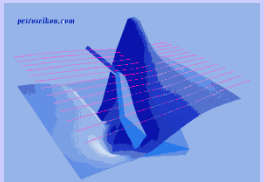
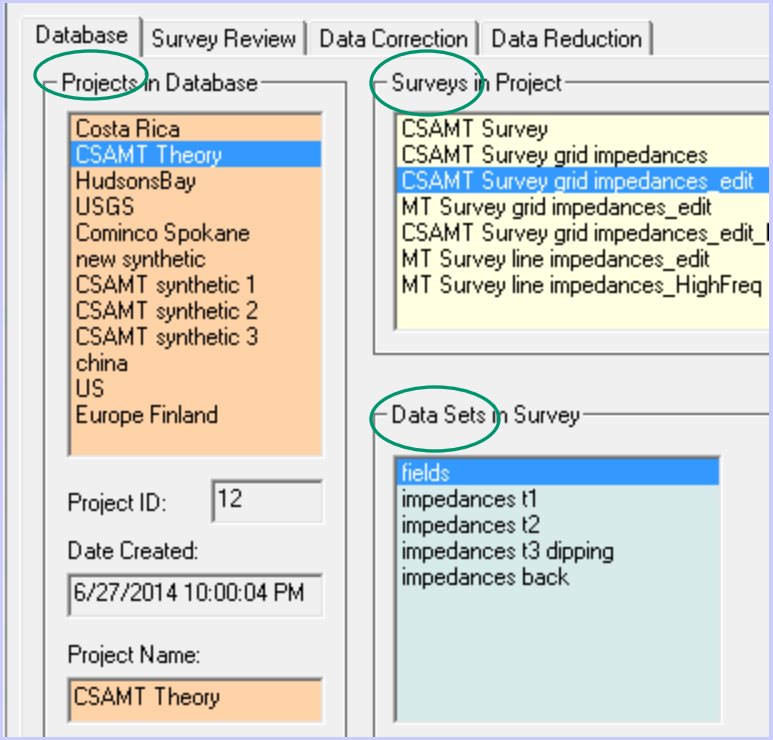
1D MT INVERSION TUTORIAL

Steps: ***Page***

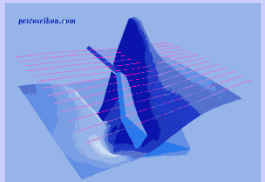


1. **Data organization and import**
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. Inversion evaluation

The data in EMIGMA is organized into Projects, Surveys and Data Sets.



Across the top, there are four tabs, *Database* (view shown above), *Survey Review*, *Data Correction* and *Data Reduction*, as discussed on the next page.



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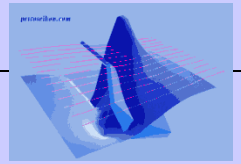
Database – Organizes the data into Projects, Surveys and Data Sets. For each data set, any corresponding models and grids are also shown (if the appropriate 'model' or 'grid' button is checked)

Survey Review - Allows the user to review the lines and data points. Data sorting, filtering and profile name modification options are available.

Data Correction – Enables the user to delete points and components. The user can also modify values in a number of ways such as applying a shift, multiplication by a factor, inverting the sign, etc.

Data Reduction – Allows the user to reduce entire data sets (measured or simulated) in a single operation

For a detailed description of each feature, please refer to the EMIGMA Manual.



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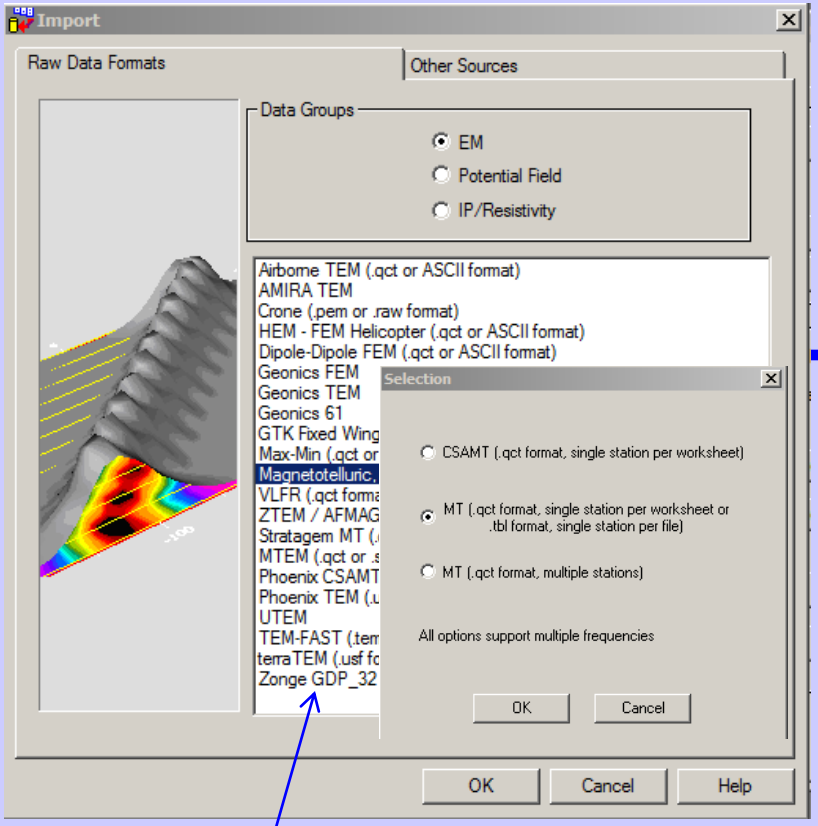
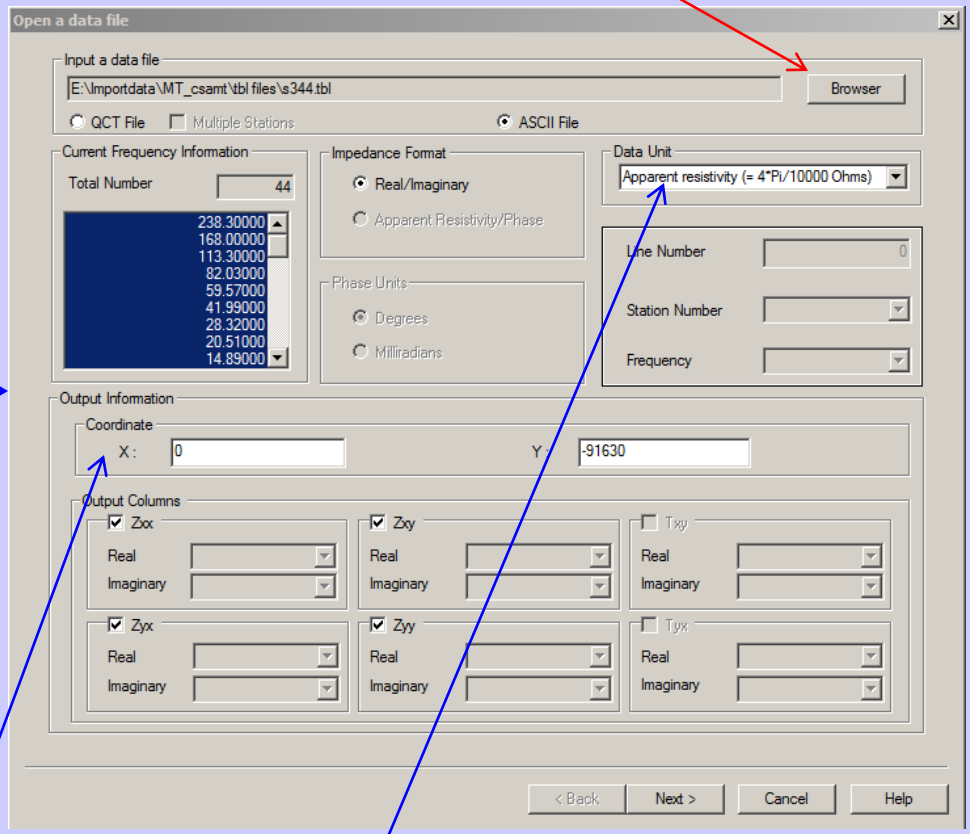
Browse and select .qct or .xyz data file for import





You can also import MT data through Zonge import

Set coordinate information and data unit (real/imaginary or apparent resistivity/phase). The data stored in EMIGMA is in real and imaginary. If you select apparent resistivity/phase, they will be converted.

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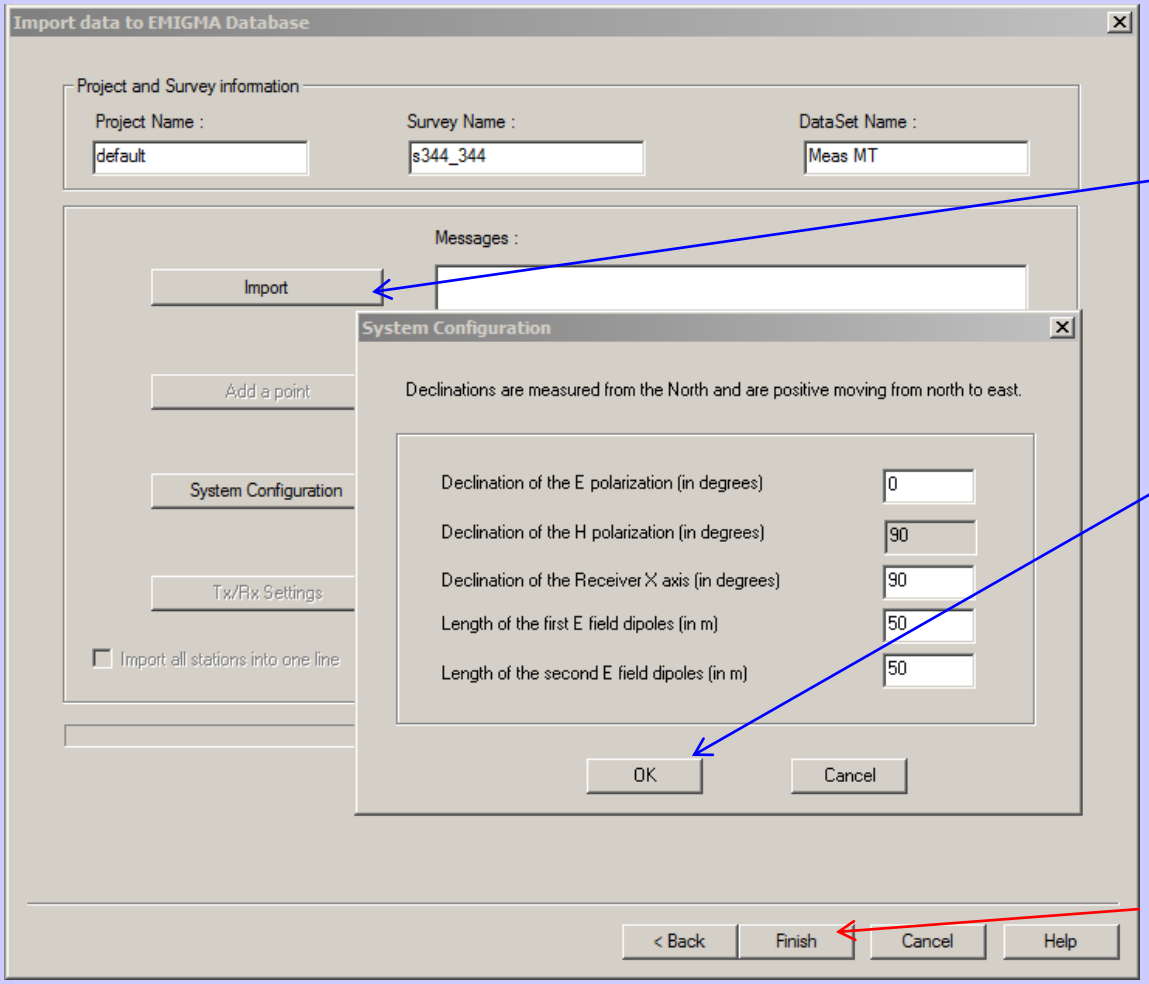

Click “Import” button and the “System Configuration” dialog will appear. Make configurations according to your system and click “OK” button to start importing.

When running a simulation, the polarization 90 degrees from the one given here is also computed (both are necessary to calculate all four elements of the matrix), but only this one is saved.

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

1. **Data organization and import**
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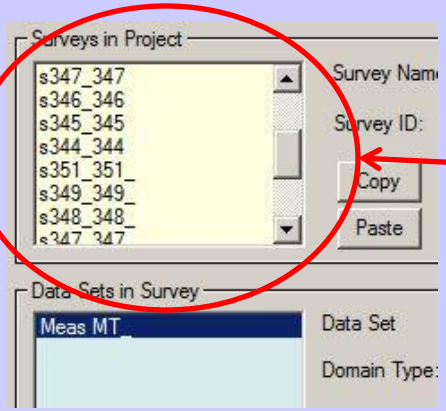
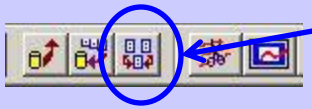
Merge data from different datasets



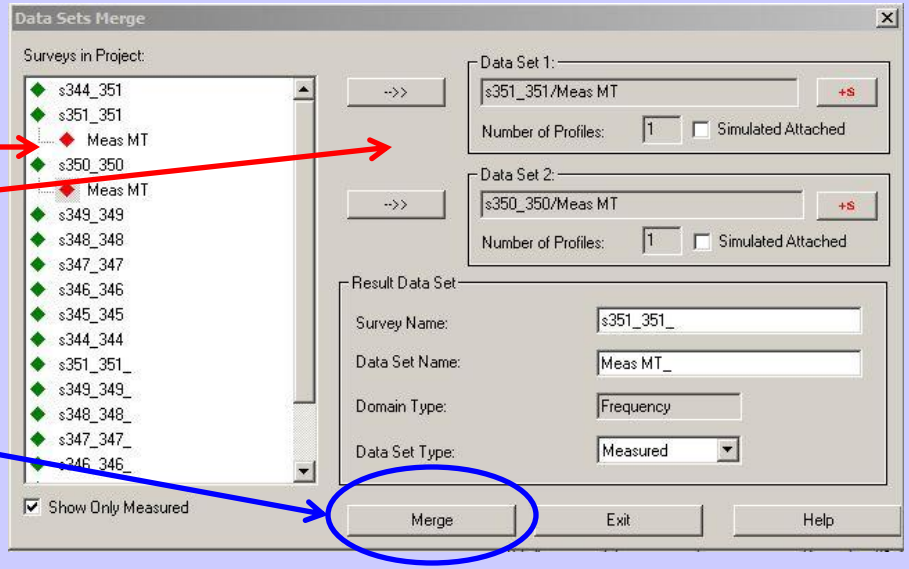
If your import files contain only one location per file as in this case, you have to import them separately as different datasets and merge them into one profile later.



Click "Merge Data Set" button to open the "Data Set Merge" dialog.

Select datasets to be merged from the table respectively, and add them to the right boxes.

Click "Merge" button to generate a new survey (in this case, named "s351_351_") containing a new dataset ("Meas MT_").



1. **Data organization and import**
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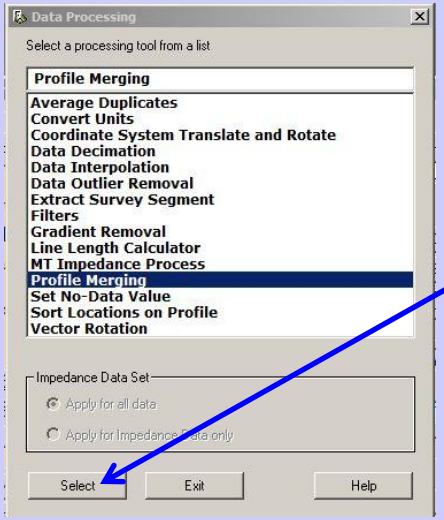
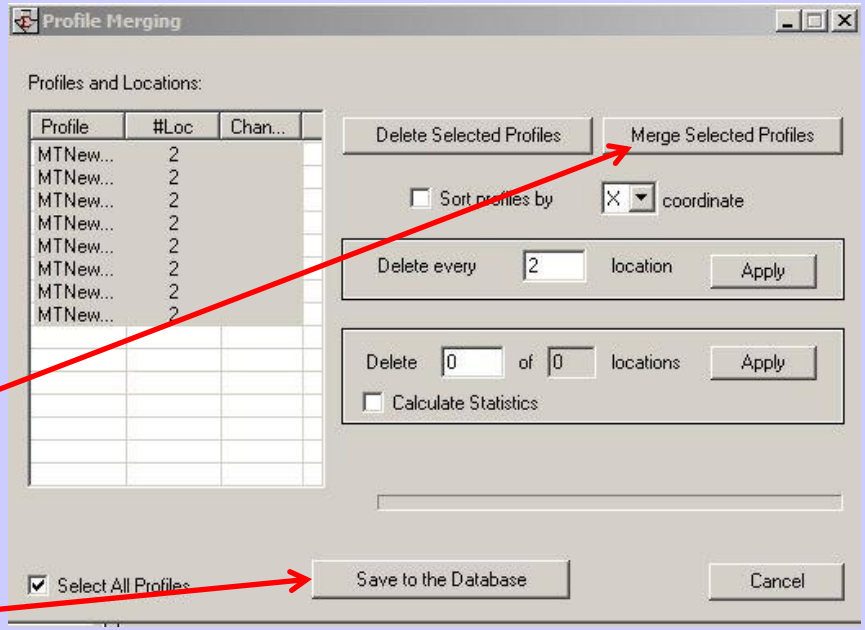
Merge profiles in the same dataset

Click “Data Processing and Filters” button to open the data processing dialog.



Select “Profile Merging” option and click “Select” button.



Select profiles to be merged from the dataset, and click “Merge Selected Profiles” button. All profiles will then be merged into one profile and saved into a new dataset by clicking “Save to the Database” button.

1. Data organization and import
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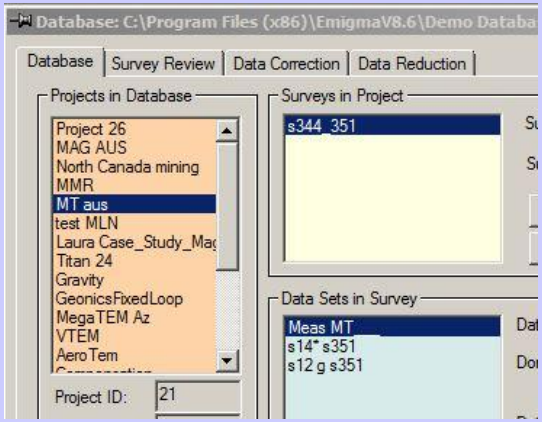
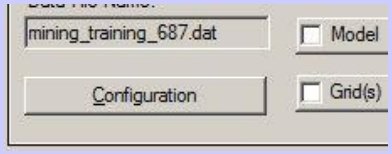
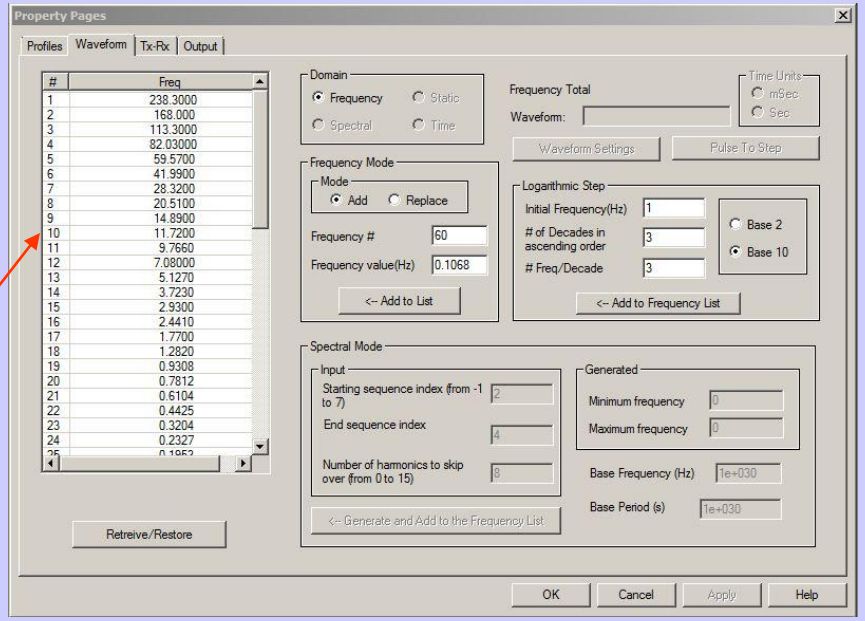
1. Check database for the survey



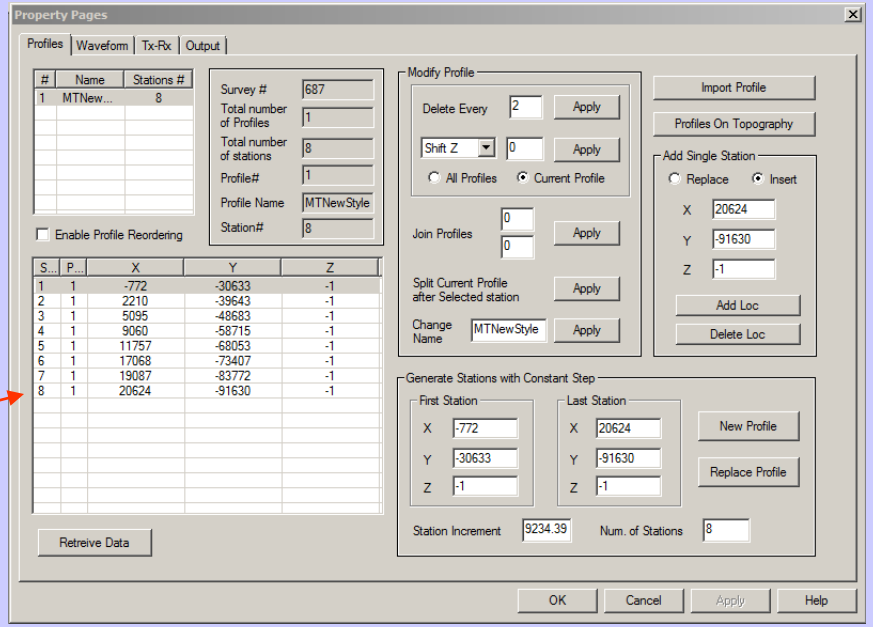
2. Click configuration



3. Check frequencies



4. Check lines and stations for their correctness



1. Data organization and import
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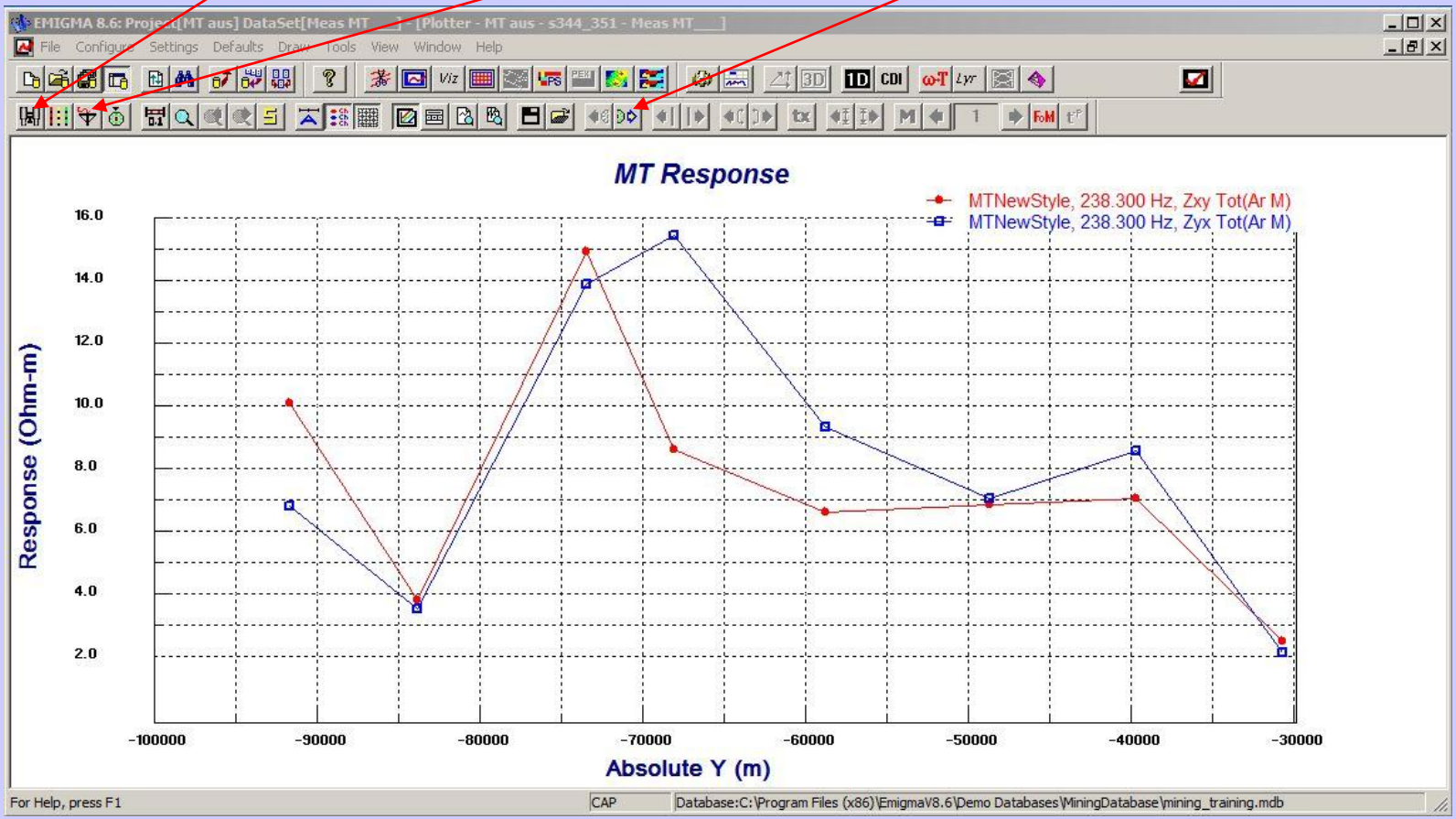
Click "Plotter"…

Load data set in Plotter

Put into Spectrum mode

Toggle between frequencies



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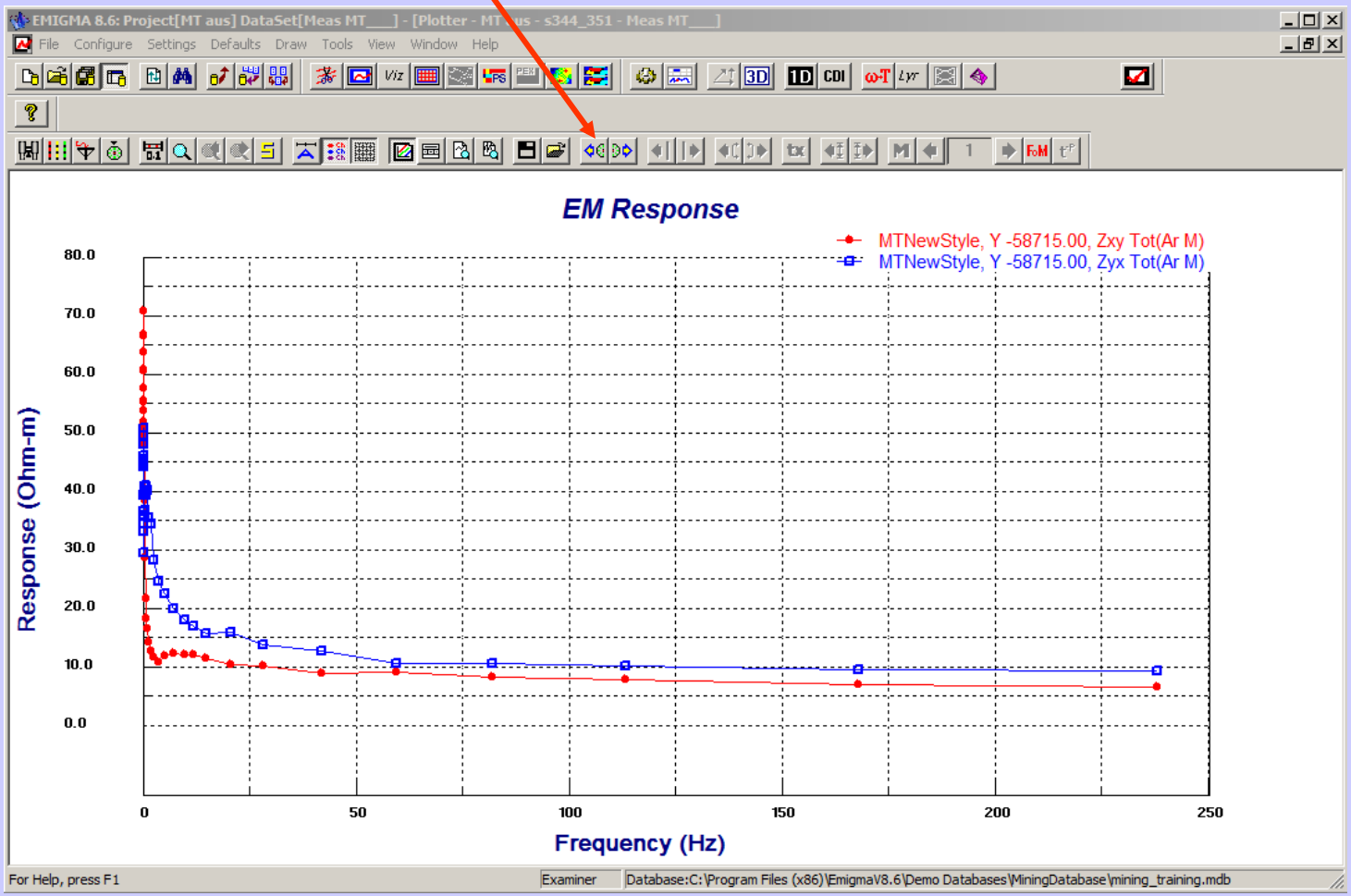
Click "Plotter"…

Toggle between stations

Spectrum



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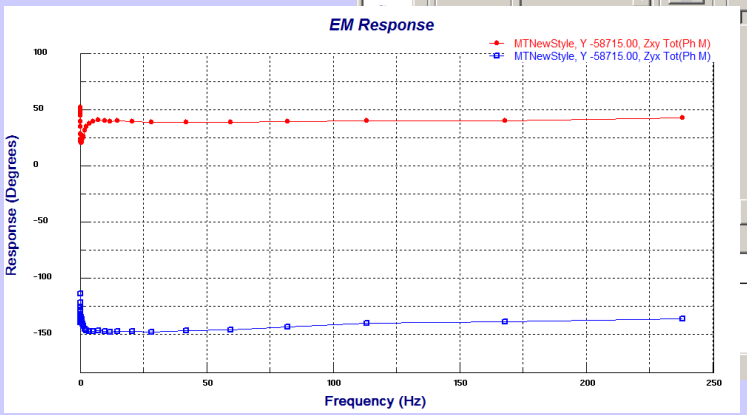
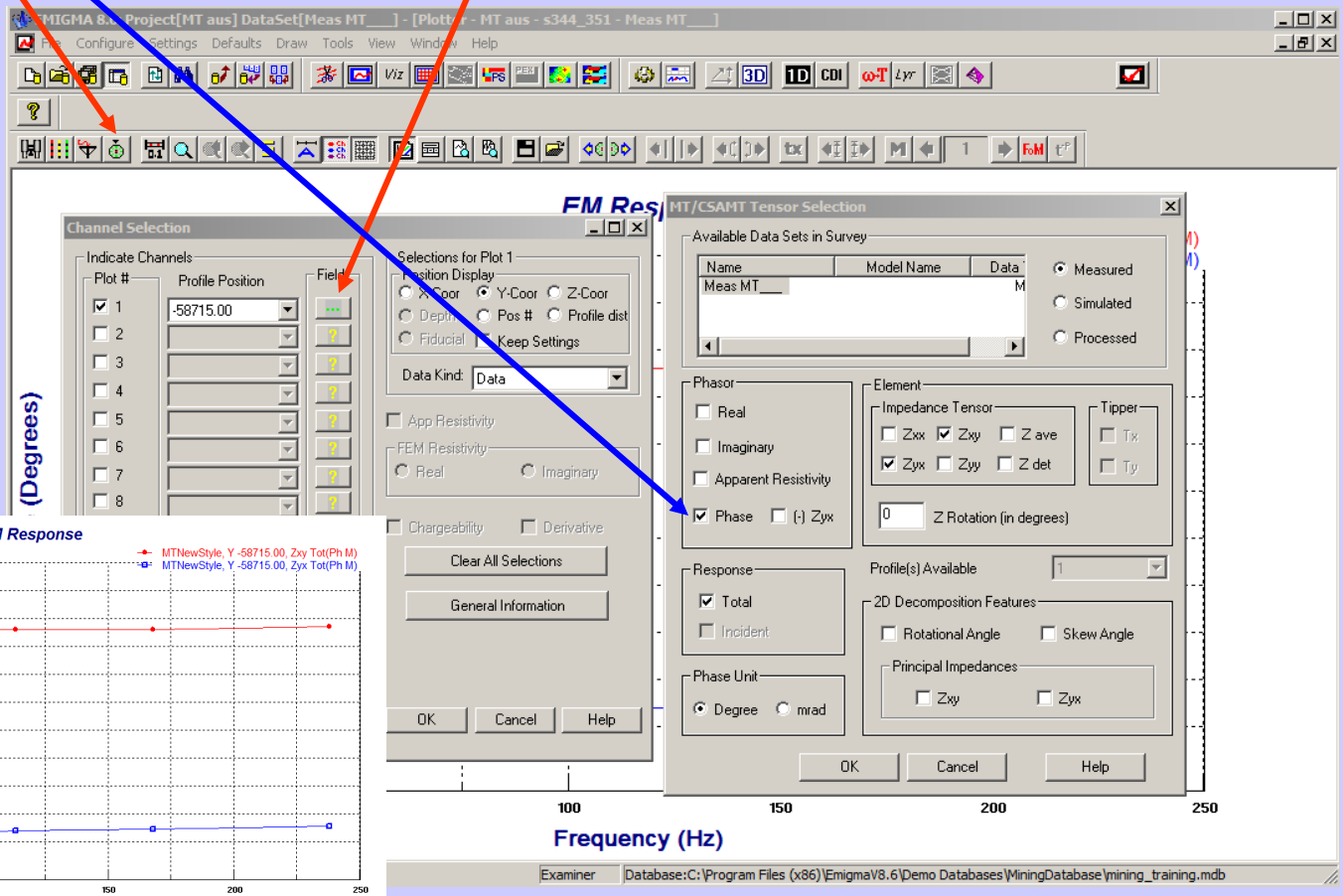
Click "Plotter"…

Click "Channels" button, and select "Field" in popup dialog

Check "Phase" option, and click "OK" to bring up the plot of phase

Phase





1. Data organization and import
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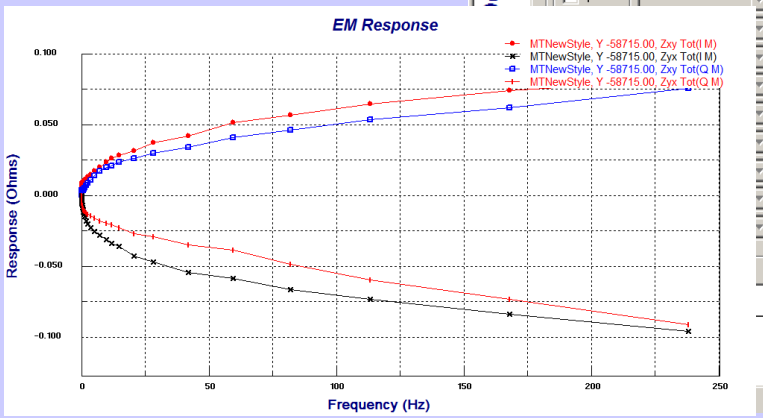
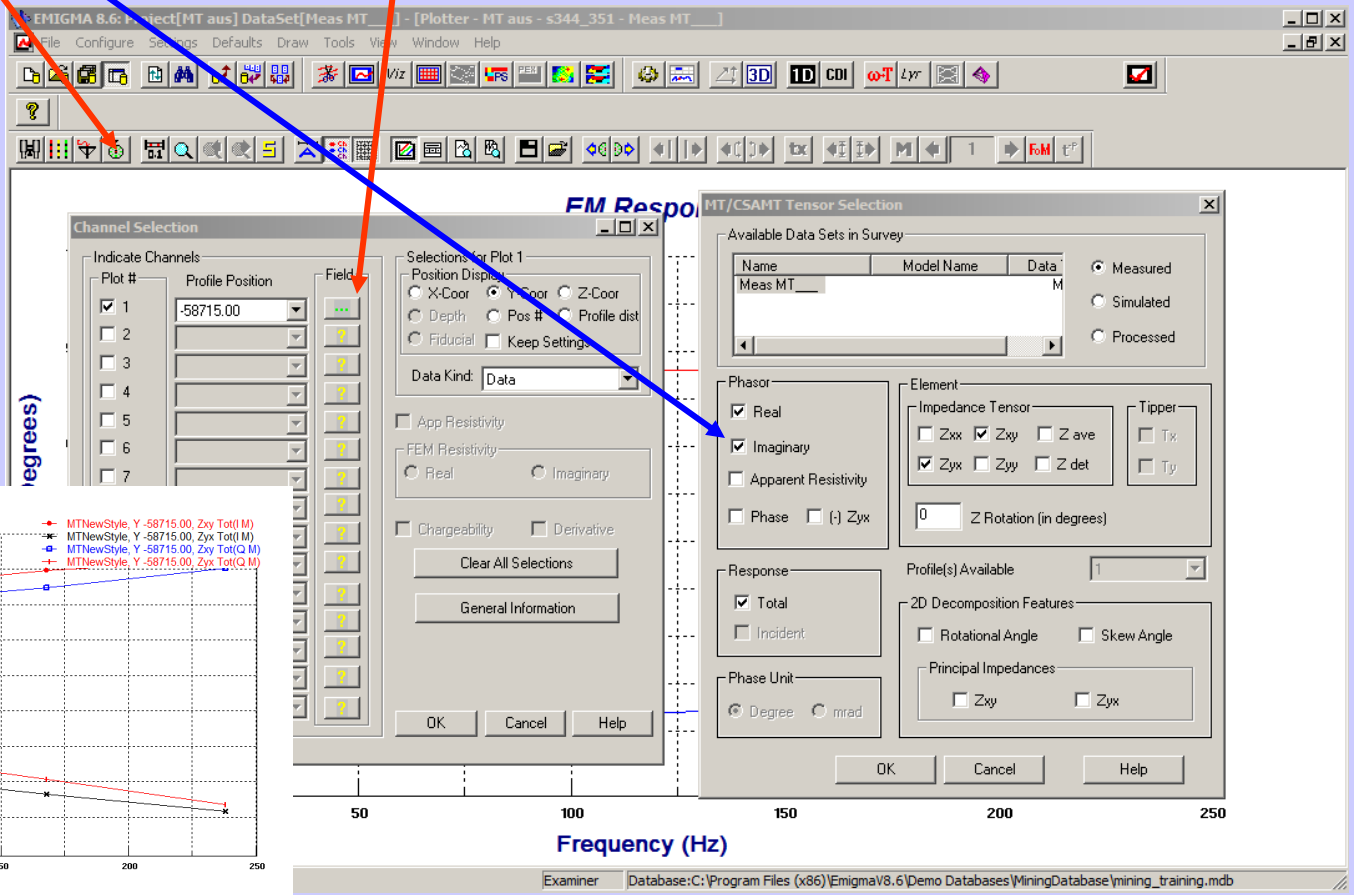
Click "Plotter"…

Click "Channels" button, and select "Field" in popup dialog

Check "Real" and "Imaginary" option, and click "OK" to bring up real/imaginary data plot

Real/Imaginary data





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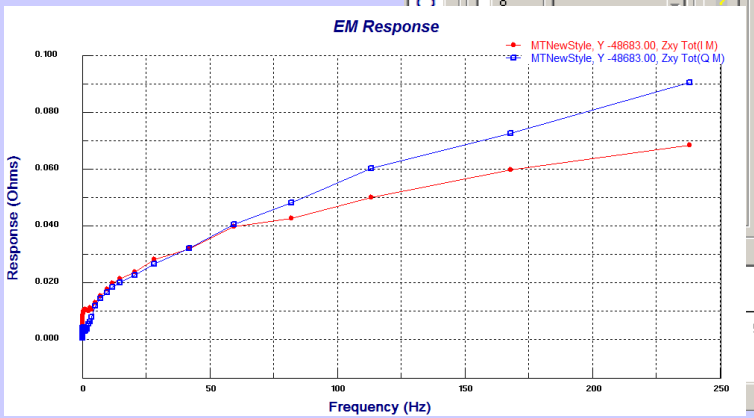
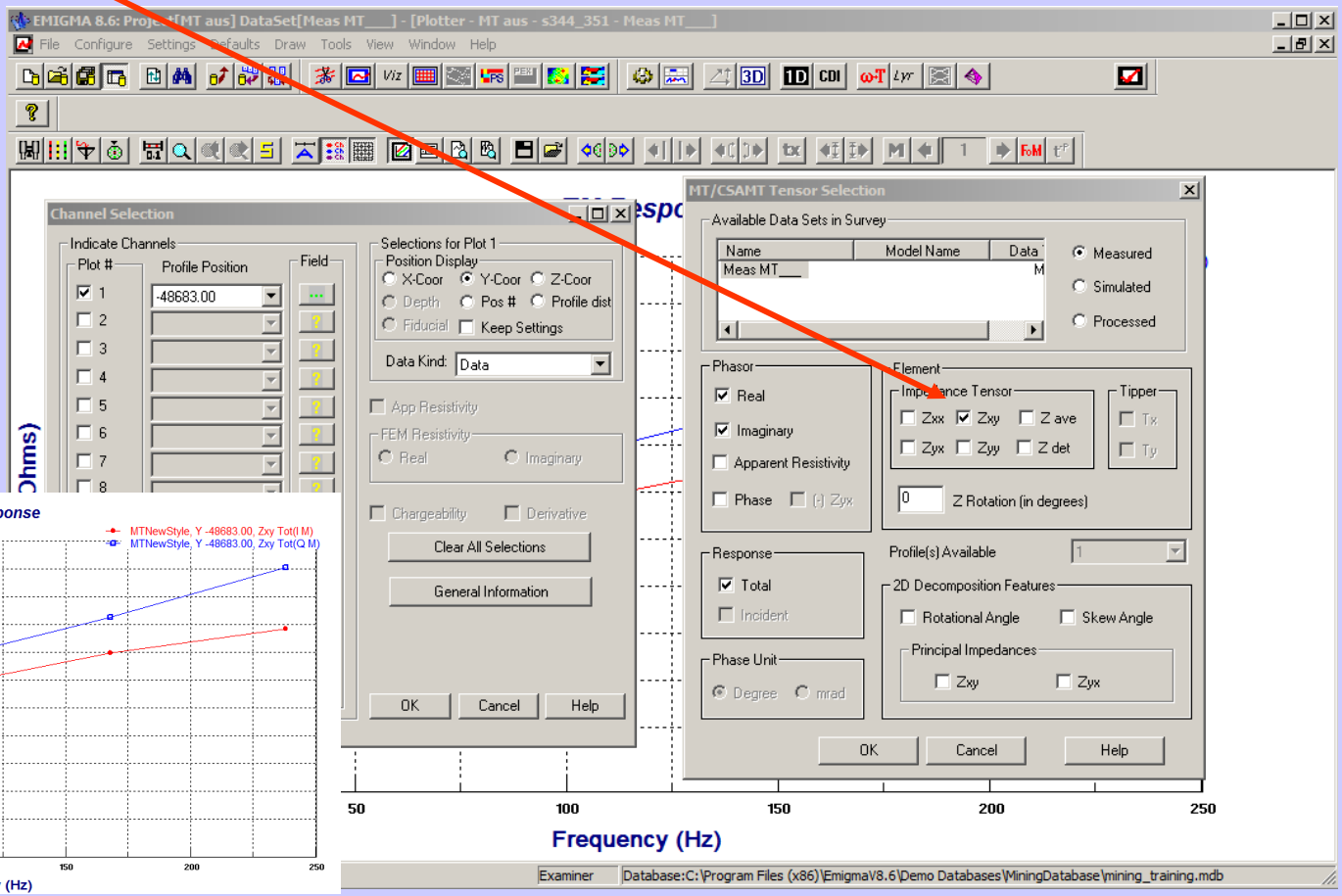
Click "Plotter"…

If you want to observe one tensor element instead of two, check only the one you want in Impedance Tensor section and click "OK" button. You can also select more elements here.

Real/Imaginary data





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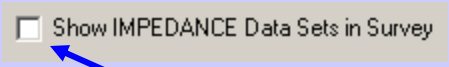
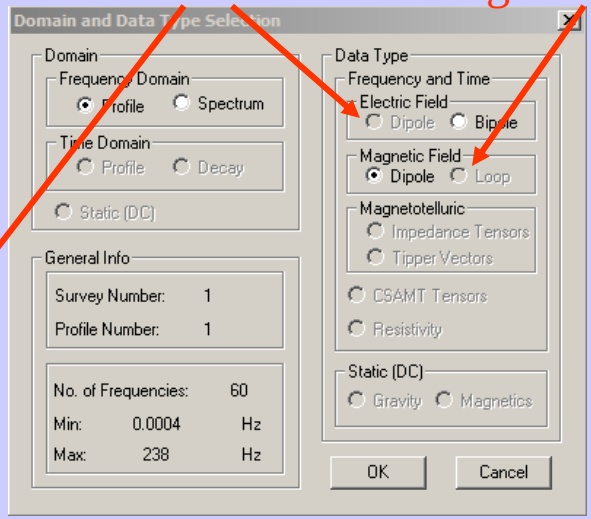
Click "Plotter"…



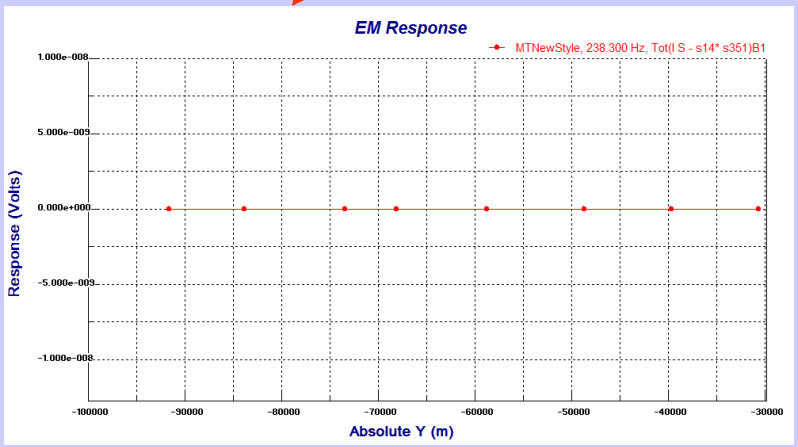
Uncheck this option to show field data, please note field data can only be shown for simulated dataset

Select whether you want to view electric field or magnetic field

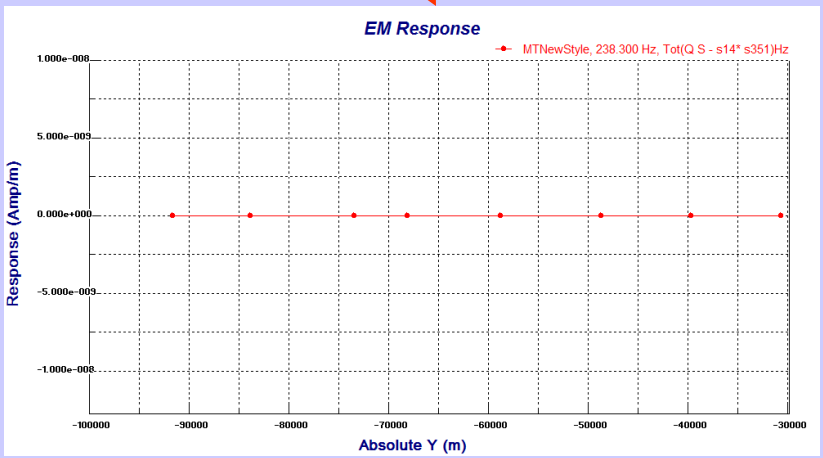
From here, we use the example of simulated dataset (s14*s352) in the same survey



E field



H field



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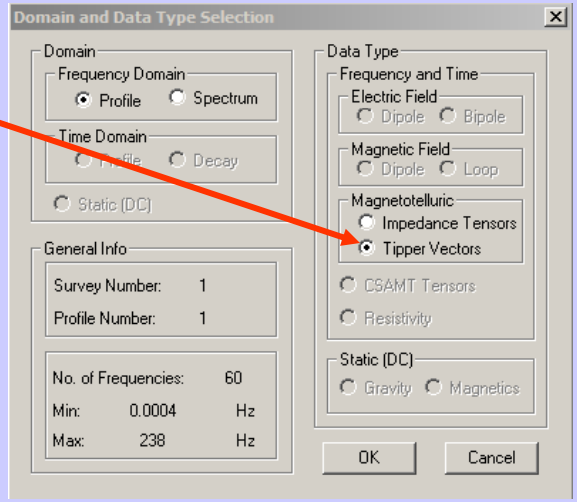
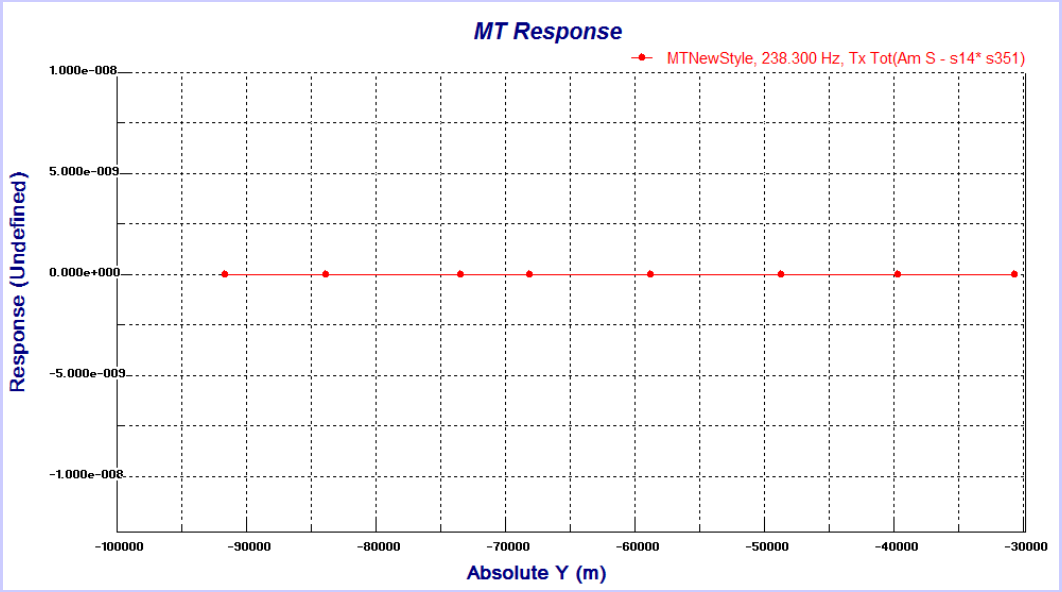
5. Inversion evaluation

Click "Plotter"…

To observe tipper data, select "Tipper Vectors" option and click "OK"



Tipper data



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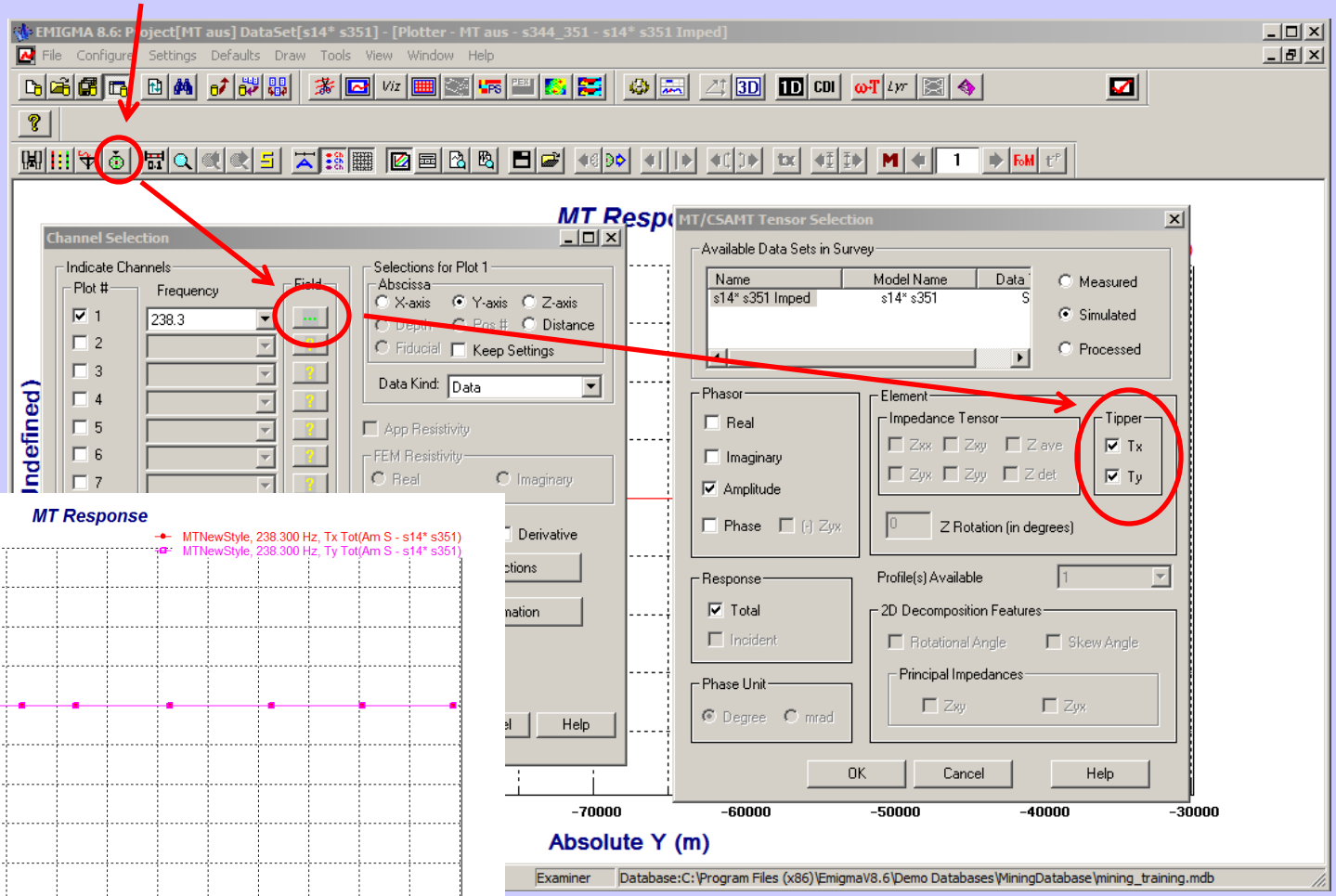
Click "Plotter"…

To observe both Tx and Ty tipper data:



Tipper data

1. Data organization and import
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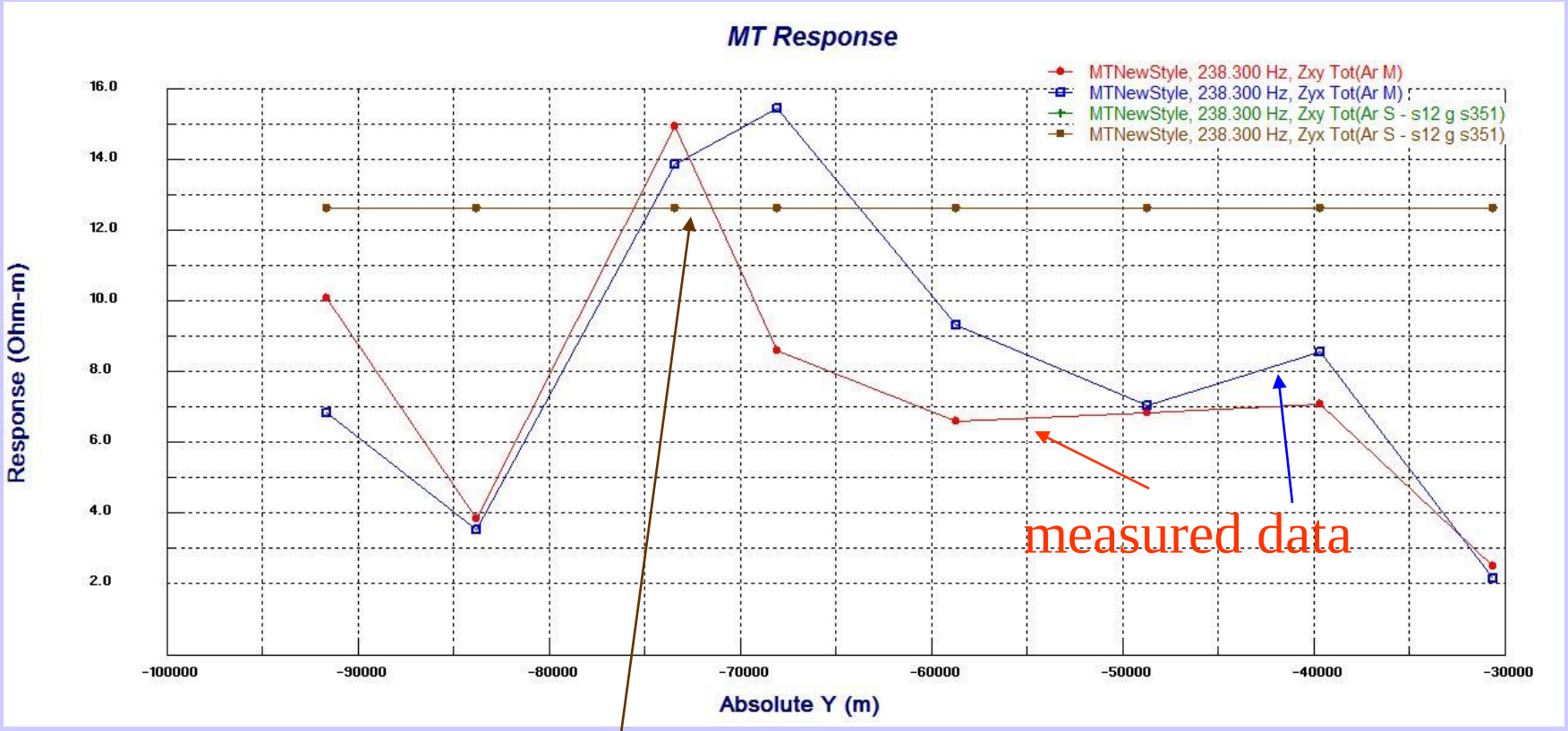
5. Inversion evaluation

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

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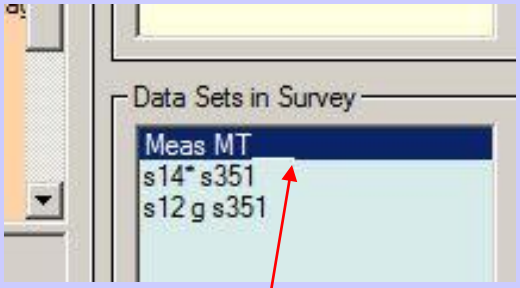
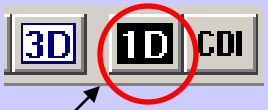
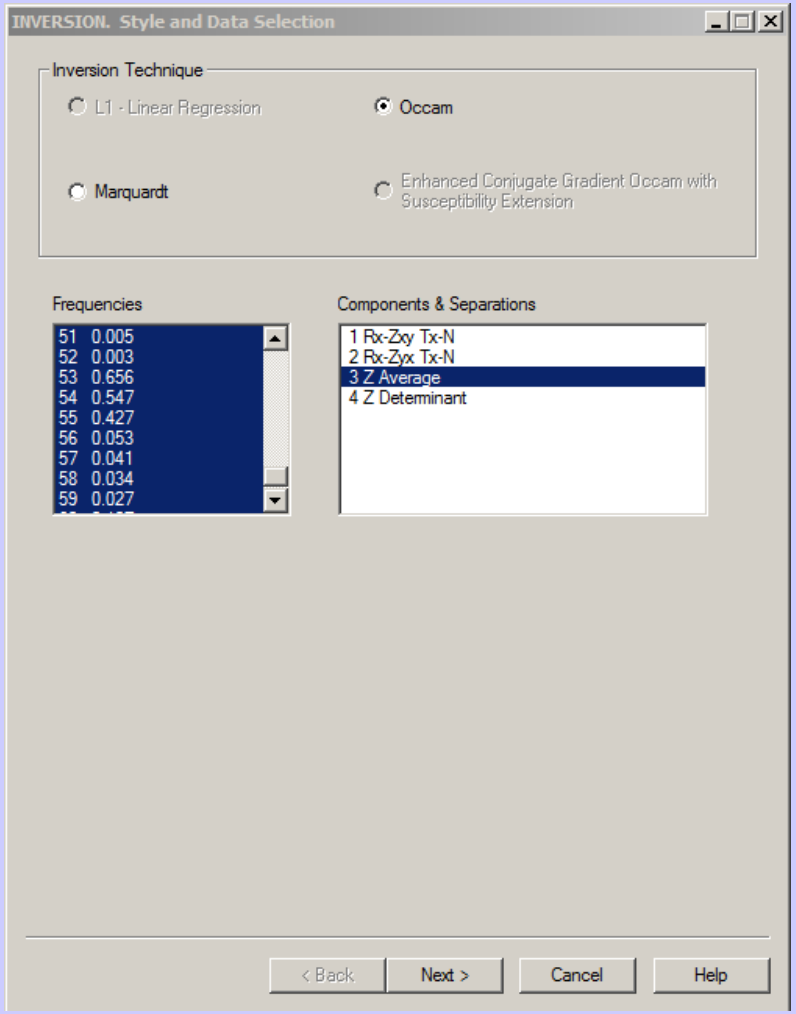
5. Inversion evaluation



Select survey data





1. Data organization and import
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5. Inversion evaluation

Inversion style

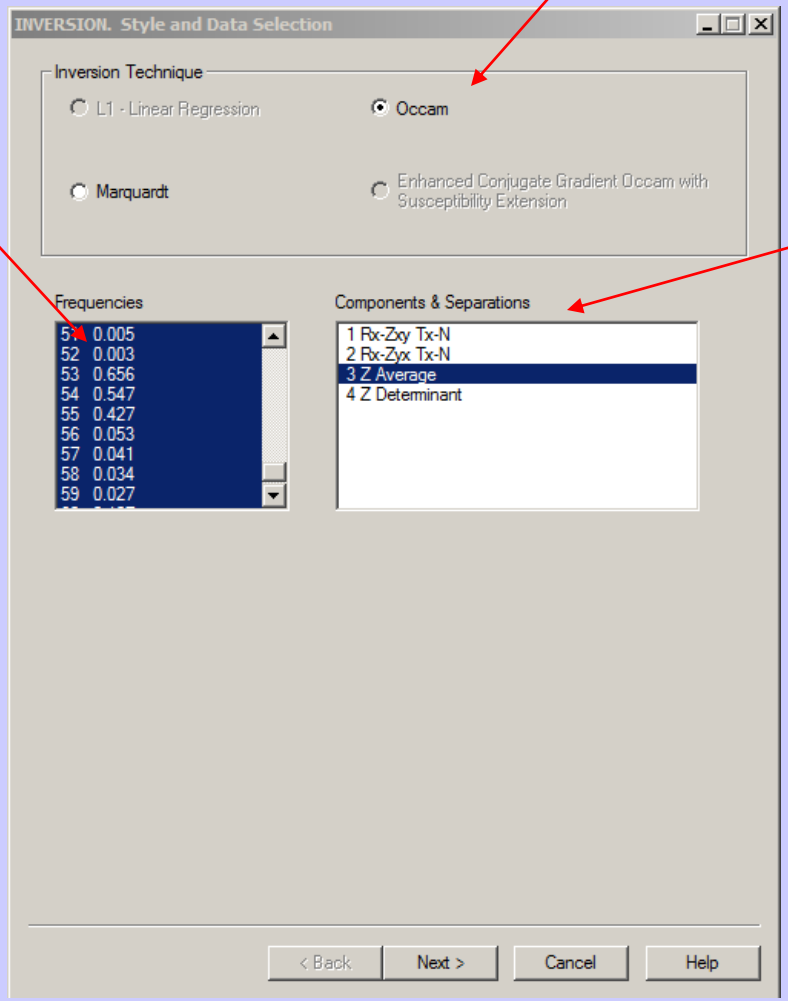
Occam: keep the layer thickness fixed and only inverse for resistivity

Marquardt: inverse for both layer thickness and resistivity

Select frequencies to be inverted.

Note: the maximum number of frequencies for an inversion is 50.

Select components used for inversion



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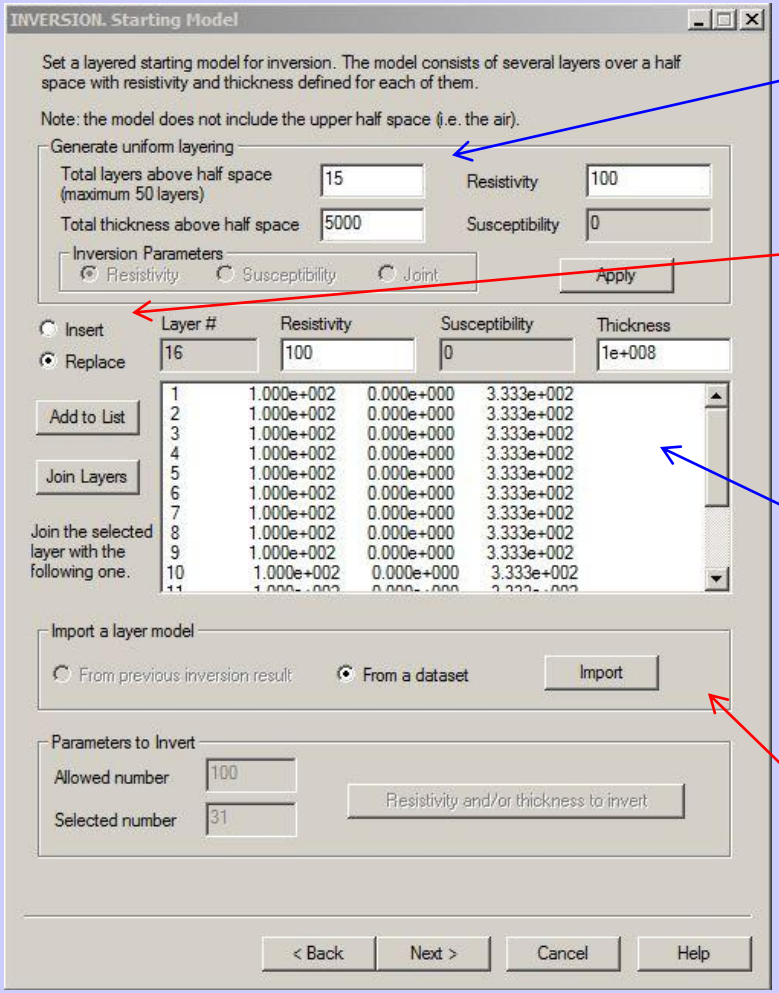
5. Inversion evaluation

Create a Starting Model



Generate a Starting model:
Select how many layers in total that you would like in the model, set the initial resistivity and thickness. Then click "Apply" button.

Insert a layer:
Set resistivity and thickness of the layer and check "Insert" radio. Select one layer from the table and click "Add to List" button. The new layer will be added below the selected one.

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 click on the parameter and make change at "Resistivity" and "Thickness" boxes above the table. Select "Replace" option and click "Add to List" button. The user may also join two adjacent layers by selecting one layer and clicking "Join Layers" button to merge this one with the layer below.

Import Layers:
If you already have a forward model that you like to use, you may import it as the starting model by clicking "Import" button and select from appeared dialog.

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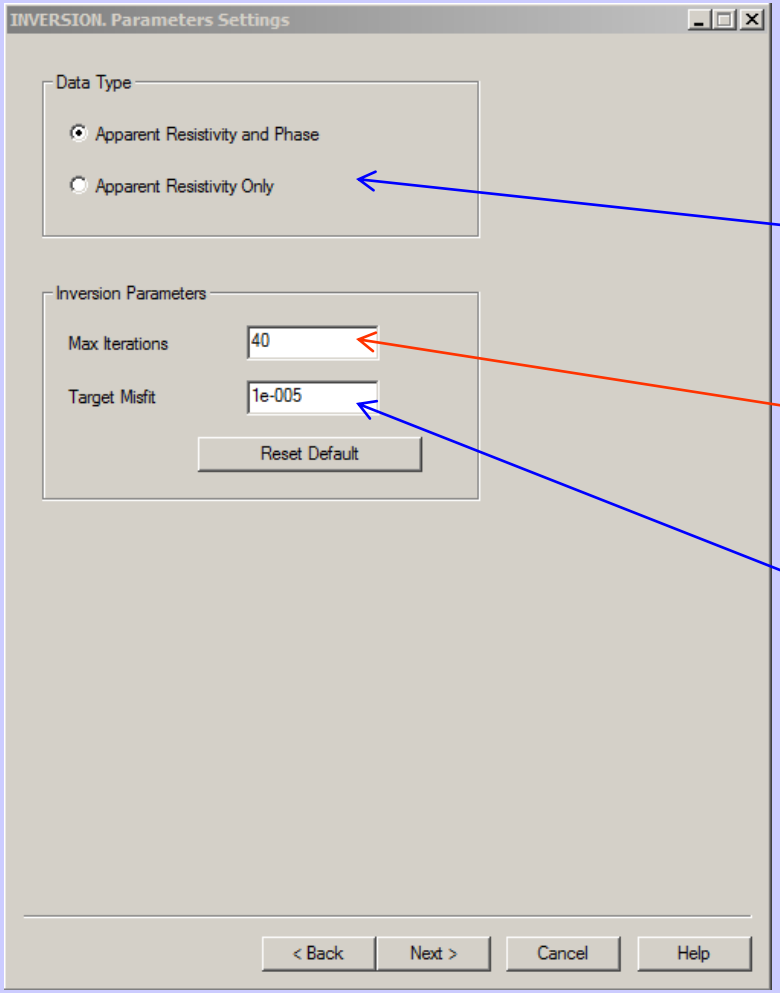
Model and Simulation Parameters Settings



Data type:
Select type of data to inverted: Apparent Resistivity and Phase, or Apparent Resistivity Only.

Max. Iterations:
A higher value will help ensure accuracy but execution time will increase

Target Fit:
The residual between the simulated data under the best model and the measured data.

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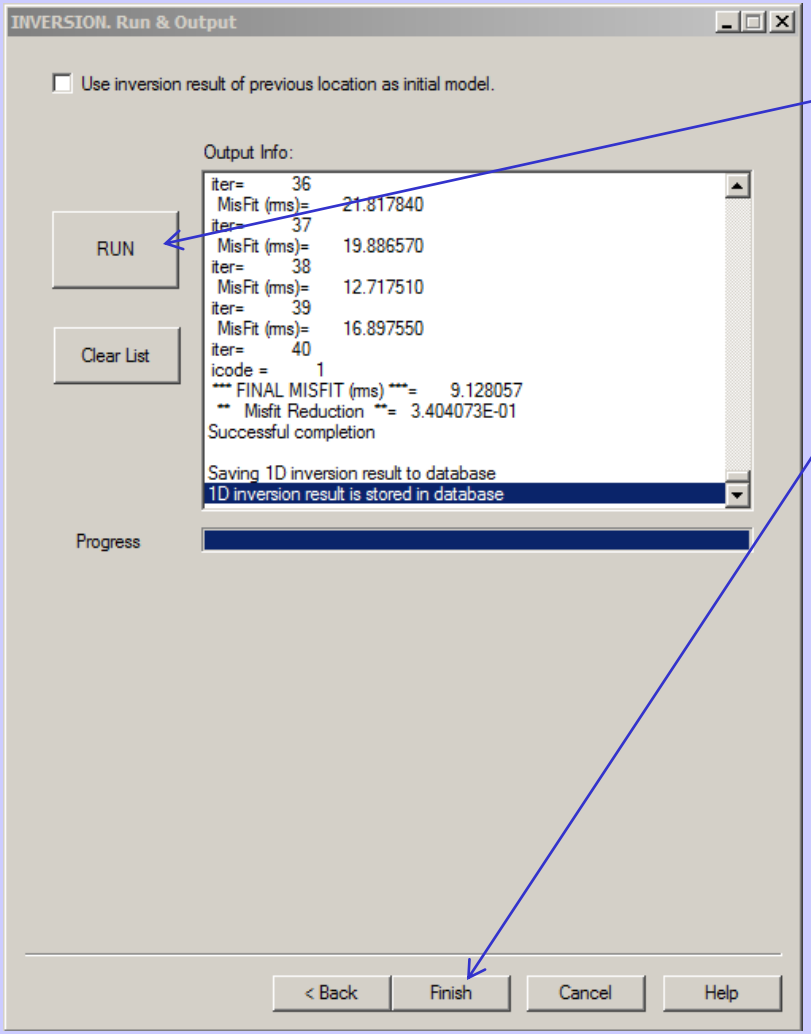
Executing the Inversion



Finally, click the "Run" button. The right window (in white) shows each data point's progress. Click "Finish" button to complete inversion procedure.

1. Data organization and import
2. Examine data
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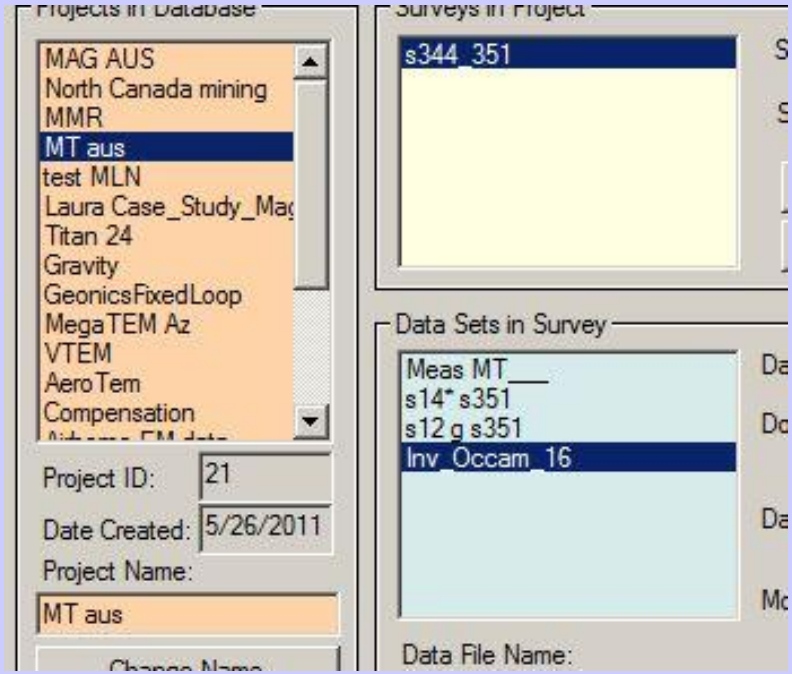
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation



In each survey, there will be several data sets after modeling, inversion and processing. In this case, we have 2 half space models and 1 inversion. The 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.

1. Data organization and import
2. Examine data
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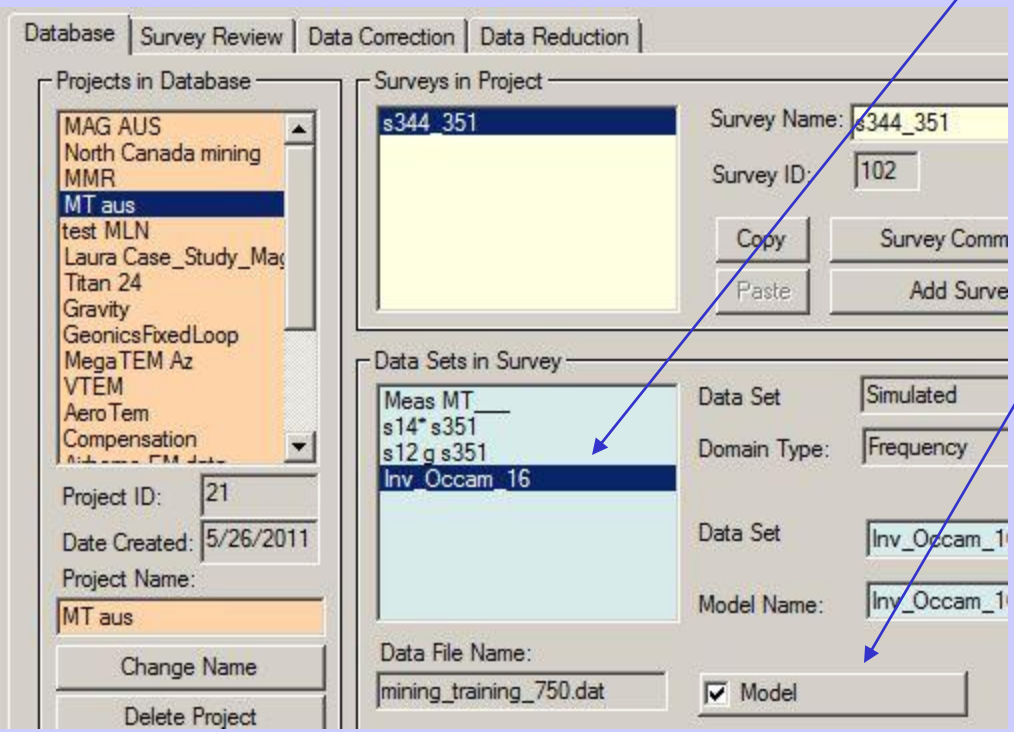
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

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

If the model button is clicked…



1. Data organization and import
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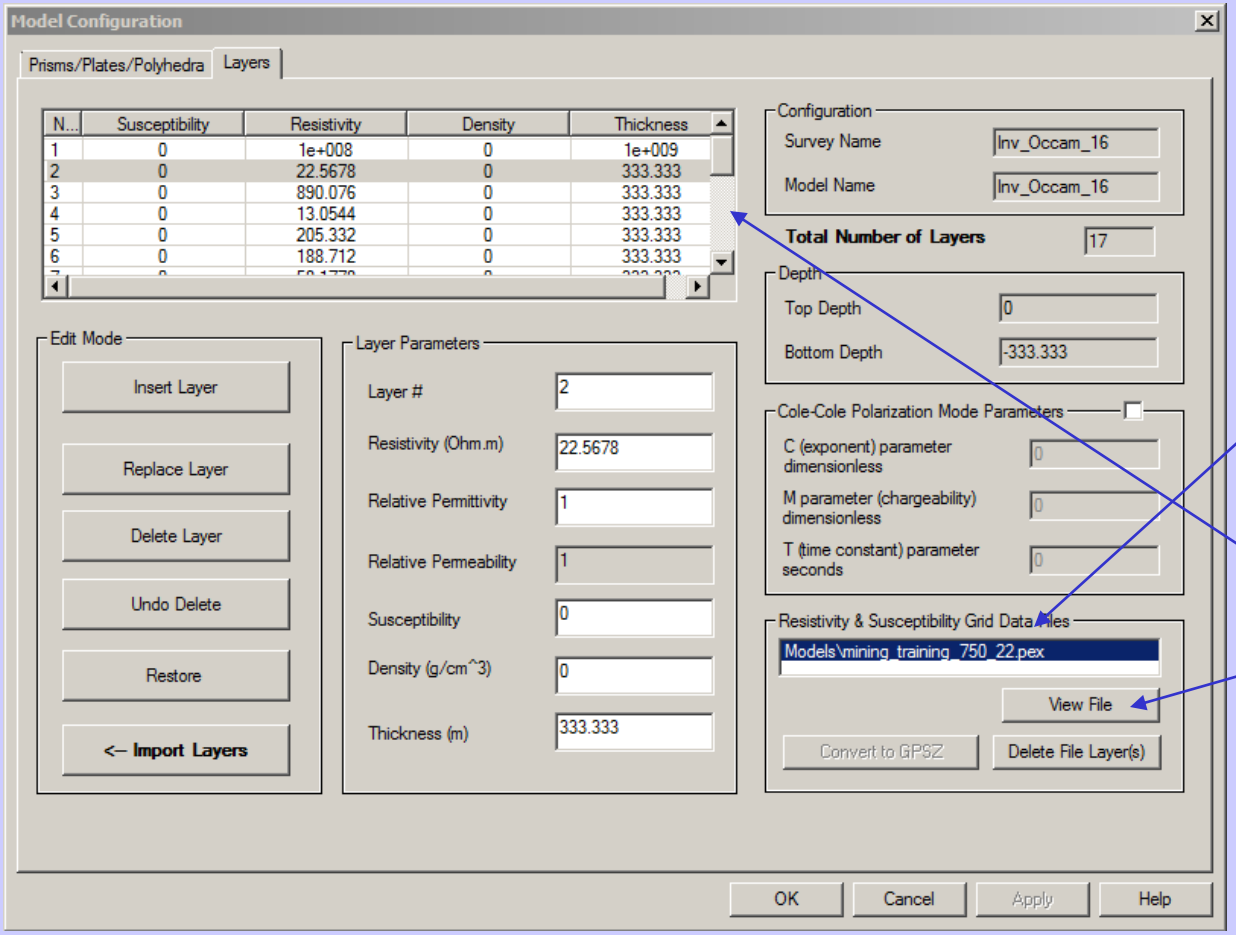
5. **Inversion evaluation**

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. Data organization and import
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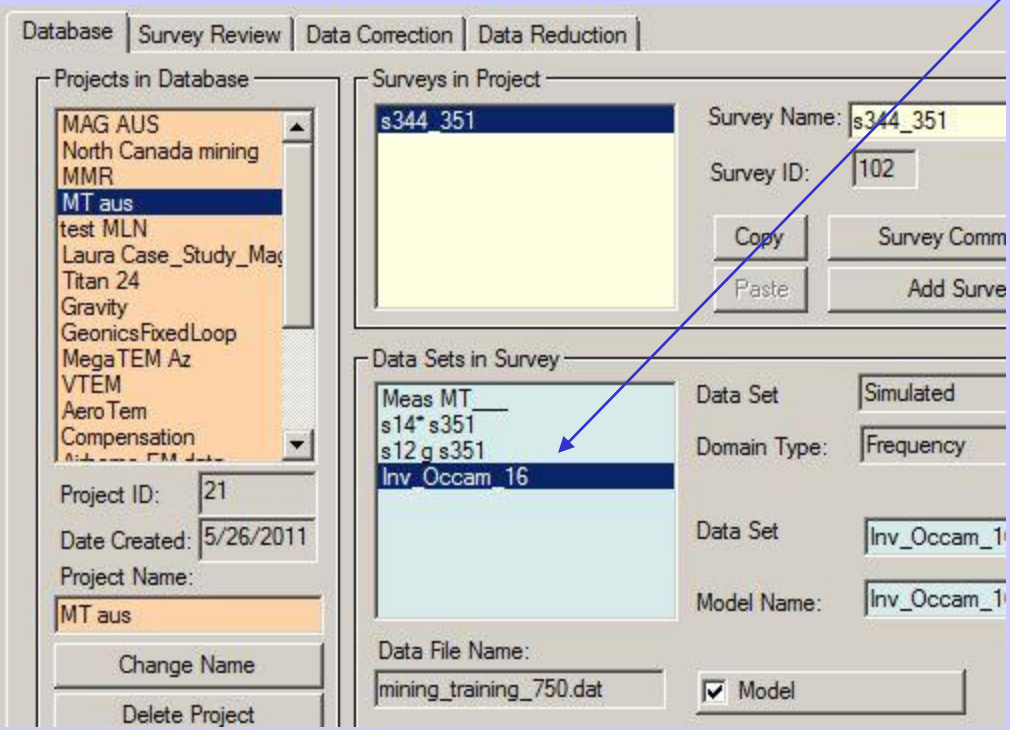
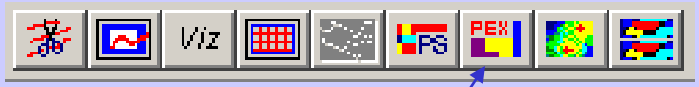
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

Select the inversion.





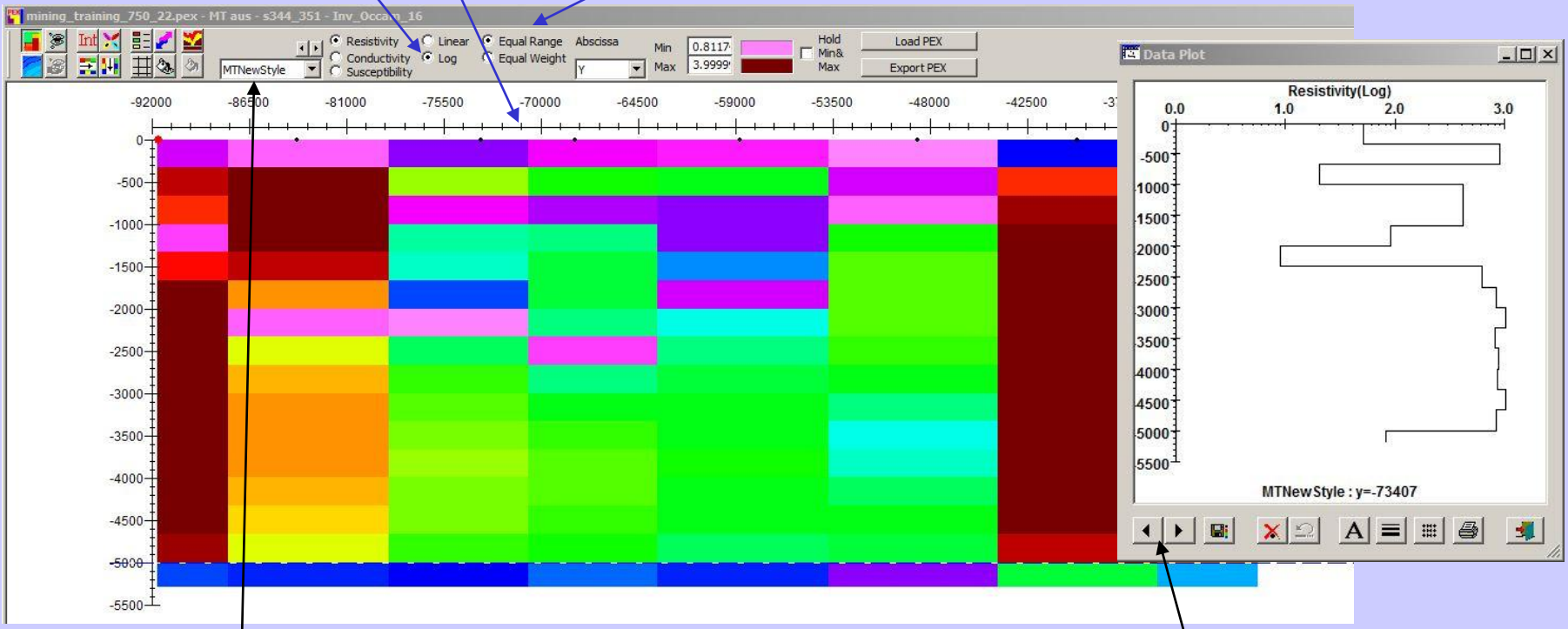
Choose CDI Viewer to view a stacked section of the results

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled 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.

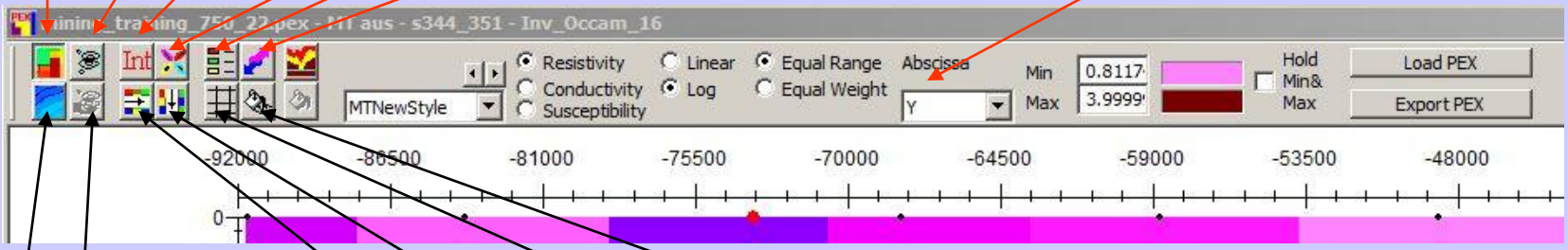
A plot of resistivity vs. depth for a single station is also provided and you may **step** along the profile. You may also save the layered model of the current point by clicking 

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Displays

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

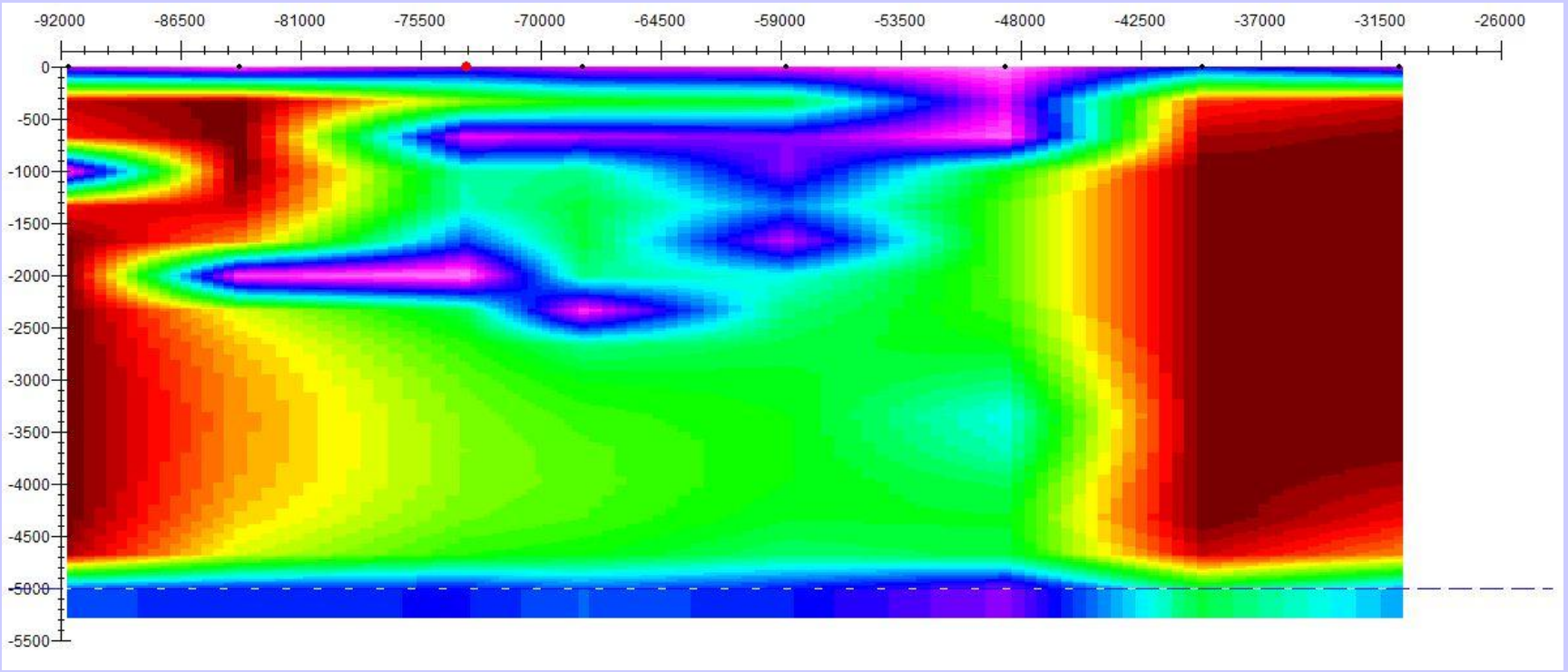
Min: Any data values below Min will be displayed as the color to the right of the edit field

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

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Displays

Choose CDI viewer to graphically view the results



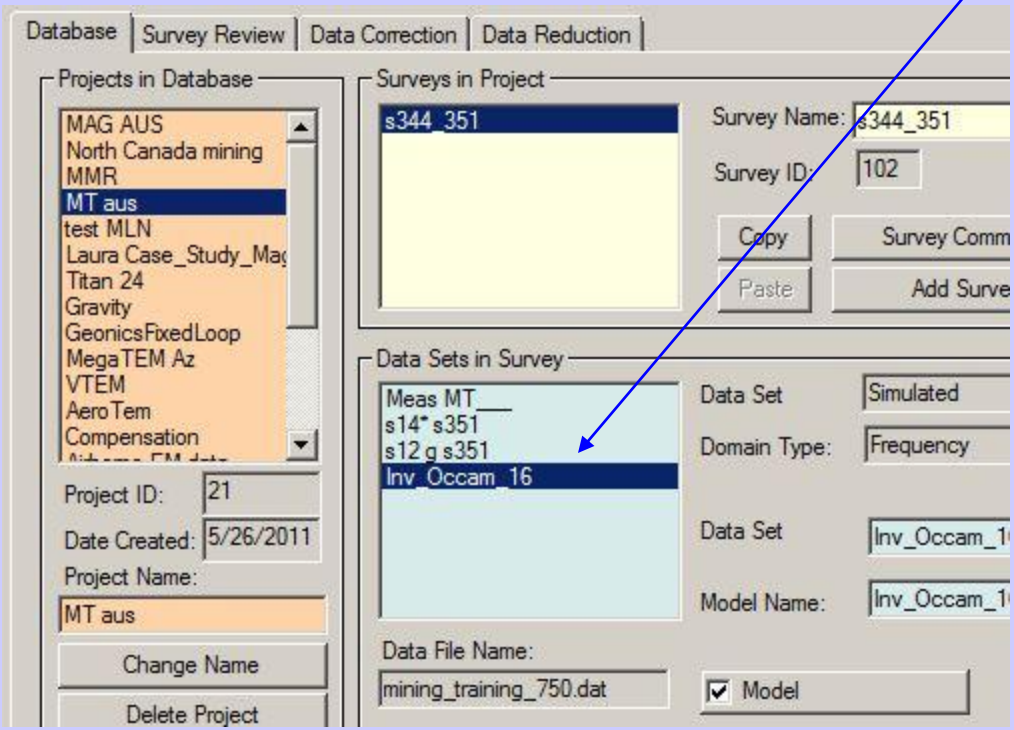
Axes may be edited by double-clicking on it, and you can change Max, Min, Labels and Titles etc. on the popup dialog

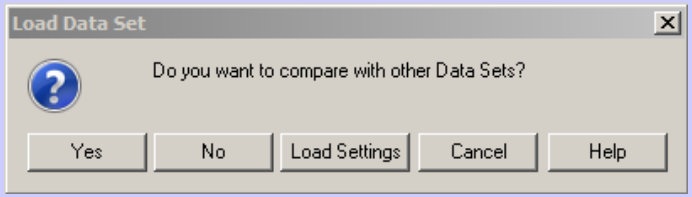
Depth and location interpolated may be repeated (note: the results of previous interpolations are used in the next interpolation so use with care)

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

To assess the success of the inversion, select the measured data and then select the plotter.



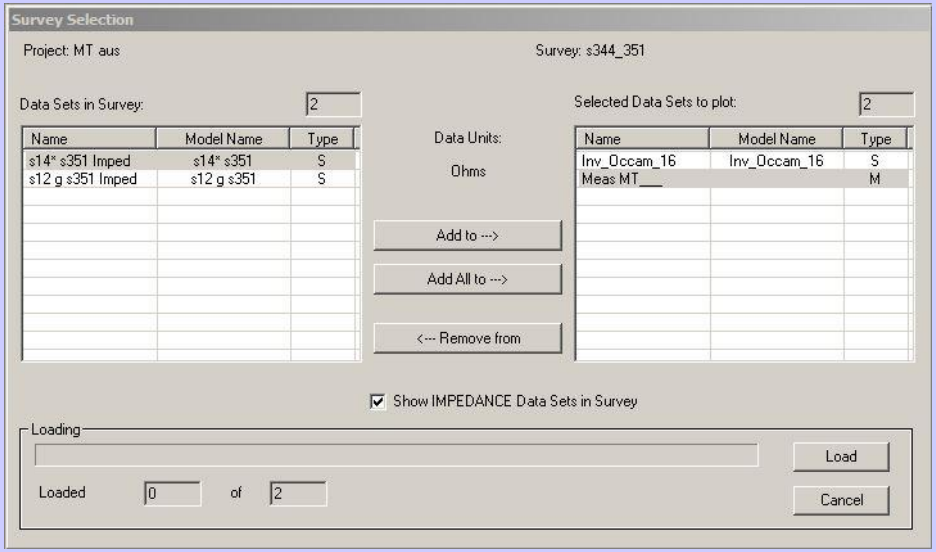


Select “Yes”, if this dialog is appeared

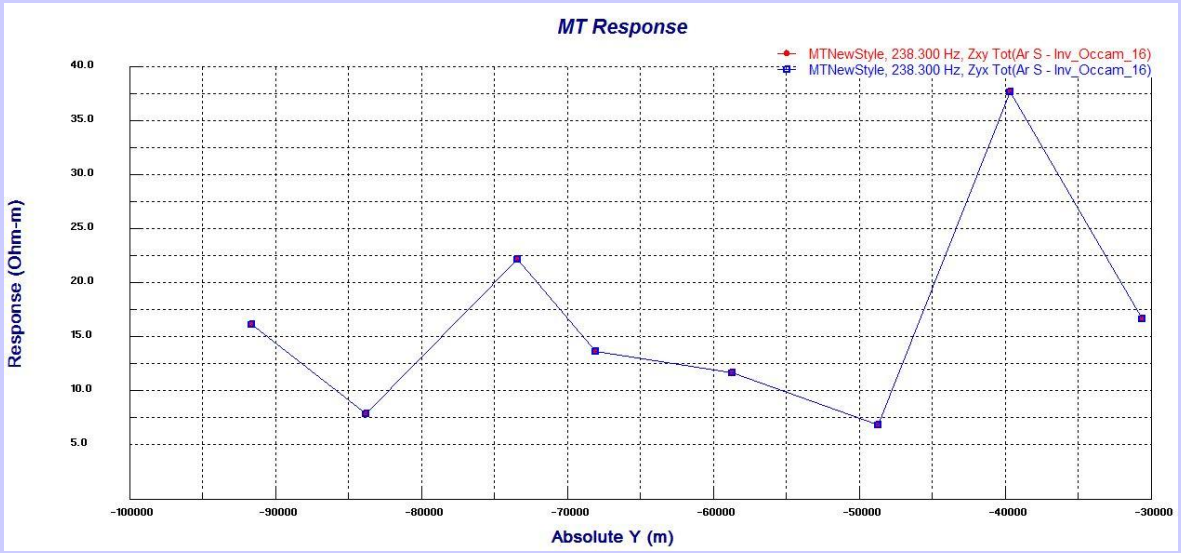
1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

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



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

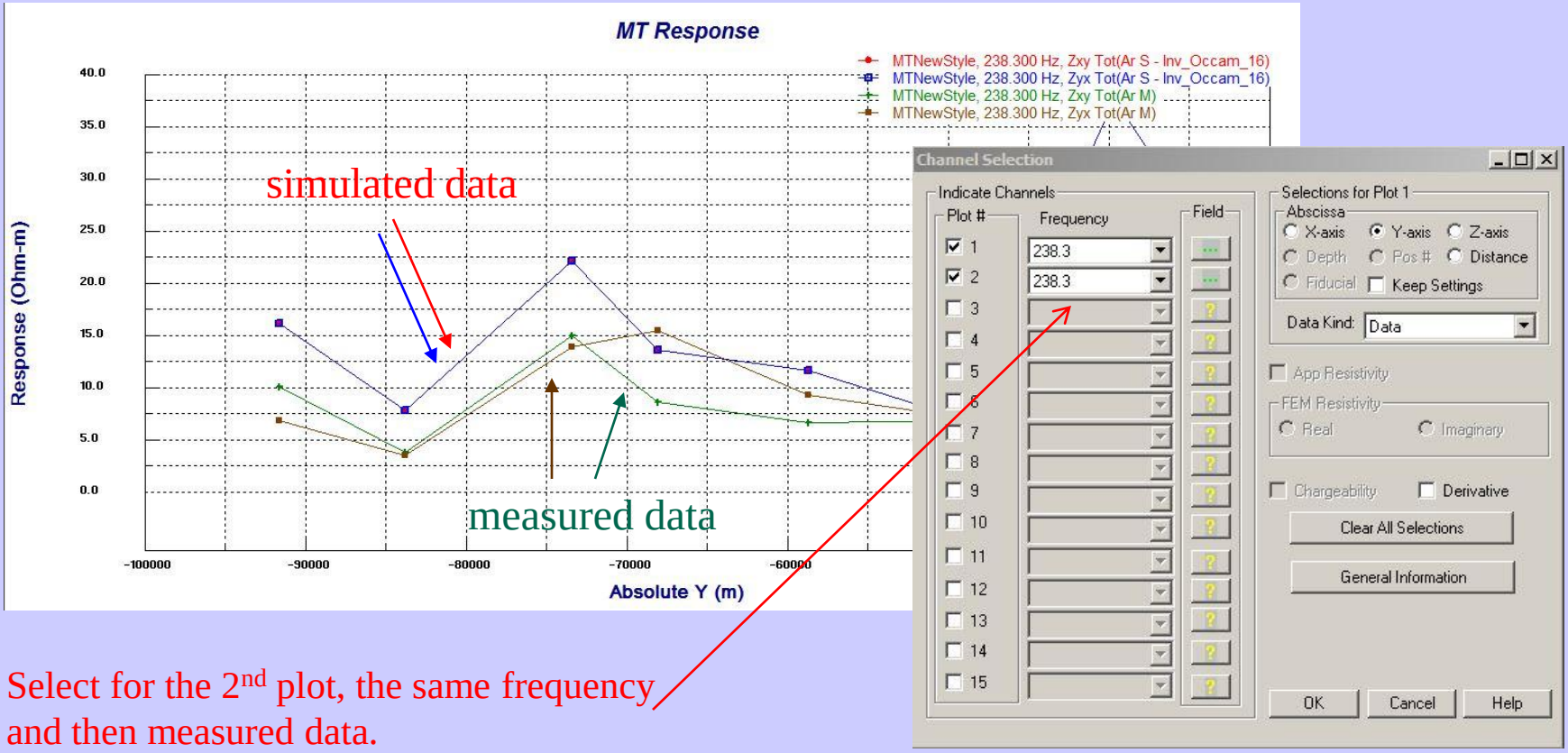


Note: The amplitude of Zxy and Zyx will always be the same for 1D model.

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

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

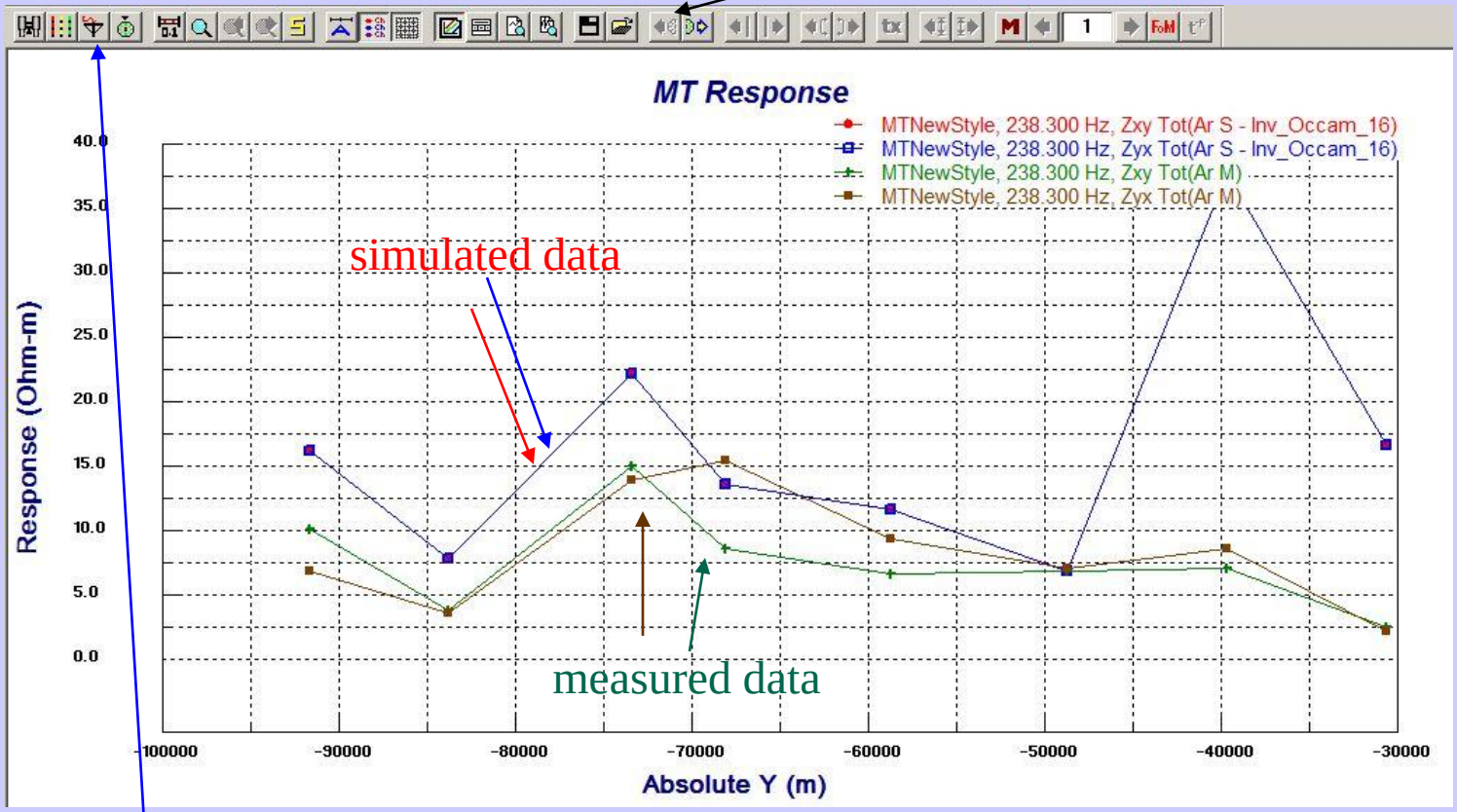


Select for the 2nd plot, the same frequency and then measured data.

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

Multiple plots can be shown for various inversions and models in "Profile" mode. The user may step through time windows by simply clicking the arrow.

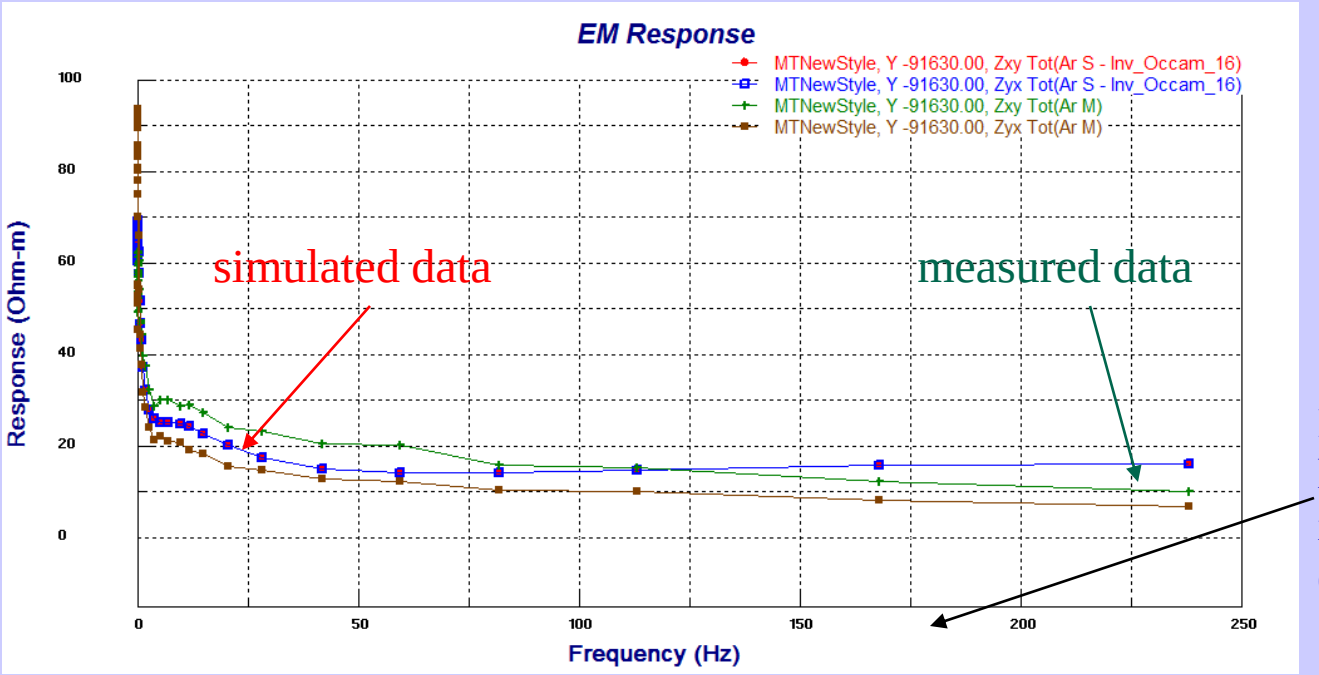


To show in "Spectrum" mode use the "Domain" button.

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

Here, spectrums are compared for a single data point in linear-linear mode. The user may move to other data points by simply clicking the arrows.



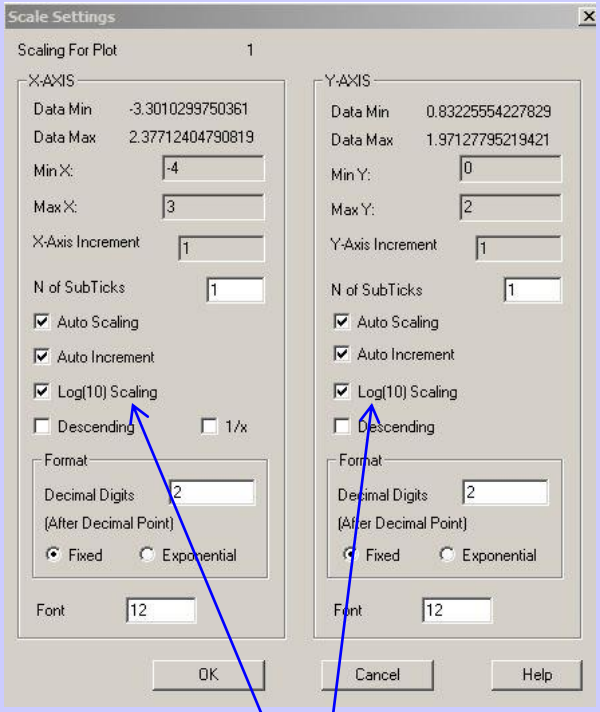
The step-frequency function of the arrows is now converted to step position.

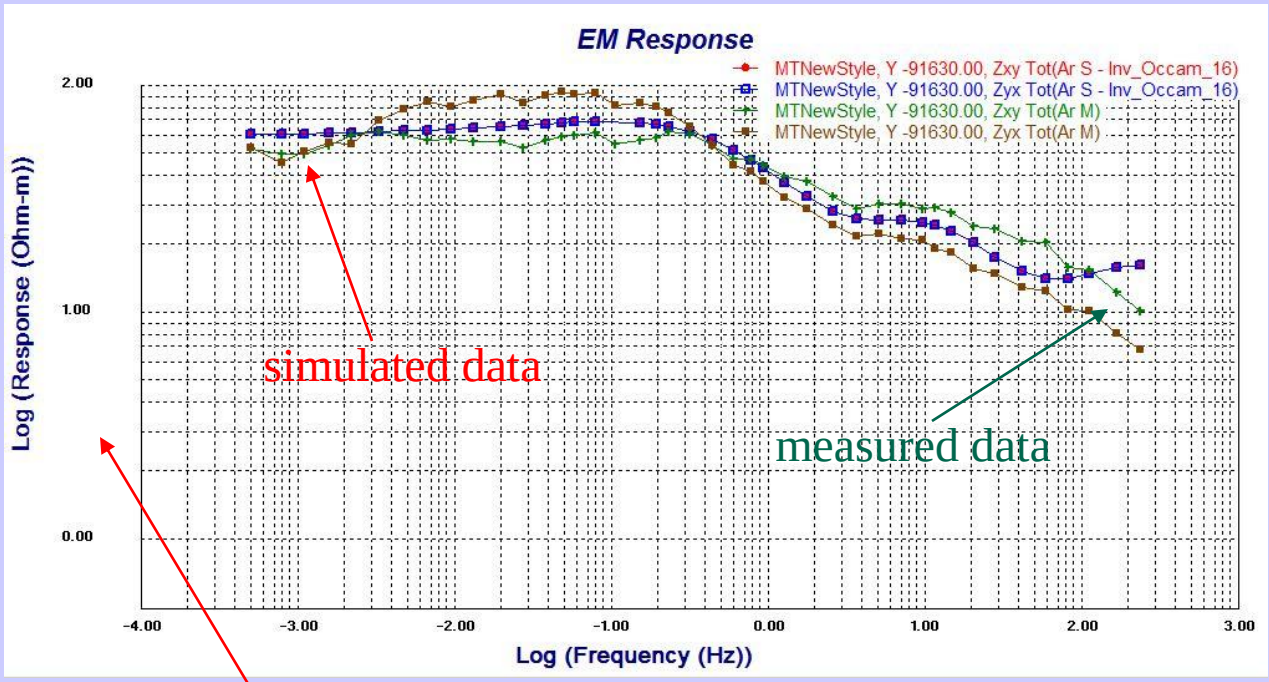
It is useful to compare in log mode. This functionality is accessed by double-clicking either axis.

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

Here, we select **log(frequency) vs. log(amplitude)**





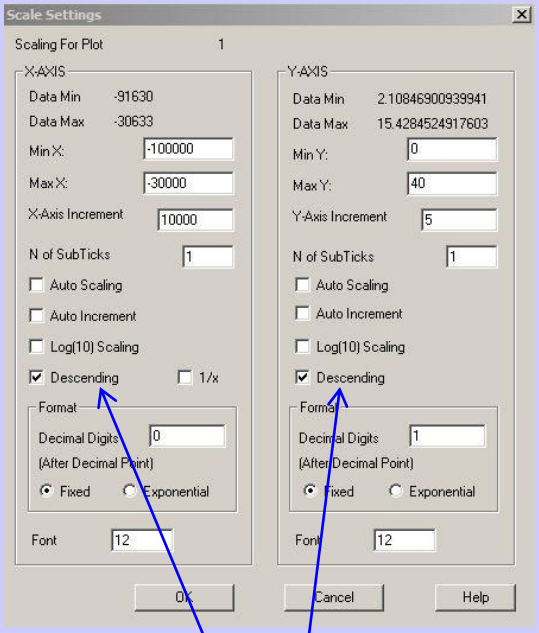
Select "Log(10) Scaling" option

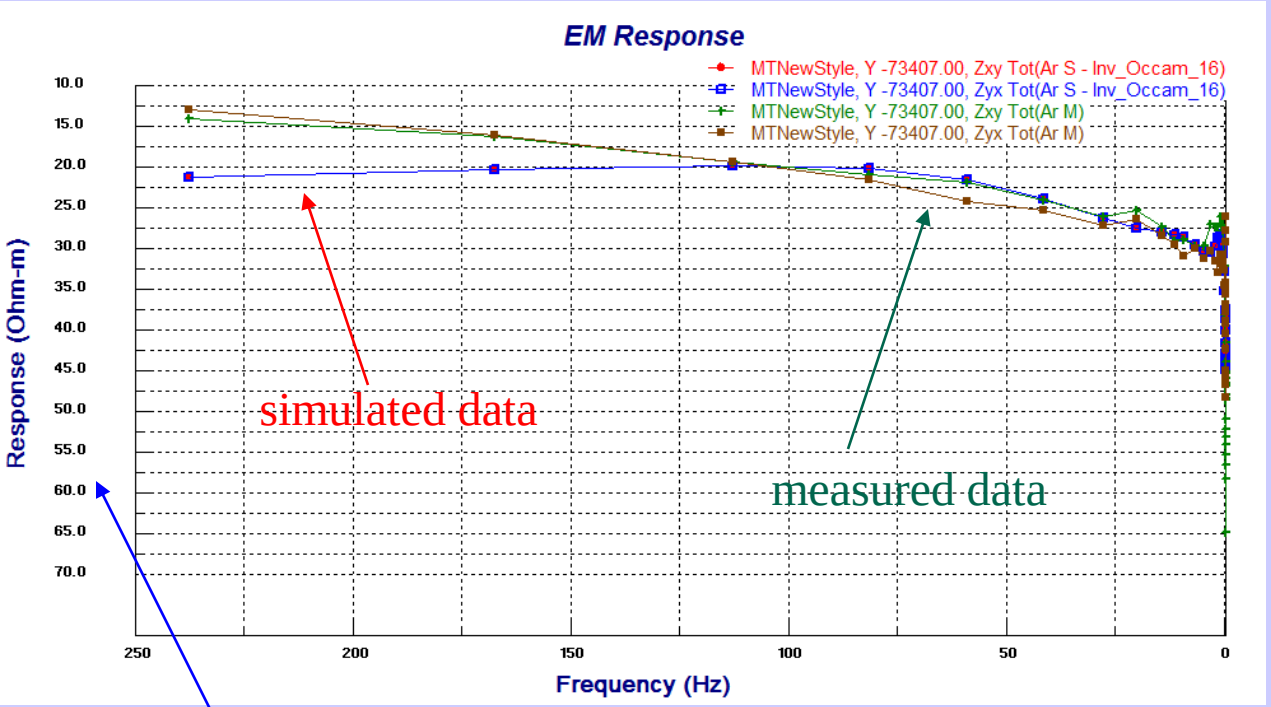
Double click axis to popup the "Scale Setting" dialog

1. Data organization and import
2. Examine data
3. Perform initial modeling
4. Perform controlled inversions
5. **Inversion evaluation**

Inversion Evaluation

Here, we select **frequency vs. amplitude**





Double click axis to popup the "Scale Setting" dialog

In CSAMT/MT, it is common to observe data in **Descending** order of frequencies (from high to low)

Note: based on results of inversion, you may run additional inversions with different settings, and compare the resulting sections in the CDI viewer and the fit in the plotter.