Processing of near-surface land CDP data in the RadExPro software

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Content

Introduction

In this tutorial, we will demonstrate how a novice user can process data of near-surface seismic reflection (CDP) survey using RadExPro software. We will pass through all standard stages of the basic CDP data processing, from geometry input until stacking and time-to-depth conversion, the so-called minimum processing graph. We assume that the user is already familiar with the theory of the CDP method and the basic technology of the reflection seismic processing.

To repeat all the steps described in the tutorial independently, it is necessary to download the seismic data example from our site:

www.radexpro.com/wp-content/uploads/tutorialFiles/Reflection-example.zip

The archive contains the input data for work: a fragment of an onshore seismic profile recorded in SEG-Y format (file *Reflection-example.sgy*) containing receiver and shot point numbers in the trace headers.

Besides, you can download the project resulting from completion of all the steps described in this tutorial – it is also available from our web-site.

In this tutorial, we did not discuss more complicated topics like refraction statics, horizon-based velocity analysis, migration, etc. You can find information on these and other procedures of seismic processing and analysis in the User Manual to the software.

As an example, we use a seismic reflection SH-waves profile. If your data in on P-waves, you can use the same processing graph, just skip the ‘Subtraction of “left” and “right” shots’ part of this tutorial.

Method of "right" and "left" shots was used for excitation of SH-waves. When using this method, excitations are induced in two directions, perpendicular to the profile line. As a seismic source, a sledgehammer was used, which delivered blows at a metal pin embedded into the soil at an inclination of ~45°.

The receiving array was a 90 m long seismic cable. Receivers with a horizontal sensitivity axes ere use, the receiver spacing was 1 m. The source was a sledgehammer, which, starting from 12-m offset, delivered, blows at every 4 meters.

The data were acquired along a straight line. For this reason, instead of X and Y coordinates we will only use one X-coordinate to define source, receiver and CDP locations along the line.

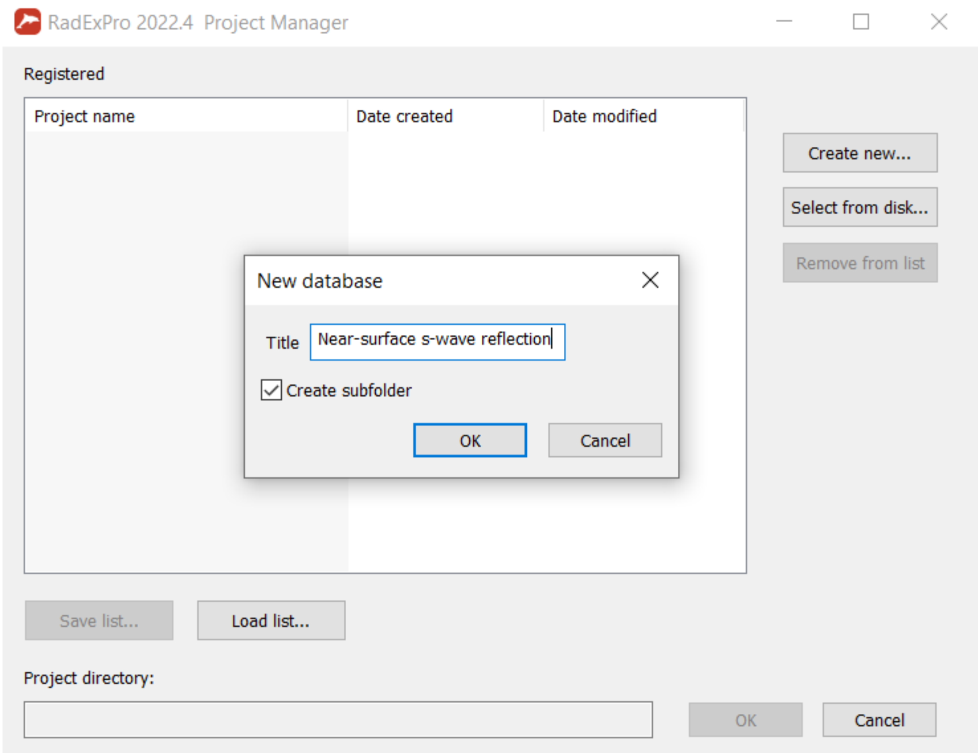
Data input, geometry assignment and binning

Creating project in RadExPro

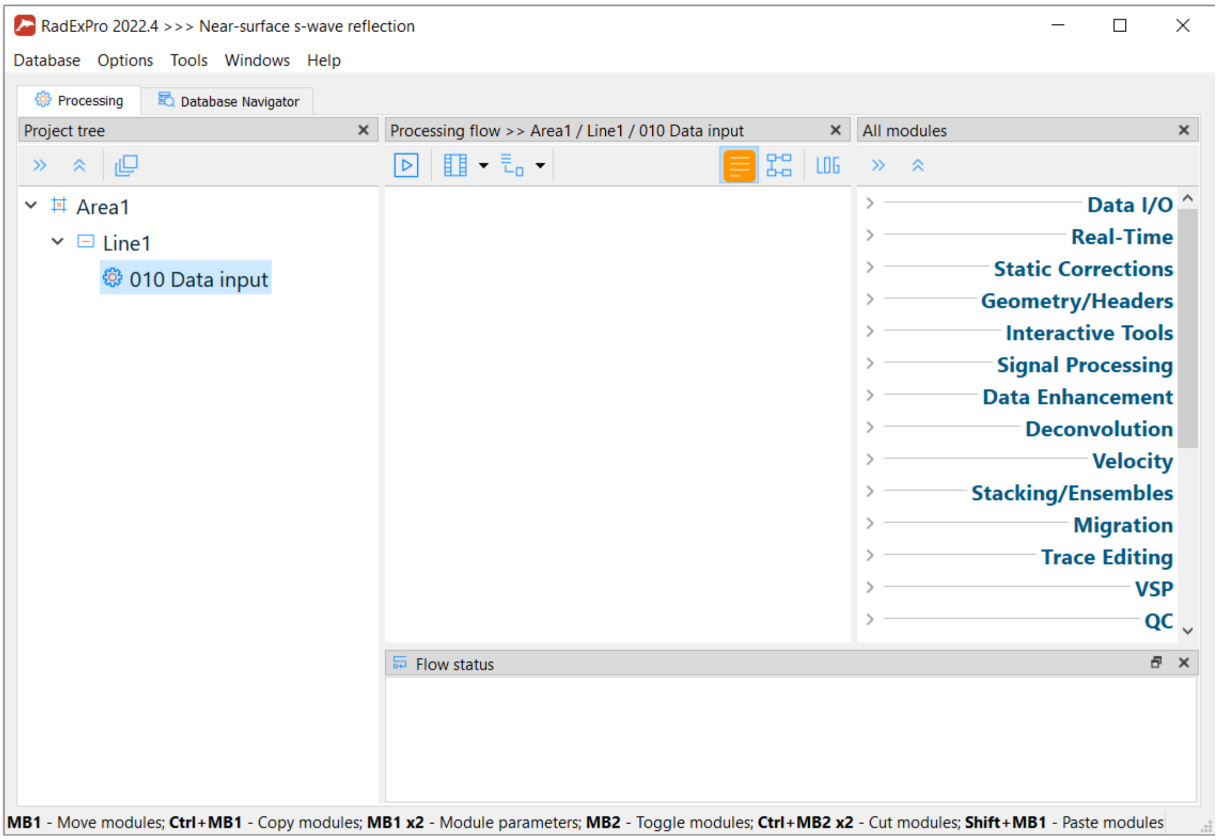
Data processing in RadExPro software is executed within the framework of the processing *projects*. A project is a database containing input seismic data, intermediate and final processing results as well as all processing flows and their parameters, velocity tables, horizon picks and other auxiliary information. Each project and all its files are stored in a separate folder on the hard disk. Before proceeding, the data should be loaded into the project.

For the detailed step-by-step description of how to create a new project and load the data see " Creating new project and loading data" tutorial available from our web-site.

Create our project in the Project Manager dialog window and name it "Near-surface S-wave reflection".



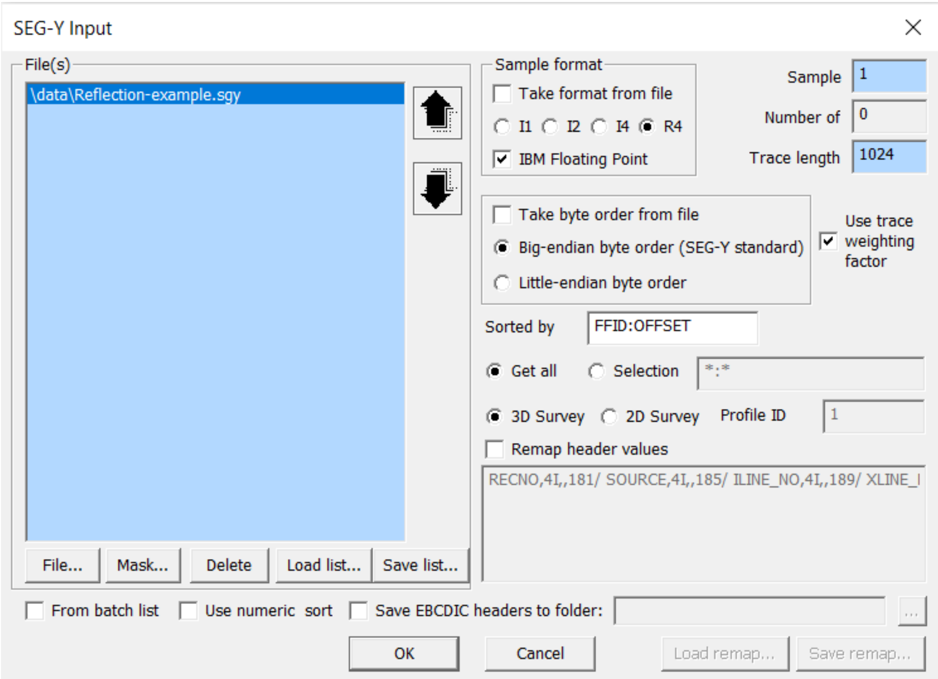
Choose "Near-surface S-wave reflection" from the project list and click the OK button. The project main window will open. Rename the first automatically generated processing flow - name it "*010 Data input*". You may also want to rename areas and lines.


RadExPro 2022.4 >>> Near-surface s-wave reflection
Database Options Tools Windows Help
Processing
Database Navigator
Project tree
Processing flow >> Area1 / Line1 / 010 Data input
All modules
Area1
Line1
010 Data input
Data I/O
Real-Time
Static Corrections
Geometry/Headers
Interactive Tools
Signal Processing
Data Enhancement
Deconvolution
Velocity
Stacking/Ensembles
Migration
Trace Editing
VSP
QC
Flow status
MB1 - Move modules; Ctrl+MB1 - Copy modules; MB1 x2 - Module parameters; MB2 - Toggle modules; Ctrl+MB2 x2 - Cut modules; Shift+MB1 - Paste modules

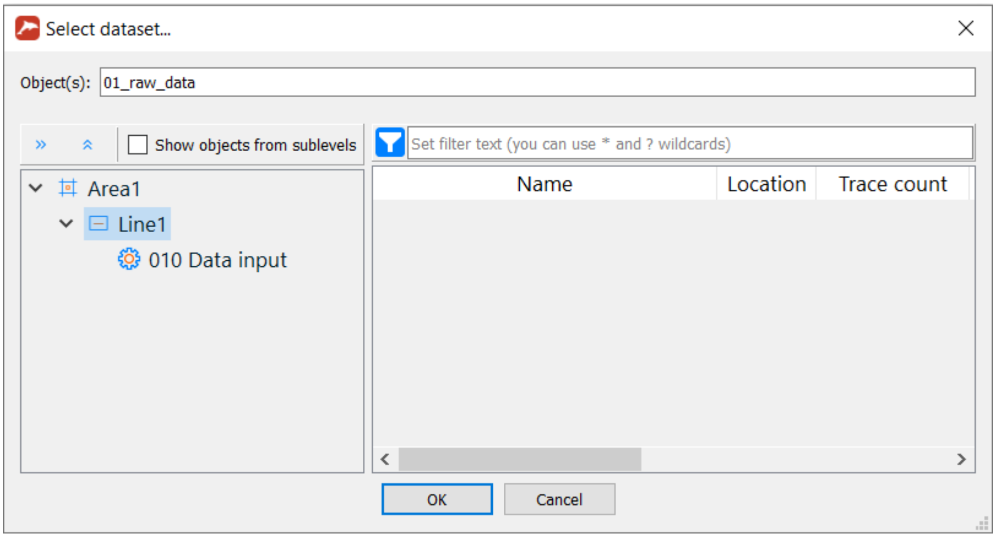
Loading input data into the project

Let us start working in the first flow "010 Data input". Let us form the processing flow consisting of SEG-Y Input and Trace Output modules.

This flow is used for loading the data into the project. It will read data from the file on disk and save them into the project database as an object of the type dataset. Since our data are in SEG-Y format, let us use module SEG-Y Input for their reading. The module automatically determines SEG-Y files' parameters. If any parameter is determined incorrectly, you can always correct it specifying the correct value manually.

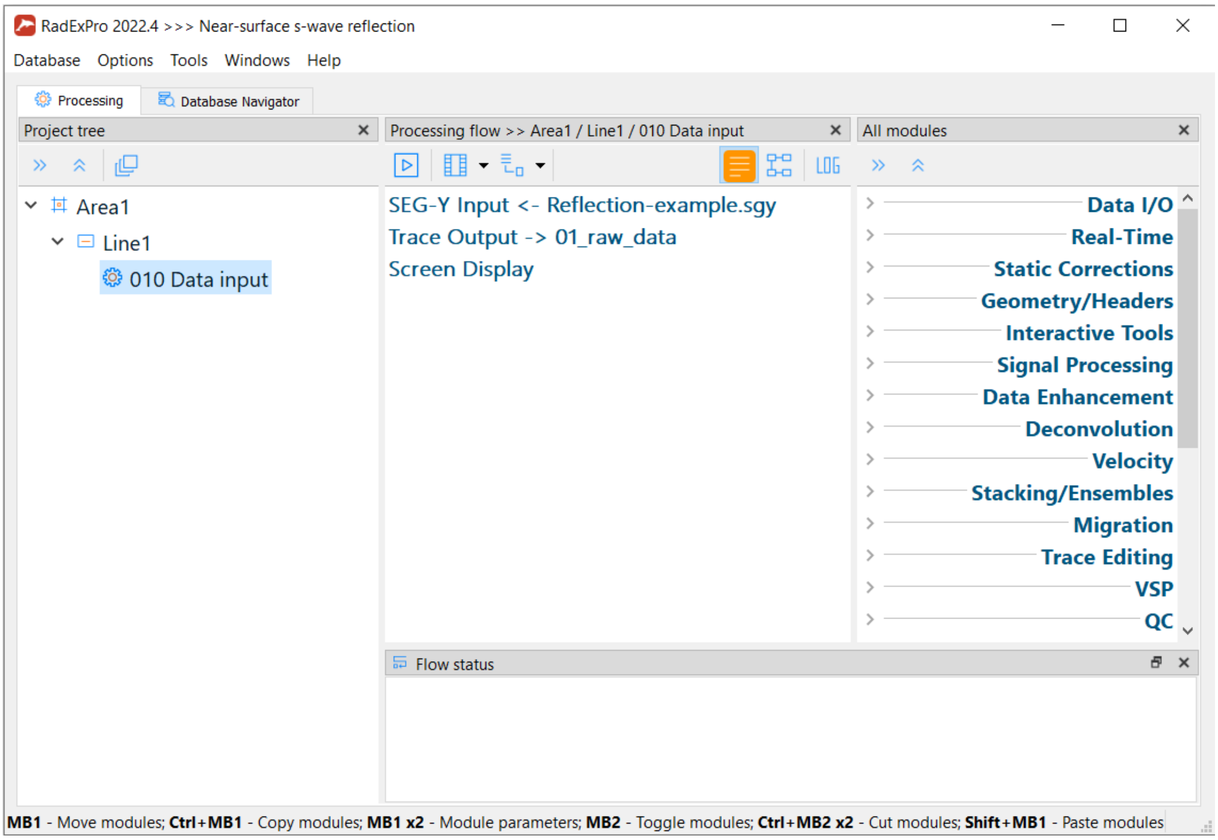


Following the SEG-Y Input, let us add Trace Output module in the flow. This module will save the loaded seismic traces into the database. Let us name the object, containing these data, '01_raw_data' and allocate it on the second level of the database in the Line (as shown in the following figure).

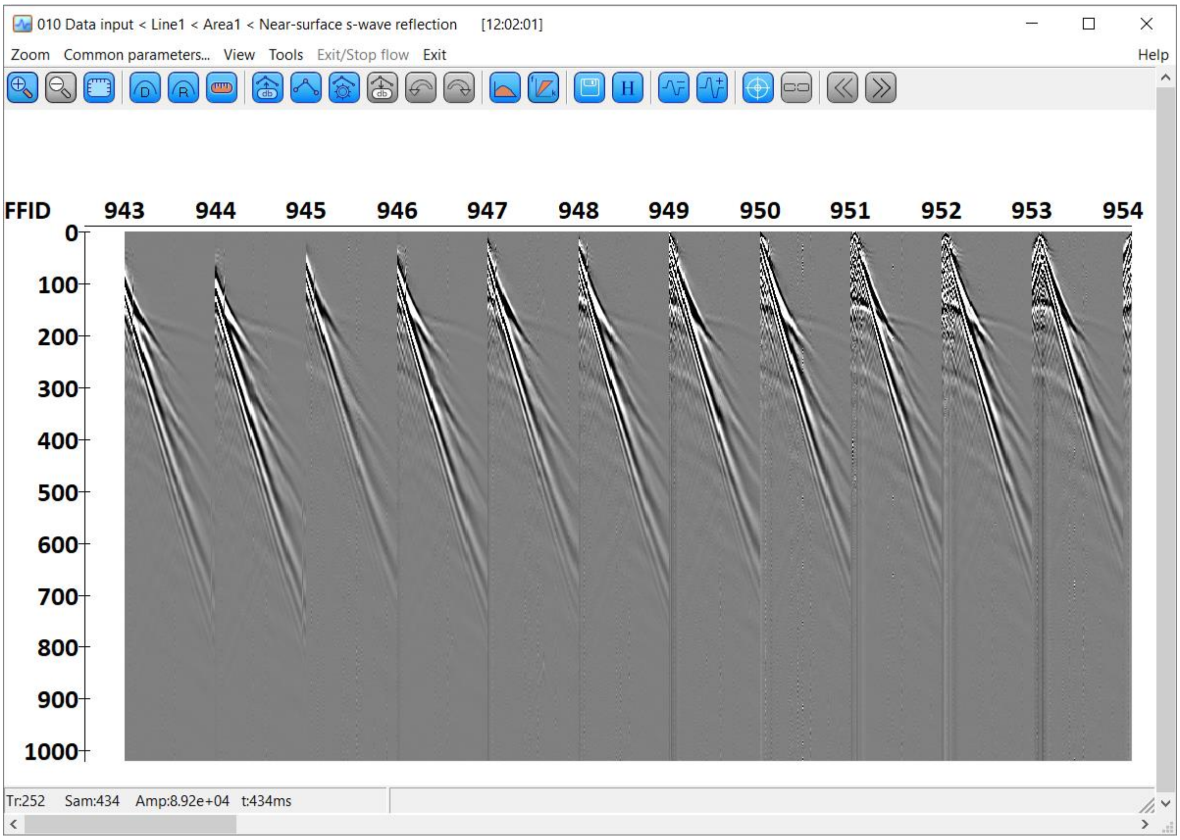


Let us add Screen Display module following the Trace Output in order to check the correctness of the data loading.

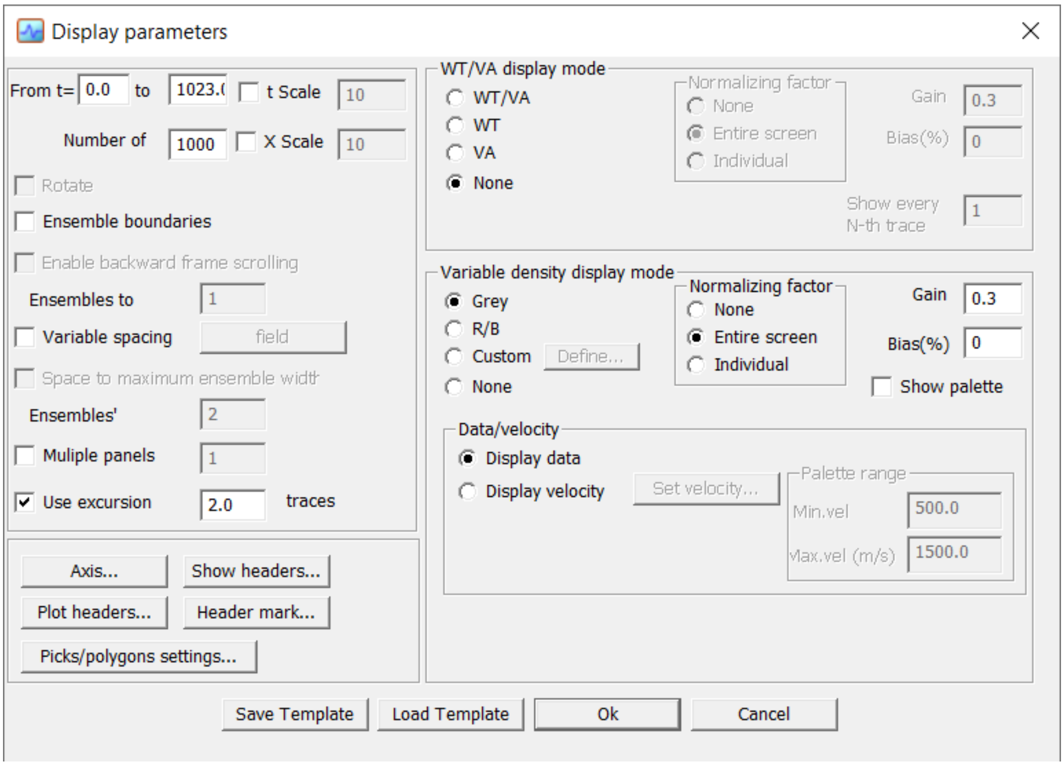
The resulting flow will look like this:



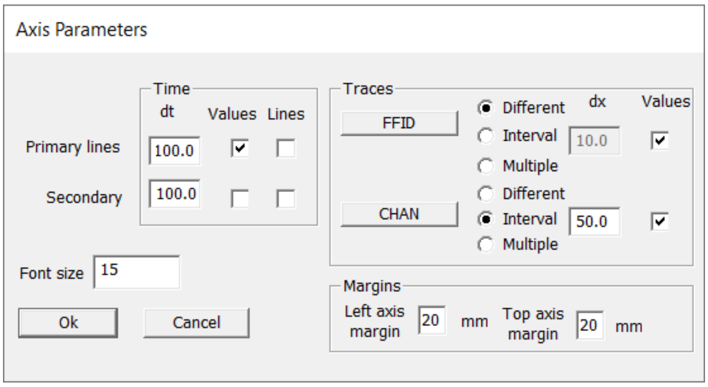
Click the Run button to execute the flow. As a result, the data will be read from the file on disk, saved into the project database and a Screen Display window, displaying the input data, will open. The Screen Display window is shown below (your window appearance will depend on the chosen parameters in the Screen Display dialog).



Here we used the following Screen Display parameters:



Setting axes (dialog button Axis...):


Axis Parameters
Time
dt
Values
Lines
Primary lines
100.0
Secondary
100.0
Traces
FFID
Different
Interval
Multiple
dx
10.0
Values
CHAN
Different
Interval
Multiple
50.0
Font size
15
Ok
Cancel
Margins
Left axis margin
20
mm
Top axis margin
20
mm

Geometry assignment and CDP binning

Geometry assignment is one of the first stages of seismic data processing. This refers to filling in the values of all required headers, which will be used in further processing.

The following fields need to be filled in the seismic trace headers for correct CDP binning and further processing according to the reflection method:

- source coordinates – SOU_X header;
- receiver coordinates – REC_X header;
- source number – SOURCE header;
- source-receiver distance – OFFSET header;

On the next step, the CDP binning is performed. For each trace, its source-receiver midpoint coordinate is calculated. Then several adjacent midpoints are grouped into a Common Mid-Point bin. Common Mid-Pint is also commonly referred to as Common Depth Point (CDP). We will use the CDP terminology further on in this manual.

Each CDP bin has its number and a coordinate of the bin center. As a result of the CDP binning, for each trace the following additional header field will be assigned:

- common depth point number – CDP header;
- coordinate of the center of the CDP bin – CDP_X header;

In a simple case of a straight-line profile with a regular acquisition geometry (this is the only case we discuss here), assigning geometry and CDP binning can be performed at one single step, using the Near-Surface Geometry Input module.

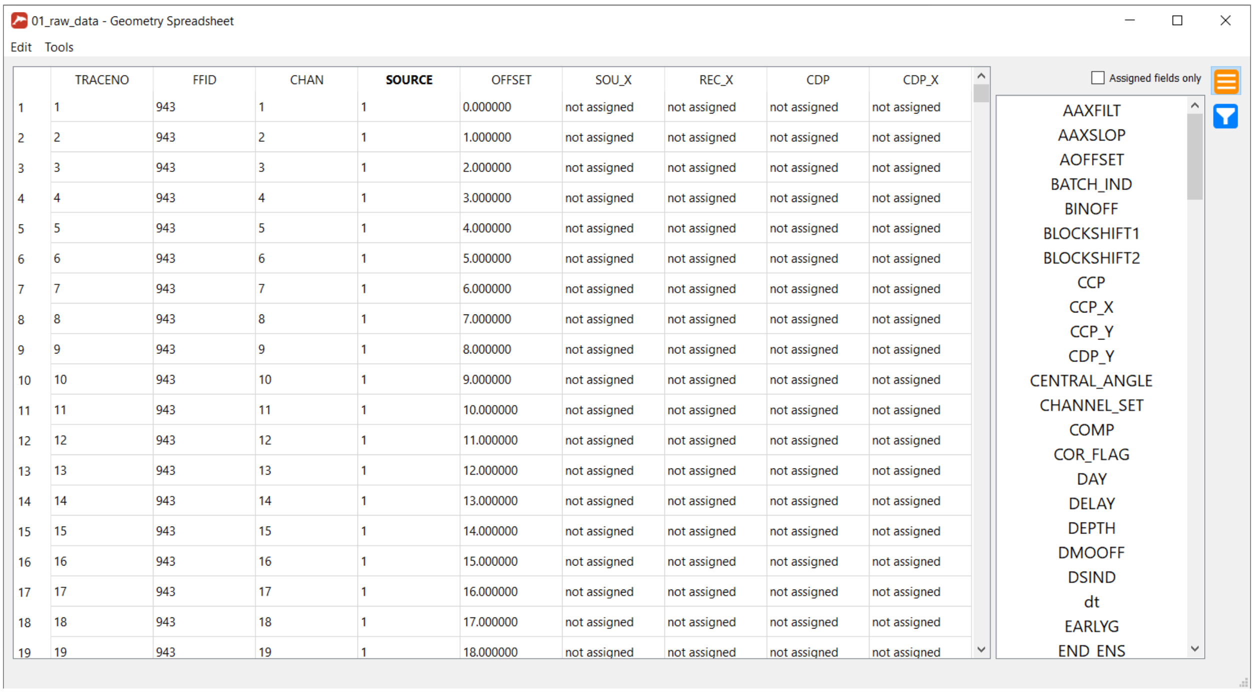
Moreover, when using CDP spacing equal to half a distance between receivers, coordinates of the midpoints fallen in every CDP bin coincide with each other and with the bin center coordinate. However, you need to understand that this will not always happen -- for example, you can increase the bin size two-fold, and then, traces with two different midpoints will fall into it, and the bin center coordinate will be between them. This can be done to increase CDP multiplicity by decreasing the spatial resolution.

In case of observations along a crooked lines when real GPS coordinates are used, geometry assignment and binning are two different steps. In this case, binning is executed as a separate procedure. In RadExPro there is a dedicated Crooked Line 2D Binning module for that. Working with this module is beyond the scope of this tutorial but can be found in the User Manual.

Before using Near-Surface Geometry Input, let us check correctness of the seismic trace headers. Let us open the dataset in the header table editor (Geometry Spreadsheet) -- go to the Database Navigator tab of the main window, find the input dataset there and double click on its name. The Geometry

Spreadsheet header editor will.

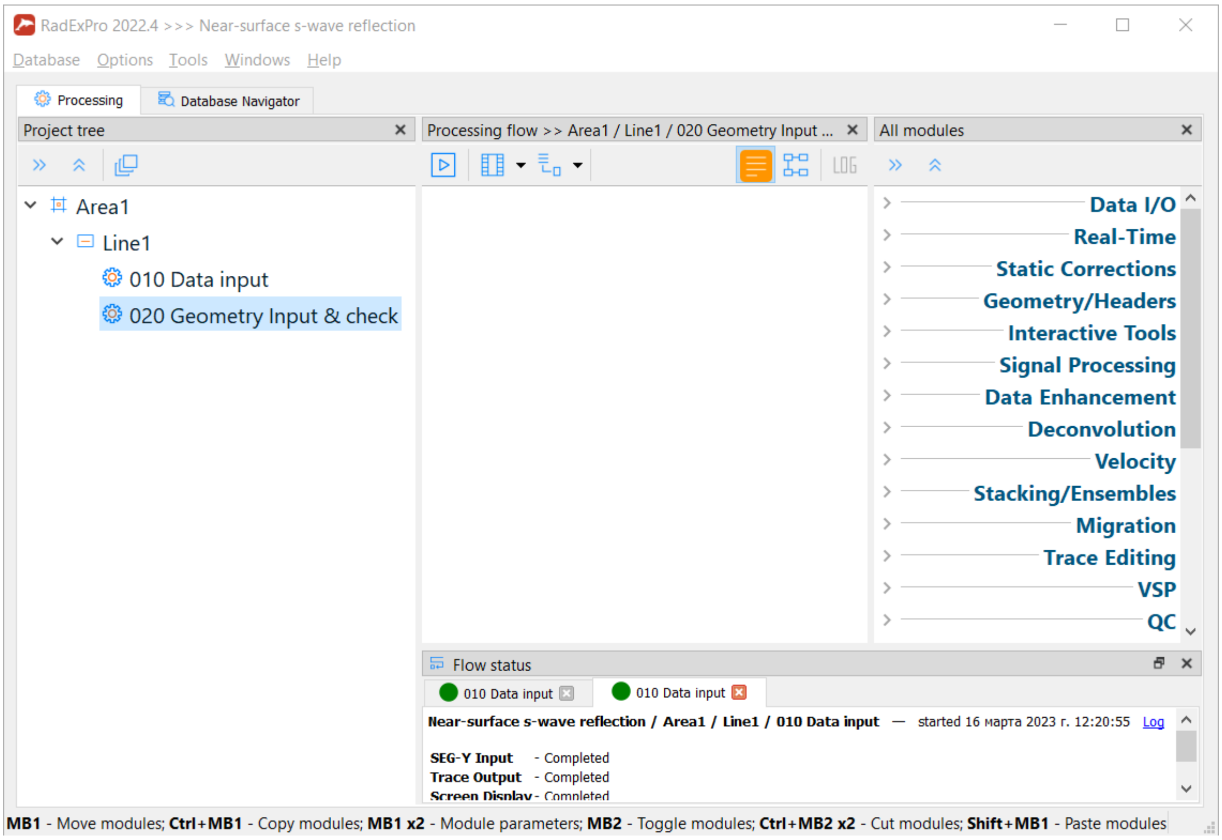
Load headers we are going to work with into the editor -- those that were supposed to be filled in the field and those, we are going to fill in. Headers can be added from the header list on the right by dragging or double-clicking:



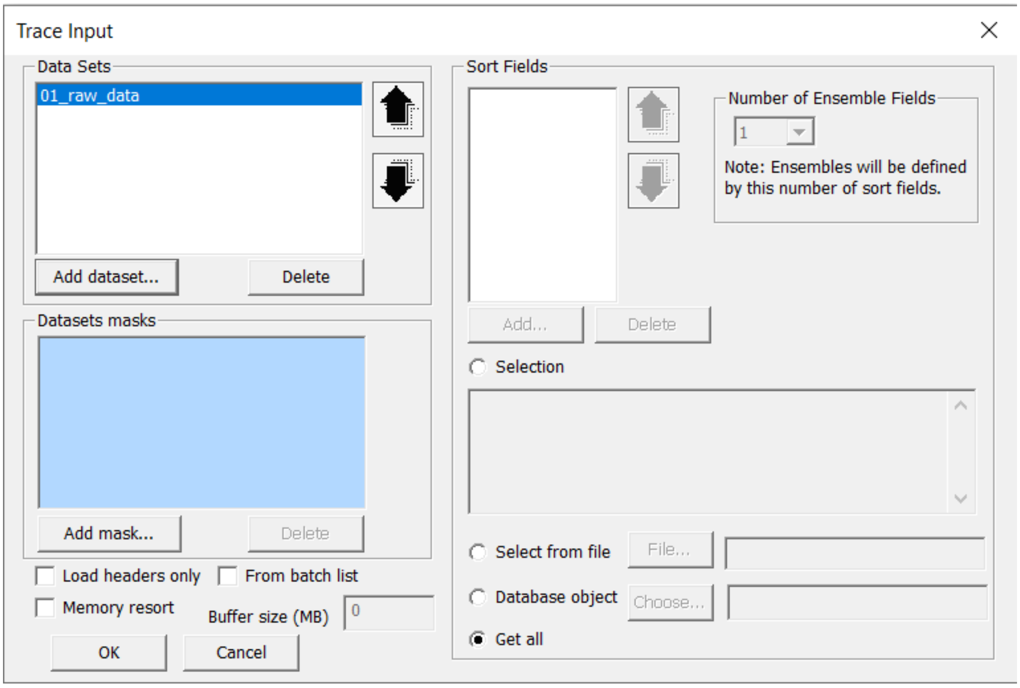
	TRACENO	FFID	CHAN	**SOURCE**	OFFSET	SOU_X	REC_X	CDP	CDP_X
1	1	943	1	1	0.000000	not assigned	not assigned	not assigned	not assigned
2	2	943	2	1	1.000000	not assigned	not assigned	not assigned	not assigned
3	3	943	3	1	2.000000	not assigned	not assigned	not assigned	not assigned
4	4	943	4	1	3.000000	not assigned	not assigned	not assigned	not assigned
5	5	943	5	1	4.000000	not assigned	not assigned	not assigned	not assigned
6	6	943	6	1	5.000000	not assigned	not assigned	not assigned	not assigned
7	7	943	7	1	6.000000	not assigned	not assigned	not assigned	not assigned
8	8	943	8	1	7.000000	not assigned	not assigned	not assigned	not assigned
9	9	943	9	1	8.000000	not assigned	not assigned	not assigned	not assigned
10	10	943	10	1	9.000000	not assigned	not assigned	not assigned	not assigned
11	11	943	11	1	10.000000	not assigned	not assigned	not assigned	not assigned
12	12	943	12	1	11.000000	not assigned	not assigned	not assigned	not assigned
13	13	943	13	1	12.000000	not assigned	not assigned	not assigned	not assigned
14	14	943	14	1	13.000000	not assigned	not assigned	not assigned	not assigned
15	15	943	15	1	14.000000	not assigned	not assigned	not assigned	not assigned
16	16	943	16	1	15.000000	not assigned	not assigned	not assigned	not assigned
17	17	943	17	1	16.000000	not assigned	not assigned	not assigned	not assigned
18	18	943	18	1	17.000000	not assigned	not assigned	not assigned	not assigned
19	19	943	19	1	18.000000	not assigned	not assigned	not assigned	not assigned

As the above table shows, the header fields corresponding to coordinates of the sources, receivers, CDP coordinates and their numbers are not filled in (not assigned). Besides, field TRACENO, which is supposed to contain trace sequential number, has been filled in out of sequence.

Let us create a new flow "*020 Geometry Input & check*", in which we will fill in the trace headers according to the available shooting geometry.

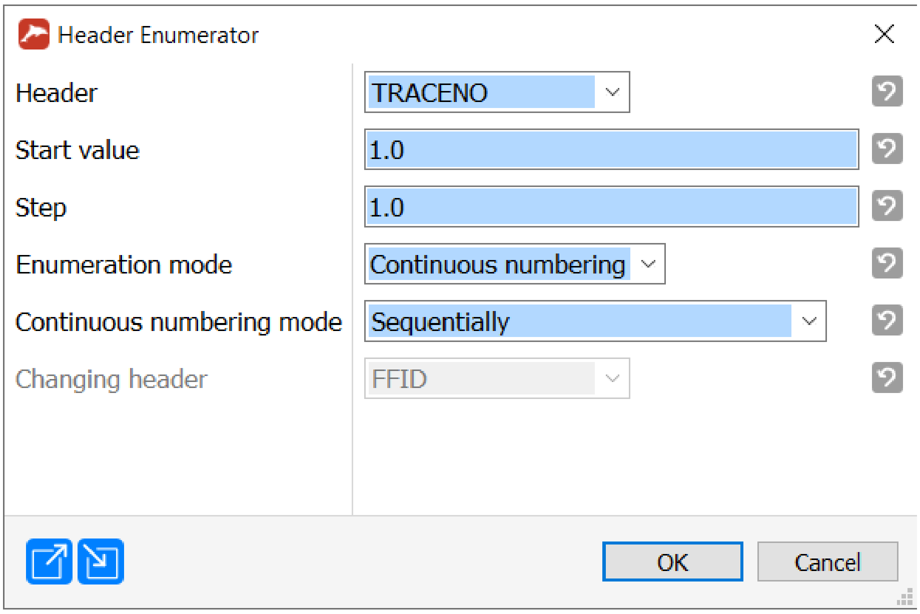


First, read the seismic dataset in this flow using Trace Input module. Choose the earlier created dataset 01_raw_data, as shown in the figure, and load all the data in that order as they go in the dataset indicating in field Selection "Get all". Click the OK - the module will be added into the flow.



In order to have Near-Surface Geometry Input module working correctly, it is necessary to feed the data to the input in the order of their sequence along the profile since computation of coordinates is executed sequentially for each source point. At the same time TRACENO header should contain the correct unique values of trace sequential numbers.

Add Header Enumerator module into the flow to populate the TRACENO with the sequential trace numbers. The numbering will start from 1 with the increment of 1.



Further, add Near-Surface Geometry Input module into the flow. This module can assign geometry to the field data collected along a straight line using the most typical acquisition set-ups for seismic reflection, refraction and surface wave analysis (MASW) methods.

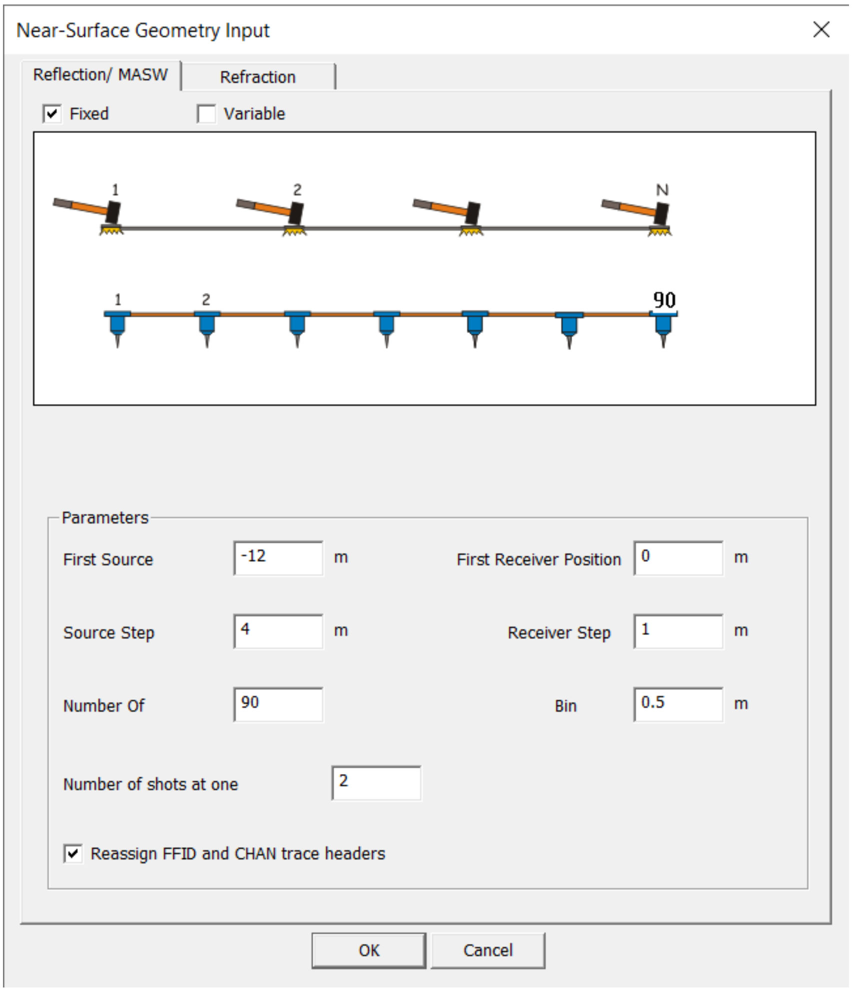
The main dialog of the module is separated into two tabs –Reflection/MASW tab and Refraction tab. Each array type has a corresponding interactive image which illustrates the current parameter of the edited tab (position of receiver, source, etc.).

In our case, we are working with a typical reflection set up with the receiver array fixed along the profile and the source points moving along the array. Therefore, let us select Reflection/MASW tab and choose "Fixed mode". In this case it is necessary to set the initial parameters for the geometry computation (all distances are set in meters):

- **First source position** – the first source point coordinate;
- **Source step** – shot interval;
- **Number of channels** – number of channels of the receiving array;
- **First receiver position** – the first channel coordinate;
- **Receiver step** – receiver group spacing;
- **Bin size** — bin size (as a rule, half the distance between receivers);

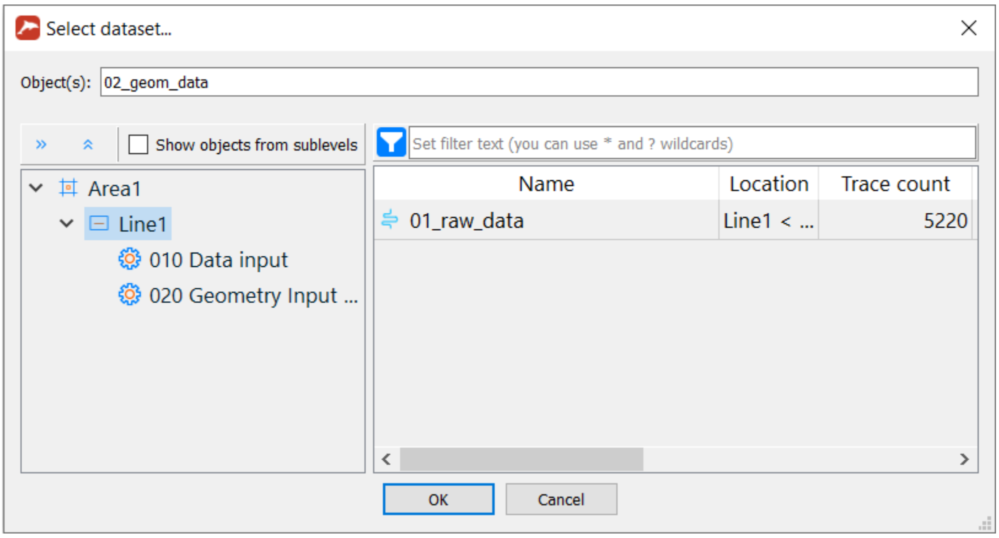
- **Number of shots at one point –** number of shots at one profile point;
- **Reassign FFID and CHAN headers –** if the header fields corresponding to SP number (FFID) and channel (CHAN), were not filled or were filled incorrectly, then this option makes it possible to re-compute them based on the filled parameters of the array data.

  The correct parameters corresponding to the shooting geometry are shown in the figure below:

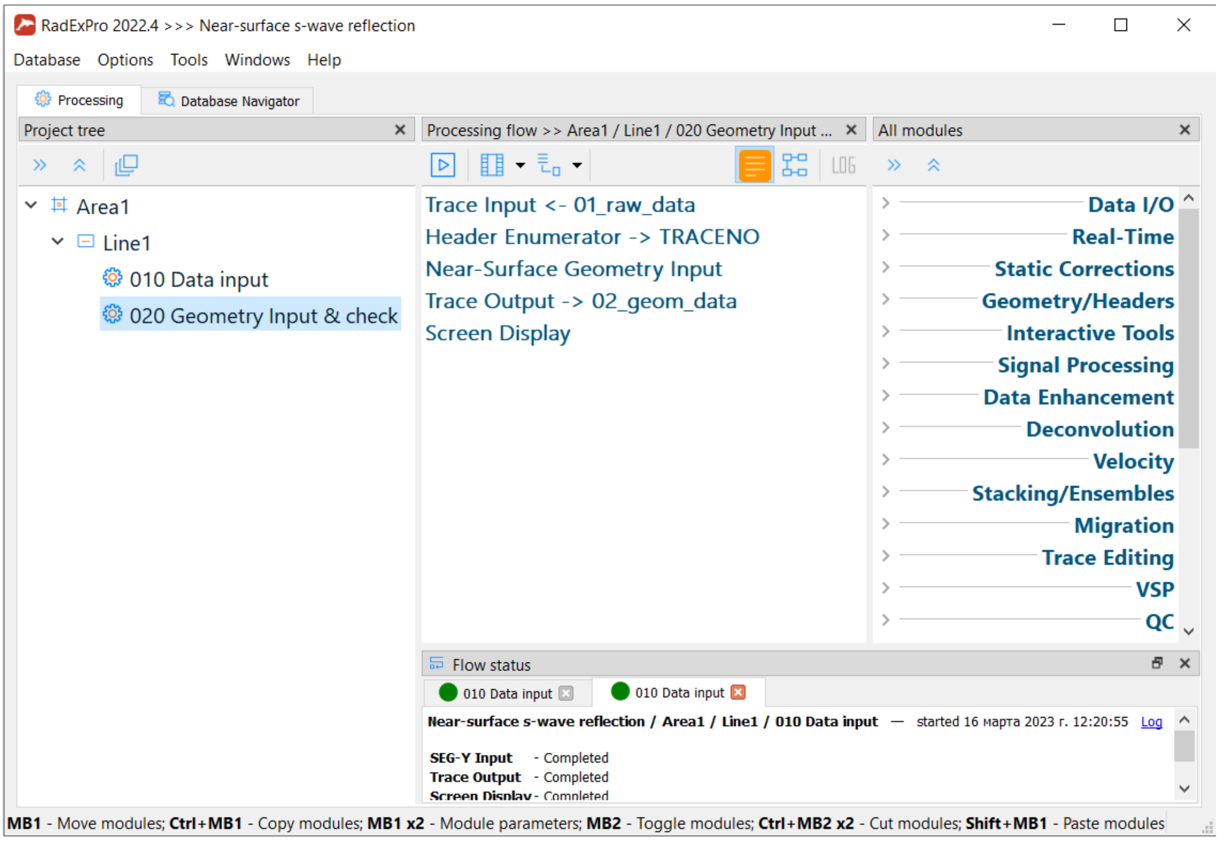


Click the OK after completion of the parameter assignment.

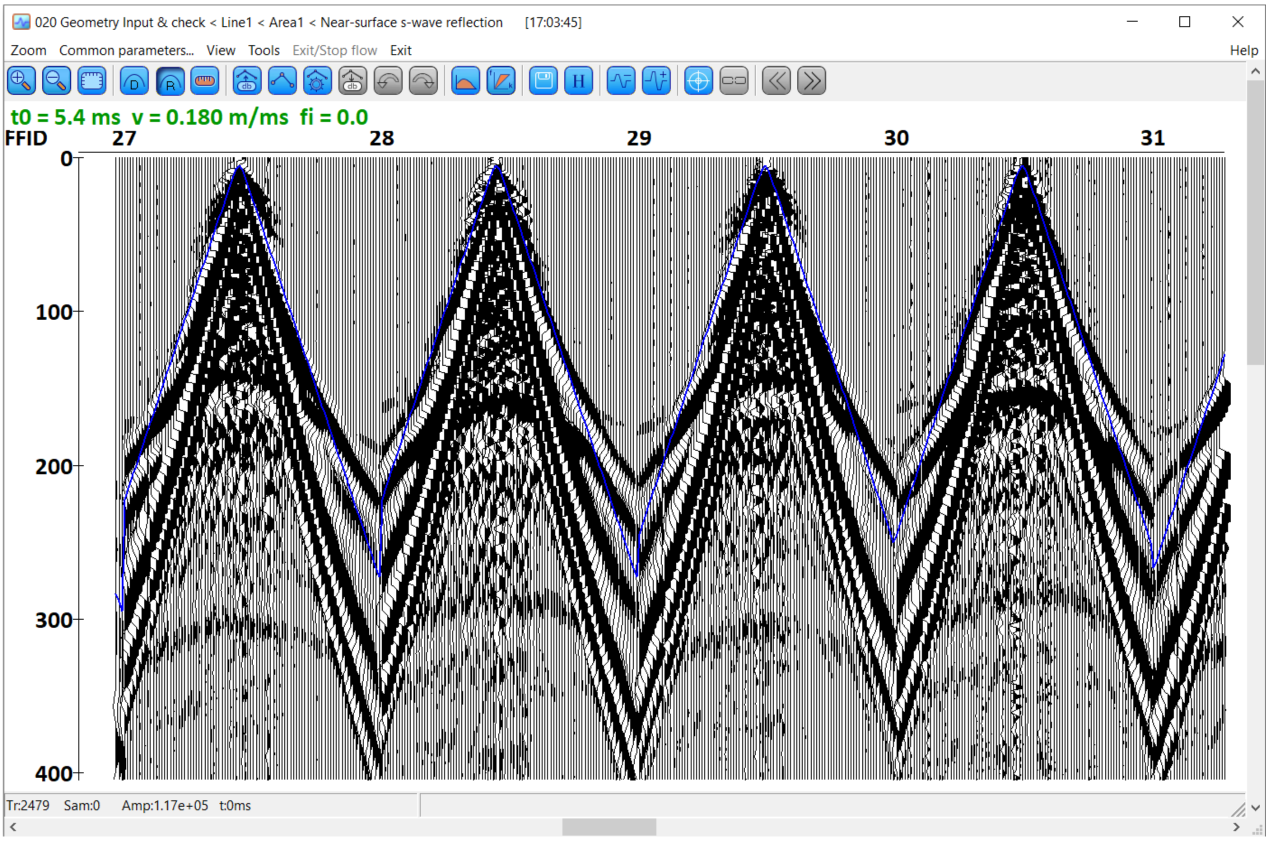
Use Trace Output module to save the data with the assigned geometry. Let us name the dataset with geometry '02_geom_data' and locate it at the second level of the database in the Line level (as shown in the next figure).



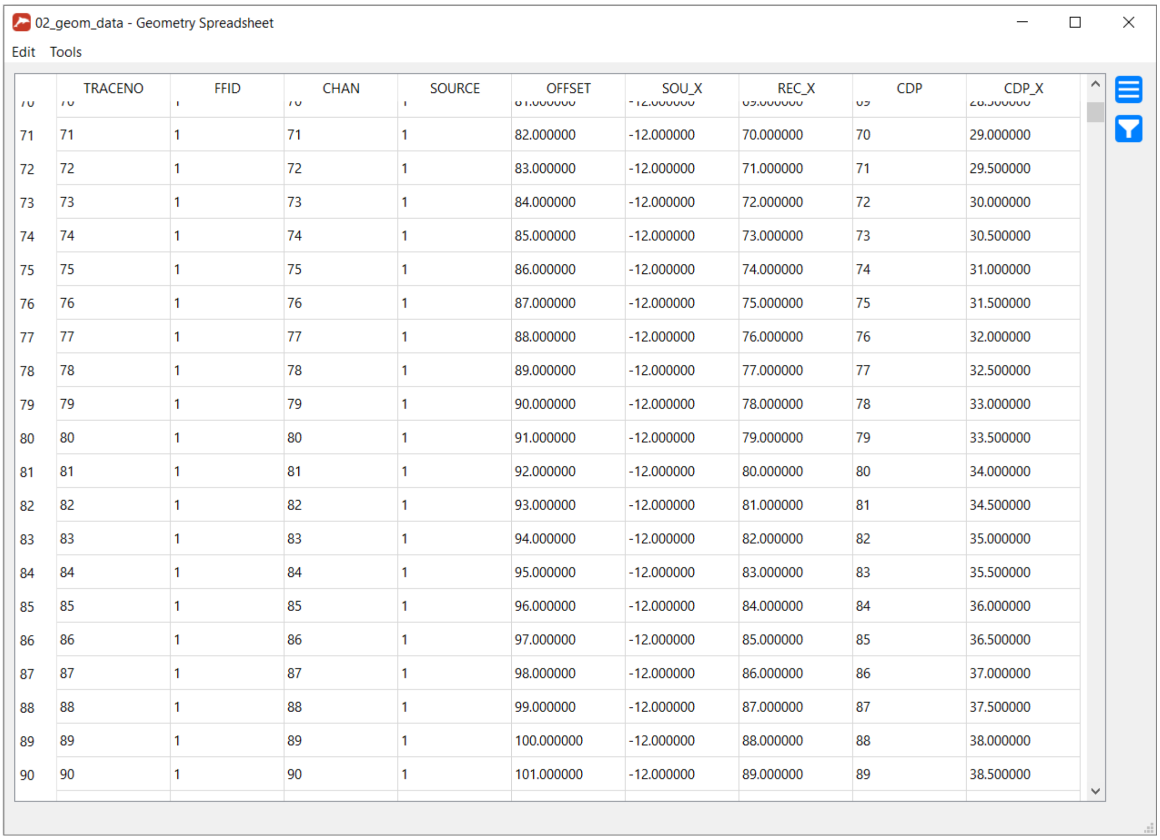
Let us put Screen Display module at the end of the flow to control the assigned geometry. As a result, the obtained flow will look like this:



Click the Run button to start the flow. As a result, a dataset with the assigned geometry has been obtained. Let us use "Approximate-Hyperbola (reflection)" tool to check correctness of the assigned geometry in the Screen Display window. Let us adjust parameters of the theoretical normal moveout curve (for more information about use of this tool see Screen Display description in the User Manual). The figure shows that the theoretical hyperbola, which vertex coincides with the recording start, collapses into two straight lines (the direct wave). In this way it is possible to see even small errors in the assigned geometry, even a shift by one channel.



Besides, we can open the dataset with assigned geometry (02_geom_data) in the Geometry Spreadsheet and make sure that all headers are assigned correctly:



02_geom_data - Geometry Spreadsheet

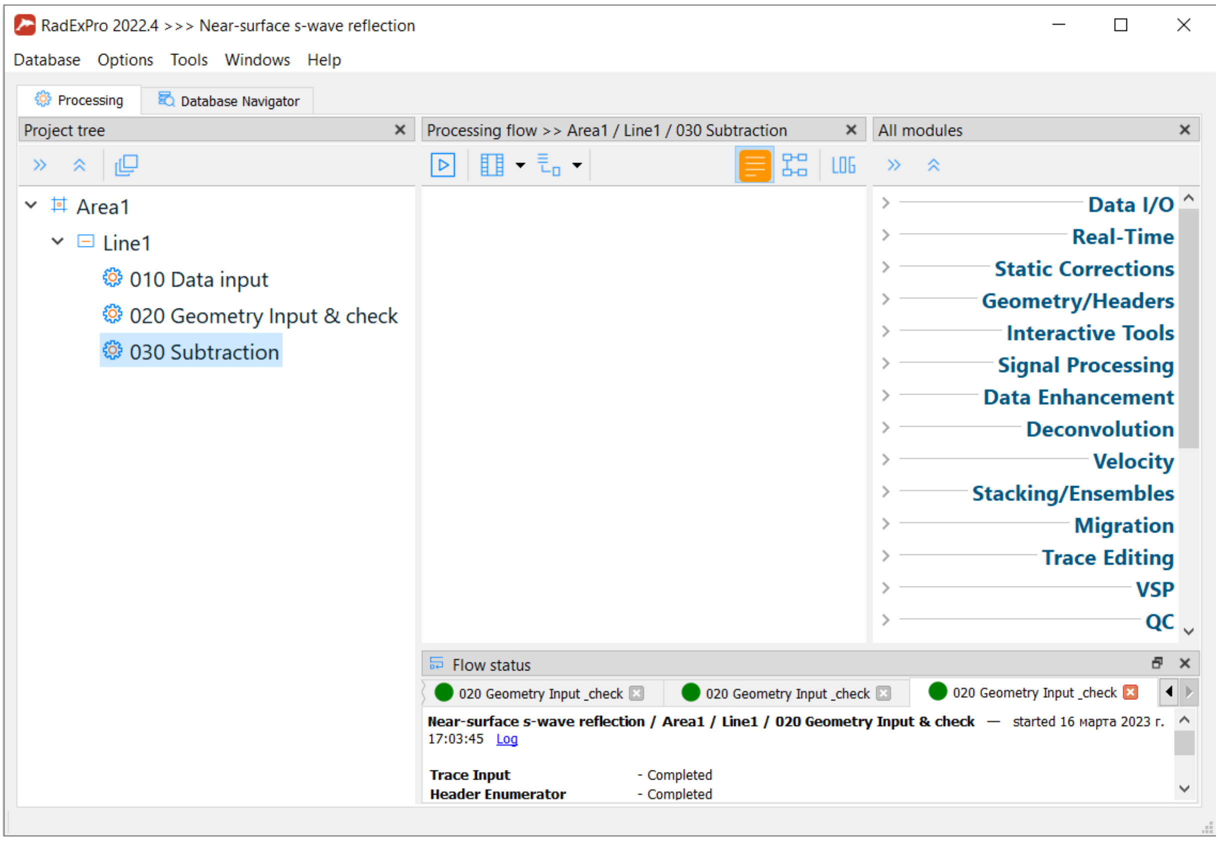
Edit Tools

	TRACENO	FFID	CHAN	SOURCE	OFFSET	SOU_X	REC_X	CDP	CDP_X
71	71	1	71	1	82.000000	-12.000000	70.000000	70	29.000000
72	72	1	72	1	83.000000	-12.000000	71.000000	71	29.500000
73	73	1	73	1	84.000000	-12.000000	72.000000	72	30.000000
74	74	1	74	1	85.000000	-12.000000	73.000000	73	30.500000
75	75	1	75	1	86.000000	-12.000000	74.000000	74	31.000000
76	76	1	76	1	87.000000	-12.000000	75.000000	75	31.500000
77	77	1	77	1	88.000000	-12.000000	76.000000	76	32.000000
78	78	1	78	1	89.000000	-12.000000	77.000000	77	32.500000
79	79	1	79	1	90.000000	-12.000000	78.000000	78	33.000000
80	80	1	80	1	91.000000	-12.000000	79.000000	79	33.500000
81	81	1	81	1	92.000000	-12.000000	80.000000	80	34.000000
82	82	1	82	1	93.000000	-12.000000	81.000000	81	34.500000
83	83	1	83	1	94.000000	-12.000000	82.000000	82	35.000000
84	84	1	84	1	95.000000	-12.000000	83.000000	83	35.500000
85	85	1	85	1	96.000000	-12.000000	84.000000	84	36.000000
86	86	1	86	1	97.000000	-12.000000	85.000000	85	36.500000
87	87	1	87	1	98.000000	-12.000000	86.000000	86	37.000000
88	88	1	88	1	99.000000	-12.000000	87.000000	87	37.500000
89	89	1	89	1	100.000000	-12.000000	88.000000	88	38.000000
90	90	1	90	1	101.000000	-12.000000	89.000000	89	38.500000

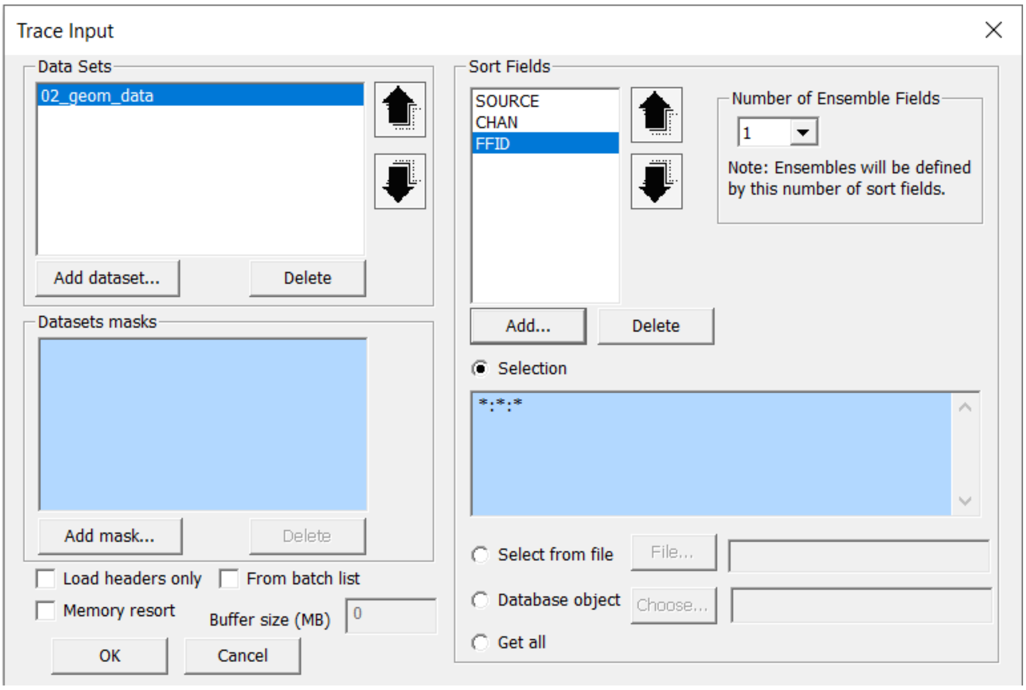
Subtraction of "left" and "right" shots

When using the method of counter shots, P and SH waves are registered. P wave is considered to be noise here, which could be reduced by subtracting "left" and "right" shots. S-waves on the collected shot “left” and “right” gathers are opposite in phase which, upon following subtracting, increases amplitudes of registered S-waves relative to P-wave amplitudes that are subtracted cophasally.

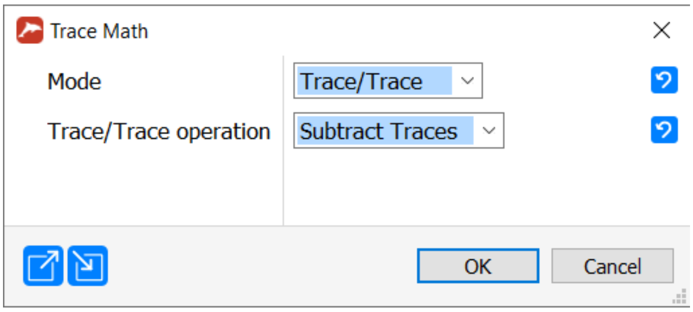
Let us create flow "*030 Subtraction*", where we are going to subtract "left" and "right" shots.



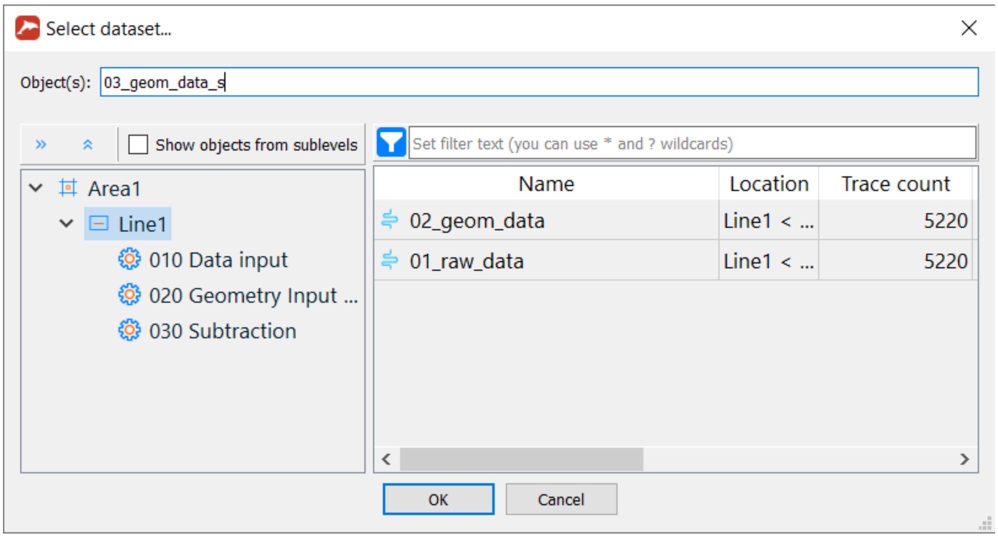
First, let us read the seismic dataset using Trace Input module. Indicate sorting as SOURCE:CHAN:FFID. With this sorting, at each source point for each channel, traces will go sequentially along the flow from two different shots: first "left" and then "right".



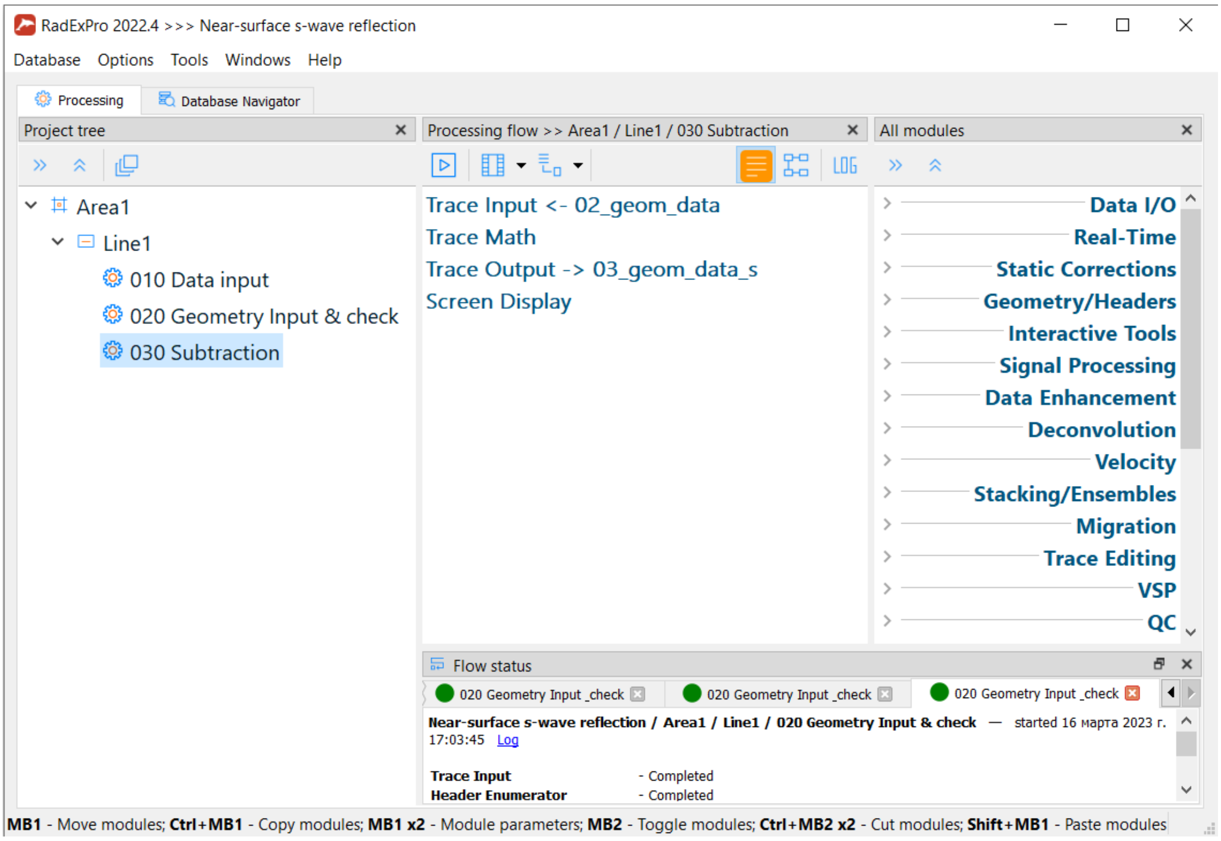
For subtraction of shots, add module Trace Math into the flow and choose trace-to-trace subtraction mode.



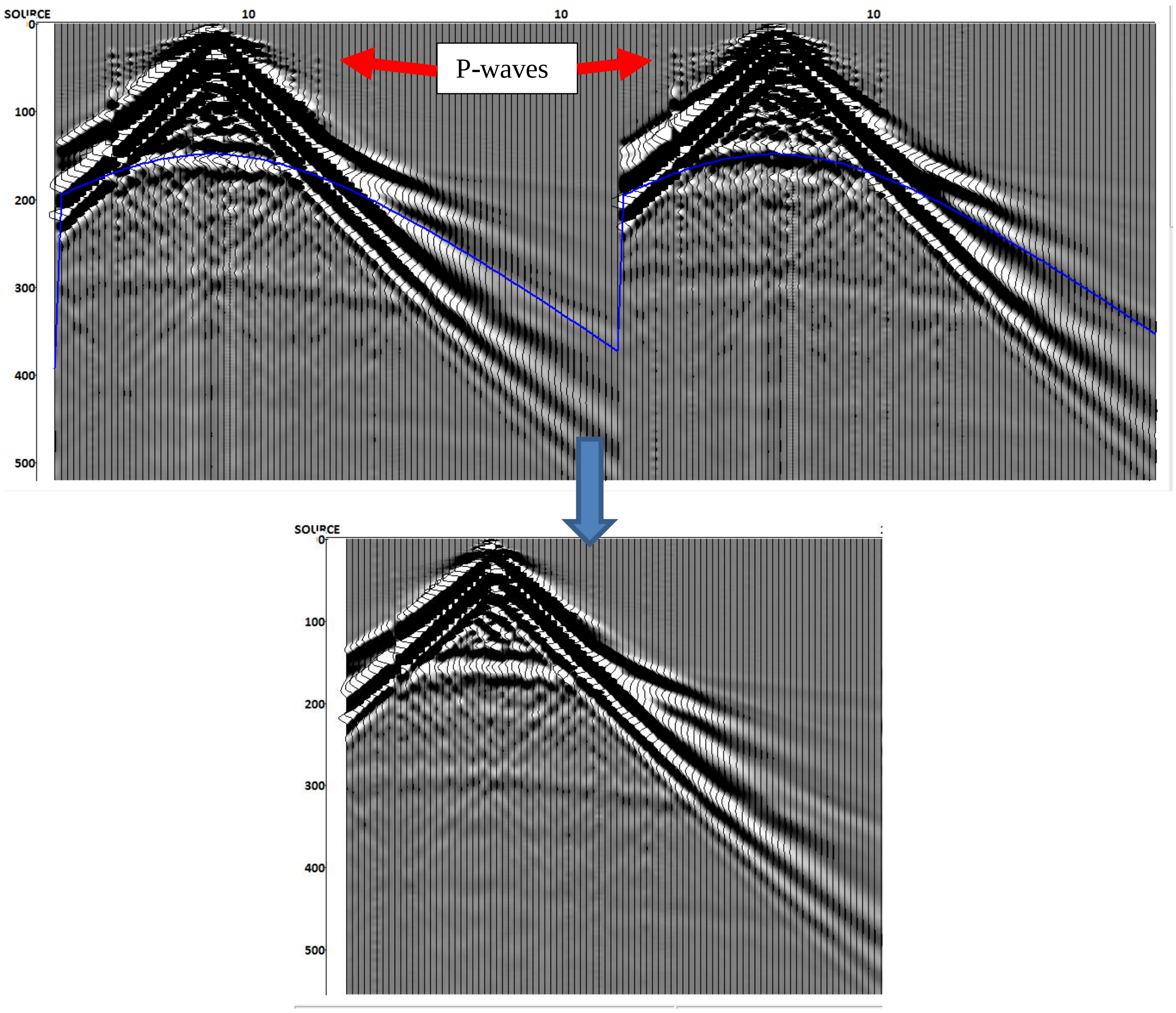
In order to save the processing results, let us write them out into a new dataset using Trace Output module. Let us name the new object 03_geom_data_s and locate it in the database at the level of Line (as shown in the next figure).



In order to assess the result, let us locate Screen Display module at the end of the flow. The resulting flow will look like this:

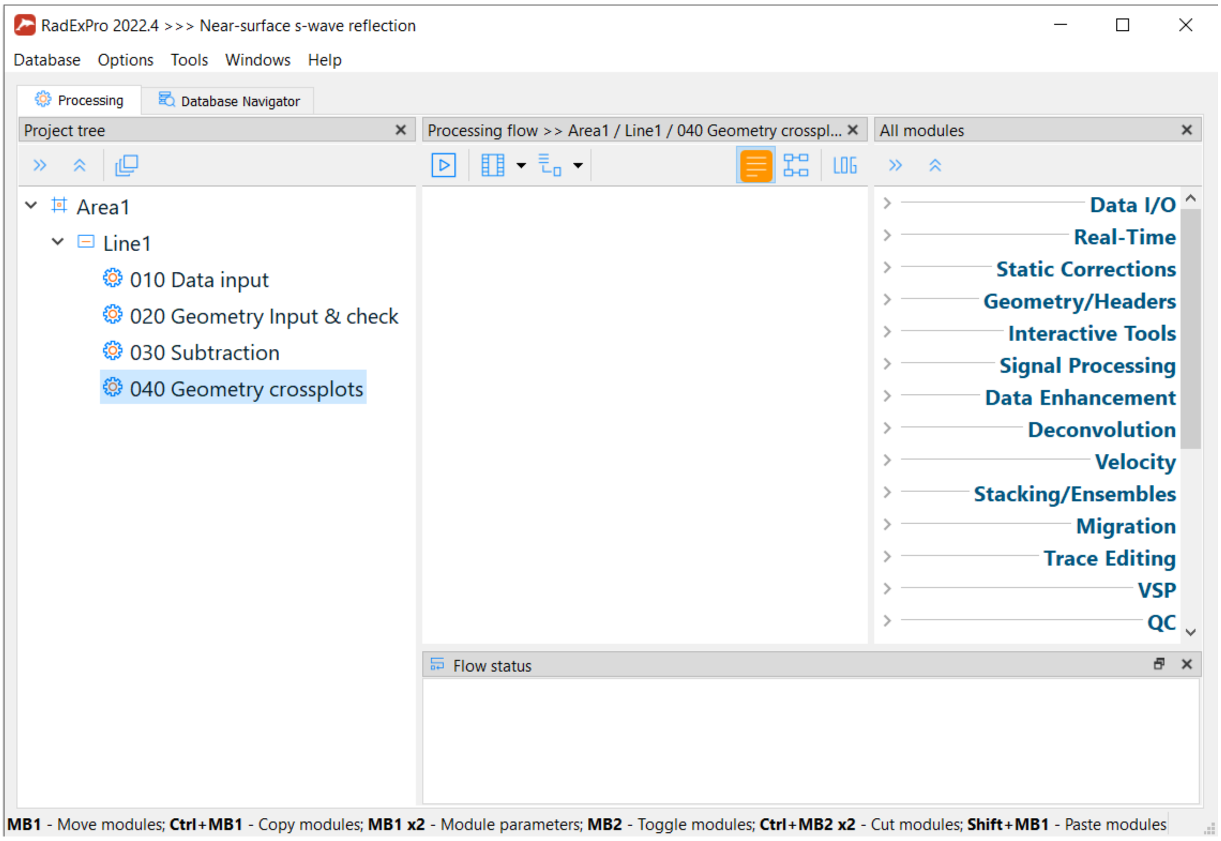


The figure shows the result of trace-to-trace subtraction procedure. Two upper seismograms (before subtraction) have different phases. After subtraction we have only one seismogram, tiny P-waves visible on the original gathers before the S-wave first arrival have disappeared.

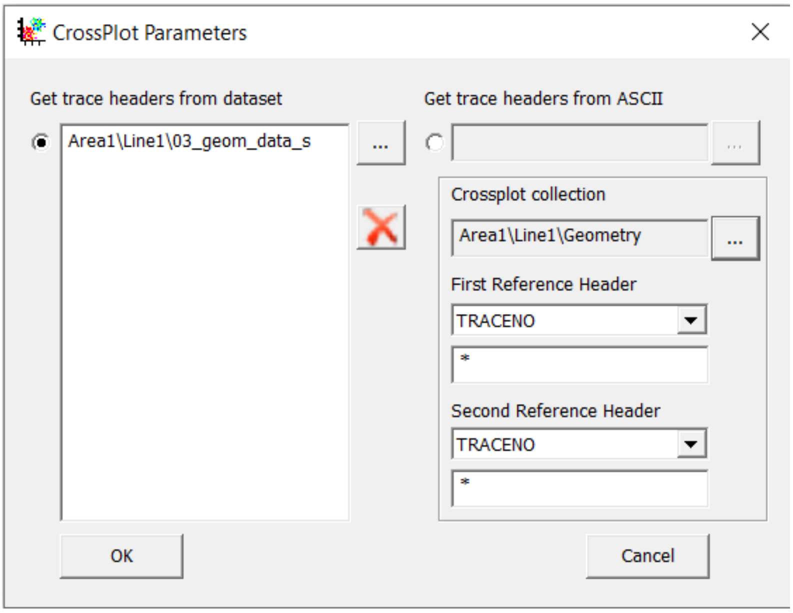

SOURCE
10
10
10
P-waves
0
100
200
300
400
500
SOURCE
0
100
200
300
400
500

Control of assigned geometry with the use of linked crossplots

An additional geometry quality control tool is construction of the so-called summation plot. Create a new flow "*040 Geometry crossplots*":



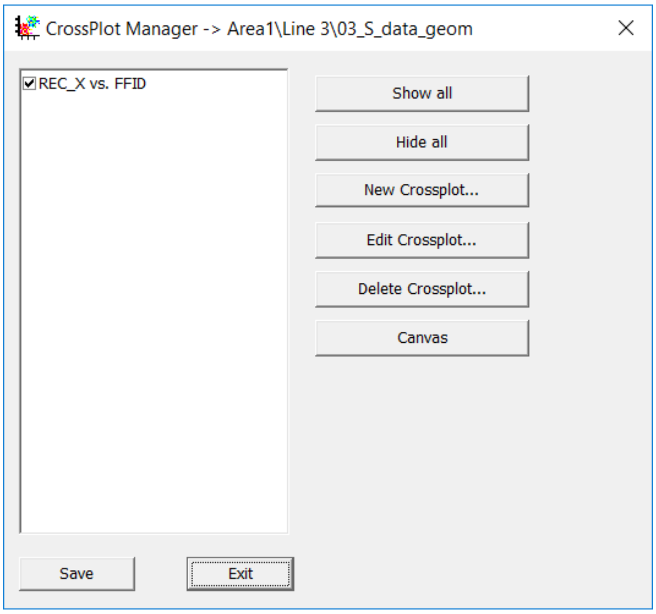
Add CrossPlot* module into the flow. This module belongs to the group of the so-called stand-alone modules and does not need any additional modules in the flow. Choose the dataset with assigned geometry and specify the path where the objects required for the module work will be stored, as shown in the picture:



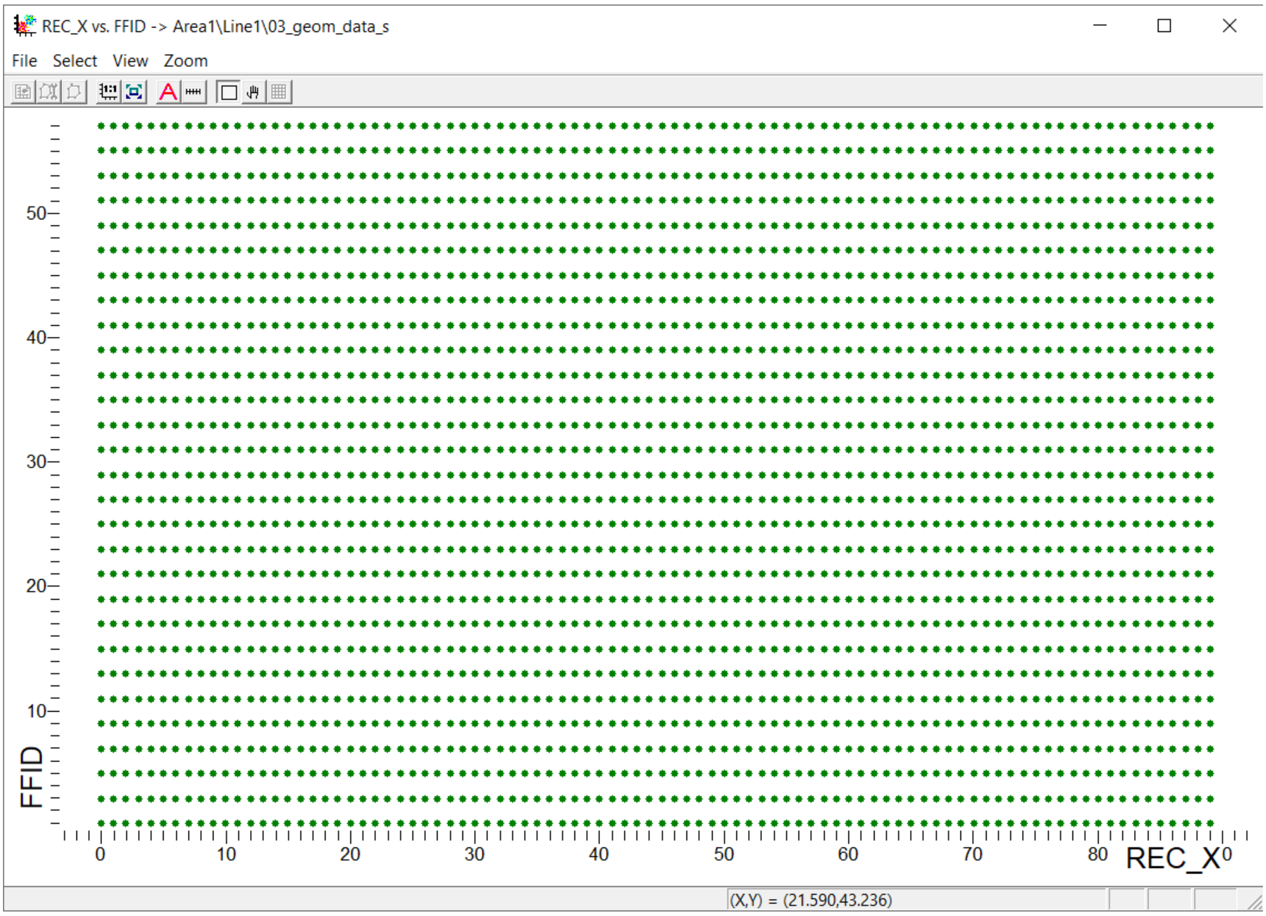
Start the flow by clicking the Run button.

Let us plot coordinates of source points, receivers and CDP's along the profile on the X-axis of the summation plot, and SP sequential number - on the Y-axis.

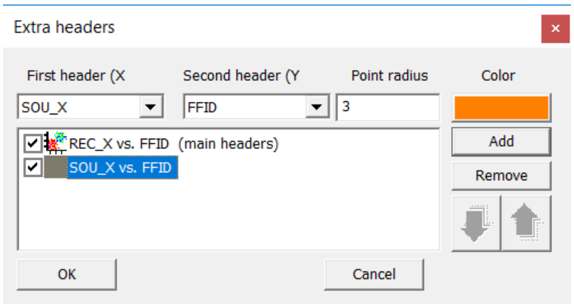
Let us start with creation of the first crossplot, at which we will depict the spatial position of receivers for each SP. For that purpose create a new crossplot (New Crossplot) and indicate headers REC_X and FFID as X and Y coordinates, respectively.



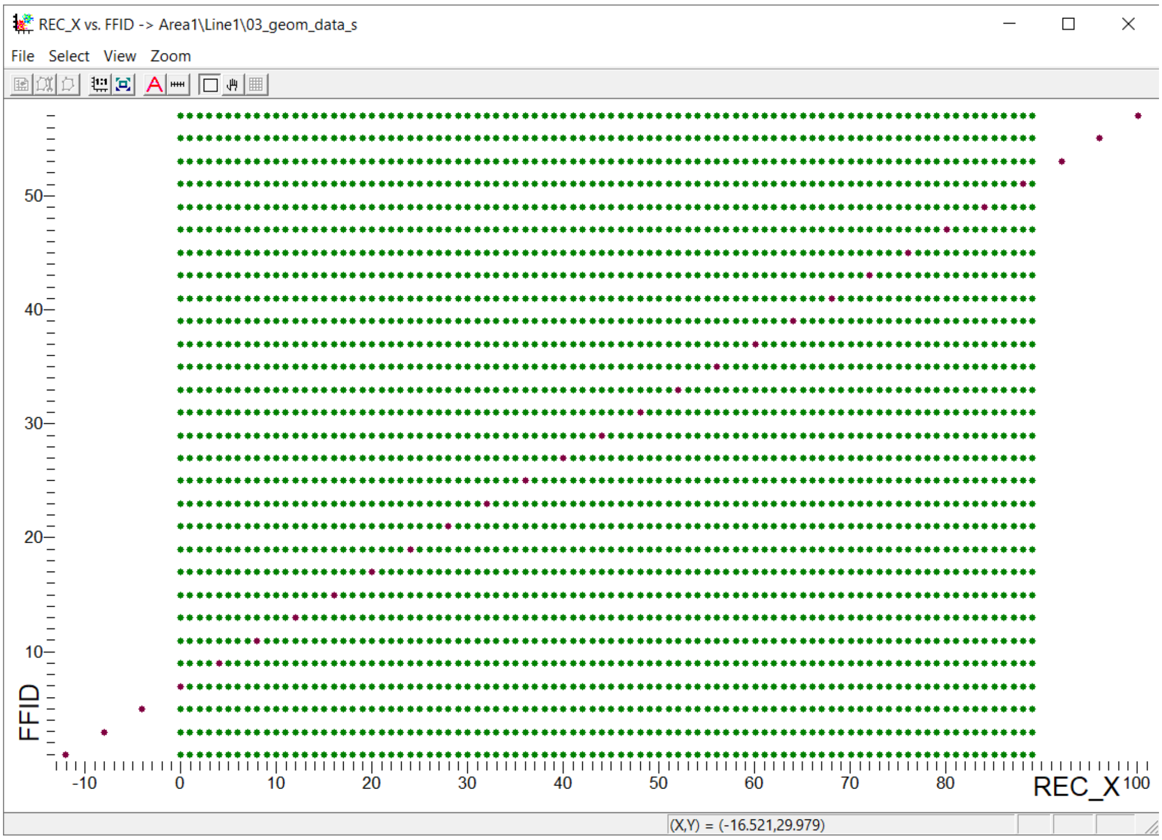
As a result, the map of receiver positions depending on SP number will appear on the screen. Note that, according to this map, the receiver positions were not changed with a change of SP number - this fully corresponds to our shooting setup with which the receiver line did not change its position in the course of the whole survey.



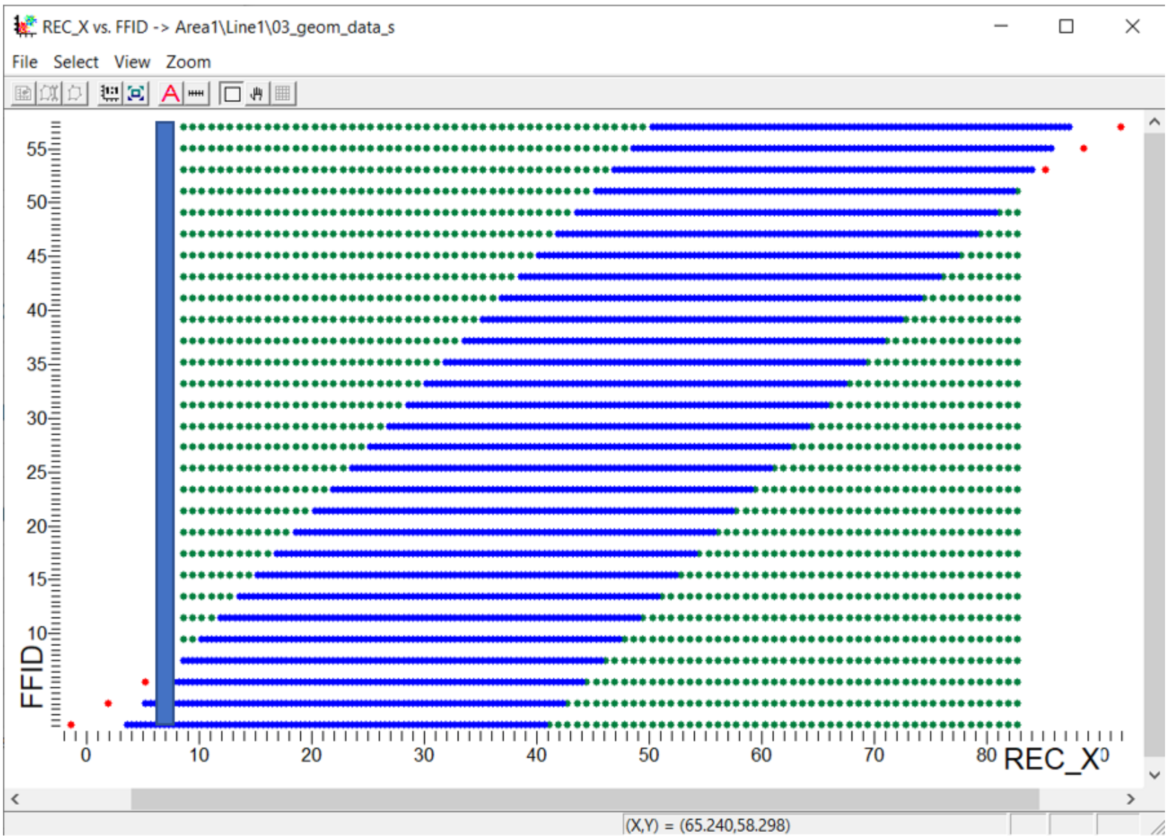
Now, let us add SP coordinates on the same crossplot (the window menu item of crossplot View->Extra Headers). Indicate headers SOU_X and FFID as X and Y axes and click the Add - as a result, the plot will be displayed in the list as shown in the figure:



As a result, the scheme of SP's changing along the profile will appear on the same crossplot. The sources are regularly spaced and their movement corresponds to the planed mixed shooting spread.



Similarly, add coordinates of CDP points (blue dots) on the crossplots:



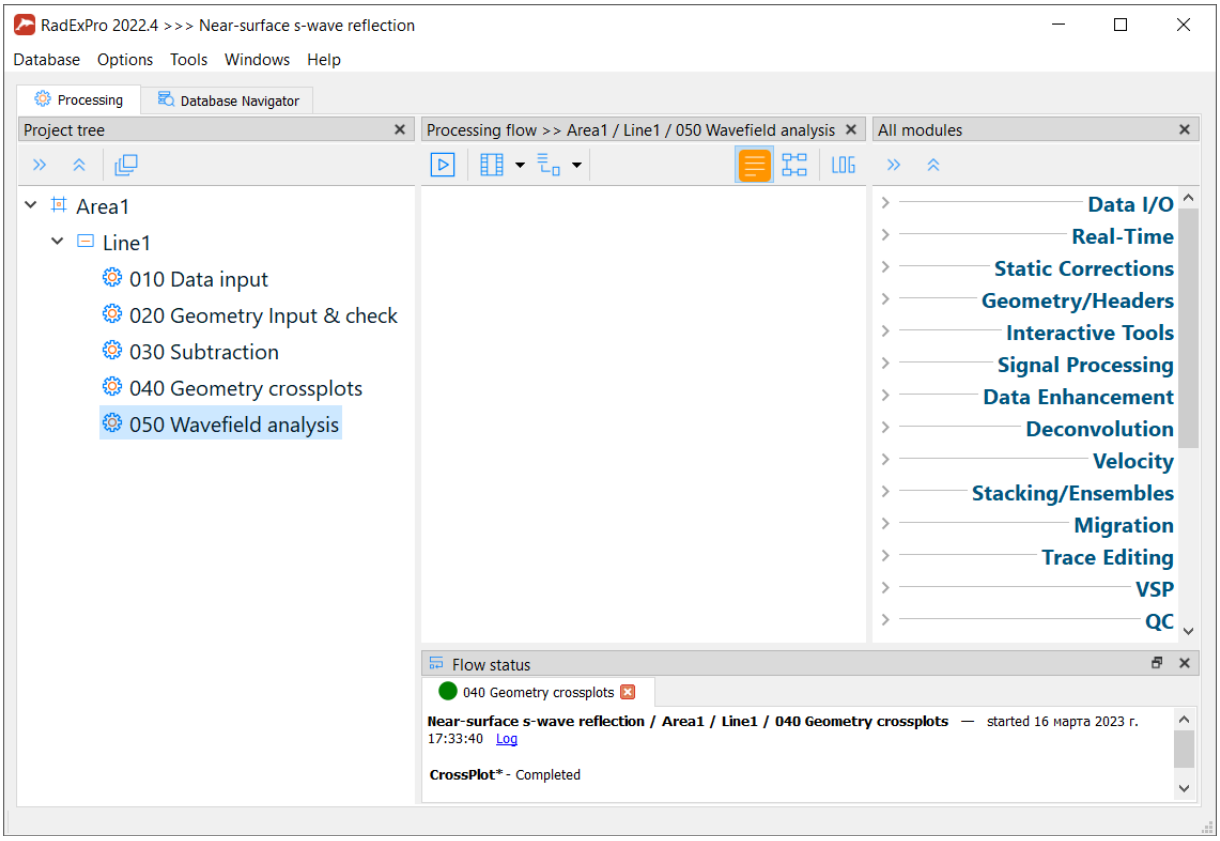
It is easy to see that the arrangement of CDP points also fully corresponds to the assigned geometry.

This crossplot also makes it possible to estimate CDP fold (number of blue points vertically) - it is changing from 1 to 23 and corresponds to the design fold.

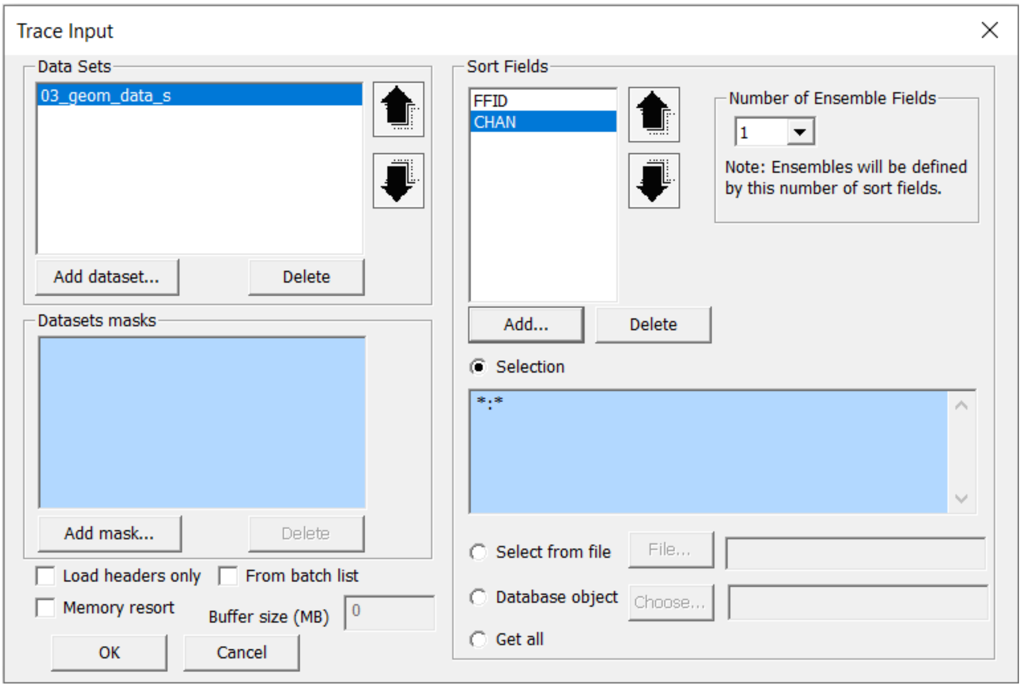
Data analysis and preprocessing

Wave pattern analysis

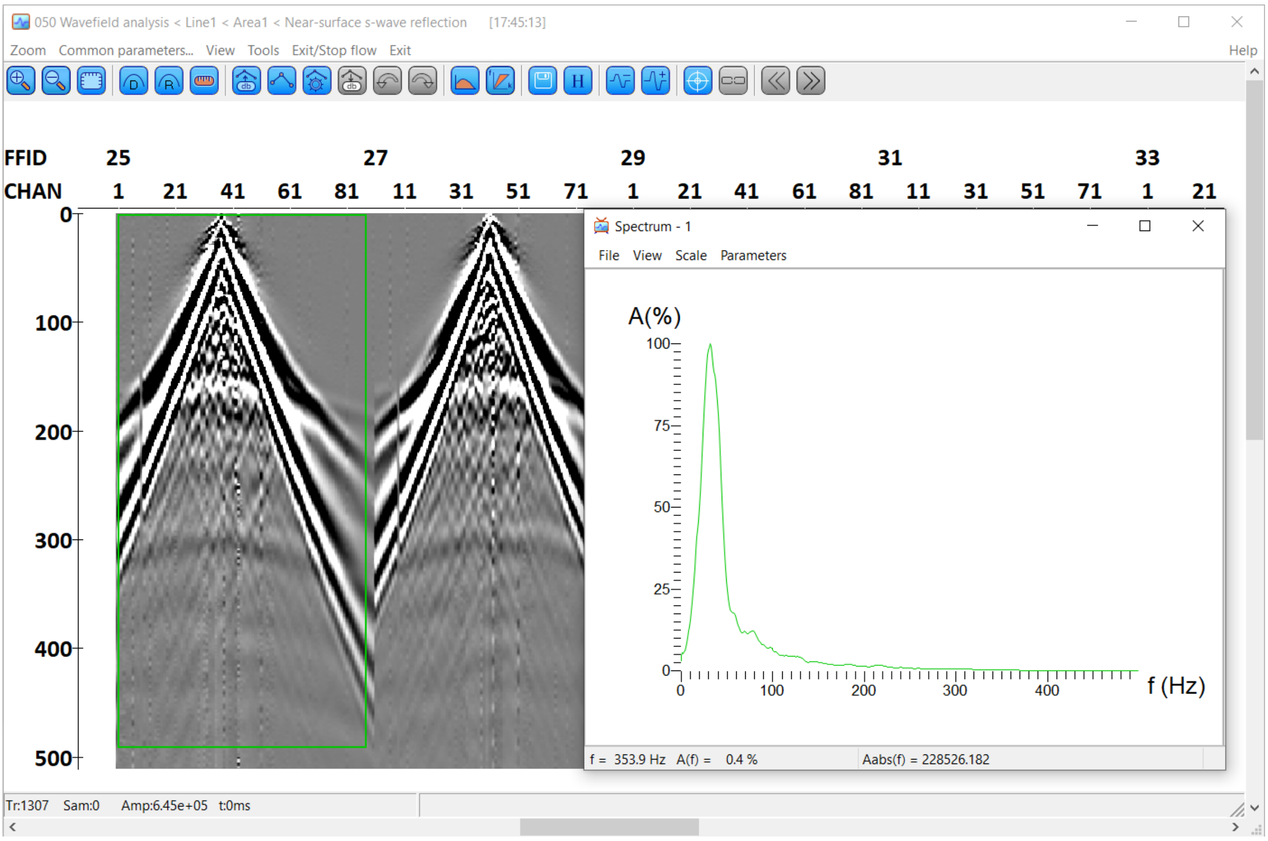
To correctly process the input data it is necessary first to find out where the desired reflected waves are. For that, let us create a separate flow "*050 Wavefield analysis*" where we will study the wave pattern.



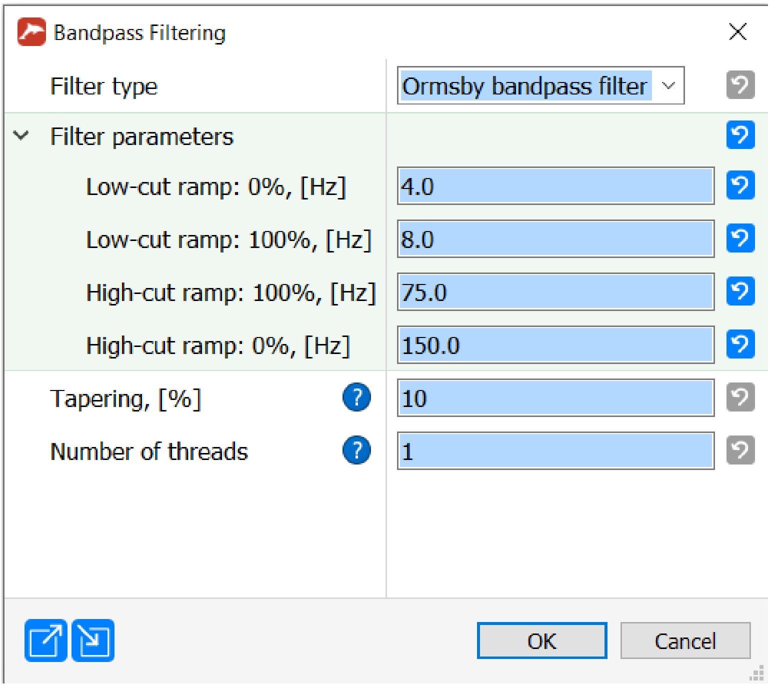
First, load the data using Trace Input module. Choose common shot point sorting (FFID:CHAN) to identify all types of waves.



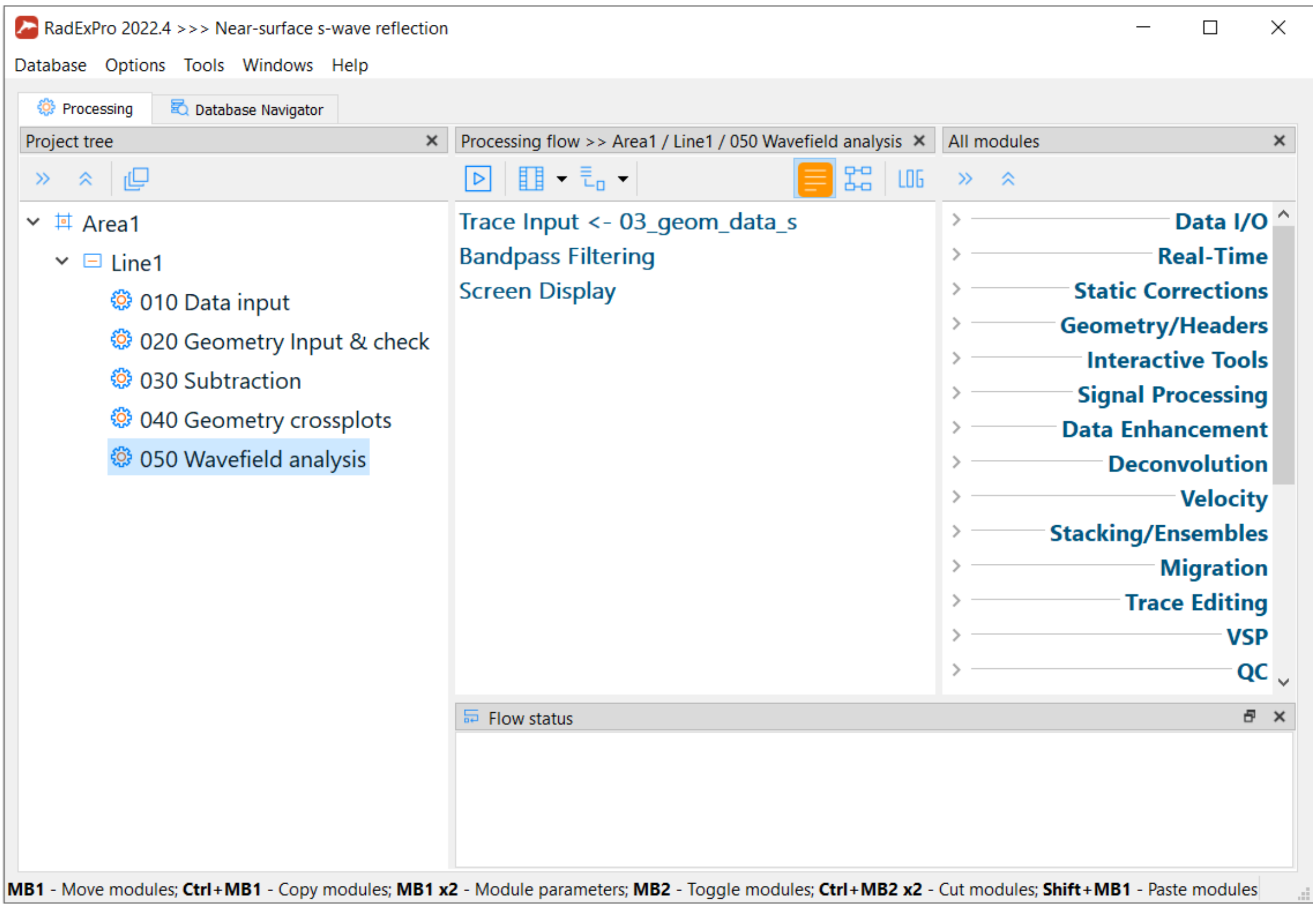
Further, add Screen Display module into the flow to view the data and estimate the noise level. For that, let us compute the amplitude spectrum of a shot gather.



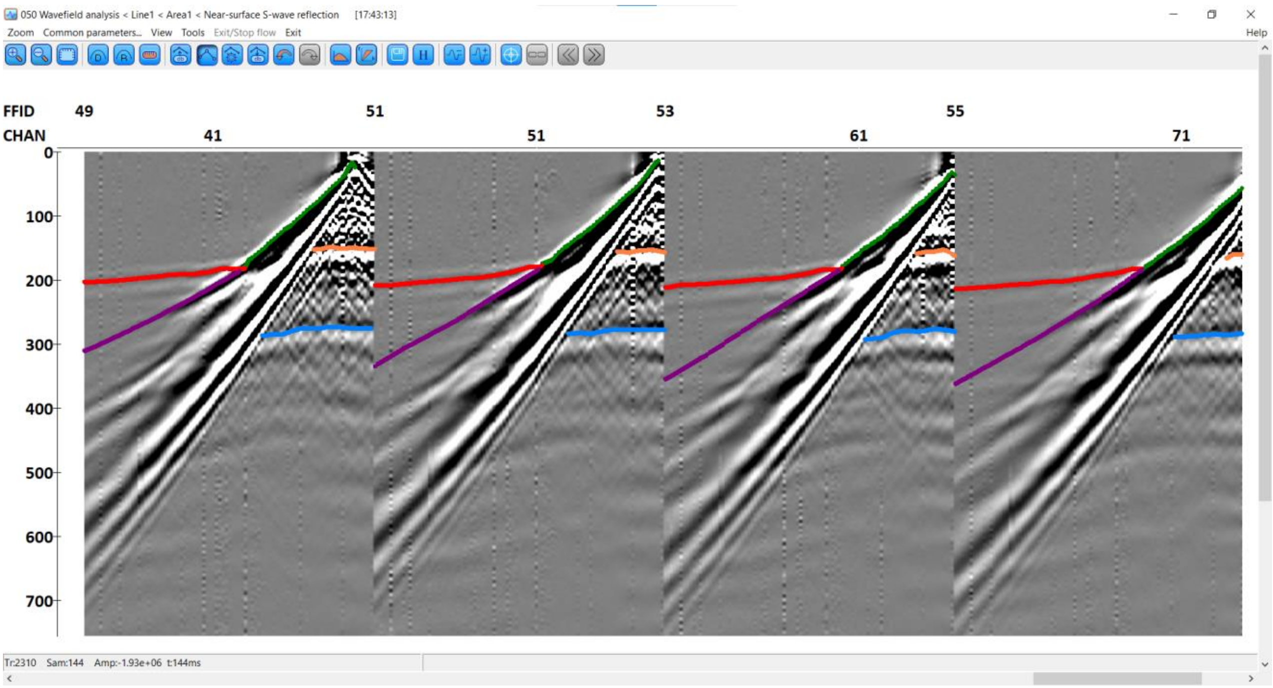
To emphasize to useful signal, let us filter out noise out using Bandpass Filter module. Choose parameters according to the amplitude spectrum display.



The flow will look like this:



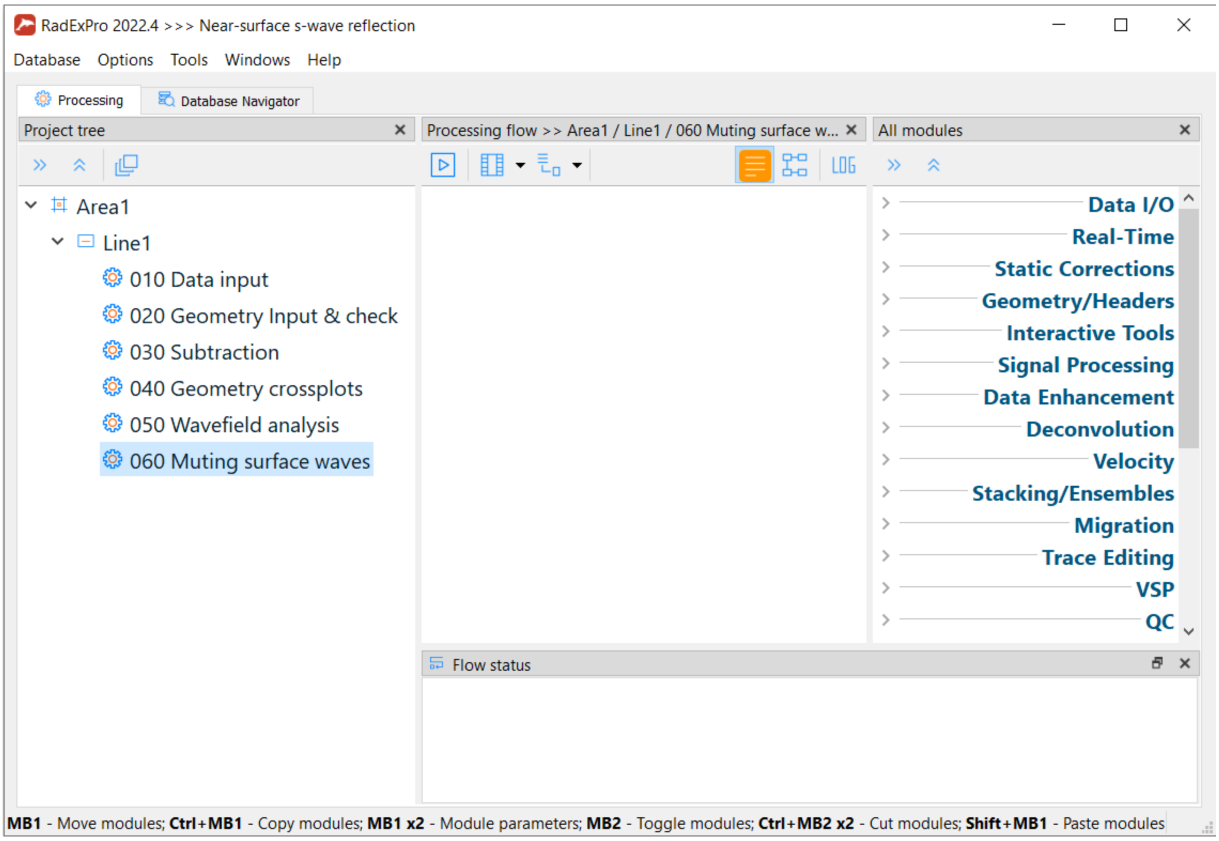
Looking at the shot gathers, we can discriminate the following types of waves: direct (green line), reflected (orange line), multiple (blue line), refracted (red line), reflected (distal part of hyperbole) (violet line). The surface wave area (the ground roll) is located below the reflected waves. For further processing it is necessary to suppress direct, refracted and surface waves. This can be done with the use of muting.



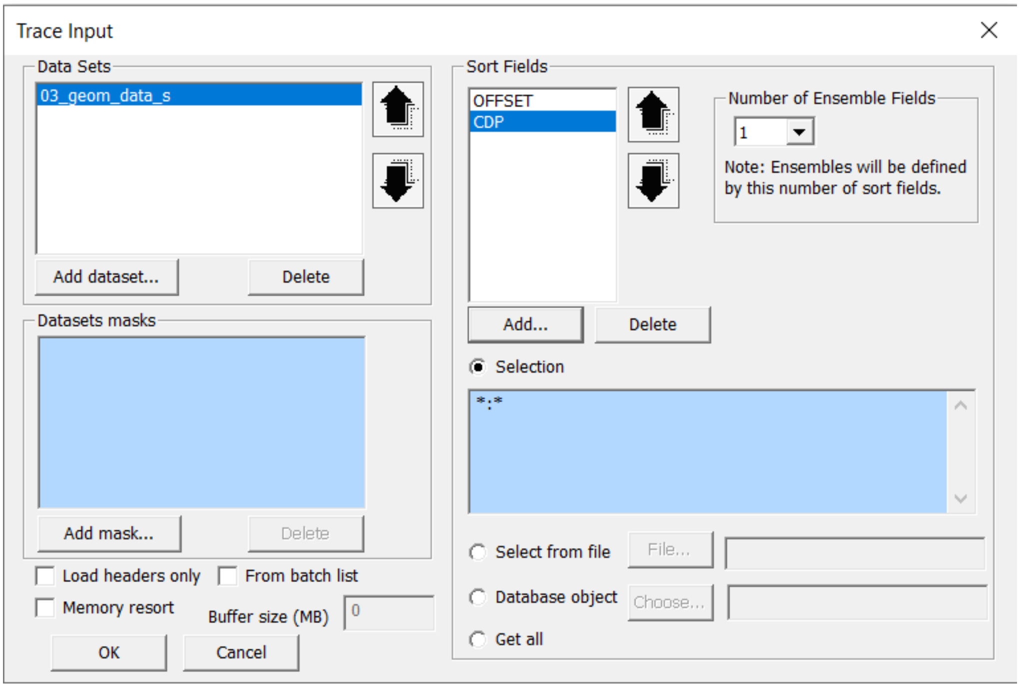
Muting

In order to be able to execute velocity analysis, apply NMO-corrections and stack the data, it is necessary first to suppress noise waves on the seismograms. The easiest procedure that can be used for that purpose is muting.

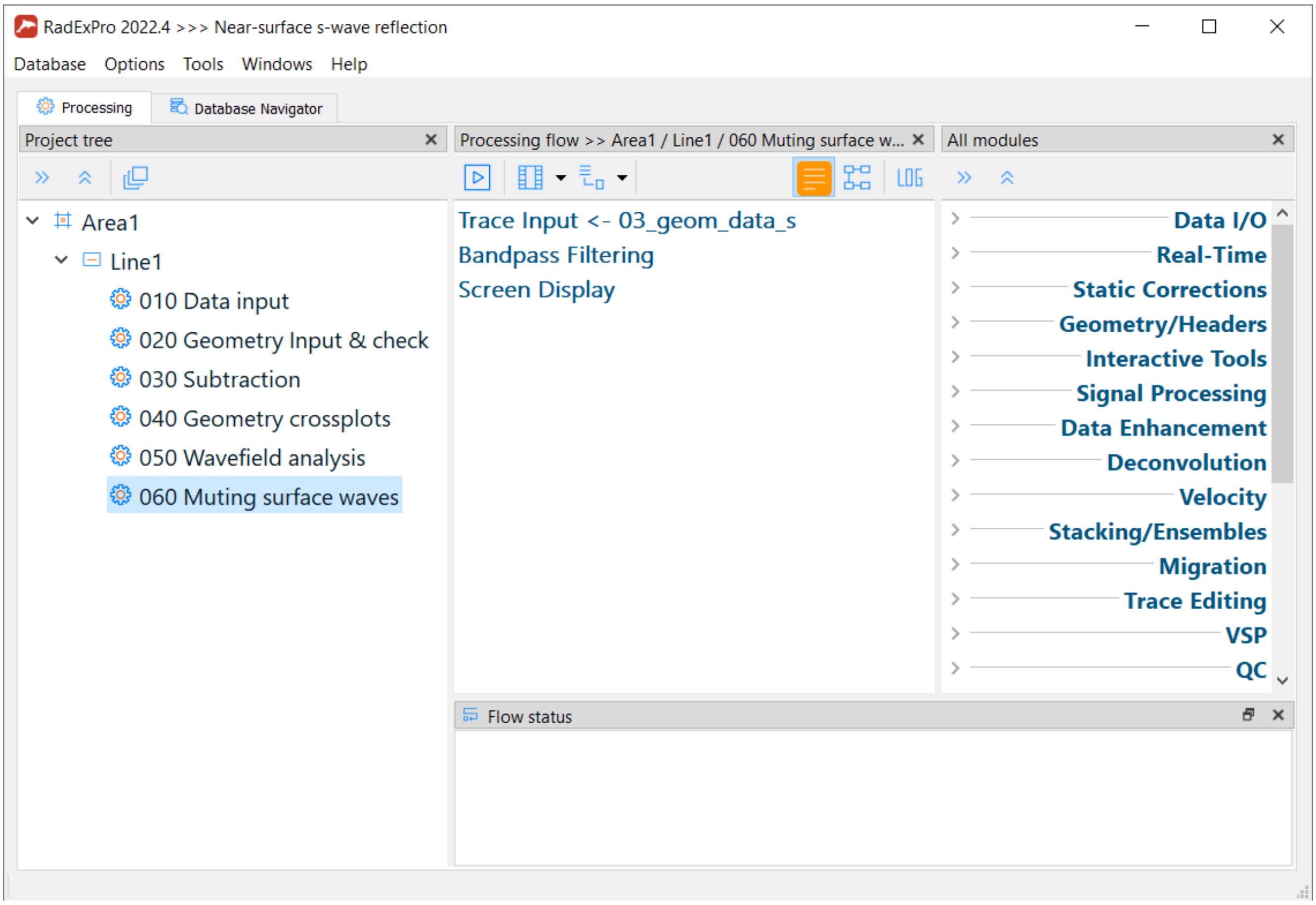
Let us create a flow where we will mute out those parts of the seismic gathers where noise waves dominate over the useful reflected waves. Let us name the flow "*060 Muting surface waves*".



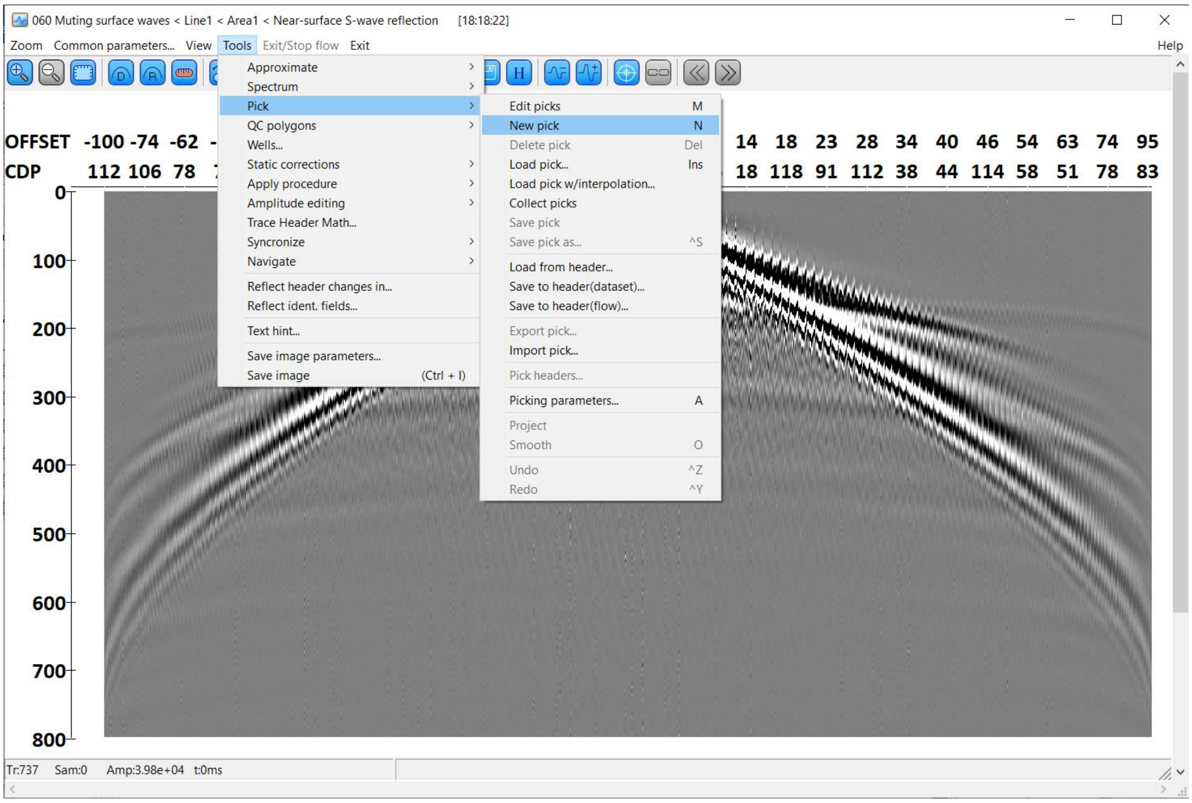
At the first stage load the data using Trace Input module with OFFSET:CDP sorting. As a result, we will get a common offset gather, on which it is convenient to pick horizons for muting.



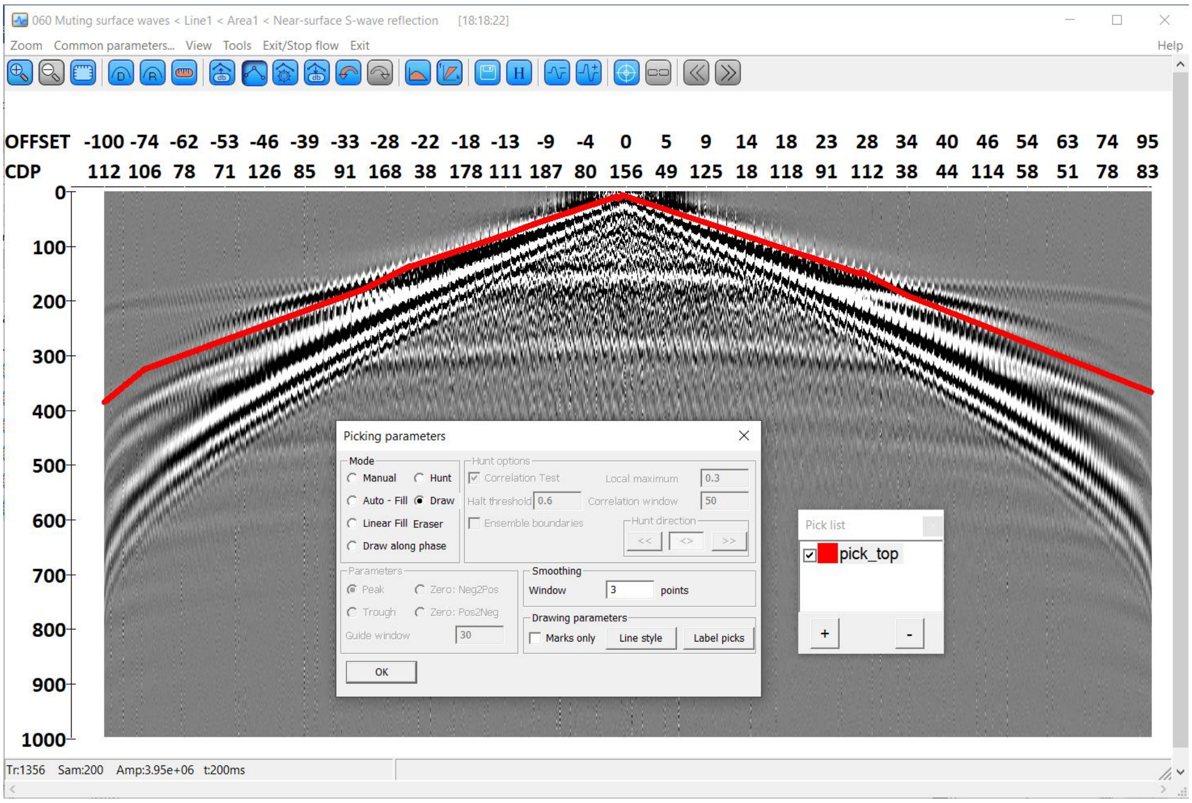
The flow will look like this (let us use the same parameters of Bandpass Filtering as at the previous processing step):



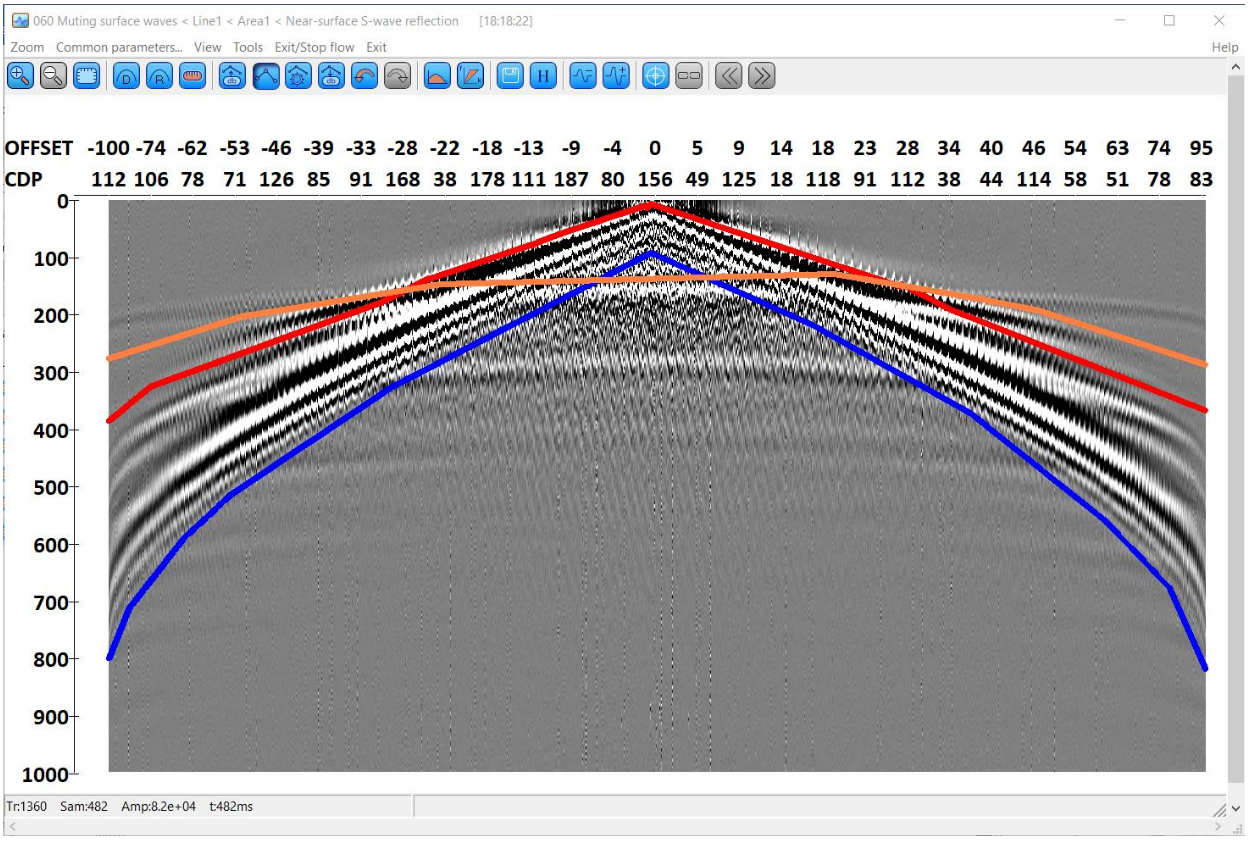
Click the Run button, and the common offset seismogram will be displayed in the Screen Display window. Let us create a new pick that we will use for muting. Select Tools/Pick/New Pick entry of the main menu and set a new pick's name.



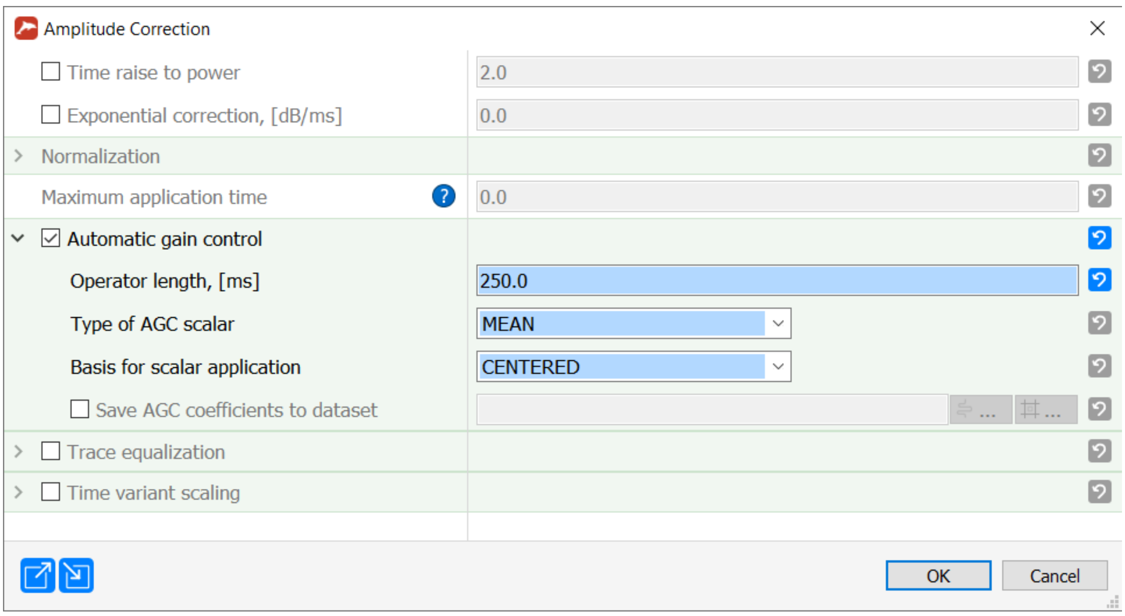
Choose picking mode "Draw" in the section of picking parameters.



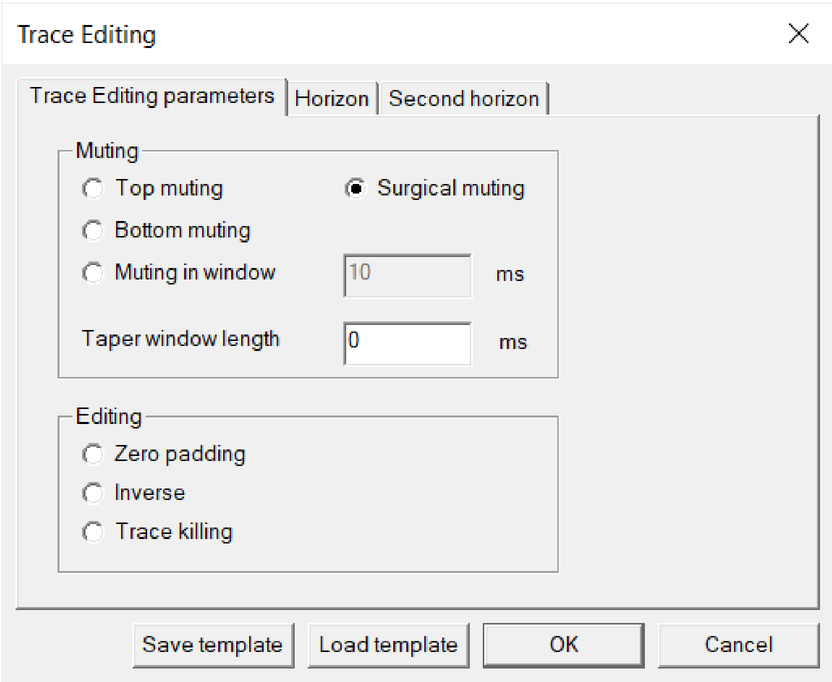
To mute the ground roll out, it is necessary to draw 2 boundaries, above and below the ground roll region (red and blue picks in the figure). In addition, we need one more boundary to remove the direct and refracted waves (orange pick in the figure).



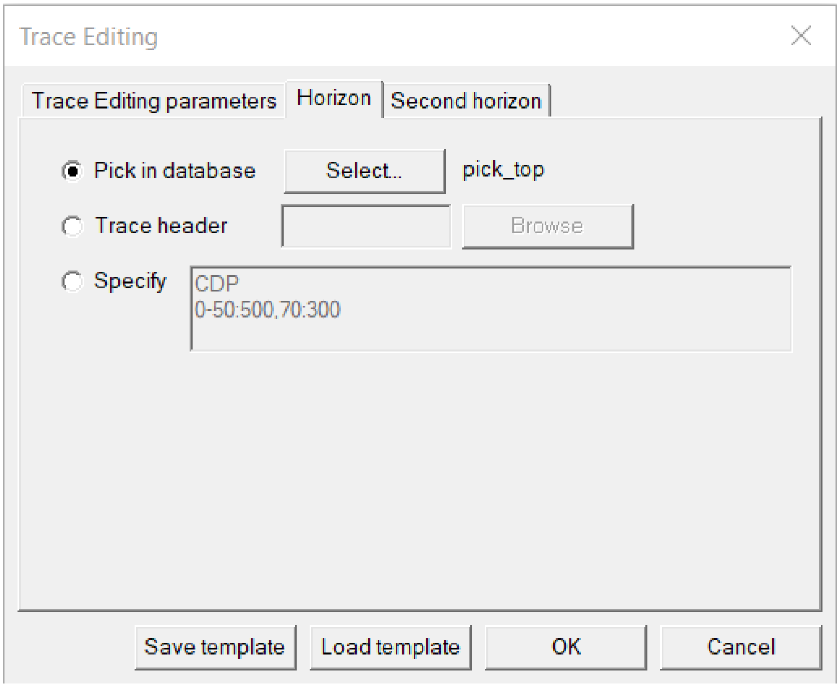
Before execution of muting, let us apply the automatic gain control -- this will help us to discriminate the useful reflected waves when running the velocity analysis.



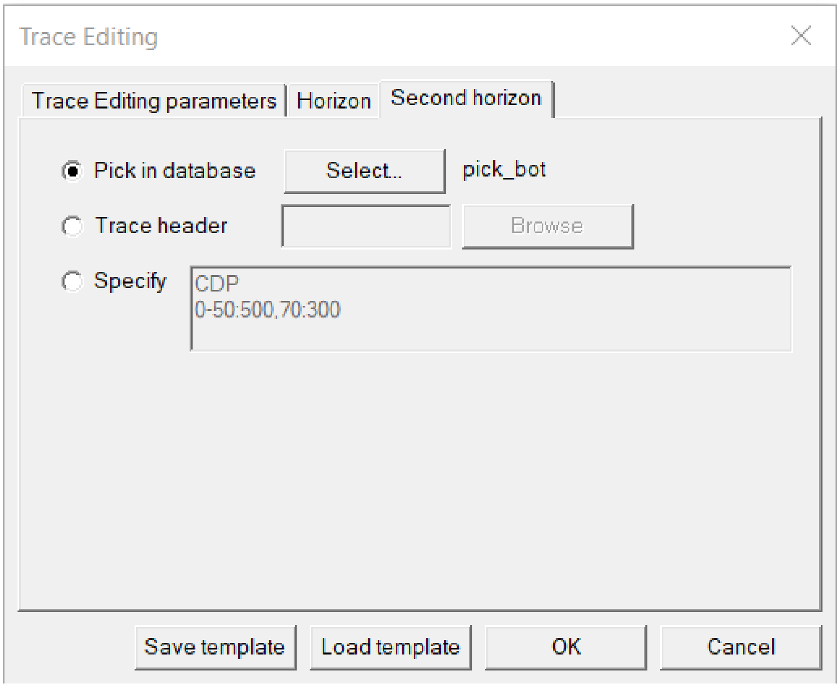
Now, let us add a module into the flow that will actually do the muting– the Trace Editing module. First, remove the ground roll using Surgical muting mode. This mode pads an interval of each trace between the two picks with zeroes.



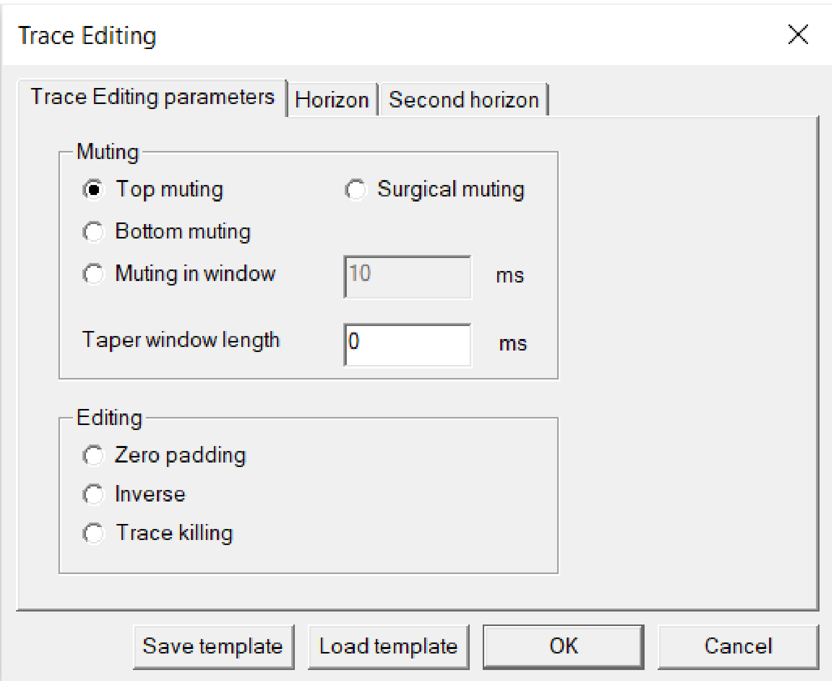
First, choose the upper pick on the Horizon tab.



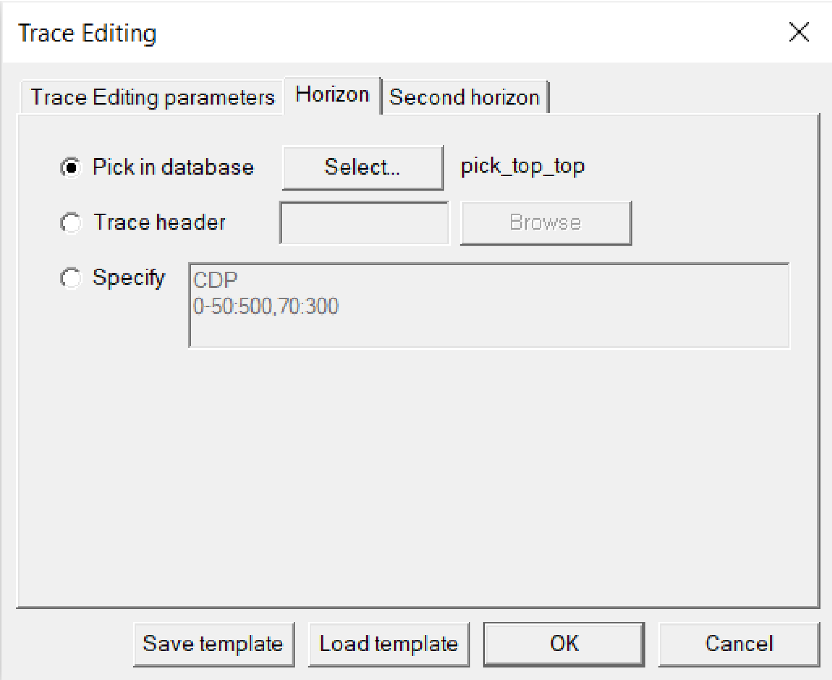
Then, choose the lower pick on the Second Horizon tab.



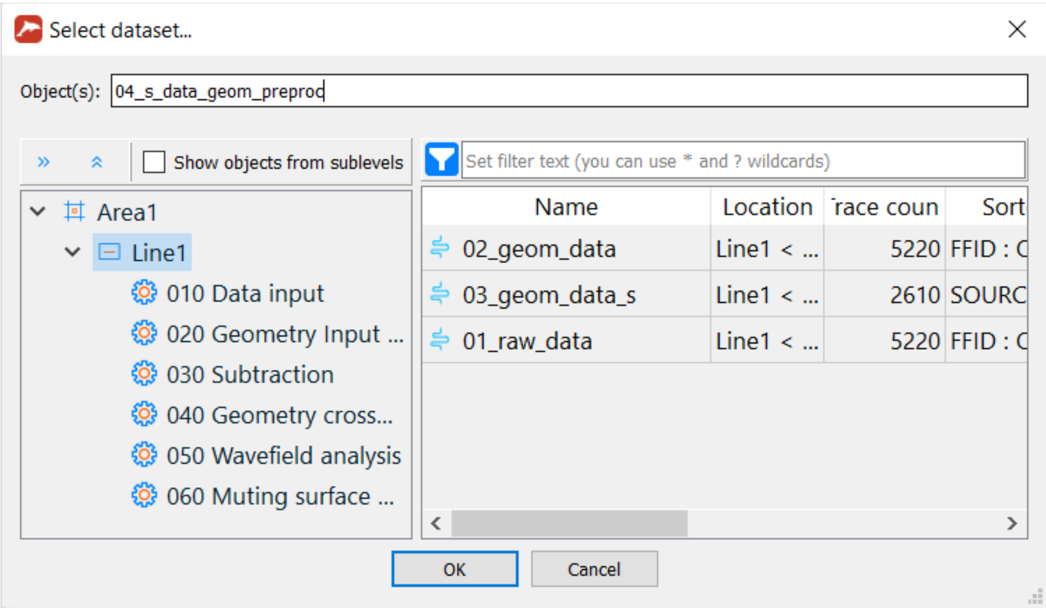
Add one more copy of the Trace Editing into the flow for muting of the refracted wave.



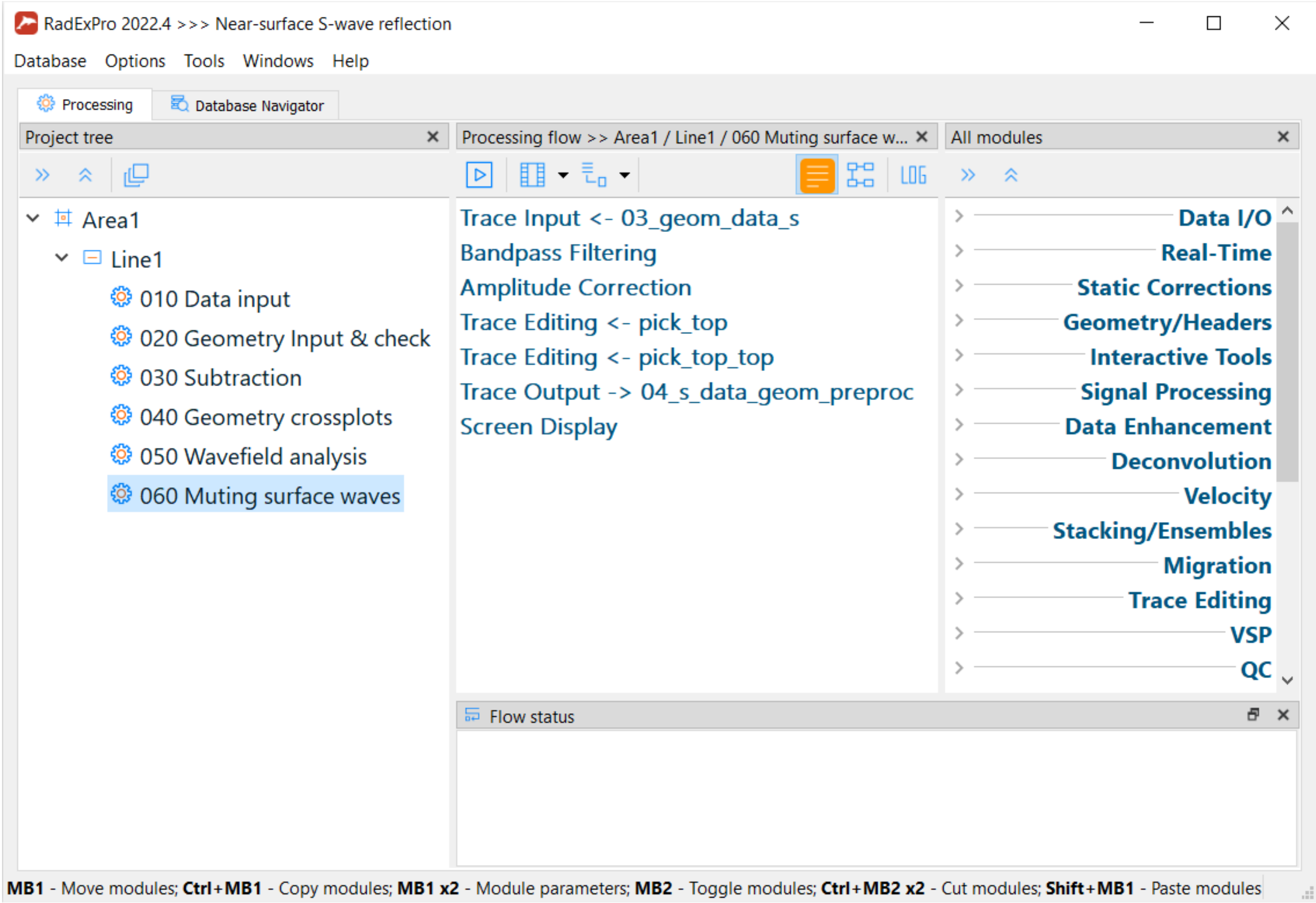
Choose the corresponding pick.



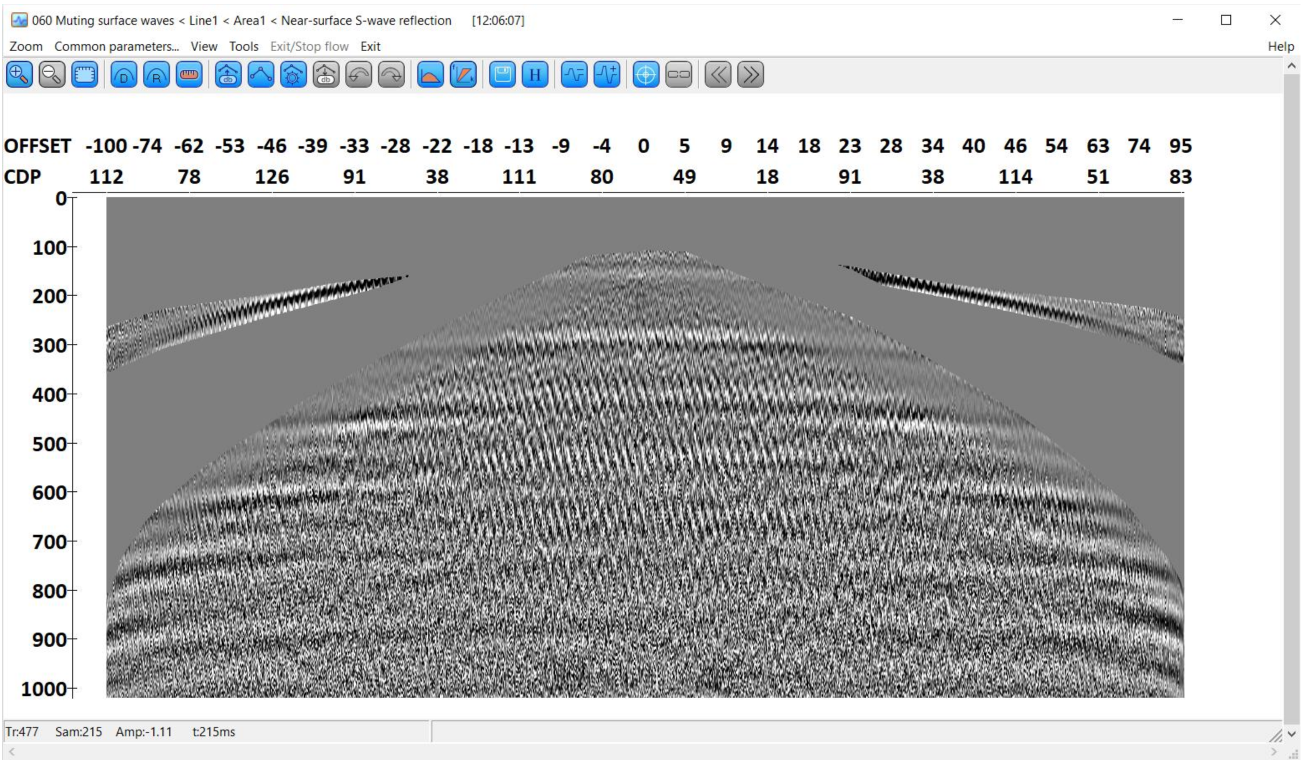
Add Trace Output module into the flow to save the data on the disk. Save the new dataset with the name "04_s_data_geom_preproc".



The flow will look like this:

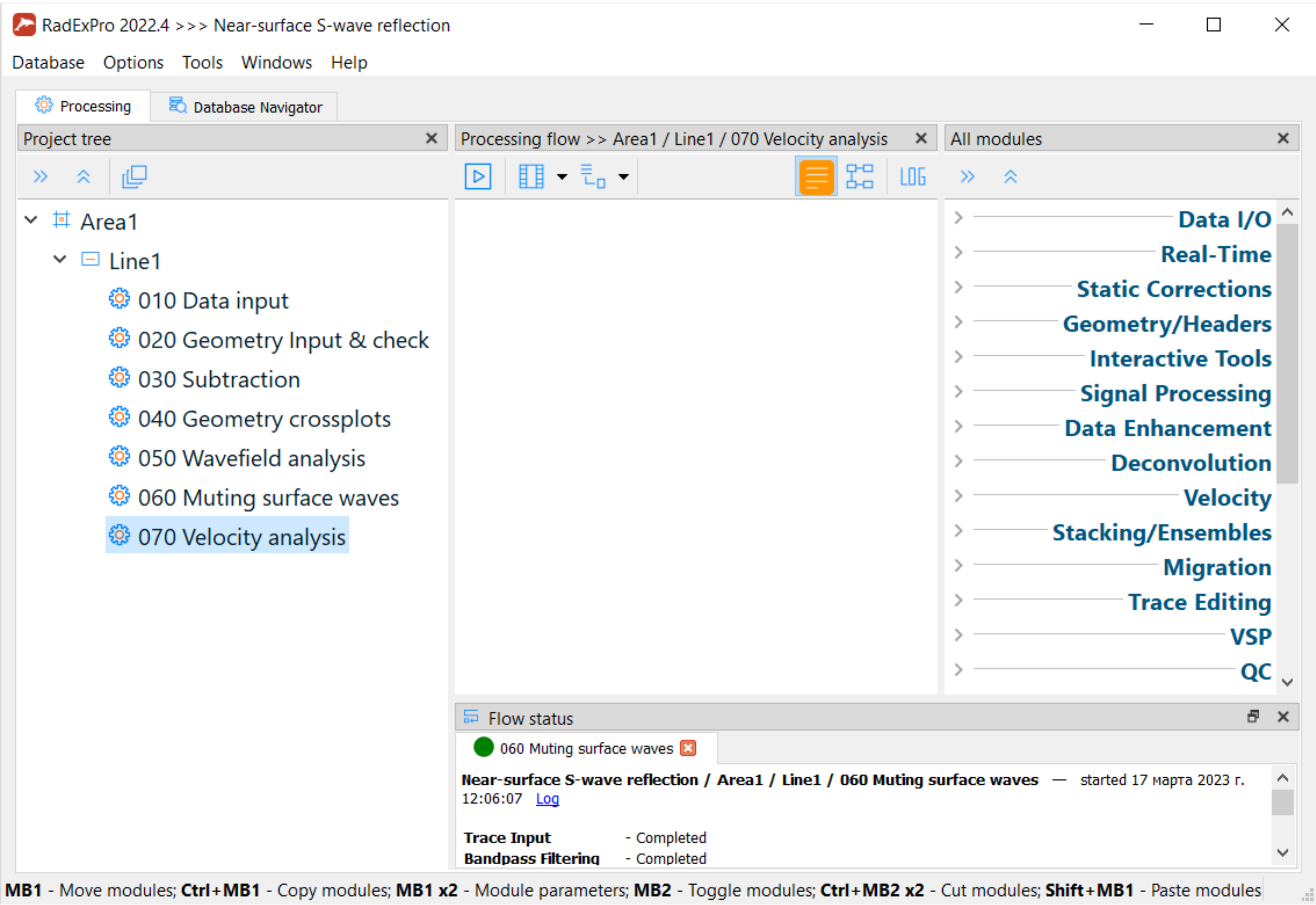


Click the Run button to start the flow. As a result, we will have a seismogram where the amplitudes of regions corresponding to the refracted/direct waves and the ground roll are set to zero.

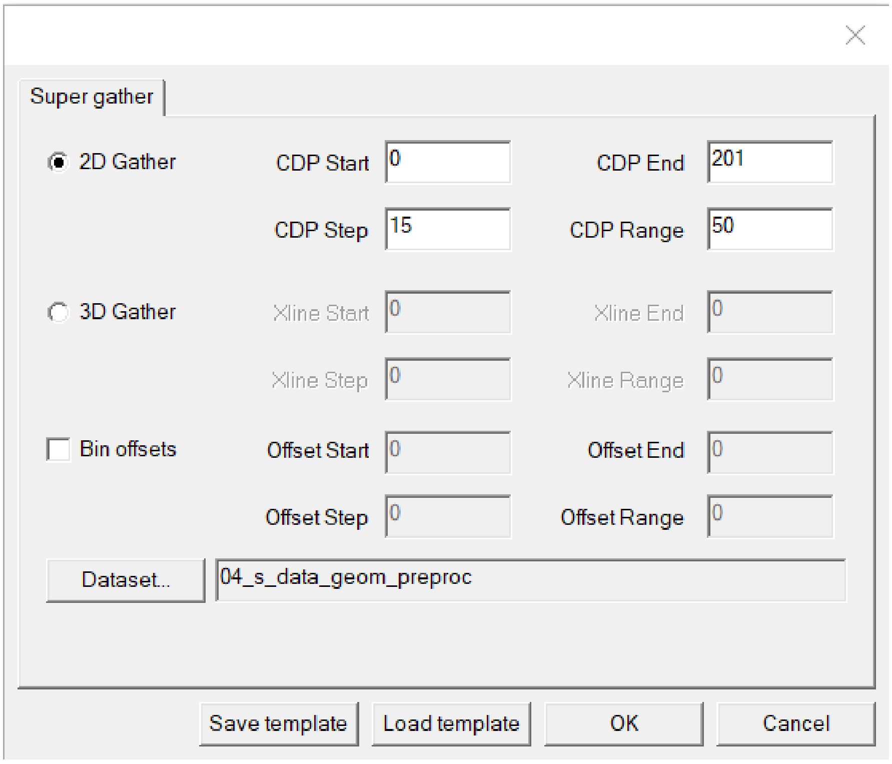


Velocity analysis

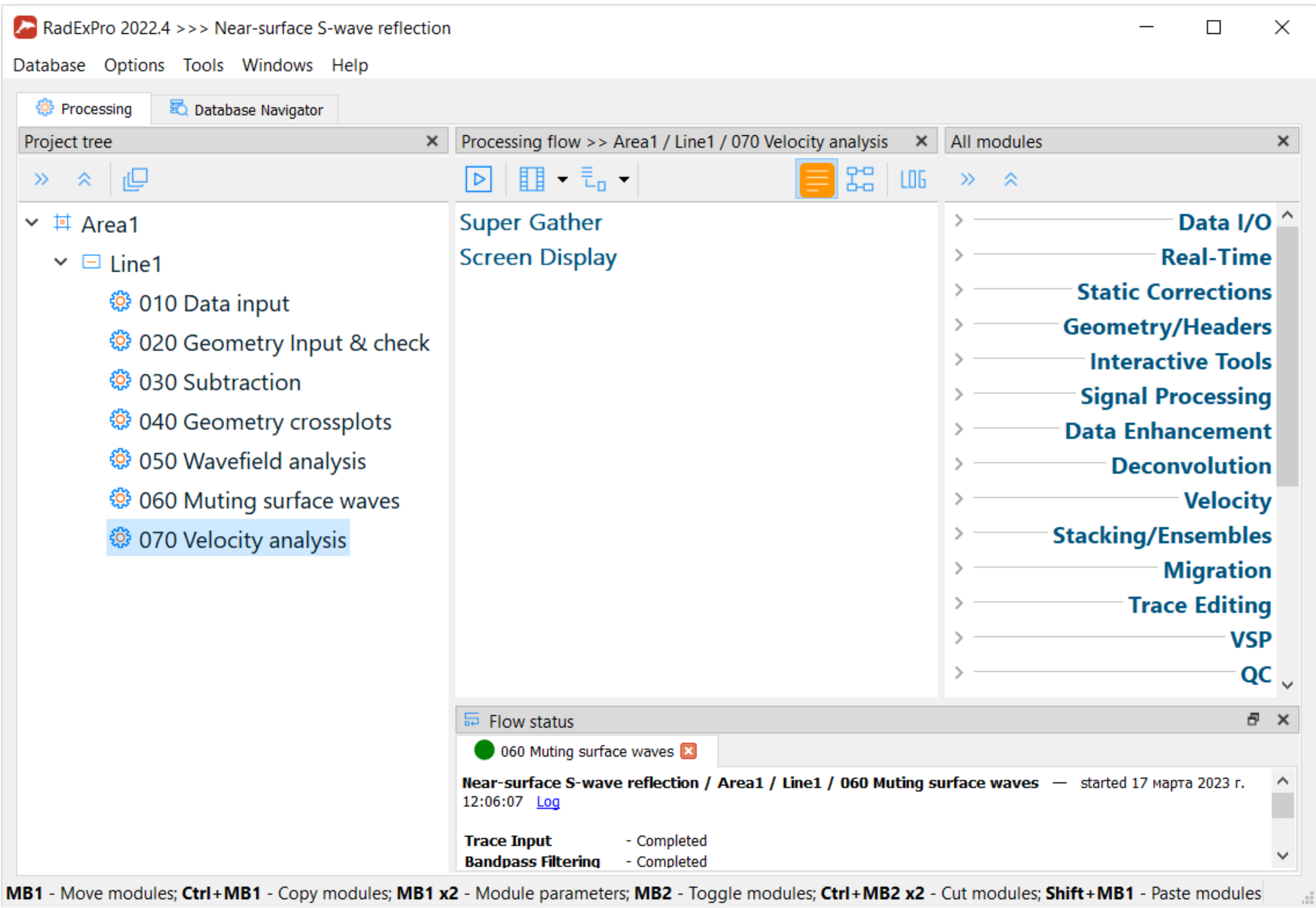
Before stacking the data to a time section, we would need to apply normal moveout (NMO) correction that is velocity dependent. Therefore, at the next stage, it is necessary to run the vertical velocity analysis. Let us create a new flow "*070 Velocity analysis*".



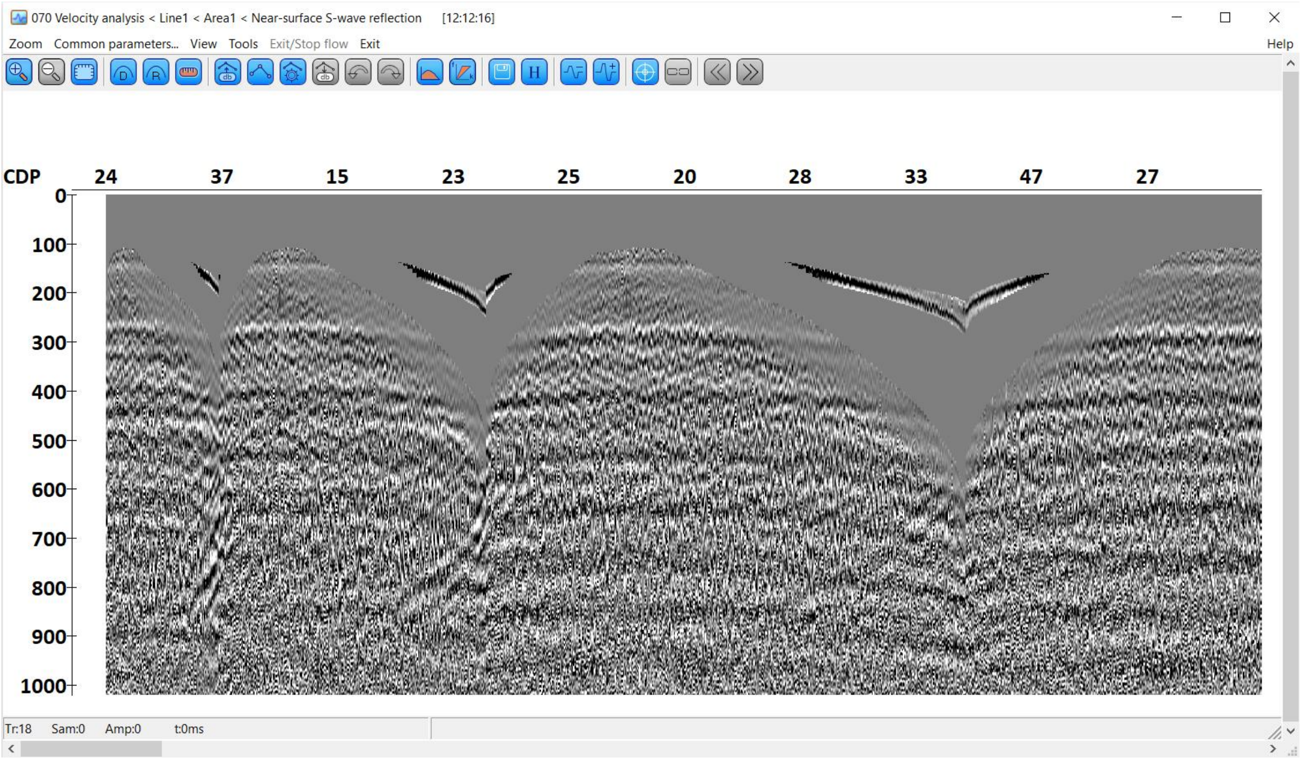
To increase signal-to-noise ratio and for more confident correlation of the reflected waves, let us prepare *supergathers* – an integration of several adjacent CDP seismograms into one bigger gather. To do this, add Super Gather module into the flow. Set the following parameters - CDP starting point = 0, spacing of CDP points = 50, number of CDP points in supergather = 15.



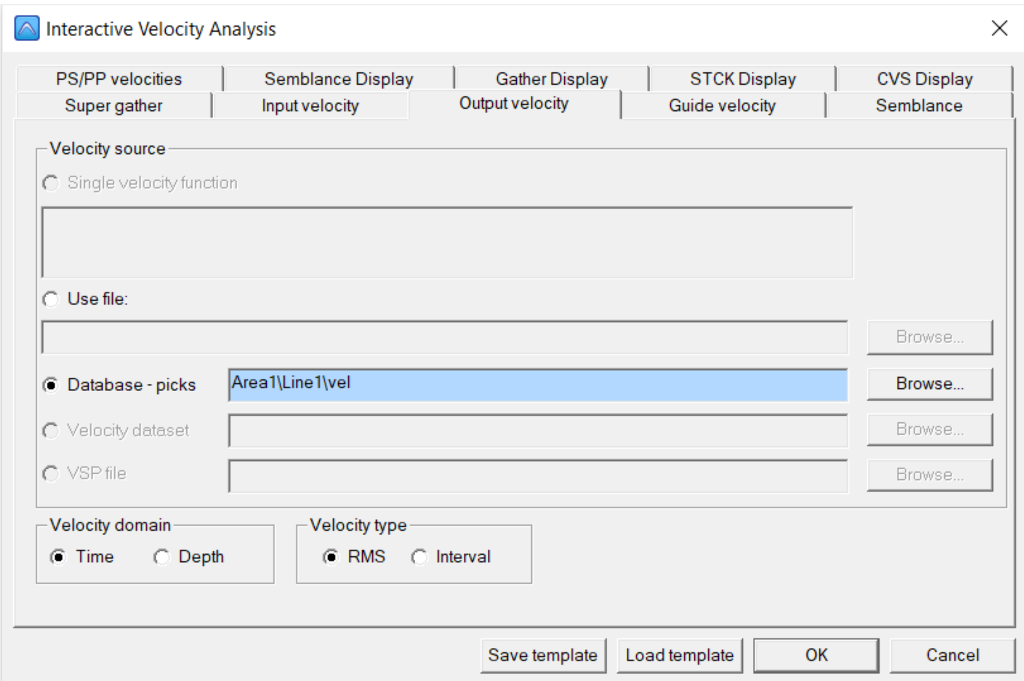
Let us view the data obtained after executing the Super Gather module with the Screen Display. The flow will look like this:



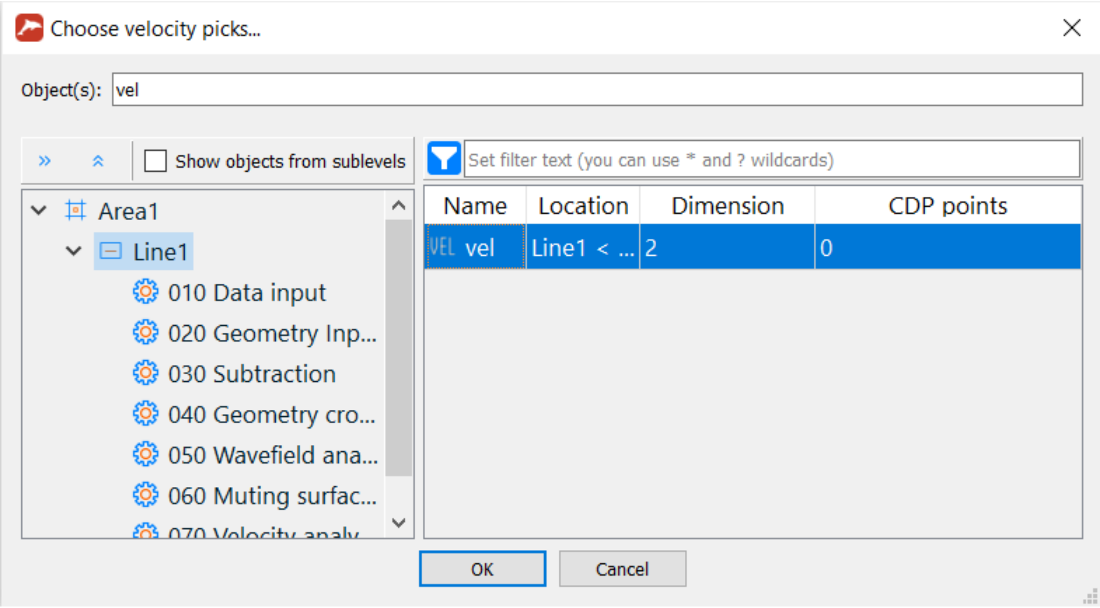
As a result, the supergathers with the specified parameters were obtained:

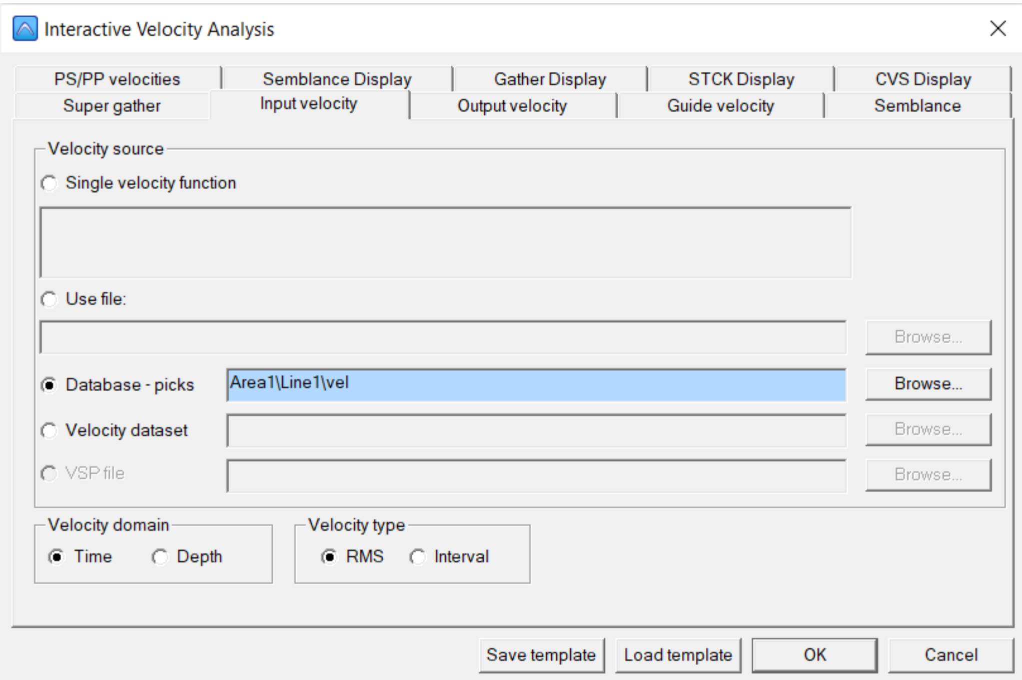


We will make velocity analysis using the Interactive Velocity Analysis module. First, let us create a database object in the Output tab of the module parameters dialog for saving the resulting velocity table (velocity pick).

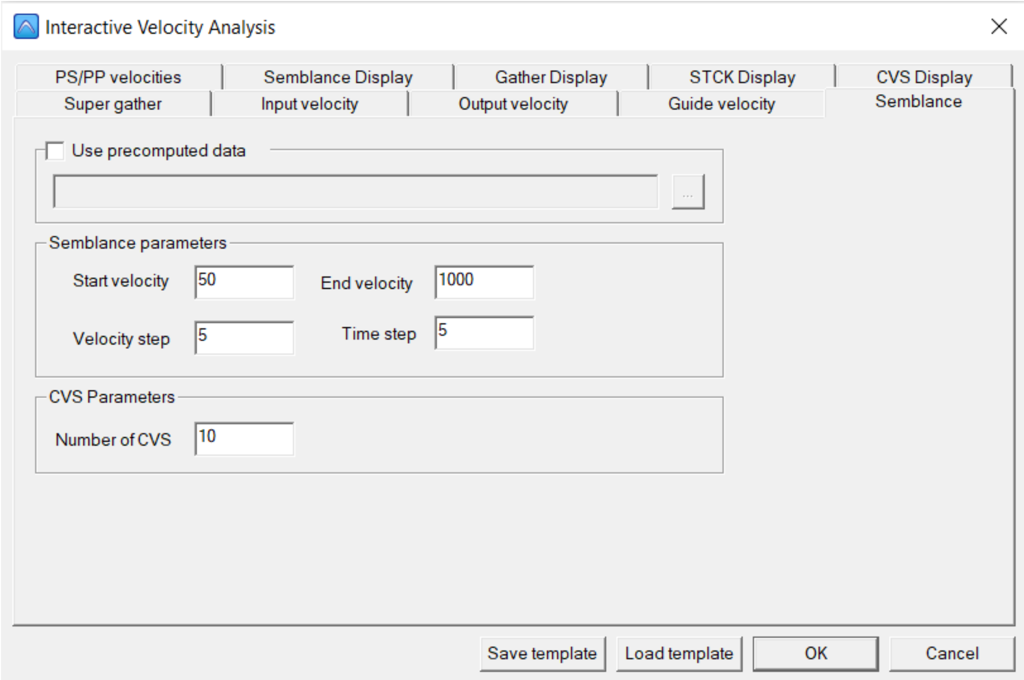


Also, let us choose the just created (though empty, so far) velocity pick in the Input velocity tab.

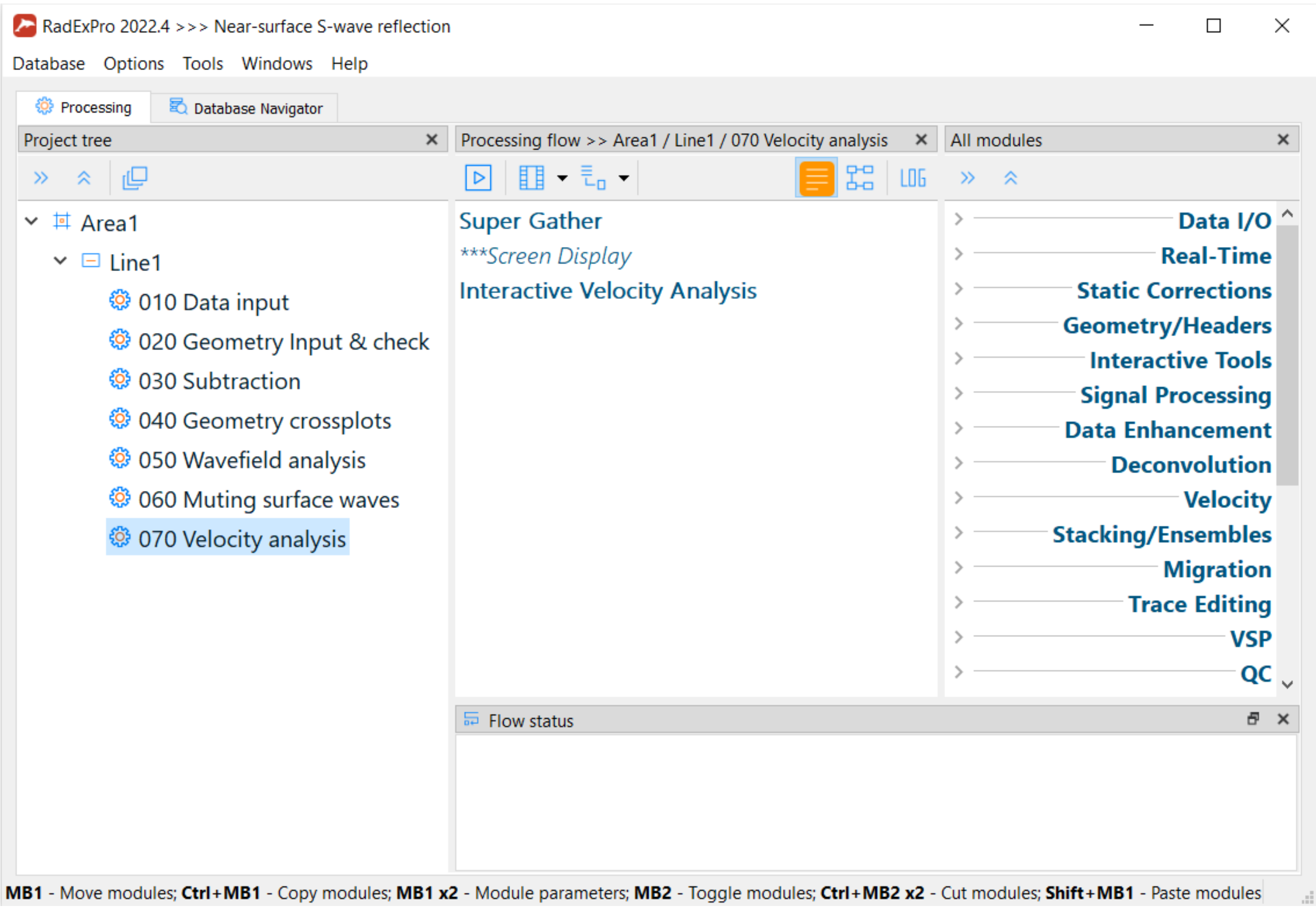




We will set the velocities semblance computation parameters in the Semblance tab.



The obtained flow will look like this:



When we run the flow with the Interactive Velocity Analysis module, a window, similar to the one shown in the picture below, will open. The window is divided into 5 parts (left to right):

- Vertical scale of the two-way travel time (ms);

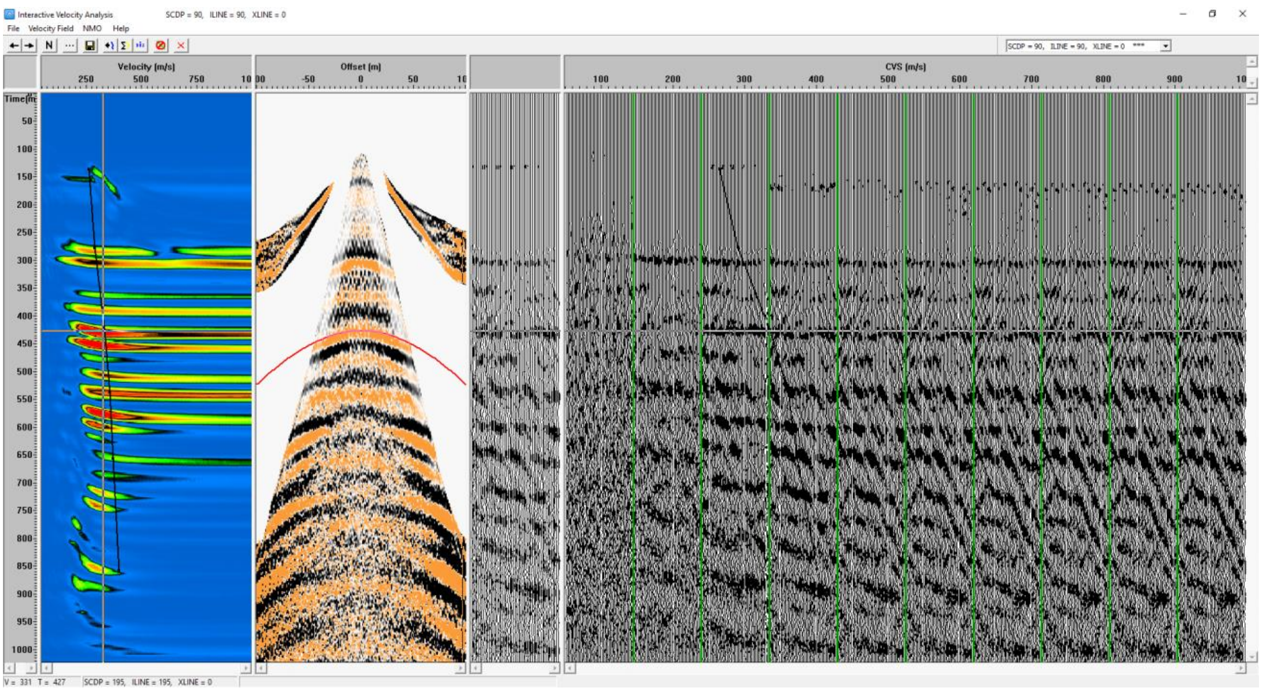
- Velocity - the semblance panel;
- Offset - the supergather panel;
- A fragment of the resulting stack – a panel with the staked traces obtained with the use of the current velocity function picked at the semblance;
- CVS – a panel with constant velocity stacks.

Let us pick a velocity function on the semblance tab. Left-click (MB1) in the right position of the velocity spectrum to add a point. It is possible to move the added point through capturing and holding it by the right mouse button (MB2). The point, nearest to the cursor position, will shift.

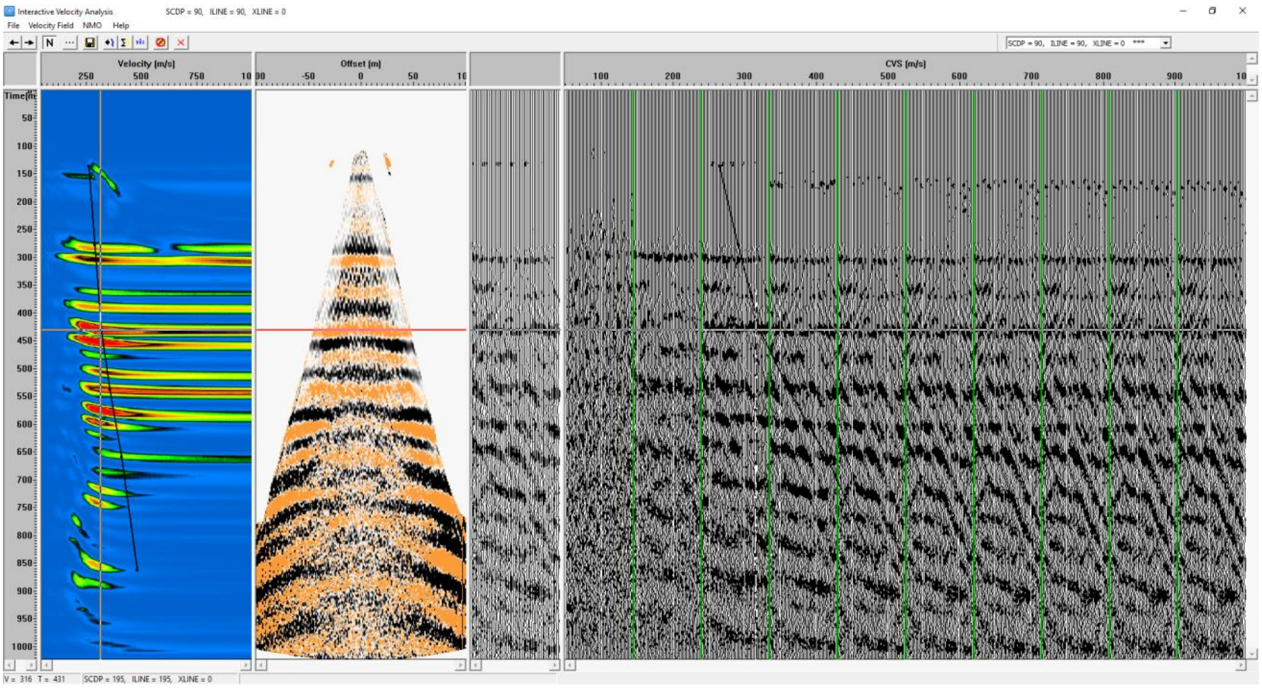
To delete a point, double right-click on it while holding Ctrl key (Ctrl+MB2 DblClick).

The first supergather may have insufficient fold, therefore we can start picking from the second or third one (where the semblance maximums have sharp boundaries).

We are picking maximums starting from the first one by time (from the top). While picking, pay attention to the maximums of the semblance, to the match of the theoretical reflection hyperbole at a given velocity to the observed reflected waves on the supergather, and, at the same time, to the fragment of the resulting stack.



To check how correctly we have picked the maximums, click the Apply NMO button on the toolbar. This will apply NMO-correction to the supergather, so that you can check how good the reflected hyperboles are flattened with the current velocity pick.

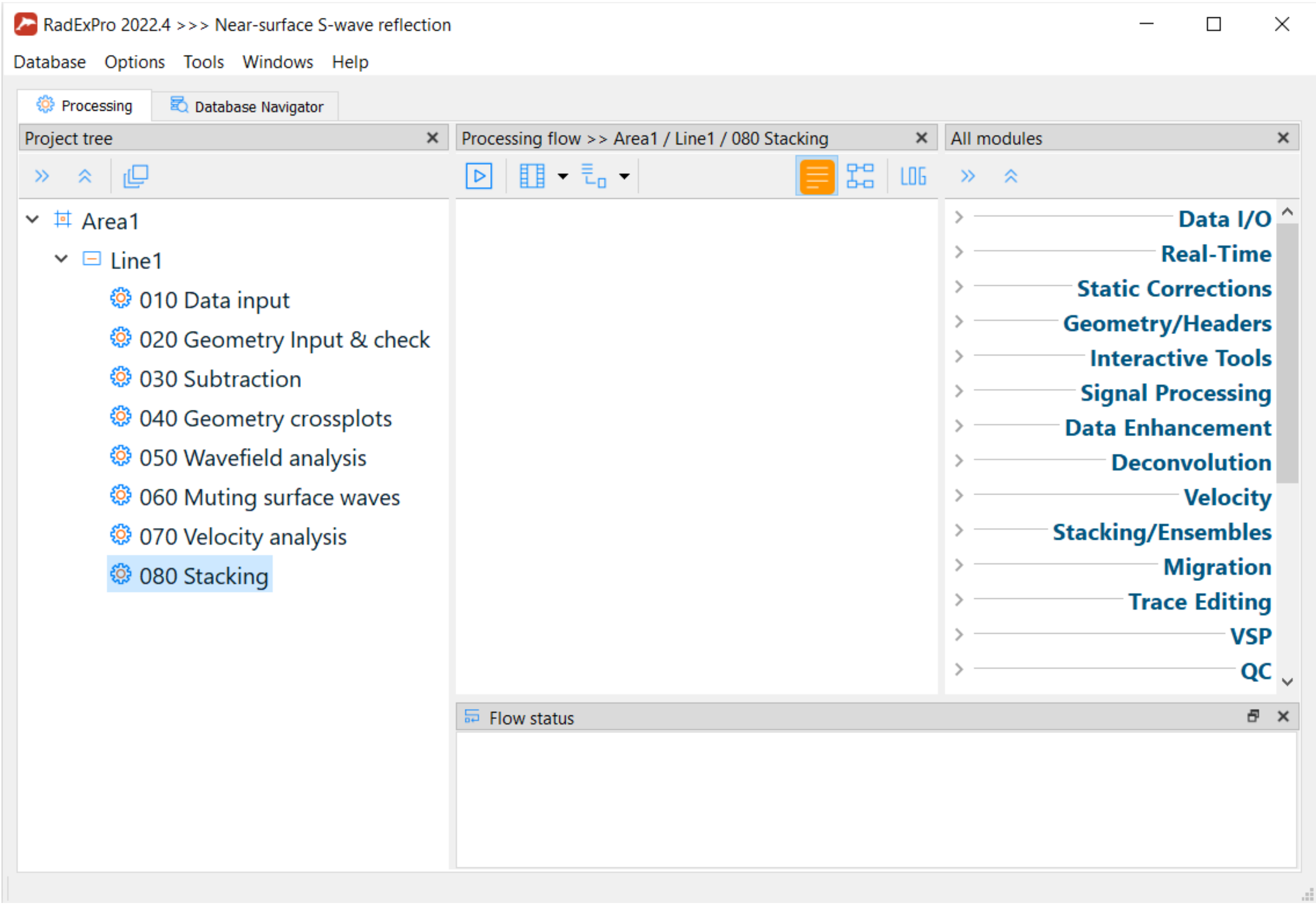


When picking velocities, it is important to observe several rules: in most cases, velocities should increase with the depth. Decrease of velocities is normally related to multiples. Sometime two lines of maximums can be observed – a higher (from primary reflections) and a lower (from multiple reflections). It is not worth picking the maximums related to multiple waves. Picking velocities for adjacent spectrums should not differ significantly (to check for that, choose Velocity Field/Show Previous menu item – it will display the previous pick together with the current one).

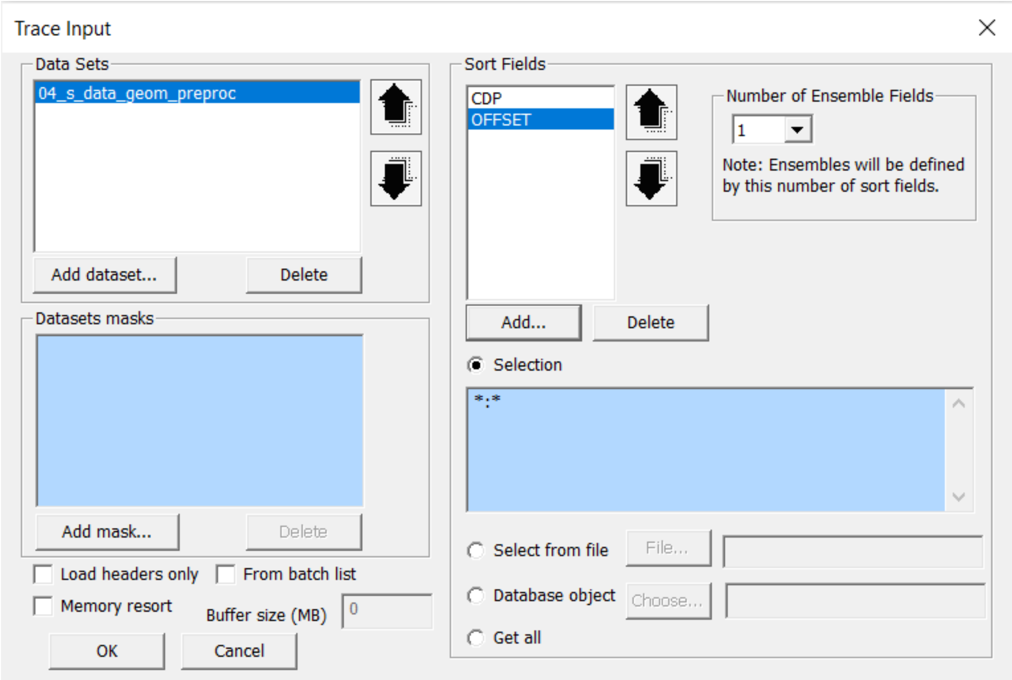
You can navigate through the supergathers using the arrow buttons at the left of the toolbar or the drop-down list at the right of it. When you are ready with the velocity picking, click the Save button to save the results of the work.

Processing, getting a seismic section

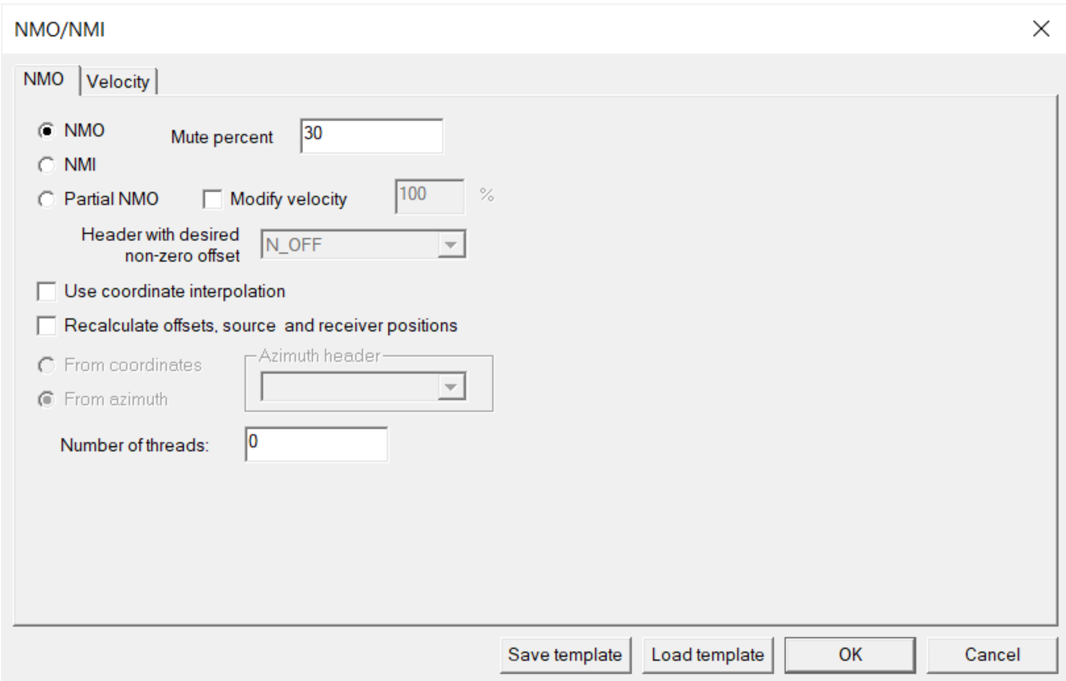
After the velocity analysis, we can move to stacking to make a seismic section. Let us create a new flow "*080 Stacking*" for that purpose.



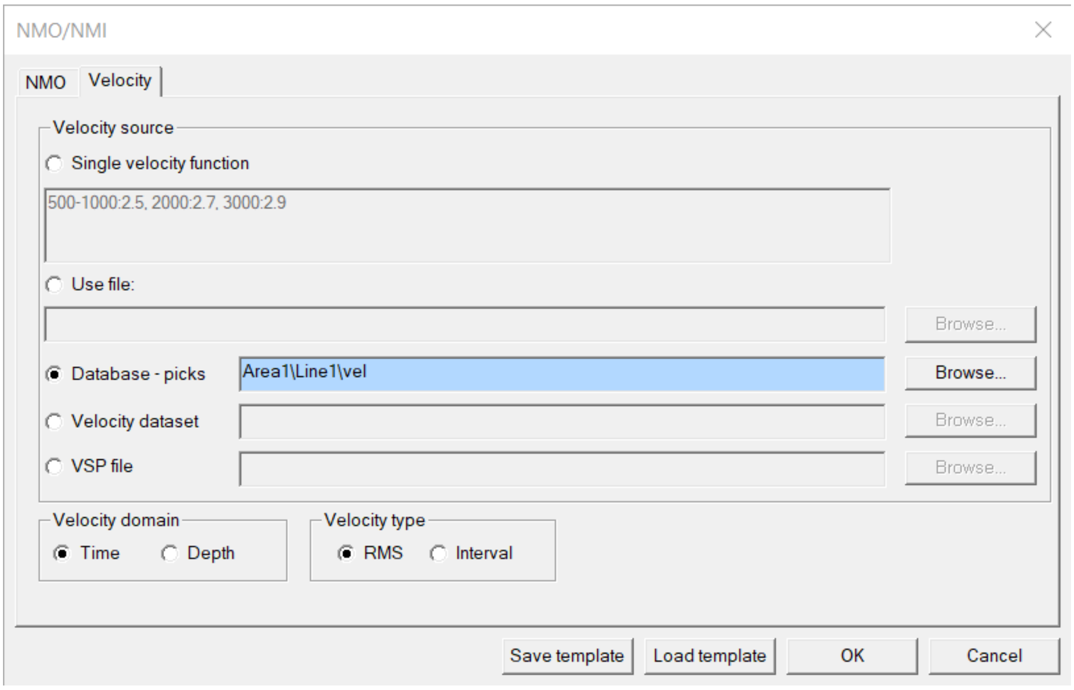
Use Trace Input to load the seismic dataset into the flow. We would need CDP gathers, so use CDP:OFFSET sorting keys.



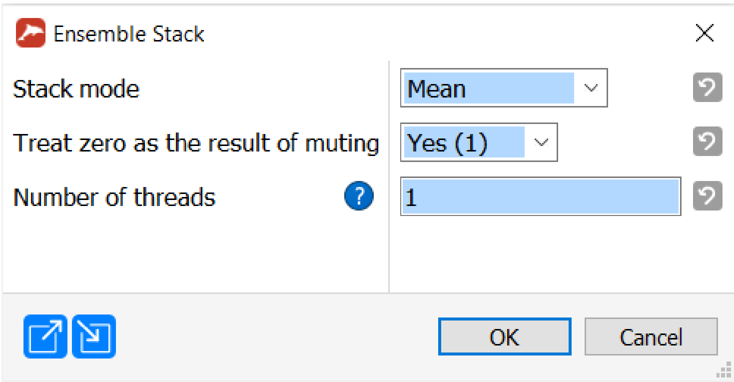
Apply NMO-correction using the NMO/NMI module:



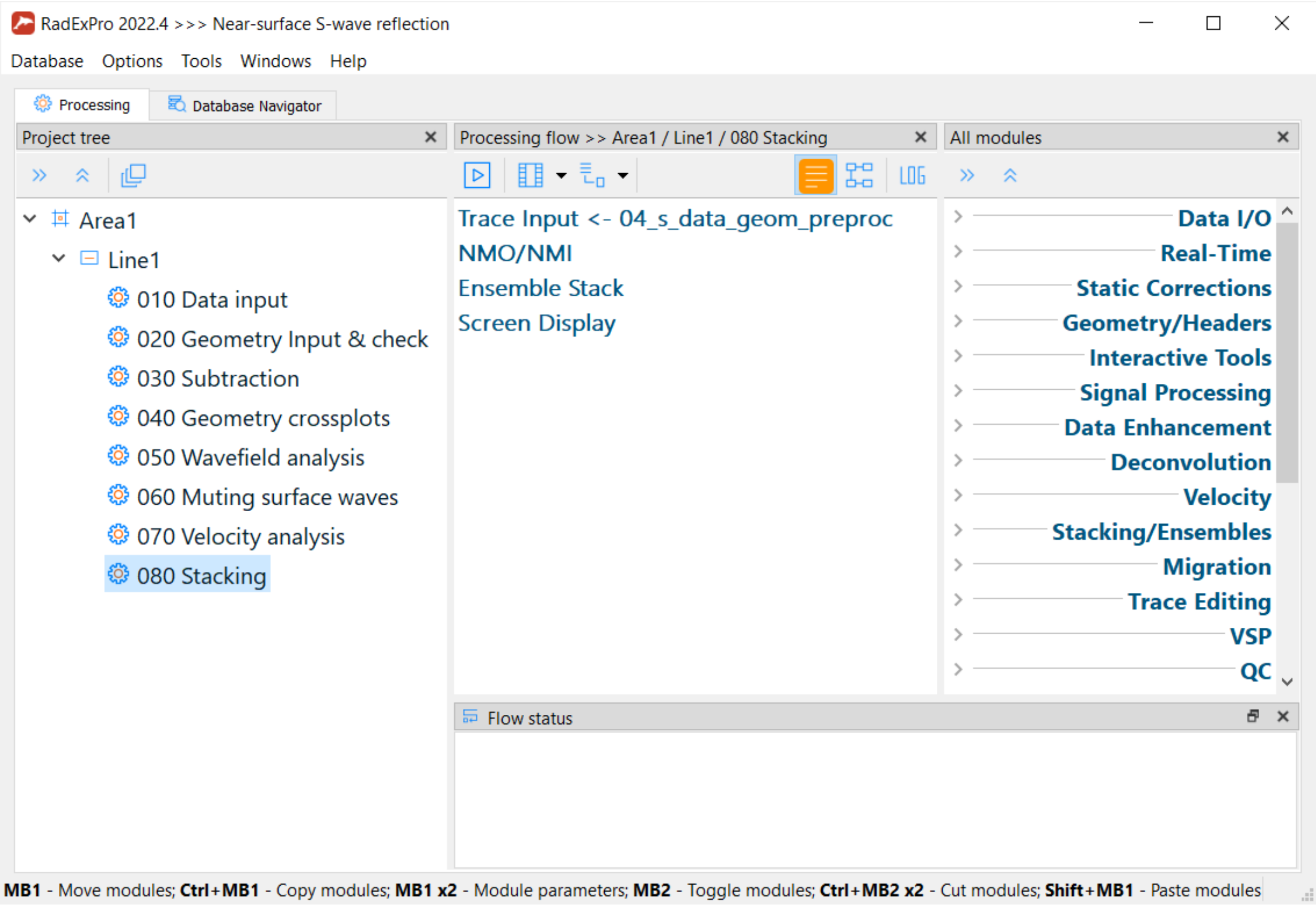
Choose the velocity pick obtained as a result of the velocity analysis.



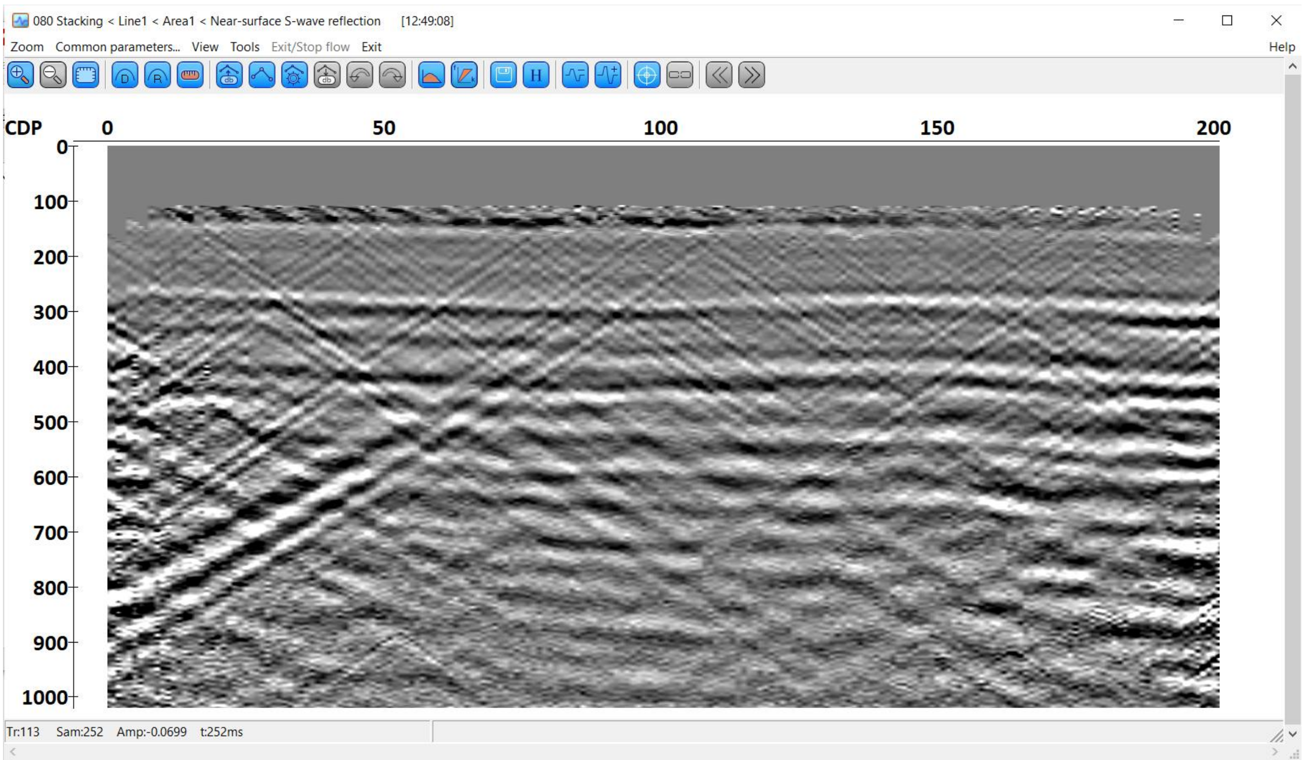
Add Ensemble Stack module to stack traces of each CDP gather into a one trace.



As a result, we have a basic flow for CDP stacking:

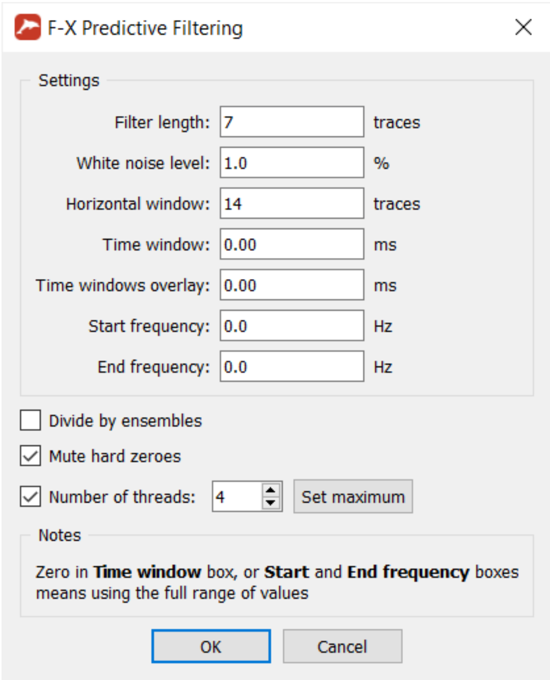


This is our initial stack – the time section:

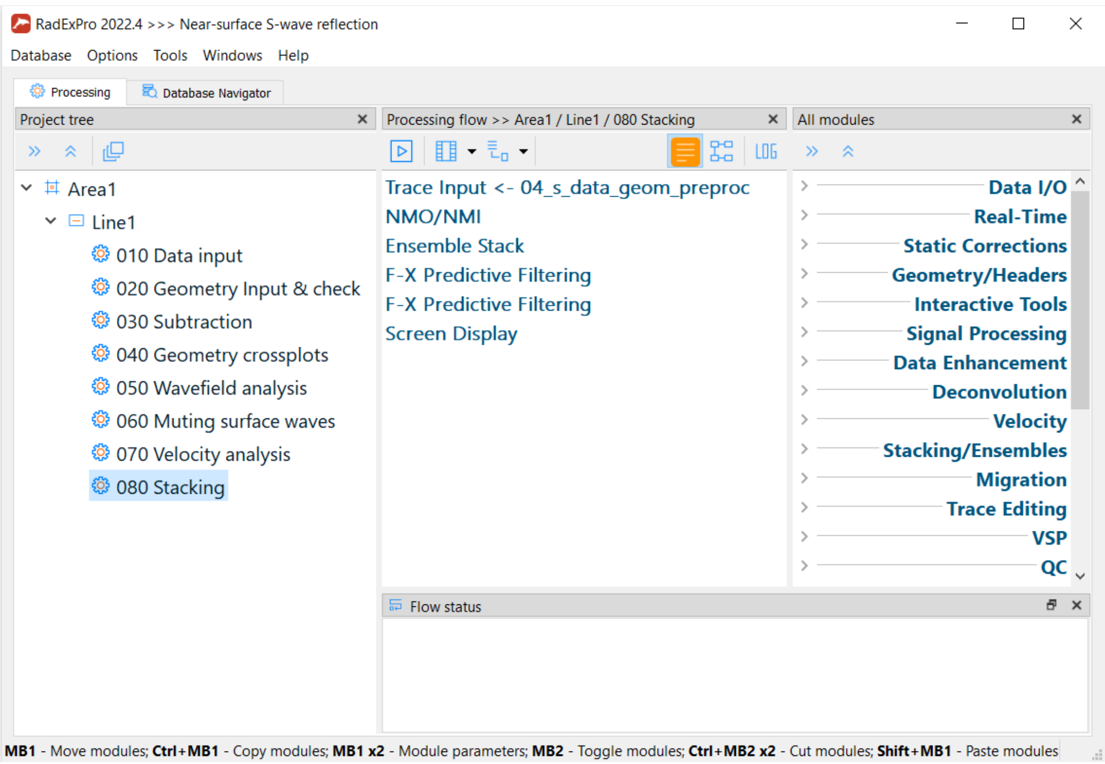


The above figure shows that there remained the noise waves with an inclination of about 45 degree on the time section as well as a random noise.

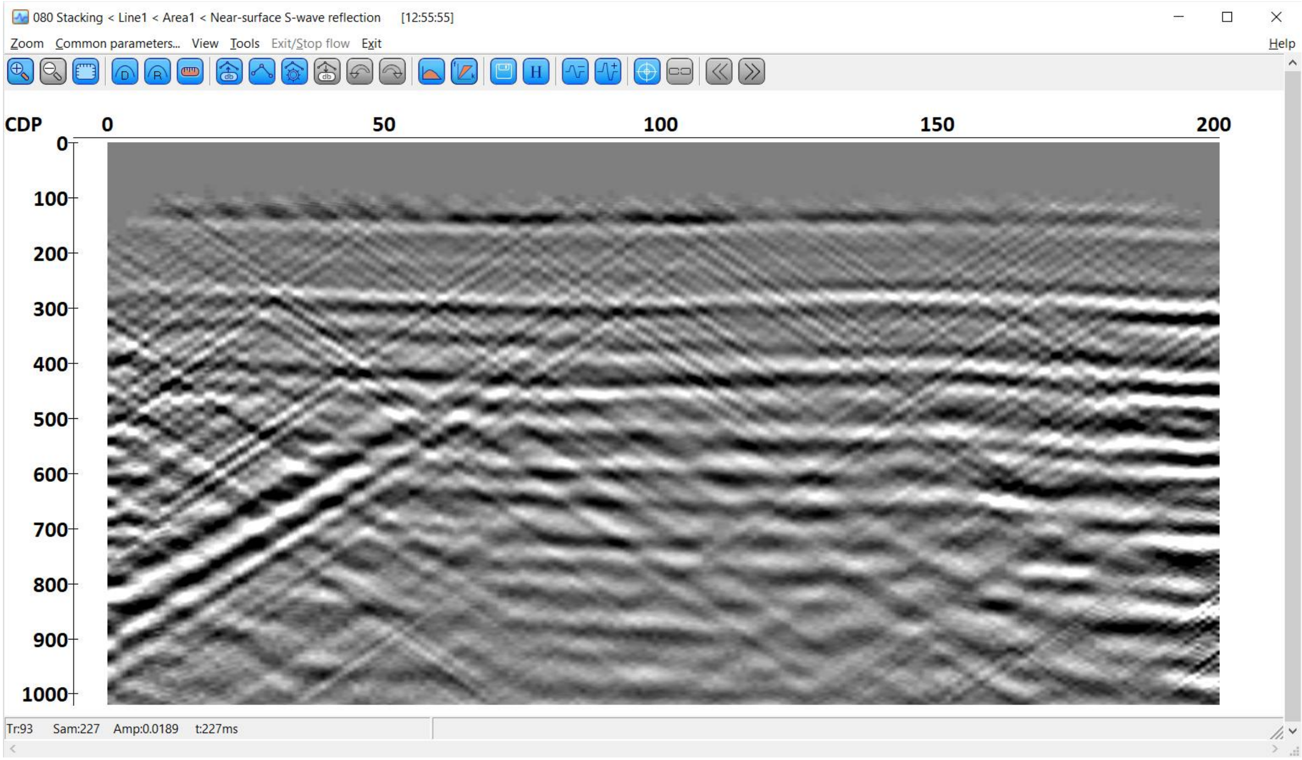
Add F-X Predictive Filtering module into the flow to suppress random noise and to increase the reflection coherence. In the flow, we will run this procedure twice, both times we will use the same parameters.



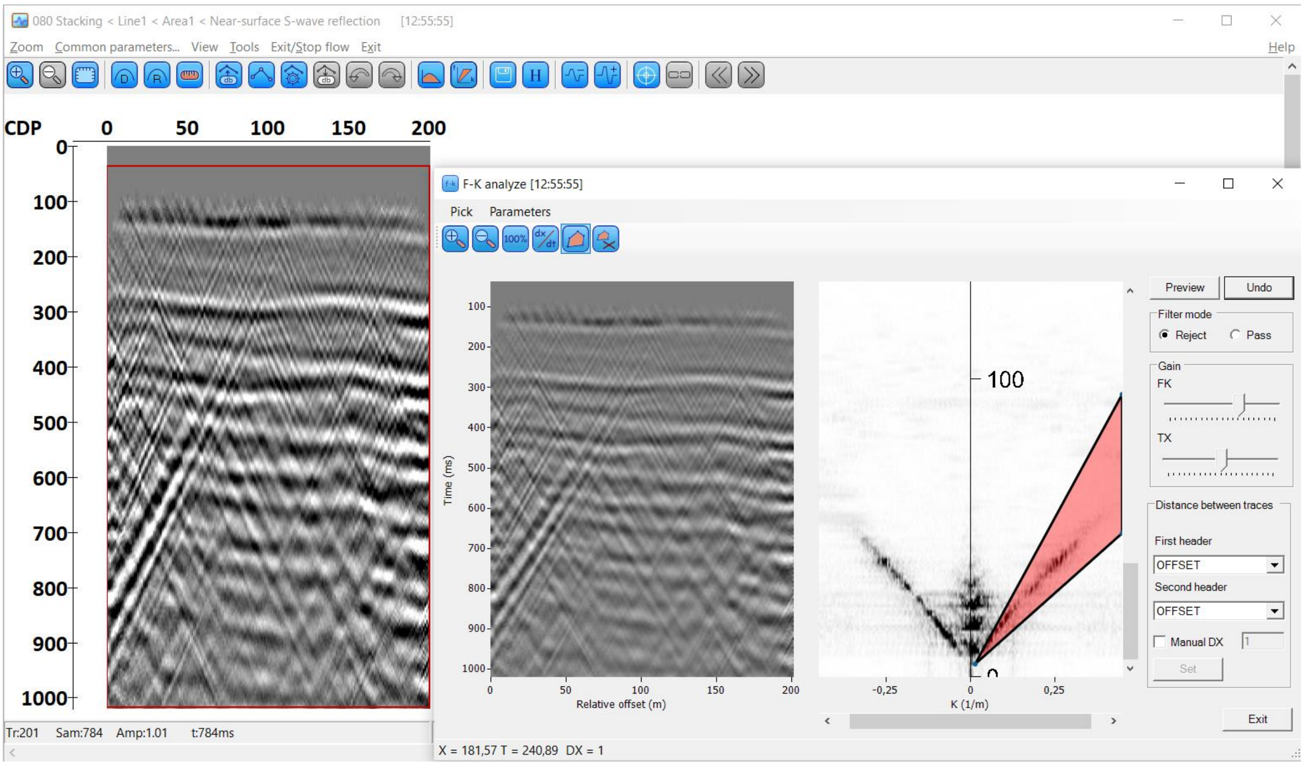
Now the flow looks like this:



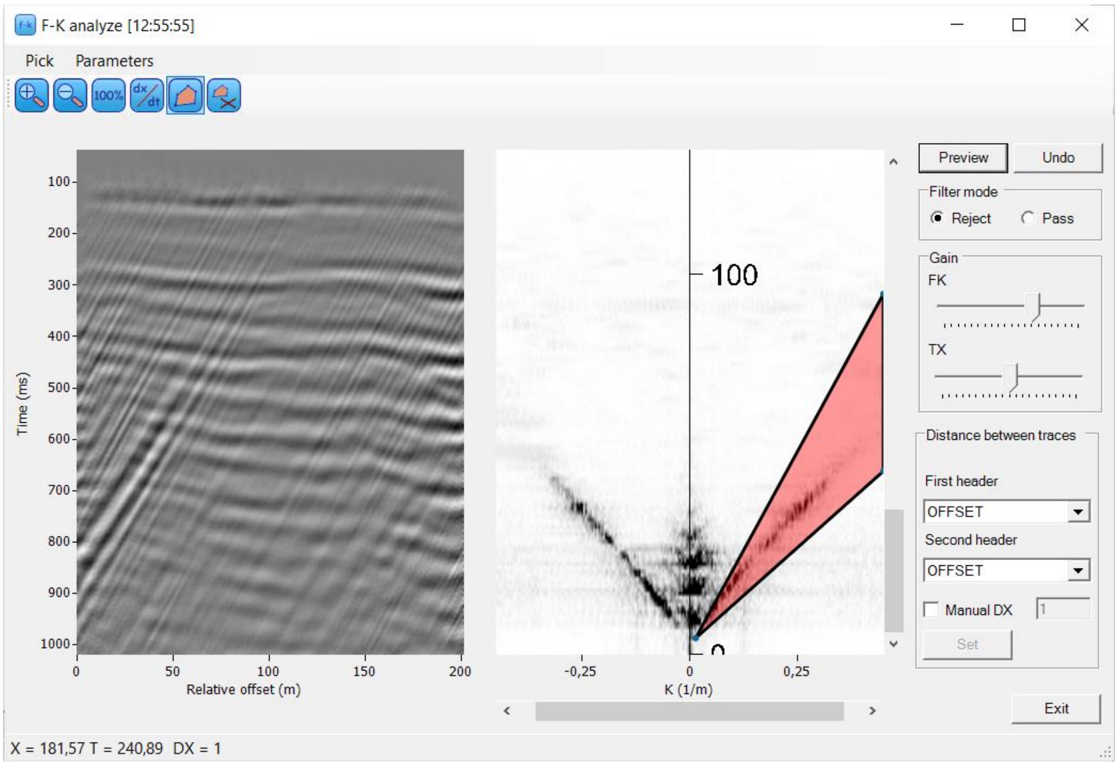
After running this flow, we will obtain the following time section:



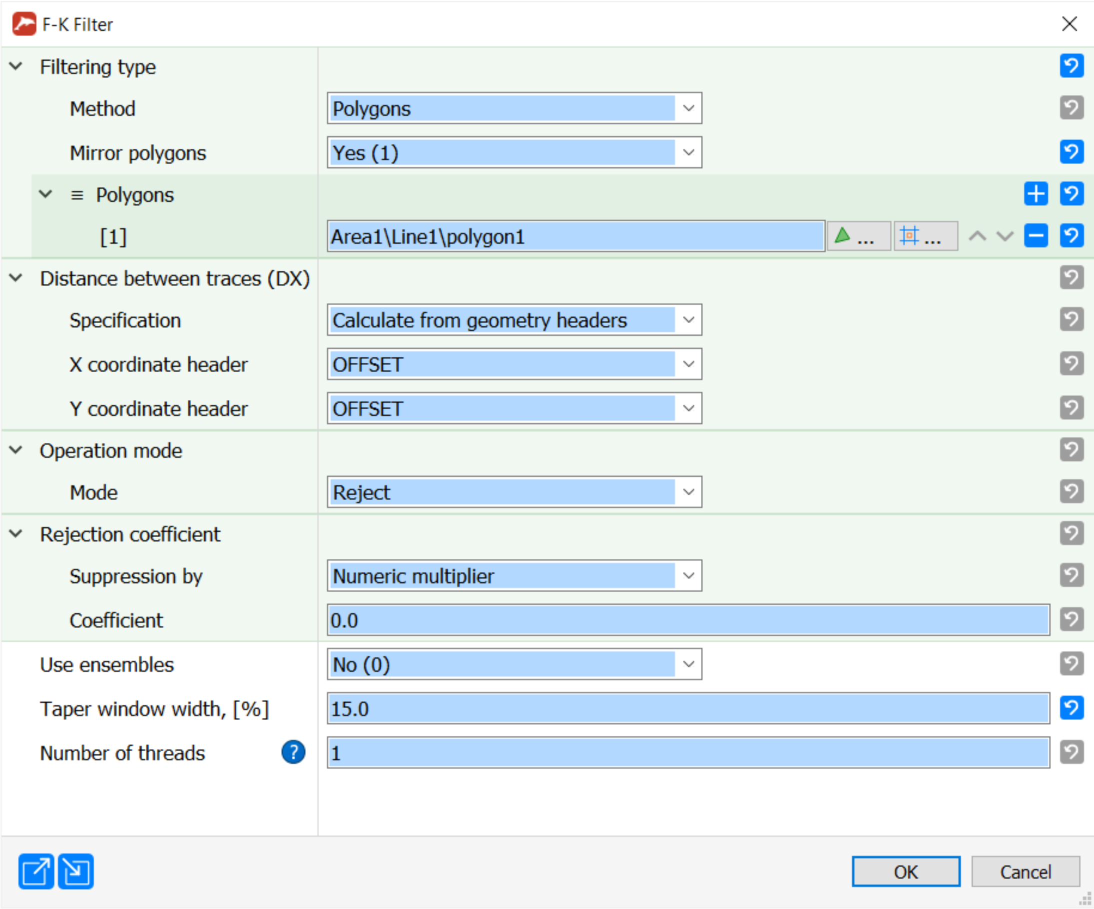
Now, let us suppress the inclined noise signals using F-K filtering. Let us analyze a 2D amplitude spectrum in the Screen Display module. Click the icon on the toolbar and select the area for analysis holding the left mouse button. We would select the whole stack as shown below:



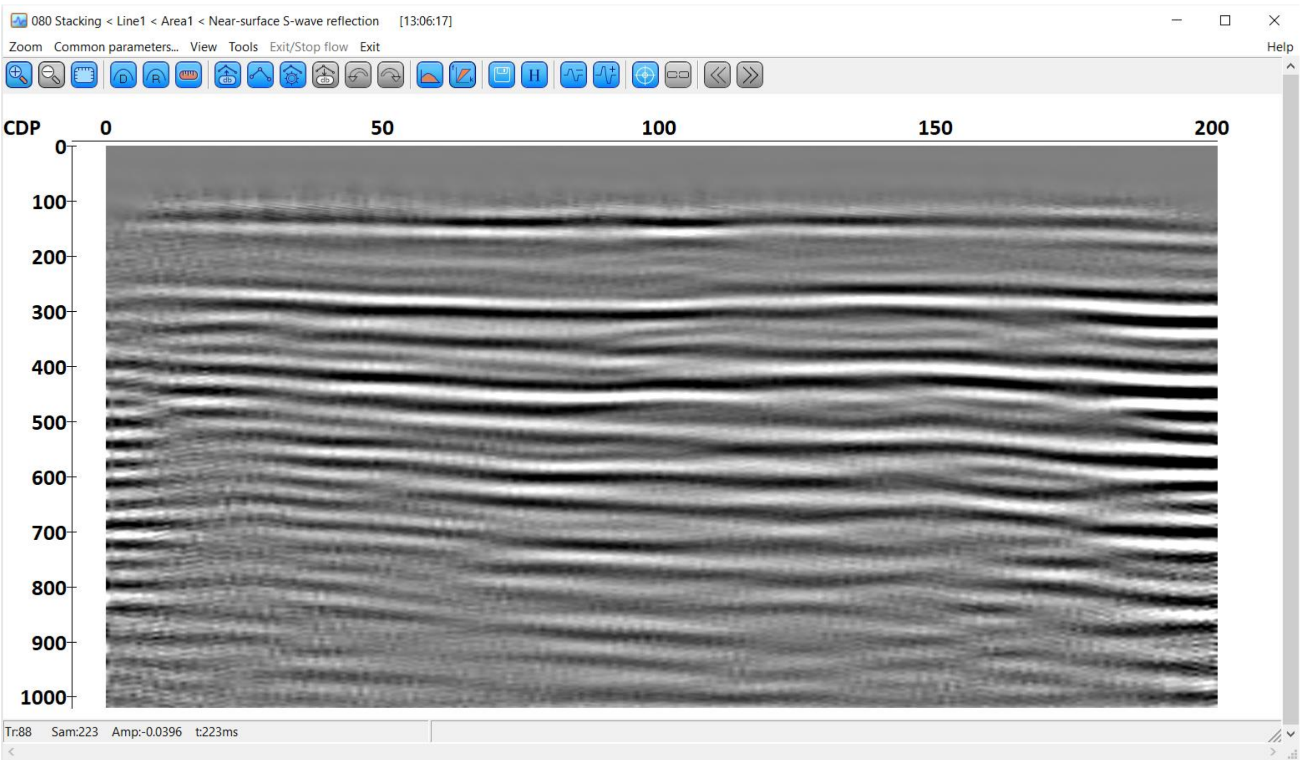
To suppress noise waves with an inclination of about 45 degree, we will pick a polygon corresponding to the noise waves at the F-K panel of the F-K Analyze window. It is possible to click the preview button (Preview) and see the result of applying the F-K filtering with the current polygon to the data. In case of presence of two noise areas, symmetric relative to the vertical axis (as in our case), it is sufficient to specify just one polygon. When the result of the preview satisfies us (noise signals are effectively eliminated in one direction), save the polygon using the Pick/Save Polygon menu item of the F-K analyze window. Shown below is the result of the filtering preview:



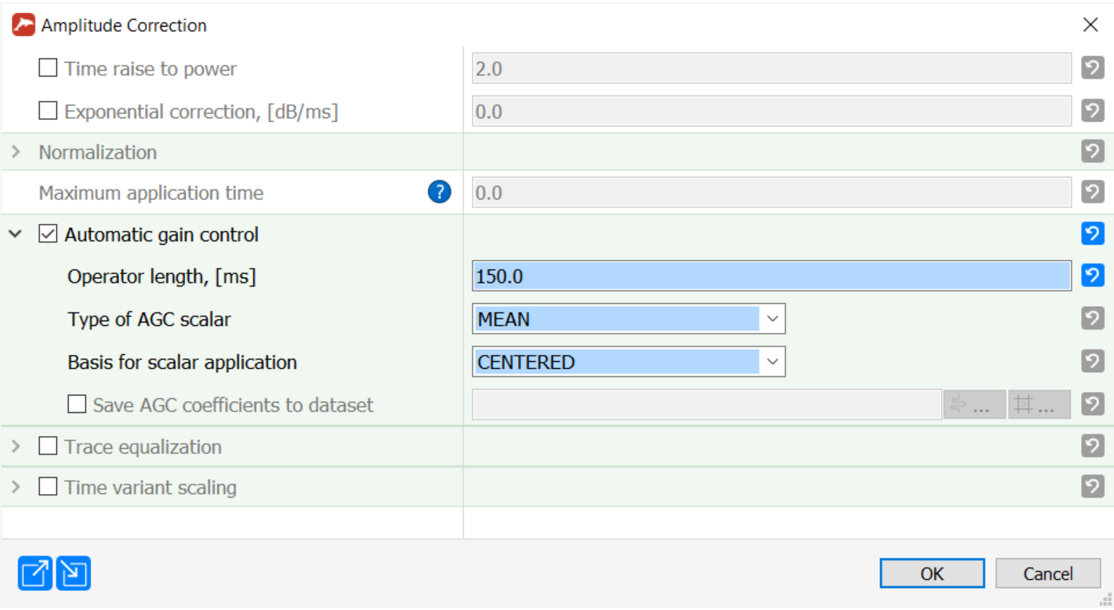
Now, when we have a polygon for the filter, let us add F-K Filter module into the flow and choose the created polygon in the parameter dialog window. To suppress also the noise events, having the opposite (symmetric) direction, check the Mirror box (the second polygon will be created being symmetric to the first one relative to the vertical axis).

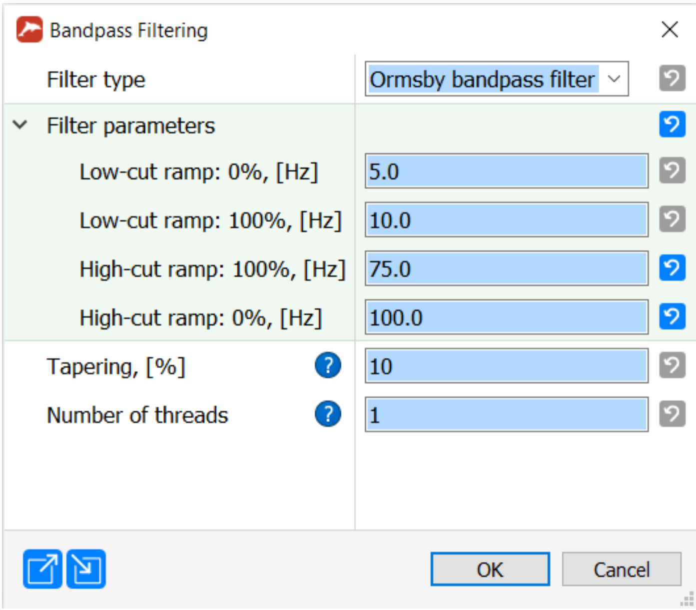


The result of the F-K filtration is shown below:

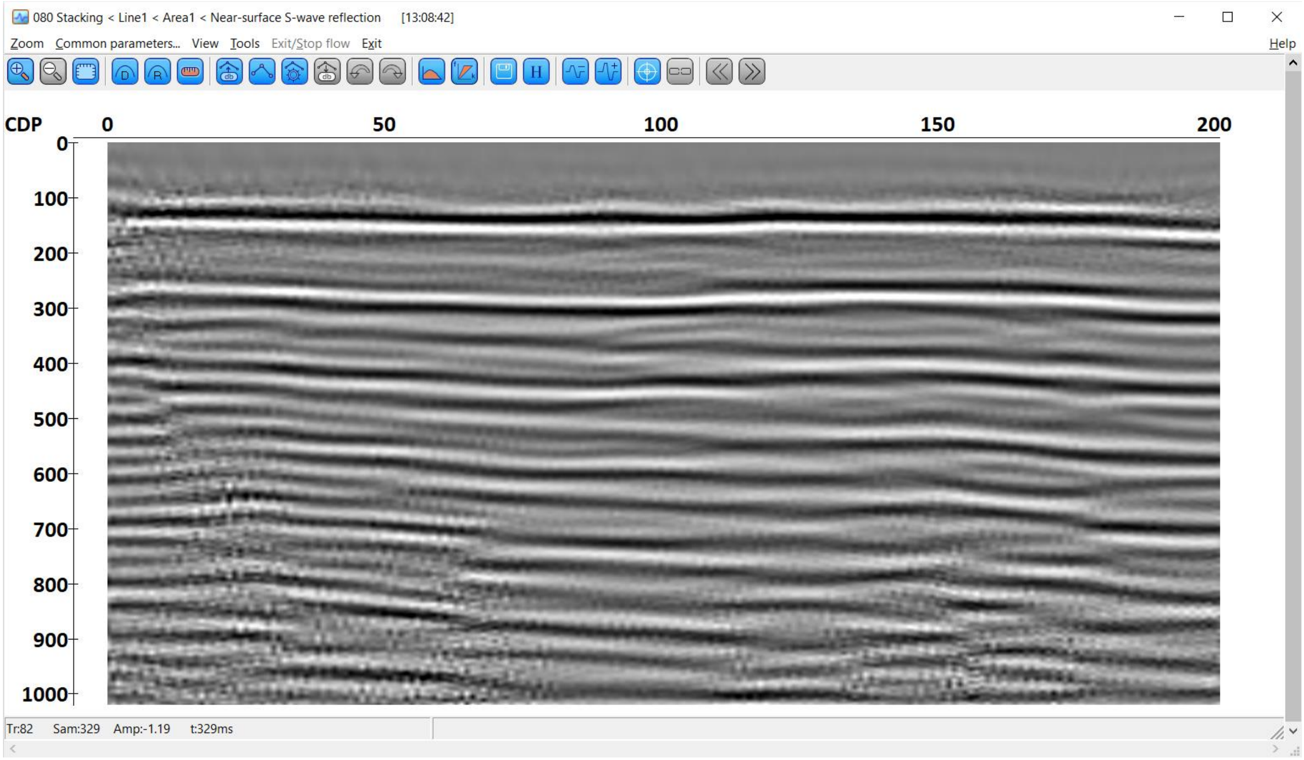


We will run the final amplitude balancing (automatic gain control – AGC) and filtration in the following way:

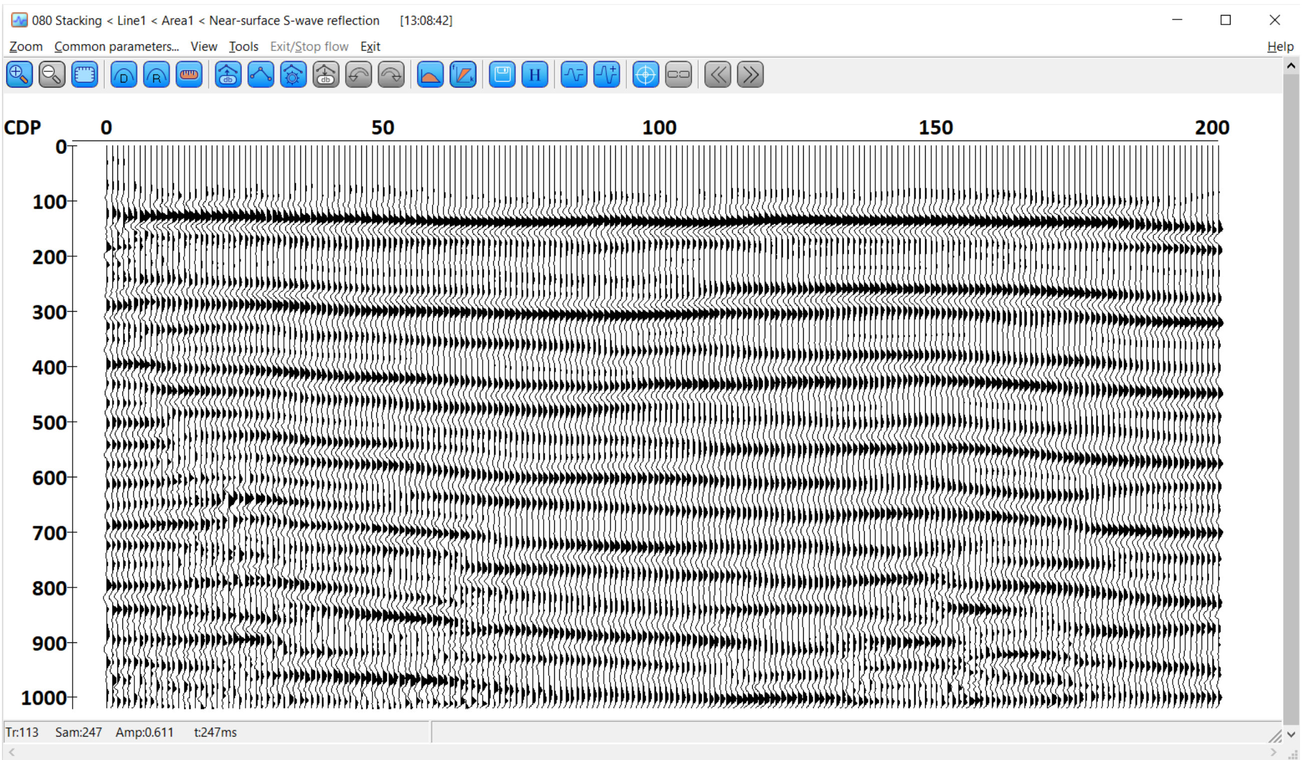




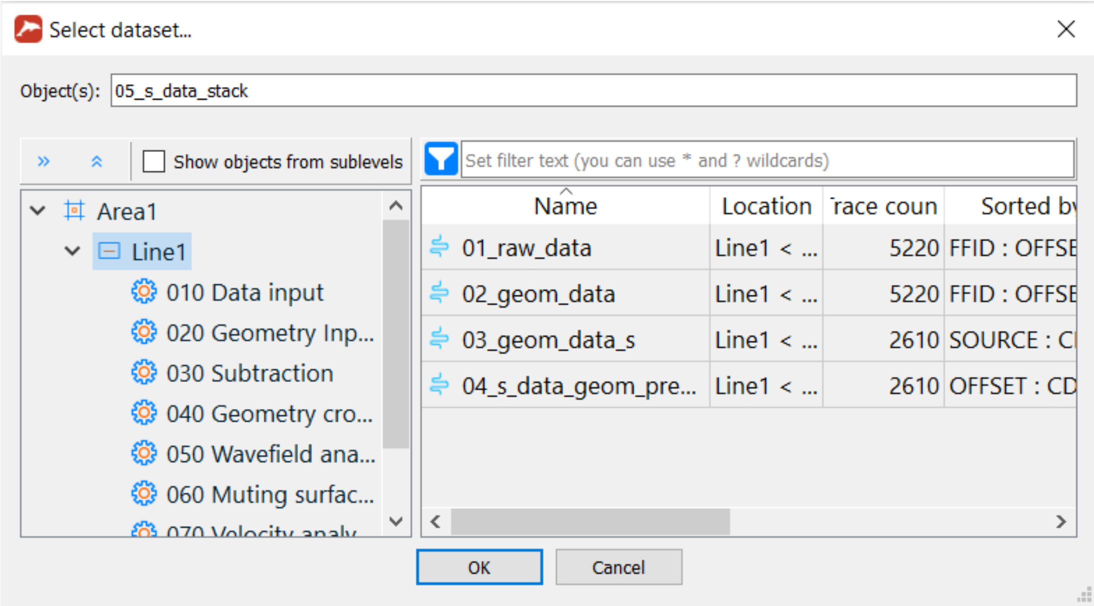
The resulting time section is shown in the figure below:



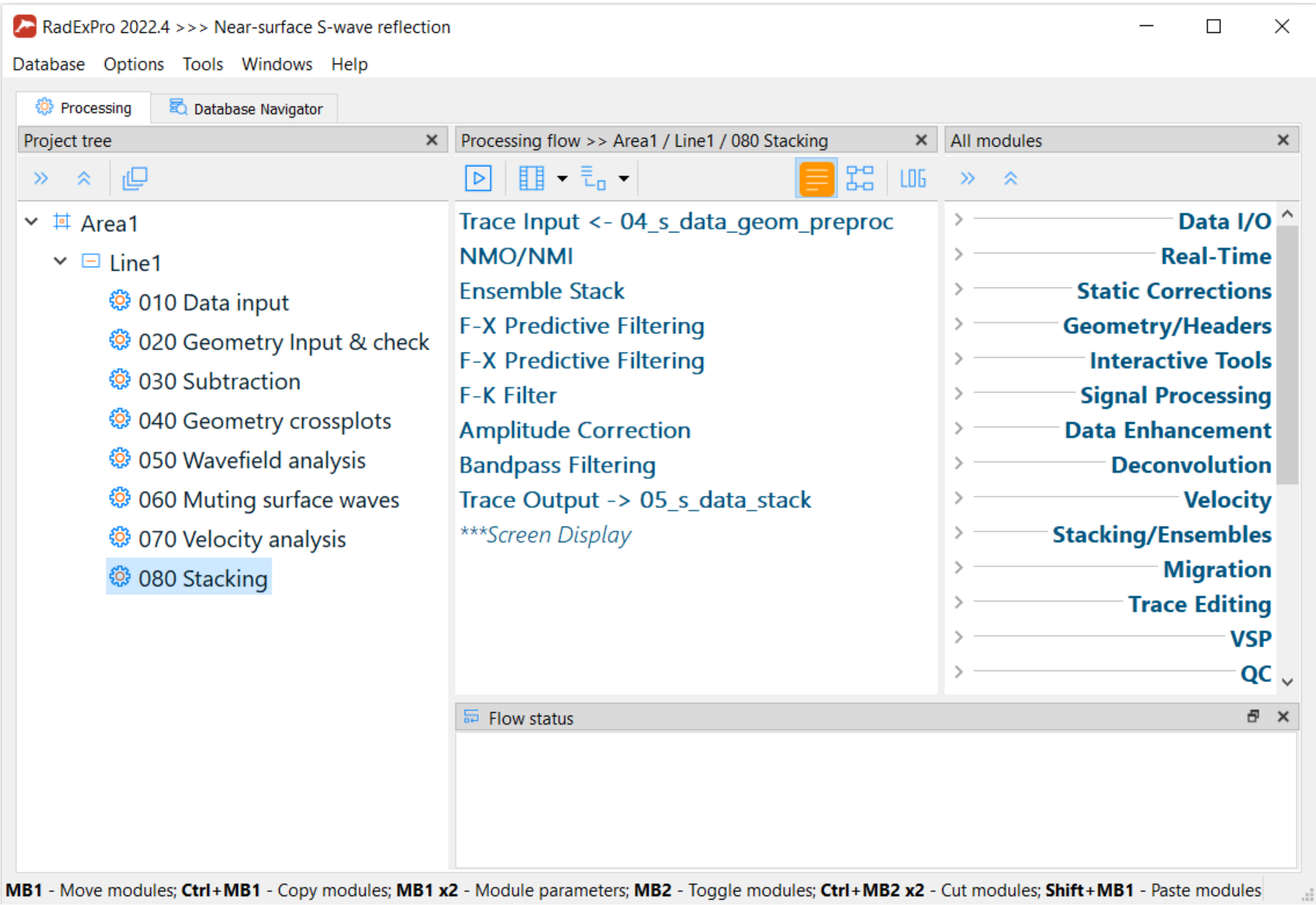
In the near-surface seismics, the resulting stacks are often displayed in the wiggle trace/variable are mode. You can select this type of display in the Screen Display parameters, the result is shown below:



Let us write the data on the second level of the project tree named ‘05_s_data_stack’.

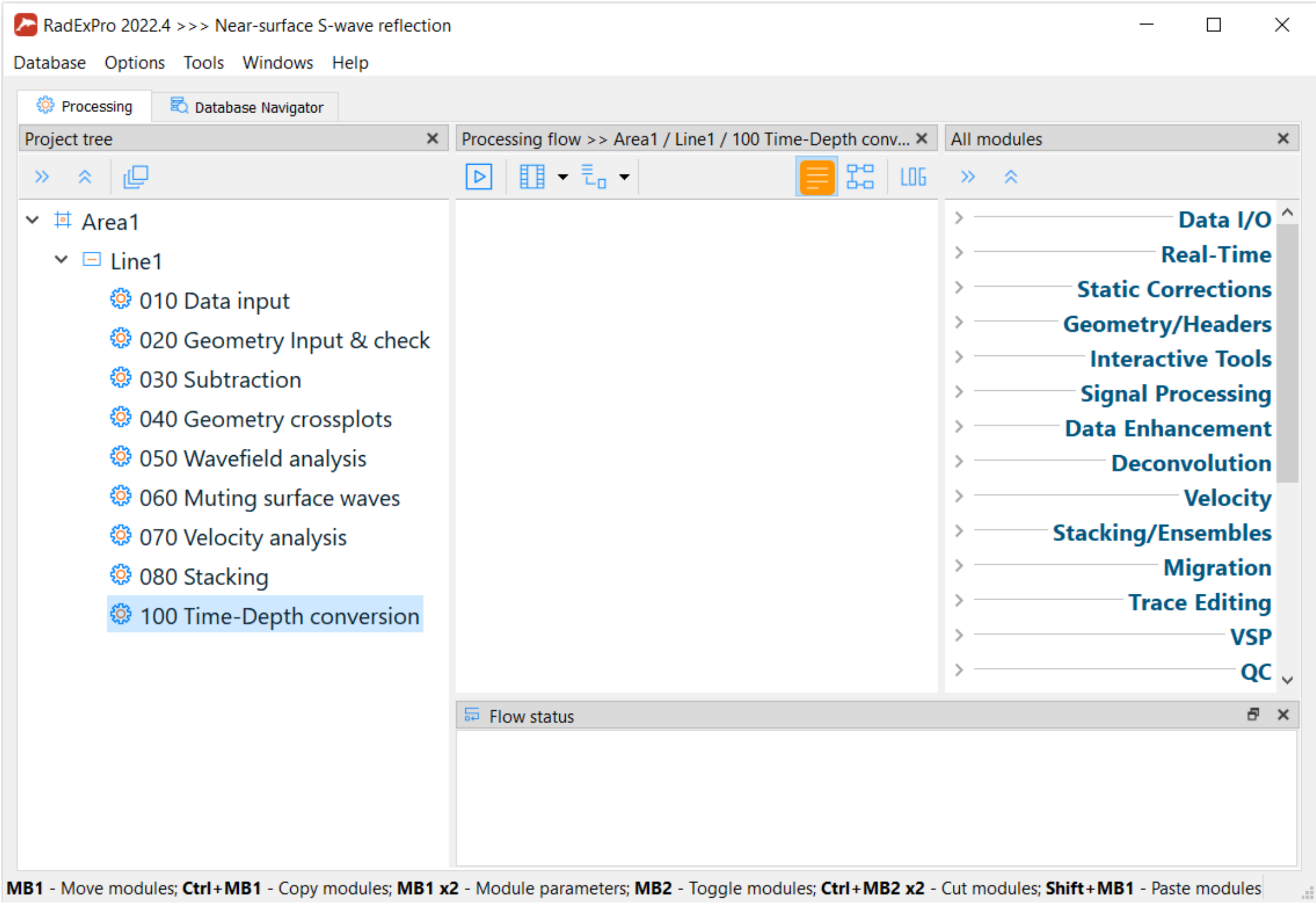


The final version of the flow will look like this:

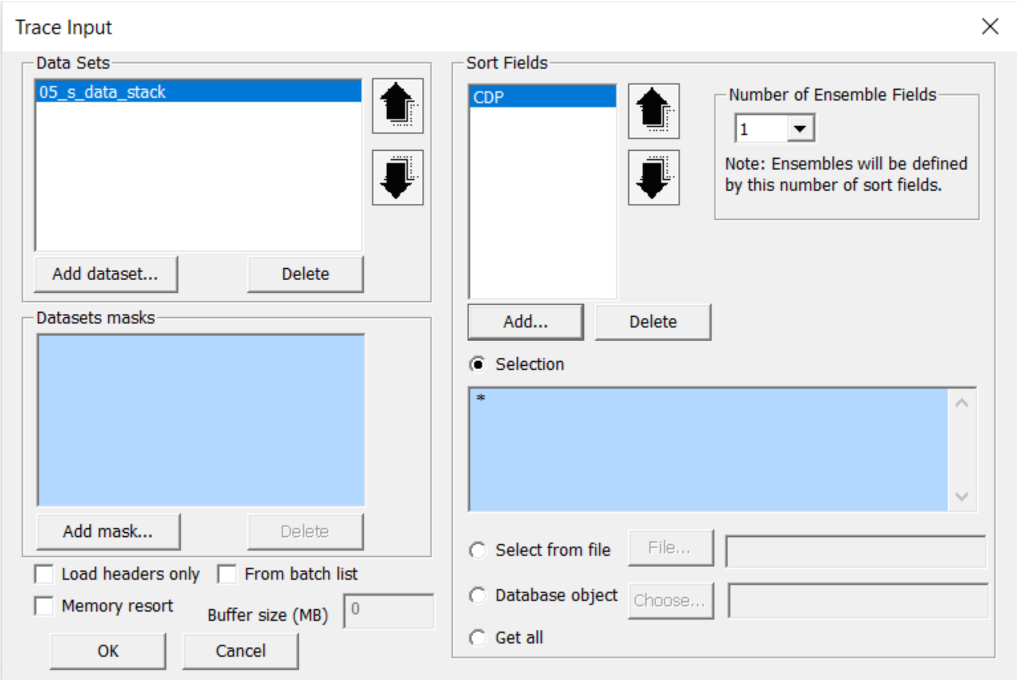


Time-to-depth conversion

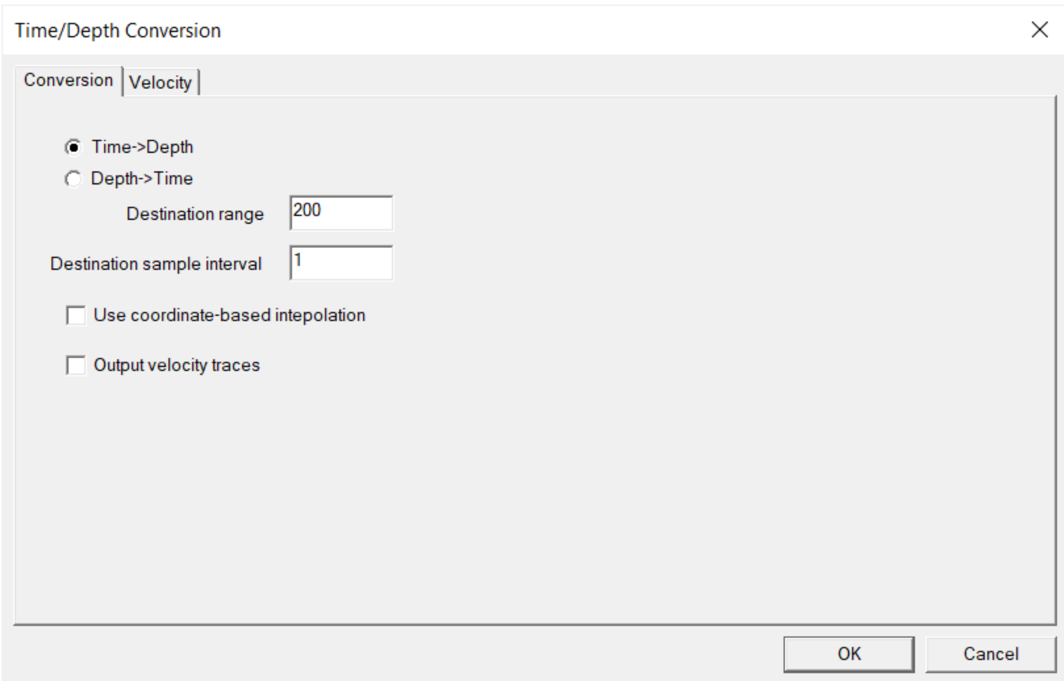
Conversion from the time domain to the depth domain is the final step of the processing. Let us use the velocities obtained earlier as a result of the velocity analysis to recompute the time section to the depth section. Create a new flow "100 Time-Depth conversion".



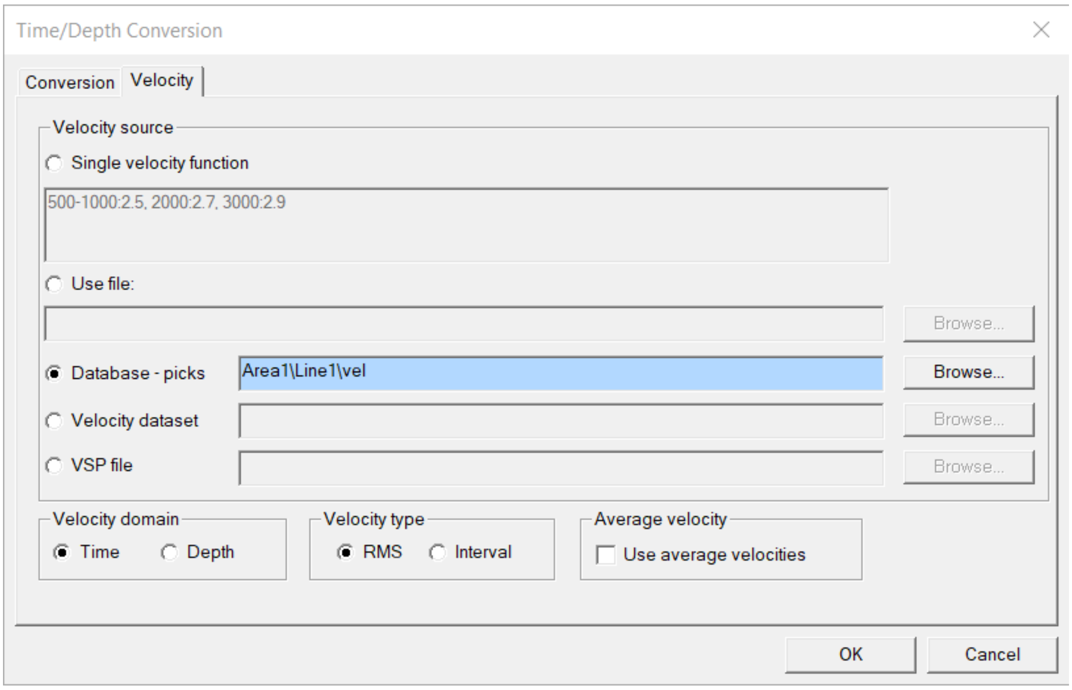
First, load the stacked time section created in the previous flow. Use Trace Input module for that, choose CDP sorting.



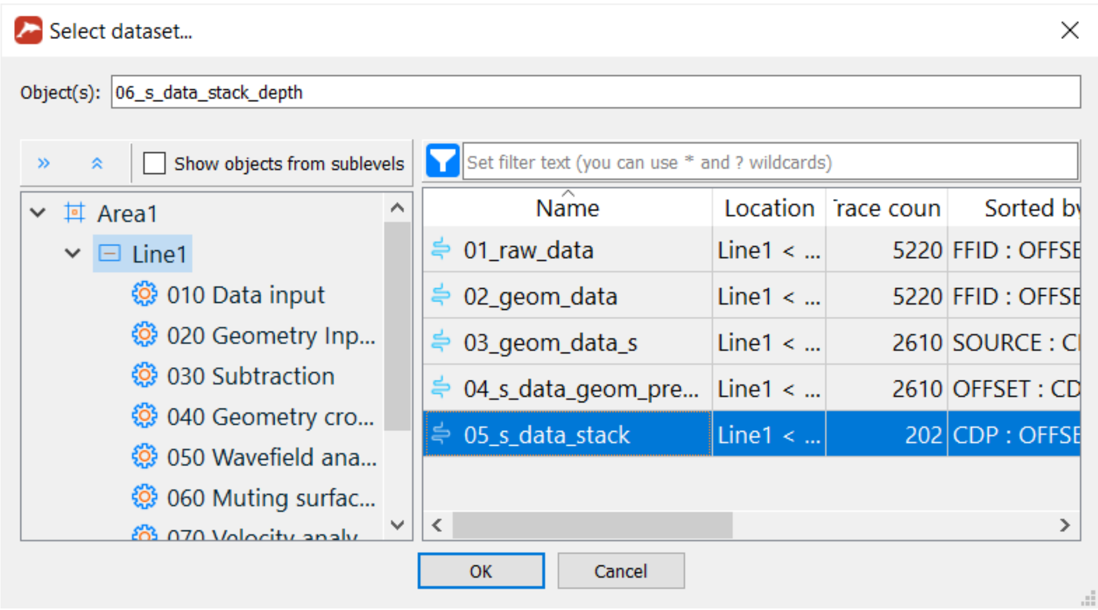
Add Time/Depth conversion module, set the following parameters on the Time/Depth Conversion panel:



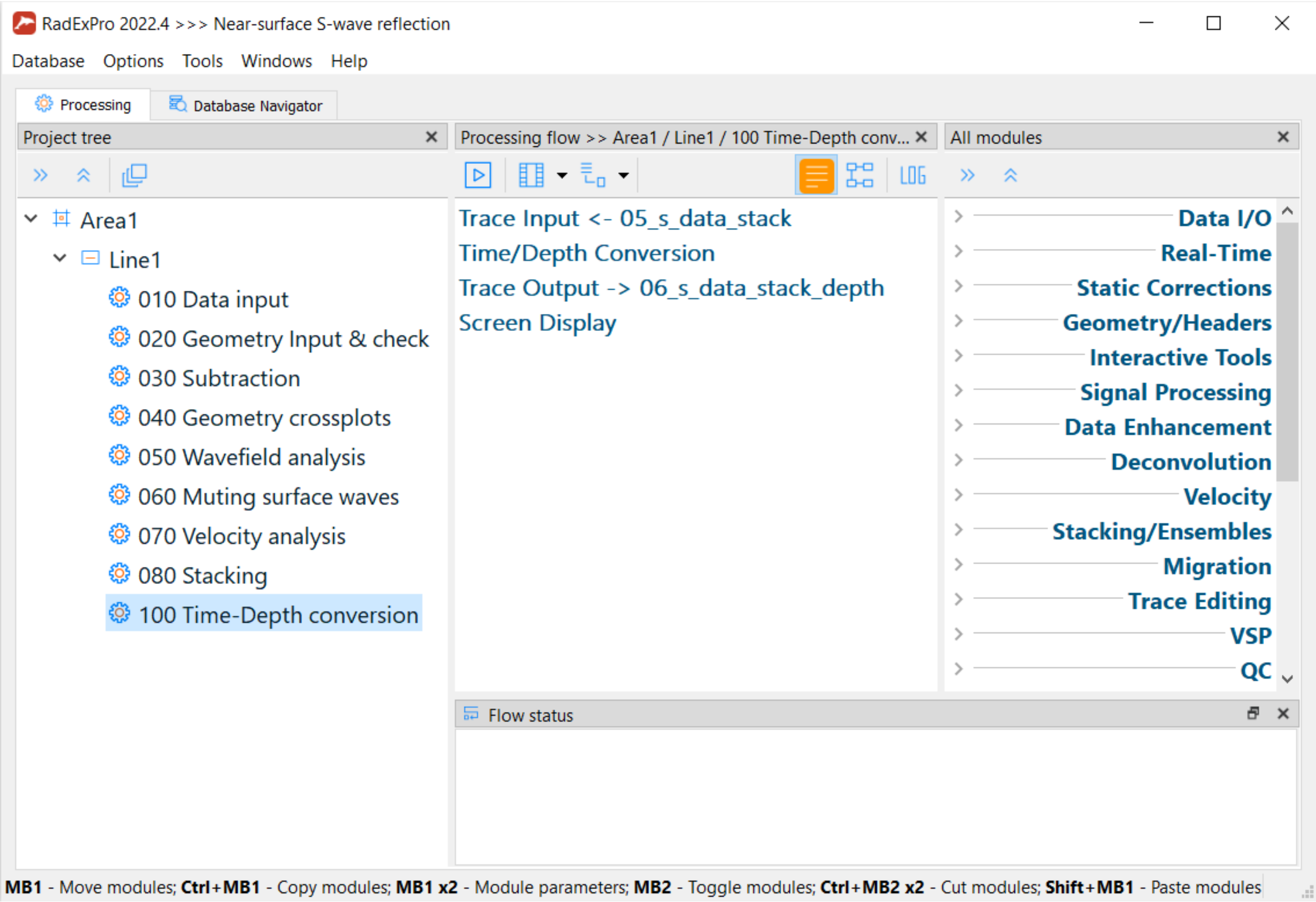
On the Velocity panel chose our ‘vel’ velocity pick as a velocity model.



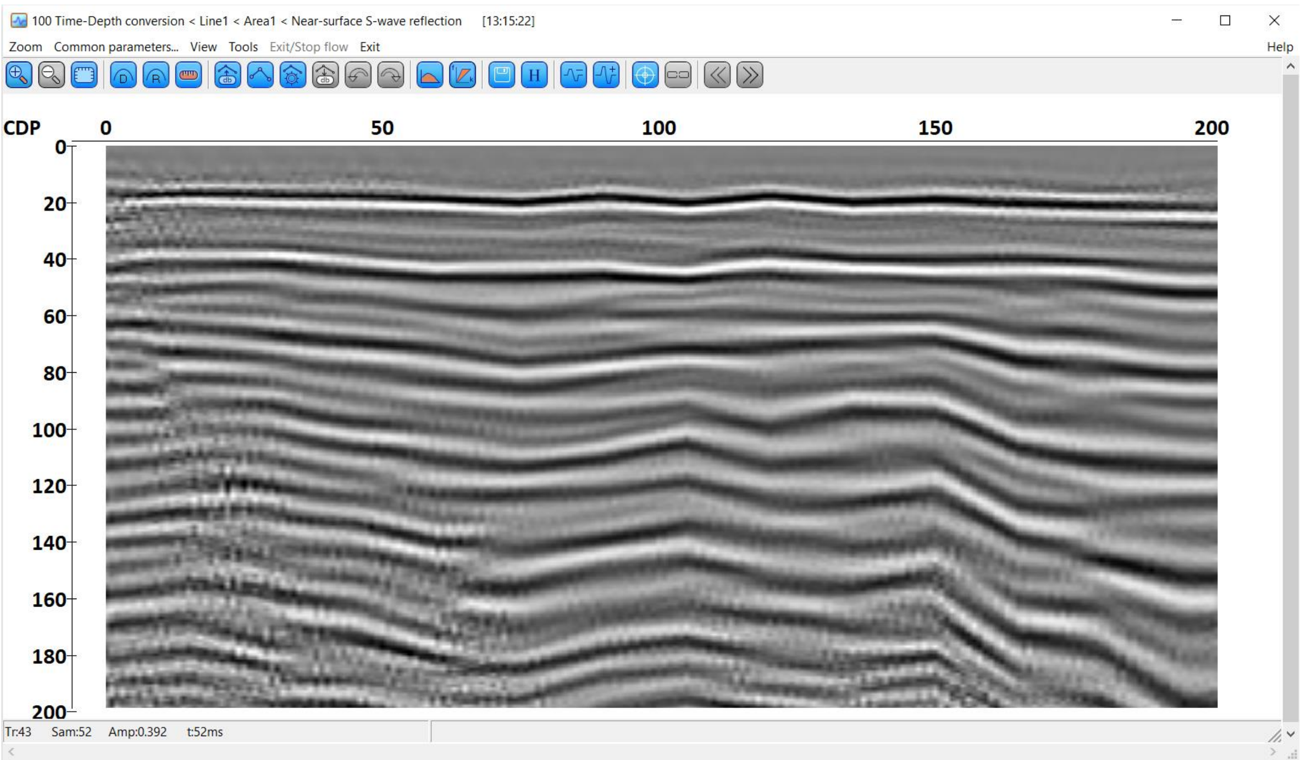
Save the result with the Trace Output, use the name '06_s_data_stack_depth'.



Add Screen Display at the end of the flow. As a result we will get the following flow:



Click the Run button. The resulting depth section is shown in the picture below.



Depending on your needs, the resulting section can be output as a file in Seg-Y format (see SEG-

Y Output module), saved as an image directly from Screen Display or printed out with a specified resolution (see Plotting module).