Tesseral Technologies Inc. #380, 1500-14th Street SW, Calgary, Alberta, Canada T3S 1C9 Tel: +1 403 483-7317 Email: <u>support@tetrale.com</u> Web: <u>www.tesseral-geo.com</u>



Multiparameter Numerical Medium for Seismic Modelling, Planning, Imaging & Interpretation QC Worldwide

TESSERAL GEO MODELING SUITE

Windows Workplace (Pro V5.2.2)

User's Manual

Table of Contents

1	About Tesseral Pro	7
	1.1 System Requirements	8
	1.2 Tesseral Pro package download and Installation	9
2	Introduction	11
	2.1 Layout of Tesseral Pro window	
	2.2 Menu overview	
	2.3 General steps for synthetic modeling	
3	Depth model building	
3		
	3.1 Building a new model	
	3.1.1 Creation of a simple 2D model3.1.2 Creation of a model from a SEISMIC file	
	3.1.2 Creation of a model from a SEISIVIC file	
	3.1.3 Creation of a model from Maps	
	3.1.5 Creation of a simple flat layered model from LAS file	
	3.1.6 Creation of a model from SPS-file	
	3.1.7 Creation of a model from PICTURE	
	3.1.8 Hybrid method for model creation	
	3.1.9 Load model in other formats	
	3.1.10 3D Model building from Maps	
	3.1.11 Introducing vertical gradients in 3D cubes	
	3.1.12 Introducing horizontal gradients in 3D cubes	56
	3.1.13 Introducing cylindrical bodies and tetrahedrons in 3D SGY cubes	
	3.1.14 3D model building from well data	61
	3.1.15 Building a thin layered 3D model	
	3.1.16 Building 3D model with complex faults using 3D View frame	69
	3.2 Polygon creation and editing	
	3.2.1 Create a polygon manually	77
	3.2.2 Change polygon's shape	
	3.2.3 Move/copy a polygon	
	3.2.4 Delete a polygon	
	3.2.5 Edit polygon's properties	
	3.2.6 Anisotropic/fracture/absorption p a r a m e t e r s	
	3.2.7 Order of polygon overlapping	
	3.2.8 Base points3.2.9 Build polygons from well's intersection data	
	3.2.9 Build polygons from well logs (thin layering)	
	3.3 Build model from 2D/3D gathers	
	3.3.1 Specify the polygon's components by underlying gather3.3.2 Thomson- Tsvankin's Anisotropy Parameters	
	3.3.3 Porous Medium Parameters	
4	Acquisition geometry for 2D	
4	4.1 Receivers move with source	
	4.2 Receivers at fixed position	
	4.3 Zero offset	
	4.4 VSP and VSP with ascending receivers	
	4.5 VSP dipole	
	4.6 Load acquisition geometry from gathers	
	4.7 Load acquisition scheme from SPS files	
	4.8 Standard dialogue box for acquisition geometry	

5	М	odeling: synthetic gather calculation	120
	5.1	Modeling method selections	
	5.2	Source wavelet	
	5.3	Additional parameters	
		Eikonal Ray Tracing Modeling	
		2.5D Elastic Anisotropic Modeling	
	5.4	Gather Calculation rocess	
	5.5	Modeling using cluster and windows network	
	5.5.1		
		Modeling using Windows network	
6		D Ray tracing	
U	6.1	Ray-path display in Frame Model	
	-		
	6.2	Ray-path display in gathers	
_	6.3	Ray-tracing parameters	
7		O Seismic Survey Design and Planning	
	7.1	3D survey	
		Load Map using backgroud picture	
		Choose 3D survey design	
		Marine surveys	
		Move and Rotate 3D survey.	
		Edit Shot and Receiver Stations Change Direction for Shot and Receiver Lines	
		3D recording patch design	
		Load survey from SPS-files	
		Load survey from SGY-files.	
) 3D survey export to SPS-files.	
		. 3D survey export to KML-file.	
		? Manage Static Layers	
	7.2	Coordinate Reference Systems Options	
	7.3	Survey planning	
		Fold Map menu and toolbar.	
		Fold Calculation Properties	
		Fold Display Options	
	7.3.4	Bin Grid Statistic	
	7.3.5	Selected Bin Informartion	
	7.3.6	Plot Statistics	214
	7.4	Manipulation with Acquisition Geometry	
	7.4.1	Changing position of Inline/Crossline axes	
	7.4.2	Changing coordinates of the Shot/Receiver	219
	7.4.3	Changing the depth of Shots/Receivers	220
	7.4.4	Placement of Shots/Receivers in Well	
8	3[O Ray-tracing	226
	8.1	3D Ray Tracing Modeling	
	8.1.1	Previewing 3D Velocity Model	228
	8.1.2	Loading the Reflecting Surface	230
		3D Ray Tracing simulation	
		Viewing the Illumination map	
		Viewing the rays	
	8.2	Source grouping for 3D modelling	
	8.3	Double couple sources in 3D modelling	

8.3.1 L	Ising the same moment tensor for all sources	
8.3.2 L	Ising 2D douple couple sources for 3D modeling	
9 3D I	Full-Wave Modeling	254
9.1	3D model as a seismic cube	
9.2	Design 3D acquisition geometry	
9.3	Setup modeling procedure and boundaries	
9.3.1 R	un 3D simulation on Windows PC	
	un 3D simulation on Linux Cluster	
10 Pro	cessing of seismic gather	
10.1	General Purpose Procedures	
-	opy Gather to SEG-Y Format	
	plit Seismogram by Shotgathers	
	plit SEG-Y File into Pieces of Limited Size	
	/ Nerge Seismograms	
	تut Out Cube/Section traces (by coordinates bounded by a rectangle)	
10.1.6 3	D Replication (create 3D grid by reproducing 2D cross-section)	
10.1.7 S	EG-Y File Resampling	
10.1.8 C	Difference of 2 Seismograms	
10.1.9 li	mport/Export Traces Coordinates	
10.1.10	Write Visible Coordinates to Trace Headers	
10.1.11	Cut Profile from 3D seismogram	
10.1.12	Export Profile to 2D Seismic File	
10.1.13	Band-pass filter	
10.2	Velocity model	
	verage Velocities from Model	
	pepth-to-Time/Time-to-Depth conversion	
	D Interpolation	
10.3	Pre-Processing	
10.3.1 0	Sathering	
10.4	Stack (Time domain)	
	inematic corrections (Normal Moveout)	
	tacking	
	MP Stack	
	Dip Moveout Stack	
10.5	2D/3D Migration	
	ime Pre-Stack Kirchhoff Migration	
	Depth Pre-Stack Kirchhoff Migration	
	D Duplex Wave Migration	
	D Converted Duplex Wave Migration (CDWM)	
	D Duplex Wave Migration from Scattered Waves Pepth 2D VSP Migration	
	Depth 3D VSP Migration	
10.6	Post-Processing	
	rost-riocessing	
	race-wise Procedures eroing of the seismic cube above surface	
	eroing of the seismic cube under surface	
	rking with Frames	
	-	
11.1	Frame types	
11.2	Frame Selection	
11.3	Frame layout	
11.4	Frame size	

11.5	Undo/Redo	
11.6	Scale of display	
11.7	Print and export	
11.8	Project tree and the database	
12 M	lodel Frame	
12.1	Properties of the Model Frame	
12.2	Model re-size	
12.3	Model export	
-	1 Model export to a seismic format	
	2 Model export to Tesseral 2D (TAM format)	
13 Fr	ame Seismic	
13.1	Load seismic files	
13.1.1	1 Plan view	
13.2	Trace display	
13.3	Operations with Seismic Frame	
13.4	Preview of 3D seismic models or 3D migration results	
13.5	Profiles	
13.6	Overlay surfaces on seismic cubes	
13.7	Horizontal sections	
13.8	Settings for Seismic Frame	
13.9	2D Snapshot Viewer	
13.10		
13.11	•	
-	lap Frame. Stratigraphic Surface Maps	
14.1	Load surface from text file	
14.2	Calculate surfaces using well data	
	1 Select fields for the project	
	2 Create Frame Map	
	3 Working area	
14.2.4	4 Surface mapping	
	5 Handling surfaces	
	5 Surface display	
	7 Build model from surfaces	
15 30	D View Frame	
15.1	Seismic Data Visualization	
15.2	Surface Visualization	
15.3	Visualization of inclinometry logs, well logs and layers	
	1 "General" tab – General well properties	
	2 Well logs visualization	
	-	
	nnex A: Measurement units	
16.1	Model Frame	
16.2	Seismic Frame	
16.3	Map Frame	
16.4	Database: transform the measurement units	
	nnex B: Geophysical database	
17.1	DBMS	

	17.2	Diagram of Classes	408
	17.3	Description of tables and basic fields	409
	17.4	Database connection, creation and copying	412
	17.5	Data loading	414
	17.6	Data editing	421
18	Anne	ex C: Licensing policy	424
	18.1	Single-user License	425
	18.2	Network License	426
	18.3	Mixed Licenses	427
	18.4	Setting up a license	428
	18.5	Installing Guardant Network Services	429
	18.6	Troubleshooting	432

1 About Tesseral Pro

Tesseral Pro is designed for calculating seismic synthetic gathers using finite-difference wave equation approximations, such as acoustic, elastic, anisotropic, visco-elastic and 2D ray- tracing (approximation by Eikonal equation). In the Tesseral Pro, the depth velocity models can be built from well data, geological surface maps or 2D/3D grids.

Also, Tesseral Pro allows building a 3D observation system and performing 3D Ray tracing.

1.1 System Requirements

Minimum	Recommended
Windows /7/8/10/11	Windows /10/11
1.5 GHz CPU	3.0 GHz CPU,
Commodity or integrated GPU	power GPU
4 GB RAM	16 GB RAM
2 GB free space on HDD	10 GB free space on HDD Network Card (access corporate database)

1.2 Tesseral Pro package download and Installation

The latest versions of the Tesseral products can be downloaded from the following links: <u>http://www.tesseral-geo.com/download.en.php</u>

To start the installation process, please unzip the file and then run the setup executable.

NOTE: If you have purchased the Tesseral Pro USB-key license, please do not insert your USB key before finishing the installation. The drivers for USB key will be set up during the installation.

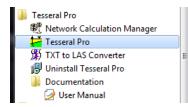
After successful installation, a Welcome dialog (below) will appear.



In the <u>User Information</u> dialogue box you may enter your name and specify if other users can use Tesseral Pro on this computer (the current user only or all the users of this computer).

😸 Tesseral Pro Setup		
User Information Enter the following in	formation to personalize your installation.	<u>e</u>
Full N <u>a</u> me: Organization:	John Smith	
	s application can be installed for the current user or r. You must have administrator rights to install the se oplication for:	
	< <u>B</u> ack Next	Cancel

After installing Tesseral Pro, just click "Tesseral Pro" in the start menu to start Tesseral Pro:



When Tesseral Pro is started for the first time, you need to enter your registration information or insert your USB key (see Licensing Policy at Section 18). After registration, the program is ready for use.

	Outgoing Code:	Please email this outgoing co Service, and then enter the ir receive.	
	Incoming Key:	W2H9KT71MX4M497MUS>	KNHAX6C6
		Please, visit http://www.tess information of how to obtain t	
		Register	Cancel
IASP	keu	Network HASP key	

Without a license, in the demo mode, the functions of synthetic gathers modeling and gathers processing are unavailable for the users.

2 Introduction

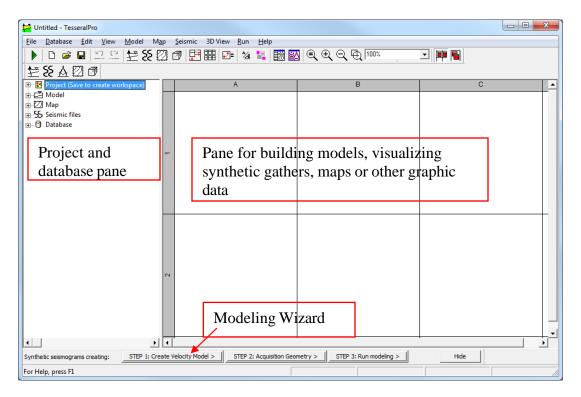
After launching the Tesseral Pro, a <u>Welcome</u> dialogue box with several options appears.



- The CREATE NEW MODEL button launches the Wizard to create a new model (Section 3.1).
- The <u>LOAD MODEL</u> button is for loading a model in TAM format used in the Tesseral 2D program, WGC format, GXII format or loading a model from a text file in various formats (Section 3.1.9).
- The <u>LOAD SEISMIC FILE</u> button enables the visualization of gathers in standard SEG-Y, internal TGR and SDS-PC formats (Section 13.1).
- The <u>OPEN PROJECT</u> and <u>OPEN LAST PROJECT</u> buttons are for loading the files of Tesseral Pro projects.

If you click Done, the standard empty window of the Tesseral Pro project will appear.

2.1 Layout of Tesseral Pro window



In the left panel the database tree (please see description in the Section 17) and the project tree (please see details in the Section 11.8) are displayed. The right panel is for building the model and visualizing gathers, maps or 3D images. All the objects in the right pane are displayed in rectangular frames (please see details in the Section 11).

At the bottom of the main Tesseral Pro window is the <u>Modelling Wizard</u>, which initiates one of the 3 main steps in a modeling process (Section 2.3).

2.2 Menu overview

- Menu File consists of the options for creating, saving or importing a project (TPA format), loading models, gathers or surfaces, printing document and exporting the project into standard raster-type or vector formats.
- Menu Database is for managing the database in Tesseral Pro, such as creating/selecting database, or importing/editing a well log data (see Section 17).
- Menu Edit is for manipulating Frames.
- Menu View is for general commands for working with Frames.
- Menu Model is for creating and modifying velocity models and acquisition geometry (Section 12).
- Menu Map is for creating/loading a surface map and different ways of displaying the surface map (Section 14).
- Menu Seismic is for loading seismic gathers in SEG-Y, SDS-PC or TGR formats (Section 13) and changing the visualization modes.
- Menu 3D View is for viewing 3D images (Section 15).
- Menu Run is for launching computation of synthetic gathers for one particular model or to process these synthetic gathers using available processing modules such as stacking and 2D migration (Section 5, 11).

2.3 General steps for synthetic modeling

At the bottom of the Tesseral Pro window, the 3 sequential steps for creating synthetic gathers are shown:

<u>STEP 1</u>. Creation of the 2D velocity model. The velocity model can be created by using well data, maps of horizons or 2D/3D layered model (SEG-Y format) or LAS file). 1D/2D vector models in various formats from other packages are also supported (Section 3.1).

STEP 2. Creation of the acquisition geometry (source and receiver distribution, section

4)

STEP 3. Set up of the modeling parameters and start a modeling job which launches one

of the following computational engines (Section 5):

- 1. 2D/3DVertical Incidence
- 2. 2D Scalar
- 3. 2D/3D Acoustic
- 4. Acoustic without multiples
- 5. 2D/3D Elastic
- 6. 2D/3D Elastic Anisotropic
- 7. 2D/3D Visco-Elastic
- 8. 2D Eikonal Ray Tracing
- 9. 2.5D Elastic
- 10. 2.5D Elastic Anisotropic
- 11. Haskell-Thomson

The procedures for processing gathers (Section 11) and the module for ray tracing (Section 6) are integrated into Tesseral Pro.

3 Depth model building

To create a depth-domain velocity model in Tesseral Pro, a Model Frame is to be used.

All the objects in the Tesseral Pro are comprised in Frames; see Section 11 for details related to different types and options for manipulating frames.

In the <u>Model</u> Frame users can build arbitrarily complex velocity models for any geological structure, add anisotropic or fracturing parameters into the background model and design the acquisition geometry. The geological model is built by overlapping a set of polygons. Within each polygon, the rock physical parameters could be homogeneous or complicated (with a linear gradient along depth). For model creation, users can use the reflection horizons, velocity, density, anisotropy and other parameters from acoustic well logging, grids of layer data in SEG- Y format, as well as 1D/2D vector models from other packages.

3.1 Building a new model

The first stage of model building is to specify the basic parameters: size of the model (width and depth), geographical reference of the coordinates, and the main source of data used for building models (grids in SEG-Y format, grids or isolines of reflection maps, well data, underlying image and etc). The menu Model > Create Velocity Model (New Frame) is used. After that, the Wizard for new model creation will appear.

Create new Model
WIZARD
SIMPLE model >
From SEISMIC file >
From SURFACES >
From database WELLS >
From LAS-file >
From SPS-file >
From Picture >
Load model from other format file
Manual setting (using Properties dialog)
Cancel

In this dialogue box, users can select one of the main data sources for creation of a depth model. In the next chapters, various options for model building will be described one by one.

3.1.1 Creation of a simple 2D model

Firstly, click the menu Model > Create Velocity Model (New Frame).

Then, select SIMPLE model > in the Create new Model pop-up dialogue box.

In the Section dialogue box, specify the model"s length and the top and bottom of the depth model.

		ne model may be me in the Section 16.	eters or feet. Sele	ct the measurement
ĺ	Section		x	
		Model		
	len 0 200	400 600 800		
	400		400	
	800		 800 	
	Length 1000	m Top 0		
	,	Bottom 1000	m	
	<	Back Next > Ca	ancel Help	

After specifying model"s size, click <u>Next</u>. You will see the <u>Base Polygon</u> dialogue box where the constant or linearly-increasing compressional velocity of the background model (base of the other polygons) can be specified.

ase Polygon						×
		Mode 25	1			
200	10	25	00		3000	
len 0	200	400	600	800	-	
					<u> </u>	
400					400	
800					800	
		0000				
Compression	a velocity	2000	r	n/s		
Vertical lin	near velocity	gradient (/=A+Depth	•B)		
V = 180		+ Depth *		_		
v - 1100		· Depth	1.52			
			Finish	-		

After clicking <u>Finish</u>, the Frame Model will be created, and you will be asked to design the acquisition geometry used for modeling, as shown below:

Acquisition Geometry				
Do you want to run "A	Acquisition Geometry WIZARD"?			
	<u>Y</u> es <u>N</u> o			

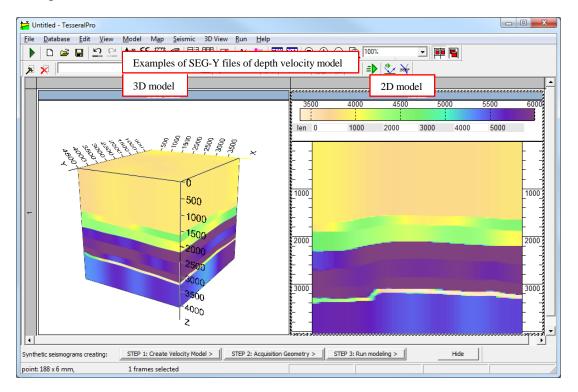
This message will always pop up after creating a new model. Please see more details about designing related source/receiver distribution in the Section 4.

After the "empty" Frame Model is created, it has to be overlapped with polygons with various velocities, density and other rock physical parameters. Please see more details about how to build a model using polygons in Section 5.

3.1.2 Creation of a model from a SEISMIC file

If you have a 2D or 3D velocity depth model in SEG-Y format, you can use it as an underlying image for the model.

For example:



This means that, instead of drawing polygons and adjusting their parameters, users have the option of using SEG-Y files directly. Users only need to select the size and location of the model. If the SEG-Y files contain only compressional velocity, then the other parameters (shear velocity, density) will be calculated automatically by using some empirical formulae. Importing density, shear velocity and anisotropy from SEG-Y files is also supported.

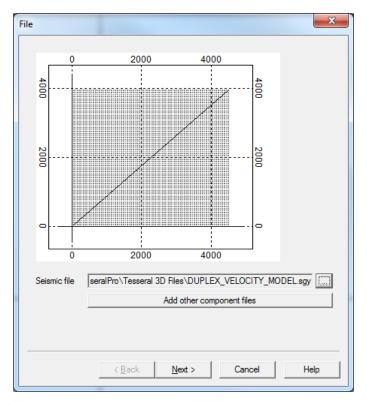
The time-domain model in SEG-Y format may also be used. But it needs to be transformed into depth model in advance; the <u>Run > Velocity Model > Time to Depth Transformation</u> menu is used for this purpose. Please see more details in the Section 10.2.2.

NOTE: In Tesseral Pro, SEG-Y files can be visualized by using the menu <u>Seismic ></u> Load Seismic File (New Frame) (please see the Section 13 for details)

After clicking the <u>Model > Create Velocity Model (New Frame)</u> menu, you will see the <u>Create new</u> <u>Model</u>dialogue box. Then click the <u>From SEISMIC file ></u> button to build the model from the seismic file.

STEP 1. Selection of a SEG-Y file with velocities

In the File dialogue, please select the 2D or 3D seismic file in one of the SEG-Y or TGR formats.



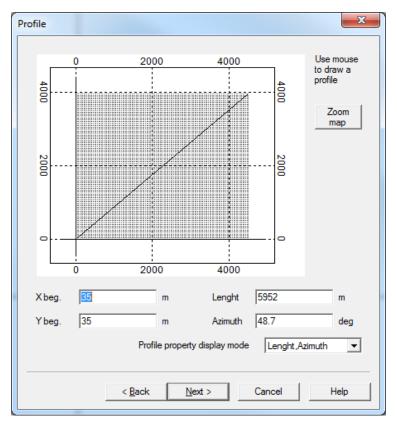
Apart from the compressional velocity data, you may also have depth-domain seismic files with density, shear-wave velocity or anisotropy data. These files may be also used as the underlying image for the corresponding components. Click the <u>Add other component files</u> button to select the files of other components in the Model from seismic files pop-up dialogue box.

Compressional Velocity	esseralPro\Tesseral 3D Files\DUPLEX_VELOCITY_MODEL.sgy	Load	Remove
Density	FesseralPro\Tesseral 3D Files\DUPLEX_DENSITY_MODEL.sgy	Load	Remove
Shear Velocity	IfTesseralPro\Tesseral 3D Files\DUPLEX_SHEAR_MODEL.sgy	Load	Remove
Anisotropy Epsilon		Load	Remove
Anisotropy Delta		Load	Remove
Anisotropy Phi		Load	Remove
	ок		Cancel

When the seismic file is selected, press the Next > button.

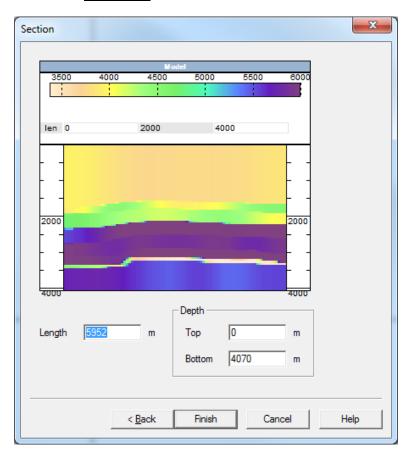
STEP 2. Selection of coordinates and the Model profile

In the next dialogue box <u>Profile</u>, if the seismic file is 3D, users need to enter the coordinates of the model profile, or draw the profile manually in the plan by pressing-dragging and releasing the left mouse button.



STEP 3. Size of the model

In the next dialogue box Section, please specify the top and the bottom of the model:

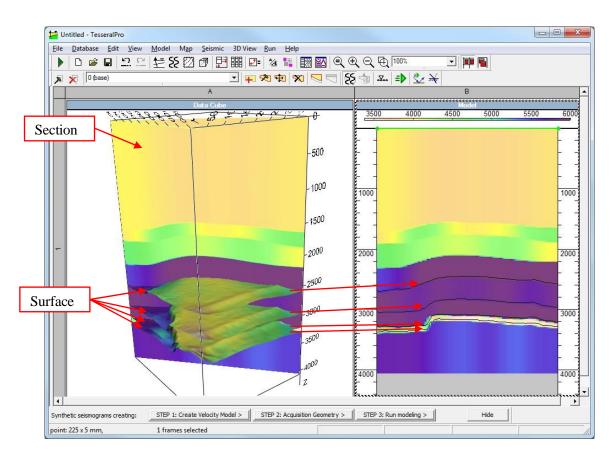


The model with the underlying seismic file is ready. Then, the users will be asked to design an acquisition geometry for the model (please see the Section 4 for details).

Users may add polygons above the underlying image to finalize the model building. In Section 3.1.8, see details about how to adjust the model sparameters, which have an underlying SEG-Y image.

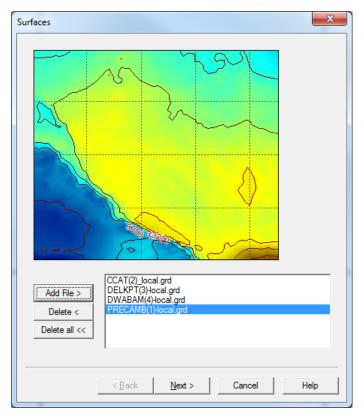
3.1.3 Creation of a model from Maps

The grids or isolines of the reflection horizons may be used for the automatic creation of model's polygons. In this case, the 2D model is built as a vertical section in the 3D cube of surfaces (see figure below). As a result, the top and the bottom of each polygon have the same shape as the surfaces for the given section.



To use this function, first click <u>Model > Create Velocity Model (New</u> Frame), and then in the dialogue box <u>Create new Model</u> click the button <u>From</u> <u>Mapsmaps</u> >.

In the opened dialogue box <u>Maps</u> click the button <u>Add File ></u> if a surface is going to be loaded from the file into the Tesseral Pro project (see figure below).

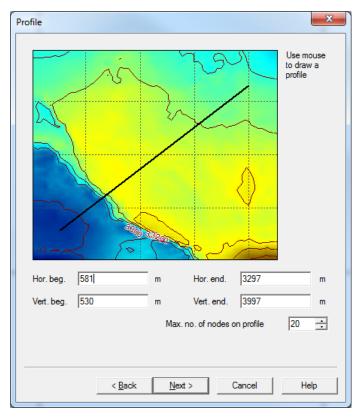


After you have selected the files with surfaces, the dialogue box <u>Choose mapping method</u> will appear, and then the dialogue box <u>Calculate Isolines</u> will appear for adjusting the parameters of the isoline image. Repeat these steps to add more layers. When all the needed surfaces are loaded, press the button <u>Next</u> \geq .

NOTE: You may select several surfaces at a time in the Add File >.

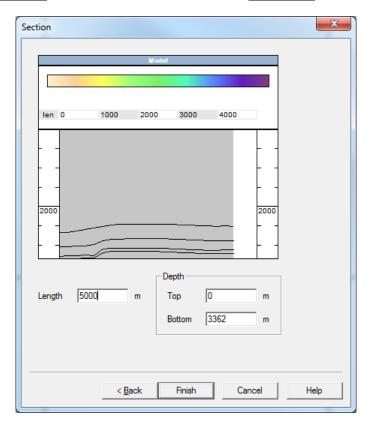
In Tesseral Pro, the surfaces may be loaded directly from files that have major text formats, or may be calculated from stratigraphic well data. Please see Section 17 about loading stratigraphic data into the database. Section 14.2 describes the functions for computing surfaces from well data.

In the next dialogue box <u>Profile</u> please specify the profile coordinates manually or draw the profile using the mouse (press-drag-release).



In the figure above, the Max. no. of nodes on profile parameter determines the number of nodes at the top and bottom of each polygon created from the surfaces.

Press the button Next > to navigate to the dialogue box Section.



In the dialogue box Section please specify the range of the model. In this dialogue

box, the lines of the polygons are shown. By default, velocities and other parameters of the polygons are not present, so the polygons are displayed in grey color. To specify the parameters for each polygon, select it by mouse and then click Model > Edit Polygon (Section 3.2.5).

3.1.4 Creation of a model from database WELLS

The well data (acoustic logging and/or density logging) are mainly used for creation of thin-layered models.

NOTE: To create a model by using well data, the following data need to be loaded into the database:
1) Coordinates of the wells;
 Survey directionality (if the survey has no directionality, vertical wells with provided altitudes is sufficient);
3) Depths of layer intersections;
4) Acoustic (density) logging data for creating thin-layer models.
Please see Section 17.5 for more details. If users wish to create a simple horizontally-

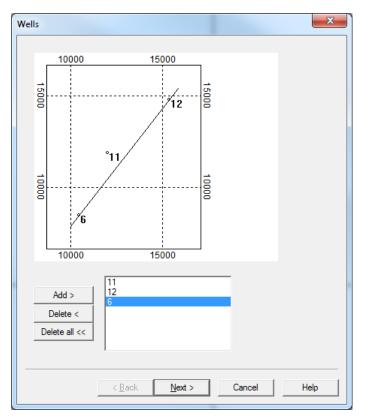
Steps for creating a model from the well data:

- 1. Click Model > Create Velocity Model (New Frame).
- 2. In the dialogue box <u>Create new Model</u>, click the button <u>From database</u> WELLS >.
- 3. In the dialogue box <u>Select Wells</u>, select the wells to be loaded from the list of <u>Wells</u>. You may mark one or several Fields, and then in the box <u>Wells</u> only wells from these Fields will be shown.

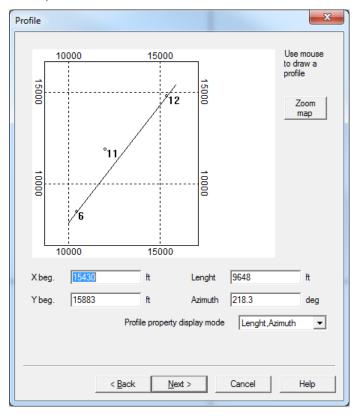
Select Wells	X
Field	
[65535] General (m) [65535] Gorobcivskoje (ft)	
1	
Wells	
11 12	
6 8 9	
9	
	OK
	Cancel
1	

After selecting the wells, press button <u>OK</u> and go to the dialogue box Wells.

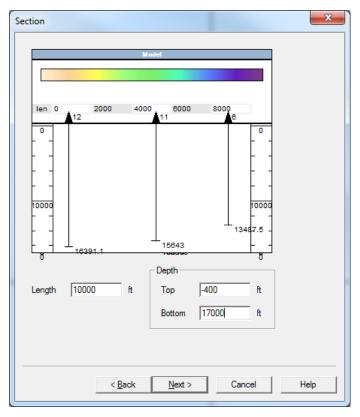
In the dialogue box <u>Wells</u>, the geographical location of the selected wells is shown, and you may add or remove wells from the profile using the buttons <u>Add</u> \geq and <u>Delete</u> \leq .



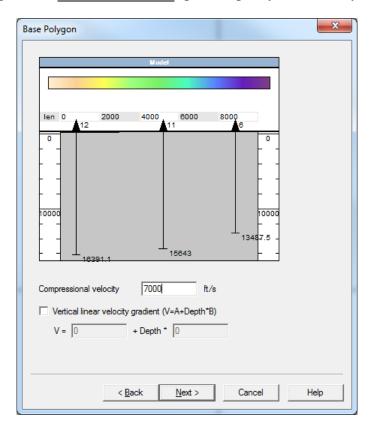
When all the needed wells are loaded into the model, press the button <u>Next</u> >. In the next dialogue box <u>Profile</u>, specify the coordinates of the model"s profile or draw the profile manually by using mouse (press-drag-release):



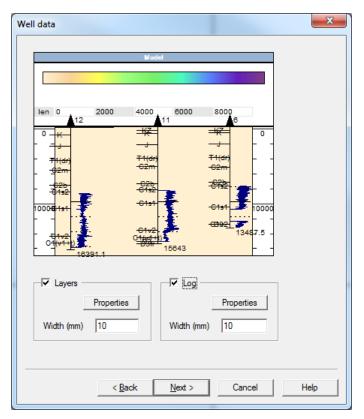
In the next dialogue box Section please set the top and the bottom of the model:



In the next dialogue box Base Polygon, please specify the velocity of the basic polygon:



In the next dialogue box <u>Well data</u>, you may select the stratigraphic arrangements and the logging data will be shown near the wells.



Check <u>Layers</u> for automatic creation of polygons by stratigraphic correspondences. Check <u>Log</u> for automatically filling the polygons with the parameters from well logging (creation of thin-layered model).

Preparation for creating a thin-layered model

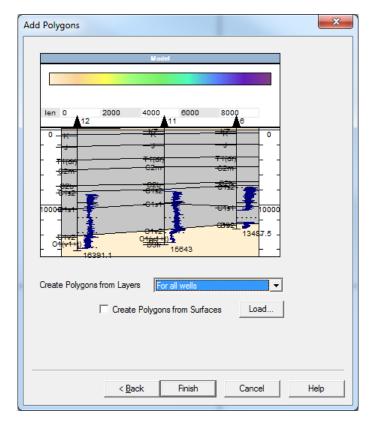
The preparation includes selecting curves for the model and adjusting the re-calculation parameters and the well logging data to characterize the polygons (velocity, density, fracturing, anisotropy).

NOTE: If \underline{log} is checked, then the acoustic logging curves will appear to the right of the well, and the parameters for re-calculating these curves are set automatically. If the logging curves do not appear, it is recommended to go to the dialogue box \underline{log} by clicking the corresponding button Properties.

In the dialogue <u>Log</u>, please select the acoustic logging curves (DT or acoustic logging) from the list of the curves for the model's wells. For further filling-in of the polygon parameters from the logging data, for the selected curves, please set <u>Specification</u> to <u>Compressional Velocity or dT</u> and also <u>Measure unit</u> to <u>usec/m</u> in order to re-calculate the parameters of the polygons from the curves' values correctly.

Log 1. Add logging curv	es				
to the wells	-Well-logs				
	DT				
Add Well-logs >	Log description				
Delete Well-log <	Net				
Delete All Well-logs <<					
	2. Set the type of the curve Autocalculation				
	and the measurement units Scale				
_ DT					
Specification Compression Velocity or dT 🗨 Measurement unit usec/m 💌					
From	To Scale				
	452 (unit/mm) Top 7874.02 ft				
1 0	452 45.2 Bottom 13399 ft				
2 0					
3 0					
, Scale type					
Line style 🔽 Scale	autocalculation By default				
	Display Well-log Informatic-6				
3. Set the scale and the lines for the curve Cancel					
L					

Then press OK and the Log dialogue box will close. As the result, in the <u>Well data</u> dialogue, the logging curves should appear near the wells. Press the <u>Next</u> > button to go to the next dialogue box <u>Add polygons</u>.

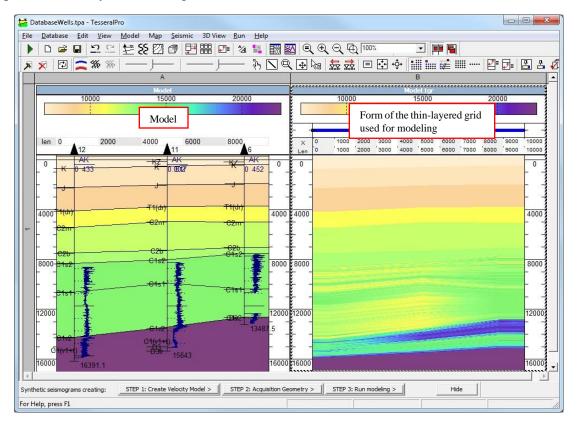


In the dialogue box <u>Add Polygons</u>, from the drop-down list <u>Create Polygons</u> from <u>Layers</u>, the following options are available for the creation of polygons:

- No do not create the polygons automatically
- <u>All layers</u> to create the polygons for all the layers which exist *at least in one* of the selected wells. It means that, if the layer exists in any of the selected wells, it will be used for the creation of polygons.
- <u>For all wells</u> create polygons for the layers which exist in *all the selected* wells. As a special case, if a layer is not present at least in one of the selected wells, it will not be used for creation of polygons.
- <u>Selected</u> select the layers manually from the list of the layers in the database. Check <u>Create Polygons from Horizon</u> to create the polygons using the previously loaded surfaces. In this dialogue box, users can load the surfaces by clicking thebutton <u>Load</u>.

As a result, the model will be created in which the velocities (and/or) other parameters will be obtained automatically from well logging data. However, as mentioned above, users need to load in advance the databases: coordinates of the wells, coordinates of layers" intersections and the logging curves (please see the Section 17.5 for more details).

The parameters interpolated by logging data (thin-layering) are not shown in the polygons. The interpolation is done automatically before the modeling job is launched. You may QC the quality of the final model by using $\underline{Model} > \underline{Export}$ to $\underline{Seismic}$ Format ($\underline{SEG-Y}$, \underline{TGR} menu item to export the velocity model to a grid file.

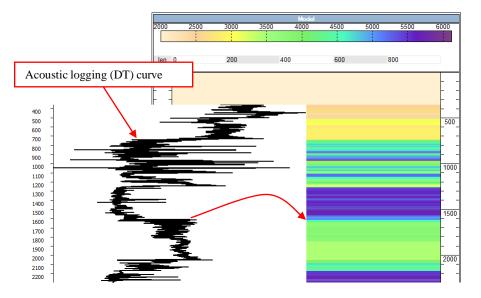


NOTE: This grid file is not used in actual calculations. It is used only for QC/visualizing the final model to be used in modeling.

In the Tesseral Pro, some special tools are implemented for creating and adjusting polygons whose properties are derived from well data. Please see Section *3.2.9* for more details. By building polygons from well data, thin-layer models are created.

3.1.5 Creation of a simple flat layered model from LAS file

In this section, a simple method is described for creating a model from acoustic logging data and/or density measurement data without loading the data in advance into database.



To start this functionality, first click <u>Model > Create Velocity Model (New Frame</u>), then in the dialogue box <u>Create new Model</u> click the button <u>From LAS-file</u>

>. In the dialogue box <u>LAS-file</u>, select the LAS-file containing the velocity and/or density.

LAS-file					X
LAS file	C:\Sheldon\Testin	gOfTesseralPro\SonicOnly	/.las		
inter a second sec				Elevation 694.299983 LAS Top 360 LAS Bottom 2303	m
-	-				
Compress	ion Velocity or dT	DT	-	us/m ?	•
Density		-Not specified-	-	units ?	•
Shear Vel	ocity or dT	-Not specified-	•	units ?	•
	< <u>B</u> ack	Next >	Cancel	Hel	>

In the dialogue box <u>LAS-file</u>, select the curve corresponding to the component of the model <u>Compressional Velocity or dT</u>, <u>Density</u>, <u>Shear Velocity or dT</u>, and then select the units of measurement for each component.

It is also recommended to set the well altitude (<u>Elevation</u>) correctly. The directionality of log data is not used for creating horizontally-layered models. However, it will not be enough to have only altitudes for conventionally vertical wells.

In the next dialogue box Section, specify the length and the model"s depth range:

Section	×
Model	
len 0 200 400 600 800	
2000	
Depth	
Length 1000 m Top 0 m Bottom 3000 m	
< Back Cancel	Help

Then specify the velocity for the basic polygon.

		Mode	-			
len 0	200	400	600	800		
					F 1	
					- 4	
1000					1000	
					<u>t</u> 1	
					- 4	
2000					2000	
	al velocity	2000	r	n/s		
Compressior	2					
	near velocity	gradient (V=A+Depth	•B)		
				*B)		
Vertical I		gradient (+ Depth *		*B)		
				*B)		
Vertical I				*B)		

In the last dialogue box <u>Create polygons from LAS-file</u>, specify the parameters which will be used for building a thin-layered model. These parameters determine the number and the thickness of the polygons created automatically from the LAS-file.

Clearance is the maximally allowed velocity variation within a polygon.

Min. Sampling rate by Depth is the minimum thickness of a polygon.

2000 3000 4000 5000 6000 Ien 0 200 400 600 800 	
2000	
2000	
2000	
2000	
Clearance 5 🕂 %	
Min. Sampling rate by Depth 10 m	
Preview: Create polygons	

For models built from well data, the polygons are filled by the interpolated parameters from the wells. If only LAS-file is used for model building, numerous thin polygons are created. To check the quality of the specified parameters, press the button <u>Create polygons</u>. Feel free to play with the parameters if you do not like the results.

3.1.6 Creation of a model from SPS-file

If you want to reproduce a field acquisition geometry while creating synthetic gathers and design the model surface using the real altitudes of sources and receivers, it is recommended to use an SPS-file to create the new model.

NOTE: The SPS-files may be also used only for reproducing the acquisition geometry in a created model. Please see details in the Section 4.7.

To use this feature, click Model > Create Velocity Model (New Frame).

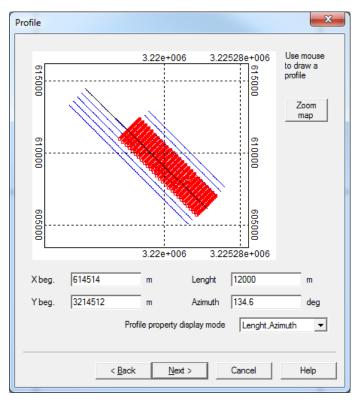
Then, in the dialogue box <u>Create new Model</u> press the button <u>From SPS-file ></u>.

Then in the dialogue box <u>Load SPS files</u>, select the files of sources, receivers and their acquisition geometry.

Also, please note that SPS scripts of all types are supported, as well as SEG scripts, KML (KMZ), and TXT file (with the following simple format: SrcX, SrcY, SrcZ, RcvX, RcvY, RcvZ)

Load SPS files	×
SPS-file type	KML auto detection SPS 1 SPS 2 SEG SP
Sources Fil	TXT
C:\Users\Stefan\Des	ktop\Tesserral Pro testing new version\KML\test Shots.kmz
Receivers F Isers\Stefan\Desktop	ile \Tesserral Pro testing new version\KML\test Receivers.kmz
Shot-Receiver Rel	ation File
Use Relation File	
	< Back Next > Cancel Help

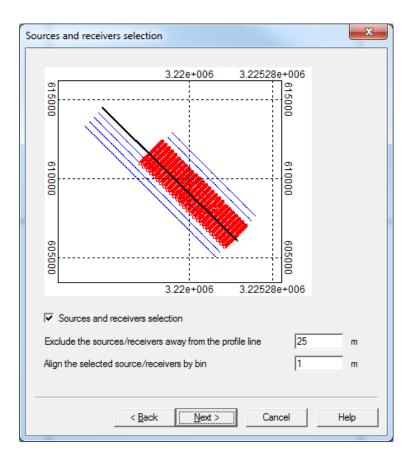
After specifying and loading the correct SPS file type, click <u>Next</u> and in the dialogue box <u>Profile</u>, specify the model profile:



In the figure above, the red rectangles indicate the sources, and the blue dots indicate the receivers. Please note that it is only possible to build 2D models in the Tesseral Pro, and so only the sources and the receivers close to the selected profile will be included.

To select the profile coordinates more accurately, please use the button Zoom map.

In the next dialogue box <u>Sources and receivers selection</u>, specify the parameters used for selecting the sources and receivers and binning the selected sources/receivers. This dialogue box is needed for proper extraction of needed sources and receivers from the loaded 3D acquisition geometry.



Then in the next dialogue box <u>Section</u>, specify the depth range of the model and how to use the altitudes of the sources and receivers saved in the SPS-files (the parameter <u>Sources</u> <u>and</u> receivers elevation):

- <u>set SPS elevations</u>: the top of the basic polygon that is to be built by the altitudes of sources and receivers.
- <u>move under model top</u>: the sources and the receivers are moved to the models" top
- <u>ignore</u>: the basic polygon of the model and the altitudes of the sources and the receivers are assigned independently.

Section	×
M odel	
len 0	
2000 	
Model depth Sources and receivers elevation Top -700 m Bottom 3000 m	•
< Back Finish Cancel He	elp

As in other model creation methods, users need to fill in the obtained model with polygons (please see details in the Section 5).

3.1.7 Creation of a model from PICTURE

This method is used for drawing model polygons manually from the underlying picture.

To use this option, click Model > Create Velocity Model (New Frame). In the dialogue box Create new Model, press the button From Picture >.

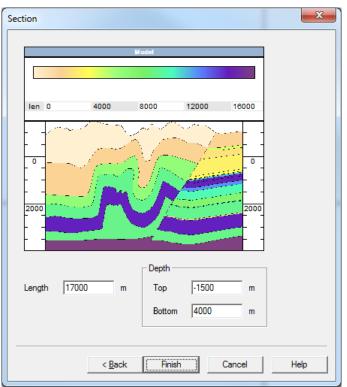
Then in the next dialogue box, select the underlying picture in a BMP, JPEG, TIFF, GEO-TIFF, GEO-JPEG format pictures with coordinates in TFW, JGW files, by clicking the button Property.

File				×
	M i e	odel		
len 0	200 400	600	800	
400			400	
800			800	
Picture				Property
	< <u>B</u> ack	Next >	Cancel	Help

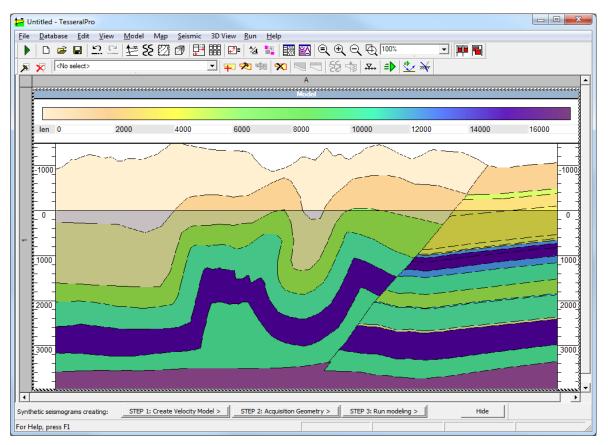
In the dialogue box <u>Picture for Model</u>, select the file of the picture and the area (part) of the picture, which will be used as an underlying image in the Frame Model.

Picture for Model	
Picture file C:\Sheldon\TestingOfTesseralPro\FoothillsG15.bmp	
	Delete picture
	ОК
Use mouse to: select work area	Cancel
Select the area using the mouse	

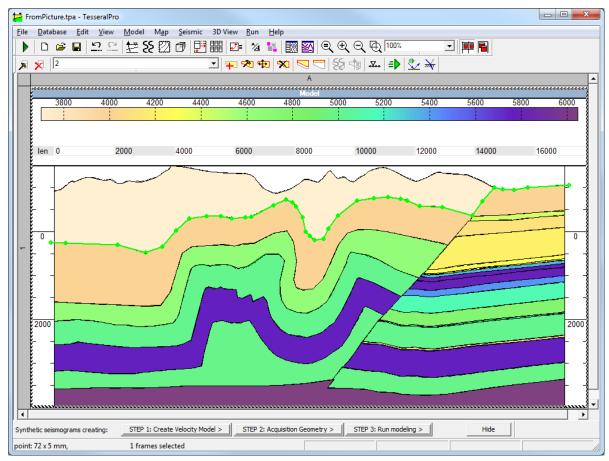
Then in the next dialogue box <u>Section</u>, specify the depth range and the length of the model.



After that, the Frame Model with the underlying picture will be created, as shown below.



This underlying picture cannot be used for modeling, but the polygons may be drawn manually by following the visible boundaries, and then velocity and other parameters for the created polygons need to be specified.



To ensure that the underlying pad image is always visible, the hand-created polygons are partially transparent.

3.1.8 Hybrid method for model creation

You may create a model by using a SPS file, surfaces, a gather for the velocity model and well data simultaneously. At first, users need to create an initial model using any of the methods. Then choose the model creation command <u>Model > Create Velocity Model (New Frame)</u> again. You will be asked whether you would like to change the existing model or create a new one.

Create model	×
The project already has got a m Press "Yes" to change the mod Press "No" to add another mod	el;
<u>Y</u> es <u>N</u> o	Cancel

Select Yes to use the other model creation method in order to change the model.

3.1.9 Load model in other formats

Use the command <u>Model > Create Velocity Model (New Frame)</u>, and then in the popup dialogue box <u>Create new Model</u>, click the button <u>Load model from other format</u> <u>file...</u>.

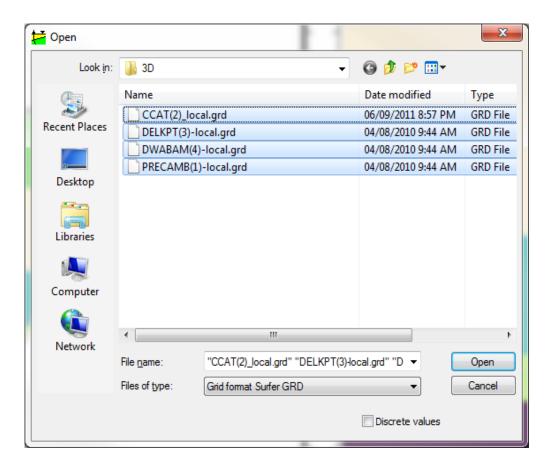
The supported formats include TAM (model format from the Tesseral 2D package), WGC, GXII and table text files. Surely, users can also load a model from another project (TPA format).

3.1.10 3D Model building from Maps

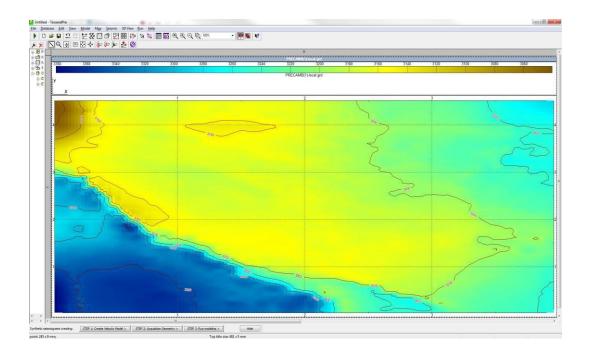
Load all surfaces you want to use for 3D model building by going <u>Map > Create</u> <u>Map</u> (New Frame) > Load TXT or GRD- surface files

For instructions on how to load or create surfaces from XYZ text files, please follow the instructions from Section 14

Select the surfaces you want to use as horizons:



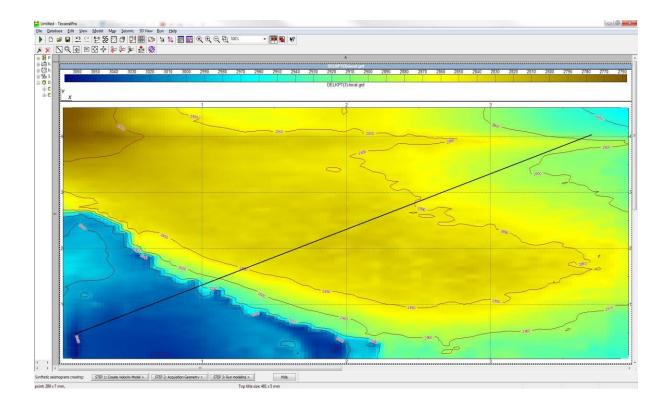
The topmost surface is shown here:



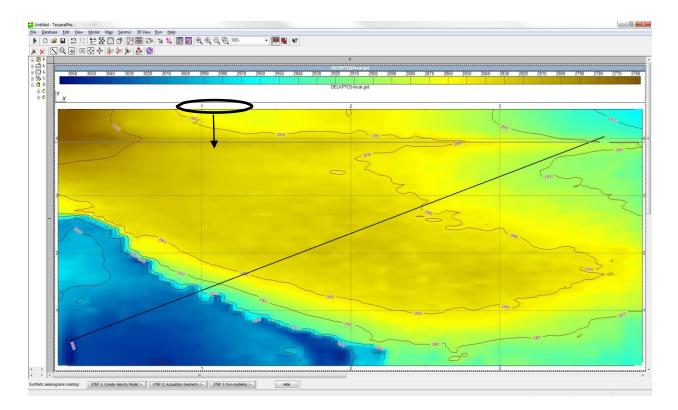
You can manage and view all surfaces individually by going <u>Map > Manage/Delete</u> <u>surfaces</u>. Next, it is advisable to order <u>Order Horizons</u> by Depth.

CCAT(2)_local.grd DELKPT(3)-local.grd DWABAM(4)-local.grd PRECAMB(1)-local.grd			\bigcirc	3200	L CS
				í Z	ر دی
Brancetter	2D Model Despection	R			Z.
Properties	3D-Model Properties Delete Map	$\left\{ \right\}$	2200	1	/ (
Deselect	Order Horizons by Depth		Displa	ay (OK)	Cancel

Once all surfaces have been loaded, values must be introduced for all layers created by these surfaces. In order to do that, a 2D cross-section needs to be generated first. This is done by accessing $\underline{Map} > \underline{Section Mode}$ and drawing the profile on the surface, by pressing- dragging-releasing the left mouse button.

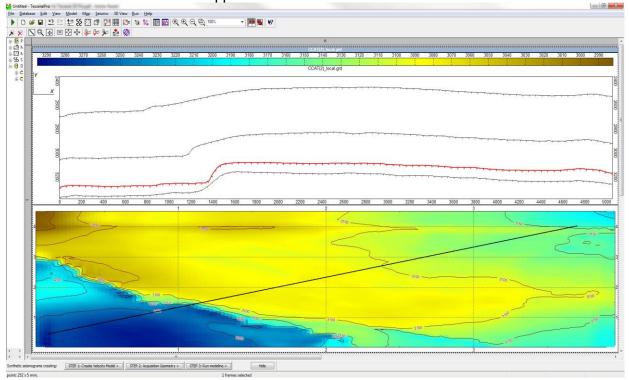


In order to see the cross section you need to bring down the (encircled) lower header:



This is done by left clicking on the lower header and then dragging it down with the left mouse button.

A two-dimensional section will appear in the stretched field:



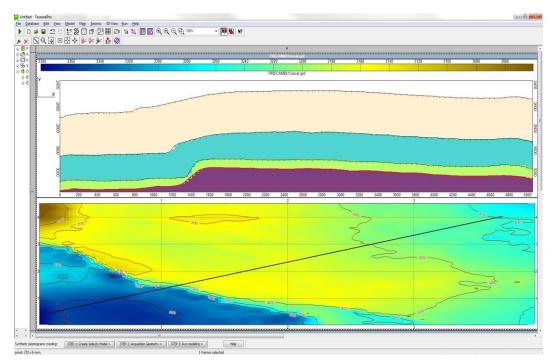
To assign a value (i.e. compressional velocity, shear velocity, density etc.) to a particular layer click on Map > Manage/Delete Maps > 3D-model Properties.

Filling cells UP	CCAT(2)_local.grd*	v top v
VALUE	2000	
Get values from	n map - not used -	•
Use well log	values	
	ls (as default)	OK Cancel

Depending on whether you want to fill the upper part or the lower part of the surface, you specify Surface type **bottom**, or Surface type **top** respectively.

Repeat this step for all loaded surfaces. Once completed, void (i.e. unfilled) space will

remain in the map frame, since all surfaces can be either $\underline{Type: top}$ or $\underline{Type: bottom}$ and not both.



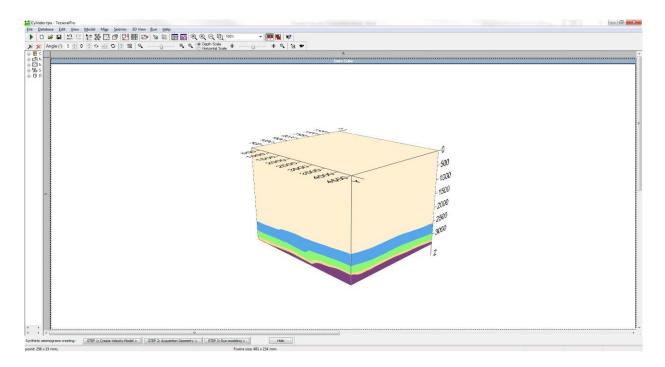
Finally to create a 3D SEG-Y file go Run > Map Frame > Create 3D SEG-Y...

Create 3D Seg-Y Mo	odel				X
Output seg-y file	3Dcube	.sgy			
	-Grid par	ameters			
		Min	Max	Step	Size
	х	40	3950	10	392
	Y	40	4510	10	448
	z	0	3380	10	339
		Set "	'Min" and "Max" fro	m Map Frame	
	- Filling Er	mpty Cells (a	is default)		
	📃 Fill	ing empty ce	ells from upper cells		
	Base	value 6	5000	1	
	Use b	ase seismogr	ram		
	_	- not used -			▼
	-Value ra	ange			
	Min	100	Max	: 10000	
				ОК	Cancel

Specify the X, Y, Z dimensions you want for your 3D model, the grid sampling, as well as the Filling cells value with which you want to fill the remaining blank layer(s). Also, specify

the pathway and name of the Output seg-y file, with .sgy extension.

If you want to fill the remaining blank layer(s) from a base seismogram (i.e. from 3D SGY cube), then load it in the Use base seismogram.



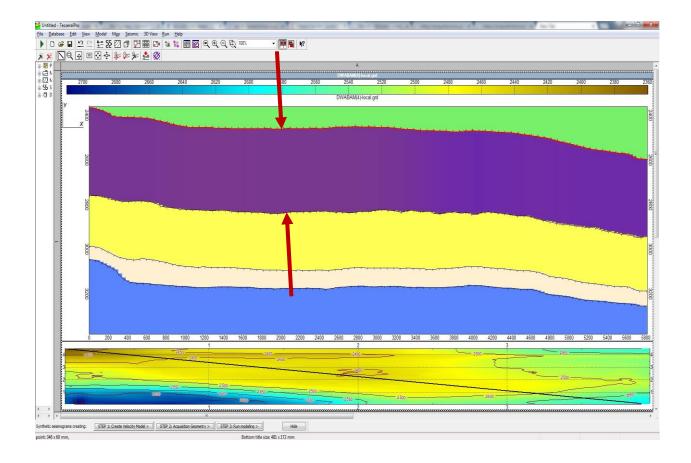
Also, it is possible to fill multiple layers from different base seismograms. In this case these base seismograms are loaded for each surface individually, in the <u>Map > Manage/</u> <u>Delete Maps > 3D-model Properties</u>>Filling Empty cells(as <u>default</u>)>Use base <u>seismogram</u>.

3D	-Model Properties	x
	Filling cells UP DELKPT(3)-local.grd v top	
	VALUE 3000	
	Get values from map - not used -	•
	Use well log values	
-		
	Filling Empty Cells (as default)	
	Filling empty cells from upper cells	
	Base value 0	
	Use base seismogram	
	C:\Users\Stefan\Desktop\DUPLEX_VELOCITY_MODEL_nt 🔻	
	Use well log values (for all horizons)	
	OK Car	ncel

Important note: If a single or several base seismograms were used for building a 3D cube, then the user will notice that after clicking <u>OK</u> in the <u>Run > Map Frame > Create</u> <u>3D SEG-Y</u>, the generated 3D SGY cube will NOT contain the assigned base seismogram.

Instead, the 3D seismogram will appear in the map frame for the assigned surface. Below you

can see the layer extracted from the 3D base cube appearing in the map frame after the generation of the SGY cube:



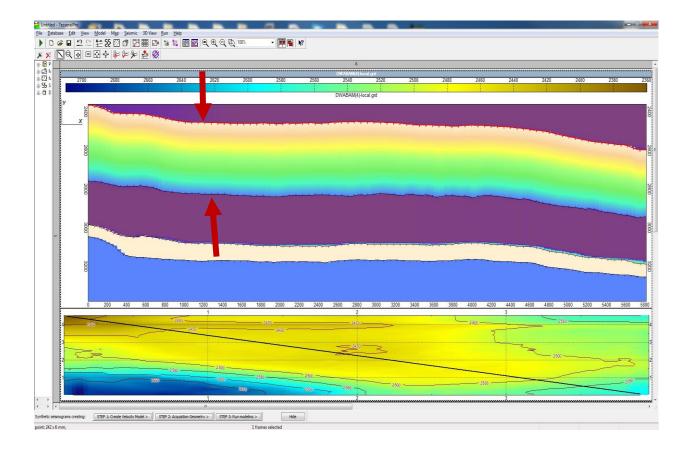
Once you repeat $\underline{\text{Run} > \text{Map Frame} > \text{Create 3D SEG-Y}}$ the second time, the correct cube will be generated. So you can always use the map frame as QC, before generating the cube.

3.1.11 Introducing vertical gradients in 3D cubes

In addition, the user can also introduce horizontal and vertical gradients to any surfaces. To introduce a vertical gradient assign <u>Map type: Top</u> and <u>Map type: bottom</u> for the upper and lower surfaces respectively, which make up the layer where the gradient is supposed to be introduced. This is done in <u>Map > Manage/Delete Maps > Properties</u>

Map properties	X
Name DWABAM(4)-local.grd -	
Map type top Value interval	
Min (depth) 2359.58509048	5200
Max (depth) 2709.72322482	
Clipping	
Gain (%)	
0	~ 2650 - 2 00 - 2 00 - 2 00
OK Cancel	

Once <u>Map type</u> has been defined, assign the gradient value for both: the upper and lower surface (i.e. to the <u>Map type: top</u> and <u>Map type: bottom</u>), in the <u>Map ></u> <u>Manage/ Delete Maps ></u> <u>Properties</u>, which this will produce the vertical gradient.



3.1.12 Introducing horizontal gradients in 3D cubes

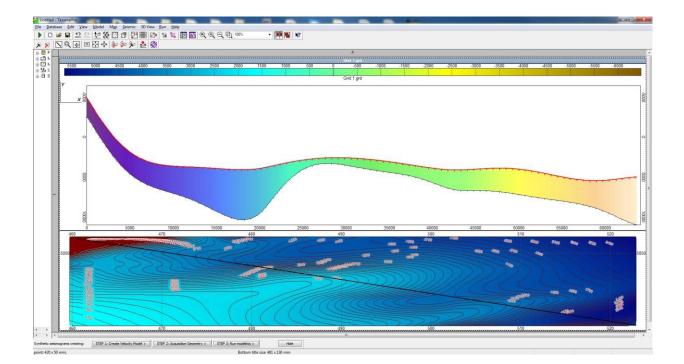
A horizontal gradient can only be introduced from surfaces. Such surfaces can be easily created by introducing the X Y V coordinates in a text file (having the .xyz extension). These velocity surfaces are loaded like any other regular surfaces $\underline{File} > \underline{Load} \quad \underline{Map} \quad \underline{file}$ and should be assigned \underline{Map} type: Parameter in the Map > Manage/Delete Maps > Properties.

Name Parameter surface.xyz	
Map type parameter Value interval Min (depth) 798.801 Max (depth) 6586.9 Clipping	
Gain (%) 0 0 0 0 0 Cance	

Afterwards, the horizontal gradient (or the velocity surface) can be assigned to the appropriate surface in the <u>Map > Manage/ Delete Maps > 3D-model Properties > > Get value from</u> <u>map.</u>

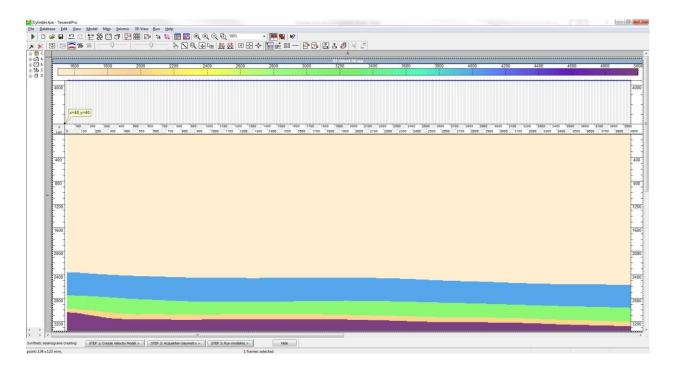
Filling cells UP	Grid 1.grd	1	▼ top	v
VALUE	2000			
Get values fro	m map	Parameter surface	хүг	•
Use well lo	g values			
		2.0		

Please note that a <u>VALUE</u> must be introduced as well, in case there are any "holes" in the velocity map in places of faulting, wedging or other complex geologic features. If there are no holes in the velocity map, then the specified VALUE will be ignored.

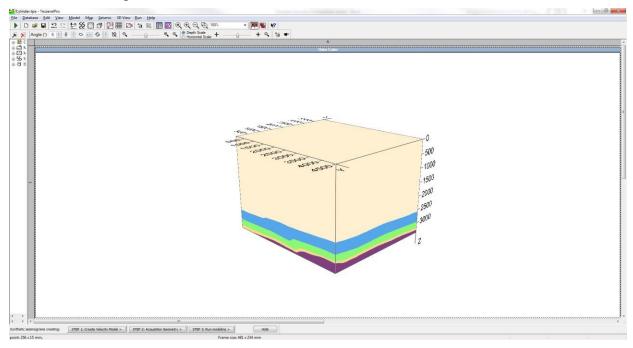


3.1.13 Introducing cylindrical bodies and tetrahedrons in 3D SGY cubes

The user can also introduce cylinders and tetrahedrons in any given 3D SGY cube. To introduce a cylinder, first of all load the SGY cube in the seismic frame <u>File>Load</u> Seismic file



The cube in 3D (optional view):

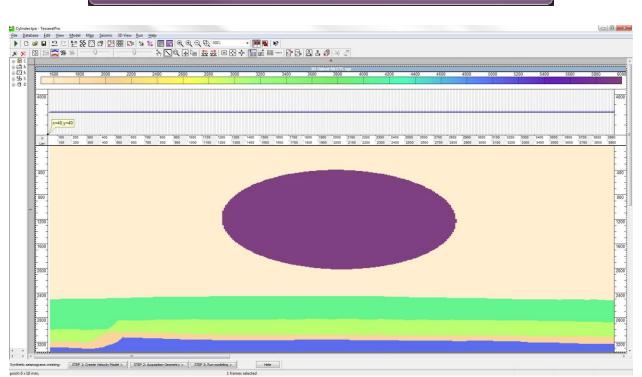


Then click Run> Velocity Model Insert cylinder in Model Cube

Specify the extension of the cylinder across X, Y and Z axes, as well as its <u>Radius</u> and

Internal value. Insert cylinder upon completion.

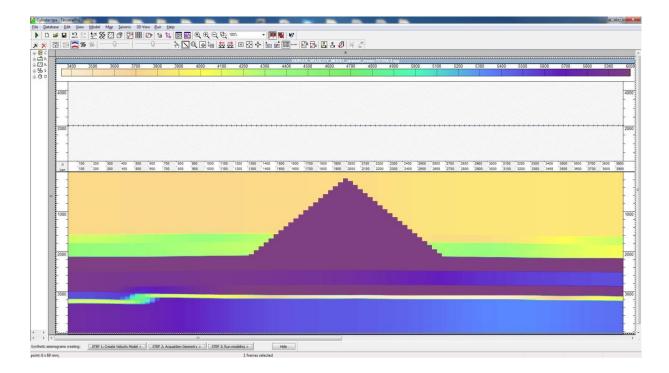
Cylin	der					×
In	nput Model File	e : C:\Users\Stef	an \Desk	top\3D mode	eling\DUPLEX_V	
	- Axis of symr	metry :				
	from X =	2000	Y =	50	Z =	2200
	to X =	2000	Y =	4000	Z =	2200
	Radius	s of Cylinder R =	1000			
	Internal val	ue (velocity) V =	6000			
Out	Output Model File : C:\Users\Stefan\Desktop\3D modeling\DUPLEX_VELOCITY_MODI					
				Inser	rt cylinder	Cancel



Please bear in mind that X scale \neq Z scale in the figure above.

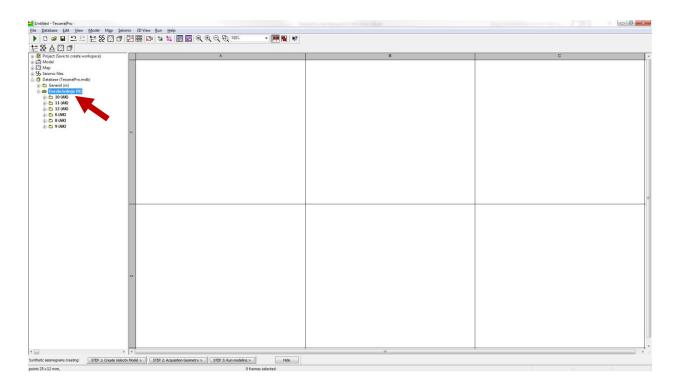
To introduce a tetrahedron, likewise load the SGY cube in the seismic frame <u>File></u> Load Seismic <u>file</u>, then <u>Run></u> Insert Tetrahedron in Model Cube. Now you will specify the coordinates of the 4 vertices, as well as the <u>Internal value</u> of this tetrahedron.

Tetra	Tetrahedron X								
Ir	Input Model File : C:\Users\Stefan\Desktop\3D modeling\Job3D-01\DUPLEX_VELOCITY								
	Vertices of tetrahedron								
	Vertex 1: X =	2000	Υ =	2000	Z =	100			
	Vertex 2: X =	2000	Y =	3900	Z =	2400			
	Vertex 3: X = 400 Y = 100 Z = 2400								
	Vertex 4: X =	3600	Y =	100	Z =	2400			
	Internal value (ve	elocity) V =	6000						
Output Model File : C:\Users\Stefan\Desktop\3D modeling\Job3D-01\DUPLEX_VELOCITY									
	Insert tetrahedron Cancel								

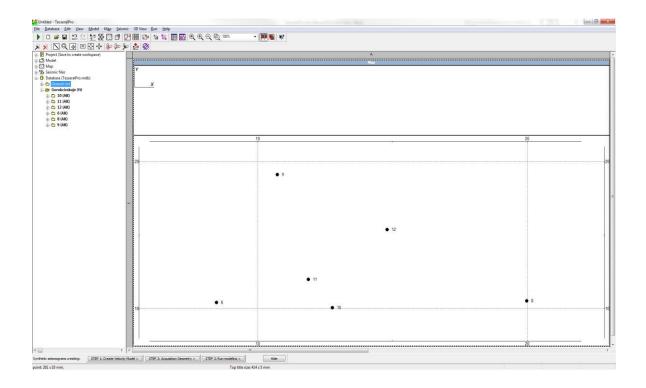


3.1.14 3D model building from well data

In order to build a 3D model from interpolated mapping of well logs, the user first needs to select the desired oil field from the <u>Database</u> (in the left window of Tesseral Pro). This is done by right clicking the field name and selecting Select field for the project.



Afterwards, the user needs to create a map with all the wells by clicking Map > Create Map (New Frame) >Show database WELLS.



The resulting blank map will contain all wells from the chosen oil field.

Next, go <u>Map > Calculation of horizon from well Tops</u> and select the stratigraphic layers that need to mapped.

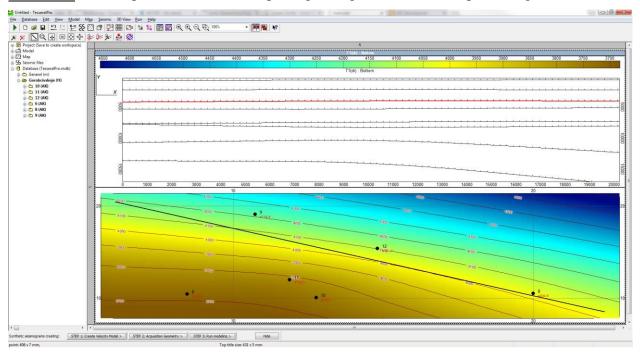
Layer name	Cre	Wells	Top/Bottom	Strata name	-
C1(v1+t) : Bottom		5	Bottom	C1(v1+t)	
C1s1 : Bottom		6	Bottom	C1s1	=
C1s2 : Bottom		6	Bottom	C1s2	
C1v2 : Bottom		6	Bottom	C1v2	
C2b : Bottom		6	Bottom	C2b	
C2m : Bottom		6	Bottom	C2m	
D3 : Bottom		3	Bottom	D3	
D3fm : Bottom		4	Bottom	D3fm	-
•					•

<u>Automatic select layers</u> provides various selection criteria for choosing these layers. For example: <u>Only by all wells</u> automatically selects only the layers that are common to all wells in the project.

Once the layers have been selected the user will have to specify the interpolation method to be used in the Choose mapping method window(see Section 14.2.4)

Choose mapping method						
Method	Spline-approximation	OK				
Analog	(do not use)	Cancel				

Beyond this point the generated stratigraphic surfaces can be examined in $\underline{Map} > \underline{Manage/Delete}$ Sufaces. Draw a profile line on the map using the right mouse button (press-drag-release).



Followed by assigning values to the void layers created by the stratigraphic surfaces in the <u>Map ></u> Manage/ Delete Surfaces > 3D-model Properties.

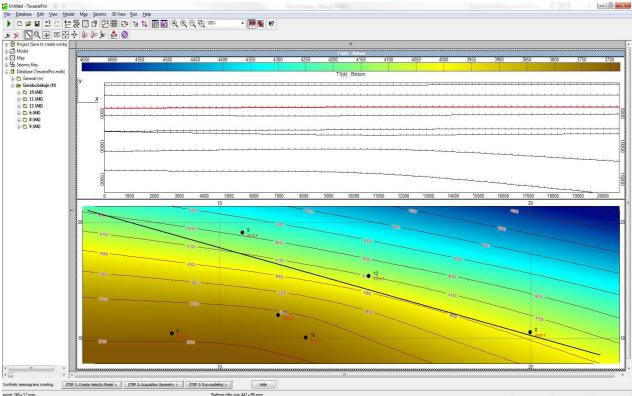
D-Model Propert	ies	C. C.	×
Filling cells UP	T1(dr) : Bottom	* bottom	*
VALUE	2000		
Get values fro	m map - not used -	-	•
Use well lo	g values		
Filling Empty Ce	ells (as default)	ОК Са	ancel

From this point on, the user should follow the instructions from Section 3.1.10 (i.e. starting with drawing a cross section across the surfaces) first using <u>Map>Section Mode</u>.

3.1.15 Building a thin layered 3D model

In order to build a 3D thin layered model from well data, the user will first need to create surfaces from the stratigraphic data in the Database wells and this procedure was explained in Section 3.1.14

For instructions on how to import log data, as well as stratigraphic and inclinometry data, please follow the instructions from Section 17.5



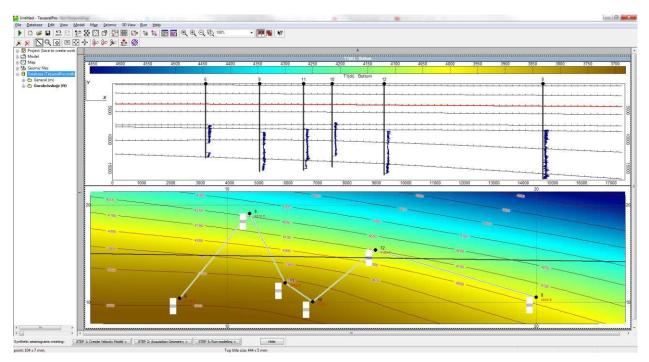
Once all surfaces have been generated, the user will have to choose the well log data used for thinlayering by accessing Map> Load Well Logs

Well <all wells=""></all>	Select W	ell Logs	-	x
DSK GK GKp GZ NGK NGKp PS PZ		<all wells=""></all>		•
GZ NGK NGKp PS PZ	DSK GK			
NGKp PS PZ	GZ			
	NGKp PS	1		
OK Cancel	P2			
OK Cancel				
		OK	Cano	;el

If you have not drawn a profile over your map frame already, please do so by going <u>Map>Section Mode</u> and draw the profile using the left mouse button.

Once the log data has been selected, the user will have to select the wells, which are to be used for 3D thin layered model building. In order to select a well, right click on it in the map frame and select <u>Add</u> well to profile. Repeat this for all desired wells.

Now, all your logs should appear in the cross section of the map frame:



The thin layering for the surfaces covered by the log data is assigned, as previously, in the $\underline{Map} > \underline{Manage/Delete Maps} > 3D-model Properties tab by checking Use well log Values.$

-Model Properti	es		×
Filling cells UP	C1s1:Bottom	▼ bottom	-
VALUE	0		
Get values from	n map - not used	÷	•
Vse well log	values		
Filling Empty Se	lls (as default)	ок с	ancel

If you would like to fill in the all the surfaces from log data checkmark <u>Map > Manage/ Delete</u> <u>Maps > 3D-model Properties> Filling Empty Cells(as default)>Use well</u> log values (for all horizons).

3D-Model Propertie	es		×
Filling cells UP	C1s1:Bottom	bottom	
VALUE	0		
Get values from	- not used -		-
🔽 Use well log	values		
	(as default)		
	ity sells from the upper cells		
Base value	0		
Use base seismo	ogram		
- not used	-	-	
Use well log v	values (for all horizons)		
	ОК	Ca	ncel

Once all surfaces have been filled select <u>Run > Map Frame > Create 3D SEG-Y</u>.

Create 3D Seg-Y Mo	odel				×		
Output seg-y file	C:\User	s\Stefan\Desk	top\Tesserral Pro	testing new vers	sion\3D Model		
	Grid par	rameters					
		Min	Max	Step	Size		
	x	5600	22850	25	691		
	Y	7825	21375	25	543		
	z	0	17050	25	683		
		Set "Mi	n" and "Max" from	m Map Frame			
	-Filling E	mpty Sells (as (default)				
	📃 Fil	ling of empty s	ells from the uppe	er cells			
	Base	value 20	00]			
	Use b	ase seismogra	m				
		- not used -			▼		
	Value r						
	Min	100	Max	10000			
		100	Max	10000			
				ОК	Cancel		

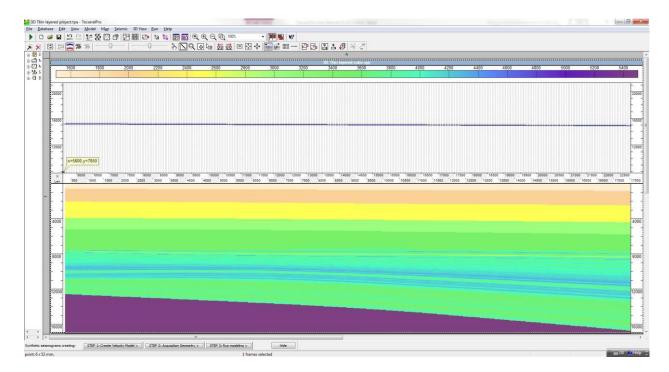
Specify the X, Y, Z dimensions you want for your 3D model, the grid sampling, as well as the <u>Filling</u> cells value with which you want to fill the remaining blank layer(s).

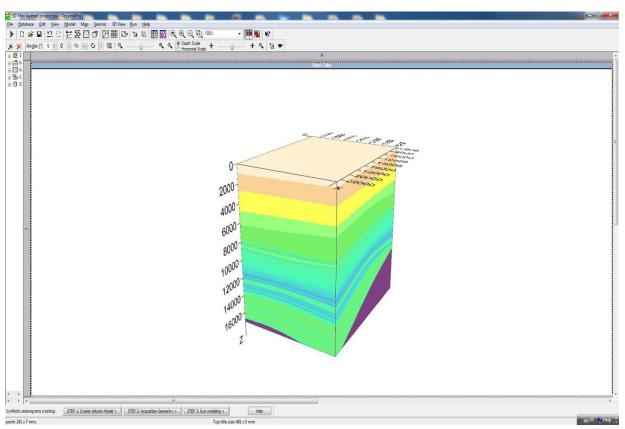
If you want to fill the remaining blank layer(s) from a base seismogram (i.e. from 3D

SGY cube), then load it in the <u>Use base seismogram</u>.

Here, you can also introduce limitations to the min. and max. values for the thin layering in the \underline{Value} Range.

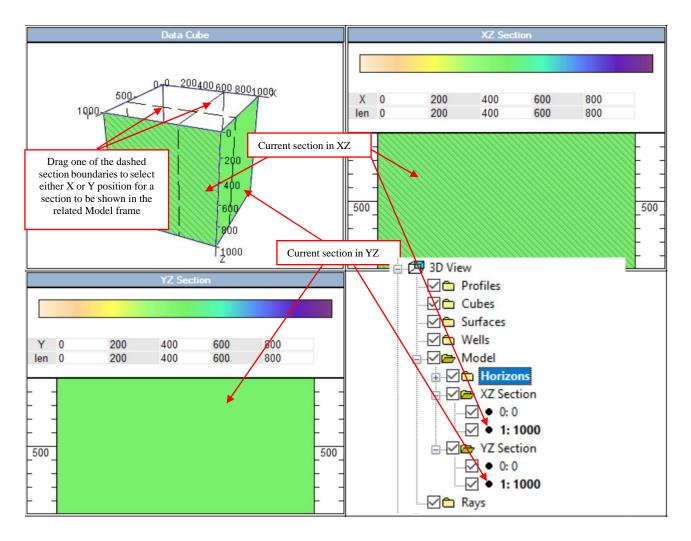
Finally, after clicking OK a thin layered cube from log data will be generated.





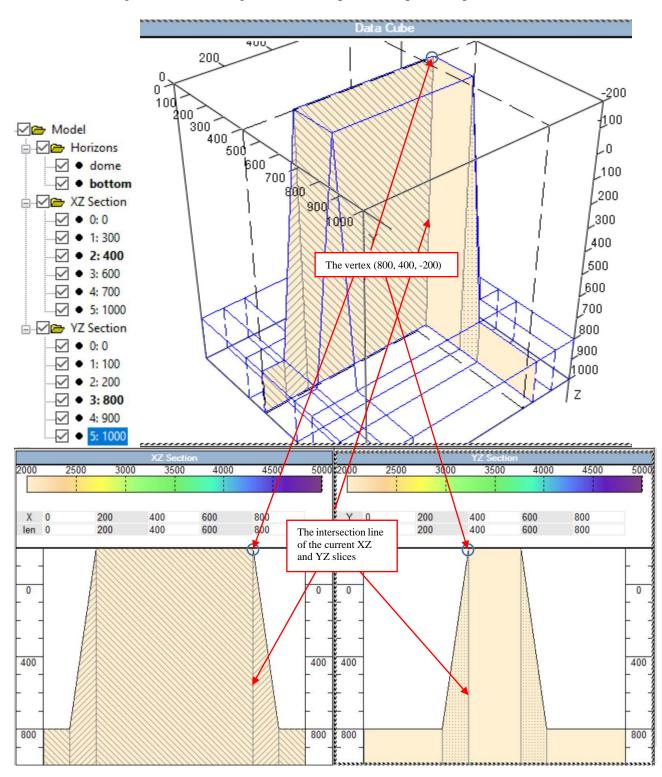
3.1.16 Building 3D model with complex faults using 3D View frame

To create from scratch or edit a 3D model use $\underline{\text{3D View} > 3D \text{ Model Edit Mode}}$. If the model is created from scratch, the dialog $\underline{\text{Create 3D Model}}$ is appeared. Specify there coordinates of the model cube boundaries and the background compressional velocity. The program proposes immediately to create a <u>Model</u> frame directly related to the 3D model and shows the <u>dialog Model Properties</u>. (The <u>Model</u> frame is used to edit the model vertical sections.) In most cases it is enough to press OK. The default model consists of just four vertical sections corresponded to the cube boundaries of min and max X, min and max Y. To select one of the sections for editing in the Model frame drag the dashed section boundary along Y by mouse in the <u>3D View</u> frame. The section nearest to the boundary at left mouse button release is selected. An alternative is to use the keyboard key combinations CTRL+ \uparrow or CTRL+ \downarrow within either the 3D View or the Model frame.



An active (selected) slice of the model cube which is shown in the <u>Model</u> frame can be edited similarly to 2D models. The main difference is the requirement for any created polygon to be of type "top". (Other types are disabled.). The program keeps an equal number of polyline vertices in each the polygon to be oundary. It is supported by automatic inserting of insufficient vertices. Similarly, any polygon created in the active section will be similarly created in other sections with interpolation between the nearest upper and down polygons. Similarly, deletion of either

single vertex or a whole polygon is repeated in all other vertical sections of the model. But drugging a polygon vertex does not affect vertices of other correspondent polygons in other sections. This is the method of drawing complex enough 3D structures.

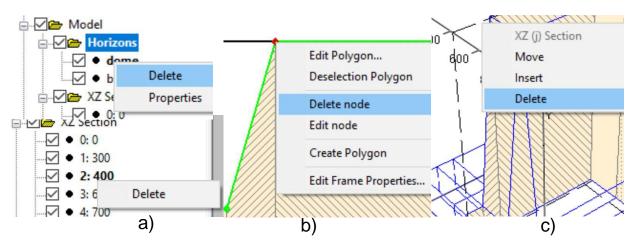


Consider editing a 3D model using the next example of a trapezoidal prism.

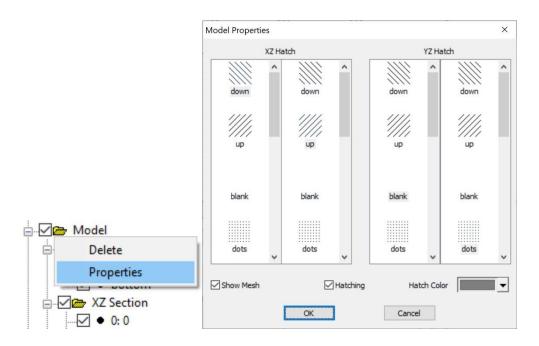
Moving a vertex in one of the <u>Model</u> frames causes it to move in the associated Model frame if the vertex belongs to the intersection line of the current sections XZ and YZ.

The vertex also moves in the <u>3D View</u> frame. The vertex can also be moved using the <u>Edit node</u> command of the vertex context menu in the Model frame. It allows entering the exact value at the

point. Moving the vertex in the XZ section does not affect the Y-coordinate, just as moving in the YZ section does not change the X-coordinate of the vertex. You can also move the entire section along one of the coordinate axes OX or OY. To do this, drag-n-drop the dashed selection box while holding CTRL. Dragging the first and the last sections leads to a change in the boundaries of the model! (In the example the boundaries are sections of numbers 0 and 5.) The section can also be moved by the <u>Move</u> command of the selected frame context menu, which is accessible by clicking the right mouse button.



For a better understanding of the model grid geometry, hatching is used. Besides, you can hide/show mesh cells (using the checkbox <u>Show Mesh</u>). These options can be configured using the <u>3D View></u> <u>3D Model Properties</u> menu command or the <u>Properties</u> command of the <u>Object Tree</u> context menu:



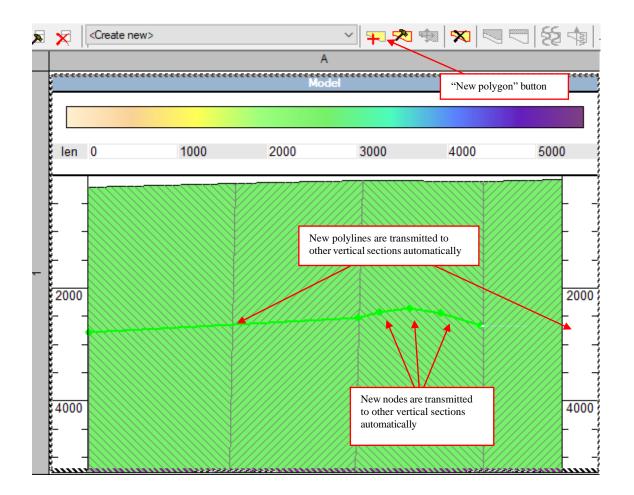
There are visual options for better understanding the model grid geometry: grid lines and hatching, transparency. They are selected in <u>Model > Wells & Polygons > Polygon Fill Options</u>:

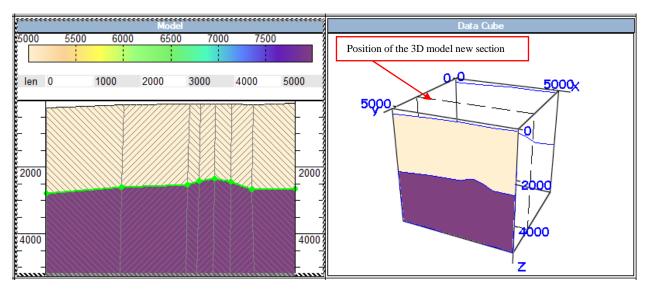
Well-log based polygon fill setting					
✓ Palette ✓ Hatching	OK				
Top and bottom point connection	Cancel				

Uncheck "Palette" here for transparency of the polygons.

A model layer is compound by plain bounded octagonal grid cells created by the corresponded (with the same number) polygons of different sections. The correspondence is expressed via the same polygon ID. The 3D model layer properties are specified in the related <u>Model</u> frame as the correspondent polygon properties. The properties dialog is also available via the <u>Properties</u> command in the context menu of the Object Tree.

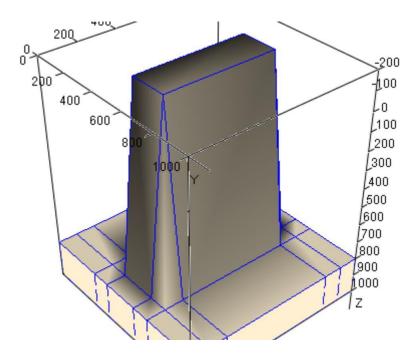
To insert a new horizon into a 3D model, create a new polygon of the "top" type in one of the linked \underline{Model} frames in the usual way. To delete a horizon, select the polygon corresponding to its top in the linked \underline{Model} frame and delete it. Or use the \underline{Delete} command in the horizon context menu in the Object Tree. The menu commands and controls of the \underline{Model} frame toolbar are used in the same way as for 2D models. 3D model editing commands can be undone/repeated using the standard $\underline{Undo/Redo}$ commands.



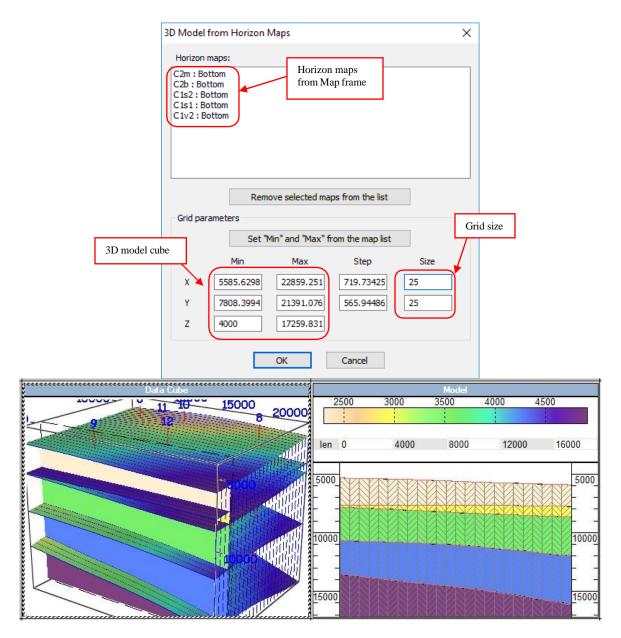


To insert new vertical section in the model use the dashed section boundary context menu called by right mouse button click. Select the context menu command <u>Insert 3D Model Section</u>. New section is inserted just in the section boundary position along Y: no "regularization" of the section set is done. So be careful. To delete a vertical section, select it either by mouse or by the keyboard key combinations CTRL+↑ or CTRL+↓ in the 3D View frame. Select the context menu command <u>Delete 3D Model</u> <u>Section</u>. To shift the selected vertical section along either X or Y axis press CTRL and drag the dashed section boundary.

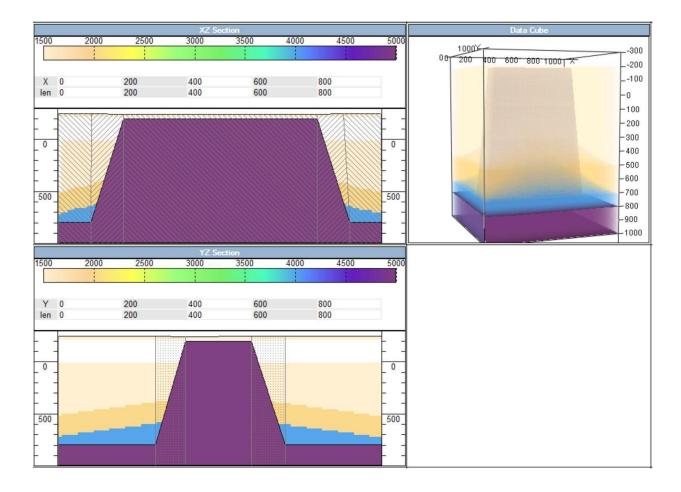
In order to see the model horizons in the <u>3D View</u> frame, disable the *editing mode* (the menu command <u>3D View > 3D Model Edit Mode</u>) and thus, activate the *view mode*. In the *editing mode*, only active (editable) sections are displayed, while in the *view mode*, all the vertical sections and horizons marked with checkmarks in the Object Tree are displayed. The checkboxes at the vertices of the <u>Horizons</u>, <u>XZ Section</u> and <u>YZ Section</u> Object Tree allow you to hide / show all the horizons, <u>XZ sections</u>, respectively, in both modes. Using the checkmark at the <u>Model</u> node, you can also hide / show the entire model.



3D Model can be also initiated from the horizon maps stored in Map frame of the project. To do it call the menu command <u>3D View > Create 3D Model from Maps</u> and specify parameters in the appeared dialog. The list of horizon maps is editable: the maps deleted from the list by the below button are excluded from the 3D model but left untouched in the Map frame. Min and Max parameters of the dialog specify the model boundaries. There is a button to automatically fit the values by the list of horizon maps. Additional parameters Step and Size specify the model grid sampling.



Ready model is stored as a regular grid in SEG-Y cube format by the menu command <u>3D View > Export</u> <u>3D Model to SEG-Y</u>. The resulting seismic cube can then be used to build a new 3D model. Such way, objects of complex shape can be inserted into a horizontally layered model. For example, so an additional horizon can be inserted above the trapezoidal prism in the considered model. Then one can specify its velocities, density and other properties using the previously exported SEG-Y cube as the background. This is done as usually in the polygon (horizon) properties dialog (see chapter <u>3.2.5</u>).



Another command <u>3D View > Export 3D Model to Text Files</u> exports separate model horizons in a text grid format.

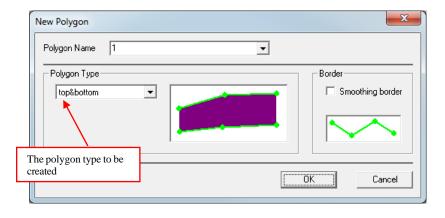
3.2 Polygon creation and editing

After an empty model (Model Frame) is created, it has to be filled with geological objects of various rock physical properties. In the Tesseral Pro, polygons are used to represent geological objects. In model building, a polygon is characterized by a set of parameters, such as compressional- and shear-wave velocity, density, anisotropic parameters and fracturing. In such manner, any area of the model can be filled with polygons with determined properties.

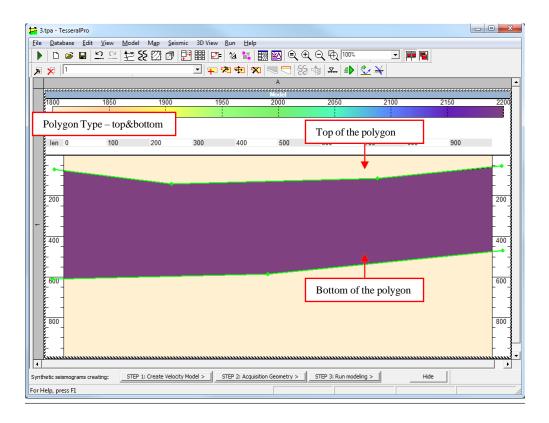
During the setup of the modeling job (synthetic gathers calculation), a grid with the given step along the section direction and depth direction is created from the polygonal model. The parameters for each node of this grid are obtained from the polygon in which the node is located. If the location of a node is overlapped by several polygons, then its parameters are obtained from the upper-most polygon.

3.2.1 Create a polygon manually

Please select the menu Model using the mouse, and then select the command New Polygon.

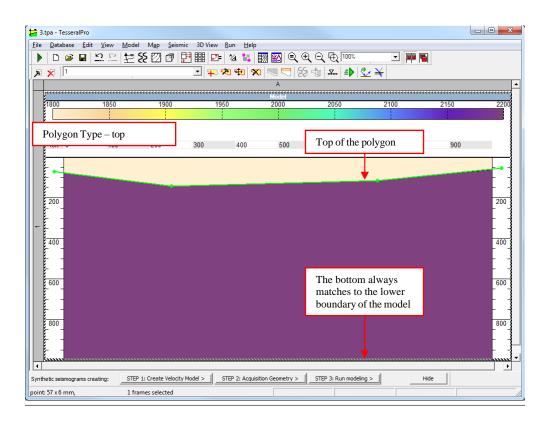


In the dialogue box <u>New Polygon</u>, please select or specify the polygon name (<u>Polygon Name</u>), and select the type of polygon to be created (<u>Polygon Type</u>). The following polygon types are supported:

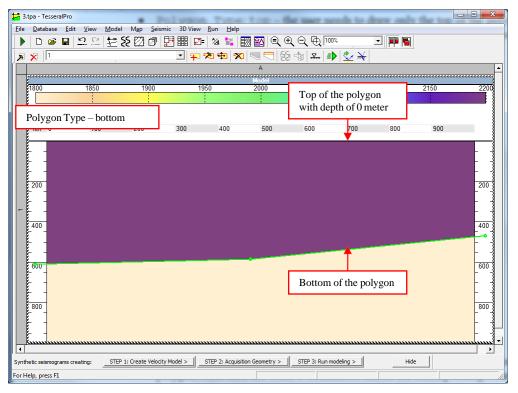


• <u>Polygon Type</u>: <u>top&bottom</u> – the user needs to draw the top and bottom of the polygon. The right and left sides will match to the corresponding boundaries of background model (base polygon).

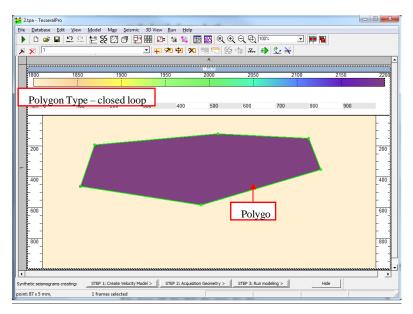
• <u>Polygon Type:</u> top – the user needs to draw only the top of the polygon. And then the other 3 boundaries will match the corresponding boundaries of background model (base polygon) automatically.



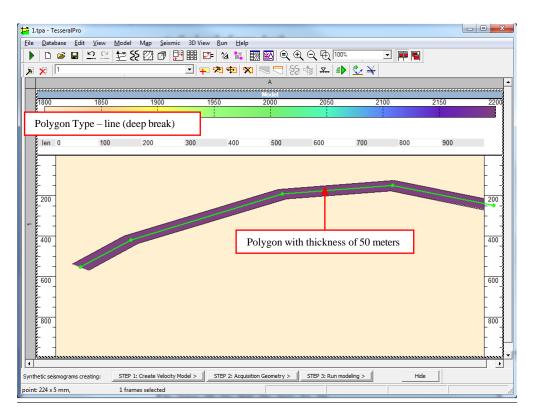
• <u>Polygon Type</u>: <u>bottom</u> – the user needs to draw only the bottom of the polygon. And then the other 3 boundaries will match the corresponding boundaries of background model (base polygon) automatically. Please note, if the top of the background model is located above the zero depth, the top of polygon will be set to the level of zero-depth.



• Polygon Type: closed loop (object) - a closed boundary need to be drawn



• <u>Polygon Type: line (deep break)</u> – only a line is drawn, its thickness can be specified by the parameter width of line (m or ft) in the dialogue box New Polygon when this type of polygon is selected.



Once the polygon has been created please right-click the mouse or double click the left mouse button (must be done within the <u>Model Frame</u>). Then, a new extended dialogue box will appear for users to edit the polygon"s properties. After exiting from the dialogue box <u>Polygon Properties</u>, users can add more nodes to the boundaries of the created polygon by clicking the mouse on its boundary.

3.2.2 Change polygon's shape

Users can select a polygon either using the mouse or from the list of all polygons in the toolbar. The boundaries of the selected polygon are shown in green color. If you want to add a node to a polygon boundary, press the left mouse button on the boundary of the polygon. If you want to remove an existing node, click it with the right mouse button. If you want to move a node, press-drag-release it with the left mouse button.

3.2.3 Move/copy a polygon

Select a polygon using the mouse by left-clicking on it or from the list in the toolbar, and then choose Model > Drag polygon menu to move the selected polygon or Model > Copy Polygon to copy it. After that, click the left mouse button inside the Model Frame to finish moving or copying.

3.2.4 Delete a polygon

Please use the menu command Model > Delete polygon to delete the selected polygon.

NOTE: To undo the previous action, please use the <u>Undo</u> command.

3.2.5 Edit polygon's properties

Please select a polygon with the mouse or from the list of polygons in the toolbar. The boundary of the selected polygon will be highlighted with a bold green line. Then, use the menu command $\underline{Model} > Edit polygon$ to edit the polygon's properties.

Polygon Properties Polygon Name 1			•			×
Polygon Type	•			Border Smo	othing border	
Component	Units	Manually	-Value	-From Seismogram	From Log	
Compression Velocity	m/s	~	2200			
Density	kg/m^3		2086	Γ		
Shear Velocity	m/s		1270			
Anisotropy & Other Properties			By default	Property seismogram	Stratification Select Well-logs	•
Drawing Properties						Cancel

<u>Polygon Name</u> is the actual name of the polygon. If a polygon reflects a layer in the well, it is recommended give it the name of that layer. In the <u>Polygon Name</u> drop-down list, the complete list of layers' names from the database is shown.

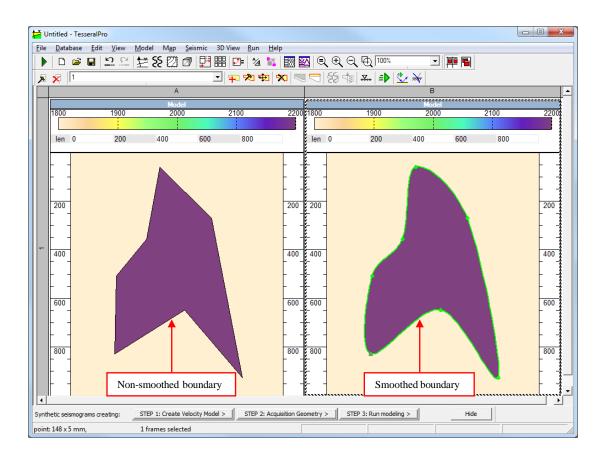
The group <u>Component</u> is for editing the velocity, density and other parameters for the polygon. If the <u>Manually</u> checkbox is not checked, the corresponding values will be calculated automatically from the other parameters using empirical formulae.

<u>From Log</u> – if checked, the polygon"s properties will be obtained by interpolating the logging data. The <u>Select Well-logs</u> button is for selecting the curves in the <u>Model</u> <u>Frame</u> and specifying their type (velocity or density) and measurement units.

<u>From Seismogram</u> – if checked, the polygon"s properties will be obtained from the data of the underlying seismic file. The <u>Property seismogram</u> button is for selecting the underlying seismic file in the Model Frame and specifying their type (velocity or density) and measurement units.

The $\underline{By default}$ button is for saving the user-specified values as the default values for future use when a new polygon with the same name is created.

The <u>Smoothing border</u> checkbox is for smoothing the polygon's boundaries automatically. In case when the <u>Polygon Type</u> is <u>top&bottom</u>, the top and the bottom boundaries will be smoothed independently.



The <u>Drawing Properties</u> button is for setting the color filling of the polygon and the attributes of its boundaries. It is only for the visualization, not affecting the calculation of synthetic gathers.

3.2.6 Anisotropic/fracture/absorption parameters

To specify the anisotropy and/or fracturing parameters, press the <u>Anisotropy & Other</u> <u>Properties</u> button. Then, in the dialogue box <u>Anisotropy & Other</u> <u>Properties</u>, specify the value for each parameter shown in the pop-up dialogue box (shown below).

Thompsen's Paramo	eters (Anisotropy)		🗖 From Seismog	jram
Epsilon 0	Delta 0	Rel	ative azimuth 0	deg
Gamma 0	Phi 0	deg	Alpha 0	deg
Fracture	Dn	Dt	Alpha deg	Azimuth deg
First Fracture	0	0	0	0
🗖 Second Fracture	0	0	0	0
Third Fracture	0	0	0	0
Compressional 0 Shear 0				3D extention
Sources type: Reflector-			OK	Cancel

By default, each polygon is isotropic.

<u>Thompsen''s Parameters</u>: ε (Epsilon), δ (Delta), γ (Gamma) and the inclination angle φ (Phi) of the symmetry axis of the transversal-isotropic (TI) background medium can be specified. The coefficients ε and δ determine the relative difference of the qP and qSV wave velocity in different propagation directions with respect to velocity along the symmetry axis of the background medium, and they are used only in the Elastic Anisotropy mode. The parameter γ determines the velocity variation of the qSH waves along different propagation direction, and it does not affect wavefield of a 2D modeling (it is added to make the description more complete and for future upgrade).

<u>Fracture</u> describes intensity of fracturing in the background medium, and is characterized by parameters δ_n (<u>Dn</u>), δ_t (<u>Dt</u>) and the fracturing inclination angle α (<u>Alpha</u>) with respect to the vertical direction. Each layer may have 0-3 different fracturing systems. The parameters δ_n (Dn), δ_t (Dt) should be within the limit of [0,...,1]. The inclination angle α (Alpha) is within the limit of $[-90^\circ,...,90^\circ]$. The parameters δ_n (Dn), δ_t (Dt) depend on the density of fractures, Poisson coefficient of the background medium and the type of materials filling in the fractures. These parameters affect both propagation velocities of all types of waves along different directions, as well as their dynamic properties (amplitude).

<u>Q-factor</u> is for specifying the parameters about the seismic energy absorption in visco- elastic medium. This parameter measures the attenuation of the wave amplitude for a wavelength. The Quality of <u>Compressional</u> and <u>Shear</u> waves can be specified separately.

Sources type: Reflector, the option Muted is for suppressing the wavefront generated by

the boundaries of all polygons when the source type is <u>Reflector</u>. Selection of the source type is described in the Section 5.1.

3.2.7 Order of polygon overlapping

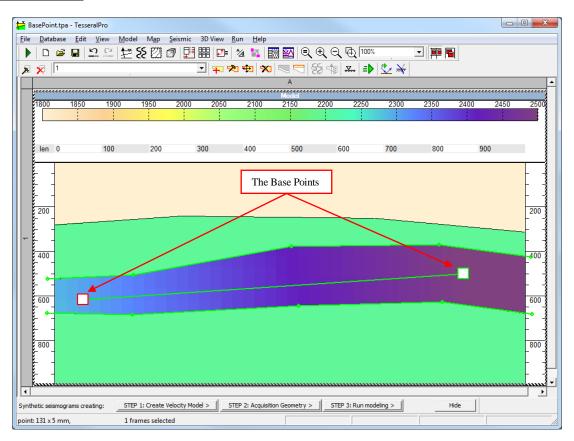
All the polygons in the model are displayed in the same order as they appear in the polygon's list (the list in the main editing toolbar). Please use the menu command $\underline{Model} > \underline{Bring Polygon}$ <u>Forward</u> to move a polygon upward, and use the menu command $\underline{Model} > \underline{Bring Polygon}$ <u>Backward</u> to move a polygon downward. These commands move the polygon up/down one level, i.e. exchange the chosen polygon and the previous or next one. To set the correct order of overlapping polygons, users may need to repeat this command several times.

3.2.8 Base points

The base points are used to specify the components with linear gradient within the polygon. Firstly, select the polygon where you would like to add some base points. To add a base point to an active (selected) polygon, please choose the command <u>Add Base Point</u> in the context menu by clicking the right mouse button, or select the command in the menu <u>Model ></u> <u>Base Points > Add Base</u> Point.

Base Point			×
Component	- Units	- Manually	Value
Compressional velocity	m/s	•	2200
Density	kg/m^3		2086
Shear velocity	m/s		1270
Coordinate			
Distance (X) 500	m		(OK)
Depth (Z) 500	m		Cancel

Please specify the coordinates of the base points and the values of each component in the dialogue box Base Point. The gradient will be calculated automatically for any 2 adjacent base points:



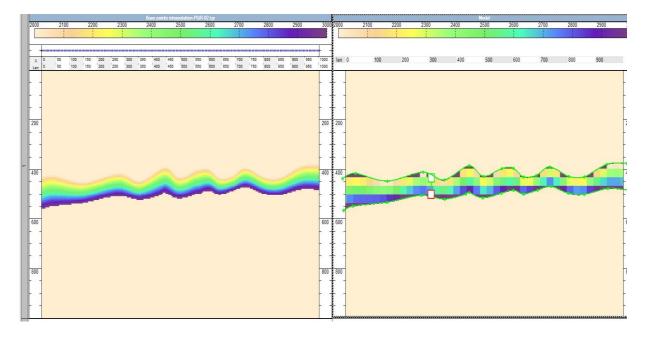
To edit the parameters at a base point, please use the Edit Base Point command in

context menu by right-clicking the base point or use the menu command <u>Model > Base Points ></u> <u>Edit Base Point</u> for the active base point marked by square with red edge. The base points may be relocated by the mouse (press-drag-release) or deleted by using the command <u>Delete Base</u> <u>Point</u> in the context menu or <u>Model > Base Points ></u> <u>Delete Base Point</u> in the tolevel menu.

Also, it is possible to interpolate between base points while following the geometry of the

polygon (i.e. like in well logs). To do that right click on the polygon and select <u>Polygon</u> <u>Properties > Interpolate like well-logs</u>.

Polygon Properties			•	1.4.1		x
Polygon Name Polygon Type	vpe				thing border	Base Points Interpolate like well-logs (account the layer top and bottom horizon geometry)
Component Compression Velocity	Units m/s	Manually	Value 3000	- From Seismogram-	From Log	
Density	kg/m^3		2200			
Shear Velocity	m/s		1730			
Anisotropy & Other Pro Porous	perties		By default	Property seismogram	Stratification Select Well-Id	gs_
Drawing Properties		Com	ponents: value ran	ge	(OK Cancel



The upper base point assigns the velocity at the very top of the polygon, while the lower base point - at the very bottom of the polygon and the generated gradient is uniform with respect to the geometry of the polygon (as shown above). The right panel is the *Model* Frame with a coarser illustration of the gradient (generated by the two base points-displayed as white squares), while the left panel is the corresponding SGY file with a finer illustration of the gradient.

3.2.9 Build polygons from well's intersection data

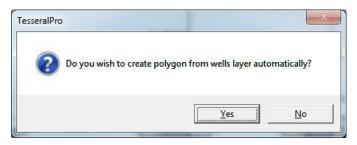
This feature is supported only for models built using wells with layers. Please see Section

3.1.4 for details about building models using well data.

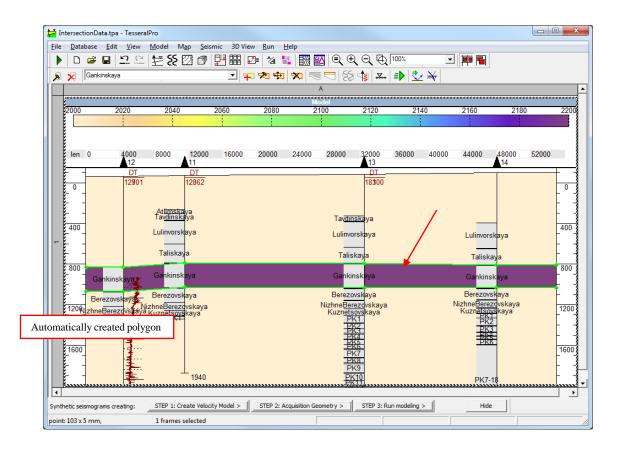
Select the Model Frame and then select the command <u>Create polygon</u>. In the dialogue box <u>New</u> <u>Polygon</u>, specify the <u>Polygon Name</u> from the list of layer's codes in the database. These polygons need to have been created in advance using Top and Bottom Markers and be saved in the Database.

New Polygon		
Polygon Name	1 	
Polygon Type	Gankinskaya Kuznetsovskaya Lulinvorskaya NizhneBerezovskaya PK1 PK10 PK11 PK12 PK13 PK14	Border Smoothing border
	PK15 PK16 PK17 PK18	E OK Cancel

If the name of a polygon matches at least one of layer names for the wells loaded into the model, you will be asked to build the polygon automatically from the layer intersection data.



Please see the results:



The automatic creation of a polygon group from several selected layers is supported, for which the menu command <u>Model > Wells & Polygons > Create Polygons</u> from Well Strata Marks is used.

Layer name	Cre	Wells	Top/Bottom	Strata name	
BP6-3-1 : Bottom		1	Bottom	BP6-3-1	
BP6-3-1 : Top		1	Тор	BP6-3-1	
🗹 Gankinskaya : Bottom		4	Bottom	Gankinskaya	
🗹 Gankinskaya : Top		4	Тор	Gankinskaya	
🗹 Kuznetsovskaya : Bottom		4	Bottom	Kuznetsovskaya	
Kuznetsovskaya : Top		4	Тор	Kuznetsovskaya	
🗹 Lulinvorskaya : Bottom		3	Bottom	Lulinvorskaya	
🗹 Lulinvorskaya : Top		3	Тор	Lulinvorskaya	
Notes - Deservation - Destant		-	D-11	NG-L	

From the list of layers, select the ones you would like to see enclosed with polygons. The result will be a depth model created automatically.

e	_		dit <u>V</u> iew		l <u>ap S</u> eism		-	<u>H</u> elp								
	D	🖻 🖣	150	133 ⊑	201				<u>8</u> Q. Đ.							
	× I	Gankins	kaya			- 4	. 🖈 束	0 🗙 🔊	17 8	\$	=> 💐	` M				
									A							
٤.		******						M	odel						******	
	2000		2200	24	00	2600		2800	3000		3200	3	400	3600		3800
2222			1			1		1					1			
2222		-														
	len	0	4000	8000	12000	16000	20000	24000	28000	32000	36000	40000	44000	48000	52000	
			DT		DT					DT		_				
	0		12901		12862					18 3 00						0
																È :
	_			Atlimska Tavdinska	ya											<u> </u>
	400				1				Tavdins	1						400
	-			Lulinvorsk	aya				Lulinvors	kaya			Lulinvors	kaya		F .
				Taliskay	a			_	Talisk	ava			Taliska	10		F .
-	800													ya		800
-	-	Gank	inskayag.	Gankinsk	aya				Gankins	kaya			Gankins	kaya		
			-3	Berezovsk	ava				Berezov	kava			Berezovs	kaya		[]
1	120QJ		ovskaya						NizhneBere:	zovskava			NizhneBerez	ovskava		1200
-	201	Kuzne	sovska	Kuznetsovs	kaya				Kuznetso PK	/skaya			Kuznetsov	якауа		- 200
ŀ	-	-							BK							+ •
E-	-								PK4							
ġ.	1600								<u> </u>							1600
Ĕ	-		- .						PK							
t-	-		-						PK							
ł	-		- F		1940				EK1	Q			PK7 1	8		
<u>K</u> 2																
the	tic seis	mogram	creating:	STEP 1: Cr	eate Velocity	Model >	STEP 2:	Acquisition Ge	ometry >	STEP 3: R	un modeling	>	Hide	1		

3.2.10 Build polygons from well logs (thin layering)

Tesseral Pro has the capability of building a thin-layered velocity model from well log data (particularly using acoustic log).

NOTE: To build a thin-layered model from well log data, it is recommended to start the process using the Wizard for model creation <u>From database WELLS</u>. Please see details in the Section 3.1.4.

<u>STEP 1. Select the acoustic logs.</u> Please select the acoustic logs (DT or AK) in the dialogue box <u>Model Properties</u> for the Model created by well data. To do this, check the checkbox near the <u>Log</u> button on the right hand side of the <u>Well data</u> group to the left or right of the well. Then click the <u>Log</u> button, and in the pop-up dialogue box <u>Log</u>, select the needed acoustic logs from the list of all well logs loaded into this model. To specify the polygon parameters from well log data correctly, please select <u>Compressional Velocity or dT</u> in the <u>Specification</u> parameter list, and <u>usec/m</u> as <u>Measurement unit</u> parameter for the selected logs.

Log	×
1. Add logging curves to the wells	
Add Well-logs > Delete Well-log < Delete All Well-logs <<	Log description
2. 5	Set the type of the curve Autocalculation
DT Specification Compression Vi	elocity or dT 🗨 Measurement unit usec/m 💌
1 0 0 2 0 0 3 0 0 Line style ▼ Scale auto	0 0 Linear V By default
3. Set the scale and the lines for the curve	olay Well-log Informatic-12

After that, the well logs will be shown near the wells in the model.

<u>STEP 2. Build polygon.</u> The common "thick" polygons are used for the thin-layered models. These polygons may be built either manually (see Section 3.2.1) or by any of the automatic methods (see the Section 3.2.9 and the Section 14.2.7).

<u>STEP 3. Set polygon components from logs</u> (From Log). Please select a polygon and then choose the menu command Model > Edit Polygon. If the acoustic logs are selected correctly (see <u>STEP</u>], the From Log checkbox should be enabled for the Compressional velocity component. Check this checkbox (From Log).

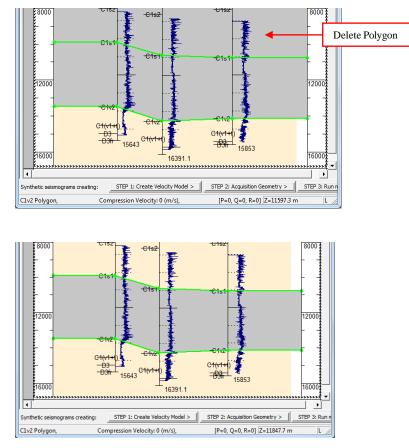
				(Select Curves or	Model			×
Polygon Properties									
Polygon Name 1			-			Well-log name		Well-log type	Measure unit
			•		Add >	DT		Compression Velocity or dT	usec/m
Polygon Type				Borde	Delete <				
top⊥	-				Auto-select <>				
	_				Auto-select <>	•		m	•
									a
			ne compone	nt				<u>OK</u>	Cancel
	fr	om log	ging data					-	
Component	Units	Manually	value	riom Seismogr	am From Log				
Compression Velocity	m/s	~	2200						
Density	kg/m^3		2086						
Shear Velocity	m/s		1270						
Anisotropy & Other Properties			By default	Property seismogram	Stratificatio Select W	4	•		
Drawing Properties						OK	Cancel		

NOTE: If the selection <u>From Log</u> is not enabled (is grayed), click <u>Select Well-</u><u>logs</u> to select the correct acoustic logs into the model.

NOTE: After checking the <u>From Log</u> checkbox and clicking <u>OK</u>, the interpolation calculation for the components won't start immediately. And the <u>From Log</u> component value will overwrite the default value when the calculation starts.

If the steps above are done correctly, you will see the result similar to the figures below.

To get the second picture you need to delete the upper polygon using "Delete Polygon" button.

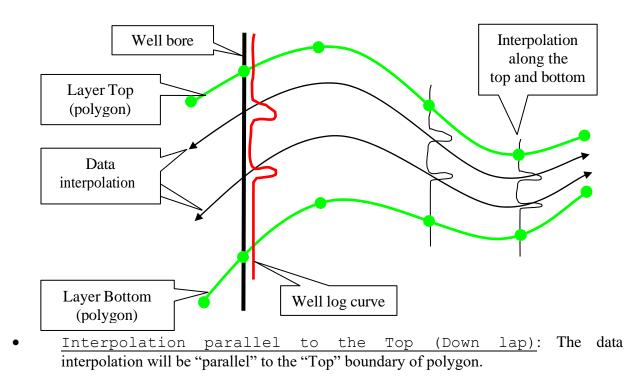


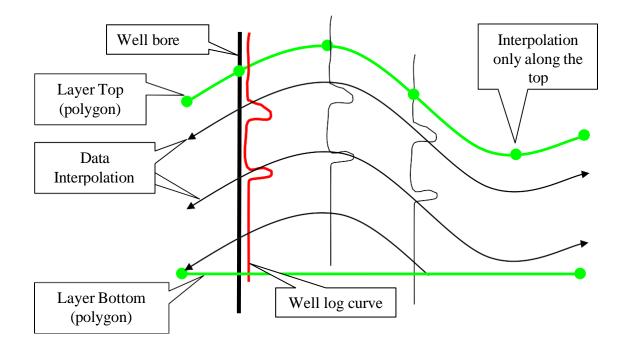
Polygon specifics while using well logs

The parameters of polygons built from well logs are calculated by interpolating the well log data along the layer. There are 3 modes of interpolation:

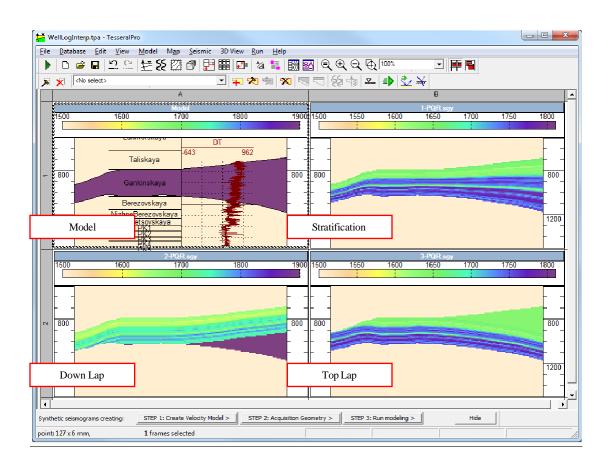
Polygon Properties					×
Polygon Name 1			•		
Polygon Type	•				rder Smoothing border
Component	Units	Manually	Value	-From Seisr	nogram From Log
Compression Velocity	m/s	◄	2200		v
Density	kg/m^3		2086		Modes of well log data interpolation in polygons
Shear Velocity	m/s		1270		
Anisotropy & Other Properties			By default	Prope	
Drawing Properties					OK Cancel

• <u>Stratification</u>: uniform compression. Stretching is proportional to the layer"s thickness.



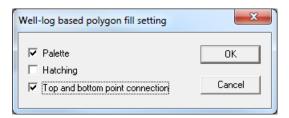


• <u>Interpolation parallel to the Bottom (Top lap)</u>: The data interpolation will be "parallel" to the "Bottom" boundary of polygon.



To display the parameters of the polygons that were obtained using logs, please use the menu command Model > Wells & Polygons > Well-Log Based Polygon.

Fill Options.



3.3 Build model from 2D/3D gathers

Tesseral Pro allows building a model by importing velocity models having the following formats: SEG-Y, SDS-PC, and TGR. A seismic model can be used during building of polygons as underlay or as a filling source for the polygons created by velocities.

NOTE : To build a mode	el by gathers,	s, it is recommended first to prepare it by the Wizard	foi
building a model From	SEISMIC	file. Please see details in the Section 3.1.2.	

While building the polygons, please use the seismic underlying image as a background "picture"; it is also recommended to adjust the model transparency using the command Edit > Palette.

ſ	Palette	
	Magnitude within 1800 2800 🗖 Edit	Palette transparency
	Palette type Default Incremental	
$\left(\right)$	Glow (%)	Ď
	Edit palette Discretization 9	
	1800 2000 2200 2400 2600 2800	
	OK Cancel	

3.3.1 Specify the polygon's components by underlying gather

In the dialogue box with polygon parameters (the menu command <u>Model > Edit Polygon</u>), please define the option <u>From Seismogram</u> for any component. The <u>From Seismogram</u> button will be disabled (gray) if an underlying gather is not defined or if a component is not selected for the gather (please see details in the Section 3.1.2).

FromSeismogram.tpa - TesseralPro				η
File Database Edit View Model Ma	p Seismic 3D View Run Help			
▶ □ ≌ 🖬 🏛 🖽 🖽 🗱 🗱	2 🖉 📑 🏭 🗗 🖌 📲	🏽 🕎 🔍 Đ, Đ, Đ 🔟)% 🔽 🎫 🖥	
🔊 🔀 C1v2	<u> </u>	\	🕨 🥸 💥	
		A		
		Aodel		
8000 100	Polygon Properties	_		×
	Polygon Name C1v2	•	The component value in	the gather
len 0 400 800 11 0 K	Polygon Type		order	
J	Concernant Units M			
	Component Units M Compression Velocity ft/s	anually - Value	nogram From Log	
T1(dr)	Density Ib/ft^3		Γ	
 C2m	Shear Velocity ft/s		Г	
	Anisotropy & Other Properties	By default		y
8000	Drawing Properties	/	ОК	Cancel
C1s1			Clsto V	
	ate Velocity Model > STEP 2: Acquisiti	on Geometry > STEP 3: Run m	odeling > Hide	
For Help, press F1				

3.3.2 Thomson- Tsvankin's Anisotropy Parameters

It also now possible to run 2.5D Elastic Modelling for mediums with orthorhombic anisotropy. An orthorhombic medium can be described by 7 dimensionless <u>Thomson-Tsvankin</u> parameters. They can be accessed in <u>Polygon Properties > Anisotropy & Other</u> <u>Properties >Thomson's</u> Tsvankin parameters

Ivanced Poly	gon Aniso	otropy Pa	arameters			X	
			used for 2D a se settings v		isotropic simu d.	lation.	
Thomsen-Tsvankin's Anisotropy Parameters							
Epsile	on1 E	psilon2	Delta 1	Delta2	Delta3		
	0		0	0	0		
	Gamn	na1	Gamma2	Azimu	uth		
	0		0	0			
			Convert ↓				
Stiffness Te		_	matrix notati				
1	2	3		5		_	
0	0	0	0	0	0	1	
	0	0	0	0	0	2	
		0	0	0	0	3	
			0	0	0	4	
				0	0	5	
					0	6	
				ОК		ancel	

In the <u>Advanced Polygon Anisotropy Parameters</u> window the user can either specify the <u>Thomson-Tsvankin's Anisotropy Parameters</u> and calculate the Elastic Stiffness Coefficients or directly specify the <u>Stiffness Tensor</u> for the chosen polygon.

3.3.3 Porous Medium Parameters

The user can now specify the porous medium parameters for any polygon in the model. In order to access these parameters- right click on the polygon of interest and select Edit Polygon > Porous

Polygon Name 2 Polygon Type bottom	•		•	Border Smoo	thing border
Component	Units	Manually	Value	From Seismogram	From Log
Compression Velocity	m/s	V	2500		
Density	kg/m^3		2200		
Shear Velocity	m/s		1450		
Anisotropy & Other Properties			Porous By default	Property seismogram	Interpolation parallel to the Bottom (Top lap) 💌

Once the <u>Porosity</u> is specified, along with the elastic wave velocities and density for the <u>Mineral</u>, <u>Dry Rock</u> and <u>Fluid</u>, the saturated rock velocities and bulk density in <u>Polygon properties</u> window will change accordingly(i.e. based on Gassman"s equation).

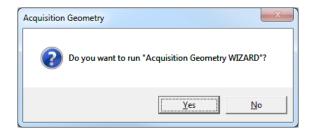
Po	rous Medium Parameters		×
	Mineral		
	Compressioanl Velocity :	6000	m/s
	Shear Velocity :	2900	m/s
-	Density :	2750	kg/m^3
	Dry rock (Skeleton with Minera	al)	
	Shear Velocity :	2673.7	m/s
	Compressional Velocity :	5316.3	m/s
	Fluid		
	Compressional Velocity :	1500	m/s
	Density :	1000	kg/m^3
	Porosity :	15	%
	ОК	Cancel]

4 Acquisition geometry for 2D

<mark>岩</mark> Untitled - Tes	seralPro					<u>_ 🗆 ×</u>
<u>F</u> ile Database <u>C</u> ro	eate <u>E</u> dit	<u>V</u> iew Model M	lap Seismic Run <u>H</u>	elp		
🗈 🖻 🖬 뚣 🎗	A 🖸	<u></u> 100%	<u> </u>	(7) (7) (7) (7) (7) (7) (7) (7) (7) (7)		🛶 🗜 🏭 💡 📢
🗣 🗹 🖻 🗶 🔎	<no sel<="" th=""><th>ect></th><th>_</th><th>x % 🔜 🤜 </th><th></th><th></th></no>	ect>	_	x % 🔜 🤜		
🕂 🛱 New Field 🔺	2000	2500	3000	3500	4000	4500
🖻 🗁 Главное						
	len	0 2000	4000 6000	8000	Sources	14000 7
	0					
			++++++++++++++++++++++++++++++++++++++			
	L with t	vers. The receiver ne active (gray-fil nown in black				
⊕ 1 23 (DT)			┯┯┯			

Sources are shown as triangles. To make a source active (selected) in the <u>Model</u> Frame, click it with the left mouse button. The active source will be filled in grey color. The receivers associated with the active source are shown as black squares. The other receivers are shown as grey squares. To move sources or receivers manually, use the mouse by pressing-dragging- releasing.

The spread of sources (shot points) and receivers (receiving points) are designed by choosing $\underline{Model} > \underline{Acquisition \ Geometry}$ menu command. In the dialogue box, the number of sources/receivers, their intervals and positions can be specified, and every source can be associated with a group of receivers. The users will be offered to arrange the sources/receivers geometry using a Wizard.



Since it is quite complicated to adjust the spread manually, it is recommended to use the Wizard.

NOTE: The dialogue box <u>Acquisition</u> Geometry Wizard is always launched at the very beginning of model creation.

In the Tesseral Pro, several acquisition design schemes can be implemented. Depending on the selected scheme, the Wizard may have 1~4 dialogue boxes.

4.1 Receivers move with source

The receivers are positioned in relation to one of the sources, and then they are repeated for other sources of the model.

STEP 1. Acquisition geometry

Observation scheme		x	
• Move receivers with source			
C Zero-offset shooting		Select a	acquisition geometry
VSP		;	
C VSP(moving source)	C Dipole VSP		
Load from file			
C Load from seismogram	C Load from SPS-file		
< <u>B</u> ack	Next > Cancel	Help	

In the dialogue box <u>Observation scheme</u>, please select <u>Move receivers with source</u>. When this mode is chosen, you should first provide the source layout, followed by the layout of receives *relative to the same source*. As a result the receiver spread will have the same distribution for every single source.

<u>STEP 2.</u> Sources – In the dialogue box <u>Sources</u>, please select the set of parameters to be set from the list, and then enter the values for each empty parameter cell. The sources will be automatically placed uniformly along the acquisition surface (above the top edge of the model polygons).

	Number of sources
/	Number a step
	C Step 40 m
	C From & step
	All parameters
\mathbf{n}	Select the parameters to set
	< <u>B</u> ack <u>N</u> ext > Cancel Help

From – is the starting position of the source line along the model section (profile)

To - is the ending position of the source line along the model section (profile)

Step - source interval

NOTE: These parameters are related with each other by a simple relation: Number = To - From / Step + 1. Therefore, changing one of these parameters leads to recalculation of

STEP 3. Receivers (for the acquisition geometry "Move receivers with source")

Receivers (geophones)			×
 Numbrer & step Step & from & to Number & step & from All parameters Number Step Specify 'From' and 'To' as shifts from current 	Number Step From To t shotpoint	40 ÷ 20 140 920	m m m
< <u>B</u> ack Finis	h (Cancel	Help

Specify the receiver distribution in the dialogue box <u>Receivers</u> (geophones). The parameters <u>From</u> and <u>To</u> do not represent the absolute distance relative to the profile origin, but the relative shift with respect to its corresponding source (negative value means placement to the left of its respective source).

4.2 Receivers at fixed position

The receivers and the sources are positioned independently. Thus, for each source, a group of receivers have to be selected.

STEP 1. Acquisition geometry

In the dialogue box <u>Observation scheme</u>, please select <u>Fixed receiver</u> <u>position</u>. In the following dialogue box, you should specify the source line independently, and then specify the group of receivers for each source.

<u>Sources</u> (for the acquisition geometry "Fixed receiver position") – The dialogue box <u>Sources</u> is the same for all types of acquisition geometries. More detailed information is given above.

STEP 3. Receivers (for the acquisition geometry "Fixed receiver position")

Receivers (geophones)			×
C Numbrer & step C Step & from & to C Number & step & from C All parameters	Number Step From	51 ÷	m
ି Number ତ Step	То	1000	m
Specify 'From' and 'To' as shifts along the p	rofile line		
< <u>B</u> ack <u>N</u> ext	> (Cancel	Help

For the scheme "Fixed receiver position", the dialogue box <u>Receivers</u> (geophones) is similar to the dialogue box <u>Sources</u>. The parameters <u>From</u> and <u>To</u> specify distance along the profile line of the model. Please see the detailed description (for the dialogue box <u>Sources</u>) above.

Please specify the number of receivers (from the whole receiver line) used both to the left and to the right of the source.

Receivers (Geophones)
Receivers are at fixed position. Specify the receiver range associated with current shot.
Number of valid receivers at LEFT side of source of source side of source
< <u>B</u> ack Finish Cancel Help

4.3 Zero offset

In this scheme, each source has only one receiver with the same coordinates. It is mainly used for ray tracing.

STEP 1. Acquisition geometry

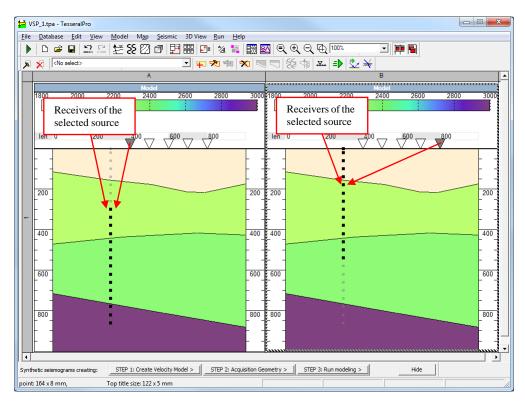
In the dialogue box <u>Observation scheme</u>, please select the option <u>Zero-offset</u> <u>shooting</u>. In the next dialogue box, you should specify the source line. Receivers will be positioned automatically in a way that only one receiver is assigned to each source and the coordinates of each receiver will be identical to its corresponding source.

STEP 2. Sources (for the acquisition geometry "Zero-offset shooting")

The dialogue box <u>Sources</u> is the same for all the acquisition geometries. The more detailed description can be found in the Section 4.1.

4.4 VSP and VSP with ascending receivers

It is used for designing VSP acquisition geometry for the case when all sources are located on the surface. The receiver line can be fixed or ascending inside the well.



<u>STEP 1. Acquisition scheme</u> – In the dialogue box <u>Observation scheme</u>, select VSP(moving source).

Observation scheme		x
C Move receivers with source C Zero-offset shooting C Fixed reseiver position		
VSP	C Dipole VSP	
C Load from file	C Load from SPS file	
< <u>B</u> ack	Next > Cancel Hel	p

<u>STEP 2. Sources</u> – The dialogue box <u>Sources</u> is similar to other acquisition schemes.

The detailed description is in the Section 4.1.

STEP 3. Receivers

Receivers (geophones)			×
 Numbrer & step Step & from & toj Number & step & from All parameters Number 	Number Step From To	15 ÷ 40 300 860	m m m
C Step Specify 'From' as model top and 'To' as mod	del bottom		
< <u>B</u> ack <u>N</u> ext	> Ci	ancel	Help

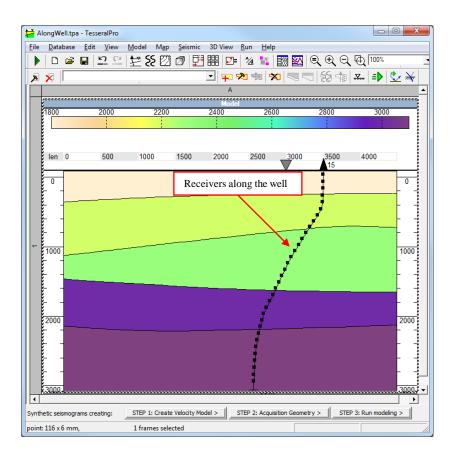
In the dialogue box <u>Receivers</u> (geophones), the receivers spread is specified for the first source.

STEP 4. Receivers (Additional parameters)

Receivers (Geophones)	×
Receiver Layout	
⑦ Vertical line 300 m	
Move receivers for every source by -80 m	
< <u>B</u> ack Finish Cancel Help	,

Specify the way receivers should be positioned: along the vertical line or along the well. The well may be selected from the list of wells, which are used in the model (in the Section 12.1, it is described how to add a well into the model).

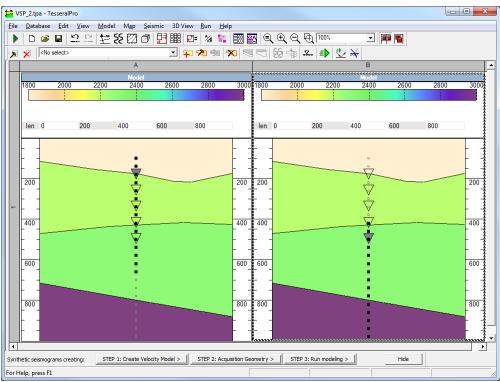
Below is an example of receiver spread along a well:



The <u>Move receivers for every source on</u> parameter is used in the observation scheme when receivers are raised in the borehole during seismic observations.

4.5 VSP dipole

Both sources and receivers are located inside the well.



STEP 1. Acquisition scheme

In the dialogue box Observation scheme select Dipole VSP.

<u>STEP 2. Sources</u> – The dialogue box <u>Sources</u> is the same as other acquisition schemes. The only difference is that the sources are located along a vertical line or along the well.

<u>STEP 3. Receivers</u> – In the dialogue box <u>Receivers</u> (geophones), like in the acquisition scheme 4.1, the layout of receivers for the first source needs to be specified.

STEP 4. Receivers (Additional parameters)

Select one of the 2 options how the receivers are located: along a vertical line or along the well.

The parameter <u>Move receivers for every source by</u> is used for the acquisition scheme when the receivers are moving up along the well during the seismic observations.

4.6 Load acquisition geometry from gathers

If you have field gathers then the information on sources and receivers coordinates from the trace headers may be used to assign the acquisition scheme for a model.

STEP 1. Acquisition scheme

In the Observation scheme dialogue box, select Load from seismogram. In the next standard <u>File open</u> dialogue box, select the seismic file. All the sources and receivers will be loaded from the trace"s header of the selected gather.

4.7 Load acquisition scheme from SPS files

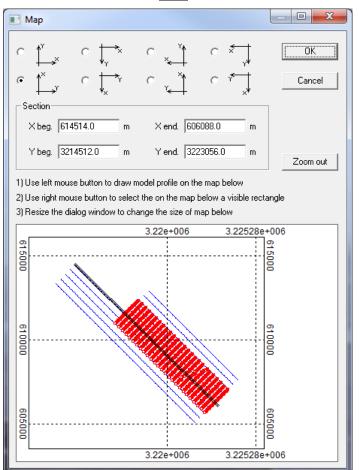
STEP 1. Acquisition scheme

In the dialogue box Observation scheme, select Load from SPS-file.

In the next dialogue box <u>SPS-files load</u>, select the SPS files. If you use the SPS file of a 3D spread, then in the group <u>Sources and receivers selection</u>, adjust the criteria for selecting sources and receivers to be loaded into the model and the binning size.

SPS-files load		×	
Sources File	C:\Sheldon\TestingOfTess	seralPro\Tesseral 3D Files\SPS\Sw1.s01	
Receivers File	C:\Sheldon\TestingOfTess	seralPro\Tesseral 3D Files\SPS\Sw1.r01	
Shot-Receiver Relation File	C:\Sheldon\TestingOfTess	seralPro\Tesseral 3D Files\SPS\Sw1.x01	
Sources and receivers selectio Exclude the sources/receivers aw Align the selected source/receiver	ay from the profile line	50 m 10 m	
		Cancel]

In the next dialogue box Map, select the model section along the receiver line.

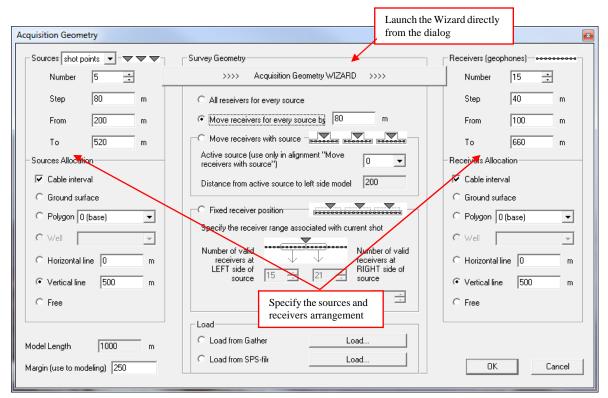


If the model length is smaller than the length of the selected profile in the Map dialogue,

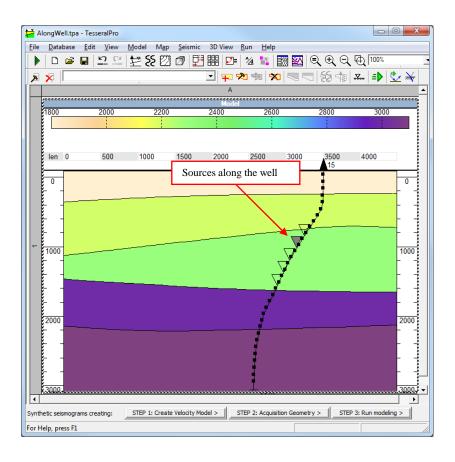
you will be asked to correct (enlarge) the model. Tesseral Pro has the capability of creating a model using only SPS files (see Section 3.1.6 for more details).

4.8 Standard dialogue box for acquisition geometry

In addition to using Wizard for the sources and receivers layout, the integrated dialogue box can be used, which is activated by $\underline{Model} > \underline{Acquisition \ Geometry}$. Then select \underline{No} when asked to run $\underline{Acquisition \ Geometry}$ Wizard.



The group <u>Sources</u> is for specifying the source layout, and the group <u>Receivers (geophones)</u> is to specify the receiver layout. The group of <u>Sources</u> <u>Allocation</u> or <u>Receivers</u> <u>Allocation</u> is to specify the line along which the sources or receivers will be positioned. If you select the option <u>Well</u> and a well from the list, then the sources (receivers) will be positioned along the selected well, as shown in the figure below.



If you select the option Free in the group <u>Sources Allocation</u> or <u>Receivers</u> <u>Allocation</u>, then each source (receiver) can be positioned in the model independently from each other. For the other options, all sources and receivers will be positioned as a group along a specific line.

5 Modeling: synthetic gather calculation

Before launching the job of computing synthetic gather, a velocity model (Section 3) and the corresponding acquisition geometry (Section 4) needs to be designed firstly and then the project has to be saved by using the command File > Save Project.

Please use the menu command $\underline{Run} > \underline{Run} 2\underline{D}$ Modeling or $\underline{Run} > \underline{Run} 3\underline{D}$ Modeling to open the modeling parameter specification dialogue.

5.1 Modeling method selections

The <u>Modeling Procedure</u> parameter is for selecting the method used for solving the wave equation. The available modeling methods include:

- Sources to Source	o compute -	ints 💌	From #: 1 To #: 5	Al	Active
Shotgahte Start Stop Step	r Record	ms <u>auto</u> ms			
Save results	to [0	C:\Sheldon\TestingOfTest	seralPro]	Browse

- <u>2D Vertical Incidence</u> is to simulate the vertical propagation of waves for horizontal boundaries. It allows quick evaluation of the arrival time and the amplitudes of the reflected waves in the time section under the condition of strict 1D propagation of seismic energy.
- <u>2D Scalar</u> is for the scalar model of the medium (i.e., liquid approximation without considering variation of density). It only takes into account the variation of compressional velocity and it is the quickest method for the modeling of 2D wave propagation.
- <u>2D Acoustic</u> is for the acoustic model of the medium, which takes into account the variation of compressional velocity and density.
- <u>Acoustic without multiples</u> is for quickly obtaining the time section of the acoustic model of the medium. As a whole, it corresponds to the exploding interface mode of other methods, but it does not take into account the multiples and the image contains fewer noises. It enables users to intuitively understand the influence of multiples on the gather and seismic image by comparing with standard acoustic method.
- <u>2D Elastic</u> is for an isotropic elastic model. This is the main modeling method, which can simulate the 2D propagation of seismic energy in solid media by taking into account the effects of wave-mode conversion and the shear waves, as well as the effect of quasi- anisotropy caused by a stack of inter-bedded thin layers.
- <u>2D Elastic Anisotropic</u> is for a 2D-anisotropic elastic model and takes into account the variation of physical properties in horizontal and vertical direction. The input model can have up to 3 systems of 2D-oriented fracturing. This modeling method can simulate the seismic energy propagation in anisotropic medium. The anisotropic

parameters and/or fracturing parameters have to be specified by the user. If these parameters are not specified, the algorithm is equivalent to the isotropic elastic method.

- <u>2D Visco-Elastic</u> is for a visco-elastic model and can be used to evaluate the effects of seismic energy absorption. It also takes into account the velocity dispersion. The quality factor needs to be specified by the user. If this parameter is not specified, this algorithm is equivalent to Elastic Modeling. This modeling method allows users to examine the influence of fluid on wave propagation.
- <u>2D Eikonal Ray Tracing</u> is the ray-tracing method for isotropic and anisotropic medium and is based on the high-frequency (optical) approximation of wave-equation modeling. It does not calculate the multiples but may take into account converted waves at the reflector. The method is not suitable for a thin-layered model. This method enables users to evaluate horizons" illumination taking into account reflection waves. (Other methods can only show incident wave energy instead of the illumination).
- <u>2.5D Elastic/Elastic Anisotropic + Visco-Elastic*</u> is for 3D isotropic or anisotropic elastic model with arbitrarily-oriented fracturing sets in 3D space. It is assumed that the variation of the rock properties goes along the model''s profile, while the variation perpendicular to the model''s plane (along the Y axis) is negligible. This method can generate not only 2D/3C gathers but also 3D/3C ones, and in case of a vector source even 3D/9C gathers can be generated. The parameters of anisotropy and fracturing have to be specified. The azimuth is relative to the profile line of the model. Additionally modeling of frequency dependent attenuation (Visco-Elastic) is also an option. <u>2D 3D</u>
- <u>3D Vertical Incidence</u> is to simulate the vertical propagation of waves for horizontal boundaries. It allows quick evaluation of the arrival time and the amplitudes of the reflected waves in the time section under the condition of strict 1D propagation of seismic energy. To access this method please first create a 3D observation system (See 7) then <u>Run></u> <u>Run 3D modeling</u>

	Mo	deling Procedur	e: 3D Ver	tical Incidence	-		•	
nput							-	
	ity Cube File	1)DUPLEX_V	ELOCITY_MO	DEL_newsort	revers.s	gy Br	owse Re	equired
S-Veloc	ity Cube File							ot Used
	Cube File	-					owse]	Auto
		-						
Quality	Cube File						owse	isabled
ources	o compute							
	į	From #: 197		To #: 19	97		All Ac	tive
				14.12				
hotgahti	er Record		Model Bou	_				
	1.000		Auto				·	
Start	0	ms	X min	35	m	X max	3955	m
	4000	ms	Y min	35	m	Y max	4515	m
Stop			Zmin	0	m	Z max	4070	m
Stop Step	2	ms						
Step	2 results to			op\Tesserral Pr	o testing	new versi	Brow	se
Step Save		C:\Users\S	tefan\Deskto	p\Tesserral Pr			Landson (se

• <u>3D-3C Acoustic</u>, <u>Elastic</u>* allows approximating wave propagation in conditions of realistically heterogeneous (in all 3 directions X, Y and Z) medium. This modelling can be applied to the objects like reefs, salt domes, different kinds of collapse/breakthrough chimneys or steeply inclined faults etc. in the areas where an accurate 3D reservoir characterization is required.

Note*: 2.5-3D-3C Full-wave (finite-difference) modelling, due to its computational intensity, is based on Parallel Options including multi-core, node, -GPU solutions allowing to run such simulations in a feasible turnaround time

To access this method please first create a 3D observation system (See 7) then $\underline{\text{Run}} \ge \underline{\text{Run}} = \underline{\text{Run}} \ge \underline{\text{Run}}$

• <u>3D-3C elastic TTI Anisotropic method</u>. For this method the anisotropic parameters <u>Epsilon</u>, <u>Delta</u> and <u>Gamma</u> of the medium needs to be assigned. Either constant values or seismic cubes are assigned for Thomsen's parameters in the <u>3D</u> <u>Anisotropic Modeling</u> window. The angle <u>Phi</u> (i.e. the angle from the vertical), as well as the <u>Azimuth</u> of the TTI axis needs to be specified.

	ation	
1 Ortho	rombic (VTI/HTI) (
You can spec Thomsen par	cify either a constant value or a seismic cube for non-zero rameters	
Epsilon	0.2 Browse	e
Delta	-0.1 Browse	e
Gamma	0.03 Browse	e
Phi Azimuth	30 Browse 45 Browse	=

For the <code>Orthorhombic (VTI/HTI)</code> as written, both <code>Phi</code> and <code>Azimuth</code> can be either 0 or 90 degrees.

Approxima	ation	
Orthor	rombic (VTI/HTI)	
You can spec Thomsen par	cify either a constant value or a seismic cube for non-zero rameters	
Epsilon	0.2	Browse
Delta	-0.1	Browse
Gamma	0.03	Browse
mt :	90	Browse
Phi Azimuth	90	Browse
		Browse

To access this method please, create a 3D observation system first (see 7), then $\underline{\text{Run}} \ge \underline{\text{Run}} = 3D$ modeling.

• <u>Haskell-Thomson</u> is a 2D/3D modelling method that is strictly designed for VTI mediums. This method, in fact, is the 3D-method for a horizontally layered medium, but it is using for 2D-models also. If this method is applied to the medium with the curved boundaries, it implicitly builds a horizontally layered medium, based on the velocities just below the source. The main advantage of this method is the possibility to calculate various types of wave fields (P, SV, SH) separately. This method is not very appropriate to the thin-layered modelx, because the calculation time is in proportion to the number of boundaries. With this method it is possible to simulate point sources only, and the sources and receivers are assumed to be located on a common horizontal surface.

This method implements spectral decomposition along X, Y and also time and as a result the wave field propagates in 1D along the Z axis. The method essentially allows the user to generate partial wave fields by allowing the user to choose the type of propagating (i.e. $\underline{\text{Down}}$ $\underline{\text{Mave}}$) and receiving (i.e. $\underline{\text{Generate wave type}}$) waves, while allowing full wave mode conversion in inter-bedded layers.

Addition	
	Threads per process Max -
	Produce time field None
	GPU
	Haskell-Thomson Additional Options
	Down wave P
	Number Slowness coefficient by x 1200 601 -
	Slowness coefficient by y 1200 601
	☑ Auto calc. number of slowness
	Generate waves type P&S
(Components: value range
< <u>B</u> ack	Mext > Finish Cancel Help

The <u>Slowness Coefficient by x</u> and <u>Slowness Coefficient by y</u> (1200 in this case), implies that the range of slowness is limited by 1200/Vs where Vs is the minimum shear wave velocity in the model. The <u>Number</u> parameter determines the number of used harmonics, (i.e. slowness). With these two variables all possible reflected and surface waves can be modeled, provided that a large <u>Number</u> of slowness is used (i.e. 601). A smaller number of slowness would result in modeling of reflected waves only, while supressing the surface ones (e.g. Rayleigh Waves).

• <u>3D-3C visco elastic method</u> is used to evaluate the effects of seismic energy absorption in a 3D medium with or without any VTI/HTI anisotropy. For this method the <u>Quality Cube file</u> (i.e. Q factor cube) needs to be loaded in the <u>3D</u> <u>Modeling General Properties</u> tab for the <u>3D Elastic</u> or <u>3D</u> Elastic Anisotropic modelling procedure.

	Мо	deling Procedure	e: 3D Ela	stic Anisotropic			•	
nput								
P-Veloc	ity Cube File	1/DUPLEX_VE	LOCITY_M	DDEL_newsort	_revers.s	gy Br	owse)	Required
S-Veloc	ity Cube File					Br	owse	Auto
Density	Cube File					Br	owse	Auto
Quality	Cube File	1				Br	owse	Enabled
ources	to compute	From #: 197		To #: 19	7			Active
		1011 #1 157		10 #. 15			All	Acuve
notgaht	er Record		Model Bou	undaries				
			Auto					
Start	0	ms	X min	35	m	X max	3955	m
	4000	ms	Y min	35	m	Y max	4515	m
Stop	2	ms	Z min	0	m	Z max	4070	m
	-			10.000				
Step		C:\Users\St	efan\Deskt	op\Tesserral Pr	o testina	new vers	Bro	MICO
Step Save	results to			op\Tesserral Pr b, launch using				wse

To access this method this method please first create a 3D observation system (See θ) then access <u>Run></u> Run 3D modeling.

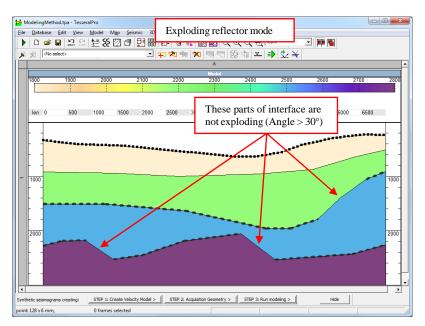
Also, in order for velocity dispersion (i.e. frequency dependency) to be taken into account, the <u>Number</u> of relaxation mechanisms must be specified in the <u>3D</u> <u>Modeling Calculation</u> <u>Properties</u>. <u>Use Apparent Velocities</u> ties the assigned velocity of the medium to the assigned frequency. Consequently, as the bandwidth of the signal is reduced (due to <u>Qs</u> and <u>Qp</u>), so is the velocity. This is absolutely consistent with applied geophysics. Whereas <u>Use Intrinsic</u> <u>Velocities</u> ties the assigned velocity to zero frequency and as a result the velocity of the propagating waves is greater than the assigned velocity in the model. The 3D viscoelastic method is most generally used to examine the effect of fluid on full 3D wave propagation. For more details see: <u>http://petrowiki.org/Acoustic_velocity_dispersion_and_attenuation</u>

	Grid Prope	rties		Threads per process	Max 👻	
Cell (dx, dz)	1	m aut	to	Produce time field	None	
Tact (dt)	0.05	ms aut	to	GPU		
				📝 Enable GPU Ope	enCL (if available)	
🔽 Generate	snapshots	1				
Start	0	ms				
Step	200	ms				
Generate by	veverv 1	. 🚖 sour	rce			
		Local (
nisotrop	oy/Fracturir					
Anisotrop		ng				
🔽 Attenuat	ion (Quality	ng				
	ion (Quality	ng				
Attenuat	ion (Quality osity	ng		⊽ Higher Order Appro	ximation (better qual	ity)
Attenuat Attenuat True Visc Number of mechanism Use appare	ion (Quality osity 	ng () 3		PML for invisible bo	undaries	
Attenuat True Visc Number of mechanism	ion (Quality osity relaxation ent velocitie ent velocitie	ng () 3		PML for invisible bo		

The following applies to 2D modeling only.

If the <u>Source</u> is specified as <u>shot points</u>, the synthetic gathers are generated successively from each source for the group of receivers associated with this source. Once the modeling job for all sources is completed, a single merged shot gather is obtained. It has the flexibility of generating the synthetic gathers for only a part of the sources by using the parameters <u>From #</u> and <u>To #</u>.

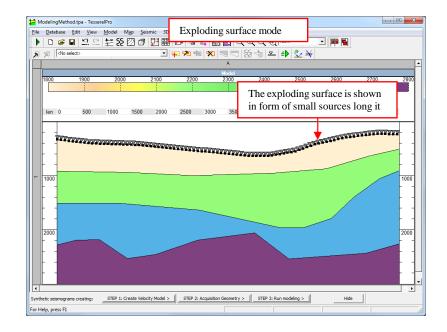
If the <u>Source</u> is specified as <u>reflector</u> (exploding reflector), it is assumed that the visible part of the boundary of each of polygons may represent a line source oriented upwards to the surface of the model. Users can specify the parameter <u>Max angle (deg)</u> to limit the maximum angle of the boundary to be used as exploding reflector (by default it is limited by a 30 degree angle).



And the method of the acquisition system in the Frame Model is changed: the sources are not shown and the parts of the boundaries emitting the wave are shown as bold dotted lines.

NOTE: It is possible to switch off the wave generation from all the boundaries of any polygon. To do it, select the polygon, call dialog box <u>Polygon Properties</u> by menu command <u>Model > Edit Polygon</u>, click the button <u>Anisotropy & Other</u> <u>Properties</u> in the dialogue box, and select <u>Muted</u> in <u>Sources type</u>: Reflector group.

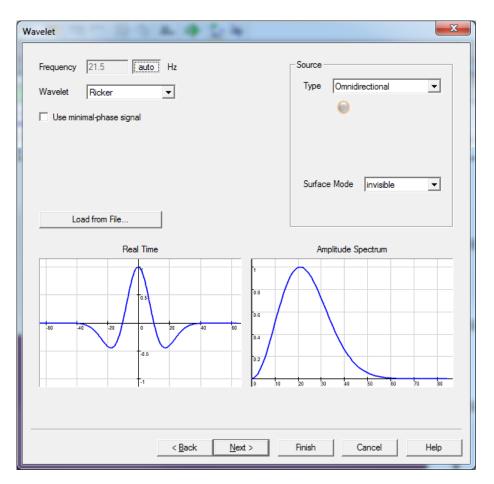
If the <u>Source</u> is specified as <u>surface</u> (exploding surface), the whole ground surface is excited at the same time. It can enable the modeling of plane-wave propagation.



NOTE: After the gather is calculated using the method of exploding surface or exploding reflector mode, If you like to recover the acquisition geometry for <u>shot points</u> sources, call dialogue box <u>Model</u> > <u>Acquisition Geometry</u> and then select <u>shot</u> points for the parameter <u>Source</u>.

In the group of <u>Shotgather Record</u>, duration of recording and the sample interval are specified in unit of ms (<u>Start</u>, <u>Stop</u>, <u>Step</u>).

5.2 Source wavelet



Select the dominant frequency of the source signal by the parameter <u>Frequency</u>. This parameter has considerable influence on quality of computed gathers and on time step needed for stable wave continuation. Generally, the higher the frequency, the longer the computation time.

- Parameter <u>Wavelet</u> is used for the selection of the signal"s form. In addition to these standard wavelet types, you may load any kind of signal from a text file by pressing the button <u>Load</u> from File.
- Parameter Source Mode is used to specify the signal"s directionality.
- Parameter <u>Surface Mode</u> If <u>invisible</u> is selected, the free-surface related reflection will not appear in the seismic wave field. If <u>free</u> is selected, the free-surface related reflection is taken into account in the wavefield.
- The option <u>Use minimal-phase signal</u> If the option is checked, the amplitude spectrum of the signal will be kept unchanged, but its phase spectrum will be changed to obtain the minimum-phase signal.
- The option <u>Suppress</u> <u>Source</u> <u>SV</u> is for suppressing shear waves. When the source is located closely to the free surface, checking this option can reduce strong surface waves in the shot gather, when <u>Elastic Modeling</u> or <u>Elastic Anisotropic</u> <u>Modeling</u> is used.

5.3 Additional parameters

Some specific parameters associated with various modeling procedures are to be specified. Therefore, the available parameters in the dialogue box <u>Addition</u> differ depending on the selected modeling procedure in the previous step (see Section 5.1).

For the finite difference solution of the wave equation, e.g., <u>Vertical Incidence Modeling, Scalar</u> <u>Modeling, Acoustic Modeling, Elastic Modeling</u> and <u>Elastic Anisotropic Modeling</u>, the dialogue box Addition consists of the following parameters:

Computation Grid Properties	Threads per process	Max	
Cell (dx, dz) 7.8 m auto	Produce time field	None	•
Tact (dt) 3.7 ms auto	GPU	oCl (f ausilabla)	
Generate snapshots		nul (ii avaliadie)	
Start 0 ms			
Step 50 ms			
Generate by every 1 🔹 source			
✓ Attenuation (Quality)			
✓ Attenuation (Quality)	🕶 Higher Order Approxi	mation (hetter quality)	
I⊄ Attenuation (Quality)	I Higher Order Approxi		
	PML for invisible bou (better suppresses re	ndaries flections in most cases)	
✓ Attenuation (Quality) Margin 1250 m auto		ndaries flections in most cases)	

- <u>Computation Grid Properties</u> are the parameters of the grid size and time step for finite-difference modeling. It is recommended to use default values by having the buttons <u>auto</u> pressed down)
- <u>Generate snapshots</u> during numerical modeling, a special file <u>Snap.tgr</u> is created, which contains the snapshots of the wavefield. The parameter <u>Start</u> is the time when generation of snapshots starts. The parameter <u>Step</u> (step of discretization) is the time interval between two successive snapshots.
- <u>Generate by every ... source</u> to specify the source interval with which the snapshot is generated.

NOTE: The snapshots file (...Snap.tgr) for each source uses lots of computer memory. Additionally, merging of the snapshots for each source into one single file (this is the last phase of synthetic gather computation) requires significant time. Thus, it is recommended not to generate snapshots if you do not need them or specify larger time interval for generation of snapshots (parameter <u>Step</u>) and omit some sources by parameter <u>Generate by every ...</u> <u>source</u>.

- The option <u>Use attenuation</u> determines whether to take into account the Quality factor during computation if it was specified for a polygon (please see details in the Section 3.2.6)
- <u>Margin</u> is for widening the computation area outside the acquisition aperture.
- <u>Threads per process</u> Determines the number of cores used during modeling. Max means that all the processor cores are used.
- <u>Produce time field</u> During the computation of the wavefield, the time field of the incident waves can be generated: <u>First Arrivals</u> for the first arrivals of the incident wave and <u>Maximum Energy</u> for the arrival of the most-energetic incident wave.
- <u>Components: value range</u> When the model is built by well database (please see details in the Section 3.2.10), the parameters limit the values of velocity and density of the polygons which are obtained from the well logging data by interpolation.

5.3.1 Eikonal Ray Tracing Modeling

For eikonal ray tracing modeling method, the parameter <u>Max. Dip of reflector</u> is added, which limits the slope angle of the reflector. The feature of <u>Snapshot</u> is not supported in case of eikonal ray tracing.

Computation Grid Properties	Threads per process	Max	
Cell (dx, dz) 4.5 m auto	Produce time field	None	
Tact (dt) 2.1 ms auto			
Eikonal Ray Tracing Options	1		
Max. Dip of reflector 60 🛨 ° (in de	grees from a horizonlal axis)		
Ignore anisotropy			
Ignore anisotropy Generate converted waves			
Generate converted waves	Components:	value range	

5.3.2 2.5D Elastic Anisotropic Modeling

For 2.5D modeling, the <u>Receiver Lines for Shotgathers</u> group is added in the first <u>General</u> dialogue box, which allows specifying the range and interval of the receiver line in the direction of the crossing line.

Modeling Procedure 2.5D Elastic Sources to compute From #: 1 Source shot points To #: 40 Shotgahter Record To #: 40 Stat ms Stop 2000 ms auto Step 2 ms Additional 3D Acquisition Geometry Parameters From Y 0 m To Y 0 m Step /2 ms Step dY / 0 m Step dY 0 m Step stems to C:\Users\Stefan\Desktop\Export_to_seismic_format_test\	General	<u>×</u>
Start 0 ms Stop 2000 ms auto From Y 0 Step 2 ms To Y 0 m Step dY 0 m 1 ines	- Sources to compute	From #: 1 All Active
Save results to C:\Users\Stefan\Desktop\Export_to_seismic_format_test\ Browse	Start 0 ms Stop 2000 ms auto	Receiver Lines for Shotgathers From Y 0 m To Y
< Back Next > Finish Cancel Help		

If a 2D VSP acquisition geometry was built, then the user can replicate it to a circular VSP survey by selecting VSP radial allocation scheme of sources.

	ocedure o compute	2.5D Elastic				
Source	shot poi	nts 🔹	From #: 1 To #: 20:	L	All	Active
Shotgahte	er Record		Additional 3D Acc	quisition Geo	ometry Paramet	ers
Start	0	ms	VSP radial alloc	ation scher	ne of sources	•
Stop	1000	ms auto	From angle	0	deg	
Step	1	ms	To angle	360	deg	
			Step angle	30	deg 12	shots p/s
			Assume ho (faster cal	rizontal lay culation)	ered model	
Save result:	a ta		too Visioona adallata dal	an Alau Vial	021	Browse
Edit the ta			top /Leismer model /Modeli ob, launch using existing		-02∖ ▼	browse

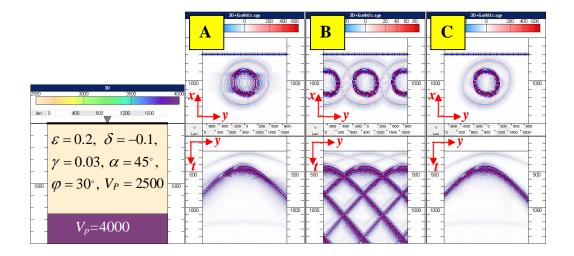
In the dialogue box Addition, the group Y Fourier Transform Spatial Frequency Range (K2) is added. It is specific for implementation of 2.5D modeling which use the spectral decomposition technique in the Y direction where variation of the rock parameters is assumed to be invariant.

Computation Grid Properties	Threads per process Max 💌
Tact (dt) 2.1 ms auto	GPU
Generate snapshots Start 0 ms Step 50 ms Generate by every 1 + source Y offset 0 m Anisotropy/Fracturing	Y Fourier Transform Spatial Frequency Range (K2) From 0 To 0 Number of K2 values per shot 0 Calculate
Attenuation (Quality) True Viscosity Number of relaxation mechanism 3 1250 m	PML for invisible boundaries (better suppresses reflections in most cases) Components: value range

The gathers in the A column are noisy due to insufficient range of spatial frequency (From, To). The gathers in the B column contain the signal from virtual sources due to insufficient

number of spatial frequencies (Number of K2 values per shot).

The gathers in the C column are correct.



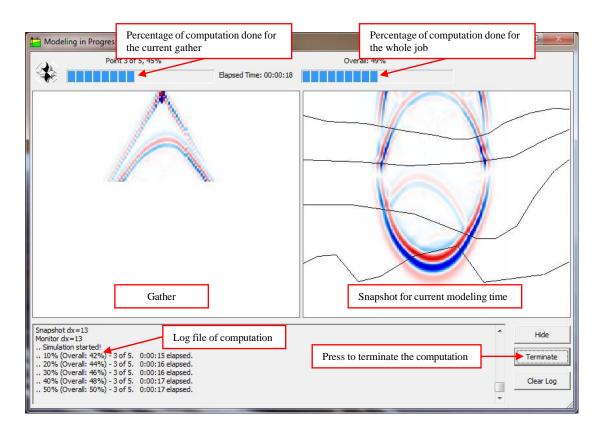
It is recommended to adjust these spectral decomposition parameters automatically by pressing the button Calculate in the lower part of the same group.

In any case, the 2.5D modeling requires huge amount of computations, just like a

complete 3D case. It is accelerated by effective parallelization, especially by using GPU (NVIDIA CUDA). To decrease the computation time, users can specify shorter time for the parameter \underline{Stop} in the dialogue box $\underline{General}$.

5.4 Gather Calculation rocess

After the modeling method and the relevant parameters are specified, please press the button <u>finish</u> to launch the job and then the <u>Modeling in Progress</u> window should appear to allow users to monitor the job progress.

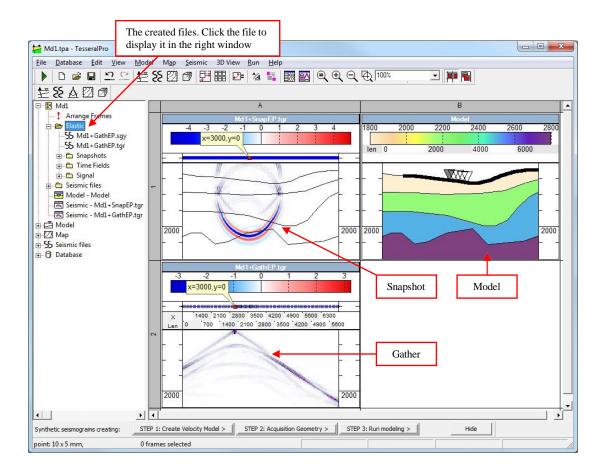


In the upper part of the <u>Modeling in Progress</u> window, the percentage of computation done for the current source is shown, and the percentage of computation done for the whole job is also shown. On the left, the part of the gather being computed is shown, and on the right, the corresponding wavefield is shown. In the bottom, the log file is echoed as job is running.

If you want to terminate computation, press the Terminate button.

If an error occurs during the computation, the message will be shown in the lower part of the <u>Modeling in Progress</u> window. To check the log messages of a finished job, choose <u>Run ></u> <u>Show Progress Dialog</u> menu command.

After the modeling job is done successfully, the <u>Modeling in Progress</u> window will be closed automatically and then the computed gathers will be displayed in the Tesseral Pro window.



The output files of the modeling will be created in the same folder with the project. In case of elastic isotropic modeling (Elastic Modeling), if the project is **ModelOne.tpa**, the following output files will be generated:

odelOne+GathEP.sgy	Gather			
ModelOne+GathEP.tgr	3-component gather TGR:			
	Vertical particle velocity, Horizontal			
	particle velocity, Normal stress			
ModelOne+SnapEP.tgr	Wavefield snapshots			
ModelOne+TimeEP.tgr	Traveltime from the source			
ModelOne+WaveEP-1.tgr	Wavelet			

Please see the Section 13 for details about outputted gathers in the Tesseral Pro.

5.5 Modeling using cluster and windows network

To use the finite difference methods (except the 2.5D Elastic Anisotropic Modeling) available in the Tesseral Pro to compute the synthetic gathers, it is enough to have a modern PC. For the 2.5D Elastic Anisotropic Modeling, the runtime can vary from several hours to several days, depending on the model size and the selected computation parameters. Due to this fact, it is recommended to use a cluster or a network of PCs to launch the 2.5D Elastic Anisotropic Modeling.

5.5.1 Modeling using a cluster

In Tesseral Pro, the model can be prepared within Tesseral Pro and the job for computation of synthetic gathers can be launched on a cluster. The cluster may work under Windows or Linux (UNIX). The Tesseral Pro package does not work directly with the cluster. It is assumed that the users copy the job and the model to the cluster explicitly, launch the job and copy the computation results back to Tesseral Pro for visualization.

To prepare the job for a cluster, call <u>Run > CLUSTER: Create task</u>. The dialogue box for job preparation is similar to the dialogue box for setting up jobs in the Tesseral Pro (see Section 5). For example, for the project **ModelOne.tpa** with 3 sources, the following files will be generated:

runtask.ini
ModelOne1.tam
ModelOne2.tam
ModelOne3.tam

Here **ModelOne1.tam**, **ModelOne2.tam**..., are the model files associated with each source. "runtask.ini" is the main file where the modeling parameters for the job are saved.

It is recommended to create an empty folder where this job will be created and saved. In this case, the benefit is that users will not need to check whether a file is related to this job or not. The 2.5D computation engine for a cluster may be downloaded from the website <u>http://www.tesseral-geo.com</u> under page "DOWNLOADS". The needed user documentation is in the archive with each program.

5.5.2 Modeling using Windows network

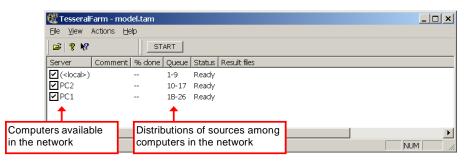
For large computation tasks, Tesseral Pro provides a special utility TesseralFarm. TesseralFarm is a utility complementary to the Tesseral Pro and it is designed to implement cluster functionality in the Windows networks. Compared to the cluster under Linux architecture, the cluster created with TesseralFarm requires far less efforts for preparation and has more flexible topology and sufficient potential for enhancement. After computers are connected to a local network and the program is tuned, the computation tasks can be broken down and allocated to each computer. TesseralFarm gives the possibility to manage computations in separate nodes and to obtain (merge) the common result.

Please see details about the installation and tuning of the TesseralFarm in separate document.

Job launch and job distribution in a Windows network is done in Tesseral Pro by calling

Run > NET: Run modeling.

It is possible to get all computers available in the network by using <u>Actions > Add</u> <u>All</u> Available Servers.



Distribution of the job among the nodes (computers) is shown in the column \underline{Queue} . For modeling, the sources allocated to each node are shown. You may change the number of sources for each node by double-clicking in the list.

When you have selected the nodes, please press <u>START</u> and the program will start copying the files to the nodes (this may happen instantaneously or may take some time, depending on the sizes of files and network speed). Once the copy of files to the nodes will be completed the computations in the nodes will begin. You can monitor the computation in each node by the messages under the column % done.

Image: Constraint of the second se					
STOP					
Ser∨er	Comment % done	Queue	Status	Result files	
✓ (<local>)</local>	30%	1-9	Working	Waiting for files	
PC2	43%	10-17	Working	Waiting for files	
PC1	31%	18-26	Working	Waiting for files	
•	Percentage of co	mputa	tion done in each of		

If you like to terminate the computations in one of the nodes, please right-click that node and select Break calculation.

If you like to terminate computations in all nodes, click STOP.

Once the computations in all the nodes are completed, the computation results are located in the folder, from which the job was launched.

👯 Tesseral	Farm - model.tam				
<u>F</u> ile ⊻iew	Actions <u>H</u> elp				
] 🛎 🤋 📢	START				
Server	Comment % done	Queue	Status		Result files
🗹 (<local>)</local>	100%	1-9	Finished joining files		
PC2	100%	10-17	Finished calculating	K	The modeling is finished.
PC1	100%	18-26	Finished calculating		The results are merged
4					Þ
					5 11 15 4

6 2D Ray tracing

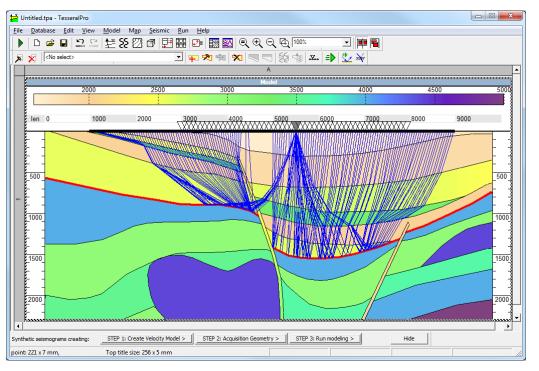
<u>STEP 1.</u> Create a new or select an existing model (the command <u>Model > Create</u> <u>Velocity</u> <u>Model (New Frame)</u> or <u>Edit > New Frame > Model</u>). The model must have sources and receivers (Model > Acquisition Geometry).

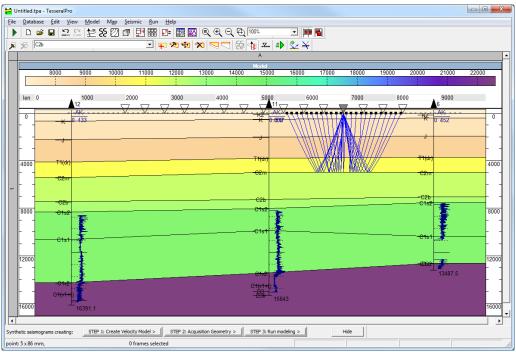
<u>STEP 2.</u> Select the polygon, for which you would like to run the ray tracing.

STEP 3. Launch the job by the command Run > 2D Model: Ray Tracing

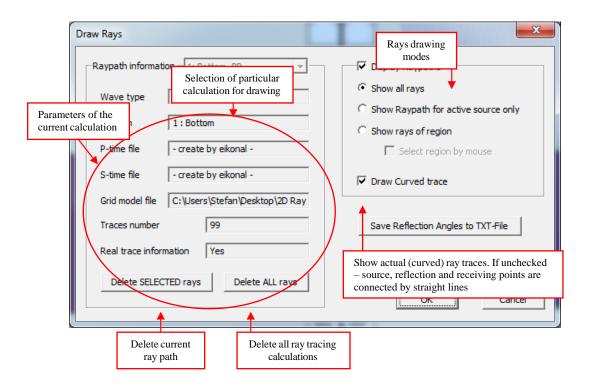
		Select the reflecting polygon	Select the reflecting boundary
	Ray Tracing		
Set the step of the grid	Reflecting boundar		Top V
	✓ Trace real rayp □ Loop	Diffraction points Diffraction points ount the boundary overlappin	
Select source for ray tracin	Wave type PP Sources Every (source)	↓ 1 ÷ 0 ÷	
	Model – 🔽 Gene Grid model file	erate before ray tracing	eralPro\Run\Md2-PQR.TGR
	P-time — ✓ Calco P-time file S-time file	C:\Sheldon\TestingOfTess	Use Anisotropy eralPro\Run\Md2+TimeEKP.TGR eralPro\Run\Md2+TimeEKS.TGR
Set the main parameters to default value	their		OK Cancel

More information about the ray tracing parameters can be found in the section 6.3. Here is the result of this method:



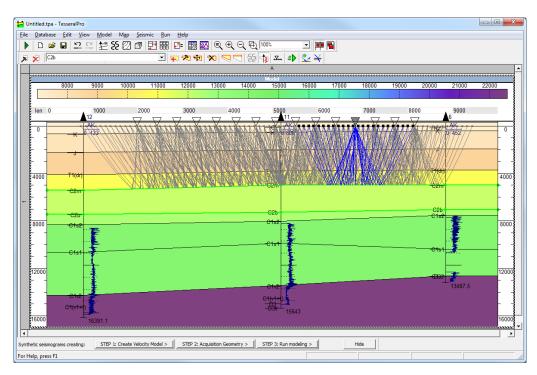


In Tesseral Pro, the ray tracing calculations can be accumulated by repeating the command $\underline{\text{Run}} > 2D$ <u>Model: Ray Tracing</u>. If the calculation is recalled with the same parameters for the same layer, its results will automatically replace the existing results. By default, the <u>Model</u> Frame shows the result of the last calculation. The ray paths displayed in the <u>Model</u> Frame for the current calculation can be changed by using the command <u>Model > Raypath Data and Visualization</u> <u>Properties</u>. In the same dialogue box, you may see the parameters of the current calculation, change the mode of displaying the rays and delete some of the past calculations. **NOTE:** All ray-tracing calculations are saved in the project file (".tpa" file). Please ensure that ray calculation results will not overwhelm the document. Delete the unnecessary calculations by the dialogue box Model > Raypath Data and Visualization

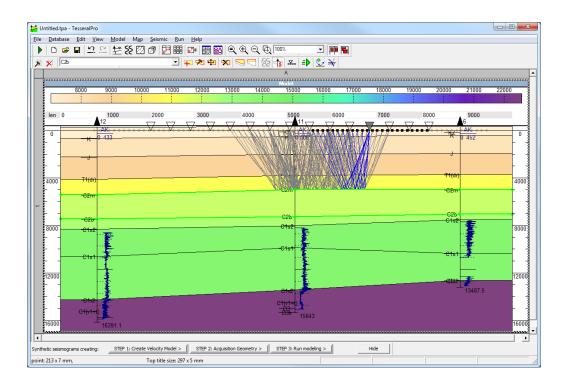


6.1 Ray-path display in Frame Model

- Show all rays The ray paths from the current calculation are shown.
- <u>Show Raypath for active source only</u> The ray paths from the active source are shown. The ray paths from non-active sources are marked in grey color.

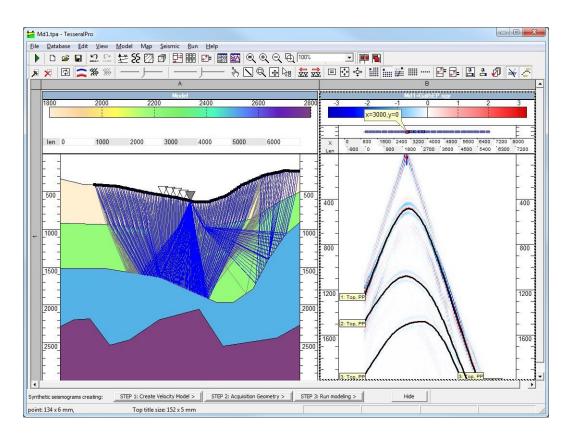


• <u>Show rays of region</u> – Display the ray paths from the current calculation whose source, receiver and reflection point are within the selected area. To define the region, in the dialogue box <u>Model > Raypath Data Visualization</u> <u>Properties</u>, please select <u>Show rays of region</u> and then check <u>Select</u> <u>region by mouse</u>. Then select the region of the model for displaying rays by pressing dragging and releasing the left mouse button. The mode of the region selection will be cancelled automatically after the left mouse button is released.



6.2 Ray-path display in gathers

Please load the field gather or the synthetic gathers calculated by the eikonal ray tracing method or finite-difference methods into the <u>Seismic</u> Frame. It is implicitly assumed that this is the gather corresponding to the model, for which the ray-tracing was done. Please use the command <u>Seismic</u> > Highlight Traced Ray Reflections to show the ray paths in the gather.



The command <u>Seismic > Connect Ray Reflection Points</u> changes the mode of displaying reflection times in a gather (lines with captions or dots).

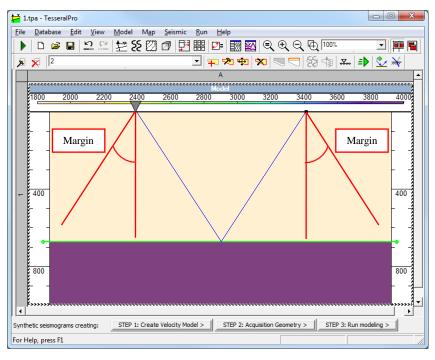
6.3 Ray-tracing parameters

Ray tracing parameters are specified in the <u>Ray Tracing</u> dialogue box, after selecting the command <u>Run > 2D Ray Tracing</u>.

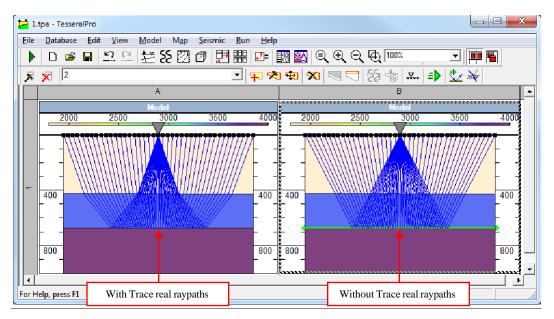
Ray Tracing	×
Reflecting boundary (polygon) 8	▼ Top ▼
Grid Cell size 4 m auto	
✓ Trace real raypaths	
Loop Diffraction points	
🔽 Separator (account the boundary overlappin	ig)
Margin, angle of 10 degree	
Hade err, angle of 7 degree	
Wave type PP 💌	
Sources	
Every (source) 1	Every (reciever) 1
From number 1	
To number 49 🗧 Select a	Il sources Select active source
Model ──_ Generate before ray tracing	
Grid model file C:\Sheldon\TestingOfTesse	eralPro\Run\Untitled-PQR.TGR
Time - Calculate by eikonal	Use Anisotropy
P-time file C:\Sheldon\TestingOfTesse	eralPro\Run\Untitled+TimeEKP.T
S-time file C:\Sheldon\TestingOfTesse	eralPro\Run\Untitled+TimeEKS.T
Default	OK Cancel

Main Parameters

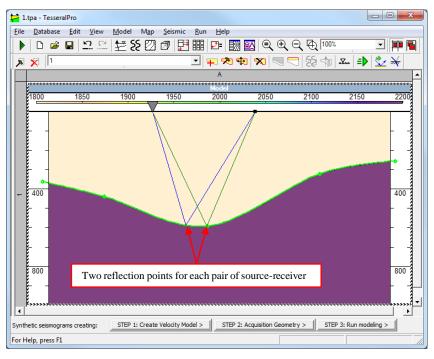
- <u>Reflecting boundary (polygon)</u> is for selecting a polygon and a reflector (top or bottom).
- <u>Grid Cell size</u> is for specifying the grid size. The bigger is the value, the faster is the calculations and the lower is the accuracy of the raypath.
- <u>Margin</u> is the maximum deflection angle.
- <u>Hade err</u>, <u>angle of</u> is the allowed deviation of the reflection angle from the incidence angle (i.e. allowed deviation of the law of reflection).



• <u>Trace real raypaths</u> is for calculating the actual raypath from the source to the reflector and then back to the receivers.



- <u>Separator (account the boundary overlapping)</u> If the boundary is fragmented by the overlapping polygons, the calculations for each piece of the boundary are done separately for all receivers and sources. and they ray paths for each compartment will be colored differently.
- $\underline{\text{Loop}}$ Up to 3 reflection raypaths are calculated for each pair of source and receiver.



- Group <u>Sources</u> Please select the sources for which you would like to run the ray tracing. The parameter <u>Every (receiver)</u> determines the step in receivers for each source.
- Group <u>Time: P-time file</u>, <u>S-time file</u> For the ray tracing, you can use the files of travel time that were previously calculated by any finite-difference modeling method (the command Run > Run modeling).
- <u>Use Anisotropy</u> Please check it if you want to take into account the anisotropy during the ray tracing.

NOTE: The anisotropy parameters are specified in the dialogue box for specifying the parameters of the model layers. Please select the command <u>Model > Edit Polygon</u>, and then in the dialogue box <u>Polygon Properties</u>, click the button <u>Anisotropy &</u> Other Properties.

- Group <u>Model</u> By default, the option <u>Generate before ray tracing</u> is checked because calculation of the model may be long (if the velocity for the model polygons is calculated by well log curves). If the model has not been changed since the last ray tracing or modeling, the new model calculation is not required and you may leave the checkbox Generate before ray tracing unchecked.
- The button Default is to set the default parameters and file names automatically.

7 3D Seismic Survey Design and Planning

3D survey design in Tesseral Pro can be done manually or a survey can be loaded from standard SPS-file.

7.1 3D survey

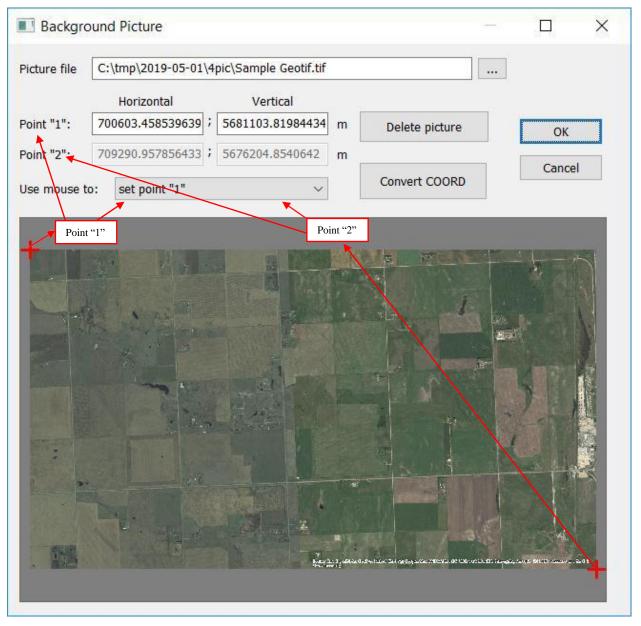
First of all you need to create a frame Map with topographic background taken from picture (see 7.1.1). If you create a 3D survey design manually, you should use the option <u>Map/Acquisition</u> <u>geometry</u> to choose the pattern and basic parameters for 3D survey (see 7.1.2). Use <u>Map/3D</u> <u>survey modes</u> menu command to adjust your design parameters and layout to match the real topographic map (see 7.1.3).

7.1.1 Load Map using backgroud picture.

Command: Map/Create Map (new frame).

Crea	ite new Map	×
۳.	/IZARD	וו
	Load TXT or GRD-surface files >	
	Show database WELLS >	
	Acquisition Geometry >	
	Select background PICTURE >	
	Cancel	

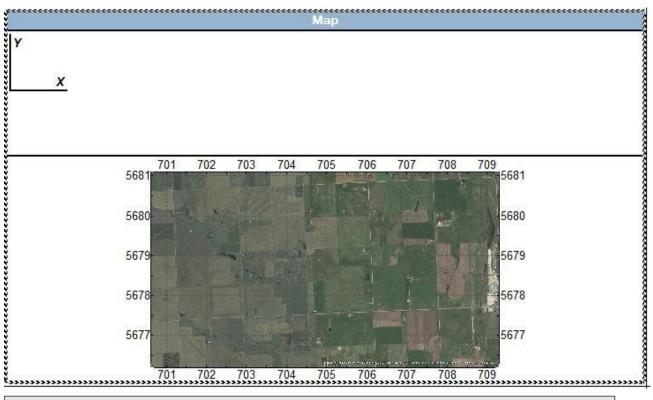
In the dialog <u>Create new Map</u>, press <u>Select background PICTURE</u> or <u>Load</u> <u>TXT</u> or <u>GRD-surface files</u> (see section 14 for the latter). Choose the picture file with the desired topographic map. Tesseral Pro supports the following picture formats: BMP, JPEG, TIFF, GEO-TIFF, GEO-JPEG with coordinates in TFW, JGW files.



You need to input coordinates for two base points in the <u>Background Picture</u> dialog to align this picture with the real topographic map. You can move these points manually in the lower part of this dialog using the mouse. For example, when you click mouse and choose <u>Point "2"</u>, the <u>Horizontal</u> and <u>Vertical</u> edit boxes become enabled for inputting applicable coordinates. The same will be true for Point "1".

If the picture coorditate system is different from the project one, specify it using the dialog called by the button <u>Convert</u> <u>COORD</u>.

The result:



NOTE: Please remember that map axis's orientation can be specified in the <u>File/Project Properties</u>dialog:

Project properties
Units of Measure Distance m velocity m/s velocity kg/m^3 v
Select Fields for the Project (for Map Frames)
[65535] General (m) [65535] Gorobcivskoje (it)
Coordinate System
If you change either the aves orientation or the selected field out all maps are removed from the project. You will need to calculate or import them again.
GeoRuler Parameters
Reference Point Coordinates :
Easting of Point (m) 0 Northing of Point (m) 0
Central Meridian of the Projection (degrees)
Ellipsoid WGS84 (GPS) 👻
OK Cancel

In Tesseral Pro the background picture for the map cannot be rotated to 90°, but it can be mirrored in relation to vertical/horizontal axis (flipped). Because of that, you put coordinates of base points in <u>Background Picture</u> dialog not as X and Y values, but as a distance along vertical and horizontal axis.

To add more background pictures and/or specify their coordinates select a frame Map by left mouse button click and call the command <u>Map/Edit Frame Properties</u>. In the <u>Map Properties</u> dialog press the <u>Background Picture</u> button in the <u>Background</u> group:

Properties	6		
Edit top title	Size Width 363 mm	Font	Work area
Edit bottom title	Height 146 mm	Palette Background	Project Properties and Coordinate orientation
ayers			Geographic Coordinate System
Active Layer		\sim	🗸 Draw Ruler
Show Grid (fill color)			✓ Draw Grid Cartesian Coordinate System
✓ Draw Isoline	Font height (%) 90 🛓	Properties	Draw Ruler
Show values in the well	Font height (%) 80 🛓	Color	Draw Grid
atabase wells		Background	
Well Title At collar	~	Show pic	ture Background Picture
✓ Draw Well Inclinometry	Inclinometry Properties	Show ge	o map
Draw Log	Log Properties	Acquisition Ge	ometry
eismic plan view		Draw	Survey Geometry
Draw Seismic frames plan		Scale : Ye	s ~ Source Receiver
Draw sources from seismic	file Load		

In the appeared dialog one can select and setup one or several background pictures:

Background Pictures (Maps/Photos)	×
C:\tmp\2019-05-01\4pic\Sample Geotif.tif	
C:\tmp\2019-05-01\4pic\Sample Geountin	
Add Edit Remove Remove all OK Canc	el

Multiple pictures (usually either 2 or 4) are used at the junction of cards or photos.

If you want to hide the background picture and not show it in frame <u>Map</u>, you should use Frame Map Properties, and uncheck Show Picture.

To remove background picture press <u>Background Picture</u> and then click either <u>Remove</u> or <u>Remove</u> All.

Now you can use the created Map frame for the 3D survey design.

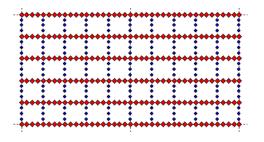
7.1.2 Choose 3D survey design.

Select the Map/Acquisition Geometry menu command.

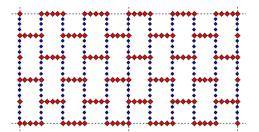
Acquisition Geometry				\times
Type of 3D survey design	3D Survey Layout	Recording Patch	Survey bearings	
	O VSP Azi	muthal	O Marine Flank	
O Template Repeat	O VSP Rad	dial		
	O VSP (1 :	source)		
O Shot in Brick Pattern	O VSP (for	rm SPS)		
⊖ Cross	VSP Ort	hogonal		
○ Load Survey from SPS ○ Load Survey from SGY		SPS-files > Seg-Y file >	Add to current geometry	:
	ОК	Отмена	рименить Справ	вка

Tesseral Pro can support different types of 3D survey design.

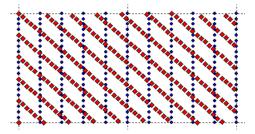
1) Orthogonal



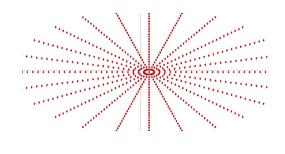
2) Shot in crankshaft pattern



3) Diagonal

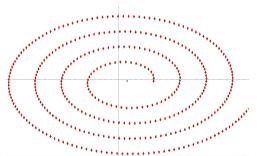


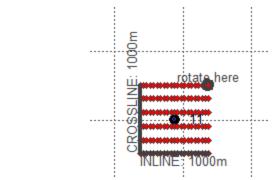
- 4) Load survey from SPS-files (see 7.1.8)
- 5) Load from SGY-files (see 7.1.8)



6) VSP azimuthal

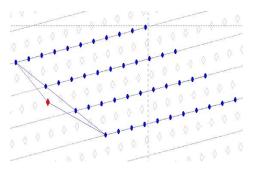
7) VSP radial





8) VSP orthogonal

9) Marine flank (see 7.1.3)



including the "flip-flop" type:

i second	
	1
• • • • •	• • • • • • •
1	· · · · · · · · · · · · · · · · · · ·
	• • • • • • • · · · · · · · · · · · · ·
· · · · · · · · · · · · · · · · · · ·	
1	
\@ • • • •	
· · · · · · · · · · · · · · · · · · ·	$\bullet \bullet $
/* * * * *	· • • • • • • •
a	
· · · · · · · · · · · · · · · · · · ·	
· · · · · · · · · · · · · · · · · · ·	
· · · · · · · · · · · · · · · · · · ·	• • • • • • • •
· · · · · · · · · · · · · · · · · · ·	
× · · ·	
· · · · · · · · · · · · · · · · · · ·	* * * * * * * /
· · · · · · · · · · · · · · · · · · ·	· • • • • • • •
· · · · · · · · · · · · · · · · · · ·	
V	
@	
· · · · · · · · · · · · · · · · · · ·	

...and several other.

In the <u>3D</u> Survey Layout tab you can specify the increment between Shot and Receiver Lines and their stations.

cquisition Geometry				>
Type of 3D survey design	3D Survey Layout	Recording Patch	Survey bearings	
Shots				
Line increment	200 m		·0	
Station increment	50 m	✓ NoSh	π	
Receivers				
Line increment	200 m	Depth of Recordin	g 2000 m	
Station increment	50 m			
	ОК	Отмена П	рименить Справ	ка

NOTE: the additional parameters right from the first column of increments depend on the survey type.

In the <u>Recording Patch</u> tab you can specify the number of receivers engaged with every shot. In <u>Inline receivers group</u> and <u>Crossline receivers group</u> you can specify the number of receivers nearest to a shot which fall into this group. If you choose the <u>By Distance</u> group you need specify the <u>Radius of the circle</u> which will enclose all receivers around the shot point.

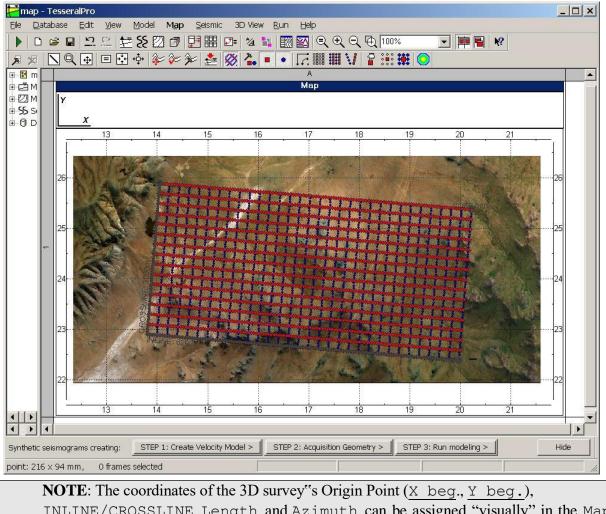
Acquisition Geometry	
Type of 3D survey design 3D Survey Layout Recording Patch Survey bearings	
C By group	
Inline receivers group	๖๏ํ๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛
Crossline receivers group 20	
By distance Radius of the circle 1000 m	≥qq
Use mask	
OK Cancel Apply Help	รจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้ วิจังกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้งกรจุ้ง

NOTE: You can design recording patch of any shape using options <u>Remove</u> <u>Receivers from Shot</u> and <u>Add Receivers to Shot</u>. These options can assign receivers to a recording patch. In this case the <u>Recording Patch</u> dialog of the <u>Acquisition Geometry</u> you can click <u>Use mask</u>, and <u>Inline receivers</u> <u>group</u> and <u>Crossline receivers</u> group will be ignored and a newly designed recording patch will be used for the whole survey.

In Survey bearings you can specify the dimensions and direction of 3D survey.

Acquisition Type of 3		ign 3D Su	vey Layout Rec	ording l	⊃ _{atch} Sur	vey bearings		×
ORIG	ain (0:0):	Xbeg.	13800	m	Ybeg.	22900	m	
INLIN	IE:	Lenght	6200	m	Azimuth	-4.8	deg	
CROS	SSLINE:	Lenght	3000	m	Azimuth	+90	▼ deg	
			ОК	Cano	el _	Apply	Help	

Result:



<u>INLINE/CROSSLINE Length</u> and <u>Azimuth</u> can be assigned "visually" in the <u>Map</u> frame using <u>Map/Section Mode command</u>. Draw a profile line using left mouse button (click- draw-release) and open the <u>Map/Acquisition Geometry</u> dialog. If you are creating a 3D survey for the first time the direction of this survey will coincide with the direction of the line which you have just drawn. If you want to change the dimension or direction of an already created survey then using the mouse you need to select the command <u>Map/3D survey</u> <u>Modes/Moving with rotation</u>. See the

7.1.3 Marine surveys

For marine surveys the configuration of the source-receiver geometry can be specified in the <u>Seismic</u> system deployed from the vessel.

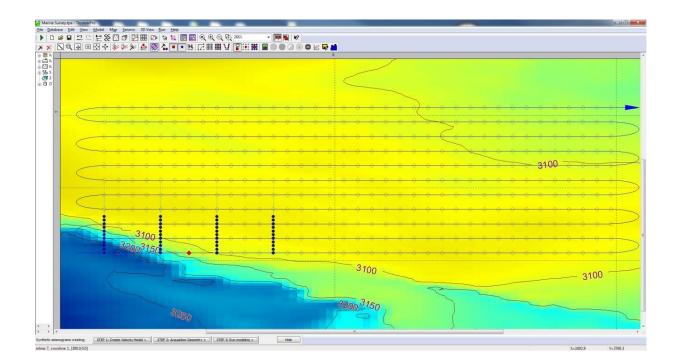
ype of 3D survey design	3D Survey Layout	Recording Patch	Survey bear	ings
Orthogonal	O VSP Azi	imuthal	Marine F	lank
O Template Repeat	O VSP Ra	dial		
ODiagonal	O VSP (1	source)		
O Shot in Brick Pattern	O VSP (fo	orm SPS)		
○ Cross	O VSP Or	thogonal		
O Load Survey from SPS	-files Select	t SPS-files >	Add to	o current
O Load Survey from SGY	-files Select	Seg-Y file >	└── geome	etry
quisition Geometry				1
quisition Geometry ype of 3D survey design	3D Survey Layout	Recording Patch	Survey bearin	
ype of 3D survey design Shots				ngs
ype of 3D survey design Shots	3D Survey Layout	Recording Patch Distance between		
ype of 3D survey design Shots Line increment				
ype of 3D survey design Shots Line increment	200 m			
ype of 3D survey design Shots Line increment Station increment	200 m	Distance between	shots 50	ngs
ype of 3D survey design Shots Line increment Station increment Receivers Distance between cal	200 m	Distance between	shots 50	ngs

The parameter <u>Distance between shots</u> is used to specify the distance between the two sources (water guns) of the "flip-flop" marine surveys. If the only water gun is used, set the distance to 0.

The <u>Free Cable</u> option allows the user to maintain the recording patch stationary for all sources along the Inline direction. The <u>Frequency of Moving</u> specifies the frequency of the recording patch displacement along the Crossline direction. For instance a frequency of 2 means that the recording patch would be displaced for every second source in the Crossline direction. The <u>Moving Step</u> is the displacement step of the recording patch along the Crossline direction for each consecutive source along the same direction. So a <u>Moving Step</u> of 200 would mean that the recording patch would be displaced 200m for every source (i.e. if the <u>Frequency of Moving</u>=1) along the Crossline direction. <u>The Start Position</u> specifies the starting position of the recording patch (i.e. the position of its lower left hand corner for a zero azimuth). So for example a <u>Starting Position</u> for <u>Inline=0</u> and <u>Crossline=0</u> means that the starting position of the recording patch would be at the lowermost left hand corner of the 3D survey, as shown below.

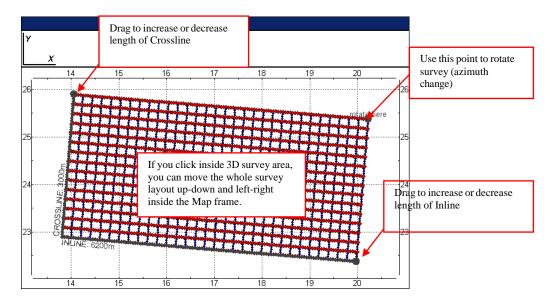
Seismic system deployed from the vessel				
Seismic cables				
Number of cables	4			
Distance between cables	200	m		
Cable length	500	m		
Step between hydrophones	50	m		
Free Cable				
Frequency of Moving	1			
Moving Step	50	m		
Start Position: Alig	in Centre)		
Inline: 0 m Crossli	ne: 0	m		
Source (air-gun) position				
Distance from the source to cables	50	m		
ОК	Can	cel		

A	Acquisition Geometry						
	Type of 3D survey des	sign 3D	Survey Layout	Record	ding Patch	Survey bearing	s
	ORIGIN (0:0):	X beg.	1180.9	m	Y beg.	1106.3	m
	INLINE:	Length	1800	m	Azimuth	o	deg
	CROSSLINE:	Length	2100	m	Azimuth	+90 🔻	deg
	L		ок	Cano	el	Apply	Help



7.1.4 Move and Rotate 3D survey.

The <u>Map > 3D</u> survey <u>Modes > Moving with rotation</u> command is used to correct the 3D survey positioning on a map. Use left mouse button (click- drag-release).



Another mode of the survey move is its vertical projection on the day surface, a selected horizon or a plane of the specified depth. The $\underline{Map} > \underline{Set Shot/Receiver Depths}$ command is used to implement the operation:

Set Shots/Receivers	Depth		\times
	✓ Shots	Receivers	
• Fixed depths :	0	0	
O Depth from map :	D3 : Bottor	n	\sim
Positions in Plan	g (fixed XY)	• station chaining (XY can change)	
	ОК	Cancel	

There are two methods of the vertical shift: the <u>station projection</u> preserves horizontal coordinates of the stations when the <u>station chaining</u> limits max distance between the neighbor single line stations along the target surface and hence may shift the stations along the line.

7.1.5 Edit Shot and Receiver Stations.

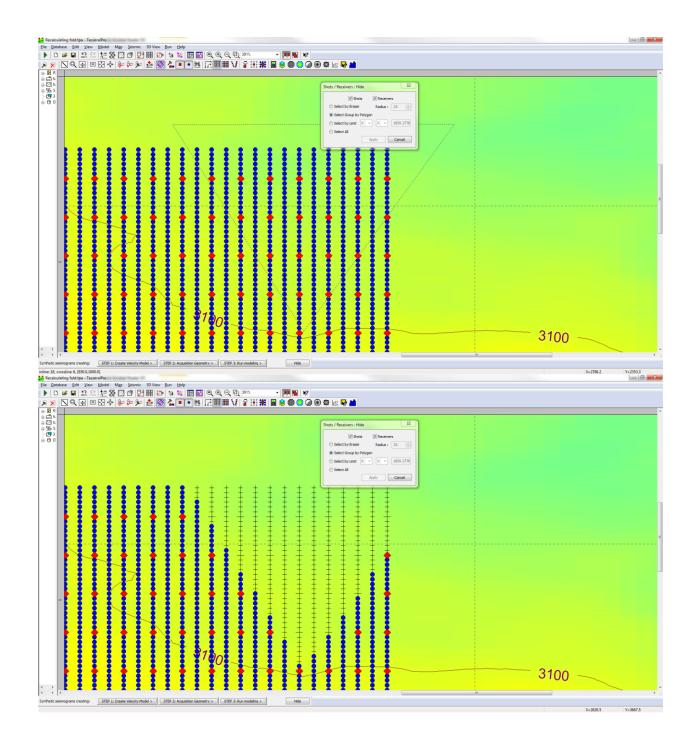
Option Map/3D survey Modes/Hide is used to hide not needed shots or/and receivers from a 3D survey.

Shots / Receivers : Hide X					
Shots Receivers					
Select by Eraser	Radius 15				
O Select Group by P	olygon				
◯ Select by Limit	X v > v 703499.25				
O Select outside of	[ромб.txt]				
◯ Select inside of	[ромб.txt]				
O Select All					
	Apply Cancel				

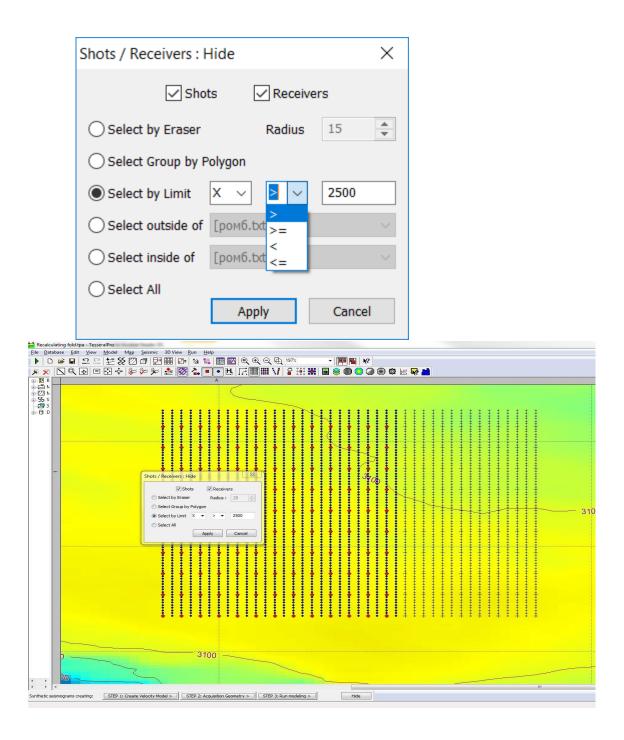
The user has the option to hide shots and receivers by $\underline{\texttt{Eraser}}$ (where the eraser is in the form of a circle with a specified <u>Radius</u>) by pressing the left mouse button, holding it and selecting the area which is to be hidden. Hidden shots/receivers will not take part in the following 3D survey design. Hidden shots and receivers will be not shown on the Map frame in most the edit modes. In some modes they are by default shown grayed and crossed. The icon color, size and form can be fitted in the frame parameters dialog.

For <u>Select Group by Polygon</u> a polygon needs to be drawn and all the shots and receivers inside it will be hidden. In order to implement it simply use the left click mouse button to draw a polygon around a group of shots and receivers. To start over the drawing click the right mouse button. Once the polygon has been drawn, double click the left mouse button and all the shots and receivers in the polygon will be hidden.

Similar options <u>Select outside of...</u> and <u>Select inside of...</u> use predefined polygons from the selected static layer.

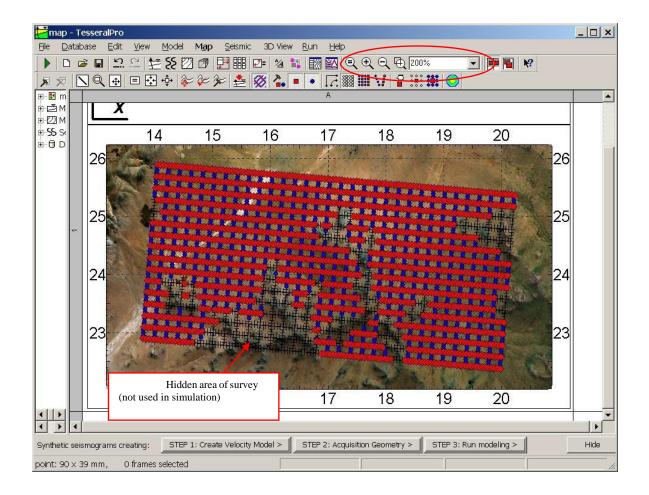


You can also hide shots and receivers by specifying a limit along the X and/or Y axis:



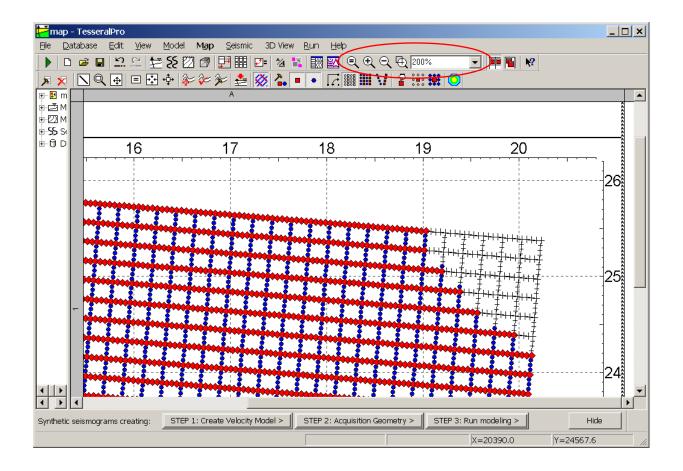
Use <u>Select All</u> to hide all shots and receivers.

If you want to bring hidden shots/receivers back into survey you need to use option Map/3D survey Modes/Show. The same methods for showing shots/receivers apply.



NOTE: If you want to use options <u>Hide/Show</u> separately for shots and receivers (for example, to hide a group of shots, but to leave receivers there), you need to check <u>Map/Show</u> <u>Shots</u> or <u>Map/Show</u> <u>Receivers</u> respectively. As a result shots or receivers will not be shown in the Map frame, and editing will be possible only for shown elements (shots or receivers).

In order to increase or decrease the editing precision use the scaling option in the View/Zoom command.



By default the icons of sources and receivers (together called stations) are scaled by zoom like other graphic elements. For better resolution, however, it is sometimes useful either completely cancel the station scaling or significantly decrease its relative speed. It is done in the frame parameter dialog:

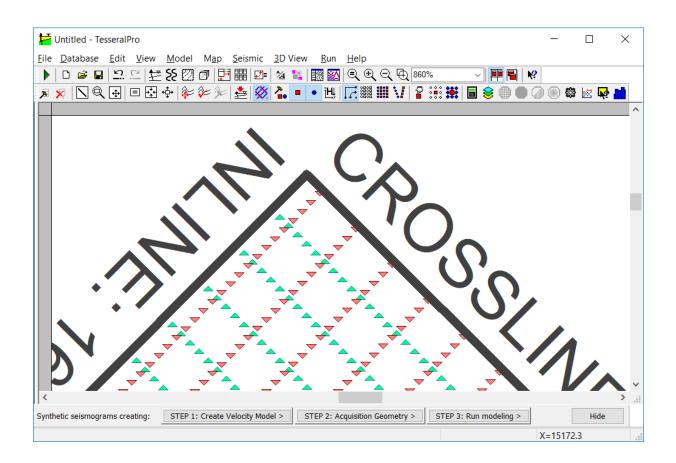
ap Properties			
Edit top title Edit bottom title	Size Width 153 mm Height 55 mm	Font Palette Background	Work area Project Properties and Coordinate orientation
Layers Active Layer		~	Geographic Coordinate System
✓ Show Grid (fill color) ✓ Draw Isoline ✓ Show values in the well	Font height (%) 90 🜩	Properties Color	└ Draw Grid Cartesian Coordinate System - V Draw Ruler V Draw Grid
Database wells Well Title At collar	V Inclinometry Properties	Background	
Draw Log	Log Properties	Acquisition Geo	ometry Survey Geometry
Seismic plan view Draw Seismic frames plan Draw sources from seismic fil	e Load	Scale Yes Sion No	Source Receiver

Here one also can setup the station icons in the dialogs activated by the buttons <u>Source</u> and <u>Receiver</u>:

Source Poi	nt Visualizatio	n Options			×	State :	Active	\sim
State :	Active	~					Active Inactive Moved Hidden	
100% :	•	200%:		•				
Symbol :	triangle down	~						
\checkmark	Line color		Line width :	0		Symbol :	triangle down	~
\checkmark	Internal color		Radius :	3			rectangle circle rhomb	
Save	as default	[ОК	Car	ncel	\checkmark	triangle up triangle down	

The button <u>Save as default</u> remembers the station settings for further projects.

Below is a sample of alternative design created by the described tools.



7.1.6 Change Direction for Shot and Receiver Lines

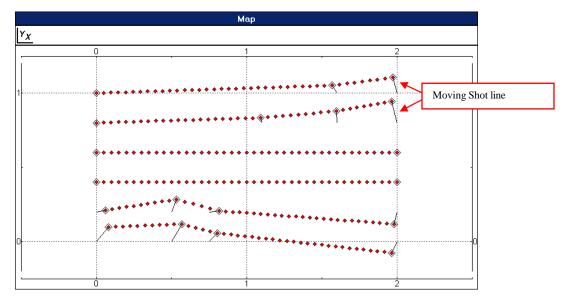
Using the menu command <u>Map/3D survey Modes/Moving Shot and Receiver lines</u> you can change the shape for Shot and Receiver Lines in order to adjust them to real land topography. In order to do that 4 types of displacements have been implemented: <u>Cable Move</u> used if you want to reposition shot/receiver lines in a cable fashion (such as orienting the shot/receiver line along a different azimuth), <u>Point Selection</u> to displace individual shot(s)/receiver(s), <u>Line Selection</u> to displace the whole line to a different position while preserving its geometry, and <u>Polygon</u> <u>Selection</u> whereby you draw a polygon around a group of shots/receivers and displace the whole group to a different position.

Moving Shots / R	Moving Shots / Receivers ×			
Selection Type Shots Receivers Cable Point Line Polygon				
Change Src/Rec	(Only VSP)			
Point:	Action :	Type:		
\sim	\sim	\sim		
From	To (y);	Step (z):		
0	0	0		
	We	ell: ~		
Select	Apply	Cancel		

The following example illustrates a Cable, and the same principle applies to selection

Point and Line modes.

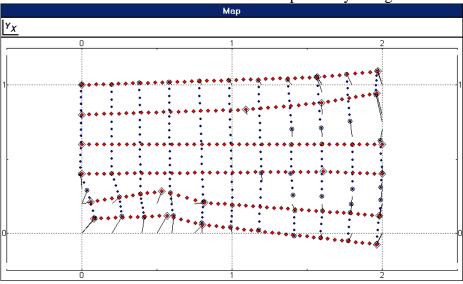
To show this example without obstacles, the background picture has been hidden (in dialog <u>Frame</u> <u>Map Properties</u> we clicked off <u>Show Picture</u>), Receivers were hidden as well (clicked off <u>Map/Show Receivers</u>).



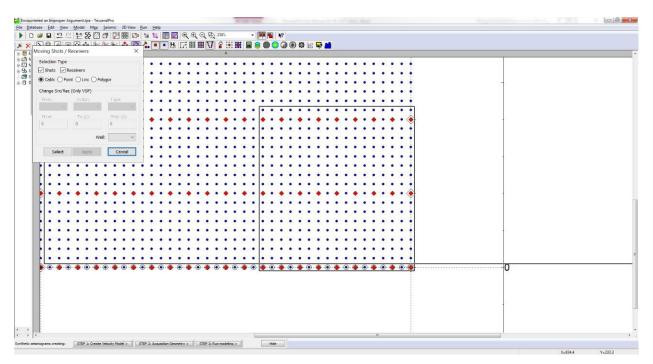
After the creation of the first 3D survey each Shot/Receiver Line has two "anchor" points which tie a line to its plane position. So you can:

- 1. Change the "anchor" position using the left mouse button (click-pull-release);
- 2. Remove an "anchor" by double clicking of the left mouse button;
- 3. Add a new "anchor" click the left mouse button at any shot point.

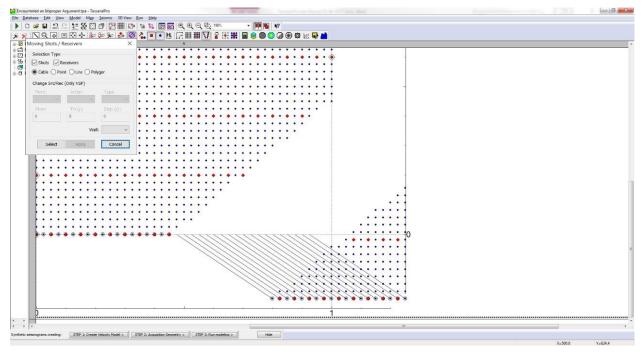
The same can be applied for Receiver Lines:



Shot and Receiver Lines can be moved independently or together:

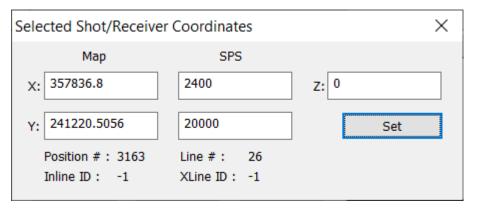


For <u>Polygon Selection</u> simply use the left click mouse button to draw a polygon around a group of shots and/or receivers. which need to be moved. Right-clicking interrupts the process of drawing a polygonal border, and double-clicking completes and saves the border drawn. After double-clicking, press the right mouse button and, without releasing it, move the mouse. The program will display the moving group as a described rectangle. Move it where you need and release the mouse button. The group will move to this place.



Station coordinates and numbers

Use the context menu command Shot/Receiver Coordinates in the Survey Line mode to show coordinates of a station selected by a left mouse button click:



The dialog is floating (non-modal) and you don't need to close it to see coordinates of another station. The coordinates can be changed and remembered by the button \underline{Set} . The change will result in moving the source or receiver in the specified coordinates.

<u>Position</u> and <u>Line</u> are formal sequential numbers that do not depend on the location of the station and inline/crossline numbers in SPS. The position number is a sequential number for continuous numbering of sources or receivers (i.e. without taking the line into account). It is not affected by either moving or deleting (or, more precisely, disconnecting) some stations. The same is true for line numbers: they are sequential and do not change if some lines are disconnected. Well, the station identification (inline/crossline numbers) in SPS is displayed by the <u>Inline ID</u> and <u>XLine ID</u> parameters. The -1 values of these parameters, which you see in the previous figure, simply mean "not defined". They are defined from the very beginning only for layouts loaded from SPS or SEGY files. Otherwise, they are set only at the time of exporting the layout to SPS.

The dialog does not disappear if you switch to another edit mode such as <u>Zoom mode</u> to increase the survey resolution. Yet it stops working until the <u>Survey Line mode</u> is restored by <u>Map > 3D Survey Edit Modes > Moving Shot and Receiver</u> Lines or the correspondent toolbar button.

7.1.7 3D recording patch design.

First of all you need to specify a recording patch for each shot in <u>Map/Acquisition</u> <u>Geometry</u> dialog in the <u>Recording</u> Patch tab (see 7.1.2). <u>Inline</u> receivers group and <u>Crossline</u> receivers group parameters identify the number of nearest receivers which will be assigned to the current source.

You can change a shape of recording patch using mask and apply it for the entire survey. First of all you need to choose a source in the middle of the survey. In <u>Map/3D survey</u> <u>Modes/View Relation</u> menu command click the selected shot point. The chosen Shot will be highlighted with a red dot, the rest of shot points will be shown as grey dots. Receiver points associated with the chosen source will be colored in blue and the rest receivers will be grey:

The Database Edit Man Cabric CD Man Data Hile
File Database Edit View Model Map Seismic 3D View Run Help
▶ ▷ ☞ ■ 끄 끄 粒 ჽჽ 껪 ๗ 閉 ▦ ഈ ◾ 図 옷 옷 옷 및 200%
🕫 🛪 🖎 🗨 🖬 🖆 🌮 🌮 🎾 🚣 🧭 💊 🔹 🔹 💽 🗔 🎬 🎬 🚺 🔓
A A
Synthetic seismograms creating: STEP 1: Create Velocity Model > STEP 2: Acquisition Geometry > STEP 3: Run modeling > Hide
inline: 63, crossline: 9, [3100.0,1600.0] X=16373.5 Y=22843.5

You can add or remove receivers around this shot point by using <u>Map/3D</u> survey <u>Modes/Remove</u> <u>Receivers</u> from Shot and <u>Map/3D</u> survey <u>Modes/Add</u> <u>Receivers</u> to Shot commands. These two commands behave similarly to the <u>Hide/Show</u> command (click-drag-release).

Example:

<mark>≓map - TesseralPro</mark> File <u>D</u> atabase Edit <u>V</u> iew I	Model M <u>ap S</u> eismic 3D View	<u>R</u> un <u>H</u> elp		_ 🗆 🗙
	Model Map Seismic 3D View		% 🔽 ẽ 📲 📢	
	∲ ∻ ≫ ≫ ≛ 🕺 👍 ■			
	·T· ♣ ♥ 𝒫 至 <u>%</u> '■● ■	A	*** <u>♥</u>	
■ Ē M				
		ĸġĸĸġĸġĸġĸġĸġĸġ	÷÷÷÷÷	
				•
Synthetic seismograms creating:	STEP 1: Create Velocity Model >	STEP 2: Acquisition Geometry >	STEP 3: Run modeling >	Hide
inline: 47, crossline: 10, [2300.0,18	300.0]		X=18752.8	Y=23021.0

Now you can pick any source in <u>Map/3D survey Modes/View Relation</u> and the group of receivers allocated for that source will have identical shape. At the same time the <u>Acquisition</u> <u>Geometry</u> dialog in the <u>Recording Patch</u> tab the "Use mask" checkbox will be automatically enabled:

Acquisition Geor	metry	1 4		×
Type of 3D surv	vey design 3D Survey Layout	Recording Patch	Survey bearings	
[—C By group ———			
	Inline receivers group	20 🚊		
	Crossline receivers group	20 📩		
	By distance Radius of the circle	000 m		
(Use mask			
	ок	Cancel	Apply	Help

In other words, the receiver patch is specified by the mask which has been shaped manually but not by parameters Inline (Crossline) receivers group.

7.1.8 Load survey from SPS-files.

Here is another useful way to create 3D survey using standard SPS-format. You can use the same command Map/Acquisition Geometry.

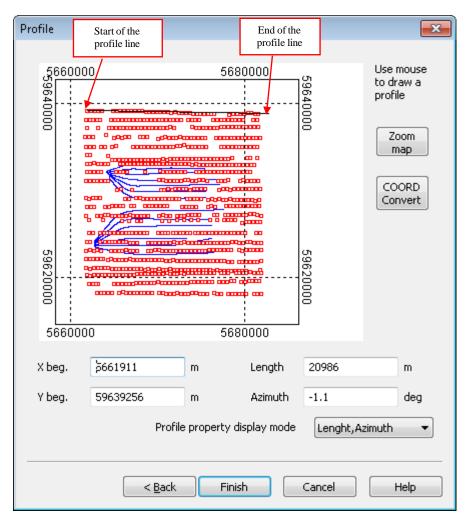
Acquisition Geometry Type	—
WIZARD	
Orthogonal >	
Template Repeat >	
Shot in brick pattern >	
Diagonal >	Z
Cross >	
VSP azimuthal >	
VSP radial >	
Marine Flank >	[* . .*]
From SPS-file >	
From SGY-file >	
(Cancel

Select Load survey <u>from SPS-file</u> and press the <u>Select SPS-files</u> button. In the next dialog load the SPS-files for shots, receivers and their relation file.

Load survey specification from files	×
Survey File Format: auto detection	
auto detection SPS 1 SPS 2 SEG SP File of Sourc KML TXT D:\People\VN\2.s01 Shape P1/90 P1/11	
File of Receivers D:\People\VN\2.r01	
File of Shot-Receiver Relation D:\People\VN\2.x01	
Sea observations	
< Back Next > Cancel Help	_

Check <u>Sea</u> observations if the SPS describes a marine (offshore) survey.

Press $\underline{\texttt{Next}>}$ and the next dialog with the 3D survey loaded from these SPS-files will be displayed.



You need to input coordinates for the ORIGIN point and the INLINE Length and Azimuth in this dialog. This line is needed to make it easier to move and rotate the 3D survey which has been loaded from SPS files. It is recommended to use mouse to draw the line on the map (click- drag-release). You do not have to be precise with line drawing.

You can zoom in this picture by pressing the <u>Zoom map</u> button to view it at a bigger

scale.

There is also an ability to specify the SPS coordinate system different from the project

one. It is implemented by pressing the button <u>COORD</u> Convert:

Coordinate conversion	×
✓ Coordinate conversion To system	
Input coord system	
● XY O GRAD	
Input Parameters of Geographic Coordinate System	
Reference Point Coordinates :	
East of Greenwich 0 North of Equator 0	
Central Meridian of the Projection 0	
Ellipsoid WGS84 (GPS)	
WGS84 (GPS) NAD83 (GRS 80) NAD27 (Clarke 1866)	
ETR289 SK-42 (Krasovsky ellipsoid)	
PZ-90 (GLONASS) GSK-2011	

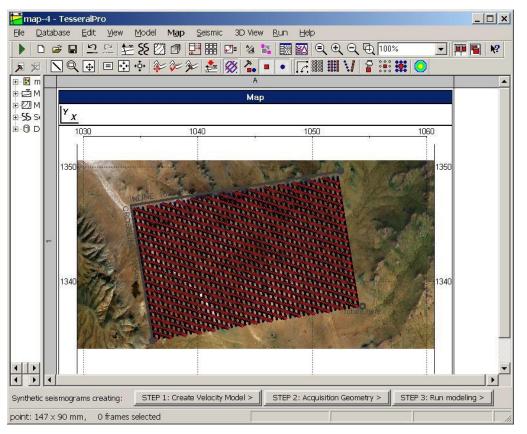
The dialog is similar to the one used in File / Project Properties to specify the project coordinate system.

As soon as you finish loading the SPS-files, you will be prompted to <u>Acquisition</u> Geometry dialog.

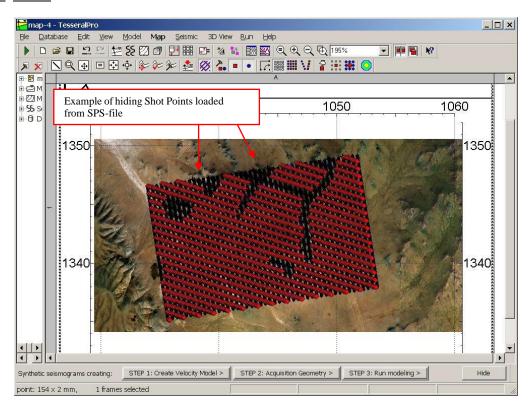
The 3D <u>survey Layout and Recording Patch</u> tabs will not be used when you proceed with the <u>Load survey from SPS-files</u> option. In the <u>Survey bearings</u> tab the dimension parameters will be ignored but the 3D survey geographical parameters are necessary:

INLINE: Lenght 18588 m Azimuth 8.8	deg
CROSSLINE: Lenght 11954 m Azimuth -90	💌 deg

Result:



You can edit survey loaded from SPS-files using the commands Moving with rotation, Hide, Show:



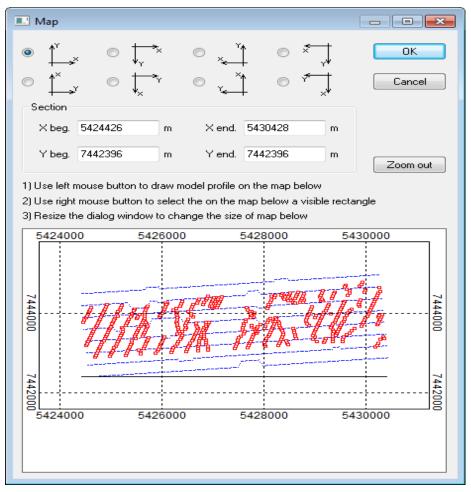
7.1.9 Load survey from SGY-files.

There is also the option of loading the seismic survey from synthetic seismogram in SGY format.

Acquisition Geometry				- ×
Type of 3D survey design	3D Survey Layout	Recording Patch	Survey bearings	
Orthogonal				
Shot in brick pattern				
Diagonal				
VSP azimuthal				
VSP radial				
Load survey from SPS	-files Select	SPS-files >		
Load survey from SGY	-files Select	Seg-Y file >		
	ОК	Cancel	Apply H	elp

Select Load survey from SGY-files and press the <u>Select SGY-files></u> button

button.



7.1.10 3D survey export to SPS-files.

The 3D survey created in the <u>Map</u> frame can be exported into standard SPS format. To do this use the <u>Map>Export to SPS</u> menu command. Select a source file name, and the receiver and relation files will be created automatically. As the result you will have three SPS files:

- S01 source; R01 receivers;
- X01 relation file.

Save Survey to Files	×
Output file path :	
C:\temp\2021-09-15\sps\test0	02.s01
SOURCE Numbers in the Outp	ut Files
Apply next numbering :	O Use imported numbers
Line Numbers	Station Numbers
start : 2001	◯ end-to-end serial numbers
Start, 2001	inline numbers:
step: 40	start : 101 step : 10
RECEIVER Numbers in the Out	tput Files
Apply next numbering :	O Use imported numbers
Line Numbers	Station Numbers
start : 101	◯ end-to-end serial numbers
start, 101	inline numbers:
step : 40	start : 2001 step : 10
	OK Cancel

Furthermore, it is possible to assign inline/crossline numbers (different from the standard n=1, 2, 3, 4, 5...) to the shots and receivers in the exported SPS file. In order to do it, select <u>Apply next</u> <u>numbering</u> for sources and/or receivers. Then specify the <u>Line Numbers</u> and the <u>Station</u> <u>Numbers</u> separately for sources and receivers. Set the values which correspond to each other, so that if a source and a receiver are located in the same position, the shot line number is the same as the receiver station number and the shot station number is the same as the receiver line number.

7.1.11 3D survey export to KML-file.

The 3D survey created in the <u>Map</u> frame can be exported into standard KML format, which is the format used for displaying objects used by Google Maps. To do this, please use the <u>Map/Export 3D</u> <u>Survey to KML</u> menu command.

SP	S File Sav	e	×
	File name	Test-1	
	Paramete	rs of Geographic Coordinate System	
	Ellipsoid	WGS84 (GPS) 🔹	
	Zone	2 (from 1 to 60)	
i			
	Referenc	e Point Coordinates :	
	East of G	ireenwich (m) 0 North of Equator (m)	0
	Central M	feridian of the Projection (degrees)	
		ОК	Cancel

Choose a name for the output KML files, the reference <u>Ellipsoid</u>, as well as the zone number. As the result 2 KML files will be generated:

Sources.kmz and Receivers.kmz;

7.1.12 Manage Static Layers.

In the map frame it is also possible to import static layers (i.e. spot boundaries) strictly for visual purposes. The importation can be done from text file using a simple format: coordinates X and Y, then the line number (as shown below). As well static layers are loaded from shapefiles and DXF (Autocad) format files.

🗐 sta	atic lay	yer-2.txt	- Not	epa	d
<u>F</u> ile	Edit	F <u>o</u> rmat	: <u>V</u> i	ew	Help
50		50	1		
100		100	1		
150		150 200	1		
250		250	1	-	
300		300	1	-	
350		350	1		
400		400	1		
450		450	1		
500		500	1		
550		550 600	1	-	
650		650	1	-	
700		700	1	-	
750		750	1		
800		800	1		
850		850	1		
900		900	1	-	
950		950 1000	1		
1050		1050	i	-	
1100		1100	1		
1150	•	1150	1		

In order upload a Static Layer select <u>Map > Manage Static Layers > From</u> File. The program shows dialog which allows one to specify the static layer coordinate system if it is different from the one of the project (to do it check <u>Coordinate conversion To system</u> and specify other coordinate system parameters of the imported file):

Coordinate conversion	×
Coordinate conversion To system	
Input coord system	
● XY ○ GRAD	
Input Parameters of Geographic Coordinate System Reference Point Coordinates :	
East of Greenwich 0 North of Equator 0	
Central Meridian of the Projection 0	
Ellipsoid WGS84 (GPS) ~	
ОК	

After importing the static layer you can select <u>View</u> and edit the properties of the line.

Static Layers	/	
Loads Static Layers:	<u>N</u> ame	<u>R</u> eload
	From File	
	Delete	<u>C</u> lose
Isolines Properties Lines Width: 5	Example	
_	© ////	
ОК	Cancel	

You can also rename it (using <u>Name</u>), add an additional static layer (<u>From File...</u>) or delete any of them (by selection in the list and using <u>Delete</u>).

The button \underline{Info} shows the area covered by the selected static layer:

Static Layers	Info	×
[Settlem	ents.shp]	
Xmin	11977620	
Xmax	12009904	
Ymin	-5658239.5	
Ymax	-5629376	
✓Set t	o Work Area	
		OK Cancel

If before <u>OK</u> one checked <u>Set to Work Area</u> then after exiting the Manage Static Layer dialog the map area will be changed by the static layer rectangle.

Once done, press <u>Close</u> and click mouse in the map frame. The new/edited static layers will appear in your map.

7.2 Coordinate Reference Systems Options

Please note that multiple coordinate reference systems are available in the frame <u>Map</u>, and they are based on the following ellipsoids: WGS-84 (GPS), NAD-83 (GRS), NAD-27 (Clarke 1866), ETRS-89, SK-42 (Krasovsky), PZ-90 (GLONASS), GSK-2011.

In order for the chosen reference coordinate system to be displayed, it is necessary in the <u>Map> Map</u> <u>Frame Properties> Project properties...</u> to set non-zero coordinates for <u>Easting</u> and <u>Northing of Point</u> (i.e. upper right hand corner of the map) for the chosen <u>Ellipsoid</u>. And also to set a value for the <u>Central Meridian of the Projection</u> (degrees) of the ellipsoid, which is conventionally set to zero.

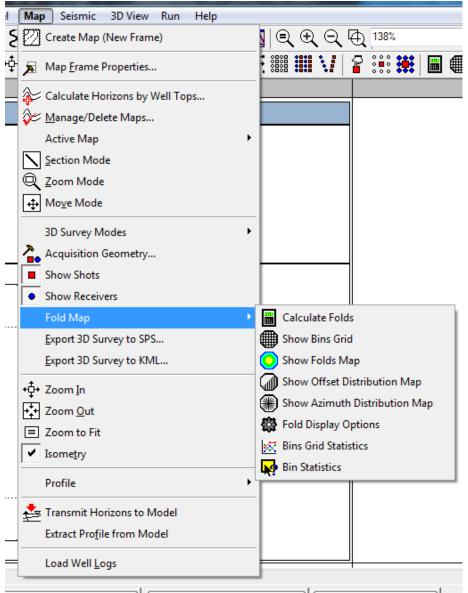
Project properties	×
Units of Measure Distance m velocity m/s Density kg/m^3 v	
Select Fields for the Project (for Map Frames)	
[65535] General (m) [65535] Gorobcivskoje (ft)	
Coordinate System	
If you change either the axes orientation or the selected field set, all maps are removed from the project. You will need to calculate or import them again.	
GeoRuler Parameters	1
Reference Point Coordinates : Easting of Point (m) 0 Northing of Point (m)	
Central Meridian of the Projection (degrees)	
Ellipsoid WGS84 (GPS)	
(OK) Cancel	

7.3 Survey planning

7.3.1 Fold Map menu and toolbar.

The planning can be accessed in one of two ways:

1) In the tab manu Map => Fold Map



D. 1: Create Velocity Model N CSTED 2: Acquisition Cennetry N CSTED 3: Dun modeling N

2) In the quick access toolbar



The following attributes can be displayed for any 3D seismic survey:



Fold Calculation Properties

- Displaying all bins by selecting Show Bins Grid



- Displaying the fold by selecting Show Fold Map



Displaying the offset distribution histogram for every bin by selecting Show Offset Distribution Map



Displaying the azimuth distribution for every bin by selecting Show Azimuth Distribution Map



Setting the display mode for the map by selecting Fold Display Options



Displaying the survey bin statistics by selecting <u>Show Bins Grid</u> <u>Statistics</u>



- Displaying the information for a particular bin by selecting <u>Show</u> <u>Selected Bin Information</u>



Showing graphical statistics for the fold map by selecting <u>Show</u> <u>Plot Statistics</u>

7.3.2 Fold Calculation Properties

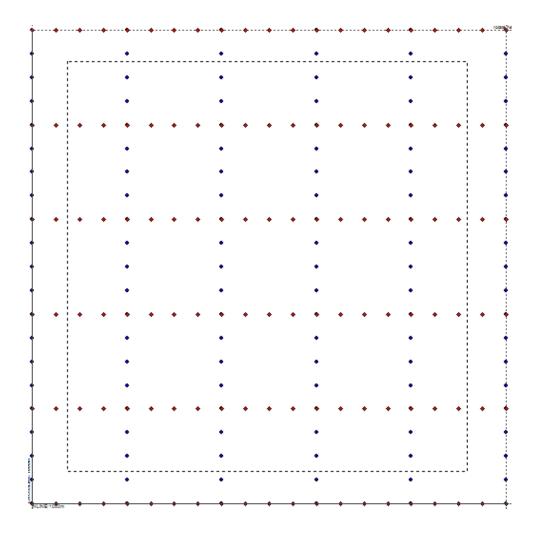
Fold Calculation Properties	
Bin Size	Recording Patch
Inline Bin Size 25	Relations from SPS-File
Crossline Bin Size 25	O By Group
Inline Bin Count 40	Stations Count 20
Crossline Bin Count 40	Line Count 5
	By Distance
Auto Fit	Circle Radius 500
Extent	Limits
Тор	From To
Left 1000 Right	Offset 0 559.01696
0 1000	Azimuth 0 🚔 359 🚔
0	
Bottom	Make Offset/Azimuth Limits Exclusive
All Mouse Selection	
	OK Cancel

The dialog is divided into four parts:

First <u>Bin Size</u>, where you can adjust the size of the grid for calculation. There are three ways to do it: the first - to set the length (<u>Crossline Bin Size</u>) and the width (<u>Inline Bin Size</u>) of the bin, the second - set the number of bins in the X (<u>Inline Bin Count</u>) and Y (<u>Crossline Bin Count</u>) direction of the planning area and the third - automatic calculation (<u>Auto Fit</u>). In this case the length of the bin is equal to half the distance between the receivers and the width equals half the distance between the sources.

<u>Second</u>, using <u>Extent</u>, you can set the scope of the calculation, i.e. determine which sources and receivers will not be included in the calculation. This can be set in three ways: to fill in the appropriate fields by clicking (<u>All</u>) - to select the entire field, press the button (<u>Mouse Selection</u>) in order to select the area manually, after which the dialog box temporarily closes in order to allow the user to select the boundaries with the mouse.

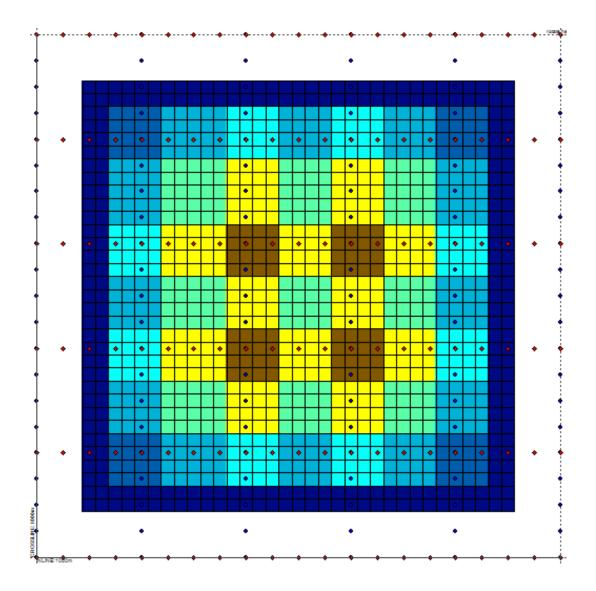
The image below, shows a selected region by Mouse Selection:



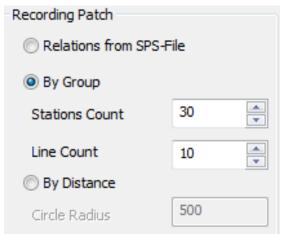
The corresponding fields displays the coordinates of the selected area:

Ex	tent		
		Тор	
	Left	841.38842	Right
	103.25131		859.84179
		161.24780	
		Bottom	
	All	Mo	use Selection

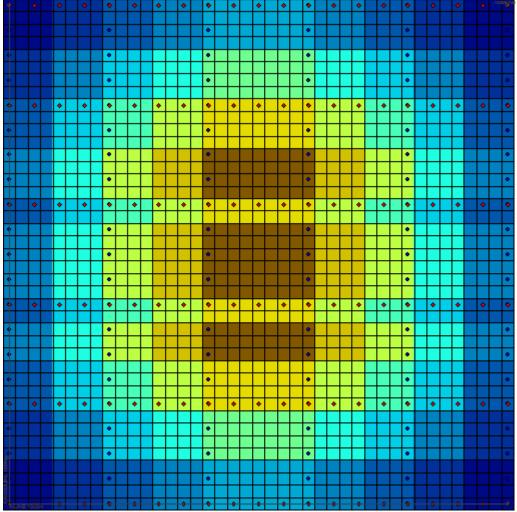
Below is the calculated **Fold Map** within the boundaries of the selected area:



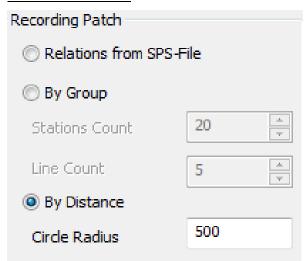
The third part of the dialog is the <u>Recording Patch</u>. It contains three different types of sourcereceiver relationships. The first one is (<u>Relations from SPS-File</u>) –which preserves the grouping from the SPS file, provided that the survey was loaded from SPS file.

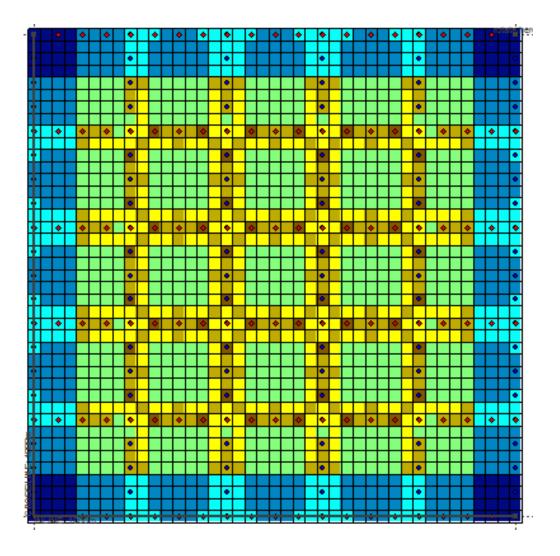


<u>The second method</u> (By Group) - set the number of receivers per line (<u>Stations</u> <u>Count</u>) and the number of lines (Line Count). The above 30/10 scheme produces the following image:

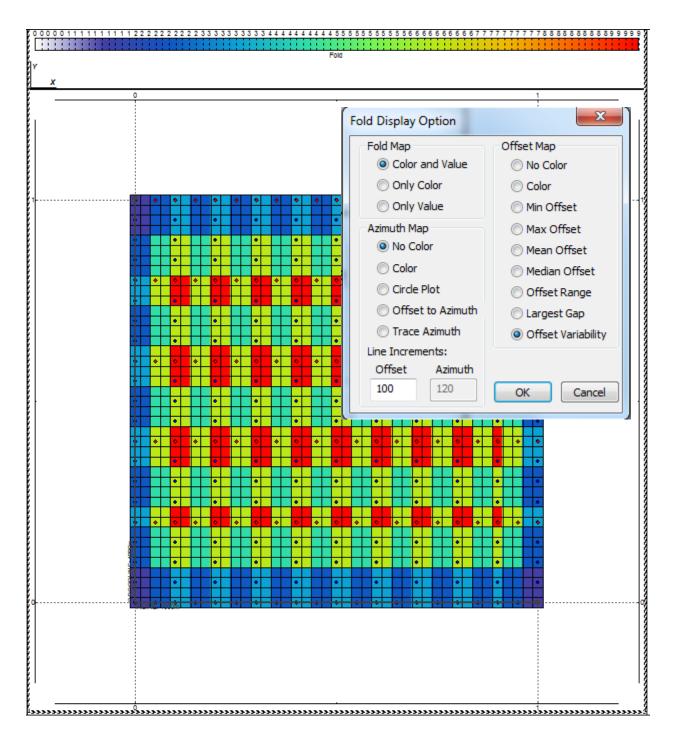


The third method (<u>By Distance</u>) - which assigns receivers for every source within a specified Circle Radius





The fourth part of the dialogue is the <u>Limits</u> - with which you can limit the <u>Offset</u> and <u>Azimuth</u> for source-receiver pairs that are included in the fold calculation. If the box (<u>Make Offset /</u> <u>Azimuth Limits Exclusive</u>) is not enabled then only sources/receiver pairs <u>From <=</u> <u>Offset / Azimuth <= To</u> will take part in the fold calculation. If enabled, then only source/receiver pairs <u>From></u> Offset / Azimuth> To will be included.

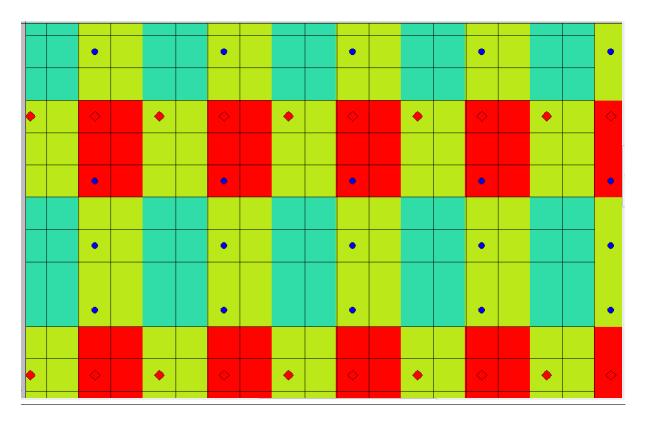


Fold Display Option - Dialog for setting the display mode for the calculated attributes (Fold, Offset and Azimuth).

For <u>Fold Map</u> there are different types of displays: <u>Color and Value</u> – Fills the bins with the appropriate colour from the colour bar and also displays their values.

4	,	6	4	4	•	б	4	4	•	6	4	4	9	6	4	
4	6	6	4	4	6	б	4	4	6	6	4	4	б	6	4	
6	\diamond	9	•	6	\diamond	9	٠	б	\diamond	9	•	6	\diamond	9	٠	
6	9	9	6	6	9	9	6	6	9	9	6	6	9	9	6	
6	9	9	6	6	9,	9	6	6	9,	9	6	6	9	9	6	
4	б	6	4	4	6	б	4	4	6	б	4	4	б	б	4	
4	•	6	4	4	•	б	4	4	•	б	4	4		б	4	
4	б	6	4	4	6	б	4	4	6	б	4	4	б	6	4	
4	•	6	4	4	•	б	4	4	•	6	4	4	•	6	4	
6	9	9	б	6	9	9	б	б	9	9	б	6	9	9	6	

Only Color - Just the color is displayed



 $\underline{\texttt{Only Value}} - \textbf{Just the value is displayed}.$

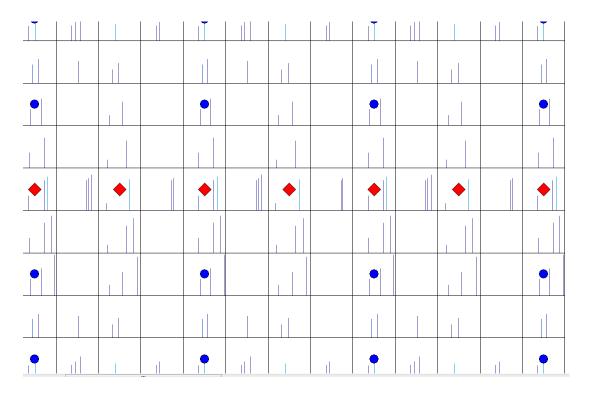
			-	7	•	•	-	-		0	-	-		•
								-						
4	-	6	4	4	•	6	4	4	•	6	4	4	-	6
4	6	6	4	4	6	6	4	4	6	6	4	4	6	6
6	•	9	•	6	•	9	•	6	•	9	•	6	•	9
6	9	9	6	6	9	9	6	6	9	9	6	6	9	9
6	9	9	6	6	9	9	6	6	9	9	6	6	9	9
4	6	6	4	4	6	6	4	4	6	6	4	4	6	6
4	•	6	4	4	•	6	4	4	•	6	4	4	•	6
4	6	6	4	4	6	6	4	4	6	6	4	4	6	6
4	ę	6	4	4	ę	6	4	4	ę	6	4	4	ę	6
6	9	9	6	6	9	9	6	6	9	9	6	6	9	9
	6 6 4 4 4 4 4	6 ◆ 6 9 6 9 6 9 4 6 4 € 4 €	6 9 6 9 6 9 6 9 6 9 4 6 4 6 4 6 4 6 4 6 4 6	6 9 6 9 6 9 6 9 6 9 9 6 6 9 9 6 4 6 4 6 4 6 4 6 4 6 4 6 6 4	6 \bullet 9 \bullet 6 6 9 9 6 6 6 9 9 6 6 6 9 9 6 6 6 9 9 6 6 4 6 6 4 4 4 6 6 4 4 4 6 6 4 4 4 6 6 4 4 4 6 6 4 4	6 \bullet 9 \bullet 6 \bullet 6 9 9 6 6 9 6 9 9 6 6 9 6 9 9 6 6 9 6 9 9 6 6 9 4 6 6 4 4 6 4 6 6 4 4 6 4 6 6 4 4 6 4 6 6 4 4 6 4 6 6 4 4 6 4 6 6 4 4 6 4 6 6 4 4 6	6 \bullet 9 \bullet 6 \bullet 9 6 9 9 6 6 9 9 6 9 9 6 6 9 9 6 9 9 6 6 9 9 6 9 9 6 6 9 9 4 6 6 4 4 6 6 4 6 6 4 4 6 6 4 6 6 4 4 6 6 4 6 6 4 4 6 6 4 6 6 4 4 6 6 4 6 6 4 4 6 6 4 6 6 4 4 6 6	6 \bullet 9 \bullet 6 \bullet 9 \bullet 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6		6 \bullet 9 \bullet 6 \bullet 9 \bullet 6 \bullet 6 9 9 6 6 9 9 6 \bullet 6 9 9 6 6 9 9 6 6 9 6 9 9 6 6 9 9 6 6 9 6 9 9 6 6 9 9 6 6 9 6 9 9 6 6 9 9 6 6 9 4 6 6 4 4 6 6 4 4 6 6 4 4 6 4 6 6 4 4 6 6 4 4 6 4 6 6 4 4 6 6 4 4 6 4 6 6 4	6 \bullet 9 \bullet 6 \bullet 9 \bullet 6 \bullet 9 6 \bullet 9 \bullet 6 \bullet 9 \bullet 6 \bullet 9 6 9 9 6 6 9 9 6 6 9 9 6 9 9 6 6 9 9 6 6 9 9 6 9 9 6 6 9 9 6 6 9 9 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 6 6 4 4 6 6 4 4 6 6 6 4	6 \bullet 9 \bullet 6 0 9 0 \bullet 0	6 \bullet 9 \bullet 6 \bullet 9 \bullet 6 \bullet 9 \bullet 6 \bullet 9 \bullet 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 9 9 6 6 6 6 6 6 6 6 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6 6 4 4 6	6

For Offset Map the following display options are available:

<u>No Color</u> – Colorless scale. The x-axis of the histogram corresponds to the inline bin direction. The scale ranges from zero offset on the left edge of the bin to max offset on the right edge of the bin. The y-axis corresponds to the offset (the maximum offset occupies almost the entire height of the bin, and the minimum offset has height close to zero). Gaps between the lines represent a discontinuous offset distribution.

<u> _</u>											
	. 1					. [•		. [•	
											,]
			•								

<u>Color</u> - Displays the "Redundancy", i.e. the number of times each offset falls into the same bin. A single offset has a colour corresponding to redundancy of zero. For more than 1 offset a color is assigned to it according to the redundancy colour bar.



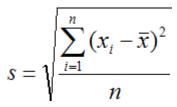
<u>Min Offset</u> – Fill the bins with the colour corresponding to the minimum offset. <u>Max Offset</u> – Fill the bins with the colour corresponding to the maximum offset <u>Mean Offset</u> – Fill the bins with the colour corresponding to the mean offset.

Median Offset - Fill the bins with the colour corresponding to the median offset.

 \underline{Offset} Range - Fill in the bins with the colour corresponding to the difference between the largest and smallest offset.

Largest Gap – This option displays a color plot of the largest offset difference between any consecutive offsets in each bin.

<u>Offset Variability</u> (Coefficient of Variation): This plot calculation is a relative dispersion measurement in each bin. This will calculate the standard deviation of the gaps in the offset range and divides the answer by the mean gap. This calculation can only produce a value for bins with at least 3 fold. Normalization is no longer performed. The lower the values in the color scale, the better the offset variability The formula for the calculation is as follows.



s= standard deviation of the offset gaps, formula shown below. x=offset gap (difference between consecutive offsets in a single bin) n=number of offset gaps (15 fold bins have 14 gaps)

The offset variability is then calculated as:

Offset Variability = s / mean of x (per bin)

For <u>Azimuth Map</u> the following display options are available:

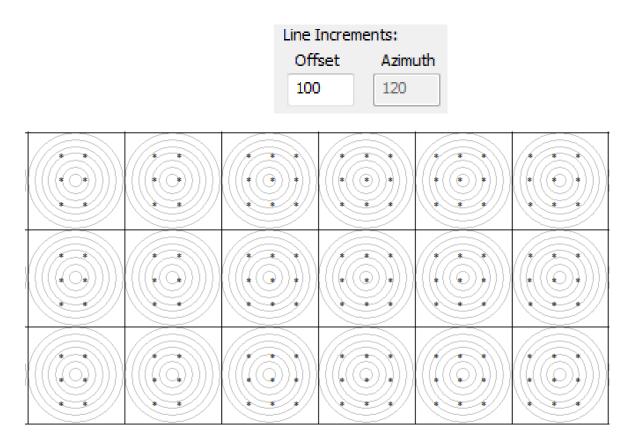
 $\underline{No \ Color}$ – Colorless scale. Showing "spiders", i.e. the distribution of azimuth directions of source-receiver pairs that fall in each bin. "Spider limb" length depends on the offset.

¥	¥	∳	X	¥	¥	∳	X	¥	¥	∳	X	¥	¥	*	X	¥	¥	*	X	¥
¥	¥	Å	X	¥	¥	Å	X	¥	¥	\neq	X	¥	¥	X	X	¥	¥	X	X	∦
∦	X	X	X	∦	X	X	¥	∦	X	X	k	∦	X	X	¥	∦	X	X	X	∦
Ж	Ж	X	X	ж	ж	×	k	ж	ж	\times	k	¥	Ж	X	k	Ж	Ж	×	×	ж
ж	ж	Х	χ	Ж	ж	Х	Х	ж	ж	X	χ	ж	ж	Х	χ	ж	ж	X	χ	ж
Ж	Х	χ	χ	Ж	Х	χ	X	Ж	Х	χ	χ	ж	X	χ	X	ж	X	χ	χ	ж
*	ж	λ	λ	*	Х	λ	λ	*	λ	Ă	λ	*	λ	Ă	λ	X	х	Ă	λ	*
¥	∦	Å	X	¥	∦	Å	¥	¥	∦	ł	¥	¥	¥	X	¥	¥	¥	X	¥	¥
¥	¥	*	Å	¥	¥	*	X	¥	¥	*	X	¥	¥	*	X	¥	¥	*	X	¥
¥	X	Å	X	¥	X	Å	X	¥	¥	X	X	¥	X	X	X	¥	¥	X	X	∦
.ν		· ·	. (.v	~	í		.ν		7			5	,			5	,		

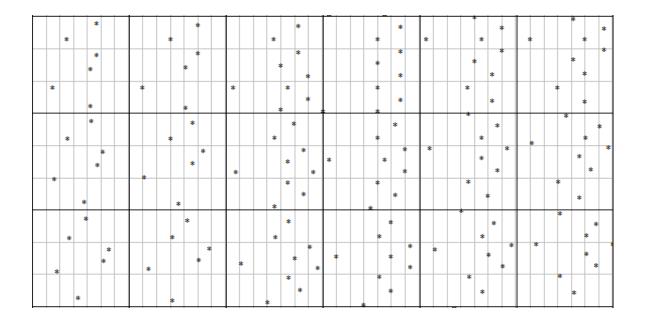
<u>Color</u> - Displays the «Redundancy», i.e. the number of times each azimuth falls into the same bin. A single azimuth has a colour corresponding to a redundancy of zero. For more than 1 azimuth a color is assigned to the "spider limb" according to the redundancy colour bar.

$ $ \times		\times		\times		\times		\times
×	\times	\times	\times	\times	\times	\times	×	×
×		\times	\times	×	×	×	X	\mathbf{X}
×	×	\rightarrow	\rightarrow	\times	\times	\times	X	×
×		\rightarrow	×	×	×	×	\times	X

<u>Circle Plot</u> - Concentric circles correspond to offset ranges, and the offset increases with increasing radius. To change the distance between circles use the - <u>Line Increment</u> in the field - in the **Offset** tab.



<u>Offset to Azimuth</u> – The midpoint locations for every bin are shown across an Offset vs Azimuth grid. The offset is plotted on the axis X axis (ranging from min to max across each individual bin), while the azimuth is plotted on Y-axis ranging from 0° to 360°, across each individual bin. To change the offset increments change the <u>Line Increments</u> parameters in the <u>Fold Display Option</u> window. Each midpoint is indicated by an asterisk at its corresponding position across the Offset vs Azimuth grid.



<u>Trace Azimuth</u> – Filling the bins with color corresponding to azimuth colour bar, meeting the criteria restrictions specified in the - <u>Line Increment</u> tab for **Offset**. In other words, the **Azimuth** is displayed as a function of the first trace greater than or equal to the specified **Offset**.

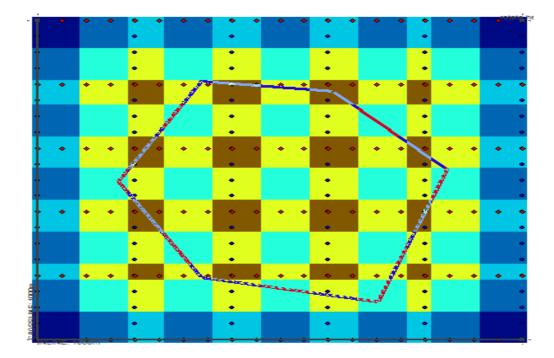
7.3.4 Bin Grid Statistic

<u>Bins Grid Statistics</u> - contains statistical information on sources/receivers, surface area and bins. It is possible to calculate the area for a particular region of interest in two ways:

1) Specify the fold range in <u>Min Fold</u> and <u>Max Fold</u>, and the total area for the bins within the <u>Min-Max fold</u> interval will be calculated. <u>Reset</u> button resets the value for the <u>Min Fold</u> and <u>Max Fold</u>.

Max Fold: Min-Max Areal: Win-Max Areal: Reset ey Statistics Reset shot Information 6 Shot Lines: 6 Total Shot Point: 126 Live Shot Point: 126 Unused Shot Point: 126 Unused Shot Point: 0 Shot Spacing: 50.00 m Line Spacing: 200.00 m Total Lenght: 6.05 sq.km Shot Point Density: 126.00 /sq.km Reset Reset Aurvey Information Reset Inline Extent: 1000.00 m Max Areal Extent: 1000.00 m Areat Inline Bin Size: 25.00 m Max Inline Bin Size: 25.00 m Max Inline Bin Count: 40 Areat	.51 sq.km	
Min-Max Areal: Reset ey Statistics Shot Information Rec Shot Lines: 6 Total Shot Point: 126 Live Shot Point: 126 Unused Shot Point: 0 Shot Spacing: 50.00 m Line Spacing: 200.00 m Inine Spacing: 126.00 /sq.km Shot Point Density: 126.00 /sq.km Shot Point Density: 126.00 /sq.km Shot Point Density: 126.00 /sq.km Grossline Extent: 1000.00 m Max Inline Extent: 1000.00 m Max Inline Bin Size: 25.00 m Max Inline Bin Size: 25.00 m Max Inline Bin Count: 40 Ar	.51 sq.km	
ey Statistics shot Information Shot Information Shot Lines: 6 Total Shot Point: 126 Unused Shot Point: 126 Unused Shot Point: 0 Shot Spacing: 50.00 m Line Shot Spacing: 200.00 m Line Shot Spacing: 200.00 m Line Shot Point Density: 126.00 /sq.km Ref Survey Information Inline Extent: 1000.00 m Areal Extent: 1.00 sq.km Sins Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Mi Inline Bin Count: 40		
ey Statistics hot Information Shot Lines: 6 Total Shot Point: 126 Live Shot Point: 126 Unused Shot Point: 0 Unused Shot Point: 0 Shot Spacing: 50.00 m Line Spacing: 200.00 m Line Spacing: 200.00 m Line Spacing: 200.00 m Line Shot Point Density: 126.00 /sq.km Ref Unvey Information Inline Extent: 1000.00 m Areal Extent: 1000.00 m Areal Extent: 1.00 sq.km Inline Bin Size: 25.00 m Inline Bin Size: 25.00 m Inline Bin Count: 40 Crossline Bin Count: 40		
shot Information Rec Shot Lines: 6 Re Total Shot Point: 126 To Live Shot Point: 126 Ur Shot Spacing: 50.00 m Re Line Spacing: 200.00 m Lir Total Lenght: 6.05 sq.km To Shot Point Density: 126.00 /sq.km Re Shot Point Density: 126.00 m Mc Crossline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km Mi Crossline Bin Size: 25.00 m Mi Inline Bin Size: 25.00 m Mi Inline Bin Count: 40 Ar		
Shot Lines: 6 Re Total Shot Point: 126 Total Shot Point: 126 Live Shot Point: 0 Ur Shot Spacing: 50.00 m Re Line Spacing: 200.00 m Lir Total Lenght: 6.05 sq.km Total Lenght: Shot Point Density: 126.00 /sq.km Re urvey Information Inline Extent: 1000.00 m Ar Areal Extent: 1000.00 m Ar Ar Inline Bin Size: 25.00 m Mi Mi Crossline Bin Size: 25.00 m Mi Ar Inline Bin Size: 25.00 m Mi Ar Crossline Bin Count: 40 Ar Ar		
Total Shot Point: 126 Total Shot Point: Live Shot Point: 126 Ac Unused Shot Point: 0 Ur Shot Spacing: 50.00 m Re Line Spacing: 200.00 m Lir Total Lenght: 6.05 sq.km Total Lenght: Shot Point Density: 126.00 /sq.km Re urvey Information Inline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km Mi Inline Bin Size: 25.00 m Mi Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Mi Inline Bin Count: 40 Ar	iver Information	
Live Shot Point: 126 Ac Unused Shot Point: 0 Ur Shot Spacing: 50.00 m Lir Shot Spacing: 200.00 m Lir Total Lenght: 6.05 sq.km To Shot Point Density: 126.00 /sq.km Re urvey Information Inline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km ins Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Mi Inline Bin Size: 25.00 m Mi Crossline Bin Count: 40 Ar	eiver Lines:	6
Unused Shot Point: 0 Shot Spacing: 50.00 m Line Spacing: 200.00 m Line Spacing: 200.00 m Line Spacing: 200.00 m Line Shot Point Density: 126.00 /sq.km Ref urvey Information Inline Extent: 1000.00 m Areal Extent: 1000.00 m Areal Extent: 1.00 sq.km Inline Bin Size: 25.00 m Inline Bin Size: 25.00 m Inline Bin Size: 25.00 m Inline Bin Size: 40 Crossline Bin Count: 40	al Receivers:	126
Shot Spacing: 50.00 m Re Line Spacing: 200.00 m Lir Total Lenght: 6.05 sq.km To Shot Point Density: 126.00 /sq.km Re urvey Information Inline Extent: 1000.00 m Mc Crossline Extent: 1.000 sq.km Ar Areal Extent: 1.00 sq.km Mi Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Mi Inline Bin Size: 25.00 m Mi	ive Receivers:	126
Line Spacing: 200.00 m Lir Total Lenght: 6.05 sq.km To Shot Point Density: 126.00 /sq.km Re urvey Information Inline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km ins Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Mi Inline Bin Count: 40 Ar	ised Receiver:	0
Total Lenght: 6.05 sq.km Total Lenght: Shot Point Density: 126.00 /sq.km Re urvey Information Inline Extent: 1000.00 m Me Inline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km Mi Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Mi Inline Bin Count: 40 Ar	eiver Spacing:	50.00 m
Shot Point Density: 126.00 /sq.km Re urvey Information Inline Extent: 1000.00 m Mc Crossline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km ins Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Ma Inline Bin Count: 40 Ar	Spacing:	200.00 m
urvey Information Inline Extent: 1000.00 m Mc Crossline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km ins Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Mc Inline Bin Count: 40 Ar	al Lenght:	6.05 sq.km
Inline Extent: 1000.00 m Mc Crossline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Mc Inline Bin Count: 40 Ar	eiver Density:	126.00 /sq.kn
Crossline Extent: 1000.00 m Ar Areal Extent: 1.00 sq.km Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Ma Inline Bin Count: 40 Ar Crossline Bin Count: 40		
Areal Extent: 1.00 sq.km Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Ma Inline Bin Count: 40 Ar Crossline Bin Count: 40	use Selected Poligor	n:
Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Ma Inline Bin Count: 40 Ar Crossline Bin Count: 40	a:	0.00 sq.km
Inline Bin Size: 25.00 m Mi Crossline Bin Size: 25.00 m Ma Inline Bin Count: 40 Ar Crossline Bin Count: 40	Mouse Sele	ection
Crossline Bin Size: 25.00 m M: Inline Bin Count: 40 Ar Crossline Bin Count: 40		
Inline Bin Count: 40 Ar	Offset:	50.00 m
Crossline Bin Count: 40	Offset:	707.11 m
	a	
Total Bins: 1190	in Fold:	0
	ax Fold:	9
Total Traces: 3364	in-Max Areal:	0.74 sq.km
Illuminated Bins: 841	Reset	
		Cancel

2) Draw the contours of the polygon using the mouse by clicking on <u>Mouse</u> <u>Selection</u>. In the meantime the <u>Survey Statistics</u> dialog is minimized and the left mouse button is used to draw a polygon. Once finished, click the right mouse button, after which the <u>Survey Statistics</u> will reappear and the corresponding <u>Area</u> will be calculated.



The result:

Mouse Selected Po	oligon:
Area:	0.32 sq.km
Mouse	Selection

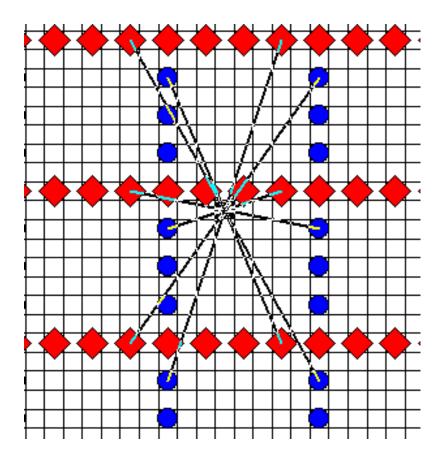
7.3.5 Selected Bin Information

After activating the option <u>Selected Bin Information</u>, click on any bin and this will bring up the <u>Selected Bin Statistics</u> dialogue with contains statistical information for that particular bin. While in this mode you can switch between the bins and the <u>Selected Bin Statistics</u> dialogue will change accordingly.

Selected Bin Statistics							
Bin		Attributes					
Number:	1120	Fold:	4	Median Offse	et: 291.55		
Centre X:	662.50	Min Offset:	212.13	Offset Rang	e: 141.42		
Centre Y:	312.50	Max Offset:	353.55	Largest Ga	p: 79.42		
		Mean Offset:	287.20	Offset Variabilit	y: 117.21		
Offset Azimuth Azimuth Show Spider Cancel							

The dialogue consists of three parts: the first one <u>Bin</u>: its serial number according to the origin and the coordinates of the seismic survey; second <u>Attributes</u> contains the statistics for that bin; and the third part – the graphic statistics for the offset and azimuth corresponding to the <u>No Color display</u> for both **Offset** and **Azimuth**.

Also there is a button <u>Show Spider</u> - to display all source-receiver pairs whose midpoints fall in a selected bin, in the form of a spider. To turn off the spider display press the Hide Spider button.



To exit this mode, you need to deactivate the <u>Selected Bin Information</u>.

7.3.6 Plot Statistics

<u>Plot</u> <u>Statistics</u> - a dialogue that displays the statistics for the calculated Fold Map using the following graphs and diagrams:

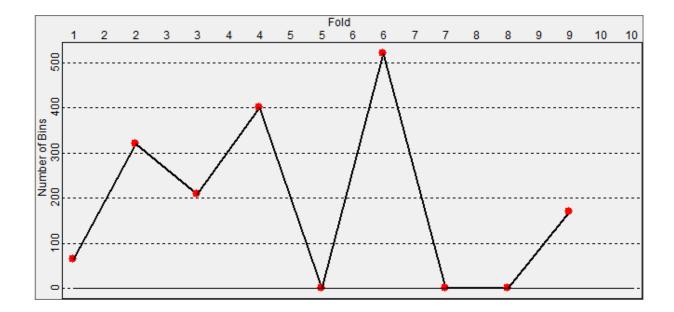
- Graph displaying the distribution of the **Number of Bins** with respect to the **Fold**



- Graph displaying the distribution of the **Number of Traces** with respect to the **Offset**.

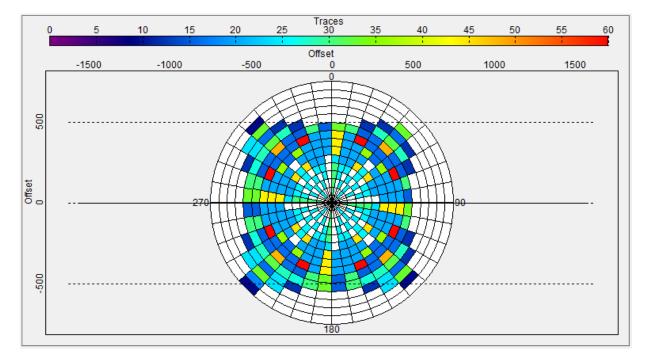


- Graph displaying the distribution of the **Number of Traces** with respect to the **Azimuth**.



The X-axis, depending on the graph, shows the **Fold**, **Offset**, **Azimuth**, and on the Y-axis the **Number of Bins or the Number of Traces**.

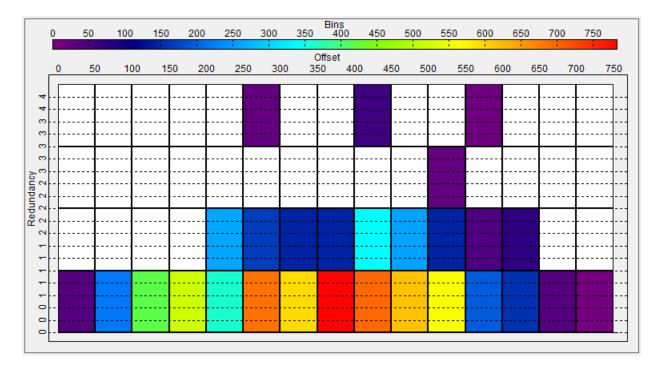
diagram which shows the distribution of traces according to Azimuth and Offset.



In this radial diagram - each circle corresponds to a particular offset. The scale of offsets is marked on the axes X and Y. The radial lines represent the azimuth and each cell in the pie chart is colored according to the number of traces that fall in each particular range of offset and azimuth.



- Radial diagram which shows the distribution of the Number of Bins according to Azimuth and Offset.



In this diagram, the X axis represents the Offset and the Y axis – the Redundancy (i.e. each cell is colored according to the number of bins that have the same).



This button opens a dialog for optional display settings, where you can set the Increments for Fold, Offset, Azimuth, as well as change the display from line graphs (As Line Graph) to histograms (As Bar Graph).

D	Display Options					
Γ	Increments]				
	Fold:	1				
	Offset:	50				
L	Azimuth:	10				
Display						
L	As Line Graph					
	🔘 As Bar Graph					
	OK Cancel					

7.4 Manipulation with Acquisition Geometry

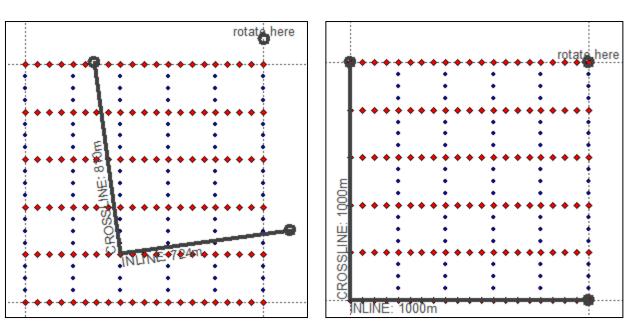
7.4.1 Changing position of Inline/Crossline axes

If, for some reason, the program does not correctly determine the Inline / Crossline coordinate system when loading the observation scheme from the SPS-file, it is possible to change the location of the axes,

for example, as in the figure below. To do this, you need to activate the mode <u>If</u> (<u>Shots</u> / <u>Receivers: Moving with rotation</u>), hold down the <u>ctrl</u> button and perform manipulation (move, rotate, change the length of one of the axes).

Before





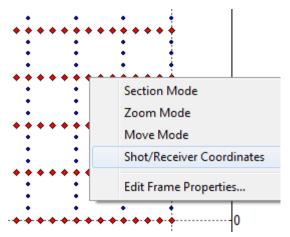
This function works only when the observation schemes are loaded from the SPS file; for schemes built in another way, the function is disabled.

7.4.2 Changing coordinates of the Shot/Receiver

To move the Shot/Receiver to the exact coordinates, you need to activate the mode



- (Moving Shot and Receiver Lines) and then point to Shot / Receiver and click the left mouse button.



Then in context menu you need to select the <u>Shot/Receiver Coordinates</u>. A dialog will appear with the current coordinates Shot / Receiver <u>Map</u> - coordinates of the map, and <u>SPS</u> - location in the Inline / Crossline observation scheme, **Z** - current depth of the Shot / Receiver.

Мар	SPS	
600	600	Z: 0
600	600	Set

If you need to get the coordinates of another Shot / Receiver, you can repeat the procedure without closing the dialog. After changing one of the coordinates, you must press <u>Set</u>, then <u>Shot/Receiver</u> position will change its location or depth. After receiving the desired result you have to close the dialog.

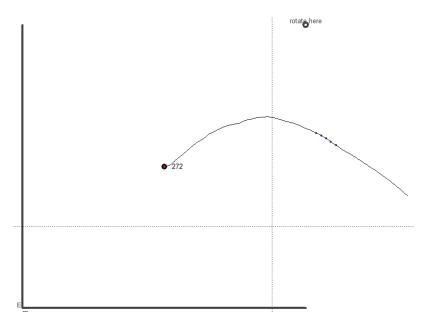
7.4.3 Changing the depth of Shots/Receivers

The button - (<u>Set Shots / Receivers Depth</u>) opens a dialog, where you can set the depth for all Shots / Receivers. There are two ways to get the depth value: the first is to set the depth manually, the second one is relative to the selected surface from the list loaded into the project.

	V Shots	Receivers	
) Static Depth	0	0	
Depth from Layer	PRECAMB(1)-local.ord	

After selecting the depth setting method, you need to determine what the depth of Shots or Receivers will be assigned to, or both, and activate the corresponding flags. After selecting the settings, click <u>OK</u>.

7.4.4 Placement of Shots/Receivers in Well



To change the initial placement of receivers in a well or to place sources in a well, use the menu command <u>Map/3D Survey Edit Modes/Moving Shot and Receiver</u> Lines. Then, in the appeared dialog select a well (from the list of database wells which belong to the selected fields and include trajectory specification in the inclinometry table):

Moving Shots / Rec	Moving Shots / Receivers ×				
Selection Type Shots Rec Cable OPoint Change Src/Rec (C	Line () Polyg	gon		
Point: Receiver ~	Action: Add	\sim	Type: Below	~	
From: 0	To: 2800		Step: 0		
		Well:	272	~	
Select	Apply		Cancel		

Start from selection of a station type in the <u>Point</u> list: either <u>Receiver</u> or <u>Source</u>. Then use the list Action to select an operation: either Add or Remove.

Moving Shots / Receivers X	Moving Shots / Receivers ×
Selection Type Shots Receivers • Cable ○ Point ○ Line ○ Polygon Change Src/Rec (Only VSP) Point: Action: Receiver Add To: Step: 0 Well: 272	Selection Type Shots Receivers Cable Point Line Polygon Change Src/Rec (Only VSP) Point: Receiver Add Interval Step: 0 Well: 272
Select Apply Cancel	Select Apply Cancel

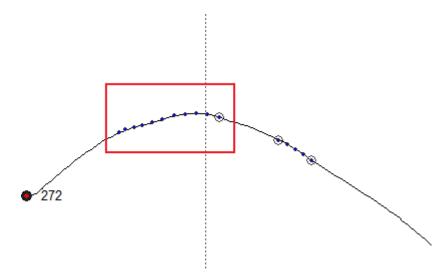
Then select a desired type of object in the list \underline{Type} :

Moving Shots / Receivers X	Moving Shots / Receivers X
Selection Type Shots Receivers • Cable Point Line Polygon Change Src/Rec (Only VSP) Point: Action: Type: Receiver Add ✓ Interval From: To: Above Below 0 2800 Well: 272	Selection Type Shots Receivers • Cable Point Line Polygon Change Src/Rec (Only VSP) Point: Action: Type: Point: Remove Interval Interval From: To: O 2800 Below Well: 272 ✓
Select Apply Cancel	Select Apply Cancel

The action $\underline{\text{Add}}$ supports the next objects:

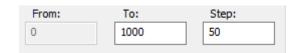
1) <u>Interval</u> requires entering the first depth along well in the field <u>From</u>, the last depth of the interval in the field <u>To</u>, and the depth increment from station to the next station in the field <u>Step</u>:

From:	To:	Step:
1000	1500	50

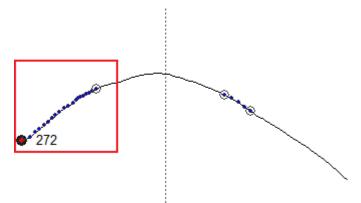


The result:

2) <u>Above</u> requires entering the last depth along well in the field \underline{To} , and the depth increment from station to the next station in the field Step:

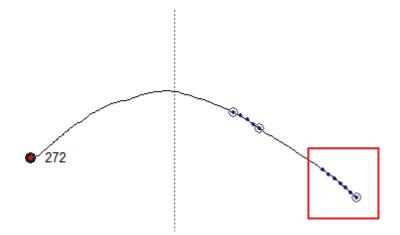


The result:



3) <u>Below</u> requires entering the first depth along well in the field <u>From</u>, and the depth increment from station to the next station in the field <u>Step</u>:

From:	To:	Step:
2500	2800	50

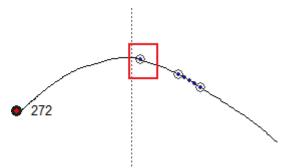


The result:

4) Depth along the well is entered in Z:

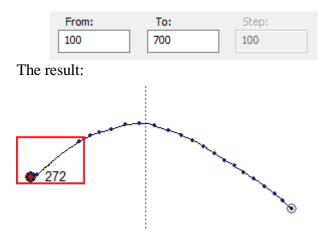


The result:

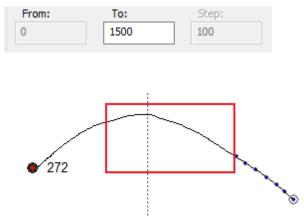


The action <u>Remove</u> supports the next objects:

1) Interval requires entering the first depth along well in the field \underline{From} , and the last depth of the interval in the field \underline{To} :



2) <u>Above</u> requires entering the last depth along well in the field <u>To</u>:

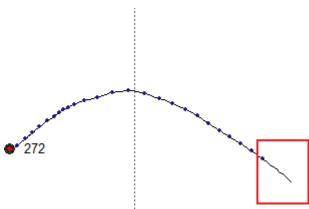


The result:

3) <u>Below</u> requires entering the first depth along well in the field <u>From</u>:



The result:



4) <u>All</u> means removal of all stations in the survey and does not need additional parameters.

Using the listed operations and objects one can form the combined surveys not covered by the basic set of acquisition geometries (such as VSP with varying step, inter-well sounding, "inverse" VSP with sources in the wells, combinations of surface observations with VSP, etc.).

8 3D Ray-tracing

To perform 3D Ray-tracing in Tesseral Pro it is necessary to have a 3D Velocity Model in SEG-Y format (see *13.4*), reflecting surface in one of standard formats (see *14.1*) and 3D survey layout (see *7*).

You can see explanations on how to create a job and run 3D Ray-tracing in Chapter 8.

You can find some specifics of viewing modeling results in Chapter 15.

8.1 3D Ray Tracing Modeling

To simulate 3D Ray tracing in Tesseral Pro, you need to create a 3D model consisting of a 3D velocity Model in Seg-Y format (see 13.4), a reflecting surface in one of the standard grid formats (see 14.1) and create a 3D survey layout (see 7).

8.1.1 Previewing 3D Velocity Model

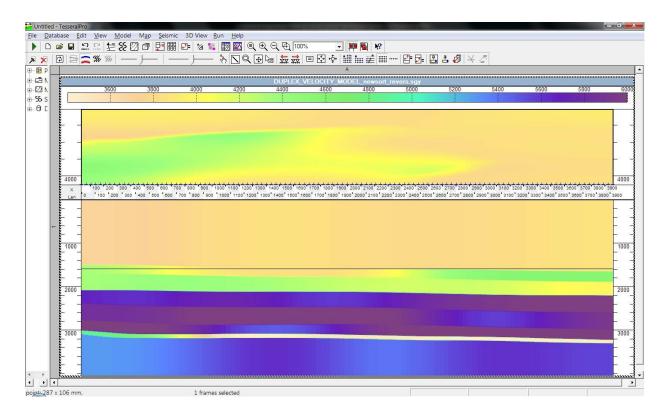
In order to preview the 3D velocity model as a SEG-Y file, the user can load it into the Seismic Frame (see Section 13) and then display it in 3D View Frame (see Section 15).

To load the 3D SEG-Y file, choose one of the <u>File > Load Seismic File</u> or <u>Seismic ></u> <u>Load Seismic File (New Frame)</u> menu commands. Select the file in the standard File Open dialog box, and in the dialog

Select type of seismic data				×
Please select the typ	e of seismic da	ata in file		
Mode	el3D.sgy			
Model or Migrated gather	Gather	VSP	Raw Traces	iow

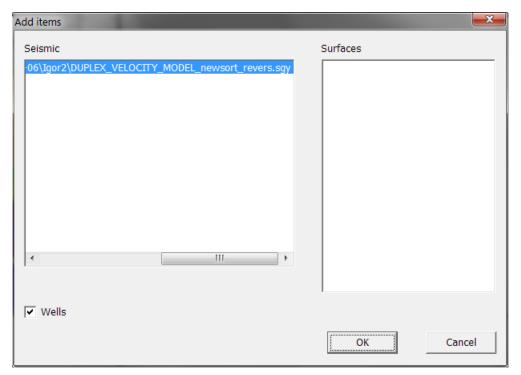
choose <u>"Model or Migrated gather"</u>. Your choice is remembered and next time you load the same file, you will not be asked.

The file will open in the new Seismic Frame.

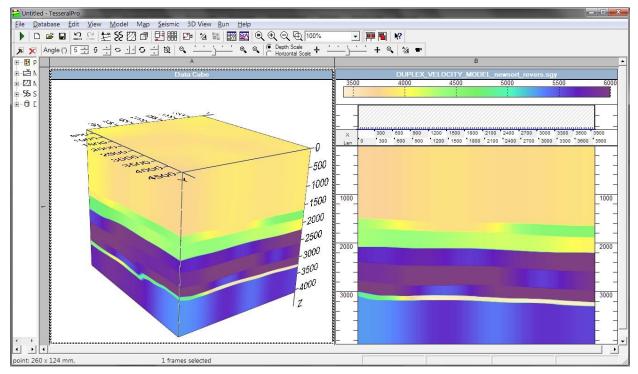


More details on managing and displaying 3D Model files can be found in Section 73.4

You can also display the same 3D Model file in 3D view. To do this, create a new <u>3D View Frame</u> by the <u>3D View > View Data Cube (New Frame</u>) menu command. In the <u>Add Items</u> dialog box, select the file you want to view:



Then the 3D Velocity model is displayed in the 3D View:



See Section 15 for details on 3D View options.

NOTE: It is not necessary for 3D ray tracing procedure to have the 3D velocity file loaded into the interface. But this step is useful for previewing the file and making sure you choose the right file for the simulation.

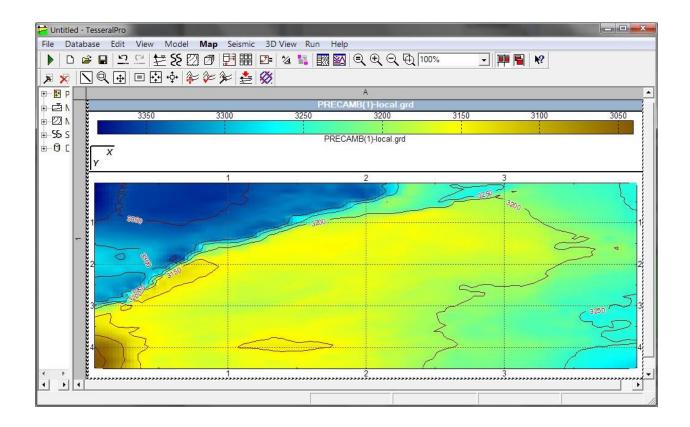
8.1.2 Loading the Reflecting Surface

The reflecting surface can be in any of the standard grid formats (see 14.1). To load it, choose the <u>File</u> \geq Load Map File menu command. If a <u>Map Frame</u> is not created, it will be created and the file loaded. Alternatively, you can use the menu <u>Map > Create Map (New Frame</u>) and in the dialog box select <u>"Load TXT or GRD-surface files"</u>.

When loading surface, you will be asked about creating isolines. This is only for display and is optional. After that, you will be presented with the <u>Surface properties</u> dialog:

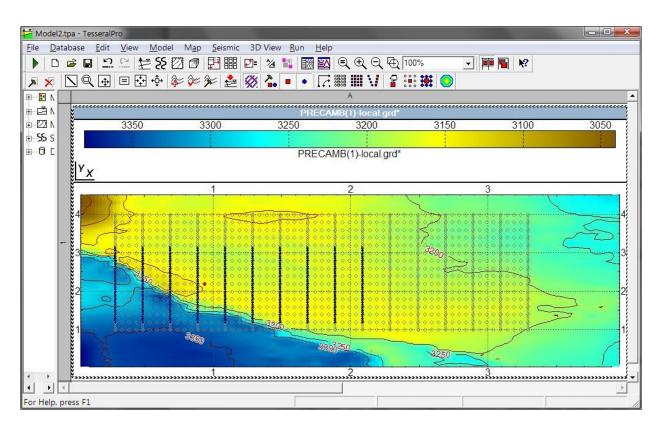
Surface properties			×
Name PRECAMB(1)-local.grd Surface type top	La Z	R	
Value interval Min (depth) 3040.378005044 Max (depth) 3380.944184191 Auto		5-	3.
Gain (%)		\$	22

More details on the options in this dialog and on working with the Map Frame can be found in Section 14. After you click OK, the surface is loaded into the Map Frame



8.1.3 3D Ray Tracing simulation

Before you start the simulation, you need to create the 3D survey layout (see Section 7). Here is an example of a reflection surface and a 3D survey layout.



To start the 3D Ray Tracing simulation, choose the $\underline{\text{Run} > 3D}$ Ray Tracing Modeling... menu command. If you have not saved the project, you will be prompted to do so. After that, the <u>3D Ray</u> <u>Tracing</u> dialog box opens:

3D Ray Trac	ing									X
		EX_VELO	CITY_MO	DEL_new	sort_re	vers.s	эду 	(optio	nal)	
Horizon		Tracing	files\CCA	T(2)_loca	al.grd]	Grid forma	t Surfer	GRD	•
-Sources t From #	to compute t: 282		To #:	282			A		Active	
Region C	ube	_				-				
X min	35	m	X max	3955		m	X step	10		m
Y min	35	m	Y max	4515		m	Y step	10		m
Z min	0	m	Zmax	4070		m	Z step	5		m
Set initia	al values from:	V	elocity Cu	be	Surf	face (Horizon)			
Output										
	ion File Name	Output	tIlmn.grd		Rays	File Ni	ame Ou	tputRay	s.txt	
Wave typ				•						
Obser	rve Attenuation	due to F	Ray Diver	gence						
Computa	tion parameters									
Output F	older ry Int	ernet File	es\Conter	nt.Outloo	k\3MOT	ZSYO				
Mode: 🧕	Precise 🔘 F	Fast			Thread	s per	process	Max	•	
							RUN		Cano	el

You can change the following options:

- <u>Output Folder</u> Specifies the folder where the input files and the computation results are stored.
- <u>Velocity Cubes</u> Specifies the 3D velocity SEG-Y file used for the 3D Model (see 8.1.1). The Shear Wave Velocity cube is specified in case of PS wave ray tracing, otherwise the Vs values are generated automatically according to Castagna's equation (i.e. the mudrock line).
- <u>Horizon File</u>. Specifies the reflection surface file (see 8.1.2)
- <u>Horizon File Type</u>. Specifies the file type used for the reflection surface. See details in **14.1**
- <u>Sources to compute</u> group. Specify the range of sources to compute. Input the range into the edit fields or click the button <u>All</u> to compute all sources, or <u>Active</u> to compute only the active selected source in the 3D survey layout (see 7)

• <u>Region Cube</u> group. Specify the 3D Model region for computation or use the button <u>From Velocity File</u> or <u>From Surface</u> to set the region based on the corresponding ranges in the files.

Also in this group, specify the computation steps. The <u>X step</u> and <u>Y step</u> determine the spatial density of rays during the computation, while the <u>Z step</u> determines the internally used time step and influences the number of links each ray contains.

NOTE: Do not set unnecessarily small values into the step boxes; doing so will significantly increase the computation time.

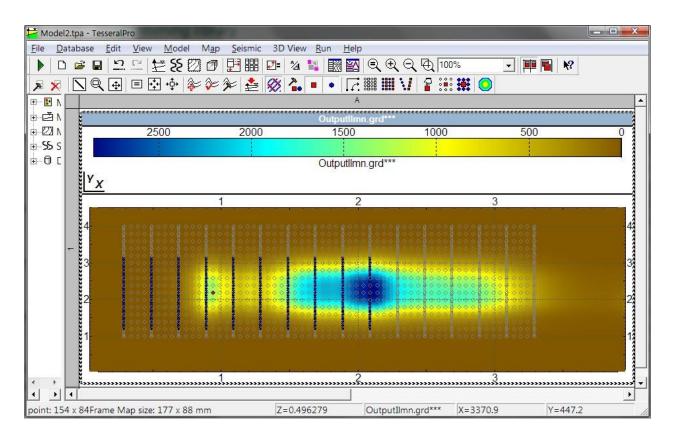
- <u>Illumination File Name</u> specifies the name of the surface file where the illumination map will be saved after the computation.
- <u>Rays File Name</u> specifies the name of the file (or group of files) where the rays from the sources reaching the receiver will be saved after the computation. The file name will be automatically amended with the source index, and one file will be created for each source in the 3D survey layout.
- The user can also choose to take into account the <u>Attenuation due to Ray</u> <u>divergence</u> and select between 2 modes of computation <u>Fast</u> and <u>Precise</u>. For the <u>Precise</u> mode Snell's Law of reflection and refraction will be taken into account and the rays will bend according to the elastic properties of <u>Velocity</u> <u>Cube</u> File. In the <u>Fast</u> Mode the incident and the reflected waves will remain perfectly straight.

Click RUN, and the simulation will start. The usual Computation dialog is displayed.

3D Ray Tracing	
Progress	Hide
<< 3D Ray Tracing >> 00:00:29	
- Point 2 of 1	Terminate
0%	
– Overall	- 🏵 -
25%	Clean
Y [3000 6000], step 10 Z [0 5000], step 20 Output Illumination File Name: OutputIlmn.grd Rays File Name: OutputRays.txt Prepare dataStarting computations <<< 3D Ray Tracing >>> started at Sun Sep 15 22:38:05 2013 100% (Overall: 25%) - 1 of 4. 0:00:27 elapsed.	

8.1.4 Viewing the Illumination map

After the computation finishes, the resulting illumination file is loaded into the <u>Map</u> Frame. (You are prompted to generate isolines, this is optional).



You can load the illumination map at a later time using the $\underline{File} > \underline{Load} \quad \underline{Map} \quad \underline{file} \quad \underline{menu}$ command. The file is located in the folder specified in the <u>3D Ray Tracing</u> dialog (see <u>8.1.3</u>).

Now you can display the reflection surface filled with the illumination map in the <u>3D View Frame</u>. To do this, choose the menu command <u>3D View > View Data Cube (New Frame</u>). The <u>Add</u> items dialog box appears:

Add items	
Seismic	Surfaces OutputIlmn.grd Top PRECAMB(1)-local.grd Top
Vells	OK Cancel

Cancel out of this dialog at this time (do **not** click OK).

The empty <u>3D View</u> Frame is created. Now choose <u>3D View > Add Map > From</u> <u>Project</u>. The <u>Add Surface From Project</u> dialog appears:

Add Surface From Project		×
All Layers (without already	Layers to be added in the	
OutputIlmn.grd Top PRECAMB(1)-local.grd Top		
2		
<		
ОК	Cancel	

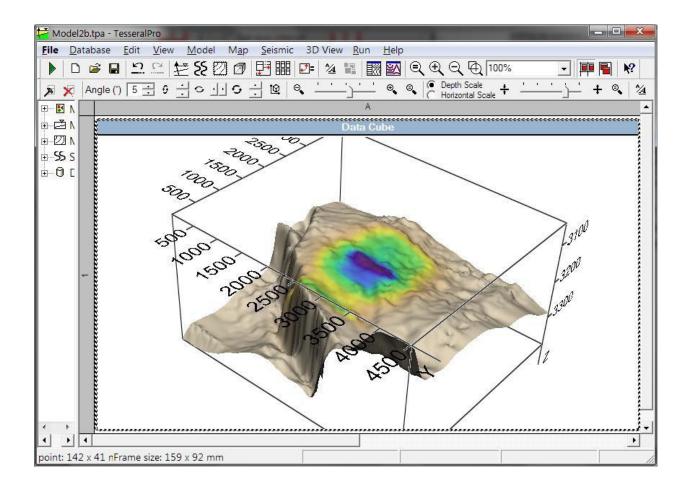
In the left list (<u>All Layers</u>) select the reflection surface and click ">". The Surface name will be moved to the next list, <u>Layers to be added</u>.

dd Surface From Project		
All Layers (without already	Layers to be added in the	1000 2000 3000
OutputIlmn.grd Top	PRECAMB(1)-local.grd Top	
	>	
		2000
	<	3000 4000
		4000
ОК	Cancel	1000 2000 3000

Click OK. In the Surface Properties dialog

Surface Properties	
Name PRECAMB(1)-local.grd; Top	
X-step 39.5859 Y-step 45.24	24
1 7	
Palette	Filling By Surface
○ Set own interval 2	Filling By Surface
 Auto fitting by surface values 	From file
○ Set general depth interval	
Apply to all	From project
OK	3 PRECAMB(1)-local.grd; Top OK Cancel

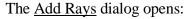
Check the "<u>Filling by another surface</u>" check box, and then click "…". In the <u>Filling by Surface dialog</u> box select "From project" radio button, and then select the illumination map surface from the list below. Click OK in both dialogs and the surfaces are loaded into the <u>3D View</u> Frame.

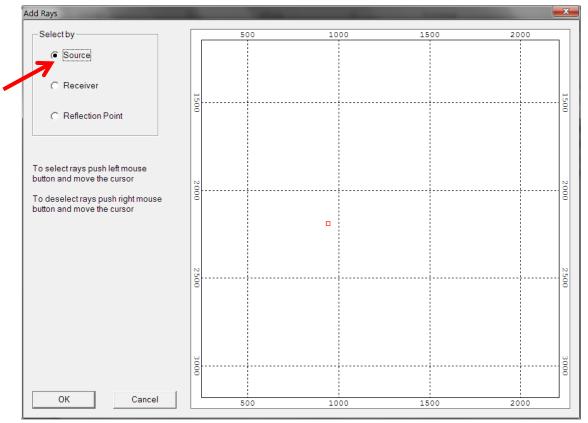


Please refer to Section 15 for instructions on how to adjust the 3D View display options (rotation, zooming, etc.)

8.1.5 Viewing the rays

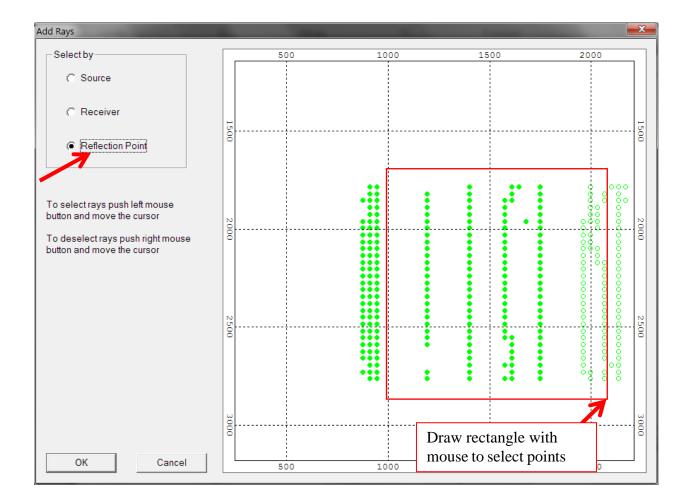
Choose the <u>3D View > Add/Remove Rays...</u> menu command. In the <u>Open File</u> dialog select the file with the ".bin" extension, having the name specified in the Ray Tracing dialog (see 8.1.3). By default, this file is named "OutputRays.bin". This file contains the catalog of all calculated rays during the simulation.





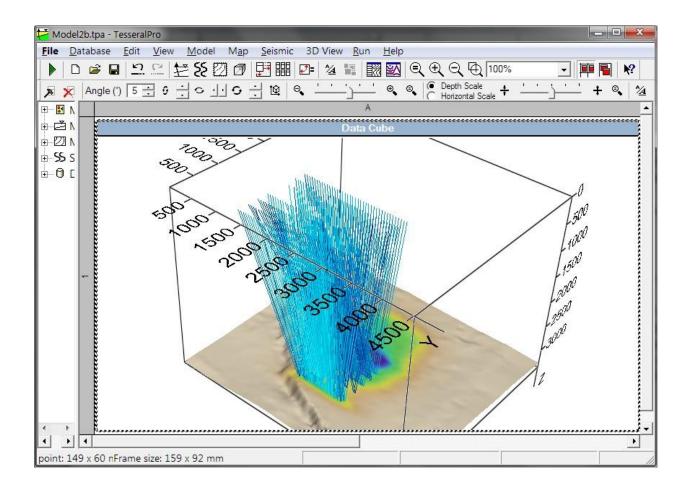
On the left, you can choose how you want to select the rays: by sources, receivers, or reflection points.

Select by	Г		500		10	000		1500		200	0
00100109										*	<u> </u>
 Source 		÷	÷	÷	÷	÷.	÷	-	÷	÷ 1	÷
		1.	1	4	- 1	1	•		- 1	:	4
Receiver		1	1	1	:	1	:	1	÷ :	:	÷.
1						ļ				•	
C Reflection Point		-]↓	-	4	- 1 -	1	- I.		:	-	+
		1	1	1	- :	11		- :	÷ .	:	÷.
		+	*	÷.	÷.	1	÷.	*	- ÷	÷ 1	÷
To select rays push left mouse		÷.		÷.	- -	÷ .	÷.		÷	÷ 1	÷
button and move the cursor		. *	*	4	- 1	E 🏥			÷	1	÷.
To deselect rays push right mouse						¦*		····-		*	·
button and move the cursor		1	-	÷	÷	÷	÷		÷	÷ 1	÷
		1.		÷.	- I -	÷ .	- I.		- I -	4	÷.
		1		4	÷.	E 🏌	÷.		÷	:	÷.
		11	1	÷.	- ± -	1	÷.	1	1 - E	÷ 1	÷.
		<u>ه</u>		÷	÷	÷.	÷	-	÷	÷ 1	÷
			****	···•	····•	+*	•••••	•••••	····•	+	+
		1	1	1	÷.	:	÷.	1	÷ :	:	÷.
		÷	<u>+</u>	÷	÷	÷	÷	<u></u>	÷	÷ 1	÷
		Ŧ		÷	÷	÷.	÷		÷	÷ 1	÷
		1	*	4	- 1	11			÷	:	÷.
			1	1	:	11	:	1	:	:	1
	8	3	*	<u>.</u>	\$	\$	*	1	:	:	:
		11	1	1.	- I -	11	- I.		- I -	- I - E	1.

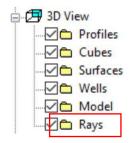


Then select the rays you want to display in the 3D View. Depending on your choice in the left of the dialog, you can select rays by sources, receivers or reflection points. Drag your mouse with the left button pressed to select the sources, receivers or reflection points; if you want to exclude certain sources, receivers or reflection points from the select them with the same procedure but using the right mouse button.

When you click OK, the rays from the selected sources, to the selected receivers, or with the selected reflection points will be shown:



The project data tree allows to hide/restore visualization of the selected rays by the checkbox <u>Rays</u> in the tree folder <u>3D View</u>.



If you want to change the color palette, choose the <u>3D View</u> \rightarrow <u>3D View</u> Frame Properties... menu command and in the <u>General</u> dialog click the <u>Rays Palette</u> button.

General	×
Top title	Size
Plane Font 3D Font	Width (mm) 311 Height (mm) 179
Projection Perspective O Orthogonal	Palette y luminance v
Axes step 5 🔹 mm	offset angle of incidence reflection point
ОК	Cancel

Use the list <u>set by</u> of the <u>Rays Palette</u> group to select an attribute to be presented by the ray colors. Each of the attributes <u>luminance</u>, <u>offset</u>, <u>angle of incidence</u> is scaled from min to max value among the selected rays and projected to the palette. (A ray has only one color according to the relative value of the selected attribute.) The attribute <u>reflection point</u> is presented differently: the ray parts from source to reflection and the ray parts from reflection to receiver are presented by two different colors (the extreme colors of the selected palette).

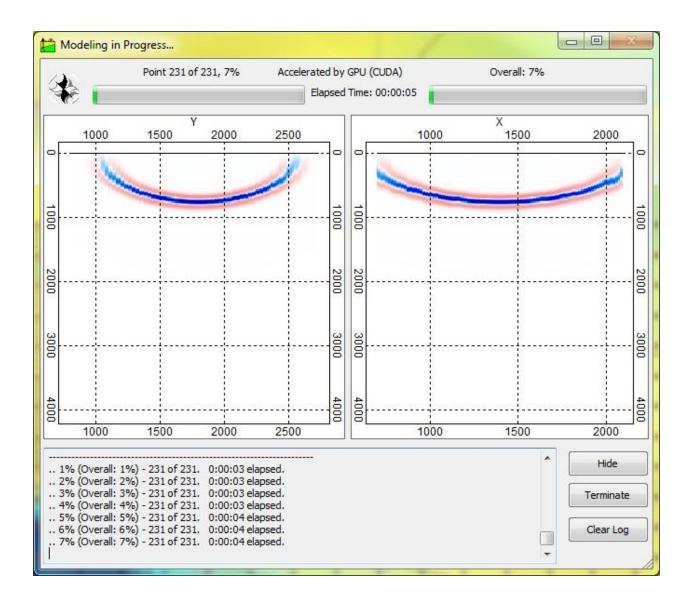
The next dialog <u>Palette</u> (called by the button <u>...</u> in the dialog <u>Rays</u> <u>Palette</u>) is used to change colors and (optionally) to limit the correspondent value interval.

Palette	
Magnitude within	16.1411190i 19.6309146i 🔲 Edit
Palette type	From light blue to dark blue
Glow (%) 100	From light blue to dark blue From red to dark blue Rainbow Uniform scale (16 colors)
Edit palette	Black-and-white scale Monochrome Default Dipolar Default Incremental User scale
16.5 17	17.5 18 18.5 19 19.5
	OK Cancel

8.2 Source grouping for 3D modelling

The user can also implement source grouping (i.e. simultaneous shooting from multiple sources) for any 3D modelling method. In order to implement it, the user will first need to load a surface (see Section 14) and build a 3D observation system (see Section 7). Afterwards select <u>Run>Run 3D Modelling</u> and follow the instructions in Section 5. After specifying all modelling settings click <u>Finish</u> and <u>Run modelling</u>.

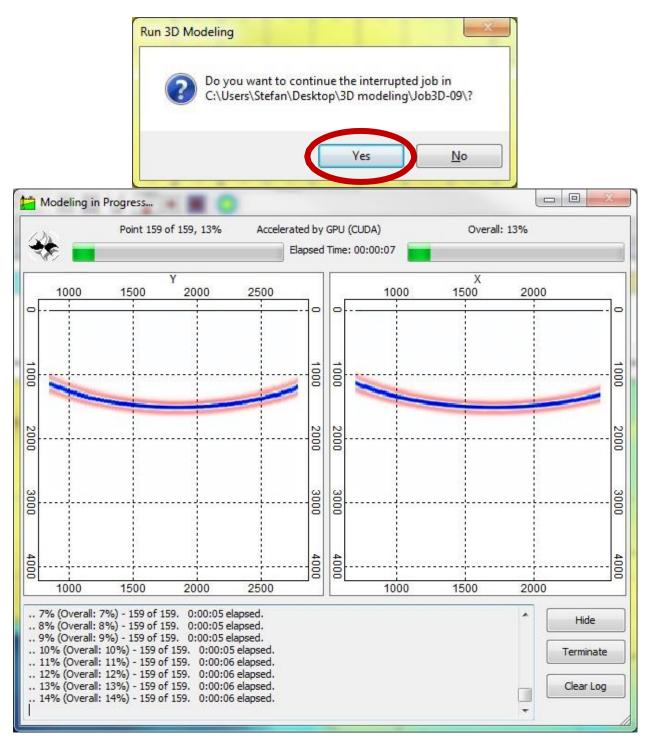
Run Modeling	x
The most important modeling p	roperties is:
Modeling Procedure	3D Acoustic
Source	1 shot points
Shotgahter Record	[04000], step 2
Wavelet	20 Hz, Ricker
Snapshots	No
Enable GPU	Yes
and others	< Back to Modeling Wizard
RUN	MODELING Quit



Click <u>Terminate</u>, as soon as at least 1% of the job has been completed. Once the job has been terminated, locate the *survey3d.txt* file in recently created job folder and open it in Microsoft Excel. The *survey3d.txt* contains the XYZ coordinates of every source-receiver pair of the designed 3D survey (i.e. the coordinates of every trace) and the user will have to fill the entire <u>Inline</u> and <u>Crossline</u> columns with zeros. Afterwards, an identical <u>Source</u> <u>Number</u> needs to be assigned for the sources that need to be grouped. For example if out of 100 sources in the 3D survey, the user wants to group just 5, then a <u>Source</u> <u>Number</u> of 1 (in actuality it can be any number) needs to be assigned to all traces pertaining to those 5 sources. In other words, every row that carries the <u>SrcX; SrcY; SrcZ</u> coordinates of the respective 5 sources need to be filled with the same number. The remaining 95 sources (that are of no interest to us), have to be assigned a different number (even though we do not care about them), for example 2, so that the whole <u>SrcNum</u> column is filled. The same methodology applies if 3 or more sets of sources, have to be grouped per modelling job.

Image with with with with with with with with			PAGE LAYOUT	FORMULAS DATA	REVIEW VIEW		Split 🗠 View Side	e by Side	F 🕞						Stefan	Prisacari
A N Src2 B B C D E F G H I J K M N N 2 884 894 0 834 894 0 834 944 0 0 0 1 Image: Cost of the section of	Normal	Page Break Page Custo Preview Layout View Workbook Views	om ws Gridlines I	Headings Zoom	100% Zoom to New Selection Winds Zoom	Arrange Freeze	Hide III) Synchron Unhide III: Reset Wi Window	ndow Position Windo	ch Macros Macros							
Image Serve Roxt Roxt Roxt Roxt Roxt Newt	A1															
2 344 834 0 834 834 0 0 0 1		A	В	С	D	E	F	G	н	I	J	К	L	M	N	
3 834 834 944 0 0 0 1 </td <td>1</td> <td>;SrcX</td> <td>SrcY</td> <td>SrcZ</td> <td>RcvX</td> <td>RcvY</td> <td>RcvZ</td> <td>Inline</td> <td>Crossline</td> <td>SrcNum</td> <td>KTau11</td> <td>KTau22</td> <td>KTau33</td> <td>KTau12</td> <td>KTau13</td> <td>KT</td>	1	;SrcX	SrcY	SrcZ	RcvX	RcvY	RcvZ	Inline	Crossline	SrcNum	KTau11	KTau22	KTau33	KTau12	KTau13	KT
4 834 834 0 834 994 0 0 0 1	2	834	894	0	834	894	0	0	0 0	1	L					
5 834 894 0 834 1044 0 0 0 1	3	834	894	0	834	944	0	0	0 0	1	L					
6 834 834 0 834 104 0 0 0 1	4	834	894	0	834	994	0	0	0	1	L					
7 834 894 0 834 1144 0 0 0 1	5	834	894	0	834	1044	0	0	0 0	1	L					
8 834 834 0 834 1194 0 0 0 1	6	834	894	0	834	1094	0	0	0 0	1	L					
9 834 894 0 834 1244 0 0 0 1 10 834 894 0 834 1244 0 0 0 1 - <td>7</td> <td>834</td> <td>894</td> <td>0</td> <td>834</td> <td>1144</td> <td>0</td> <td>0</td> <td>0 0</td> <td>1</td> <td>L</td> <td></td> <td></td> <td></td> <td></td> <td></td>	7	834	894	0	834	1144	0	0	0 0	1	L					
10 834 894 0 834 1294 0 0 0 1 <td< td=""><td>8</td><td>834</td><td>894</td><td>0</td><td>834</td><td>1194</td><td>0</td><td>0</td><td>0 0</td><td>1</td><td>L</td><td></td><td></td><td></td><td></td><td></td></td<>	8	834	894	0	834	1194	0	0	0 0	1	L					
111 834 894 0 834 1344 0 0 0 1 <t< td=""><td>9</td><td>834</td><td>894</td><td>0</td><td>834</td><td>1244</td><td>0</td><td>0</td><td>0 0</td><td>1</td><td>L</td><td></td><td></td><td></td><td></td><td></td></t<>	9	834	894	0	834	1244	0	0	0 0	1	L					
121 834 894 0 1034 894 0 0 0 1 <t< td=""><td>10</td><td>834</td><td>894</td><td>0</td><td>834</td><td>1294</td><td>0</td><td>0</td><td>0</td><td>1</td><td>L</td><td></td><td></td><td></td><td></td><td></td></t<>	10	834	894	0	834	1294	0	0	0	1	L					
13 834 894 0 1034 994 0 0 0 1 <td< td=""><td>11</td><td>834</td><td>894</td><td>0</td><td>834</td><td>1344</td><td>0</td><td>0</td><td>0 0</td><td>1</td><td>L</td><td></td><td></td><td></td><td></td><td></td></td<>	11	834	894	0	834	1344	0	0	0 0	1	L					
14 834 894 0 1034 994 0 0 0 1 <td< td=""><td>12</td><td>834</td><td>894</td><td>0</td><td>1034</td><td>894</td><td>0</td><td>0</td><td>0 0</td><td>1</td><td>L</td><td></td><td></td><td></td><td></td><td></td></td<>	12	834	894	0	1034	894	0	0	0 0	1	L					
15 834 894 0 1034 1044 0 0 0 1 <t< td=""><td>13</td><td>834</td><td>894</td><td>0</td><td>1034</td><td>944</td><td>0</td><td>C</td><td>0 0</td><td>1</td><td>1</td><td></td><td></td><td></td><td></td><td></td></t<>	13	834	894	0	1034	944	0	C	0 0	1	1					
16 834 894 0 1034 1094 0 0 0 1 17 834 894 0 1034 1144 0 0 0 1 18 834 894 0 1034 1194 0 0 0 1 18 834 894 0 1034 1194 0 0 0 1 18 834 894 0 1034 1244 0 0 0 1 18 834 894 0 1034 1244 0 0 0 1 18 834 894 0 1034 1244 0 0 0 1 <td>14</td> <td>834</td> <td>894</td> <td>0</td> <td>1034</td> <td>994</td> <td>0</td> <td>C</td> <td>0 0</td> <td>1</td> <td>L</td> <td></td> <td></td> <td></td> <td></td> <td></td>	14	834	894	0	1034	994	0	C	0 0	1	L					
17 834 894 0 1034 1144 0 0 0 1 <t< td=""><td>15</td><td>834</td><td>894</td><td>0</td><td>1034</td><td>1044</td><td>0</td><td>C</td><td>0 0</td><td>1</td><td>L</td><td></td><td></td><td></td><td></td><td></td></t<>	15	834	894	0	1034	1044	0	C	0 0	1	L					
18 834 894 0 1034 1194 0 0 0 1 19 833 894 0 1034 1244 0 0 0 1 19 834 894 0 1034 1244 0 0 0 1 10 833 894 0 1034 1244 0 0 0 1 10 <th10< th=""> <th10< th=""> 10</th10<></th10<>	16	834	894	0	1034	1094	0	C	0 0	1	Ĺ					
19 834 894 0 1034 1244 0 0 0 1 Note: Section: Sectio	17	834	894	0	1034	1144	0	0	0	1	L					
A B C D E F G H I J K L M N 934 894 0 1234 1944 0 0 1	18	834	894	0	1034	1194	0	0	0 0	1	L					
And Control Contro Control Control Control <td>19</td> <td>834</td> <td>894</td> <td>0</td> <td>1034</td> <td>1244</td> <td>0</td> <td>0</td> <td>0 0</td> <td>1 1</td> <td>L</td> <td></td> <td></td> <td></td> <td></td> <td></td>	19	834	894	0	1034	1244	0	0	0 0	1 1	L					
Name Los Los Note Los Note No Note Note Note	н	DME INSERT PA	GE LAYOUT FORM	NULAS DATA BE	VIEW VIEW					1. 4					7 🗉 –	• +
A B C D E F G H I J K L M N 934 894 0 1234 894 0 0 0 1 - <t< th=""><th>н</th><th>DME INSERT PA</th><th>GE LAYOUT FORM</th><th>NULAS DATA BS s Bar Q gs Zoom 100%</th><th>VIEW VIEW</th><th>Split.</th><th>C: View Side by Side D: Synchronous Scr D: Beset Window P</th><th></th><th>Aacros</th><th>: 4</th><th></th><th>) (R)</th><th></th><th></th><th>7 🗉 –</th><th>• +</th></t<>	н	DME INSERT PA	GE LAYOUT FORM	NULAS DATA BS s Bar Q gs Zoom 100%	VIEW VIEW	Split.	C: View Side by Side D: Synchronous Scr D: Beset Window P		Aacros	: 4) (R)			7 🗉 –	• +
934 894 0 1234 894 0 0 0 1	HO Page Br Previe Workt	MAE INSERT PA	GE LAVOUT FORM ∂ Ruler ☑ Formuk ⊘ Gridlines ☑ Headin Show	a Bar Q h	Zoom to election Window A	Split Split Panes - Unhide V	View Side by Side Synchronous Scr Baset Window Pa Window	olling Switch Suition Windows *	Aacros	i d		, R	•		7 🗉 –	⊷+ 5/X
934 894 0 1234 944 0 0 0 1	Page Br Previe Workt	ME INSERT PA eak Page Custom w Layout Views sook Views * 1 X V ,	IGE LAVOUT FORM \exists Ruler \bigtriangledown Formula \exists Gridlines $$ Heading Show f_X	a Bar gs Zoom 100% Zoom	Zoom to New Arra Vindow A	v	Vindow	e olling Switch Windows •	dacros dacros			R	•		7 E — Stefan Prisacari	5/X
934 894 0 1234 994 0 0 1 934 894 0 1234 1044 0 0 1 934 894 0 1234 1094 0 0 1 1 934 894 0 1234 1094 0 0 0 1 <t< td=""><td>Page Br Previe Workt</td><td>MME INSERT PA</td><td>GE LAVOUT FORM Ruler I Formula Gridlines I Heading Show B B</td><td>s Bar gs Zoom 100% Zoom</td><td>Coom to New Arra Relection Window A</td><td>E</td><td>F</td><td>G</td><td>dacros H</td><td>I</td><td>J</td><td>ĸ</td><td>°^</td><td></td><td>7 E — Stefan Prisacari</td><td>5/X</td></t<>	Page Br Previe Workt	MME INSERT PA	GE LAVOUT FORM Ruler I Formula Gridlines I Heading Show B B	s Bar gs Zoom 100% Zoom	Coom to New Arra Relection Window A	E	F	G	dacros H	I	J	ĸ	°^		7 E — Stefan Prisacari	5/X
934 894 0 1234 1044 0 0 0 1 934 894 0 1234 1094 0 0 0 1 934 894 0 1234 1144 0 0 0 1 934 894 0 1234 1194 0 0 0 1 934 894 0 1234 1244 0 0 0 1 934 894 0 1234 1244 0 0 0 1 934 894 0 1234 1244 0 0 0 1 934 894 0 834 894 0 0 0 2 984 894 0 834 994 0 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1094 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1244 0 0 2 984 894 0 834 1244 0 0 <td< td=""><td>Page Br Previe Workt</td><td>AME INSERT PA</td><td>GE LAVOUT FORM Ruler ♥ Formula Goldlines ♥ Headin Show fx B B 894</td><td>s Bar gs Zoom 100% Zoom C 0</td><td>D 1234</td><td>E 894</td><td>F O</td><td>G G G G</td><td>H O</td><td>I</td><td>J</td><td>ĸ</td><td>°</td><td></td><td>7 E — Stefan Prisacari</td><td>5/x</td></td<>	Page Br Previe Workt	AME INSERT PA	GE LAVOUT FORM Ruler ♥ Formula Goldlines ♥ Headin Show fx B B 894	s Bar gs Zoom 100% Zoom C 0	D 1234	E 894	F O	G G G G	H O	I	J	ĸ	°		7 E — Stefan Prisacari	5/x
934 894 0 1234 1094 0 0 1 934 894 0 1234 1144 0 0 1 934 894 0 1234 1194 0 0 1 934 894 0 1234 1194 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1344 0 0 1 934 894 0 834 894 0 0 0 1 984 894 0 834 944 0 0 2 1 1 984 894 0 834 944 0 0 2 1 <td< td=""><td>Page Br Previe Workt</td><td>A 934</td><td>GE LAVOUT FORM Ruter ⊘ Formuti Gridlines ⊗ Headin Shaw Shaw B B 894 894 894</td><td>s Bar gs Zoom 100% Zoom 100% Zoom</td><td>D 1234 1234</td><td>E 894 944</td><td>F 0 0</td><td>G G O</td><td>H O O</td><td>I 1 1</td><td>J</td><td>ĸ</td><td>° °</td><td></td><td>7 E — Stefan Prisacari</td><td>5/X</td></td<>	Page Br Previe Workt	A 934	GE LAVOUT FORM Ruter ⊘ Formuti Gridlines ⊗ Headin Shaw Shaw B B 894 894 894	s Bar gs Zoom 100% Zoom 100% Zoom	D 1234 1234	E 894 944	F 0 0	G G O	H O O	I 1 1	J	ĸ	° °		7 E — Stefan Prisacari	5/X
934 894 0 1234 1144 0 0 1 934 894 0 1234 1194 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1344 0 0 1 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 <td>Page Br Previe Workt</td> <td>MME INSERT PA Reak Page Cuttorn Uspott Views A 934 934 934</td> <td>GE LAVOUT FORM I luter ♥ Formula Coditines ♥ Headin Show B 894 894 894 894</td> <td>a Bar gs Zoom 100% Zoom 0 0</td> <td>D 1234 1234 1234</td> <td>E 894 944 994</td> <td>F O O O</td> <td>G O O O O</td> <td>H O O O O</td> <td>I 1 1 1</td> <td>Ĵ</td> <td>ĸ</td> <td>Ĺ</td> <td></td> <td>? ⊡ — Stefan Prisacari</td> <td>5/X</td>	Page Br Previe Workt	MME INSERT PA Reak Page Cuttorn Uspott Views A 934 934 934	GE LAVOUT FORM I luter ♥ Formula Coditines ♥ Headin Show B 894 894 894 894	a Bar gs Zoom 100% Zoom 0 0	D 1234 1234 1234	E 894 944 994	F O O O	G O O O O	H O O O O	I 1 1 1	Ĵ	ĸ	Ĺ		? ⊡ — Stefan Prisacari	5/X
934 894 0 1234 1194 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1344 0 0 1 984 894 0 834 894 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1144 0 0 2 984 894 0	Page Br Previe Workt	MME INSERT PA Reak Page Cuttors Layout Views A 934 934 934 934	GE LAVOUT FORM B Mar	200m 10% 200 10%	D 1234 1234 1234 1234 1234	E 894 944 994 1044	F 0 0 0 0	G Oling Switch Windows O O O O O	Hacros H O O O O O	I 1 1 1	Ĵ	ĸ	L		? ⊡ — Stefan Prisacari	5/X
934 894 0 1234 1244 0 0 1 934 894 0 1234 1294 0 0 1 934 894 0 1234 1244 0 0 1 934 894 0 1234 1344 0 0 1 984 894 0 834 894 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1144 0 0 2 984 894 0	Page Br Previe Workt	ME INSERT PA esk Page Cutom P Lgoot View A 934 934 934 934 934	GE LAVOUT FORM Table ∑ Formula GedTies ∑ Headin B 894 894 894 894 894	200m 10% 200 200 200 200 200 200 200 200 200 2	D 1234 1234 1234 1234 1234 1234 1234	E 894 944 994 1044 1094	F O O O O O	G G O O O O O O O O O	H O O O O O O O O	I 1 1 1 1 1	J	ĸ	L		? ⊡ — Stefan Prisacari	5/X
934 894 0 1234 1294 0 0 1 934 894 0 1234 1344 0 0 1 984 894 0 834 894 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1244 0 0 2	Page Br Previe Workt	ME INSERT PA esk Page Cutom P Lgott Veres A 934 934 934 934 934 934 934	GE LAVOUT FORM Rule	a Bar ge Zoom 100% Zoom 100% Zoom 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	D 1234 1234 1234 1234 1234 1234 1234 1234 1234 1234 1234	E 894 944 994 1044 1094 1144	F 0 0 0 0 0 0 0	G G G O O O O O O O O O O O O O	H O O O O O O O O O O	I 1 1 1 1 1 1 1	J	K	È I		? ⊡ — Stefan Prisacari	5/X 2/9
934 894 0 1234 1344 0 0 1 984 894 0 834 894 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1244 0 0 2	Page Br Previe Workt	MME INSERT PA Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint Page Constraint Image: Constraint	GE LAVOUT FORM Bute ∑ Formul Share B 894 894 894 894 894 894 894	a Bar ge Zoom 100% Zoom 100% Zoom 100% Zoom 100% Zoom 100% Zoom 100% Zoom 100% Zoom 100% D 0 0 0 0 0 0 0 0 0 0	D D 1234 1234 1234 1234 1234 1234 1234 1234 1234 1234 1234 1234 1234 1234	E 894 944 994 1044 1094 1144 1194	F 0 0 0 0 0 0 0 0	G G G O O O O O O O O O O O O O	H O O O O O O O O O O O O	I 1 1 1 1 1 1 1 1 1	J	K	Ē I		? ⊡ — Stefan Prisacari	5/X
984 894 0 834 894 0 0 2 984 894 0 834 944 0 0 2 984 894 0 834 994 0 0 2 984 894 0 834 994 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1094 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1244 0 0 2	Page Br Previe Workt	MME INSERT PA Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second	GE LAYOUT FORM Buter → Formula Condines → Feeder B 8994 8994 8994 8994 8994 8994 8994 8994 8994	Bar 2000 100% 20000 100% 2000 100% 2000 100% 2000 100% 2000 100% 2000 100% 2	D 1234 1234 1234 1234 1234 1234 1234 1234	E 894 944 994 1044 1094 1144 1194 1244	F 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 1	J	K	È I		? ⊡ — Stefan Prisacari	5/X
984 894 0 834 944 0 0 2 984 894 0 834 994 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1094 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1244 0 0 2	Page Br Previe Workt	MME INGERT PA Image: Constraint of the second views Image: Constrainton views Image: Constrainton views<	66 LAYOUT FORM Rule	Eur 2200 100% 2200 100% 200% 2	D 1234 1234 1234 1234 1234 1234 1234 1234	E 894 944 994 1044 1094 1144 1194 1244 1294	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G O O O O O O O O O O O O O O O O O O O	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 1 1	Ĵ	K	L L		? ⊡ — Stefan Prisacari	5/X
984 894 0 834 994 0 0 0 2 984 894 0 834 1044 0 0 2 984 894 0 834 1094 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1244 0 0 2	Page Br Previe Workt	MME INGERT PA Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the second views Image: Constraint of the se	66 LAVOUT FORM Paler Formula Formu	Eur 2200 100% 2200 00 000 00 00 00 00 00 00 00 00 00	D 1234 1234 1234 1234 1234 1234 1234 1234	E 894 944 994 1044 1094 1144 1194 1244 1294 1344	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Ĵ	K	L I		? ⊡ — Stefan Prisacari	5/X
984 894 0 834 1044 0 0 2 984 894 0 834 1094 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1144 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1244 0 0 2	HC Page Bi Previo Works	NME INGERT PA Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views	GE LAVOUT FORM Rule: ▼ Formula Coditions ♥ Headin B 894 894 894 894 894 894 894 894	Ebr 22000 100%; 22000 000% 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	D 1234 1234 1234 1234 1234 1234 1234 1234	E 894 994 1044 1094 1144 1194 1244 1294 1344 894	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 1 1 2	Ĵ	K			? ⊡ — Stefan Prisacari	5/X
984 894 0 834 1094 0 0 0 2 984 894 0 834 1144 0 0 0 2 984 894 0 834 1194 0 0 0 2 984 894 0 834 1194 0 0 2 984 894 0 834 1244 0 0 2	HC Page Bi Previo Works	NME INGERT PA Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Construction of the second views Image: Consecond vie	GE LAVOUT FORM Rule: Codines B B B B 894 8	Ebr 0 pr 2200m 100% 2200m 000 0 0 0 0 0 0 0 0 0 0 0 0	D 1234 1234 1234 1234 1234 1234 1234 1234	E 894 944 1044 1094 1144 1194 1244 1294 1344 894 944	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2	Ĵ	K			? ⊡ — Stefan Prisacari	5/x
984 894 0 834 1144 0 0 0 2 984 894 0 834 1194 0 0 0 2 984 894 0 834 1244 0 0 2	HC Page Bi Previo Works	MME INGET PA Image: Page Current Views Image	GE LAVOUT FORM Rule: Codines B B B B B B B B B	E Bar ge 2 Zeem 100% , Zeem 0 0 0 0 0 0 0 0 0 0 0 0 0 0	D 1234 123	E 894 944 994 1044 1094 1144 1194 1244 1294 1344 894 994	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2	J	K			7 E — Stefan Prisacari	5/x
984 894 0 834 1194 0 0 0 2 984 894 0 834 1244 0 0 2	HC Page Bi Previo Works	MME INGET PA Image: Constraint Page Constraint Versus Image: Constraint Versus Image: Constraint Versus A 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 984 984 984	GE LAVOUT POBM Rule: Codines B B B B B B B B B	E Bar ge 2 Zoom 100% , Zoom 100% , Zoom 0 0 0 0 0 0 0 0 0 0 0 0 0 0	D 1234 123	E 894 944 1044 1094 1144 1194 1244 1294 1344 894 994 994 1044	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2	J	K			7 E — Stefan Prisacari	5/x
984 894 0 834 1244 0 0 0 2	HC Page Bi Previo Works	MME INGET PA Image: Constraint of the second versus Image: Constraint versus Image: Constraint versus A 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 984 984 984 984 984 984	GE LAVOUT COBM Cadina C Formal Share Share B 894 894 894 894 894 894 894 894	E Bar ge 2 Zoem 100% , Zoem 100% , Zoem 0 0 0 0 0 0 0 0 0 0 0 0 0 0	D 1234 123	E 894 944 1044 1094 1144 1194 1244 1294 1344 894 994 1044 1094	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2	J	K			7 E — Stefan Prisacari	5/x
	HC Page Bi Previo Works	MME INGET PA Image: Constraint of the second versus Image: Constraint versus Image: Constraint versus A 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 934 984 984 984 984 984 984	GE LAVOUT COBM Padre ☐ Formal Shares B B B B B B B B B	E Bar ge 2 Zoem 100% 2 Zoem 100% 2 Zoem 0 0 0 0 0 0 0 0 0 0 0 0 0 0	D 1234 123	E 894 994 1044 1094 1144 1194 1244 1294 1344 894 994 1044 1094 1144	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2	J	K			7 E — Stefan Prisacari	5/X
	HC Page Bi Previo Works	MME INGET PA Image: Page Call Image: Page Call Image: Page Call Image: Page Call 934 934 934 Image: Page Call	GE LAVOUT COBM Patter ☐ Formal Statuse Gedituse Gedituse B 894 8	E Bar 6 ge 2 Zoem 100% , Zoem 100% , Zoem 0 0 0 0 0 0 0 0 0 0 0 0 0 0	D 1234 123	E 894 994 1044 1094 1144 1194 1244 1294 1344 894 994 1044 1094 1144 1194	F 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	H 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2	J	K			7 E — Stefan Prisacari	5/X

Once the <u>SrcNum</u> column has all been filled, save and overwrite the existing *survey3d.txt* file with the updated one (make sure to also save it in TXT format). Afterwards, go back your map frame which contains the previously built 3D survey and click <u>Run>Run 3D</u> <u>Modelling>Yes</u>.



Once the computation is complete, the total number of seismograms produced will equal the total number of shot groupings. For the example above, you will end up with a total of 2 shot gathers, (one for the 5 grouped sources and another one for the remaining 95 grouped sources).

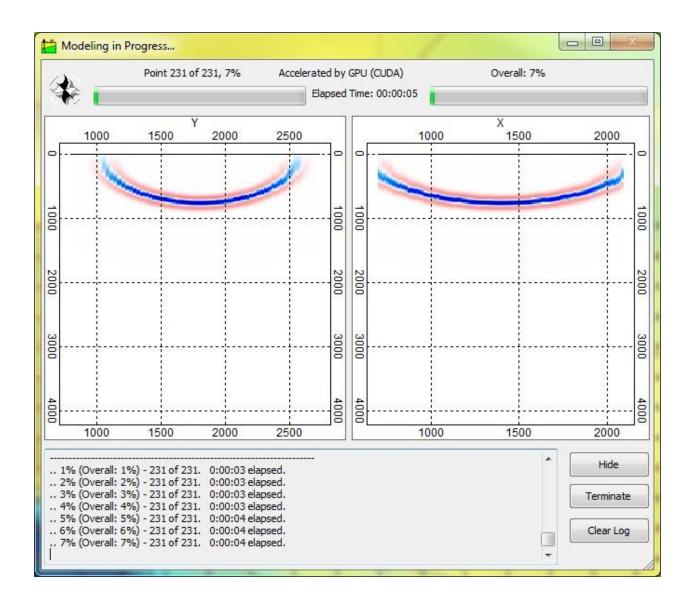
8.3 Double couple sources in 3D modelling

It is now possible to simulate arbitrary oriented double couple sources, expressed by stress matrices (or moment tensors) in *survey3d.txt*.

This functionality can be implemented for any 3D modelling method (except for the 3D acoustic).

In order to implement it, the user will first need to load a surface (see Section 14) and build a 3D observation system (see Section 7). Afterwards click <u>Run>Run 3D Modelling</u> and follow the instruction in Section 5. After specifying all modelling settings click Finish and Run modelling.

Run Modeling	×
The most important modeling p	roperties is:
Modeling Procedure	3D Acoustic
Source	1 shot points
Shotgahter Record	[04000], step 2
Wavelet	20 Hz, Ricker
Snapshots	No
Enable GPU	Yes
and others	< Back to Modeling Wizard
RUN	N MODELING Quit



Click Terminate, as soon as at least 1% of the job has been completed.

Once the job has been terminated, locate the *survey3d.txt* file from the recently created job folder and open it in Microsoft Excel. The *survey3d.txt* contains the XYZ coordinates of every source-receiver pair of the designed 3D survey (i.e. the coordinates of every trace) and the user will have to fill the entire <u>Inline</u>, <u>Crossline</u> columns with zeros and the <u>SrcNum</u> with -1, which simply disables it during computation!

mal	Page Break Page Cust Preview Layout View Workbook Views	Show	Headings Zoom	100% Zoom to Selection Zoom	Arrange Freeze		aus Scrolling Swit	ch Macros						
	В	C	D	E	F	G	Н	I	J	К	L	М	N	0
1	SrcY	SrcZ	RcvX	RcvY	RcvZ	Inline	Crossline	SrcNum	KTau11	KTau22	KTau33	KTau12	KTau13	KTau23
2	894	0	834	894	0	0	C	-1	0.707	-0.707	0	C	0	0
3	894	0	834	944	0	0	C	-1	0.707	-0.707	0	C	0	0
4	894	0	834	994	0	0	C	-1	0.707	-0.707	0	C	0	0
5	894	0	834	1044	0	0	C	-1	0.707	-0.707	0	C	0	0
6	894	0	834	1094	0	0	C	-1	0.707	-0.707	0	C	0	0
7	894	0	834	1144	0	0	C	-1	0.707	-0.707	0	C	0	0
8	894	0	834	1194	0	0	C	-1	0.707	-0.707	0	C	0	0
9	894	0			0						0		-	0
10	894	0	834		0	0	C	-1	0.707	-0.707	0	C	0	0
11	894	0	834	1344	0	0	C	-1	0.707	-0.707	0	C	0	0
12	894	0		894		0	C	-1			0	C	0	0
13	894	0		944	-						0			0
14	894	0		994	0			2	10700000000		0	C	0	0
15	894	0		1044	0	0	-		0.707		0	-	-	0
16	894	0	1034	1094	0	0	C) -1	0.707	-0.707	0	C	0	0
17	894	0	1034	1144	0	0	C) -1	0.707	-0.707	0	C	0	0
18	894	0	1034	1194	0	0	C	-1	0.707	-0.707	0	C	0	0
19	894	0	1034	1244	0	0	C) -1	0.707	-0.707	0	C	0	0

Introduce the moment tensor for <u>KTau11</u>, <u>KTau22</u>, <u>KTau33</u>, <u>KTau12</u>, <u>KTau13</u>, <u>KTau23</u>, for all relevant sources.

Please make sure to assign identical moment tensors to all traces, pertaining to a unique source. In other words, the moment tensor needs to remain constant for every source-receiver pair in the table.

Once the KTau columns have been filled, save and overwrite the existing survey3d.txt

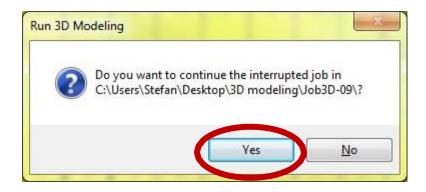
file with the updated one (make sure to also save it in TXT format).

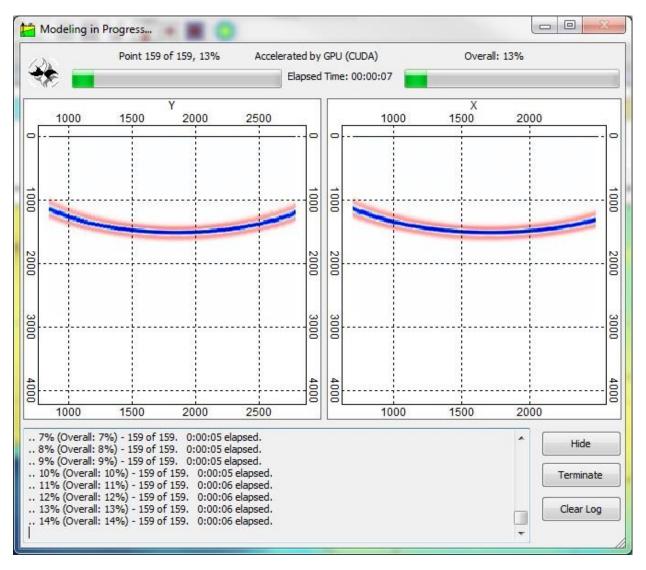
Now open the *runtask.ini* file, located in the same modelling folder as *survey3d.txt* and change

[Source] Type=0; Omnidirectional To [Source] Type=10; Double Couple

Afterwards, save the *runtask.ini* file (File>Save) in the exact same location.

Then, go back your map frame which contains the previously build 3D survey and click Run>Run 3D Modelling>Yes.





8.3.1 Using the same moment tensor for all sources

If the user would like to use the same moment tensor for all sources in the 3D survey, then it is sufficient to **ONLY** modify the *runtask.ini* file as follows (leaving the *survey3d.txt* intact):

Remove

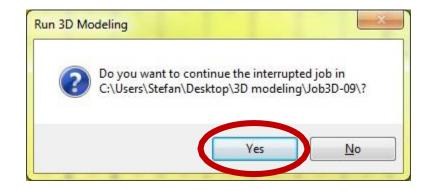
[Source]

Type=0; Omnidirectional And replace it with:

[Source]

Type=8; K11=...; K22=...; K33=...; K12=...; K13=...; K23=...;

Once the moment tensor has been specified, save the *runtask.ini*, go back to your map frame which contains the previously build 3D survey and click Run>Run 3D Modelling>Yes.



8.3.2 Using 2D douple couple sources for 3D modeling

It is also possible to have all double couple source propagate in 2D only (i.e. in XZ, YZ or XY direction). For that you will have to modify the *runtask.ini* file as follows:

Remove:

[Source] Type=0; Omnidirectional

And replace it with:

[Source] Type=8; DoubleCoupleAxis=XZ

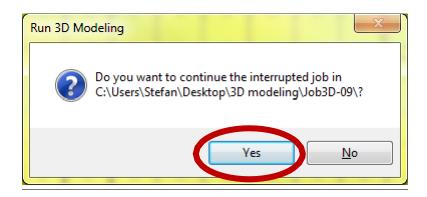
Or

Type=8 DoubleCoupleAxis=XY

Or

Type=8 DoubleCoupleAxis=YZ

Afterwards, save the *runtask.ini*, go back your map frame which contains the previously build 3D survey and click <u>Run>Run 3D Modelling>Yes</u>.



9 3D Full-Wave Modeling

To run 3D Acoustic and Elastic full-wave modeling you"ll need to:

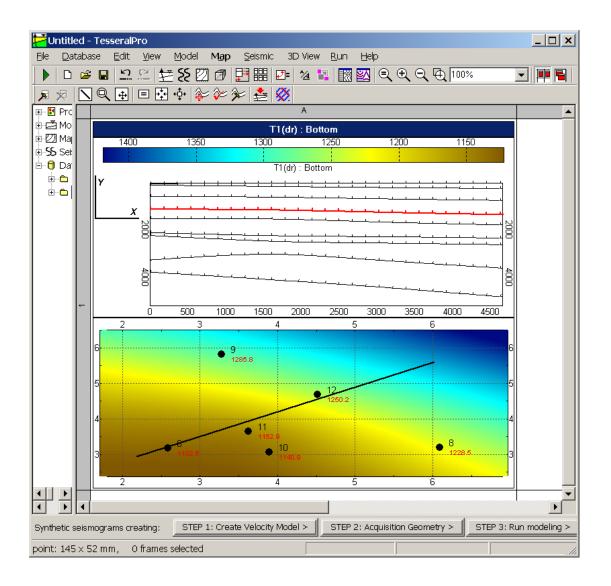
- 1. Build a 3D model as a seismic cube SEG-Y file (.sgy)
- 2. Setup 3D survey geometry
- 3. Setup modeling parameters

9.1 3D model as a seismic cube

Using command $\underline{\texttt{Map}} > \texttt{Create} \ \underline{\texttt{Map}}$ create new frame $\underline{\texttt{Map}}$ with the surfaces form DB or GRD-files

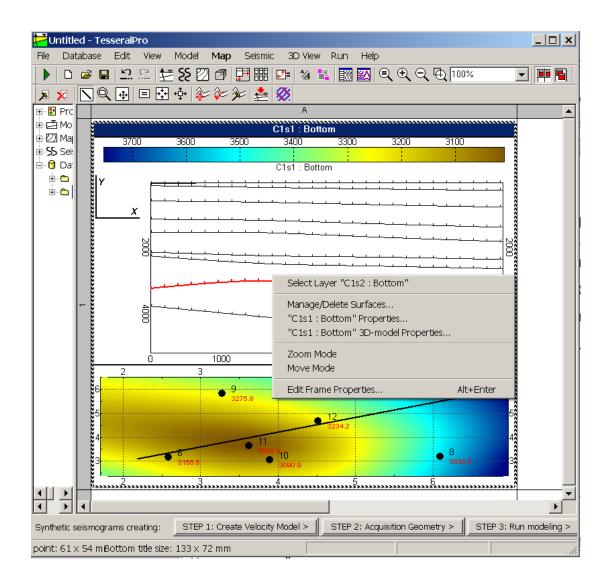


Use command Map > Section mode to draw the section (profile) line on <u>Map</u> frame. The section with the layers should appear in top title.



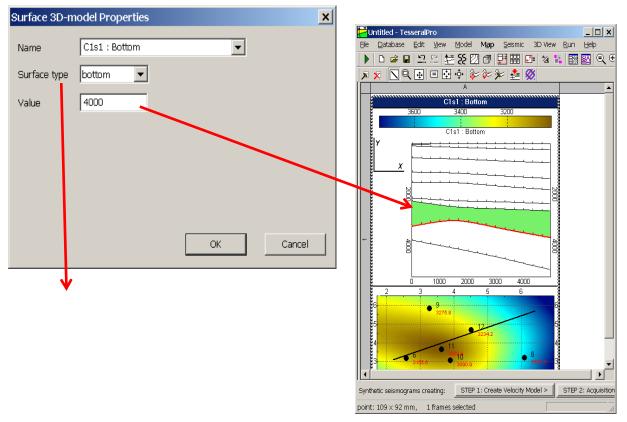
If you can't see the section, please expand the heading area by the mouse.

The highlighted by red color layer is the currently active one (it is shown in the frame). Right-click on top title and select the command «<u>Select Layer</u>» to choose another active layer. Then right-click on button «... <u>3D model</u>».



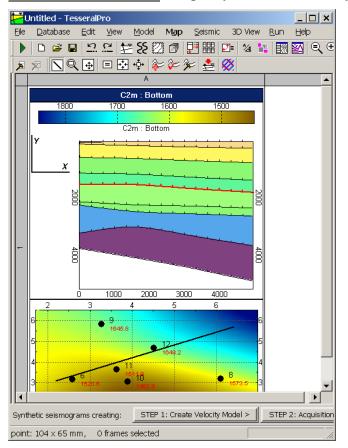
This command can also be accessed by menu Map > Active Map > 3D model properties.

In the dialog <u>3D model properties</u> option <u>Map type</u>: select <u>top</u> to assign velocity values *beneath* the surface, or <u>bottom</u> – *above* the surface.



Then right-click on section and use command <u>Select Layer "..."</u> and <u>"..."</u> 3D

model Properties to specify velocities in all layers.



For adjusting palette of the section's velocities (not map) use the button $\times \underline{\text{Edit Bottom}}$ $\underline{\text{Title}} \times in$ the Map > Map Frame Properties dialog, then \times Show Section Palette \times .

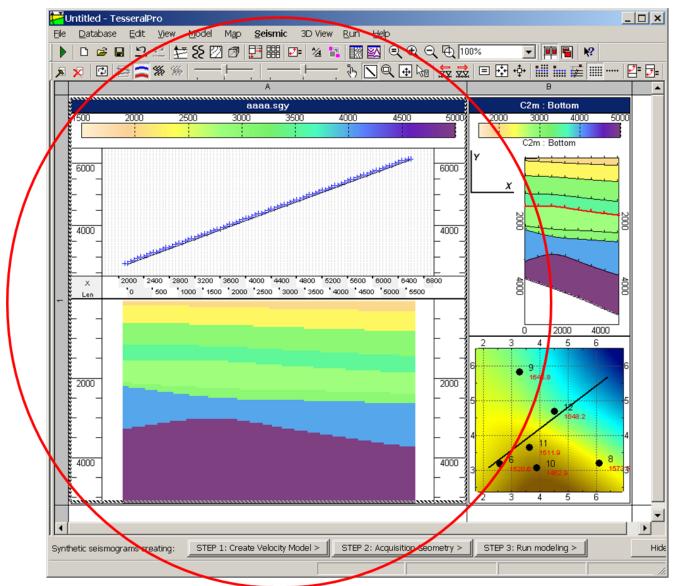
Map Bottom Title			×
Size			
Width (mm)	85	[Font
Hight (mm)	72		Background
Palette Show Se	ection Palette	Height (%)	100 *
Section	Autocalc Dept	۱ <u> </u>	
	Тор 27.8	m	
	Bottom 5197.6	m	
	Fill Section Palett	e type	
		ОК	Cancel

To create 3D SGY file use command <u>Run > Map Frame > Create 3D Seg-Y</u> and adjust grid parameters:

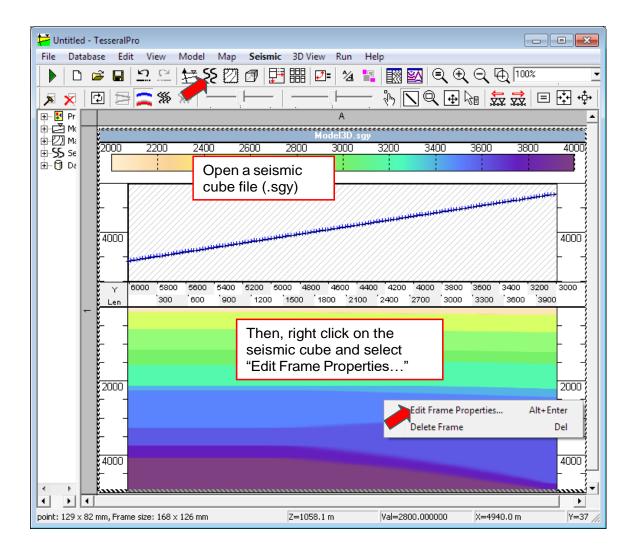
Create 3D Seg-Y N	1odel					×
Output seg-y file	C:\TEM	1P\2014-02-0	7\aaaa.sgy			
	_Grid p	arameters —				7
		Min	Max	Step	Size	
	x	1750	6950	50	105	
	Y	2400	6500	50	83	
	z	0	5150	50	104	
		Set "Mir	n" and "Max" fron	n Map Frame		
	Filling	cells				_
	Value	by default	6000	K		
	F	illing of empty	y values from the	upper cells		
				OK	Can	cel

If there is no velocities data in the model, the program will use the default values.

Result:



When you have 3D model as seismic SGY file with the cube of velocities, open it:

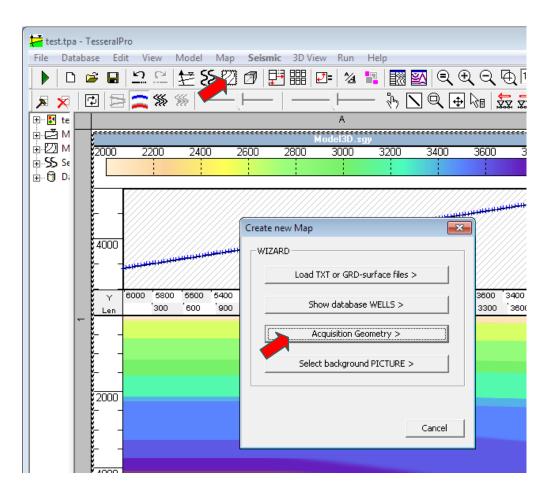


Seismic Propertie	(×
Common Plane Trace Scale		
_ Show	Profile Line	
View Mode: View as a model 🗨	🖊 🗖 Extend line	
Traces per page: 100	by: 20 m	
✓ Draw horizontal section ✓ Popup current shot's X,Y		
Coordinate Orientation	Receivers	
	C Black crosses	
↓ ↓ × × ↓ ↓ ↓	C ay dots	
	Contour	
	C None	
OK Cancel	Apply Help	

It is handful to change seismic view mode to "Contour" in the Seismic Frame"s properties

9.2 Design 3D acquisition geometry

Next step is creating of a Map Frame to build 3D acquisition geometry



Use the <u>Acquisition Geometry Wizard</u> to design the survey. These steps are skipped here. For detailed description of 3D survey design please see section 7 of this manual.

Sun	vey bearings			— ———————————————————————————————————
	ORIGIN (0:0):	X beg. 0	m Ybeg. 0	m
	INLINE:	Lenght 1000	m Azimuth 0	deg
	CROSSLINE:	Lenght 1000	m Azimuth +9	0 🔻 deg
		< <u>B</u> ack	Finish Cano	el Help

It is important, however, to specify inline and crossline lengths of the observation zone.

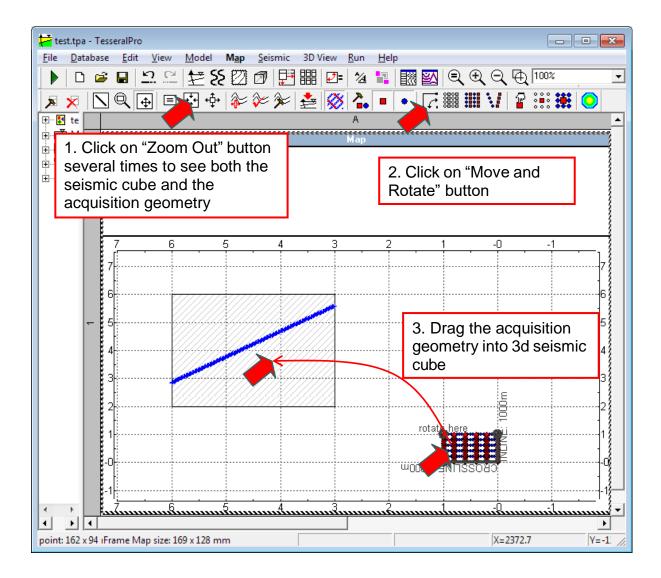
After the acquisition geometry is built now let's place the 3D seismic cube into the map and combine it together. Click on Edit Frame Properties button as shown below:

test.tpa - TesseralPro <u>F</u> ile <u>D</u> atabase <u>E</u> dit <u>V</u> iew <u>N</u>	<u>/</u> odel Map <u>S</u> eismic	3D View <u>R</u> un <u>H</u> u	elp		×
	₩ \$\$ 🖾 🖉 🗗) == ½ 肯	. 🔣 🖾 🔍 🗨	् 🕀 100%	•
🚽 🗶 🔍 🗣 🗉 🤆	፰ 💠 🌾 ≽	🛓 🚿 🐍 🗖	•	/ 🔒 🏥 🗰 🤇	
	Due a cuti e c"	A	******		▲
Click on "Edit Frame	Properties	Мар			
⊞					
<u>Y</u>					
					~
	1			-0	
1rotat	here	••••••••••	•	•••	13
		•		Ē	
	••••	• • • • • • • • • • • • • • • • • • •	••••		~~~~
	••••••		• • • • • • • •	·	0000
		•			-
		•			
	• • • • • • •		• • • • • • •	•	1
□		•	: :		
			₩0001":3NITSS	СВОЗ	
	1	I			
					• •
					1

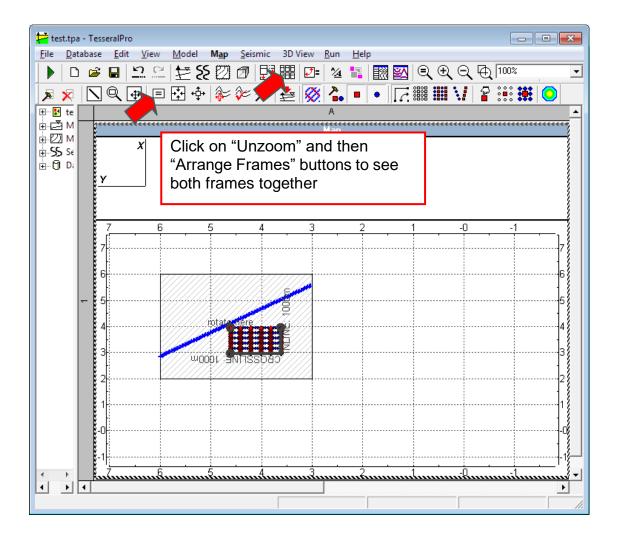
Enable "Draw Seismic frames plan" to combine the model with acquisition geometry on the map:

Map Properties			×
Edit top title V Edit bottom title	Size Width 104 Height 66 Work area	mm	Font Palette Background
Layers Active Layer ✓ Show Grid (fill color) ✓ Draw Isoline Font height (%)	90 🔹	Isolir	▼ nes Properties
Database wells Well Title At collar Value Color Font height Draw Well Inclinometry	▼ ht (%) 80 ÷	Backg	sition Geometry Draw Geometry round Show picture Background Picture
Seismic plan view Draw Seismic frames plan Draw sources from seismic file	Load		K Cancel

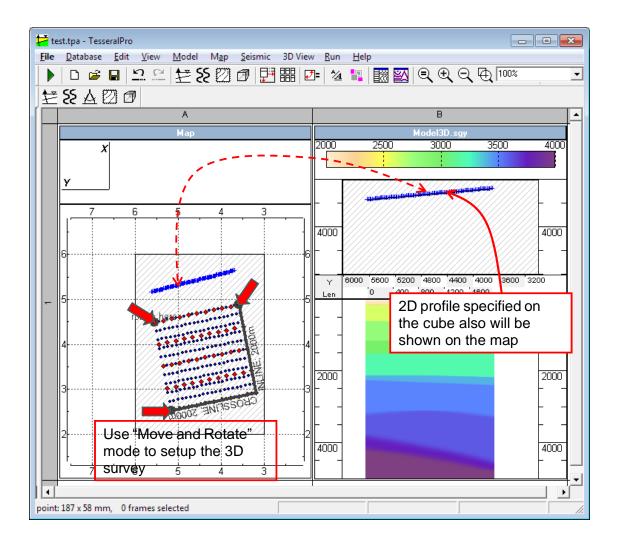
Click on "Zoom Out" several times so the seismic cube's area became visible on the map. Switch to "Move and Rotate" mode and drag the acquisition geometry into the model area.



Now, click on "<u>Unzoom</u>" and "<u>Arrange Frames</u>" to see the model with the acquisition survey.

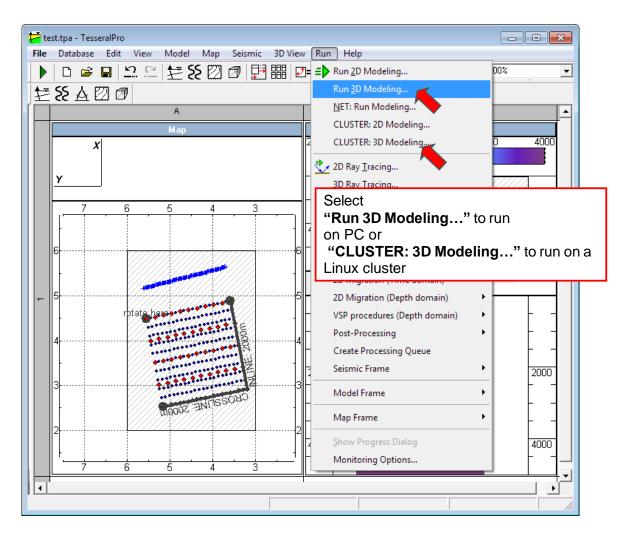


You can continue to design the survey by moving and rotating inline and crossline positions on the map. 2D profile drawn on the surface of the model seismic cube will be visible also on the map.



9.3 Setup modeling procedure and boundaries

After the seismic cube velocity model is loaded and the survey had been set up use either <u>"Run > Run</u> <u>3D Modeling ...</u> to setup and run the full-wave modeling or <u>"Run > CLUSTER: 3D</u> <u>Modeling ...</u> to create modeling job for Linux cluster.



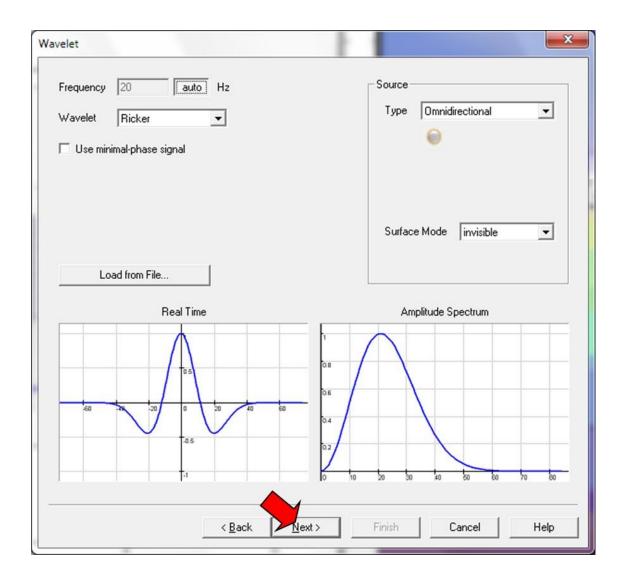
To run acoustic or elastic simulation a P-velocity cube must be provided. Density can be calculated automatically based on built-in correlation tables. The elastic simulation of the S- velocity cube may also be provided or calculated automatically.

Simulation of the special boundaries is automatically configured using P-velocity cube.

These boundaries could be adjusted manually if needed.

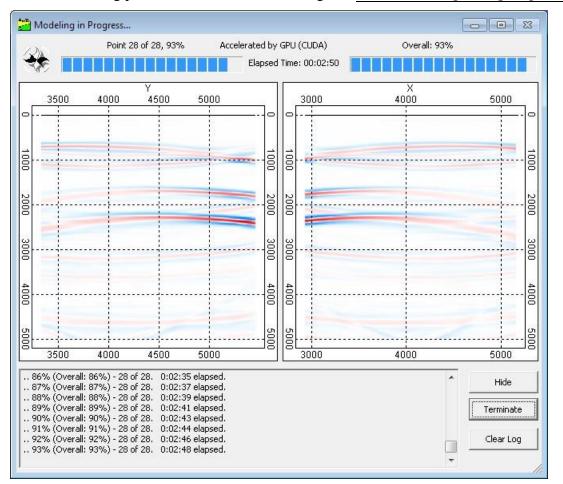
ſ	D Modeling General Properties		—
		coustic	Specify a velocity cube
	P-Velocity Cube File D:\Workdir\Test\Model: S-Velocity Cube File	3D.sgy Browse Browse	Required Not Used
Select Shot Points to simulate	Density Cube File Sources to compare From #: 100	Browse To #: 100 All	Auto
	Shotgahter Record Model Bo Start 0 ms X min Stop 2000 ms Y min Step 2 ms Z min	determin 2000 m 3000 m specified	pundary will be ed by the velocity t also it can be manually (to e depth for
	Save results to D:\Workdir\Test\Task' can specify a folder hich the task will be ed.	Next > Finish Cancel	Browse

Specify signal form, frequency and direction in the dialog window <u>Wavelet</u>:



3D Acoustic Calcula 3D Acoustic Calcula 3D Acoustic Calcula	
Computation Grid Properties Signal Frequency Cell (dx, dy, dz) Tact (dt) Tact (dt) Image: Tact (dt) <	Hardware Threads per process Max Enable GPU (if CUDA available) Required Memory (Host): 634 MB Required Memory (GPU): 1.5 GB Generate Time Field X Step: 12 m Y Step: 12 m
You can use "auto" buttons to Marg	(better suppresses reflections in most cases) gin also affects ired memory Memory estimation (per node) is available to evaluate resources required to run the simulation
< <u>B</u> ack <u>N</u> e	ext > Finist Cancel Help

9.3.1 Run 3D simulation on Windows PC



The 3D modeling process is monitored in a dialog box 3D Modeling in progress.

After the calculation is completed gathers of the X, Y, Z particle velocity and the pressure will be generated.

9.3.2 Run 3D simulation on Linux Cluster

The task contains:

- 1. The model seismic velocity cube
- 2. Acquisition geometry (survey32.txt)
- 3. Task settings (runtask.ini)

You can put this folder to a Linux cluster to run the faster parallel computation. Also the cluster engine will use all available memory to handle very large computation jobs.

Solution → Task	✓ 4y Search Task	<u>×</u>
Organize 👻 Include in library 👻 Share w	ith 🔻 Burn »	∷ - □ 0
Videos Name 3D Model Model3D.sgy Cube Image: Computer Image: Computer Image: Computer Image: Local Disk (€:) Image: Computer	Date modified 23.11.2007 12:40 03.12.2013 16:47 03.12.2013 16:47	Type SGY File Configuration sett Text Document
Modeling task settings 3 items State: 3 Shared	Acquisition geometry	4

10 Processing of seismic gather

Some of the commands in the Run menu are for processing generated synthetic gathers.

IMPORTANT NOTE!

All processing history and user defined settings are saved in the computation.log

10.1 General Purpose Procedures

In the <u>Model</u> Frame, the model consists of polygons (model in vector format). In some other programs such as ray tracing, migration and other processing procedures in Tesseral Pro, the input model is assumed to be in form of grid. To export <u>Model</u> Frame to a grid file, use the command <u>Run/General</u> Purpose Procedures/Export Model to Seismic Format (SEG-Y, TGR).

	Seismogram calculation	
	Seismic file name	Create a standard name for the output file
Grid step in the output file	C:\Users\Stefan\Desktop\Tesseral Data\Tests\SGY\Vertical_Inc Sampling Rate Step by lenght 47 m Step by depth 50 m	
Create files with grids of anisotropy	Export Medium Anisotropic Properties	
Limitations for values of parameters (in case thin-layering is formed from logging curves)	Components: value range Cancel	
\mathbf{h}		
	Component Units Min value Max value Compressional velocity m/s 100 10000	
(
	Shear velocity m/s 0 6000	
	OK Cancel	

The output file may be in SEG-Y format. For isotropic model, 3 output files are created for the compressional velocity, shear velocity (<name of the output file>–PQR_R.SGY) and density (<name of the output file>–PQR_Q.SGY) components respectively.

The output grid files may be in TGR format (i.e. the internal Tesseral format). Separate output files are created for all 3 components of the depth model (compressional, shear velocity and density), as well as anisotropy parameters if the checkbox Export Medium Anisotropic Properties was checked.

10.1.1 Copy Gather to SEG-Y Format

The command <u>Run > General Purpose Procedures > Copy Seismogram</u> to <u>SEG-Y</u> Format is used to transform files from the internal TGR or SDC PC formats into the standard SEG-Y format.

Copy seismog	gram to seg-y format
Input file	C:\Sheldon\TestingOfTesseralPro\Run\Md2+SnapEP.tgr
	Component Vertical Particle Velocity
	Write coordinate from model
Output file	C:\Sheldon\TestingOfTesseralPro\Run\Md2+SnapEP-VIEW.sc
	OK

The TGR format does not contain the geographical coordinates of the traces and the altitudes of the receivers. Check the box <u>Write coordinate from model</u> to obtain this information from the <u>Model</u> Frame and then write it into the trace header of the output SEG-Y file.

10.1.2 Split Seismogram by Shotgathers

The command <u>Run > General Purpose Procedures > Split</u> <u>Seismogram by</u> <u>Shotgathers</u> is for splitting merged synthetic gathers into separate files in terms of the number of shot points (one file for each shot gather).

Split seismo <u>c</u>	gram by sources
Input file	C:\Users\Stefan\Desktop\Tesseral Data\M1+GathAP-Z.sgy
	OK Cancel

10.1.3 Split SEG-Y File into Pieces of Limited Size

The command <u>Run > General Purpose Procedures > Split SEG-Y</u> File by <u>Limited Size Pieces</u> is to split the SEG-Y files into separate files, each file not exceeding the size specified in the <u>Output file Size (MB)</u> parameter.

Split SEGY File	2	×
Input file	C:\Sheldon\TestingOfTesseralPro\Ru	n\Md2+GathEP.sgy
	Output File Size (MB)	1000
	Temporary Memory Buffer Size (MB)	100
	C	OK Cancel

10.1.4 Merge Seismograms

The command <u>Run > General Purpose Procedures > Merge</u> <u>Seismograms</u> is for merging the selected files into one (the output file will have all the traces of the input files in the same order as they were entered in the list). If the coordinates of the selected files match each other exactly, the procedure will work differently (it will stack the traces and the output file will have the same number of traces as the input one). This procedure can be used to sum the different cubes after migration.

Merge seismogr	ams	x	
Files to merge	C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-1.sgy C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-2.sgy C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-3.sgy	 ×	Add file(s) to the group
		D	elete file(s) from the group
Component			
	Delete original files after successfull merging		
Output file	C:\Sheldon\TestingOfTesseralPro\Md2+GathEP.sgy		
	Cancel		

10.1.5 Cut Out Cube/Section traces (by coordinates bounded by a rectangle)

The command <u>Run > General Purpose Procedures > Cut Out Cube/Section</u> is mainly used for preparing field gathers for duplex wave migration or for extracting part of the traces falling into a user-defined rectangle. It can speed up DWM processing for a huge dataset.

ſ	ut part of cube
	Input file C:\Sheldon\TestingOfTesseralPro\Run\FieldGathers.sgy
Only traces inside t rectangle will be in	e region rectangre
output file.	X from m X to m
	Y from m
	Y to m The condition for selecting traces
	Add trace if Source or Receiver
	Output file C:\Sheldon\TestingOfTesseralPro\FieldGathers-CUT.sgy
	Cancel

10.1.6 3D Replication (create 3D grid by reproducing 2D cross-section)

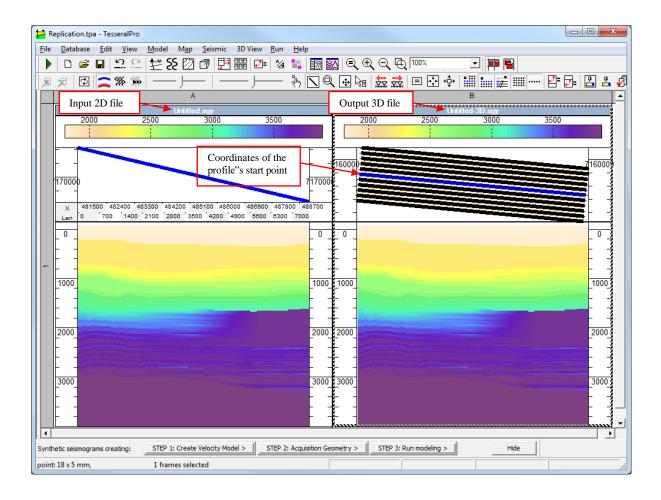
The command <u>Run > General Purpose Procedures > 3D Replication</u>

is used for:

- Creating the 3D acquisition data (multiple shot lines) from a single shot line (with multiple receiver lines) generated by 2.5D modeling to create a true 3D dataset from 2D acquisition.
- Creating a 3D velocity model from a 2D velocity model.

	Seismogram 3	D replication				×	
	Input file C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.TGR						
		Com	ponent	Compression V	elocity	-	
Initial coordinates and azimuth of the profile	Inline (Profi	e)		Crossline 🔫			The lines in the output 3D file
L	Azimuth	0	m	Left Limit	0	m	
	X beg.	0	m	Right Limit	0	m	
	Y beg.	0	m	Step	0	m	
Output file		C:\Sheldon\Te	stingOfTe	sseralPro\Untitlee	Car		

NOTE: <u>Input File</u> is a depth velocity model or gathers of a single shot line (grid in SEG-Y or TGR format). To obtain depth velocity model in SEG-Y or TGR format, the command Model > Export to Seismic Format (SEG-Y, TGR) is used.



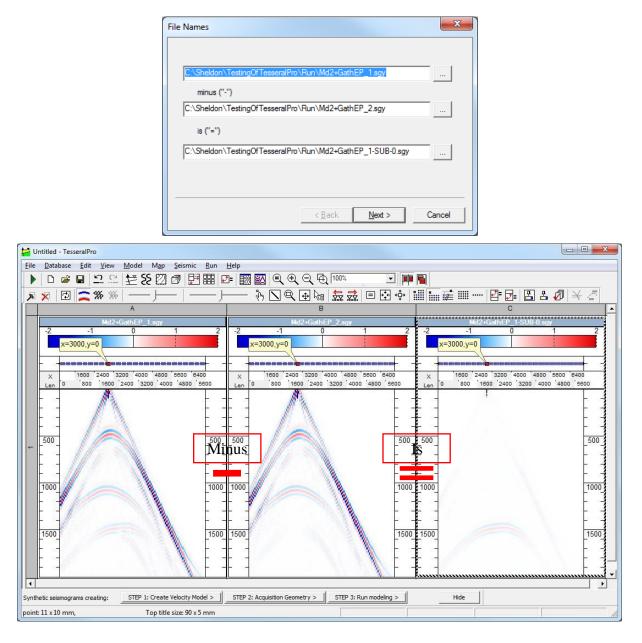
10.1.7 SEG-Y File Resampling

Choose the command Run > General Purpose Procedures > SEG-Y File Resampling.

Resampling	×
Input file	C:\Sheldon\TestingOfTesseralPro\Md2+GathEP.sgy
Output File	tingOfTesseralProVMd2+GathEP-RESAMPLING.sgy
	Input file trace step 2
	Output file trace step 4
	Cancel

10.1.8 Difference of 2 Seismograms

The command $\underline{\text{Run}} > \underline{\text{General Purpose Procedures}} > \underline{\text{Difference of 2}}$ Seismograms is used to calculate the difference between 2 synthetic gathers created by similar models. It may be used, for example, to evaluate how the perturbations of the model's parameters influences the output gather. It can also be used to obtain the differences between migrated cubes or sections.



10.1.9 Import/Export Traces Coordinates

The coordinates of sources and receivers in the headers of the traces can be exported into a text file using Run > Seismic Frame > Export Traces Coordinates.

The coordinates of sources and receivers in the text file can be imported by using <u>Run ></u> <u>Seismic</u> <u>Frame > Import Traces Coordinates</u>.

10.1.10 Write Visible Coordinates to Trace Headers

To write the modified coordinates of traces to the headers of seismic files, the command <u>Run</u> > Seismic Frame > Write Visible Coordinates to Trace Headers is used.

In Tesseral Pro, the seismic files can be displayed with transformed/rotated coordinates using the following commands:

- Seismic > Rotate to Align X Axis along Section Profile
- Run > General Purpose Procedures > Import Traces Coordinates (load coordinates of traces from text files)
- <u>View > Raw Trace View Window</u> (in this dialogue box, the trace coordinates can be assigned from non-conventional cells of the trace headers).

Please see Section 13 for more details.

After using the ways mentioned above to change the trace coordinates, the headers of the seismic files are not changed and the information on trace coordinates is written into an additional file <gather name>.inf for further use in the Tesseral Pro.

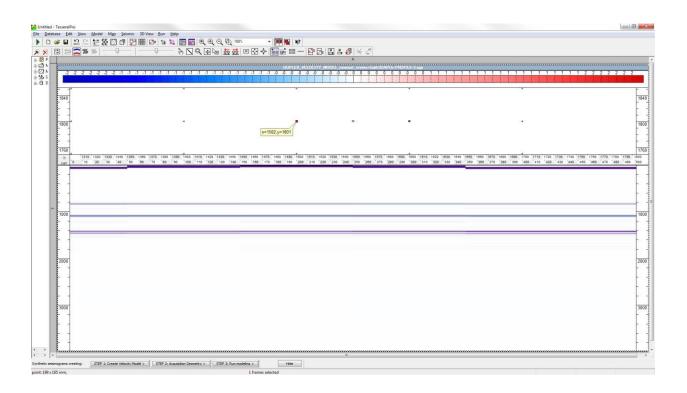
10.1.11 Cut Profile from 3D seismogram

This function is used for the extraction of shot gather traces along a straight line or a polyline from a 3D seismogram.

To access this function please load the 3D seismograms (File>Load Seismic file), followed by Run>General Purpose Procedures>Cut Profile from 3D seismogram.

Eile Datal	oase j	Edit View Model Map Seismic 30 View Bun Help	
	*	$\exists \Box = \exists E \otimes A = 0 0 0 0 0 0 0 0 0 0$	
8 0 0			
	200		2000
	160	xx1502,y=1001	1600
	Ler		1800
	-		
	100		1000
	-		
	200		2000
	300		3000
	1		
	-		<u>t</u>].
Synthetic sets	mogram	s creating:STIP 1: Create Velocity Model >STIP 2: Acquestor Generatry >STIP 1: Run modeling >Hide	,

(Cut profile fro	m cube			_		x
	Input file	C:\User	s\Stefan\Desktop	o\3D m	odeling\Job3D	0-01\DUPLEX_VEI	
	Profile by	line					
		X from	1301	m	X to	1796	m
		Y from	1790	m	Y to	1808	m
		Step	83	m			
		Export o	oordinates A	s is		-	
	Profile fro	m seismic f	file coordinates				
		C:\User	s\Stefan\Desktop	o\Tesse	erral Pro testir	ng new version\S	
	O Survey fro	om SPS file	:			Load SPS file	
	2.5D r	esult file					
1	Output file	C:\User	s\Stefan\Desktop	o\3D m	odeling\Job3D	0-01\DUPLEX_VEI	
				(OK	Cance	!



If you would like to extract the coordinates by line, then either specify the <u>X</u> from, <u>X</u> to, <u>Y</u> from, <u>Y</u> to and <u>Step</u> or draw the profile in the seismic frame <u>Seismic>Edit</u> <u>Mode>Draw Profile</u> before accessing the <u>Cut</u> Profile from <u>3D</u> seismogram

function (for additional information on profiles please see 13.5).

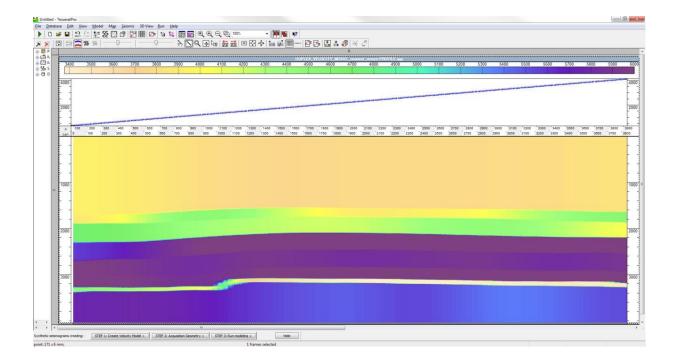
The traces can be also extracted according to the target survey geometry-<u>Survey</u> from SPS file (see Section 3.1.6), or from a text file of traces coordinates - <u>Profile</u> from Seismic File coordinates(see section 10.1.9).

10.1.12 Export Profile to 2D Seismic File

To export a 2D profile from seismic cube, first of all load the 3D cube (File>Load Seismic <u>file</u>), draw the profile in the seismic frame (see 13.5) followed <u>Run > Seismic Frame ></u> Export Map to 2D Seismic file.

3400 3500	3600 3700 3800	3900 4000 410		400 4500 46	00 4700 4800	4900 5000	5100 5200				800 5900
4000			and the second								لللغطيط
							ه و و و و		add a date of the sea		
						فسلمع فسلم فسلم	1 de la compañía de l				
2000				فخفععععم	and						
			and the second second								
	and a second and a second a se										
X 100 200	300 400 500 600	700 800 900 1000	100 1200 1300 1400 18 00 1500 1600 1700 1800 1900 20	00 1000 1700 1800	1900 2000 2100 2	200 2300 2400 21	00 2000 2700	2800 2900 3000	3100 3200 3300	3400 3500 3600	3700 3800
1000											
2000											
3000			A COLORED OF COLORED O								-

Create seismoo	gram from prof	île			×
File Name	C:\Users\Stef	an\Desktop\3D modeling\DUPLI	EX_VELOC	ITY_MODE	L_newsort_rev
- Traces cool	rdinate	Grid propertis			
Real coordinate		imes axes: Step by length	35	m	ОК
Along profile		Z axis: Step by depth (5	m	Cancel
					Cancer



10.1.13 Band-pass filter

Input fi	ile nd i	t's synte	tic seis	mogram∖	Elastic A2	b Model+Gat	thAP-Z.sgy	
Trape	ezoid Ang	les				1	_	
f1	5	Hz	f2	15	Hz	Ļ	112 1314	
f3	25	Hz	f4	30	Hz		20	m
								_
Output	tile amp	ie model	and it	s syntetic	: seismogr	ram\₿andpas	s filter.sgy	

The user can also multiply any signal spectrum in the frequency domain (equivalent to convolution in time domain) with a filter spectrum, by specifying the <u>F1</u>, <u>F2</u>, <u>F3</u>, <u>F4</u> corner frequencies of the trapezoidal frequency band-pass filter, as well as the <u>Length</u> of the filter in time domain.

10.2 Velocity model

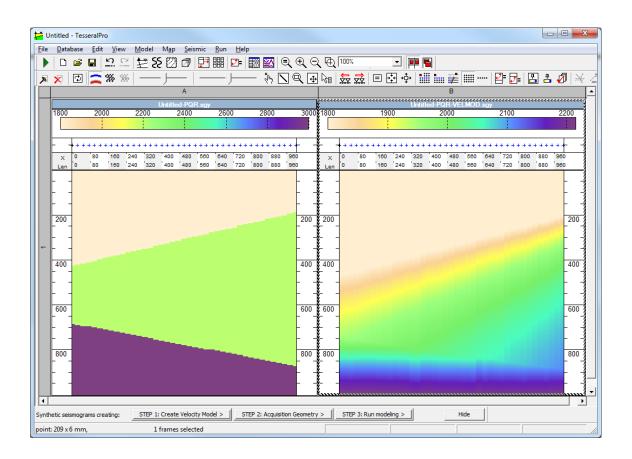
These procedures process the velocity model.

10.2.1 Average Velocities from Model

This is done by the command Run > Velocity Model > Average Velocities from Model

Average Velocity	y Model
-Layered Veloc	ity Model in Depth Scale
Input file	C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.sgy
-Average Velo	city Model in Time Scale
Max t0 (msec	c) 2000 Time Step (msec) 4
Output file	C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR-VELMOD.sgy
	Cancel

The <u>Input file</u> is the layered velocity model, which may be obtained from the <u>Model</u> Frame by the command Model > Export to Seismic Format (SEG-Y, TGR).



10.2.2 Depth-to-Time/Time-to-Depth conversion

The command <u>Run > Velocity Model> Depthto time</u> transformation transforms migrated sections (cubes) from depth domain to time domain.

Depth to Time transform	ation
Input file (Depth scale)	C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.s
	Component
Velocity seismic file	C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.s
	Depth scale Velocity Model
Output file (Time scale)	C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR-2
	Trace parameters (Output file)
	From 0 ms
	To 2000 ms
	Step 2 ms
	OK Cancel

NOTE: <u>Velocity seismic file</u> is the layered velocity model, which may have been obtained from the <u>Model</u> Frame by the command <u>Model > Export to</u> Seismic Format (SEG-Y, TGR) (please see Section 12.3.1 for details).

The commandRun >VelocityModel>Time toDepthTransformationtransforms the velocity model from time domain to the depth domain.

NOTE: <u>Velocity seismic file</u> is the file of layered model grid in time domain. It may have been created from the depth model by using the transformation <u>Depth to</u> <u>Time Transformation</u>. It means that, in the procedure <u>Depth to Time</u> <u>Transformation</u>, if the <u>Input file</u> and <u>Velocity seismic file</u> represent the velocity model, the <u>Output file</u> will be the same model but in time domain.

10.2.3 3D Interpolation

With the help of <u>Run>Velocity Model> Interpolation</u>, the user can resample the grid step for any 3D SGY cube by interpolating between adjacent grids.

To implement this function, first of all you will need to load the 3D SGY:

File>Load Seismic File followed by Run>Velocity Model>Interpolation.

Interpolation			×			
Please select Input model file:						
C:\Users\Stefan	\Desktop\Sta	andard training	material\2D 🛄			
Output cube						
Turn OFF	x	Y				
Min :	35	35				
Max :	3955	4515]			
Turn ON						
Point (0;0) :	35	35]			
Point (x;0) :	35	4515]			
Point (0;y) :	3955	35]			
For all :			1			
Step :	35	35				
	Min	Max	Step			
Z :	0	4070	5			
Output model file:						
C:\Users\Stefan	\Desktop\Sta	andard training	material\2D …			
	ОК	Cancel				

 $Reassign \ a \ new \ grid \ \underline{\texttt{Step}} \ a long \ X, \ Y, \ Z, \ as \ well \ as \ their \ \underline{\texttt{Min}} \ and \ \underline{\texttt{Max}} \ in \ \underline{\texttt{Turn}} \ \ \texttt{OFF} \ and \ click \ \underline{\texttt{OK}}.$

By default, the X, Y, Z coordinates for the whole cube are elected. The <u>Output model</u> file will have the newly reassigned grid step, as you can see in its trace headers.

10.3 Pre-Processing

These procedures are for preliminary processing.

10.3.1 Gathering

The procedure is intended for extracting gathers by the criteria of common shot point, common midpoint or common receiver point or obtaining gathers with common offsets. The procedure applies for both 2D and 3D gathers. Use the command Run > Pre-Processing > Gathering (GATHER).

Gathering (GATHER)		×
Input file	C:\Sheldon\Tes	tingOfTess	eralPro\Run\Md2+GathEP.sgy
	G	omponent	_
Axis X —			Bin 1 m
Start	0	m	
Stop	5000	m	Mode © Common Mid Point
Axis Y —			Common Mid Point
Start	0	m	C Common Shot Point
Stop	,	m	C Common Offset
	<u> </u>		Number of channels
- Samp	ling Rate		120 -
X Step	25	m	Number of seismograms
Y Step	0	m	1 *
Output file	C:\Sheldon\Tes	tingOfTess	eralPro\Run\Md2+GathEP-GATHER
			Cancel

10.4 Stack (Time domain)

The procedure is for time-domain stacking.

10.4.1 Kinematic corrections (Normal Moveout)

The <u>Normal Moveout</u> procedure applies kinematic corrections to gathers of various type, e.g., common midpoint gathers, common receiver gathers (Gathering program) and common shot gathers. The result is the time domain gathers after NMO correction. Use the command <u>Run > Stack</u> (Time domain) > Normal Moveout (NMO).

Normal Move	eout (NMO)
Input file	C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP.sgy
Velocity file	C:\Sheldon\TestingOfTesseralPro\Run\Md2-PQR-VELMOD.sgy
	⊙ m/s C ft/s
	Component
Axis X —	Axis Y
Start	0 m Start 0 m
Stop	5000 m Stop 0 m
Output file	C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-NMO.sgy
	OK Cancel

The average velocity model (parameter <u>Velocity file</u>) may be created from layered depth velocity model by the command <u>Run > Velocity Model > Average</u> <u>Velocities from Model</u>. To obtain a time slice of the subsurface image after Normal Moveout correction, use the <u>Stacking</u> procedure.

10.4.2 Stacking

The procedure <u>Stacking</u> is meant for stacking traces with a common coordinate after the <u>Normal</u> Moveout.

Before applying the <u>Staking</u> procedure, the kinematic correction needs to be applied using the <u>Normal Moveout</u> procedure. The command <u>Run > Stack (Time domain) > Stacking</u> (STACK) is used

Stacking (ST/	ACK)
Input file	C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-NMO.sgy
	Component
Axis X —	Axis Y
Start	0 m Start 0 m
Stop	5000 m Stop 0 m
Accuracy	Normalization © Just sum
	C Average of summed traces
	$\ensuremath{\mathbb{C}}$ Geometric mean of the above
Output file	C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-NMO-STACK.sg
	Cancel

Accuracy is the bin size used for stacking common depth point traces.

10.4.3 CMP Stack

This is used for direct creation of time section by common midpoints (midpoint stacks) without applying the procedures Normal Moveout and Stacking. The CMP Stack procedure uses the medium"s average velocity (parameter Velocity file). The command Run > Stack (Time domain) > CMP Stack (SUM) is used.

CMP Stack (S	UM)
Input file	C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP.sgy
Velocity file	C:\Sheldon\TestingOfTesseralPro\Run\Md2-PQR-VELMOD.sgy
	Component
Axis X —	Axis Y
Start	0 m Start 0 m
Stop	5000 m Stop 0 m
Accuracy	1 m
	Gradient 0.5
Output file	C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-SUM.sgy
	OK Cancel

The average velocity model may be created from layered depth velocity model by the command <u>Run ></u> <u>Velocity Model > Average Velocities from Model</u>. The <u>Gradient</u> parameter is for NMO stretch mute.

10.4.4 Dip Moveout Stack

The user can also implement a <u>Dip Moveout Stack</u> (which implements NMO correction first, followed by DMO correction and stacking, i.e. 3 in 1).

It is well known that conventional normal moveout correction (NMO) introduces mispositioning of data, and hence mis-stacking when a dip is present. <u>Dip Moveout</u> correction (DMO) is a technique that converts non-zero-offset seismic data after NMO to true zero-offset locations and reflection times, irrespective of dip. The combination of NMO and DMO followed by post-stack time migration is equivalent to, but can be implemented much more efficiently than full time migration before stack (JAKUBOWICZ, H. (1990), A SIMPLE EFFICIENT METHOD OF DIP-MOVEOUT CORRECTION¹. Geophysical Prospecting, 38: 221–245. doi:10.1111/j.1365-2478.1990.tb01843.x)

The <u>DMO Stack</u> procedure uses the medium's average velocity (parameter <u>Velocity</u> <u>file</u>). <u>Step</u> describes the sampling (i.e. binning) for stacking across \underline{X} and \underline{Y} -axes (in case of 3D seismic).

1)ip Moveout	Stack (DMO)				×
	Input file	n\Desktop\Tes	sseral tests\Te	est\Job-02\Ur	ntitled +GathAP-Z	.sgy
	Velocity file	esktop\Tesse	ral tests\Test	Job-02\Untit	ed-PQR-VELMOD	.sgy
		◉m/s ⊚f	it/s			
		C	Component			-
	Axis X			Axis Y		
	Start	45	m	Start	0	m
ł	Stop	950	m	Stop	0	m
	Step	5	m	Step	0] m
			m		Gradient 0.5	
					<u> </u>	
	Output file	top\Tesseral t	tests\Test\Job	02\Untitled+	+GathAP-Z-DMO-	2.sgy
				C	К	ancel

10.5 2D/3D Migration

Procedures for the migration of time-domain 2D gathers

10.5.1 Time Pre-Stack Kirchhoff Migration

The procedure is for creating migration image directly from gathers without creating CMP time section or post-stack migration. The command <u>Run > 2D Migration (Time domain) > Time</u> <u>Pre-Stack Kirchhoff Migration (PSM)</u> is used.

Pre-Stack Kirch	hhoff Migration (PS	M)	×
Input file	C:\Sheldon\Testing	DfTesseralPro\Run\Md2+GathAP.sgy	
Velocity file	∫ ∙om/s Cft/s	Component	
Profile coord		Output section	
From (24	00; 0)	Start 0 m	Gradient 0.5
To (53	75; 0)	Stop 2975 m	j
	Adjust	Step 25 m	
- Apertures - X-coordinat	e (m) Add Delete Delete All) Al (m) Ar (m) Add	Normalization © Just sum © Average © Average of order 1/2 © Average of order 1/4
		oad Save	
Output file	C:\Sheldon\Testing(DfTesseralPro\Run\Md2+GathAP-PSM.sg	y

This migration needs the time-domain average velocity model as input, which may be obtained by using the commands $\underline{Model} > \underline{Export to Seismic Format (SEG-Y, \underline{TGR})}$ and then $\underline{Run} > \underline{Velocity Model} > \underline{Average Velocities from Model}$. Users can specify velocity measurement units in the model ($\underline{m/s}$ or $\underline{ft/s}$).

If the migration aperture is not specified, the program may use the default values. To

specify the apertures explicitly, the buttons in the <u>Apertures</u> group are used: <u>Add</u>, <u>Delete</u>, <u>Delete</u> All, <u>Load</u> (from a file), and <u>Save</u> (to a file).

The migrated section is specified by the parameter <u>Profile Coordinates</u> (whose direction is specified by the <u>Adjust</u> button) and <u>Output Section</u> (size and step along the profile). These are mandatory parameters to be input by the user.

The signal stretching is limited by <u>Gradient</u>, whose default value is 0.5. If the gradient is too small, the images will be too "spread"; if the gradient is too big, some objects may disappear.

The result may be normalized (in this case, the noise and the low signals will be amplified). Usually normalization is not applied (the <u>Just</u> sum option).

The migrated time section is saved to the <u>Output file</u>. To transform it from time scale to the depth domain, use the command <u>Run > Velocity Model > Time to Depth</u> <u>Transformation</u>.

10.5.2 Depth Pre-Stack Kirchhoff Migration

The command Run > 2D Migration (Depth domain) > Depth Pre- Stack Kirchhoff Migration (DPSKM) performs the Depth Pre-Stack Kirchhoff Migration. The result is in depth domain. To transform it to time domain, use the command Run > Velocity Model > Depth to time Transformation.

input file	Sample m	odel and it's synte	tic seismogram	Elastic A2b	Model-	-GathAP-Z.sg	у	Gradie	nt	0.5		
	⊚ m/s	⊚ ft/s	Componen	t 🗌			•	1.4.4.4.4	· · · ·	1.1.1.1.1.1.	(\rightarrow)	
Model file	lures\San	nple model and it's	syntetic seism	ogram\Elast	ic A2b N	1odel-PQR.sg	у	Min time s from dire		0.1	s	
								Vp/Vs	2			
Profile coo	rdinates							Coordinat	es along	Z-axis		
Start X	1036	m Start Y	0	m				Start Z	0		m	
Stop X	5836	m Stop Y	0	m				Stop Z	574		m	
🔽 Use a	s output sec	tion	Adjust		Step	2.5	m	Step Z	2		m	
Time estim	ation setting		pertures									
Step	2	m	X-coordinate (m) Add			and the second se	(m)				
Margin	50	m		Delete Delete All	*	0 0.493 0	0 150 0	0 150 0				
						Load		Save				
Output file	C:\Users	Stefan \Desktop \S	tandard trainin	ig material∳	Processi	ng prc 📖	min(Xs-	et Restriction	3	iax(Xs-Xr) 0] m

For migration, the layered velocity model has to be in depth domain, which may be obtained by using the menu command $\underline{Model} > \underline{Export}$ to $\underline{Seismic}$ Format ($\underline{SEG-}$ \underline{Y} , \underline{TGR}). The velocity measurement units in the model can be specified (m/s or ft/s).

If the migration aperture is not specified, the program uses the default values. To specify

the apertures explicitly, the buttons in the <u>Apertures</u> group are used: <u>Add</u>, <u>Delete</u>, <u>Delete</u> <u>All</u>, Load (from a file), and Save (to a file), each of which invoke a simple dialogue box.

The migrated section is based on the 2D data. The size of the processing area and the corresponding step along the profile (in X direction) is assigned in <u>Coordinates along X-</u> axis.

The signal stretching is limited by the <u>Gradient</u>, whose default value is 0.5. If the gradient is too small, the images will be too "spread"; if the gradient is too big, some intervals may disappear.

This program uses the eikonal solver to compute time fields. Discretization of the computation grid is specified by <u>STEP X/Z</u> in the <u>Time estimation settings</u> group. The additional frame (<u>Margin</u>) gives the option of removing the influence of the edge effects. It is recommended to set it to 5-10 grid steps.

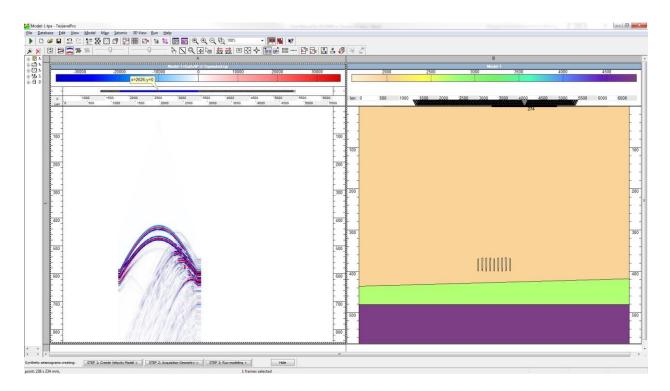
Min time shift from direct wave is used for supressing shot gathers by a particular time interval after the direct wave arrival (if necessary!), in order eliminate uncessary migration noise.

Also, by specifying $\underline{Vp/Vs}$ of the medium directly below the observation system, the user esentially mutes the direct compressional and shear wave on the shotgaters, and therefore eliminates unnecessary migration noise asociated with these waves.

10.5.3 2D Duplex Wave Migration

Duplex Wave Migration (DWM) is a newly developed technology capable of imaging events with dips 60 $^{\circ}$ to 90 $^{\circ}$. Duplex waves are strong enough to be used for geological purposes.

Duplex waves get reflected twice: from a sub-horizontal surface followed by reflection from the subvertical surface or vice versa. 2D DWM supports only PPP type reflections.



Before running 2D DWM, the user first of all needs to import the 2D synthetic seismograms in SGY format, as well as the 2D model which generated these seismograms. This is done by clicking on <u>File></u> <u>Open</u> in the upper menu.

Once the model and its respective seismograms have been loaded the user can then

proceed to the DWM settings tab by clicking Run>2D Migration (Depth domain)>Duplex Wave Migration.

nput file	Job-02\F	Processing Edited m	nodel\ModelBC_Ba	ase_CS - Edited +G	athEP-Z.sgy	Reflecting bou	undary (polygon)			
	● m/s) ft/s	Component		•	Mbrly		•	Тор	
10del P <mark>f</mark> ile	C: \Users	\Stefan\Desktop\L	eismer model\Moo	deling-Alex\Job-02\	Processing Ec 🛄					
Orientatio	n of Profile i	in Plan								
Start X	2000	m Start Y	0 n	n						
Stop X	4800	m Stop Y	0 n	n		-	_		_	
🔽 <mark>M</mark> igrat	e whole Pro	file	Adjust	Step	2.5 m					
Time estim	ation settin	gs	•				Aperture	f source-r	eceiver gr	oup
Sampling	5 1	^т 💿 ну 🥇		и 🖌 🦯	Gradient	0	from -100			m
Margin	50	m 🔓	<u> </u>			1	from 100	an same of	receiver g to 1000	group
Threshold	0.1	S								
				deling-Alex\Job-02\						

In the <u>Duplex Wave Migration</u> tab, the user will need to double check that the <u>Input file</u> is the correct SGY file, containing the appropriate synthetic seismograms and also specify the name as well as the location of the Output File (i.e. the migrated seismic section).

The DWM algorithm is designed to image the DW energy that will arrive at a time greater than that of the primary base boundary. A beam tube construction eliminates the migration noise that would result from the base boundary primary reflections in the migration summation. For this reason in the <u>Model</u> <u>P_file</u>, the user needs to upload the SGY P wave velocity model (in depth domain), that contains just the horizontal and the sub-horizontal geological structures, without the vertical heterogeneities, that will ultimately be imaged by this method. The depth model can easily be generated by going Model>Export to Seismic Format (SGY) in the upper menu.

The user will also need to select the <u>Reflecting boundary (polygon</u>) or base boundary for duplex waves reflection. For exactly this reason the imported 2D model MUST at the very least have the base boundary as a polygon (see section 3.2). The base boundary should of course be below the sub-vertical heterogeneities that need to be imaged by DWM.

The migrated section is specified by the parameters <u>Start X</u> and <u>Stop X</u> as well as <u>Start Y</u> and <u>Stop Y</u> in the <u>Profile Coordinates</u> tab (whose direction can also be specified by the <u>Adjust</u> button). The parameter <u>Step</u> is recommended to be identical to the grid step that was used for forward modeling.

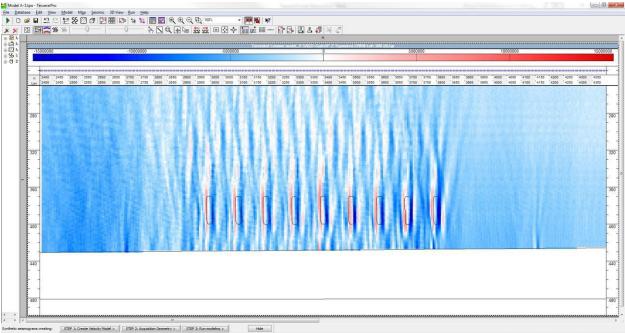
This program uses the eikonal solver to compute time fields. Discretization of the computation grid along the X and Z axis is specified by Step in the Time estimation settings group.

In the Aperture tab the migration aperture for duplex waves is assigned. The user can specify a left aperture by specifying the distance to the left of the source receiver group or a right aperture to the to the right of the source receiver group. Also, a symmetric aperture can be assigned by specifying both. The left aperture is to the left of the leftmost source/receiver in the observation system, while the right aperture is to the right of the rightmost source/receiver.

The signal stretching is limited by Gradient, whose default value is 0. If the gradient is too small, the images will be too "spread"; if the gradient is too big, some objects may disappear. There are two possible orders of reflections- HV and VH (i.e. reflection from the horizontal boundary followed by the reflection from the sub vertical boundary (HV) and vice versa (VH).

For offset restrictions use min (Xr-Xs) and max(Xr-Xs). Only the specified traces will be processed by DWM, the rest will be omitted. Please note that the specified values can be negative for traces to the left of the source and positive for traces to the right of the source.

The Threshold is used for suppressing the shot gathers by a particular time interval after the compressional direct wave arrival (if necessary!), in order eliminate unnecessary migration noise.



point: 374 x 5 mm

10.5.4 2D Converted Duplex Wave Migration (CDWM)

Converted Duplex Wave Migration can be applied to PPS, PSS and PSP type duplex wave, as you can see in the <u>CDWM</u> window. And depending on the type of converted duplex waves, you may be required to use the X component (i.e. horizontal particle velocity) of the synthetic seismograms and also load the <u>S Model File</u>.

input file	ner mode	l Modeling	-Alex\Job	o-02\ModelBC	_Base	ted +GathEP-Z.sgy		Reflecting bou	ndary (pol	ygon)			
	⊚ m/s	⊚ ft/s		Compone	nt [•	Keg River			•	Гор	~
Model P file	Desktop	Leismer m	odel\Mod	eling-Alex M	odelBC	G - Edited -PQR.sgy							
Model S file	sktop\Leis	smer mode	el Modelin	g-Alex\Mode	IBC_Ba	Edited -PQR_R.SGY							
Orientatio	n of Profile i	n Plan											
Start X	2000	m	Start Y	0	m								
Stop X	4800	m	Stop Y	0	m			-					
🔽 <mark>M</mark> igrat	e whole Pro	file		Adjus	t	p 2.5 r	m						
Time estim	ation setting	gs		-					Aperture	loft of a			
Sampling	5 r	n	Vs	6	200	6			Sec. 1	-300	m to		n
		() H	V R		🔊 VH	Gradient		0	🔽 to the	right of	source-re	ceiver ç	grou
Margin	50 r	n				Ó	0.000		from	100	m to	1000	m
							2		🔄 betwe	en sour	ce and re	eiver:	
Threshold	0.1	s Sequ	ence of v	vaves migrate	ed P	(requires X-compon	ient o	of seismogram)		5	_m From	i left poi	nt
	el\Modeli	na-Alex\J	ob-02\Mo	delBC_Base_	P	thEP-Z-CDWM.sgy)	_		-5	m from	i right po	bint
Output file						aler a de mineg/		Office t D	lestrictions				

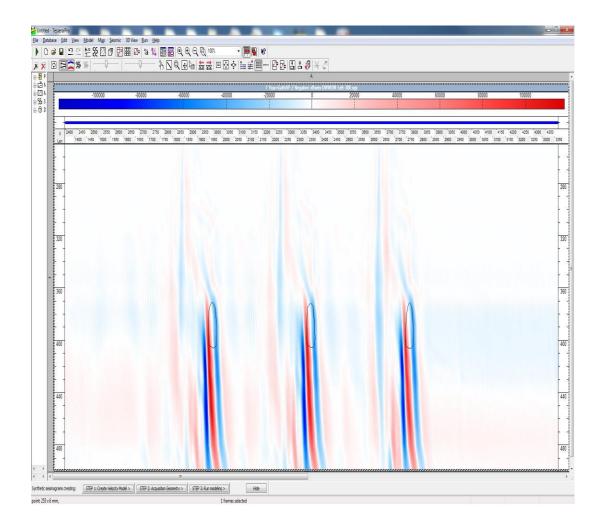
The user also the option of specifying internal apertures (i.e. <u>between source and receiver</u>). This option should be used for the imaging of transmitted converted waves.

10.5.5 2D Duplex Wave Migration from Scattered Waves

Application of DWM for scattered waves is most suitable for targets below the last strong reflecting horizon, such as faults, salt domes and other steep structure flanks.

nput file	1er model	Modeling-Alex Vo	b-02\ModelBC_I	Base_CS - Edite	d +GathEP-Z.sgy		
	<mark>⊚</mark> m/s	⊚ ft/s	Component			•	Depth interval 50 m
lodel P file	Desktop↓	.eismer model∖Mo	deling-Alex\Mod	elBC_Base_CS	- Edited -PQR.sgy		
Orientatio	n of Profile ir	1 Plan					
Start X	2000	m Start Y	0	m		_	
Stop X	4800	m Stop Y	0	m			
I v igrat	e whole Prot	file	Adjust	Step	2	m	
Time estim	ation setting	js		-			Aperture To the left of source-receiver group:
Sampling	2 n	" 💿 ну 🦹		VH K	Gradient	0	from -300 m to 0 m
Margin	250 n				<u>6</u>		from 100 m to 1000 m
utput file	Modeling	-Alex\lob-02\Mo	elBC Base CS	- Edited +Gath	P-Z-DWMSW.sgy		Offset Restrictions

Unlike for DWM for PPP and converted waves, no base boundary is specified for this method. Instead, the <u>Depth interval</u> or the base boundary depth step for scattered duplex waves relative to the bottom off the model is specified. The automatically generated base boundaries are perfectly horizontal and they are computed for the entire model depth.



10.5.6 Depth 2D VSP Migration

To run 2D depth VSP migration choose <u>Run > VSP procedures</u> (Depth <u>domain</u>) > 2D Depth Kirchhoff VSP Migration (PSDM) from the menu. The next dialog will appear.

put file	C:\seis	_data\2D migr\u	p2.sgy					Gradie	nt 0.5		
			Compo	nent			~				
odel file								Min time from dire		s	
								Vp/Vs	1.73264		
Profile co	ordinates				Output :	section		Coordinat	es along Z-ax	is	
Start X	-1998.3	ft Start Y	0	ft	Start	7898.3	ft	Start Z		ft	
Stop X	7001	ft Stop Y	0	ft	Stop	8999.3	ft	Stop Z		ft	
			Adj	just	Step	47.6	ft	Step Z		ft	
Time estir Step Margin	200	ft ft	Apertures fo X-coordina			T (s) /	N (ft) A 0	r(ft) 0	⊠ho	aves reflecte rizontal bour aves reflecte rrtical bounda	ndary
						Load	Offs	Save et Restriction	s		
utput file	C:\seis_d	ata\2D migr\up2	PSDM-1.sgy	/			min(Xs-	-Xr) 0	ft max(X	<-8r) 0	ft

The dialog automatically picks up a shotgather for migration from the current <u>Seismic</u> frame. (If the shotgather is not selected or does not fit, select another one using the button \ldots). The output file will contain the migrated section. Its name is also automatically generated if the name of the input shotgather file is selected by adding the suffix "+ PSDM" to its name. If a file with the same name already exists, an additional version number is added (a digit from 0 to 9).

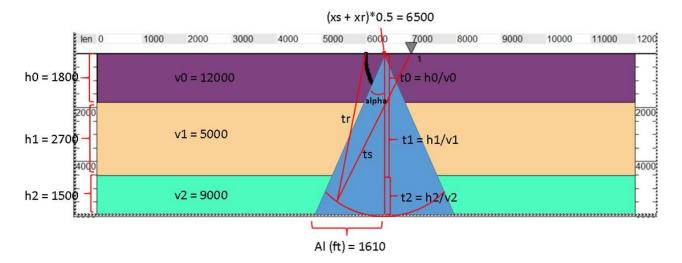
<u>Min time shift from direct wave</u> is used in order not to exclude the trace fragment of T0 times from *t*-*s* to t+s, where *t* is the first arrival time of the wave incoming from the source to the receiver, and *s* is the value of this parameter in seconds. (The value of *t* is automatically calculated for each trace according to the velocity model during the migration process.)

The checkboxes <u>Waves</u> reflected from horizontal boundary and <u>Waves</u> reflected from vertical boundary determine which borders to build in migration: (horizontal, or vertical); in our case, the borders are only horizontal, so select the top flag.

The <u>Start</u>, <u>Stop</u>, <u>Step</u> of the migrated section grid in depth (<u>Output Section</u>) are automatically determined from the velocity model (<u>Model</u> frame).

The spatial <u>Step</u> of the section grid (both in length and depth) in the <u>Time</u> <u>estimation</u> <u>settings</u> section may be different from the corresponding output section sampling (<u>Step</u> from the <u>Output</u> <u>Section</u>). The former is used internally for calculation of wave propagation times by eikonal algorithm. Its default value is estimated by a heuristic rule. A smaller step provides greater accuracy of the calculated times for the cost of quadratic deceleration. (I.e., the deceleration coefficient is of the power of 2 relative to the scale factor of the change in step). The <u>Margin</u> next to the <u>Step</u> is needed to weaken the influence of the edges of the model.

Each sample of the input seismogram trace is "smashed" within a cone (a triangle in 2D) which is defined by the migration apertures. For each trace, the triangle is plotted from the midpoint between the x-coordinate of the source (xs) and the x-coordinate of the receiver (xr).



The migration apertures can both vary along the recording time axis in the vertical direction T0 and depending on the position of the source. The default aperture values are selected so that the angle at the apex of the alpha cone is about 15 degrees. The ellipse arc shows at which points of the output section the trace value of the input seismogram will be summed over time t=ts+tr (= 1.715 in the next figures), where *ts* is the first arrival time of the down going wave from the source to media cell, and *tr* is the first arrival time of the media cell to the receiver.

-coordina	or horizontal bou ate (ft)	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
3448	Add		T (s)	AI (ft)	Ar (ft)	
		•	O	0	0	
	Delete		1.715	1610	1610	
	Delete All	*	0	0	0	

The migration apertures can be different for different shotpoints. If there is just one aperture X-coordinate, the aperture is used for all traces (and so its X is ignored).

Having completed entering the migration parameters, click \underline{OK} to start the migration calculation and get the result.

	Data	base	Edi	t <u>V</u> i	ew	Mode	Map	<u>S</u> e	ismic	<u>3</u> D V	iew	Run	<u>H</u> elp						
	D	6	H	5	<u>[]</u>	臣	55 Ø] Ø	1		? =	^∕₄		**	🛛 🔍 🔍	€ € 100%	•	- 🏴 🖻	N?
		4	Þ	1	***	\$				-	-	-	2	3		1 🖓 🚽	式 🗉 🔂	+‡+ i iii i	≠ ‼
							Α									В			
111						цр2-Р	SDM-1	sgy					21	D	NOfault-	3-lavers	offset	well1	1
-		-150	-	100	-5	0	0	50		100	15	0	4000		6000	8000	1000		2000
	_			4				1		1	1								
-													X	0		4000	8000	1.	200
-	x	6000	610	0 82	0 83	00 640	0 6500	6600	6700	6800	6900	7000	Y	0		0	0	0	
2	Len	0					500	1.00.00					len	0	1	4000	8000	1	200
deres deres de			-	_	_			_	_	_	-	2000	abaraharaha	-				-	-
adama handa	2000												2000					20	000
	4000											4000	4000					4	000
Access.														-				-	-

10.5.7 Depth 3D VSP Migration

To run 3D depth VSP migration choose Run > VSP procedures (Depth domain) > 3D Depth Kirchhoff VSP Migration (3D PSDM) from the menu.

Please note that only migration of P waves reflected from horizontal boundaries has been implemented for this method.

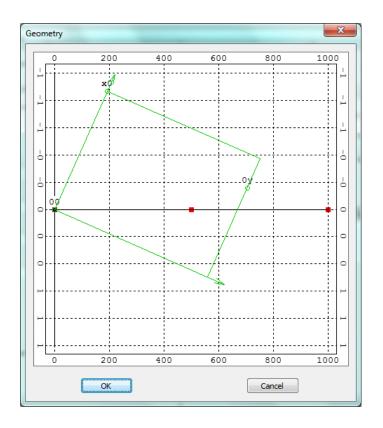
nput file	'SP all sh	iots\DU	PLEX_VELO	CITY_MOD	EL_nev	sort_rever	s+Gath3	DAPUz.sgy		Gradient	0.5	
	<mark>⊚</mark> m/s	Ø	ft/s	Compo	onent				•	**************************************	0	
Model P f	ile C:\Use	ers\Ste	fan \Deskto	p\Tesseral t	ests\3	O VSP Mode	elling test'	\3D VSP all sh	κ	Time estimation	on settings	
Model S f	ile									Step X/Y/Z	5	m
Output cu	ibe									Margin	50	m
X00	446,4	m	Y00	1259	m	Step X	50	m				
Xx0	3022	m	Yx0	379.8	m	Step Y	50	m	Apert	ures		
~~~	5022		140	57510		Step (	50		•	T (s) 0	Radius (m) 0	
ХОу	-145.9	m	Y0y	3979.8	m	☑ (	Rotated /	Axes	*	1.801 0	1090 0	
Start Z	0	m	Stop Z	4070	m	Step Z	5	m		Load	Save	)
Dutput file	C:\Users			eflected fror al boundary Tesseral tes		VSP Modelli	ng test\3l	D VSP all she		time shift n direct wave Cancel	0.1	s

<u>Input file</u> -3D seismogram file. If the file type is TGR (as opposed to SGY) it is necessary to specify the Component of the data file that is to be processed.

Next you must load the depth Model P file and specify the size of the output migrated cube.

The output (imaging) area is rectangular. And there are two ways to define this rectangle:

In general case the output rectangle is defined manually by coordinates of 3 sequential corner points:  $\underline{X \times 0}$ ,  $\underline{Y \times 0}$ ,  $\underline{X 00}$ ,  $\underline{Y 00}$ ,  $\underline{X 0y}$ , and  $\underline{Y 0y}$  in the <u>Rotated Axes</u> group. Approximate values may be used. The program adjusts the coordinates to form a true rectangle.



 If the output rectangle boundaries are parallel to coordinate axes it can be alternatively defined by the parameters: <u>StartX</u>, <u>StopX</u>, <u>StartY</u>, and <u>StopY</u>. The program supports output of vertical sections, so combinations like StartX=StopX and StartY=StopY are enabled.

<u>StartZ</u>, <u>StopZ</u> is depth interval of the output array. <u>StopZ</u> must be below (bigger) then boundary depths of the model file.

<u>StepX</u>, <u>StepZ</u>, <u>StepZ</u> are the grid steps for the output array.

To specify the circular aperture explicitly enter directly the T(s) and Radius(m) in the

Apertures group. If the migration aperture is not specified, the program uses default values.

Min. time shift from direct wave(s) is used for muting VSP gathers by a particular time interval in order to eliminate the migration noise associated with the direct wave arrival.

The rest of the parameters in <u>Depth VSP Migration</u> window are exactly the same as for <u>2D</u> Time/Depth Pre-Stack Kirchoff Migration (Please see section 10.5).

## 10.6 Post-Processing

Procedures for post-processing of seismic data:

#### 10.6.1 Trace-wise Procedures

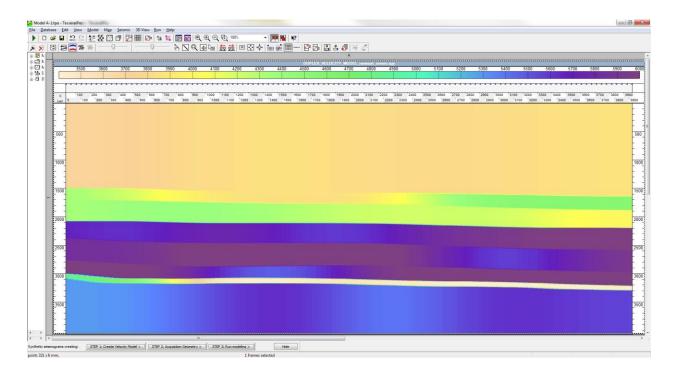
One Trace Procedures		x
Input file C:\Users\Ste	fan\Desktop\Export_to_seismic_format_test\Test-1+Gath/	
Zero Balancing     Linear Gain     Normalization	window lenght     0     ms       top gain     1     bottom gain     1       align traces by     energy     v	
Auto Gain Add White Noise	window lenght 0 ms noise 0	%
Random Shift		ns ns
☐ Shift	length 0 r	ns
Final Scaling	magnitude 100 % offset 0	
Output file C:\Users\Ste	fan\Desktop\Export_to_seismic_format_test\Test-1+Gath/	]

Check a box to apply the function to all the traces.

- Zero Balancing for balancing the traces to zero average value.
- <u>Linear Gain</u> is for increasing the amplitude of the top (<u>top gain</u>) or bottom (bottom gain) parts of the traces.
- Normalization is to normalize a trace using one of selected criteria.
- <u>Auto Gain</u> is to smooth the trace automatically. The parameters of such smoothing may be: <u>window length</u> is the time (or depth, metrical) interval for which the smoothing is carried out, <u>noise</u> is a threshold (noise threshold in percent of the maximal amplitude) and outside this threshold smoothing is suppressed.
- <u>Add White Noise</u> (in percent of the maximal amplitude) is to add white noise to the traces.
- <u>Random shift</u> is to add a random shift to the traces.
- Smoothing is to cut out the high frequency noises, if they are in the image.
- Shift is to shift the whole trace up or down along the time direction.
- <u>Final Scaling</u> (in percent of the maximal amplitude) is to change the absolute value of the amplitudes.

#### 10.6.2 Zeroing of the seismic cube above surface

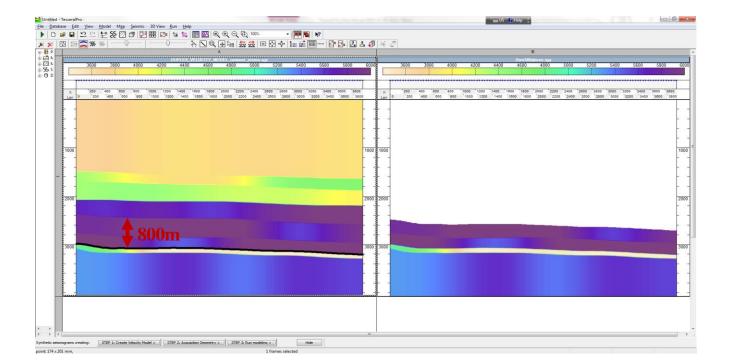
With the help of this function the user can mute any given 3D seismic cube above the specified horizon. To implement this function first of all load the SGY cube File>Load seismic file...



...followed by Run>Post processing>Zero Seismic Cube above a surface.

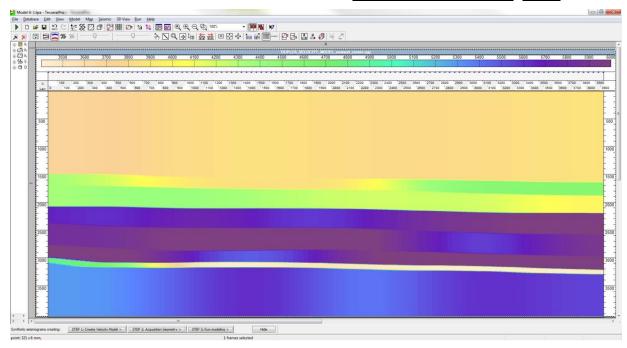
Input		
Seismic cube	C:\Users\Stefan\Desktop\Tesserral Pro testing new version\DUPLE	
Surface map	C:\Users\Stefan\Desktop\Tesserral Pro testing new version\3D Mo	del building tes 🛄
Layer height	800 m	
Output		
Output cube	C:\Users\Stefan\Desktop\Tesserral Pro testing new version\DUPLE	X_VELOCITY_N

Make sure the correct cube has been loaded in the <u>Seismic cube</u> dialogue, then load the <u>Surface</u> <u>map</u> (i.e. the horizon) and specify the <u>Layer height</u>, which is the distance above the horizon of the specified Seismic cube that should be preserved.



#### **10.6.3** Zeroing of the seismic cube under surface

With this function the user can mute any given 3D seismic cube below the specified horizon. To implement this function first of all load the SGY cube File>Load seismic file...



...followed by Run>Post processing>Zero Seismic Cube under a surface.

<b>I</b>
C:\Users\Stefan\Desktop\Standard training material\2D and 3D ray tracing\3D Ra
C:\Users\Stefan\Desktop\Standard training material\2D and 3D ray tracing\3D Ra
300 m
D Ray Tracing files\DUPLEX_VELOCITY_MODEL_newsort_revers_crop_under.sgy
OK Cancel

Make sure the correct cube has been loaded in the <u>Seismic cube</u> dialogue, then load the <u>Surface</u> <u>map</u> (i.e. the horizon) and specify the <u>Layer height</u>, which is the distance above the horizon of the specified <u>Seismic cube</u> that should be eliminated.

	▣앞◈▥ਛੋ▥┉╚в▮◬◖◗ँँँ	
DUPLEX VILOCITY MODEL PROVIDENT		
3600 3800 4000 4200 4400 4600 4800 5000		5800
X 200 400 800 800 1000 1200 1400 1600 1800 2000 2200 2400 x 0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400		0 3000 38
500		
1000		
1500	1500 1500	
2000		
2500	2500 2500	
<b>300m</b>		
3500	3500	

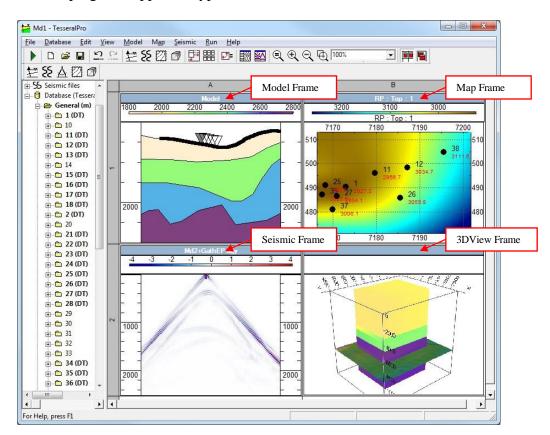
# **11 Working with Frames**

In this section, the general guidelines for manipulating different Frames are presented.

Tesseral Pro supports 4 types of Frames – model, surface, gather and 3D-view. The parameters for a Frames' display can be customized in the dialogue box and with the help of the options in the corresponding menu. Frames can be deleted, moved and duplicated. Operations with one or more Frames are supported as well. A Frame can be printed or exported to an exact vector (raster-type) picture (WYSIWYG technology). There are the two main modes to display Frames: <u>Document view</u> and Tablet view. More information can be found below.

## 11.1 Frame types

The Tesseral Pro program supports 4 types of Frames:

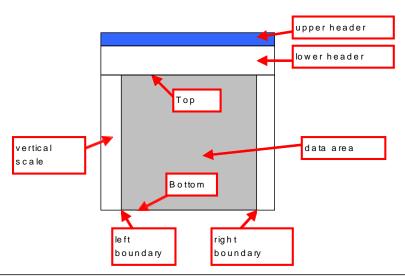


- <u>Model Frame</u> (Model) is the Frame in depth. Model is always created in depth. The velocity model is formed by polygons based on the well logging and/or seismic data. The polygons are created by the user manually or automatically from the map of stratigraphic horizons (see Section 14.2.7). Information related to velocity, density and anisotropy or fracturing can be entered in each polygon. The polygon parameters are set manually in the dialogue box or may be loaded from the well logging data for selected wells (thin layering). Information about shot and receiver points is also entered into the model. The built velocity models with shot-receiver layouts are used for calculation of the synthetic gathers. For more details about the Model Frame, please see Section 3, 4, and 12.
- <u>Surface Frame</u> (Map) is the Frame where the map of the wells location within the field and the map of the surface calculated by the well data or imported from external text files are displayed. The information needed for calculation of the surfaces, namely the coordinates of the layers and the wells intersections, should be loaded to the database in advance. Tesseral Pro has 9 methods for map generation, such as spline-approximation, Kriging and multiple regression. The cross-section model (Model Frame) for any section traced in the map is built automatically on the basis of the calculated (loaded) surfaces. More details about the Map Frame can be found in the Section 14.
- <u>Seismic</u> <u>Frame</u> (Seismic) displays gathers in SEG-Y, SDS-PC, and TGR formats. 3D gathers display also is supported. Please see Section 13 for details about the Frame Seismic.

• <u>3D View Frame</u> is for visualization of 3D images. Please see Section 15 for details about the 3D View Frame.

To create a new frame, use the command  $\underline{File > New Frame}$ . After that, in the dialogue box of the frame parameters, the default values may be changed.

Each type of frame has its own 2 headers (the upper and the lower one). In the upper header, any text is displayed (by default, the upper header looks like the header of a pane in Windows), and the lower header contains special information specific for each type of Frame.



**NOTE**: Double click on the header of any frame to "expand" this frame to the whole window size (equivalent to the command <u>View > Frame Full Screen</u>). The repeated double click on a frame header arranges frames in form of "grid" inside the window (equivalent to the command <u>View > Arrange Frames</u>).

### **11.2 Frame Selection**

Please use the left mouse button to select a Frame from the document field. The selected Frame will be shown inside a dotted rectangle. To cancel the selection, click outside the Frame boundaries using the left mouse button. The selection or de-selection of several Frames is implemented by the standard method for Windows. To select several Frames, please use the left mouse button together with the <u>Ctrl</u> or Shift key.

Also in the <u>Document View Mode</u>, you can select a group of Frames by pressing the left mouse button outside the Frames on the blank field of the document and then dragging it (while pressing the left mouse button) to create a rectangular area. All Frames that fall inside this area will be selected.

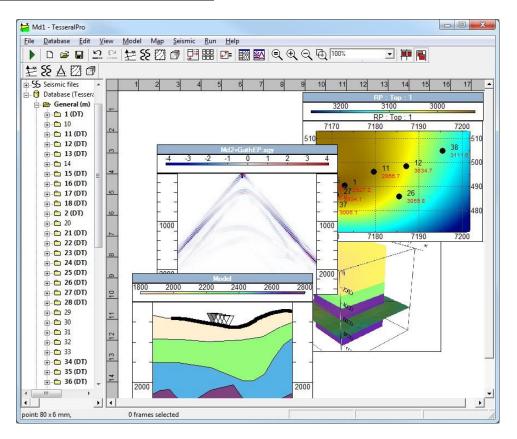
The last Frame selected is assumed to be the main Frame, and all the individual (non- group) commands will be applied to it. To change the selection of a Frame, click on it with the left mouse button while holding the <u>Shiftkey</u>. To select a Frame as the main one, please click on it with the left mouse button while holding the <u>Ctrl key</u>.

To select all Frames at once, please use the command <u>View > Select All</u> <u>Frames</u>, and to de-select all the Frames, use the command <u>View > Deselect All</u> <u>Frames</u>.

## 11.3 Frame layout

In order to move a Frame within the Tesseral Pro main window, please press and hold the left mouse button on the upper headline of the Frame and just drag it. There are two modes of Frame layout.

1. View > Document View Mode - Frames are freely distributed in the document.



In this mode, the Frames can overlap each other, therefore the commands  $\underline{\text{View}} > \underline{\text{Bring Frame}}$ Forward and  $\underline{\text{View}} > \underline{\text{Bring Frame}}$  Backward are used to set the right visualization order.

2. <u>View > Tablet View Mode</u> – Frames are only distributed in table cells. To change the size of any cell, please drag it with the mouse (while holding the left mouse button) from any Frame side, or change the size of the column (row) of the table in the internal axis of the Frame window.

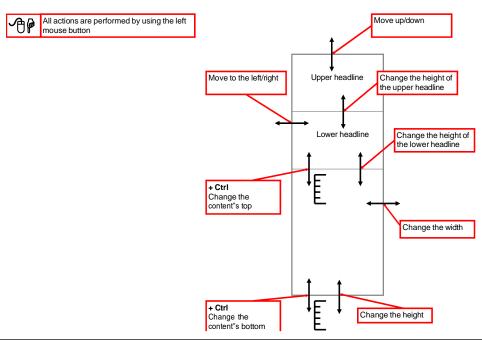
If you drag a Frame into a cell used by another Frame, the old Frame will be moved to the nearest free cell.

**NOTE**: Please use the command <u>View</u> > Arrange Frames to sort the Frames automatically according to the sizes of their windows. For an easier way to work with selected Frame, please use the command View > Frame Full Screen.

### 11.4 Frame size

The width and the height of the Frames are adjusted in the dialogue box  $\underline{Edit} > \underline{Edit}$   $\underline{Frame}$ <u>Properties</u>. The height of the upper and the lower headers is defined in the dialogue boxes of the upper and the lower headers, respectively. For the Frames displayed in depth or time scale (Model and Seismic), the height and the width are calculated automatically from the top, bottom and scale information. The sizes of the Frames may be changed by the mouse, which can be done by dragging the Frame's borders while pressing the left mouse button. While several Frames are selected, the changes will be only applied to the main (last) selected Frame. The size of the remaining Frames will be the same. The height and the width of the upper and the lower headers will be changed by pressing and dragging the lower headline border.

**NOTE**: It is possible to change the top and the bottom of any Frame with the scale by dragging the top or the bottom with the <u>Ctrl</u> key pressed.



The next picture shows the different ways to change the Frame parameters

**NOTE**: While changing the Frames' sizes in the Tablet View Mode, the sizes of all Frames in the same table row and column are also changed.

### 11.5 Undo/Redo

Working with Frames, you may undo any action (or sequence of actions) using <u>Edit > Undo</u>. To redo the action that you"ve undone, please use <u>Edit > Redo</u>. Commands <u>Undo</u> and <u>Redo</u> are not supported while working with files (menu <u>File</u>), database (menu <u>Database</u>) and calculating and editing seismic surfaces (<u>Map > Add New Horizon from Well Tops</u>, <u>Map ></u> Manage/Delete Maps, Map > Active Map).

# 11.6 Scale of display

To scale the document (zoom in/out), please use the command  $\underline{\text{View} > \text{Zoom}}$  or the scaling buttons in the main toolbar.



### 11.7 Print and export

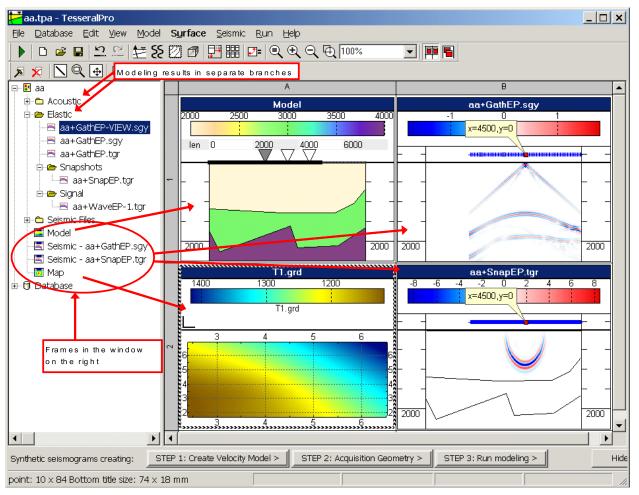
Documents are created on the principle of WYSIWYG by using Frames. For more details, please see section 11.3.

Please use the command <u>File > Print</u> to print a document.

Apart from printing, documents can be exported as a picture in any of the following formats (TIFF, EMF, WMF and BMP) by using the command File > Save as Picture.

## 11.8 Project tree and the database

After the new project is saved (command  $\underline{File} > \underline{Save Project}$ ), or after loading of an old project, in the left window of Tesseral Pro, the tree of the opened project is shown. This tree helps to systemize all loaded and created files.



The point is that, during the modeling of synthetic gathers, several files are created and they are all located within the same folder (please see details in the Section 5.4). Additionally, after launching several jobs for the same model using different modeling techniques, more sets of output files are created. All these files are located in the same folder, and it may be complicated to find the needed one:

Organize 👻 Include in library 🔻	Share with 🔻 🛛 Burn 🛛 New fol	der	8=	• 📶
🚺 Downloads 🔦	Name	Date modified	Туре	Size
Recent Places	Md2.tpa	2/15/2013 10:11 AM	TesseralPro Docume	744 KB
and the second	Md2+GathAP.sgy	2/15/2013 10:10 AM	SGY File	326 KB
🗟 Libraries	Md2+GathAP.sgy.cr0	2/15/2013 10:10 AM		
Documents	Md2+GathAP.tgr	2/15/2013 10:10 AM	TGR File	881 KB
J Music	Md2+GathEP.sgy	2/15/2013 10:11 AM	SGY File	326 KB
Pictures	Md2+GathEP.sgy.cr0	2/15/2013 10:11 AM	CR0 File	6 KB
Videos E	Md2+GathEP.tgr	2/15/2013 10:11 AM	TGR File 1,175	
	Md2+SnapAP.tgr	2/15/2013 10:10 AM	TGR File	41,308 KB
Computer	Md2+SnapAP.tgr.cr0	2/15/2013 10:10 AM	CR0 File	17 KB
Local Disk (C:)	Md2+SnapEP.tgr	2/15/2013 10:11 AM	TGR File	165,545 KB
🎍 dell	Md2+SnapEP.tgr.cr0	2/15/2013 10:11 AM	CR0 File 29 I	
An example of a folder	Md2+WaveAP-1.tgr	2/15/2013 10:10 AM	TGR File	8 KB
with results of Acoustic	Md2+WaveEP-1.tgr	2/15/2013 10:11 AM	TGR File	8 KB
and Elastic modeling	Md21.tam	2/15/2013 10:11 AM	/ TAM File 1	
Program Files (x86)	Md22.tam	2/15/2013 10:11 AM	TAM File	16 KB
ProgramData	Md23.tam	2/15/2013 10:11 AM	TAM File	16 KB
Sheldon	🞽 Md24.tam	2/15/2013 10:11 AM	TAM File	16 KB
Tesseral Data	🞽 Md25.tam	2/15/2013 10:11 AM	TAM File	16 KB
Tesseral Technologies	Mod2D.log	2/15/2013 10:11 AM	Text Document	9 KB
UserDocs Tesseral	📳 runtask.ini	2/15/2013 10:11 AM	Configuration settin	1 KB

The project tree will simplify this task. The branches in the tree have the same names as the corresponding modeling method (<u>Acoustic</u>, <u>Elastic</u>, etc.). The remaining seismic files, which are created, for instance, by procedures of gather processing, are located in the branch <u>Seismic files</u> of the project tree. A double mouse click on a file in the project tree will create a <u>Seismic</u> Frame for this file in the right window of Tesseral Pro.

The last nodes of the project tree are frame nodes (Model, Map, Seismic).

The branch «Database» connects to the Tesseral Pro database (please see details in the Section 17).

Double click these items to maximize the corresponding size in the window on the right.

# **12 Model Frame**

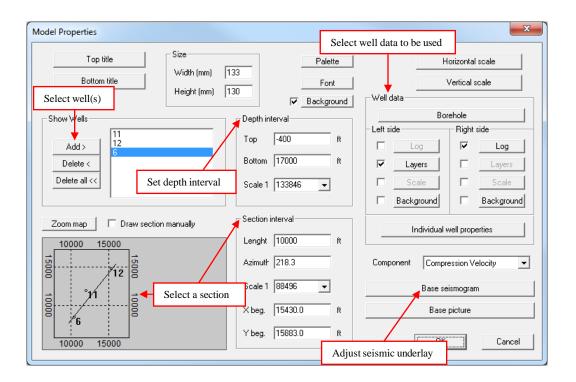
The <u>Model</u> Frame is used for creating depth velocity models using polygons, well data, underlying seismic images (2D or 3D models). After that, the velocity depth model is used for calculating synthetic gathers.

Please see:

- Section 3 for details about model creation
- Section 3.2.9 and 17.5 for using well data
- Section 3.1.10 about filling of a model with polygons, Section 4 about creation of the acquisition geometry
- Section 5 about launching job of modeling a synthetic gather
- Section 13 about displaying computed gathers, seismic models and field gathers Please see below for some additional features about using the Model Frame.

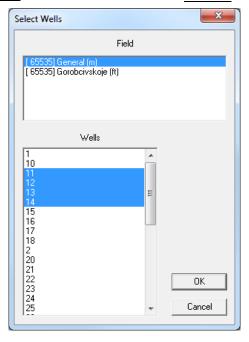
## 12.1 Properties of the Model Frame

To invoke the dialogue box with properties for an existing Model Frame, please select the command Model > Model Frame Properties.

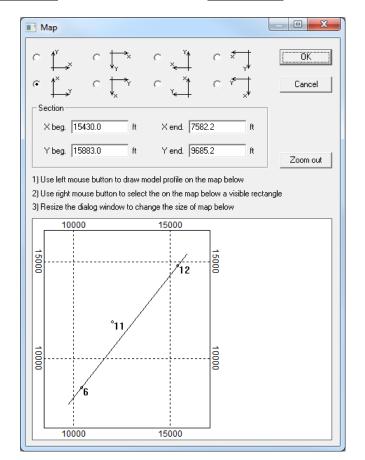


All the parameters input via the model building Wizard, may be changed manually in the dialogue box Model Properties.

To select wells for the model – Please click the button Add >.

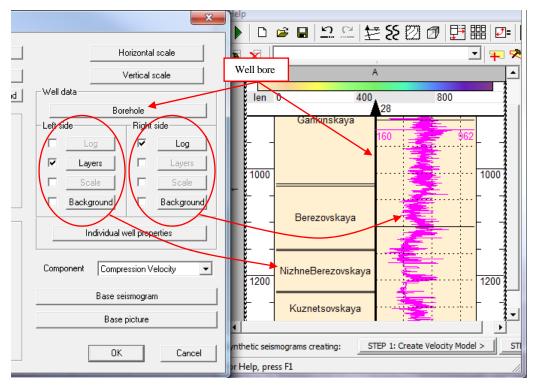


<u>To select a section line</u> – along which the model section will be created. After checking the option <u>Draw section manually</u>, in the lower left corner of the <u>Model Properties</u> dialogue box, you can draw the section line by using the mouse by pressing-dragging-releasing. To define the section line more precisely, you can: A) Select the origin coordinates, the azimuth and the length of the line in the <u>Section interval</u> group; or B) Click the <u>Zoom map</u> button to load the map for visual input.



<u>To set depth interval</u> – In the <u>Depth interval</u> group, please specify the top and the bottom of the model.

To select the data to be displayed for the well - In the Well data group,

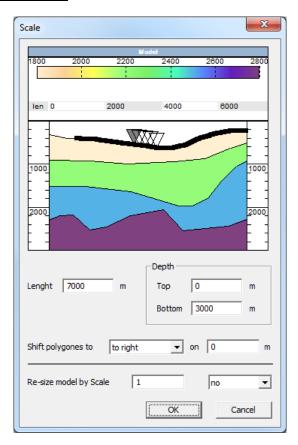


<u>Left side</u> - The data to be displayed on the left side of the well bores <u>Right side</u> - The data to be displayed on the right side of the well bores Please select the type of well data you want to display.

 $\underline{Log}$  – The well log data. From the dialogue box of the well log parameters, please select the logs you want to display. For more details, see the Section 3.2.10.

### 12.2 Model re-size

The command Model > Scale is used.



Using this command, you may change the size of the model by stretching or compressing all polygons and location of sources and receivers consistently, which is done by specifying the parameter  $\underline{\text{Re-size}}$  model by Scale.

**NOTE**: If you like to change the measurement units for the whole project (<u>ft to m</u> or <u>m</u> <u>to ft</u>), it is recommended to use the command <u>File > Project Properties</u> (please see details in the Section 16).

If the parameter <u>Length</u>, <u>Top</u> or <u>Bottom</u> is changed, the polygons of the model will not be stretched nor shifted.

# 12.3 Model export

It is possible to export a model to any of the 3 seismic formats (TGR, SDS-PC or SEG-Y), and to a TAM format used by Tesseral 2D.

#### 12.3.1 Model export to a seismic format

Please use the command Model > Export to Seismic Format (SEG-Y, TGR).

Seismogram calculation	<b>—</b>				
Seismic file name	Fit file name				
C:\Tesseral Technologies\Tesseral Pro\Mode	il.sgy				
Sampling Rate					
Step by length 50 m					
Step by depth 50 m					
Export Medium Anisotropic Properties					
Components: value range	Cancel				

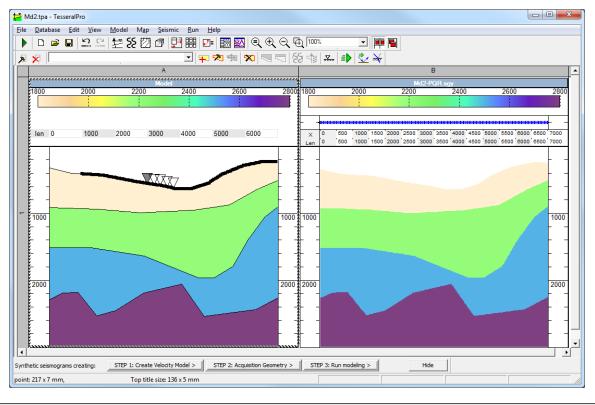
Components: value range			<b>×</b>
Component	Units	Min value	Max value
Compressional velocity	m/s	100	10000
Density	kg/m^3	1000	3800
Shear velocity	m/s	0	6000
		ок	Cancel
	L L	UN	Caricei

In this dialogue box, please specify the cell size, the name of the output file. The minimum and maximum values of each component in the <u>Components: value range</u> window are to limit the possible spikes after interpolating the well log data.

**NOTE:** If the TGR file contains multiple components or if you export a model in SDS-PC or SEG-Y formats, then 3 files will be generated (one file for each component). File with the selected name will contain the data of <u>Compressional velocity</u> (<**file name>**– **PQR.sgy**), <u>Density</u> (**<file name>**–**PQR_Q.SGY**) and <u>Shear velocity</u> (**<file name>**– **PQR_R.SGY**).

After creating these files, a <u>Seismic</u> Frame should appear in the Tesseral Pro window to display the gathers created from the model.

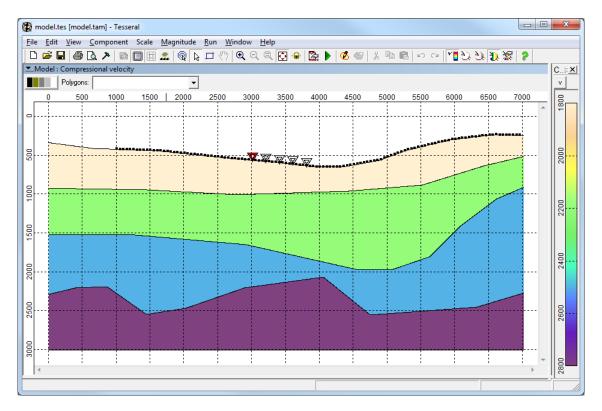
Please see results



**NOTE**: The acquisition parameters data are not exported when model is exported to any seismic format.

#### 12.3.2 Model export to Tesseral 2D (TAM format)

Please use the command Model > Export to Tesseral 2D Format (TAM).



While the model is being exported to TAM file, the thin layering data is not exported, but the acquisition geometry data is exported.

# **13 Frame Seismic**

This is the frame to display files in SEG-Y, SDS-PC or TGR formats. The frame is to support displaying 2D/3D field and synthetic gathers, models, migrated slices/cubes, VSP gathers, multi-component files, snapshots of wave field propagation, etc.

### 13.1 Load seismic files

The seismic files are loaded by using the command <u>Seismic > Load Seismic</u> <u>File (New Frame)</u> (S). If several files are loaded at once, then they will be displayed in the joint coordinate space.

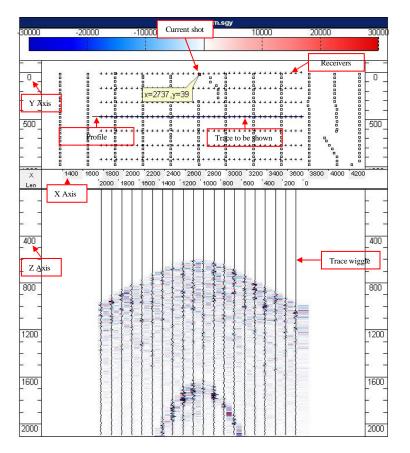
If a seismic file is opened for the first time, it is proposed to select its type to apply the appropriate display mode, as shown below.

Select type of seismic data			×
Please select the ty	pe of seismic	data in file	
Field	IData.sgy		
Model or Migrated gather	Gather	VSP	Raw Traces
			I don't know

Your selection will determine the displaying mode (please see Section 13.2), which can be changed at any time by using the <u>View Mode</u> command on the <u>Seismic</u> menu or the button from the toolbar.

After that, your seismic file will be read. If a file is opened for the first time, it may take a long time to create the index files of the trace coordinates, which will be used later for optimizing the display.

The Frame Seismic represents a rectangular graphic object which includes the images of the source/receiver spread (above) and the traces (below). On the edge of the frame, the scale for the X/Y/Z axis is displayed. On the top, the color palette of the trace values is shown:



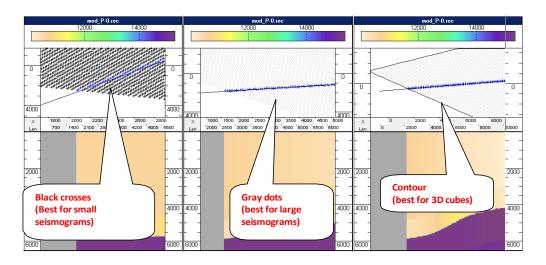
In the source/receiver spread, the positions of sources (small squares) and the coordinates of traces (small crosses) are shown. The current source is marked in red and its coordinates are shown in a balloon. The trace view may include the wiggle of the trace and the images corresponding to the palette. The coordinates of the sources and receivers in the spread may be displayed differently. These settings

can be changed in the Frame Properties dialog, which is called by the button ( $\blacktriangleright$ ) (please see the Section 13.8).

While moving the mouse cursor in the sections area (the vertical or the horizontal slice), the mouse cursor's coordinates and the corresponding trace value are displayed in the status bar.

Z=5185.9 ms	Value=493.0	X=768640.0 m	Y=997660.0 m

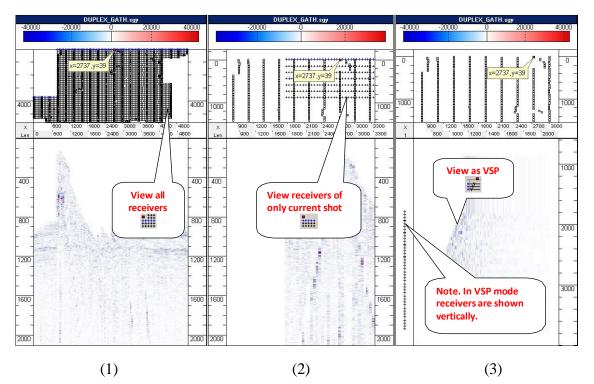
#### 13.1.1 Plan view



The positions of the sources are always displayed as small squares, but the way of displaying the receiver"s position depends on the display mode. For the seismic data with a small number of traces, the receiver"s position is shown as crosses. For large gathers, the receiver"s position is shown as grey dots. For very big gathers or cubes, the receiver"s position is shown as contours.

## 13.2 Trace display

In Tesseral Pro, there are several modes to display traces, and each of the modes is suitable for a specific task and type of seismic data. To preview gathers, 3 modes are commonly used, as illustrated in the figure below (from left to right: "<u>Show All Receivers</u>", "<u>Show Current Shotgather</u>" and "Show as VSP").



- 1. In the <u>Show All Receivers</u> mode, the spread of all the sources and receivers is shown in the top view. This mode is used if you want to have an overview of the whole field under study, and also get the sections of trace profiles belonging to several different sources.
- 2. The <u>Show Current Shotgather</u> mode is for displaying shot gathers. Only the traces of the current source are shown. It can also be used to show the traces of the chosen receivers along any profile.
- 3. The  $\underline{VSP}$  mode is used for visualization of the VSP traces. The sources are located vertically (usually inside a well) and the traces are shown from left to right.

# 13.3 Operations with Seismic Frame

While working with the <u>Seismic</u> Frame, 4 Edit Modes can be used: <u>Select Source Mode</u> (b), <u>Draw</u> <u>Profile Mode</u> (b), <u>Zoom Mode</u> (c) and <u>Move Mode</u> (b).

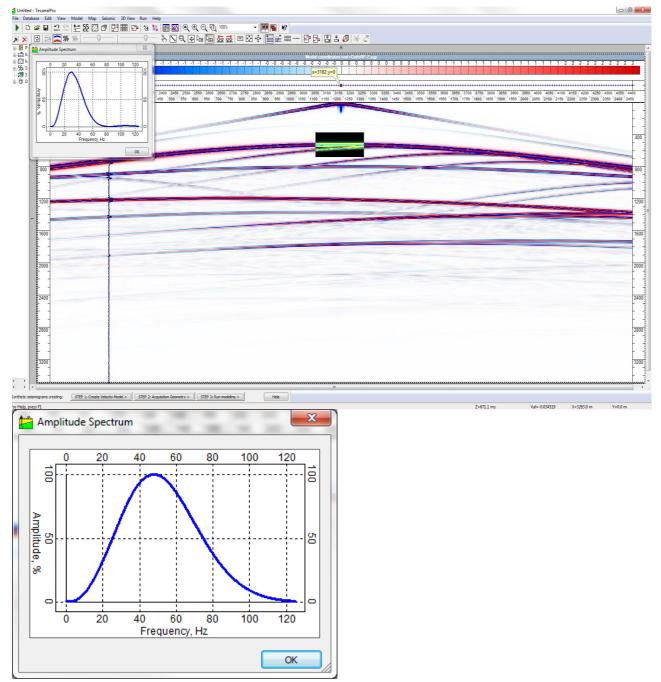
The <u>Select Source Mode</u> allows selecting an active source and this source will be marked in red on the acquisition surface and its coordinates will be shown in a balloon. The <u>Draw</u> <u>Profile Mode</u> allows selecting the vertical section by drawing a line on the top view. In this case, the receivers will fall into the section if their distance to the profile is less than the given one (this distance is computed automatically during the opening of the seismic file, but it may be changed in the settings). In the <u>Zoom</u> <u>Mode</u> and the <u>Move</u> <u>Mode</u>, it is possible to zoom in and drag both the acquisition surface and the vertical section.

Let's describe each of the modes for displaying seismic files.

- "<u>Select Source Mode</u>" (*) enables to show the current source and its corresponding traces.
- "<u>Draw Profile Mode</u>" (N) enables to draw a profile manually in the top view. Please see Section 13.5 for more details. Additionally, in this mode, a horizontal section can be shown.
- "Zoom Mode" ( $\bigcirc$ ) enables to enlarge the image for the given area.
- "Zoom In" (* ) enables to enlarge image.
- "Zoom Out" ( ) enables to reduce image.
- "Zoom 100%"  $(\Box)$  enables to zoom out the image fully.
- "Zoom To" opens a dialogue box to set the zoom parameters.
- Move (+) allows you to move the image within the frame.
- "<u>Rescale to Make X Scale = Y Scale</u>" ( ² ) changes the Frame sizes so that the proportions of the geographic coordinates in the top view correspond to the visual ones.
- "<u>Rescale to Make X Scale = Z Scale</u>" (D=) changes the Frame sizes so that the proportions of the geographic coordinates of the traces correspond to the visual ones.
- "<u>Normalize Palette by Visible Data</u>" ( ) fixes the maximum and the minimum in the color palette to match the minimal and maximal values in the data currently visible in the Frame.
- "<u>Normalize Palette by All Data</u>" ( ) fixes the maximum and the minimum in the color palette to match the minimal and maximal values in the seismic files currently loaded in the Frame.
- "<u>Show Component</u>" enables to select the components to be displayed (for the TGR format).
- "<u>Next/Previous Shotpoint</u>" ( ) enables to set next/previous source as the current source.
- "<u>Export Traces Coordinates</u>" enables to export the trace coordinates to a text file.

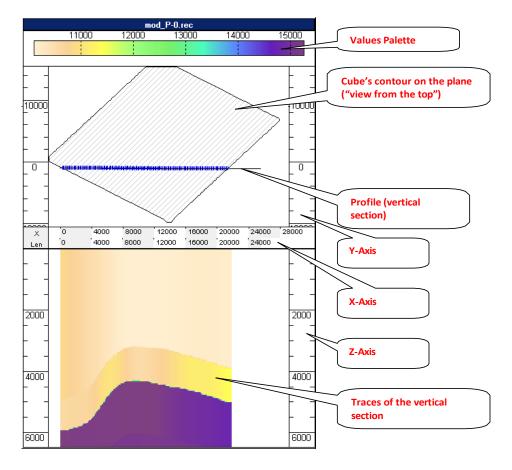
- "<u>Import Traces Coordinates</u>" enables to import the trace coordinates from a text file.
- "<u>Refresh</u>" (E) re-load the data in the Frame (re-read all the data from the seismic files).
- "Apply Settings to all Seismic Frames" ( 🖄 ) enables to apply the settings of the current Frame to other Frames.

Furthermore, the user can display the amplitude spectrum for any area of the seismogram by clicking on <u>Spectrum Mode</u> and selecting the region for which the amplitude spectrum is to be calculated. To select the region simply hold the left mouse button, move the mouse to draw the region and release the left mouse button. To obtain the amplitude spectrum for a different region simply select a different region using the same procedure.



## 13.4 Preview of 3D seismic models or 3D migration results

Users can preview the 3D raster cubes in the <u>Seismic</u> Frame using the mode <u>Show as Model</u> (IIII) and forming horizontal and vertical slices along any user-defined profile. As such cubes are in the format of seismic data, the cube's content is in form of traces. In this case, to describe the X and Y coordinates, the coordinates of the trace's receiver are used, and the Z coordinate is determined from the trace itself. In the general case, the coordinates of the source are ignored, but for compatibility with the seismic data preview tools, it is more suitable either to suppose that the source coordinates are equal to the receiver coordinates, or to create one source for the receivers having Y=const (this is implemented in Tesseral Pro), for which the X coordinate will be equal to the minimal X coordinate of receivers.



## 13.5 Profiles

The easiest way to create a profile is to switch to "<u>Draw Profile Mode</u>" (), then <u>kraw</u> the line manually on the top view, only those traces whose distance to the profile is within the pre-defined value specified in the object"s properties will be included into the section. If the pre-defined distance is too large, the traces outside the profile will be displayed. If the pre- defined distance is too small, fewer or no traces will be included into the section.

#### Section properties

The detailed properties of the profile are specified by choosing the menu <u>Seismic ></u> <u>Section</u> Properties.

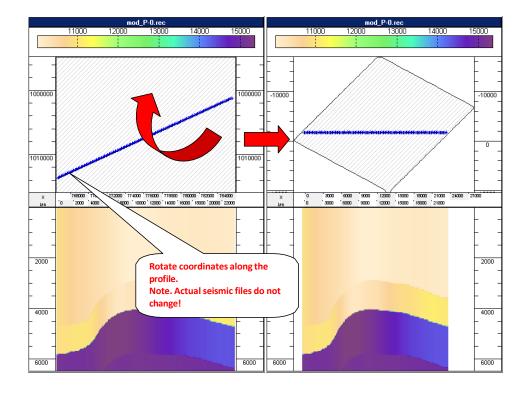
Seismic Properties		×
Common Units Layout Profile	Zoom Rulers	_
Vertical section (Profile)	216 m Y 4112 m	
End: X	3886 m Y 1218 m	
Length 4673.8	m Finder-circle (max distance from profile line to trace) 35 m	
Azimuth -38	deg Distance fitting	
Horizontal slice	Curvature	ור
Start: Z 1394 m	Straight (Z=const)	
End: Z 1394 m	m	
	Line Style	
	OK Cancel Apply Help	

In this box, the profile coordinates, its length and azimuth may be defined, as well as the maximum distance between profile and a trace.

A vertical section may be exported to a separate seismic file, which may be then used as an underlying image for a model. The menu <u>Run > Seismic Frame > Export</u> <u>Section to 2D</u> Seismic File is used.

The seismic data loaded into a Frame may be rotated along the profile, by using the menu

<u>Seismic > Rotate to Align X Axis along Section Profile</u>. But the content of the actual seismic files will not be modified as the rotation will only modify the corresponding auxiliary files with suffix ".cr0".

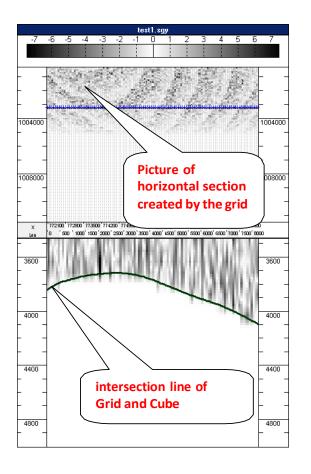


## 13.6 Overlay surfaces on seismic cubes

You may load a surface and obtain the intersection line between this surface and a 3D cube. To do this, please specify the <u>Seismic</u> Frame's properties and specify the name of the file containing the surface.

Seismic Properties	×
Common Units Layout Profile ;	Zoom Rulers
Vertical section (Profile)	0 m Y 0 m
End: X	0 m Y 0 m
Length 0 m	Finder-circle (max distance from profile line to trace) 35 m
Azimuth 0 de	eg Distance fitting
Horizontal slice	Curvature
Draw color map	Straight (Z=const)
Start: Z 0 m	From grid/surface file
End: Z 0 m	C:\Users\Stefan\Desktop\INPEX tra

Tesseral Pro supports loading surfaces in the following formats: XYV, CSV, DAT, Surfer, Schlumberger, Triple TXT, ZMap, Paradigm, GeoQuest, Landmark, Charisma-YX, Charisma-XY, ASC.



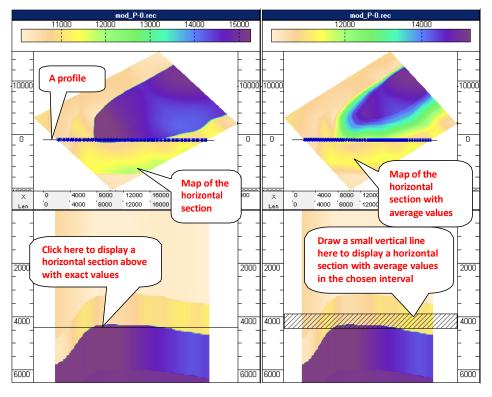
The intersection line between the surface and the cube is shown as dark green line in the vertical section.

While working in the <u>Profile Drawing</u> mode, when you click an arbitrary point on the vertical section, then a horizontal section will be created automatically such that it runs through the chosen point and is parallel to the loaded surface. This image will appear in the top view.

### 13.7 Horizontal sections

Tesseral Pro implements a rather unconventional (for other gather-viewing software) mode for displaying horizontal slices. This mode is useful for 2D visualization of the raster 3D cubes.

In the figure below, the horizontal (above) and the vertical (below) sections of the raster 3D velocity model are shown. In these sections, the profiles lines are shown, along which the horizontal/vertical sections were created. The profile line in the horizontal section is for creating a vertical section, and vice versa.



To build a horizontal section, just switch to the drawing mode and click on an arbitrary point in the vertical section. Then, the horizontal section passing through the given point will be created automatically and displayed in the top view (see the top image). If a vertical line is drawn in the vertical section, a horizontal section will be created, whose value at each position is the average value spanning the drawn line (see the bottom image). The area, for which the horizontal section is created, will be shown by hatching.

To remove the horizontal section while in the drawing mode, please click an arbitrary point in the vertical section while pressing "Ctrl" button.

## 13.8 Settings for Seismic Frame

The majority of the visualization options can be accessed in the <u>Seismic</u> Frame settings. The parameters for displaying gather are specified in the <u>Seismic Frame Properties</u> tab under the <u>Seismic</u> menu.

The properties dialog box is divided into several tabs. In the "<u>Common</u>" tab, the general properties for the visualization of the object are specified, and in the "<u>Layout</u>" tab, where the parameters for visualization of the acquisition surface are defined.

The <u>Units</u> tab in the <u>Seismic Properties</u> window is for changing (scaling) the coordinates and values of the trace data in case a gather is displayed incorrectly in the Frame. In this case, the original file is not modified, and the changes are saved into an additional file

<seismogram_file_name>.cr0. These new modified values will be loaded next time the file is opened.

Seismic Properties	·					×
Common Units	Layout Profile	Zoom R	ulers			
- Seismic File Pr Seismic Dat Com	a Type: Model	ssional veloc	▼ ity ▼	SGY	Headers	
Seismic File Me	asurement Unit —		Trace statis	tics		
Z Axis	Depth	•		N of traces	14577	
Distance	: [m	•	Samp	les per trace	815	
Velocity	: m/s	•		Z step	5	m
Density	kg/m^3	-	Zmin 0	Zmax	4070	m
			Reset	t Coordinates		?
		ОК	Cancel	Apply		Help

If you need to restore the trace parameters and coordinates, please delete the corresponding <seismogram_file_name>.cr0 file or select <u>Update</u> in the <u>Common</u> tab in the <u>Seismic Property</u> dialog.

You can change color representation for displaying seismic data. The package includes 10 standard palettes (blue-yellow-magenta, iridescent, black-white and etc.). You can create a custom palette by clicking on Edit button in Common tab. The minimal and the maximal values for the color palette may be specified manually or left for the program to calculate these values automatically (for each vertical section and for the whole dataset).

You can load seismograms into the <u>Seismic</u> object by clicking the <u>Add</u> button in the <u>Common</u> tab of the frame properties. Loading multiple files is allowed. It is assumed that all sources and receivers are in the same coordinate system. If this is not the case, you can (temporarily) correct the coordinates of individual seismic files using a linear transformation set using the settings in the Properties button

in the <u>Common</u> tab. The <u>Calculate</u> button allows you to restore the main parameters of the selected files by recalculating them from the disk. The same button cancels all previously made linear transformations of the coordinates of the sources and receivers.

Seismic Properties	Seismic Properties
Common Units Layout Profile Zoom Rulers	Common Units Layout Profile Zoom Rulers
Location File Name: pp\Haskell-Thompson test\Untitled+GathAP-Z.sgy Browse	Orientation of Coordinates
Seismic Viewer  Model/Cube  Seismogram  VSP Seismogram  Raw Traces	$ \begin{array}{c} \bullet & \bullet^{Y} \\ \bullet & \bullet^{Y} \\ \bullet & \bullet^{X} $
Palette Seismic File(s) Show Edit. Min Value: -6512 Invert Amplitudes Calculate Max Value: 6512	Draw Features Draw Recievers Axis direction
Show       Show     Transform       Image: Show     23 %       Image: Show     1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Inignight zeros grey     III     Gray dots       Traced Ray Reflection Points     III     Contour       Show points     Style     None
Gain: OK Cancel Apply Help	Receivers" view modes

In the Layout tab, it is possible to define the parameters for visualizing the acquisition system. In the drop-down list of <u>Seismic viewer</u> from the <u>Common</u> tab you may select the display mode for the acquisition system. These modes are described in more details below.

For different seismic files, the number of the receivers may vary from hundreds to millions, and therefore several ways of displaying these receivers are implemented, such as small black crosses, grey dots and contours.

		ofile Zoom	Rulers				
Seismic File Prop	_			_			
Seismic Data		smogram		-	SGY	Headers	
Compo	onent: Ver	tical Particle \	/elocity (Z)	•			
Seismic File Mea	surement Un	it	Trace s	tatistics			
Z Axis:	Time	T		N of	traces	100	
Distance:	m	-	5	Samples pe	r trace	1001	
Velocity:	m/s	~			Z step	2	ms
Density:	kg/m^3	-	Zmin	0	Zmax	2000	ms
							_
			F	Reset Coor	dinates		?

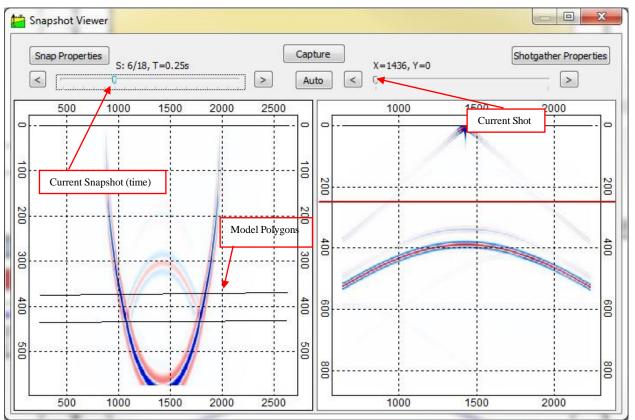
The <u>Common</u> tab also allows adjusting the traces displayed in the vertical section. In the <u>Show</u> group, users can select whether the traces will be displayed as wiggles or image based on the user-defined palette. For multi-component seismic data, users can select the component to be displayed in the Seismic File Properties group from the Units tab.

In the <u>Rulers</u> tab, the parameters for displaying the Vertical and Horizontal rulers are specified. By default, both rulers are shown on the left and the right side of the object, but users have the option to either display the vertical scale on the left side, or just on the right side.

The profile parameters (vertical or horizontal section) can be defined in the **Profile** tab.

### 13.9 2D Snapshot Viewer

To show the snapshots together with the shot gather, please choose the <u>Snapshot</u> <u>View</u> <u>Window</u> command under the <u>View</u> menu.



Please press the Select Snap button to select the file with a snapshot. Please press the

<u>Select Shotgather</u> button to select the corresponding gathers. If the Model Frame is opened in the Tesseral Pro, the contours of the model will be shown in the snapshot. Navigation through snapshots and gathers is done with help of the corresponding sliders.

You can save the snapshots as a video by pressing <u>Capture</u> after which the <u>Animation Properties</u>window will appear.

Animation Propert	ies X
Output Movie file:	:'s syntetic seismogram\snapshot.avi
Scope Current W	Vindow   Program Window
Options Frames per Compres	second: 10 sion Microsoft Video 1
	OK Cancel

The movie will be saved in AVI format and the user must also specify the number of Frames

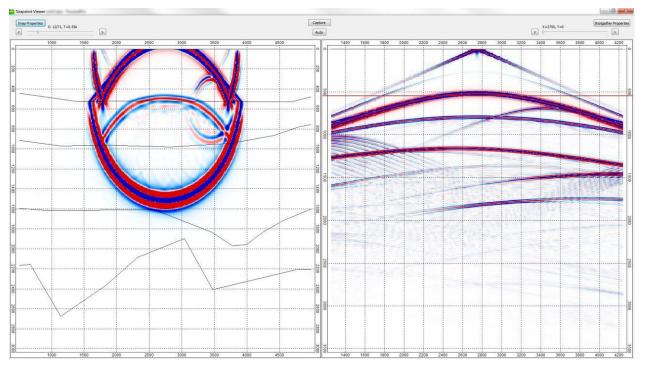
The user can specify the Compression Quality of the video by clicking Compression.

Select Compression	×
Compressor:	OK
Microsoft Video 1 ▼	Cancel
Compression Quality: 85	Configure
∢ ▶	About

Also, the <u>Temporal Quality Ratio</u> for the compressor can be subsequently specified by selecting Configure.

Configure			x
Microsoft Vi Ve	deo 1 Con rsion 1.00	npressor	
Copyright (C) Mic Portions Copyr			
Temporal Quality Ratio:		0.75	ОК
•		۴	Cancel

Once all setting are specified, click <u>Okay</u> and the program will start recording the Tesseral Pro interface. Please note that closing the <u>Snapshot Viewer</u> window from this point on will interrupt the recording, and everything recorded so far will be saved as a video! If the user wants to record the <u>Snapshot Viewer</u> window only, it is recommended that you extend it to full screen and use the <u>Program Window</u> Scope in the <u>Animation Properties</u> window.



To stop recording press <u>Capture</u> and the video will be saved in the specified location, with the specified name in the <u>Movie file</u> dialogue.

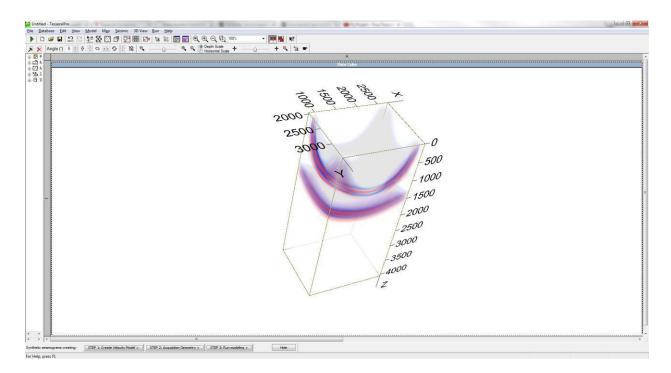
# 13.10 3D Snapshot Viewer

In order to generate 3D snapshots please select check <u>Generate 3D snapshots</u> and select <u>Setup</u> <u>3D Snapshots</u> in the <u>3D modelling</u> Calculations Properties window.

Computation Grid Properties	Hardware
Signal Frequency 20 Hz	Threads per process Max 💌
Cell (dx, dy, dz) 10 m auto	Enable GPU (if CUDA available)
Tact (dt) 0.47 ms auto	GeForce GTX TITAN Black (4 G 👻
Margin 500 m auto	Required Memory (Host): 1.1 GB ?
Margin 500 m auto	Required Memory (GPU): 2.2 GB
Generate 2D snapshots	Generate Energy Field(s)
Start 0 ms	Maximum Energy
Step 50 ms	Maximum Divergence
	X Step: 10 m
Generate by every 1 📩 source	Y Step: 10 m auto
Generate 3D snapshots	Z Step: 10 m
Setup 3D Snapshots	

D Wave Field Snapshot		
For shot points:	0 ; All shot points	(can be several, separated by spaces.
For moments in time:	0.5	s E.g. "123")
Mesh steps		Generate Components
X step: 15	m	Stress
Y step: 15	m auto	Particle Velocity:
Z step: 15	m	🗆 X 🔲 Y 🔍 Z
		OK Cancel

The user then needs to specify the <u>Shot Points</u> and the <u>Component</u> for which snapshots need to be generated, as well as for which <u>Moments in Time</u>. The user can also adjust the default values for the <u>Mesh Step</u> for wave field propagations along the X, Y and Z axis.



As a result a SGY file will be generated for each specified shot point and its respective component, which will contain a snapshot image of the propagating wavefield at the specified time. In order to view the snapshot, the generated SGY file needs to be opened in <u>3D View</u> frame (<u>3D View>Add SEG-Y</u> <u>cube</u>). In order to achieve the best display, the user will need to adjust the visualization parameters in the 3D View>Selected object properties window.

Cube Properties	×
File name C: \Users\Stefan\Deskto	op\3D Elastic anisotropic method test
X-step IS Y-step	15 Z-step 15
Palette	
Specify interval	Opacity 90 %
O Auto fitting by cube values	
Palette	
ОК	Cancel

Typically for an optimum visualization of the wavefield, a value 85%-95% for the <u>Opacity</u> works best. Also, reducing the <u>Magnitude within the Palette</u> will also enhance the display of the whole wavefield.

Palette		1.1	×
Magnitude within	-2	2	📝 Edit
Palette type	Default Dipola	1	•
Glow (%)	1 1		
100			
🔲 Edit palette		Discretization	9 🚔
2 2 1	-1 0	1 1	2 2
		K	Cancel

# 13.11 Prepare seismic files for loading

Sometimes, for unconventional gathers, some preliminary preparation is necessary before loading. Most often, the problems with loading SEG-Y files are caused by incorrect reading of the data related to the timing of the signal registration and incorrect reading of the data related to coordinates and altitude of sources and receivers. Partially, these problems can be solved in the <u>Seismic Properties</u> dialogue box (the <u>Seismic > Seismic Frame Properties</u> command).

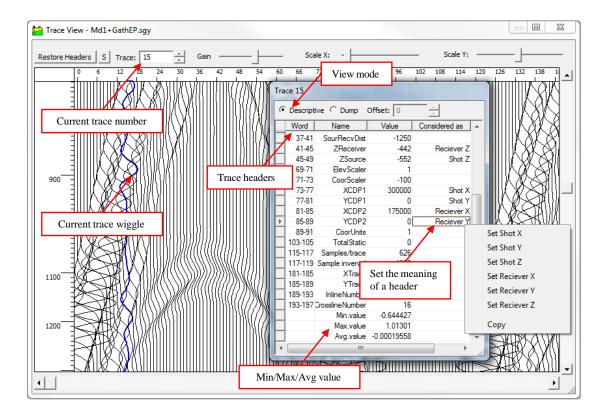
Seismic Pro	perties									×
Common	Units	Layout	Profile	Zoom	Rulers					
	: File Pro mic Data Comp	-	Seismog Vertical I		elocity (Z)	•	SGY	Headers		
Seismic	File Mea	suremen	t Unit		Trace	statistics				
	Z Axis:	Time		-		No	of traces	60		
Di	istance:	m		-		Samples	per trace	501		
v .	elocity:	m/s		-			Z step	2	ms	
	Density:	kg/m^	3	-	Zmin	0	Zmax	1000	ms	
						Reset Co	ordinates		?	ļ
				ОК	Can	el	Apply		Help	

In the <u>Seismic File Properties</u> dialogue box, please select the measurement units for scaling of the trace coordinates and of the trace interval. In this case, the content of the gathers itself will be not be changed. All changes will be saved in an auxiliary file named **<name of the gather file>.cr0**. If you press the <u>Apply</u> button in the <u>Seismic File Properties</u> dialogue box, the file with the suffix .cr0 will be deleted and the previously entered scaling constants will be cleared.

Sometimes, the trace coordinates in a SEG-Y file"s header are located in non-standard cells.

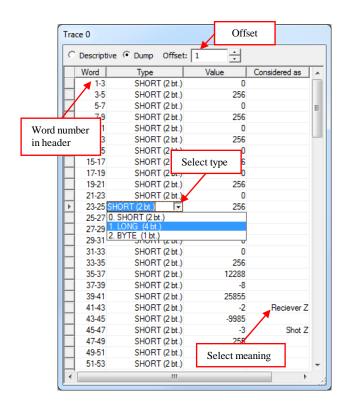
· · ·	Dump Offset:			_		
Word	Name	Value	Considered as	*		
1-5	Trc.num(line)	1				
5-9	Trc.num(reel)	1				
9-13	FFID	1				
13-17	Trc.num(orig.)	1				
17-21	Energy.Src.Pt	1				
21-25	CDP	1				
25-29	Trc.num(CDP)	1				
29-31	Trc.type	1				
31-33	VStackNumb	0				
33-35	CDPFold	0				
35-37	DataUse	1				
37-41	SourRecvDist	-2000				
41-45	ZReceiver	-412	Reciever Z			
45-49	ZSource	-552	Shot Z	E	П Г	
69-71	ElevScaler	1				The standard locations of
71-73	CoorScaler	-100				source"s and receiver"s
73-77	XCDP1	300000	Shot X	h	K	X/Y/Z coordinates in a
77-81	YCDP1	0	Shot Y			SEG-Y file"s header
81-85	XCDP2	100000	Reciever X			
85-89	YCDP2	0	Reciever Y			
89-91	CoorUnits	1		4		
103-105	TotalStatic	0				
115-117	Samples/trace	626				
117-119	Sample inverval	4000				
181-185	XTrace	1000				
185-189	YTrace	0				
189-193	InlineNumber	1				
193-197	CrosslineNumber	1				
	Min.value	-2.47745				
	Max.value	2.93494				
	Avg.value	0.000128982		-		

To prepare a gather for loading, please choose the <u>Seismic > Raw Trace View Window</u> command. After the seismic file is chosen, 2 windows will be opened. In one of the windows, the trace preview is shown in the same order as the traces in the file, and in the second window, the table with headers of an individual trace is shown.



The key point for preparing a seismic file for loading is to select the headers" cells which correspond to the coordinates of the source and receiver. It is possible to allocate the coordinates of the source and the receiver to any cell in the headers by clicking the right mouse button in any cell of the header. This information (assign some header cells to the coordinates) will be saved in the file **<name of the gather file>.inf**, and, from now on, it will be used by the program.

Preview of all the trace headers enables to look through the trace headers as a set of values without name. You may specify the parameter offset to shift the starting point of displaying <u>the</u> headers.



The trace header may be displayed in two modes: Descriptive mode and Dump mode. In the Descriptive mode, only the headers with known names are listed. In the Dump mode, all headers are listed.

While looking through the header as a whole, the location of words is in the first column, the data type is in the  $2^{nd}$  column and the values are shown in the third column. As different data types have different length of words, the lower part of the header is shifted automatically.

Tesseral Pro supports the following data types: CHAR (1 byte, -127~128), SHORT (2 bytes, -32767~32768), LONG (4 bytes, -2147483647~2147483648).

# 14 Map Frame. Stratigraphic Surface Maps

In Tesseral Pro, a model can be built from stratigraphic surface maps. The model is built automatically as a vertical slice cutting through the calculated (loaded) surfaces vertically along the selected line.

More information about building models by using stratigraphic surfaces is described below. Firstly, let"s describe the relevant capabilities for loading, calculating, displaying and processing surfaces.

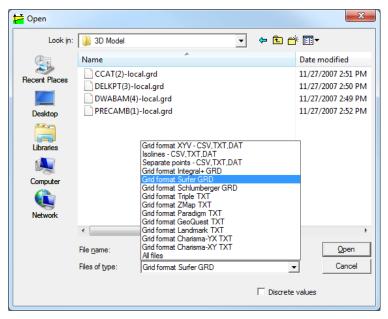
# 14.1 Load surface from text file

Tesseral Pro supports loading surface from text files in various formats (the command <u>File > Load</u> <u>Surface File</u>). It is also possible to load grids in the following formats: XYV, isolines, separate points, Integral+, Surfer, Schlumberger, Triple, ZMap, Paradigm, GeoQuest, Landmark and Charisma.

The user can also generate surfaces on his own, by introducing in a text file the XYZ coordinates of the surface in 3 separate columns and then saving the file with an XYZ extension.

Stand         Prind           Stand
Date and object         Beplace and object           Bitting         Editing           3 - + 2 + + 1 + +         2 + + 3 + + 4 + + 5 + + 6 + + 7 + + 8 + + 9 + + 10 + + 11 + + 12 + + 13 + + 14 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 17 + + 15 + + 16 + + 17 + 17 + 16 + + 17 + 17 + 1
Defined intert wett         Ellipseital           3
Data d Insert sert Setting 3 + + 2 + + 1 + + 2 + + 3 + + 4 + + 5 + + 6 + + 7 + + 8 + + 9 + + +10 + + 11 + + + 12 + + 13 + + 14 + + + 12 + + 16 + + 17 + + + + + + + + + + + + + + + +
Editing         Editing           3 + + 2 + + 1 + +         2 + + 1 + + 2 + + 3 + + 4 + + 5 + + 6 + + 7 + + 8 + + 9 + + 10 + + 11 + + 12 + + 13 + + 14 + + 15 + + 16 + + 17 + + 15 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 116 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 17 + + 16 + + 16 + + 16 + 17 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 + + 16 +
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
517106         5045962         4750           513974         5041486         5000           511718         5041934         4750           509364         5042402         4000           506912         5042802         3750           504656         5043338         3750           504656         5043336         4000           502792         5043708         4000           497006         5044758         3000           497006         5044758         3000           498065         5044272         2500           483072         5047568         2750           483078         5047562         2300           479743         5048283         3750           473860         5044264         4000           4739743         5048288         3750           473869         504464         4000           475329         5049166         4000           475329         5049166         4000           475329         5049634         3750           470916         5050862         3000           470916         5050862         3000
513974         5041486         5000           511718         5041534         4750           509364         5042402         4000           506512         5042802         3750           504656         5043338         3750           504656         5043338         3750           504792         5043708         4000           497006         50444258         3500           4930705         5044559         3000           497006         5044752         2750           497006         5044752         2750           493072         504559         3000           493072         504562         2500           493372         5047562         2750           493372         5047562         2750           493372         5047564         2750           493372         5047564         2750           493373         5048288         3750           477860         504828         3750           477829         5049634         4000           475329         5049634         3750           470916         5050843         3500           470916         5050842
513974         5041486         5000           511718         5041534         4750           509364         5042402         4000           506512         5042802         3750           504656         5043338         3750           504656         5043338         3750           504792         5043708         4000           497006         50444258         3500           4930705         5044559         3000           497006         5044752         2750           497006         5044752         2750           493072         504559         3000           493072         504562         2500           493372         5047562         2750           493372         5047562         2750           493372         5047564         2750           493372         5047564         2750           493373         5048288         3750           477860         504828         3750           477829         5049634         4000           475329         5049634         3750           470916         5050843         3500           470916         5050842
511718         5041934         4750           509364         5042402         4000           506912         5042890         3750           504362         5043388         3750           504362         5043396         4000           50730         504456         5043396           504362         5043396         4000           50730         5044702         4760           497006         5044858         3500           497006         5044858         3500           493278         5045794         2750           48865         5046476         2500           483073         5047626         2750           483073         5047628         3750           47960         504826         3750           47329         5049166         4000           475329         5049164         4070           472975         5049634         3750           470916         505063         3500           470916         505063         3500
509364         5042402         4000           5065912         5042890         3750           504656         5043338         3750           504656         5043338         3750           504792         5043708         4000           502792         5043702         3750           497006         5044858         3500           493070         5045794         2750           492298         5045794         2750           480499         5045767         2500           493372         5047567         2750           403372         5047562         2750           403373         5048288         3750           473860         5048284         4000           475329         5049166         4000           475329         5049166         4000           475329         5049634         3750           470916         505043         3500           470916         505043         3500
506912         5042890         3750           504362         5043338         3750           504362         5043396         4000           502792         5043708         4000           497106         5044702         3150           497106         5044702         3150           493278         5045794         2000           493278         5045794         2750           48865         5046476         2500           483073         5047626         3300           483073         5047626         3300           479760         504827         2500           483073         5047626         3300           479760         504828         3750           479760         5049634         4000           472975         5049634         3750           470916         5050843         3500           470916         5050843         3500
504362         5043396         4000           502792         5043708         4000           497790         5044702         3750           497790         5044702         3750           497790         5044702         3750           493278         5045599         3000           493278         5045594         2750           48865         5046476         2500           483372         5047568         2750           483372         5047562         2300           479743         5048288         3750           47860         5048464         4000           475329         5049166         4000           472975         5049634         3750           470916         505043         3500
502792         5043708         4000           497790         5044702         3750           497006         5044858         3500           493006         5045794         2750           492298         5045794         2750           48865         5046476         2500           487099         5046822         2500           483778         504758         2750           473743         504828         3750           4739743         504828         3750           475329         5049166         4000           475329         5049634         3750           470916         5050632         3000
497790         5044702         3750           4977906         5044858         3500           493278         5045599         3000           493278         5045599         3000           493278         5045794         2750           48865         5046476         2500           483372         5047568         2750           483372         5047568         2750           483373         5047626         3300           479743         5048288         3750           478860         5048464         4000           475329         5049166         4000           472975         5049634         3750           470916         505082         3000
497006         5044858         3500           493278         5045599         3000           492298         5045794         2750           48865         5046476         2500           487099         5046827         2500           48372         5047562         2750           48374         504766         2500           493743         504768         2750           4739743         5048246         4000           47329         5049166         4000           472975         5049634         3750           470916         5050862         3000
493278         5045599         3000           49228         5045794         2750           48865         5046476         2500           48709         5046827         2500           483372         5047568         2750           483373         5047626         3300           479743         5048288         3750           47860         5048444         4000           475329         5049166         4000           472975         5049634         3750           470916         5050632         3000
492298         5045794         2750           48865         5046476         2500           487099         5046827         2500           483072         5047568         2750           483073         5047626         3300           493074         5047626         3700           493075         5048247         3100           49360         5048264         3170           47329         5049166         4000           472975         5049634         3750           470916         5050643         3500           466796         5050862         3000
488865         5046476         2500           487099         5046827         2500           483372         5047568         2750           483372         5047568         2750           483373         5047626         3300           479743         5048288         3750           47860         5048464         4000           475329         5049166         4000           472975         5049634         3750           470916         5050433         3500           466796         5050862         3000
487099         5046827         2500           48372         5047568         2750           483078         5047626         3300           479743         504828         3750           478860         5048464         4000           475329         5049166         4000           472975         5049634         3750           470916         5050643         3500           470916         5050642         3000
483372         5047568         2750           483378         5047626         3300           479743         5048288         3750           47860         5048464         4000           475329         5049166         4000           472975         5049634         3750           470916         5050632         3500
483078         5047626         3300           479743         5048288         3750           478860         5048464         4000           475329         5049166         4000           472975         5049634         3750           470916         5050634         3500           466796         505082         3000
478800         5048464         4000           475329         5049166         4000           472975         5049634         3750           470916         5050043         3500           466796         5050862         3000
475329         5049166         4000           472975         5049634         3750           470916         5050043         3500           466796         5050862         3000
472975 5049634 3750 470916 5050043 3500 466796 5050862 3000
470916 5050043 3500 466796 5050862 3000
466796 5050862 3000
464933 5051232 1250

In the standard <u>File Open</u> dialogue box, please select the surface file and specify the proper format from the <u>File type</u> list for the selected surface file.

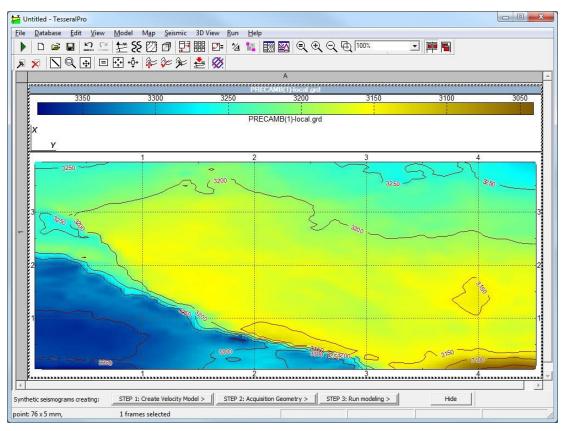


You may select several files of the same type for a group loading.

Then, in the next dialogue box <u>Calculate Isolines</u>, please specify the parameters for calculating the isolines or click Cancel, if you do not want isolines to be shown on the surface.

Calculate Isolines			
Calculate isolines with step 🗾 🛐			
Size of working area			
Width 129 Height 113			
Magnitude of values			
Lowest 2982.19873			
Highest 3295.04257			
OK Cancel			

Please see the results



Please repeat this operation to load other surfaces.

Tesseral Pro saves all loaded surfaces as a general block in a Tesseral Pro document. Please use the <u>Map</u> Frame to display a surface. While deleting the <u>Map</u> Frame, the last showed surface in this Frame is not deleted and it will remain in the block of the calculated (loaded) surfaces in the Tesseral Pro document. You can show this surface in another <u>Map Frame</u> by selecting it from a list. Please use <u>Map ></u> <u>Manage/Delete Maps</u> to manage the surfaces loaded in Tesseral Pro. More detailed information can be found in the Section 14.2.5.

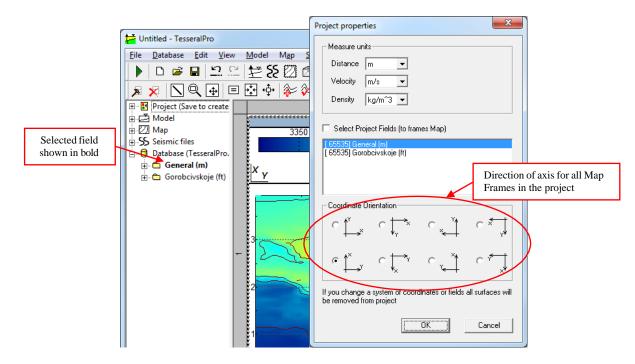
**NOTE:** The <u>Undo</u> and <u>Redo</u> commands do not apply to actions performed on surfaces (loading, calculating, processing, deleting), but they do work for the changes related to the <u>Map</u> Frame (selecting a surface for display, color adjustments, scaling, Frame re-size and

## 14.2 Calculate surfaces using well data

To build surfaces by using the intersection of well layers, Tesseral Pro requires an existing MS Access or MS SQL Server database with well coordinates, altitudes and/or inclinometry and stratigraphic well depth values. More detailed information about how to load such information into the geophysical database can be found below in the Section *17*.

#### 14.2.1 Select fields for the project

As the database may include several independent fields, users need to select the "working" field before surface building, which can be done using the command  $\underline{File} > \underline{Project Properties}$ . Please also select the directions of the coordinate axis for the surface maps you want to build.

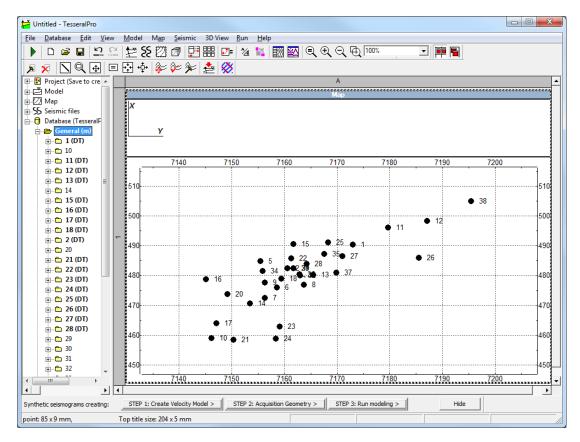


**NOTE:** Once Tesseral Pro is loaded, it is not yet connected to the database. Please use the <u>Load Database</u> button in the left part of the window to connect to DBMS MS SQL Server or to MS Access and to load the Tesseral Pro database. More information about connecting to the database can be found in the Section 17.4.

**NOTE**: It is also possible to select a field using the command <u>Select a field for</u> <u>the project</u> from the context menu by right-clicking the mouse on the field"s name in the database tree.

#### 14.2.2 Create Frame Map

Please use the command  $\underline{Map} > Create Map$  (New Frame). Then, a map with the wells of the selected field will appear.



All commands for editing the map are located in the Map menu.

#### 14.2.3 Working area

The working area (the area where the surface is built) is defined by an interval (m or ft) along the X and Y axis. The working area is defined in the Map Properties dialogue box of the Map Frame.

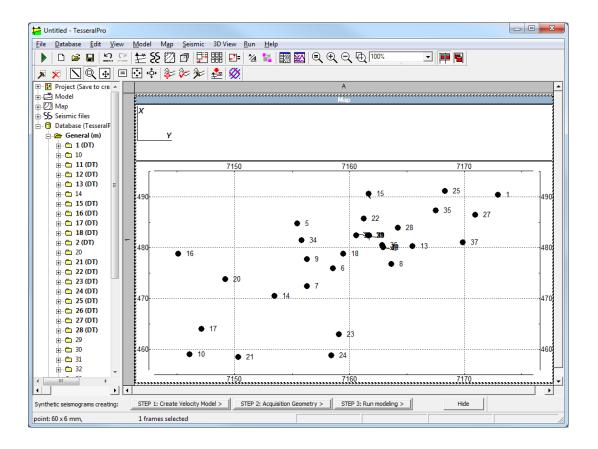
Map Properties	×		
Edit top title     Size       Edit bottom title     Width     159 m       Height     76 m       Project Properties and Coordinate orientation     Work area	Palette		
Layers     Active Layer CCAT(2)_local.grd      Show Grid (fill color)      Draw Isoline Font height (%) 90	Isolines Properties		
Well Title At collar	Craw     Geometry	Work Area	X
₩ Name	Background	X min 35	ОК
Value     Color     Font height (%)     80        V     Draw Well Indinometry	Show picture Background Picture	X max 3955	Cancel
Seismic plan view		Y min 35	
Draw Seismic frames plan     Draw sources from seismic file     Load	OK Cancel	Y max 4515	

The working area can also be selected visually by the mouse in the following modes: Map

<u>Zoom Mode</u> or <u>Map</u> > <u>Move Mode</u>. In both modes the selection (displacement) of the area is done by left-clicking the mouse on the Map Frame (press-drag-release).

**NOTE:** If the area was selected incorrectly: (1) To cancel the last action, please use  $\underline{Edit}$  > Undo; (2) To zoom the area, use the command  $\underline{Map} > \underline{Zoom} \ \underline{Mode}$ , and then select the area again.

Please see the results



#### 14.2.4 Surface mapping

Surface mapping is based on the intersection data of well layers. Tesseral Pro supports 8 mapping methods, such as the spline-approximation and Kriging.

To create new surface maps, please use the <u>Map > Calculation of Horizon</u> from Well <u>Tops</u> menu command. In the <u>Add new surfaces</u> dialogue box please select the layers, for which you want to build the surface maps.

	Add new surfaces				×
	Select strata				
	Layer name Cre	Wells	Top/Bottom	Strata name	•
Select layer(s)	AN1: Bottom	5	Bottom	AN1	
· · · ·	AN1: Top	5	Тор	AN1	
from list	AN2 : Bottom	5	Bottom	AN2	
	AN2 : Top	5	Тор	AN2	
	AN3 : Bottom	13	Bottom	AN3	
	AN3 : Top	13	Тор	AN3	
	AN4 : Bottom	8	Bottom	AN4	
	AN4 : Top	8	Тор	AN4	
Use the list to select		<b>,</b> III	D	ANIE	
layers automatically	Automatic select layers No		•	ОК	Cancel
	No				
	Only by all wells Only exists Only tops				
	Only bottoms Unselect				

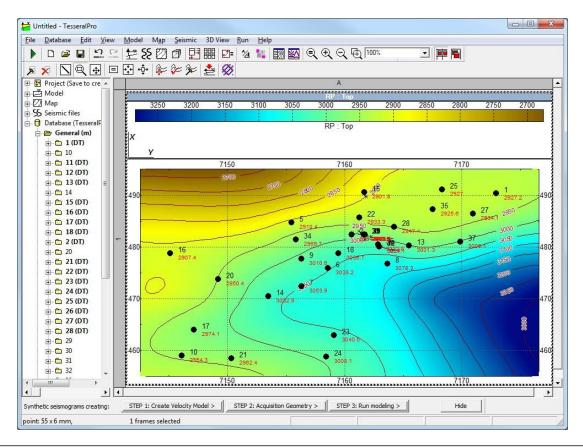
Next, select one of the mapping methods available from the list.

Choose ma	oping method		×
Method	Spline-approximation	•	OK
Analog	(do not use)	•	Cancel

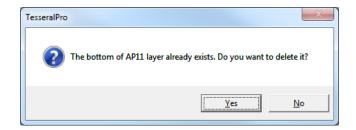
**NOTE**: Depending on the input data, the most suitable method is selected automatically from the list.

The surface calculation for the selected layers will be done automatically by the selected mapping method.

Please see the results

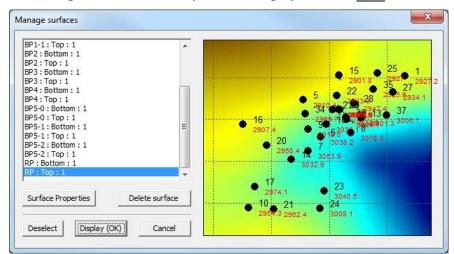


**NOTE:** If you want to re-build surfaces using another mapping method or to build other layer surfaces, please choose the command  $\underline{Map} > \underline{Add} \ \underline{New} \ \underline{Horizon} \ \underline{from}$ <u>Well Tops</u> again. The program will propose you to delete the existing surface if you want to re- calculate it again.



#### 14.2.5 Handling surfaces

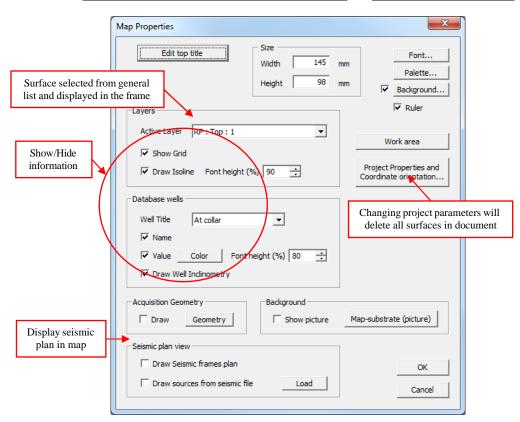
Please use the command  $\underline{Map} > \underline{Manage/Delete Maps}$  to delete and modify the properties (name, top and bottom) of any surface displayed in the Map Frame.



**NOTE:** The <u>Undo/Redo</u> commands are not supported while handling surfaces (creating, loading, deleting).

#### 14.2.6 Surface display

The display parameters for the <u>Map</u> Frame can be changed in the <u>Map</u> Properties dialogue box (the command Edit > Edit Frame Properties or Map > Map Frame Properties).



**NOTE:** The <u>Map</u> Frame "does not contain" the loaded and calculated surfaces. All surfaces are saved into a common block in the Tesseral Pro document (<u>Map > Manage/Delete</u> <u>Maps</u>). The <u>Map</u> Frame is used to display any of the loaded (calculated) surfaces. It means that, in any <u>Map</u> Frame, you can show any surface from the common list. Deleting a surface from this list will lead to its "disappearing" from all <u>Map</u> Frames where this surface was shown. The commands <u>Map > Active Map</u> (rotation, displacement, and smoothing) can also change the surface data itself (not only its display in the Frame).

To change the palette of the surface, please select the <u>Map</u> Frame with the mouse and then use the command <u>Edit > Palette</u> or click the <u>Palette</u> button in the <u>Map</u> <u>Properties</u> dialogue box.

Palette	×	
Magnitude within 3251.5080 2727.5393 Edit		
Palette type Fr	om brown to dark blue	
Glow (%)  100	· · · · · · · · · · · · · · · · · · ·	
Edit palette	Discretization 9 🛨	
3200 310	3000 2000 2000	
	RP:Top:1	
	Cancel	

The displayed amplitude of the surface cannot be changed (scaled down) in the <u>Palette</u> dialogue box. But it can be changed by using the command <u>Map > Active Map></u> Properties.

Here, it is also possible to change the model"s name and the surface type. To change the surface itself (not only its display), please use the commands <u>Scale</u>, <u>Smooth</u>, <u>Rotate</u> from the menu <u>Map</u> > <u>Active</u> Map and in this case the commands <u>Undo/Redo</u> are not applicable.

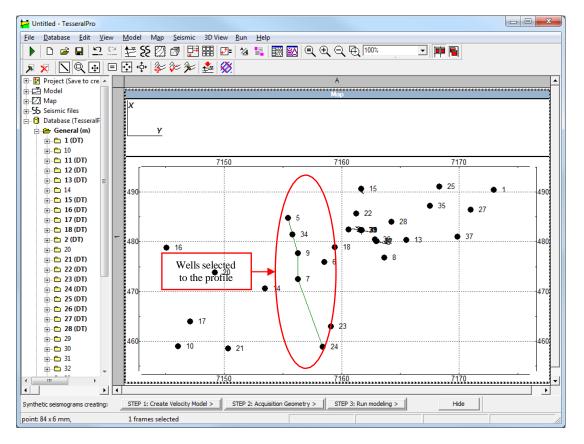
#### 14.2.7 Build model from surfaces

Before building a model using surfaces, it is recommended to load or calculate these surfaces in Tesseral Pro. You do not need to have all surfaces ready before building the model. This process can be iterative, i.e., you can delete, add, re-calculate surfaces and re-build the existing model using the new surface data.

The steps to building a model from surfaces are as follows:

<u>STEP 1. Select the wells for the section line (profile)</u> – To select wells among those displayed in the Map Frame, please right-click the mouse button on the well you want to add to the profile. Then, in the context menu, select the command Add Well to Profile. The picture will not be changed after selecting the first well. Please repeat the process to add the other wells.

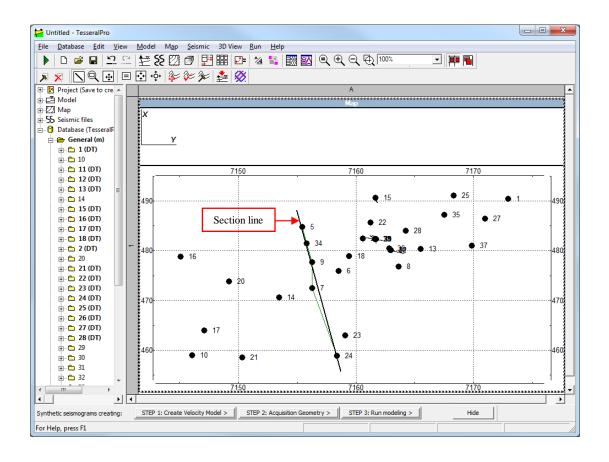
Please see the results



To delete a well from the profile, please use the command <u>Delete Well from Profile</u> in the context menu or the <u>Map > Profile</u> menu. To clean the entire profile, use the command <u>Map > Profile > Empty Profile</u>.

<u>STEP 2. Draw section line</u> – Please select the mode <u>Map > Section Mode</u>. Then use the left mouse button to draw (press-drag-release) a section line.

Please see the results



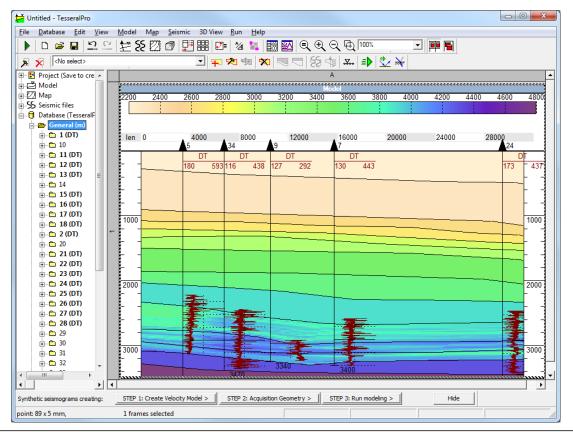
<u>STEP 3. Create a model</u> – Please use the command <u>Map > Transmit Horizons</u> to <u>Model</u> to launch the Wizard for creating a model. More detailed information can be found in the Section 3.1.3.

**STEP 4. Support of thin layering** – If you would like to fill the polygon"s parameters by the well log data, you need to load these log curves to the wells in the model via the dialogue box <u>Polygon</u> Properties (the command <u>Model > Edit Polygon</u>, after you select the polygon).

In the <u>Polygon Properties</u> dialogue box that opens, please select the acoustic log for automatic parameter setting <u>From Log</u> for the polygons created by surfaces. The remaining parameters of the <u>Model</u> Frame can be set right now or later via the dialogue box <u>Model > Model Frame</u> Properties. More details can be found in the Section 3.1.

Model Properties		×
Top title Size Width (mm)	Palette	Horizontal scale
Bottom title Height (mm)	98 Font Well data	Vertical scale
Show Wells	Depth interval	Borehole
Add > 14	Top 0 m	Right side
Delete < 20	Bottom 3102 m	
Delete all <<	Scale 1 31653.1 💌 🔽 Sca	ale 🗖 Scale
	Backg	round 🔲 Background
Zoom map Draw section manually	Select logs to be displayed on wells	dividual well properties
7.14e+006 7.16e+006	Azimutr 139.2 Component	Compression Velocity
16 2014	Scale 1 254544 💌	Base seismogram
4600000	X beg. 483289.0 m	Base picture
8 7.14e+006 7.16e+006	Y beg. 7141619.0 m	OK Cancel

Please see the results



**NOTE:** Choosing the command  $\underline{Map} > \underline{Transmit Horizons to model}$  again when the <u>Model</u> Frame already exists will cause the model to be automatically re-built (1) from the selected section and profile in the map or (2) from the existing maps of the layer surfaces in the document.

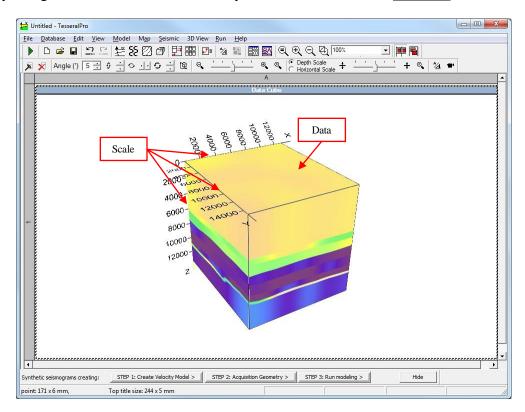
**<u>STEP 5. Adjust model</u>** – More details can be found in the Section 3.1.10.

**NOTE**: During the adjustment of the polygons" parameters that have been created automatically from the <u>Map</u> Frame, please use the <u>By default</u> button in the <u>Polygon</u> <u>Properties</u> dialogue box to memorize these parameters; they will be automatically filled next time you create polygons from the same layers.

# 15 3D View Frame

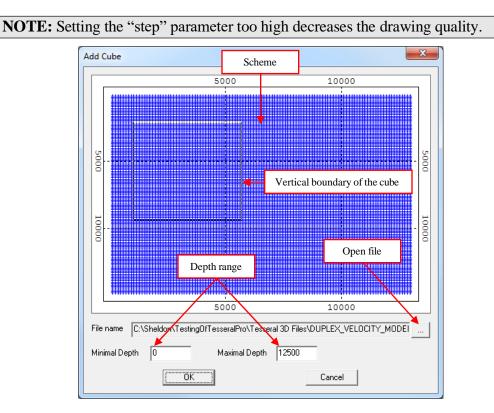
In Tesseral Pro, the <u>3D View</u> Frame is used for visualizing the spatial distribution of the data from a database, a project or from a user file. To rotate the data contained in this Frame, please use the toolbar buttons when this Frame is selected. The data are displayed in a cube. You can customize the scale of each edge of the cube by using <u>Object Properties</u>. Use the linear <u>Zoom</u> slider to zoom the display. For the axis, different scales may be adjusted (<u>Horizontal/Depth Scale</u>). To access object properties, please double-click on the object or use the command <u>3D View > Object</u> Properties (in the 2nd case, the object should have been selected in advance by the mouse).

The data can be loaded into the cube using the  $\underline{3D}$   $\underline{\forall iew}$  menu. All the data loaded to the cube are displayed together in a unified coordinate system. Let's describe the  $\underline{3D}$  View Frame in more details.



### 15.1 Seismic Data Visualization

<u>The 3D View</u> frame allows displaying seismic data in the SEG-Y, SDS-PC and TGR formats. To load the cube, please use the command <u>3D View > Add Cube</u>. The <u>Add Cube</u> dialogue box will appear. Then, please load the target file. The receivers are shown as small blue crosses. Initially, the whole area is covered by the selected receivers. To select a rectangular part of the whole area, please draw the diagonal of the square you want to select while holding the left mouse button. Use the minimum/maximum depth parameter to limit the depth range of the cube. By default, the depth range is from the minimum to the maximum throughout the cube. After pressing <u>OK</u>, the <u>Cube Properties</u> dialogue box appears for users to specify the cube properties. The parameter step is the distance between the two neighboring nodes of the loaded grid along each of axis. This parameter can be increased to speed up drawing. The other parameters in this dialogue box are used to adjust the color palette. By default, the range of the palette is set from the minimum to maximum values obtained from the file. To set the range of the palette automatically for the displayed data, please select the <u>Auto fitting by</u> <u>cube</u> <u>values</u> option.

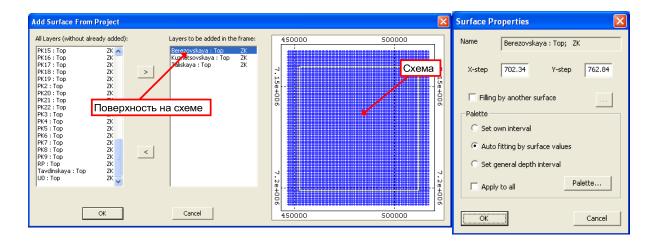


The procedure of loading profiles is practically the same as described above.

# 15.2 Surface Visualization

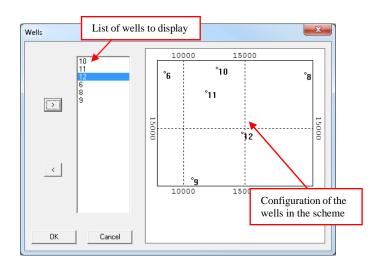
Surfaces are loaded from files in the same way. The command <u>3D View > Add Map > From</u> <u>Project</u> is for loading surfaces from a Tesseral Pro project.

After clicking <u>OK</u> in the <u>Add Map From Project</u> dialogue box, the <u>Map Properties</u> dialogue box will appear for each loaded surface. The palette can be defined either from the active surface or from any other surface (check the <u>Filling by another surface</u> option). The interval of the palette can be set by the user (<u>Set own interval</u>) or by the minimum and maximum values in the surface (<u>Auto fitting by surface values</u>) or by the minimum and maximum values in all surfaces in the Frame (<u>Set general depth interval</u>). Check the option <u>Apply</u> <u>to all</u> to apply the palette settings to all available surfaces.



### 15.3 Visualization of inclinometry logs, well logs and layers

To load wells from the database, please use the menu command <u>3D View > Add/Remove Wells</u>, then in the <u>Wells</u> dialogue box define the list of wells you would like to see in the Frame. To set well properties, use the command <u>3D View > Well</u> Properties.



#### 15.3.1 "General" tab – General well properties

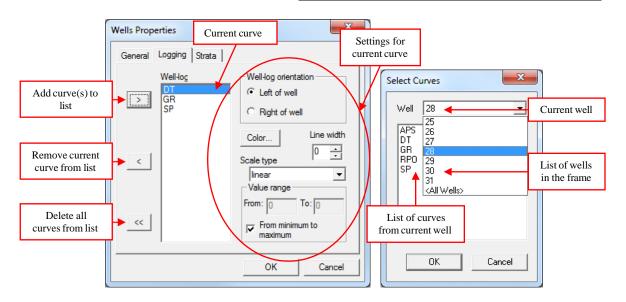
A well can be shown in form of a line or a 3D pipeline with a given radius (the <u>Fictive</u> <u>Radius</u> parameter) by checking the <u>Pipeline View</u> option. If the <u>Number of slices to form a</u> <u>pipe</u> parameter is increased, the image quality will be improved, however, this can affect the program performance. The <u>Length of a straight pipe section</u> parameter is not for displaying the inclinometry data saved in the database, but for selecting the values from the database, provided that the distance along the well between the two neighboring values is bigger than the given value of this parameter. This parameter affects performance of the program in the same way as the parameter <u>Number of slices to form a pipe</u>. You can limit the well in depth by using the parameters <u>Min and Max after checking the Depth range</u> option.

The parameters <u>Width of well-log display region</u> and <u>Stratum</u> <u>marker: fictive</u> <u>radius</u> are used to adjust the display of the corresponding well logs and layers and are described below.

3D View	3D View		
Wells, consisting of line segments	"Volumetric" wells		
I			

#### 15.3.2 Well logs visualization

To add a well log into the Frame, please use the <u>Well Properties</u> dialogue box, and then go to the <u>Logging</u> tab. The <u>Well-log</u> list contains the names of the curves to be displayed in the Frame. All the options to the right of the list are for adjusting the active curve. The curves are added to the list by using the <u>Select Curves</u> dialogue box. Initially, the list in the <u>Select Curves</u> dialogue box contains all available curves from the wells in the Frame (if the Frame does not have any wells, the dialogue box will contains the list of all curves in the database). To obtain the list of the curves for one specific well, please select the required well from the list. The curve will be displayed in the Frame on the left or on the right of the well. The width of each curve can be edited in the <u>Well Properties</u> dialogue box. A value of 0 means that the curve will not be smoothed and it will have the minimum possible width. The curves with higher width values will be smoothed. The other settings for the curves are similar to the ones described in Section 3.2.10. The width of the region for curve display can be adjusted in the "General" tab by setting the Width of well-log display region parameter.



#### 15.3.3 Layer Visualization

You can display special marks at the intersections of wells with the tops of layers. To do this, go to the <u>Strata</u> tab in the <u>Well Properties</u> dialogue box. The list on the left of the dialogue box shows available layers. The layers in the list on the right will be displayed in the Frame as circles on the wells. You can define the circles" width in the <u>General</u> tab by setting the <u>Stratum marker: fictive</u> radius parameter.

## 16 Annex A: Measurement units

To select the measurement units, the command  $\underline{File} > Project Properties}$  is used.

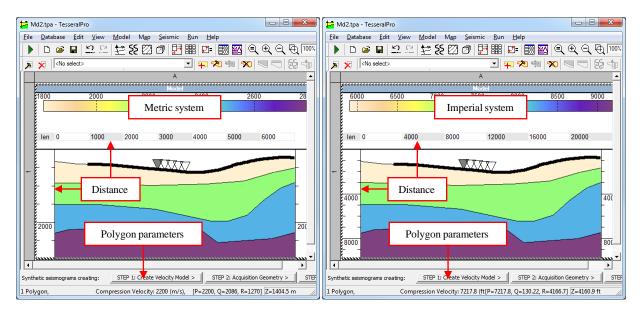
	Project properties
Measurement units for the project	Measure units Distance m Velocity m/s Density kg/m^3 Select Project Fields (to frames Map) [65535] General (m) [65535] Gorobcivskoje (ft) [65535] New Field
	Coordinate Orientation $\uparrow \uparrow \downarrow \downarrow$

Different data types and different frame types handle the measurement units selected in the project properties in a different way. For example, the database does not depend on the project, and each oil field (and even well) may have their own measurement units for depths and logging data depending on initially loaded data. Each gather could have been created in metric or imperial system, but it should correctly loaded into Tesseral Pro. Every kind of data can be "adjusted" to the chosen measurement units by using the appropriate settings and commands in Tesseral Pro.

The following section describes how to convert various input data into the measurement units you need.

### 16.1 Model Frame

The <u>Velocity</u> and <u>Density</u> parameters determine the output units for velocity and density in the model polygons" properties. <u>Distance</u> represents the units for model"s length/width, coordinate binding and acquisition geometry. If the measurement units are changed in the project, the <u>Distance</u> may be re-calculated. If parameters <u>Velocity</u> and <u>Density</u> are changed, the polygons" data display is also changed.



If the model is loaded from other formats ( $\underline{File} > Load Model$ ), for which the measurement units are unknown, users need to specify the measurement units (Metric or Imperial) in the dialogue box below.

C	Change the Model Frame to Fit Import
	The New Model Region
	Top: 0 ft
	Left : 0 ft Right : 1000 ft
	Bottom : 3100 ft
	Input Units: 🔘 Metric 🔘 Imperial
	OK Cancel the model region change and continie import

After that, the loaded model will be transformed into the project's measurement units (if the file's measurement unit differs from the project's one). Additionally, the Distance of the loaded model may be adjusted manually by the command  $\underline{Model} > \underline{Scale}$ . It is possible to select the scaling coefficient for the model and transform the measurement units from ft to m or vice versa.

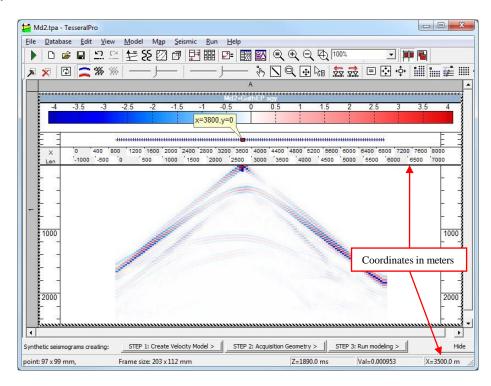
cale						x
			odel			
1800	2000	2200	2400	260	0 2	800
len 0	500	0 10	0000	15000	20000	
[ ]~		W	<b>X</b> 7			-
F <b>}</b>						-
4000					40	00
	_		-		-	_
						_
8000					80	00
			Depth -			
Lenght 2	2966	m	Тор	0	m	
			Botton	n 3000	m	
						_
Shift polygo	nes to	to right		on 0		īm
		1.5 right		1 1		
Re-size mod	el by Scal	e 3.	2808399	m	to ft	•
			ОК		Cancel	

Separately, in a special way, units of measurement are configured for the database wells used in constructing the model. Details below in the <u>Database</u>, <u>Conversion of Units of Measurement section</u>.

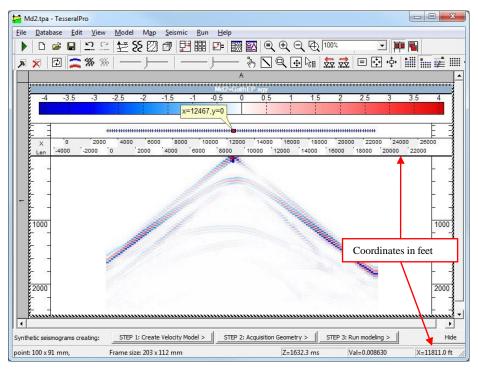
### 16.2 Seismic Frame

If the measurement units are changed in the project, only the display in the current project's Seismic Frame is updated: gathers' distance, velocity and density are shown in the chosen measurement units; however, the data files themselves are **not** modified.

For example, if you have selected *ft* as distance units for the project, the display of trace coordinates will change accordingly. For instance, if the <u>Distance</u> option in the project is set to *meters*, a SEG-Y file is displayed as follows:



If the Distance option is set to *feet*, the same SEG-Y file is displayed as follows:



When the displayed data is in seismic formats <u>TGR</u> or <u>SEG-Y</u>, and the data is velocity or density, then their values will be scaled in accordance with the selected measurement units.

Please select the component of the seismic file to be displayed by specifying the <u>Component</u> parameter in the <u>Seismic File Properties</u> dialogue box which is invoked by <u>Seismic ></u> Seismic Frame Properties.

Seismic Properties		×
Common Units	Layout Profile Zoom R	tulers
Seismic File Pro Seismic Data Comp		SGY Headers
- Ceierrie File Me	asurement Unit	Characteristics of gather data
Z Axis: Distance: Velocity: Density:	Time v m v n/s v	Trace statistics         N of traces         60         Samples per trace         501         Z step         2         ms         Zmin         0         Zmax         1000         ms
The measuremen of data in the file		Reset Coordinates ?
	ОК	Cancel Apply Help

### 16.3 Map Frame

If the project's measurement units are changed, the loaded and computed surfaces will be deleted. To transform the size of the loaded surface from m to ft or vice versa, use the command  $\underline{Map} > Active$ Map > Scale Boundaries.

Scale su	rface		×
Xmin	: Xmax:	Ymin:	Ymax:
From	rectangle		
35	3955	35	4515
to re-	ctangle		
35	3955	35	4515
	Convert from ft	tom Co	onvert from m to ft
	[	OK )	Cancel

In the dialogue box above, please press <u>Convert from ft to m</u> or <u>Convert from m to</u> ft to convert the measurement units for the selected surface.

To convert the surfaces built by a database of well intersections, it is possible to change the distance measurement units in the database (oil field or well), and then build the surface again.

### 16.4 Database: transform the measurement units

Please see Section 17 for details about content and filling of the database.

The contents in the database do not depend on the selected measurement units in the project. Furthermore, some data in the database (for example, a particular field) may contain data in the imperial measurement system and other data may be in the metric one. To transform the data for such field from one measurement system to another, please select the field with mouse in the database tree, and then choose the command Database > Convert Units.

Convert units	X
Field: ALL	Well: ALL
Data to convert	Direction • meters to feet • feet to meters
<ul><li>✓ Strata</li><li>✓ Logs</li></ul>	Convert Cancel

In the dialogue box above, select the data you would like to convert and conversion direction (from ft to m or from m to ft).

**NOTE**: Before well data is used for model building, the data must be converted to the project's measurement units (the command Database > Convert Units).

The values of curves loaded to the database may also be converted, but it has to be done one by one. To do this, please select the needed curve in the database tree, and choose the command <u>Database</u> > <u>Data Properties</u>.

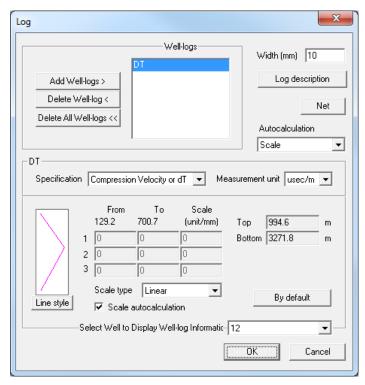
🔳 Log Prope	ties 🗾
Field G Well 1	eneral (m)
File Name	las Method DT
Description	
Position -	
Start 20	0 Stop 3200 Step 0.2000000
Points 15	50 Vmin 177.47500 Vmax 305.45800
Edit Log	Manual Draw <u>Smoothing</u> <u>Delete</u> Show Initial Log <u>Intransform</u> <u>Select All</u> 305.45
2892 2896 2900 2904 2908 2912 2916 2920 2924	
Scaling <u> </u> Scale = 566	OK Cancel

In the Log Properties dialogue box, check Edit Log and press Transform. In the next dialogue box Transforming Data enter the scaling coefficient.

Transforming Data	×
Multiply by:	Add: 0
C Interval	All log
	OK Cancel

It is recommended to perform such data transformation for all the acoustic logs in all wells of the same deposits, so that the same measurement units are used.

After having normalized the logging data, it is possible to choose the measurement units for all curves of the model during model creation by well data, by specifying the <u>Measurement unit</u> parameter in the Log dialogue box.



While the polygon's parameters are filled with interpolated well data, the logging data are first converted to the selected measurement units of the project (m/s, ft/s, kg/m³, g/cm³). To ensure correct conversion of the measurement units, the measurement units for logging must be correctly set in the <u>Measurement unit</u> parameter.

# 17 Annex B: Geophysical database

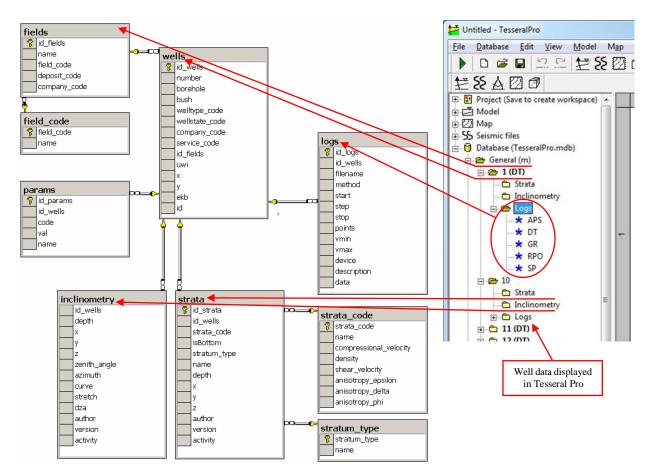
To connect to the database, expand the upper node of the <u>Database</u> tree in the left pane of the Tesseral Pro window.

ſ	<mark>ដ</mark> Ur	titled - Tess	seralPro											
	<u>F</u> ile	<u>D</u> atabase	<u>E</u> dit	<u>V</u> iew	<u>M</u> odel	M <u>a</u> p	<u>S</u>	eismic	3D View	<u>R</u> un	<u>H</u> elp			
		D 🖻		<u>) (×</u>	l≢3	<b>٤</b> 🛛	10	ין ד		]=   1⁄2	11 🔣 🜌	€,⊕	$( \bigcirc \bigcirc ]$	100%
	₽	<b>85</b> ∆ [	20											
		Project (Sa	ave to cr	eate woi	rkspace)		Т				A			
	⊡ E	Model												
		Map				- 11								
	E S	Seismic fil	es			- 11								
đ	[ <u>.</u>	Database	$\mathbf{\Sigma}$			- 11								
	<u> </u>					- 1								
						- 1								

## 17.1 DBMS

Tesseral Pro uses DBMS MS SQL Server or MS Access to store well log data.

## 17.2 Diagram of Classes

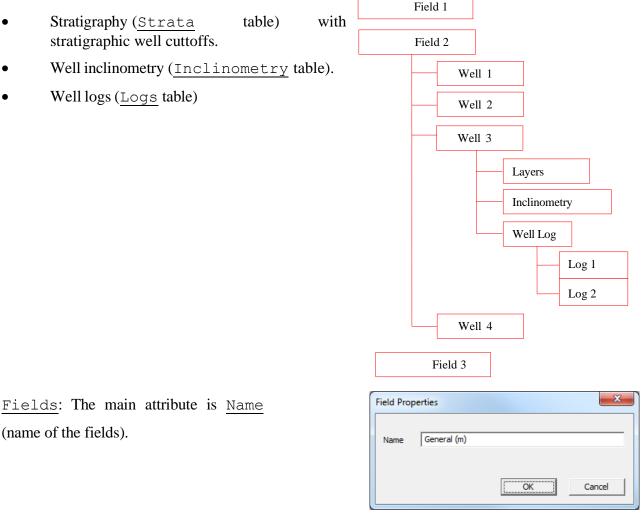


## 17.3 Description of tables and basic fields

Tesseral Pro has the following well log data structure:

The upper level is Fields (<u>Fields</u> table). The database can contain several fields. The fields contain wells (Wells table). Each well may only belong to a single field.

A well can contain:



Wells: Belongs to a field. The main attributes are:

- Number Well number (name)
- $\underline{x}, \underline{y}$  Well coordinates
- <u>EBK</u> Elevation Kelly Bush (corresponds to the <u>Elevation Kelly Bush</u> parameter in the Well Properties dialogue box)
- <u>Borehole</u> Well bottom (corresponds to the <u>Bottom</u> parameter in the <u>Well</u> <u>Properties</u> dialogue box)

Well Properties		
Field General (m)		
Number 1	Elevation Kelly Bush (EKB)	85.6
× 490454.81	Bottom	0
У 7172923.5		
	ОК	Cancel

<u>Inclinometry</u>: Belongs to the well. It contains the table with coordinates of the marks along the borehole.

- <u>Depth</u> Depth mark from the wellhead
- $\underline{x}, \underline{y}$  Borehole deviation from the wellhead at the current depth mark
- $\underline{z}$  Absolute depth of the current well mark from the sea level; positive values mean

"below the sea level", negative otherwise

Inclinometry			
depth	x	у	z
0	0	0	-85.6
20	0	0	-65.6
40	0	0	-45.6
60	0	0	-25.6
80	0	0	-5.6
100	0	0	14.4
120	0	0	34.4
140	0	0	54.4
160	0	0	74.4
180	0	0	94.4
200	0	0	114.4
220	0	0	134.4
240	0	0	154.4
260	0	0	174.4
280	0	0	194.4
300	0	0	214.4
320	0	0	234.4
340	0	0	254.4
360	0	0	274.4
380	0	0	294.4
400	0	0	314.4
420	0	0	334.4
440	0	0	354.4
460	0	0	374.4
480	0	0	394.4
500	0	0	414.4
•			•
			Close

Strata: Belongs to the well. It contains the table of the well's layer-intersections. The main attributes are:

- <u>Well strata</u> is the name of layers
- <u>Type</u> defines the stratigraphic type (layer/mass/suite/stage and etc) of the current layer. The table of allowed database"s stratigraphic types is <u>strata type</u>
- <u>Strata code</u> is the layer code in the database"s code table <u>strata code</u>. It is used for automatic building of surfaces by using the layer-intersections
- <u>Depth</u> is the depth of layer intersection
- $\underline{x}, \underline{y}, \underline{z}$  are the absolute coordinates of the layer intersection
- Is Bottom -,,1" for bottom, ,,0" for top

Field strata	Well strata	Depth	Type	Is Bottom	x	у	z	Ţ
14 (Atlimskaya)	Atlimskaya	354.1	stratum	0	490454.8	7172923.5	268.5	
14 (Atlimskaya)	Atlimskaya	393.0	stratum	1	490454.8	7172923.5	307.4	
15 (Tavdinskaya)	Tavdinskaya	395.1	stratum	0	490454.8	7172923.5	309.5	
15 (Tavdinskaya)	Tavdinskaya	454.3	stratum	1	490454.8	7172923.5	368.7	
16 (Lulinvorskaya)	Lulinvorskaya	456.9	stratum	0	490454.8	7172923.5	371.3	
16 (Lulinvorskaya)	Lulinvorskaya	684.8	stratum	1	490454.8	7172923.5	599.2	
17 (Taliskaya)	Taliskaya	689.8	stratum	0	490454.8	7172923.5	604.2	
17 (Taliskaya)	Taliskaya	855.0	stratum	1	490454.8	7172923.5	769.4	
18 (Gankinskaya)	Gankinskaya	859.4	stratum	0	490454.8	7172923.5	773.8	
18 (Gankinskava)	Gankinskava	1102.6	stratum	1	490454.8	7172923.5	1017.0	

Strata Code: Belongs to the layers (stratigraphy). It contains the table with the codes of field layers. The main attributes are:

- <u>Number</u> is the layer code in the database's code table <u>strata</u> code
- <u>Name</u> is the name of the layer code

• <u>n.of wells</u> is the number of wells, where a layer with the specific code is used

Number	Name	n.of wells
1	KZ	5
2	K	6
3	J	6
4	T1(dr)	6
5	C2m	6
6	C2b	6
7	C1s2	6
8	C1s1	6
9	C1v2	6
10	D3	3
11	D3fr	3
12	C1(v1+t)	5
13	D3fm	4
14	Atlimskaya	20
15	Tavdinskaya	22
16	Lulinvorskava	48
Add		OK

Strata type: Belongs to the layers (stratigraphy). It contains the table of layer types.

The main attributes are:

- <u>stratum type</u> is the layer's code in the layers codes table of the database <u>strata code</u>:
- <u>name</u> is the layer name

Logs (log curves): Belongs to the well.

It contains the table of the well logs.

The main attributes are:

- Method is the layer's name
- <u>Start</u>, <u>Stop</u> are the curve's top and bottom
- <u>Step</u> is the curve's sampling step
- Vmin, Vmax are the curve's amplitude rang

Log Propertie	25			×
Field Gen	eral (m)			
Well 1				
File Name 1.las	S		Method	DT
Description				
Position				
Start 200	Stop	3200	Step	0.2000000
Points 1550	Vmin	177.47500	Vmax	305.45800
Edit Log	🔲 Manual Draw	Smool	thing	Delete
	🔽 Show Initial Lo	g Trans	form	Select All
177.47				305.45
		<u> </u>		<b>_</b>
2892		- 2	-	
2896		$\leq$		
2900				
2904				
2908				
2912	•	2		
2916		-é,		
2920		Ş		
2924		-		-
Scaling 🔳				Þ
Scale = 566		OK		Cancel

### 17.4 Database connection, creation and copying

<u>Connection</u> to the database is established automatically while loading Tesseral Pro or by using the command Database > Connect.

Conn	ect to database		
c	- SQL Server Provider: Server: Database:	SQL Server 2005 Express (local)	MS Access (".MDB)     File Name:     C:\Tesseral Technologies\Tesseral Prov Browse
c	- Custom Connect		eral Technologies\Tesseral Pro\TesseralPro.mdb;Jet OLEDB:Syst
			Authentication
			Password: Default Connect Cancel

Please select the DBMS you would like to connect to, and adjust the connection parameters. The MS Access test database TesseralPro.mdb with several wells is included in the installation.

To back up the Database, please use the command Database > Backup. For MS Access:

It creates a copy of the ".mdb" file by using the standard Save As dialogue box. For MS SQL Server:

Backup Database	×
Database Name: TesseralPro	
Data Properties	
Backup to:	
ram Files\Tesseral Pro\TesseralPro.bak Browse	
This path is local to SQL Server. If you are using Tesseral Pro and Microsoft SQL Server on different computers, please use the path on SQL Server computer. This is why Browse button is disabled.	
Cancel Backup	

Please provide the full path and name for the backup copy. It is recommended to back up the database before operations that could lead to data loss like loading and deletion, so that, in case of any incorrect actions, the database can be recovered from the backup copy.

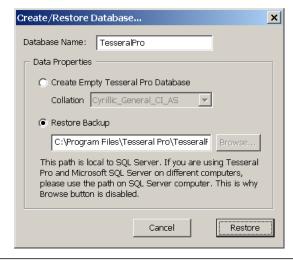
To create or restore a Database, please use the command Database > Create/Restore.

MS Access creates a new ".mdb" file while creating a new database by using the standard

Save As dialogue box. Restoring such Database is not supported, so please use the command

Database > Connect to connect to another ".mdb" database.

When MS SQL Server creates a new database, please enter the <u>Database Name</u>, and then select <u>Create Empty Tesseral Pro Database</u>. To restore a database from the backup copy, please select <u>Restore Backup</u>, and then define the full file path and the name of the backup created previously.



**NOTE**: All current data will be lost while restoring the database from a backup copy

## 17.5 Data loading

The data is loaded into Tesseral Pro either from LAS files (to the <u>Logs</u> table) or from text files to the tables <u>Wells</u>, <u>Inclinometry</u>, <u>Strata</u> and <u>Strata</u> code. Data can either be loaded to an existing well, or loaded to a field, in which case the program "distributes" the data from the file over the existing wells or creates new wells automatically.

Data in text files (TXT, CSV, and TAB) must be presented in the form of columns (the columns are separated by spaces, tabs or semicolons). It is preferable that each column has its own header. For example,

Well Number	Х	у	ekb	borehole
1	490454.8	7172923.5	85.6	3502
2	482493.0	7160560.5	96.4	3812
5	484796.1	7155446.5	89.7	3555
6	475956.6	7158533.5	100.0	3456
7	472471.0	7156297.5	100.4	2544
8	476867.3	7163649.5	91	3514
9	477733.9	7156292.5	98.2	3098
10	459056.6	7146075.5	92	3113
11	496123.6	717966674.9	11	3221
12	498422.6	718709668.9	12	2801
13	480333.9	7165486.5	87.7	4121
14	470601.8	7153447.5	105.6	3434

The first column is the obligatory well number where the data is to be loaded. To prepare data for loading, please use the command <u>Database > Prepare Text Tables</u>. To load prepared text files or files in LAS format, please use the command Database > Import Data.

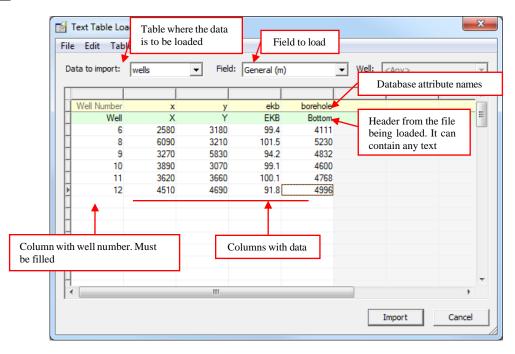
<u>STEP 1. Create a field</u> – Please use the command <u>Database > Add Field</u>, and then set the name of the new field in the pop-up dialogue box

<u>STEP 2. Load well coordinates, elevations and well bottoms</u> – Please use the mouse button to select the field into which you would like to load the data, and then choose the command Database > Prepare Text Tables

🛃 Text Table Lo	ader						×
File Edit Tak	ole						
Data to import:	wells	▼ Fiel	d: General (r	n)	▼ Well:	<any></any>	Ŧ
							A
▶ Well Number							
-							
-							
-							
							Ψ.
•		111	_				•
						Import	Cancel

In the Data to import list, please select wells.

If you have a text table with the necessary information, please use the command  $\underline{\texttt{File}} > \underline{\texttt{Open}}$  in the  $\underline{\texttt{Table Loader}}$  dialogue box. If the data are in Microsoft Excel or Word format, use the  $\underline{\texttt{Copy}/\texttt{Paste}}$  commands to transfer the data from the MS Office document to  $\underline{\texttt{Text Table}}$  Loader via the Clipboard.



The first column from the text table is obligatory and contains the number of wells into which the data is to be loaded. The light green (second) row is optional and it is intended for the headers from the input file. In the first yellow row, all the attribute names of the columns you want to load should be entered. Click the mouse inside each of the cells to select the attribute, into which the data from the column are to be loaded.

It is not necessary to load coordinates, bottom of the hole, and altitude all in one table; sequential data loading (amending) to the wells from several files is supported.

Please use the command File > Save as textin the Text Table Loader

dialogue box to save the prepared table as a text file.

**NOTE**: There is no <u>Undo/Redo</u> command in the <u>Text Table Loader</u> dialogue box. Therefore, it is recommended to save partial results periodically by using the <u>File</u> > Save command.

When the table is ready, please press Import to load the data into the selected field.

After data has been imported, it is recommended to QC the result; use the mouse to select any loaded well and then choose the command Database > Data Properties.

Well Properties		X
Field General	(m)	•
Number 1 x 4904	Elevation Kelly Bush (EKB) 54.81 Bottom	85.6
y 71729	923.5	Cancel

© Tesseral Technologies -User Documentation-

In the <u>Well Properties</u> dialogue box, you can modify any data and save them to the database using the OK button.

<u>STEP 3. Load inclinometry</u>. Generally, loading inclinometry is similar to loading well coordinates. Please select a field where you would like to load the inclinometry data by the command <u>Database</u> > Prepare Text Table, and then select inclinometry from the Data to import list.

Data to import:	inclinometry	▼ Field:	General (m)		▼ Well:	<any></any>	-
Well Number	depth	x	У	z	zenith_angle	azimuth	CI
WellNumber		Х	Y	Z			=
1	0	0	0	-85.6			
1	20	0	0	-65.6			
1	40	0	0	-45.6			
1	60	0	0	-25.6			
1	80	0	0	-5.6			
1	100	0	0	14.4			
1	120	0	0	34.4			
1	140	0	0	54.4			
1	160	0	0	74.4			
1	180	0	0	94.4			
1	200	0	0	114.4			
1	220	0	0	134.4			
1	240	0	0	154.4			
1							•

To use the inclinometry data in Tesseral Pro, the columns <u>depth</u>, <u>x</u>, <u>y</u>, <u>z</u> need to be filled. The remaining columns are only informative and they do not influence the borehole shape. Apart from the first column (well number), the order of the other columns is not important. The rows order for a single well is also not important, but it is not recommended to have the data in the file related to the same well shaped like "blocks"; it is better to sort all wells

by well number.

Once the table is ready, please press Import to load the data into the selected field.

After loading, it is recommended to check the loading result. For this purpose, please select the <u>Inclinometry</u> branch for any of the loaded wells, and then choose the command <u>Database</u> > <u>Data</u> Properties.

I I	nclinometry				X
	depth	x	у	z	*
	0	0	0	-85.6	
	20	0	0	-65.6	
	40	0	0	-45.6	
	60	0	0	-25.6	
	80	0	0	-5.6	
	100	0	0	14.4	
	120	0	0	34.4	
	140	0	0	54.4	
	160	0	0	74.4	Ŧ
				- F	
				Close	

For correct mapping, the table <u>Inclinometry</u> must be filled (for the wells you want to use for mapping). If you have no inclinometry data, the wells can be assumed to be vertical, and

then the inclinometry data can be generated automatically; this can be done by the command Database > Create Inclinometry.

Create vertical inclinometry		x
Field:	Select wells:	
General (m)	1 10	<b>^</b>
Select wells without inclinometry	11 12	E
Select wells with altitude and bottom	13 14 15	
Create inclinometry	16 17 18	
Done	2 20	-

In this dialogue box, please select the wells for inclinometry generation from the list on the right, and then press <u>Create inclinometry</u>. For automatic creation of inclinometry, the information about the well's altitude and bottom hole is used from the <u>wells</u> table. While creating inclinometry in the absence of this data, you will be prompted to enter the altitude and bottom of the hole manually in a dialogue box.

Use the buttons <u>Select wells without inclinometry</u> and <u>Select wells</u> with altitude and bottom for automatically selecting the wells in the list.

The result of executing <u>Create</u> inclinometry is shown below for a well.

Inclinometry			×
depth	x	у	Z
0 3280	0	0 0	-68.9 3211.1
•		[	Close

**NOTE:** In case that the selected well already had inclinometry data, the old data will be deleted.

**NOTE:** If you do not like the results of loaded inclinometry, please select the field with the mouse and then use the command <u>Database > Delete from Field ></u> Inclinometry and repeat loading again.

<u>STEP 4. Load stratigraphy</u>. Generally, loading stratigraphy is similar to loading well coordinates and well inclinometry. Please select the field you want to load the stratigraphic lay- outs with the mouse and then choose the command <u>Database > Prepare Text Tables</u>. Please select <u>strata</u> from the <u>Data to import</u> list.

Data to import:	strata	▼ Field:	General (m)	•	Well: <an< th=""><th>iy&gt;</th><th>-</th></an<>	iy>	-
Well Number	isBottom	depth	name				
WellNumber	IsBottom	Depth	Name				E
6	1	140	KZ				
6		225	K				
6		685	J				
6	1	1232	T1(dr)				
6	1	1620	C2m				
6	1	2240	C2b				
6	1	2392	C1s2				
6	1	3255	C1s1				
6	1	3950	C1v2				
6	1	4111	D3fr				
6	1	3950	D3				
7	1	135	ΚZ				
7	1	283	К				_
1	1 1	077 			-		•

The main attributes are <u>name</u> (layer name), <u>depth</u> (layer-intersection depth along the borehole), <u>isBottom</u> (1-bottom, 0-top). If the absolute coordinates of the layer-intersection are available, it is worth loading them into the database. Otherwise these coordinates will be calculated automatically every time before calculating a layer surface map.

Apart from the first column (well number), the order of the other columns is not important. It is recommended to sort the rows in advance by well numbers.

Once the table is ready, please click Import to load the data into the selected field.

During the loading process, if a layer name is not found in the <u>strata_code</u> table, you will be prompted to assign/create a layer code for this layer in the dialogue box below.

Assign a value
K J J T1(dr) C2m C2b C1s2 C1s2 C1s1 C1v2 D3
Apply to all new     Create new     Assign     Assign Empty     Cancel

<u>Create</u> New is for inserting a new row into the database's layer code table. The new layer code in the well is assigned to this row.

Assign is to assign the layer code in the well selected from the list.

Assign Empty is for setting the layer code in the well to "0".

Cancel for no action

**NOTE:** The layer code is of great importance for surface-layer building by layerintersection data and automatic creation of polygons in the model. The attribute <u>name</u> is ignored in both cases and only the <u>strata_code</u> is used. Thus, it is recommended, whenever possible, to identify the new layer name with an existing code from the Assign

It is recommended to check the results of the loaded Stratigraphy by selecting the <u>Strata</u> branch of any loaded well and then choose the command Database > Data Properties.

Field strata	Well strata	Depth	Type	Is Bottom	x	у	z	1
1 (KZ)	KZ	426.5	stratum	1	0.0	0.0	0.0	
2 (K)	к	820.2	stratum	1	0.0	0.0	0.0	
3 (J)	J	2329.4	stratum	1	0.0	0.0	0.0	- 11
4 (T1(dr))	T1(dr)	4068.2	stratum	1	0.0	0.0	0.0	Ξ
5 (C2m)	C2m	5124.7	stratum	1	0.0	0.0	0.0	- 11
6 (C2b)	C2b	7299.9	stratum	1	0.0	0.0	0.0	- 11
7 (C1s2)	C1s2	8021.7	stratum	1	0.0	0.0	0.0	
8 (C1s1)	C1s1	10465.9	stratum	1	0.0	0.0	0.0	
9 (C1v2)	C1v2	14042.0	stratum	1	0.0	0.0	0.0	
12 (C1(v1+t))	C1(v1+t)	14977.0	stratum	1	0.0	0.0	0.0	1

**NOTE:** If you do not like the results of the loaded stratigraphy, please select the field with the mouse and then use the command <u>Database > Delete from Field ></u> Strata and repeat the loading process again.

<u>STEP 5. Load well log data</u> – The well logging curves are loaded from LAS files for a well or a field with the command <u>Database > Import data</u>. A selection of multi LAS files is supported in the dialogue box. After having selected the file(s) and clicking the <u>Open</u> button, a dialogue box will appear for loading the curves into the well.

Import Logs				×
File: C:\Sheldon\TestingOfT	esseralf	Pro\SonicOnly.I	as	
<b>V</b> DT	Static			
GR	Start:	360	Step:	0.2000000
	Stop:	2303	Count:	9714
Impo	rt	Skip		Cancel

Please click Import to load the selected curves into the database.

For QC of the loaded result, please select a curve from the <u>Logs</u> branch of the well, and then choose the command <u>Database > Data Properties</u>.

Log Pro	operties				×
Field Well	General (m)				
File Name	11.las			Method	DT
Description	n				
- Position					
Start	2873.1999	Stop	3325.1999	Step	0.2000000
Points	2118	Vmin	127.74800	Vmax	362.18798
Edit Lo	9 🗆 Ma	nual Drav	/ Smoo	thing	Delete
	🔽 sh	ow Initial I	Log Trans	form	Select All
12	7.74				362.18
2904 - 2908 - 2912 - 2916 - 2920 - 2924 - 2928 - 2932 -			apt of head have been by		
2936 2940		-	-E		•
Scaling 🔄	_				•
Scale = 56	56		OK		Cancel

## 17.6 Data editing

A partial editing of the data loaded from LAS or text files for fields and wells can be done by using the dialogue box (<u>Database > Data Properties</u>).

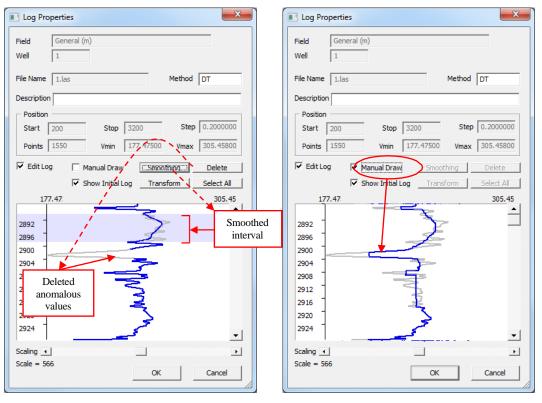
Field strata	Well strata	Depth	Type	Is Bottom	x	у	z	
1 (KZ)	KZ	426.5	stratum	1	0.0	0.0	0.0	
2 (K)	к	820.2	stratum	1	0.0	0.0	0.0	
3 (J)	J	2329.4	stratum	1	0.0	0.0	0.0	
4 (T1(dr))	T1(dr)	4068.2	stratum	1	0.0	0.0	0.0	=
5 (C2m)	C2m	5124.7	stratum	1	0.0	0.0	0.0	
6 (C2b)	C2b	7299.9	stratum	1	0.0	0.0	0.0	
7 (C1s2)	C1s2	8021.7	stratum	1	0.0	0.0	0.0	
8 (C1s1)	C1s1	10465.9	stratum	1	0.0	0.0	0.0	
9 (C1v2)	C1v2	14042.0	stratum	1	0.0	0.0	0.0	
12(C1(v1+t))	C1(v1+t)	14977.0	stratum	1	0.0	0.0	0.0	-

In the <u>Well Strata List</u> dialogue box, the layer codes in the database can be inserted, deleted or modified by using the Field Strata button.

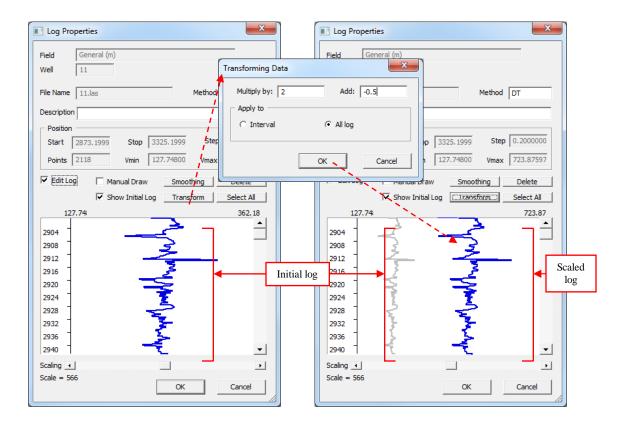
Strata Code			x
Number	Name	n.of wells	
1	KZ	5	
2	к	6	=
3	J	6	
4	T1(dr)	6	
5	C2m	6	
6	C2b	6	
7	C1s2	6	
8	C1s1	6	
9	C1v2	6	
10	D3	3	
11	D3fr	3	
12	C1(v1+t)	5	
13	D3fm	4	
14	Atlimskaya	20	
15	Tavdinskaya	22	
16	Lulinvorskava	48	Ŧ
Add		ОК	
Delete		Canc	el

**NOTE:** To change the layer code name, please double click on *its* current name and then change the name in the edit field.

<u>To edit the log curve</u>, choose the command <u>Database > Data Properties</u> and select the curve name from the database tree.



In the <u>Log Properties</u> dialogue box, please check <u>Edit Log</u> checkbox to enter the log editing mode. Then select the log interval by the mouse (press-drag-release), or use the button <u>Select All</u> to select the entire log. The selected log interval can be smoothed by using the <u>Smoothing</u> button or scaled by using the <u>Transform</u> button, or deleted by using the <u>Delete</u> button. A log interval can be drawn manually by using the mouse (press-drag-release) while the <u>Manual Draw</u> checkbox is checked.



# **18 Annex C: Licensing policy**

Tesseral Technologies Inc provides several ways to license Tesseral Pro. For detailed information about license policy, please contact <a href="mailto:support@tetrale.com">support@tetrale.com</a>.

### 18.1 Single-user License

A *local alpha-digital key* is bundled to a particular computer. Licensing with the alpha- digital key does not allow using this key in any other computers. This may be the most suitable choice for the package"s trial license, a public standalone PC or permanent user-independent workplaces like a computer class at a training facility.

A *local hardware key (HASP)* provides the licensing when the HASP is plugged into a USB port of a computer. User can install the same Tesseral product on other workstations and use the same key. So this type of licensing is the most suitable for occasionally using Tesseral package on multiple work-places, e.g. both at home and in the office.

### 18.2 Network License

A network license is unique for the client's network. The license key is usually installed on one of the network PCs called a Server. It may be the best choice for bigger or scattered companies. Due to the increasingly toughening policies in Windows system administration, it may require some additional network administrating efforts (eliminating possible interference with particular network security features and local network Firewall settings) to support such configuration, but this type of licensing allows multiple users to utilize the common license directly from multiple network PCs, but a program must be initially installed on each of computers where Tesseral is running.

- A network alpha-digital key license is unique for the client's network. The license key is installed on one of the PCs from the network (a Server PC); it may be a virtual machine because this type of licensing does not require special hardware.
- A network hardware (HASP) key provides licensing when HASP is plugged into a USB port of any computer in the local network or VPN (Virtual Personal Network) to which the user's computer is connected.

### 18.3 Mixed Licenses

Any combination of the types of keys mentioned above can be used by the client for licensing Tesseral products. For example, a network HASP key for 3 workplaces, 2 local USB HASP keys and 2 alphadigital keys can be purchased and used together as a license for 3+2+2=6 workplaces. Each type of key may be accompanied by a particular variant of the Tesseral product.

Licensing for evaluation period is usually done with local alpha-digital key.

### 18.4 Setting up a license

**Licensing with Hardware key (HASP)** allows users to run the Tesseral package by plugging an electronic USB device (called the HASP key – "Hardware Against Software Piracy") supplied by Tesseral Technologies Inc into a computer's USB port. The HASP key (Guardant) driver is Microsoft-certified.

A HASP key is initially coded for the latest version of a particular Tesseral product and configuration and might not work with future versions released as the package is developed. Upon the user request and payment for upgrade, this key can be coded for the upgraded version and product configuration via email (users will receive necessary instructions in this case).

HASP key can be coded for un-limited period (permanent) or limited period (trial or leasing period), and, after this period, the package will not work until user gets a new permanent HASP key from Tesseral Technologies Inc or a code from Tesseral Technologies Inc via e-mail.

A HASP key is not bundled with a particular Tesseral installation CD.

The user must keep the HASP key and not lose it, because the company does not provide replacement of the HASP key, because it is impossible to verify the number of licenses actually used in this case. If a HASP key is damaged, users must inform company's Customer Service by e-mail and then send it via mail to the provided address to get a replacement key for its market price (about US\$ 50 for shipping and handling).

The green indicator on the USB device means that the drivers are correctly installed.

#### **IMPORTANT NOTE!**

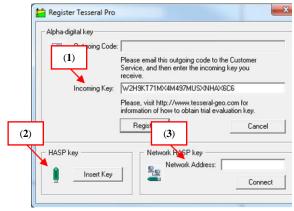
The new (2008) HASP drivers are strictly linked to the Windows" (not computer's!) bit number (32 or 64 bit). During the installation, the program recognizes the Windows type and installs the corresponding drivers. Insert the USB key only after the installation has finished. You can't mix 32-bit with 64-bit drivers if you have to install them manually.

The first time you run Tesseral Pro, the Registration Dialogue (see figure below) request users to specify corresponding license information.

Depending on the license type, you have several options:

- (1) Enter the alpha-digital key and press "Register"
- (2) Insert the USB key and press "Insert Key"
- (3) Enter the address of a Network Key

Server and press "Connect"



### 18.5 Installing Guardant Network Services

To use network USB keys, it is required to install the Guardant Network Services on your computer that will serve as the key server. If you are not using network license, you may skip this section.

The Guardant Network Services can be downloaded for free by following this link: <u>http://www.geopoisk.com/tesseral/download/GuardnetNetServices.zip</u>

Detailed guide for installing Guardant Network Services can be downloaded by following this next link:

http://www.tesseral-geo.com/documentation/en/license/ TesseralNetworkLicenseInstallation.pdf

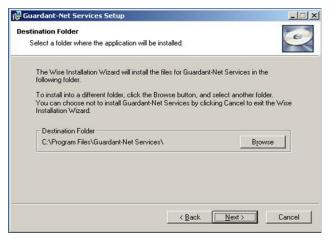
More technical details are described in the key vendor's manual: <u>http://www.tesseral-</u> <u>geo.com/documentation/en/license/Guardant_LAN_Guide.pdf</u> Unzip and run the installation program:



STEP 1. Click Next >



**<u>STEP 2.</u>** Select the Destination Folder and press Next >



**<u>STEP 3.</u>** Insert your USB key and then press Next >

🙀 Guardant-Net Services Sel	tup	_	
	Please, insert Guardant Network key now		
and a			Please, press
		the <b>Ne</b>	<b>xt</b> button <b>after</b>
TERT.		you in:	sert your key
THE		/	
	< Back Next >	Cancel	

a) You may run "Network key monitor" to check if your key is working properly

Set Program Access and Defaults Windows Update					
Programs	,	Accessories	Þ		Network key monitor
Documents	•	👼 Startup	•	2	Network key service
Settings	•	Internet Explorer Outlook Express		믱	Uninstall
Search	+				
Help					
Run					
Shut Down	~				
	Windows Update Programs Documents Settings Search Help Run	Windows Update  Programs  Documents  Settings  Search  Help Run	Windows Update  Programs  Documents  Settings Search Help Run	Windows Update  Programs  Documents  Settings  Search Help Run	Windows Update  Programs  Documents  Settings  Search Help Run

b) ... and check: The "Host name"



<u>STEP 4.</u> To use the Remote USB key, please enter the "Host name" in the Tesseral registration dialogue box and press "Connect"

Outgoing Cod	e: Please email this outgoing co Service, and then enter the ir receive.	
Incoming Key		KNHAX6C6
	Please, visit http://www.tess information of how to obtain t Register	
HASP key	Network HASP key	

### 18.6 Troubleshooting

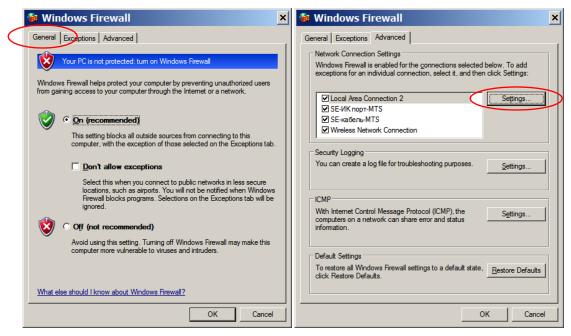
Read this part only when you encounter problems

- 1. <u>Technical information for system administrators</u>
  - Guardant Network Services use the following TCP/IP ports (both ingoing and outgoing):
    - 3182/TCP
    - 3183/UDP
    - 3184/UDP
  - Configuration files for advanced settings:
  - For server: NNKSRV32.INI (in Guardant Net Services directory)
- For client: GNCLIENT.INI (In Tesseral Directory)
- 2. Setting up the Firewall for system administrators

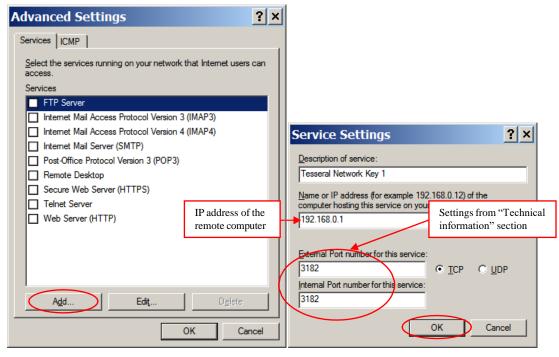
### a. Open Start > Settings > Control Panel then Windows Firewall

My d Documents	🕏 Control Panel									_	
	File Edit View Favorites										<b>R</b>
Burn CDs & Q	G Back 🔻 🕤 🔻 🧊 🔎 Search	h 🜔 Folders	•								
DVDs	Address 🔂 Control Panel			~.	-	~				<u> </u>	Go
2	Control Panel *	Filter	G.	×.	õ	-	-	<b>P</b>	REAL	2	
avasti We Antivirus H	Switch to Category	AC3 Filter	Accessibility Options	Add Hardware	Add or Remov	Administr Tools	Automatic Updates	Broadcom ASF Con	Broadcom Control	Date and Time	
	View		J7	Paruware	Kemov		opulaes	P			
WORD		9	Folder	Folder Size				古古		Java	
WORD	See Also *	Display	Options	Folder Size	Fonts	Game Controllers	Intel(R) GMA Driv	Internal NIC Configura	Internet Options	Java	
	<ul> <li>Windows Update</li> <li>Help and Support</li> </ul>	i	( )		-	-		-		0	
Excel 2003	Melp and Support	Keyboard	Mouse	Network	Network	Phone and	Phone	Power	Printers	QuickTime	
		-	(Prom	Connecti	Setup	Modem	Monit	Options	and Faxes	_	
, <u>e</u>		9	3	1	•	五	O,	2			
PowerPoint 2003		Regional and La	Scanners and Ca	Scheduled Tasks	Security	SigmaTel Audio	Sounds and Audio De		System	Taskbar and St	
<b>39</b>			3	Ca			And Dem			und Still	
Paint		User	Windows	Windows	Wireless	Wireless	Почта				
		Accounts	CardSpace	Firewall	Link	Netwo	10410				
🚱 Set Program Access	and Defaults										
😻 Windows Catalog											
Windows Update									My Cor	noutor	
WebMoney Keeper (									My COI	nputer	
Programs Favorites											
Documents											
Settings	+ 🛃 Control Pa	anel									
P Search	' 😒 Network (	Connections	•								
<ul> <li>Help and Support</li> <li>Run</li> </ul>	💁 Printers a		•								
	Taskbar a	and Start M	enu								
Log Off Vadik Turn Off Computer.											
an on computer.											

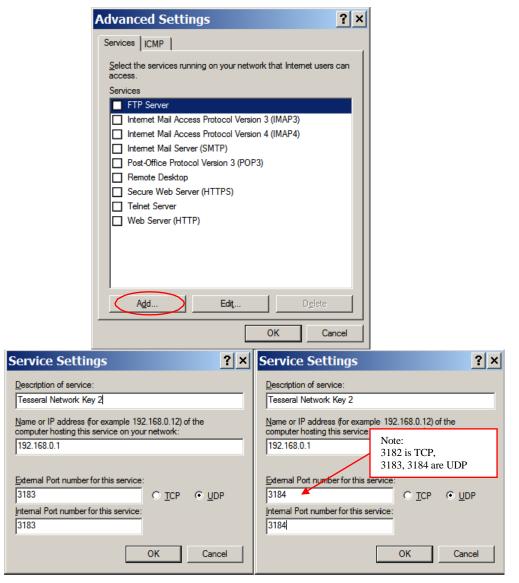
**b.** Setting up the Firewall: Click "Advanced" tab then "Settings" button



c. Click "Add", then enter connection data for "3182" port, then click "OK"



d. Repeat for the "**3183**" and "**3184**" ports



### **Questions and Answers:**

**a. Q**: Network key monitor shows "blank" window

🐙 Guardant Net Monitor	_O×
Servers View Help	
💐 🖻 🕐	
Found servers:	

Please, try following:

- Check if the green indicator in the USB key is lit. If not, please download and install the latest drivers.
- Try to reboot your server

- Check your firewall (please see 2 in Section 18.6)
- **b. Q**: Tesseral 2D/Pro does not "see" the network key

1	Dutgoing Code:
	Unable to connect the network server!
	_

Please, try the following:

- Check your firewall (please see 2 in Section 18.6)
- Check the configuration in *gnclient.ini* file in Tesseral program directory