5 MT-MODULE

This is a description of the MT data handling, processing and inversion system implemented in the Workbench as an embedded module.

The MT module consists of three main parts:

8. An importer, importing the MT raw data ascii files to a database. The raw data files are linked to spatial positions through a location file listing station names and utm-positions for all data.
9. A processing part. The processing displays the imported data and allows the user to remove bad data points and/or specify extra noise to specific data. The changes are saved to a database.
10. An inversion part. The inversion part has many features for laterally constrained inversion, vertical smoothing of models and adding a priori information allowing the user full control of the setup of the inversion process.
11. Visualization of inversion results.

The following part will describe each part individually, without going into too many details. But first a short introduction to the workbench program itself.

5.1 WORKBENCH INTRODUCTION

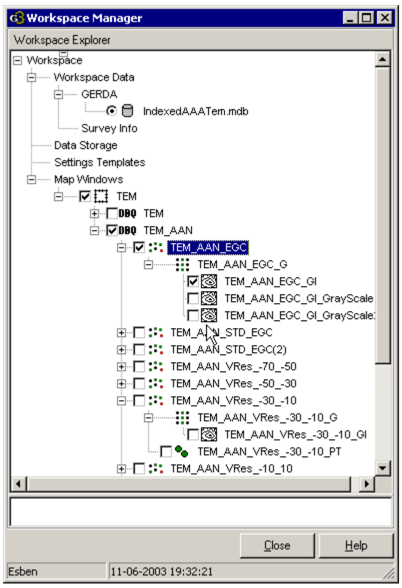

Figure 5.1 Workspace Manager

The Workbench is a relatively newly developed program. The program is the HGG platform for presentation, processing and inversion of geophysical data. It is divided into modules for GERDA database management, import of existing data into GERDA (TEM, HEM, MT, PACES, and CVES), data presentation of geophysical theme maps and statical analysis of models. Most users work with only parts of the program. Geophysicist uses the data processing modules while geologists/hydrologists use the theme maps and interpretation facilities.

The program is built around a workspace which is managed in the **Workspace Manager** (Figure 5.1). The manager gives access to geophysical theme layers, gridding, statistics and some map functions.. Themes can be presented on the map together with standard background themes as roads, buildings, and streams. The maps have similar facilities as found in the well known GIS programs, MapInfo and ArchView. Data points can be toggled on and off, and grids can be presented as images or as colored points.

The geophysical models from TEM, HEM, MT, PACES and CVES data can also be presented on profiles. This presentation can be combined with geological logs.

Specifications for GERDA are available at www.gerda.dk while the Workbench can be downloaded from www.hgg.au.dk. GERDA is developed by the Geological Survey of Denmark and Greenland (GEUS), Danish consultants, the Danish counties and HGG. The Workbench is developed by the HGG programming team.

5.2 RAW DATA IMPORT

First the raw data are imported to a GERDA database handling the data in the Workbench. The main window of the raw data import is displayed in Figure 5.2. The left panel shows the contents of the location file that has been loaded. The left panel shows the ascii-files with raw data that have been loaded. The **Check Match**-bottons checks for inconsistencies between data files and location file. Before import, Settings regarding the data-set need to be set. These are found clicking the **Settings**-botton displayed in Figure 5.3.

The dialog has two tabs. The first tab is called **Processing** and holds information on dates and name of processing person and most importantly the name of the data set as it will be identified in the database. The second tab is **Acquisition**, holding information on the coordinate system and on uniform standard deviation on the data.

When this information has been entered, the data are ready for import by clicking **Import** on the main dialog (Figure 5.2).

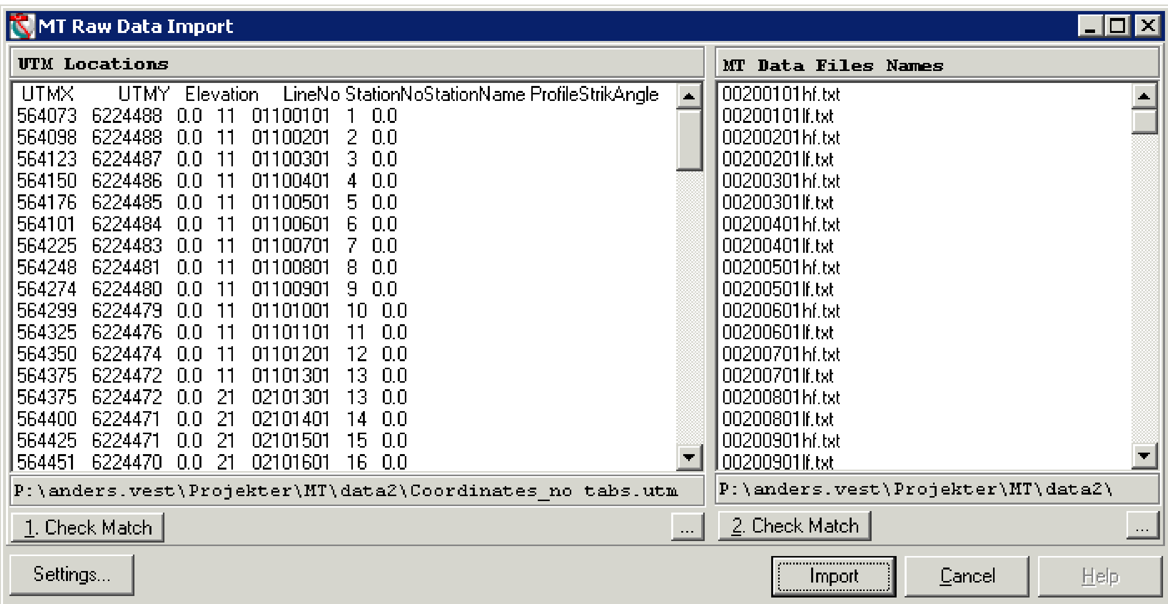

Figure 5.2 Import main dialog

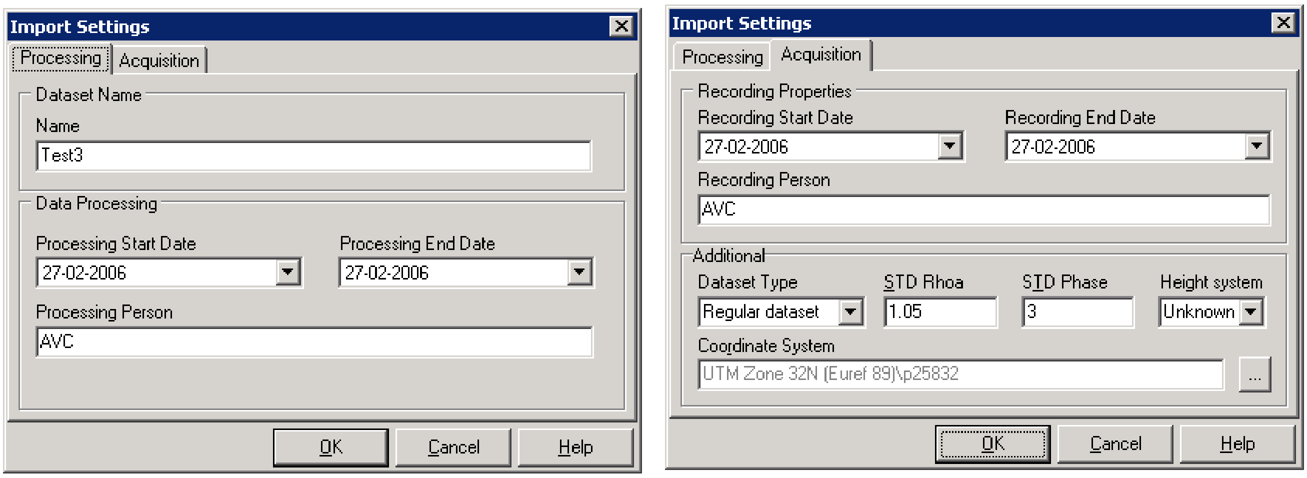

Figure 5.3 Import settings

5.3 DATA PROCESSING

The data processing starts by loading the imported data from the database. The main dialog is displayed in Figure 5.4. The panel lists all MT stations (soundings) found in the selected database. Under **Settings** the user defines what information is displayed for the data (e.g. line number, station number, station name, polarization, strike angle, position, etc.).

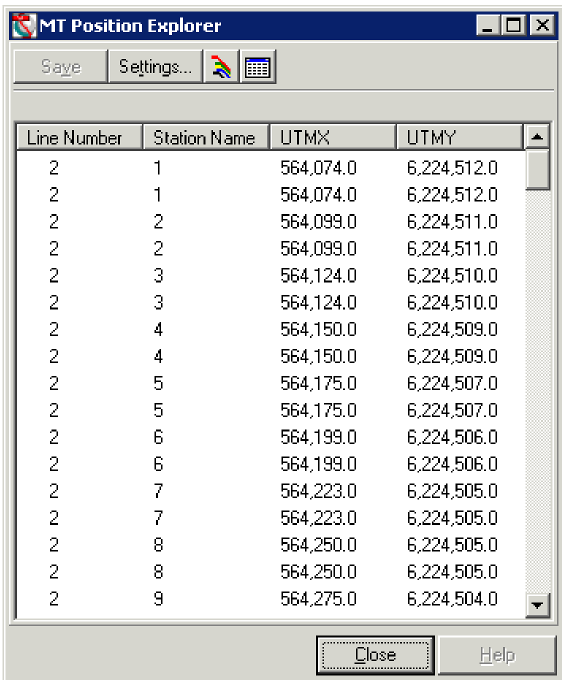

Figure 5.4 Processing main dialog

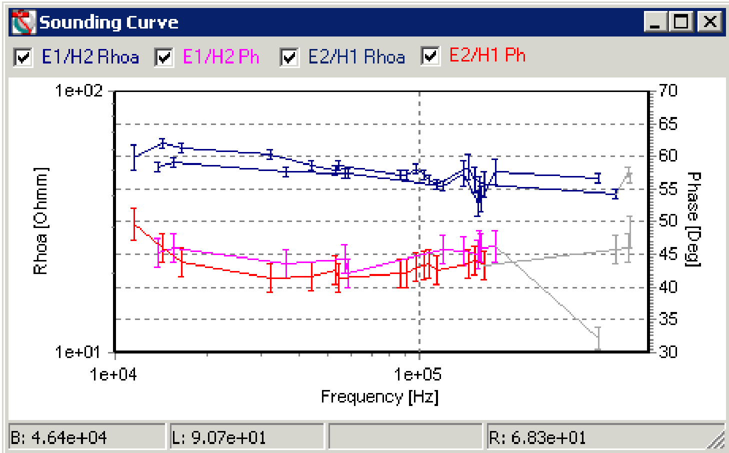

Figure 5.5 Processing x,y-plot og data

Selecting one or more of the soundings enables two types of display - 1) a traditional x-y-plot of the data (Figure 5.5) or 2) a tabular view of the data (Figure 5.6). On either of the two displays four bottons enable activation/deactivation of the four types of data:

1. E1/H2 Rhoa
2. E1/H2 Phase
3. E2/H1 Rhoa
4. E2/H1 Phase

The appearance of the x-y-plot can be adjusted to suit the preferences of the user. By default the axes are scaled to cover the range of the data to be dispayed. It is also possible to make prints of the plots.

Sounding Data

Stations

- Line 2, Station 1, Pol. 1
- Line 2, Station 1, Pol. 2
- Line 2, Station 2, Pol. 1
- Line 2, Station 2, Pol. 2
- Line 2, Station 3, Pol. 1
- Line 2, Station 3, Pol. 2
- Line 2, Station 4, Pol. 1
- Line 2, Station 4, Pol. 2
- Line 2, Station 5, Pol. 1
- Line 2, Station 5, Pol. 2
- Line 2, Station 6, Pol. 1
- Line 2, Station 6, Pol. 2
- Line 2, Station 7, Pol. 1
- Line 2, Station 7, Pol. 2
- Line 2, Station 8, Pol. 1

Data

Freq.	H1/E2 Rhoa	H1/E2 Ph.	H1/E2 Rhoa STD	H1/E2 Ph. STD
19569	50.99	45.31	1.05	3.00
22087	53.67	45.94	1.05	3.00
51918	49.27	43.54	1.05	3.00
80986	48.39	44.41	1.05	3.00
82779	48.28	42.04	1.05	3.00
170898	43.55	45.72	1.05	3.00
198059	48.35	45.45	1.05	3.00
221863	37.36	45.11	1.05	3.00
224915	42.00	46.20	1.05	3.00
228271	38.90	45.96	1.05	3.00
252075	49.12	46.17	1.05	3.00
549011	46.71	32.07	1.05	3.00

Figure 5.6 Processing tabular view of data

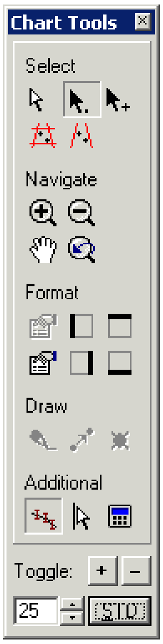

Figure 5.7 Editing tools for processing

The editing of the data is done using any of the select tools available (Figure 5.7). Entire soundings can be deleted as well as individual data points and extra noise can be ascribed to the data. In the presented example (Figure 5.5) The phases measured for the highest frequencies have been deleted and some measured rhoa values have had extra noise ascribed. Extra noise can be ascribed on the tabular view as well by direct text-editing in the table.

If changes are made to the datase during processing the changes are written to the database and the data set is ready for inversion.

5.4 INVERSION

The inversion shares most of its features with the inversion modules for other data types such as TEM and CVES data.

First the user selects which part of the data that he or she wants to invert. It is possible to invert on all data or a subset. The subset can be defined both by polarization (E1/H2 or E2/H1), data type (Rhoa, Phase or both) and line number (e.g. only profile 3 n a data set with 10 profiles). The dialog for these settings are displayed in Figure 5.8. Different polarizations are always inverted to different models, whereas Rhoa and Phase-values for the same polarization can be inverted together for a common model.

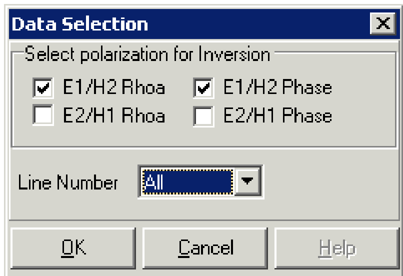

Figure 5.8 Choose data for inversion

After the data section the settings for the inversion has to be set. The **Inversion Settings**-window has 5 tabsheets as displayed in Figures 5.9 to 5.13, each controlling different aspects of the inversion setup.

The first tab, **Model**, controls the setup of the model. This includes the number of layers, resistivities and thicknesses of the starting model and inclusion of a priori information.

The second tab is **Constraints** and it controls the lateral and vertical constraints regularizing the model. If no constraints are applied models are inverted as individual soundings.

The third tab sheet is **Sections** defining the length of sections used in one inversion job. The computational time needed for inversion will increase rapidly for model sections with more than 1000 model parameters.

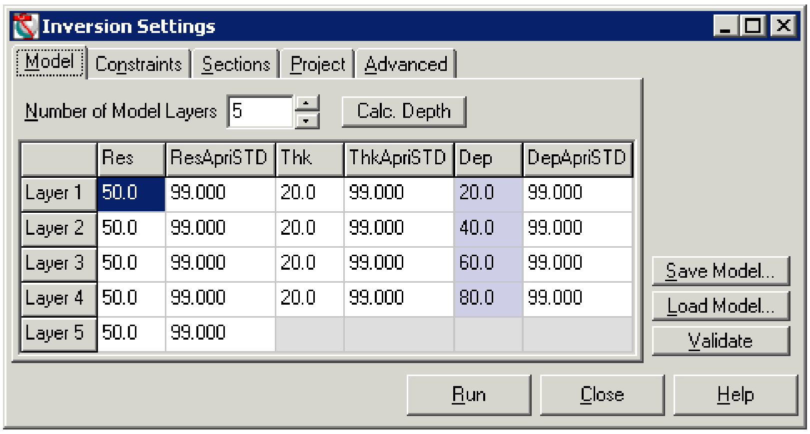

Figure 5.9 Inversion Settings - Model

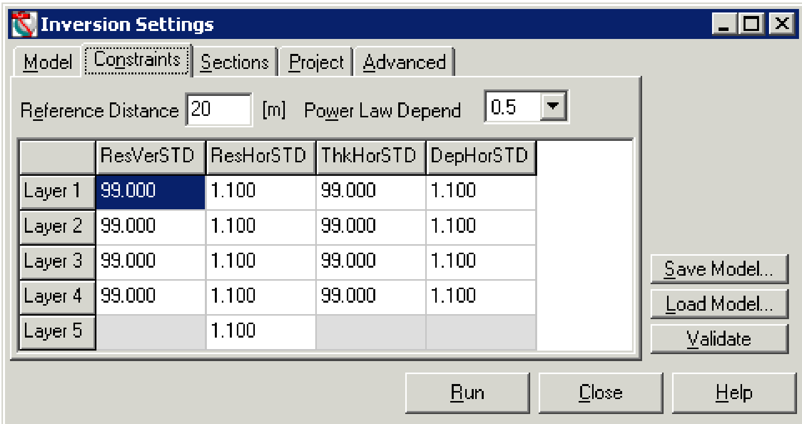

Figure 5.10 Inversion Settings - Constraints

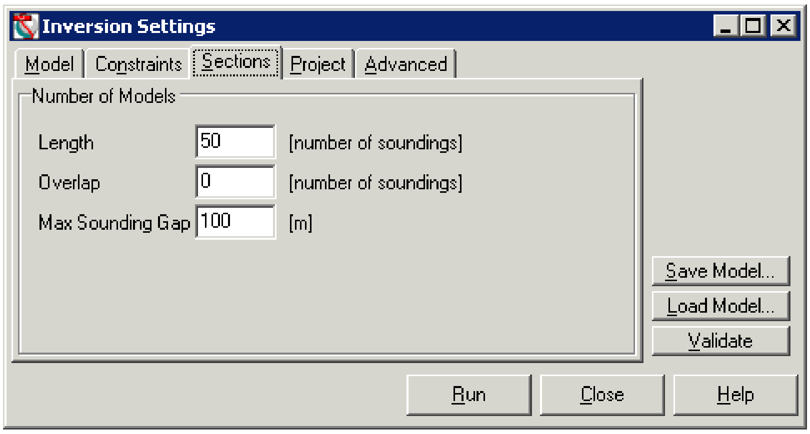

Figure 5.11 Inversion Settings - Sections

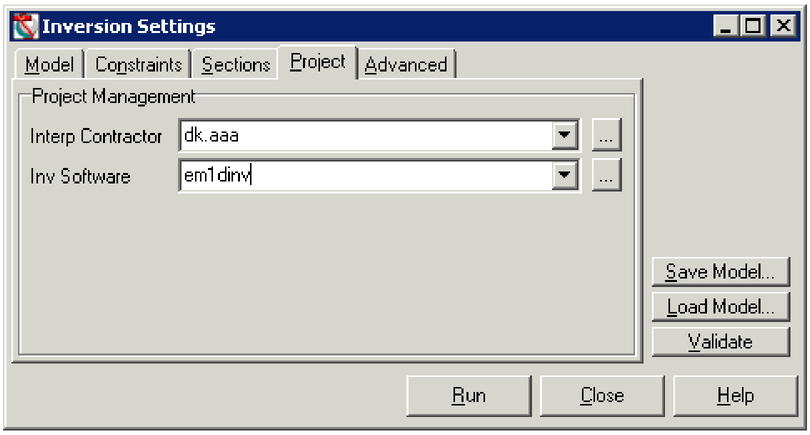

Figure 5.12 Inversion Settings - Project

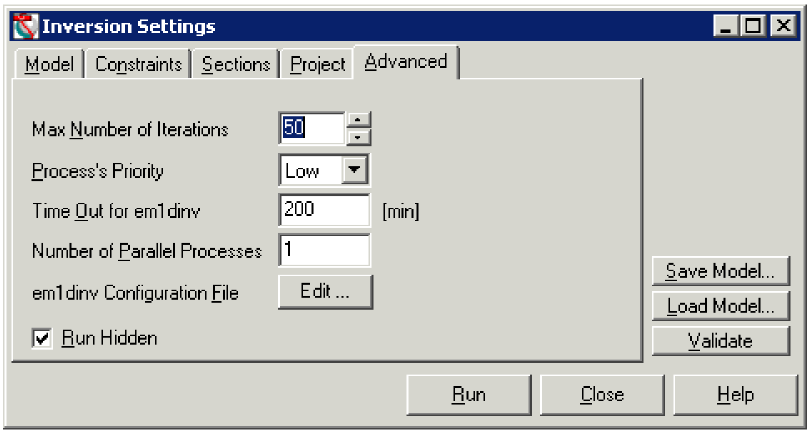

Figure 5.13 Inversion Settings - Advanced

The fourth tab, **Project**,holds information on the project and the software used.

The fifth tab, **Advanced**, is intended for those that want to control more parameters of the inversion. The defaults will do for most people.

When the settings have been entered as desired by the user the inversion is started by clicking **Run**.

5.5 INVERSION EVALUATION

When the inversion has finished the results can be viewed and evaluated using dialogs very similar to the ones used under processing with the addition of plot of models and data fits. All forms are linked to the GIS-map,

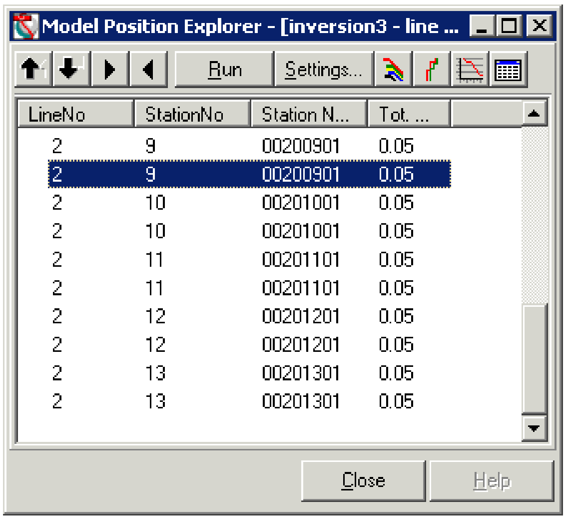

Figure 5.14 Main dialog.

which means that a selected sounding on any of the forms shown will appear selected on the GIS-map as well (and vice versa).

The main dialog (Figure 5.14) is very similar to the one used for processing, though with a few extra bottons. The arrow-bottons in the upper left corner are used for various autoplay functions which come in handy for very large data sets. The main bottons for evaluation are the four bottons in the upper-right corner.

The first botton (Figure 5.15) enables display of oberved data versus forward data of the inverted models. Curves can be shown for a single sounding as well as for a full suite of soundings. .

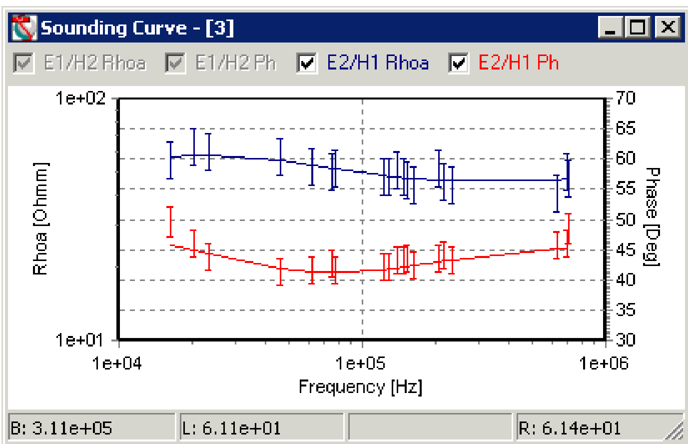

Figure 5.15 Observed data and forward data.

The second botton (Figure 5.16) displays a simple line plot of the resulting models.

The third botton (Figure 5.17) is a profile plot of the soundings plotted individually as a bar. The **Settings**-botton gives access to full control of barwidth colorscale and a number of other parameters. Residual curves an be shown on this plot as well. ,

The last botton enables a table view of the model parameters from the inversion. The tabular view includes a model parameter analyses allowing detailed evaluation of the inverted mode.

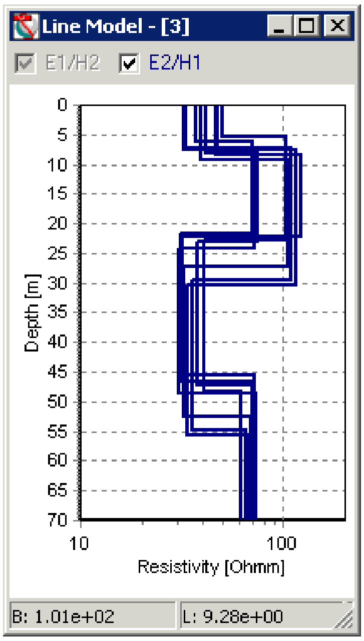

Figure 5.16 Inversion results as line models.

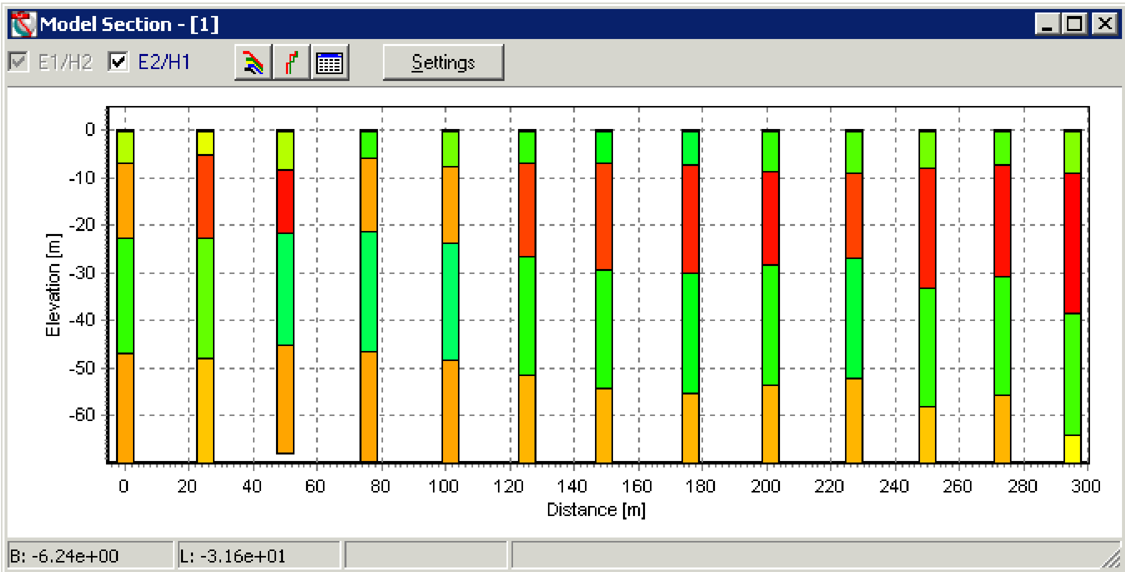

Figure 5.17 Inversion result as bar-model plot.