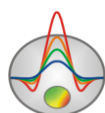


Program of two-dimensional seismotomography data processing and interpretation.

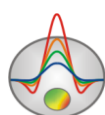
(surface, well and water variations)

ZONDST2D

Function and resources of program.....	3
Velocity of elastic waves.....	4
Program installation and moving off.....	6
Program registration.....	7
System requirements.....	7
Measures.....	7
<i>Seismogram picking mode</i>	7
The work beginning with mode.....	8
Toolbar of seismogram picking	8
Seismogram picking function menu.....	9
File reading and processing general settings dialogue	11
Observations geometry input.....	12
Seismograms visualization and scaling settings.....	13
Seismogram scales setting dialogue.....	14
Traces graphic settings dialogue.....	14
Mode of seismogram browse.....	15
Main seismogram picking mode options.....	16
Multisection cell options.....	18
Data filtration dialogue	22
<i>Field data inversion module</i>	23
Data file creation and opening for inversion.....	23
Main window toolbar.....	24
Main window function menu.....	24
“Hot” keys.....	27
Status panel.....	27
Start model settings dialogue.....	27
Format of basic data file.....	29
I data file part: observation data.....	29
II data file part: topography data.....	30
III data file part: model data.....	32



Graphics plane.....	32
Measurements editor.....	34
Data inversion.....	35
Inversion settings dialogue.....	35
Cell summarization dialogue.....	43
Model visualization performances and parameters.....	44
Interpretation results saving.....	48
Project information	49
Data import and export.....	49
Exported image settings dialogue.....	51
Log and stratigraphy data file format.....	52
Modelling.....	54
Creation of synthetical observation system.....	55
Model editor.....	56
Work with model.....	58
Cell configuration settings dialogue.....	58
Application 1: Graphics set editor.....	61
Application 2: Graphic editor.....	62
Application 3: Editor of legend for graphics.....	64
Application 4: Axes editor.....	65
Application 5: Dialogue of model parameters settings.....	69
Application 6: Contour-section setup dialogue.....	70



Function and resources of program

Program “ZONDST2D” oriented to two-dimensional processing and interpretation of seismotomographic profile data. Comfortable interface and wide capabilities allow to determine formulated geological problem with maximal effectiveness.

Program divided into two main components. First intended for first motion picking on seismograms. Second - for solving of direct and inverse seismotomography problem.

Special interface (created for maximal first arrival picking simplify and automatize) was designed for processing of seismograms. The emphasis is on visualizations variety and availability of often used functions. In solving of rays trace primal problem using special algorithm of Shortest path's method. The given algorithm is characterized by high speed of calculations and controllable accuracy.

At modeling of a time field environment breaks a network of rectangular cells with constant value of speed.

For the decision of a return problem (inversion) Newton's method with regularization is used. Regularization raises decision stability and allows receiving more smooth distribution of speed in the environment.

$$(A^T W^T W A + \mu C^T R C) \Delta m = A^T W^T \Delta f - \mu C^T R C m \quad (1)$$

where A – a matrix of the partial derivative measured values on cut parameters (Jacobean), C – the smoothing operator, W – a matrix of relative errors of measurements, m – a vector of parameters of a cut, μ – controller parameter, Δf – the vector of discrepancy between observed and calculated values, R – the focusing operator.

By working out of a return problem the special attention is given the account of the aprioristic information (separate measurements weight, change of parameters ranges).

«ZONDST2D» possesses powerful system of profile data visualization, the measurement editor and method sensitivity and resolution analysis system.

In the measurement editor user can see parameters of the measurement unit, set weight (importance) of separate measurements and correct values of the measured characteristics. There is a possibility to appoint weight of measurements according to a rating or to fix those cells model which change of parameters practically doesn't influence results of measurements.

In resolution analysis system user studies function of model sensitivity – i.e. degree of influence of each model cell on measurement results.

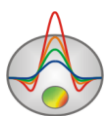
$$S = \text{diag}(A^T A) \quad (2)$$

Sensitivity research allows making an optimum choice of supervision system for the decision of the assigned geological problem.

«ZONDST2D» uses a simple and clear format of data file which allows combining various systems of supervision on one profile. The program allows to import and display measurement results by other methods. It promotes to more complex approach to data interpretation.

In «ZONDST2D» the modeling system including all basic types of supervision systems used in a seismotomography is provided. Choice of unit parameters and quantity of measurements points is carried out by the user in a dialogue mode.

The program «ZONDST2D» represents the convenient device for automatic and interactive interpretation of a seismotomographic data and can be used on IBM PC compatible personal computers with operating system Windows.



Velocity of elastic waves

According to elasticity theory seismic waves velocities v_p and v_s depends on surrounding density ρ and it's elasticity modulus E and σ .

$$v_p = \sqrt{\frac{E}{\rho} \frac{1-\sigma}{(1+\sigma)(1-2\sigma)}} \quad (3)$$

$$v_s = \sqrt{\frac{E}{\rho} \frac{1}{2(1+\sigma)}} \quad (4)$$

In rocks this parameters defined by great number of diverse factors – lithologic and granulometric content, cavitation (porosity, cavernosity, fracturing), fluid saturation, intrastratal pressure, metamorphism and tectonic action, occurrence depth, age, temperature etc.

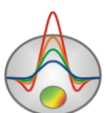
Density influence on velocity variation is smallish at all, as far as in majority of rocks density variation range limited from 1.4 to 3.2 g/cm³. Minimal relative changes of ρ are typical for igneous rock, maximal – for sedimental, but it's not more than 20-30%. From structure of aforesaid formulas follow reverse dependence velocity from density: if density rather increase (decrease) on $\varepsilon\%$ and values of elastic modulus stay permanent than velocity relatively decrease (increase) on $\varepsilon\%$.

On experimental data, for the majority of rocks positive correlation between their densities and seismic speeds v_p and v_s is typical, i.e. more dense breeds usually are also more high-speed. Such situation as though contradicts considered formulas, however this disagreement – only seeming. The matter is that with increase in density of breed ρ , as a rule, its Young's modulus E therefore there is an increase in speeds v_p and v_s even faster increases. The Young's modulus E in various rocks changes on some degrees - from level nearby 102 MPa in thin sedimentary formations to level of an order 105 MPa (106 kg/sm²) in strong igneous rocks. At the expense of this factor of size of seismic velocities can differ in tens times.

Poisson's ratio σ theoretically changes in a range 0-0.5. Elastic properties of hard crystal rocks come nearer to the left limit, to right - soft plastic deposits. In liquid incompressible environments where there are no shift deformations, $\sigma = 0.5$. In the majority of rocks Poisson's ratio has values from 0.15 till 0.35, i.e. varies relatively average value 0.25 within everything ± 0.1 . However in the formulas defining by v_p and v_s the size σ enters in such a manner that even its small variations strongly affect values of velocities.

Impact on elastic rocks characteristics by set of factors leads to that there is no unequivocal communication between geological rock determination and its high-speed characteristic: absolutely different rocks can have identical values of speeds, and rocks of one name can essentially differ on the speeds. Therefore for various rocks or their complexes it is possible to specify only limits of probable values of speeds.

Velocity of longitudinal waves in upper disintegrated part of loose rocks usually isn't exceed 1 km/s. In a fundamental terrigenous deposit it's exceed 4 km/s rarely and carbonate and hydrochemical rocks could increase to 6 km/s. In igneous and metamorphic rocks v_p amount to 6.5-7 km/s, at all increase with it basicity growth and metamorphism rate. Near Earth crust bottom (Mohorovičich discontinuity) value v_p judging by refracted wave velocity rating amount 8 km/s. Material constitution of rocks on this depth reliably unknown.



Velocities of cross waves at all change according to velocities of longitudinal waves. Theoretically ratio $\gamma = \frac{v_s}{v_p}$ can be in limits from 0 (fluids) to $1/\sqrt{2}=0.7$ (if $\sigma=0$). Majority of consolidate rocks value γ compose 0.4-0.6, that is match to σ values range 0.4-0.2. But in very loose argillo-arenaceous rocks value γ can compose 0.2-0.3 and even less. At all regularities of allocation v_s explored not so good as v_p .

Rocks with the same lithologic composition may visibly differ in seismic waves because of internal structure determined by forming conditions. It's well notably on terrigenous rocks, formed in a different hydrodynamic conditions: sediments, formed in low-energy environment of shelf and granulometric more similar, have lesser velocities than deposits accumulated in high-energy littoral environment and granulometric less assorted. In relation to low-speed turn out organogenic carbonates as compared with chemogenic.

Significant factor for values of seismic waves is rock voidage degree, first of all porosity. On the other equal assumption with growth of porosity in rocks it seismic velocity decrease. This dependence is most expressed in terrigenous deposits at which the size of porosity can reach 30-40 %. Such rocks as sand and sandstones consider as the heterogeneous environments consisting of a hard skeleton (grains) and porous filled with a fluid (liquid, gas and their mix). For similar model speed of v_p , is estimated by the approximate empirical ratio known as the equation of average time:

$$\frac{1}{v_p} = \frac{k_p}{v_f} + \frac{1-k_p}{v_t} \quad (5)$$

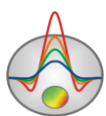
where k_p -factor of porosity, v_t and v_f — speeds of longitudinal waves in a hard skeleton and a fluid.

Dependence $v_p(k_p)$ has exponential character. Presence of gas in waterlogged rocks reduces to decreasing general elasticity and deceleration in it, as a result of high compressibility. In total porous saturation by water takes place deflation of rock compressibility and spasmodic enhancing of velocity v_p . In complete saturation of porous by water there is deflation of rocks compressibility and spasmodic increase of v_p . Degree of water saturation has no impact on cross waves velocity v_s . This effect is used by seismic to estimation of ground water level in friable sediments.

Freezing of the pore water, caverns, cracks, causes quick increase of seismic velocities in rock, as speed of v_p in ice almost in 2.5 times over than in water. Depending on porosity, the relative content of the frozen and not frozen water, its mineralization and temperature velocity of longitudinal waves can increase on 1-2 km/s. It essentially changes high-speed characteristics of the sedimentary section in spread zones of frozen rocks: here is observed velocities inversion when from a surface on some depths interval velocities decrease in transition from frozen to thawed deposits.

For sedimentary rocks is typical more or less essential increase in speed with depth of their occurrence because of growth of mountain pressure. It is caused on the one hand porosity decreasing, what according to (5) increases v_s as far as $v_t > v_f$. From the other hand, velocity v_t depends on touch area of neighbor rock grains that increases with pressure boost. It results to increasing of Young's modulus and velocities v_t and v_p . Velocities increasing with depth attributable to terrigenous rocks which differs by high initial porosity. In less porous carbonate deposits this property is shown much more poorly, and at chemogenic rocks it practically isn't appreciable.

With identical material constitution and an equal depth more ancient rocks differ in higher velocities. Such effect account for action time of diagenesis, metamorphism and tectonic stress



processes. Rocks are more hard and elastic because of these processes. This coupling quite weak: velocity increases approximately as a radical of the sixth degree from absolute age of deposits.

In porous deposits on considerable depths velocity depends on a ratio of external geostatic pressure from overlying thickness and intrastratal pressure of the fluid which filling pores. The first reducing porosity increases velocity. The second creating thrust in rock grains prevents porosity reduction and decreases velocity. The effective pressure defining value of velocity is almost equal to a difference of external and internal pressure. In certain cases fluid outflow from sandy deposits under the influence of geostatic pressure is complicated by screening effect of containing clay rock. For this reason intrastratal pressure appears above than normal hydrostatic pressure on this depth, and speed of v_p in a layer – below normal level.

Zones of tectonic violations are characterized by considerable reduction of seismic velocities which can make to 30-40 % and more, depending on disintegration degree of rocks. Usually this effect is more strongly expressed for cross-section waves therefore the relation of speeds $\gamma = \frac{v_s}{v_p}$ in zones of tectonic violation, seal failure and fracturing of rocks has the lowered value.

With permanent lithologic layer structure of sedimentary rock in it can be observed the lateral changes of velocity connected with plicate structural forms. Reduction of speed to arc parts of raisings where the fracturing of rocks is more strongly developed is more often noted. But can take place and the false effect caused by the raised dinamometamorphizm in crest of folds.

Experimental data testify that variations of seismic velocities can display changes of a tension of rock massifs. In particular, reduction of velocities and appearance of their anisotropy can be dated for zones of seal failure and fracturing of rocks with tectonic origin.

Other important property which is quite often found in massifs of rocks is the anisotropy of their elastic properties resulting in dependence of sizes of seismic velocities from the direction. Such effect arises both at the expense of thin-layer structure of deposits and owing to evolution of spatially oriented fracturing of rocks. According to experimental data, among lithologic homogeneous formations the greatest anisotropy characterizes clay deposits which differ the ordered scaly structure. There for longitudinal waves of k_p reaches values 1.2-1.5 and more. In sandstones k_p seldom exceeds level 1.1-1.2. Carbonate deposits have poor anisotropy of velocities. For cross waves anisotropy is usually higher, than for longitudinal waves in the same sections.

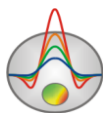
Other reason to anisotropy of seismic velocities is the intensive fracturing of rocks breaking continuity of their mineral skeleton. In the presence of cracks system with fixed direction velocity of waves along it is maximum, and across – is minimum. The defined anisotropy factor depends on a form and the relative sizes of cracks in comparison with the prevailing length of a wave, and also from elastic properties of filler of cracks [Boganik G. N., Gurvich I.I. Seismic exploration. 2006].

Program installation and moving off

The program “ZONDST2D» is delivered on a compact disc or on the Internet. The set of delivery includes the real Instruction. You can load the last updates of program on a site: <http://zond-geo.ru>.

For installation of the program copy the program from a compact disc in the chosen directory. For updating installation, simply write down the new version of the program over the old.

Before the first start of the program it is necessary to establish the driver of a protective key of SenseLock. For this purpose open the SenseLock folder (the driver can be loaded from a compact



disc, or on a site) and start the file InstWiz3.exe. After installation of the driver insert a key. If everything is right in the bottom system panel there will be a message that the key is found.

For removal of the program erase the working catalog of the program.

Program registration

To register the program press in the main menu the “Registration file” point. In the appeared dialogue choose a name of the registration file and keep it. The created file is sent to the address specified in the contract then the user receives the unique password connected with serial number of a hard disk which is necessary for entering in "Registration" point. The second option of registration of the program is binding with the help, a delivered key of SenseLock. Thus it is necessary, that in operating time key was inserted into the USB socket.

System requirements

The program “ZONDST2D” can be installed on the computer with Windows 98 operating system and above. Recommended parameters of system: P IV-2 GHz processor, 512 Mb. memory, a display resolution 1024 X 768, color mode - True color. (It is not necessary to change a display resolution in an operating mode with data).

As the program at present actively uses system register resources, in systems above Windows XP, it should be started on behalf of the manager (the right button of a mouse on a program badge – to start on Administrator behalf).

Measures

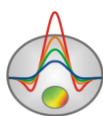
Geometrical units (coordinates of sources and receivers, topography) – meters.

Units of the first introductions time – milliseconds.

Units of speed of seismic waves – kilometers per second.

Seismogram picking mode

The purpose of processing of field data is receiving hodograph of first-arrival time of a target wave. To start a field data processing it is necessary to have the file or files of field supervision of the SEG-Y format. Process of seismogram picking is made in the special module (fig. 1) which is called by the Create survey point of the main menu of the program or the button on a toolbar. After a call of this module it is necessary to load into it field records and to start dive process.



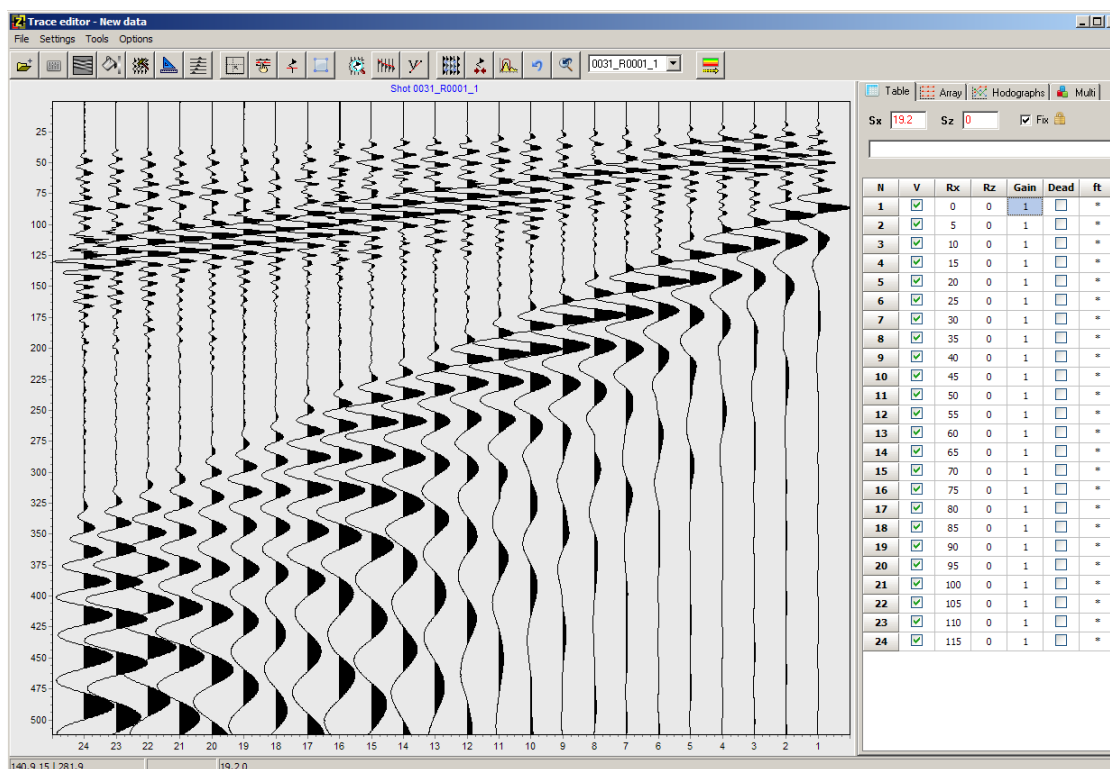


Fig. 1. Active window of seismogram picking module **Trace editor**.

The window is divided into two parts: a graph of mapping seismograms (at the left), Multisection cell for control and display of parameters of system of supervision (on the right).

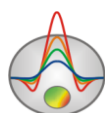
The work beginning with mode

Work begins with opening of the file or several SEG-Y files or the project file. Right after file loading there is *Show parameters for every file* dialogue. If to press *Yes*, there will be a window in which the user is offered to choose the necessary seismic trace and to set coordinates of sources and receivers if it is necessary (coordinates of receivers and sources it is possible to set later). Before loading of SEG-Y of files it is necessary to be convinced in correctness settings of reading the **Settings/File options** file (in the section “File reading and processing general settings dialogue” in details).

Toolbar of seismogram picking

The toolbar serves for a fast call of most often used functions in the module. It contains the following action buttons (at the left - to the right):

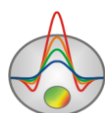
	To open the file or a files set of field data in the SEG-Y format or the working draft.
	To call a dialogue of general settings of file reading and processing.
	To show a substrate representing seismogram in an interpolated look.
	To call a dialogue of graphic settings of an interpolated substrate.
	To call a dialogue of seismic traces graphic settings.
	To call a dialogue of image scale control




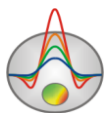
	To unfold seismic traces on ninety degrees. Depending on data type it is convenient to use vertical or horizontal seismogram orientation.
	To show the crossing lines following the cursor.
	To activate a mode of active trace allocation by a mouse. Active trace is highlighted by green color (default) and drawn last. It is not necessary to use this mode during a picking since it strongly slows down program work.
	To activate a mode of exact positioning of the first arrival times. New value is choosing in the closest point of change of mark on the seismic trace.
	To display an active window in the form of frame.
	To activate a mode of increase/allocation of seismogram area. Allocation is carried out with tensile rectangle by mouse.
	To activate a first-arrival picking mode. The choice of the first arrivals is carried out by the left button of mouse. The pressing of the mouse right button disconnects the chosen value on a hodograph. At the pressed SHIFT key the program interpolates values of the first arrivals between positions of the first and second pressing of mouse.
	To activate a mode of velocity determination between two points. For determination on the chosen seismogram area necessary to choose the first point position. Further, without releasing of mouse button to move cursor to the necessary position. Value of velocity will be displayed in the window status panel (the second section). Before determination of speed be convinced that coordinates of receivers are set correctly.
	To determine a working data window. The window sizes are set in a mode. The working window is used at a filtration and self scaling of seismic traces.
	To zoom according to size of working window.
	To call dialogue of a filtration of data.
	To cancel filtration results.
	To pass to the previous area of seismogram selection.
	To choose active seismogram from the list. In the list are all seismograms of project.
	To pass to a window of modeling and data inversion.

Seismogram picking function menu

File/Open SEG-Y/Project	To open the file, file set of field data in the SEG-Y format or the working project.
File/Save project	To keep correlation data and results to the working project.
File/Close project	To close all seismograms.
File/Print preview	To call dialogue of image printing.
File/Include topography	To connect to project file with information about ZondST2D format changes topography (format will be described later).
File/Project information	To show information about loaded project.
Settings/Image options	To call a dialogue of interpolation substrate graphic settings.
Settings/Image visible	To show a substrate representing seismogram in an interpolation view.



Settings/Graphics options	To call dialogue of seismic traces graphic settings.
Settings/File options	To call a dialogue of file reading and processing general settings.
Settings/Scaling options	To cause dialogue of image scales control.
Settings/mSec units	Specifies in what units display data(in milliseconds or counting).
Settings/Cross-hole survey	This option should be chosen if data of crosswell measurements are used.
Tools /Set working area	To fix a data working window. The sizes of a window are set in a mode  . The working window is used when self-scaling seismic traces. If the option Fix is included the working window is appointed for all the subsequent seismograms of project.
Tools/Select all	To establish all seismogram a working window of data.
Tools/Filtering	To call a dialogue of data filtration.
Tools/Undo filtering	To return to initial data.
Tools/Rotate plot	To develop seismic traces on ninety degrees. Depending on data type it is convenient to use vertical or horizontal seismogram orientation.
Tools/Picking mode	To activate a mode of a first-arrivals picking. Selection of the first introductions is carried out by the left mouse button. The pressing of the right mouse button disconnects the chosen value on a hodograph. With pressed SHIFT key the program interpolates values of the first arrivals between positions of the first and second mouse pressing.
Tools/Zoom mode	To activate a mode of increase/allocation of seismogram area. Allocation is carried out with tensile rectangle by mouse. Further it is possible to activate self-scaling mode for the chosen window.
Tools/Display cross	To show the crossing lines following the cursor.
Tools/Edit source pos	To call a dialogue of a fast coordinate dimensioning of a source for the list of files.
Options /Delete current shot	To remove current seismogram from the project.
Options/Delete empty shots	To remove from the project all seismograms for which the dive isn't carried out.
Options/Seismogram summarization	To add to flowing seismograms which were chosen in the <i>Multi</i> tab in the field of <i>Shot</i> .
Options/Trace summarization	To add to the active trace, the appropriate traces of seismograms chosen in the Multi tab in the field of Shot.
Options/ Sort shots by filename	To sort seismograms by names of files.
Options/ Sort shots by position	To sort seismograms by source provisions.
Options/ Sort trace by offset	To sort routes seismograms by distance from



	source.
Options/Copy trace	To copy the active seismic trace in clipboard.
Options/Paste trace	To copy data from clipboard to the active seismic trace.
Options/Reciprocity error	To show an average error of data correlation, calculated on the basis of a reciprocity principle.
Options/Start times error	To show graphics of expected errors of moment mark definition, calculated on the basis of a reciprocity principle.
Options/Start times error 2	To show graphics of expected errors of moment mark definition, the calculated on the basis of comparison observed and calculated hodographs. Called after the solution of a return task.
Options/Undo action	To cancel the last picking action.

File reading and processing general settings dialogue

To call dialogue of file reading and processing general settings is possible by means of the option **Settings/File options** or the toolbar button.

The **SEG-Y** tab contains options managing directors of files format of field data (fig. 2).

Before creation of the new project from the SEG-Y files it is necessary to be sure that settings of this tab correspond to used files.

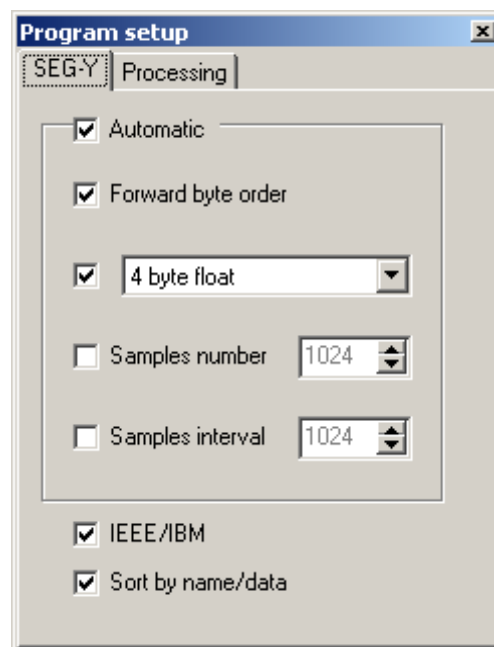
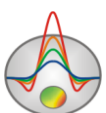


Fig. 2. **Program setup** dialog box, **SEG-Y** tab.

The option **Automatic** activates a mode of automatic format detection. If this option is disconnected - following settings are available.




The option **Forward byte order** - establishes an order of reading bytes. The pop-up list is intended for a choice such as data.

The option **Samples number** – establishes number of counting in the seismic trace.

The option **Samples interval** – establishes an interval of digitization of the seismic trace (in mSec).

The option **IEEE/IBM** – establishes a format of number of PC/UNIX. The options **IEEE/IBM** and **Forward byte order** are mainly used.

The option **Sort by name/data** – specifies to the program order of seismic trace sorting– by file name or by date.

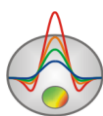
The **Processing** tab includes subsidiary settings. The first pop-up list is intended for a choice of algorithm of Fourier transformation (the fast - FFT or usual DFT). The second pop-up list allows choosing type of automatic updating of the first-arrivals in a mode . **To null** value – bring to a point of an excess of the seismic trace, to maximum – bring to a local extremum of the seismic trace.

Observations geometry input

If source-receiver geometry isn't entered at the record of **SEG-Y** files, to enter these data is possible by program options. Conveniently originally to enter geometry indexes (1,2,3 ...), and then to load file of coordinates by option in the **Hodographs** tab of multisection sell (described in the section “Options of multisection cell” in details).

The dialogue **Set source positions** called by means of the option **Tools/Edit source pos** allows to enter indexes of source positions in list of accumulation files (fig. 3).

In the top line of this dialogue in the fields dx and dz the index increment on the X and Z is specified. The button «+» binds an index to the following file on the X equal $S_x + dx$ and on Z – $T_z + dz$. For fast filling of the columns S_x and S_z on accumulation at the same provision of source it is necessary to put cursor on S_x of the last file, and with the clamped SHIFT button to click on S_x of first file relating to current source position.



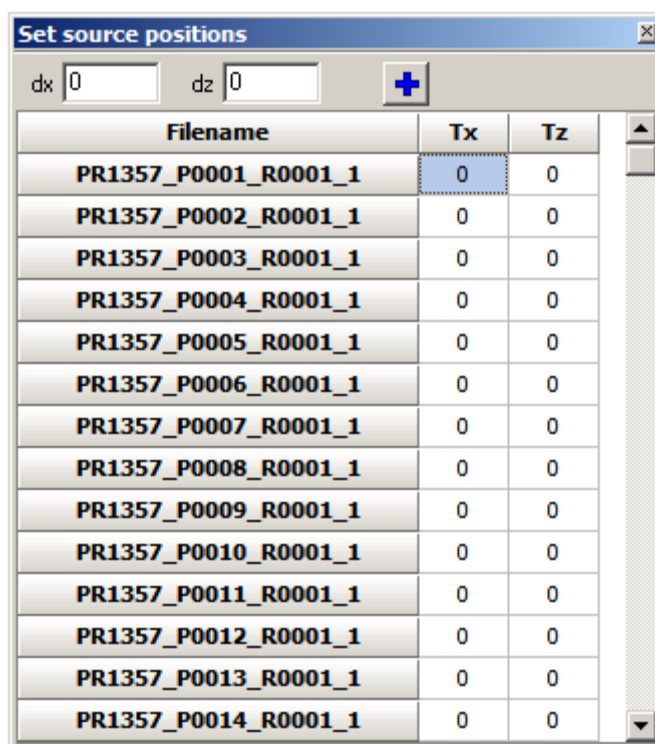



Fig. 3. **Set source positions** dialog box.


Source and receivers indexes can be entered also in the Rx, Rz and Sx, Sz columns in the **Table** tab of multisection cell.

In the **Hodograph** tab of multisection cell it is possible to keep or load supervision geometry in form of the file with the *.crd expansion. It is recommended to save such file as it allows deleting the entered geometry which is incorrect from the project before introduction of any geometry or demands changes (described in the section «Options of multisection cell» in details).

Seismograms visualization and scaling settings

For convenience of analyst work in Picking mode various possibilities of scaling and visualization seismograms are provided.

The increase in a separate area or its moving is carried out in allocation/increase mode  (the tool – “a tensile rectangle”). For selection of area which is necessary for increasing, the mouse cursor moves down and to the right, with the pressed left button (the Fig. 4A).

To move to the previous area of seismogram allocation it is possible by option . For return to initial scale, the same actions are made, but the mouse moves up and to the left (the Fig. 4B).

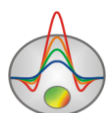
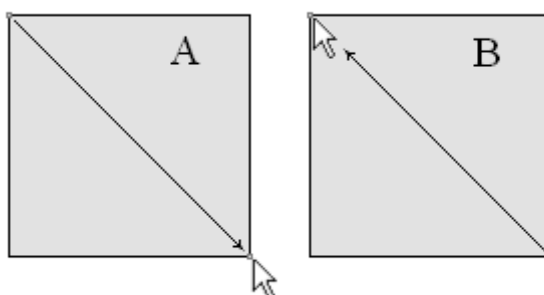


Fig. 4. The direction of mouse movement at scale change.

Seismogram scales setting dialogue

To open dialogue of control of seismogram scales possible by means of the option **Settings/Scaling options** or the button on a toolbar. (fig. 5).

Dialogue contains the options defining graphics scales of seismic traces and all image. The **Norm style** area establishes normalization type of seismic traces schedules.

Common maximum value - scales schedules on the general seismogram maximum.

Trace maximum value - each graphic scales on own maximum.

Average maximum value – graphic scales on average maximum seismogram value.

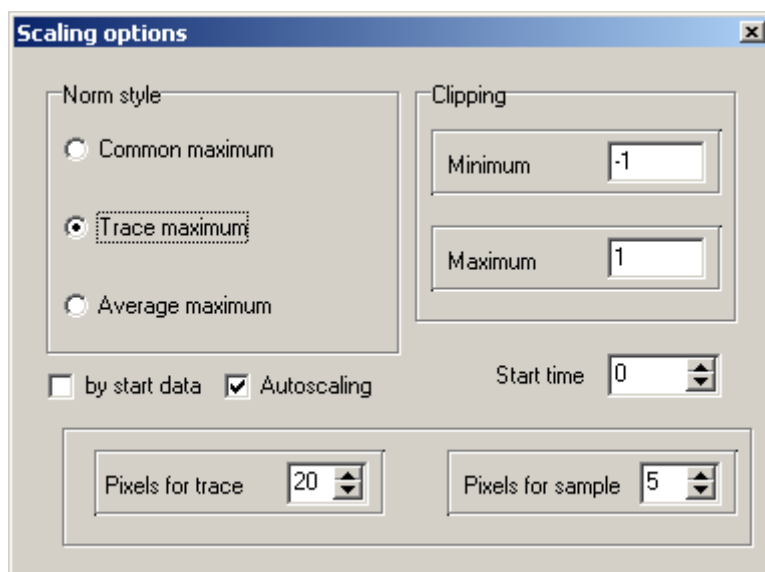


Fig. 5. **Scaling options** dialog box.

The **Clipping** area establishes limiting values of schedules maxima and minima on reaching which schedules are cut off.

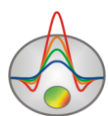
Maximum and **Minimum** values are set on the assumption of distance between the next traces to equally unit.


The option **By start data** – indicates to the program that scaling of schedules will be made with reference to initial (not filtered) data values.

The option **Autoscaling** – determines image scale of the count. If the option is included, the scale gets out automatically proceeding from the window size. If the option is disconnected – scales of the image are set by the options **Pixel for trace** (number of pixels on one trace) and **Pixel for sample** (number of pixels on one counting).

The option **Start time** sets a moment mark value (positive number in mSec or counting) for all seismic traces. The axis of times/counting is displaced so that to a moment mark there corresponded an axis zero. Emergence of negative values on an axis is thus possible.

Traces graphic settings dialogue



To cause dialogue of graphic settings of seismic traces is possible by means of the option **Settings/Graphics** options or the button  on a toolbar. (fig. 6).

The **Trace** tab contains the options which are responsible for appearance of seismic traces graphics. Two main First and Second areas are responsible for settings of the main and additional (being displayed over the main in the Multi mode) seismograms.

The Negative and Positive areas include color settings of minima and maxima of schedules (Fill color – color of filling, Transparent – without filling).

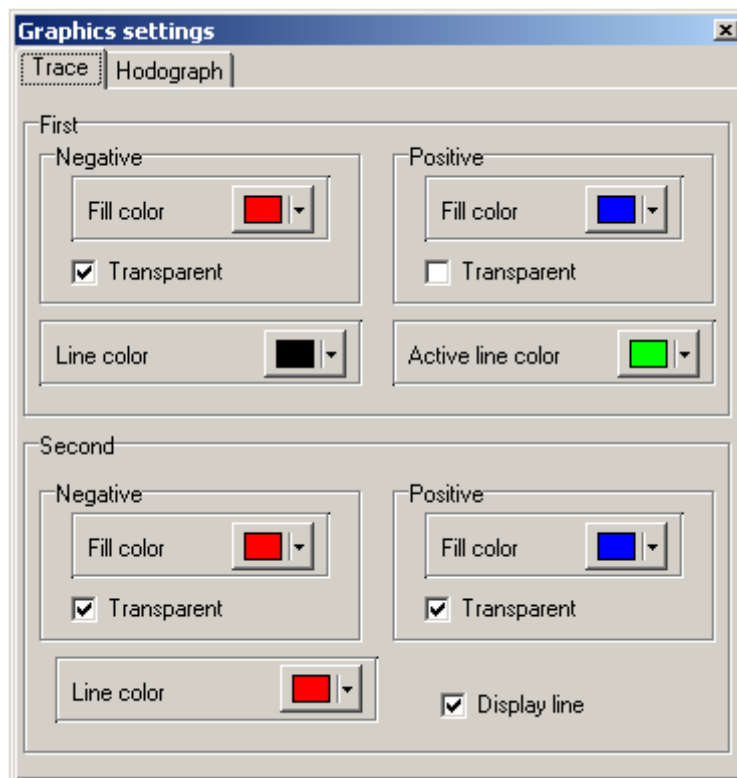



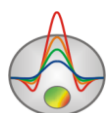
Fig. 6. **Graphics settings** dialog box.

The option **Line color** sets line color of graphics. The option **Active line color** sets line color of the active graphic. The option **Display line** - indicates whether it is necessary to draw graphic lines.

The **Hodograph** tab contains hodograph color settings being displayed on seismograms during a picking. The options **Current, Previous, Next, Reciprocity, Calculated** set colors for the current, previous, following, mutual and calculated hodograph. If the option is included – this hodograph will be displayed (if it is).

Mode of seismogram browse

Depending on data type it is convenient to use vertical or horizontal seismogram orientation. The button  on taskbar or the option **Tools/Rotate plot** allows to turn seismogram on 90o (the Fig. 7).



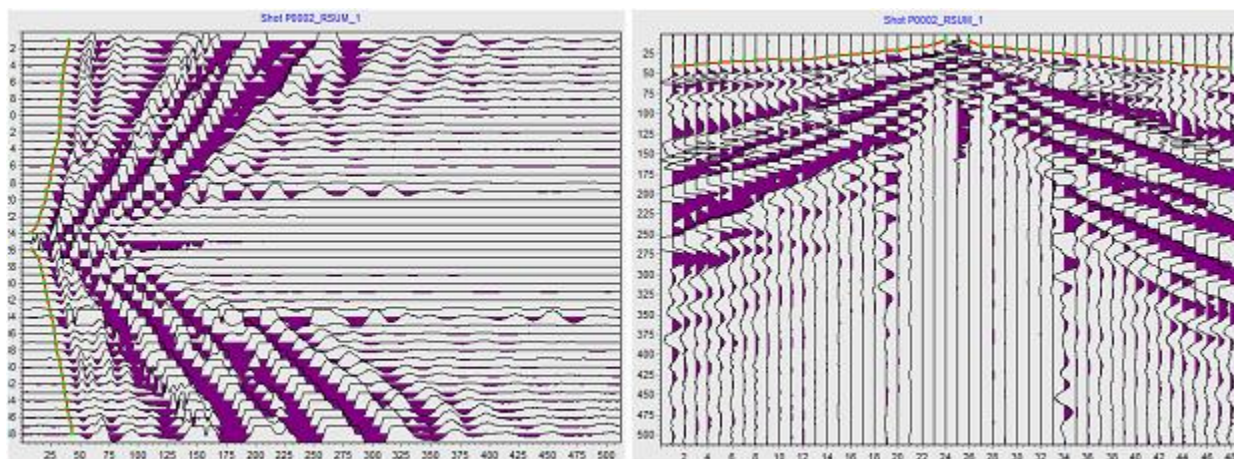



Fig.7. Horizontal and vertical seismogram orientation.

To show substrate which represents seismogram in interpolated view is possible with using button  on a taskbar or menu function **Settings/Image visible** (Fig.8). Color palette can be adapted having caused **Color palette** dialogue by the button on the taskbar or menu function **Settings/Image options** (the Fig. 9).

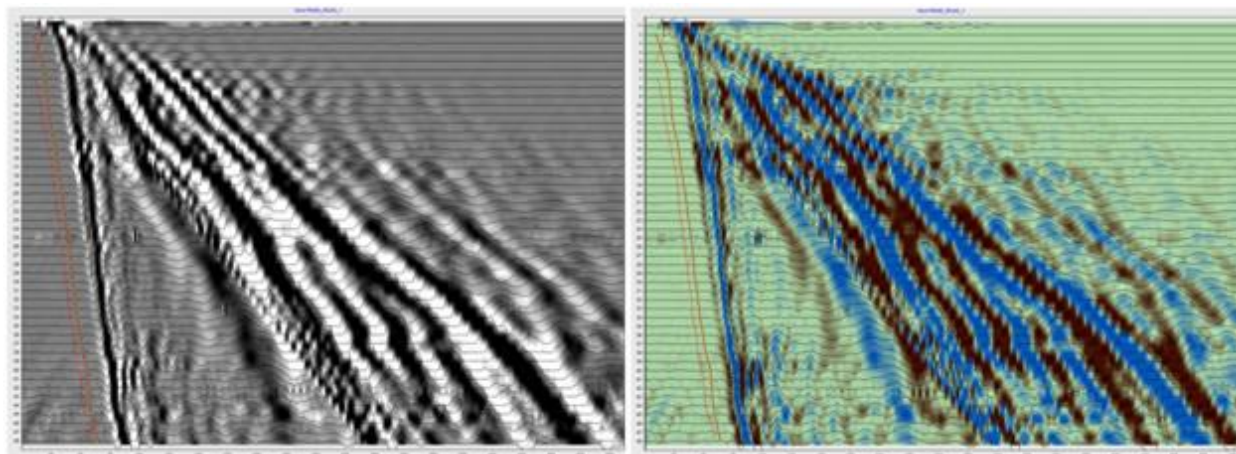


Fig. 8. Display seismogram options in an interpolation look.

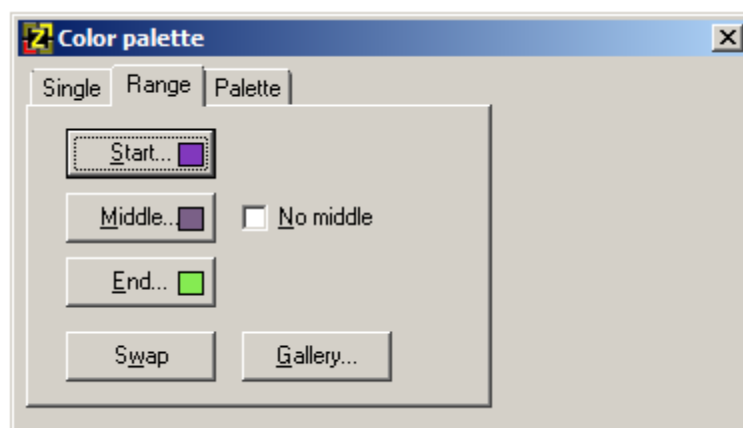
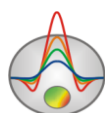


Fig. 9. Color palette dialogue.

Main seismogram picking mode options



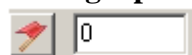
Seismogram possible to sort:

- by names of files - **Options/Sort shots by filename;**
- under source provisions - **Options/Sort shots by position;**
- by distance from a source - **Options/Sort trace by offset.**

Change of gain factor of the separate seismic trace is made by a mouse wheel when aiming on it of cursor or in the **Table** tab of multisection cell (details in the section “Option of multisection cell”).

Grading and summation seismograms are carried out at work with the **Multi** tab of multisection cell (details in the section “Option of multisection cell”).



To correct mark value of the moment possibly with the help the option **Start time** in the **Scaling options** window or in the **Hodograph** tab of multisection cell by means of a field






. Options set mark value of the moment (positive number in mlSek or counting) for all seismic traces. The axis of times/counting is displaced so that to a mark of the moment there corresponded an axis zero. Emergence of negative values on an axis is thus possible.

Real coordinates of sources and receivers can be loaded in form of file in the **Hodograph** tab of multisection cell (details in the section «Option of multisection cell »).



The program provided work with separate seismogram traces at the included selecting mode. Sum separate routes probably, adding to the active trace, the respective seismogram trace chosen in the **Multi** tab in field of **Shot** by means of option **Options/Trace summarization**. With option **Options/Copy trace** and **Paste trace** it is possible to copy separate seismic traces from one seismogram to another.

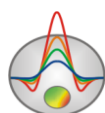
The first arrivals choice is carried out in the **picking mode**  by left mouse button. The pressing of right mouse button disconnects the chosen value on a hodograph. At the pressed SHIFT key the program interpolates values of first arrivals between positions of first and second mouse pressing. The observed hodograph is displayed by red color, calculated (if return to process of hodograph editing after **trace editor** inversion  – dark blue.

The program allows displaying mutual first arrival times in seismogram picking time. To activate this function it is possible by means of pressing of the following buttons:

Selecting  + **picking mode**  + in **graphics settings**  gets out the **hodographs** tab where the option **reciprocity** is activated. Mutual times will be displayed on traces by other colors which is possible to set in the **Hodograph** tab of **Graphics setting** dialogue (in the section «Dialogue of graphic settings of seismic traces » in details). Transition to mutual traces of seismogram is carried out by pressing of combination CTRL+ALT+click of left mouse button on the necessary trace.


Action cancellation (sword-play, input of coordinates) is carried out by a combination of the CTRL+Z keys.

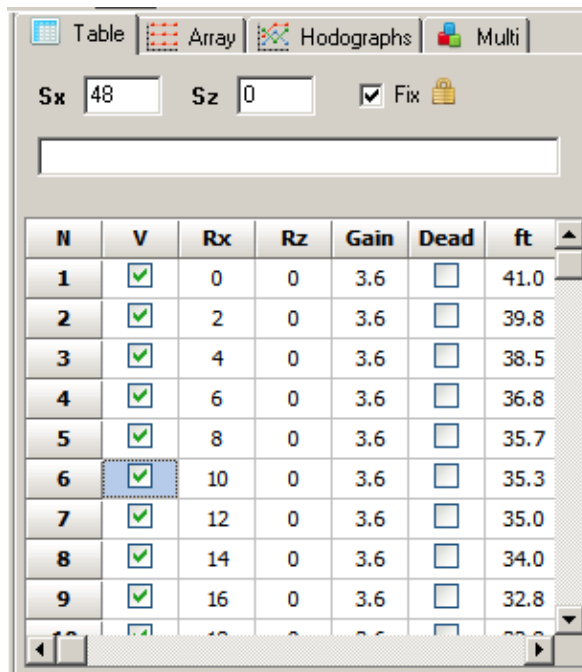
Creation of a matrix and transition to the module of inversion of data is carried out by means of the button  on the taskbar. With help of the button  in the **Hodograph** tab of multisection cell it is possible to keep hodograph and coordinates in FirstTomo and XTomo format files.



Multisection cell options

The multisection cell for control and display of parameters of system of supervision contains the following sections:

The **Table** tab  contains the table with coordinates of receivers, gains and other settings of active seismogram traces (fig. 10).



N	V	Rx	Rz	Gain	Dead	ft
1	<input checked="" type="checkbox"/>	0	0	3.6	<input type="checkbox"/>	41.0
2	<input checked="" type="checkbox"/>	2	0	3.6	<input type="checkbox"/>	39.8
3	<input checked="" type="checkbox"/>	4	0	3.6	<input type="checkbox"/>	38.5
4	<input checked="" type="checkbox"/>	6	0	3.6	<input type="checkbox"/>	36.8
5	<input checked="" type="checkbox"/>	8	0	3.6	<input type="checkbox"/>	35.7
6	<input checked="" type="checkbox"/>	10	0	3.6	<input type="checkbox"/>	35.3
7	<input checked="" type="checkbox"/>	12	0	3.6	<input type="checkbox"/>	35.0
8	<input checked="" type="checkbox"/>	14	0	3.6	<input type="checkbox"/>	34.0
9	<input checked="" type="checkbox"/>	16	0	3.6	<input type="checkbox"/>	32.8

Fig. 10. **Table** tab

The options **Sx** and **Sz** establish horizontal and vertical coordinate of a source for active seismogram

The same coordinates are set by means of Set source positions dialogue (in the section « Observations geometry input» in details).

The pressing of the right mouse button allows setting an increment of coordinates for all the subsequent seismograms.

The entry field is intended for input of comments to current seismogram.

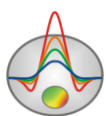
The option **Fix** is intended for inclusion of the general (through) trace parameters editing mode for all seismograms. The general parameters are coordinates of receivers, factors of strengthening, indicator of channel unavailability.

The **V** column – to include/disconnect the seismic trace. The pressing of the left button on heading of a column activates, right disconnects all routes.

The **Rx** column – establishes horizontal coordinate of the seismometer. By pressing of the right mouse button on table cell it is possible to set a coordinate increment for all subsequent cells.

The **Rz** column – establishes vertical coordinate of the seismometer. By pressing of the right mouse button on a cell of table it is possible to set a coordinate increment for all subsequent cells.

The **Gain** column – establishes factor of strengthening of the seismic trace. At the wrong polarity of record it is necessary to enter factor of strengthening with a minus sign. The pressing of



left button on heading of a column increases, right reduces (on the module) all seismogram gains. By pressing of the right mouse button on a table cell it is possible to set gain value for all subsequent cells. In the Fix mode of strengthening are established for all the subsequent seismograms.

The **Dead** column – the failure indicator. This seismic trace won't picking.

The **Ft** column – establishes value of time of the first introduction of the route (in counting).

The **Array** tab contains the count with the observation scheme (fig. 11).

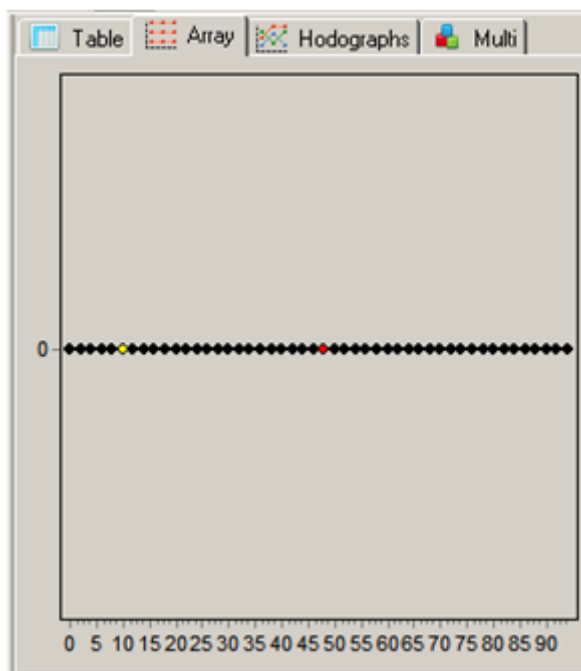
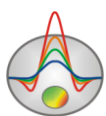


Fig.11. **Array** tab.

The shot point of active seismogram is displayed by red color. For the correct display of the acquisition scheme it is necessary to enter coordinates of receivers and sources. Exact coordinates can be loaded from the file in the **Hodographs** tab.

CTRL combination + click of the left mouse button on the PV schematic situation will carry out transition on corresponding seismogram the allocated point of explosion in the left seismogram mapping window.

The **Hodographs** tab is intended for display and editing of hodographs of all seismograms. In the course of a dive in this tab there are hodographs graphics. By pressing the graphic corresponding to it seismogram gets out (fig. 12).



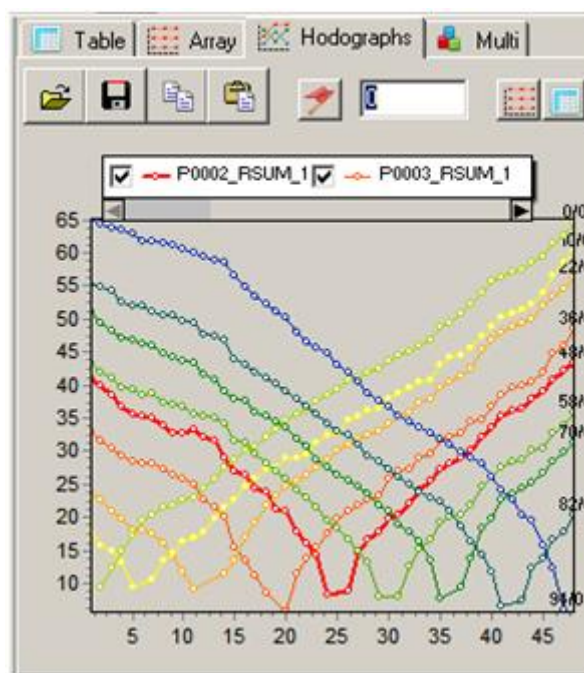



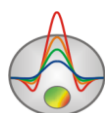
Fig. 12. **Table** tab

Editing of the measured values is made by dragging of a point of the schedule with the pressed left button of a mouse. All hodograph moves with the pressed SHIFT key.

Allocation of one and respectively removal of other schedules is made by the button of a mouse on a legend with the pressed SHIFT key. By repeated pressing return operation is made. For scrolling of schedules the mouse wheel is used. For this purpose it is necessary to allocate some next schedules (on a legend) and to roll a wheel of a mouse having placed the cursor on a legend. Indexes of active schedules will change.

The button  - opens the text file for performance of the following operations


Laccolite god file	To load a hodograph from the file of a format of the program of Laccolite in flowing seismogram
Laccolite god directory	To load all hodograph from a files directory of the program format of Laccolite into the project. Names of files with hodograph should correspond to project seismogram names
XTomo file	To load hodograph from the XTomo program file. The positioning of hodograph is carried out on sources coordinates
Coordinates	To load the file with real sources and receivers coordinates. In the beginning happens conveniently to work with coordinates set in common form (for example: 1, 2, 3 etc.), further it is necessary to change initial coordinates on real by means of the Coordinates file. The file has the following format of columns: Xbeg Zbeg Xreal Zreal
Crd file	To load the *.crd file with geometry of observation (it is in more detail described in






	the section “ Observations geometry input”)
2dCoordinates	To load the *.txt file with geometry of observation (it is in more detail described in the section “ Observations geometry input”)

The button


Laccolite god file	To save current hodograph in File with Laccolite format.
Laccolite directory	To save all hodographs of project in File directory with Laccolite format. The hodographs file names correspond with seismogram project names.
XTomo file	To save hodographs with coordinates in File with XTomo format
FirstTomo	To save hodographs with coordinates in File with FirstTomo format
Crd file	To save *.crd file with source-receiver configuration(in the section“ Observations geometry input” in details)

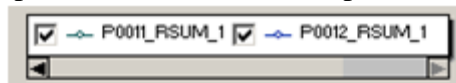
The button  copies the current hodograph in the buffer.

The button  - inserts a hodograph in flowing seismogram from the buffer.

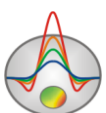
The button   - exposes as a moment mark value of time or the counting, chosen as the toddler in a window seismogram. The entry field allows setting a moment mark by keyboard. The times/counting axis is displaced so that to a mark of the moment there corresponded an axis zero. Emergence of negative values on an axis is thus possible.

Buttons also allow displaying in separate windows of the **Table** and **Array** tab that considerably facilitates work with data, allowing seeing full information about processed seismogram. In the **Array** window the same functions, as in the tab with the same name are carried out. Also the combination of the ALT+click keys of left mouse button on situation PV allows

displaying the corresponding hodograph in the **Hodographs** tab. The button  includes or switches off all hodograph. It is possible to choose also separate hodograph in the field of a legend.



The **Multi** tab is intended for combined display of two seismograms (fig. 13). It happens it is useful at comparison, summation seismogram, the analysis of relative seismic traces. The second seismogram is displayed by the line without filling and displayed according to scale of the first. At display two seismograms at the same time it is necessary to set coordinates of receivers and sources.



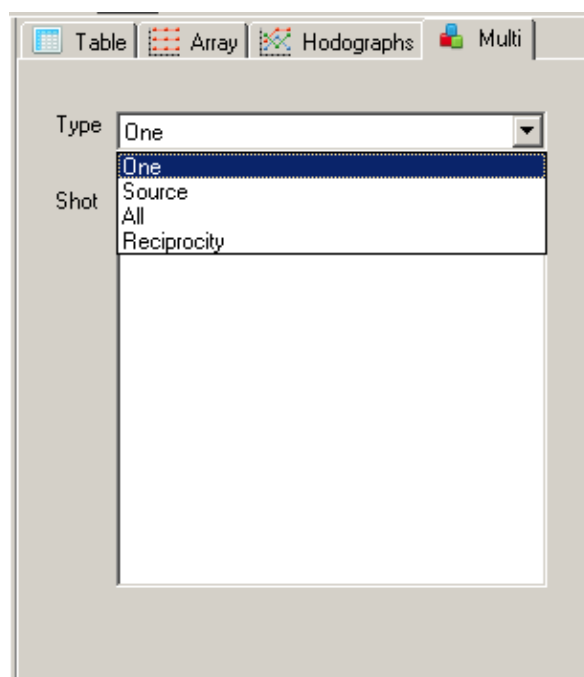





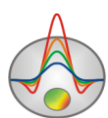
Fig. 13. **Multi** tab

The option **Type** sets type of display of two seismogram. To **One** value – to display one seismogram. **Source** - as the second seismogram is used one of seismogram corresponding to the current position of a source (repetitions, accumulation). All seismogram for an active source are displayed in the field of the list below in which it is possible to choose them. **All** - as the second seismogram is used any seismogram of the project. All project seismograms are displayed in the field of the list below in which it is possible to choose them. **Reciprocity** – to display mutual seismogram (input of sources and receivers coordinates is obligatory).

In the **Source** and **All** mode there is a small toolbar allowing to add  chosen seismogram to current or remove  chosen seismogram. The seismogram choice is carried out by mouse click a (are noted by a tick). The button  settles an invoice factor of correlation seismogram from the list with active seismogram (in the chosen working window). This option is used for the analysis seismogram received at one provision of a source more often.

Data filtration dialogue

Dialogue represents the tool for the analysis of specters and filtration of field seismogram. In the left part of a window the counts displaying the calculated range of the working window and a form of the filter (fig. 14) are located. Changing of filter form is made by right mouse button (to the closest point of an excess of the filter).



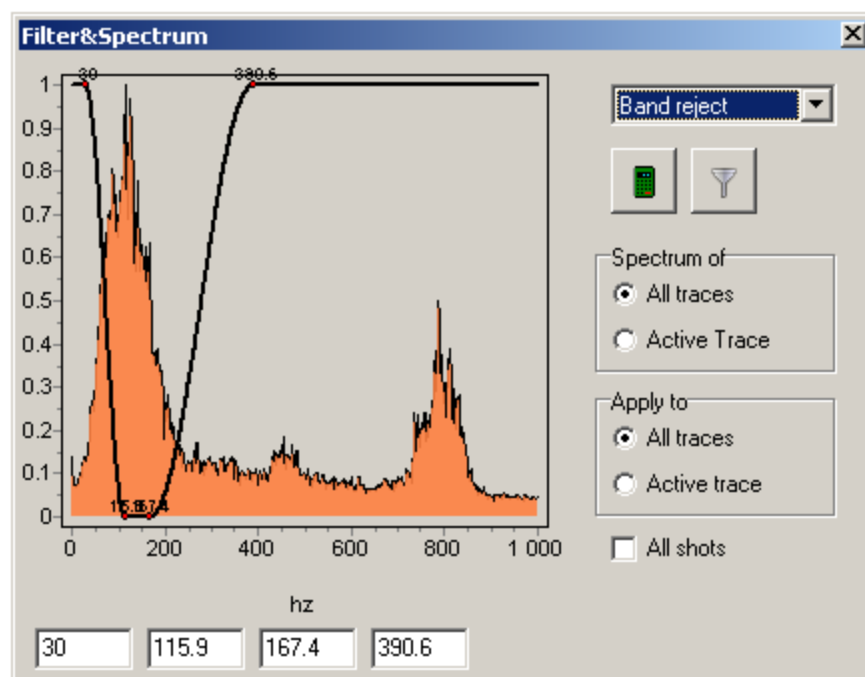





Fig. 14. **Filter&Spectrum** dialogue


The emerging list allows choosing filter type. In the program smooth analogs of filters of low and high frequencies, strip filters are used. The calculate spectrum  button counts a range for the chosen seismogram area (**All traces** - a working window, **Active trace** - the active route) and displays it in the column. The **apply filter**  button starts filtration procedure for the chosen seismogram area.

The **Spectrum** establishes seismogram area for which the range will pay off. **All traces** value – a range pays off for seismogram. **Trace** value – a range pays off for the active route.

The **Apply to** area defines seismogram area to which filtration procedure will be applied. **All traces**-value a filtration is applied to all data. **Active trace** value – a filtration is applied to the active route. Active trace is allocated in the **selecting**  mode. The option All Shots applies the chosen filter to all seismograms.

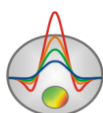
Field data inversion module

Data file creation and opening for inversion

To start interpretation in the ZONDST2D program it is necessary to make data processing in the module of a dive of the first introductions (**Create survey**) and to pass to an inversion mode , or to create the file of data of the defined format, containing information on geophones coordinates, topography and value of the first introductions. «ZONDST2D» also supports the most popular formats of data: XTOMO.

Usually one file contains data on one profile of supervision. The text files of data organized in a format of the ZONDST2D program, have «*.ST» expansion. (in the section “Format of basic data file” in details).

Zond data file	To open the file of data or the file of the
----------------	---



	project of the Zond format.
Program configuration	To open the file with program parameters.










For the correct work of the program the file of data shouldn't contain:

- the nonconventional symbols dividing records in line (use TAB or SPACE symbols)
- absurd values of measurement parameters (for example, negative values of times of the first introductions)

It is desirable, that the total number of measurements containing in one file didn't exceed 10000, and the number of unique positions of sources/receivers didn't exceed 500.

Main window toolbar

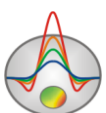
Toolbar works for shortcut high-usage program functions. It contains next functional buttons:

	To open data file
	To call data retention dialogue
	To call inversion settings dialogue
	To call source/ receiver editor
	To activate direct modeling process
	To activate or stop(with recurrent pressing) inversion process
	To cancel alteration step of subsurface model
	To call first-arrivals picking mode. If project with seismograms is loaded – it is possible to edit first-arrivals values in compliance with theoretical hodographs values(from inversion). After exiting from window(button  in this case isn't necessary to push)new values move in Inversion module

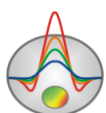
Main window function menu

Menu item titles and its appointment are listed below:

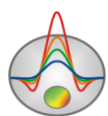
File/Create survey	To call the first-arrivals time picking module
File/Syntetic survey	To call dialogue of synthetic measuring system creation
File/Open file	To open data file
File/Save file	To call data saving dialogue
File/Edit data	To open data file used by the program in the Notepad editor
File/Project information	To show information about the loaded project
File/Print preview	To call printing dialogue of program main window.
File/Recent	The last used files
File/Reg file	To create the registration file
File/Register	Program registration
File/Exit	Exit the program
Options/Mesh constructor	To call dialogue of initial model control



Options/Program setup	To call inversion parameters control dialogue
Options/Data editor	To call the measurements editor .
Options/Observed graphics	To call dialogue of control of observed graphs parameters.
Options/Calculated graphics	To call dialogue of calculated graphs parameters control
Data/First times	To represent values of the first arrivals.
Data/ Apparent resistivity	To represent values of apparent velocities.
Data/Hodographs	To display of the first arrivals hodograph graphs
Data/IsoOffset	To display first arrivals graphs corresponding to an identical spacing between the receiver and source.
Data/Ray paths/Direct	To show on model seismic rays connecting sources and receivers (option of a homogeneous environment).
Data/Ray paths/Calculated	To show on model seismic rays connecting sources and receivers calculated for the current model.
Model/Block section	To represent model in the block form.
Model/Smooth section	To represent model with smooth parametrization.
Model/Contour section	To represent model in the form of a contour cut.
Model/Velocity	To represent velocity model.
Model/Sensitivity	To represent function of sensitivity of model in the form of a contour cut.
Model/dVelocity	To represent model of a full velocity gradient.
Model/Extend bottom	In the presence of a relief this option stretches the bottom model cells to a depth maximum.
Model/Cut by rays	To cut off a part of model not covered with the calculated seismic rays.
Advanced/Inverse procedure/Underwater options/ Velocity	Establish velocity in water
Advanced/Inverse procedure/Underwater options/ Invert	To include selection of water velocity
Advanced/Inverse procedure/Underwater options/ Sublayers number 3	Establishes number of water layer partitions
Advanced/Inverse procedure/Display process	Shows graphs of inversion parameters change in each iteration and in the general process of selection (An error of data, an error of model, the damping factor, the weighed error of data).
Advanced/Inverse procedure/Average window 8x4	With activation of this option as background m_0 value for model misclosure calculations used the median in a window (is used only at smooth inversion of Occam)
Advanced/Inverse procedure/Invert start times	Activate a mode of automatic marks selection of the moment at inversion. This option should be included at problems with definition of marks of the moments.
Advanced/Inverse procedure/Optimize/	To activate or cancel a mode of step length



Length- step	automatic choice. The given mode reduces to acceleration of algorithm convergence, but in certain cases doesn't allow getting round local minimums of decision.
Advanced/Inverse procedure/Optimize/Damping	To activate or cancel a mode of an automatic choice regularizer. The given mode leads to acceleration of algorithm convergence, but in certain cases doesn't allow getting round local minimums of decision.
Advanced/Inverse procedure/Optimize/Full optimization	To activate or cancel a mode of full optimization regularizer. The given mode is necessary if the decision gets to a local minimum.
Advanced/Cells summarization	To cause dialogue of association of cells of a cut (reducing and cut smoothing).
Advanced/Velocity-Offset plot	To show the count of dependence of seeming velocities from offset. This dependence allows setting initial model for inversion. The factor establishes a parity between depth and offset.
Advanced/ t_0 fields	To display on model a field of the first arrivals times. At moving under the table the field will change depending on coordinate of the chosen source.
Advanced/Reverse	To unwrap a data set at loading.
Advanced/Shift	To displace across on a constant value a data set at loading.
Advanced/Set weight	To establish weight of measurements for a current data profile.
Advanced/ Weight as offset	To establish weight of each measurement according to distance between a source and the receiver at inversion.
Advanced/Receiver RMS	Shows value relative are misclosure for each source/receiver.
Advanced/Real topo coordinates	To display real profile excess.
Advanced/Extended nodes	Adds complementary units along the edges of model.
Advanced/Orientation	Establishes model orientation and data in a working window depending on system of supervision (auto), or compulsorily (vertical, horizontal).
Import /Export/Carotage data	To open and show a file with logging data and stratigraphic columns.
Import/Export /Import model/data	To import to the program any data or model. ^
Import/Export /Remove data	To remove from the project schedule received of imported data
Import/Export /Save selection	To keep parameters allocated in the cells model editor.
Import/Export /Load selection	To open a file with the allocated cells and to insert from a current position of the cursor.
Import/Export /Extract 1d log	To keep a vertical profile of velocities for the set horizontal coordinate.



Import/Export /Load 1d log	To insert into model a vertical profile of velocities and their limits on the set horizontal coordinate.
Import/Export/Section file	Import a file of a format of program SectionCor (*.sec).
Import/Export/Output setting	Options of the exported image
Export ray paths	To keep the radial scheme in a text format.

Imported data file must consist of two columns: gaging point, value. As a vertical axis of imported data the first axis of graphics plane acts. Imported model must be included in Zond2D project file. In time of it loading new window with model will appear. With tracking in modeling area position of active cell viewing on model from imported file.

“Hot” keys


Cursor keys/cursor in model editor	Changing of model active cell
Delete/ cursor in model editor	To clean active cell
Insert/ cursor in model editor	To bind current value to active cell
F/ cursor in model editor	To fix active cell value
X/ cursor in model editor	To use tool magic wand for selection of area
V/ cursor in model editor	To remove selection
Up/down/ cursor on color scale	To change current value
Space	To calculate direct task

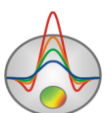
Status panel

Status panel of program separated on several sections contained different information.

Cursor and active cell position
Active cell parameters
Model editor operating conditions
Process display
Relative mistie
Additional information. For example quantity of measurements and model cells or process status in the inversion time.

Start model settings dialogue

After creation of "*.ST" data file it should be loaded by button  or corresponding menu point. At successful loading of file, there is a dialogue of starting model control in which it is offered to choose parameters of a network and initial high-speed model of the containing environment. Also it is possible to load this dialogue through the main menu of the **Options/Mesh Constructor** program (fig. 15)



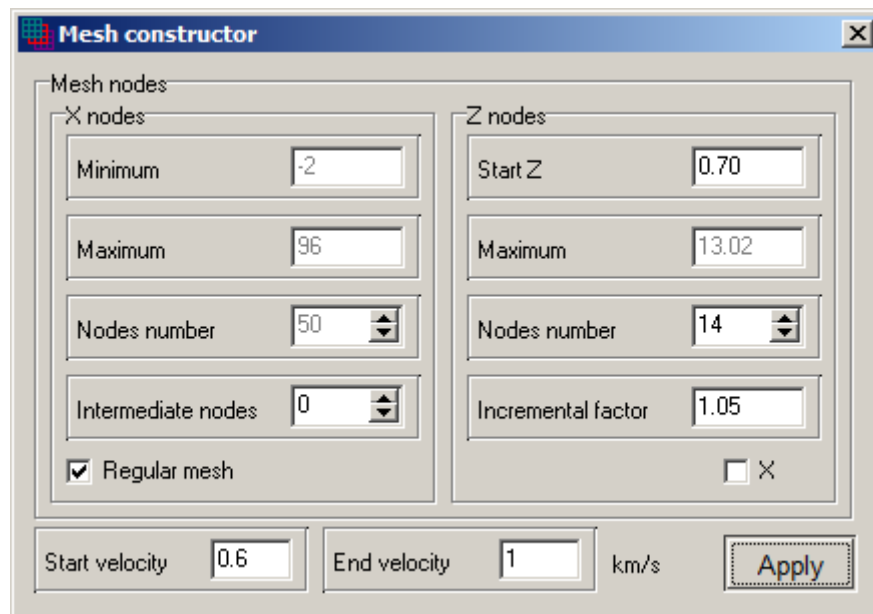


Fig. 15. Mesh constructor dialog box.

The **Z nodes** area contains options allow setting parameters of vertical model grid. The program automatically chooses these parameters, being guided by the following rules:

- Depth of the bottom layer corresponds to a distance half between receivers.
- The number of layers corresponds to the doubled quantity of a unique rating for this measuring system and doesn't exceed 16.
- Thickness of the subsequent layer at 1.05 times more the previous.

Start Z/Minimum – fixes thickness of the first layer. This size should correspond approximately to cell length and satisfy necessary resolution. If the option X is established specifies the minimum vertical model coordinate.

Maximum – specifies depth of the bottom layer. It is necessary to mean that the maximum depth shouldn't be too great, since influence of parameters of a cut with depth decreases.

Nodes number – establishes quantity of layers of model. There are usually enough 15-18 layers for the model description at land works. If the option X is established specifies number of vertical model nodes.

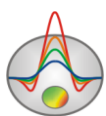
Incremental number/Intermediate nodes – establishes a ratio between thicknesses of adjacent layers. Values of this parameter usually choose in a range from 1 to 2. If the option X is established defines number of intermediate nodes of a network (between receivers).

The **X** – establishes vertical nodes of a network of model in positions of receivers. This option is convenient for applying at interpretation of log data.

Regular mesh – includes algorithm of creation of a vertical system at which additional nodes get out of a condition of splitting uniformity. The option should be included in case of strongly differing distances between the next sources/receivers (it is positively reflected in the solution of a straight line and a return task).

The **X nodes** area contains options allow setting parameters of a horizontal model grid.

Minimum – indicates the minimum coordinate of a measurement profile.



Maximum - indicates the maximum coordinate of a measurement profile.

Nodes number – indicates number of horizontal model nodes. If the system of supervision with one well (i.e. one coordinate is used x for all set of data) – this option sets number of complementary units at the left and right of well.

Intermediate nodes – fixes number of additional knots between unique positions of sources/receivers on a profile (0-4).

Regular mesh – includes algorithm of creation of a horizontal mesh at which additional nodes get out of a condition of uniformity of splitting. The option should be included in case of strongly differing distances between the next sources/receivers.

Start velocity – fixes speed of the top layer of starting model.

End velocity – fixes speed of the bottom layer of starting model. Values of intermediate layers speeds are by linear interpolation between the first and the last.

After control of parameters of a network the **Apply** button is pressed, and the program passes to an operating mode.

To correct a mesh: to add or remove intermediate nodes of a mesh, to level height or width of cells, it is possible also having used options in the model editor (in detail in the section «Editor of model»). Alternative of file of data using is creation of synthetic system of the supervision, allows stimulating various geological situations for the most widespread tomographic installations (it is detailed in the section "Modelling").

Format of basic data file

Program presents multipurpose data format engaging information about current and measuring sources/receivers, marks relative relief elevation and first arrivals values. ZONDST2D program data format have a dilation *.ST.

Data file provisionally can divided into three parts: 1) Observed data, 2) Topography data (In case of their existence), 3) model data (saving into the file after inversion or modeling).

I data file part: observation data

First line – contains control keys, indicating to the program which data is contained in such or another column.

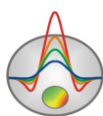
In “ZONDST2D” accepted next notation First line (keys) for coordinates of sources and receivers:

Sources S_x , S_y , S_z

Receivers R_x , R_y , R_z

Y and Z coordinates necessary to bring as appropriate. For example in using of flatbed observation system, compound measuring system (surface-well) or changes on water area [sample_with_z_source](#), [sample_with_chdata](#).

With insertion Z-coordinates of sources/receivers it is necessary to remember that positive values indicate source/receiver dipping relative to observation surface (for example in observations in a well way).



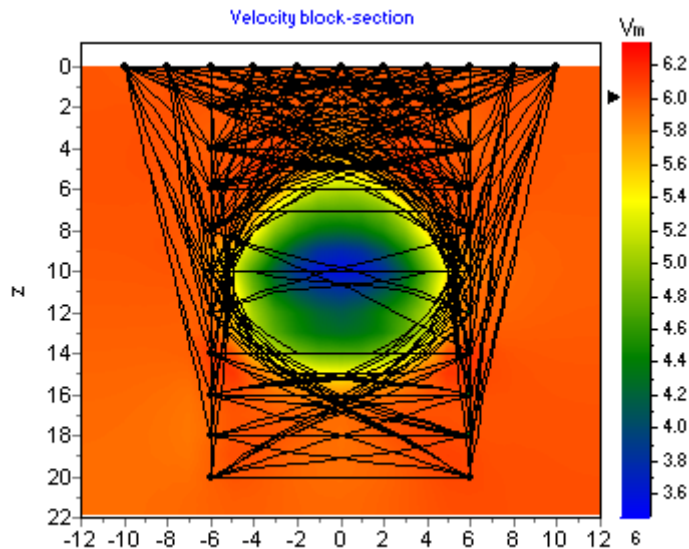


Fig.16. System of supervision well-well, well-surface, surface-surface.

Negative coordinates are used only at water measurements (the surface of measurements considered a bottom).

For the measured values:

Times of the first introductions (mlSec) **ft**

The error, or weight of measurements is set in a column with **Weight** key, defines quality of measurements. Values of measurement scales should be set in a range from zero to one. In the absence of data on measurement errors of (i.e. in the absence of a column with **Weight** key) the program automatically appoints weight 1 to each measurement.

The second and the next lines contain actually this, corresponding to each measurement, written down in the same sequence, as operating keys of the first line.

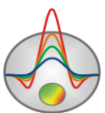
Further the column of additional nodes of a horizontal mesh (if it is necessary) is entered. The coordinate of each new node is entered after a symbol *******. Additional nodes of mesh are usually entered for expansion of area of model for extreme receivers of a cable or in the presence of a sharp relief outside of [sample_with_ext_nodes](#) cable.

II data file part: topography data

If there are data on a relief, further follows the line with the word **topo**, and then the list from coordinates and relief growth. To various techniques of relief assigning there correspond the following additional keys.

topo this key is used, if coordinates of receivers and topographical shooting are specified in horizontal projections of [topo1](#).

topo ~ reduction to the horizontal plane (fig. 17). The relief curve is approximated by a straight line on a method of the smallest squares, then turns with all points of a relief to coincidence to a horizontal axis. This way should be applied, when works are made along a slope with known absolute values of a relief of [topo2a/topo2b](#).



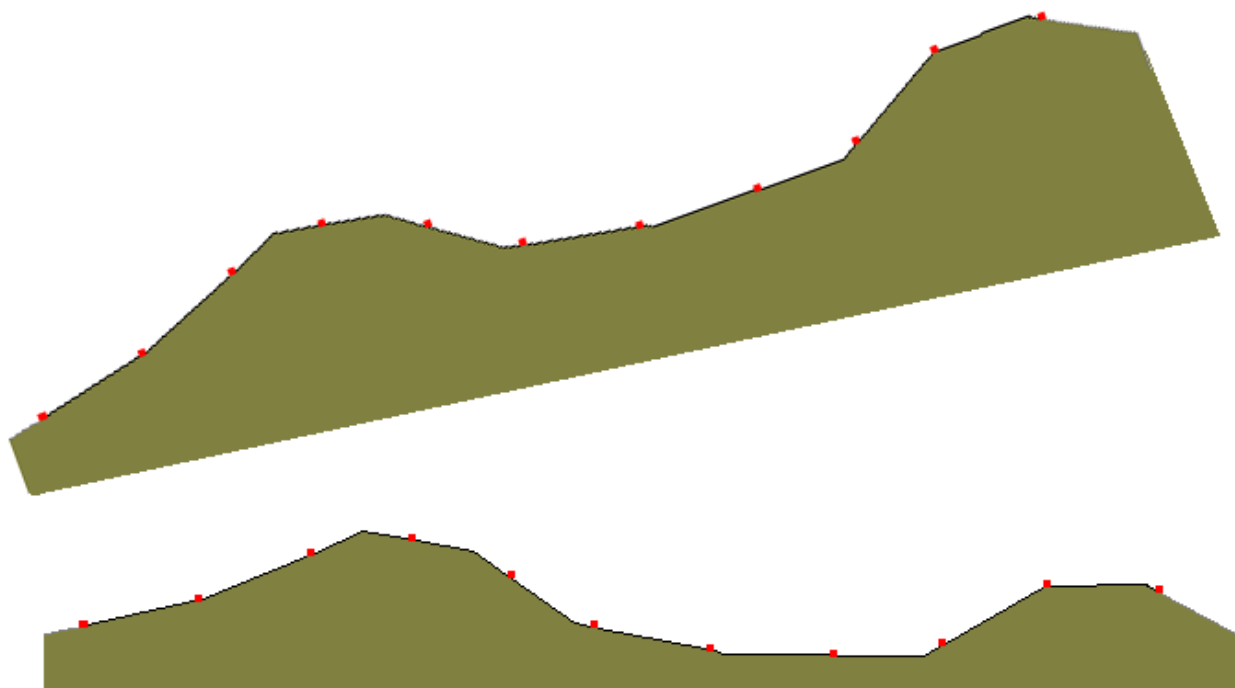


Fig.17. Relief reduction along a slope to the horizontal plane.

topo# profile coordinate dimensioning by length(“serpentine”)(Fig.18.). Horizontal coordinate of receivers in this case is distance along cable(not X projection). X-coordinates of receivers are recounted from length into horizontal view. In the next to the key line must be noted connection of one of sources/receivers **P** on cable to relief point. Second note – receiver coordinate(in length), first note – corresponding coordinate X on the topographic excess list [topo3](#).

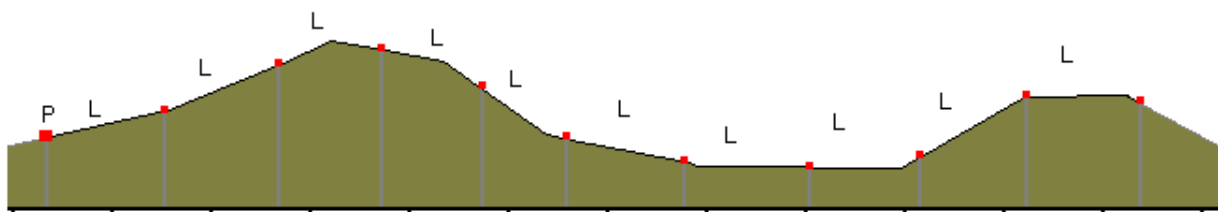
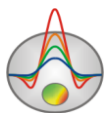


Fig. 18. Position of receivers with distance between them taking into account relief changes (along a plait).

topo^ furnished the clue is necessary, if data of topography and coordinate of receivers are set in distances along [topo4](#) plait.

Keys can be combined for example [topo ~#](#).

topow – this key is used if carried out interpretation of data received at work on water areas (on a water surface and at the bottom). In this case as coordinates of a relief the profile of a bottom or a bottom passing to a land (if the mixed measurements are used) (fig. 19) is used. Thus in the same line through a gap it is necessary to specify a water level (coordinates of a bottom rather set below a profile (in system of coordinates in which the relief is set)), speed in water and number of additional partition of a water layer (2-4). The last two parameters can be changed, using the menu of functions of the main window of the [water1](#) program. It is possible to set the combined [water3](#) systems when measurements are made at a bottom and on a surface of a water layer. For this purpose it is necessary to enter vertical coordinates of receivers concerning level of a profile of a bottom.



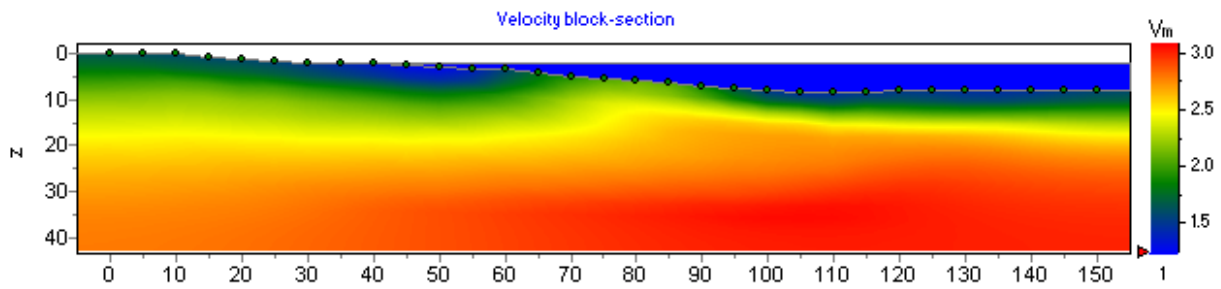


Fig. 19. The high-speed cut received as a result of mixed measurements on land and water area.

topo* – in a water case furnished the clue simplifies topography data input if the cable is on [water2](#) water surface.

By default in a window of model, excess in a relief are displayed concerning zero at **option Real topo coordinates** activation are displayed excess which are specified in the file. At **Grid file** saving with real excesses in the exported file the option **Real topo coordinates** should be included.

III data file part: model data

The environment model description begins with model keyword. In the first line the following parameters are written consistently down: speed of the environment, the minimal speed of a color scale, the maximal speed of a color scale, factor of a model distortion with a relief (**topo coefficient**).

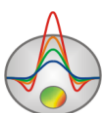
The second and third lines contain lists of horizontal and vertical coordinates of knots of a network (length of n and m).

The following lines n-1 of long m-1 contain a matrix of speeds of model.

Graphics plane

The plan of graphics serves for display of values of hodographs of the first arrivals of **Options/Data/First times** and apparent velocities of **Options/Data/Apparent velocity** along a profile in the graphics form.

In the main menu of the **Options/Data program** it is possible to choose a way of graphics creation or the **Hodographs** (the Fig. 20A) or schedules for a certain rating of **IsoOffset** (the Fig. 20B).



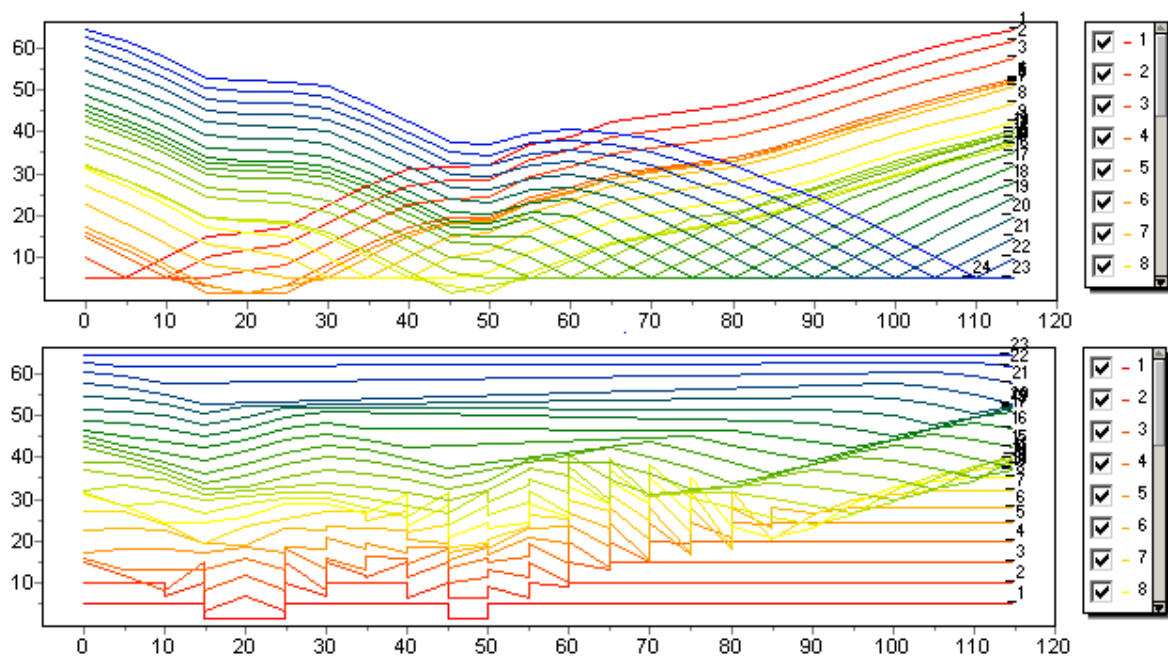


Fig.20. Graphics plane: A. **Hodographs**, B. **IssoOffset**.

Work with graphics plane carrying out by mouse:

Growth of separate area or its moving realizing in the mode with pressed button (tool – “elastomeric rectangle”). For selection area, which is necessary to grow, mouse cursor is moving down and right with pressed button (Fig.21A). For reversion to initial scale produced the same actions but mouth moves up and left.

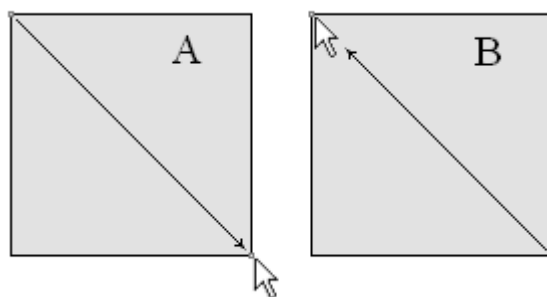
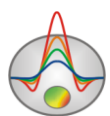


Fig. 21. Direction of mouse moving in scale changing.

By pressing of the left mouse button a graphic on point are made following actions: other graphics are cleaned and positions of sources/receivers for an active point (to release mouse button) are displayed. Editing of the measured values is made by dragging of a point of the schedule with the pressed right button.

Allocation of one and accordingly removal of other schedules is made by mouse button on a legend with pressed key SHIFT. At repeated pressing is made return operation. For scrolling of schedules is used mouse scroll. For this purpose it is necessary to allocate some the next schedules (on a legend) and to twist a mouse scroll having placed the cursor on a legend. Indexes of active schedules will change. By pressing of the right button of the mouse a schedule point – measurement will be allocated in the table.



Dialogue of adjustment of schedules is caused from the main menu Options/Observed (Calculated) graphics.

In a mode of display of the data in the form of schedules there is a possibility to exclude some measurements from processing, setting it weight 0. Separate measurement can be excluded by pressing ALT and the left button of the mouse on a schedule point, by pressing of the right button of the mouse and ALT on the schedule, all measurements belonging to this schedule will have weight 0.

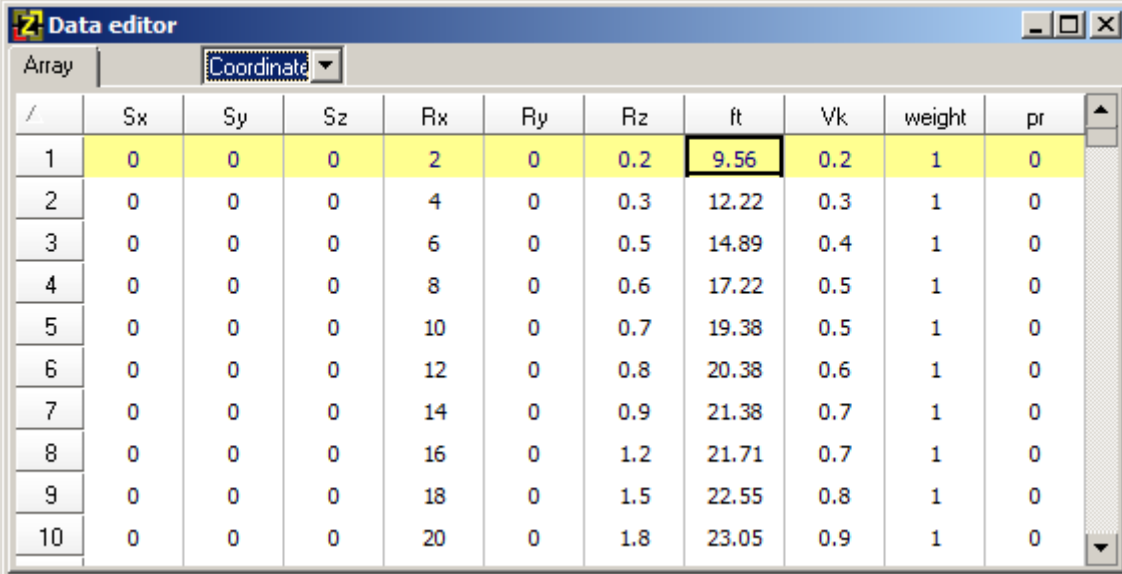
By pressing of mouse right button with key SHIFT on an axis or the schedule there is an emerging menu allowing to cause dialogue of adjustment of parameters of the given object.

Measurements editor

The editor of sources/receivers is caused by means of the menu of functions Options/Data editor and serves for visualization of system of supervision and the measured values. (Fig. 22). The table contains 10 columns:

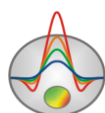
Sx	Source location according to X*.
Sy	Source location according to Y*.
Sz	Source location according to Z*.
Rx	Receiver location according to X*.
Ry	Receiver location according to Y*.
Rz	Receiver location according to Z*.
ft	First arrival time value
Vk	Apparent velocity of longitudinal waves propagation
pr	Index of profile measurement
Weight	Measurement weight

* - by means of option **Coordinates/Positions** switching over the table position of receivers and sources can be displayed in this window in initial coordinates, which contain in the file of data (a mode – **Coordinates**) or in the calculated horizontal projections (a mode – **Positions**).



Data editor										
Array Coordinate										
/	Sx	Sy	Sz	Rx	Ry	Rz	ft	Vk	weight	pr
1	0	0	0	2	0	0.2	9.56	0.2	1	0
2	0	0	0	4	0	0.3	12.22	0.3	1	0
3	0	0	0	6	0	0.5	14.89	0.4	1	0
4	0	0	0	8	0	0.6	17.22	0.5	1	0
5	0	0	0	10	0	0.7	19.38	0.5	1	0
6	0	0	0	12	0	0.8	20.38	0.6	1	0
7	0	0	0	14	0	0.9	21.38	0.7	1	0
8	0	0	0	16	0	1.2	21.71	0.7	1	0
9	0	0	0	18	0	1.5	22.55	0.8	1	0
10	0	0	0	20	0	1.8	23.05	0.9	1	0

Fig. 22. Data editor dialog box.



Two penultimate columns in case of need can be edited by means of the keyboard. It is not necessary to enter absurd values for times of the first introductions. Weight of measurements are set in a range from 0 to 1.

When moving cursor in the list the positions of sources and receivers of active measurement are displayed on the plan of schedules and model.

At activation of option **Options/Data/Ray paths/Calculated** at each situation a source - the receiver in a window of model is displayed the scheme of beam trajectories calculated on the basis of parameters of model (fig. 23).

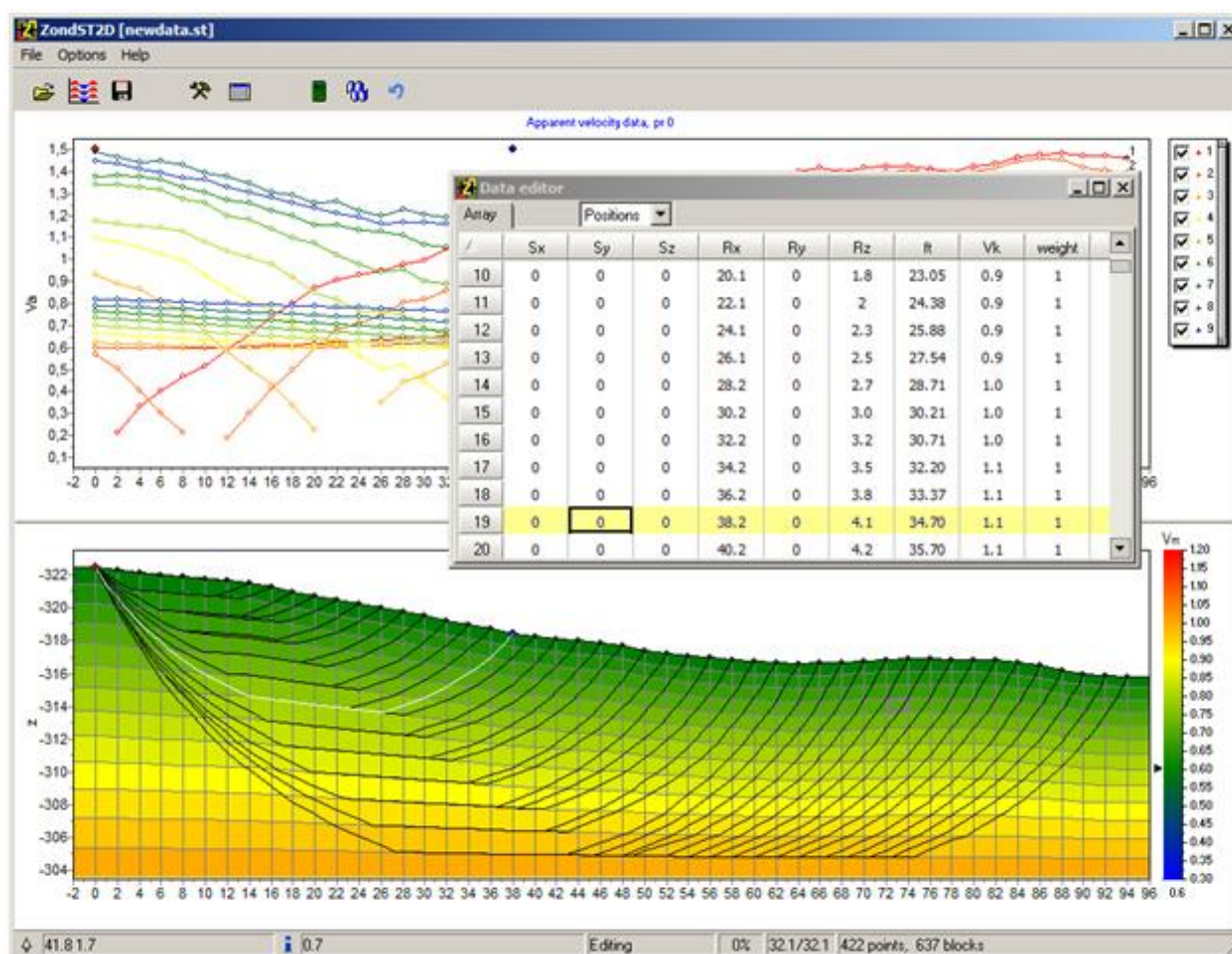


Fig. 23. Viewing radial trajectories in a program active window using **Data editor** dialogue.

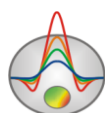
Data inversion

After loading data File and control of starting model by the following step it is necessary to choose type of inversion and to adjust parameters. Dialogue of control of parameters of inversion can be caused by means of the button or **Option/Program setup** menu point.

Inversion settings dialogue

Dialogue is intended for control of the parameters connected with the solution of a direct and an inverse problem.

Default – appropriates to value parameters "by default".



The Inversion tab is intended for control of parameters of inversion (fig. 24).

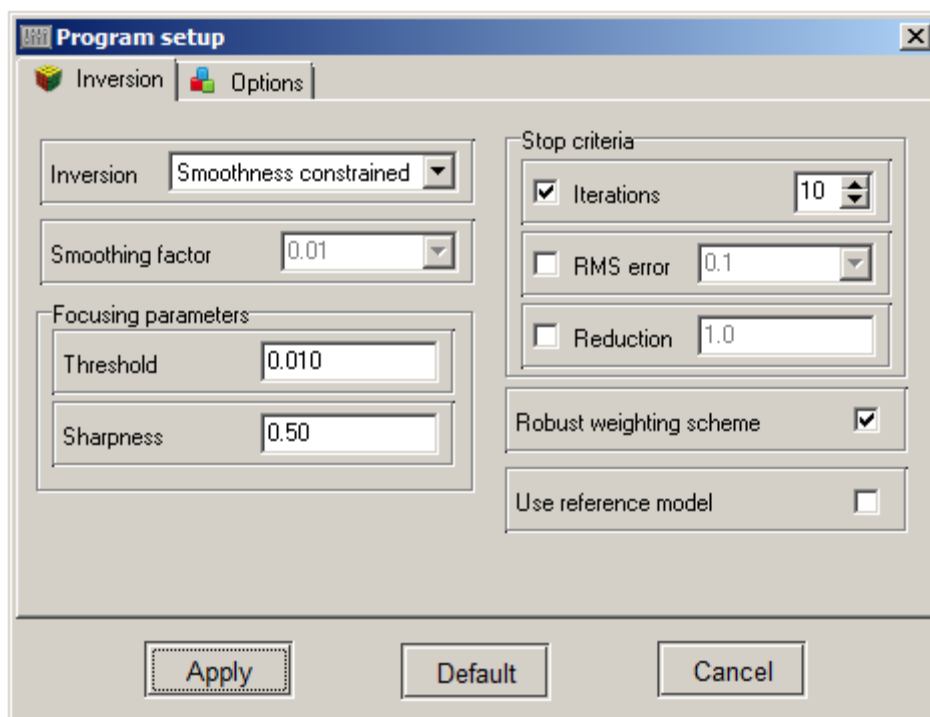


Fig.24. **Program setup** dialog box, **Inversion** tab

The option Inversion defines algorithm by means of which the inverse problem will be solved.

Let's consider various algorithms of inversion, on an example of model of the environment consisting of several blocks (fig. 25).

Parameter distribution in test model differs from really meeting distribution of speeds of elastic fluctuations in environments, but allows showing distinctions of algorithms of inversion visually.

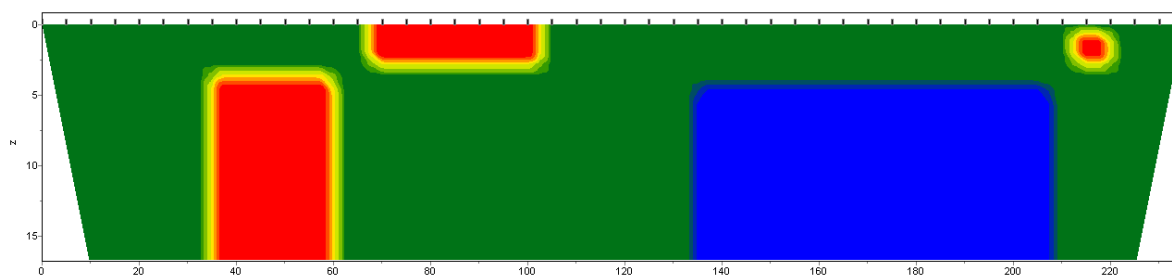
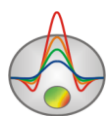


Fig.25. Test model of the environment.

For testing of algorithms we will calculate a theoretical response for this model and we will impose five-percentage Gaussian noise.

Smoothness constrained – inversion on a smallest quadrates method with using of the smoothing operator. As a result of application of this algorithm receive smooth (without sharp borders) and steady distribution of parameters (fig. 26).



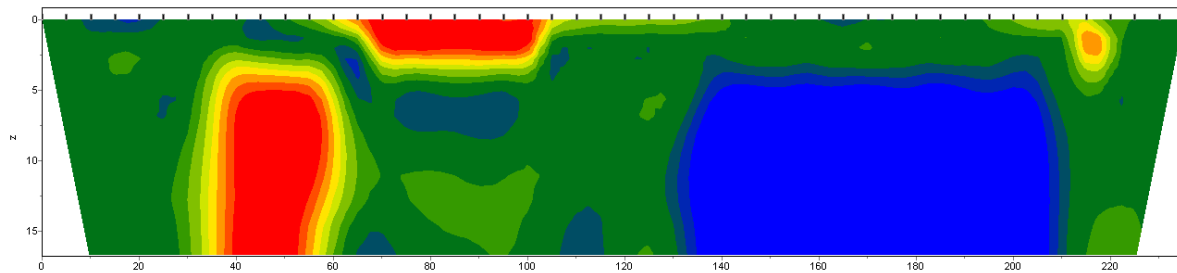


Fig. 26. The restored model as a result of *Smoothness constrained* inversion.

The matrix equation for this option of inversion looks as follows:

$$(A^T W^T W A + \mu C^T C) \Delta m = A^T W^T \Delta f \quad (6)$$

Apparently from the equation at inversion doesn't minimize contrast of model. This algorithm allows to reach the minimum values are mistie. It is recommended to use it at the initial stages of interpretation, in most cases.

Occam – inversion by a smallest quadrates method with using of the smoothing operator and additional minimization of contrast [Constable, 1987]. As a result of application of this algorithm receive the most smooth parameterization (fig. 27).

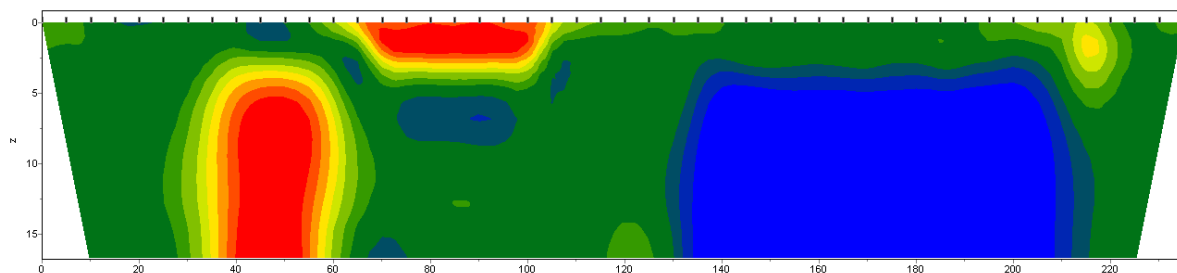


Fig. 27. The restored model as a result of *Occam* inversion.

The matrix equation for this option of inversion looks as follows:

$$(A^T W^T W A + \mu C^T C) \Delta m = A^T W^T \Delta f - \mu C^T C m \quad (7)$$

Degree of smoothness of resultant model is directly proportional to **Smoothness factor** value. It should be noted that too great values of parameter can lead to increase are mistie.

Marquardt – classical algorithm of inversion on a smallest quadrates method with regularization in damper parameter (Ridge regression) [Marquardt, 1963]. At small number of cut parameters, the algorithm allows to receive contrast model of the environment (fig. 28).

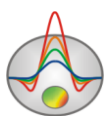
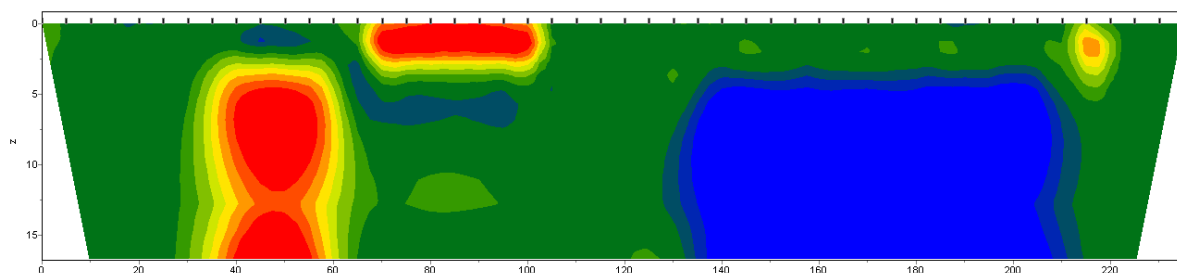


Fig. 28. The restored model as a result of Marquardt inversion.

The matrix equation for this option of inversion looks as follows:

$$(A^T W^T W A + \mu I) \Delta m = A^T W^T \Delta f \quad (8)$$

Careless using of this updating of inversion can lead to receiving unstable results or increase in a mean square deviation that is an algorithm divergence.

It is best of all to apply the **Marquardt** method, as specifying (for reduction are mistie) after carrying out inversion by means of algorithms of **Smoothness constrained** or Occam.

Focused – inversion on a smallest quadrates method with using of the smoothing operator and additional focusing of contrast [Portniaguine, 2000]. As a result of application of this algorithm receive piecewise smooth parametrization that is the model consisting of blocks of having constant resistance (fig. 29).

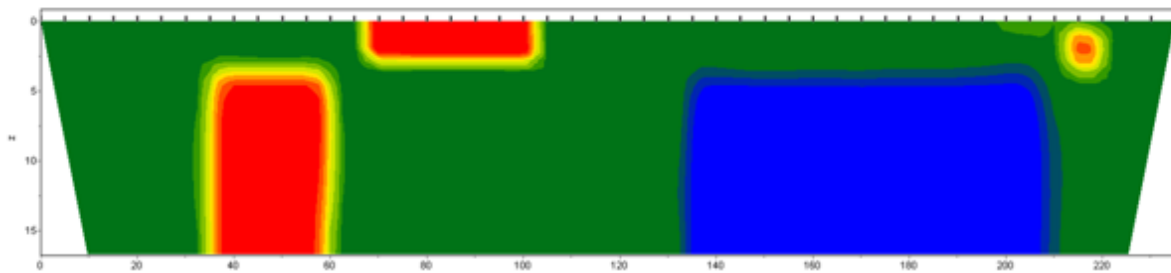


Fig. 29. The restored model as a result of Focused inversion.

The matrix equation for this option of inversion looks as follows:

$$(A^T W^T W A + \mu C^T R C) \Delta m = A^T W^T \Delta f - \mu C^T R C m \quad (9)$$

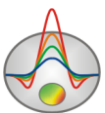
Using of this option of inversion demands a careful choice of parameter of threshold contrast of **Threshold**. This parameter determines threshold value of contrast of the next cells, by which achievement parameters of these cells are not averaged among themselves (that is it is considered that between cells there passes border). Dependence of degree (or weight) averaging of two next cells of R_i from a threshold of contrast of e and contrast between these cells of r_i looks as follows:.

$$R_i = \frac{e^2}{e^2 + r_i^2} \quad (10)$$

Blocks – parameter selection of separate areas differing on resistance. Areas with identical resistance are considered as uniform blocks (fig. 30).

The matrix equation of this inversion way looks as well as for algorithm of **Marquardt**:

$$(A^T W^T W A + \mu I) \Delta m = A^T W^T \Delta f \quad (11)$$



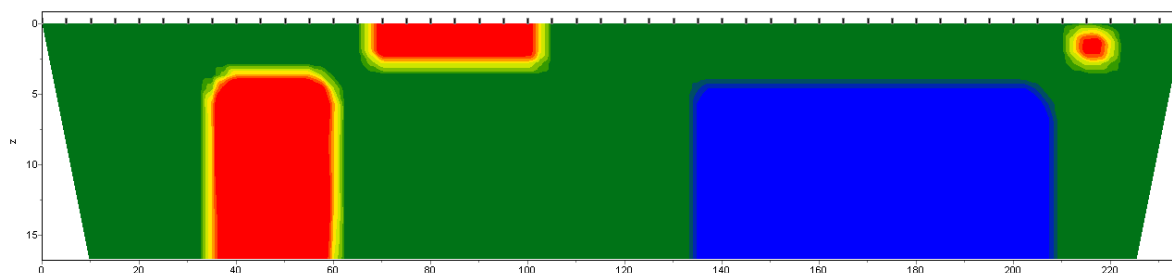


Fig. 30. The restored model as a result of **Blocks** inversion.

The algorithm is better to use at a stage of previous methods results specification (**Focused** better than all), previously having united cells in the necessary blocks by means of the option **Cell summarization**. At a choice of separate blocks manually it is necessary to use the editor of model, allocating separate areas in different parameters. Separate blocks will be allocated with border in operating time with a window of this dialogue.

Smoothing factor – establishes a ratio between measurements mistie minimization and model mistie (for example smoothnesses). For the hindrances given with high level or to receive more smooth and steady distribution of parameters, great values of the smoothing parameter get out relatively: 0.5-2; at high quality of measurements values are used: 0.005-0.01. At great values of the smoothing parameter receive big values of mistie data (fig. 31) more often. It is used in algorithms of inversion of **Occam** and **Focused**.

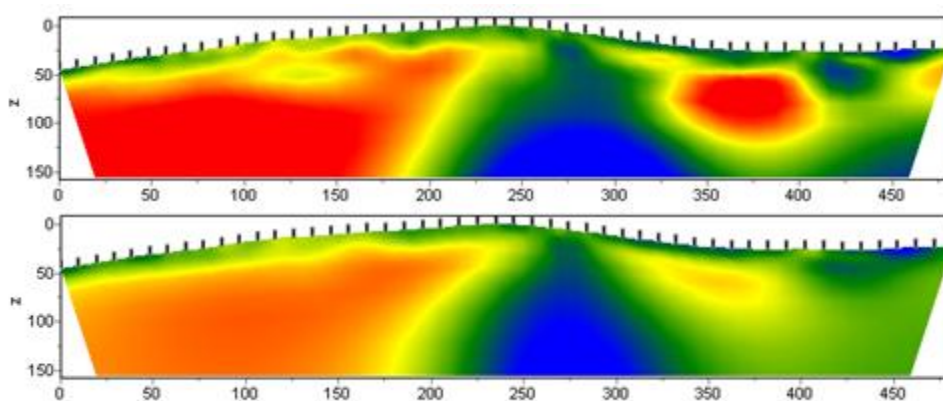


Fig. 31. The models received as a result of **Occam** inversion with the **smoothing factor** parameter: 0.01 (A) and 1.0 (B).

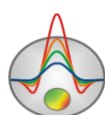
The resultant mistie for a case A – 4.5 %, for B – 6 %.

Robust weighting scheme – this option should be included if at data are present separate strong jumping connected with systematic errors of measurements. If the number of reject in data comparably with number of high-quality measurements this algorithm can't give positive results.

The **Stop criteria** area contains criteria of inversion stop.

Iterations – if an option is activated, process of inversion stops on reaching established number of iteration.

RMS error – if an option is activated, process of inversion stops on reaching the established mistie value.



Reduction – if an option is included, process of inversion stops at repeated mistake increase (on the established value in %) for two consecutive iterations.

Focusing parameters area

Threshold – establishes threshold value of contrast of the next cells on which achievement parameters of these cells aren't averaged among themselves (that is it is considered that between cells there passes border). Values of this parameter get out an empirical way (0.001-1) (the Fig. 32). The choice of very small parameter value can lead to an algorithm divergence (thus it is necessary to increase its value). Too great values of parameter lead to receiving smooth distribution.

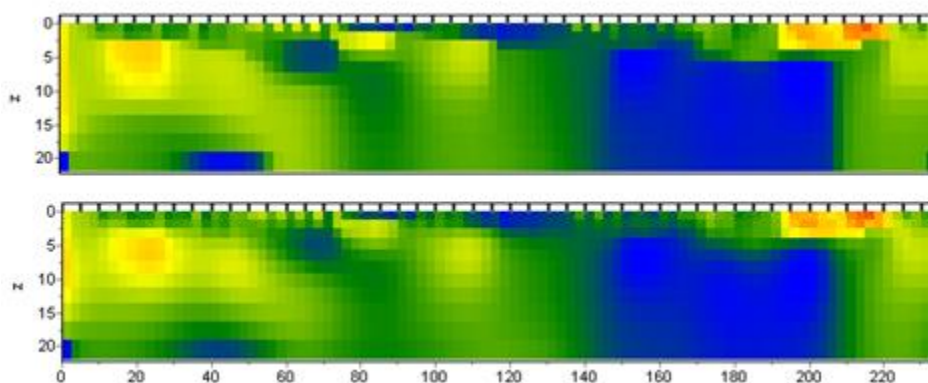


Fig. 32. The models received as a result of inversion of *Focused* with the **Threshold** parameter: 0.01 (A) and 0.1 (B).

Sharpness – defines a ratio between minimization of anomaly generative objects volume (0), and receiving piecewise smooth distribution in the environment (1) (fig. 33). Values of this parameter get out an empirical way (0.7).

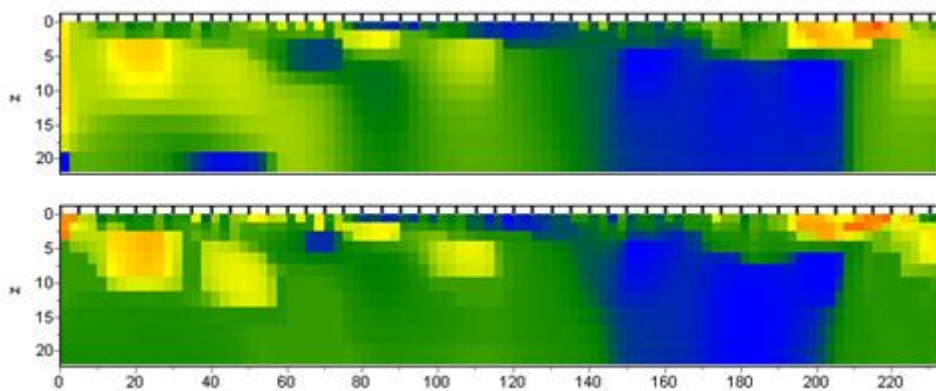
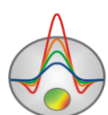


Fig. 33. The models received as a result of inversion of *Focused* with the **Sharpness** parameter: 0.8 (A) and 0.2 (B).

Focused filter – defines the mechanism of focusing filter creation. If **Own** value is chosen, the filter will be under construction on the current parameters (in the current mode of interpretation). In case of **Other** value is used the focusing filter constructed on other parameter of the environment. For example, the model of resistance with the borders corresponding to our ideas of parameters of the environment is received. Now to receive polarizability model in the same



borders it is necessary to pass to a mode of interpretation of induced polarization method data and to choose **Other** and **Threshold** value corresponding to expected features of polarizability section.

Use reference model – to use starting model, as aprioristic. At inclusion of this option the resultant model will strongly not differ from starting (fig. 34). To use starting model it is possible at inversion by algorithms of *Occam* and *Focused*. The divergence between starting and resultant model can be regulated, changing a ratio between minimization measurement mistie and model mistie. That is the value of the smoothing parameter is lower, the can differ starting and resultant model more.

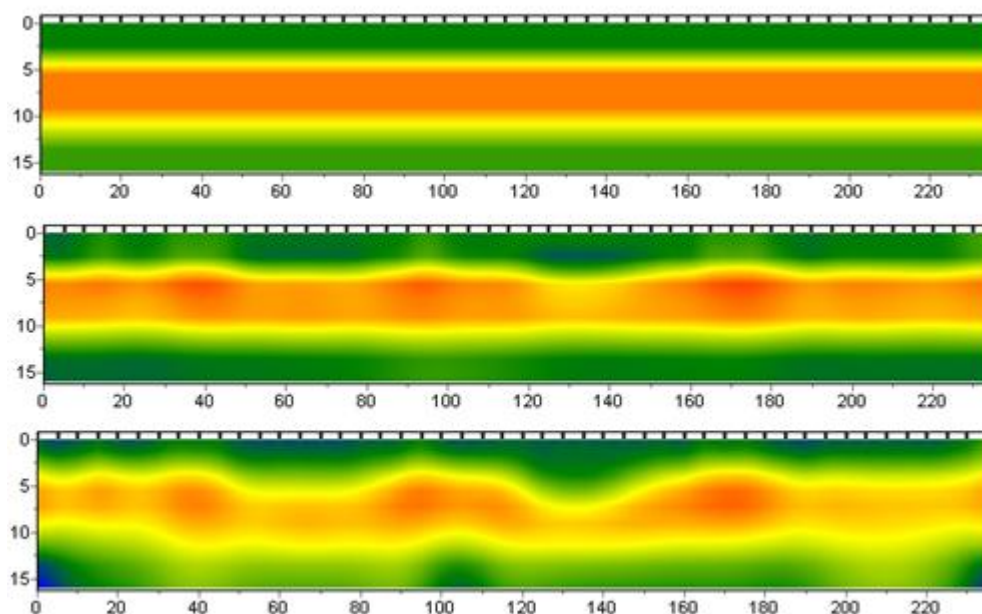


Fig. 34. Starting model (A), the models received as a result of *Occam* inversion with using of starting model (B) and without it (C).

The second Options tab is intended for control of additional parameters of inversion (fig. 35).

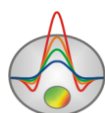
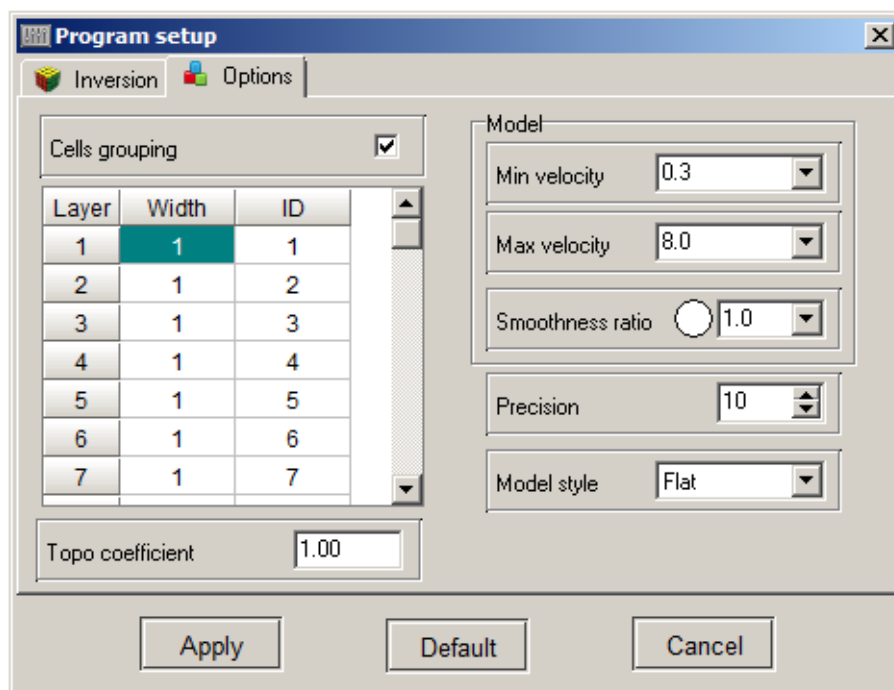


Fig. 35. **Program setup** dialog box, **Options** tab

Model area

Min velocity, Max velocity – establishes limits of change of parameters of model at inversion.

Smoothness ratio – defines a ratio of smoothing degree in the horizontal and vertical directions. For horizontally layered structures using values of this parameter <1 for vertically layered >1 . Usually, for this parameter are used values from 0.2 to 1 (fig. 36).

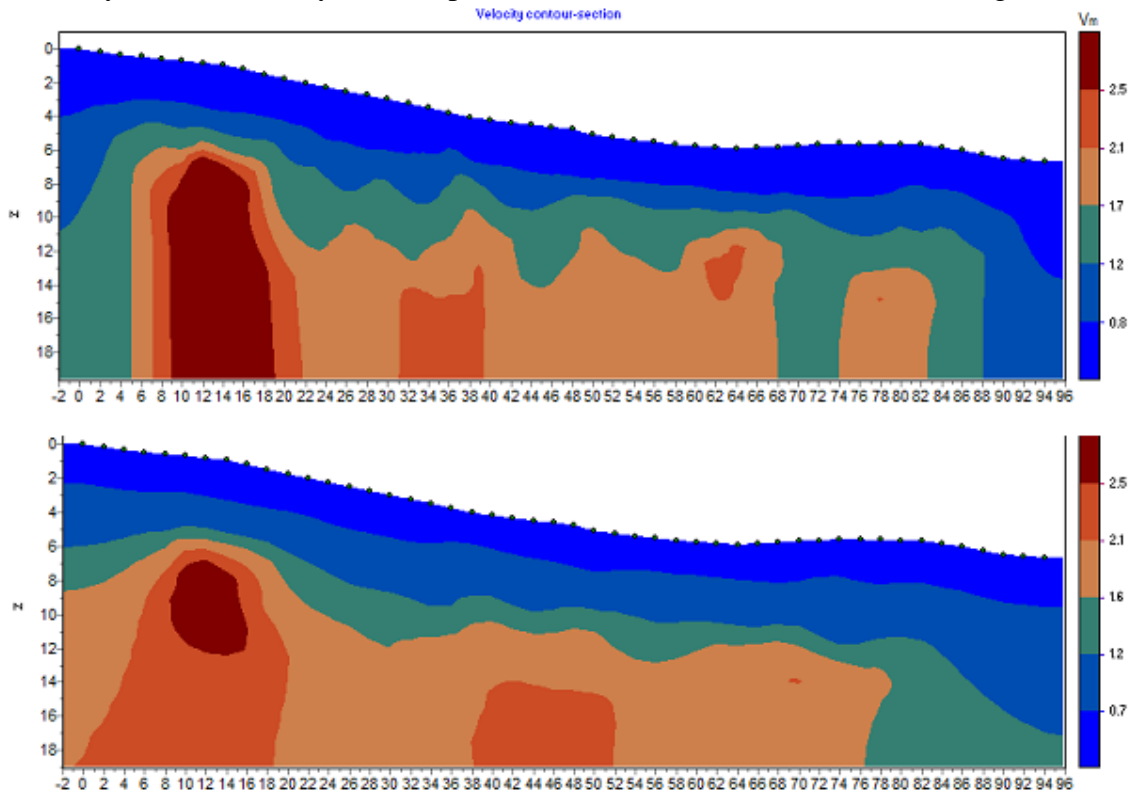


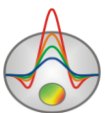
Fig. 36. High-speed models as a result "smooth" inversion with the **Smoothness ratio** parameter: 1 (A) and 0.5 (B).

Precision – establishes level of accuracy of the solution of a direct task. There is usually enough 10. Accuracy of calculations can be supervised visually in a form of beams.

Model style –block or interpolation model type. **Flat**– to everyone corresponds to a block/cell constant value of speed. **Smooth** – to each block/cell corresponds a certain value of speed. Value between knots created by way of linear interpolation.

Cell grouping – use this option in case of big models. The option makes active the list allowing to unite adjacent cells and to receive smaller number of defined parameters in time of inversion. In case of using this option the cells quantity for the solution of a direct problem remains the same and quantity of cells for inversion decreases. In an ideal the number of selected parameters should be close to data number.

The list contains three columns: in first (**Layer**) is specified number of initial mode layer; in third (**ID**) is established number of a layer of an inversion system; in second (**Width**) it is necessary to specify quantity of cells (in horizontal direction), containing in inversion system everyone cell for this layer. The Inversion system will be represented in the editor of model during its control. Double pressing of left mouse button on cells in the **Width** column is allowing combine cells in a



horizontal direction for current layer. The right button pressing - for current and all underlaying layers.

Double pressing of the left button of a mouse cells in the **ID** is allowing combine column in vertical direction. The right button pressing - for current and all underlaying layers.

Below examples of three inversion networks are given: in the first the inversion system corresponds modeling (fig. 26A), in the second, since the second layer, cells are incorporated in groups on two (fig. 26B), in the third, since the second layer, cells are incorporated in groups on four cells (fig. 26C).

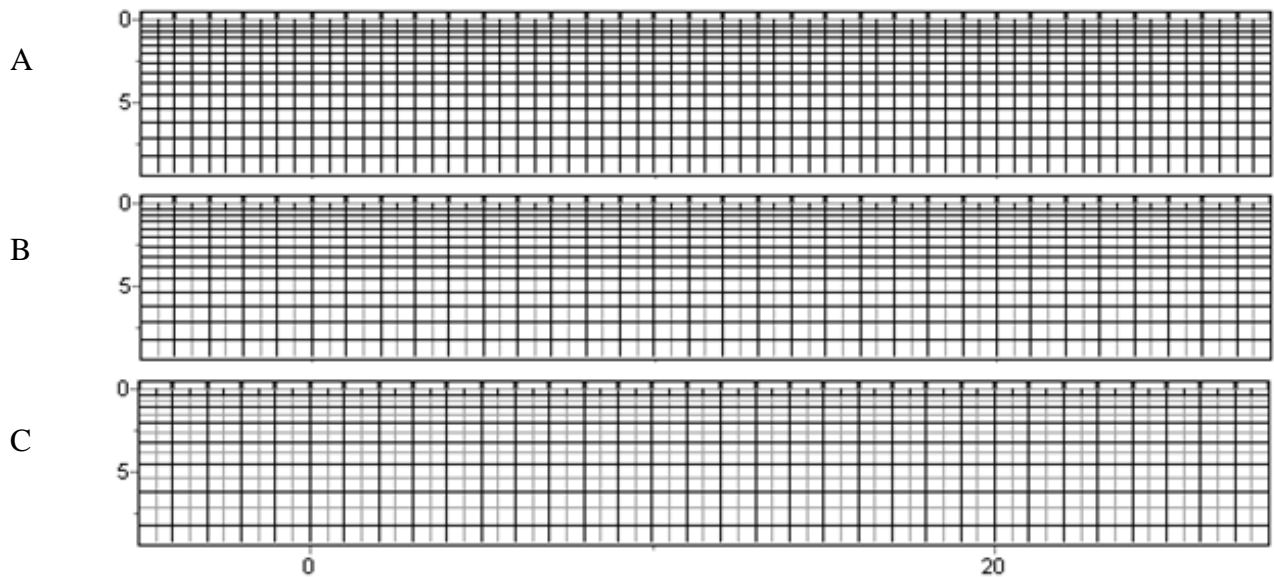


Fig. 37. Examples of inversion system.

Topo coefficient – to set shape-distortion ratio of relief with depth (0-5). 0–the relief of each subsequent layer repeats the previous. 1- relief gradation with depth, the last layer – flat (fig. 38). The distorted depth calculated by the following formula:

$$z^*(x, z) = Topo(x) + z \cdot \left(1 + \frac{\max(Topo) - Topo(x)}{\max(z)} \cdot Tcoeff\right) \quad (12)$$

where Topo– relief excess, z - depth from a surface.

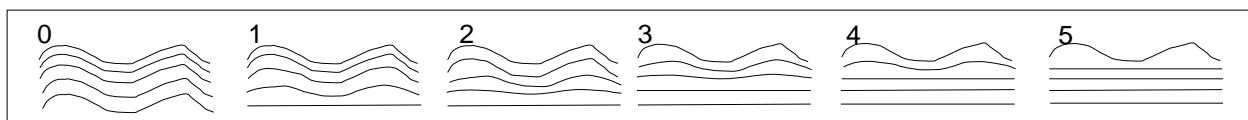
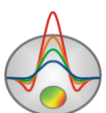


Fig. 38. Distortion of layers of model with using of **Topo coefficient** parameter from 1 to 5.

Cell summarization dialogue


The option Cell summarization allows to smooth or coarsen (to break into blocks) the current model. The block model can be used at Blocks type inversion. In this case parameter



selection is made for each block. Before splitting into blocks it is best of all to use focusing inversion.

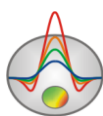
It time of using **Blocks** mode depending on parameter of contrast (**Contrast factor**) association of cells is made with similar parameters in area with constant value. The option **Start layers** sets layer number since which this operation is made.

In the **Smooth** mode is made averaging of parameters of cells of model depending on a smoothing factor (Smooth factor). The option **End layers** sets layer number to which this operation is made.

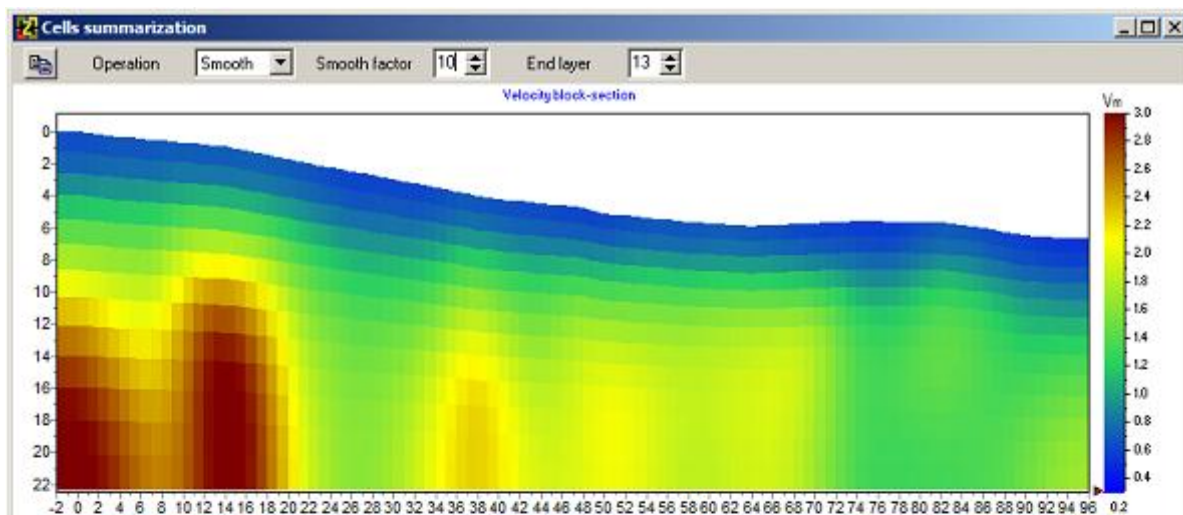
The button  copies the received model the editor of model.

Model visualization performances and parameters

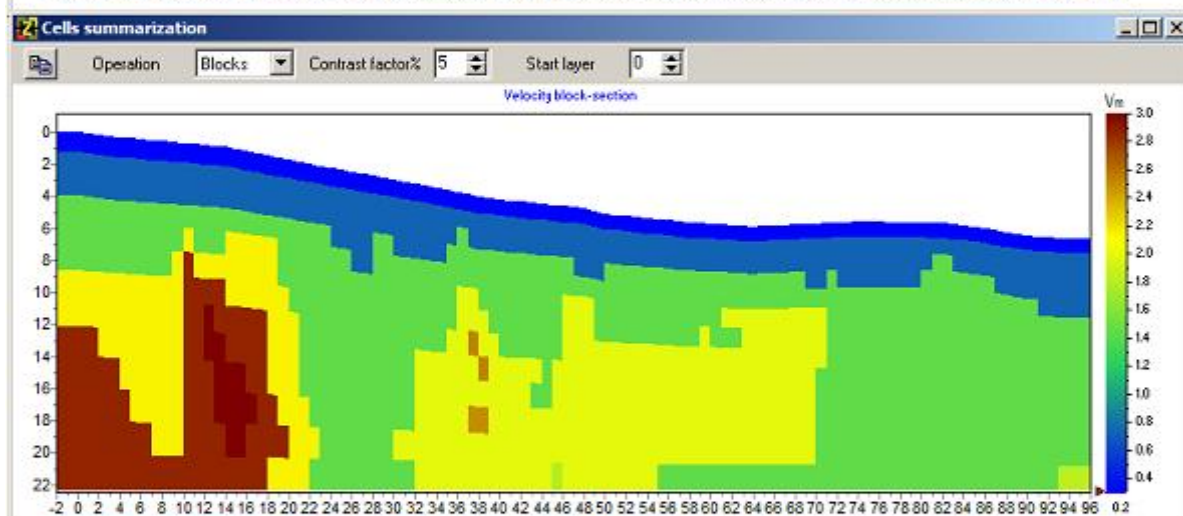
It is possible to display model in the form of Options/Model/Block-section cells (fig. 40A), in a smooth interpolation Options/Model/Smooth-section palette (fig. 40B), and also in the form of planimetric coal mine Options/Model/Contour-section (fig. 40C).



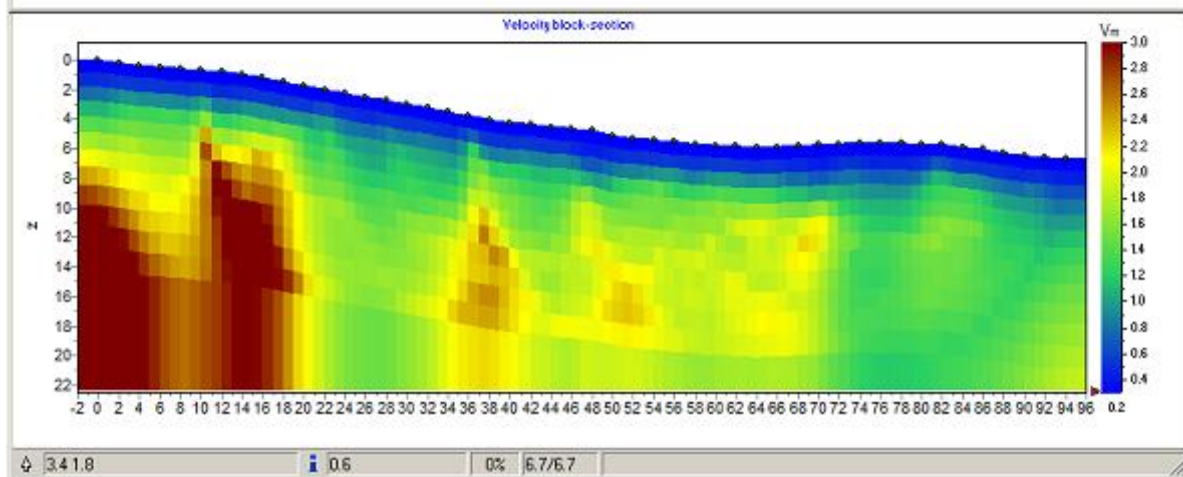
A



B

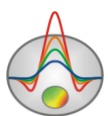


C



ig.
39.

An example of smoothing (A) and blocking (B) of high-speed model (C) in time of using **Cell summarization** dialogue.



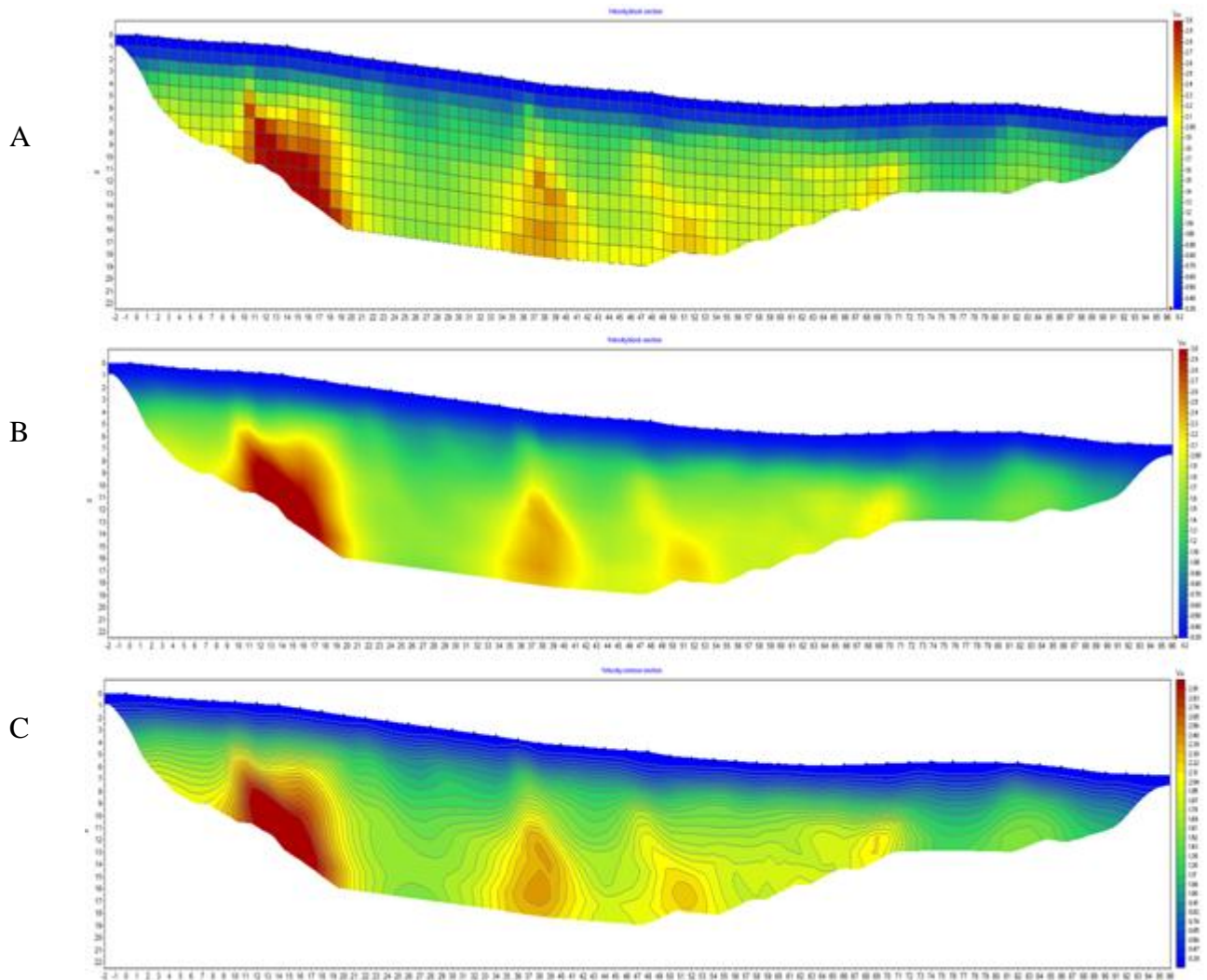
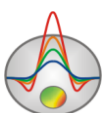


Fig. 40. Options of model display:

Block-section (A), Smooth-section (B), Contour-section (C).

By double pressing of a mouse in different areas of the editor of model there are context menus with the following options:

Top area	Display model mesh	Specifies, whether it is necessary to represent a system.
	Display objects border	Specifies, whether it is necessary to represent object border.
	Display color bar	Specifies, whether it is necessary to represent a color scale.
	Setup	To call dialogue of model parameters control.
	Zoom&Scroll	To include an increase and scrolling mode.
	Print preview	To unpack model.
Color scale	Set minimum	To establish the minimum value of a color scale.



	Set maximum	To establish the maximum value of a color scale.
	Set incremental factor	To define the minimum and maximum values of a color scale concerning value of the containing environment.
	Automatic	Automatically to define the minimum and maximum values of a color scale.
	Log scale	To establish logarithmic scale for a color scale.
	Set halfspace value	To define value of parameter of the containing environment.
	Set cursor value	To establish current parameter value.

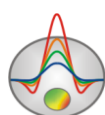
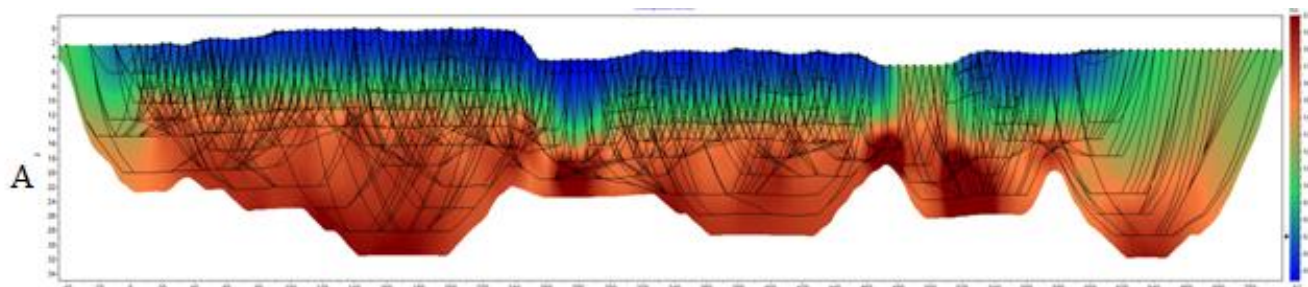
Dialogue of control of parameters of the Setup model at work in the Block-section and Smooth-section mode is described in the Appendix 5: Dialogue of control of parameters of model, in the Contour-section mode is described in the Appendix 6: Dialogue of control of parameters of a planimetric cut.

When moving the cursor of a mouse on created in the course of work with the program to windows, in the left section of the panel of the status of the main window of the program the coordinates corresponding to own axes of this window are displayed.

On the chosen mode of display of model depends additional possibilities of the program. Mathematical modeling is necessary for carrying out in the Block-section mode. Distribution of integrated sensitivity is displayed in a mode of a planimetric cut (Contour-section) - the option Option/Model/Sensitivity (fig. 41C).

In the same mode thanks to the option Option/Model/dVelocity it is possible to calculate and display model of a full gradient of speeds (fig. 41B).

Reliability of this or that site of model determine by density of beam trajectories. By means of the option Data/Ray path/Calculated it is possible to display the scheme of beam trajectories calculated for this model. The option Options/Model/Cut bay ray allows to hide model zones on which as a result of inversion don't pass beam trajectories (the Fig. 41A).



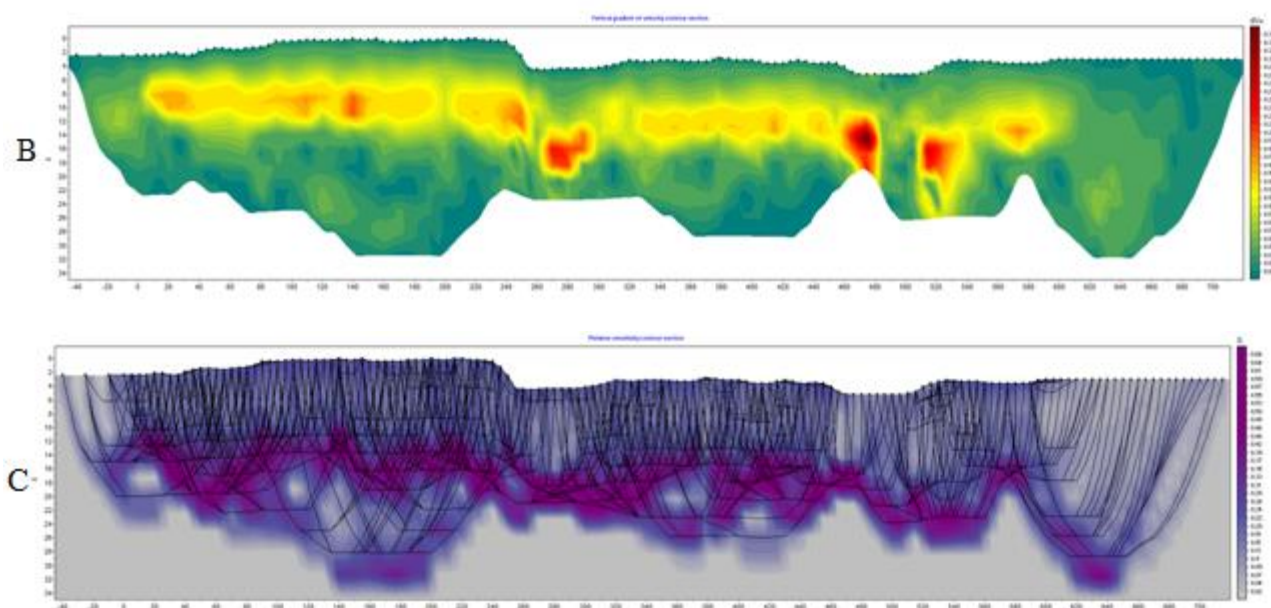



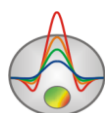
Fig. 41. A. High-speed model with the calculated radial trajectories and with the cut-off zone of unauthenticity. B. Model of a full gradient of speeds. C. Allocation of integrated sensitivity for this model.

Interpretation results saving

The result of interpretation of a profile of data is stored in the ZONDST2D format file (*.ST expansion) (in detail in the section «*Format of basic data file*»). In this file field data, values of relative scales of measurements and the current model of the subsurface model. At the subsequent loading, for creation of model of the environment, data from the file are used.

To save result of interpretation, it is possible having pressed the button  of a toolbar or point of the menu corresponding to it. In the appeared dialogue, it is also possible to choose a format of data, for preservation of observed(**Observed**) or calculated (**Calculated**) for the current model, values of first arrival times and also images (**Model, WorkSheet**) in the *.BMP format in necessary scale. The scale of the image can be adjusted by means of **Options/Import/Export/Output settings dialogue** (described in the section «*Data import and export*»).

Zond project data	To save measured values and current subsurface model
Zond calculated data	To save calculated values
Zond observed data	To save measured values
Worksheet	To save three graphic window section in BMP format
Model	To save lower graphic window section in BMP format. For image scale control it is necessary to use Output settings dialogue
Program configuration	To save program
Zond model with calculated	
Grid file	To save model dat-file
Section file	To save current model in SectionCorrector



	format
--	--------

Project information

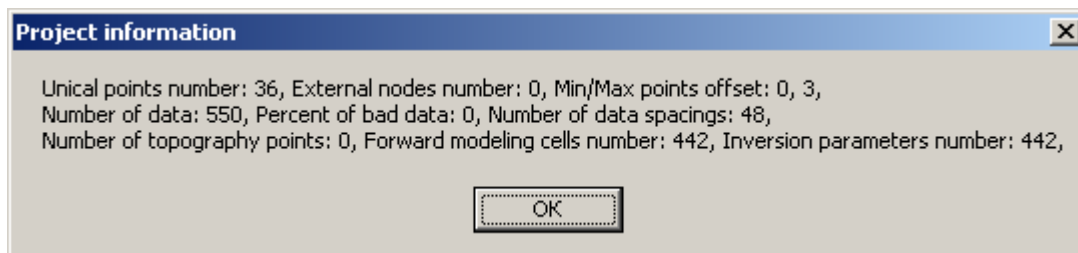


Fig.42. **Project information** dialogue window

To see information about current project is possible by option **File/Project information** of main menu. In an opened window consequently viewing following information:

Unical points number	Number of unique provisions of the feeding line or the source/receiver
External nodes number	Number of additional knots of model along the edges
Min/Max points offset	Minimum / maximum rating
Number of data	Number of measurements
Percent of bad data	Percent not qualitative data (from total number)
Number of data spacings	Quantity of a unique rating
Number of topography points	Number of measurements of topography
Forward modeling cells number	Quantity of cells used at the solution of a direct task
Inversion parameters number	Quantity of cells used at the solution of a return task

Data import and export

In the presence of logging measurements or lithologic columns they can be loaded into a model window by means of the option **Import/Export/Carotage data** (fig. 35). The format of the file is in detail described in the section «*Log and stratigraphy data file format*». An example in a directory - [sample_with_bhdata](#).

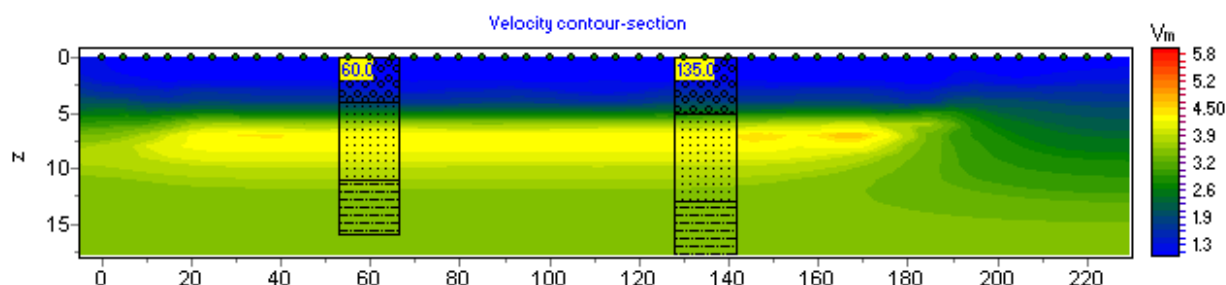
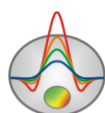


Fig. 43. High-speed model with the marked lithologic columns.



Import model/data is an option allows to load model of the *.ST format and other interpretative programs of a ZOND package in a separate window (fig. 44). This option can be useful for example by comparison of results on the next profiles or at complex interpretation of these various methods. If as the imported file to use the two-columnar XY file with *.dat expansion, in a window with calculated data will show graphic attached to right axis [sample_with_exported_graphic](#) axis will be displayed.

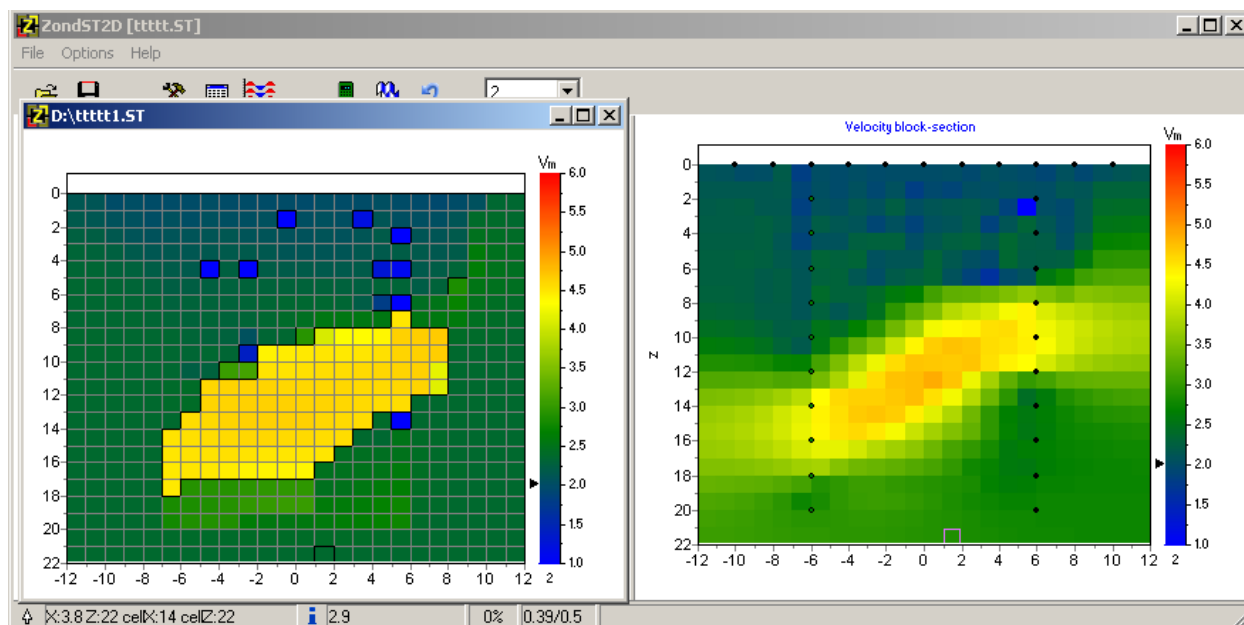


Fig. 44. A working window of the program with imported high-speed model.

Using the option **Save/Load selection** it is possible to keep or load the kept fragment of model. For saving of a fragment it is necessary having included a mode of model display in a blocks type using the option **Selection** to allocate an interesting fragment and to press Save selection [sample_with_impmodel](#).

To keep or load a vertical speeds profile for the set horizontal coordinate it is possible by means of the option **Extract 1d log/Load 1d log**. At saving of a vertical profile it is necessary to set the X-coordinate in a dialog box. When loading of vertical profile it is required to indicate a range on an axis X. This option can be used for example for convergence of interpretation results in case if profiles are crossed.

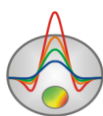
In the presence of aprioristic information there is a possibility of its using (as a substrate) by means of the option **Import/export/Section file**. It can be for example geological or geoelectric sections. For this purpose in dialogue of model control the **half-space transparency** mode gets out. After that it is necessary to load a graphic image of the *.sec format in required scale of [sample_with_sectfile](#). The *.sec file has the following structure:

The 1st line – the file name with the image;

The 2nd line – through a space four coordinates of the left top and bottom right corner of the image are specified consistently

```
X1 Y1 X2 Y2.
sect.emf
0 0 152.4 53.3
```

In the **Blocks section** mode those cells which values it is distinct from the host medium will be displayed. Thus, there is a possibility to model abnormal objects over a substrate (fig. 45).



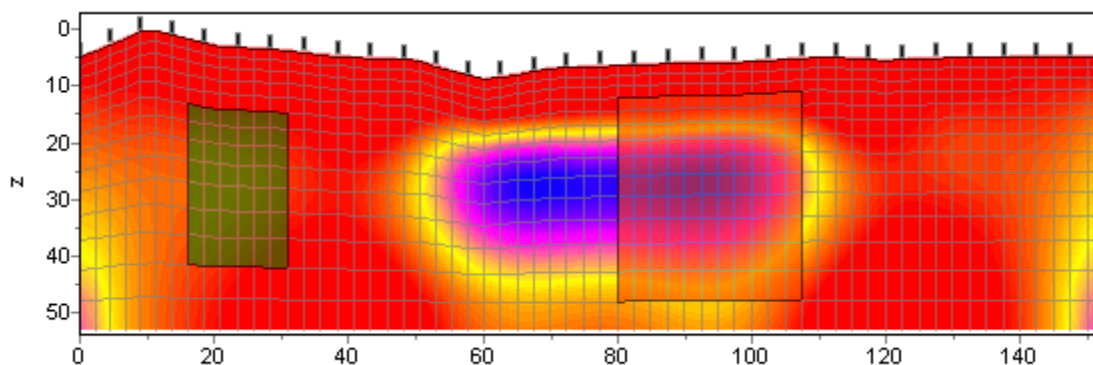


Fig. 45. Model in the **Block-section** mode with a substrate.

In the **Smooth section** mode of a substrate color and the current model will mix up, and it will be possible to see features of two cuts at the same time (fig. 46).

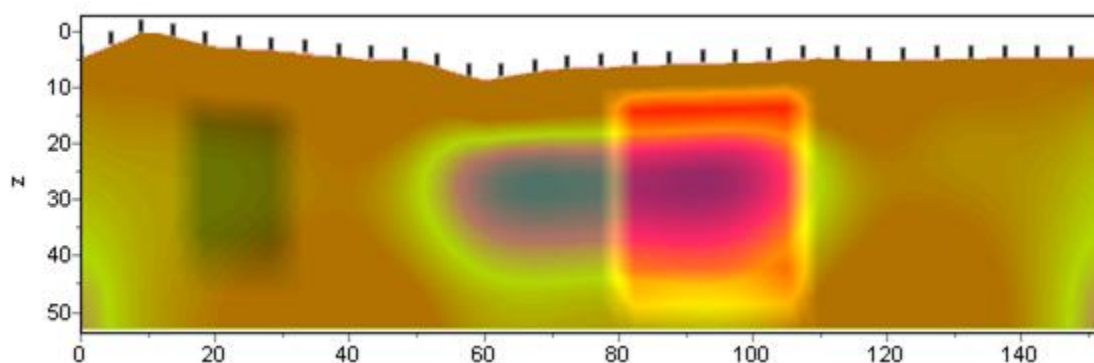
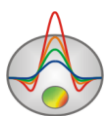


Fig. 46. Model in the **Smooth-section** mode with a substrate.

In the section *«Interpretation results saving»* are described various possibilities of export as data, and resultant model. For further geological interpretation and drawing up of reporting graphics there is a possibility to keep the current model in dates file. For import to other Zond programs it is necessary to keep model in a SectionCorrector program format. The model can be kept as the raster image defined permission and the size with use of dialogue of Output settings.

Exported image settings dialogue

Output settings dialogue with activated option **Automatic** allows to adjust vertical **Vertical scale**, horizontal scale of **Horizontal scale**, resolution of the exported image of **Print resolution** in dpi and **Font size** font size (fig. 47).



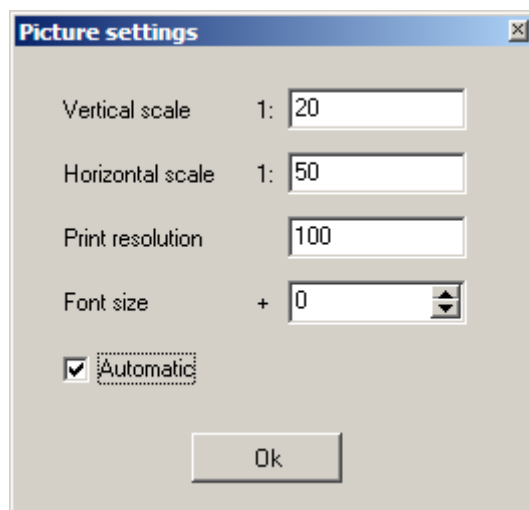


Fig. 47. Picture settings dialog box.

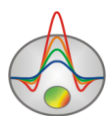
Log and stratigraphy data file format

Log data and lithologic columns are stored in files of a certain format. The first type of files with the *.txt expansion are actually this, logging or lithologic. At creation of log data file is used the following structure of the file:

The first column contains depth of a point of record (from an earth surface), the second column contains logging measurements. The third and fourth columns contain zero.

Below is given an example of the log data file:

0.5	118.3035394	0	0
1	126.9002384	0	0
1.5	123.4170888	0	0
2	116.1519574	0	0
2.5	117.240884	0	0
3	111.9424174	0	0
3.5	142.0405875	0	0
4	125.3686538	0	0
4.5	521.0730567	0	0
5	735.5232592	0	0
5.5	707.7315998	0	0
6	706.3561614	0	0
6.5	725.9945623	0	0
7	722.433627	0	0
7.5	717.0991126	0	0
8	716.9836552	0	0
8.5	725.5024012	0	0
9	722.3551713	0	0
9.5	731.5717173	0	0
10	723.5097884	0	0
10.5	726.8844987	0	0
11	725.962034	0	0
11.5	743.2485878	0	0
12	726.4061156	0	0
12.5	734.399887	0	0



13	727.9166309	0	0
13.5	116.1921851	0	0
14	517.9613065	0	0
14.5	125.3706264	0	0
15	111.2952478	0	0
15.5	131.911879	0	0
16	107.9217309	0	0
16.5	114.9327361	0	0
17	134.0939196	0	0
17.5	138.4457143	0	0
18	129.1165104	0	0

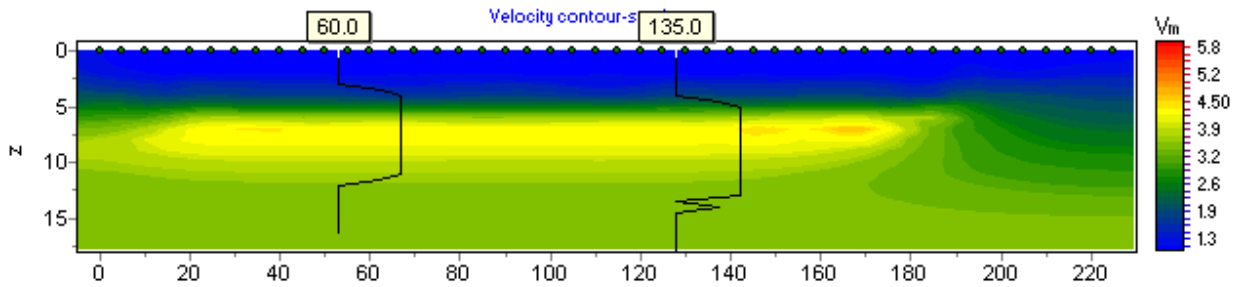


Fig. 48. Velocity model with the marked well logs.

At file creation with lithologic information is used the following structure of the file:

The first column contains depth (from an earth surface) the lithologic horizon.

It is necessary to fill the second column with zero.

The third column contains color of a layer on a lithologic column.

The fourth column holds filling type on a lithologic column.

Below the list from the first 23 fillings which can be used, at creation of a lithologic column (fig. 49) is provided.

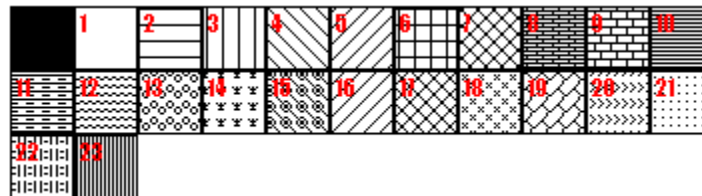


Fig. 49. Options of lithologic column shading.

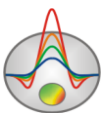
It is given an example the file of lithologic data below.

```

0 1 0 13 Top of 1 layer
4 1 0 13 Buttom of 1 layer
4 1 0 19 Top of 2 layer
11 1 0 19 Buttom of 2 layer
11 1 0 27 Top of 3 layer
16 1 0 27 Buttom of 3 layer

```

The second type of files (*.crt expansion) – the operating file specifying type of data and a display way. The description of CRT file structure for display of lithologic or well logs for any quantity further follows.



2280.txt First line - a file name with log data or a lithology
 Well 2280 Second line - the well Signature (it will be displayed on a well)
 18 2 2 1 0 1 0 0 Third line contains operating parameters -
 Record 18 – well coordinate on a profile.
 2-width of the image (in percentage of length of a profile, usually 1-20).
 2-type of data display 0-3.

0-log data (in a look the schedule); the File example - carot1.crt
 1-log data (an interpolation color column) is used for display of data the
 color scale of a section; the File example - carot2.crt
 2-lithologic column; the File example - strati.crt
 3-logdata (a color column) colors of displayed data correspond to a model
 scale, color on a column gets out according to value of model color scale;

1-Parameter of a normalization of these logging charts 0-2.

0,1-for all data the general minimum and a maximum is used;
 1,2-to subtract from each well log its average value;

0-A log method index (if it is necessary to display at the same time some log types, it is
 necessary to enter indexes for each of methods) 0 – n-1, where n – quantity of methods.

1-Graphic colour.

0- Data scale logarithmic 0, linear 1.

0-Vertical movement of a well of rather terrestrial surface.

3246.txt the description of the following well on a profile

well3246
 102 2 2 1 0 1 0 0

For creation of files with lithologic data it is recommended to use the **BHEditor** program.
 To download the program it is possible on a site <http://zond-geo.ru>.

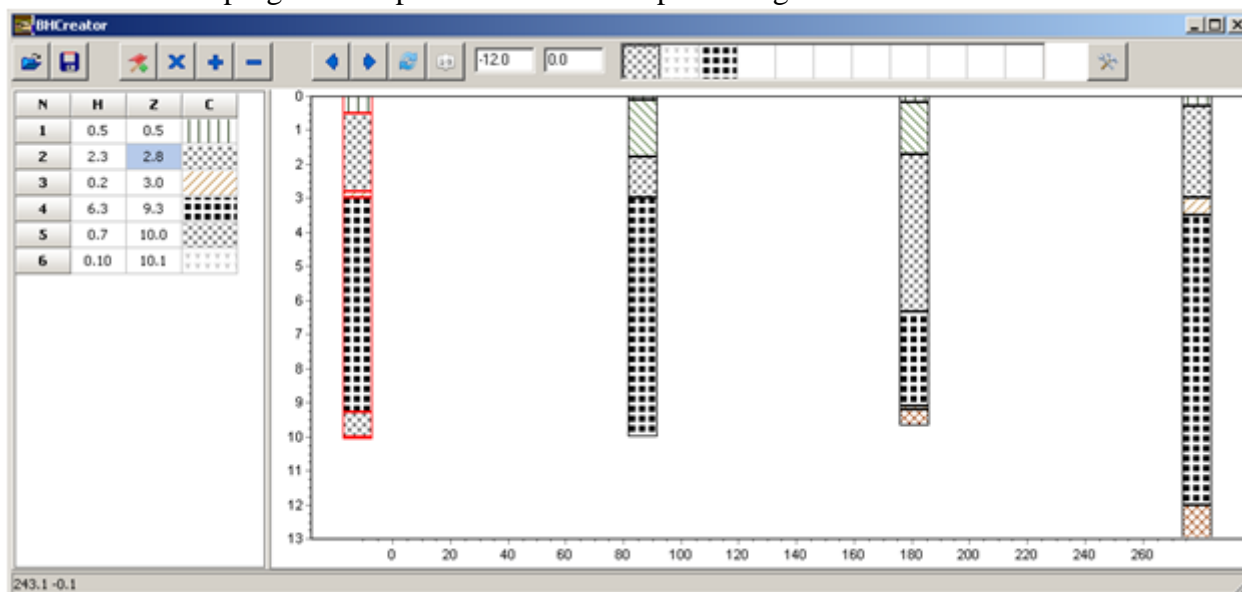
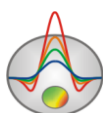


Fig. 50. Active window of the **BHEditor** program.

Modeling



Modeling – the important process preceding field works. It allows choosing optimum parameters of measuring system for the solution of the put geological problem. Having armed with aprioristic information on research object, the interpreter can model various geological situations, planning geophysical works.

Creation of synthetical observation system

The window is broken into three parts: a graph of mapping of positions of sources/receivers (at the left), the table of sources/receivers coordinates (on the right above) and the table of the current hodograph (on the right below) in which is displayed the list of pairs of indexes a source receiver (fig. 51).

The graph is intended for display of unique positions of sources/receivers and their indexes. Here is carried out the choice (by mouse) sources and receivers. The active source is represented by red color, receivers of the current group the dark blue.

In the table of coordinates to contain horizontal and vertical coordinates of sources/receivers which can be edited. By pressing of the right mouse button on a cell of the table it is possible to set a coordinate increment for all subsequent cells.

The table of the current hodograph contains indexes of a source and group of receivers for an active hodograph which can be edited. At the wrong input of indexes they are highlighted by the red.

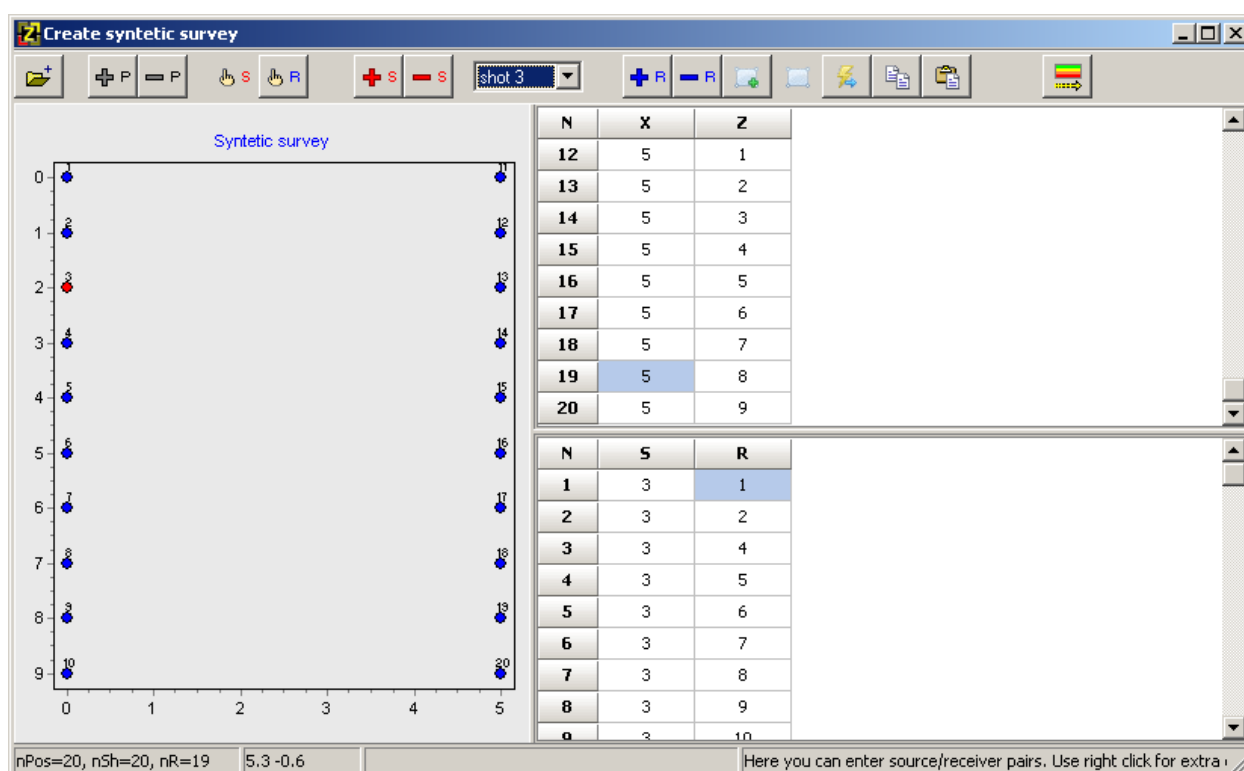
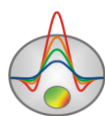


















Fig. 51. Create synthetic survey program window

The toolbar serves for a fast call of functions most often used in the program. It contains the following action buttons (at the left - to the right):



	To open the file with coordinates of sources/receivers.
	To add a new position of the source/receiver. The new position is displayed in the left graph of a window, coordinates in the top table on the right.
	To remove flowing (in the table) a source/receiver position.
	To include a mode of a choice of the current source. The choice of a position of a source for the current hodograph is carried out by a mouse in the left graph. After a source choice the program is switched in a mode of a choice of receivers.
	To include a mode of a choice of the current receiver. The receiver choice for the current hodograph is carried out by a mouse in the left count. If the choice is carried out with the pressed SHIFT button, in the bottom table the new pair (source / receiver) is added, differently the new position is appropriated to the current receiver.
	To add a new hodograph. After addition the program is switched in a mode of a choice of receivers. The choice of the current hodograph is carried out in the emerging list on the right.
	To remove the current hodograph.
	The emerging list for a choice of the current hodograph.
	To add pair source/receiver in a hodograph (in the bottom table).
	To remove the current pair source/receiver from a hodograph.
	To allocate group of receivers positions which will be added in the current hodograph. Allocation is carried out in the right count by a rubber rectangle by mouse.
	To allocate group of receivers positions which will exchange current hodograph. Allocation is carried out in the right count by a rubber rectangle by means of a mouse.
	To cause a pop-up menu of functions of automatic creation of system of hodograph. <i>Select all positions</i> – to Choose all positions, except a source position in a hodograph. <i>Deselect all positions</i> – to Remove all receivers from a hodograph. <i>Create full array</i> – to Create system of supervision in which the source is in each position, and to each source there corresponds group of all other receivers.
	To copy indexes of receivers of the current hodograph in the buffer.
	To load indexes of receivers into the current hodograph from the buffer.
	To pass to a modeling mode.

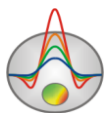
After creation of synthetic system of supervision the button is pressed and there is a dialogue of control of parameters of a network on which completion of work on a toolbar of the main window of the program, action buttons for work with data become more active, and in the right section of the panel of the status there is a summary of data and model.

When moving the cursor of a mouse on created in the course of work with the program to windows, in the left section of the panel of the status of the main window of the program the coordinates corresponding to own axes of this window are displayed.

Model editor

Creation of the high-speed environment is made in the editor of model – the bottom graphic section of a window of the program at the block-section mode. The editor of model serves for change of parameters of separate cells of model by mouse. To the right of area of editing of model there is the color scale connecting value of color with value of speed. For a choice of the current value it is necessary to right-click on a scale, thus its value is represented below a color scale.

The size and the provision of a color scale can be changed, having pulled it for a cursor, with the pressed left or right button of a mouse.

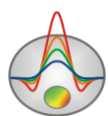


Work with cells of model is similar to editing of the raster image in graphic editors. When moving cursor in the field of model, on the bottom panel of the status of the main window of the program coordinates and parameters of an active cell in which there is a cursor are displayed. Active at present the cell is surrounded with a rectangle – the cursor. The allocated or fixed cell is noted specks of white or black points. By double pressing on vertical and horizontal axes and by pressing of the right button of a mouse in the field of the editor of model there are the options, allows us to edit a network created at work with dialogue of Mesh constructor.

Vertical axis	Log scale	To establish log scale for a vertical axis.
	Set maximum	To establish value of the bottom layer depth.
	Redivide	To establish equal thickness of layers for all model layers (in this scale).
	Thick mesh	To remove every second node of a vertical grid.
	Thin mesh	To add intermediate knots in a vertical grid.
Horizontal axis	Redivide	To establish identical width for the cells located between unique provisions of electrodes.
	Thick mesh	To remove every second node of a horizontal grid (if in this node isn't located electrode).
	Thin mesh	To add intermediate nodes in a horizontal grid.

With pressed right mouse button in the area of model editing shows up context menu with next options:

Display cell setup	To call dialogue of cell parameters settings
Cell to cursor value	To use active cell parameter as current value
Edit mode	To activate editing mode
Selection\Free form selection	To select cells set in editing area by mouse. Area has prescribed limits by user.
Selection\Rectangular selection	To select cells set in editing area by mouse. Area has rectangular type.
Selection\Elleptical selection	To select cells set in editing area by mouse. Area has elliptic type.
Selection\Magic wand	To select cells set in editing area by mouse. Active cell and adjoining with it cells (which parameters are close to it parameter) are selected.
Selection\Remove selection	To remove selection.
Mesh options\add column /row	To add new vertical or horizontal border. New border is shown by pushing mouse in selected place.
Mesh options\remove column /row	To remove selected vertical or horizontal border.
Mesh options\resize column /row	To change thickness of array or column by mouse.



Clear model	To clear current model.
-------------	-------------------------

Work with model

Work is made by means of a mouse:

The pressing of the left mouse button on a cell changes its parameter for the current.

The increase in a separate site or its moving is carried out in the **Zoom&Scroll** mode with the pressed button. For allocation of a site which is necessary for increasing, the mouse cursor moves down and to the right, with the pressed left button. For return to initial scale are made the same actions, but the mouse moves up and to the left.

For operative creation of model in the program are provided some modes of cells allocation: a rectangle, in the form of an ellipse, a free form and on a certain value of parameter. To cause the corresponding options possibly by pressing of the right button of a mouse in the field of model editing (options are described in the section *«Model editor»*).

The pressing of the left mouse button with pressed SHIFT on a cell increases its parameter. The pressing of the right mouse button with pressed SHIFT on a cell reduces its parameter. The percent (on which changes value) is specified in dialogue of control of model parameters. If the active cell belongs to allocation all above described operations are applied to all allocation.

The pressing of mouse button with pressed CTRL allows moving the allocated cells set within editing area by means of a mouse. When moving allocation with the pressed left button of a mouse contents of the allocated cells are copied in a new place. When moving allocation with pressed right mouse button contents of the allocated cells are cut out and copied in a new place.

It is also possible to set values of parameter to the allocated cells using dialogue of control of **Cell setup** cell parameters (fig. 33).

Cell configuration settings dialogue

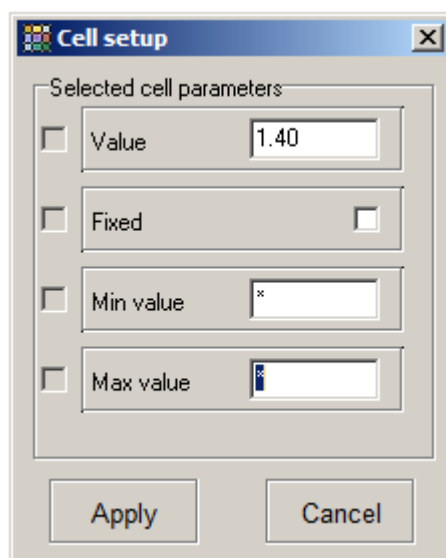
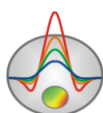


Fig. 33. **Cell setup** dialog box.



Dialogue is intended for a choice of parameters of a cell or allocation.

Value – establishes value of cell parameter.

Fixed – fixes or releases cell parameter.

Min value, Max value – defines a range of change of parameter of a cell.

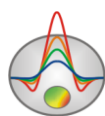
Apply to selected – if an option is included, these settings are used by all cells of allocation.

Main objective of mathematical modeling are the assessment of level of a signal and an assessment of resolution of the chosen system of supervision. To calculate a response of seeming parameters from the set high-speed model (to solve a direct problem) it is necessary to press the button toolbars.

To restore initial model (to solve a inverse problem) for the calculated from set model data is possible having kept theoretical signals with the filter - **Zond calculated data**, and then to open as observed. To compare the restored and initial model is possible having used the **option Import model/data** (the section *«Data import and export»*), previously having kept initial model selected the filter of files - **Zond model with calculated**.

By double pressing of mouse in different areas of the editor of model there are context menus with the following options:

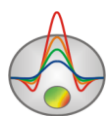
Upper area	Display model mesh	Shows is it necessary to show grid
	Display objects border	Shows is it necessary to show object border
	Display color bar	Shows is it necessary to show color scale
	Setup	To call dialogue of model parameters settings
	Zoom&Scroll	To activate mode loupe and scroll
	Print preview	To print model
Color scale	Set minimum	To set minimal value of color scale
	Set maximum	To set maximal value of color scale
	Set incremental factor	To define minimal and maximal value of color scale relative to host medium values.
	Automatic	To define automatically minimal and maximal value of color scale
	Log scale	To set logarithmic scale for color scale
	Set halfspace value	To define value of host medium parameter
	Set cursor value	To set current parameter point
Vertical axis	Log scale	To set logarithmic scale for vertical axis
	Set maximum.	To set value of buttom layer



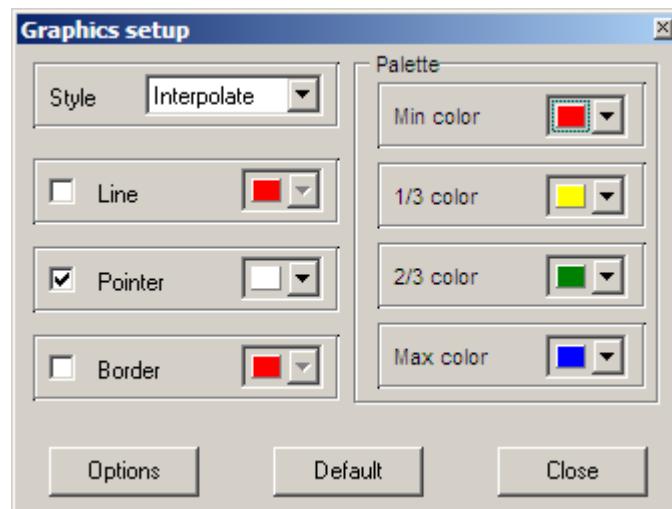
		depth
	Redivide	To set equal thickness for all layers of model (in this scale)
	Thick mesh	To remove each second node of vertical grid
	Thin mesh	To add intermediate nodes in a vertical grid
Horizontal axis	Redivide	To set equal width for cells disposed among unique positions sources/receivers
	Thick mesh	To remove each second node of horizontal grid(if in current node isn't disposed source/receiver)
	Thin mesh	To add intermediate nodes to horizontal grid

By right mouse button pressing in area of model editing shown up context menu with next options:

Display cell setup	To call dialogue of cell parameter settings
Cell to cursor value	To use active cell parameter as a current value
Edit mode	To activate editing mode
Selection\Free form selection	To select cells set in limits of editing area by mouse. Area has prescribed limits by user.
Selection\Rectangular selection	To select cells set in limits of editing area by mouse. Area has rectangular type.
Selection\Elleptical selection	To select cells set in limits of editing area by mouse. Area has elliptic type.
Selection\Magic wand	To select cells set in limits of editing area by mouse. Active cell and adjoining with it cells (which parameters are close to it parameter) are selected. Degree of closeness is defined in a dialogue of model parameters settings.
Selection\Remove selection	To remove selection
Mesh options\add column /row	To add new vertical or horizontal border. New border appears by press of mouse in selected area.
Mesh options\remove column /row	To remove selected vertical and horizontal border.
Mesh options\resize column /row	To change thickness of array or column by mouse
Clear model	To clear current model.



Application 1: Graphics set editor



The editor is intended for control of color sequence of a graphics set.

The option **Style** establishes algorithm of a task of a color palette for graphics.

At a choice of **Interpolate** value is used the interpolation palette constructed with using of flowers set in options: **min color**, **1/3 color**, **2/3 color** and **max color**. **Const** value establishes identical value colors (option color) for all graphics. **Random** value sets casual colors to all graphics.

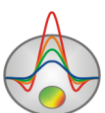
The option **Line** allows setting a certain color for connecting lines of graphics. At the disconnected option is used color from a palette, the value of color set in **Line** differently is used.

The option **Pointer** allows setting a certain color for filling of graphics indexes. At the disconnected option is used color from a palette, the value of color set in **Pointer** differently is used.

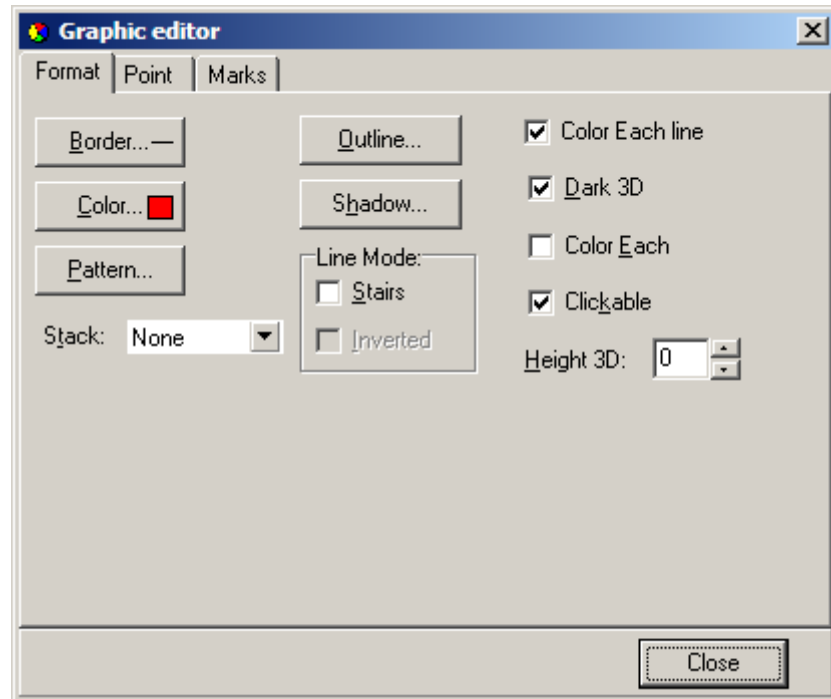
The option **Border** allows setting a certain color for an inking of graphics indexes. At the disconnected option is used color from a palette, the value of color set in **Border** differently is used.

The **Options** button causes dialogue of graphic control.

The **Default** button establishes settings of graphics equal to values by default.



Application 2: Graphic editor



The editor is intended for control of graphic appearance. It can be caused click of the right mouse button with the pressed SHIFT key on graphics.

The **Format** tab contains settings of connecting graphic lines.

The **Border** button causes dialogue of control of parameters connecting graphic lines.

The **Color** button causes dialogue of graphic color choice.

The **Pattern** button causes dialogue of a choice of graphics filling parameters.

The **Outline** button causes dialogue of control of inking connecting graphic lines parameters.

The **Shadow** button causes dialogue of appearance control of a shadow falling from the graphic.

The **Point** tab contains settings of graphic indexes.

The option **Visible** is allowing show/hide graphic indexes.

The option **Style** establishes an index form.

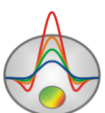
The option **Width** sets width of index in terms of screen.

The option **Height** sets index height in terms of the screen.

The option **Inflate margins** defines, whether will increase the size of the image according to the indexes size.

The **Pattern** button causes dialogue of a choice of index filling parameters.

The **Border** button causes dialogue of control of parameters of the index leading round line.



The **Gradient** button causes dialogue of control of indexes gradient filling.

The **Marks** tab contains settings of signatures to graphic indexes.

Style tab.

The option **Visible** is allowing show/hide signatures to graphic indexes.

The option **Draw every** is allowing to draw every second, the third etc. the signature depending on the chosen value.

The option **Angle** defines an angle of rotation of the text of signatures to indexes.

The option **Clipped** establishes, whether it is necessary to draw the signature to the index if it leaves for graph area.

The **Arrows** tab serves for control of appearance of an arrow going from the signature to the index.

The **Border** button causes dialogue of control of arrow line parameters.

The **Pointer** button causes dialogue of control of arrow tip form (a Point tab option).

The option **Length** sets length of arrow.

The option **Distance** sets distance between a tip of arrow and the graphic index.

The option **Arrow** head defines of arrow tip appearance. **None** – is used tip set by the **Pointer** button. **Line** – is used a classical thin arrow. **Solid** – is used a classical thick arrow.

The option **Size** sets the size of a tip if is used the classical arrow.

The **Format** tab contains graphic settings for a frame round the signature to the index.

The **Color** button causes dialogue of a choice of frame background color.

The **Frame** button causes dialogue of control of frame line.

The **Pattern** button causes dialogue of a choice of parameters of frame background filling.

The option **Bevel** sets frame style: usual, raised or shipped.

The option **Size** sets level of a raising or frame immersion.

The option **Size** is allowing display a frame with the rounded-off corners.

The options **Transparent** and **Transparency** set degree of frame transparency.

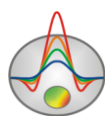
Text tab:

The **Font** button causes dialogue type control for indexes signature.

The **Outline** button causes dialogue of control of indexes signatures letters outline lines.

The option **Inter-char** spacing establishes fit for the indexes signatures text.

The **Gradient** button causes dialogue of control of gradient filling for the text of index signatures.



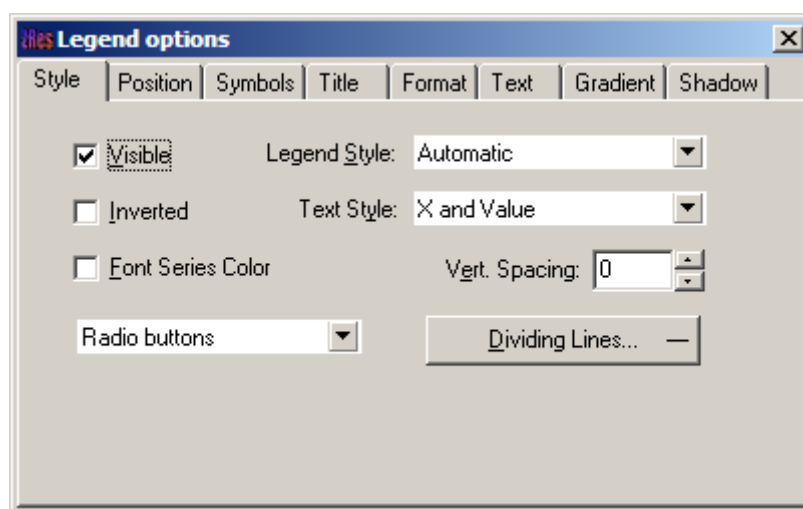
The option **Outline gradient** specifies where gradient filling of the text will be used: on lines of an inking or internal area of letters.

The **Shadow** button causes dialogue of appearance control of a shadow falling from the text of indexes signatures.

The **Gradient** tab contains settings of gradient filling for a framework round signatures to indexes.

The **Shadow** tab contains settings of appearance of a shadow falling from a framework round signatures to indexes.

Application 3: Editor of legend for graphics



The editor is intended for control of appearance of schedules and a legend to them. It can be caused click of the right button of a mouse with the pressed SHIFT key on a legend to the right of the schedule.

Thus there is a pop-up menu with a tabs set.

The **Style** tab allows adjusting style of legend display, to choose a format of the data signature to a legend, to display borders between signatures in a legend etc.

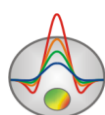
To the **Position** tab allows it to choose the legend location concerning the plan of graphics.

The **Symbols** tab sets parameters of legend symbols display.

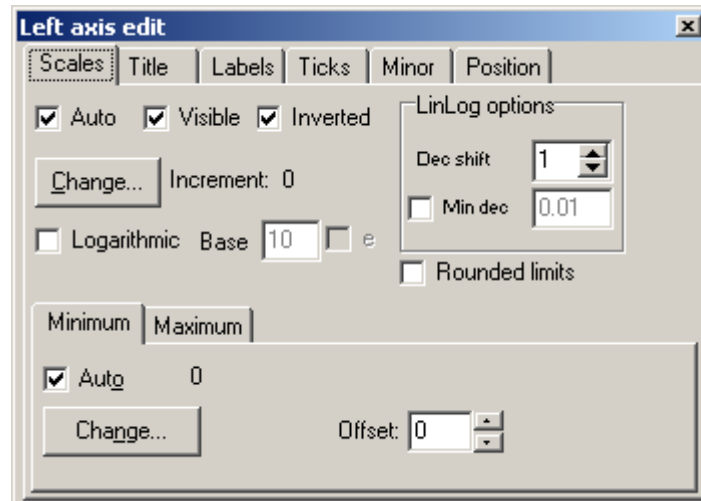
The **Title** tab sets the name of a legend and allows it to adjusting its format.

The **Text** tab allows adjusting a format of legend signatures.

The **Format**, **Gradient** and **Shadow** tabs contain settings of a window of a legend, its gradient filling and a shadow.



Application 4: Axes editor



The editor is intended for control of graphic and large-scale parameters of axes. It can be caused click of the right mouse button with the pressed **SHIFT** key on an interesting axis. Thus there is a pop-up menu with two points: **options** and **default**. The first causes the dialogue, the second establishes values equal to values by default.

The first tab of dialogue - **Scales** contains options connected with control of large-scale parameters of an axis.

The option **Auto** specifies to the program how is defined the minimum and an axis maximum. If the option is included, limits of an axis are automatically, differently are set by the user in the **Minimum** and **Maximum** areas.

The option **Visible** allows it to show/hide the chosen axis.

The option **Inverted** defines axis orientation.

The **Increment change** button causes dialogue of axis labels step task.

The option **Logarithmic** establishes axis scale - logarithmic or linear. In case of a sign-variable axis it is necessary to use **LinLog options** area options in addition.

The option **Base** defines the logarithm basis for a logarithmic axis.

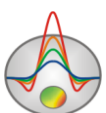
The **LinLog** options area contains the options intended for control linearly - a logarithmic axis. Linearly - the logarithmic scale allows it to represent sign-variable or a zero containing data in logarithmic scale.

The option **Dec Shift** establishes a space (in logarithmic decades) rather maximum on the module of axis limit to zero. The minimum (prezero) decade has linear scale, the others logarithmic.

The option **Min dec** sets and fixes value of the minimum (prezero) decade if the option is included.

The option **Rounded limits** specifies to the program, whether it is necessary to approximate values of axis minimum and maximum.

The **Minimum** and **Maximum** areas contain a set of options on control of axes limits.



The option **Auto** defines how the axis limit - automatically is defined or is set by the Change button.

The option **Offset** establishes percentage shift of axis limit concerning its actual value.

The **Title** tab contains options connected with control of heading of an axis.

Style tab:

The option **Title** defines the text of heading of an axis.

The option **Angle** defines an angle of axis heading text rotation.

The option **Size** defines a space of the text of axis heading. At the set 0 space is found automatically.

The option **Visible** allows it to show/hide axis heading.

Text tab:

The **Font** button causes dialogue of control of a font for axis heading.

The **Outline** button causes control dialogue of outline lines of axis heading letters.

The option **Inter-char** spacing establishes interaliteral distance for the text of axis heading.

The **Gradient** button causes dialogue of control of gradient filling for the text of axis heading.

The option **Outline** gradient specifies where to apply gradient filling of the text: on lines of an inking or internal area of letters.

The **Shadow** button causes dialogue of control of appearance of a shadow falling from the text of heading of an axis.

The **Labels** tab contains options connected with control of signatures of an axis.

Style tab:

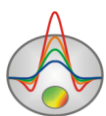
The option **Visible** allows it to show/hide axis signatures.

The option **Multiline** is used for a task of multiline axis signatures.

The option **Round** first approximates the first axis signature.

The option **Label** on axis cleans signatures falling outside the axes limits.

The option **Alternate** places axis signatures in two rows.



The option **Size** defines a space of axis signatures. At the required 0 indent is finding automatically.

The option **Angle** defines an angle of the text rotation of axis signatures.

The option **Min separation %** sets the minimum percentage distance between signatures.

Text tab:

The **Font** button causes dialogue of font control for axis signatures.

The **Outline** button causes dialogue of outline lines of axis signatures letters control.

The option **Inter-char spacing** establishes interliteral distance for text of axis signatures.

The **Gradient** button causes dialogue of control of gradient filling for text of axis signatures.

The option **Outline** gradient specifies where gradient filling of text will be used: on lines of outline or internal area of letters.

The **Shadow** button causes dialogue of appearance control of a shadow falling from the text of axis signatures.

The **Ticks** tab contains options connected with control of axis main labels.

The **Axis** button causes dialogue of axis line control.

The **Grid** button causes dialogue of control of axis main labels grid lines.

The **Ticks** button causes dialogue of control of lines of the main axis external labels. The option **Len** establishes its length.

The **Inner** button causes dialogue of control of lines of the main axis internal labels. The option **Len** establishes its length.

The option **Centered** – aligns a grid of axis labels.

The option **At labels only** specifies to the program to draw the main labels only in signature presence on an axis.

The **Minor** tab contains options connected with control of intermediate axis labels.

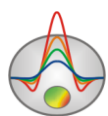
The **Grid** button causes dialogue of grid lines of intermediate axis labels control.

The **Ticks** button causes dialogue of control of lines of intermediate axis external labels. The option **Length** establishes its length.

The **Minor** button causes dialogue of the main internal axis labels lines control. The option **Len** establishes its length.

The option **Count** establishes quantity of minor labels between the main.

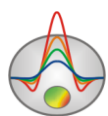
The **Position** tab contains options the defining sizes and the provision of an axis.



The option **Position %** establishes axis shift on the column of rather standard situation (in percentage of screen units count size, depending on value chosen as the option **Units**).

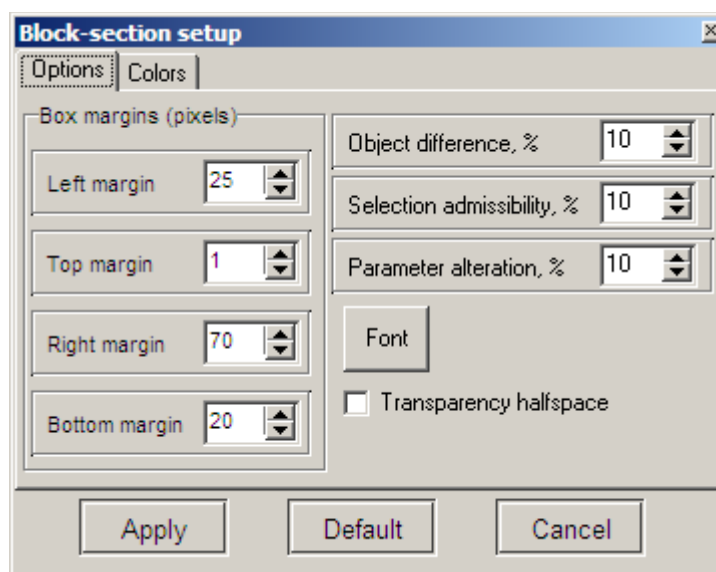
The option **Start %** establishes shift of axis beginning on the column of rather standard situation (in percentage of the size of the count).

The option **End %** establishes shift of axis end on the column of rather standard situation (in percentage of the size of the count).



Application 5: Dialogue of model parameters settings

Options tab



Box margins area

Left – establishes a space (in pixels) images from the left window edge

Right – establishes a space (in pixels) images from the right window edge.

Top – establishes a space (in pixels) images from the upper window edge.

Bottom – establishes a space (in pixels) images from bottom window edge.

Object difference - establishes the maximum value of connection of parameters of adjacent cells at which excess between them is drawn the border.

Selection admissibility - establishes admissible level of distinction of parameters of adjacent cells at which cells are uniform object and are allocated in common (in a mode of allocation of **Magic Wand**).

Parameter alteration – defines increment size to parameters of the allocated cells (as a percentage concerning value of parameter), at work in the **Edit** mode with the pressed SHIFT key.

The **Font** button causes dialogue of control of a font.

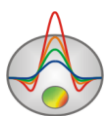
Colors tab

Color bar area

The options **Min color**, **1/3 color**, **2/3 color** and **Max color** set interpolation sequence of colors which establishes dependence between value of model parameter and a certain color.

Others area

Body border – allows it to set color of border between the next cells if distinction degree between them is more than the value set in the option Parameter alteration.

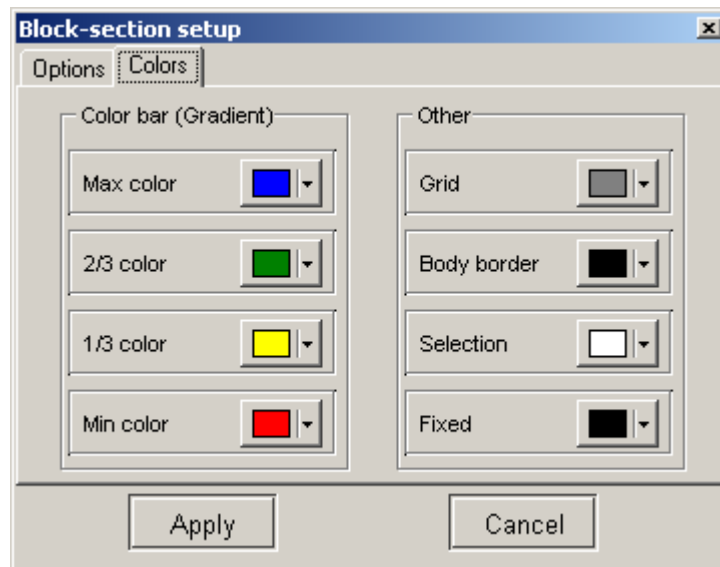


Grid – establishes color of a grid.

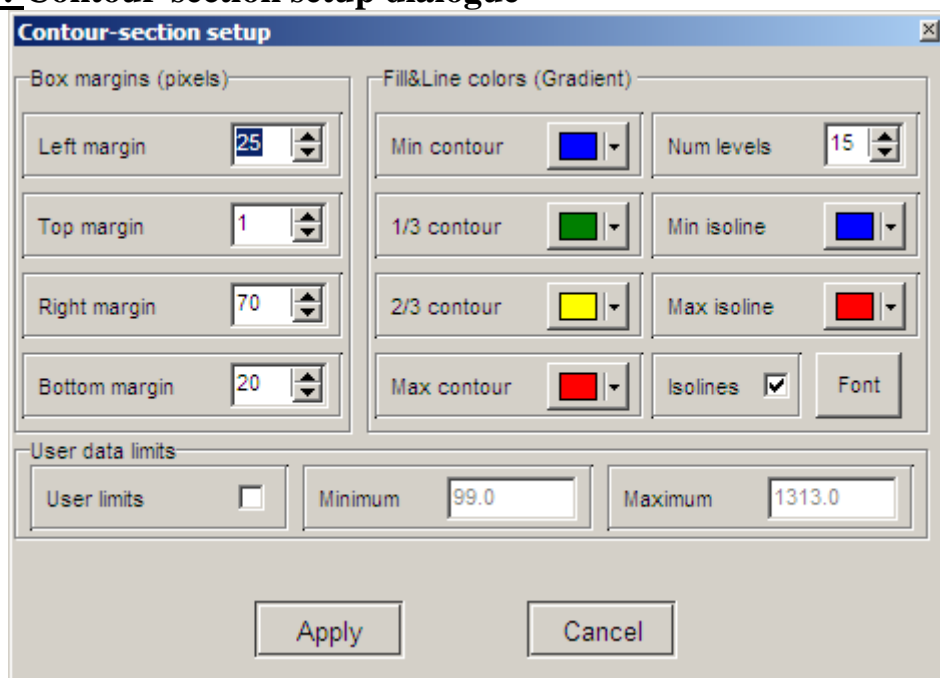
Selection - establishes color of allocated cell label.

Fixed - establishes color of a fixed cell label.

Transparency halfspace – includes a transparency mode of cell if value of parameter corresponds to value of the containing environment.



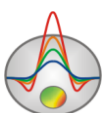
Application 6: Contour-section setup dialogue



Dialogue serves for control of parameters contour section.

Box margins area

Left margin – establishes a space (in pixels) images from the left window edge.



Right margin – establishes a space (in pixels) images from the right window edge.

Top margin – establishes a space (in pixels) images from the upper window edge.

Bottom margin – establishes a space (in pixels) images from bottom window edge.

Fill&Line colors area

The options **Min contour**, **1/3 contour**, **2/3 contour** and **Max contour** set interpolation sequence of flowers from **Min contour** to **Max contour** through **1/3 contour** and **2/3 contour**. The palette created thus is used for space shading between the next isolines.

The field **Num levels** – defines quantity of isolines sections. Sections of isolines are defined by an even linear or logarithmic step, depending on data type.

The options **Min isoline** and **Max isoline** set interpolation sequence of flowers from **Min isoline** to **Max isoline**. The palette created thus is used when posing isolines.

The option **Isolines** – specifies to the program, whether it is necessary to draw isolines.

User data limits area

The option **User limits** - specifies to the program to use the minimum and maximum values of data or to use values of the fields **Minimum** and **Maximum** at a task of isolines sections.

The field **Minimum** – establishes the minimum value at task of isolines sections.

The field **Maximum** – establishes the maximum value at task of isolines sections.

