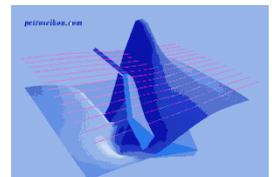


# 1D RESISTIVITY INVERSION TUTORIAL

## *Steps:*

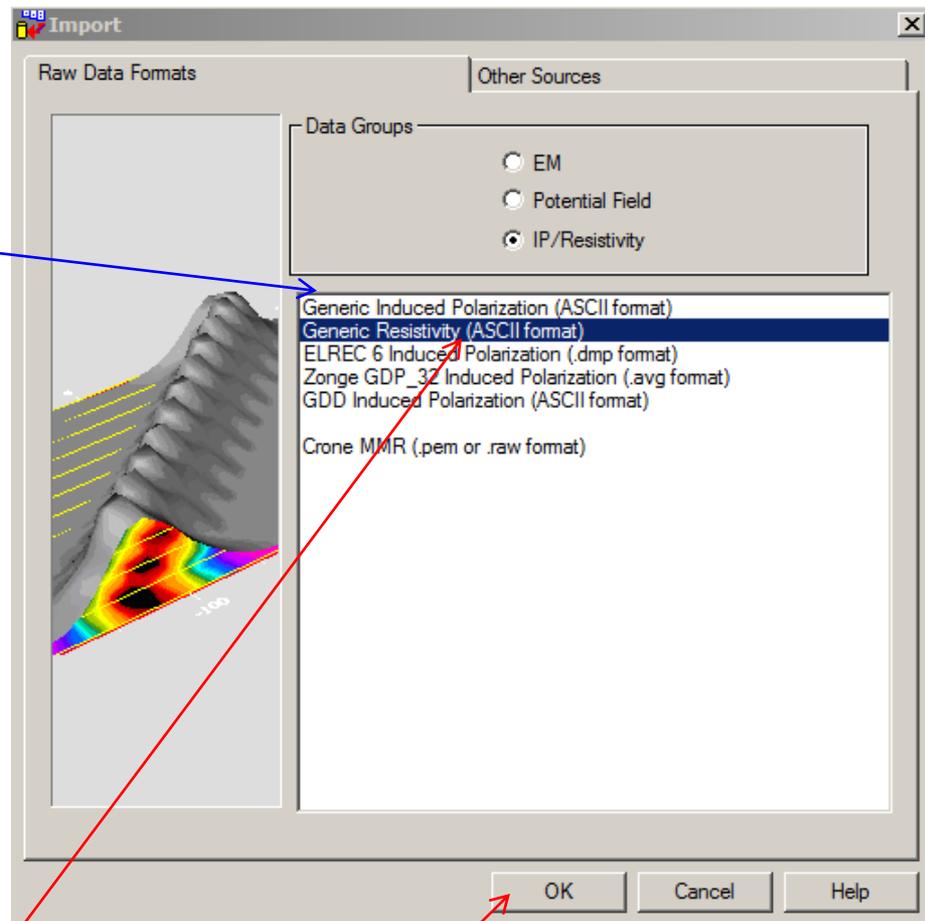
	<i>Page</i>
<b>1. Import data</b> to new or existing database	2
<b>2. Examine data</b>	6
<b>3. Perform initial forward modeling</b>	8
<b>4. Perform controlled Marquardt or Occam Inversions</b>	9
<b>5. Inversion evaluation</b>	15



**1. Import data**

2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
5. Inversion evaluation

Select “Generic Induced Polarization”  
if your data is from IP survey



Select “Generic Resistivity” and click “OK” button

**1. Import data**

2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
5. Inversion evaluation

Browse and select data file for import

Inputs. Import Wizard. Setup 1.

File Name: E:\Importdata\Resistivity\Titan\L-69743N\_ong\_qct\_work\_east\_flip\_nodupl.xyz Browse

Select one line as a header line

(0)	C2Y(0)	P1X(0)	P1Y(0)	P2X(0)	P2Y(0)
-	79773.00	41200.00	69743.00	41400.00	6974
-	79773.00	41200.00	69743.00	41400.00	6974
-	79773.00	41400.00	69743.00	41600.00	6974
-	79773.00	41200.00	69743.00	41400.00	6974
-	79773.00	41400.00	69743.00	41600.00	6974
-	79773.00	41200.00	69743.00	41400.00	6974
-	79773.00	41600.00	69743.00	41800.00	6974

Reset a Header  
Select a header line with the column labels and click on Reset button  
Reset

Resistivity Only (Static Domain) or Resistivity/Phase (Frequency Domain)

General information from file

Electrode Array Selection

Dipole - Dipole  
 Pole - Dipole  
 Pole - Pole  
 Gradient

Distance to infinity Pole(m):

Time base (mSec):   
 Dipole Length:   
 Number of Windows:   
 Reference Point at:

Line Direction

East-West  
 North-South

Line label in selected column

Output Normalization

Normalize to current (Resistivity)  
 Normalize to primary voltage (IP)

< Back Next > Cancel Help

Select electrode array type and set the distance to infinity pole

Set line direction and select the data column for the line

Set dipole length and reference point position

Click "Next" button to proceed to next step

**1. Import data**

2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
5. Inversion evaluation

Select vertices for both transmitter and receiver, as well as the units of coordinate

Select the column which contains voltage data and set its units

If current is included in data file and you want to use it for normalization, check "Current" option and select the column label of current from the dropdown list. Otherwise, uncheck this option and input 1 in the box below

Click "Next" button to proceed to the next step

Data Information. Import Wizard. Step 2.

File View

C1X()	C1Y()	C2X()	C2Y()	P1
41500.00	69743.00	.	79773.00	
41700.00	69743.00	.	79773.00	
41700.00	69743.00	.	79773.00	

Time delay: 0

On-Time window: 0

Window centre(s): 0

Window width: 0

System

Transmitter Vertices:

Electrode 1: 1 C1X()

Electrode 2: 3 C2X()

Receiver Vertices:

Electrode 1: 5 P1X()

Electrode 2: 7 P2X()

Coordinate Units:  meters  feet

Voltage: 10 VP0

Units:  mVolts  Volts  Apparent Resistivity

Current: [ ]

Units: 1  mAmp  Amp

Phase [ ]

Phase Units:  Degree  Rad  mRad

Frequency (Hz): 0

Units

Column #, name	Window width	Column #, name	Window width
<input type="checkbox"/> Window 1	0	<input type="checkbox"/> Window 11	0
<input type="checkbox"/> Window 2	0	<input type="checkbox"/> Window 12	0
<input type="checkbox"/> Window 3	0	<input type="checkbox"/> Window 13	0
<input type="checkbox"/> Window 4	0	<input type="checkbox"/> Window 14	0
<input type="checkbox"/> Window 5	0	<input type="checkbox"/> Window 15	0
<input type="checkbox"/> Window 6	0	<input type="checkbox"/> Window 16	0
<input type="checkbox"/> Window 7	0	<input type="checkbox"/> Window 17	0
<input type="checkbox"/> Window 8	0	<input type="checkbox"/> Window 18	0
<input type="checkbox"/> Window 9	0	<input type="checkbox"/> Window 19	0
<input type="checkbox"/> Window 10	0	<input type="checkbox"/> Window 20	0

Data Units:  mV/V  V/V  mSec

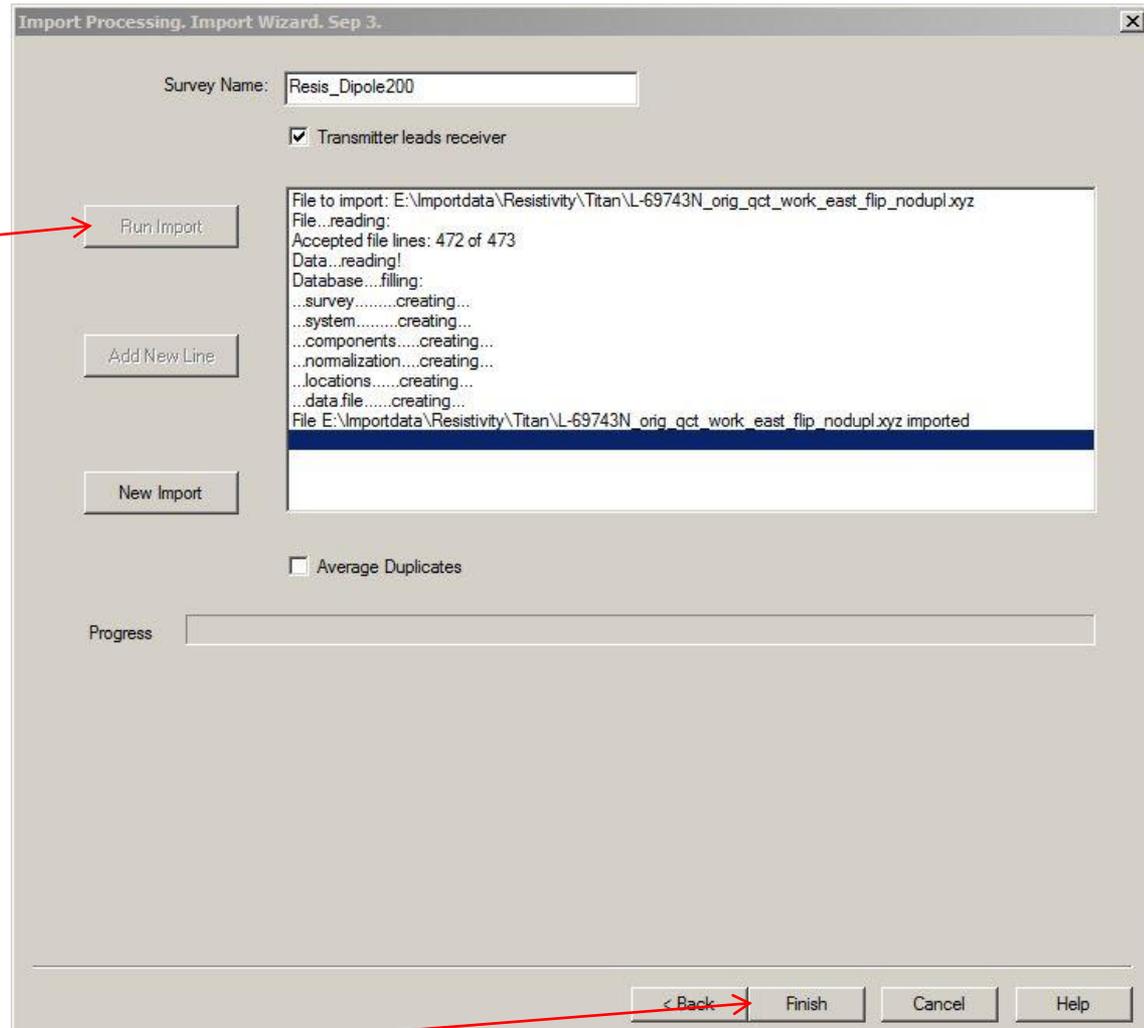
Time Window Units:  mSec  Sec

< Back Next > Cancel Help

**1. Import data**

2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
5. Inversion evaluation

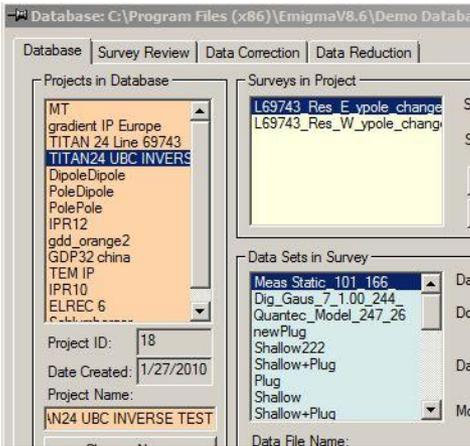
Click “Run Import” button to start importing data into database



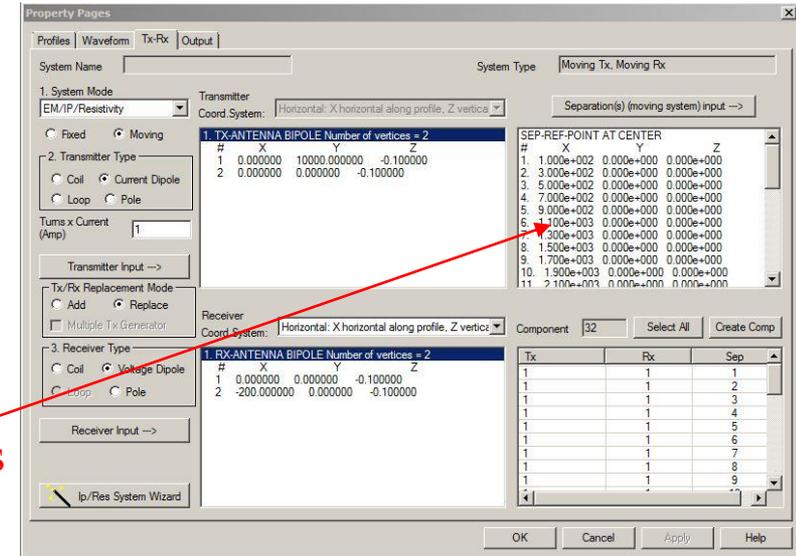
After processing is done, click “Finish” button to complete the import procedure

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
5. Inversion evaluation

### 1. Check database for the survey



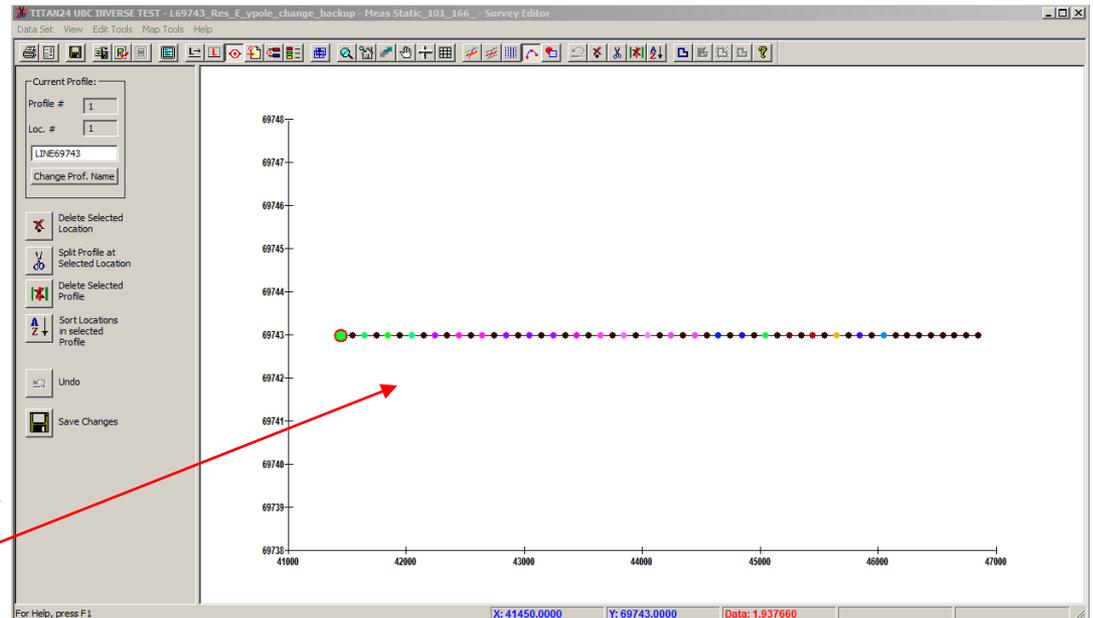
### 3. Check separations



### 2. Click configuration



### 4. Check lines and stations by clicking "Survey Editor" button



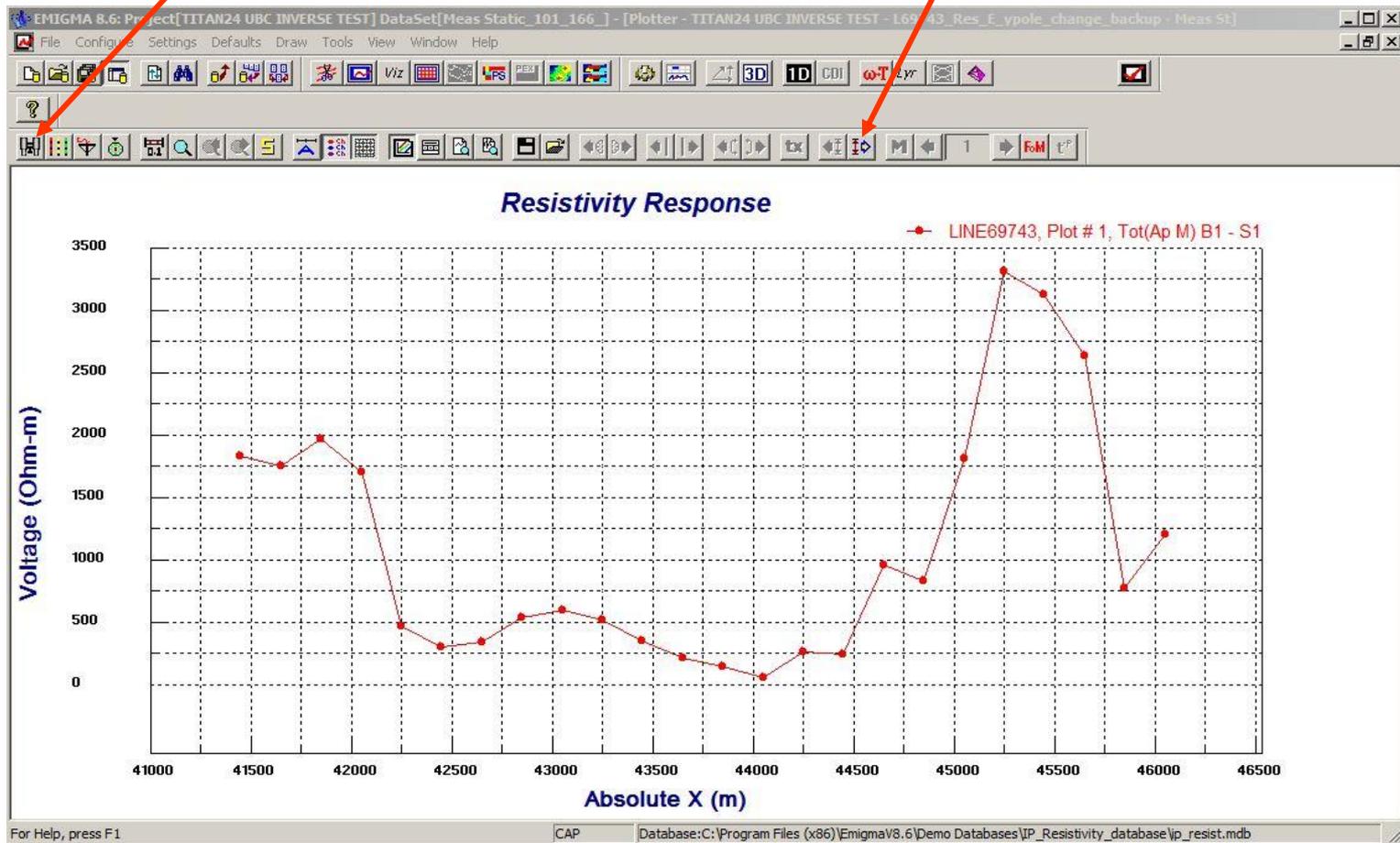
1. Import data
- 2. Examine data**
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
5. Inversion evaluation



Click "Plotter"...

Load data set in plotter

Toggle between separations

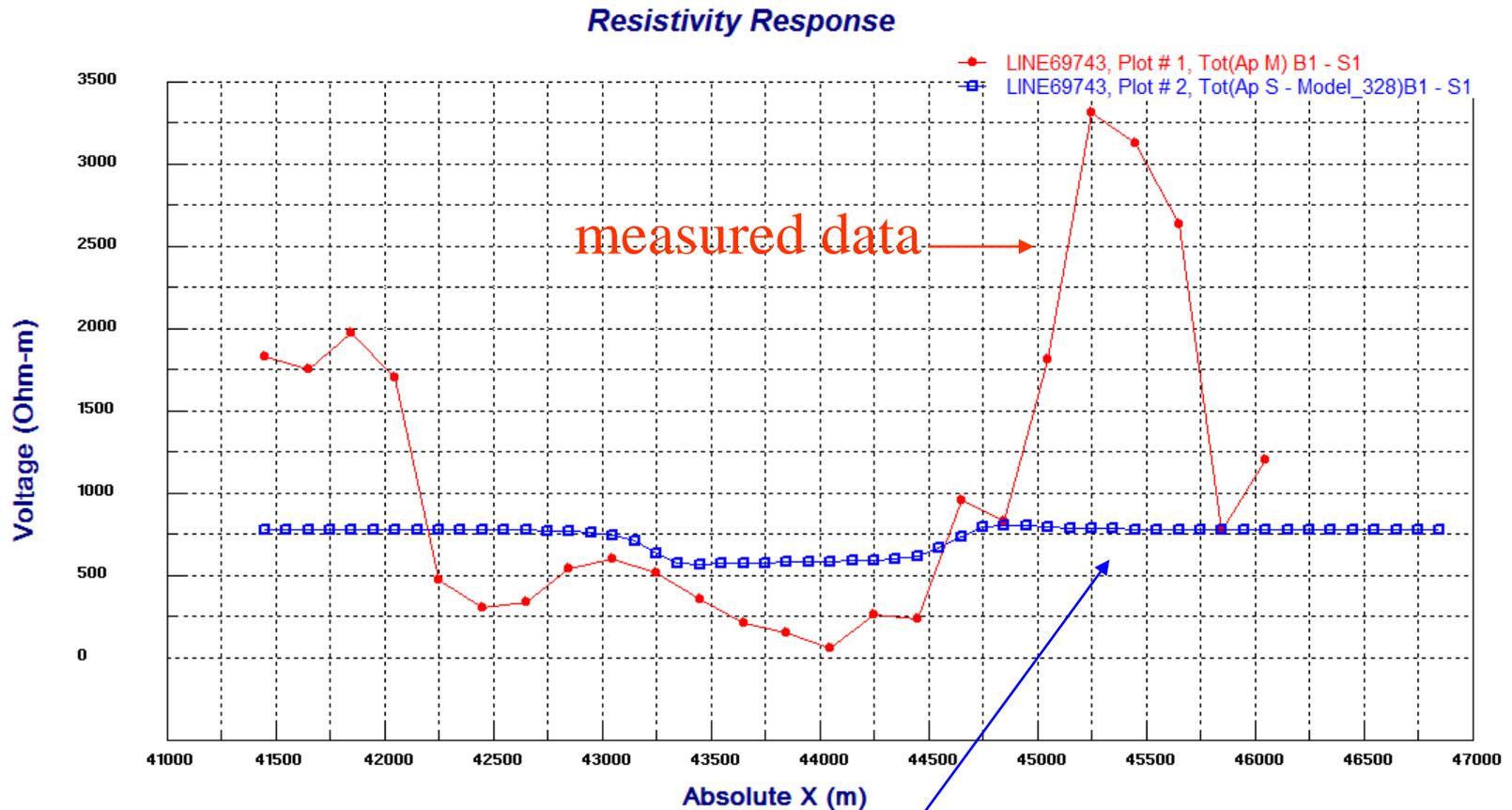


1. Import data
2. Examine data
- 3. Perform initial modeling**
4. Perform controlled Marquardt or Occam Inversions
5. Inversion evaluation

Resistivity Inverse

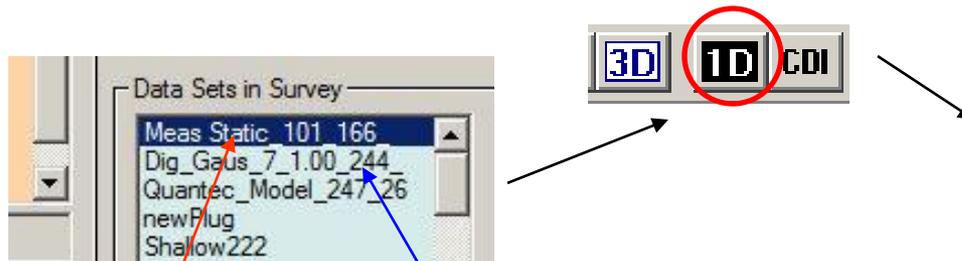
8

*Note: Performed some initial modeling to get a “feel” of the background resistivity and estimate parameters of initial model for inversion.*



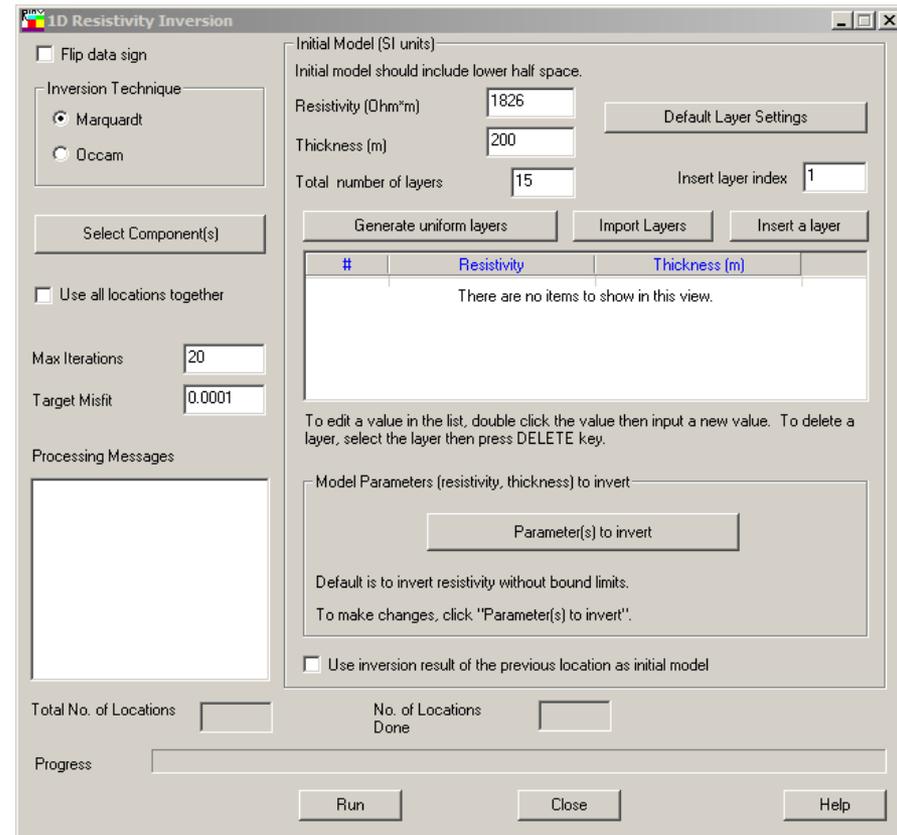
simulated data with a forward model

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform controlled Marquardt or Occam Inversions**
5. Inversion evaluation



Select survey data

Note: you can also use processed data, if processing such as interpolation is done on data



1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform controlled Marquardt or Occam Inversions**
5. Inversion evaluation

**Inversion type:**

Marquardt: each layer per data point consists of 2 model parameters: thickness and resistivity (both inverted).

Occam: each layer has a fixed thickness and the inversion only inverts for resistivity.

Flip data sign if it is not in accordance with system

Open a dialog for selecting components to be inverted

Set maximum number of iterations and data misfit

Check "Use all locations together" to do inversion with all locations at the same time, which creates more accurate model than using single locations.

Use inversion result of the previous location as initial model will create smooth model

Initial Model (SI units)  
Initial model should include lower half space.

Resistivity (Ohm\*m)

Thickness (m)

Total number of layers  Insert layer index

#	Resistivity	Thickness (m)
1	750.000000	250.000000
2	2000.000000	250.000000

To edit a value in the list, double click the value then input a new value. To delete a layer, select the layer then press DELETE key.

Default is to invert resistivity without bound limits.  
To make changes, click "Parameter(s) to invert".

Use inversion result of the previous location as initial model

Total No. of Locations  No. of Locations Done

Progress

**Generate an initial model:**

Input how many layers in total that you would like in the model, set the resistivity and thickness. Then click "Generate uniform layers" button to generate a series of uniform layers with specified parameters. If you click "Insert a layer" button, the layer with specified resistivity and thickness will be inserted to the layer with index specified in Insert layer index box. User could also import existing model by clicking "Import Layers" button.

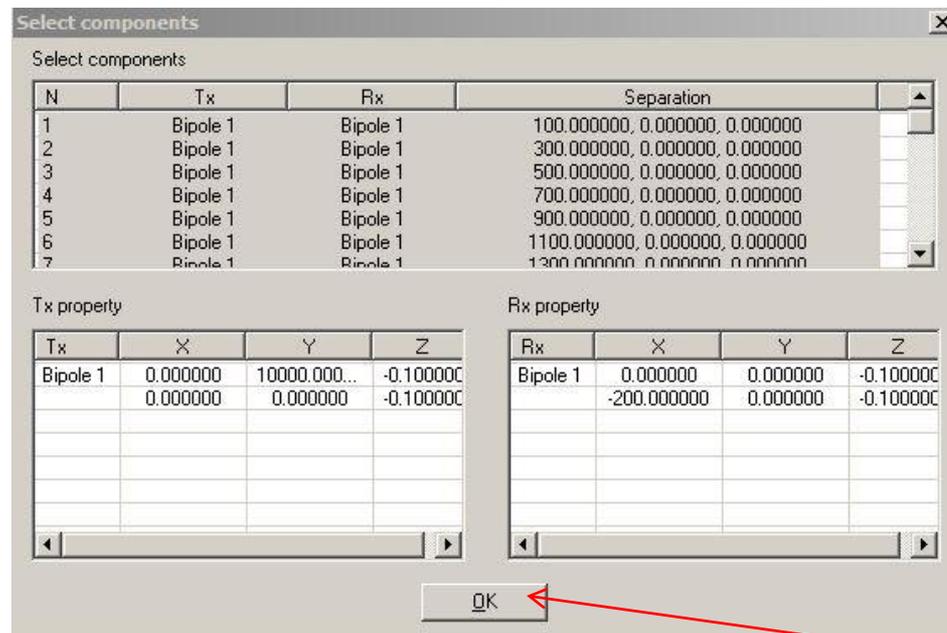
User could directly change model parameters by double clicking their corresponding boxes in the table.

Set parameters to be inverted. Users could set bounds on parameters at appeared dialog

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform controlled Marquardt or Occam Inversions**
5. Inversion evaluation

Selection of components

Click “Select Component(s)” button



Click “OK” button after it is done

Users can select components involved with inversion. For the case of 1D resistivity inversion, different components are actually different separations. Use more components in inversion will make the inverted model more accurate

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform controlled Marquardt or Occam Inversions**
5. Inversion evaluation

## Create a Starting Model

Initial Model (SI units)  
Initial model should include lower half space.

Resistivity (Ohm·m)

Thickness (m)

Total number of layers  Insert layer index

#	Resistivity	Thickness (m)
1	750.000000	250.000000
2	2000.000000	250.000000

To edit a value in the list, double click the value then input a new value. To delete a layer, select the layer then press DELETE key.

**Import Layers:** If you have created a forward model that you like, you may import it as a starting model or if you have a previous inversion that you like, you may import it as a starting model.

**Insert a layer:** You may insert additional layers at any stage.

### Generate a Starting model:

First select how many layers in total that you would like in the model, set the initial resistivity and thickness. Then click “Generate Uniform Layers”.

### Editing Starting model:

After making a starting model (whether by importing or generating), the user may edit either the resistivity or the thickness of the layer. Simply double-click on the parameter setting.

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform controlled Marquardt or Occam Inversions**
5. Inversion evaluation

## Constrain Model Parameters

**Set model parameters to invert**

Click an "Invert" or "Set Bound" item to select/de-select the option. If "Set Bound" option is checked, to edit min/max bound value, double click the value, then input new value.

**Resistivity Settings**

Layer #	Resistivity	Invert	Set Bound	Bound - Min	Bound - Max
1	750.000000	<input checked="" type="checkbox"/> Invert Resistivity	<input type="checkbox"/> Set Bound		
2	2000.000000	<input checked="" type="checkbox"/> Invert Resistivity	<input checked="" type="checkbox"/> Set Bound	1000.000000	3000.000000

Invert All    Set All Bounds    Remove All Bounds    Apply Selected Min Bound to All    Apply Selected Max Bound to All

**Thickness Settings**

Layer #	Thickness (m)	Invert	Set Bound	Bound - Min	Bound - Max
1	250.000000	<input checked="" type="checkbox"/> Invert Thickness	<input type="checkbox"/> Set Bound		

Invert All    Set All Bounds    Remove All Bounds    Apply Selected Min Bound to All    Apply Selected Max Bound to All

OK    Cancel    Help

Model Parameters (resistivity, thickness) to Invert

Parameter(s) to invert

### Resistivity Constraints:

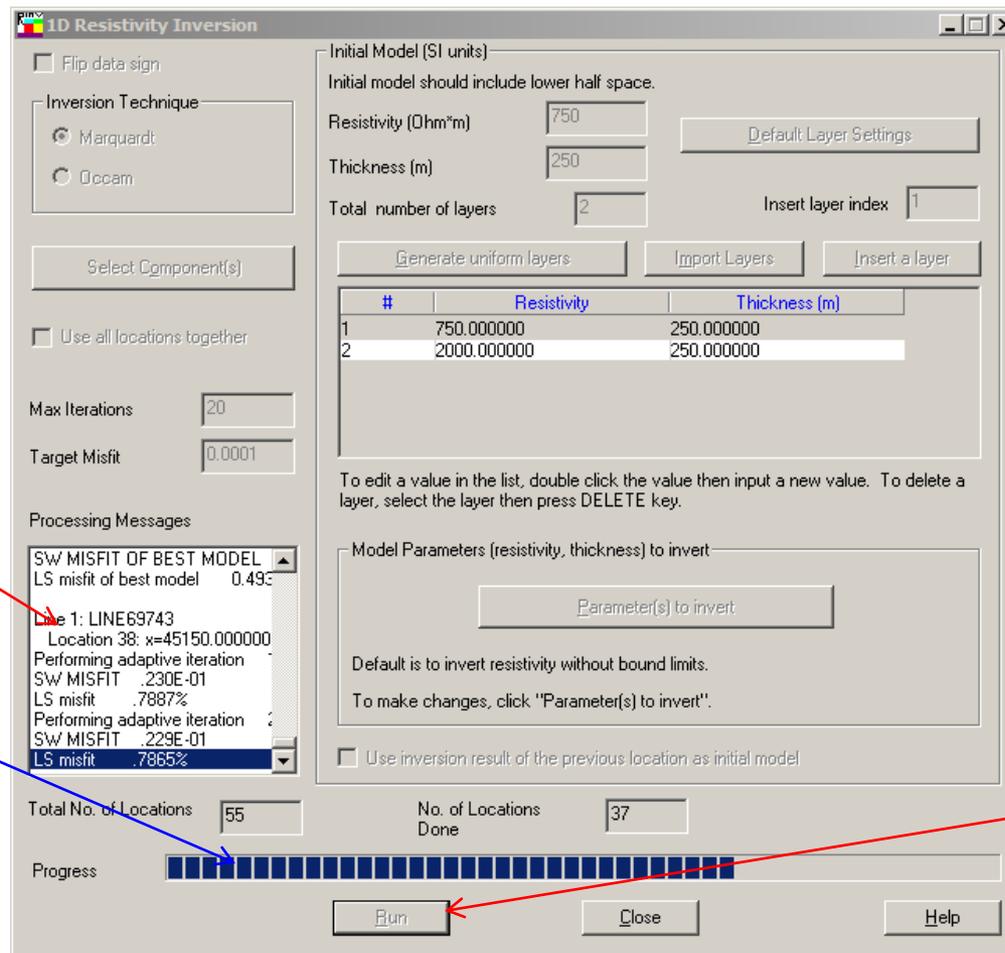
It is useful to constrain the layer resistivity to ranges that are possible in the geological environment.

### Thickness Constraints:

This option is only available under the Marquardt technique. Constraining the thickness to not be too large helps gain resolution. Constraining the thinness of the layer is a question of geological meaningfulness.

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform controlled Marquardt or Occam Inversions**
5. Inversion evaluation

## Executing the Inversion



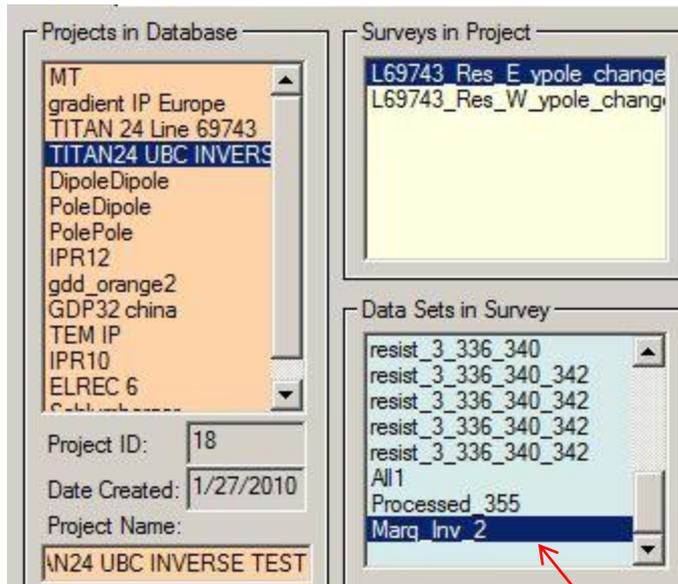
The left window (in white) shows each data point's progress.

The "Processing progress" bar shows the total progress of this inversion.

Click "Run" button to start inversion process

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

## Inversion Evaluation



In each survey, there will be several data sets after modeling, inversion and processing. In this case, we have multiple forward models and one inversion model. Each forward model has a new data set containing the simulated data under the model. Similarly, each inversion contains a new dataset containing the simulated data set under the inversion model (for each point) and attached to that data set is the inversion model.

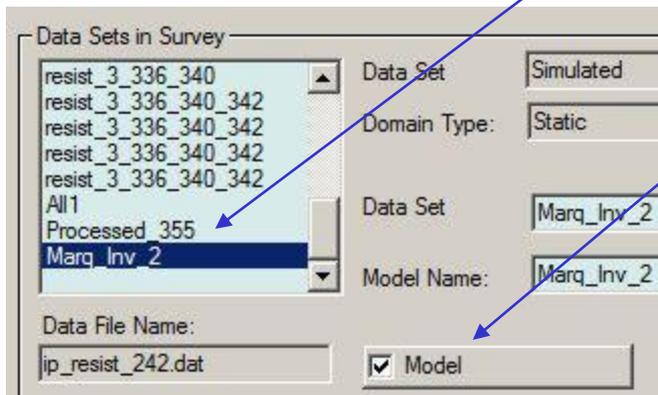
Our inversion model dataset (with Marquardt type inversion)

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

## Inversion Evaluation

An inversion is selected. You will note the “Model” button is checked.

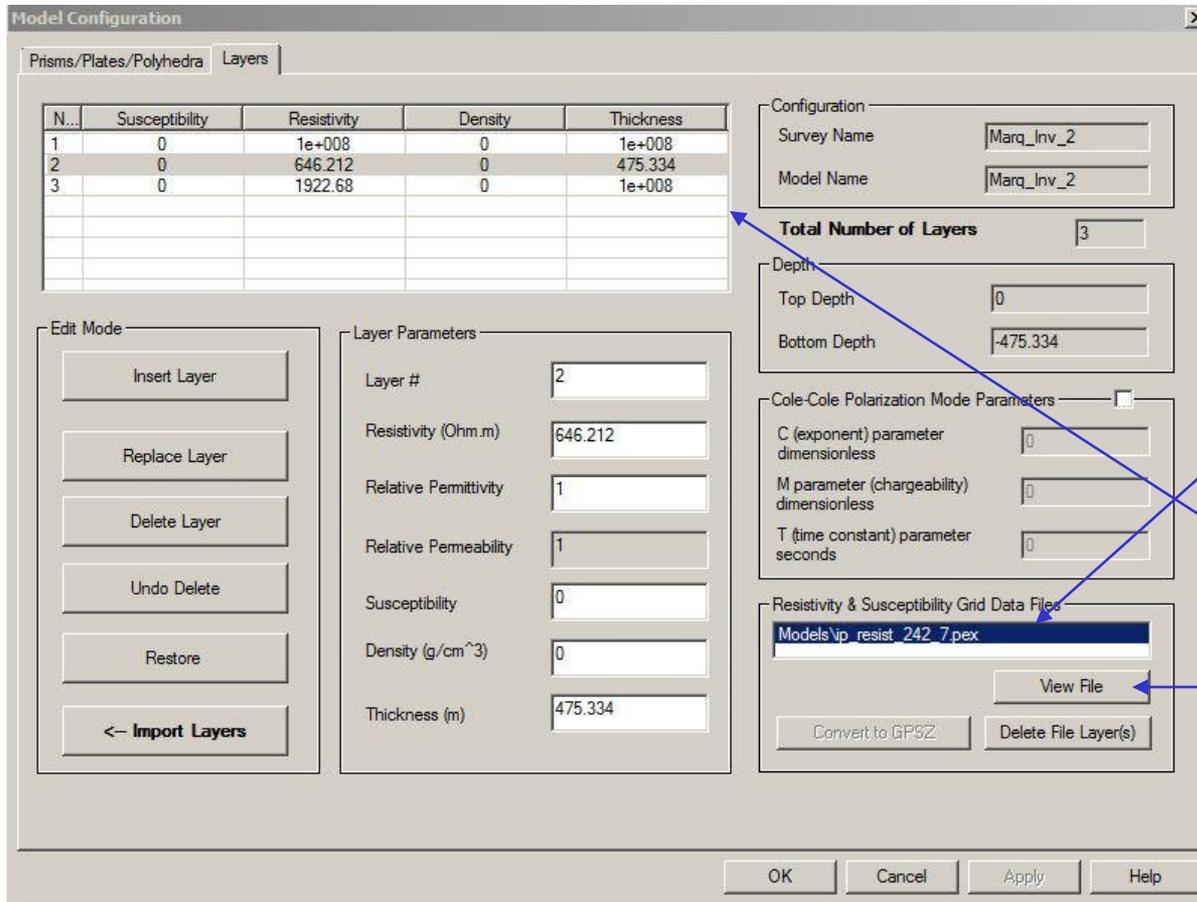
If the model button is clicked...



1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

## Inversion Evaluation

a window will open



Attached to the database in a subdirectory called “Models” is the inversion results in a simple ASCII XYZ file (\*.pex) which may be viewed here. This file may easily be imported to another application although graphical viewing tools are provided within EMIGMA.

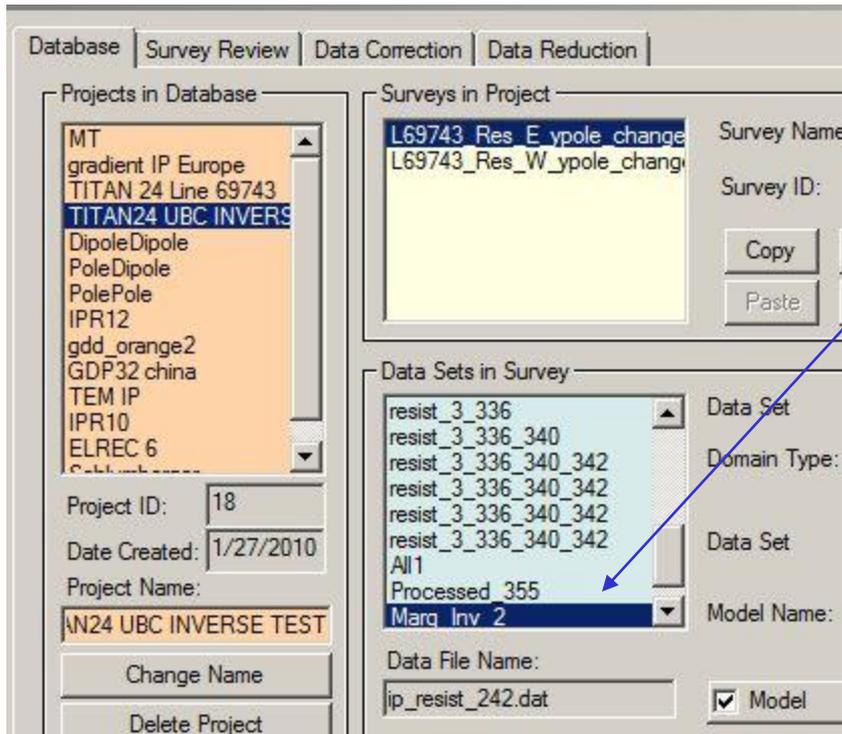
The 1D model for the final data point is also included.

Click “View File” button to view the data file of the saved 1D layered model.

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

## Inversion Evaluation

Select the inversion.



Choose CDI Viewer to view a stacked section of the results

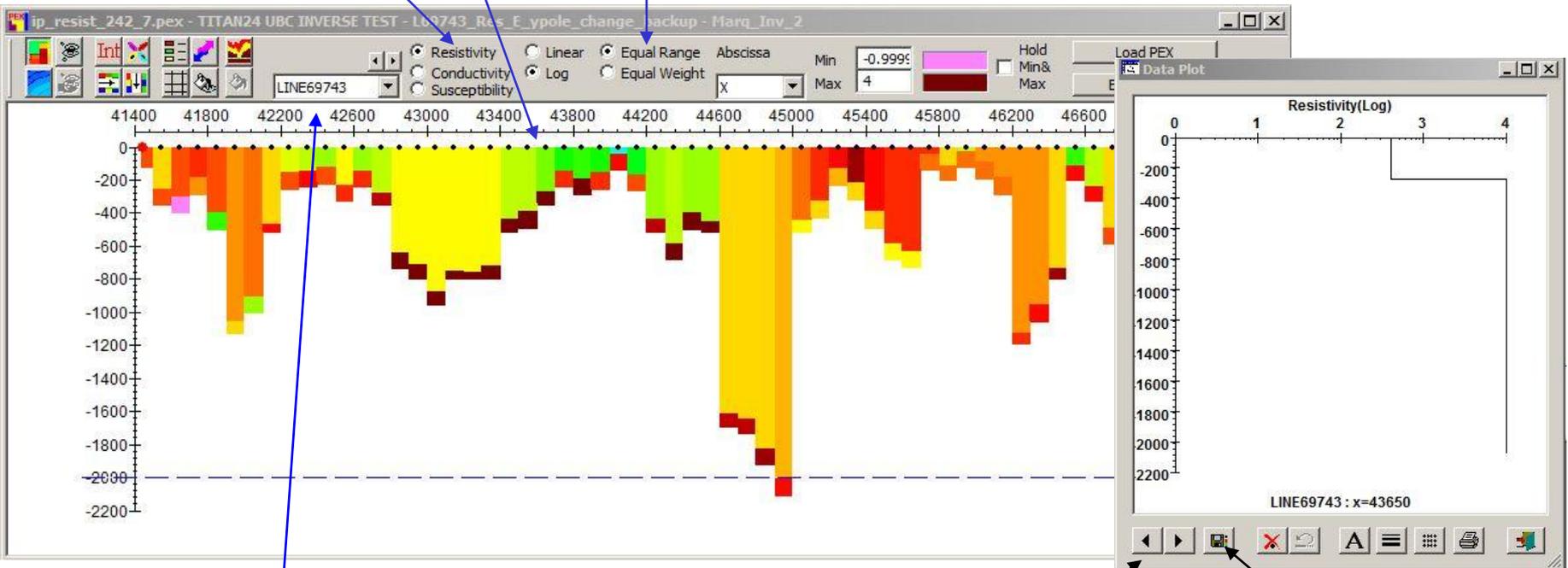
1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

## Inversion Displays



Choose CDI viewer to graphically view the results

The results for each **data point** are shown (without interpolation) initially in **log(Resistivity)** with **Equal Range** display.



If there is more than one line then **other lines** may be selected.

A **simple line drawing** is also provided and you may **step** along the profile. You may also save the layered model of the current point by clicking

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
5. **Inversion evaluation**

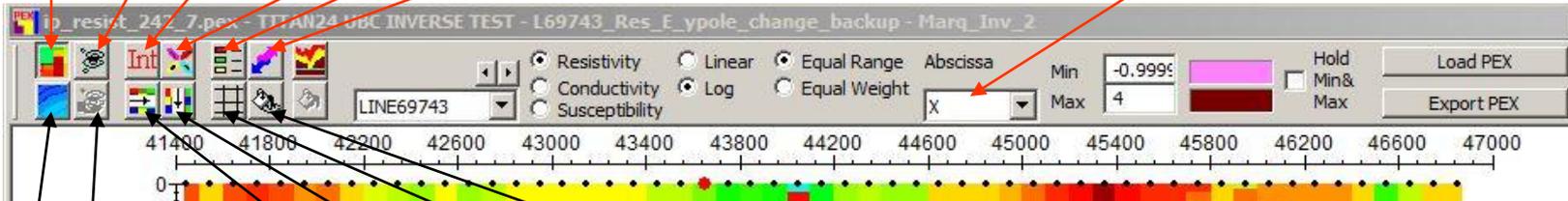
## Inversion Displays

Resistivity Inverse  
20



Choose CDI viewer to graphically view the results

- Show Contour Lines
- Show Grid
- Interpolate
- Reset
- Show Legend
- Proportional View
- Use X or Y coordinate



- Filled Contour
- Contour Attributes
- Depth Interpolation
- Location Interpolation
- Show Grid Lines
- Refresh View

**Equal Range:** assign different colors to different ranges which are equal independently of the number of data falling within these ranges

**Equal Weight:** assign colors to different ranges which are unequal but covering the same number of data

**Min:** Any data values below Min will be displayed as the color to the right of the edit field

**Max:** Any data values above Max will be displayed as the color to the right of the edit field

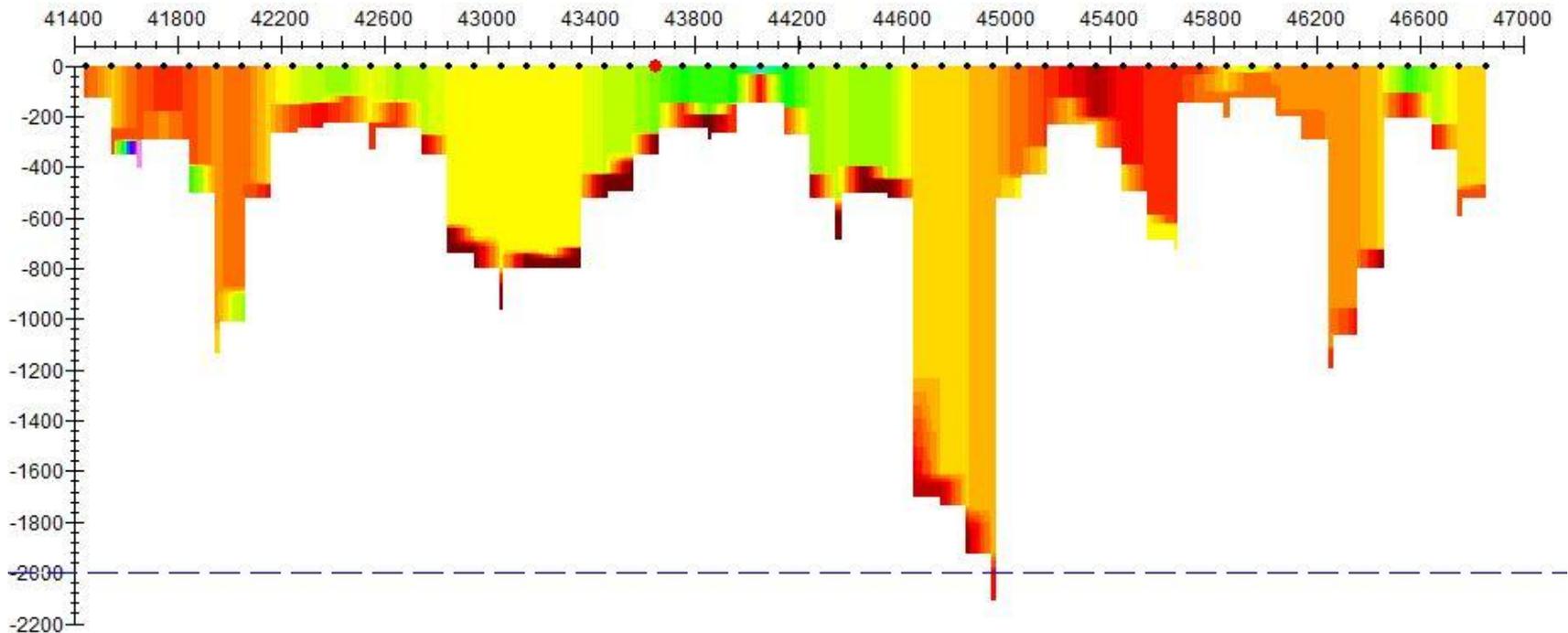
1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

## Inversion Displays

Resistivity Inverse  
21



Choose CDI viewer to graphically view the results



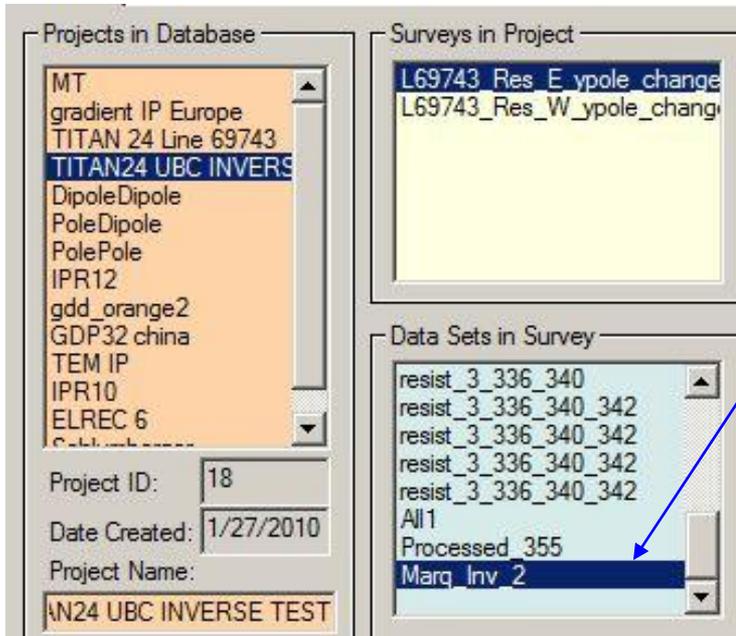
Axes may be edited by double-clicking on it, and you can change Max, Min, Labels and Titles etc. on the popup dialog

Depth and location interpolated may be repeated (note: the results of previous interpolations are used in the next interpolation so use with care)

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

## Inversion Evaluation

To assess how well the inversion model fits the data at each station, select the inversion data set and then select the plotter.



Select “Yes”, if this dialog is appeared

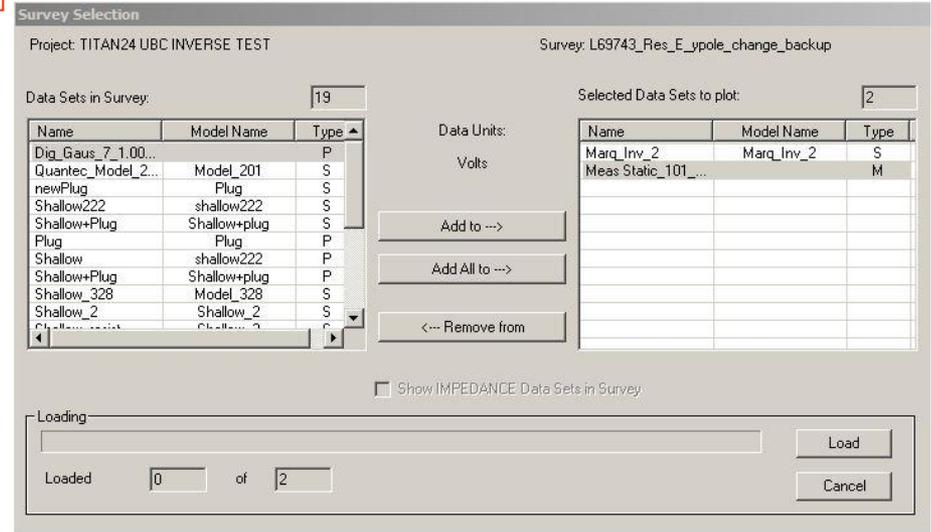
1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

## Inversion Evaluation

Resistivity Inverse

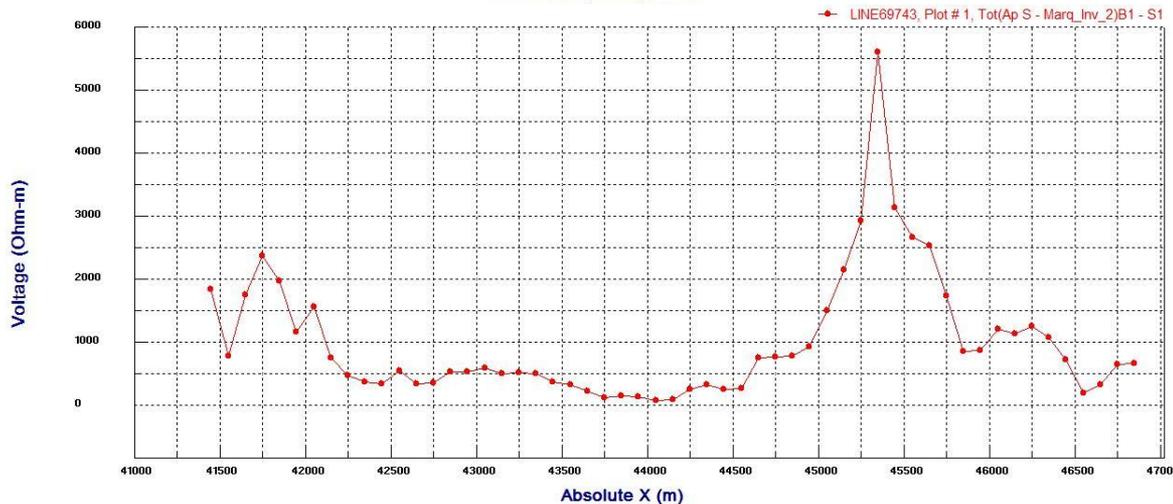
23

Select the data sets required for comparison and then click “Load”



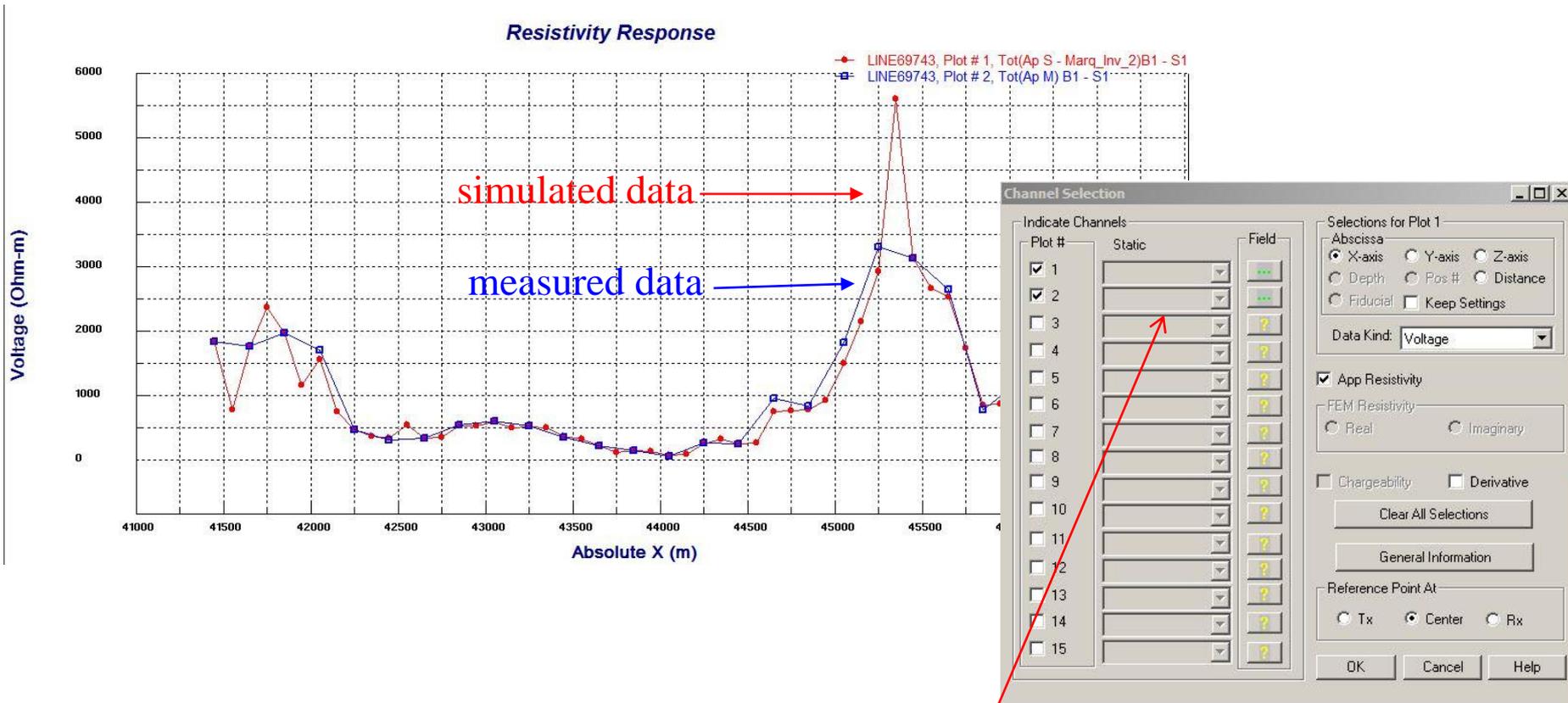
All selected data sets are then loaded to the Plotter application and the plot appears showing the simulated data of the first separation.

↓ Resistivity Response



1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
- 5. Inversion evaluation**

The user may select other data sets to plot by simply double clicking on the plot.



Select for the 2<sup>nd</sup> plot on measured data

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform controlled Marquardt or Occam Inversions
5. **Inversion evaluation**

## Inversion Evaluation

Resistivity Inverse  
25

Multiple plots can be shown for various inversions and models in “Static” mode. The user may step through different separations by simply clicking the arrow.

