

ZONDRES2D

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Introduction

«ZONDRES2D» is a computer program that will automatically determine a 2.5-D model of the subsurface for the profile data obtained from multi-electrodes soundings by method of the resistivity and the induced polarization (DC-IP). Friendly interface and wide possibilities of data imaging allow deciding the given geological problem with maximal effectiveness.

The finite element method as a mathematic instrument is used to decide the forward and inverse problem. This method gives better results than the mesh ones.

The medium is divided on the triangle cells grid different resistivities while the point source field modeling is. The potential's behavior inside the grid cell is approximated to the linear basis function.

$$N(x, z) = \frac{(a + bx + cz)}{2A}$$

The point source field inside a 2D-medium has 3D structure. Using a Fourier transform the task solution could transduce in spatial frequency domain.

$$\frac{\partial}{\partial x} \left(\sigma \frac{\partial \phi}{\partial x} \right) + \frac{\partial}{\partial z} \left(\sigma \frac{\partial \phi}{\partial z} \right) - \lambda^2 \sigma \phi = -I \delta(x) \delta(z)$$

$$\frac{\partial \phi}{\partial n} + \nu \cdot \phi = 0$$

where ϕ – spectral potential value, λ - spatial frequency, I - current intensity value, σ - medium resistivity, $\delta(x)$ - Dirac delta- function .

The subsequent deciding of equations for the set of spatial frequencies and using of an inverse Fourier transform for resulted spectral potentials give the desired values of the point source potential in grid nodes.

$$U(x, y, z) = \frac{2}{\pi} \int_0^{\infty} \phi(x, \lambda, z) \cos(\lambda \cdot y) d\lambda$$

The regularization method of Newton (or quasi-Newton) is used for deciding the inverse problem. The regularization increases the solution stability and allows receiving of more smooth resistivity and polarizability distribution.

$$(A^T W^T W A + \mu C^T R C) \Delta m = A^T W^T \Delta f - \mu C^T R C m$$

where: A – the Jacobian matrix of partial derivatives; C - is a smoothing matrix; W - is a data weighting matrix; m - is a model parameters vector; μ - is the damping factor; Δf - is the discrepancy vector between observed and calculated data; R - is a focusing operator.

During program's development the special attention was devoted to account priory information (data weights, parameter's limits).

«ZONDRES2D» contains the powerful system of profile data visualization, the electrodes editor and the system of sensitivity and method resolution analyzing.

To display the observed and calculated values and its difference or measurement weights the program uses two types of graphs: graphics plan and pseudosection.

In the electrodes editor the user can: read electrodes array geometry, set the data weights and correct the observed data. Also, it is possible to set the data weights in accordance with the response level and summary sensitivity of given measure or to fix those model cells whose parameters changing has no effects in result.

With help of the sensitivity's analyzing the user researches the model's sensitivity function, or amount of any model's cell effect in measure results.

With help of the resolution capability analyzing the user researches the model's sensitivity function, or amount of any model's cell effect in measure results.

$$S = \text{diag}(A^T A)$$

The researching of sensitivity allows choosing the optimal type and parameters of electrodes array for deciding the given geological problem.

«ZONDRES2D» uses the simple and clear data file format permitting to unite several types of electrodes array for one profile. The apparent resistivity, the resistance and the apparent polarizability can be used in data files. The program allows to import and to present the measure results by other methods that assist to interpret the data with more integration.

«ZONDRES2D» presents the modeling system including all main type of arrays which the DC-IP method uses. Selecting the array parameters and observations number is realized by user in dialog mode.

«ZONDRES2D» is the power instrument for automatic and interactive interpretation of multi-electrodes DC-IP data and it can be run on IBM-PC compatible PC using the Windows.

System Requirements

Before installing and using the «ZONDRES2D» program make sure that your computer system meets the following requirements:

- IBM-compatible Pentium IV 2000MHz or higher PC
- Windows 98/SE/ME/2000/XP/NT operating system.
- At least 512 MB system memory
- 1024x768 screen, True color (No changing screen mode is recommended when the program is run).

Installation and removing

Software «ZONDRES2D» is delivered as the two 3.5 FDD package or the CD's package or via the NET. "User Guide" is included too.

For Installation:

1. Run «ZONDRES2DS.EXE».
2. Choose directory in «Install ZONDRES2D » as you would like.
3. Shortcut group « ZONDRES2D » appears when installation finished.

For Deleting: «ZONDRES2D» use "Master of installing/removing".

1. Choose «ZONDRES2D» item.
2. Push "add/remove" button.

Data File Operation

For starting up « ZONDRES2D » create data file of certain format which contains electrodes coordinates and observed data.

«ZONDRES2D» supports also most popular data formats: RES2DINV (geotomo Software, M.H. Loke), SENSINV2D (geotomographie, T. Fleschner), ABEM data и ProfileR (A. Binley).

Usually, one profile data correspond to one file. ANSI data files of «ZONDRES2D» have «*.z2d »- extension. See "**Data file format**" for detailed information.

Zond Id file conversion	Import data from ZondLP file format data file
Zond data file	Open data file of ZondRes2D file
Program configuration	Open configuration file
ProfileR data file	Open ProfileR format data file
ABEM data file	Open ABEM data file.
Res2dInv	Open Res2dInv data file.
Sens2dInv	Open Sens2dInv data file

For correct running the data file cannot contain next elements:

- incorrect symbols of records separator (TAB and SPACE use only)
- Absurd data values.

Desirably, data total must be no more 5000 records for one file and but the electrodes unique position total is no more 500.

Data File Format

The program presents universal data format including the information about coordinates of potential and current electrodes, topography of profile and observed data (resistance or apparent resistivity and apparent polarizability).

Data file format is *.Z2D

First line contains control keys indicating to the program which data contain in that or another column.

In «ZONDRES2D» is accepted the next symbols (keys) for electrodes coordinates and observed data:

Current - **C1 C2**

Potential - **P1 P2**

For observed data:

Apparent resistivity - **Ro_a**

Resistance (electric potential ratio to current value) - **Res**

Apparent polarizability - **Eta_a**

Accuracy or measurement weight is set in column **Weight**. The meanings of measurement weight should be set from 0 to 1 range. If the weights is absent the program automatically sets the weight = 1 for each record.

The second and next lines contain the data that correspond to each measuring. These records are written in such sequence as control keys of first line.

If the different number of electrodes in arrays are used on profile, the symbol * is write instead of missing electrode coordinate.

After file reading (if this necessary is) the data normalization is realized by formula that corresponds to DC apparent resistivity.

$$\rho_a = G \cdot \frac{|U|}{C}$$

Where, G – the geometric array factor, U – the observed response and C – the current intensity value.

Interpretation Results Saving

Interpretation result of profile data is save in «ZONDRES2D» format file (extension *.z2d). This file keeps the observed data, the measurement weights and model's parameters. Saved model will be used in next following loading.

Press the  button in the toolbar panel or menu item if you want to save the result of interpretation. Also you can select the data file format for saving the observed and calculated data of current model and pictures (Model, WorkSheet) in format *.BMP when the dialog appeared.

Zond project data	Saves the observed data and current model.
Zond calculated data	Saves the calculated data.
Zond observed data	Saves the observed data.

ProfileR observed data	Saves the observed data in ProfileR program format.
ProfileR calculated data	Saves the calculated data in ProfileR program format.
Res2dInv observed data	Saves the observed data in Res2dInv program format.
Res2dInv calculated data	Saves the calculated data in Res2dInv program format.
Worksheet	Saves three graphic panes of window in BMP format.
Model	Saves bottom graphic pane of window in BMP format.
Program configuration	Saves program settings.

Program Start Up

Toolbar

The toolbar is appointed for quick run the most using functions. The following table lists the keys found in the tool bar with their corresponding functions (from right to left):

	Opens the data file.
	Saves data.
	Runs the dialog of inversion parameters setup.
	Runs the electrodes editor.
	Starts the forward problem calculation.
	Starts (one click) or cancels (repeat click) the inversion process.
	Selects the data interpretation mode of resistivity method (DC).
	Selects the data interpretation mode of induced polarization method (IP).

Main Menu Function

The following table lists the items found in the Menu with their corresponding functions:

File/Open file	Opens data file.
File/Save file	Saves file.
File/Edit data	Opens the current file in Notepad editor.
File/Default array	Runs the dialog of synthetic measurement system generation.
File/Import data	Imports the arbitrary data or model in program.^
Options/Mesh constructor	Runs the model constructor setup dialog.
Options/Program setup	Runs the inversion parameters setup dialog.
Options/Electrode editor	Runs the electrodes editor.
Options/Graphics setup	Runs the graphics parameters setup dialog.
Data/Apparent resistivity	Displays the apparent resistivity values.
Data/Resistance	Displays the resistance values.
Data/Pseudo-section	Displays the observed and calculated data in pseudosection.
Data/Graphics-plot	Displays the observed and calculated data in graphics plot.
Data/Vertical axis/PsZ	Uses the measurement point pseudo-depth as vertical coordinate axis for pseudosection construction.
Data/Vertical axis/Spacing	Uses the measurement point spacing as the vertical coordinate axis for pseudosection construction.
Data/Calculated data	Displays the calculated pseudosection in second part of window
Data/Data misfit	Displays the misfit pseudosection in second part of window.
Data/Data weights	Displays the measurement weights pseudosection in second part of window.

Data/Iso-pole graphics	Runs the iso-pole graphics plot, where each graphic corresponds to certain source position.
Data/Iso-psZ graphics	Runs the graphics plot features, where each graphic corresponds to certain pseudo-depth (the array geometric factor).
Model/Block section	Displays the model editor.
Model/Contour section	Displays model as the contour section.
Model/Resistivity	Displays the resistivity/polarizability model.
Model/Sensitivity	Displays the model sensitivity function as the contour section.

^ Imported data file must be consisting of two columns: measurement coordinate and value. The right axis of graphics plot serves the vertical axis of imported data. The imported model must be contained in the Zond 2D project file, after its loading the new window which contains model appears. If you move the cursor in the model field the active cell position is mapped onto the model from the imported file.

“Hot” Keys

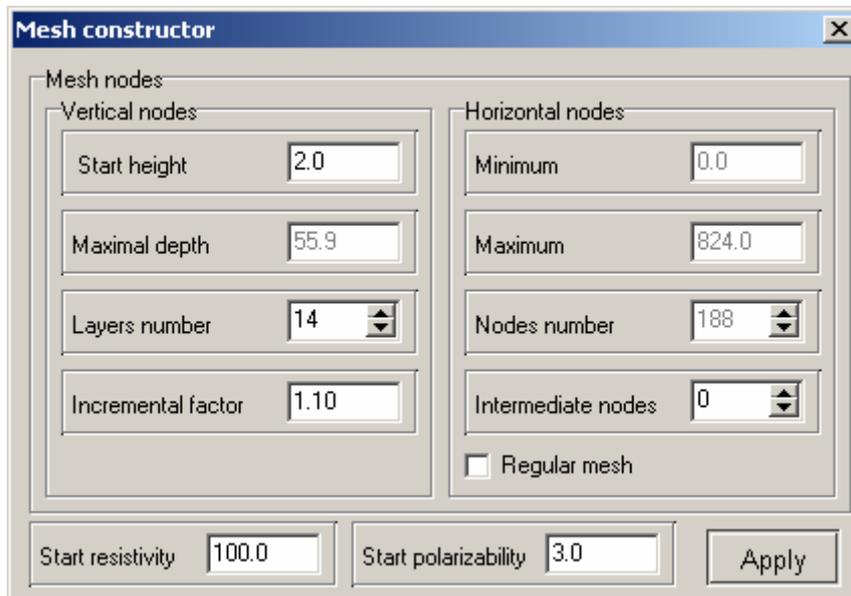
Left, Right, / cursor in the model editor	Changes the active cell of model.
Delete/cursor in the model editor	Clears the active cell.
Insert/ cursor in the model editor	Inserts the current value to the active cell.
F / cursor in the model editor	Fixes the active cell value.
X / cursor in the model editor	Uses the “magic wand” tools for selecting homogenous area.
V /cursor in the model editor	Removes the selection.
Up/Down /cursor in the color scale	Changes the current value.
Space	Calculates the forward problem.

StatusBar

The status tab of program is shared by some sections that contain different information:

Cursor and active cell coordinates.
Active cell parameters.
Model editor mode.
Calculation progressbar.
Model relative error.
Additional information

As the «*.Z2D» data file is ready load it by pressing of  button or the suit main menu item. After successful loading the start up dialog appears that offers you to select the grid parameters and to set the start half-space resistivity and polarizability.



The **Vertical nodes** field contains the options which sets the vertical grid's parameters. The program automatically selects these parameters by means of the next rules:

- The depth of bottom's layer is half of maximal pseudo-depth for used measurement system
- The number of layers is double quantity of the array's unique geometric factors for used measurement system but not exceed 16.
- The thickness of the next layer is 1.1 times more than the previous one.

Start height sets the thickness of first layer. This value must approximately equal to the width of cell and model resolution.

Maximal depth sets the depth of bottom layer. You should remember that the maximal depth must not be too much because the influence of section parameters decrease with depth.

Layers number sets the number of model's layers. Usually 12-14 layers are enough for model's description. You should not set large values for this parameter because the computation speed will be slow

Incremental factor sets the ratio between thicknesses of adjacent layers. Usually, this parameter value is selected from 1 to 2.

The **Horizontal nodes** field contains the options which sets the horizontal grid's parameters.

Minimum shows (sets) the minimal coordinate of profile.

Maximum shows (sets) the maximal coordinate of profile.

Intermediate nodes sets the number of complementary nodes between the unique positions of electrodes in the profile (0 - 4). It is positively for the accuracy of the forward problem solution, especially when you use the total potential calculation scheme.

Half-space resistivity sets the resistivity of start's model.

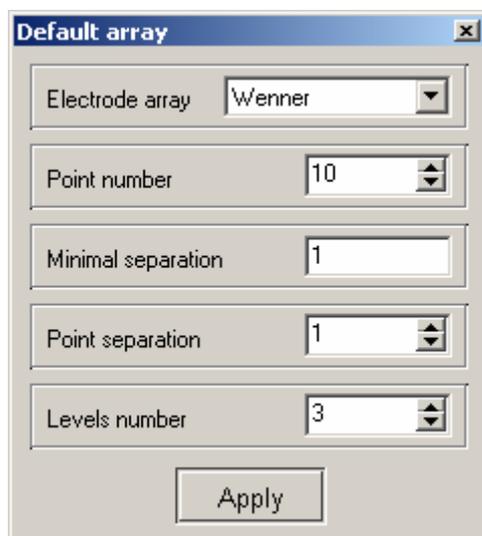
Half-space polarizability sets the polarizability of start's model.

Regular mesh starts the construction algorithm of horizontal mesh where the complementary nodes are selected from condition of split uniformity. You should run this option if the distance between adjacent electrodes is very different (It is positively for the accuracy of the forward and inverse problems solution).

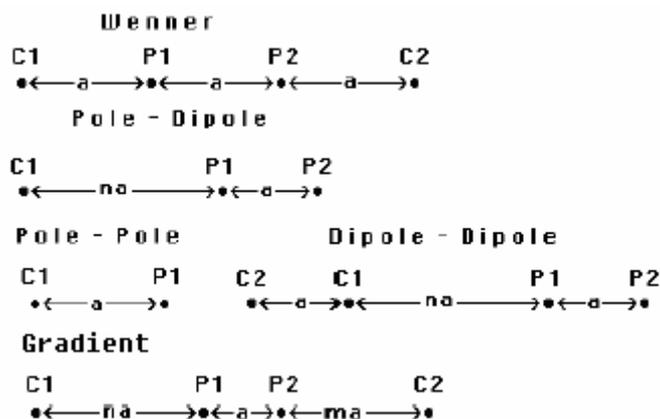
Press the **Apply** button after the mesh setup is finished and the program passes to work mode.

The alternative of data file is the using of synthetic observation system that allows to construct the various geological situations for the most widely-distributed electrodes arrays.

To pass in the syntetic modeling mode you can select the Main Menu option: File/Default array. This option runs the dialog that contains the options for selecting measuring system parameters.



Electrode array sets the array type.



Point number defines the number of source line/point positions on the profile (for all arrays types except Wenner array). For Wenner array this option defines the number of sounding points on the profile. The sounding is the collection of measurement with the Wenner array whose centers coincide.

Minimal separation (a) defines the unit length (in meters) on which multiply the distance between electrodes.

Point separation sets the distance (in 'a' units) between source line/point positions in the profile (for all arrays types except Wenner array). For Wenner array this option defines the distance between adjacent soundings.

The potential line length and the minimal distance from a potential to current electrode are equal **a** (for all arrays types except Wenner array). For Wenner array the length of potential line depends on the **a** as the **Levels number* a** value.

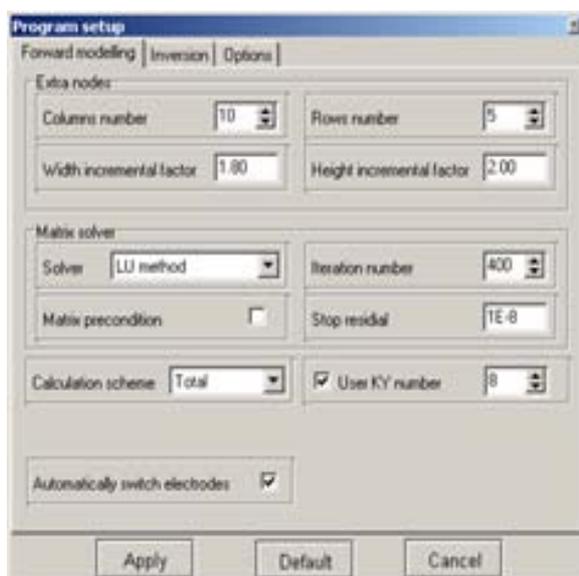
Levels number (n) defines the number of potential line/point position for any source (the number of unique geometric factors of electrodes array on the profile). For **Gradient** array the numbers of measurements are equal to $2*n$. For Wenner array this option sets the number of measurement whose centers coincide.

Press the **Apply** button after the array's parameters setup is finished, and the mesh setup dialog appears. When setup is completed the functional buttons for working with data appear in the Main Menu toolbar, and also the short information about current model appears in the right side to status panel.

If you move cursor at the windows which are made in the program process, in left side of main menu status panel displays the coordinates corresponds to proper axis of the current window.

Program Settings

The dialog serves to setup the parameters for the forward and inverse problem.



Most of options are contained in first tab - **Forward modeling** and are used by program for forward problem decision.

Extra nodes defines the number of nodes and cells sizes of external mesh. This option is used for satisfaction of the electric potential boundary conditions. Ideally, the boundary of modeling area must be infinitely far from the source.

The mixed boundary conditions (Neuman + Dirichlet) are used in forward problem calculation. These conditions allow receiving of the satisfactory results while the distance to the external boundary is not so much. So, in the field work the external boundary is moved to the distance in two times more than the maximal spacing of measurement system.

Columns number sets the number of the external nodes from the left and right in regard to the model visual field. To calculate the total potential you must use the 5-10 external nodes and to calculate the secondary potential you must use the 1-4 ones.

Width incremental factor sets the ratio of the width of adjacent external mesh nodes (1-2). The width of columns increases with moving away from model's border.

Rows number sets the number of the external mesh nodes from the bottom in regard to the model visual field. To calculate the total potential you must use the 3-5 external mesh nodes and to calculate the secondary potential you must use the 1-2 ones.

Height incremental factor - sets the ratio of the thickness of adjacent external mesh nodes (1.5-3). The thickness of layers increases with moving away from model's bottom.

Secondary or Total potential defines the algorithm of the electric potential calculation. If this option is on the secondary potential is calculated. This mode is slower and do not include the measurement surface relief but it allows receiving the very accuracy results when you use the rough mesh parameters. To calculate the total potential (the option is off) you must use the more heavy mesh (1-2 nodes between the electrodes positions in the profile) and move further the peripheral boundary of model. It links with high error of the potential measure close to the potential electrode.

User KY number sets the number of spatial frequencies λ using by Inverse Fourier transform. The speed of forward problem solution is directly proportional to this parameter value that defines the diapason of the electrode spacing changing and that is selected by experienced way.

When this option is off the program automatically defines the optional number of spatial frequencies.

The above described selecting of parameters is the mesh calibration. This process must warn all next following stages of data operation

Below the practice advises of the mesh calibration are represented:

The result of calibration is the fit of all calculated apparent resistivity values with the half-space resistivity.

In first the parameter **User KY number** is selected (the account for secondary potential is performed!) You must use the least parameter value under the satisfaction result is received.

Then the solution accuracy is researched for total potential. The number of intermediate nodes and peripheral mesh parameters are selected until the satisfaction result is done. Note that the most accuracy result is received for mesh with equidistant nodes only.

Matrix solver is the options complex for the matrix inversion algorithm adjusting.

Solver sets the method of the matrix inversion.

Seidel is the fastest method. Sometimes this series has slowly convergence, especially while the matrix has bad conditionality.

CG (conjugate gradients) is the medium rate method but it is the sufficiently stationary method (especially if the **precondition** option is on). It is recommended in many cases.

SVD (singular decomposition) is the slowest method. It allows to inverse the matrix even in case of much condition number. (Such situation is present with high-contrast models).

Matrix precondition – the program transforms the matrix for decreasing of condition number when this option is on.

Iteration number defines the iteration number that the inversion procedure stops 50 – 400.

Stop residual sets the computer accuracy value. Achieving this value the matrix inversion procedure is stopped 10^{-7} - 10^{-9} .

Automatically switch electrodes - the program automatically replaces the electrodes for positivity of array's geometric factor when this option is ON.

The **Inversion** tab defines the inversion parameters setup.



Least-squares inversion contains the options dealing with solution of the inverse problem .

Style is the type of the section parameters reconstruction procedure.

Smoothness constrained is inversion by the least-squares method with using the smoothing operator. In result of this algorithm's using you receive the smooth (without sharp boundaries) and the most stable distribution of parameters. It is recommended in many cases.

$$(A^T W^T W A + \mu C^T C) \Delta m = A^T W^T \Delta f$$

Occam is the inversion by the least-squares method with using the smoothing operator and the contrastness minimization. In result of this algorithm's using you receive the most smooth parameters distribution.

$$(A^T W^T W A + \mu C^T C) \Delta m = A^T W^T \Delta f - \mu C^T C m$$

Marquardt is the inversion by the least-squares method with the regularization by the damping factor. The algorithm allows receiving the model with sharp boundaries. Uncareful using of this inversion modification can lead to receiving of the unstable results or to increase the mean-square error. The best way - to use the **Marquardt** method as correcting after **Smoothness constrained** or **Occam** inversion.

$$(A^T W^T W A + \mu I) \Delta m = A^T W^T \Delta f$$

Occam-Marquardt is the second and third methods combination and allows receiving of the compact structure.

Blocks is the parameters fitting of individual areas. These parameters differ in resistivity or polarizability. The areas with the same parameter are treated as one block. It will be better if you use this algorithm in revision stage of the previous method's results, but formerly you must select the required blocks.

Focused is the inversion by the least-squares method with using the smoothing operator and the object focusing. In result of this algorithm's using you receive the piecewise smooth parameters distribution, that is the model consisting of the areas with constant parameter.

$$(A^T W^T W A + \mu C^T R C) \Delta m = A^T W^T \Delta f - \mu C^T R C m$$

Uncareful using of the focusing inversion's parameters can lead to the divergence and to the receiving of the unstable models.

Quasi-Newton is the special algorithm modification using the simplified calculation method (approximation) of partial derivatives matrix. The convergence of Quasi-Newton method is usually slower - in case of high contrast section is especially.

QN iteration number is the iteration's number of QN method after the iteration with the standard scheme of Jacobian calculation.

Andrew Binley ProfileR is the using of inversion algorithm that had been developed by the doctor Andrew Binley, English geophysicist. The many of described parameters have no

inversion process influence if this option is ON. The mesh is transformed by the next way: in vertical direction -16 nodes, one intermediate node between the adjacent electrodes positions.

Smoothing factor contains the damping factor setup options.

Start value sets the starting value of the damping factor. This value depends of many factors: the Jacobian's condition number, the signal to noise ratio, the number of model parameters. This value is selected by the empirical way. For data with high noise level or for receiving the more smooth distribution, the big values of damping factor are selected: 0.05 - 0.5. The values 0.005 - 0.01 are used for high quality data.

Behavior defines the damping factor's decreasing variant from iteration to iteration. The choice of the quick changing of the damping factor increases the algorithm convergence rate but it can impair the results stability (it occurs when the damping factor has very small values).

Const after iteration stops the modification process of damping factor after you select the iteration number (if this option is on). You must use this option when the algorithm diverges in the last iterations (it occurs when the damping factor has very small values).

The **Data noise** area.

Percentage of noise defines the signal to noise ratio in percent (this parameter is used if **Andrew Binley ProfileR** option is ON). Usually, this parameter is varied from 1 to 5 percents.

Robust weighting scheme you must check ON this option if data contains the high noise level.

Stop criteria area contains the inversion halt criterions.

Iterations the inversion stops if selected iteration number is achieved (if this option is ON).

RMS error the inversion stops if selected RMS level is achieved (if this option is ON).

Reduction when the RMS error increases repeatedly for two sequential iterations (on the selected value, in percents) the inversion terminates (if this option is ON).

The **Focusing** area.

Threshold sets the maximal value of contrastness of adjacent cells. If contrastness of adjacent cells more than selected value then parameters of these cells are not averaged (sharp boundary between cells). The value of this parameter is set by empiric way (from 0.001 to 1). The very small value may cause the divergence of algorithm, and you must increase it. On the other hand, the very big parameter value leads to the more smooth distribution.

Sharpness defines the ratio between the minimization of anomalous object's volume (0) and the construction of piecewise-smooth distribution (1). The value of this parameter is set by empiric way (0.5).



The **Options** tab **contains** additional inversion parameters.

The area **Step-length calculation** contains the options which allow controlling the optimization of length of corrections vector during inversion.

Stop after iteration stops the optimization process after selected iteration (if this option is On). You must use this option if the iteration's result lies in local minimum of solution.

Search number is the number of iterations for step-length optimization (the 2-4 iteration is usually enough).

Step-length limit sets the maximal value of corrections vector. The limitation of step length prevents the very big parameters variation from iteration to iteration (5-10).

Model area contains options dealing with model.

Min resistivity, Max resistivity sets the model parameter's limits for inversion.

Depth smoothing defines the degree of model smoothing with depth, if this option is ON. Since the resolution of the resistivity method decreases with depth, the damping factor used in the inversion least-squares method is normally also increased with each deeper layer. Use a larger value (>1) if the model shows unnatural oscillations in the resistivity values in the lower sections, else (<1).

Smoothness ratio specifies the ratio of smoothness in horizontal and vertical direction. Set this parameter larger than 1 for an area with a strong lateral resistivity variation, but smaller than 1 for a layered earth. Set this parameter to 1.0 if you do not have enough information about the geology of your project site.

Logarithmic norm for most cases, it is better if this option is ON. If the apparent resistivity data contains the negative or zero values the option must be OFF.

Show warnings. The program produces the warnings during the inversion if the option is ON.

User inversion mesh enables the table which allows to unite adjacent cells and to decrease number of parameters in inversion. Check On this option for models with great number of cells.

The table contains three columns: in the first is shown the index of base mesh layer; in the second is set the index of inversion mesh layer; in the third one you must set the number of cells (in horizontally) contained in each inversion mesh cell for given layer. The inversion mesh will be displayed in model editor during inversion mesh editing.

Model cutting angle sets the slope angle for cutting model cells from the left and from the right. Each layer's cutting cells will be united in one.

Use **reference model** sets for using start model as a priory one. When this option is ON, the resulting model is almost the same as starting model.

Electrodes Editor

The editor of electrodes serves for visualization of system of supervision and the measured values. The first tab contains the table allowing to adjust parameters of each measurement. The table contains 9 columns:

ID	Index of measurement
Used	The indicator, whether specifying is used measurement at inversion.
C1	Position of the first source point on a profile. ^
C2	Position of the second source point on a profile.
P1	Position of the first potential electrode on a profile.
P2	Position of the second potential electrode on a profile.
$\rho\alpha$	Value of the measured apparent resistivity.
Res	Value of the measured resistance.
Weight	Weight of measurement.

^ in case of absence of one of electrodes its coordinate is replaced with a symbol *.

Last three columns, in case of need, can be edited with the help of the keyboard. It is not necessary to enter absurd values for apparent resistivity or the resistance. Weights of measurements are set in a range from 0 up to 1.

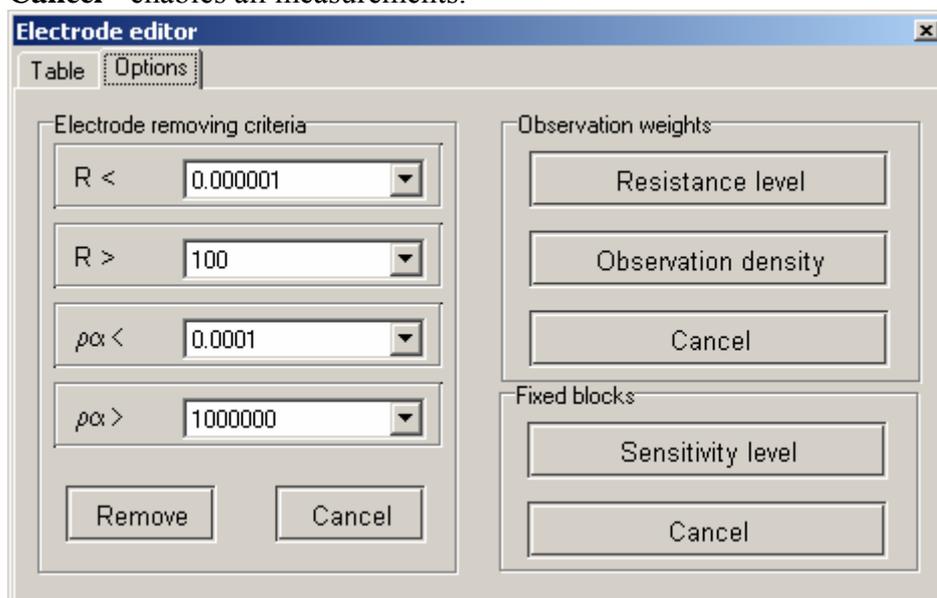
At moving the cursor under the table, positions of electrodes of active measurement are displayed on a pseudo-section or the plan of graphs.

Second tab **Options** contains the options allowing automatically to set weight of measurements or to exclude measurements with abnormal high or low values of data.

Area **Electrode removing criteria** contains criteria of removal of measurements.

Remove - disables the measurements which are not satisfying established criteria.

Cancel - enables all measurements.



Area **Observation weights** contains the options allowing automatically to set weight of measurements.

Resistance level - sets weights of measurements in accordance with a level of the measured resistance.

Observation level - sets weights of measurements in accordance with a level of relative sensitivity of measurements for the given model.

Cancel - sets weights of all measurements as 1.

Area **Fixed blocks**.

Sensitivity level - to fix parameters of those cells, which value of the sensitivity, less than the set level.

Cancel - to release parameters of all cells of model.

Graphics planning

The graphics plan serves to display the apparent resistivity values along the profile as graphic form.

Planning is produced by mouse.

To scale up of some part and/or to drag it the holding mouse click is used. To highlight it the cursor is moved down and right with holding left click. To return to the previous scale the same way is used but the cursor is moved up and left.

If you use the left click in graphic point you can cancel the other graphics, and the electrodes position displays for the active point until you holds click. To edit the measuring values you can drag the graphic point holding right click.

If you use the right click in vertical axis you can run the **Graphics Setup** dialog.

Graphics Setup

This dialog is obtained for making up the graphics interface.

The field **Gradient colors** contains the options that set the gradient color palette for graphics.

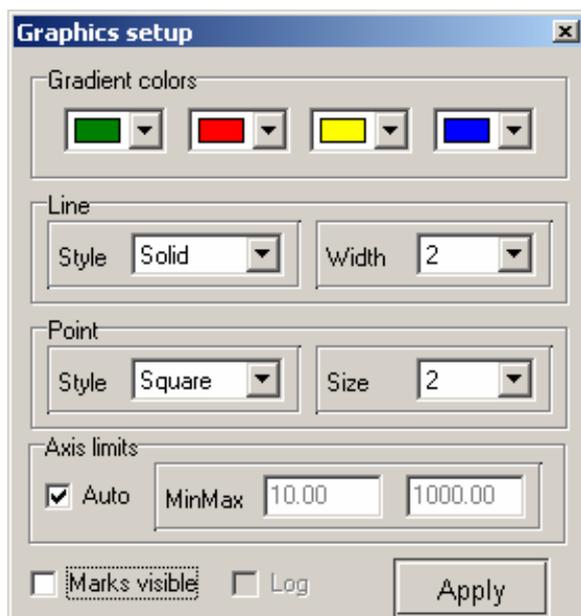
The fields **Line** and **Point** contains the options which set the curve line and point parameters.

The field **Axis limits**.

Auto –the program automatically selects the minimal and maximal values of vertical axis if the option is on (see option **MinMax** described above).

Marks visible runs the subscriber mode for marking graphics.

Log sets the logarithmic scale in vertical (right) axis. This option is valid for the imported data only.



Pseudosection

The pseudosection serves to display the apparent resistivity values in profile as the isolines.

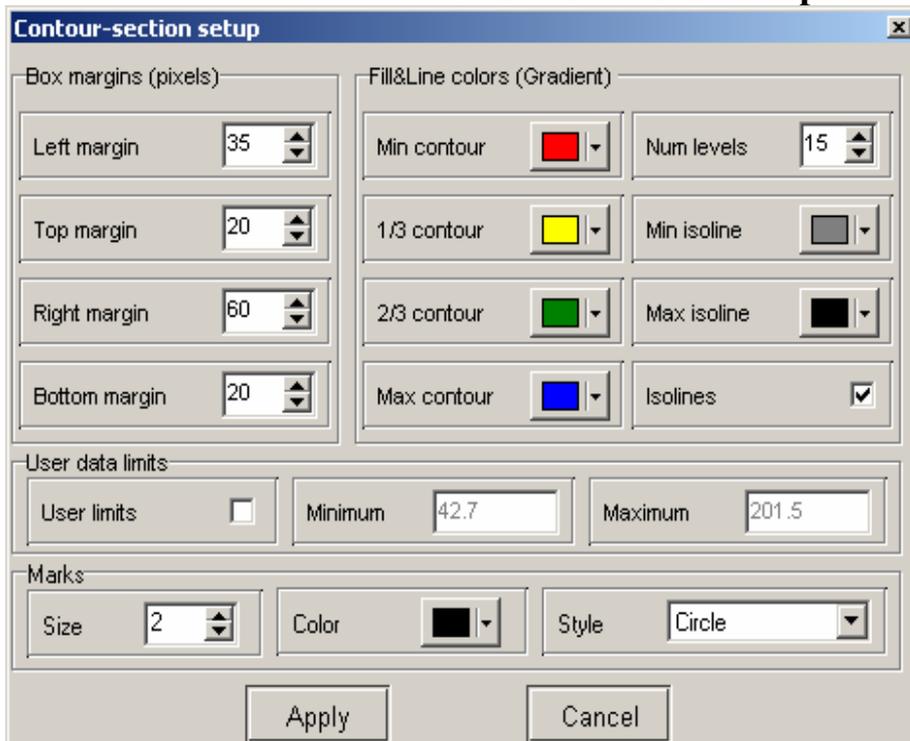
There are the next axes for drawing: in profile measuring coordinate and the apparent depth of soundings. The color gradient sets the ratio between displaying value and color.

You can change size and place the color pallet. Pull it for slider holding the right or left click.

The double click on the object area runs the context Menu:

Log data scale	Uses the logarithmic scale for color bar.
Display grid point	Displays the measuring point marks.
Display ColorBar	Displays the color bar.
Setup	Runs the pseudosection setup dialog.

Contour-section Set Up



This tab serves to setup the parameters of pseudosection.

Box margins

The field [***Left margin***] sets the margin (in pixels) of picture from window left edge.

The field [***Right margin***] sets the margin (in pixels) of picture from window right edge.

The field [***Top margin***] sets the margin (in pixels) of picture from window top edge.

The field [***Bottom margin***] sets the margin (in pixels) of picture from window bottom edge.

Fill Line colors

Next options [***Min contour***], [***1/3 contour***], [***2/3 contour***] and [***Max contour***] set the interpolation array of colors from [***Min contour***] to [***Max contour***] via [***1/3 contour***] and [***2/3 contour***]. This color desk is used to paint the space between the neighbor isolines.

The field [***Num levels***] defines the number of isoline section. The isoline section is set by uniform linear or logarithmic step in depending of data type.

Next options [***Min isoline***] and [***Max isoline***] set the interpolation array from [***Min contour***] to [Max contour]. This color desk is used to paint the isolines.

Option [***Isolines***] sets whether it paints the isolines.

User data limits

Option [*User limits*] sets whether it uses the max or min values or to use the settings of fields [*Minimum*] and [*Maximum*] when you set isoline sections.

The field [*Minimum*] sets the minimum value when you set isoline sections.

The field [*Maximum*] sets the maximum value when you set isoline sections.

The field [*Marks*] contains the options that define the pseudosection point's graphic parameters.

Model Editor

Model editor serves to change the cell parameters with help of mouse. In the right side of editor field the color bar is laid. It links the color and resistivity values. To select the current value you can do the right click on the color bar, and this value will display under it.

You can change size and place the color pallet. Pull it for slider holding the right or left click.

The handling with the model cells is like as the pixels editing in the raster graphic editor. When you move the cursor both the parameters the coordinates of active cell display in status panel in the bottom of program main window. The active cell is surrounded by the rectangle-cursor.

The selected or fixed cell is marked by point in the middle of cell.

The double click on the model editor different areas runs the context Menus:

In the top area	Display model mesh	Displays the model mesh
	Display objects border	Displays the objects border
	Display objects border	Displays the color bar
	Setup	Runs the setup dialog of model parameters
Color scale	Set minimum	Sets minimum value of color bar
	Set maximum	Sets maximum value of color bar
	Set incremental factor	Sets incremental factor that is the minimum and maximum value of color bar in depending of half space value
	Automatic	Sets automatically the minimum and maximum value of color bar
	Log scale	Sets the logarithmic scale in color bar
	Set halfspace value	Sets half space value
	Set cursor value	Sets current value of parameter
Vertical axis	Log scale	Sets the logarithmic scale in vertical axis
	Set maximum	Sets the bottom layer depth value

	Redivide	Sets the same thickness of layers for all model layers in given scale
	Thick mesh	Deletes the each second node in vertical grid
	Thin mesh	Adds the intermediate nodes in vertical grid
Horizontal axis	Redivide	Sets the same width of cells situated between the uncial electrode positions
	Thick mesh	Deletes the each second node in horizontal grid(if the electrode misses in given node)
	Thin mesh	Adds the intermediate nodes in horizontal grid

The right click on the model editor area runs the context Menu with the next options:

Display cell setup	Runs the cell setup dialog
Cell to cursor value	Sets the value in active cell as the cursor value
Edit mode	Runs the Edit mode
Selection\Free form selection	Highlights the row of cells in edit field by mouse.The field is limited by User.
Selection\Rectangular selection	Highlights the row of cells in edit field by mouse. The field is like as the rectangular form.
Selection\Elleptical selection	Highlights the row of cells in edit field by mouse.The field is like as the elleptical form.
Selection\Magic wand	Highlights the row of cells in edit field by mouse. The field is like as the active cell with the adjacent ones which have the parameters close to its parameter. The closeness range is set in setup dialog.
Selection\Remove selection	Removes the selection
Mesh options\add column /row	Adds the new vertical or horizontal boundary. The new boundaries display in selected point by clicking in.
Mesh options\remove column /row	Removes the selected vertical or horizontal boundary
Mesh options\resize column /row	Resizes the thickness column or row by mouse.
Clear model	Clears the current model

Cell parameter set up dialog

The dialog serves to select the cell parameters or to highlight one.

Value sets the cell parameter value

Fixed fixes or frees the cell parameter

Min value, Max value sets the size of changing of cell parameter

Apply to selected sets given settings for all highlighting cells if this option is on.

Modeling

Use the mouse for modeling

Left click in selected cell to change its parameter over the cursor one.

To zoom up the some part or to displace it you must click in with holding 'ALT'.

To highlight this part you must move the cursor down and to the right holding left click.

To return back to the previous scale you must move the cursor up and to the left holding left click.

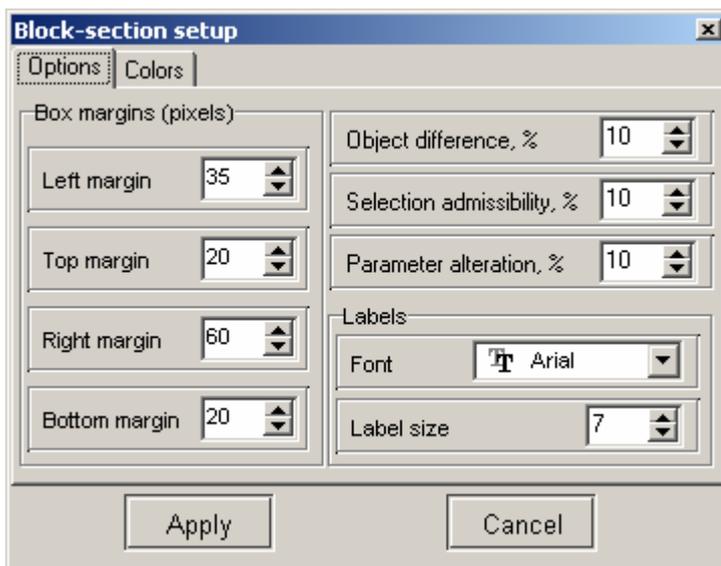
Left click in selected cell together with 'SHIFT' to increase the parameter value.

Right click in selected cell together with 'SHIFT' to decrease the parameter value. The percent of the value changing is set in Model set up dialog. If the active cell is highlighted the all above described is valid for the all highlighted cells.

To displace the highlightings you must click in with holding 'CTRL'. The content of these cells are copied in the new place if you displace cells with left click, and the content is cut and pasted if you displace cells with right click.

Model's Parameter Set Up

Options -This tab serves to setup of section parameters.



Box margins

The field [*Left margin*] sets the margin (in pixels) of picture from window left edge.

The field [*Right margin*] sets the margin (in pixels) of picture from window right edge.

The field [*Top margin*] sets the margin (in pixels) of picture from window top edge.

The field [*Bottom margin*] sets the margin (in pixels) of picture from window bottom edge.

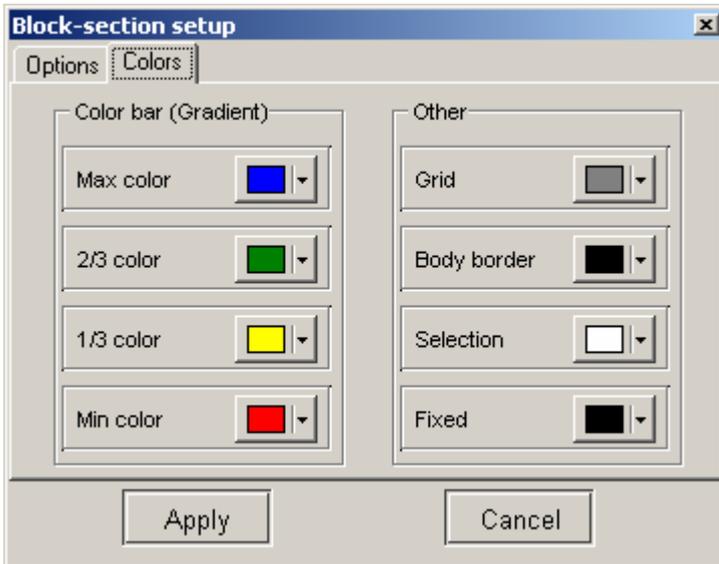
Object difference sets the maximal value of the adjacent cell parameter difference which exceeding leads to the boundary line is drawing between ones.

Selection admissibility sets the threshold of the adjacent cell parameter difference which defines the unit cell objects that highlighted together in Magic Wand-mode.

Parameter alteration sets the value of the selected cell parameter increment (in percent) in Modeling (Edit mode with 'Shift' holding).

Labels sets the font type for the all program objects.

The tab **Colors**



The field **Color bar**

Min color, **1/3 color**, **2/3 color**, **Max color** sets the color interpolation sequence which defines the depending between the model parameter value and the certain color.

The field **Others**

Body border sets the color of boundary line between the adjacent cells if the **Parameter alteration** value is exceed.

Grid sets the color of mesh.

Selection sets the color of selected cell mark.

Fixed sets the colors of fixed cell mark.