Land seismic QC attributes: computation, mapping and interactive analysis in RadExPro – Tutorial

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Introduction

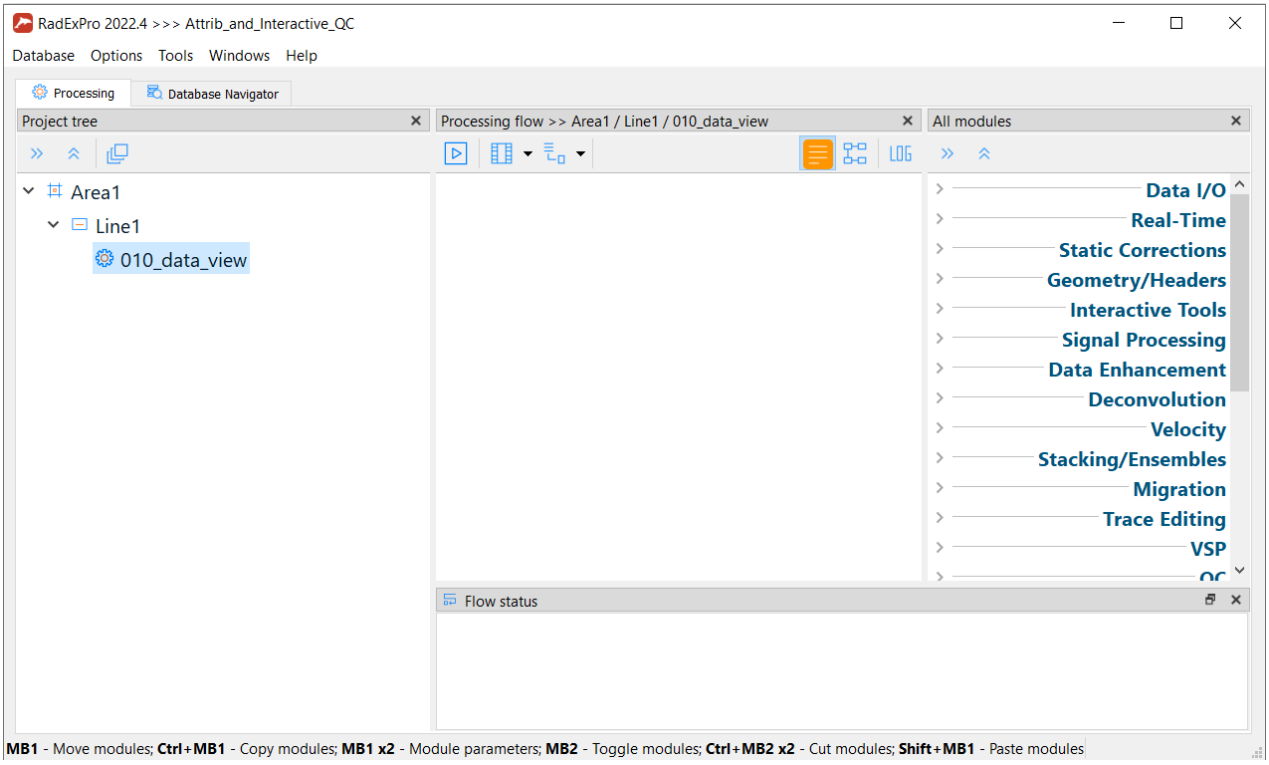
In this tutorial, we will demonstrate how to compute seismic data QC attributes (amplitude and frequency estimates, signal/noise ratio) in RadExPro software. In the second part of the tutorial, we will discuss interactive analysis of the attribute maps using Interactive QC* module.

If you want to repeat all the steps described here on your own, you can download Attrib_and_Interactive_QC demo project. The project was specially designed to demonstrate only the steps that we need. The following preliminary steps were made beforehand:

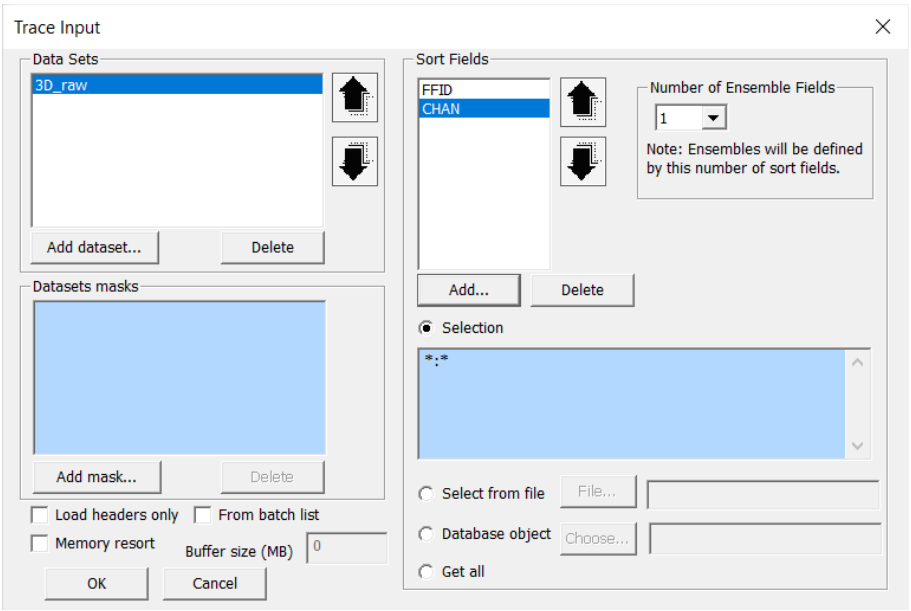
- A fragment of 3D land seismic data was loaded into the project, geometry was assigned;
- CDP binning was completed using 3D CDP Binning module.
- Several auxiliary header fields, not available by default, were added into the project, using Database/Edit header fields... command of the main menu: QC_BAD_TRC, QC_TOTAL_BAD_TRC, QC_CONS_BAD_TRC.

Input Data Display

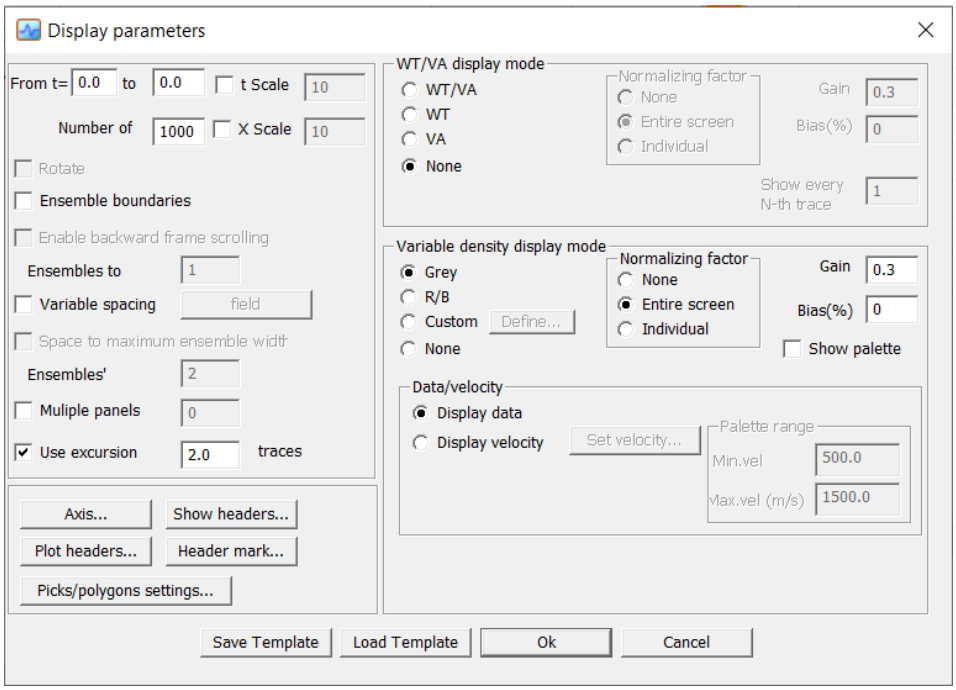
Open Attrib_and_Interactive_QC project. The main project window looks like this:



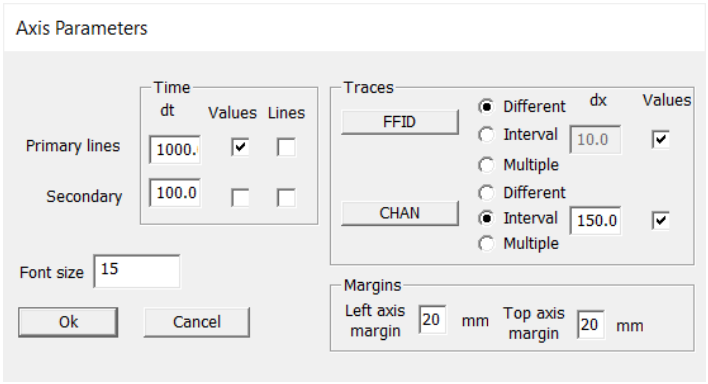
Enter the already created flow *010_data_view* to view data. Add data input module Trace Input into the flow, select the input dataset 3D_raw (it is located at Line 1 level). Choose an option Selection and click the Add button to add FFID, CHAN headers as sorting fields. This way the data will be loaded as shot gathers:



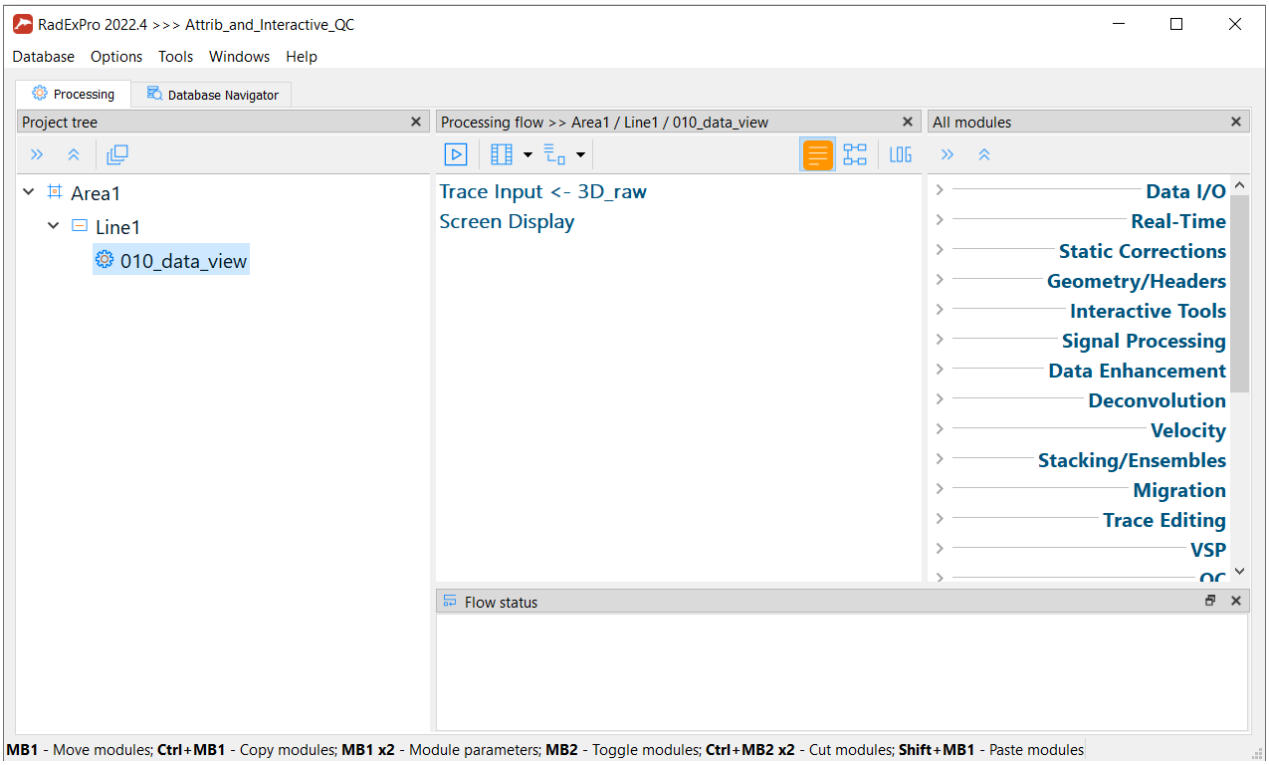
Click the OK and add data viewing module Screen Display into the flow. Set display for grey-scale image (Grey), number of traces on the display – 3000:



Click the Axis button and adjust captions along the horizontal axis. Shot numbers (FFID) will be signed every time when their value changes, channel numbers (CHAN) at every 150th channel:

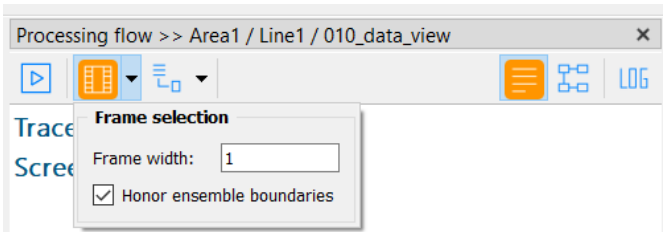


The flow will look like that:



We could already run it as it is, but we should treat it as if we were dealing with a large 3D survey which exceeds the computer's RAM capacity – that is, enable the framed mode of flow execution. To do this, click the arrow on the right of Framed Mode button on the toolbar.

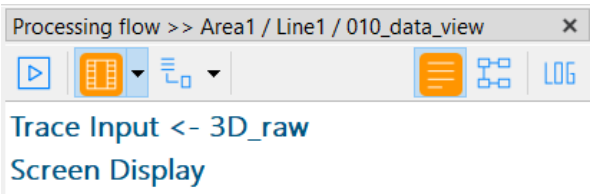
Set the frame size (Frame Width) in the opened dialog box to 1 trace and enable Honor ensemble boundaries option. This will let the software load the first trace and continue reading traces into the frame until the end of the ensemble. Thus, in the first frame all traces of the first FFID will be loaded.



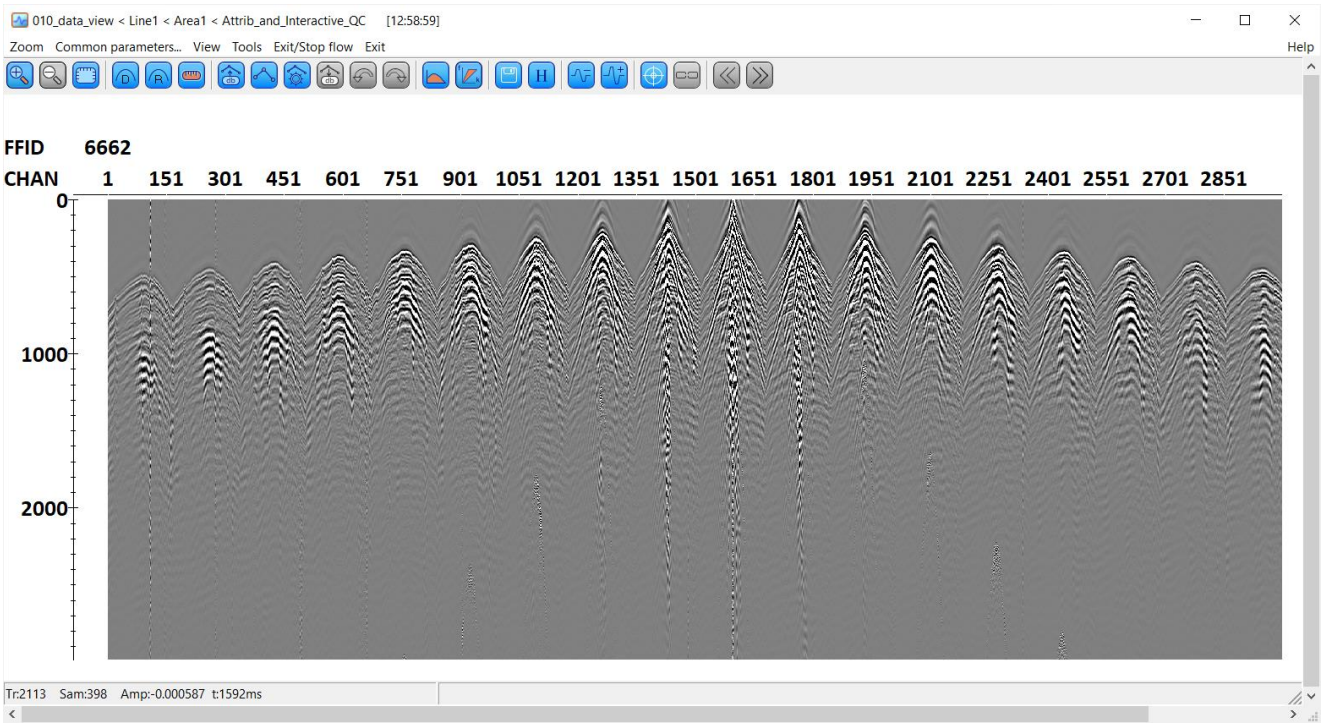
IMPORTANT: In RadExPro, the ensembles are defined by the Trace Input module. An ensemble is considered to include all traces with matching values of the headers selected as the first N Sort Fields (N is specified in the Number of Ensemble Fields field).

After setting the Frame Mode parameters, click the Framed Mode button to switch on the framed mode flow execution. The button will turn orange at that.

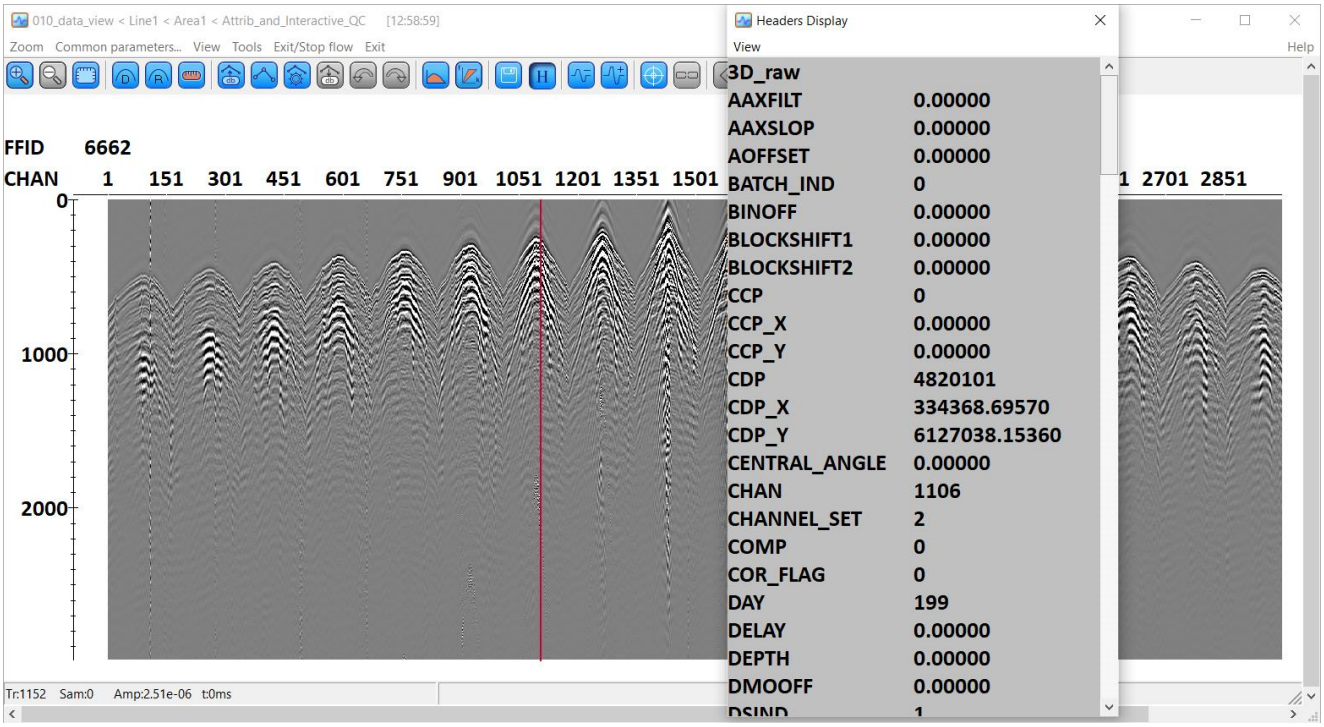
Now it is possible to start the flow – click the Run button on the toolbar.



The data of the first frame data will be displayed in the Screen Display window.



You can see that the data are displayed sorted by FFID:CHAN (shot number:channel). Click the H button on the toolbar, and then click on any trace to see the headers related to it:



Here you can make sure that geometry is assigned to the data and that CDP numbers are properly calculated.

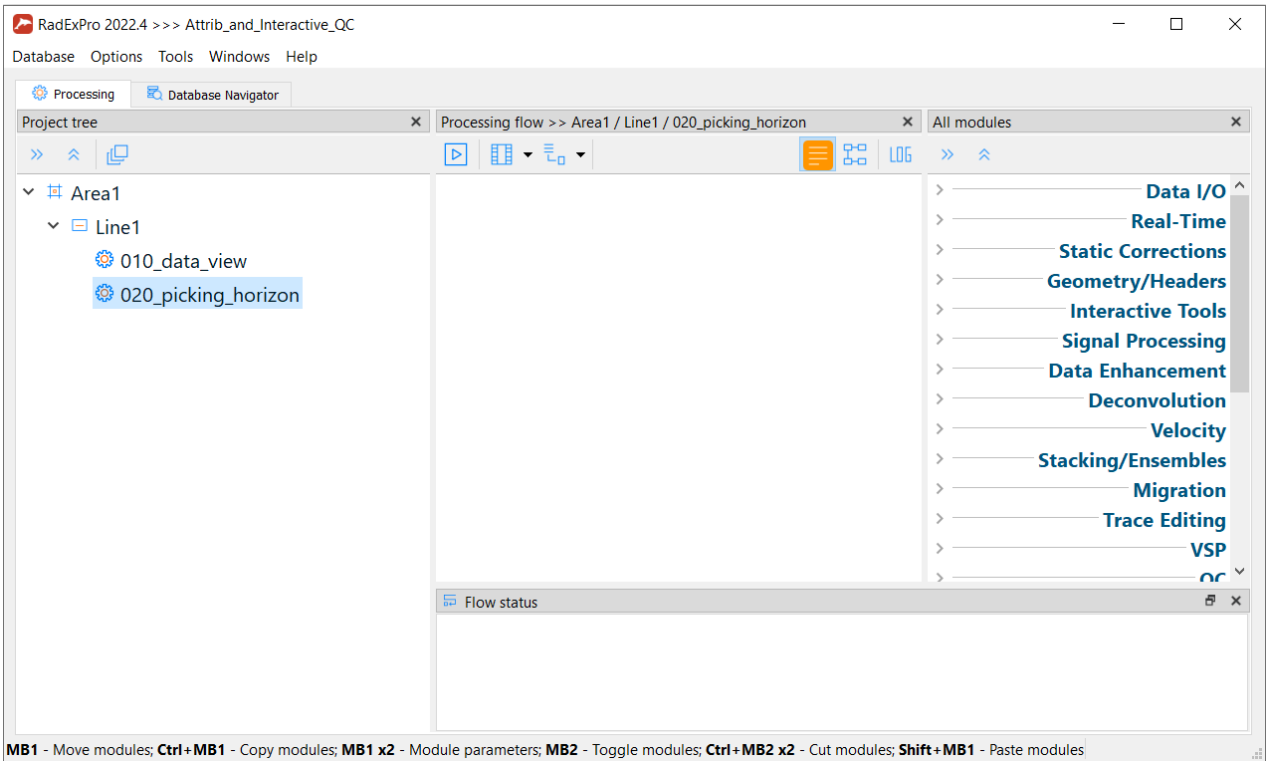
As the flow is running in the framed mode, when you exit from the Screen Display by the Exit command of the menu, the next frame will be launched and its contents will be displayed in the re-opened window of the module. To exit from the module and interrupt execution of the flow, use Exit/Stop Flow command.

Computation of Trace Attributes

Automatic picking of first breaks for attributes computation

On each trace, we are going to estimate an RMS amplitude of seismic events just below the first arrivals and an RMS amplitude of the background noise (microseism) at the end of the trace. We will compute these attributes in the SSAA module that requires a horizon pick and a window related to this horizon. We will pick the first breaks automatically using the First Break Picking module.

Create a new flow – *020_picking_horizon*:



Enter it and add Trace Input module. Choose the input dataset, indicate sort keys (Sort Fields) FFID and CHAN. Since the input data are stored exactly in this gathering, no additional sorting during their reading (and associated time loss) will occur.

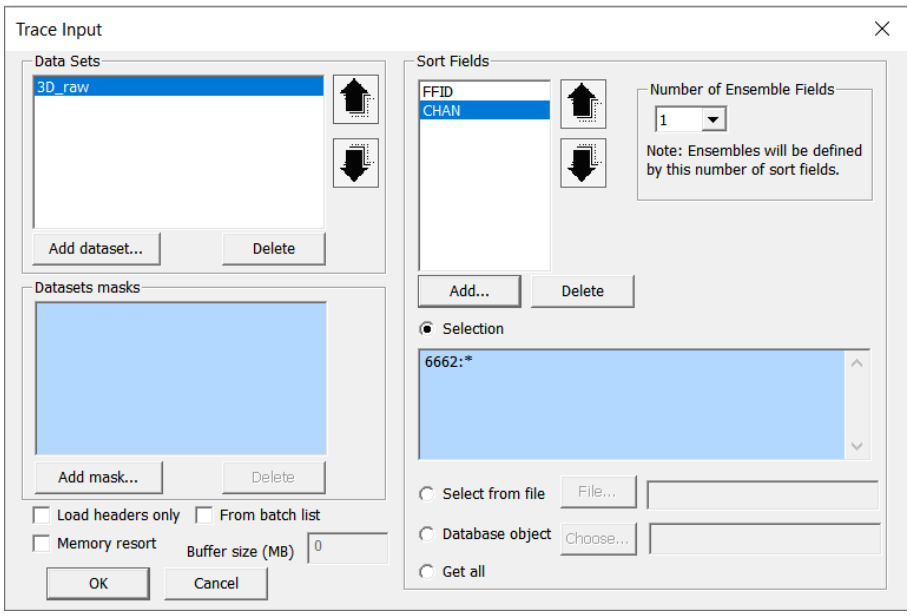
We do not deed to load the whole dataset to test the picking. One shot gather with the whole range of offsets will be sufficient. Indicate the following trace selection mask in Selection field:

*6662:**

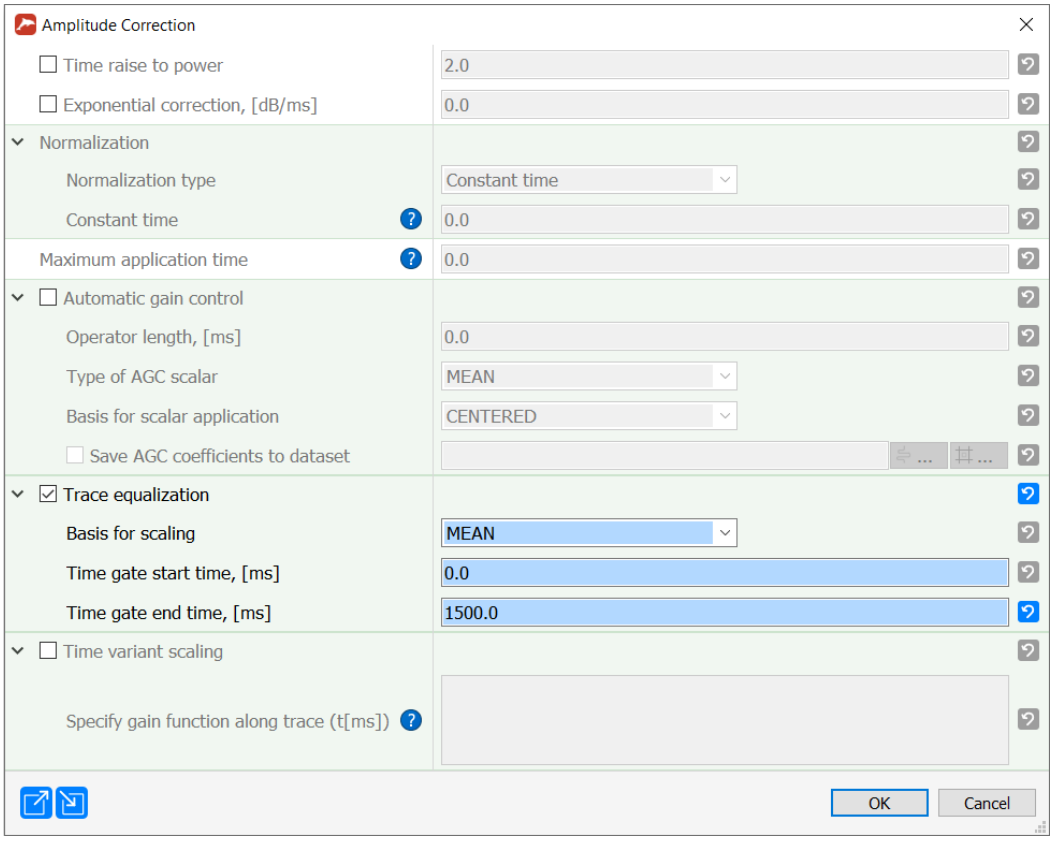
This selection mask means that for the first sorting field (FFID) only traces with the header

value 6662 will be chosen, while for the second sorting field (CHAN) any value of the header will be allowed.

Trace Input parameter dialog will look like this:



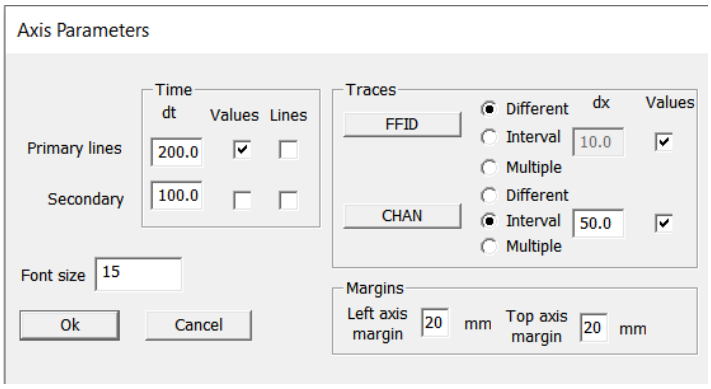
Let us make trace equalization using the Amplitude Correction module to decrease amplitude variations between traces and, correspondingly, to improve horizon tracking:



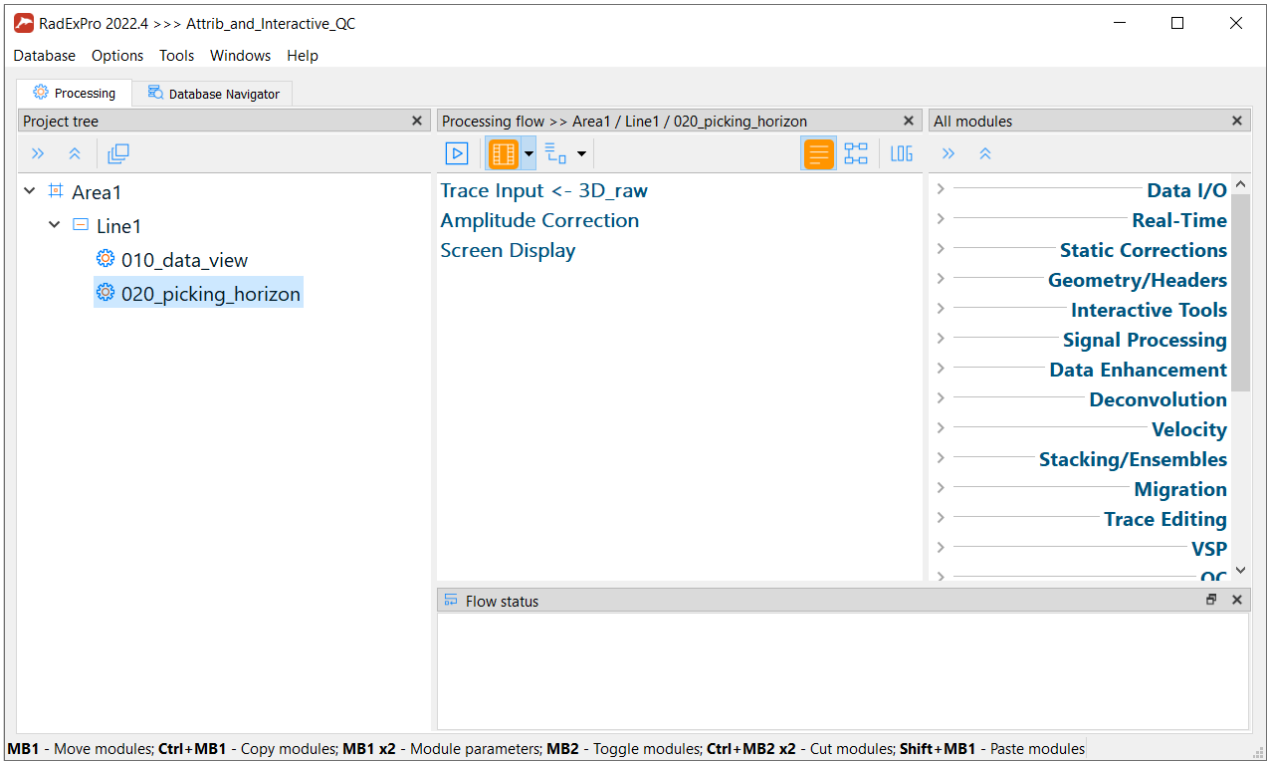
Add module Screen Display into the flow. Indicate the vertical scale - from 0 to 1500 ms and horizontal scale - 500 traces per screen (Number of traces).

The parameter window will look like that:

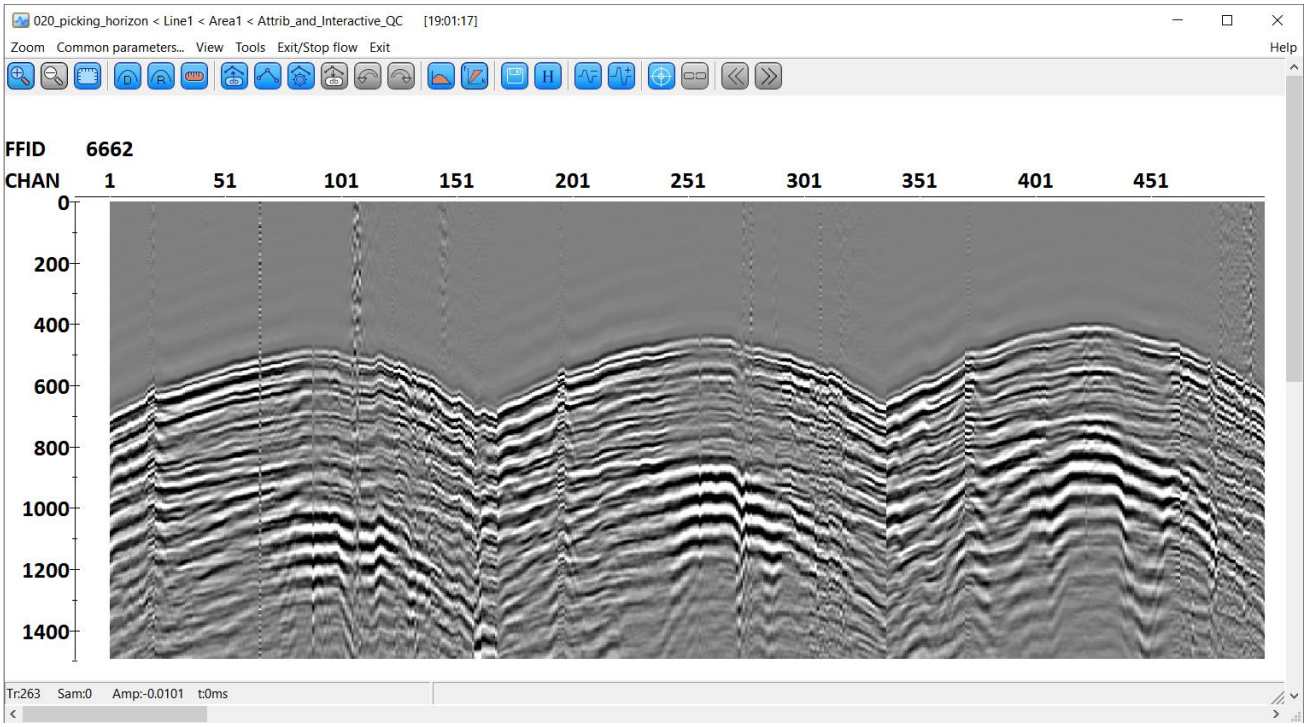
Click the Axis button to adjust captions along vertical and horizontal axes. Put time marks every 200 ms and FFID values every time when they change as well as CHAN values at each 50th trace:



Prior to starting the flow, do not forget to switch on the framed mode of its execution:

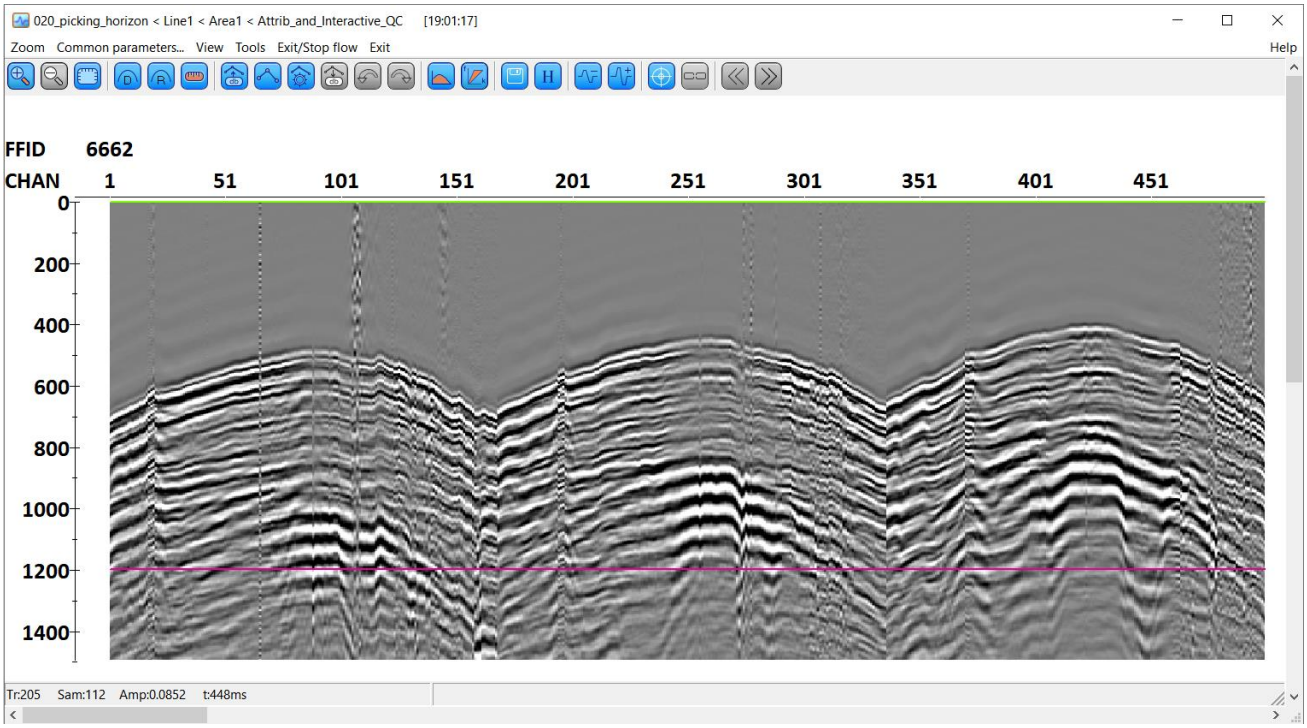


Run the flow to view the data and adjust the picking parameters. A Screen Display window will open.

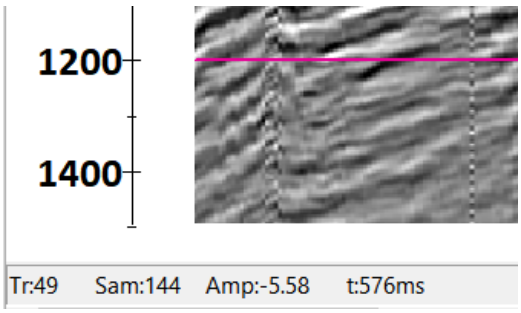


It is possible to create an approximate horizon above the first breaks to use it as an initial horizon. However, in this particular case it seems reasonable to use constant value of 0 ms since first-

arrival times are changing from line to line. Setting a higher value of the initial horizon may result in wrong picking of the first arrivals. We will search for the first breaks within 1200 ms window, that is the search interval is 0 - 1200 ms. This interval is shown below:



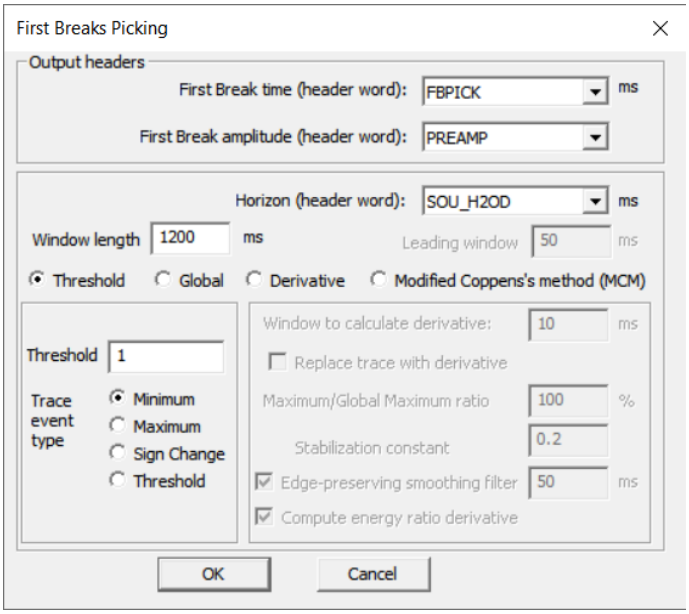
When moving the mouse cursor around the screen, look at the status bar showing the current trace number, sample number, amplitude, and two-way travel time.



Compare amplitudes along the first break event and above it. If you used the same processing parameters as we did, you will see that the peak amplitudes along the first break have are around 1-2, while above it they are normally less than 0.3. This gives us an idea of the threshold that we can use to determine the boundary – let us try 1 and see what happens.

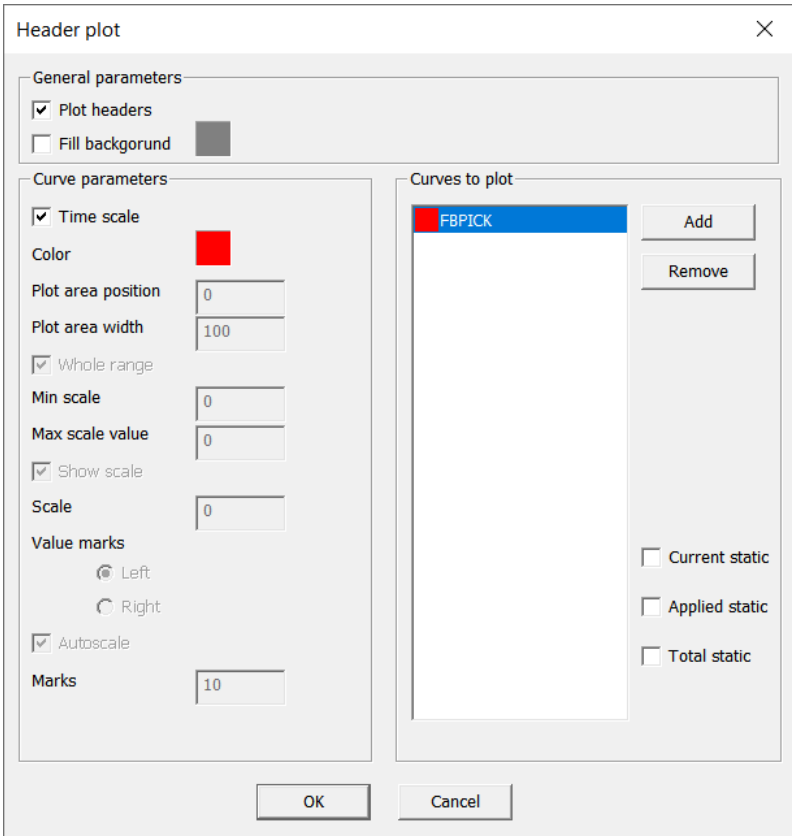
Attention: If you used other processing parameters, the amplitudes will be different! Check them prior to using the parameters that we recommended here.

Ok, now we know everything that we need to create a flow for the automatic picking. Close Screen Display and add module First Break Picking into the flow. Set the following parameters:

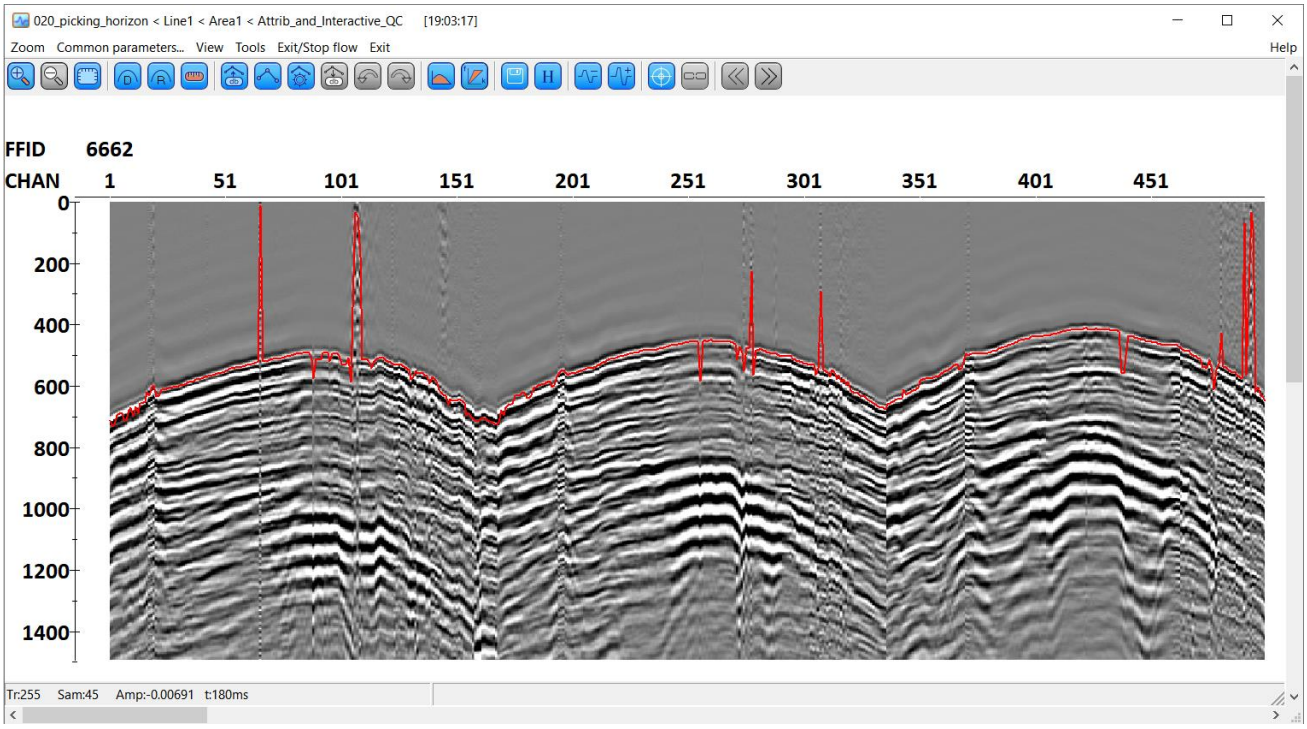


Horizon (header word) – this is the trace header, starting from which the search for first-arrival time will be executed. Here is default header is SOU_H2OD, let us leave it as is. This header in the dataset has no values, and the module will interpret this as 0.

Lastly, prior to starting the flow the following shall be done: let us customize header plots in the module Screen Display to display the results of First Break Picking – FBPICK header. In the Screen Display parameters click the Plot Headers button and choose FBPICK for plotting a graph in time scale:



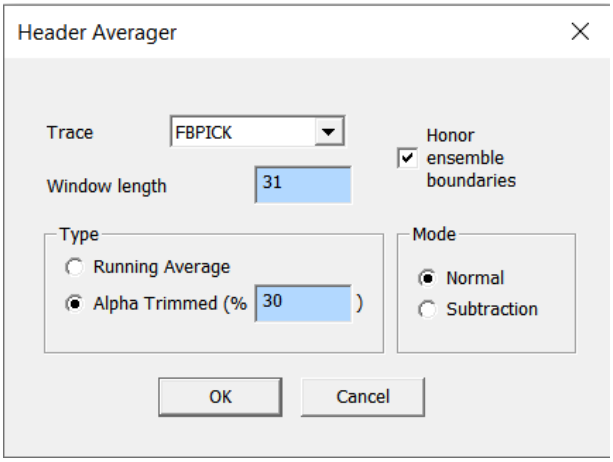
Run the flow. The result is shown below:



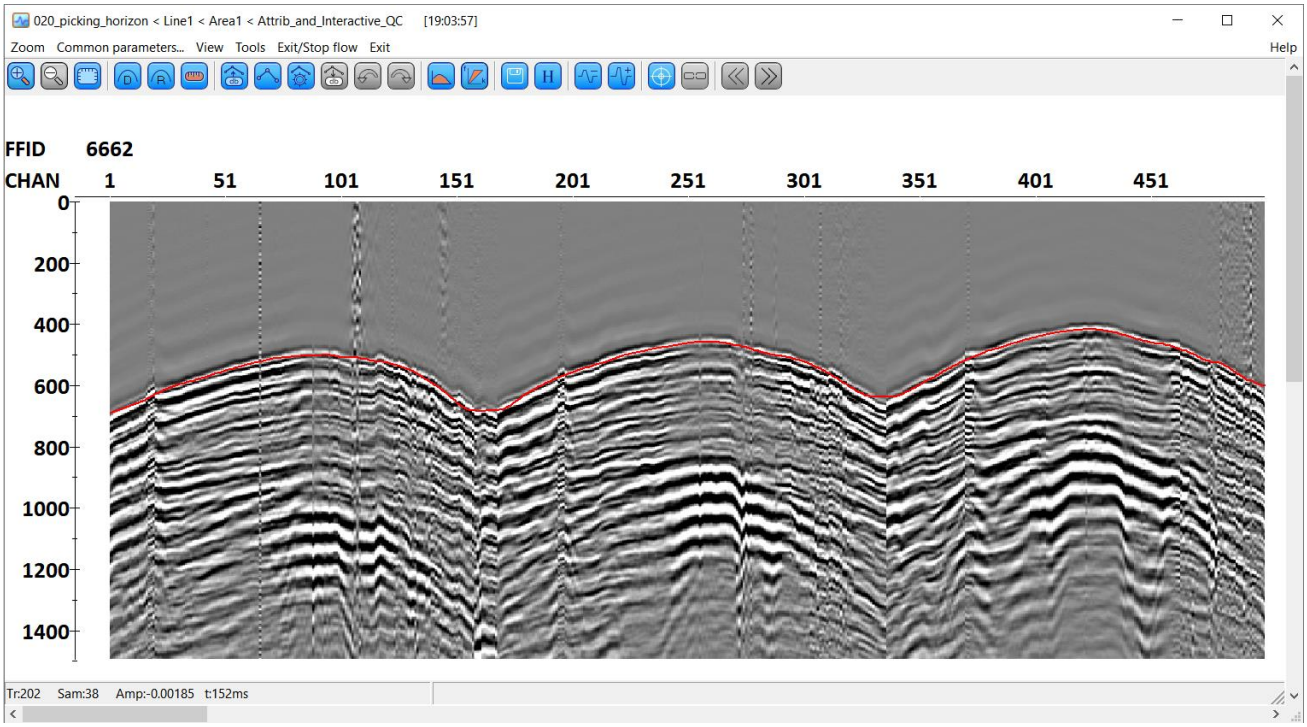
As you can see, the automatic picking with the given parameters worked almost good. We will fix the occasional errors through averaging of the obtained picking with the use of module Header

Averager. This approach is quite suitable for our purposes since in this case it is acceptable if the picking is not very accurate.

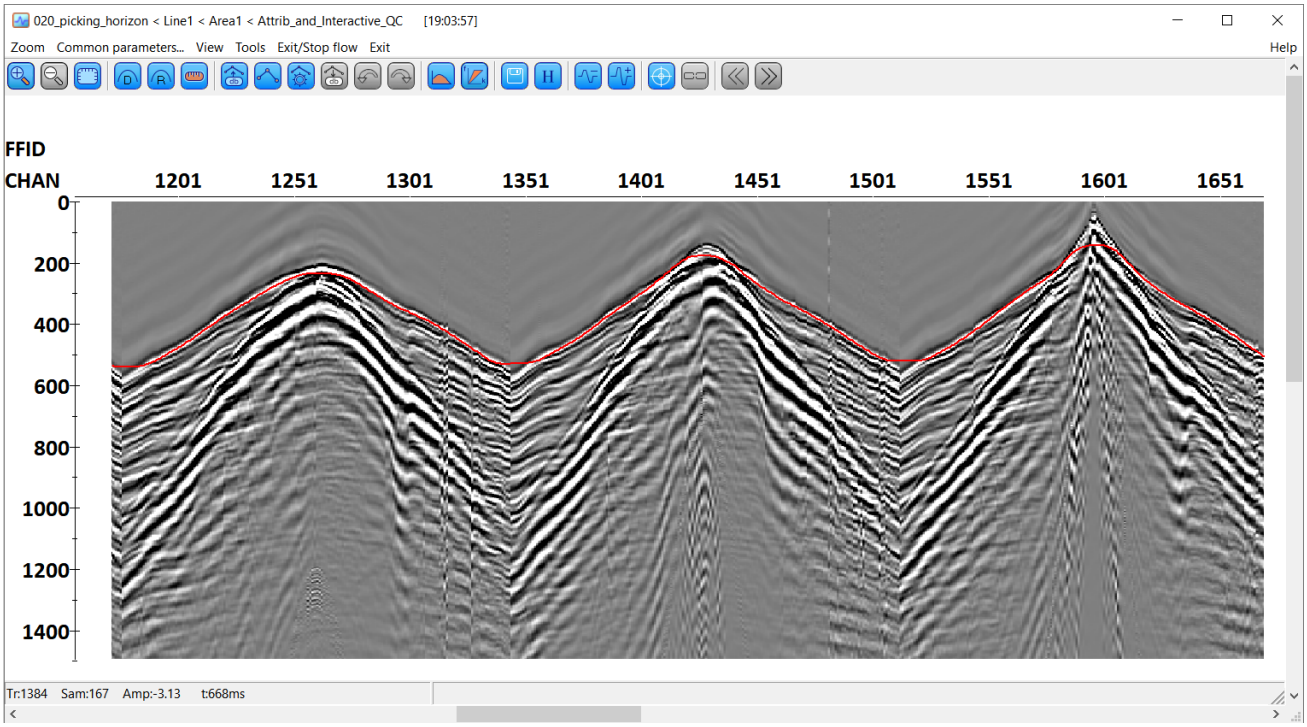
For averaging FBPICK values add Header Averager module into the flow right after the First Break Picking. The module parameters are presented below:



Run the resulting flow:



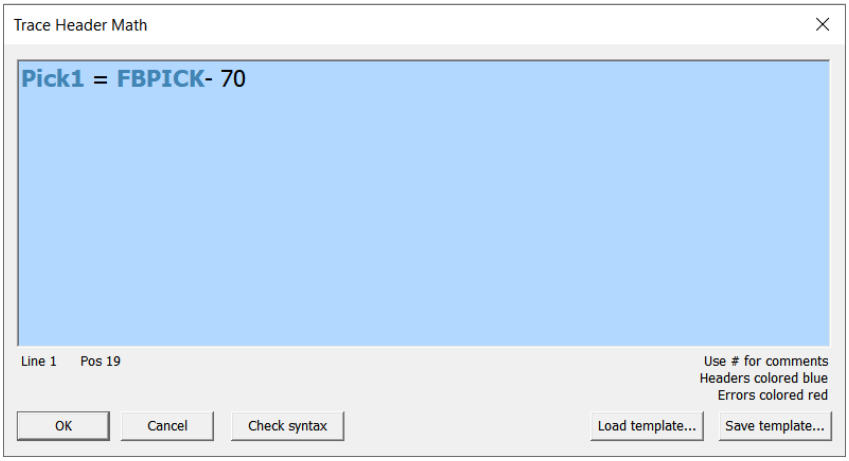
As a result, the obtained pick of the first breaks is suitable as a horizon, relative to which RMS amplitudes of the signal will be computed. Scroll top to the right and see how the module worked on other channels:



Now, it is necessary to shift the pick slightly up so that it is above the first break (we do want include the first break itself into the amplitude estimate) and save the result.

Return into the flow and add Trace Header Math module to shift the pick (place it after the Header Averager). Here, let us write an expression that shifts the pick upwards by 70 ms:

Pick1 = FBPICK – 70



Further, the obtained values of headers FBPICK and Pick1 shall be stored (so far they exist only as the data headers in the flow). It is possible to save them using Trace Output to a new dataset; however, creating one more copy of the input data just because of the changed headers seems excessive.

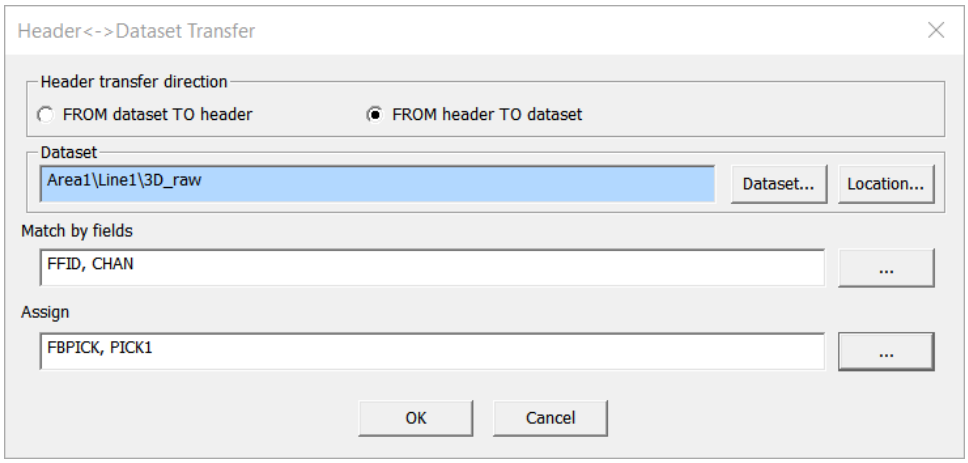
One more method, sometimes useful, lies in the possibility of entering Trace Length module and setting new trace length equal to 0 prior to saving the data. Then, the traces will be trimmed, so that the dataset saved in this way will include the headers only. It can be useful to employ this method if it is further planned to perform any intensive work only with the headers - their smoothing, computation of derived attribute, etc.

Here, we will use the most comfortable and universal method of saving the changed headers – re-wright them back into the input dataset using a module for exchanging headers between the flow and the data on the hard disk – Header<->Dataset Transfer.

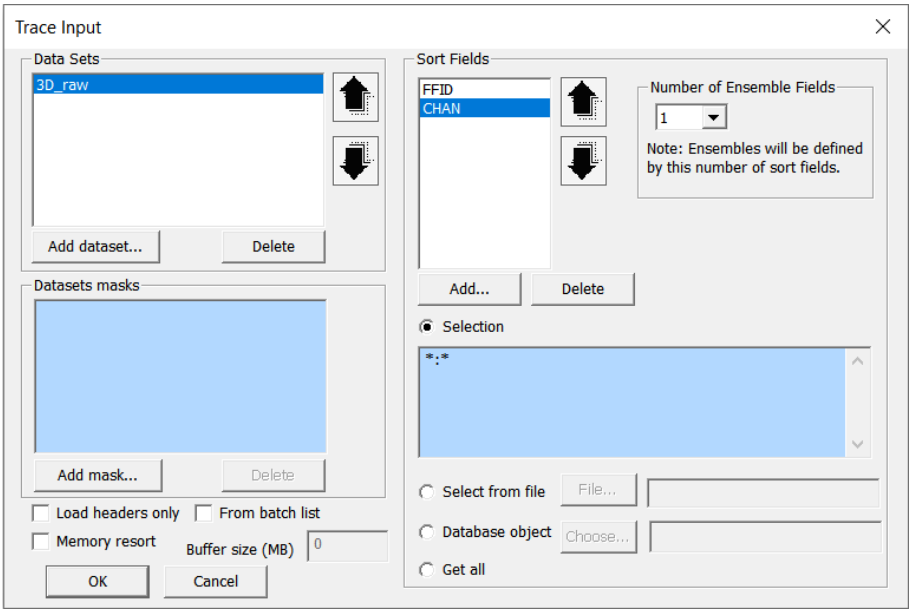
Add Header<->Dataset Transfer module into the flow. Indicate direction of the module's work (from the flow header to the dataset - FROM header TO dataset), select a dataset, into which the flow headers are to be written (3D_raw).

Indicate the headers, by which the module will determine a required trace (Match by fields). In this case, two headers - FFID, CHAN - are sufficient as picking was made for each trace of a shot gather.

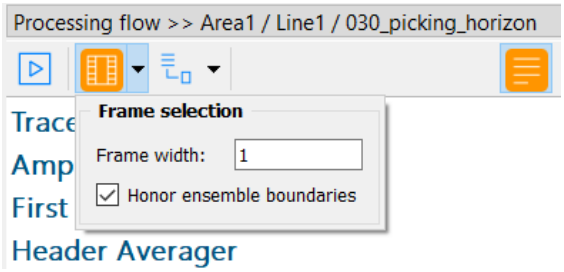
List the headers to be re-written (Assign fields). These are FBPICK and Pick1:



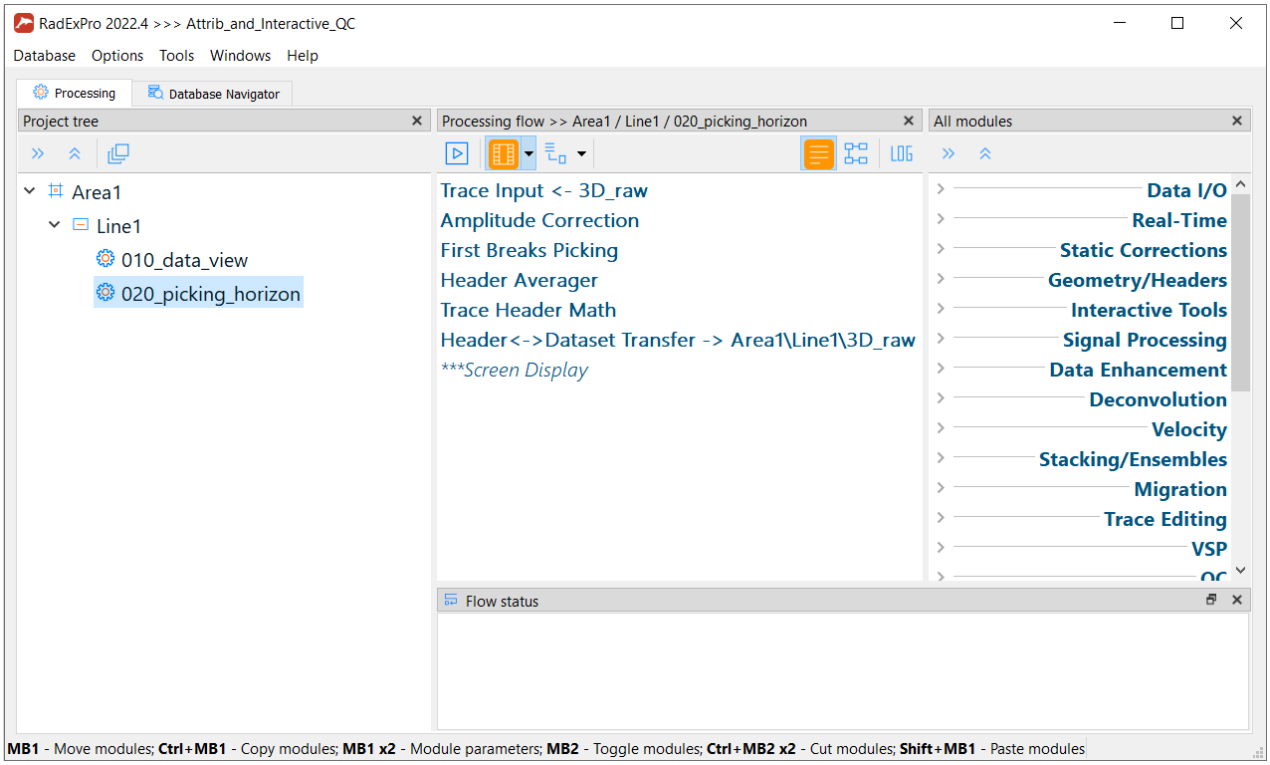
The flow is ready. Prior to starting its run, enter the Trace Input and remove limitations on the input since at this moment we will need all of the data. Replace the selection mask by *:* (as shown below):



Before running the flow do not forget to switch on the framed mode of its execution (after all, we are pretending that it is a whole big 3D volume that we work on).



Prior to starting execution of the final flow right-click on the Screen Display module to de-activate (comment-out) it. When a module is commented, it will be omitted at the flow start:

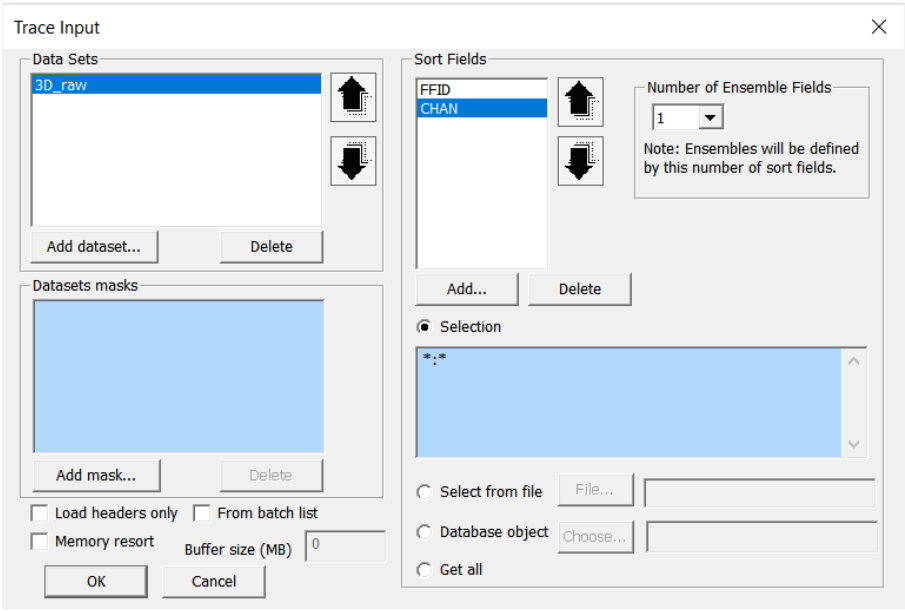


Upon completion of the flow, if you wish, you can to look through the filled fields of the headers using the Geometry Spreadsheet tool.

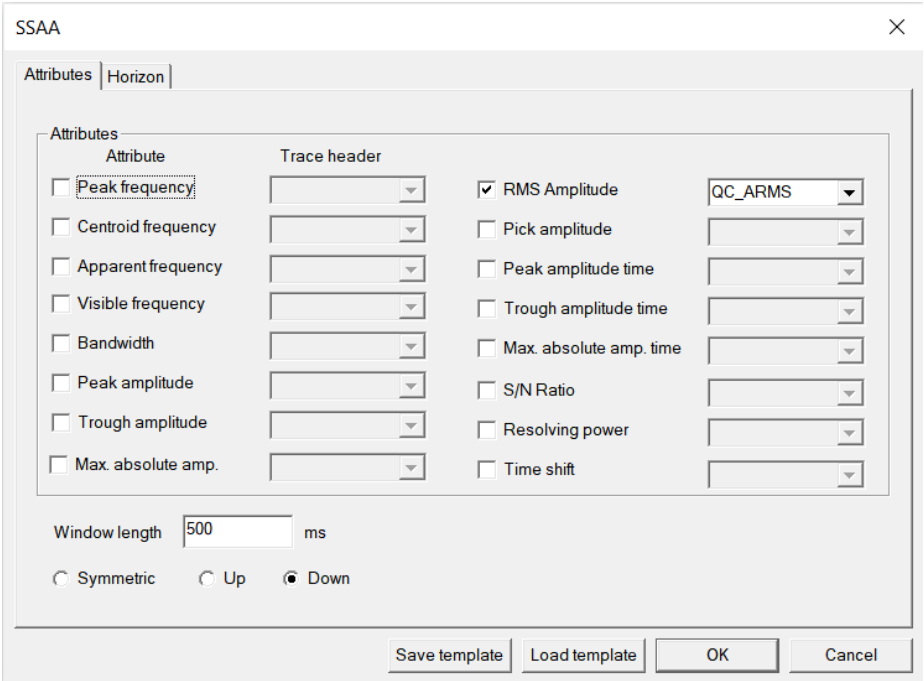
Computation of Attributes

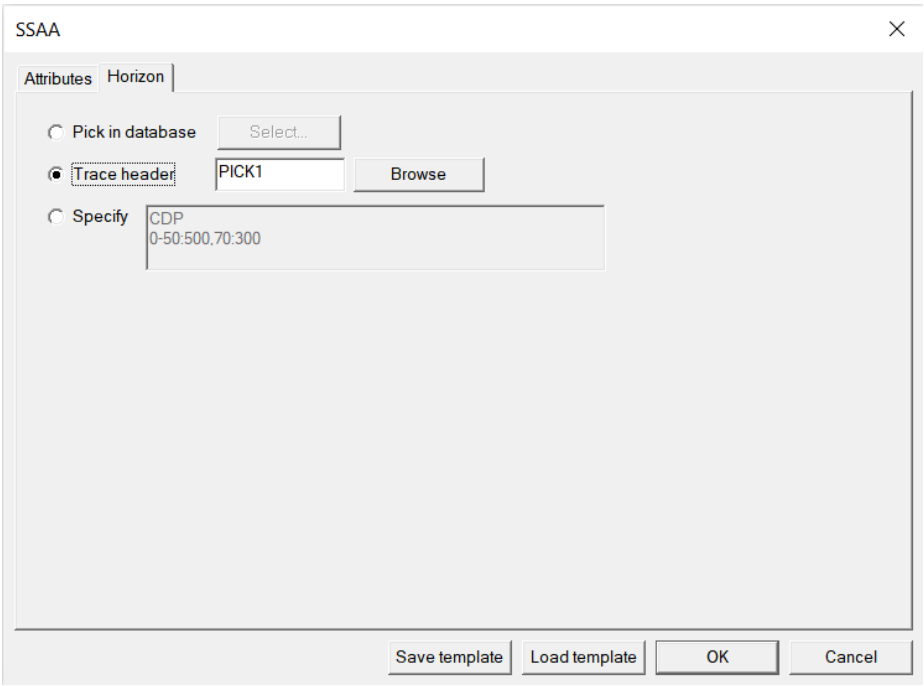
Now, when we have a horizon that defines where the attributes are to be computed, let us proceed to the computation. Let us create a new flow for that purpose – *030_per-trace attributes*.

Add a Trace Input to the flow. Choose dataset 3D_raw, indicate the sort keys (Sort Fields) FFID and CHAN.



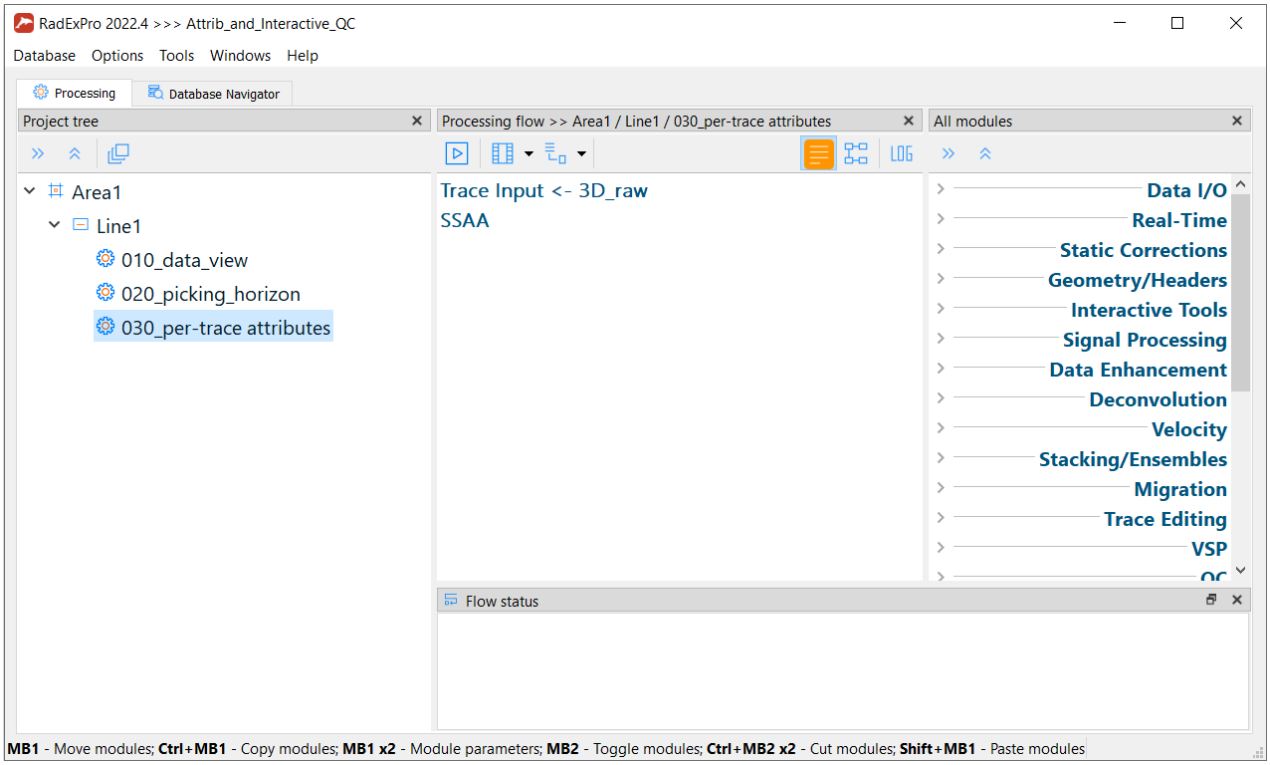
For computation of the attributes, we will use SSAA module. This module allows computation of a number of seismic attributes -- frequency, amplitude, time corresponding to maximum and minimum amplitude, signal-to-noise ratio (for detailed information on the module operation see RadExPro User Manual). Add SSAA into the flow:





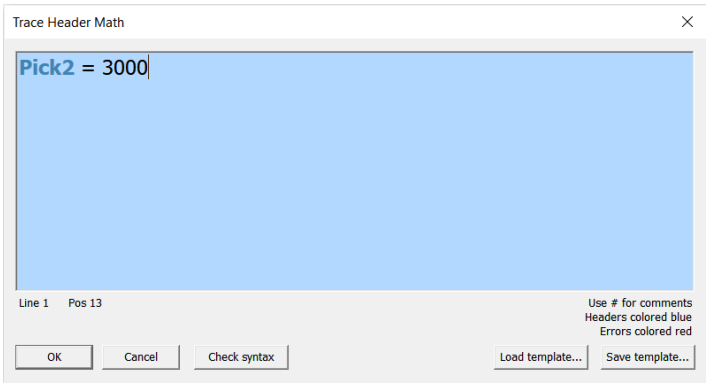
Set parameters as shown in the figure above: set 500 ms downwards from the header indicated in the Horizon tab (Pick1 populated in the previous flow) as the computation window (Window Length). Let us compute values of RMS amplitude within the window (RMS Amplitude) and save them into QC_ARMS header of each trace.

Now the flow looks like this:

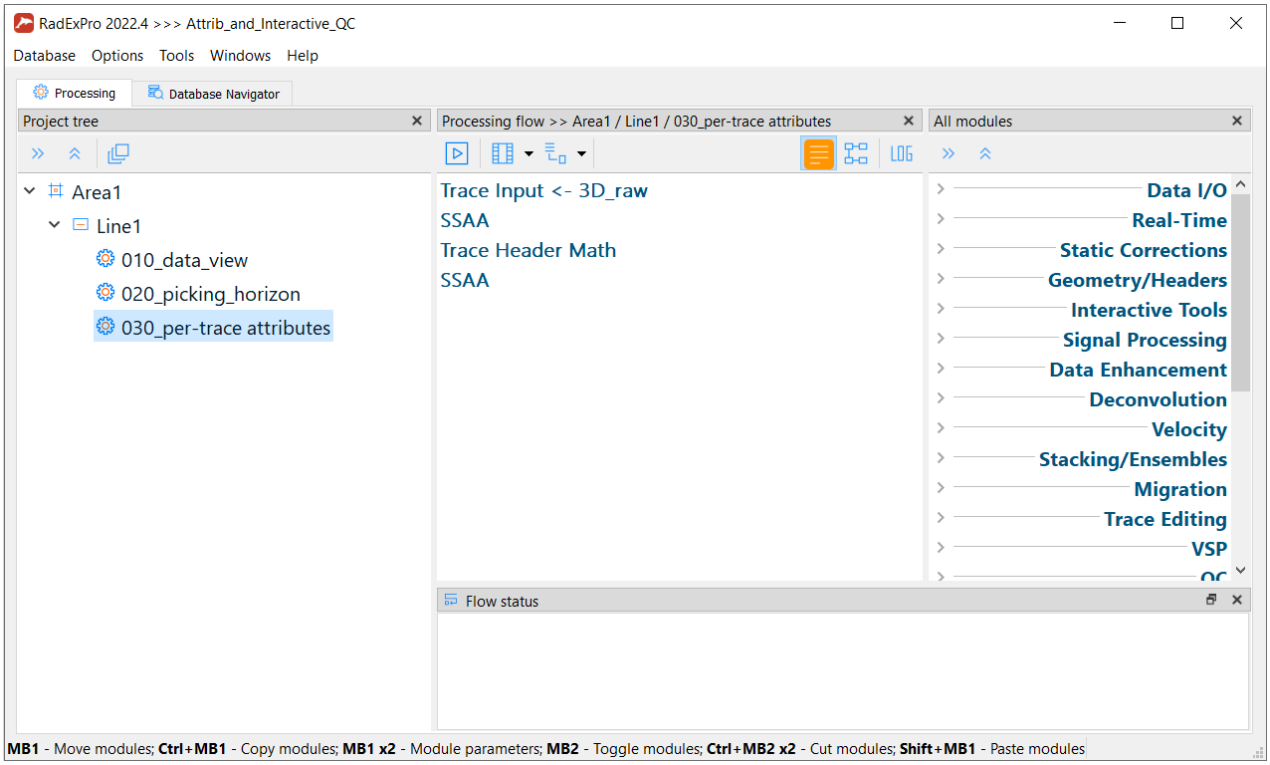


Further, let us create a horizon, defining where RMS amplitudes for the background noise (microseism) will be computed. We will use the very end of each trace where the signal is supposed to be attenuated. Add Trace Header Math module and write the following expression:

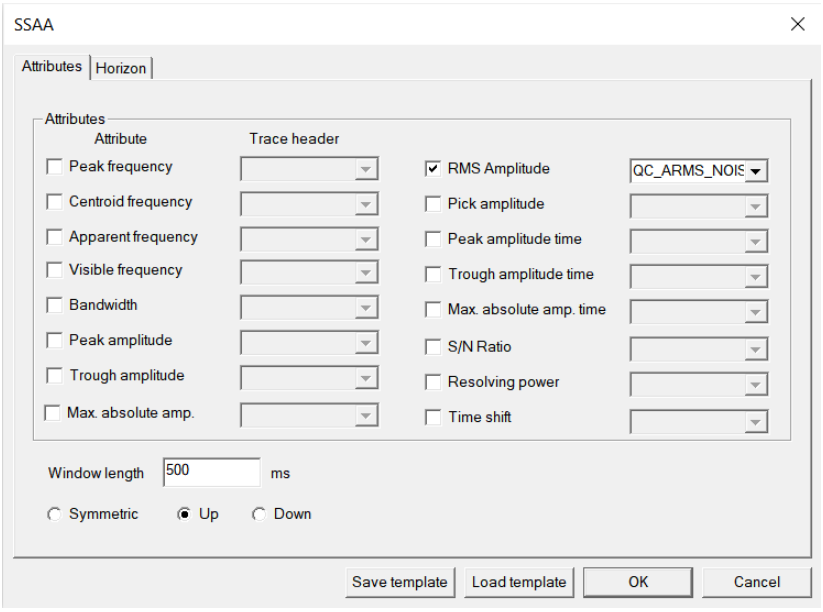
Pick2 = 3000

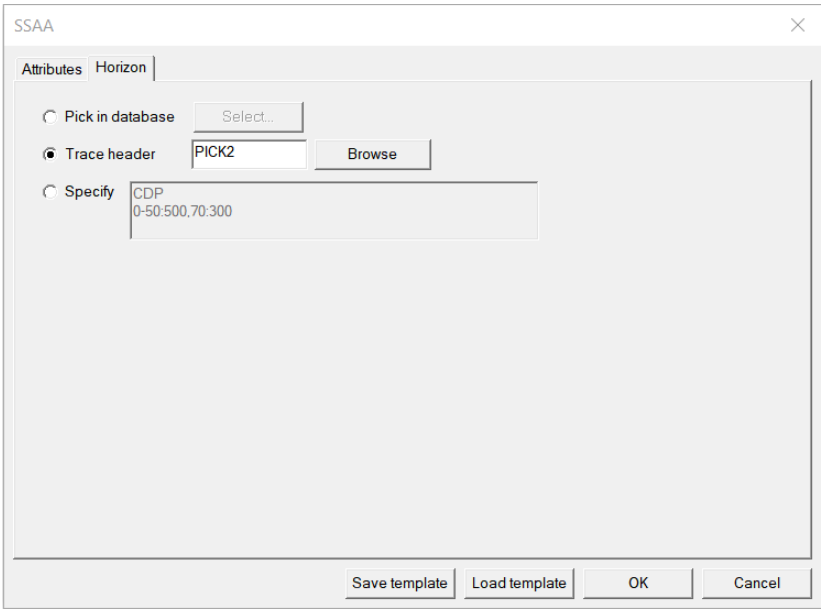


Following Trace Header Math, add one more copy of the SSAA module to compute the amplitude for the microseism. The easiest way to do that is to copy the module that already exists in the flow (Ctrl+c, Ctrl+v).

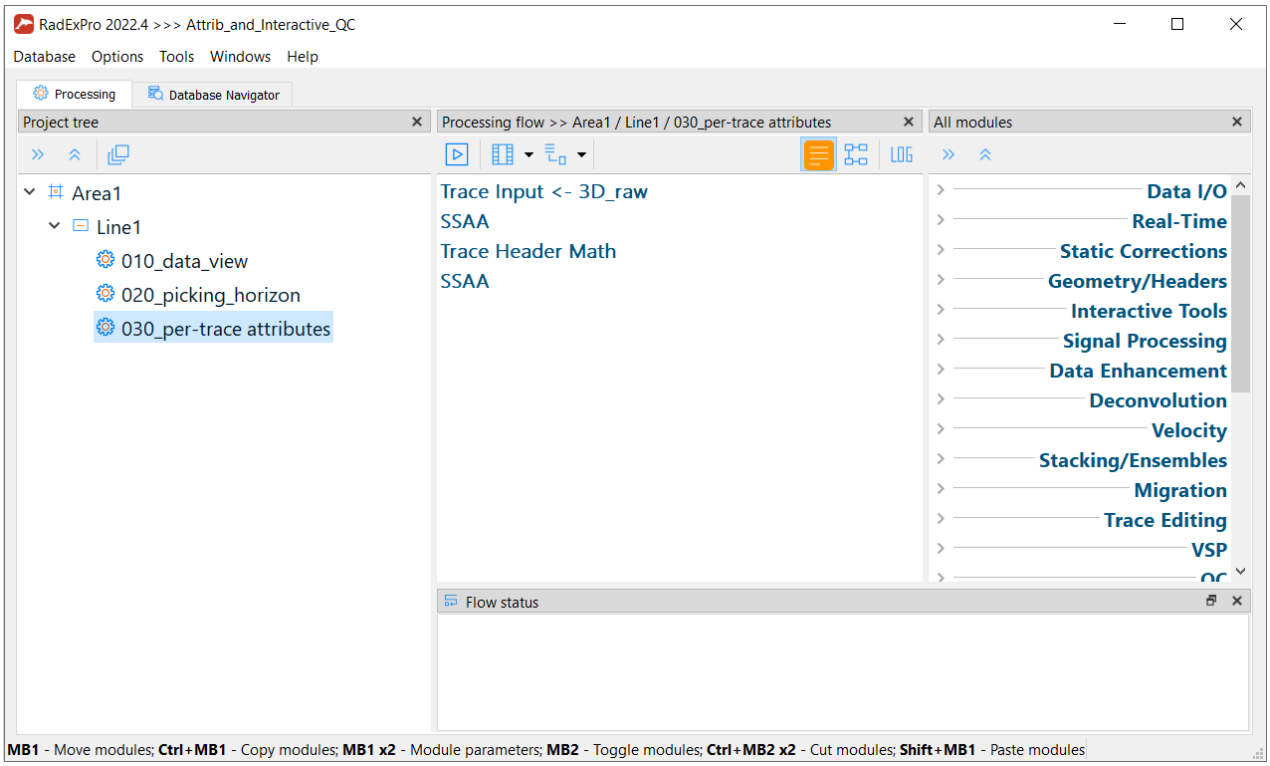


Now enter the second copy of the module and change the parameters: change the header for the RMS amplitude values to QC_ARMS_NOISE, the window now will be counted upwards from the Pick2 horizon:

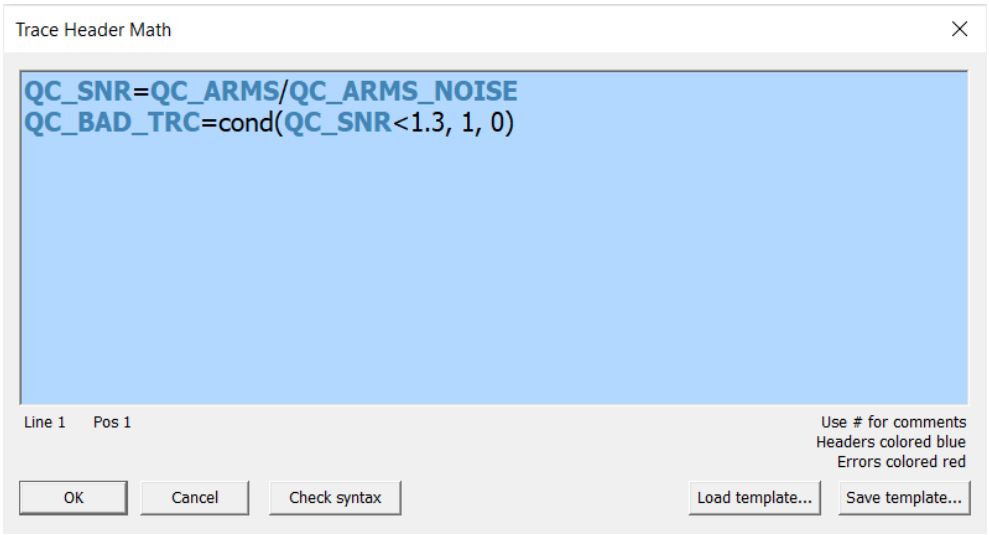




Now the flow looks like this:



Add one more instance of Trace Header Math where we will compute derived: signal-to-noise ratio and a parameter corresponding to a bad trace:



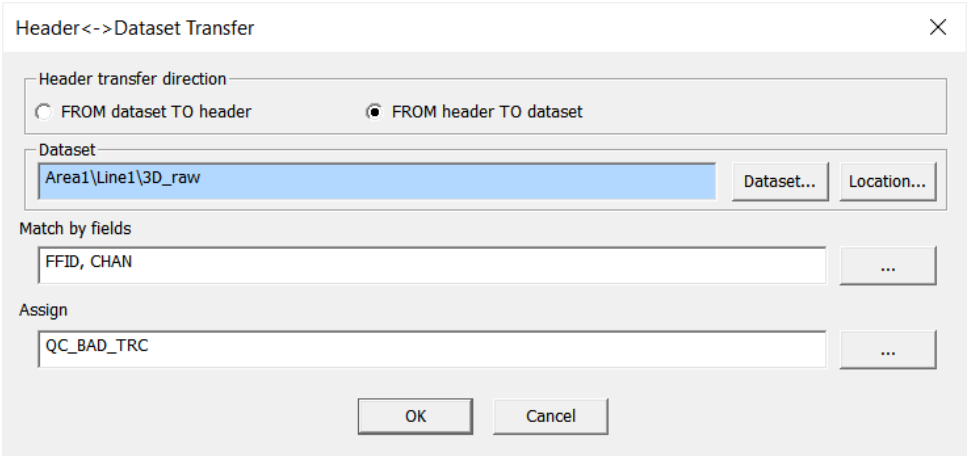
Write the following expressions in the module's edit window:

```
QC_SNR=QC_ARMS/QC_ARMS_NOISE
QC_BAD_TRC=cond(QC_SNR<1.3, 1, 0)
```

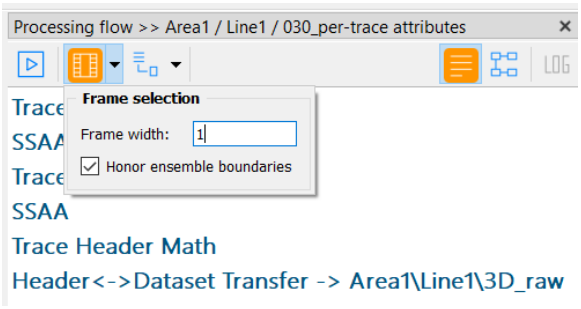
In the first line signal-to-noise (QC_SNR) is computed as ratio of the amplitude on the first breaks to the microseism amplitude.

In the second line, if the signal-to-noise value turned out to be less than 1.3, then a value of 1 (that is defect) is assigned to QC_BAD_TRC header, otherwise - 0. This is only the simplest example of how random composite quality coefficients can be calculated in the program. They, naturally, can be made more complicated, for example, to determine some points-based system of quality assessment that most adequately corresponds to the studied area and customer's requirements.

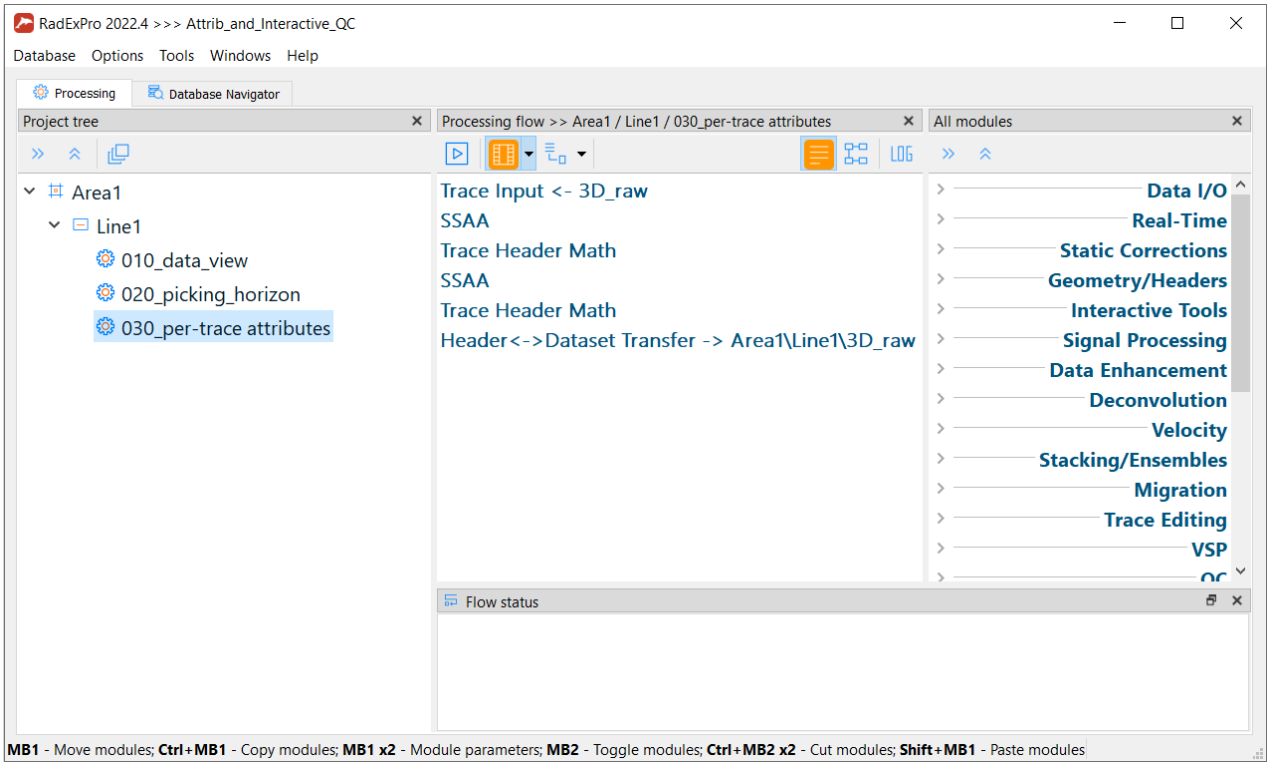
As in the previous flow, let us save the computation results using Header<->Dataset Transfer module:



The flow is ready. Once again, do not forget to switch on the framed mode.



Run flow:

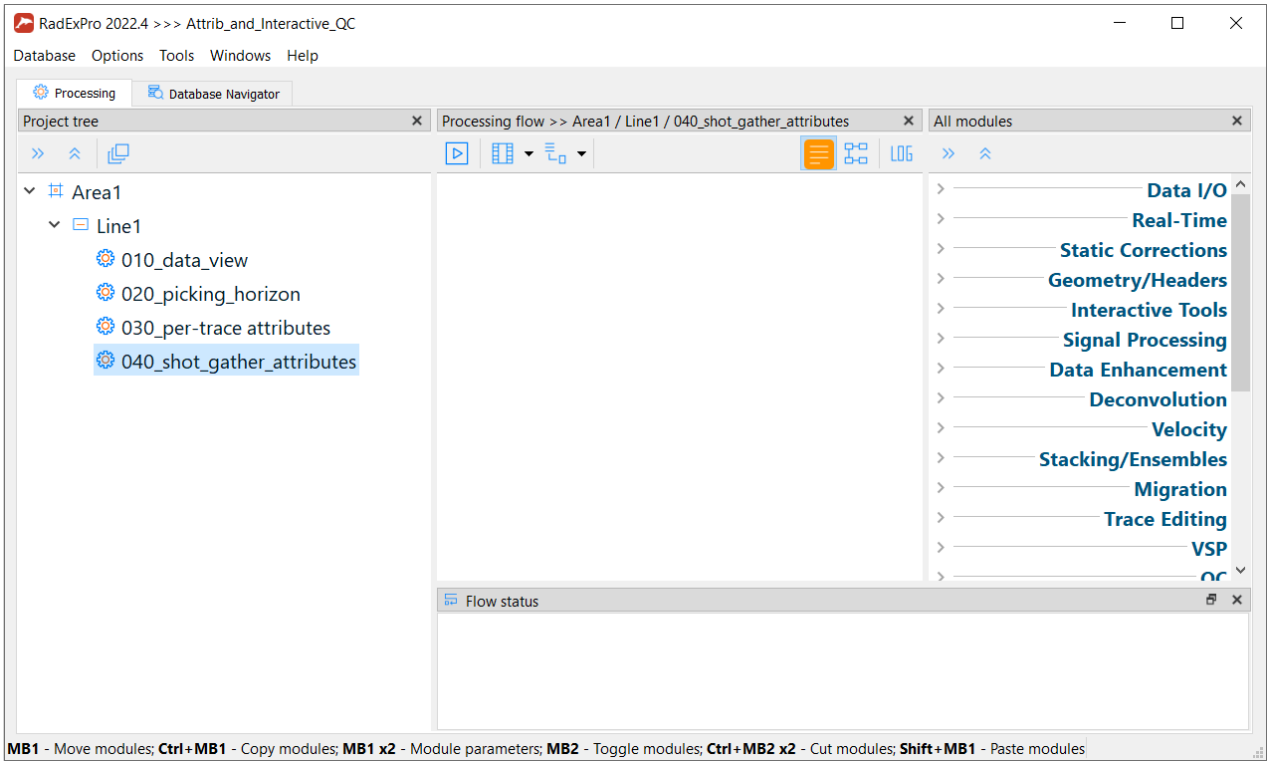


Computation of Gather Attributes

Defining windows for attribute computation

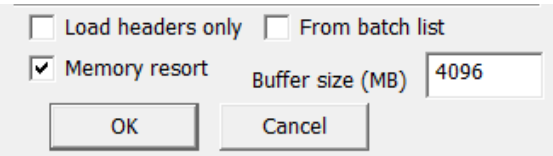
On each common shot point gather, we would like to compute an RMS amplitude of a signal in the target reflection area, apparent frequency in the target reflection area and RMS amplitude of the background noise. For this purpose, it is necessary to define space-time windows corresponding to the target reflections and microseism. Let us do it interactively in Screen Display module.

Create a new flow - *040_shot_gather_attributes*:



Enter it and add Trace Input module.

To compute QC attributes on shot gathers it is necessary to feed the data to the input in FFID:OFFSET sorting. Then, it is possible to interactively assign space-time windows for different types of waves. Choose dataset 3D_raw, indicate sorting keys (Sort Fields) FFID and OFFSET. For the purpose of quick sorting of the data bulk in the memory, check Memory Resort box (it will use the same sorting algorithm that is used in the Resort module) and indicate the maximum buffer size which can be used by the module. The buffer should be at least two times smaller than the size pf physical RAM available. Here we will use the buffer of 4096 Mb.

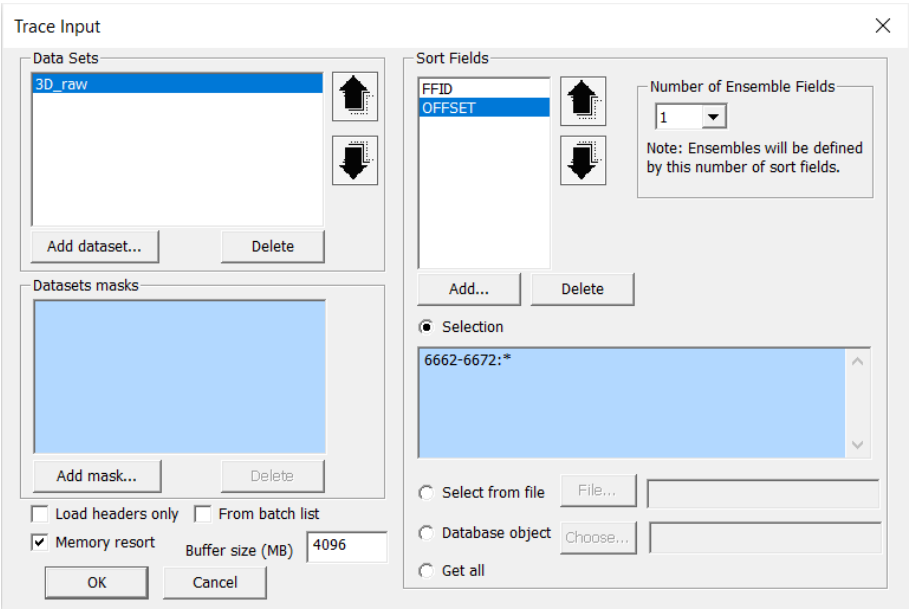


The space-time windows for the attribute computation are linked to time and offsets only, therefore, there we do not need to read all the data to set them up. Let us read the first 4 shot gathers and the whole range of offsets available in them. For that, we will type the following expression in the Selection field:

*6662-6672:**

The selection mask means that only traces with values from 6662 to 6672 will be chosen for the first header from the Sorting fields list (FFID), and all traces for the second header (CHAN).

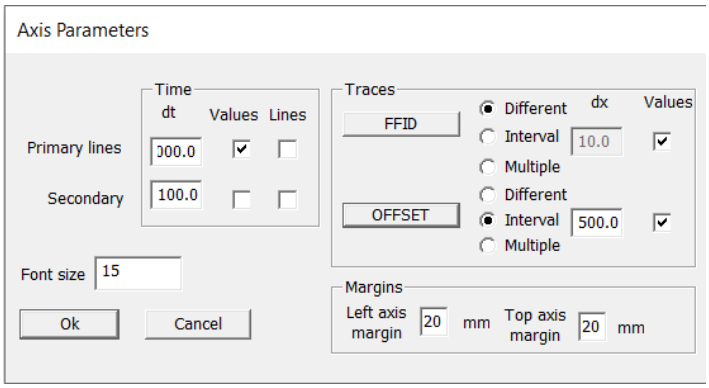
Trace Input dialog window will look like this:



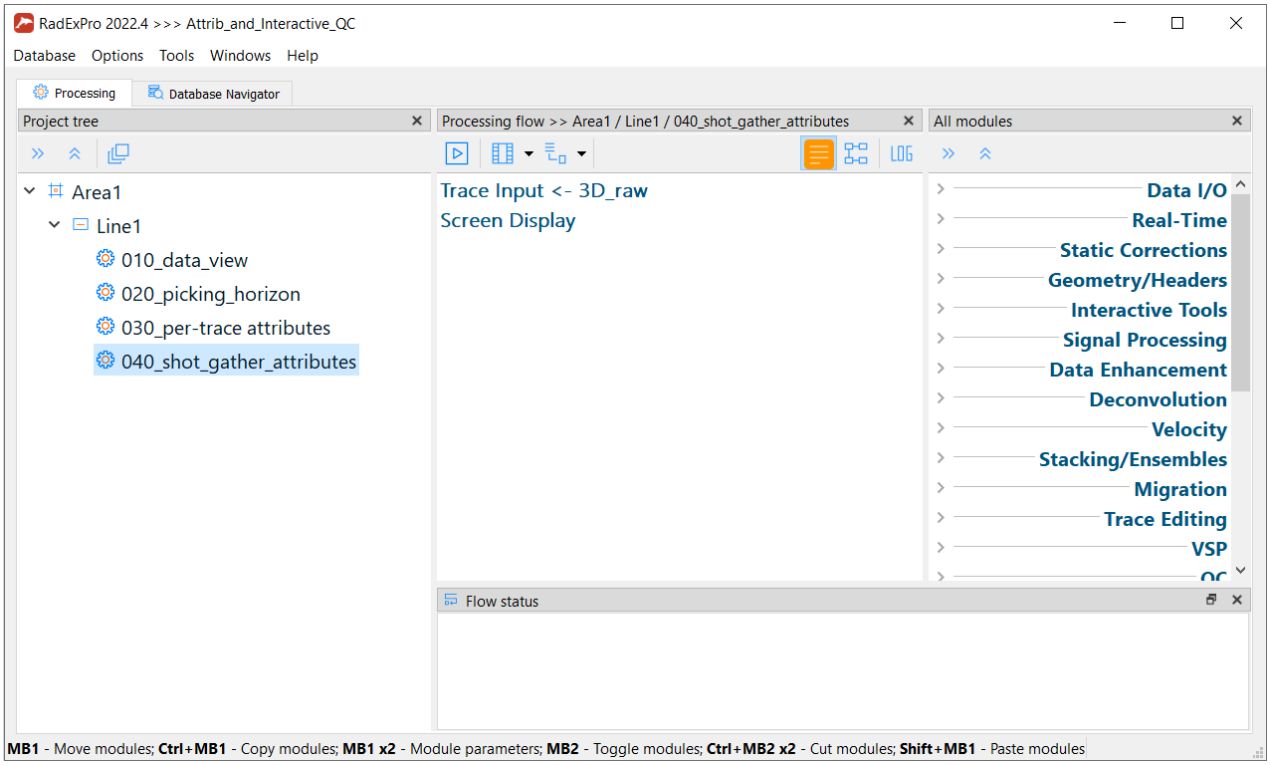
Add Screen Display module into the flow. Indicate the horizontal scale - 6000 traces per the screen (Number of traces) and check the Ensemble Boundaries box so that the module shows gaps between ensembles. Since the number of the keys determining the ensemble (Number of Ensemble Fields) in module Trace Input is indicated as 1, and the first sort key in Sort Fields list is FFID, the program will consider every set of traces with the same FFID to be a separate ensemble. That is, with these settings ensembles would correspond to common shot gathers.

The parameter window will look like that:

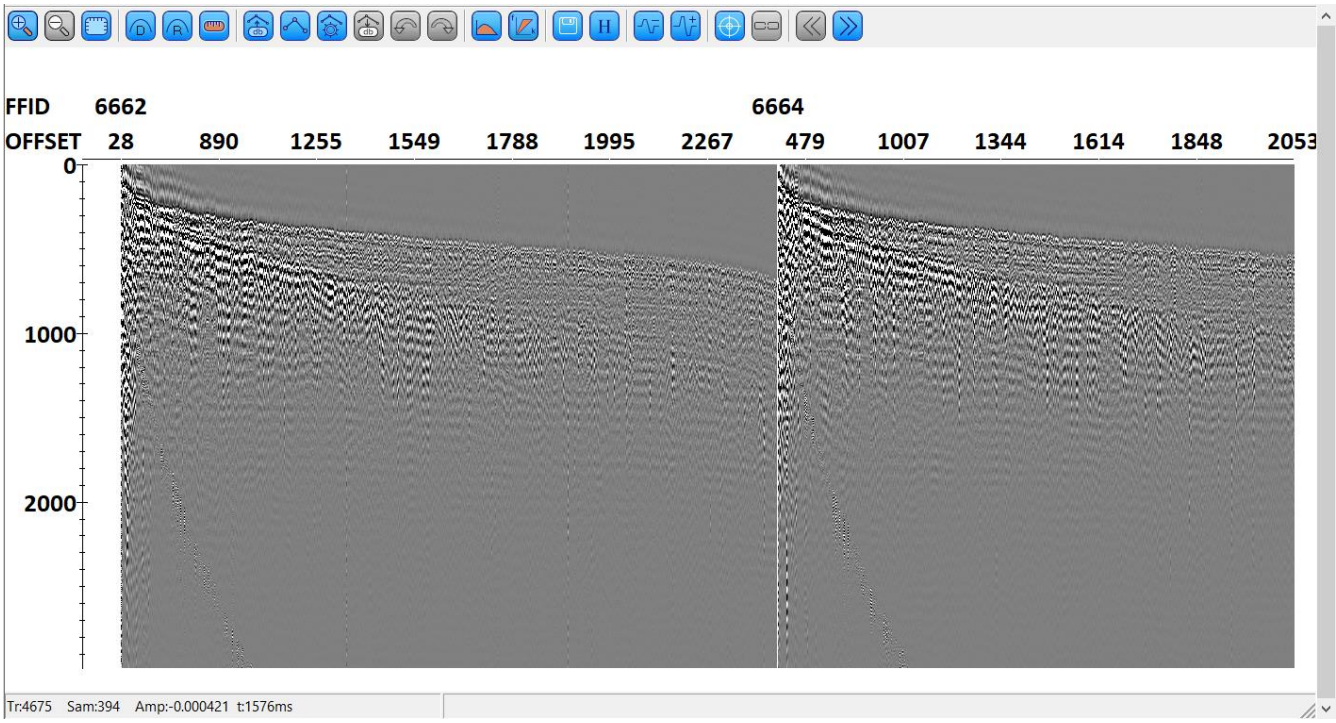
Push Axis button to adjust labeling along the horizontal axis. Let us lable FFID values every time when they are changing, and OFFSET values for each 500th trace:



Since only few seismograms are input into the flow, we do not need to use the framed mode here and will run the flow as it is:

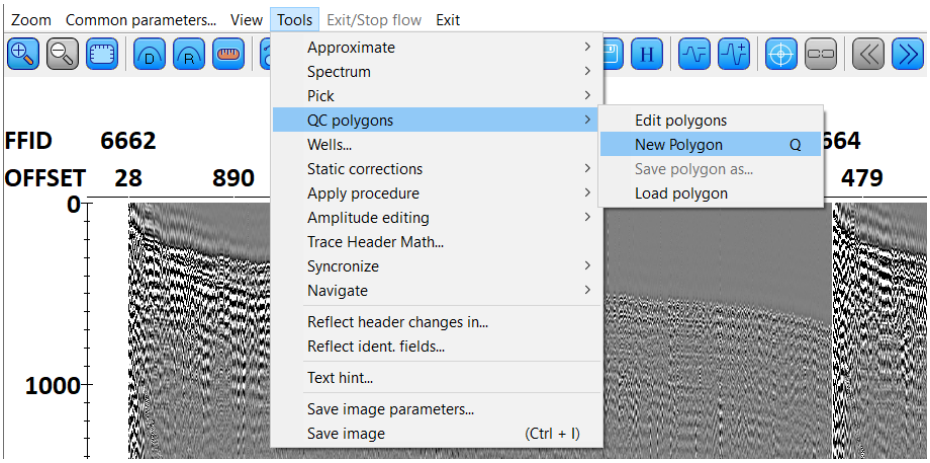


Window of Screen Display module will open. Note that the gathers are now separated by gaps:



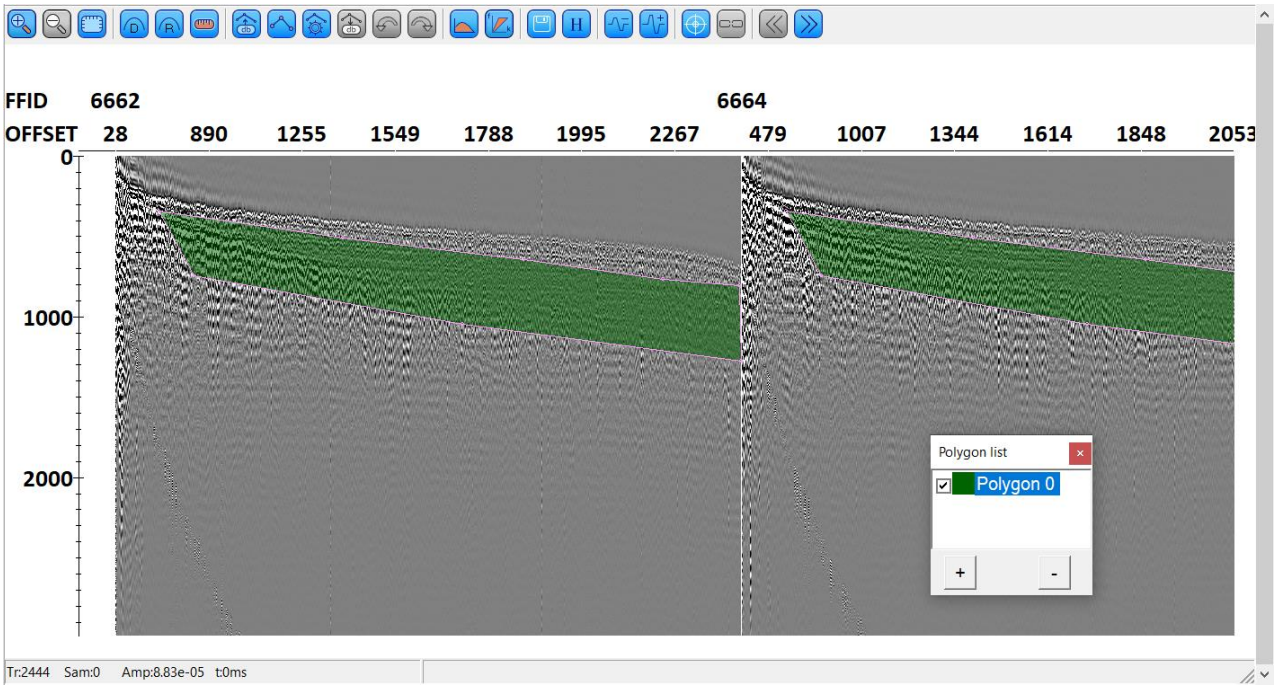
Enter *Tools/QC polygons* menu and choose *New polygon* command to create a new window

for computation of attributes (new "polygon"):

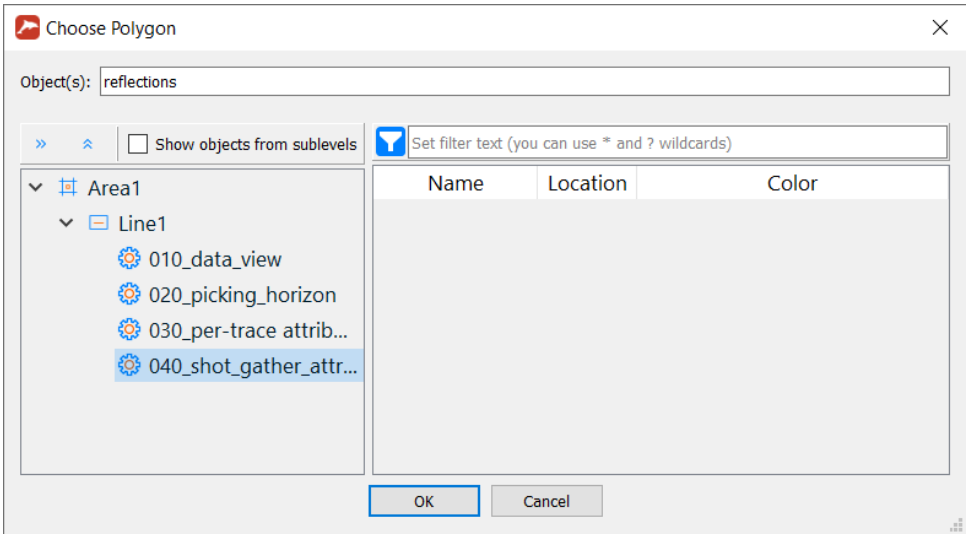


A pop-up window with the list of polygons will open. A polygon picked in the list (just created Polygon 0) can be interactively set and edited on the screen:

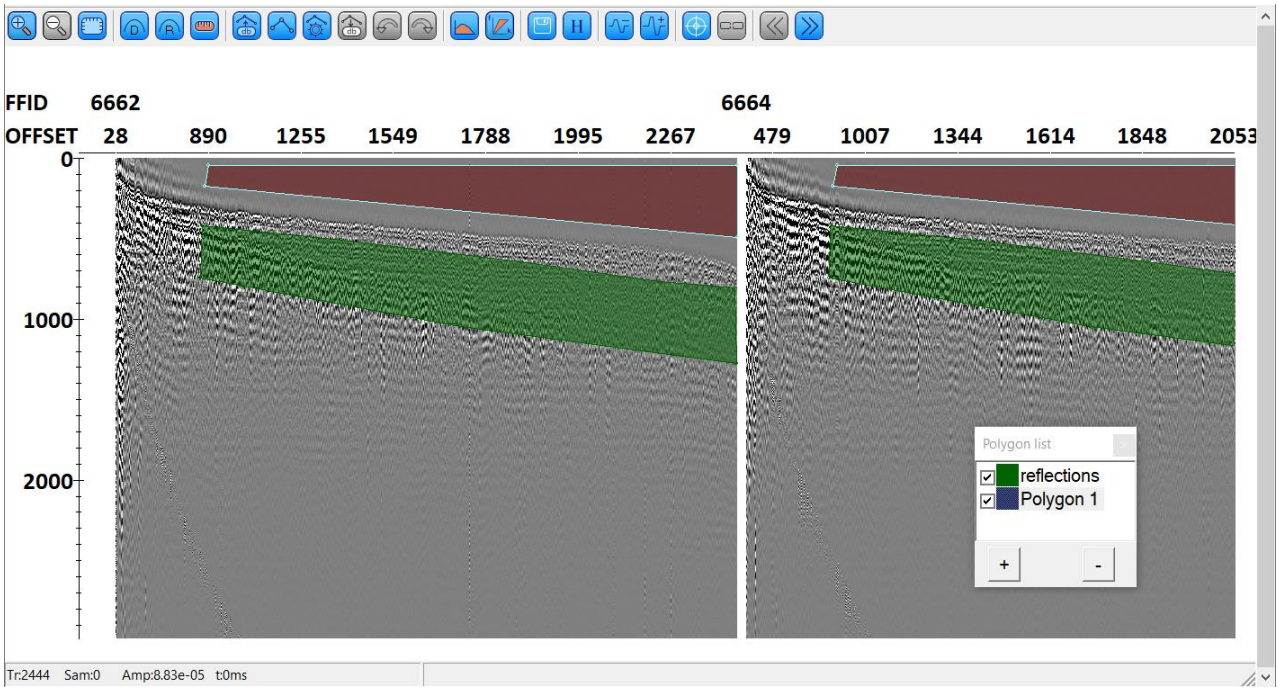
Let delineate a polygon around the target reflection area clicking successively the left mouse button on the screen. It is possible to set a polygon on any seismogram - it will be similarly depicted on all of them:



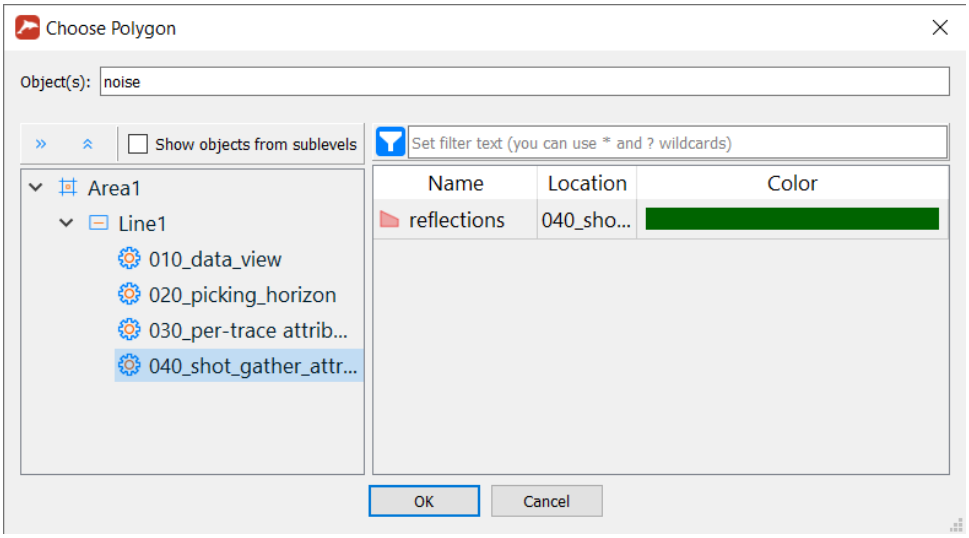
After having the polygon created, right-click on its name in the polygon list and choose *Save polygon as* in the opened context menu. Save the polygon in the database at the level of the current flow with the name reflections:



Now, create one more polygon in the background noise area (above the first breaks) in a similar way:



Save it there also with the name noise:

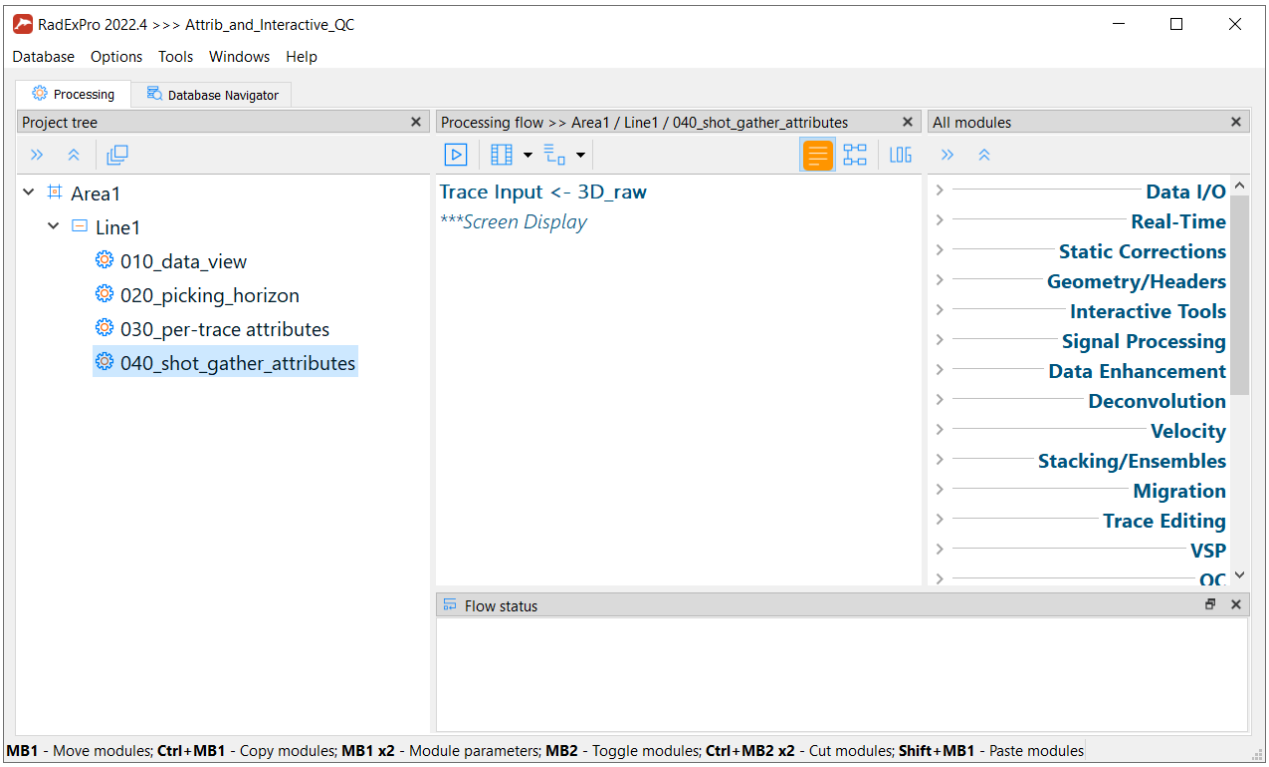


At this, creation of windows is completed. If desired, before exit it is possible to scroll in Screen Display window to the right and see other seismograms to make sure that reflections and noise polygons were set similarly and correctly everywhere.

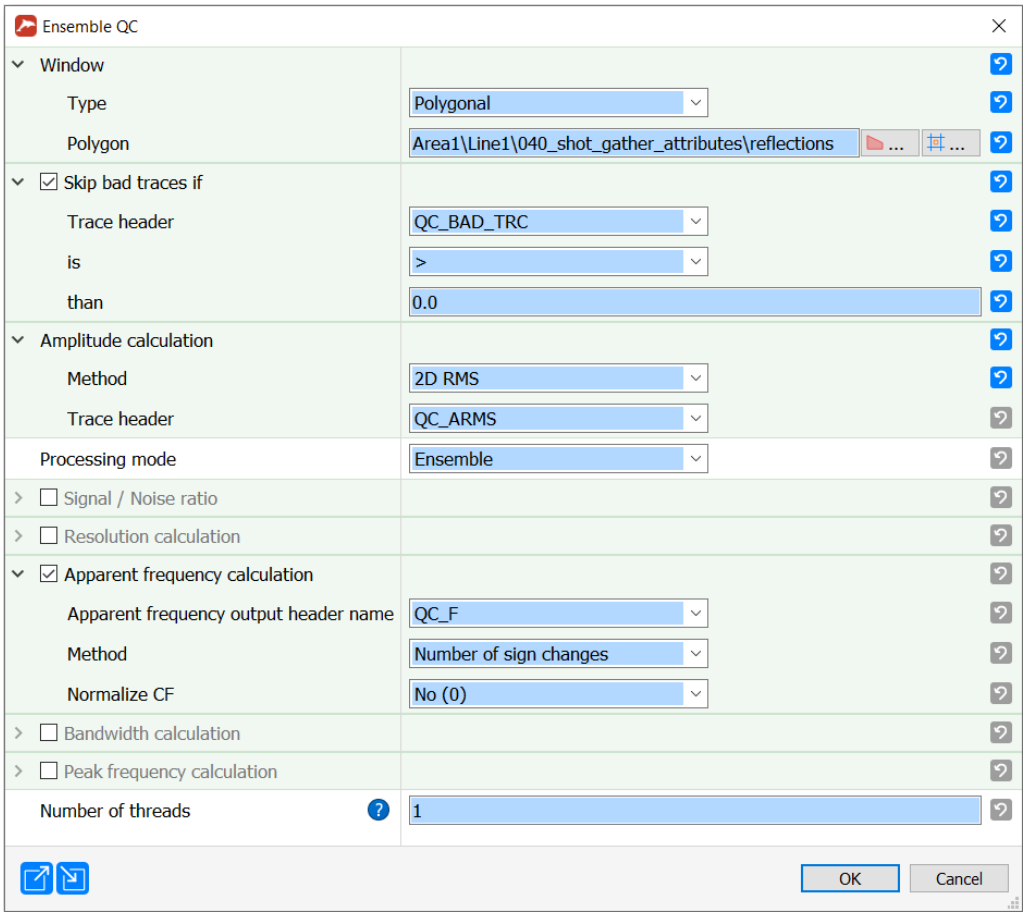
Computation of attributes in windows

Now, when we have window for the attribute computation, it is possible to proceed directly to the computation. We will continue working in the same flow.

Firstly, right-click on Screen Display to comment it out:



Then, add Ensemble QC module into the flow. This module allows estimation of several QC attributes by a seismogram:



Let us set the parameters as shown in the figure above: choose a polygon with the target reflections - reflections as a computation window (Window). (As an alternative, it is also possible to set a rectangular window of ranges of offsets and times).

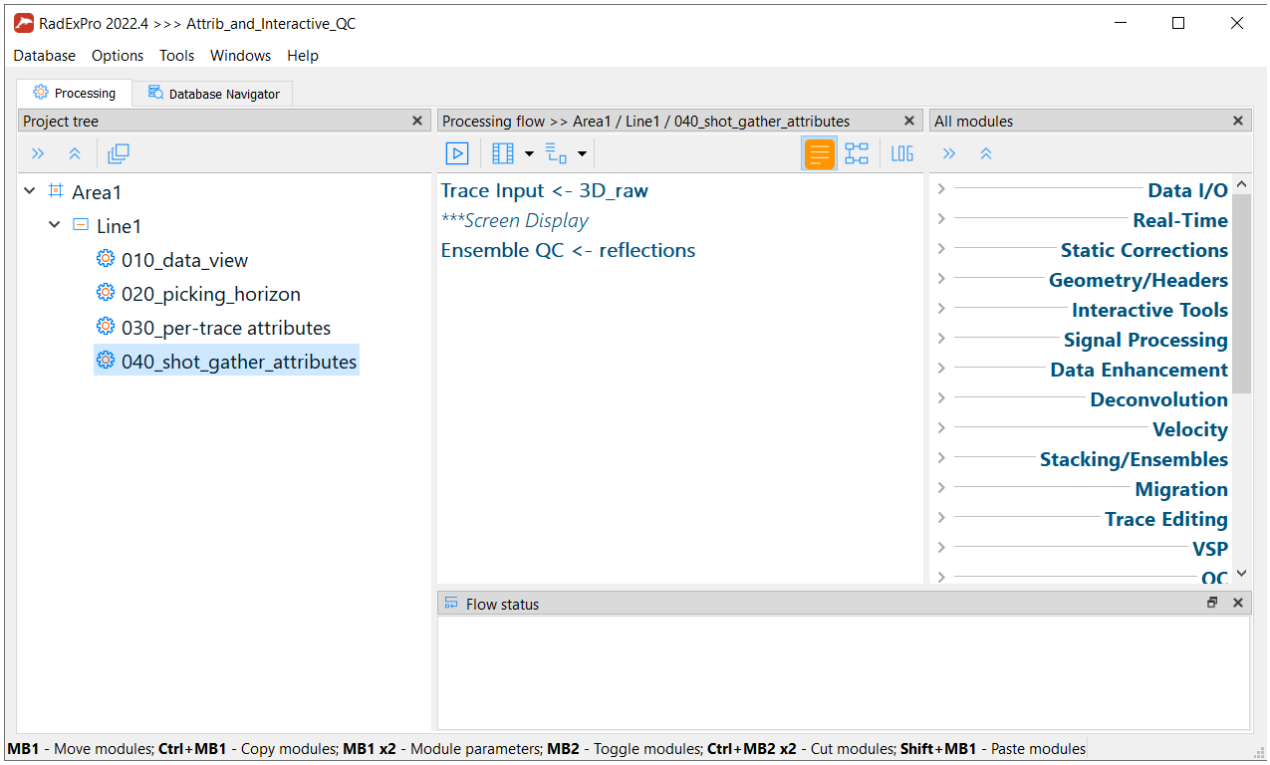
While computing the ensemble attributes we do not want the traces, which we have already marked as bad, to take part in the computation. So, we will switch on Skip bad traces option if QC_BAD_TRC header has a value of greater than 0.

Let us compute RMS amplitudes in the window (2D RMS) and save them in QC_ARMS header of each trace.

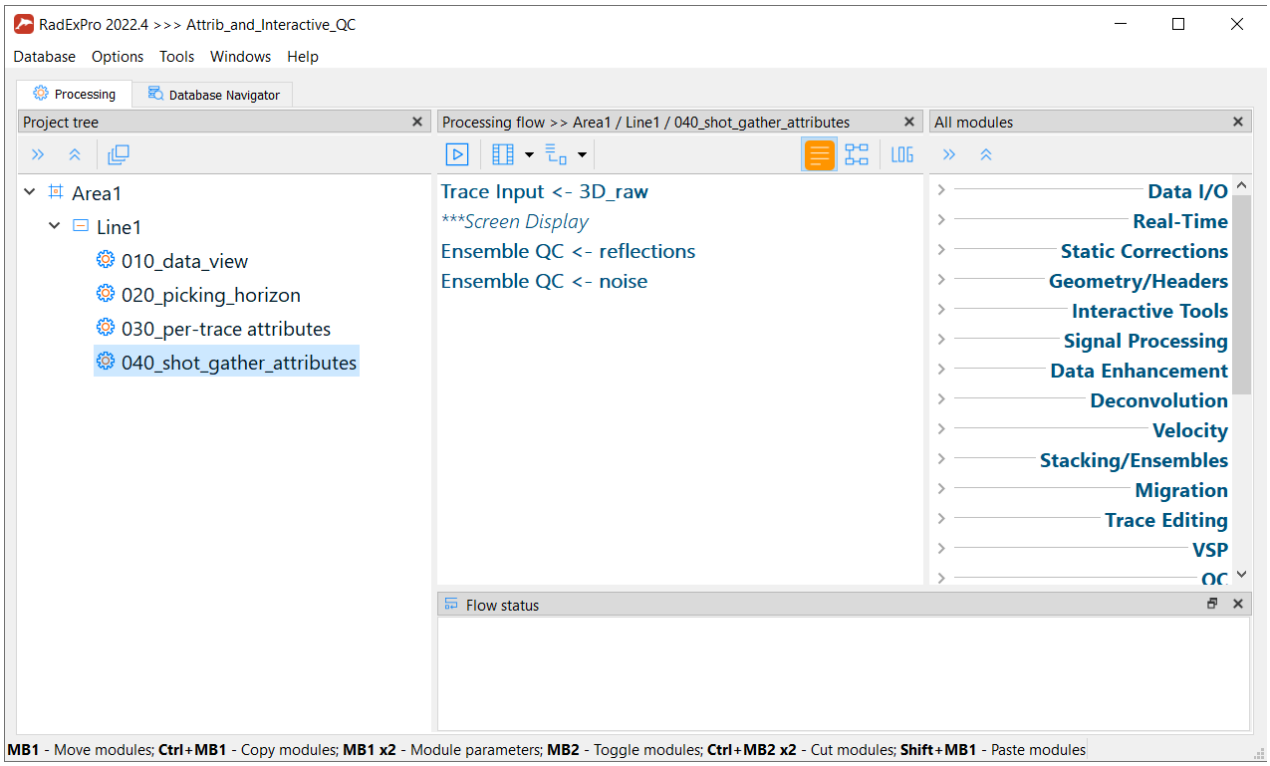
We are not going to compute correlation signal-to-noise ratio and resolution now, so we will uncheck Compute Signal/Noise Ratio and Compute Resolution options.

We will estimate apparent frequency of the signal by the number of sign changes within the window, and values will be saved in QC_F header field.

Now the flow looks like this:

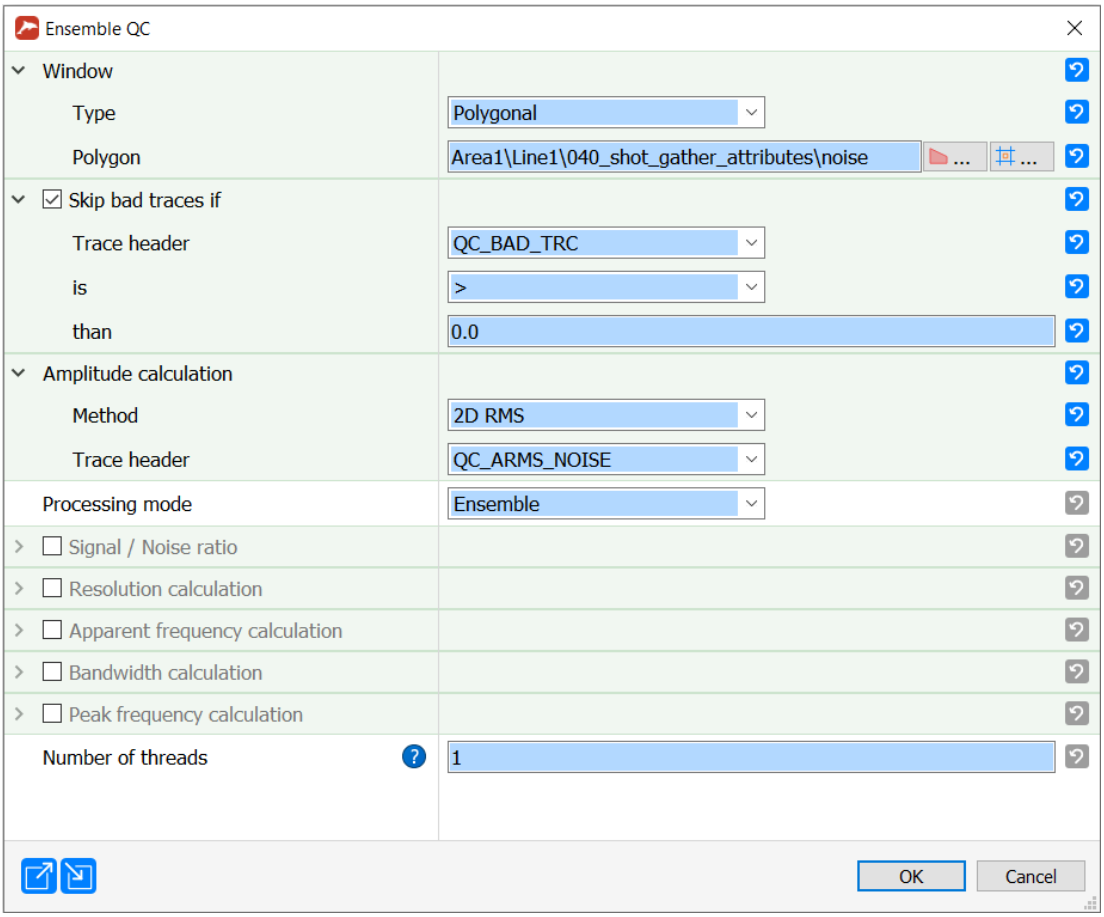


Add one more copy of Ensemble QC module to compute the amplitude in the background noise window. The easiest way to do that is to copy module (Ctrl+c, Ctrl+v) which already exists in the flow.

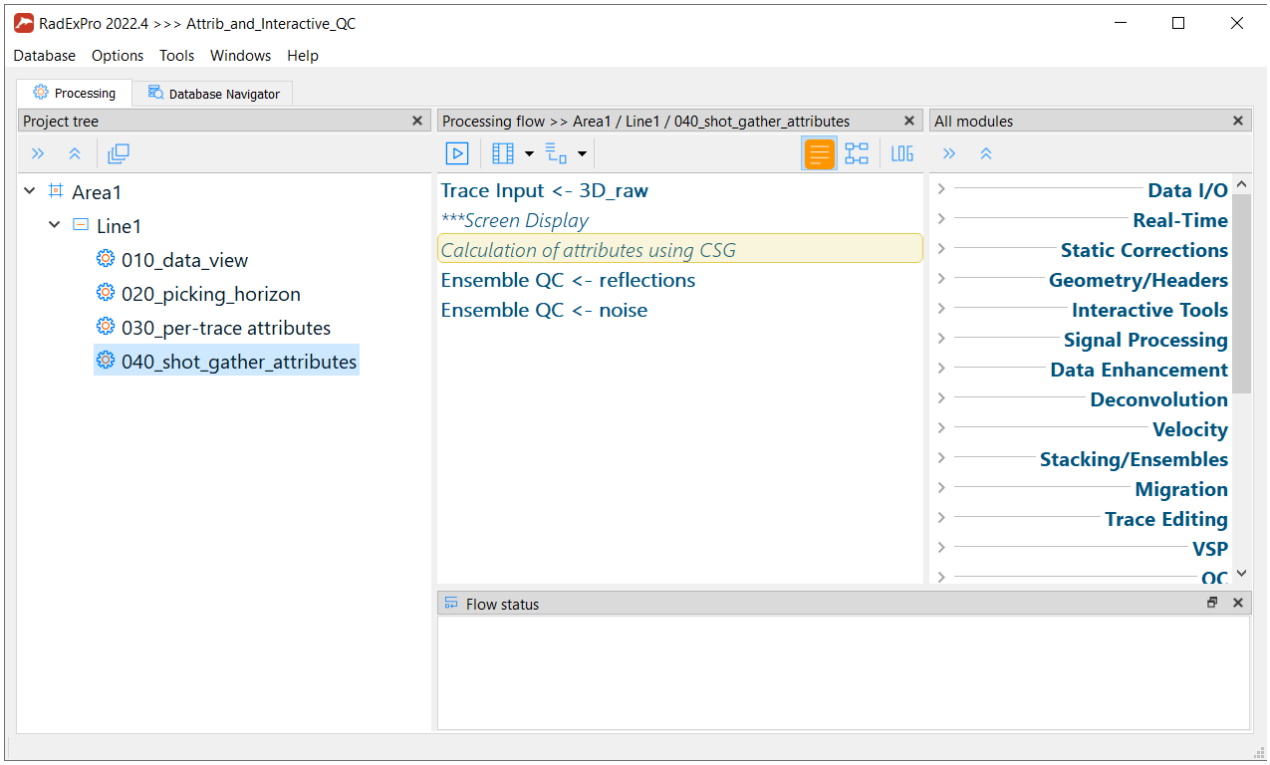


Now, enter the second copy of the module and change its parameters: change the polygon

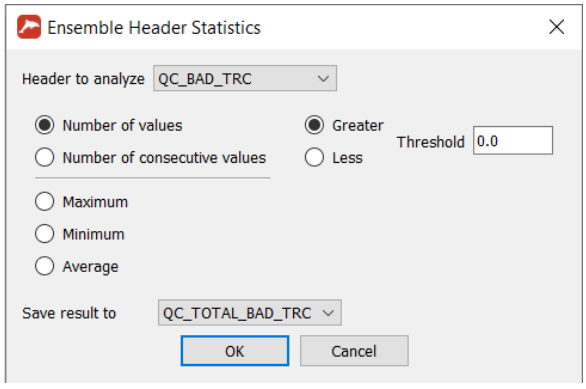
determining the attribute computation window to the background noise polygon - noise. Select a header, in which RMS amplitude values – QC_ARMS_NOISE will be saved. Uncheck computation of the apparent frequency:



Now the flow looks like this:

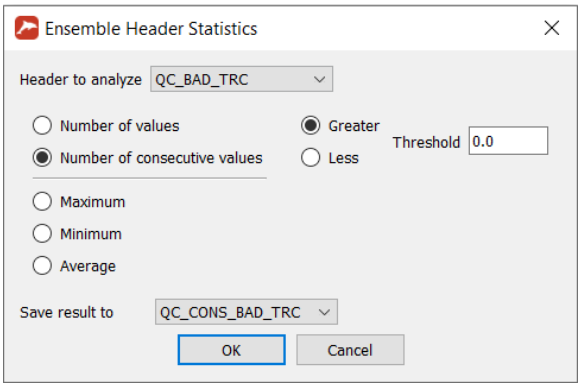


This was about QC attributes of seismic gathers, computed for all traces of each gather except for those marked as bad traces. So, now, let us consider bad traces separately. We will compute both total number and the number of sequentially following each other bad traces in the gather. We will do that using Ensemble Header Statistics module.

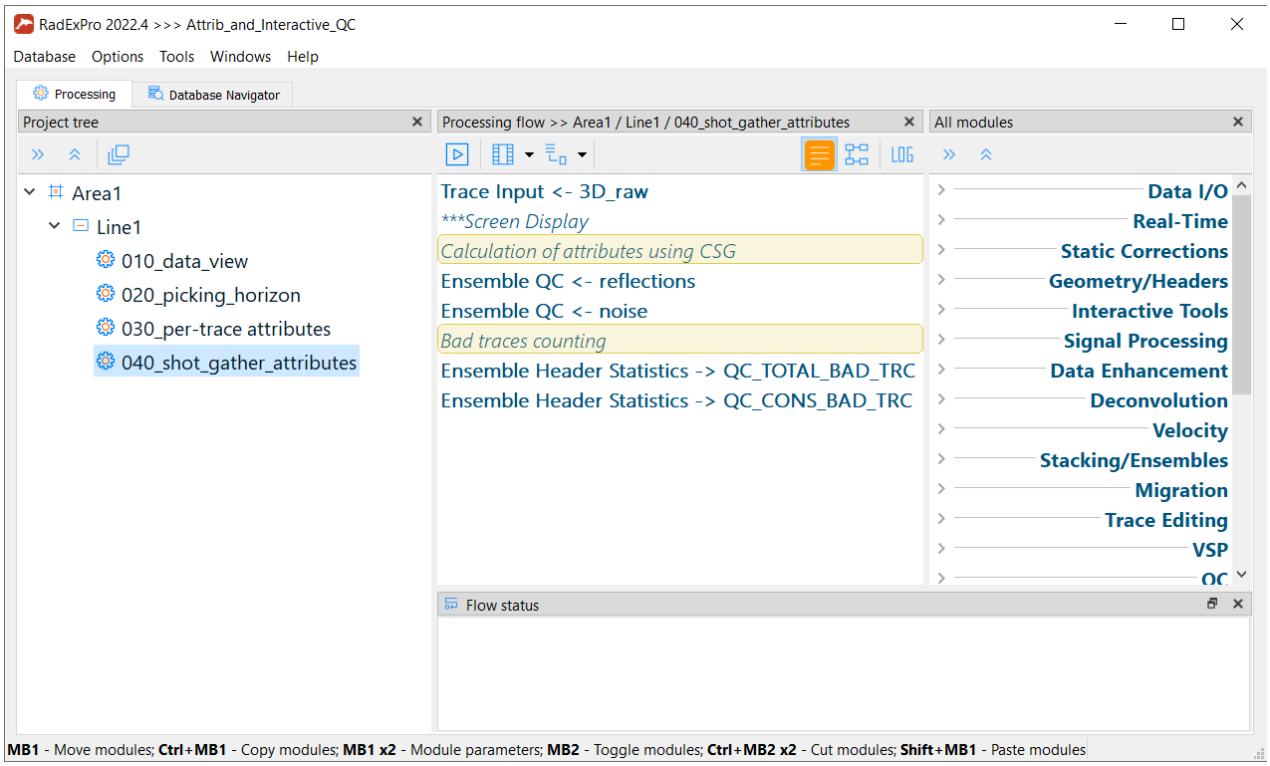


We will analyze QC_BAD_TRC header. The number of traces exceeding the preset condition (value of header QC_BAD_TRC greater than 0) will be assigned to QC_TOTAL_BAD_TRC header.

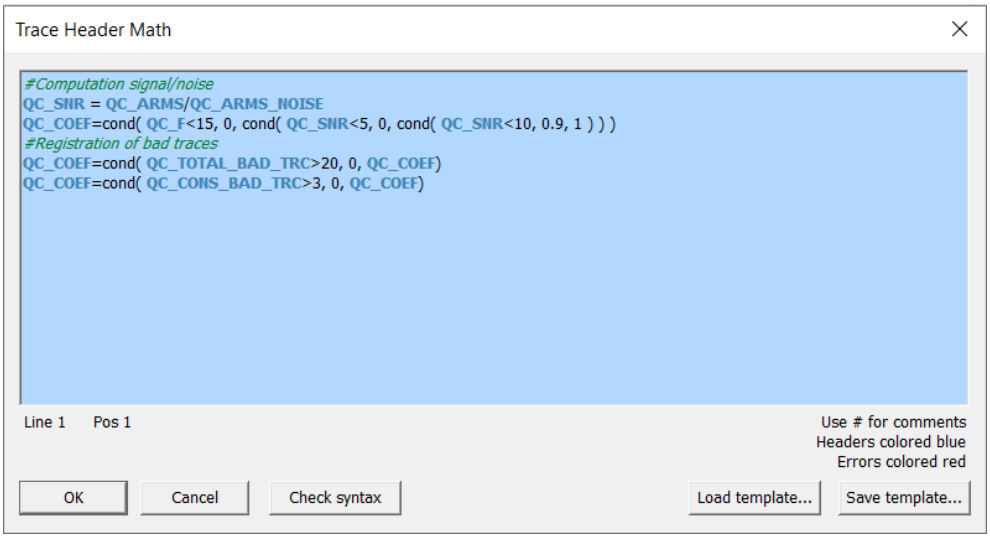
Copy Ensemble Header Statistics module and change the parameters for computation of the number of sequentially following each other bad traces. Save the obtained value in QC_CONS_BAD_TRC header.



The resulting flow looks like this now:



Add Trace Header Math module, we will use it to compute derived attributes: signal-to-noise ratio (QC_SNR) and an integrated quality coefficient (QC_COEF) which helps us to quickly discriminate bad seismograms:



Write the following expressions in the module's edit window:

#Computation signal/noise

QC_SNR = QC_ARMS/QC_ARMS_NOISE

QC_COEF=cond(QC_F<15, 0, cond(QC_SNR<5, 0, cond(QC_SNR<10, 0.9, 1)))

#Registration of bad traces

QC_COEF=cond(QC_TOTAL_BAD_TRC>20, 0, QC_COEF)

QC_COEF=cond(QC_CONS_BAD_TRC>3, 0, QC_COEF)

The first and the forth lines contain comments that do not influence module operations.

In the second line, signal-to-noise ratio (SNR) is computed as a ratio of the RMS amplitude of the target reflections to that of the background noise.

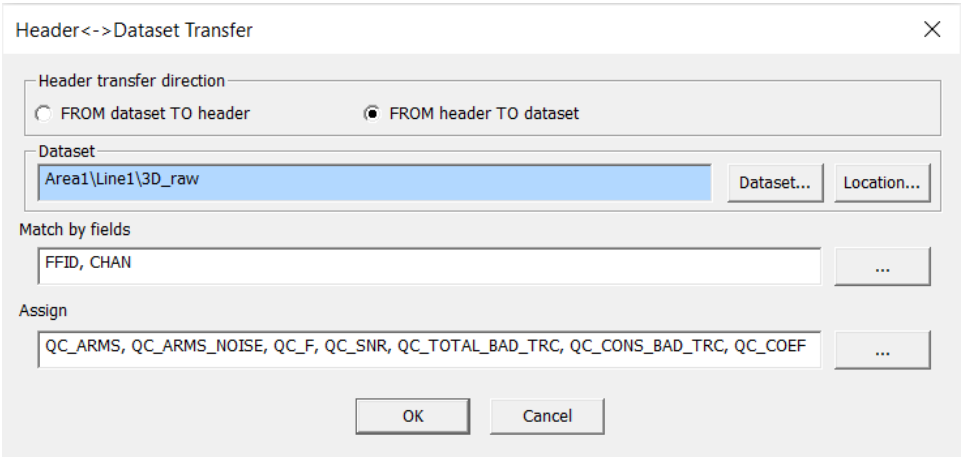
In the third line, computation of quality coefficient is performed based on values written in QC_F и QC_SNR headers. If the apparent frequency is lower than 15 Hz, a value of 0 (that is defect) is assigned to QC_COEF header, otherwise it depends on the signal-to-noise ratio value.

- QC_SNR<5 - QC_COEF equal to 0
- QC_SNR<10 - QC_COEF equal to 0.9
- Otherwise, QC_COEF is equal to 1

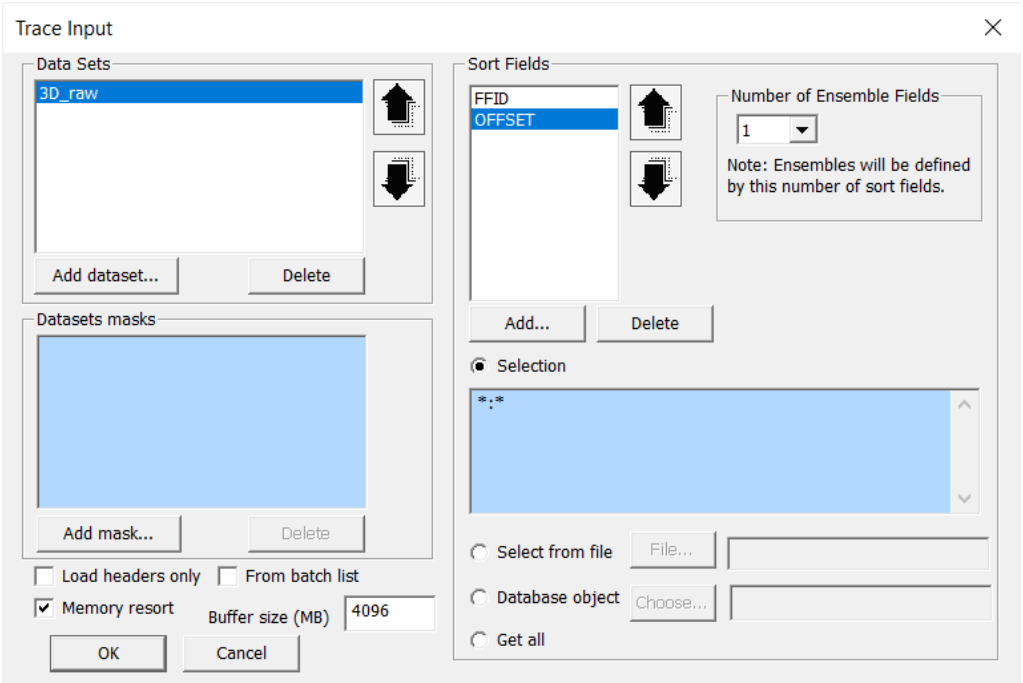
In the fifth and sixth line, we would adjust a COEF values to take into account the total number of bad traces and the maximal consecutive number of bad traces in the gather -- QC_TOTAL_BAD_TRC and QC_CONS_BAD_TRC. If the total number of bad traces is more than 20 or

the number of sequentially following each other bad traces is more than 3, then the shot is assigned a value corresponding to defect.

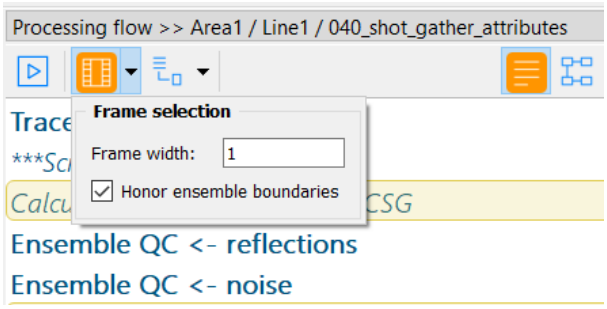
Further, save the obtained values of attributes using Header<->Dataset Transfer module that we already know. We will write the obtained headers (QC_ARMS, QC_ARMS_NOISE, QC_F, QC_SNR, QC_TOTAL_BAD_TRC, QC_CONS_BAD_TRC, QC_COEF) to 3D_raw dataset:



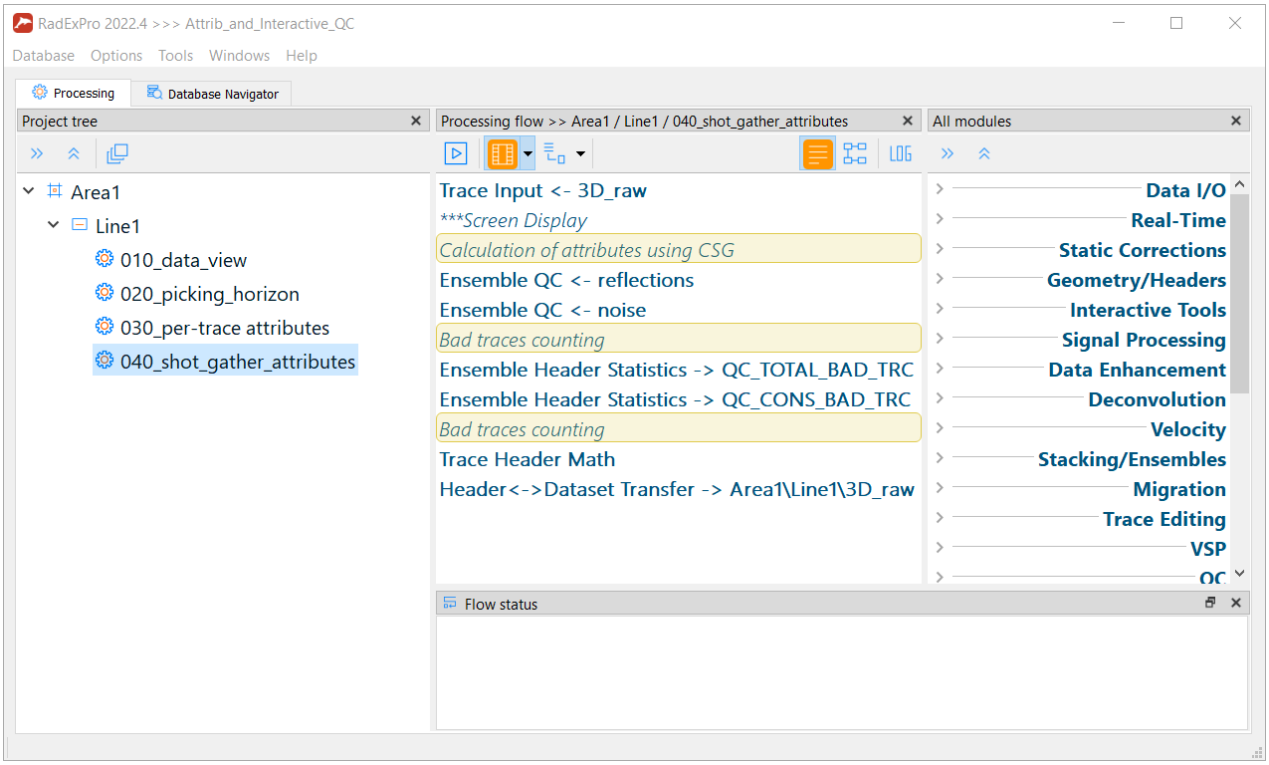
The flow is ready. Before running it, enter the Trace Input module parameters and remove limitations on the shot gather input since now we will need all the data. Replace the selection mask by *:* (as shown below):



Do not also forget to switch on the framed mode!



Start the flow execution:



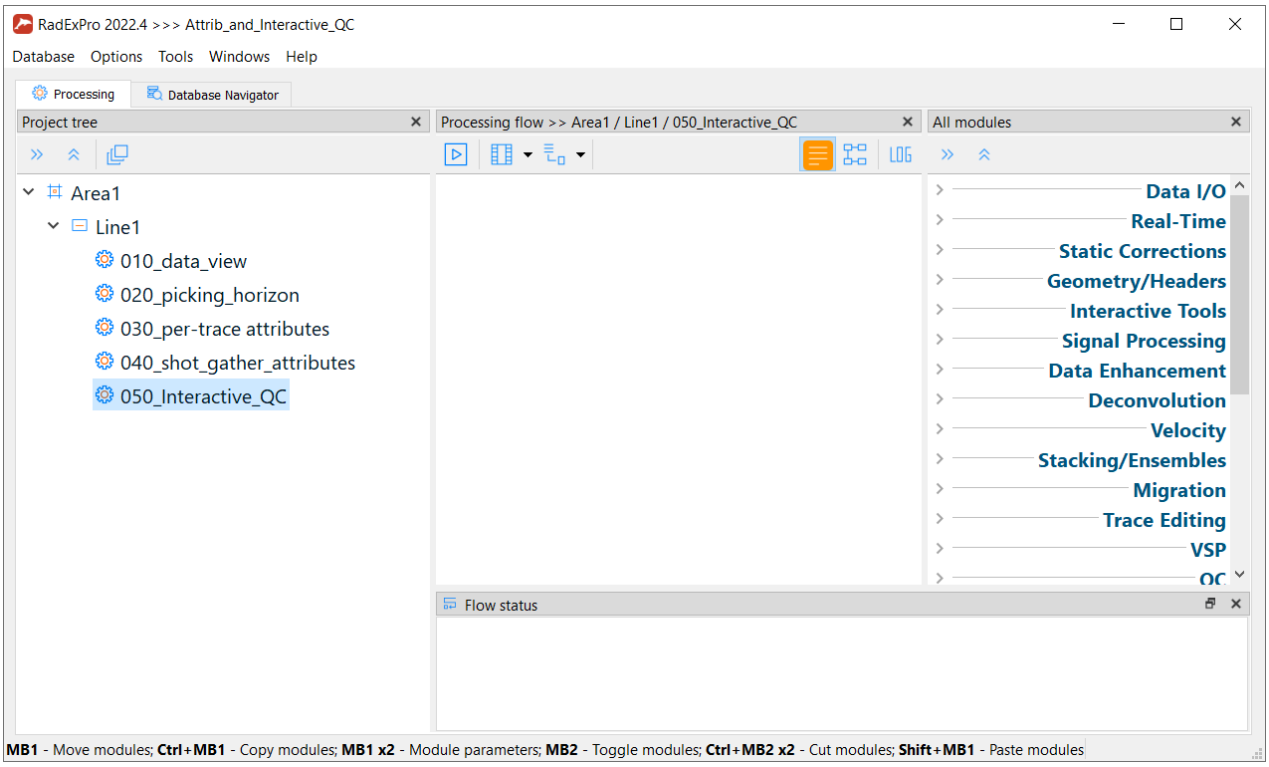
Upon completion of the flow, if you want, you can check the filled header fields using Geometry Spreadsheet tool.

Attribute Mapping in Interactive QC module

Capabilities of map generation and analysis of QC attributes using Interactive QC* module are demonstrated in this section. Interactive QC module is an interactive environment for onshore 3D/2D seismic data QC (in fact, it can also be used for QC of the data from ocean bottom cables). The module makes it possible to work with several shot point (SP) maps, several receiver point (RP) maps, CMP map and general location maps at the same time. Each map can be colored according to a selected attribute. From each of the maps you can open a seismogram – a shot gather, a receiver gather or a CDP gather. All maps and the seismogram window inside the module are fully synchronized with each other.

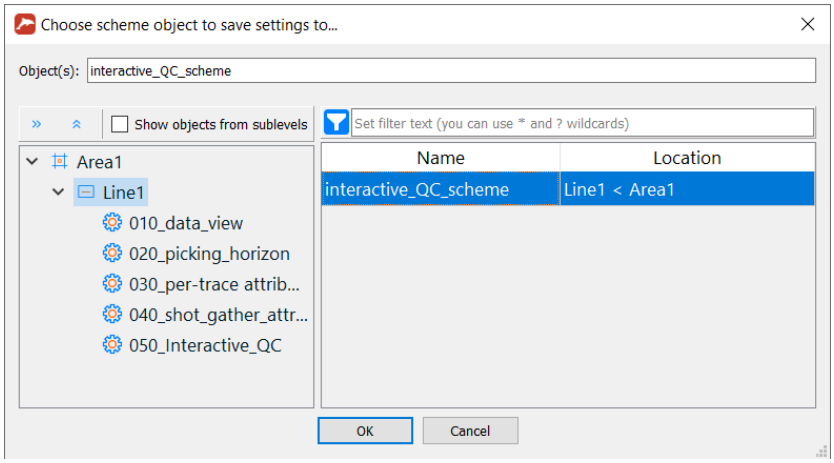
ATTENTION! The following headers should be correctly filled out to ensure the correct work of the module: S_LINE, SOU_SLOC, R_LINE, REC_SLOC, FFID, CDP (or/and ILINE_NO and XLINE_NO), SOU_X, SOU_Y, REC_X, REC_Y, CDP_X, CDP_Y. In case of 2D data it is recommended to write RP number along each 2D line to REC_SLOC header and assign a constant to R_LINE (e.g. line number). The same way you may use SOU_SLOC for SP number and CDP for XLINE_NO, while assigning line number to S_LINE and ILINE_NO. The input dataset must be sorted by FFID.

Create a new flow - *050_Interactive_QC*:

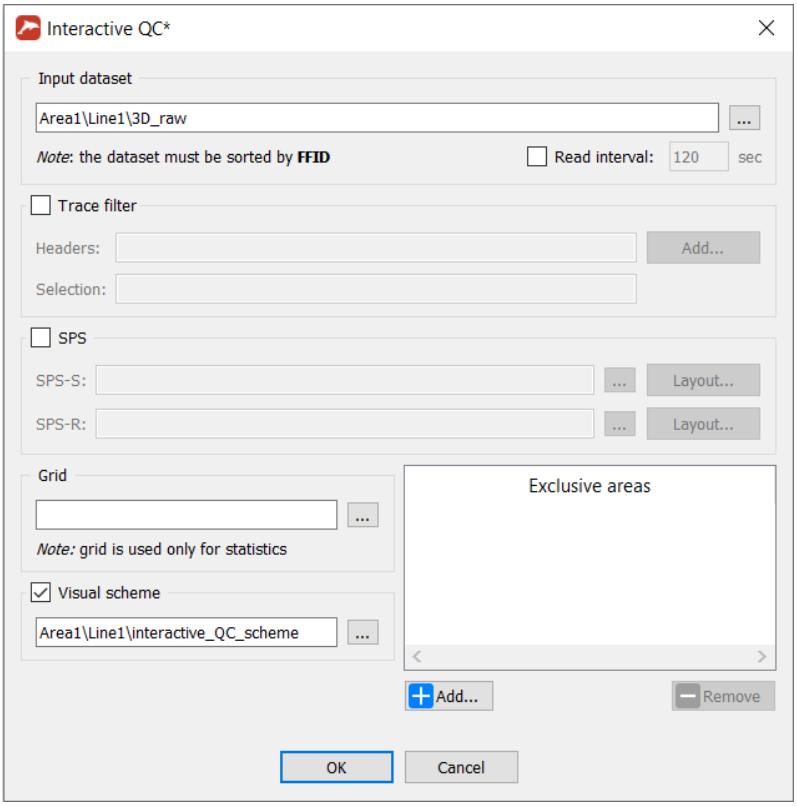


Enter it and add Interactive QC * module. Asterisk at the end of the module name means that

this module should be alone in the flow - it does not require any modules of data input or output. Choose dataset 3D_raw, in addition create a new data base object - "visualization scheme" (Visual scheme). The scheme is a database object where the module can save its internal parameters – display settings, window positions and the like. The scheme is automatically saved when the main window of the module is closing, and it is loaded when the window is opened. Name this scheme interactive_QC_scheme:



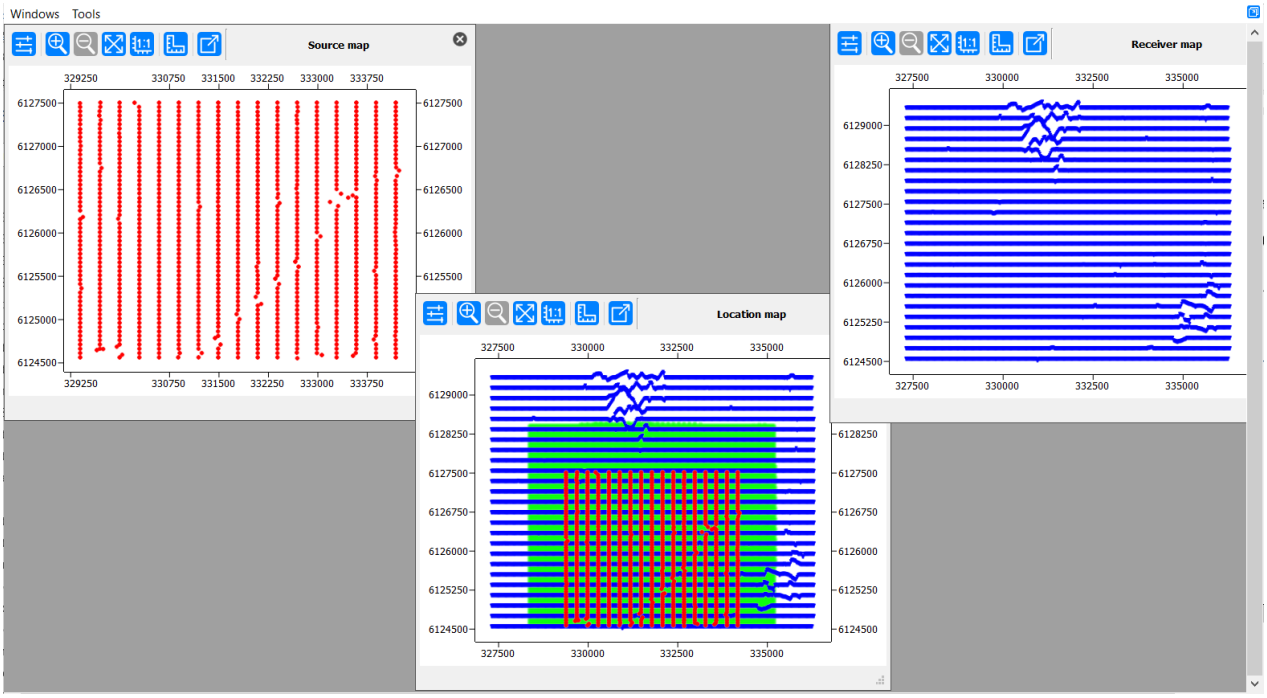
Finally, the module window should look like this:



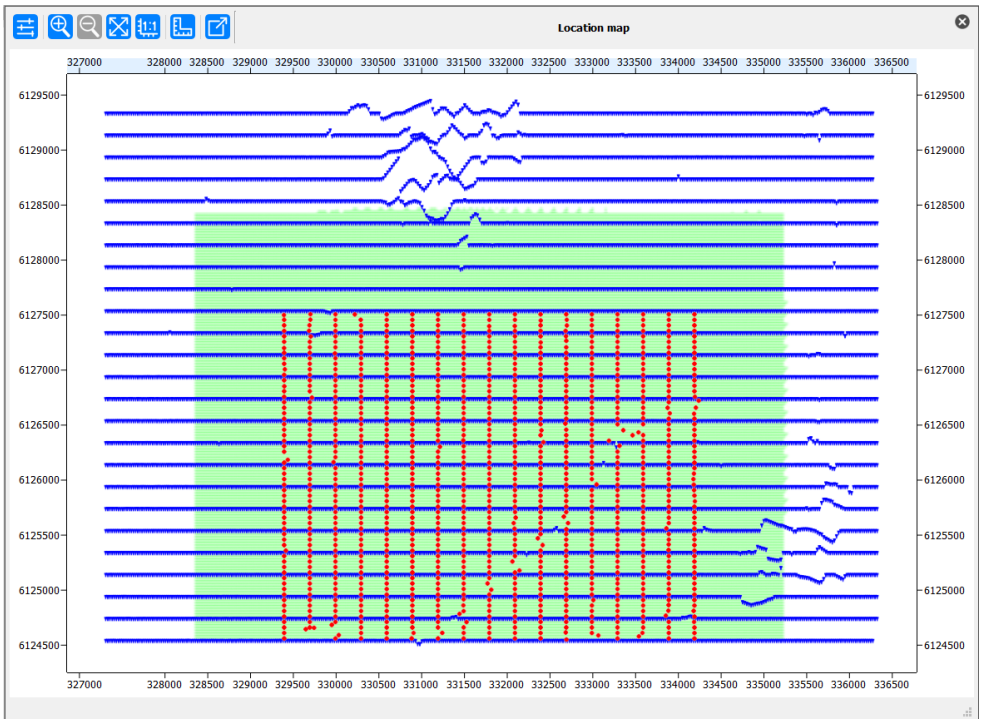
Run the flow.

Location and CDP fold map

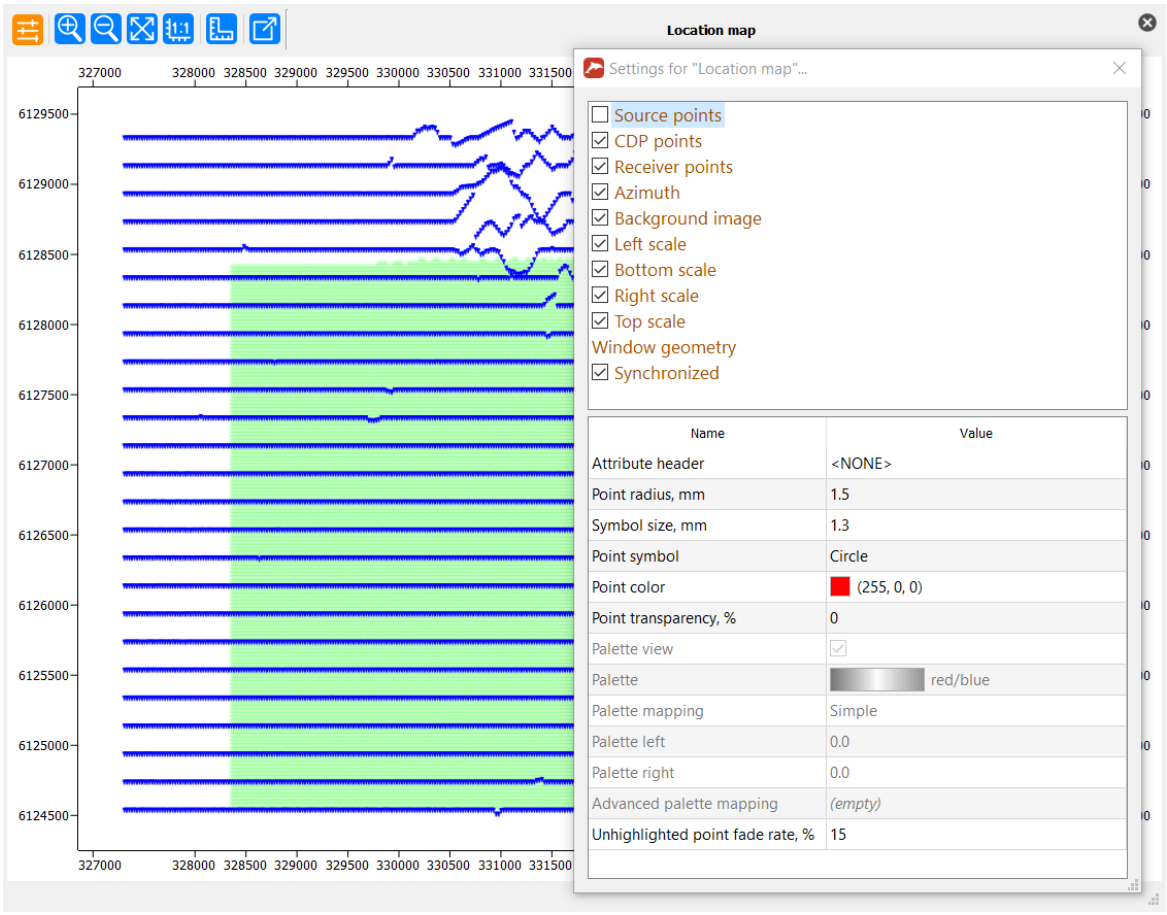
When the main window opens, three maps are displayed by default: SP (Source map), RP (Receiver map) and general surveying scheme (Location map).



Let us examine Location map in more detail. Source locations are shown in red, receiver locations - in blue, and green points corresponds to CDP's:

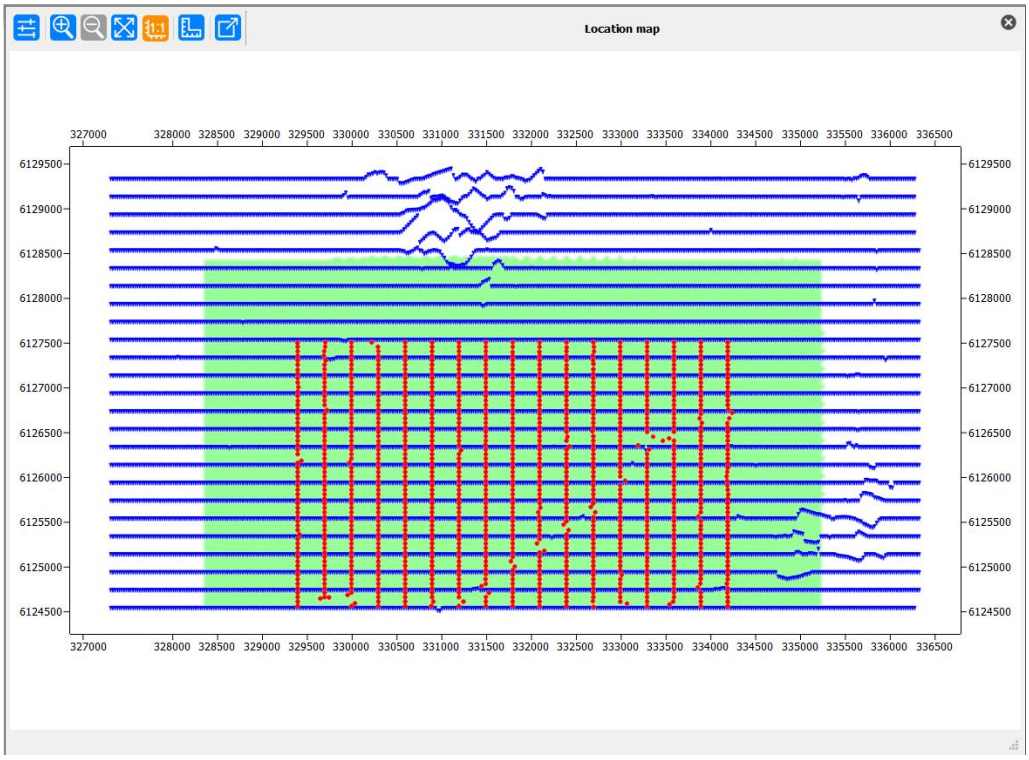


Click the **Settings** button to adjust the image settings.

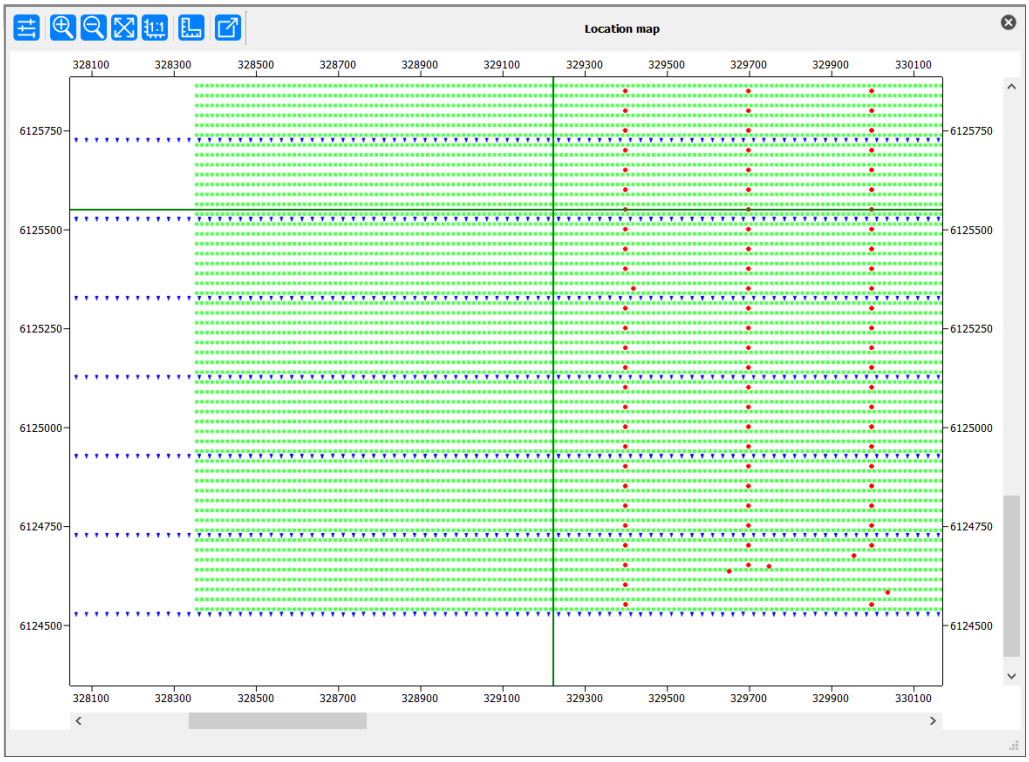


Settings specify mapping of the required points and their parameters (color, size, symbol to be displayed, etc.).

Click the 1:1 icon on the toolbar to display the whole map on the same scale along X and Y axes.



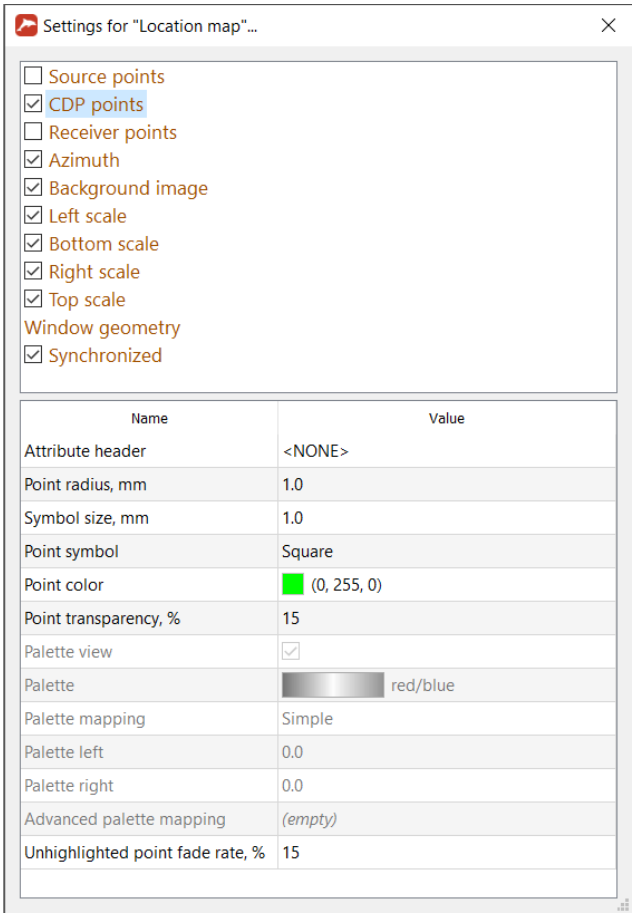
You can zoom to a fragment of the map using the scaling frame. Click the **Zoom** button on the toolbar and select a rectangular area of the map to zoom up with a left mouse button..



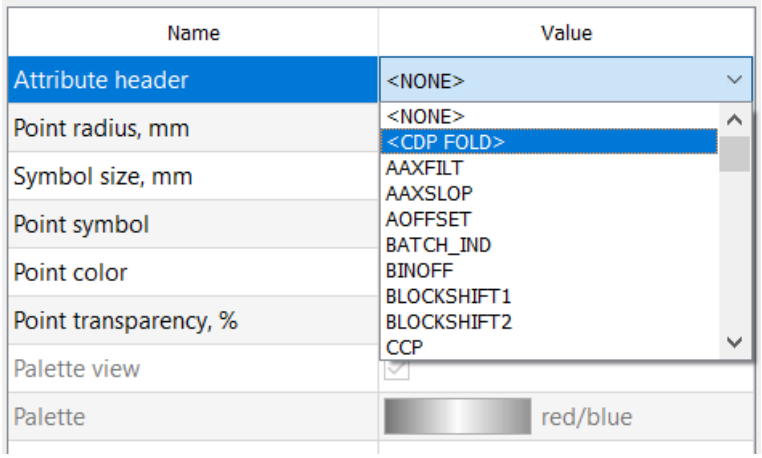
You can unzoom with the **Unzoom** button. Besides, it is possible to zoom/unzoom the

map elements using mouse wheel when its cursor is located in the map area.

Let us leave only CDP points visible and switch off the others (SP and RP) in the map settings. At the same time, change transparency of the CDP points (Point transparency) from 85% to 15%.



Module Interactive QC can compute and display CDP fold. Find the **Attribute Header** parameter and change its value from <NONE> to the <CDP FOLD> in the drop down list.

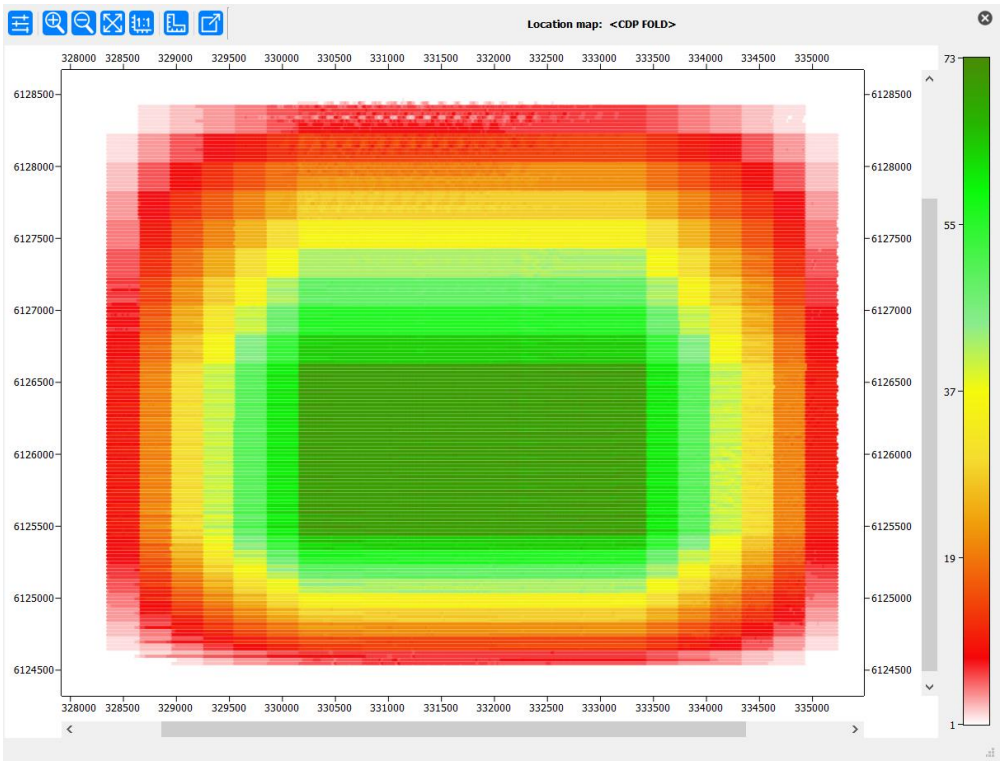


Select fold_map as the color palette for this attribute and leave the value range without

changes.

Name	Value
Attribute header	<CDP FOLD>
Point radius, mm	1.0
Symbol size, mm	1.0
Point symbol	Circle
Point color	(0, 255, 0)
Point transparency, %	0
Palette view	☑
Palette	fold_map
Palette mapping	Simple
Palette left	0.0
Palette right	0.0
Advanced palette mapping	*(empty)*
Unhighlighted point fade rate, %	15

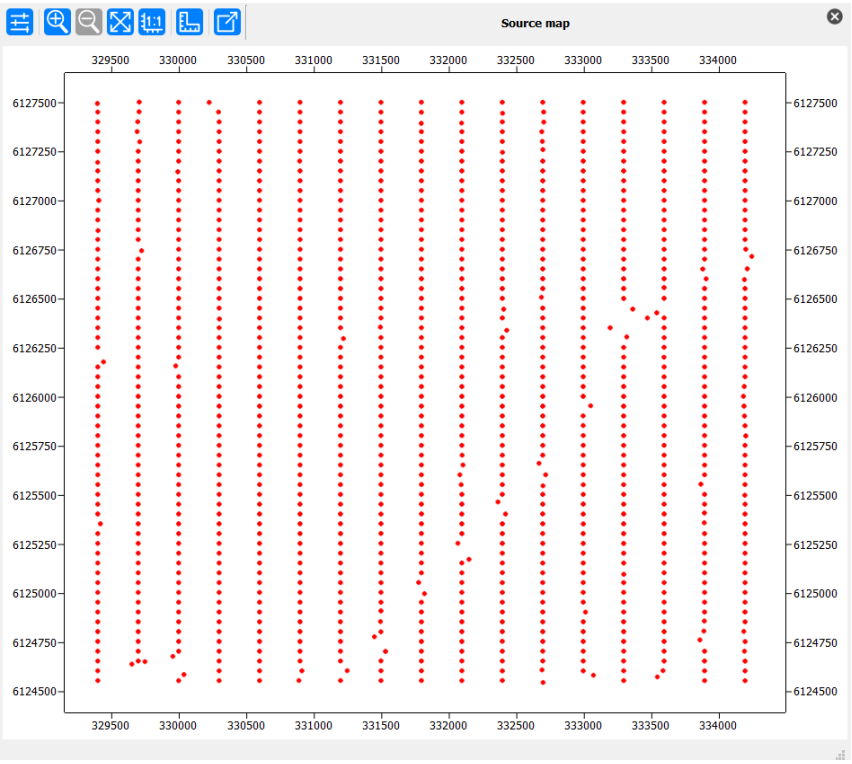
Switch back to the location map - one can see that CDP points are now colored in accordance with their fold values:



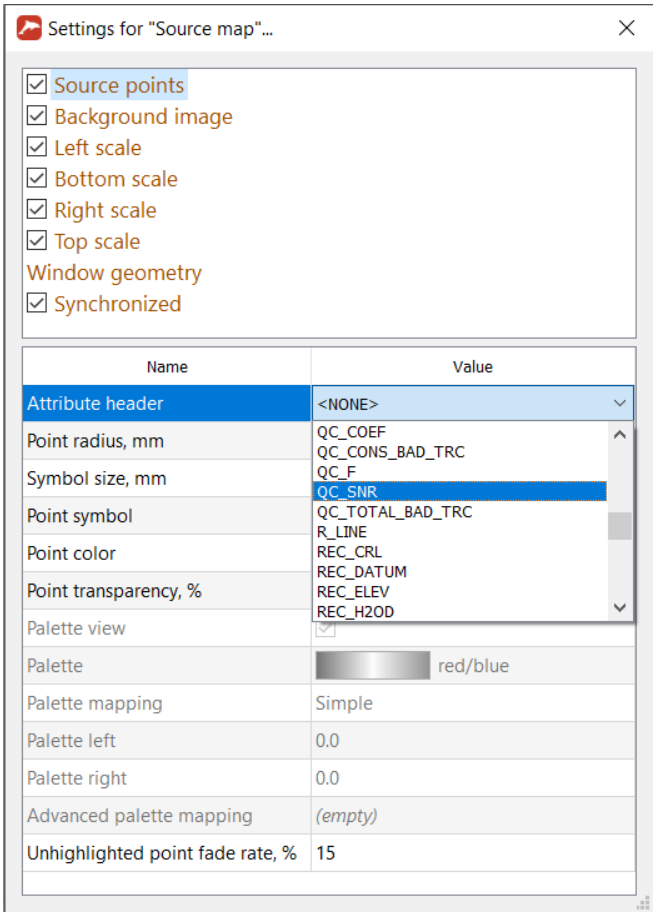
Signal-to-noise ratio map

Earlier we have calculated signal-to-noise ratio value for each shot point and saved the, to the QC_SNR header field. Let us make a map showing the areal distribution of the SNR values.

To do so, get back to the base of such a map - a Source map:

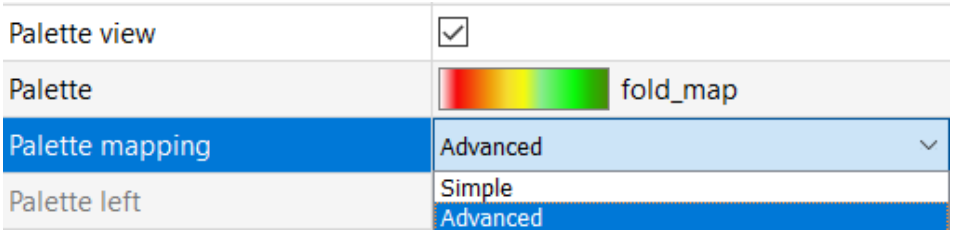


Go to Settings-> Source points-> Attribute header on the Source map and select QC_SNR header in the drop-down list:



Let us set the color palette for the given attribute based on parameters we have used for the quality coefficient calculation. First, go to Palette parameter and select *fold_map* palette that is, basically, from red through yellow to green.

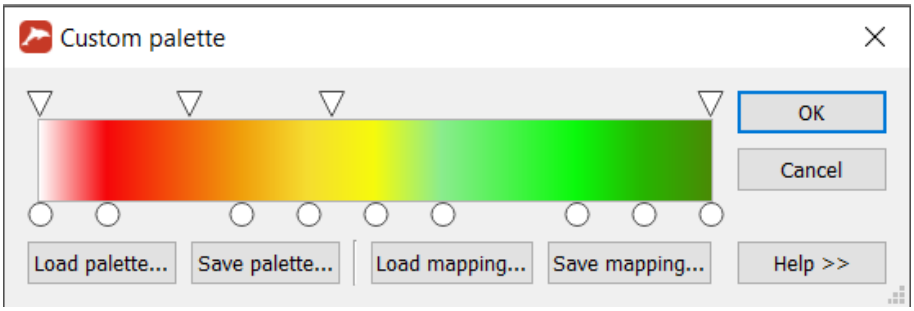
Now switch Palette mapping from Simple to Advanced – this allows us to set up a piecewise linear correspondence between the attribute values and the palette. To do this, we need to edit Advanced palette mapping parameter.



Let us set up following reference points for the palette mapping:

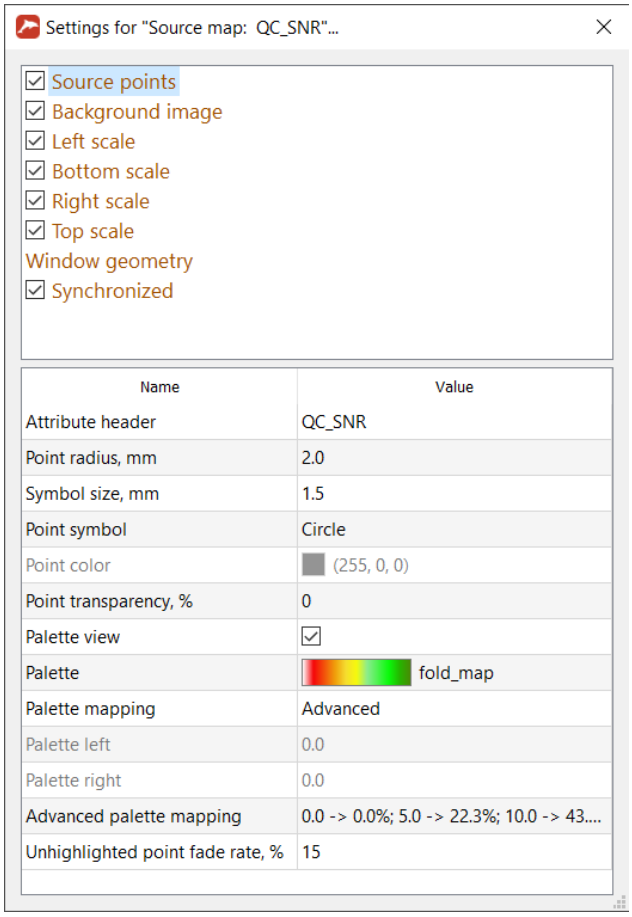
- reference point 1 - red color, value - 0
- reference point 2 - yellow color, value - 5
- reference point 3 - green color, value 10

- reference point 4 - green color, value - 100

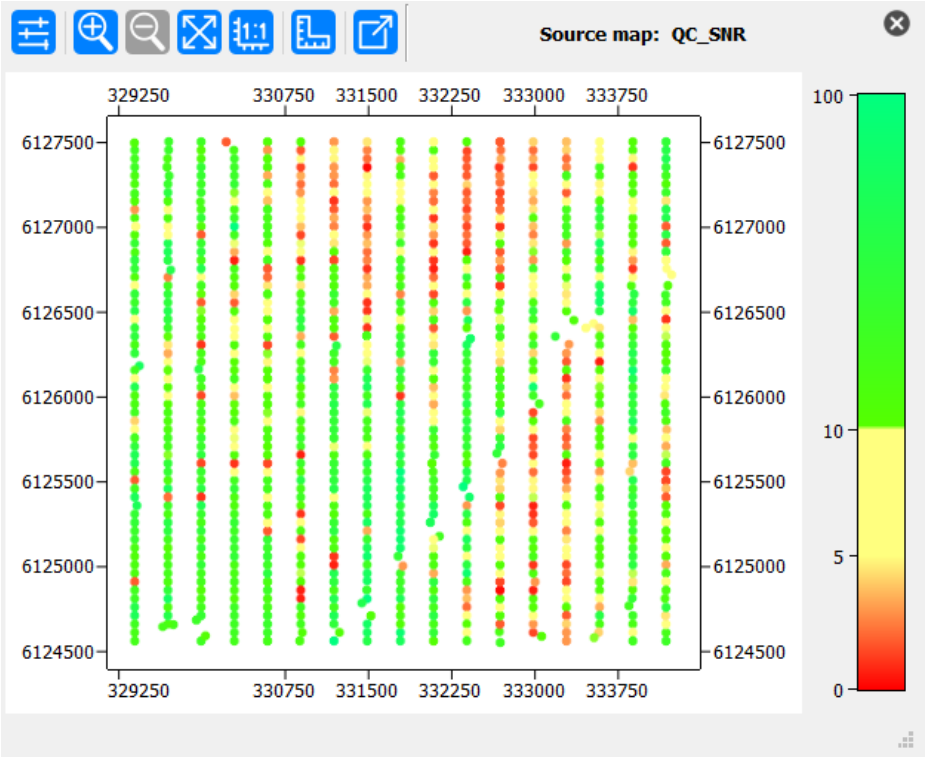


Use Shift+left-click above the color bar to add reference points and edit corresponding values.

Click the OK button, the parameter setting window will look like this:



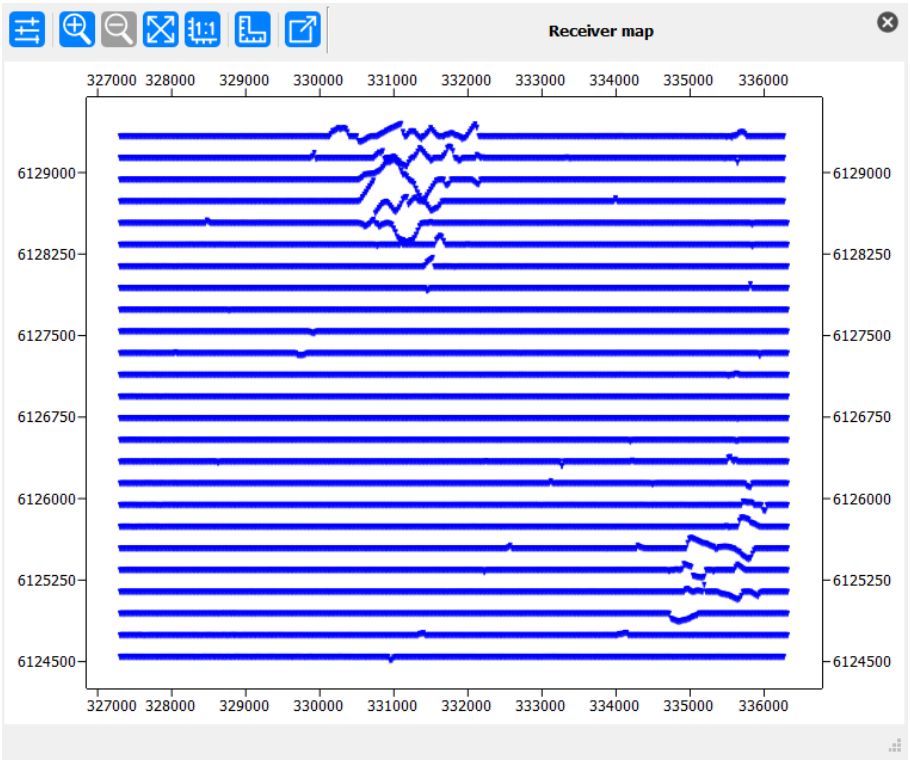
And this is how our Source map looks like with the color-coded SNR:


Source map: QC_SNR
329250
330750
331500
332250
333000
333750
6127500
6127000
6126500
6126000
6125500
6125000
6124500
100
10
5
0

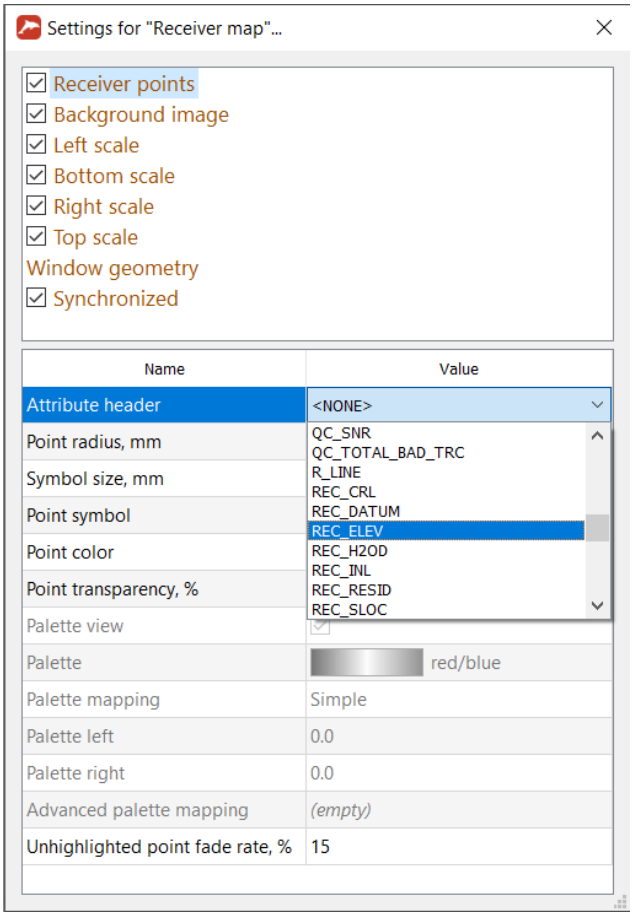
Elevation map

Now, let us make an elevation map. We will base it on a Receiver map because the RP's are typically denser than SP's. The elevations of the receivers are stored in the REC_ELEV header; they were loaded to the dataset together with the location information during the geometry assignement.

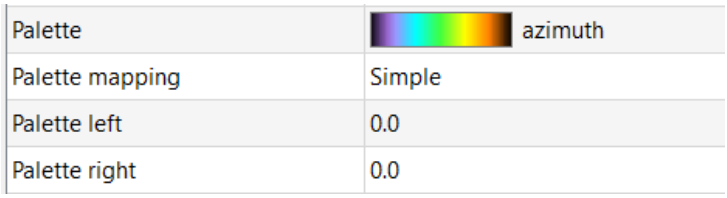
Let us go to a Receiver map:



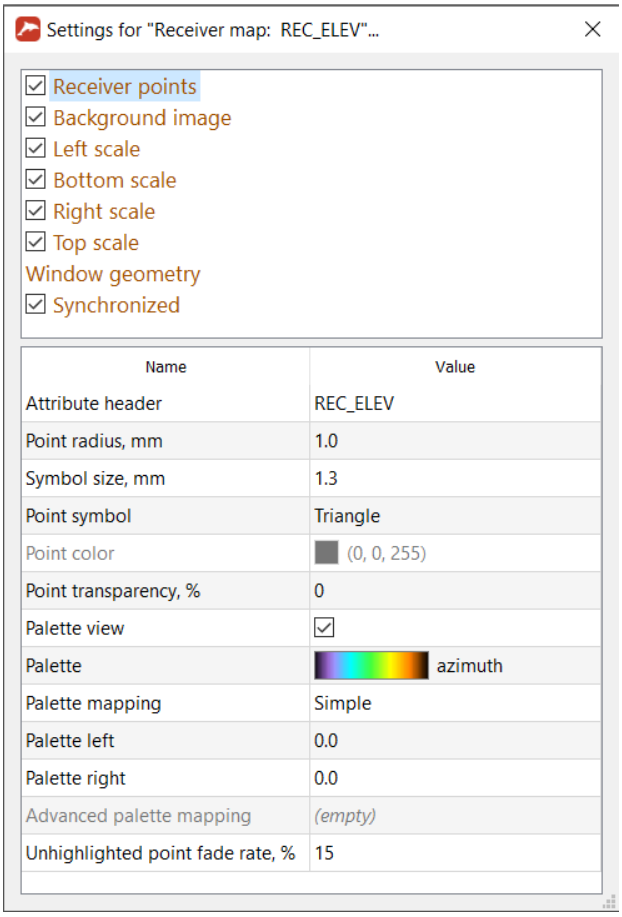
Similarly to the SNR map, go to Settings-> Receiver points-> Attribute header and select REC_ELEV header to be color-coded.



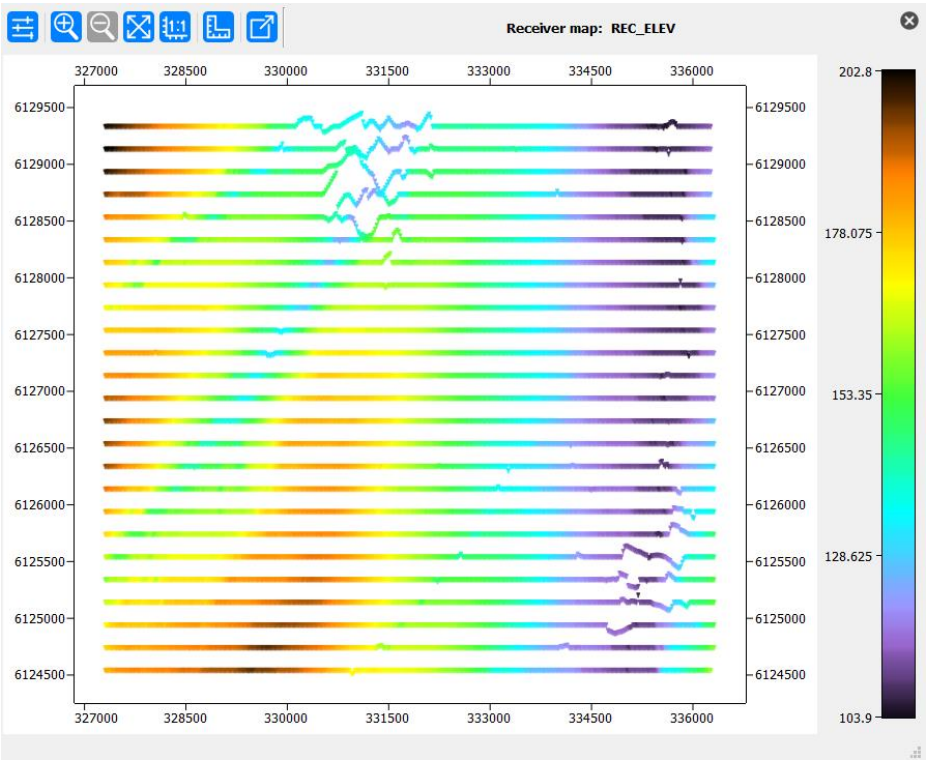
Choose a palette from the list of the predefined color pallets. We would use *azimuth* pallet here. Leave the default settings for Palette left and Palette right values – in this case minimum value of the attribute is mapped to the left side of the palette, and the maximum one - to the right side:



Click the OK button, the parameter setting window should look like this:



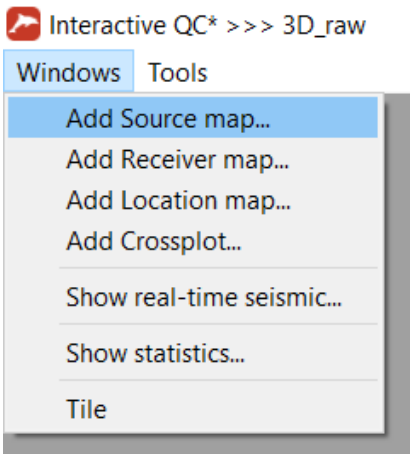
The Receiver map colored in accordance with the receiver elevation values is shown below:



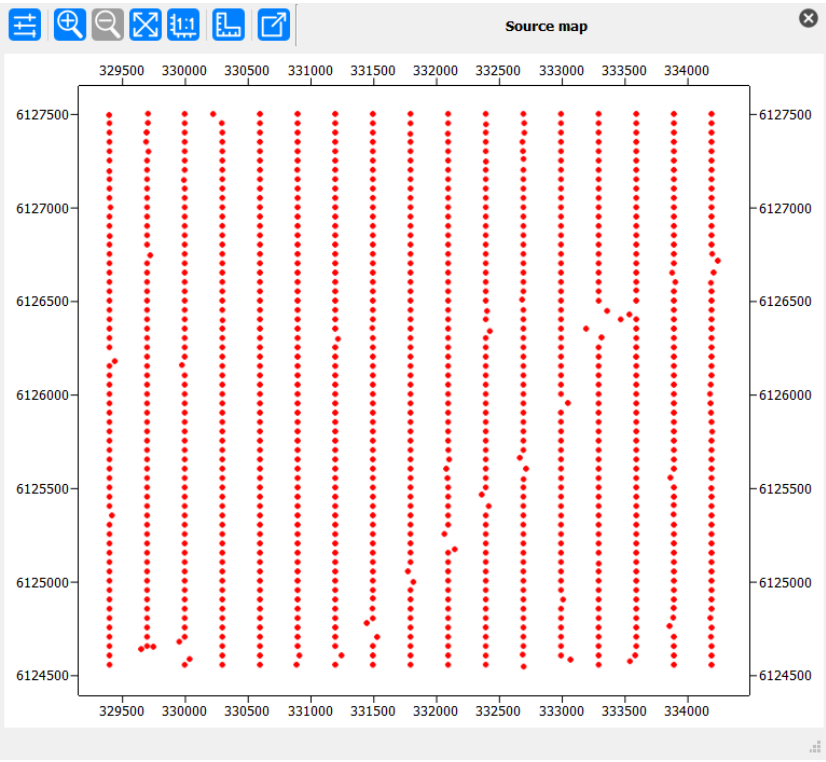
Apparent frequency map

Generate map of apparent frequency similarly to the signal-to-noise ratio map. Values of this attribute were computed for each shot by estimating the number of zero crossings and saved in the QC_F header.

First, we need a basis for this map - another Source map. Add it using **Windows/Add Source map** menu command:

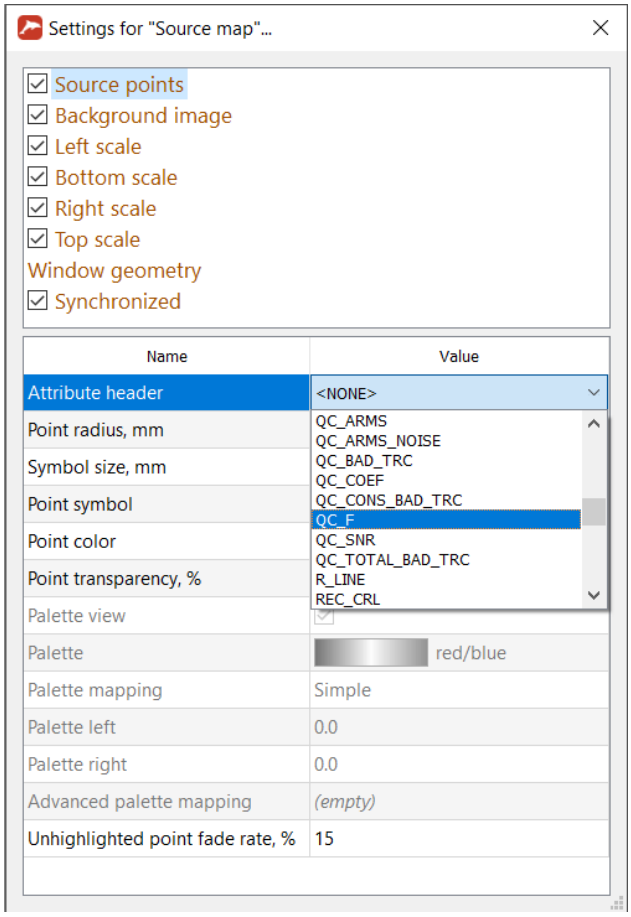


We will see a new SP map we are already familiar with:



Similarly to the signal-to-noise ratio map, in the map parameters choose header QC_F in the

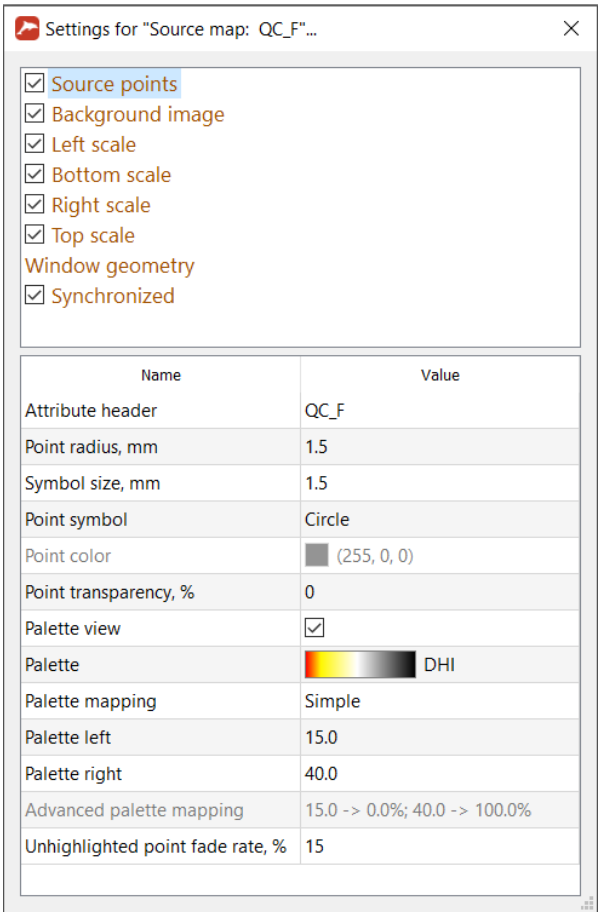
Settings-> Source points-> Attribute header:



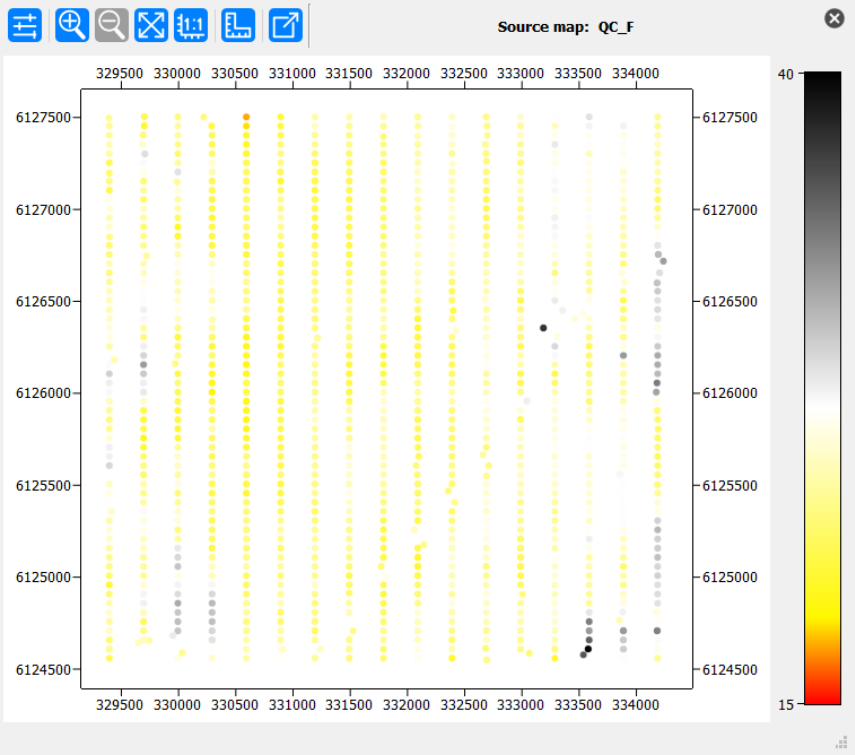
For this attribute, let us select *DHI* palette from the list of the predefined color pallets. This time we will use Simple palette mapping, with the values from 15 to 40 (set Palette left – 15, Palette right – 40):

Palette	DHI
Palette mapping	Simple
Palette left	15.0
Palette right	40.0

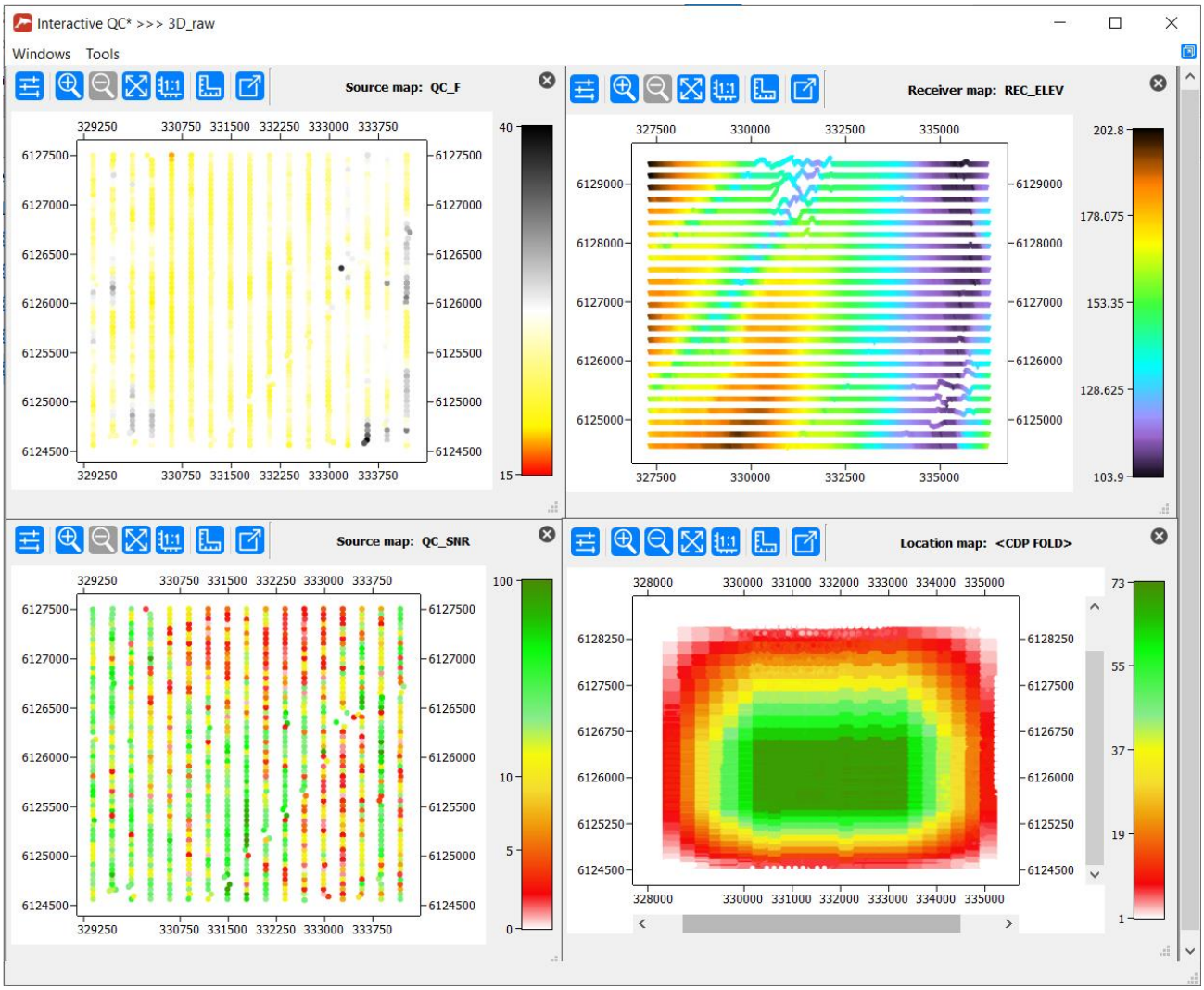
The parameter window will look like this:



And this is how the Source map looks like with the Apparent Frequency color-coded:



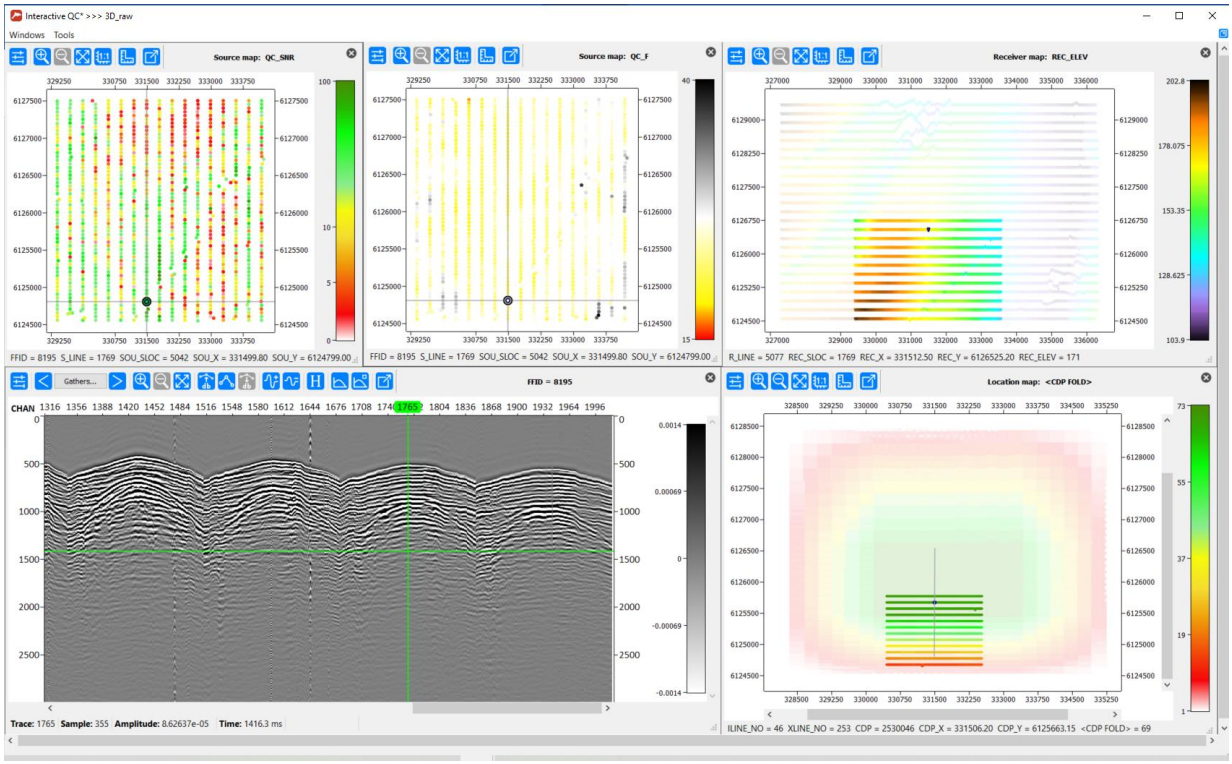
As a result, the module window with all the maps will look like this



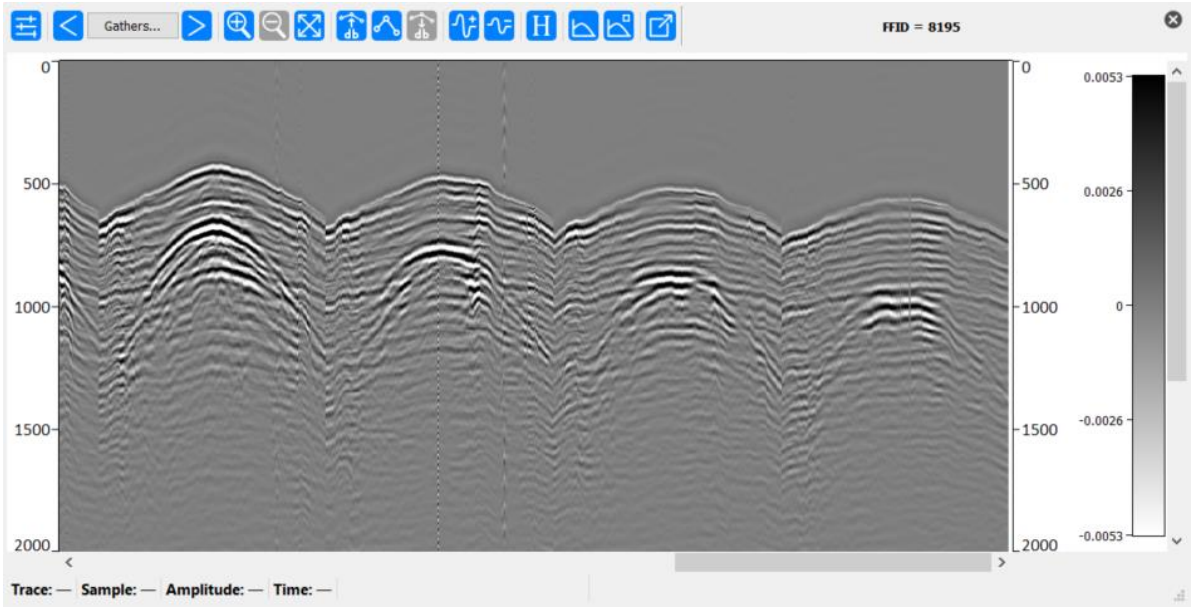
Viewing common shot, common receiver and CDP gathers, header plots

Left-click on a point of one of the maps (Source, Receiver, Location/CDP), and a seismogram corresponding to the selected Shot Point/Receiver Point/CDP will open in a separate window.

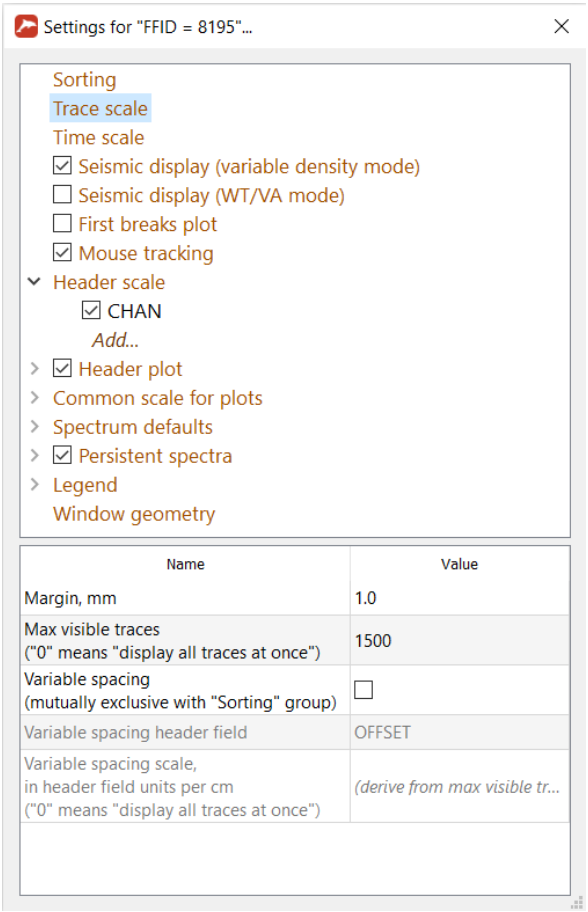
For example, click on a Shot Point on a Source map and a common shot gather corresponding to that shot point will open. At the same time, all Receiver maps will highlight active receiver template and all CDP maps will highlight all CDP's where the selected SP was involved:



You can move the mouse cursor above the seismogram window, and the SP's, RP's and CDP's corresponding to the current trace under the cursor will lit up on all maps where they are present.

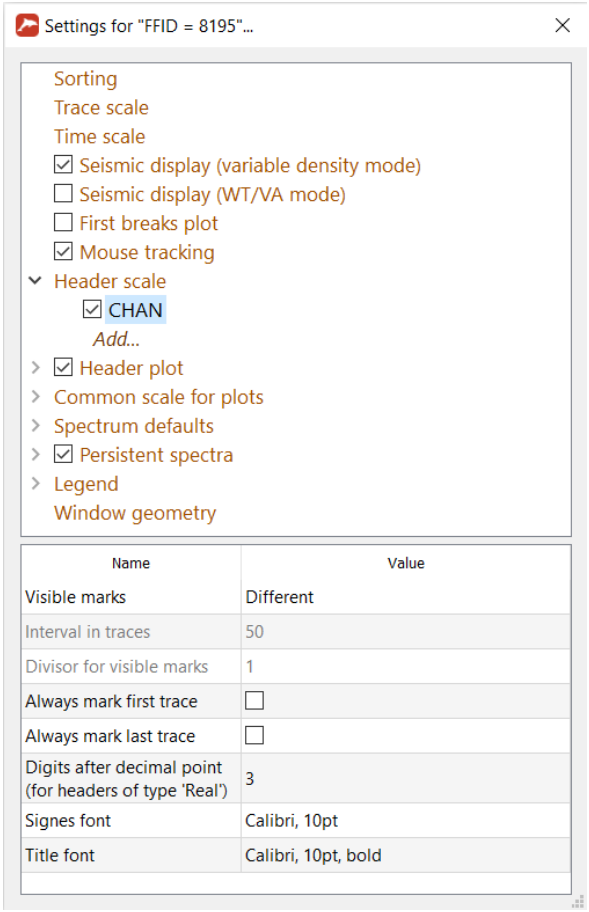


Go to the seismogram settings and change the number of traces displayed. To do that, click the Settings button on the toolbar, go to Trace Scale section and change the initial value in the Max Visible Traces parameter to 1500:

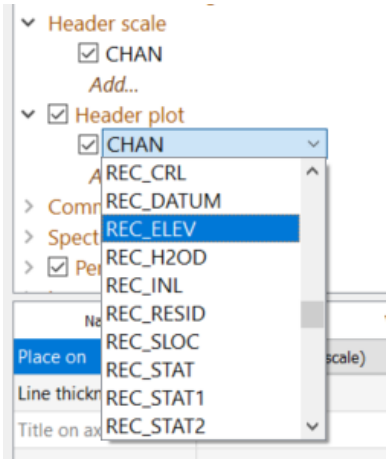


Add labels on the horizontal axis of the seismogram to make values of CHAN header -- click

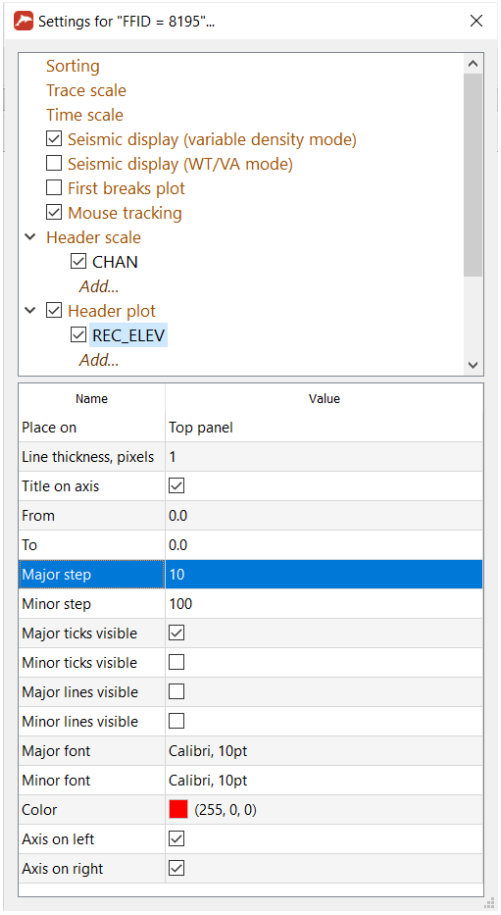
the arrow located close to the Header Scale section and then click Add... By default, header CHAN is proposed as an axis label, let us leave it as it is.



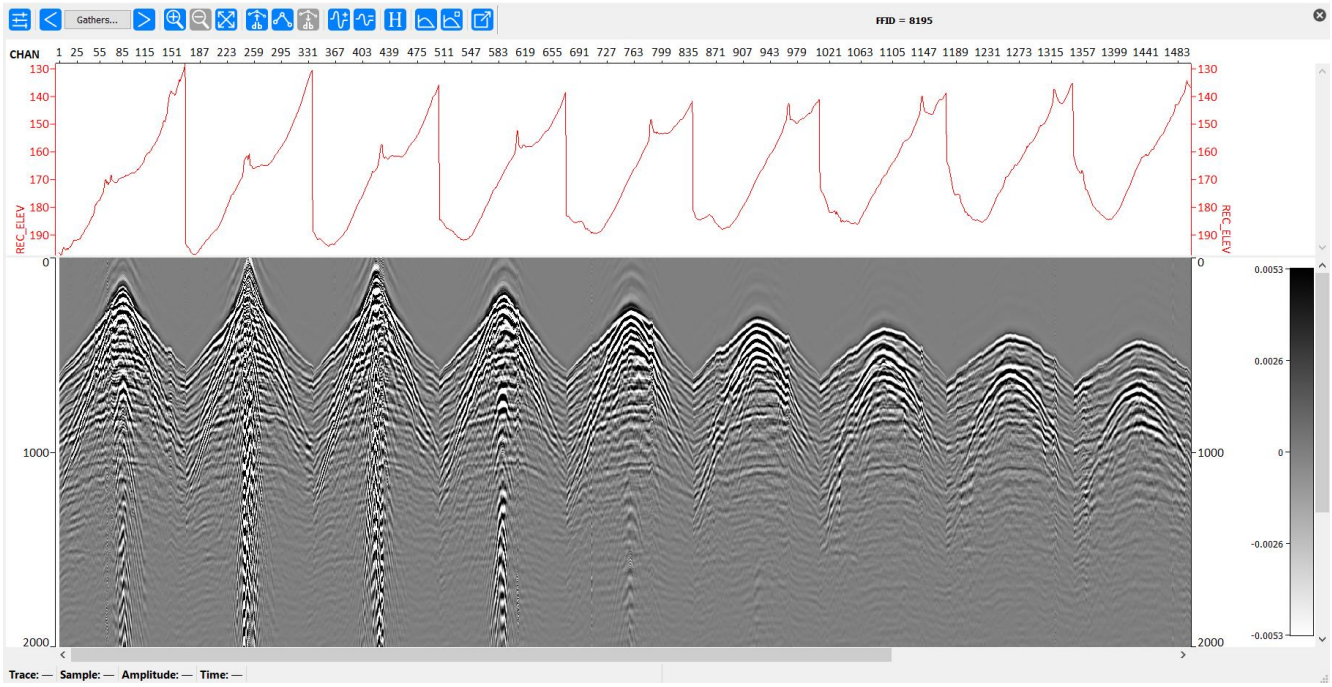
Next, let us add a header plot. Suppose, we are going to plot REC_ELEV values on top of our seismogram. Proceed to the Header Plot section for displaying the given plot, similarly to the header scale, the default header to be plotted is CHAN, but now we are going to change it. Click on the header name and select REC_ELEV in the drop-down list:



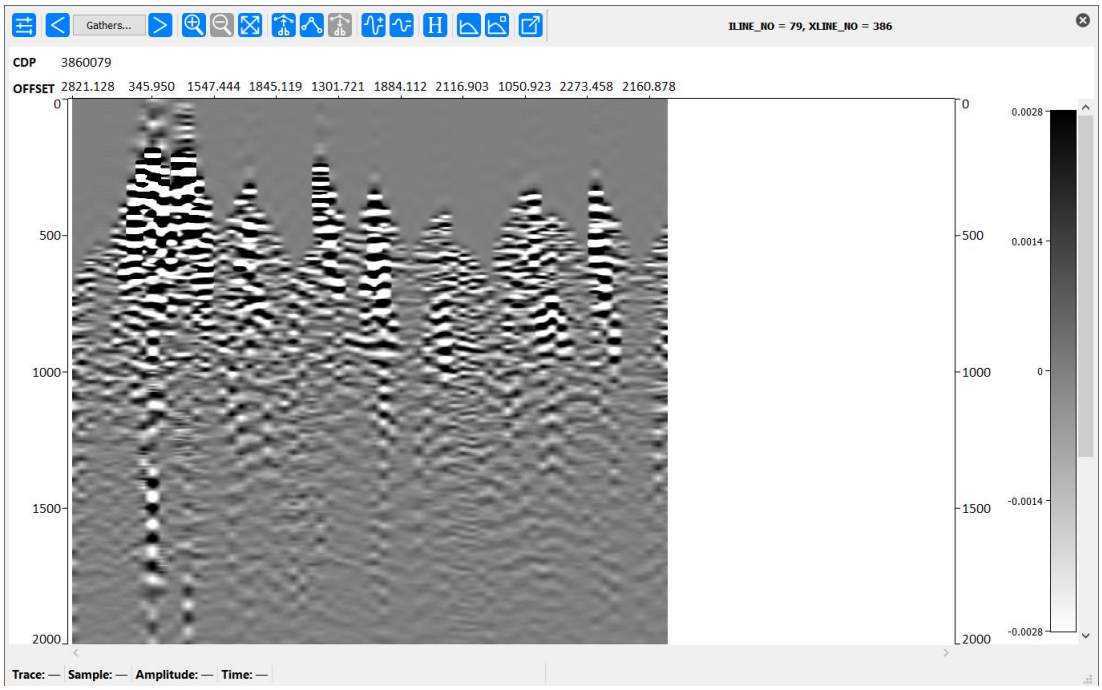
We can set up REC_ELEV header plot parameters at the bottom of section of the window. Let us place it on the Top Panel and change Color of the line to red. Set Major Step to 10. As a result, the REC_ELEV header plot parameters will look like this:



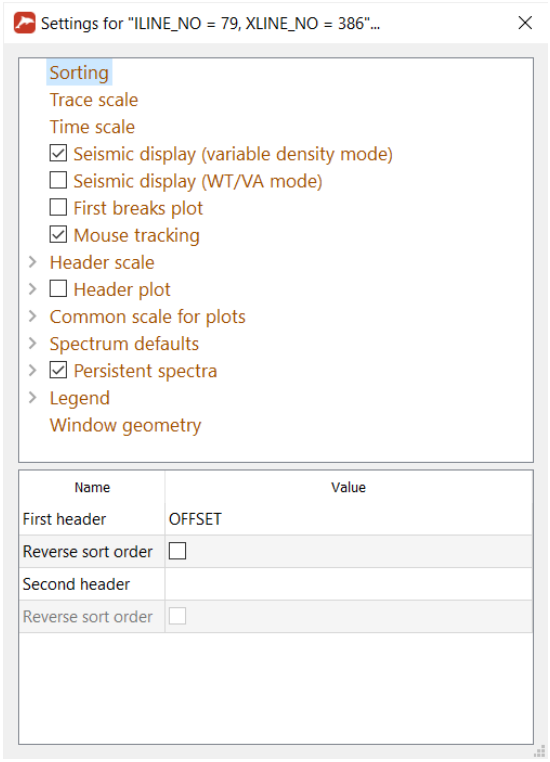
Close the parameters window of seismogram display and have a look at the shot gather with channel numbers marked along the horizontal axes and a receiver elevation plot on top of it:



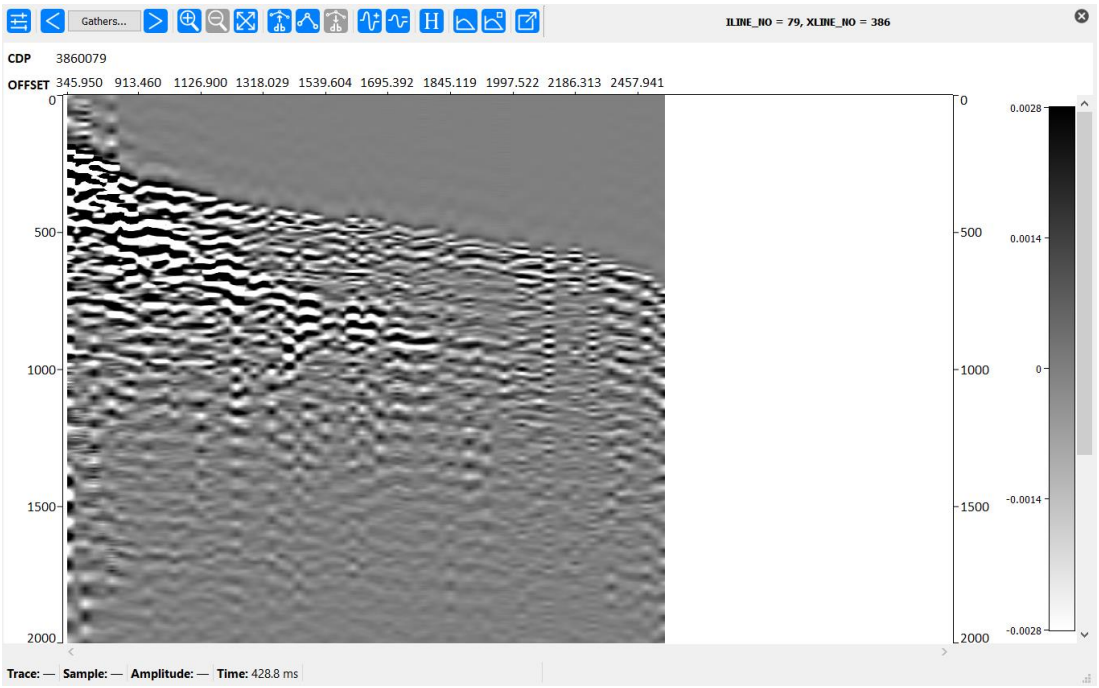
The same way we can display a CDP gather. Left-click on a CDP on a Location Map and a CDP gather will appear, though the way it looks is not very familiar so far:



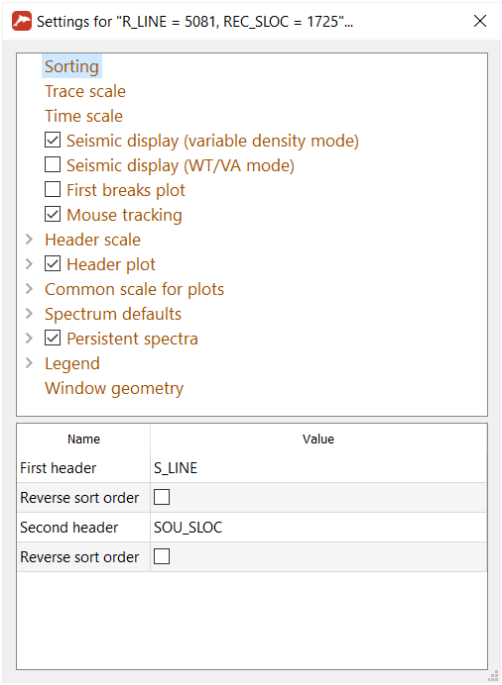
The reason is that the traces within the gather are not sorted. Let us sort them by OFFSET. You can specify the desired Sorting by OFFSET in the seismic display settings as shown below:



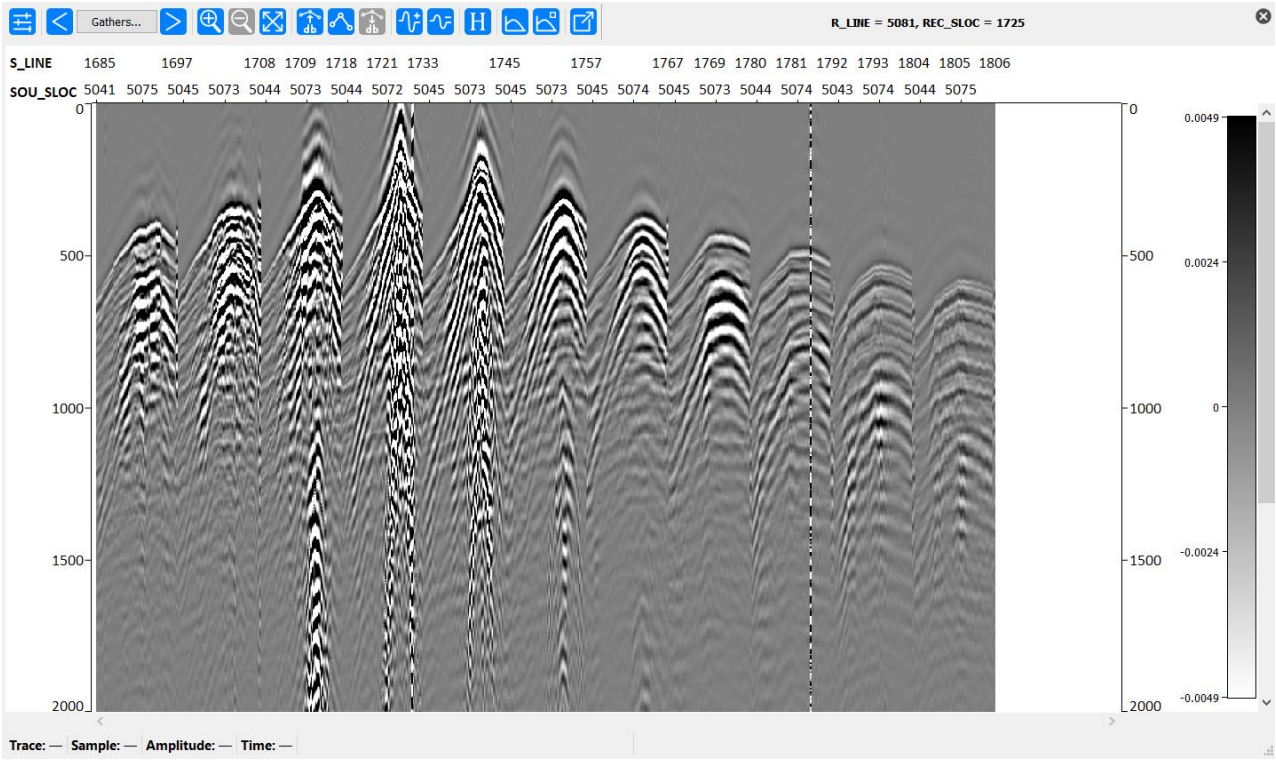
The CDP gather sorted by OFFSET is shown below:



We can display a common receiver gather the same way. Left-click on a receiver point on a Receiver Map and a corresponding receiver gather will open. In the seismic display parameters sent Sorting as S_LINE:SOU:SLOC as shown below:

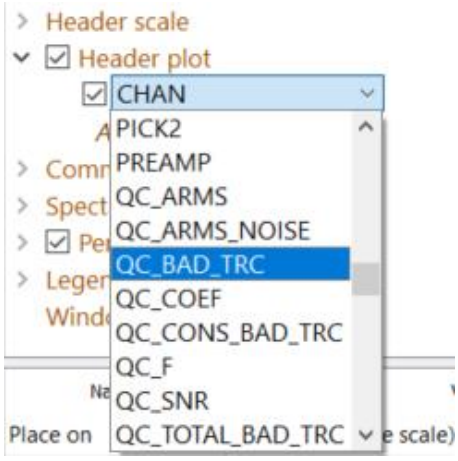


As a result, a common receiver gather will open; you can set horizontal scale to display S_LINE and SOU_SLOC values:

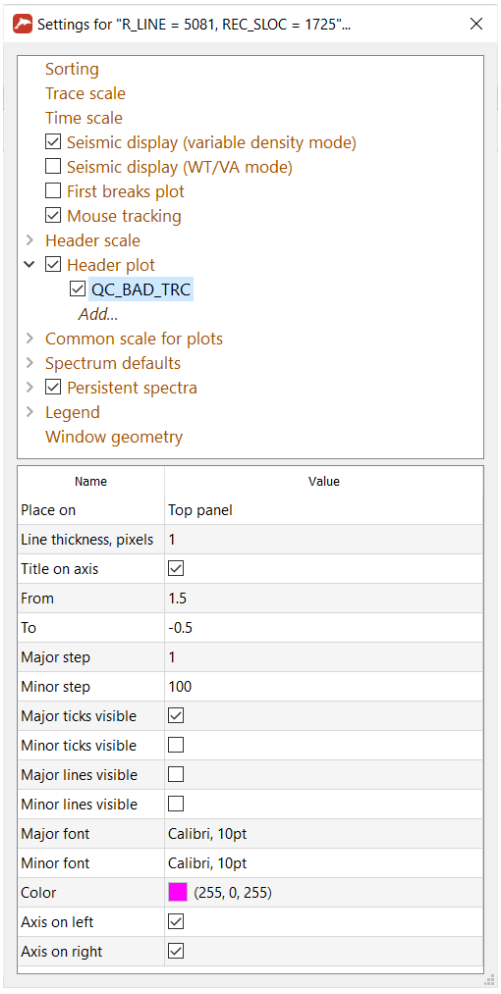


Let us the plot the trace-to-trace attribute QC_BAD_TRC above receiver gather seismogram. As you remember, this attribute marks bad traces with the value 1, otherwise it is 0, so we will be able to see which traces were automatically marked as bad. We will do it the same way as we have

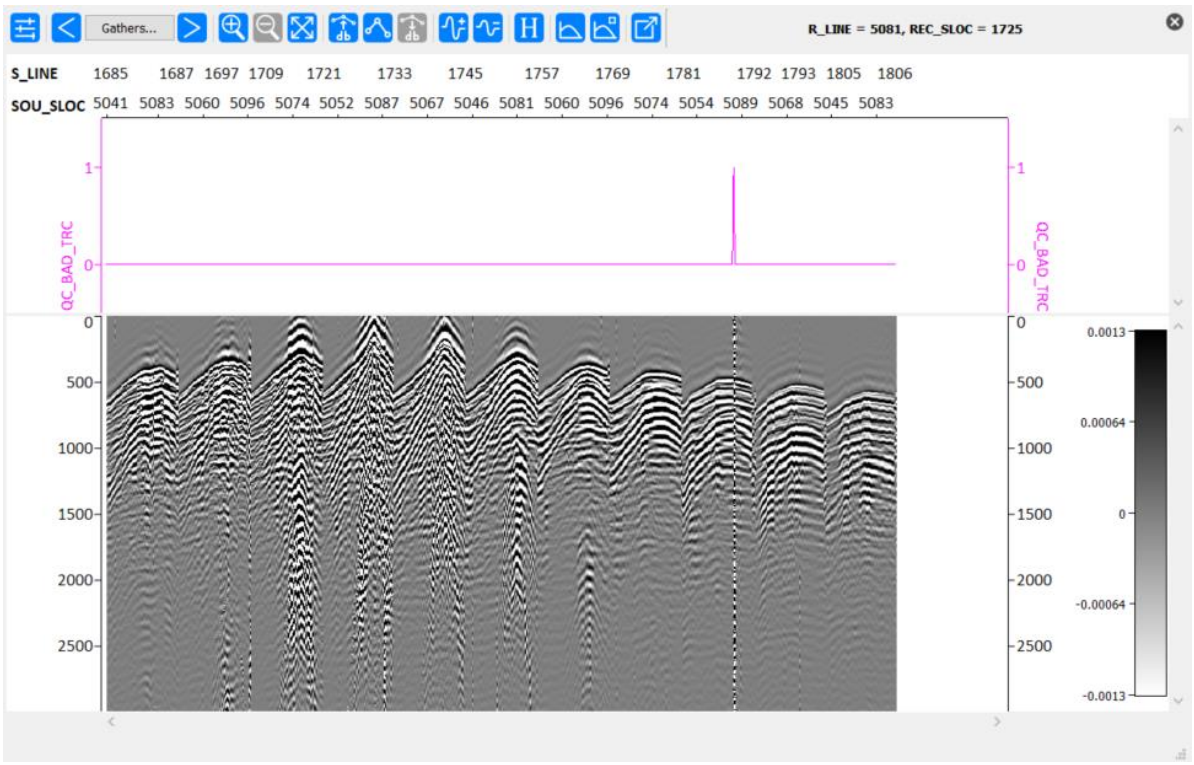
plotted receiver elevation vales: in the Header Plot section of the parameters, click Add, click the default header name and in the drop-down list change it the QC_BAD_TR:



Again, in the Header Plot parameters below we will indicate that is will be Placed on the Top Panel and select a Color for the plot line. Set the Major Step 1 and the range From 1.5 To -0.5. The Settings window will look like this:

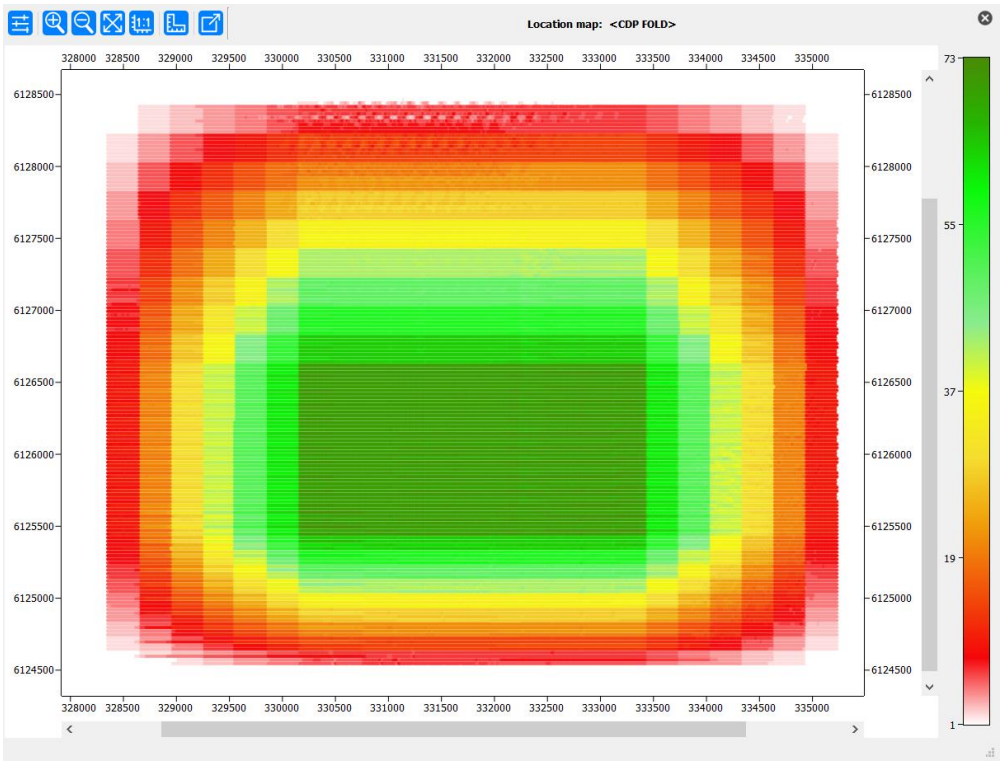


Now you can see the common receiver gather with a bad trace mark displayed on top of the seismogram. As you can see, the bad trace mark correctly identifies a dead channel record:

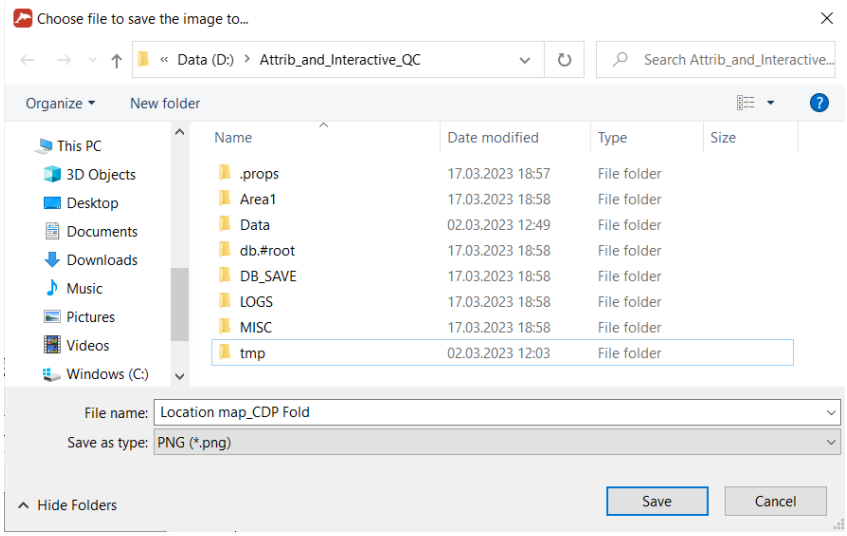


Deliverables: saving images and export to ASCII

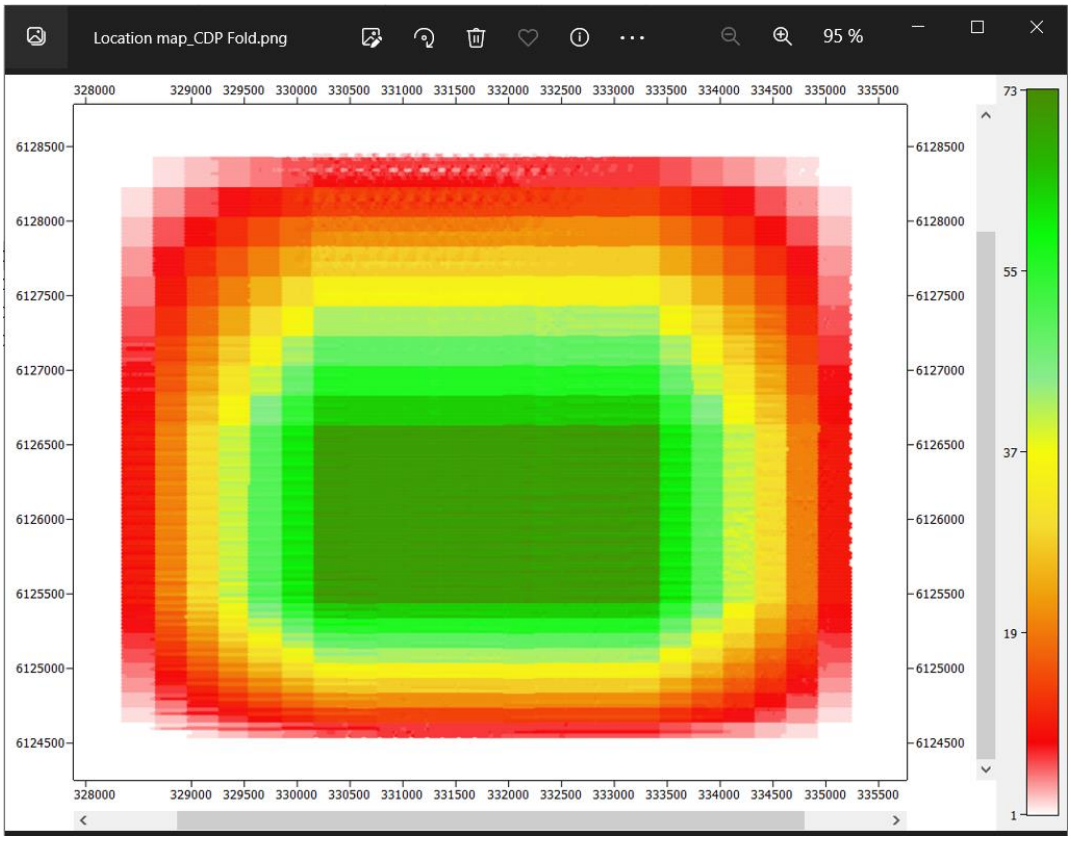
The main deliverables of the interactive QC are the attribute maps and tables. Let us save a map as an image. Select a map you would like to save (let it be the CDP map with the fold) and click the Save Image icon on the toolbar:



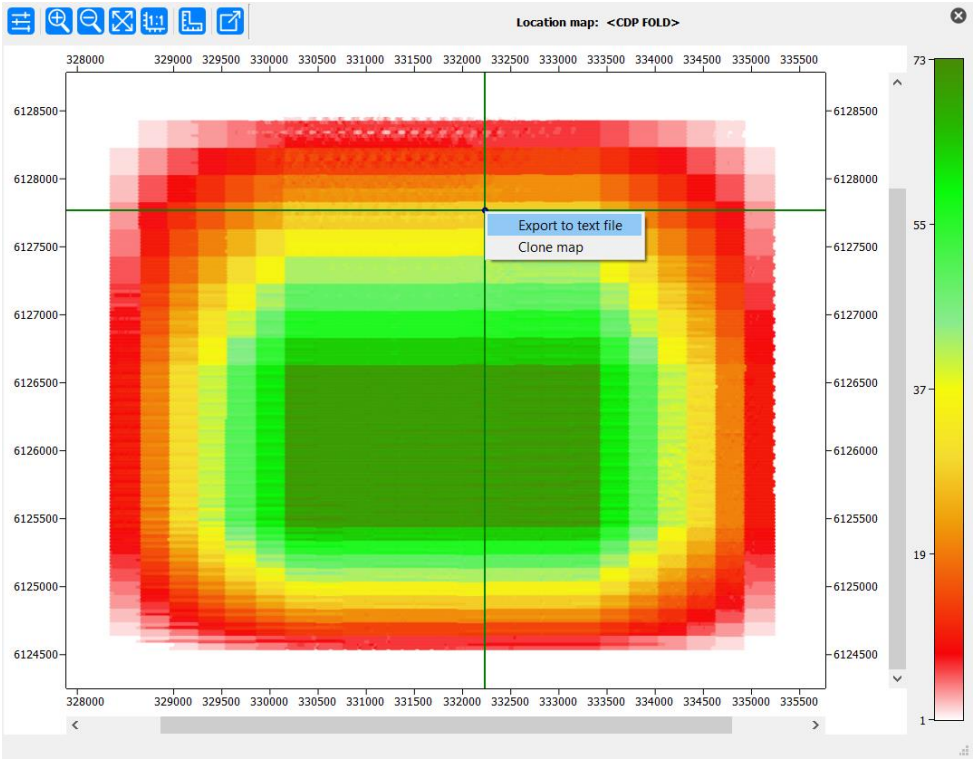
In the standard Windows File Save… dialog select image format, location and file name:



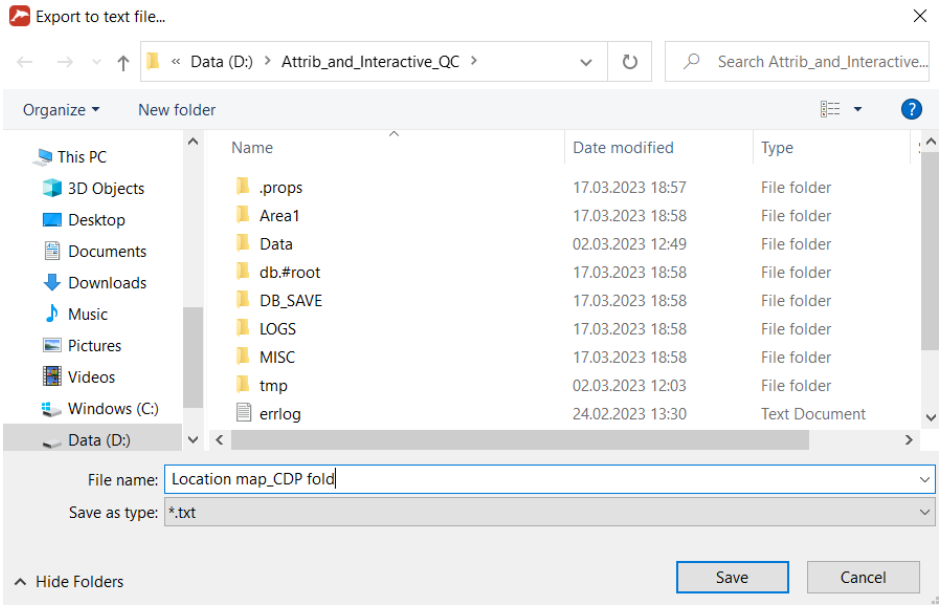
You can view the resulting file any image viewer:



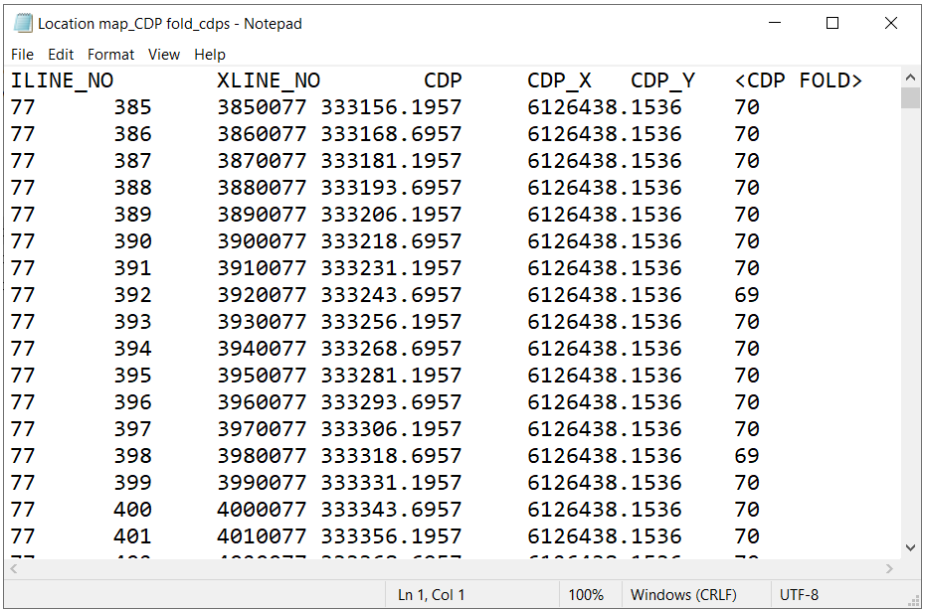
Additionally, you can export values of all headers associated with the CDP Fold Location Map (including the fold attribute itself) to aт ACII file. Right-click on the map and in the context menu select Export to text file… command:



Select an export folder and a file name:



The content of the resulting ASCII file is shown below. It contains indexes and coordinates of the mapped points as well as the value of the attribute that was selected for the color code (in this case it is <CDP_FOLD>):


Location map_CDP fold_cdps - Notepad

File Edit Format View Help

ILINE_NO	XLINE_NO	CDP	CDP_X	CDP_Y	<CDP FOLD>
77	385	3850077	333156.1957	6126438.1536	70
77	386	3860077	333168.6957	6126438.1536	70
77	387	3870077	333181.1957	6126438.1536	70
77	388	3880077	333193.6957	6126438.1536	70
77	389	3890077	333206.1957	6126438.1536	70
77	390	3900077	333218.6957	6126438.1536	70
77	391	3910077	333231.1957	6126438.1536	70
77	392	3920077	333243.6957	6126438.1536	69
77	393	3930077	333256.1957	6126438.1536	70
77	394	3940077	333268.6957	6126438.1536	70
77	395	3950077	333281.1957	6126438.1536	70
77	396	3960077	333293.6957	6126438.1536	70
77	397	3970077	333306.1957	6126438.1536	70
77	398	3980077	333318.6957	6126438.1536	69
77	399	3990077	333331.1957	6126438.1536	70
77	400	4000077	333343.6957	6126438.1536	70
77	401	4010077	333356.1957	6126438.1536	70

Ln 1, Col 1 100% Windows (CRLF) UTF-8