1
1D-LCI INVERSION

This section will give a description of the 1D-LCI module, which is an integrated function of the Workbench. General functions, visualization of geophysical models, etc. are described in previous chapters.

The chapter begins by giving a description of the inversion settings, goes on to the runnig of inversions, the inspection of inversion results and finally gives a runthrough of a suggested workflow.

Extra information about different functionalities is often available by accessing the online help (**F1**).

SMOOTH MODELS

Inversions with smooth models can give a good impression of complex geological structures in the survey area. Furthermore they are a very strong tool to use in a readjustment of the processing.

If the focus of investigation is a shallow target the thickness of the layers should be decreased.

1.1
INVERSION SETTINGS

The Inversion Settings form is the control center used in the setup of the inversion job. Settings which can be saved to and loaded from inv files. The Validate button validates the syntax.

Inversion set up is designed for use with Laterally Constrained Inversion.

A description of the tab sheets of the Inversion Settings form and the settings belonging to these will be given below.

MODEL

The Model tab sheet is seen in figure 1.1. Here the starting model in terms of layer parameters and a priori constraints is specified.

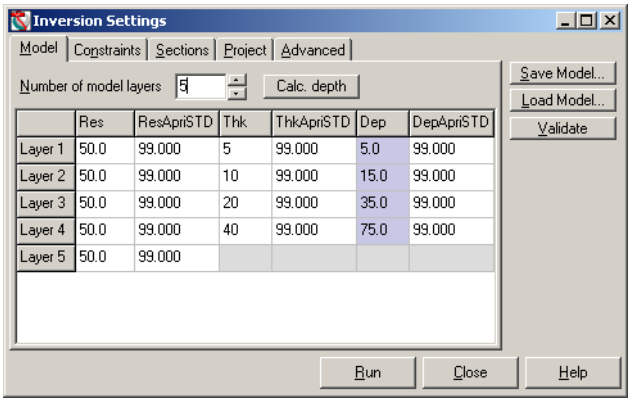

Figure 1.1 The Model tab sheet where layer parameters for the

Pressing the Calc. Depth button updates the Dep column (depth) if changes have been made to layer thicknesses. This is particularly important when using a priori constraints on depths.

CONSTRAINTS

This tab sheet is concerned with horizontal and vertical constraints (see figure 1.2). Horizontal constraints are scaled by distance using a reference distance and power function:

$$C = 1 + (C_{opt} - 1)\left(\frac{\Delta GPS}{Dist_{ref}}\right)^{n}$$

Where C is the used constraint, C_{opt} is the optimal constraint at a sounding distance of $Dist_{ref}$ and ΔGPS is the actual sounding distance.

Constraint factors are entered in the tabular section of the form. Vertical and horizontal constraints on resistivities are available along with horizontal constraints on thicknesses and depths.

Constraints can be thought of as a rubber band with a certain strength. A smaller constraint value is equivalent to a less elastic rubber band. The rubber band does not have a specific max length, but as you get further away from the starting point it gets less elastic. Constraint values are given as factors, i.e. a factor of 1.1 means that the parameter can vary between the starting value divided by/times 1.1.

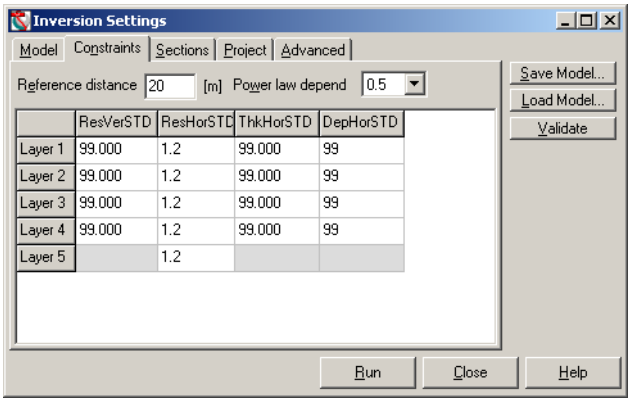

Figure 1.2 The Constraints tab sheet. The model in terms of constraints are given here.

Setting a constraint factor to a value of 99 is equivalent to disabling it.

SECTIONS

In Sections the model section of the inversion is set up (see figure 1.3).

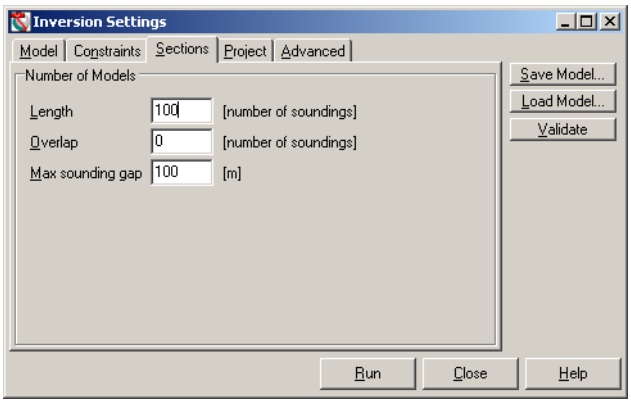

Figure 1.3 The Sections tab sheet. Here the parameters controlling the model section are given.

Settings include:

- **Length** controls the maximum length of the section (in number of soundings). A new section is however started if the distance between two neighboring soundings exceeds a certain number.
- **Max Sounding Gap** defines when a new section is created.
- **Overlap** is currently not in use.

PROJECT

Here information about the Interpretation Contractor and the Inversion Software can be entered.

ADVANCED

This tab sheet holds different settings concerning the actual inversion process. It is seen in figure 1.4. Settings here are:

- **Max Number of Iterations**: The maximum number of iterations before the inversion job is stopped.
- **Process Priority**: The windows priority of the inversion code.
- **Time Out for em1dinv**: Not in use.
- **Number of Parallel Processes**: Enables the possibility of running more than one process simultaneously. Useful for processors supporting the hyperthreading technology or dual core processors.
- **Min number of data points**: Minimum number of data points in the sounding before it is used in the inversion.
- **em1dinv Configuration File**: Opens up a text editor where the em1dinv configuration file can be viewed and edited. A Validate function, validating the syntax of the file, is also available.

- **Run Hidden**: No em1dinv DOS window is shown during inversion.

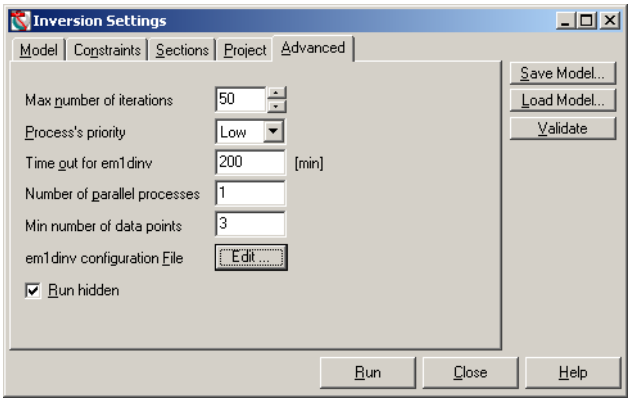

Figure 1.4 The Advanced tab sheet where different parameters controlling the inversion process are given.

1.2 RUNNING INVERSIONS

The inversion process is controlled by a Workbench application called Embi (figure 1.5). When the Run button is pressed in the Inversion Settings window files are written out to a temporary library on the computer (This is usually a place like C:\Documents and Settings\user.name\Local Settings\Temp\EMBIInv###\) and Embi is started. It also creates an Inversion Node as a subordinate to the Processing Node.

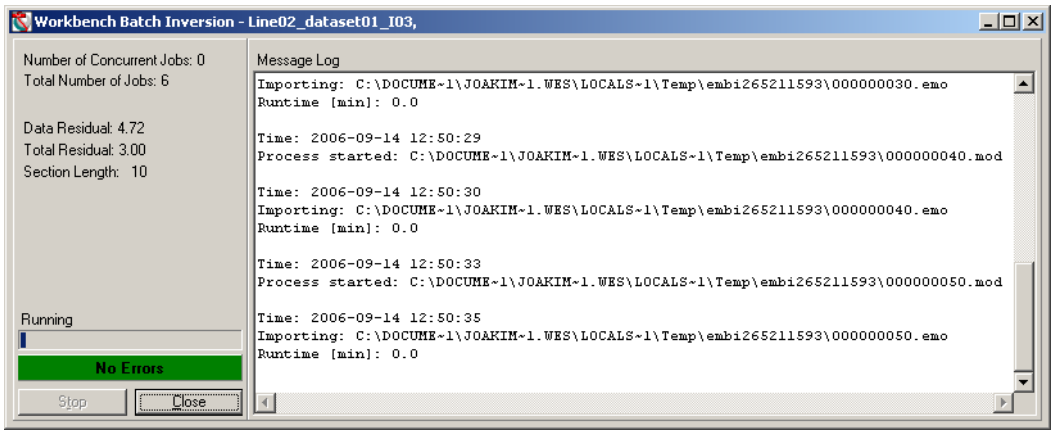

Figure 1.5 The Embi window. In the left side of the screen various information about the inversion process are given. Notice the highlighted Close button indicating that the inversion process has finished.

Embi writes model files based on the settings that were given in the Inversion Settings window and starts inversion jobs by sending commands to the inversion code. Jobs are started continuously; when one inversion job is finished results are written in the

database, the next model file is read and the job is started. The inversion jobs are finished when the Close button is highlighted. Temporary files are deleted when Embi is closed.

Embi requires access to the database at all times. It does however not require that the workbench is running. This makes it possible to split the inversion up and run multiple instances of Embi simultaneously and even on more than one computer as long as there is access to the database. If errors occur (i.e. missing access to database, various errors in the inversion routine, etc.) a message will be posted.

1.3 INSPECTING INVERSION RESULTS

Results can be viewed by selecting Show Inversion Results, which is available via the right-click menu on the Inversion Node. This opens up the Model Position Explorer, which shows a list of the models in chronological order, as seen in figure 1.6. Selected models are highlighted on the GIS Map. The menu bar consists of the following buttons:

- **Get Previous/Get next**: Moves focus to previous/next models.
- **Autoplay/Autoplay backwards**: Automates Get Previous/Next.
- **Run**: Currently not in use.
- **Settings**: Opens up a settings window as explained below.
- **Model Curve**: Plot window showing the selected models as model curves.
- **Model Line**: Plot window showing the selected models as line models.
- **Model Section**: Plot window showing the selected models as model sections. This will also be explained later on.
- **Model Parameters**: Plot window showing model parameters for the selected models.

The Commands and Save buttons in the bottom of the form will be discussed later on.

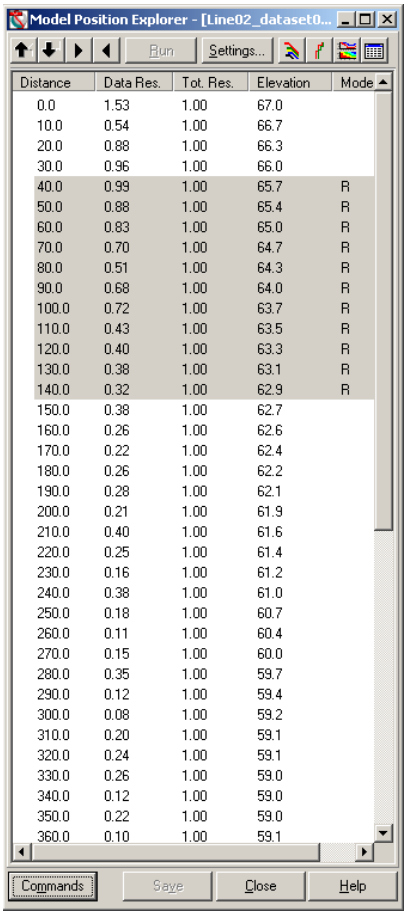

Figure 1.6 The Model Position explorer where models can be selected for inspection

MODEL POSITION EXPLORER SETTINGS

The Model Position Explorer Settings form consists of two tab sheets: Properties and Columns.

In the former different properties concerning the function of the list window can be controlled. It is for example possible to choose GIS Map symbols, the speed of the auto scrolling process, whether all models should be shown or just every other, third, etc.

Under the Columns tab sheet it is possible to control the layout of the Model Position Explorer by specifying which columns should be visible. These vary according to data type but among other include the number of data points, the data - and total residual.

THE MODEL SECTION PLOT

The Model Section plot show the models selected in the Model Positions Explorer on a depth section. Models are shown as either model bars or filled sections. Via this plot one or more of these models can be selected and shown on Model Curve, Model Line or Model Parameter plots, just as was the case via the Model Positions Explorer except that only the models selected on the Model Sections plot are shown here. Selected models are highlighted on the GIS Map.

The Settings button opens up a window offers the option to alter things like axis properties, model displays and map symbols. It is also possible to shift models along the x-axis making it possible to see otherwise overlapping model bars.

ADJUSTMENT OF PROCESSING

From the inversion plots it is possible to make adjustments to the processing. When inspecting the model fit it may very well be the case that data points are found which should be removed. These can be toggled off via the Sounding Plots in the same manner as in the manual processing phase. The usual processing tools are used to do this.

The processing/adjustment must be saved to the database by hitting the Save button, which is available if edits have been made.

The Commands menu also offers a quick way of removing unfitted data points via the Filter Unfitted Data function where data points that deviate more than a specified number of STDs from the forward data are automatically removed.

Edits made to the processing are only visible as long as the Model Positions Explorer is open, i.e. if it is closed and reopened they will not be visible. The reason behind this is that the inversion results are based on the processing before the adjustments and as such this should be what is shown when evaluating the results. The results are of course visible upon reopening the processing forms or via new inversions.

RESUBMISSION OF MODEL SECTION

If all or parts of the LCI section needs to be inverted again with an altered starting model this can be done using the Redefine Start Model and Resubmit Inversion Job functions, which are available in the Commands menu.

To redefine the starting model of parts of the section follow these steps:

1. Select a group of models
2. Press Redefine Start Model. This brings up the Redefine Start Model window
3. Enter (altered) layer parameters and constraints.
4. Press OK to save the altered model definition for the selected soundings.
5. Repeat steps 1-4 again for a new selection if needed.

It is also possible to start an inversion job with a section containing only the

selected models (press Submit button). If so the possibility of altering the settings from the Section and Advanced tab sheets becomes available. The resubmission of only selected models is meant as a way of testing a redefined starting model on parts of a section and should as such not be used in the final inversion.

By pressing the Resubmit Inversion Job button the entire section (all models) are resubmitted. The starting model can be altered for parts of these by using the Redefine Start Model function prior to resubmission.

1.4 SUGGESTED WORKFLOW

How one best works with the inversions is of course a personal matter and somewhat dependent on the data type and geological target. Experience has however shown that the following workflow may fulfill most needs:

1. After processing the data run a preliminary smooth layer inversion.
2. Make adjustments to the processing based on this. Using the Autoplay and/or Filter Unfitted Data functions speeds up this process.
3. Use the Model Section to determine the amount of layers for the few layer inversion.
4. Run the few layer inversion.
5. Use the Model Section to estimate the penetration depth.
6. Adjust the few layer inversion if needed and set up the final smooth layer inversion.
7. Inspect the results.
8. Make theme maps, profiles, etc.

HINTS AND TIPS

- More model layers (e.g. smooth models) mean more model parameters and more calculation time. Smooth layer inversions are for example time consuming due to the large amount of layer parameters. Therefore it is not advisable to use section lengths of more than 80 soundings.
- Try lowering the speed of the Autoscroll function if the Sounding Curve plot does not update properly or lags behind.
- One of the forces of smooth models is their ability to fit every (feasible) data point. They are therefore a good tool to use in the processing adjustment.