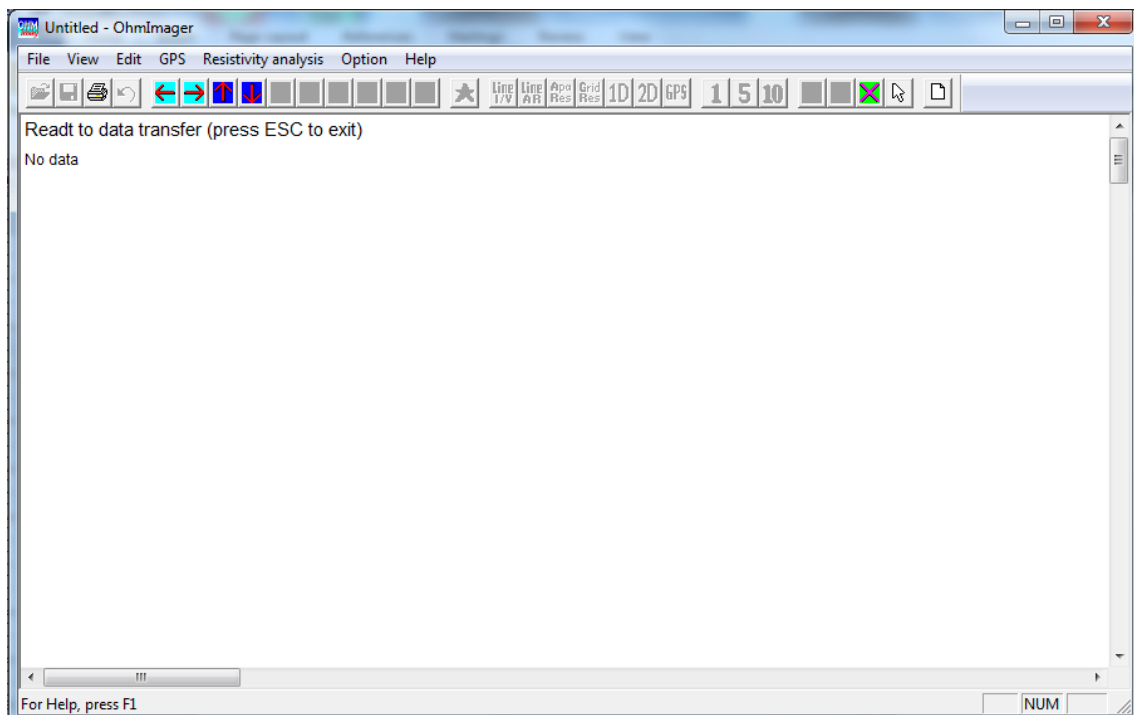
Click the *OK* button. A following dialog box appears when the serial has been successfully opened.



Click the *OK* button and the following dialog box appears.



Click the *OK* button and the following display is shown so that OhmImager is ready to data transfer.



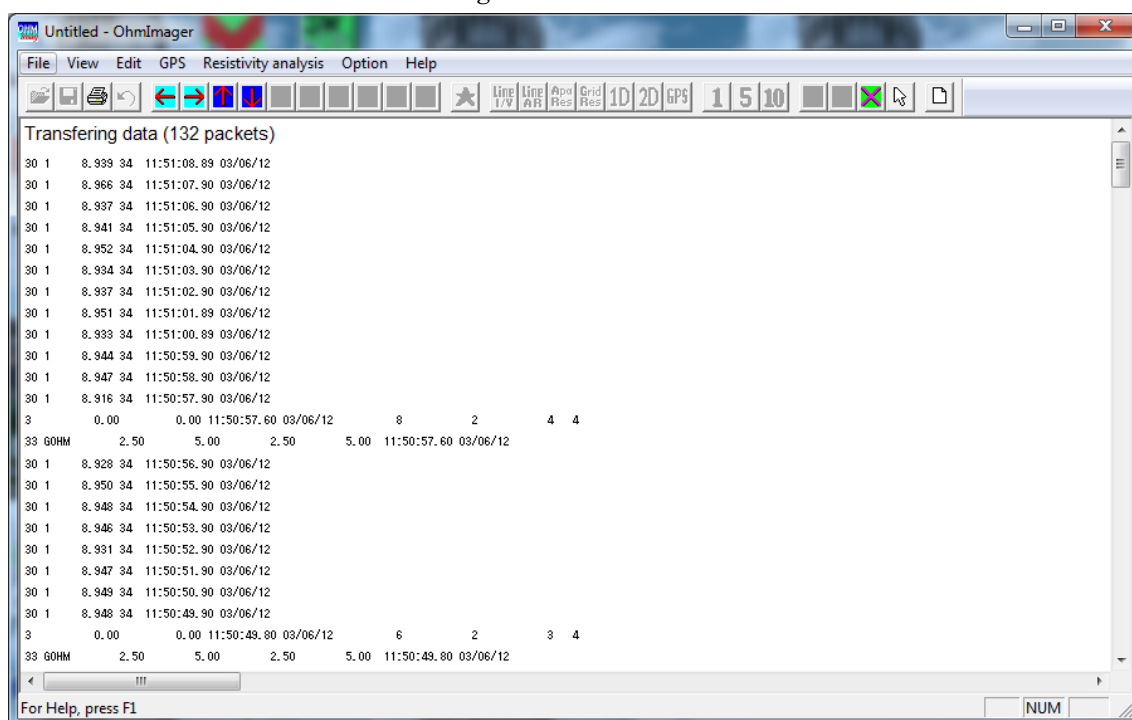
⑩ Data transfer

Transfer data with following procedure.

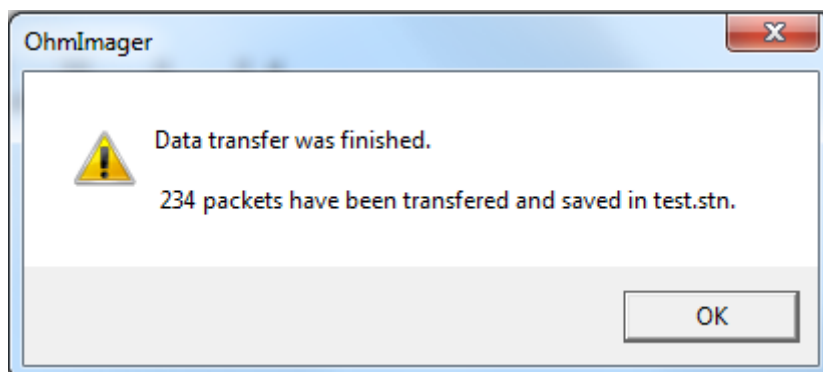
- 1) Turn on a console (G858) and select *OHMMAPPER* in main menu.
- 2) Select *DATA TRANSFER*.
- 3) Select *MANUAL ASCII TRANSFER*.
- 4) Select file number by *File* and set *Baud rate* as same value set at ⑪.
- 5) Set a cursor to *START TRANSFER* and press the *ENTER* button. Data transfer is started.

For detailed operation of data transfer, refer *OhmMapper TR1 Operation Manual*.

Window looks as shown below during data transfer.

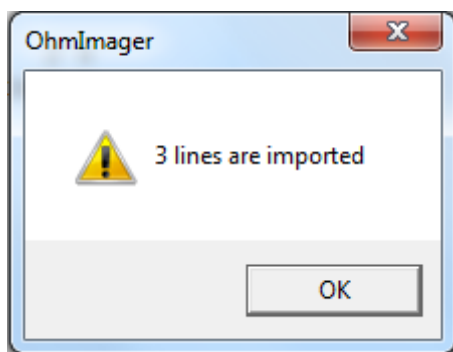
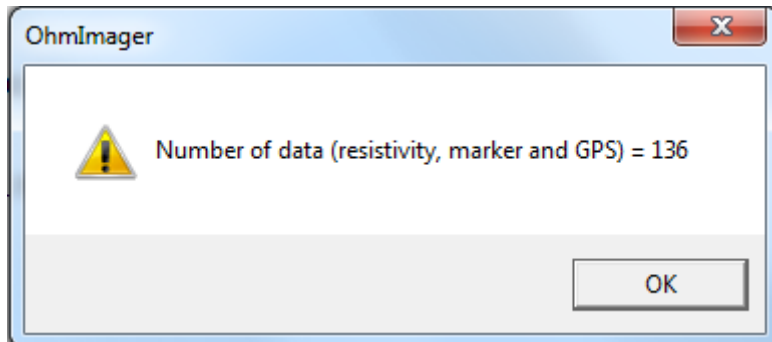


A following dialog box appears when data transfer is completed.

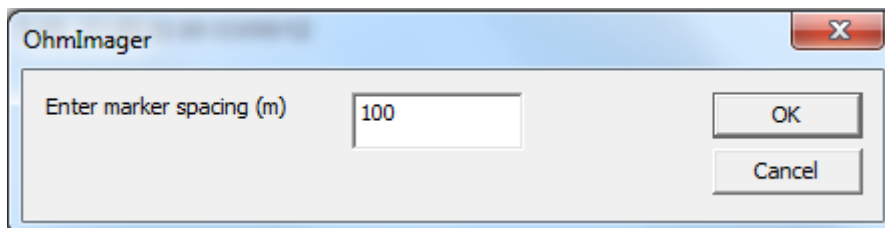


Transferred data is automatically saved in the destination file (.stn) set at ⑮. Data can be processed later using this file.

Click the *OK* button and numbers of transferred data and lines are shown.



Click the *OK* button and standard Marker spacing can be set.



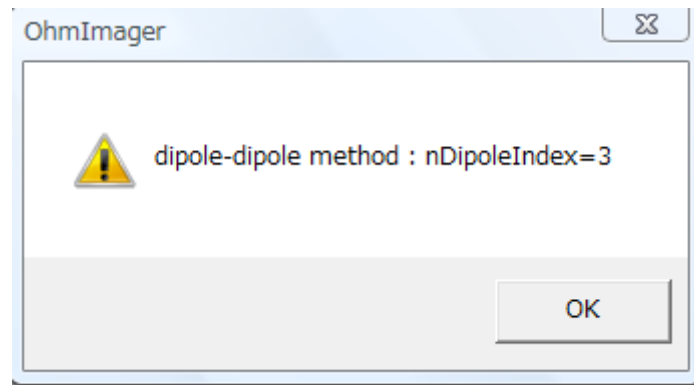
Processing can be continued from the step ② of section 3.1.

3.4 Data processing with MagMap

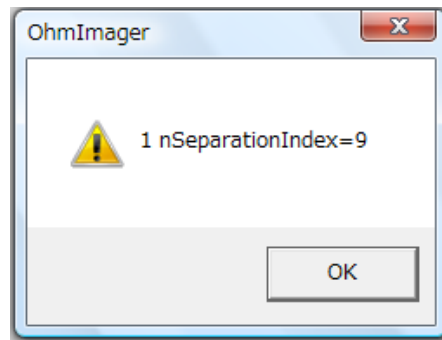
If MagMap2000 is used for pre-processing, ASCII format files, MagMap data files (.stn) and files exported for RES2D (.dat) can be processed by OhmImager. The .stn files can be handled as the .sto files and analysis can be started from step ② in the section 3.1. The files exported for RES2DINV (.dat) are processed with the following procedure.

⑰ Open RES2DINV file (.dat)

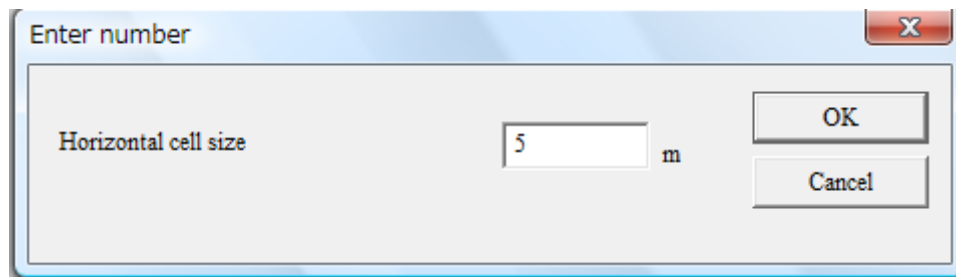
Select *Import RES2DINV file (*.dat)* in the *RES2DINV* menu in the *File* menu and select a RES2DINV file (*.dat).



Number of dipole sizes (nDipoleIndex) is shown. For example, number must be 2 when two kinds of dipole cables, 2.5m and 5m length cable (dipole size of 5m and 10m), are used in a measurement. Click the *OK* button.



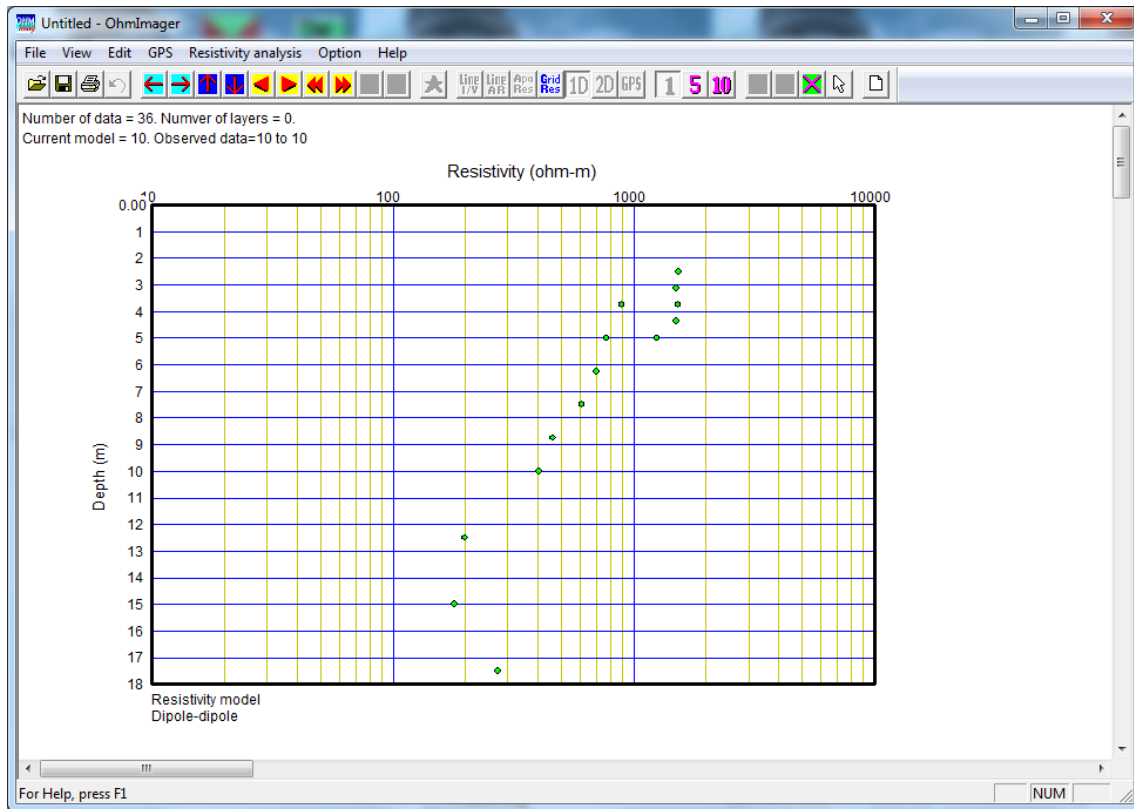
Numbers of transmitter-receiver separation (N-space) are shown for each dipole size. Click the *OK* button and set the horizontal cell (grid spacing) size in the dialog box as shown in the step ⑤ of section 3.1.



Click the OK button and a gridded 1D resistivity model is shown. Use the



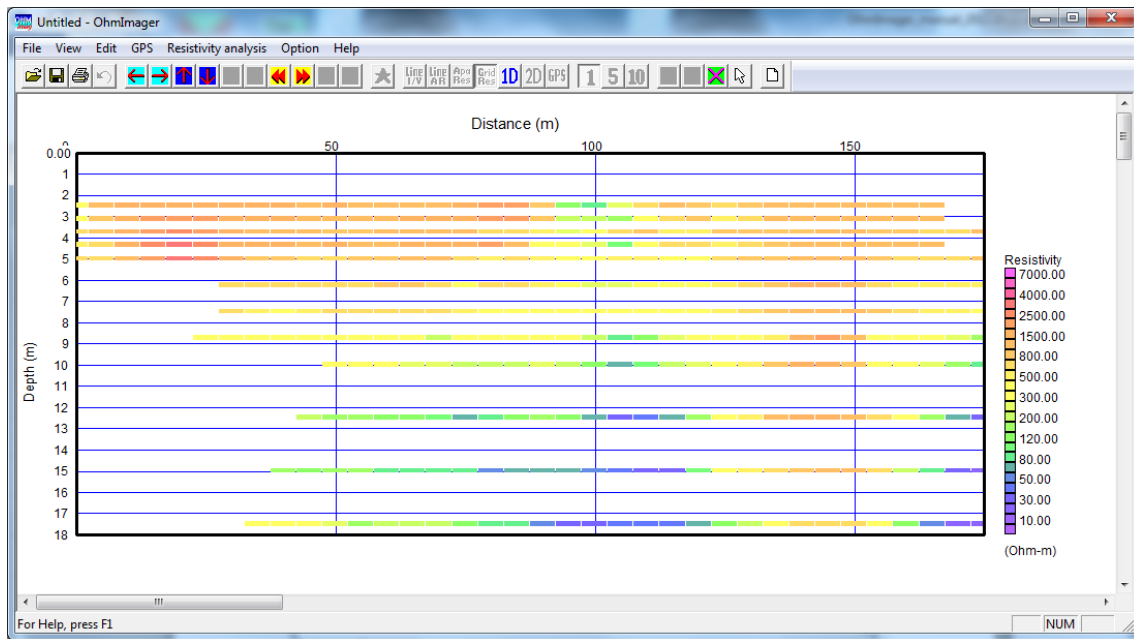
buttons to scroll 1D models.



Select *Show 2D apparent resistivity data (gridded data)* in the *View* menu or click the



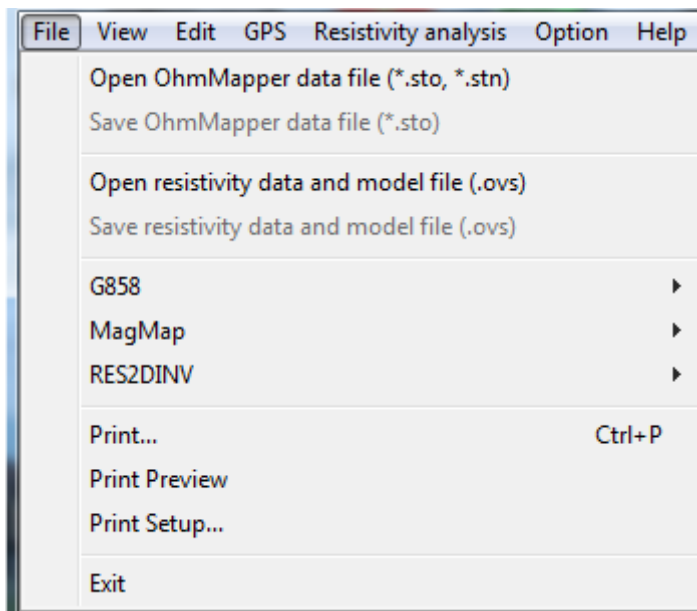
button to show gridded 2D apparent resistivity section.



Processing can be continued from the step ⑥ of section 3.1.

4. The OhmImager functions

4.1 File menu



4.1.1 Open OhmMapper data file (*.sto, *.stn)


To open OhmMapper data files measured by the OhmLog (.sto) or files processed and saved by MagMap2000 (.stn), select *Open OhmMapper data file (*.sto, *.stn)* in the File menu. See the section 3.1 for more detail.

4.1.2 Save OhmMapper data file (*.sto)


To save an OhmMapper data (.sto), select *Save OhmMapper data file (*.sto)* in the File menu. Only measured data and GPS locations can be saved in .sto files. Use Plotrefa file (.ovs) for saving processed data in general. The Plotrefa file (.ovs) can save all information of processing, such as, measured data (resistance), GPS locations, gridded apparent resistivity and resistivity models.

4.1.3 Open resistivity data and model file (.ovs)



To open resistivity data and model file (Plotrefa files : .ovs), select *Open resistivity data and model file (.ovs)* in the File menu or click the  button. The Plotrefa file (.ovs) can save all information of processing, such as, measured data (resistance), GPS locations, gridded apparent resistivity and resistivity models.

4.1.4 Save resistivity data and model file (.ovs)

To save resistivity data and model file (Plotrefa files : .ovs), select *Save resistivity data and model file (.ovs)* in the *File* menu or click the  button. The Plotrefa file (.ovs) can save all processed information, such as, measured data (resistance), GPS locations, gridded apparent resistivity and resistivity models.

4.1.5 G858

4.1.5.1 Import G858 data by manual transfer

To transfer measured OhmMapper data from a console (G858) through a serial cable, select *Import G858 data by manual transfer* in the *G858* menu in the *File* menu. See the section 3.1 for more detail.

4.1.6 MagMap

4.1.6.1 Save data file (*.stn) for MagMap

To save measured resistance and GPS information to a file for MagMap2000 (.stn), select *Save data file (*.stn) for MagMap* in the *MagMap* menu in the *File* menu. Use this function for processing OhmMapper data recorded by the OhmLog using MagMap2000. Only measured data and GPS locations can be saved in .stn files. Use Plotrefa file (.ovs) for saving processed data in general.

4.1.7 RES2DINV

4.1.7.1 Import RES2DINV file (.dat)

To import resistivity data file (*.dat) exported from RES2DINV or MagMap2000 into the OhmImager, select *Import RES2DINV file (.dat)* in the *RES2DINV* menu in the *File* menu. See the section 3.4 for more detail.

4.1.7.2 Export RES2DINV file (.dat)

To export resistivity data processed by OhmImager to RES2DINV, select *Export RES2DINV file (.dat)* in the *RES2DINV* menu in the *File* menu.

4.1.8 Print

To print the current OhmImager display, select *Print* in the *File* menu, press Ctrl+P

or click the  button.

4.1.9 Print Preview

To display the print image, select *Print preview* in the *File* menu.

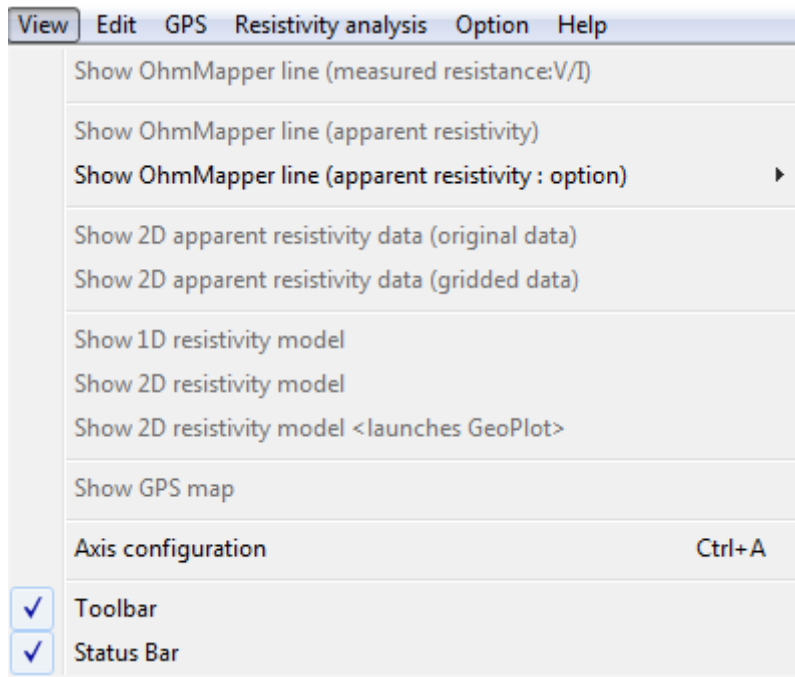
4.1.10 Print setup

To set up printing parameters, select *Print setup* in the *File* menu.

4.1.10 Exit


To close OhmImager, select Exit in the File menu.

4.2 View menu




4.2.1 Show OhmMapper line (measured resistance : V/I)

To show an OhmMapper line as measured resistance (V/I) against distance set from the Markers or GPS locations, select *Show OhmMapper line (measured resistance : V/I)*

in the *View* menu or click the  button. See section 2.1 for more detail.

4.2.2 Show OhmMapper line (apparent resistivity)



To show an OhmMapper line as apparent resistivity against distance set from the Markers or GPS locations, select *Show OhmMapper line (apparent resistivity)* in the



View menu or click the  button. See the section 2.1 for more detail.

4.2.3 Show OhmMapper line (apparent resistivity : option)


4.2.3.1 Show all receivers

To switch showing one receiver or all receivers in line view, select *Show all receivers* in the *Show OhmMapper line (apparent resistivity : option)* menu in the *View* menu.


Clicking the  button (one receiver) or the  button (all receivers) also switches

them. Use the   buttons to scroll a receiver to be shown when one receiver is shown.






4.2.4 Show 2D apparent resistivity data (original data)

To show measured OhmMapper data as apparent resistivity against distance and apparent depth, select *Show 2D apparent resistivity data (original data)* in the *View* menu or click the  button. Color of data indicate apparent resistivity and high resistivity data is shown with yellow to red colors and low resistivity data is shown with green to blue colors as a legend shown in the right side of the view. See the section 2.2 for more detail.


4.2.5 Show 2D apparent resistivity data (gridded data)

To show gridded OhmMapper data (horizontally averaged) as apparent resistivity against distance and apparent depth, select *Show 2D apparent resistivity data (gridded data)* in the *View* menu or click the  button. See the section 2.3 for more detail.

4.2.6 Show 1D resistivity model

To show gridded data as a function of depth, select *Show 1D resistivity model* in the *View* menu or click the  button. Resistivity models (initial or inverted) and/or theoretical apparent resistivity for the resistivity model can be also shown. Use the     buttons to scroll 1D models to be shown. See the section 2.4 for more detail.

4.2.7 Show 2D resistivity model


To show a 2D resistivity model that consists of gridded 1D resistivity models (initial or inverted), select *Show 2D resistivity model* in the *View* menu or click the  button.

See the section 2.5 for more detail.

4.2.8 Show 2D resistivity model <launches GeoPlot>

To show a 2D resistivity model (initial or inverted) by GeoPlot, select *Show 2D resistivity model <launches GeoPlot>* in the *View* menu. See the section 2.6 for more detail.

4.2.9 Show GPS map

GPS locations can be shown on a map with UTM coordinate. To show the GPS map, select *Show GPS map* in the *File* menu or click the  button. See the section 2.7 for more detail.

4.2.10 Axis configuration

To set axis configuration of above mentioned views, Select *Axis configuration* in the *View* menu or press *Ctrl+A*.

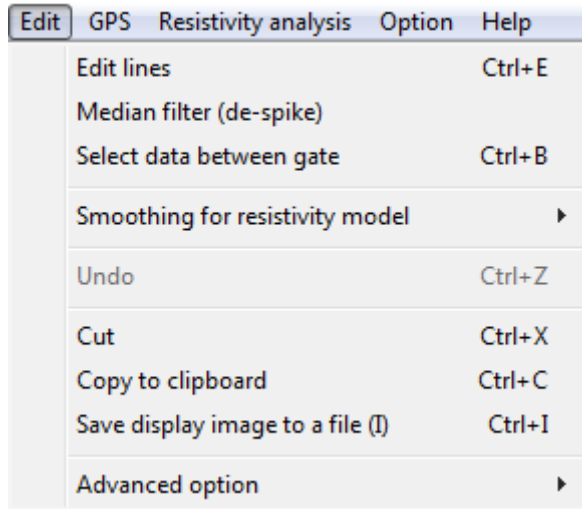
4.2.11 Toolbar

Selecting Toolbar will hide or display Toolbar.


4.2.12 Status bar

Selecting Status bar will hide or display Status bar.

4.3 Edit menu



4.3.1 Edit lines

To edit Lines and Markers, select *Edit lines* in the *Edit* menu or click the  button or press *Ctrl+E*. See the step ③ in section 3.1 for more detail.

4.3.2 Median filter (de-spike)

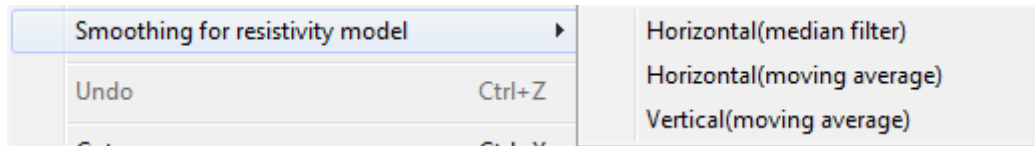
To remove spike noise by a median filter, select *Median filter (de-spike)* in the *Edit* menu. See the step ④ in section 3.1 for more detail.

4.3.3 Select data between gate

A selected block between gate including noise can be deleted. To set the gate, select *Select data between gate* in the *Edit* menu or press *Ctrl+B*. See the step ④ in section 3.1 for more detail.

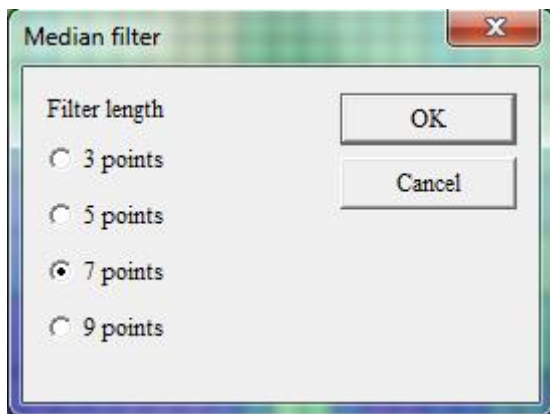
4.3.4 Smoothing for resistivity model

Following sub menus belong to *Smoothing for resistivity model* in the *Edit* menu. Outline of the sub menus is described here. See the step ⑧ in section 3.1 for more detail.



4.3.4.1 Horizontal (median filter)

A resistivity model is smoothed in horizontal direction by a median filter. The median filter is effective to remove isolated noise as spike noise. To apply the median filter, select *Horizontal (median filter)* in the *Smoothing for resistivity model* menu in the *Edit* menu. A following dialog box appears.



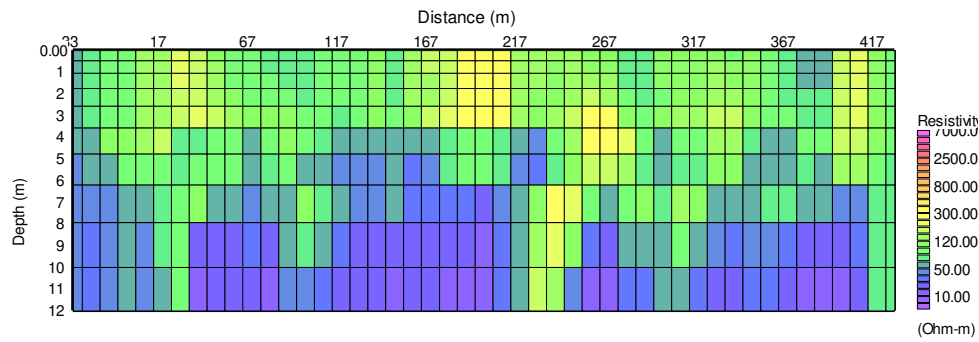
Select a filter length. Longer filter yields smoother result.

4.3.4.2 Horizontal (moving average)

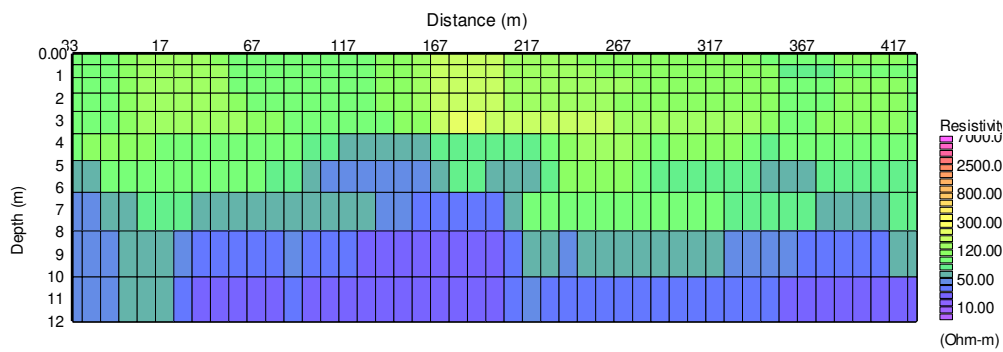
A resistivity model is smoothed in horizontal direction by a moving average. To apply the horizontal moving average, select *Horizontal (moving average)* in the *Smoothing for resistivity model* menu in the *Edit* menu.

4.3.4.3 Vertical (moving average)

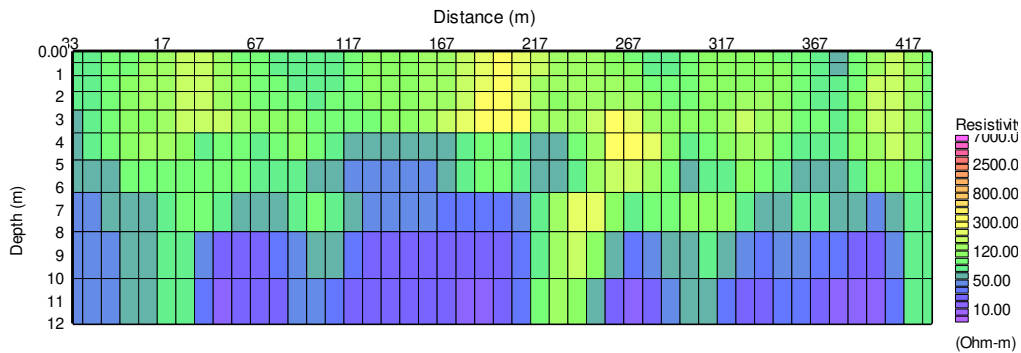
A resistivity model is smoothed in vertical direction by a moving average. To apply the vertical moving average, select *Vertical (moving average)* in the *Smoothing for resistivity model* menu in the *Edit* menu.



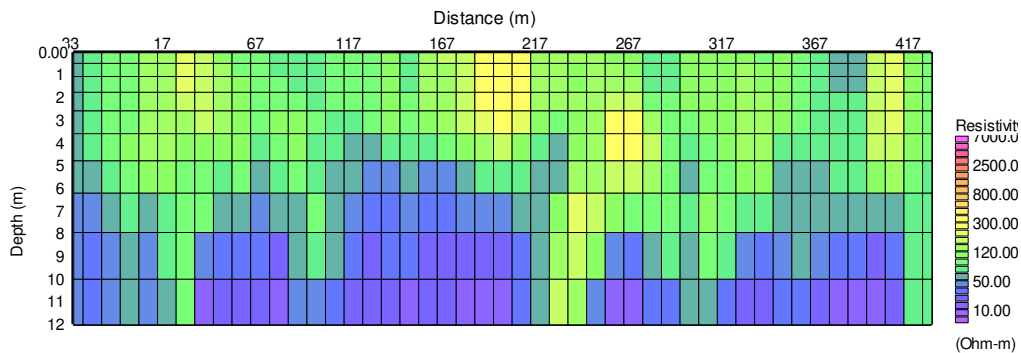
Resistivity model before smoothing



Resistivity model smoothed by horizontal median filter with filter length of 7.



Resistivity model smoothed by horizontal moving filter.



Resistivity model smoothed by vertical moving filter.

4.3.5 Undo

To cancel last operation, select *Undo* in the *Edit* menu or press *Ctrl+Z*.

4.3.6 Cut

To delete selected data, select *Cut* in the *Edit* menu or press *Ctrl+X*.

4.3.7 Copy to clipboard

To copy display image to clipboard of Windows, select *Copy to clipboard* in the *Edit* menu or press *Ctrl+C*. Copied image is an Enhanced Meta file and can be pasted on any application on Windows.

4.3.8 Save display image to a file

To save display image to a file, select *Save display image to a file* in the *Edit* menu or press *Ctrl+I*. Images can be saved as .png, .jpg, .bmp and .gif files.

4.3.9 Advanced option

4.3.9.1 Interpolated by time

Distance of each data is normally set from dividing the distance of two Markers by number of data when setting survey lines distance using the Markers. Check this option to set distance of data based on the proportion of their measurements time. It assumes that the measurement speed was constant. Use this option when the data has no measurements in between the Markers.

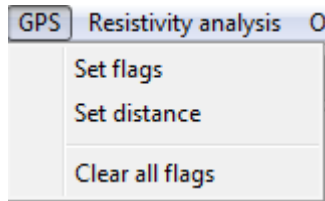
4.3.9.2 Save current line to ASCII file

To save apparent resistivity data of current line to ASCII file, select *Save current line to ASCII file* in the *Advanced option menu* in the *Edit* menu. File format is as follows.

Distance of operator, Apparent resistivity (from transmitter side to operator side).

200.000000	35.464558	38.364048	18.131462	18.389914	11.171417
208.333328	36.802841	34.101376	26.663914	21.017044	7.979583
216.666672	35.464558	31.543772	25.597357	19.703478	12.767334
225.000000	35.464558	36.658978	21.331131	19.703478	14.363250
233.333328	36.133701	37.511513	21.331131	24.957739	4.787750
241.666672	35.464558	30.691236	26.663914	19.703478	6.383667
250.000000	35.464558	34.953911	22.397688	18.389914	3.191833
258.333344	36.133701	36.658978	19.198017	19.703478	3.191833

4.4 GPS menu



4.4.1 Set flags

To set distance of data using GPS locations, a survey line is defined along the GPS trajectory. Select *Set flags* in the *GPS* menu to define the survey line. The survey line is defined as a polyline that connects at least two flags. See step ⑫ in section 3.2 for more detail.

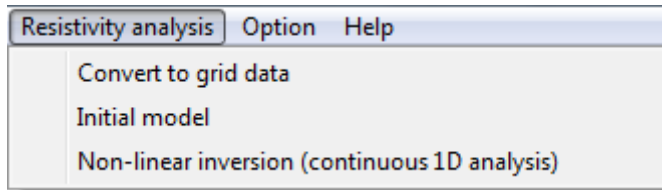
4.4.2 Set distance

After completion of flag setting, each OhmMapper data is projected to the survey line and distance is given to each data. To set the distance to each data, select *Set distance* in the *GPS* menu. See step ⑬ in section 3.2 for more detail.

4.4.3 Clear all flags

To clear all flags and restart flag setting, select *Clear all flags* in the *GPS* menu.

4.5 Resistivity analysis menu



4.5.1 Convert to grid data



OhmMapper can continuously measure resistance (V/I) of the ground at very small sample spacings. Considering spatial sensitivity and horizontal resolution of resistivity method, however, analyzing individual data is meaningless. Therefore, the OhmImager horizontally averages measured resistance or apparent resistivity with appropriate spacing and applies one dimensional inversion to each averaged data (ρ -a curve) to obtain resistivity models. This horizontal averaging is called as *Gridding*. To perform

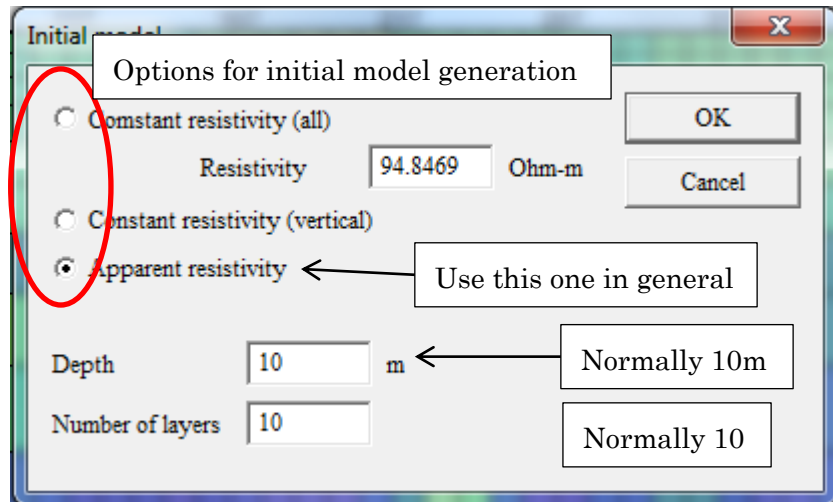
gridding, select Convert to grid data in the Resistivity analysis menu or click the



button. See the step ⑤ in section 3.1 for more detail.

4.5.2 Initial model

To generate an initial model for an inversion, select *Initial model* in the *Resistivity analysis* menu. See step ⑥ in section 3.1 for more detail. The following dialog box is displayed.

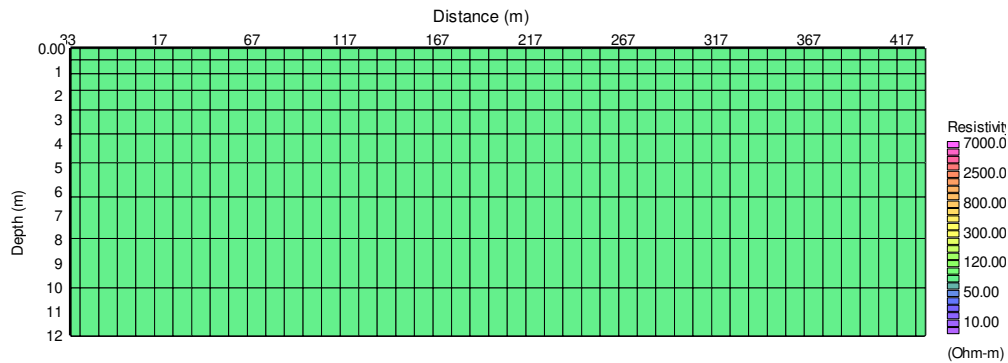


- Options for initial model generation

The initial models can be generated by following three methods. Use apparent resistivity (C) in general.

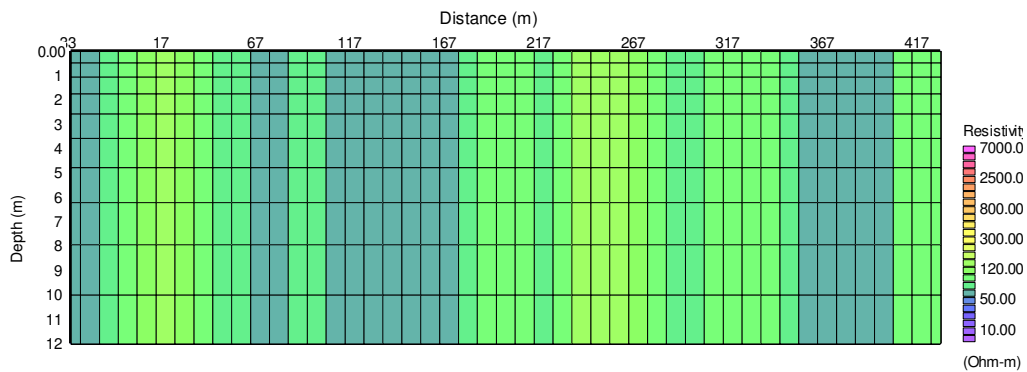
A : Constant resistivity (all)

Calculate average apparent resistivity for all data and generate a constant resistivity model. Average resistivity is shown in the edit box and it can be manually changed. This initial model generally yields smooth and stable inversion results. Use this option when data includes many noises.



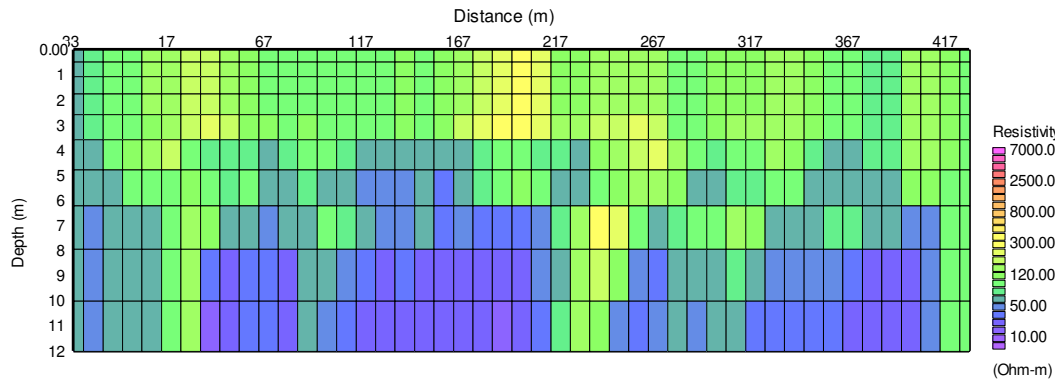
B : Constant resistivity (vertical)

Calculate average apparent resistivity for each p-a curve and generate a resistivity model in which each 1D (vertical) resistivity model has constant resistivity. Resistivity is constant in vertical direction and changes in horizontal direction. This initial model also yields smooth and stable inversion results. Use this option when data includes many noises.



C : Apparent resistivity(use this option in general)

Generate resistivity model based on apparent resistivity and apparent depth. Resistivity changes both horizontal and vertical directions.



- Depth and number of layers for initial model

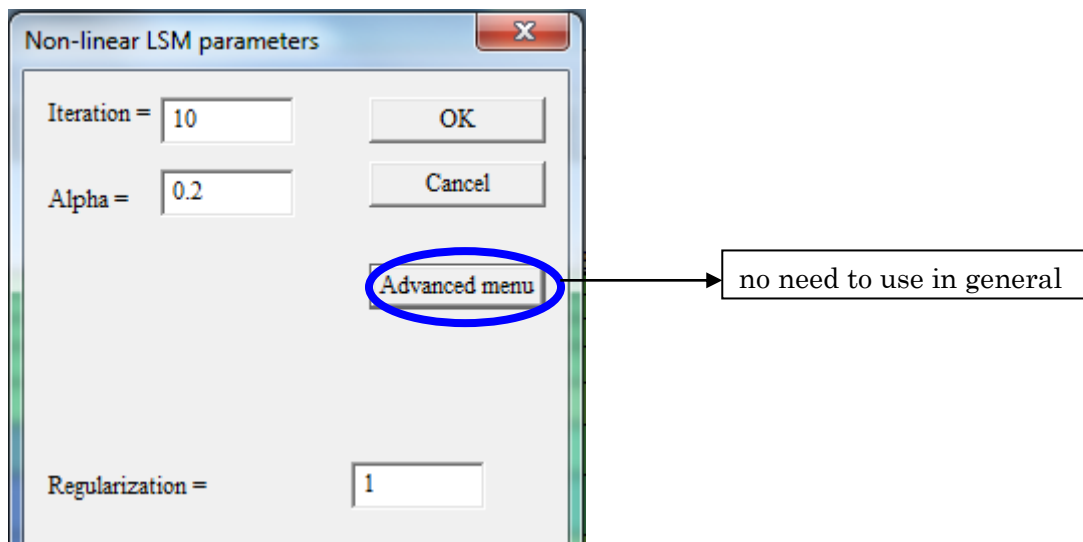
Set up depth to bottom of model and number of layers to edit boxes *Depth* and *Number of layers* respectively. Resistivity down to the defined depth at *Depth* is represented by layers defined at *Number of layers*. Thickness of layers increase as depth increases. Set *Depth* as 10m and *Number of layers* as 10 in general.

4.5.3 Non-linear inversion (continuous 1D analysis)

An inversion in terms of 1D non-linear least squares method is successively applied to 1D resistivity models. A linear-filter method is used for calculating theoretical apparent resistivity. To perform the inversion, select *Non-linear inversion (continuous 1D analysis)* in the *Resistivity analysis* menu. A following dialog box appears and parameters for inversion can be set. In general, parameters do not need to be changed. See step ⑨ in section 3.1 for more detail of the inversion.

- Iteration

Number of iterations in the inversion. A non-linear least square method iteratively modifies the resistivity model so that the difference between observed and theoretical resistivity decreases. Increase number of iteration when speed of conversion is slow. Use 10 in general.



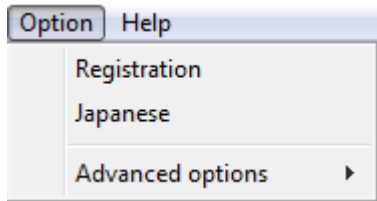
- Alpha

Alpha controls stability and conversion speed of inversion between 0 and 1. Small *Alpha* stabilizes the inversion and makes conversion slower. Use small *Alpha* when the inversion is unstable. Resistivity does not change when Alpha is zero. Use 0.2 in general.

- Regularization

Regularization controls smoothness of resistivity in vertical direction. Larger value of *Regularization* yields smoother resistivity model. Use 1 in general.

4.6 Option menu



4.6.1 Registration

To show registration status of OhmImager, select *Registration* in the *Option* menu. No need to use in general.

4.6.2 Japanese

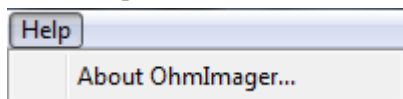
Check “Japanese” in the Option menu to change axis labels to Japanese. English is used in default setting.

4.6.3 Advanced options

4.6.3.1 Reverse Y axis text for clipboard copy

Reverse Y axis text for clipboard copy controls how the labels for vertical axis appear when *Copy to clipboard* in the *Edit* menu is selected. If *Reverse Y axis text for clipboard copy* is selected, the vertical axis label appears written top to bottom. If not selected (the default), the vertical axis label appears written bottom to top.

4.7 Help menu



4.7.1 About OhmImager

To report the software version information, select *About OhmImager* in the *Help* menu.

5. File format

5.1 Plotrefa file (.ovs)

```

2000 7 3.000000      : Header information (not used)
0 116 5.000000      : Dummy, number of  $\rho$ -a curves in a file, dummy
7.273106 4 0.000000  : Distance (m) of  $\rho$ -a curve, number of data in the  $\rho$ -a curve, dummy
2.500000 104.011070 3 2.000000 : Dipole size (m), apparent resistivity (ohm-m),
                                number of averaged data, N-space

2.500000 53.380451 2 3.000000
2.500000 39.567127 2 4.000000
2.500000 42.439896 1 5.000000
12.273106 4 0.000000      : Distance of  $\rho$ -a curve (m), number of data in the  $\rho$ -a curve, dummy
2.500000 126.577141 2 2.000000 : Dipole size (m), apparent resistivity (ohm-m),
                                number of averaged data, N-space

2.500000 56.252670 2 3.000000
.
.
2.500000 62.726463 1 9.000000
116 10      : Number of  $\rho$ -a curves in a file, number of layers
7.273106 7.273106 7.273106 7.273106 7.273106 7.273106 7.273106 7.273106
: Distance (m) of left side of each cell, from surface to the bottom of model.
0.000000 -0.480795 -1.057748 -1.750093 -2.580905 -3.577881 -4.774252 -6.209898 -7.932672
-10.000000 : Elevation (m) of left top of each cell, from surface to the bottom of model.
.
.
577.273132 577.273132 577.273132 577.273132 577.273132 577.273132 577.273132 577.273132
577.273132 577.273132 : Distance (m) of right side of cells placed at right end of the model.
0.000000 -0.480795 -1.057748 -1.750093 -2.580905 -3.577881 -4.774252 -6.209898 -7.932672
-10.000000 : Elevation (m) of right top of cells placed at right end of the model.
0 : Dummy
115 10 : Number of  $\rho$ -a curves -1, number of layers
7.273106 : Distance (m) of  $\rho$ -a curve
0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
: Dummy
120.811890 118.215652 107.652328 90.546242 39.466618 35.952564 32.651600 31.448727 31.300840
31.472975 : Resistivity (ohm-m) of each cell
12.273106

```

5.2 RES2DINV file (.dat)

Block model Xutm=X*0.000000+7.8 Yutm=X*1.000000+0.0 : Header information (not used)

2.500000 : Not used

3 : Not used

1436 : Number of data

1 : Not used

0 : Not used

19.773106 5.000000 1.500000 37.514330 : Distance (m), dipole size (m),
N-space, apparent resistivity (ohm-m)

22.273106 5.000000 1.500000 37.833905 .

24.773106 5.000000 1.500000 39.431779 .

27.273106 5.000000 1.500000 34.062921 .

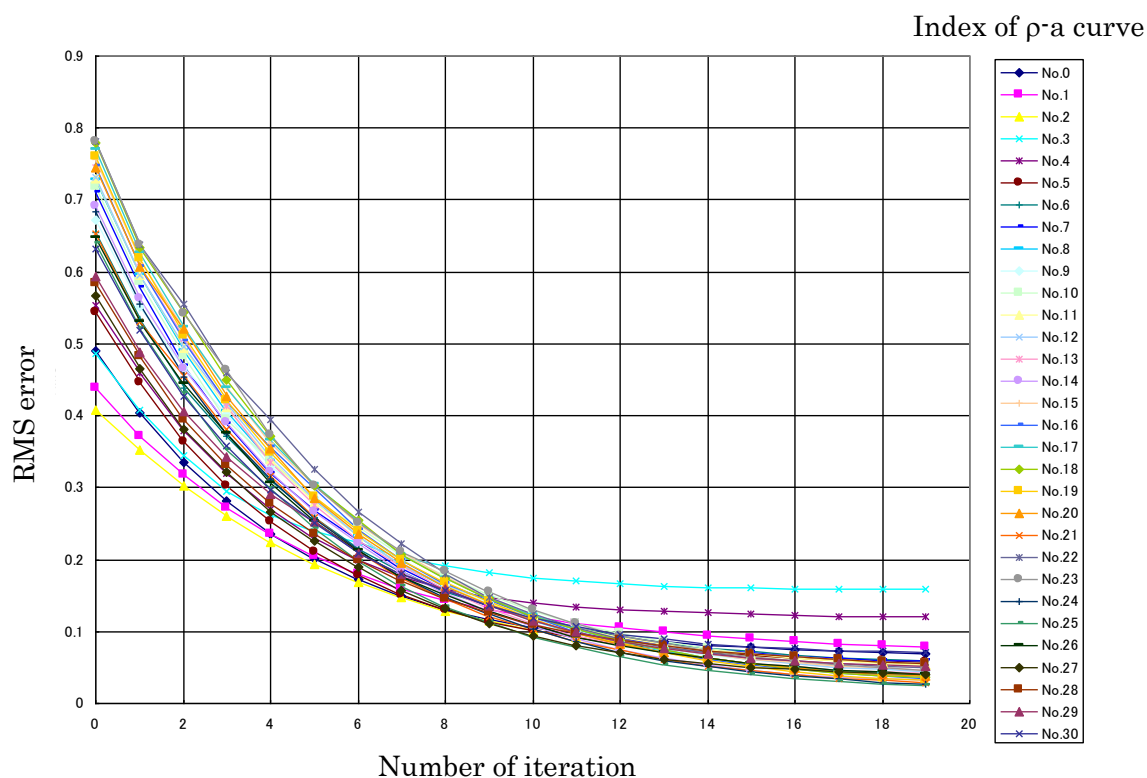
29.773106 5.000000 1.500000 33.636195 .

32.273106 5.000000 1.500000 39.349066 .

* N-space can be calculated as (rope length+(m-1)/2*Dipole size)/(dipole size). m indicates index of receiver (1,2...5).

5.3 Conversing process of inversion (rms.txt)

Index of ρ -a curve	RMS error from initial model to end of iteration.
0	0.078000 0.075321 0.072822 0.070526 0.068578 0.066857 0.065479 0.064069 0.063029 0.061909
1	0.098657 0.095888 0.093662 0.092418 0.090844 0.089671 0.088581 0.087620 0.087428 0.087183
2	0.061576 0.058891 0.055890 0.054208 0.052921 0.051883 0.050965 0.050286 0.049480 0.049031
3	0.060660 0.058738 0.057522 0.055258 0.053355 0.052029 0.051192 0.051131 0.050788 0.050913
4	0.046750 0.043009 0.039919 0.037408 0.035345 0.033581 0.032256 0.031106 0.030106 0.029387
5	0.052850 0.048923 0.046030 0.043833 0.042753 0.041292 0.040719 0.039861 0.038684 0.037815
6	0.052571 0.050121 0.048350 0.047067 0.045734 0.044674 0.043656 0.042932 0.042257 0.041812
7	0.056905 0.053951 0.050891 0.049043 0.047262 0.045553 0.044593 0.043427 0.042564 0.041677



Example of conversion process.