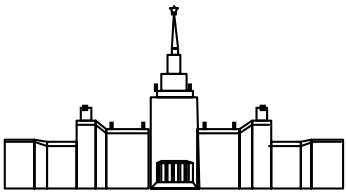


MOSCOW STATE UNIVERSITY
GEOLOGICAL FACULTY
DEPT. OF GEOPHYSICS

GEOSCAN-M Ltd.

WIN!

With IPI2Win

IPI2Win v. 2.1, IPI_Res2, IPI_Res3

User's Guide

Moscow - 2001

Contents

Introduction

Product description

IPI2Win is designed for automated and interactive semi-automated interpreting of vertical electric sounding and/or induced polarization data obtained with any of a variety of the most popular arrays used in the electrical prospecting. IPI2Win is to be run on an IBM PC -compatible personal computer under Window ’95/’98/NT operating system.

System requirements

IPI2Win can be run on any computer with Window ’95/’98/NT operating system. Monitor should be in 256 colors mode or higher.

Copyright

IPI2Win Overview

IPI2Win is designed for vertical electrical sounding and/or induced polarization data curves 1D interpreting along a single profile. It is presumed that a user is an experienced interpreter willing to solve the geological problem posed as well as to fit the sounding curves. Targeting at the geological result is the specific feature distinguishing IPI2Win among other popular programs of automatic inversion.

The special attention is paid to the user-friendly interactive interpreting. Due to handy controls the interpreter is able to choose from a set of equivalent solutions the one best fitting both geophysical data (i. e. providing the least fitting error) and geological data (i. e. geologically sensible resistivity cross-section). Comparing various concepts of the geological structure along the surveyed observation line rather than independent formal sounding curves inversion is the approach implemented in IPI2Win. This approach provides the opportunity to use the *a priory* geological data and extract information to the greatest possible extent in the complicated geological situations.

Getting started

Installing IPI2Win

IPI2Win is distributed on a single 3.5-inch floppy-disk. The set also includes this manual and a protective plug.

To install IPI2Win on your computer insert floppy-disk into the disk drive and run the file INSTALL.EXE by any appropriate means. The command line must be as follows:

```
> drive_letter: INSTALL
```

Type the path to the location where IPI2Win should be installed in the *IPI2Win Setup* window. The path can also be pointed out using the *Browse...* button of that window. After this, click the *Next* button of the window. Read the message and be sure that the program is to be installed to the desired location. If so, click the *Install* button of the window. To change the target location, click the *Back* button of the window. Restart your computer when the installation is finished.

The *IPI2Win* group with *IPI2Win* and *Uninstall IPI2Win* items will appear in the *Programs* section of the Windows'95 main menu.

IPI2Win can be installed on any number of computers. Only one copy at a time can be used as a protective plug is needed to run IPI2Win.

The protective plug must be stuck into the parallel (printer) port of the computer where IPI2Win is to be run. To do this, turn off the power supply of the computer and the printer (if the latter is connected to the computer) properly, detach the printers' parallel data cable from the computer (if the latter is connected to the computer), stick the protective plug into the parallel port of the computer and fasten it, then stick the printers' parallel data cable into the plug (if needed) and fasten it. Then turn on the power supply of the computer and the printer.

Uninstalling IPI2Win

To uninstall IPI2Win choose the *Uninstall IPI2Win* item from the *IPI2Win* group of the *Programs* section of the Windows'95 main menu.

Running IPI2Win

Using the created icon is the recommended way of running IPI2Win.

WARNING! Make sure that the protective plug is stuck into the parallel (printer) port of the computer where IPI2Win is run.

If no protective plug is found on the computer, the *Error* window is displayed, containing the message *«This is a protected program»*. No further operation is then available. IPI2Win is terminated after clicking the *OK* button of the *Error* window.

IPI2Win Controls

This section contains a brief description of IPI2Win menu items (those of the menu bar are underlined and italicized) with the corresponding hot-keys (in the rectangular brackets [...]) and toolbar buttons (in the figured brackets {...})

File

Open [F3],{ New profile} opens data file.

Reopen displays the list of recently opened data files to choose one to open.

New VES point [Ctrl-Alt-N], {Make new VES point  } displays the table to enter data (apparent resistivity or voltage) for a new sounding point to insert into the opened or new data file.

Add file, {Add data file  } appends data from another file to the currently opened profile.

Save [F2], {Save  } saves current data and result files to the same location

Save as... saves current data and result files to another location

Export displays the list of data formats to choose the mode of saving IPI data

Info... [Ctrl-I] {Profile comments  } displays *Information* window to deal comments, VES names, topography

Print section prints the cross-section(s) displayed in the *Pseudo cross-section and resistivity cross-section* window (this window will be referred to as the cross-section window)

Print curves [Ctrl-P] prints the curve currently displayed and the table of the cross-sections parameters for the corresponding sounding point

Print setup... displays *Print setup* window to change printer and/or page layout

Preview  displays *Print preview* window to see how the active window will be printed

Exit [Alt-X] {Exit  } quits IPI2Win

Edit

Undo [Alt-BkSps] {UnDo  } discards the latest change of the model.

Restore [Ctrl-F7] restores the model for the sounding point (i. e. discards all the changes of the latest model editing session for the point)

Copy [Ctrl-Ins] {Copy  } stores the current model properties and the bitmap image of the current window in the Clipboard

Cut model [Shift-Del] {Cut  } clears current model and stores it in the Clipboard

Paste model [Shift-Ins] {Paste  } applies model properties previously stored in the Clipboard to the current sounding

Copy curve stores theoretical curve (standard spacings and corresponding apparent resistivity values) in the Clipboard; items stored can be pasted into a spreadsheet

Edit file [Ctrl-E] {Edit file  } runs Notepad and opens the current data file in it

Edit curve [F4] {Edit field curve  }displays *Edit field curve* window for manual data input/correction

Copy all model [Ctrl-A] stores model properties for all sounding points in the clipboard; items stored can be pasted into a spreadsheet or a word processor

Delete all results clears model parameters for all VES points currently displayed

Copy model&curve stores model properties as the pseudo-log chart and field curve spacings and apparent resistivity values in the Clipboard; items stored can be pasted into a spreadsheet

Copy curve stores the synthetic curve (standard spacings and apparent resistivity values in the Clipboard; items stored can be pasted into a spreadsheet

Copy app. resist. only stores a bitmap image of the pseudo cross-section in the Clipboard without axes and labels

Synthetic curve [Ctrl-T] replaces the field sounding curve at the current sounding point with the theoretical curve for the model with current properties

Point (also available via context menu: click the mouse right button on the curve window)

Next [Ctrl-Left] displays the sounding curve and model properties for the next sounding point of the current data file

Previous [Ctrl-Right] displays the sounding curve and model properties for the previous sounding point of the current data file

First [Home] displays the sounding curve and model properties for the first sounding point of the current data file

Last [End] displays the sounding curve and model properties for the last sounding point of the current data file

Inversion [Space] {Inversion  } implements the automated interpretation for the current sounding curve using current model parameters as the initial model

Profile inversion [Ctrl-F3] implements the automated interpretation for all sounding curves of the currently opened profile using current model parameters for each point as the initial model

Profile interpolation [Shift-Ctrl-F3] implements the automated interpretation for the all the uninterpreted sounding curves of the currently opened profile using model parameters for other points as the initial model

New model [F7] {New model  } implements the automated interpretation for the current sounding curve using the least number of layers principle

Option... displays *Options* window to set the fitting accuracy for using the least number of layers principle

Profile new model [Alt-F3] implements the automated interpretation for the all sounding curves of the currently opened profile using the least number of layers principle

Model (also available via context menu: click the mouse right button on the model window)

Chg table [Ctrl-T] switches the modes of the model parameters table (layers in line/column)

Fixing [Ins] fixes the highlighted model parameter for further automated interpreting

Split [Ctrl-N] {Split the layer  } splits the current layer in two with parameters depending on those of initial layer

Join [Ctrl-Y] {Join two layers  } joins the current layer with the underlying one into one layer with parameters depending on those of initial layers

Minimum sets the least possible (within the equivalence limits) value for the selected model parameter

Maximum sets the greatest possible (within the equivalence limits) value for the selected model parameter

Section (also available via context menu: click the mouse right button on the section window)

Zoom in [Alt-F5] increases the horizontal scale of the cross-section window

Zoom out [Shift-F5] decreases the horizontal scale of the cross-section window

All profile [Ctrl-F5] displays the whole profile in the cross-section window

More depth [Gray -] decreases the vertical scale of the cross-section window

Less depth [Gray +] decreases the vertical scale of the cross-section window

Options... [Ctrl-F1] {  } displays the *Section options* window for customizing *cross-section* window

Pseudo-section displays apparent the resistivity pseudo cross-section only in the *cross-section* window

Resistivity section displays the resistivity cross-section only in the *cross-section* window

Both sections displays both apparent resistivity pseudo cross-section and resistivity cross-section in the *cross-section* window

VES/IP [F9], {Section mode  } switches apparent resistivity/apparent chargeability pseudo cross-sections in the *cross-section* window (in VES-IP mode only)

Lin/Log scale [Ctrl-Z] switches the linear/logarithmic scale for the apparent resistivity pseudo cross-section vertical axis

Horizontal mirror reverses the order of sounding points in the *cross-section* window

Transformations ▶

No transformation {No transformation  } restores apparent resistivity pseudo cross-section

Accuracy {Fitting error pseudo section  } displays the curve fitting error for all spacings of all curves in the form of pseudo cross-section

V-transformation {Vertical derivative transformation  } displays the pseudo cross-section of the apparent resistivity/chargeability derivative by the spacing

H-transformation {Horizontal derivative transformation  } displays the pseudo cross-section of the apparent resistivity derivative/chargeability by the sounding point coordinate on the profile

Options

displays the *Options* window for customizing IPI2Win

Window

Cascade cascades opened windows in a standard Windows fashion

Tile tiles opened windows in a standard Windows fashion

IPI_V6 [Ctrl-6] arranges opened windows like in the IPI v. 6 for DOS

IPI_V7 [Ctrl-7] arranges opened windows like in the IPI v. 7 for DOS

IPI_V8 [Ctrl-8] arranges opened windows in the IPI2Win default fashion

Help

Contents {Help contents  *}*displays the help contents window on the current topic

Search for help on... displays the keyword search window

How to use help displays the help on help window

About displays the developers' information and the program mode and data restrictions

Available through the Toolbar only:

{*Conductance* {S(H)  } displays the *Conductance* window to calculate the resistivity cross-section conductance up to a given depth and to create a plot along the profile

{Edit mode  } displays the *Edit mode* floating toolbar to select the mouse action when editing the model in the cross-section window

Menu contents and actions may slightly vary depending on the IPI2Win release

Data managing

Understanding data managing

To start the process of interpreting IPI2Win needs a data file of the certain format containing the information on the measurement system and apparent resistivity (and apparent chargeability in the VES-IP mode) values for desegmented curves (*.dat) or for segmented curves (*.dtg). A dtg-file may also contain potential difference and electric current values for Schlumberger and half-Schlumberger arrays. A dtg-file can be used with resistivity data (VES mode) only.

If a dtg-file contains potential difference values, apparent resistivity values are calculated and saved to a dat-file with the same name.

If the dtg-file contains segmented curves, these curves are desegmented automatically by parallel shifting all the segments to the level of the rightmost segment.

The dat-file created is used for the interpreting and no further alteration of the field data in the dtg-file takes place in the course of IPI2Win running.

The results of interpreting for a certain dat-file are stored in the result file (*.res) with the same name.

Only one data file can be opened at a time. Usually one profile of sounding points is stored in one file.

The users of multi-electrode arrays shall keep in mind that a sounding curve is regarded as the data element in IPI2Win. Before using IPI2Win the data must be presented as a set of sounding curves for one of the arrays available in IPI2Win. Converters to the dat-file format are freely available from the Grid files (Surfer by the Golden Software, Inc.) files. A converter from the dat-file format to the Loke 2D inversion program format is also freely available.

WARNING! If a dat-file is copied or moved elsewhere, the corresponding res-file must be placed to the same new location as well. Deleting a res-file will result in loosing the interpreting results for the corresponding dat-file.

Specifying the data file

To specify the data file the *Open data file* window is used. Standard Windows navigation capabilities are used to select the disk and the folder containing the desired file as well as its name. Besides that it is possible to pick up one of the recently opened files by choosing the ***File**, Reopen* menu item, and then by choosing the file name from the list or from the drop-down list near the {*New profile*} button in the toolbar.

To specify the type (dat, dtg or both) choose *IPI-format*, *DTG-format* or *All IPI formats* items respectively from the *File type* drop-down box.

WARNING! If in the local network, it is possible to open a data file from another computer. Before this, be sure, that both read and write access is provided for the network disk on another workstation.

Data file formats

Dat-file format

Dat-files is a plain text file with DAT extension and definite structure. Format of data in each line except 5-th may be arbitrary.

1-st & 2-nd lines. any text.

3-rd line: three integers and one character, delimited by spaces.

The 1st integer (N_{pt}) specifies the total number of sounding points in the file (up to 400)

The 2nd integer is 0 if the file contains VES data (VES mode) or 1 if the file contains VES-IP data (VES-IP mode)

The 3rd integer ($N_{spc\ max}$) specifies the greatest possible number of values at a sounding point, that is the greatest number of spacings (up to 50).

The character is one of the following: S, V, W, D, N, U, L, Z, B - and specifies the array type: S, - Schlumberger and dipole equatorial, V, W, N - Wenner, D - Dipole axial, U - pole-pole two-electrode array AM, L - array with linear current electrodes, Z - vertical array for river survey, B - bottom array for river survey (Schlumberger array at the bottom of the 1st layer).

4-th line. A list of spacings, containing $N_{spc\ max}$ space-delimited items. The spacings should be ordered from the smallest to the greatest. A spacing means:

for Schlumberger array - the half-distance between the current electrodes;

for the half-Schlumberger array - the distance between the current electrode and the center of the measurement line;

for Wenner array - the half-distance between the current electrodes (V) or one third of distance between the current electrodes (W), or [Wenner β] (N);

for the Dipole axial array - the distance between the centers of current and measurement lines.

5th line: up to 10characters beginning from 1st column - the name of the current sounding point.

6th line: VES mode: one integer - the number of values apparent resistivity at the current sounding point N_{spc_rho}.; VES-IP mode: two space-delimited integers - the number of apparent resistivity values at the current sounding point N_{spc_rho} and the number of apparent chargeability values at the current sounding point N_{spc_eta} Neither N_{spc_rho} nor N_{spc_eta} should exceed $N_{spc\ max}$ value.

7th line: A list of apparent resistivity values, containing N_{spc_rho} space-delimited items. The items order in the list should correspond that of spacings.

8th line (VES-IP mode only): A list of apparent chargeability values, containing N_{spc_eta} space-delimited items. The items order in the list should correspond that of spacings.

Lines from 5th to 7th (VES-IP mode - from 5th to 8th) should be repeated N_{pt} times, three (VES-IP mode - four) lines for each sounding point.

Sounding points should be ordered in the same sequence as at the observation line.

Dtg-file format

Dtg-file is a plain text file with DTG extension and definite structure. Format of data in each line except 5-th may be arbitrary.

1-st & 2-nd lines. any text.

3-rd line: five integers and one character (probably immediately followed by '_' character), delimited by spaces.

The 1st integer (N_{pt}) specifies the total number of sounding points in the file

The 2nd integer is 0 usually (is introduced for compatibility with the data files for earlier DOS version of the program)

The 3rd integer ($N_{spc\ max}$) specifies the greatest possible number of values at a sounding point, that is the greatest number of spacings.

The 4th integer (N_{segm}) specifies the number of overlaps of segments in the curve, that is the number of measurement lines N_{mn} - 1. N_{segm}=0 for non-segmented curve (one measurement line), N_{segm}=1 for a curve with one overlap of segments (two measurement lines), etc.

The 5th integer (K_D) specifies the type of data.

K_D=0 if the file contains apparent resistivity values.

K_D=3 and K_D=4 if the file contains potential difference values and values of non-stabilized current (separate current value for each measurement) for half-Schlumberger (3 electrodes) and Schlumberger (4 electrodes) respectively.

K_D=-3 and K_D=-4 if the file contains potential difference values for half-Schlumberger (3 electrodes) and Schlumberger (4 electrodes) respectively, assuming the current to be stabilized (equal for all measurements).

WARNING! IPI2Win is capable of calculating apparent resistivity for Shlumberger and half-Schlumberger arrays only. For Wenner, dipole axial and pole-pole arrays apparent resistivity values should be calculated by other means.

The character is one of the following: S, Q, W, D, U or L - and specifies the array type: S - Schlumberger, V, W - Wenner, D - Dipole axial, U - pole-pole two-electrode array AM, L - array with linear current electrodes. To specify that the curve segments overlap at one spacing, the '_' character is placed immediately after the letter; otherwise overlapping at two consequent spacings is assumed.

4th line: For a segmented curve - a list of spacings numbers (NOT values), on which overlaps start, containing N_{segm} space-delimited items. For a non-segmented curve (N_{segm}=0) the 4th line is blank (but NOT skipped).

5th line: a list of measurement lines lengths, containing N_{segm}+1 space-delimited items.

6th line. A list of spacings, containing $N_{spc\ max}$ space-delimited items. The spacings should be ordered from the smallest to the greatest. A spacing means:

for Schlumberger array - the half-distance between the current electrodes;

for the half-Schlumberger array - the distance between the current electrode and the center of the measurement line;

for Wenner array - the half-distance between the current electrodes (V) or one third of distance between the current electrodes (W);

for the Dipole axial array - the half-distance between the centers of current and measurement lines.

7th line: if K_D=-3 or K_D=-4 (stabilized current), the 7th line contains a value of the current. Otherwise it is skipped and sounding points description follows from it immediately after the 6th line.

8 (7)th line: up to 8 characters beginning from 1st column - the name of the current sounding point.

9 (8)th line: one integer - the number of values at the current sounding point N_{spc}. It should not exceed $N_{spc\ max}$ value.

10 (9)th line: A list of apparent resistivity or potential difference values.

(10)th line A list of current values.

The items order in the lists should correspond to that of spacings.

The number of items in potential difference and current values list will exceed N_{spc} for a certain value as two values (for smaller and for greater measurement line) correspond to each overlap spacing. The values for a given overlap spacing follow immediately one another; the first of them corresponds to the smaller measurement line.

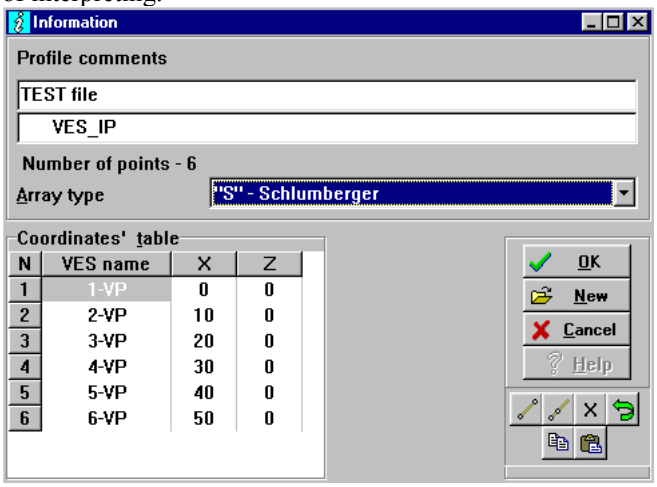
Lines concerning sounding point should be repeated N_{pt} times, three or four lines for each sounding point.

Sounding points should be ordered in the same sequence as at the observation line.

Specifying topographical features

Identifying the data

After opening a data file the *Information* window appears. This window can also be opened in the course of interpreting.



The *Information* window

The *Profile comment* field contains the two first lines of the opened file. It is possible to edit their contents here. It will be saved to the same file afterwards on exiting IPI2Win or on saving the file.

Array type for the opened file can be changed by choosing the desired type from the *Array type* drop-down list.

If the file was opened by mistake it is possible to open another file by clicking the *New* button in the *Information* window.

Specifying point location

The information concerning the sounding points' names, locations and altitudes is displayed in the table. Values can be typed in the table cells. It is possible to use {Copy} and {Paste} buttons of the *Information* window when editing the table cells contents as well as standard Window shortcut keys [Ctrl-Ins] and [Shift-Ins]. Any editing operation can be undone by pressing the {Undo} button of the *Information* window.

The current names of sounding points from the opened file are listed in the *VES name* column of the *Coordinates table* field. The names can be edited by typing new VES name in the selected cell of the column.

The sounding points coordinates along the observation line are listed in the *X* column of the *Coordinates table* field. By default the first point's coordinate is assumed to be 0 and all other points are placed at the distance of 10 meters between the neighboring points. These values are coordinates in the «plain mathematical» sense (NOT distances measured on the uneven surface).

The coordinates can be edited by typing new coordinate value in the selected cell of the column. If points are named by their coordinates, the names can be transformed to the coordinates by clicking {*X-coord. from VES names* X} button in the *Information* window.

It is also possible to fill the cells of the selected range within the *X* column using extrapolation or interpolation. To extrapolate coordinates: 1) type the coordinates of the 1st and the 2nd points in the corresponding cells of the desired range; 2) select the desired range; 3) click the {*Extrapolation* } button in the *Information* window. To interpolate coordinates: 1) type the coordinates of the 1st and the last points in the corresponding cells of the desired range; 2) select the desired range; 3) click the {*Interpolation* } button in the *Information* window.

Specifying point altitudes

The sounding points altitudes are listed in the *Z* column of the *Coordinates table* field. By default all the altitudes are assumed to be 0.

The altitude of a point can be edited by typing new value in the selected cell of the column. It is also possible to fill the cells of the selected range within the *Z* column using extrapolation or interpolation.

To extrapolate altitudes: 1) type the altitudes of the 1st and the 2nd points in the corresponding cells of the desired range; 2) select the desired range; 3) click the {*Extrapolation*  } button in the *Information* window. To interpolate altitudes: 1) type the altitudes of the 1st and the last points in the corresponding cells of the desired range; 2) select the desired range; 3) click the {*Interpolation*  } button in the *Information* window.

Saving and discarding changes

To accept the entered topographical information click the *OK* button in the *Information* window.

To discard all the changes in the topographycal information click the *Cancel* button in the *Information* window.

To discard all the changes in the topographycal information without closing the *Information* window click the {*UnDo*} button in the *Information* window.

WARNING! Once entered, all topographical information on sounding points of a certain file is stored in the file with the same name and DPR extension; if dat-file is copied or moved elsewhere, dpr-file must be placed to the same new location as well. Deleting dpr-file will result in loosing the topographical information concerning the corresponding dat-file.

Data alteration

Data correction

The apparent resistivity (VES-IP mode: and/or apparent chargeability) values of the sounding curve displayed in the curve window can be edited if needed. To edit the displayed curve press the [F4] key, choose the *Point*, Edit field curve menu item or click the {*Edit field curve*  } button on the toolbar. The curve (VES-IP mode: - both resistivity and chargeability curves) will be displayed in the *Edit field curve* window along with the table of spacing and apparent resistivity (VES-IP mode: and chargeability) values.

To change an apparent resistivity value on a spacing drag the corresponding circle, marking the data point, to the appropriate position with a mouse. It is also possible to select the corresponding cell in the table and type a new apparent resistivity value in it. When editing the curve is finished, use the horizontal scrollbar of the *Edit field curve* window to select another curve to edit. Click the *OK* button of the *Edit field curve* window to accept all the changes for all the curves edited or the *Cancel* button of the *Edit field curve* window. The latest change can be discarded by clicking the {*UnDo*  } button of the *Edit field curve* window.

It possible to copy the apparent resistivity values of the current curve to the Clipboard by clicking the {*Copy*} button of the *Edit field curve* window. To replace the apparent resistivity values for the current curve with those previously copied, click the {*Paste*} button of the *Edit field curve* window.

The scrollbar in the *Information* window can be used to start editing the next or previous sounding curve without closing the *Information* window.

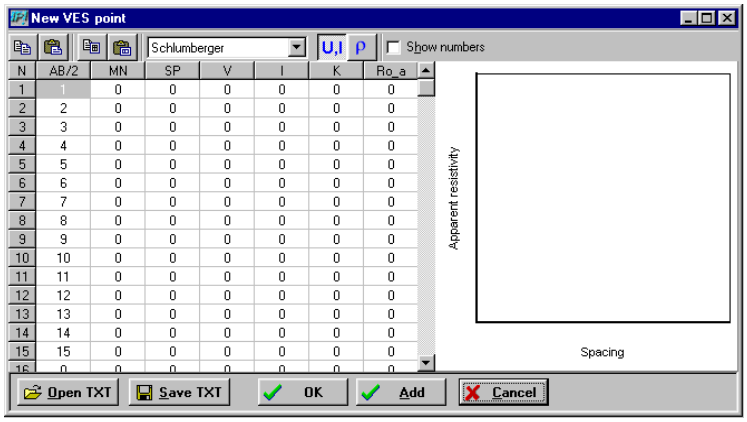
WARNING! After editing the curves, new apparent resistivity values will be saved to the same file. The old apparent resistivity values will be stored in the file with the same name and BAK extension. The bak-file will be overwritten at the next opening the corresponding dat-file.

Creating a profile of several files

To create a profile of several dat-files, open the first of them (the one containing the curves with the least coordinates). Then choose the *File, Add file* or click the {*Add new data*} button in the toolbar and open the next desired file. The curves from it will be added to the profile after its last point.

Entering data

The dtg-file is generally created using the external text editor (i. e. Windows Notepad). IPI2Win internal utility for creating data file is run by choosing the *File, New VES point* menu item, or by clicking the {Make new VES point} button in the toolbar, or by pressing the [Ctrl-Alt-N] key. The *New VES point* window will appear.



The *New VES point* window

The apparent resistivity curve (VES-IP mode - and apparent resistivity curve) is displayed in the right part of the window.

The left part of the window is a table of field data, each line represents a spacing. The columns of the table are spacings (*AB/2* column), measurement line length (*MN*), apparent chargeability (*SP*), voltage (*U*), current (*I*), coefficient (*K*), apparent resistivity (*Ro_a*). Spacing and measurement line length must be typed into the correspondent cells of the table. To enter voltage, current and apparent chargeability, click the *Input SP, U, I* button of the window, then type the values in the corresponding cells. To enter apparent resistivity, click the *Input app. resistivity* button of the window, then type the values in the corresponding cells. When editing the table, one can use the {*Copy*} and {*Paste*} buttons of the window. It is also possible to create the table of the same structure in some spreadsheet, store it in the Clipboard and then paste into the table by clicking the {*Paste table*} button of the window. The table from the external spreadsheet can also be saved as a text file, which can be imported into the table clicking the {*Open TXT*} button of the window

The table contents can be stored in the Clipboard by clicking the {*Copy table*} button of the window. The stored items can be pasted then into a spreadsheet or word processor. The table contents can also be saved as the text file by clicking the {*Save TXT*} button of the window.

The array type must be selected from the *Array* drop-down list of the window. For the meaning of spacing for different array types see the «Dat-file structure» paragraph.

After all the data are entered, click the {*Add*} button of the window to append the curve to the currently opened file or the {*OK*} button of the window to start creation of the new data file. In any case, *Save as...* window will be displayed, where the file name must be pointed out or typed in the *File name* text box.

Viewing data

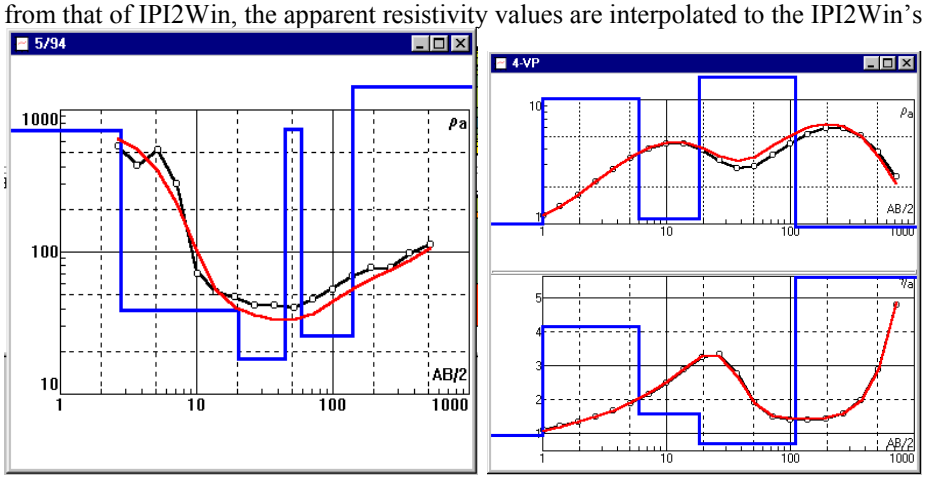
Viewing curves and models

The sounding curve for a certain point is displayed in the curve window titled with the sounding point name. The point name is duplicated in the *Name of VES location* field of the status line immediately below the toolbar. Only one curve can be displayed at a time. The position of the sounding point on the profile is marked by a vertical line on the cross-sections in the cross-section window.

The field values of the apparent resistivity are marked by circles. To switch displaying the circles on/off click the right mouse button on the curve window and choose the *Marks* item from the context menu. The curve itself is presented by a black line, which is a smoothing spline on the field values. The curve is plotted in the logarithmic scale for both spacing and apparent resistivity axes. The number of the orders on either of the axes is determined automatically, so the scale of the curve plot may vary at the different sounding points.

To proceed to the next (previous) sounding point use the scroll bar in the status line or press [Ctrl-Right] ([Ctrl-Left]) key. It is also possible to click a desired sounding point on the pseudo cross-section or on the resistivity cross-section in the *cross-section* window.

WARNING! The set of spacing values is fixed within IPI2Win. If the actual set of spacing values differs from that of IPI2Win, the apparent resistivity values are interpolated to the IPI2Win's spacing grid.



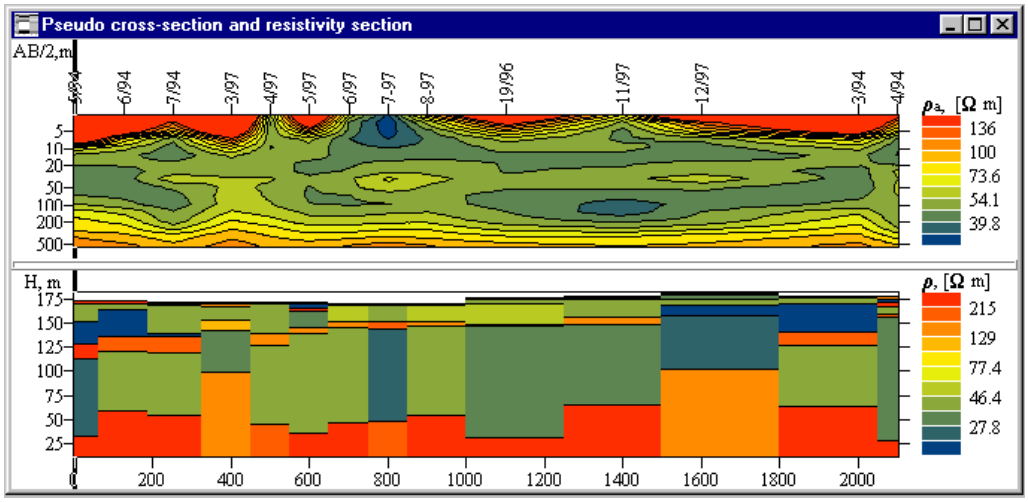
The *Curve* window (VES mode - left, VES-IP mode - right)

Viewing cross-sections

Overview

The pseudo cross-section of a specified value and/or resistivity cross-section are displayed (VES-IP mode: or chargeability cross-section) in the *Pseudo cross-section and resistivity cross-section* window, the latter below the former in the equal horizontal scale. The top horizontal ruler represents the names of the sounding points, while the bottom horizontal ruler represents the coordinates of the sounding points. Vertical line marks the sounding point for which the sounding point is displayed in the curve window. Color scale columns are displayed besides the cross-sections, separately for the apparent resistivity (chargeability) pseudo cross-section and resistivity (chargeability) cross-section. The following values can be displayed in the form of the pseudo cross-section: apparent resistivity (by default); apparent chargeability (VES-IP mode only); fitting error for all spacings of all curves; apparent resistivity derivative by the spacing; apparent resistivity derivative by the sounding point coordinate on the profile.

It is possible to alter the ratio of pseudo cross-section and resistivity (chargeability) cross-section by dragging the divider in the *cross-section* window. To view the pseudo cross-section or the resistivity (chargeability) cross-section only choose the *Section, Pseudo-section* or, respectively, the *Section, Resistivity section* menu item. Choose the *Section, Both sections* menu item to restore the initial cross-section window appearance.



The *cross-section* window

In VES-IP mode, to switch between apparent resistivity and apparent chargeability pseudo cross-section choose the *Section, VES/IP* menu item, or click the {Section mode} button in the toolbar, or press the [F9].

It may be sometimes useful to display the sounding points in the reversed order. To do so choose the *Section, Horizontal mirror* menu item. Using mirroring, mind that on saving the mirrored profile the present sounding points order will be saved.

Scaling the cross-sections

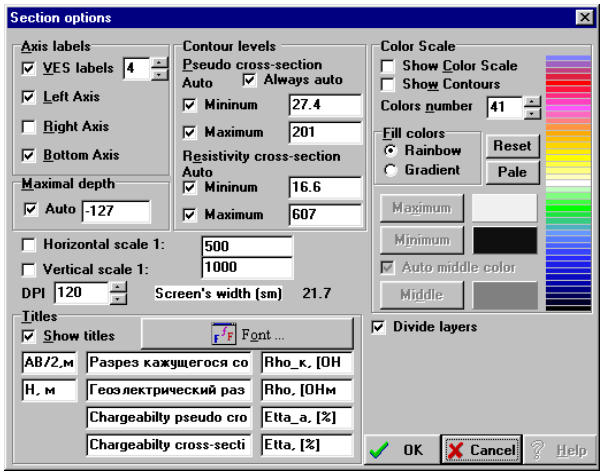
The horizontal and vertical scales of the cross-sections can be change accordingly to the user's need. To change the horizontal scale choose the *Section, Zoom in* menu item to increase the scale or the *Section, Zoom out* menu item to decrease the scale, or press the [Alt-F5] or [Shift-F5] keys respectively. It is also possible to mark the desired part of the profile by dragging with a mouse with a left button pressed beginning from some point of the profile; the scale will be changed to display sounding points within the selected area, marked with the rectangle, only. Choose the *Section, All profile* menu item or press the [Ctrl-F5] key to view all the profile again.

To change the vertical scale choose the *Section*, *Less depth* menu item to increase the scale or the *Section, More depth* menu item to decrease the scale, or press the [Gray +] or [Gray -] keys on the numeric keypad respectively. It is also possible to mark the desired part of the profile by dragging with a mouse with a left button pressed beginning from some point on the vertical axis of the resistivity cross-section; the scale will be changed to display the cross-section within the selected area, marked with the rectangle, only.

The pseudo cross-section can be displayed in the linear or logarithmic vertical scale. To switch between the linear or logarithmic vertical scale choose the *Section*, *Lin/log scale* or press the [Ctrl- Alt-Z] key.

To specify certain horizontal scale value and maximal depth value choose the *Section*, *Options* menu item or press the [Ctrl-F1] key or click the {*Section options*  } toolbar button; the *Section options* window will appear. To specify a certain horizontal scale, switch on the *Horiz. scale* checkbox of the window and type the desired scale value in the neighboring text box. To specify a certain value of the maximal depth, type the desired value in the text field of the *Maximal depth* field. When the desired values are entered, click the *OK* button of the window. To restore automatic scaling, switch off the *Horiz. scale* checkbox and/or switch on the *Auto* checkbox of the *Maximal depth* field on, then click the *OK* button of the window. To switch between scaled and non-scaled way of displaying the cross-sections without changing the scale, switch on (off) the *Scaled* checkbox in the bottom of the main window of the program.

It is possible to specify the bitmap resolution for printing the cross-section. To do this, set the desired resolution value in dots per inch in the *DPI* numeric box of the *Section options* window. The cross-section appearance on the screen will be changed as well. Use Print preview to see the results of changing resolution.



The *Section options* window.

Labeling the cross-sections

The labels may appear in the cross-section window. These are sounding point names in the top of the cross-section window, horizontal coordinates in the bottom of the cross-section window, spacings near the pseudo cross-section vertical axes and depths (altitudes) near the resistivity (chargeability) cross-section vertical axes. Text comments may be entered as well and the axes may be named. To label the cross-section, choose the *Section*, *Options* menu item or press the [Ctrl-F1] key; the *Section options* window will appear.

Symbol substitutes can be used in text labels according to Table 1.

Table 1
Symbol substitutes in cross-section labels

Typed in the text box	Appears on the cross-section
Rho	ρ
Etta	η
OHm	Ω
Phi	φ
<Symbol>_< Symbol >	< Symbol >$_{<\text{ Symbol }>}$

To display (remove) labels of a certain type, switch on (off) the corresponding checkbox of the *Axis labels* field of the window. The *VES labels* check box is for sounding point names, the *Left Axis* and *Right Axis* check boxes are for vertical axes labels, the *Bottom Axis* checkbox is for the horizontal coordinates.

To display (remove) text comments, switch on (off) the *Show titles* checkbox of the *Titles* field of the window. Two (VES-IP mode - four) rows of text boxes are present in the *Titles* field. The upper row if for the apparent resistivity pseudo cross-section, the lower one is for the resistivity cross-section. The leftmost text box contains the name of the vertical axis of the corresponding cross-section. The rightmost text box contains the name of the color scale column of the corresponding cross-section. The central text box may contain any text to be displayed above the corresponding cross-section (the name of the observation line, etc.). The other two rows appearing in the VES-IP mode are similar and deal with chargeability cross-sections. Type the desired text in the corresponding text box, then click the *OK* button of the window.

True Type fonts are used to display (and print) the labels and text comments. To change the font settings, click the *Font* button of the *Titles* field; the standard Windows' *Font* window will appear. The font settings are uniform for all the texts of the cross-section window.

Specifying colors of the cross-section

Color scales are used to represent the resistivity and apparent resistivity (and/or chargeability and apparent chargeability in the VES-IP mode) values on the cross-sections. The contour levels are estimated automatically using the data limits if the *Auto* checkboxes of the *Contour levels* field of the *Section options* window are switched on. Otherwise the desired values of data limits can be typed in the neighboring text boxes of the field. The default number of contours is 11, it can be altered from 3 to 84 in the *Colors number* numeric field of the *Color scale* field of the *Section options* window. In the Gradient mode (see the next paragraph) the quantity of color levels is arbitrary, in the Rainbow mode the level quantity can be changed with the quotient of 2.

The default or custom color set can be chosen in the *Fill colors* field in the *Color scale* field of the *Section options* window by clicking the *Rainbow* or *Gradient* button respectively. The Rainbow color set is formed by a gradual change of colors from the color, corresponding to the greatest apparent resistivity values, to

that corresponding to the smallest, through the consequent colors of the solar spectrum. The Gradient color set is formed by a gradual change of colors from the color, corresponding to the greatest apparent resistivity values, to that corresponding to the smallest, by changing their ratio in the color. To specify color, corresponding to the greatest (smallest) values click the *Maximum* (*Minimum*) button in the *Color scale* field of the *Section options* window, then click the desired color of the *Color* window and click its *OK* button. The color, corresponding to the average resistivity value can also be specified. To do so, click the *Middle* button of the *Section options* window, then click the desired color of the *Color* window and click its *OK* button. To disable the middle color switch on the *Auto middle color* checkbox in the *Color scale* field.

It may be useful to make the cross-sections more expressive to look at by emphasizing some levels and/or layers with a special color. To do so, click the desired color box in the *Color scale* field of the *Section options* window, then click the desired color of the *Color* window and click its *OK* button.

It is possible to display contour lines on the resistivity cross-section. To do this, switch on the *Show contours* checkbox of the *Color scale* field in the *Section options* window. Displaying contours slows down the drawing of the apparent resistivity pseudo-cross-section.

The layers boundaries in the resistivity cross-section can be drawn in black lines (by default) or not. To switch between these modes switch the *Divide layers* checkbox on (off).

To restore the default mode of displaying the cross-section click the *Reset* button in the *Color scale* field of the *Section options* window.

Interpreting sounding data

Overview

The concept of the profile interpreting is the foundation of IPI2Win. It means that data for a profile are treated as a unity representing the geological structure of the survey area as a whole, rather than a set of independent objects dealt separately. The concept is implemented mainly by using the interactive semi-interactive mode rather than the automated interpreting model.

IPI2Win is capable of solving resistivity electrical prospecting 1D forward and inverse problems for a variety of commonly used arrays for the cross-sections with resistivity contrasts within the range of 0.0001 to 10000.

The forward problem is solved using the linear filtering. The filters are developed at the Near-surface Electrical Prospecting Lab, Geophysical Dept., Geological Faculty, Moscow State University, Moscow, Russia. The thoroughly tested filters and filtering algorithm implementation provide fast and accurate direct problem solution for a wide range of models, covering all reasonable geological situations.

The forward problem for chargeability is solved using the Komarov's equation for the apparent chargeability $\eta_a = \frac{\rho_a - \rho_a^*}{\rho_a}$, where the apparent resistivity ρ_a is estimated for the layered cross-section with $\{\rho_1 .. \rho_N, h_1 .. h_{N-1}\}$ parameters and the apparent resistivity ρ_a^* is estimated for the layered cross-section with $\{\rho_1(1-\eta_1) .. \rho_N(1-\eta_N), h_1 .. h_{N-1}\}$ parameters.

The inverse problem is solved using a variant of the Newton algorithm of the least number of layers or the regularized fitting minimizing algorithm using Tikhonov's approach to solving incorrect problems. *A priory* information on layers depths and resistivities can be used for regularizing the process of the fitting error minimizing. The inverse problem is solved separately for each sounding curve.

The IPI2Win authors suppose that the approach involving interactive semi-automated interpreting is preferable taking both the effectiveness and the geological sense into consideration. This approach provides the opportunity of more complete and accurate taking *a priory* data into account. Some of these, being rather of descriptive than quantitative nature, can hardly be introduced as formal parameters into the interpreting model. In this case the interpreter's experience and geological erudition may occur to be of even greater importance than the calculation accuracy.

Creating and editing the model

Overview

The model parameters for the current sounding point (the resistivity (and chargeability in VES-IP mode), the thickness and the upper boundary depth and altitude) are presented by a blue line of the pseudo-log plot in the curve window. They are also listed in the table in the separate window titled with the fitting error values (model window). The theoretical sounding curve for the current model parameters values is plotted in red in the curve window. Fitting error values (VES mode - one, VES-IP mode - two) represent the relative difference between the theoretical and field apparent resistivity curves and mean square deviation between the theoretical and field apparent chargeability curves (VES-IP mode only, in brackets, with «±») for the current sounding point and its current model parameters. Fitting errors are also displayed in the *Fitting error* field of the status line.

Error = 19.8 %

N	ρ	h	d	Alt.
1	718	2.78	2.78	169.7
2	39.1	17.7	20.5	152
3	17.6	23.7	44.2	128.3
4	726	14.8	59.1	113.4
5	25.7	79.6	139	33.78
6	1464			

Error = 0.9579%(±0.04322%)

N	ρ	η	h	d	Alt
1	1.556	2.835	1.169	1.169	-1.169
2	20.78	1.182	1.671	2.84	-2.84
3	0.5041	3.147	2.748	5.588	-5.588
4	15.3	0.8877	68.51	74.1	-74.098
5	2.961	10.06			

The *Model* Window (VES mode - left, VES-IP mode - right)

At first the opening of the data file the resistivity cross-section is empty. The best fitting two-layered model is automatically suggested for the initial interpreting model of the present sounding point. Model editing

involves altering the quantity of layers (from 2 up to 30) by means of splitting or joining them (to add or to remove a layer respectively) and changing the properties of the layers.

Altering the quantity of the layers

To split the current layer (i. e. the layer, highlighted in the model window) press the [Ctrl-N] keys, choose the *Model, Split* menu item or click the {*Split the layer*} button on the toolbar. The layer is then split in two. The resistivity and chargeability values of these new layers are equal to those of the initial layer. The total thickness of the new layers is equal to that of the initial layer and the ratio of the new layers' thicknesses is 2:3. Splitting the deepest layer (the semi-space) results in adding a layer immediately above the semi-space; the thickness of the layer added is 1.5 of the total thickness of the overlapping layers.

To join two consequent layers (i. e. the layer, highlighted in the model window and the following one) press the [Ctrl-Y] keys, choose the *Model, Join* menu item or click the {*Join two layer*} button on the toolbar. The layers are then united in a single layer. The resistivity of the new layer is the mean geometrical of those of the two initial layers. The chargeablity of the new layer is the mean of those of the two initial layers. The thickness of the new layer is equal to the total thickness of the two initial layers. Joining layers is impossible if the semi-space is highlighted as the current layer.

Altering the properties of the layer

To edit layer properties click at the desired cell of the table in the model window, type the new value of the parameter in the cell and press the [Enter] key. The theoretical curve will be redrawn for the present values of the model parameters. Use arrow keys to proceed to the next cell in the arrow direction.

It is also possible to alter model parameters by dragging the pseudo-log plot segment with a mouse. The theoretical curve is redrawn synchronously with altering the parameters in this manner. Dragging a vertical segment changes the depth of the corresponding boundary, while dragging a horizontal segment changes the resistivity of the layer. If the [Ctrl] key is pressed while dragging a segment both the resistivity and boundary depth are being altered. If only the boundary depth is to be altered it may be more convenient to drag this boundary in the cross-section window rather than in the cross-section window.

Getting a model from another point

The model from the current point is automatically transferred to the next selected sounding point if model is yet empty for it. Consequent curve interpreting takes place usually and thus this effect results in automatic transfer of the model to the next point.

The model for a certain sounding point can also be copied into the Clipboard and then assigned to another sounding point by pasting it from the Clipboard. To do this, select the point with the desired model and choose the *Edit, Copy* menu item, or press [Ctrl-Ins] keys, or click the {*Copy*} button on the toolbar. Then select the sounding point to which the copied model is to be transferred and choose the *Edit, Paste* menu item, or press [Shift-Ins] keys, or click the {*Paste*} button on the toolbar.

Clearing the model

Sometimes it is necessary to delete the model for a certain point, i. e. to start the intrepreting «from the very beginning». To do this, select the point with the desired model and choose the *Edit, Cut model* menu item, or press [Shift-Del] keys, or click the {*Cut* } button on the toolbar.

To clear the models for the points, currently displayed in the cross-section window, choose the *Delete all results* menu item.

Discarding the changes

Any completed editing operation can be discarded by pressing the [Alt-Backspace] keys, choosing the *Edit, Undo* menu item or clicking the {*UnDo*} button on the toolbar. The editing operation is completed when the [Enter] key is pressed after typing a value in the cell of the table in the model window or the mouse button is released after dragging the pseudo-log plot segment. Pasting a model from the Clipboard and implementing the automated interpreting of any kind is also a completed editing operation. Only the latest editing operation can be undone.

To discard all model changes for the point made since it was selected choose the *Edit, Restore* menu item

Automated curve interpreting

The least quantity of layers approach for a single point and the whole profile

The most formal way of automated interpreting is applying of the least quantity of layers approach. To implement the automatic interpreting using this approach for a single sounding curve select the sounding point to interpret and choose the *Point, New model* menu item, or press the [F7] key or click the {*Automatic minimization with number of layers selection*} button in the toolbar. A model will be created with the least quantity of layers providing the best fitting of the field curve for the present sounding point and the theoretical one. The least quantity of layers approach is regarded as a know-how by the IPI2Win developers.

To implement the least quantity of layers approach for all the curves of the profile, and choose the *Point, Profile new model* menu item, or press the [Alt-F3] key.

This approach is likely to introduce the extremely thin layers with extremely great or small resistivity values. The properties of such layers can be edited afterwards manually within the equivalence area. The least quantity of layers approach is to be used to create a rough initial model for the further manual (interactive) interpreting in case there is a lack of *a priory* data. It is also possible to use this approach to estimate the limits of the equivalence area.

Implementing the least quantity of layers approach is controlled by the greatest and the least fitting error values, specifying the limits of the fitting error for the model search, along with the specified least quantity of layers in the model and (IP mode only) the chargeability fitting error weight when solving the inverse problem. To specify these values choose the *Options* menu item. In the *Options* window click the *New model* tab, then type the new value of the least fitting error value in the *Minimal error (%)* text field, the new value of the greatest fitting error value - in the *Maximal error (%)* text field, the chargeability fitting error weight - in the *Charg. weight* text field, the least least quantity of layers in the model - in the *Min. layers number* text field of the *Options* window.

In VES-IP mode the resistivity and chargeability curves are both involved in the inversion process.

Regularized fitting error minimizing (Newton algorithm)

Implementing the Newton algorithm for a single point and the whole profile

Within IPI2Win, regularized fitting error minimizing is actually more frequently applied for the automated curve interpreting than the Newton algorithm. To implement the automatic interpreting using this approach, select the sounding point to interpret, create the initial model by any of the above mentioned means and then choose the *Point, Inversion* menu item, or press the [Space] key, or click the {*Inversion*} button on the toolbar. The parameters of the initial model will be altered to provide the best fitting of the field curve for the present sounding point and the theoretical one. The quantity of layers is not altered.

To implement the same approach to all the curves of the profile, create the initial model by any of the above mentioned means and then choose the *Point, Profile inversion* menu item, or press the [Ctrl-F3] key.

If a similar initial model seems to fit several consequent points, it is possible to make model interpolation for this fragment of the profile. To do this, clear the models for the desired points, then create the initial model for the first point of the fragment and then choose the *Point, Profile interpolation* menu item, or press the [Shift-Ctrl-F3] key.

The initial model is created using the *a priory* data, derived from the geological cross-section and/or the drilling data provided by the customer or available due to other reasons. These data are usually generalized by the interpreter to represent the electrical properties of the rocks constituting the geological cross-section.

In VES-IP mode the resistivity and chargeability curves are both involved in the inversion process.

Fixing the model parameters

If the certain properties of some layers are known for sure it is possible to fix them before automated interpreting. The fixed parameters are not changed while minimizing fitting error. Fixing the model parameters is the way of more strict and controllable regularization of the minimization process.

To fix a parameter, click the desired cell of the table in the model window, then choose the *Model, Fix* menu item, or press the [Ins] key. To release a fixed parameter, click the cell containing the desired parameter, then do the same action, i. e. choose the *Model, Fix* menu item, or press the [Ins] key.

Interactive semi-automated interpreting

Interactive semi-automated interpreting is the main mode of data interpreting implemented in IPI2Win. This paragraph expresses mainly the authors' approach to the sounding data interpreting. This approach is derived from a vast experience of interpreting practical sounding data while solving various geological problems.

The process is usually started with visual analysis of the apparent resistivity pseudo cross-section. The zones are distinguished on the observation line with similar types of sounding curves. Some transient palaces usually occur between the neighboring zones. The curves within the zones may be usually interpreted using 1D approach, while the transient curves differ considerably from 1D curves.

Sounding points with typical curves are selected on the observation line for each of the zones distinguished. The curves for these points are interpreted using the *a priory* data available. If the geological cross-section is available from a borehole for the certain sounding points, the initial model for the point is created using its data. The number of layers depths of the boundaries according to the borehole column, while the resistivities are asserted using the litological information. Some geological layers may be joined into uniform geoelectrical layers according to their electrical properties and thus their influence on the sounding curve.

After interpreting the typical curves the models are transferred to other points of the corresponding zones. The model for each curve actually needs editing. Automated interpreting with fixing certain parameters can be applied to do so or manual model editing can be implemented. The interpreting within each zone is thus implemented.

For the transient curves more radical model altering may be needed. The transient curves are interpreted paying attention rather to how the models of the points match the general concept of the geological structure along the observation line than to the fitting error of separate curves. A sort of facial alteration is introduced (i. e., the resistivity and/or chargeability of the layer varies gradually while the thickness of the layer is kept constant) or else the boundary of the layer is gradually sloped up or down until it sticks the overlapping or underlying boundary. The choice of any variant depends mainly on the *a priory* data and, to some extent, of the interpreter's preferences. The developers' experience in sounding data interpreting demonstrates that altering both resistivity and depth of a layer should be generally avoided.

The geoelectrical cross-section thus obtained is actually regarded as the first-order approximation of the model of the geological structure along the observation line. This cross-section is analyzed taking its geological sense into account and matching of the result obtained and *a priory* data available. Some alterations of the cross-section result usually from such analysis. Some layers, even having no considerable influence on the sounding curves, may be formally introduced into a model if the existence of such layers is taken for sure due to the *a priory* data. During this stage of interpreting more attention is paid to corresponding of the cross-section to the geological situation and its general appearance, but the fitting error is still kept as small as possible.

Editing the model in the cross-section window

It is possible to alter the model parameters using solely the mouse in the resistivity cross-section image.

The currently available editing operation is determined by the mouse pointer appearance inside the cross-section window according to Table 2.

Table 2
Editing operation in the cross-section window

Mouse pointer appearance	***Menu item*:** **operation contents; implementation**
	*Select layer*: assign the resistivity value of a layer to any other layer on any other point; drag-and-drop the layer from one point to the desired layer of the destination point
	*Chg. depth*: alter the boundary depth on a sounding point; drag-and-drop the boundary to the desired position
 *Chg. resist.*:	alter the layer resistivity on a sounding point pressing the left mouse button, move the mouse in vertical direction starting from the middle of the layer, watch the resistivity value in the model window and by the mark on the resistivity color bar.
	*Add*: add a layer to the model of the current point; click the mouse left button on the desired depth of the desired point
	*Remove*: remove a layer (boundary) from the model of the current point; click the mouse left button on the desired boundary of the desired point

To choose the operation, display the additional toolbar by clicking the кнопке {Edit mode  } or the context menu by clicking the right mouse button on the cross-section window.

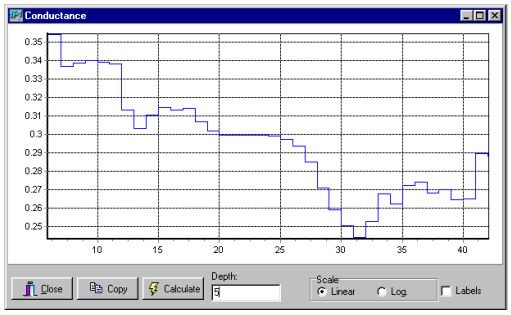
Additional interpreting tools

Estimating the equivalence limits

To estimate the equivalence limits for one of the model parameters for a certain point select the sounding point, then choose the cell with the desired parameter. To set the parameter to the greatest value within the equivalence limits choose the *Model, Maximum* menu item or press the [Ctrl-Alt-D] key. To set the parameter to the least value within the equivalence limits choose the *Model, Minimum* menu item or press the [Ctrl-Alt-X] key.

Calculating conductance

To calculate the geoelectrical cross-section conductance to a certain depth, choose the *Transformation>Conductance* context menu item or click the {*S(H)*} button in the toolbar. The *Conductance* window will appear.



The *Conductance* window

Type the depth value in the Depth text box of the window, then click the {Calculate} button in it. The conductance plot along the profile will appear in the window. Linear or logarithmic scale is available for the plot's conductance (vertical) axis. To choose one of them, check the *Linear* or *Log* item respectively in the *Scale* field of the window. Switching the *Labels* checkbox of the window on causes the sounding point names to displayed on the plot.

The results can be stored in the Clipboard by clicking the Copy button of the window. The stored values can be pasted then into a spreadsheet or word processor as a table.

Другие дополнительные средства интерпретации доступны в пункте меню *Section, Transformation* ►

Fitting error pseudo cross-section

To display the fitting error pseudo-cross section for the apparent resistivity (VES-IP mode - or apparent chargeability), display the desired pseudo cross-section choose the *Transformation>Accuracy* context menu item or click the {*Fitting error*} button in the toolbar. Examining the fitting error pseudo-cross section may be useful to distinguish the zones along the profile or in some depth (spacing) intervals, where the fitting error is the greatest. Such zones are likely to be connected with 2D or 3D effects.

Vertical derivative transformation

To display the vertical derivative transformation (derivative by the spacing) for the apparent resistivity (VES-IP mode - or apparent chargeability), display the desired pseudo cross-section choose the *Transformation>V-Transformation* context menu item or click the {*Vertical derivative transformation*} button in the toolbar. The derivative can be calculated by the spasing or by spacing logarithm. To switch between these modes choose the *Transformation>dR/dLnR* context menu item. Vertical derivative is likely to highlight the characteristic points of sounding curves: extrema as zero points and bendings as extrema.

Horizontal derivative transformation

To display the horizontal derivative transformation for the apparent resistivity (VES-IP mode - or apparent chargeability), display the desired pseudo cross-section choose the *H- Transformation>Transformation* context menu item or click the {*Horizontal derivative transformation*} button in the toolbar. The extrema of the horizontal derivative are likely to mark the places where one horizontally layered model is changed radically to the other.

Managing results

Saving results

The interpreting results are saved into a file with the same name as the dat-file curently opened and RES extension. Saving results takes place when a dat-file is saved, i. e. on implementing Save operation, on exiting IPI2Win or before opening another dat-file. No res-file is created or saved if none of model parameter for any sounding point was altered. No backup files is created for res-files.

The res-file is placed into the folder where the corresponding dat-file is located. If a dat-file is moved elsewhere the corresponding res-file must be moved to the same location. Otherwise the results of interpreting are likely to be lost.

Automatic saving of the files after at certain time intervals is available. To specify the autosave parameters choose the *Options* menu item. In the *Options* window click the *Autosave* tab, then type the new value of the autosaving time interval value in the *Autosave every* text field and switch on the *Autosaving* checkbox to enable autosaving. Switch that checkbox off to disable autosaving.

WARNING! Avoid altering the contents of a res-file unless using IPI2Win. The res-file format and, particularly, the order of the sounding points must strictly correspond to those in dat-file.

Result file format

Res-file is a plain text file of definite structure. The format of each line is as follows.

1st and 2nd lines - any text; the lines duplicate those of the corresponding dat-file.

3rd line - one integer - the number of models (N_m) stored in the file.

4th line - up to 10 characters beginning from 1st column - the name of the current sounding point; transferred from the dat-file by IPI2Win.

5th line - one integer and one real;

the integer is the quantity of layers (N_l) in the model for the current point;

the real is the fitting error for the current point for the current model parameters.

6th line - a list of N_l items - real numbers separated with spaces - representing the resistivity values ordered from the surface to the deepest.

7th line - a list of N_l-1 items - real numbers separated with spaces - representing the thickness values ordered from the surface to the deepest.

8th line (VES-IP mode only) - a list of N_l items - real numbers separated with spaces - representing the chargeability values ordered from the surface to the deepest.

WARNING! Lines 6 and 7 (VES-IP mode -lines 6-8) contain also the inner data of IPI2Win. Items following the lists of values in these lines must not be altered otherwise than by IPI2Win.

Lines from 4 to 7 (VES-IP mode - from 4 to 8) are repeated N_m times, four (VES-IP mode - five) lines per each interpreted point.

Printing cross-sections

To print a cross-section (apparent resistivity or chargeability or any transformation pseudo cross-section, resistivity or chargeability cross-section or both pseudo cross-section and cross-section), switch to the cross-section window, display the desired cross-sections (see the Viewing cross-sections paragraph) and choose the *File, Print* menu item. The displayed image will be printed on the current printer. To change the printer choose the *File, Print* menu item and choose the desired printer from the *Change printer* drop-down list of the *Print setup* window.

The cross-section is printed on the paper of the size set in the *Paper size* drop-down list of the *Print setup* window. The image may fit a single sheet or to be of a certain horizontal scale (see the Scaling the cross-section section of this manual for setting scale). It may be useful to see a preview of the page with the cross-sections. To do this, choose the *File, Preview* menu item, or click the {Preview} button in the toolbar.

To save ink when printing on the color printer select the *Section, Options...* menu item and click the *Pale* button of the *Section options* window.

If a table of results is needed in the printed form, choose the *Edit, Copy all model* menu item or press the [Ctrl-A] keys. The parameters of all the models will be stored in the Clipboard. The copied values can be pasted into a spreadsheet or a word processor and then printed from it. General agreements concerning the Clipboard operation should be fulfilled.

Saving an image of the cross-section

A color bitmap image of a cross-section (apparent resistivity pseudo cross-section, resistivity cross-section or both) can be saved as into the file of the Windows bitmap format (BMP) with the same name as the corresponding dat-file. To do this, switch to the cross-section window, display the desired cross-sections (see the Viewing cross-sections paragraph) and choose the *Edit, Copy* menu item. The bitmap image of the cross-section will be stored in the Clipboard. The image can be pasted into any program capable of managing bitmaps, i. g.

graphic application. Pasting the image is to be done using the *Edit, Paste special...* menu item of the desired application.

IPI_Res2
Making geological cross-section

(Prof. V. A. Shevnin)

The IPI_Res2 is designed for presenting results of VES interpretation in the form of geological cross-section with profile points along the horizontal axis and real boundary depths or altitudes along the vertical axis including the altitudes of the day surface, legend for layers marking and text descriptions of layers.

The IPI_Res2 is a DOS program. To run it, type in the DOS command line:

```
ipires2e [mode]
```

and press *Enter*.

The [mode] can be skipped or it can be one of the following;

`/@n` - print on the HP LaserJet printer with resolution n dpi, (n=[75, 100, 150, 300])

`/P` - cancel printer test on running the IPI_Res2

`/On` - use the specified port `n` for output, (`n` may be any from the list: `LPT1, LPT2, COM1, COM2` or `file name`

`/G` - use EGA mode

`/T` - do not include text in the DXF file.

All the operations after running the IPI_Res2 are controlled by pressing the keys.

Input files are: *.dat, *.res and *.dpr (if any) with horizontal and vertical scales and coordinates of all VES locations. The desired *.dat file should be opened after running the program. Internal IPI_Res2 data are stored in *.n? files in the same folder as input files. In case the interpretation was changed using IPI after creating the geological cross-section with IPI_Res2, the *.n? files should be deleted before updating the geological cross-section.

Operation with program includes four stages.

Selection of geological bodies in cross-section - stage 1.

After opening the *.dat file you can see on the screen two cross-sections. The upper one is the geoelectrical cross-section from IPI. Lower cross-section is a resulting picture of the 1-st stage. When certain data file is opened for the first time, lower cross-section is empty and to the right of it you may see the «Layer resistivity»-«boundary depth» cross-plot.

Moving the cursor arrow with the arrow keys among VES locations and different layers you observe small red cross moving at the cross-plot. You may see some "clouds" of points at that diagram, corresponding to proposed geological bodies. Such "clouded" representation helps to distinguish geological bodies in the cross-section, according to vicinity of points from the center of a "cloud". This process is a kind of geological classification. The main idea of 1-st stage consist of dividing total cross-section into separate geological bodies on a base of a similarity of blocks resistivities and their depth position. After automatic procedure it is possible to correct bodies using a priory representations and definite geological conception.

Geological body according to our conception is region in cross-section consisting of some blocks from different VES's with similar resistivities and boundaries depths. New body among other characteristics has resulting resistivity which is calculated as mean geometrical value of all blocks for all VES's in its boundaries. The total number of different bodies shouldn't be more than 10, but each body may consist of several parts without touching between them (that is fragmented). You may use for division cross-section into geological bodies automatic and heuristic algorithm. To begin procedure you should mark representative examples for each body (better from up to down). Then the program on the base of similarity to representative examples begin classified all layers for all VES locations into several geological bodies.

This automatic classification may be good or bad, depending on the difference in bodies properties. But in any case you may correct its result. Using your own and a priory representation you may reclassify some parts of cross-section, by pressing keys with appropriate numbers of bodies. If some bodies have the same color due to similar resistivity, you may hatch one of them by pressing *Enter*.

Supplying patterns to the geological bodies - stage 2.

For printing cross-section you need to hatch each geological body with separate symbols in black and white. You may select ready hatch characters (among samples in upper part of the screen) or edit them to new ones.

For editing one should press *F4*. There are three different regimes of editing, marked by arrow color.

When regime is called "*Moving*", arrow is of red color.

When regime is called "*Adding new points*" arrow is black. When regime is called "*Erasing*", Arrow is white.

Pressing *Enter* you will go to 2-nd regime, and with *Esc* to 3-rd one. To return back to 1-st regime, you need press *Enter* or *Esc* once more.

To finish editing press *Y* if you want to save new variant, or *N*, to stay previous one.

Scaling the cross-section and creating the legend - stage 3.

Before printing one need to specify vertical and horizontal scales by typing the desired values and type comments (descriptions) for each geological body. The total length of picture depends on horizontal scale, this value one can see in right lower corner of the screen.

Comment for each body may consist of 1 to 3 lines with no more than 18 symbols. The order of comments depend on the order of bodies number, but if you wish, you may rearrange them. For that one need to mark definite comment by pressing *Enter* and after moving cursor to new position press *Enter* once more.

Printing or saving the image - stage 4.

Epson (LX, FX)- or Hewlett-Packard LaserJet compatible printers can be used. For printing press *P*. To stop printing press *Esc*.

WARNING! If you use a network printer, make sure the printing from DOS applications is enabled (consult your tech support if needed).

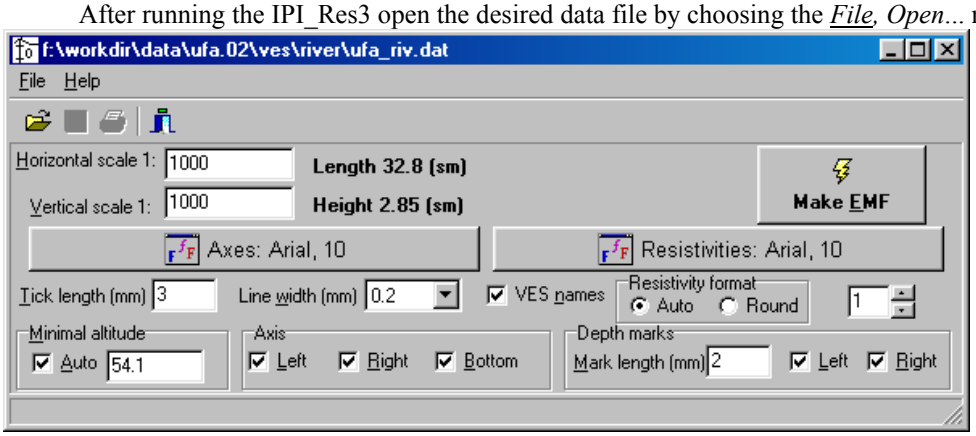
The cross-section image can also be saved in the AutoCAD Data Exchange format (*.DXF) by pressing *Ctrl-P*.

Note If you work with the same data in second time the program restores all previous commands (distribution of layers in bodies, hatch characters, scales, comments). All this information is keeping in three files with extensions "N", "N2" & "N3". If you changed layers number by IPI program for any VES location, then running IPI_RES2 may sometimes give crash of program due to difference in *.res and N's files. In this occasionally happens, you need to delete these N files and begin to work a new.

IPI_Res3
presenting the results in the form of geoelectrical columns

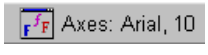
The IPI_Res 3 is designed for presenting the results sounding curves intrepretation in the form of geoelectrical columns. The *.dat, *.res and *.dpr files are needed for the IPI_Res3. The cross-section image is saved in the Enhanced Metafile (Windows) *.emf.

After running the IPI_Res3 open the desired data file by choosing the *File, Open...* menu item.



IPI_Res3 main window

Specify the horizontal and vertical scales by typing the values in the *Horizontal scale 1:* and *Vertical scale 1:* text fields respectively. Mind the sizes of the image displayed next to these fields.

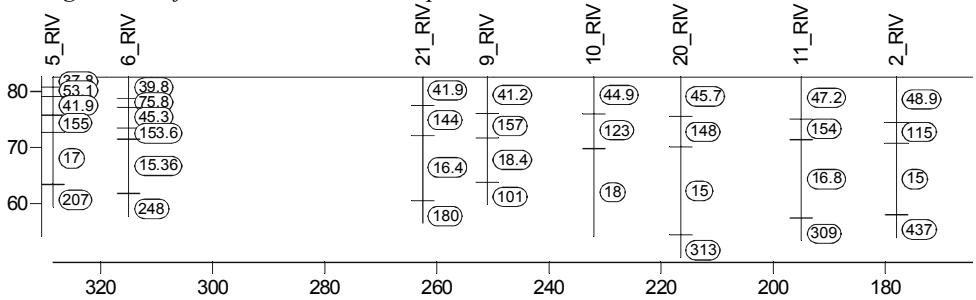
Specify the font properties for axes labels and VES names by pressing the 

button and for resistivity values by pressing the 

button.

Set the axes *tick length* and *line width* in millimeters in the corresponding fields. To display/hide the axes labels and VES names switch on/off the corresponding checkboxes. Set the axes tick length in the *Mark length (mm)* text field of the *Depth mark* field and set the axes ticks appearance by switching on/off the *Right* and *Left* checkboxes in the *Depth mark* field.

Select the resistivity value format in the *Resistivity* field; if *Rounded* format is selected specify the number of significant digits in the numeric box next to the *Resistivity* field. Set the geoelectrical column tick length in the *Mark length (mm)* text field of the *Depth mark* field and set the axes ticks appearance by switching on/off the *Right* and *Left* checkboxes in the *Depth mark* field.



The interpretation results as geoelectrical columns

To see the columns click the 

button. To save it, choose the *File, Save as...* menu item; type the file name WITH EMF EXTENSION. To print the image choose the *File, Print...* menu item; see the *Printing cross-section* part of this Manual for details.