

# 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:

RadExPro 2022.4 >>> Attrib_and_Interactive_QC Database Options Tools Windows Help			- 🗆 X
· · · · · · · · · · · · · · · · · · ·			
🍄 Processing 🛛 Database Navigator			
Project tree	× Processing flow >> Area1 / Line1 / 010_data_view	×	All modules ×
» ≈ @	▶ 🔲 ▾ Ē₀ ▾	📃 🎇 🛛 🔲	» «
✓ <sup>III</sup> Area1			> Data I/O ′
✓			> Real-Time
O10_data_view			> Static Corrections
			> Geometry/Headers
			> Interactive Tools
			> Signal Processing
			> Data Enhancement
			> Deconvolution
			> Velocity
			> Stacking/Ensembles
			> Migration
			> Trace Editing
			> VSP
			>
	5 Flow status		5 ×

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:

Trace Input	×
Data Sets 3D_raw	Sort Fields  FFID CHAN  CHAN  Number of Ensemble Fields  I I I Note: Ensembles will be defined by this number of sort fields.
Add dataset Delete	Add Delete
	*:*
Add mask Delete	C Select from file File,
Load headers only     From batch list       Memory resort     Buffer size (MB)	C Database object
OK Cancel	O Get all

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

From t= 0.0 to 0.0 to to 10	WT/VA display mode C WT/VA C Normalizing factor Gain 0.3
Number of 1000 X Scale 10 Rotate Ensemble boundaries	C WT     Image: Constraint of the secret of th
Enable backward frame scrolling         Ensembles to       1         Variable spacing       field         Space to maximum ensemble width         Ensembles'       2         Muliple panels       0         Use excursion       2.0         Axis       Show headers	Variable density display mode © Grey © R/B © Custom Define © None © Individual © Data/velocity © Display data © Display velocity © St velocity Min.vel Min.vel Mix.vel (m/s) 1500.0
Plot headers Header mark Picks/polygons settings Save Template	Load Template Ok Cancel

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 150<sup>th</sup> channel:

Axis Paramete	rs	
Primary lines	Time dt Values Lines	FFID © Different dx Values C Interval 10.0
Secondary		CHAN (Interval 150.0)
Font size 15		Margins
Ok	Cancel	Left axis 20 mm Top axis 20 mm margin 20 mm

The flow will look like that:

# RadExPro seismic software

RadExPro 2022.4 >>> Attrib_and_Interactive_QC		- 🗆 X
Database Options Tools Windows Help		
Processing   Database Navigator		
Project tree ×	Processing flow >> Area1 / Line1 / 010_data_view X	All modules ×
»		» *
✓	Trace Input <- 3D_raw	> Data I/O ^
✓	Screen Display	> Real-Time
010_data_view		> Static Corrections
		> Geometry/Headers
		> Interactive Tools
		> Signal Processing
		> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		>VSP
	Flow status	8 ×
MB1 - Move modules; Ctrl+MB1 - Copy modules; MB1 x2 - Ma	odule parameters; MB2 - Toggle modules; Ctrl+MB2 x2 - Cut modules; Shi	ft+MB1 - Paste modules

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.

Process	ing flow >> Area1 / Line1 / 010_data_view	/ ×
	<b>□</b> ▼ Ē. ▼	📒 🎇 🛛 🛯
Trace	Frame selection	
Scree	Frame width: 1	
	Honor ensemble boundaries	

**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.

$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

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

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🕢 010_dat	a_view < Li	ne1 < Area	a1 < Attri	o_and_Inter	active_QC	[12:58:59	]					Headers Display		×	2	- [	) ×
Zoom Con	nmon parar	neters \										View		_			Help
												3D_raw AAXFILT AAXSLOP	0.00000 0.00000				
FFID	6662											AOFFSET	0.00000				
CHAN	1	151	301	451	601	751	901	1051	120	1 135	1 1501	BATCH_IND	0	-1	2701	2851	
0												BINOFF BLOCKSHIFT1 BLOCKSHIFT2 CCP CCP_X CCP_Y CDP	0.00000 0.00000 0.00000 0 0.00000 0.00000 4820101				
2000												CDP_X CDP_Y CENTRAL_ANGLE CHAN CHANNEL_SET COMP COR_FLAG DAY DELAY	334368.69570 6127038.15360 0.00000 1106 2 0 0 199 0.00000				
Tr:1152 Sar <	m:0 Amp	:2.51e-06	t:0ms			*						DEPTH DMOOFF DSIND	0.00000 0.00000 1	v			// *

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 reopened 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.

RadExPro 2022.4 >>> Attrib_and_Interactive_QC		- 🗆 X
Database Options Tools Windows Help		
Processing		
Project tree ×	Processing flow >> Area1 / Line1 / 020_picking_horizon	All modules ×
» ≈ @		» *
✓ ♯ Area1		> Data I/O ^
✓ □ Line1		> Real-Time
😳 010_data_view		> Static Corrections
020_picking_horizon		> Geometry/Headers
		> Interactive Tools
		> Signal Processing
		> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		> VSP
	5 Flow status	5 ×
MB1 - Move modules; Ctrl+MB1 - Copy modules; MB1 x2 - Mo	odule parameters; MB2 - Toggle modules; Ctrl+MB2 x2 - Cut modules; Shi	ft+MB1 - Paste modules

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	×
Data Sets	Sort Fields
Add dataset Delete	FFID       Image: CHAN       Number of Ensemble Fields         Image: CHAN       Image: Image: CHAN       Image: Image: Image: CHAN         Image: Image: CHAN       Image: Image: Image: CHAN       Image: Imag
Datasets masks	Add Delete
	Selection
	6662:*
Add mask Delete	C Select from file File
Load headers only From batch list	C Database object Choose
Memory resort Buffer size (MB)	
OK Cancel	C Get all

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:

Amplitude Correction		×
☐ Time raise to power	2.0	9
Exponential correction, [dB/ms]	0.0	9
✓ Normalization		2
Normalization type	Constant time	9
Constant time ?	0.0	9
Maximum application time ?	0.0	າ
✓ □ Automatic gain control		9
Operator length, [ms]	0.0	9
Type of AGC scalar	MEAN	2
Basis for scalar application	CENTERED	2
Save AGC coefficients to dataset		9
✓ ✓ Trace equalization		2
Basis for scaling	MEAN	2
Time gate start time, [ms]	0.0	2
Time gate end time, [ms]	1500.0	2
✓ ☐ Time variant scaling		2
Specify gain function along trace (t[ms]) 🕜		9
	OK Cancel	

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:

Display parameters	×
From t= 0.0 to 1500.( t Scale 10 Number of 500 X Scale 10 Rotate Ensemble boundaries	WT/VA display mode     Normalizing factor     Gain     0.3       O WT/VA     O None     Bias(%)     0       O VA     Individual     Bias(%)     0       Image: None     Show every     1
Enable backward frame scrolling         Ensembles to       1         Variable spacing       field         Space to maximum ensemble width         Ensembles'       2         Muliple panels       1         Vse excursion       2.0	Variable density display mode © Grey © R/B © Custom Define © None © Individual © Display data © Display velocity © Display velocity Set velocity Min.vel 500.0 Max.vel (m/s) 1500.0
Axis       Show headers         Plot headers       Header mark         Picks/polygons settings       Save Template	d Template Ok Cancel

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:

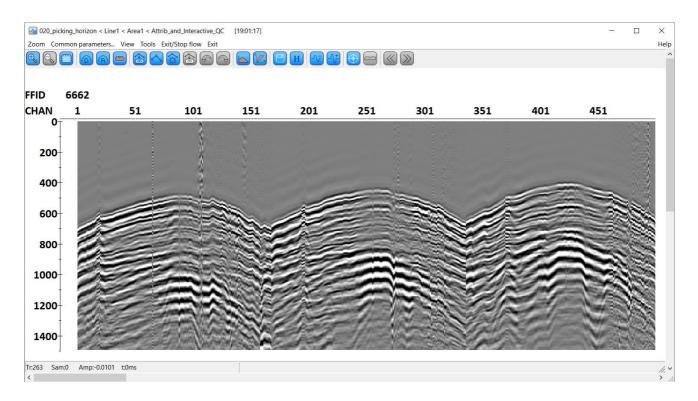
Axis Paramete	rs	
	Time dt Values Lines	FFID FFID
Primary lines	200.0	○ Interval 10.0 ▼ ○ Multiple
Secondary	100.0	CHAN Different CHAN Interval 50.0
Font size 15		- Margins
Ok	Cancel	Left axis 20 mm Top axis 20 mm margin 20 mm

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

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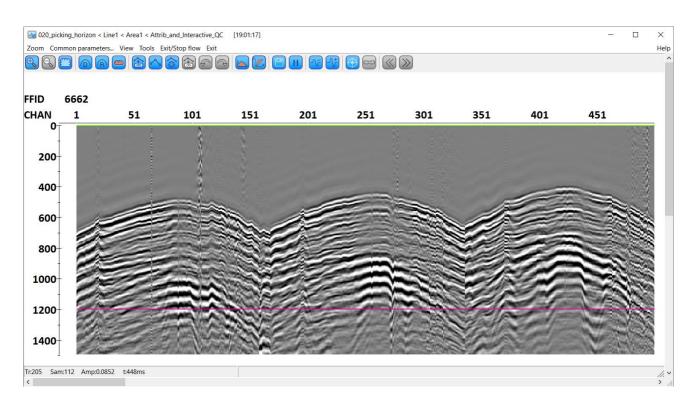
Processing      Database Navigator roject tree	Processing flow >> Area1 / Line1 / 020_picking_horizon	× All modules
»		LOG » ×
′ <sup>i</sup> i Area1	Trace Input <- 3D_raw	> Data I/O
✓	Amplitude Correction	> Real-Time
010_data_view	Screen Display	> Static Corrections
010_ddd_view		> Geometry/Headers
		> Interactive Tools
		> Signal Processing
		> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		> VSP
		>OC
	Flow status	5

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

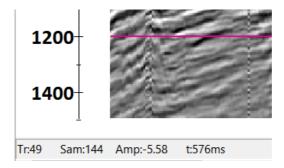


It is possible to create an approximate horizon above the first breaks to use it as an initial horizon. However, in this particular case it seems reasonable to use constant value of 0 ms since first-

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.

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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:

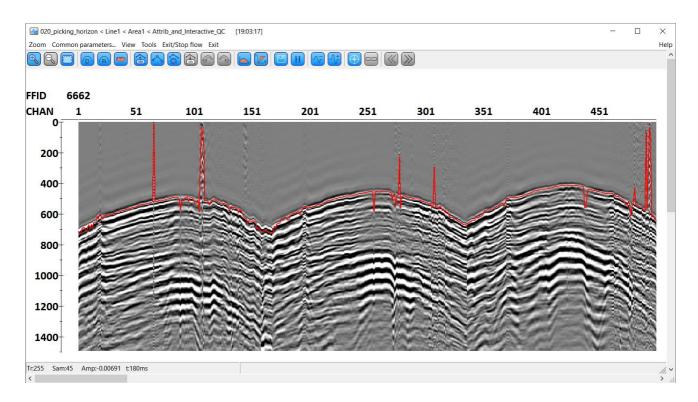
First Break	-		×
-Output h	First Br	eak time (header word): FBPICK mplitude (header word): PREAMP	▼ ms
Window	length 1200	Horizon (header word): SOU_H2OD ms Leading window 50	▼ ms
• Thres	hold C Global	C Derivative C Modified Coppens's meth	od (MCM)
Threshold	1	Window to calculate derivative: 10	ms
Trace event type	<ul> <li>Minimum</li> <li>Maximum</li> </ul>	Maximum/Global Maximum ratio	%
type	C Sign Change C Threshold	Stabilization constant 0.2	ms
		Compute energy ratio derivative	
	OK	Cancel	

Horizon (header word) – this is the trace header, starting from which the search for firstarrival 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:

Header plot			×
General parameters Flot headers Fill backgorund			
Curve parameters Time scale Color Plot area position Plot area width Whole range	0 100	Curves to plot	Add Remove
Min scale Max scale value Show scale Scale Value marks © Left © Right Autoscale	0 0 0		Current static Applied static Total static
Marks	10 ОК	Cancel	

Run the flow. The result is shown below:



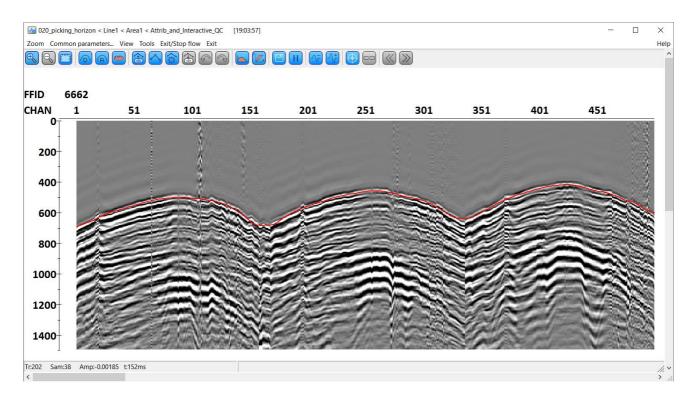
As you can see, the automatic picking with the given parameters worked almost good. We will fix the occasional errors through averaging of the obtained picking with the use of module Header

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:

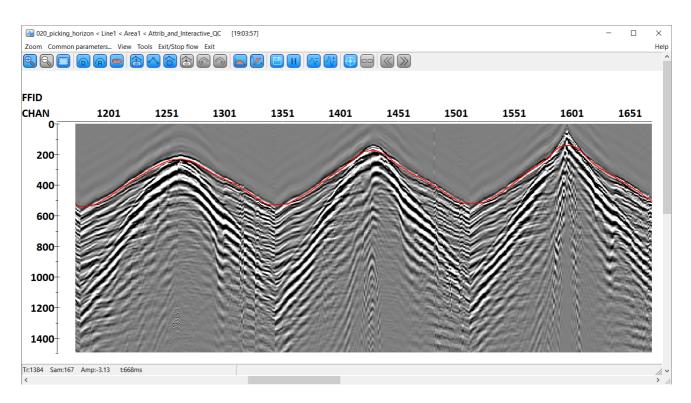
Header Averager	×
Trace FBPICK        Window length     31	Honor ensemble boundaries
Type C Running Average ( Alpha Trimmed (% 30)	Mode Normal Subtraction
OK Cance	4

#### 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:

Pick1 = FBPICK - 70



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:

Trace Header Math	×
Pick1 = FBPICK- 70	
Line 1 Pos 19	Use # for comments Headers colored blue Errors colored red
OK Cancel Check syntax	Load template Save template

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:

Header<->Dataset Transfer		×
Header transfer direction C FROM dataset TO header	FROM header TO dataset	
Dataset Area1\Line1\3D_raw		Dataset Location
Match by fields		
FFID, CHAN		
Assign		
FBPICK, PICK1		
	OK Cancel	

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):

19

Trace Input	×
Data Sets       3D_raw       Image: Constraint of the set of	Sort Fields FFID CHAN
Datasets masks	Add Delete
Add mask     Delete       Load headers only     From batch list       Memory resort     Buffer size (MB)       OK     Cancel	Select from file     File      Database object     Choose      Get all

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).

Processing flow >> Area1 / Line1 / 030_picking_horizon		
	🔲 🗸 🗧	
Trace	Frame selection	
Amp	Frame width: 1	
First	✓ Honor ensemble boundaries	
Header Averager		

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

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roject tree	Processing flow >> Area1 / Line1 / 020_picking_horizon	All modules
»	▶	» *
□ Area1	Trace Input <- 3D_raw	> Data I/O
✓  □ Line1	Amplitude Correction	> Real-Time
010_data_view	First Breaks Picking	> Static Corrections
	Header Averager	> Geometry/Headers
020_picking_horizon	Trace Header Math	> Interactive Tools
	Header<->Dataset Transfer -> Area1\Line1\3D_raw	> Signal Processing
	***Screen Display	> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		>VSP
	5 Flow status	8

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.

Trace Input	×
Data Sets	Sort Fields
3D_raw	FFID CHAN CHAN Number of Ensemble Fields 1 Note: Ensembles will be defined by this number of sort fields.
Add dataset Delete	
Datasets masks	Add Delete
	Selection
	×:* \
Add mask Delete	C Select from file File
🗌 Load headers only 📗 From batch list	
Memory resort Buffer size (MB)	C Database object Choose
OK Cancel	C Get all

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:

SSAA					×
Attributes Horizon					
Attributes Attribute Peak frequency Centroid frequency Apparent frequency Visible frequency Bandwidth Peak amplitude Trough amplitude Max. absolute amp. Window length 500 C Symmetric C Up	Trace header		MS Amplitude ick amplitude eak amplitude time rough amplitude time ax. absolute amp. /N Ratio esolving power ime shift	ne	IS
	0			01	
	Save	template	Load template	OK	Cancel
SSAA					×
Attributes Horizon					
Pick in database     Frace header     PICK1     Specify     CDP     0-50:500,70:300	Brows	e			
J					
	Save	template	Load template	ОК	Cancel

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:

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RadExPro 2022.4 >>> Attrib_and_Interactive_QC Database Options Tools Windows Help		- 🗆 X
🔅 Processing 🗾 Database Navigator		
Project tree ×	Processing flow >> Area1 / Line1 / 030_per-trace attributes	All modules ×
» ≈ []		» *
∽ ♯ Area1	Trace Input <- 3D_raw	> Data I/O ^
✓ □ Line1	SSAA	> Real-Time
🕸 010_data_view		> Static Corrections
© 020_picking_horizon		> Geometry/Headers
-1 5-		> Interactive Tools
030_per-trace attributes		> Signal Processing
		> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		>VSP
	5 Flow status	
	PP FIOW Status	5 ~
MB1 - Move modules; Ctrl+MB1 - Copy modules; MB1 x2 - Mo	dule parameters; <b>MB2</b> - Toggle modules; <b>Ctrl+MB2 x2</b> - Cut modules; <b>Shi</b>	ft+MB1 - Paste modules

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

Trace Header Math	×
Pick2 = 3000	
Line 1 Pos 13	Use # for comments Headers colored blue Errors colored red Load template Save template

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).

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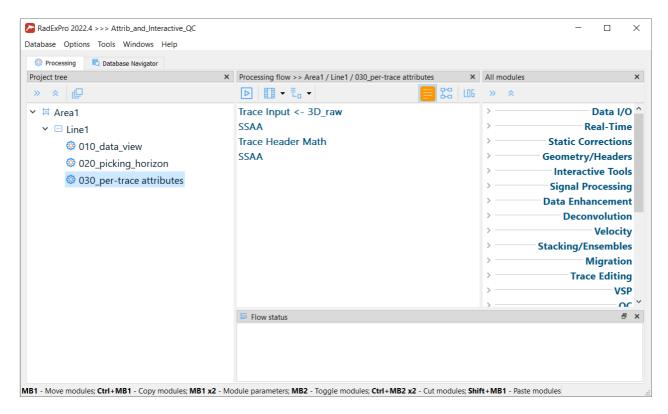
RadExPro 2022.4 >>> Attrib_and_Interactive_QC Database Options Tools Windows Help		- 🗆 X
Processing Statabase Navigator		
Project tree ×	Processing flow >> Area1 / Line1 / 030_per-trace attributes	All modules ×
» ≈ @	▶ 🗊 • ≒ • 📄 🔛 🔟	» *
✓ III Area1	Trace Input <- 3D_raw	> Data I/O ^
✓ □ Line1	SSAA	> Real-Time
010_data_view	Trace Header Math	> Static Corrections
© 020_picking_horizon	SSAA	> Geometry/Headers
-1 3-		> Interactive Tools
030_per-trace attributes		> Signal Processing
		> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		>VSP
	5 Flow status	
	E FIOW STATUS	<b>P</b> ^
MB1 - Move modules; Ctrl+MB1 - Copy modules; MB1 x2 - Mo	dule parameters; <b>MB2</b> - Toggle modules; <b>Ctrl+MB2 x2</b> - Cut modules; <b>Shi</b>	ft+MB1 - Paste modules

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:

SSAA	>	×
Attributes Horizon		
Attributes     Trace header       Peak frequency	✓     ✓     RMS Amplitude     QC_ARMS_NOIS ▼       ✓     Pick amplitude time     ✓       ✓     Peak amplitude time     ✓       ✓     Trough amplitude time     ✓       ✓     Max. absolute amp. time     ✓       ✓     S/N Ratio     ✓       ✓     Resolving power     ✓       ✓     Time shift     ✓	
C Symmetric    O Down		
	Save template Load template OK Cancel	

SSAA				×
Attributes Horizon				1
C Pick in database Select C Trace header PICK2 C Specify CDP 0-50:500.70:300	Browse			
	Save template	Load template	ОК	Cancel

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:

Trace Header Math	×
QC_SNR=QC_ARMS/QC_ARMS_NOISE QC_BAD_TRC=cond(QC_SNR<1.3, 1, 0)	
Line 1 Pos 1 OK Cancel Check syntax	Use # for comments Headers colored blue Errors colored red Load template

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:

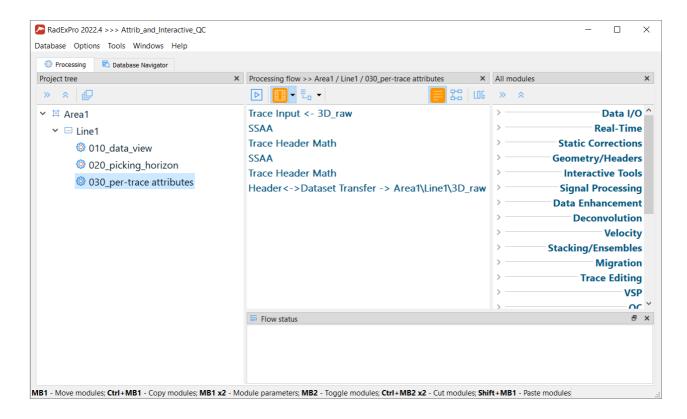
27

Header <-> Dataset Transfer		×
Header transfer direction	FROM header TO dataset	
Dataset Area1\Line1\3D_raw		Dataset Location
Match by fields		
FFID, CHAN		
Assign		
QC_BAD_TRC		
	OK Cancel	

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

Processing flow >> Area1 / Line1 / 030_per-trace attributes ×
Trace Frame selection
SSAA Frame width: 1
Trace Honor ensemble boundaries
SSAA
Trace Header Math
Header <-> Dataset Transfer -> Area1\Line1\3D_raw

### Run flow:



# **Computation of Gather Attributes**

# Defining windows for attribute computation

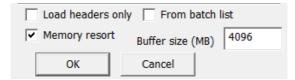
On each common shot point gather, we would like to compute an RMS amplitude of a signal in the target reflection area, apparent frequency in the target reflection area and RMS amplitude of the background noise. For this purpose, it is necessary to define space-time windows corresponding to the target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

Project tree	×	Processing flow >> Area1 / Line1 / 040_shot_gather_attributes	All	modules
» ≈ @		▶ 🗓 • ₺ • 📒 🔛 💴	»	*
🖌 📮 Area1			>	Data I/O
✓ □ Line1			> -	Real-Time
010_data_view			> -	Static Corrections
© 020_picking_horizon			> -	Geometry/Headers
030_per-trace attributes			>	Interactive Tools
040_shot_gather_attributes			> -	Signal Processing
a 040_shot_gather_attributes				Data Enhancement
				Deconvolution
			2	Velocity
				Stacking/Ensembles
			Ľ.	Migration Trace Editing
			Ś.	VSP
			Ś.	
		5 Flow status		5

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:

Transformet	×
Trace Input	
Data Sets	Sort Fields
3D_raw	FFID       Image: Second
Add dataset Delete	
Datasets masks	Add Delete
	© Selection
	6662-6672:*
Add mask Delete	C Select from file File
Load headers only From batch list	
Memory resort Buffer size (MB) 4096	C Database object
OK Cancel	○ Get all

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:

💁 Display parameters	
From t= 0.0 to 0.0 t Scale 10 Number of 6000 X Scale 10 Rotate Forsemble boundaries	WT/VA display mode     Normalizing factor     Gain     0.3       C WT     C None     Entire screen     Bias(%)     0       C None     Show every     1
Enable backward frame scrolling         Ensembles to       1         Variable spacing       field         Space to maximum ensemble width         Ensembles'       2         Muliple panels       0         Vise excursion       2.0         Axis       Show headers	Variable density display mode © Grey © R/B © Custom Define © None © Individual © Display velocity © Display velocity © Display velocity Set velocity Min.vel Min.vel Min.vel (m/s) 1500.0
Plot headers Picks/polygons settings Save Template	ad Template Ok Cancel

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:

Axis Parameter	rs	
	Time dt Values Lines	Traces     Image: Constraint of the second sec
Primary lines	0.000	C Multiple
Secondary	100.0	OFFSET © Interval 500.0 V
Font size 15		Margins
Ok	Cancel	Left axis 20 mm Top axis 20 mm margin 20 mm

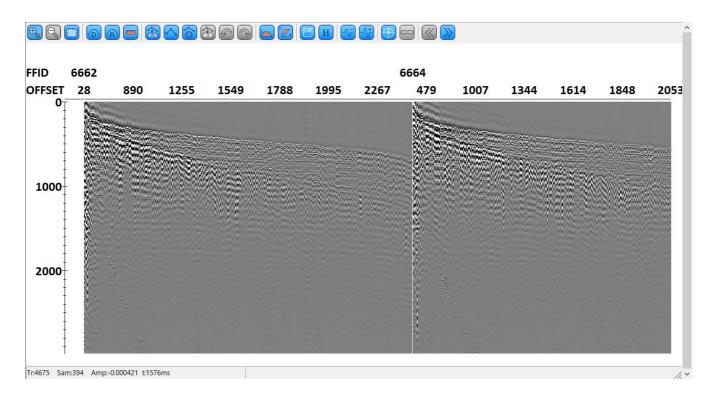
Since only few seismograms are input into the flow, we do not need to use the framed mode here and will run the flow as it is:

# RadExPro seismic software

RadExPro 2022.4 >>> Attrib_and_Interactive_QC Database Options Tools Windows Help		- 🗆 X
Processing   Database Navigator		
Project tree ×	Processing flow >> Area1 / Line1 / 040_shot_gather_attributes ×	All modules ×
» ≈ @	▶ 🖩 – 🖥 –	» «
✓ ♯ Area1	Trace Input <- 3D_raw	> Data I/O ^
✓ □ Line1	Screen Display	> Real-Time
🔅 010_data_view		> Static Corrections
<pre>@ 010_uuu_view @ 020_picking_horizon</pre>		> Geometry/Headers
-1 3-		> Interactive Tools
030_per-trace attributes		> Signal Processing
040_shot_gather_attributes		> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		>VSP
	5 Flow status	5 ×
MB1 - Move modules; Ctrl+MB1 - Copy modules; MB1 x2 - Mo	dule parameters; MB2 - Toggle modules; Ctrl+MB2 x2 - Cut modules; Shi	ft+MB1 - Paste modules

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







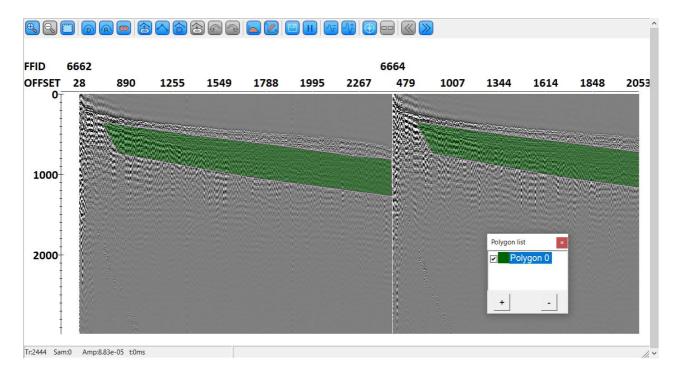
for computation of attributes (new "polygon"):

	画 💈 Approxima	ate	>			
	Spectrum		>			<i>y</i> 🥑
	Pick		>			
	QC polygo	ons	>	Edit polygons		
FID 6662	Wells			New Polygon	Q 564	
FFSET 28	890 Static corre	ections	>	Save polygon as	479	2
	Apply proc	cedure	>	Load polygon	473	
	Amplitude	editing	>		With the second s	250
-	Trace Head	der Math				
	Syncronize	2	>			Sec.
	Navigate		>	2 + 69 yr y 1		20
	Reflect hea	ader changes in				
	Reflect ide	-			Sec. 1	ante de Ante de
- Accession	Text hint					996
1000+	Text minu			A State of the second sec	Contest (C) Market	Sec.
A STATE OF A	Save imag	e parameters		Contraction of the second second second	Part With the	1000

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:



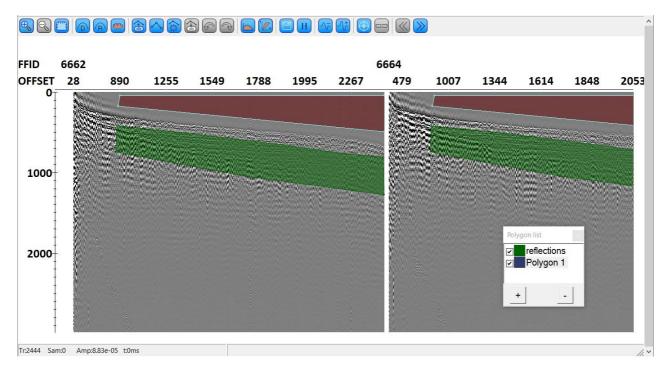
Let delineate a polygon around the target reflection area clicking successively the left mouse button on the screen. It is possible to set a polygon on any seismogram - it will be similarly depicted on all of them:



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:

Choose Polygon			×
Object(s): reflections			
» 🔹 🗌 Show objects from sublevels	Set filter text (yo	ou can use * and ?	wildcards)
✓ III Area1	Name	Location	Color
✓ ⊡ Line1			
😳 010_data_view			
😳 020_picking_horizon			
😳 030_per-trace attrib			
040_shot_gather_attr			
	ОК	Cancel	

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:

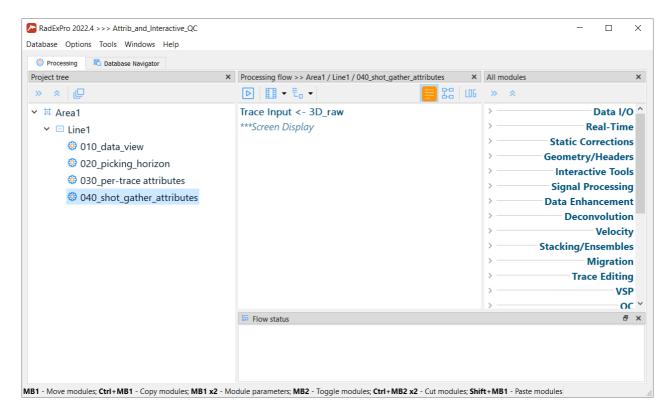
	oise			
»	Show objects from sublevels	Set filter text (ye	ou can use * and ? wild	cards)
🗸 🛱 Are	ea1	Name	Location	Color
× 🖃	Line1	reflections	040_sho	
	🔅 010_data_view			
	🔅 020_picking_horizon			
	🔅 030_per-trace attrib			
	🔅 040_shot_gather_attr			

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:

~	Ensemble QC		×
~	Window		2
	Туре	Polygonal	- 2
	Polygon	Area1\Line1\040_shot_gather_attri	ibutes\reflections
~	Skip bad traces if		2
	Trace header	QC_BAD_TRC	- 2
	is	>	· 2
	than	0.0	2
~	Amplitude calculation		2
	Method	2D RMS	- 2
	Trace header	QC_ARMS	2
	Processing mode	Ensemble	· 9
>	□ Signal / Noise ratio		9
>	Resolution calculation		2
~	Apparent frequency calculation		9
	Apparent frequency output header name	QC_F	2
	Method	Number of sign changes	2
	Normalize CF	No (0)	· 2
>	Bandwidth calculation		2
>	Peak frequency calculation		9
	Number of threads (?)	1	9
			OK Cancel

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.

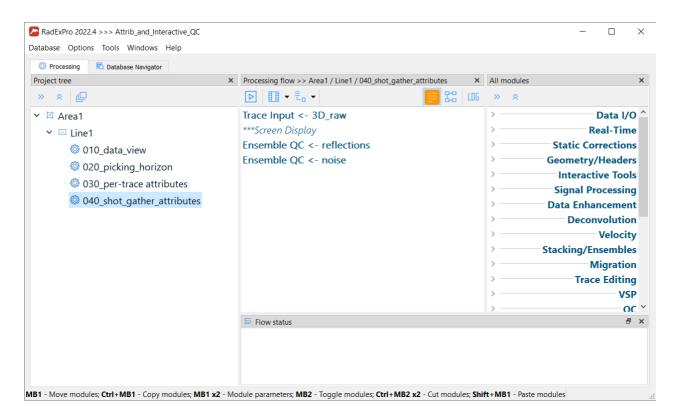
Now the flow looks like this:

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## RadExPro seismic software

RadExPro 2022.4 >>> Attrib_and_Interactive_QC Database Options Tools Windows Help		- 🗆 X
Processing  Database Navigator		
Project tree ×	Processing flow >> Area1 / Line1 / 040_shot_gather_attributes ×	All modules ×
» ≈ @	▶ 🖩 - 🖥 - 📔 🎇 🛛 🚺	»
✓ ♯ Area1	Trace Input <- 3D_raw	> Data I/O ^
✓	***Screen Display	> Real-Time
010_data_view	Ensemble QC <- reflections	> Static Corrections
		> Geometry/Headers
© 020_picking_horizon		> Interactive Tools
030_per-trace attributes		> Signal Processing
040_shot_gather_attributes		> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		> VSP
		> OC ¥
	5 Flow status	ē ×
MB1 - Move modules; Ctrl+MB1 - Copy modules; MB1 x2 - Mo	dule parameters; MB2 - Toggle modules; Ctrl+MB2 x2 - Cut modules; Shi	ft+MB1 - Paste modules

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:

Caracteria	×
✓ Window	2
Туре	Polygonal V
Polygon	Area1\Line1\040_shot_gather_attributes\noise
✓ ☑ Skip bad traces if	2
Trace header	QC_BAD_TRC V
is	> >
than	0.0
✓ Amplitude calculation	9
Method	2D RMS V
Trace header	QC_ARMS_NOISE ~
Processing mode	Ensemble v
> 🗌 Signal / Noise ratio	2
> Resolution calculation	2
> Apparent frequency calculation	2
> Bandwidth calculation	2
>  Peak frequency calculation	2
Number of threads	1 2
	OK Cancel

Now the flow looks like this:

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## RadExPro seismic software

Processing  Database Navigator           Project tree	Processing flow >> Area1 / Line1 / 040_shot_gather_attributes	All modules
» ≪ []		
<ul> <li>✓ I Area1</li> </ul>	Trace Input <- 3D_raw	> Data I/O
✓ □ Line1	***Screen Display	> Real-Time
010_data_view	Calculation of attributes using CSG	> Static Corrections
	Ensemble QC <- reflections	> Geometry/Headers
<pre></pre>	Ensemble QC <- noise	> Interactive Tools
030_per-trace attributes		> Signal Processing
040_shot_gather_attributes		> Data Enhancement
		> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		>VSP
		>oc
	➡ Flow status	đ

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.

Ensemble Header Statistics × Header to analyze QC_BAD_TRC Number of values Greater Number of consecutive values Less Maximum Minimum Average Save result to QC_TOTAL_BAD_TRC × OK Cancel		
Number of values     Number of consecutive values     Less     Maximum     Minimum     Average Save result to     QC_TOTAL_BAD_TRC	Contemporation Provided Activities	×
Number of consecutive values       Less         Maximum       Minimum         Average       Save result to	Header to analyze QC_BAD_TRC ~	
Number of consecutive values     Less       Maximum     Minimum       Average       Save result to     QC_TOTAL_BAD_TRC ~		
<ul> <li>○ Minimum</li> <li>○ Average</li> <li>Save result to</li> <li>QC_TOTAL_BAD_TRC ∨</li> </ul>		
○ Average Save result to QC_TOTAL_BAD_TRC ∨	O Maximum	
Save result to QC_TOTAL_BAD_TRC ~	O Minimum	
	◯ Average	
OK Cancel	Save result to QC_TOTAL_BAD_TRC ~	
	OK Cancel	

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.

Ensemble Header Statistics	×
Header to analyze QC_BAD_TRC	~
<ul> <li>Number of values</li> <li>Number of consecutive values</li> </ul>	) Greater Threshold 0.0 ) Less
O Maximum	
O Minimum	
O Average	
Save result to QC_CONS_BAD_TRC	Cancel

#### The resulting flow looks like this now:

Processing  Database Navigator		
roject tree	× Processing flow >> Area1 / Line1 / 040_shot_gather_attributes ×	All modules
» « @		» «
🗸 🖽 Area1	Trace Input <- 3D_raw	> Data I/O
✓   □ Line1	***Screen Display	> Real-Time
010 data view	Calculation of attributes using CSG	> Static Corrections
<pre></pre>	Ensemble QC <- reflections	> Geometry/Headers
_, _,	Ensemble QC <- noise	> Interactive Tools
030_per-trace attributes	Bad traces counting	> Signal Processing
040_shot_gather_attributes	Ensemble Header Statistics -> QC_TOTAL_BAD_TRC	> Data Enhancement
	Ensemble Header Statistics -> QC_CONS_BAD_TRC	> Deconvolution
		> Velocity
		> Stacking/Ensembles
		> Migration
		> Trace Editing
		> VSP
		>OC
	5 Flow status	8

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:

Trace Header Math	×
<pre>#Computation signal/noise QC_SNR = QC_ARMS/QC_ARMS_NOISE QC_COEF=cond( QC_F&lt;15, 0, cond( QC_SNR&lt;5, 0, cond( QC_SNR&lt;10, 0.9, 1 ) )) #Registration of bad traces QC_COEF=cond( QC_TOTAL_BAD_TRC&gt;20, 0, QC_COEF) QC_COEF=cond( QC_CONS_BAD_TRC&gt;3, 0, QC_COEF)</pre>	
Line 1 Pos 1 OK Cancel Check syntax	Use # for comments Headers colored blue Errors colored red Load template

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.

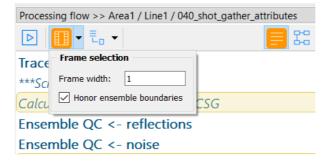
Further, save the obtained values of attributes using Header<->Dataset Transfer module that we already know. We will write the obtained headers (QC\_ARMS, QC\_ARMS\_NOISE, QC\_F, QC\_SNR, QC\_TOTAL\_BAD\_TRC, QC\_CONS\_BAD\_TRC, QC\_COEF) to 3D\_raw dataset:

Header<->Dataset Transfer	×
Header transfer direction       C     FROM dataset TO header       Image: FROM beader TO dataset	
Dataset Area1\Line1\3D_raw Dataset	Location
Match by fields	
FFID, CHAN	
Assign	
QC_ARMS, QC_ARMS_NOISE, QC_F, QC_SNR, QC_TOTAL_BAD_TRC, QC_CONS_BAD_TRC, QC_COEF	
OK Cancel	

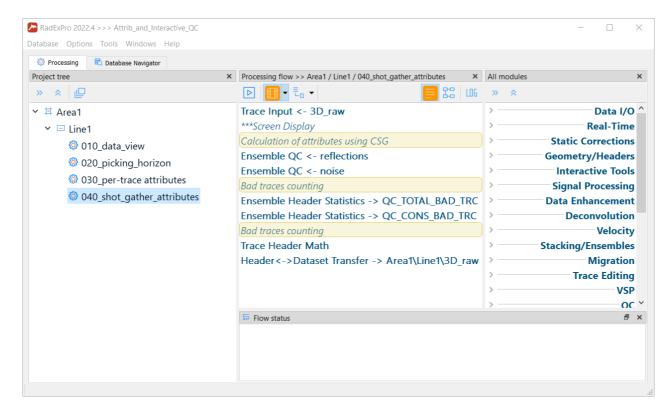
The flow is ready. Before running it, enter the Trace Input module parameters and remove limitations on the shot gather input since now we will need all the data. Replace the selection mask by \*:\* (as shown below):

Trace Input	×
Data Sets 3D_raw Add dataset Delete	Sort Fields FFID OFFSET Number of Ensemble Fields 1 Note: Ensembles will be defined by this number of sort fields.
Datasets masks	Add Delete   Selection  *:*
Add mask Delete Load headers only From batch list	C Select from file File
Memory resort         Buffer size (MB)         4096           OK         Cancel	C Database object Chaose

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:

Options Tools Windows Help			
cessing 🔀 Database Navigator			
ree			×
	▶ 🖽 • ≒ • 📄 ฿฿   ୦୦	» «	
Area1		> Data l/	<b>'0</b> ^
□ Line1		> Real-Tin	ne
O10_data_view		> Static Correctio	ns
		> Geometry/Heade	rs
020_picking_horizon		> — Interactive Too	ls
030_per-trace attributes		> Signal Processi	ng
040_shot_gather_attributes		> Data Enhanceme	-
050_Interactive_QC		> Deconvolutio	on
		> Veloci	ty
		> Stacking/Ensembl	es
		> Migratio	on
		> Trace Editin	
		>V	SP
		>	oc ~
	5 Flow status	1	5 ×
	₩ Flow status	> >	

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:

Choose scheme object to save settings to X				
Object(s): interactive_QC_scheme				
» 🔹 🗌 Show objects from sublevels	Set filter text (you can use * and	? wildcards)		
✓	Name	Location		
✓ 🖃 Line1	interactive_QC_scheme	Line1 < Area1		
😳 010_data_view				
😳 020_picking_horizon				
😳 030_per-trace attrib				
😳 040_shot_gather_attr				
050_Interactive_QC				
	OK Cancel			

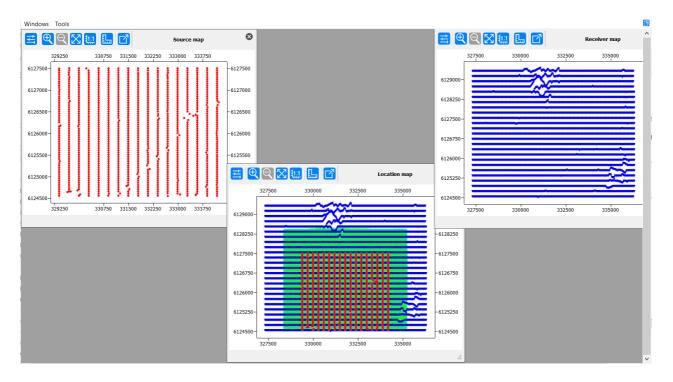
Finally, the module window should look like this:

Input dataset			
Area1\Line1\3D_raw			
Note: the dataset must be sorted by FFID		Read interval:	120 se
Trace filter			
Headers:			Add
Selection:			
SPS			
SPS-S:			Layout
SPS-R:			Layout
			20,000
Grid		Exclusive areas	
Note: grid is used only for statistics			
Visual scheme			
Area1\Line1\interactive_QC_scheme	<		
	+Add		Remove
ОК	Cancel	1	

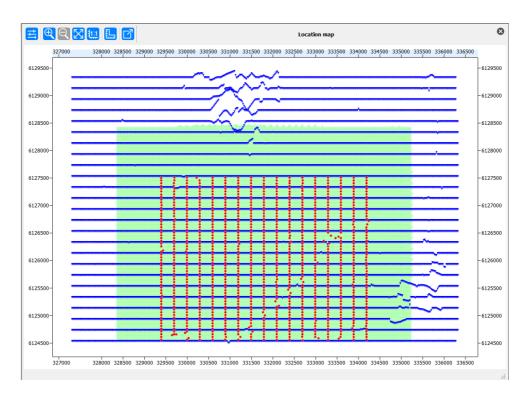
Run the flow.

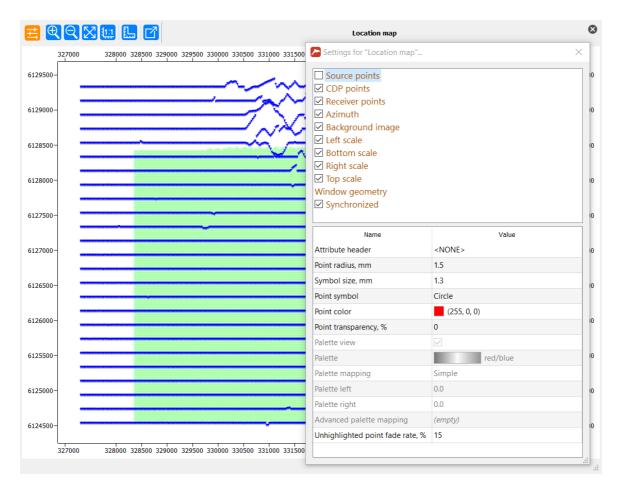
# Location and CDP fold map

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:

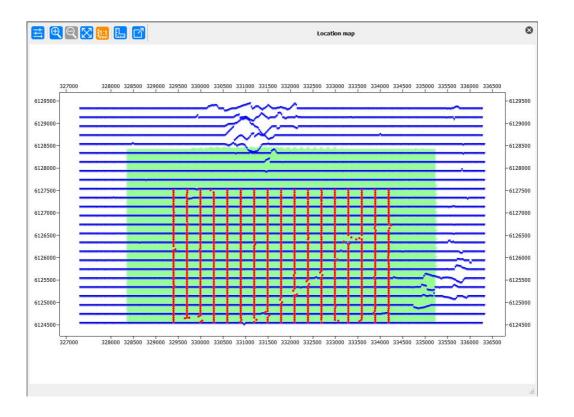




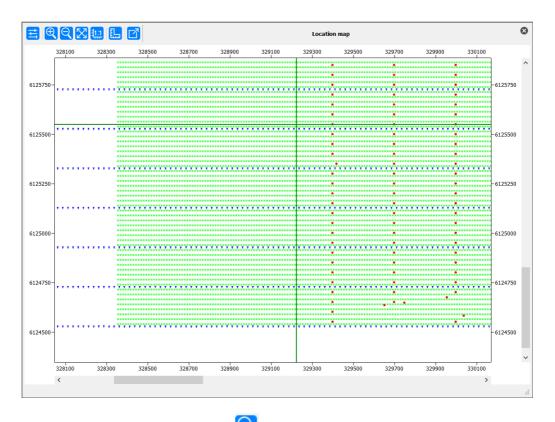
Click the **Settings** button to adjust the image settings.

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 Soutton. 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%.

Settings for "Location map"	×				
<ul> <li>Source points</li> <li>CDP points</li> <li>Receiver points</li> <li>Azimuth</li> <li>Background image</li> <li>Left scale</li> <li>Bottom scale</li> <li>Right scale</li> <li>Top scale</li> <li>Window geometry</li> <li>Synchronized</li> </ul>					
Name	Value				
Attribute header	<none></none>				
Point radius, mm	1.0				
Symbol size, mm	1.0				
Point symbol	Square				
Point color	(0, 255, 0)				
Point transparency, %	15				
Palette view					
Palette	red/blue				
Palette mapping	Simple				
Palette left	0.0				
Palette right	0.0				
Advanced palette mapping	(empty)				
	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.

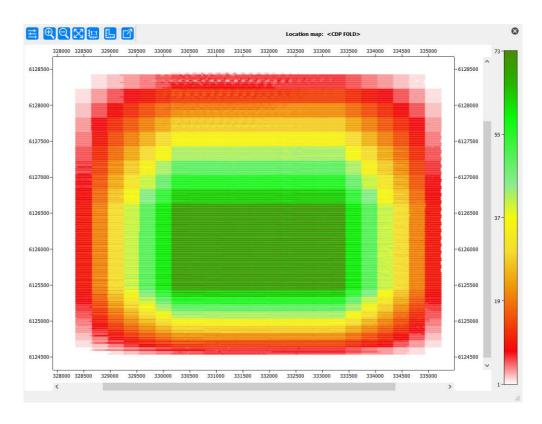
Name	Value	
Attribute header	<none></none>	~
Point radius, mm	<none> /</none>	^
Symbol size, mm	AAXFILT AAXSLOP	
Point symbol	AOFFSET BATCH IND	
Point color	BINOFF BLOCKSHIFT1	
Point transparency, %	BLOCKSHIFT2	
Palette view	CCP	Ŧ
Palette	red/blue	

Select fold\_map as the color palette for this attribute and leave the value range without

### changes.

Name	Value
Attribute header	<cdp fold=""></cdp>
Point radius, mm	1.0
Symbol size, mm	1.0
Point symbol	Circle
Point color	(0, 255, 0)
Point transparency, %	0
Palette view	$\checkmark$
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:

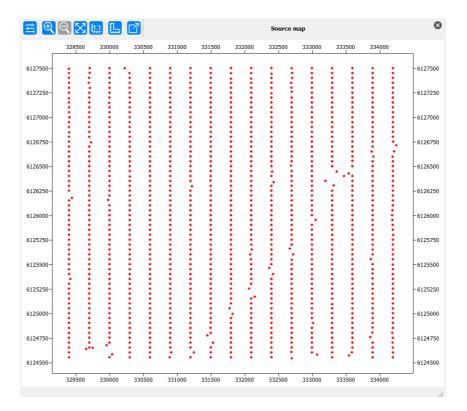


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# Signal-to-noise ratio map

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:

Settings for "Source map"	×
<ul> <li>Source points</li> <li>Background image</li> <li>Left scale</li> <li>Bottom scale</li> <li>Right scale</li> <li>Top scale</li> <li>Window geometry</li> <li>Synchronized</li> </ul>	
Name	Value
Attribute header	<none> ~</none>
Point radius, mm	QC_COEF
Symbol size, mm	QC_F QC_SNR
Point symbol	QC_TOTAL_BAD_TRC
Point color	R_LINE REC_CRL
Point transparency, %	REC_DATUM REC_ELEV
Palette view	REC_H2OD Y
Palette	red/blue
Palette mapping	Simple
Palette left	0.0
Palette right	0.0
Advanced palette mapping	(empty)
Unhighlighted point fade rate, %	15

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.

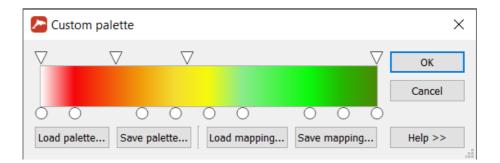
Now switch Palette mapping from Simple to Advanced – this allows us to set up a piecewise linear correspondence between the attribute values and the palette. To do this, we need to edit Advanced palette mapping parameter.

Palette view	$\checkmark$	
Palette	fold_map	
Palette mapping	Advanced	~
Palette left	Simple	
Falette lett	Advanced	

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

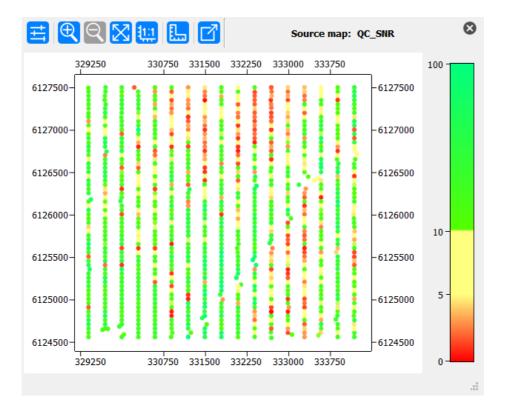
• reference point 4 - green color, value - 100



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:

Settings for "Source map: QC_S	5NR"
<ul> <li>Source points</li> <li>Background image</li> <li>Left scale</li> <li>Bottom scale</li> <li>Right scale</li> <li>Top scale</li> <li>Window geometry</li> <li>Synchronized</li> </ul>	
Name	Value
Attribute header	QC_SNR
Point radius, mm	2.0
Symbol size, mm	1.5
Point symbol	Circle
Point color	(255, 0, 0)
Point transparency, %	0
Palette view	
Palette	fold_map
Palette mapping	Advanced
Palette left	0.0
Palette right	0.0
Advanced palette mapping	0.0 -> 0.0%; 5.0 -> 22.3%; 10.0 -> 43
Unhighlighted point fade rate, %	15

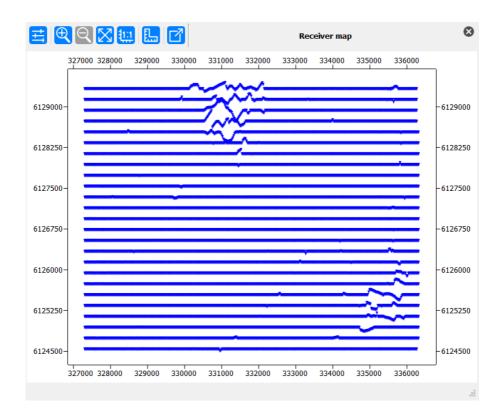
And this is how our Source map looks like with the color-coded SNR:



## **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.

Settings for "Receiver map"		×
Receiver points		
Background image		
✓ Left scale		
Bottom scale		
Right scale		
✓ Top scale		
Window geometry		
Synchronized		
Name	Value	
Attribute header	<none></none>	$\sim$
Point radius, mm	QC_SNR QC_TOTAL_BAD_TRC	^
Symbol size, mm	R_LINE	
Point symbol	REC_CRL REC_DATUM	
Point color	REC_ELEV REC_H2OD	
Point transparency, %	REC_INL REC RESID	
Palette view	REC_SLOC	~
Palette	red/blue	
Palette mapping	Simple	
Palette left	0.0	
Palette right	0.0	
Advanced palette mapping	(empty)	
Unhighlighted point fade rate, %	15	

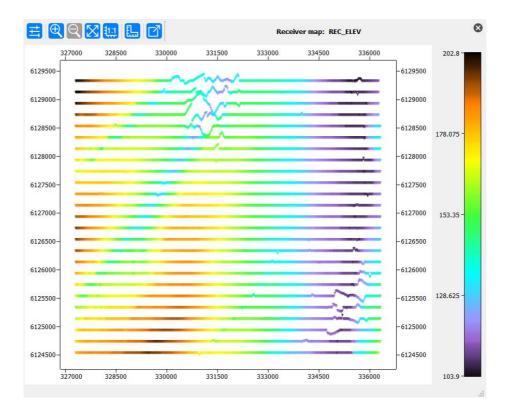
Choose a palette from the list of the predefined color pallets. We would use *azimuth* pallet here. Leave the default settings for Palette left and Palette right values – in this case minimum value of the attribute is mapped to the left side of the palette, and the maximum one - to the right side:

Palette	azimuth
Palette mapping	Simple
Palette left	0.0
Palette right	0.0

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

Settings for "Receiver map: RE	C_ELEV" ×
Receiver points	
Background image	
✓ Left scale	
Bottom scale	
Right scale	
✓ Top scale	
Window geometry	
Synchronized	
Name	Value
Attribute header	REC_ELEV
Point radius, mm	1.0
Symbol size, mm	1.3
Point symbol	Triangle
Point color	(0, 0, 255)
Point transparency, %	0
Palette view	$\checkmark$
Palette	azimuth
Palette mapping	Simple
Palette left	0.0
Palette right	0.0
Advanced palette mapping	(empty)
Unhighlighted point fade rate, %	15

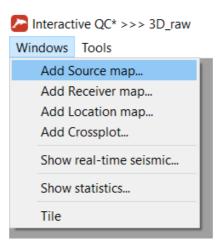
The Receiver map colored in accordance with the receiver elevation values is shown below:



## 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:

<u></u> <u></u>	Q 🔀	<u>1</u>		7			Sou	irce map			۵
	329500	330000	330500	331000	331500	332000	332500	333000	333500	334000	_
6127500-											-6127500
6127000-											-6127000
6126500-								•		• •	-6126500
6126000-											-6126000
6125500-											-6125500
6125000-							•••••			······································	-6125000
6124500-	329500	330000	330500	331000	331500	332000	332500	333000	333500	334000	-6124500
											.:

Similarly to the signal-to-noise ratio map, in the map parameters choose header QC\_F in the

Settings-> Source points-> Attribute header:

Source points		
Background image		
✓ Left scale		
Bottom scale		
Right scale		
✓ Top scale		
Window geometry		
Synchronized		
Name	Value	
Attribute header	<none></none>	~
Point radius, mm	QC_ARMS QC_ARMS_NOISE	^
Symbol size, mm	QC_BAD_TRC OC_COEF	
Point symbol	QC_CONS_BAD_TRC	_
Point color	QC_F QC_SNR	
Point transparency, %	QC_TOTAL_BAD_TRC R_LINE	
Palette view	REC_CRL	
Palette	red/blue	
Palette mapping	Simple	
Palette left	0.0	
Palette right	0.0	
Advanced palette mapping	(empty)	
Unhighlighted point fade rate, %	15	

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):

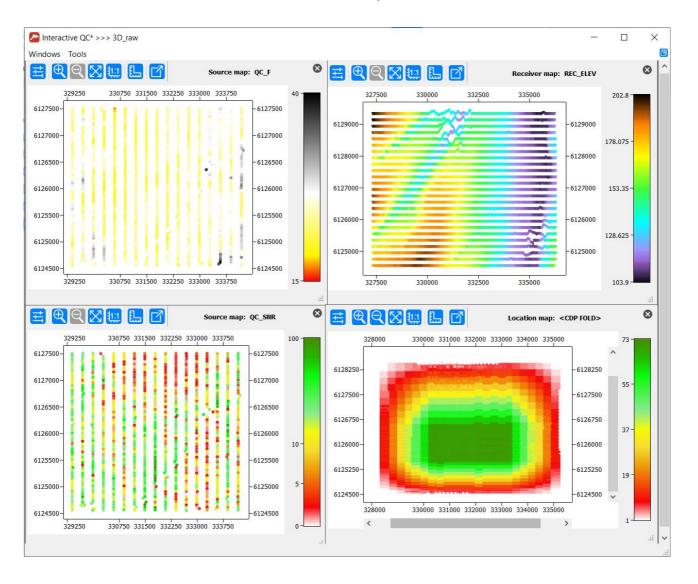
Palette	DHI
Palette mapping	Simple
Palette left	15.0
Palette right	40.0

The parameter window will look like this:

Settings for "Source map: QC_F	" ×
<ul> <li>Source points</li> <li>Background image</li> <li>Left scale</li> <li>Bottom scale</li> <li>Right scale</li> <li>Top scale</li> <li>Window geometry</li> <li>Synchronized</li> </ul>	
Name	Value
Attribute header	QC_F
Point radius, mm	1.5
Symbol size, mm	1.5
Point symbol	Circle
Point color	(255, 0, 0)
Point transparency, %	0
Palette view	$\checkmark$
Palette	DHI
Palette mapping	Simple
Palette left	15.0
Palette right	40.0
Advanced palette mapping	15.0 -> 0.0%; 40.0 -> 100.0%
Unhighlighted point fade rate, %	15

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

₫ 🗨	2	3	Ŀ					Source	e map: Q	QC_F		8
ſ	329500	330000	330500 I	331000	331500 I	332000	332500	333000	333500 I	334000	_	40 -
6127500-											-6127500	
6127000-											-6127000	
6126500-											-6126500	
6126000-										• •	-6126000	
6125500-											-6125500	
6125000-		•									-6125000	
6124500-	: ~		330500	• •		332000	332500	•	333500	334000	-6124500	15-
	525500	220000		551000	551000	552000	552500	222000	555500			

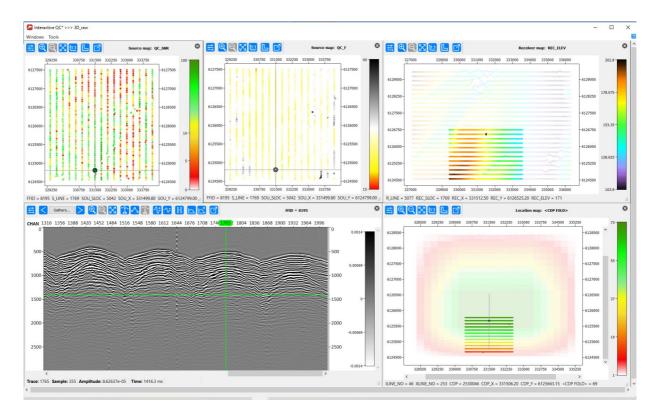


#### As a result, the module window with all the maps will look like this

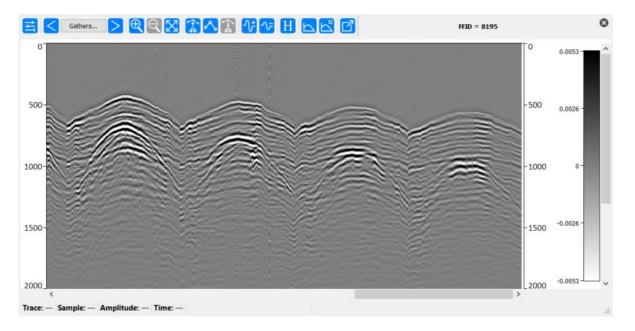
## Viewing common shot, common receiver and CDP gathers, header plots

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:

Sorting	
Trace scale	
Time scale	
Seismic display (variable densit	ty mode)
Seismic display (WT/VA mode)	
First breaks plot	
Mouse tracking	
✓ Header scale	
CHAN	
Add	
> 🗹 Header plot	
Common scale for plots	
Spectrum defaults	
> 🗹 Persistent spectra	
> Legend	
Window geometry	
Name	Value
Margin, mm	1.0
Max visible traces ("0" means "display all traces at once")	1500
Variable spacing (mutually exclusive with "Sorting" group)	
	OFFSET
Variable spacing header field	
Variable spacing scale,	
· · · · ·	(derive from max visible tr

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.

Sorting Trace scale Time scale Seismic display ( Seismic display ( First breaks plot Mouse tracking Header scale CHAN Add Meader plot Common scale for Spectrum defaults Persistent spectr	plots	
<ul> <li>Legend</li> <li>Window geometry</li> </ul>	u	
<ul> <li>Legend</li> <li>Window geometry</li> </ul>		
> Legend	Value Different	
> Legend Window geometry Name	Value	
> Legend Window geometry Name Visible marks	Value Different	
<ul> <li>Legend Window geometry</li> <li>Name</li> <li>Visible marks</li> <li>Interval in traces</li> </ul>	Value Different 50	
<ul> <li>Legend Window geometry</li> <li>Name</li> <li>Visible marks</li> <li>Interval in traces</li> <li>Divisor for visible marks</li> </ul>	Value Different 50	
<ul> <li>Legend Window geometry</li> <li>Name</li> <li>Visible marks</li> <li>Interval in traces</li> <li>Divisor for visible marks</li> <li>Always mark first trace</li> </ul>	Value Different 50 1 1 1 2 3	
<ul> <li>&gt; Legend Window geometry</li> <li>Name</li> <li>Visible marks</li> <li>Interval in traces</li> <li>Divisor for visible marks</li> <li>Always mark first trace</li> <li>Always mark last trace</li> <li>Digits after decimal point</li> </ul>	Value Different 50 1 1 1 2 3	

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:

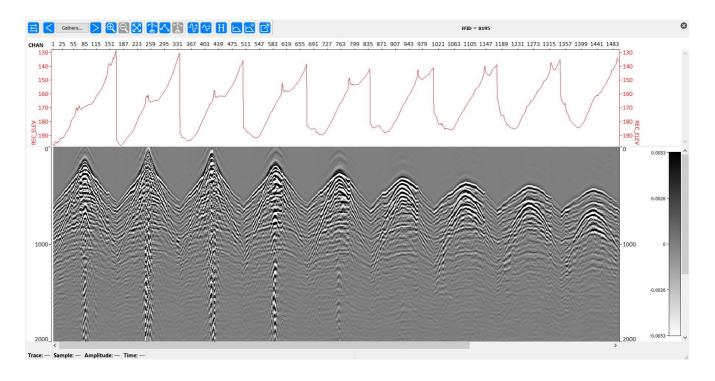
	-	
<ul> <li>Header scale</li> </ul>		
CHAN		
Add		
✓ ✓ Header plot		
CHAN	~	
A REC_CRL	^	ī –
> Comr REC_DAT	UM	
> Spect REC_ELEV	/	
> Per REC_H2O	D	
REC_INL		L
Na REC_RESI	D	
Place on REC_SLOG	C	scale)
REC_STAT		scale)
Line thickr REC_STAT		
Title on ax REC_STAT	2 ~	
		-

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:

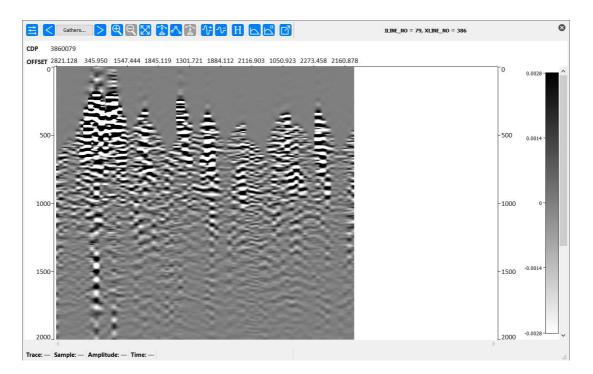
Settings for "FFID	= 8195"	>
Sorting		^
Trace scale		
Time scale		
Seismic dis	play (variable density mode)	
Seismic dis	play (WT/VA mode)	
First breaks	plot	
Mouse trac	king	
✓ Header scale		
CHAN		
Add		
✓ ✓ Header plo		
REC_ELE	V	
Add		~
Name	Value	
Place on	Top panel	
Line thickness, pixels	5 1	
Title on axis	$\checkmark$	
From	0.0	
То	0.0	
Major step	10	
Minor step	100	
Major ticks visible		
Minor ticks visible		
Major lines visible		
Minor lines visible		
Major font	Calibri, 10pt	
Minor font	Calibri, 10pt	
Color	(255, 0, 0)	
Axis on left	$\checkmark$	
Axis on right		

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:

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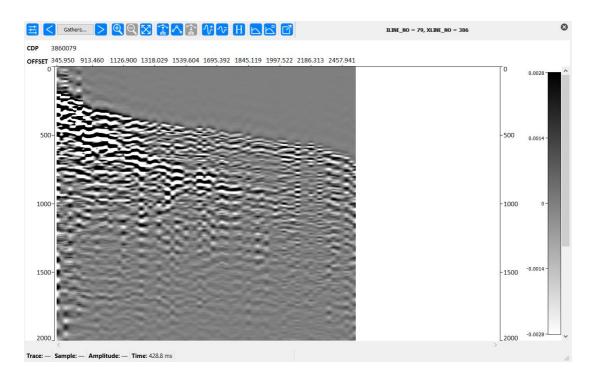
The same way we can display a CDP gather. Left-click on a CDP on a Location Map and a CDP gather will appear, though the way it looks is not very familiar so far:



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:

Sorting         Trace scale         Time scale         Seismic display (variable density mode)         Seismic display (WT/VA mode)         First breaks plot         Mouse tracking         Header scale         Header plot         Common scale for plots         Spectrum defaults         Persistent spectra         Legend         Window geometry         Value         First header         OFFSET         Reverse sort order         Second header	NO = 386" ×	Settings for "ILIN
First header OFFSET Reverse sort order	· · · · · · · · · · · · · · · · · · ·	Trace scale Time scale Seismic dis First breaks Mouse trace Header scale Header scale Common scal Spectrum defa Spectrum defa Legend
Reverse sort order	Value	Name
		First header
Second header		Reverse sort order
Second neuder		Second header
Reverse sort order		Reverse sort order

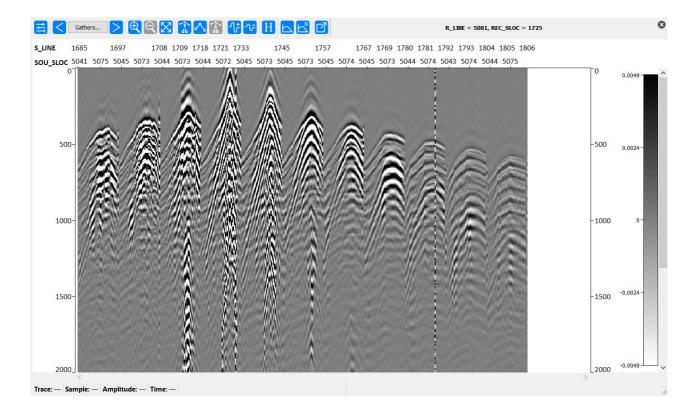
The CDP gather sorted by OFFSET is shown below:



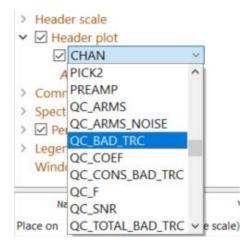
We can display a common receiver gather the same way. Left-click on a receiver point on a Receiver Map and a corresponding receiver gather will open. In the seismic display parameters sent Sorting as S\_LINE:SOU:SLOC as shown below:

Sorting		
Trace scale		
Time scale		
Seismic dis	play (variable density mode)	
Seismic dis	play (WT/VA mode)	
First break		
🗹 Mouse trad	king	
> Header scale		
> 🗹 Header plo	t	
> Common scal	e for plots	
> Spectrum def	aults	
> 🗹 Persistent :	spectra	
Legend		
Window geor	netry	
Name	Value	
First header	S_LINE	
Reverse sort order		
Second header	SOU_SLOC	
Reverse sort order		

As a result, a common receiver gather will open; you can set horizontal scale to display S\_LINE and SOU\_SLOC values:



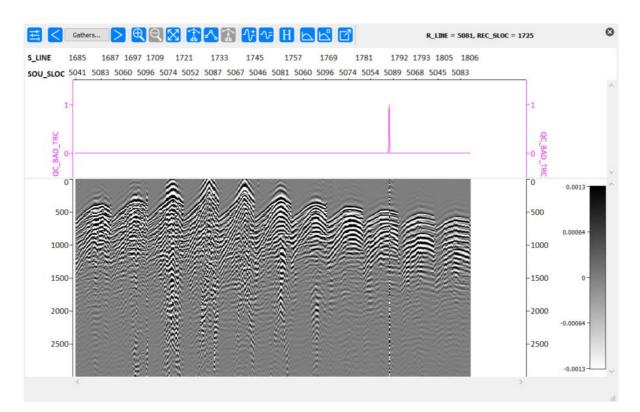
Let us the plot the trace-to-trace attribute QC\_BAD\_TRC above receiver gather seismogram. As you remember, this attribute marks bad traces with the value 1, otherwise it is 0, so we will be able to see which traces were automatically marked as bad. We will do it the same way as we have plotted receiver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

Sorting		
Trace scale		
Time scale		
	ay (variable density mode)	
	ay (WT/VA mode)	
First breaks p		
Mouse tracki	ng	
> Header scale		
✓ ✓ Header plot		
QC_BAD_	TRC	
Add		
Common scale		
Spectrum defau		
> Persistent sp	ectra	
> Legend		
Window geome	try	
Name	Value	
Place on	Top panel	
Line thickness, pixels	1	
Title on axis		
From	1.5	
То	-0.5	
Major step	1	
Minor step	100	
Major ticks visible	$\checkmark$	
Minor ticks visible		
Major lines visible		
Minor lines visible		
Major font	Calibri, 10pt	
Minor font	Calibri, 10pt	
Color	(255, 0, 255)	
	-	
Axis on left		

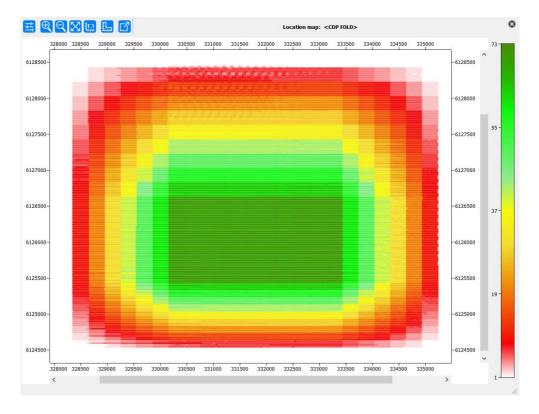
Now you can see the common receiver gather with a bad trace mark displayed on top of the seismogram. As you can see, the bad trace mark correctly identifies a dead channel record:



# 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

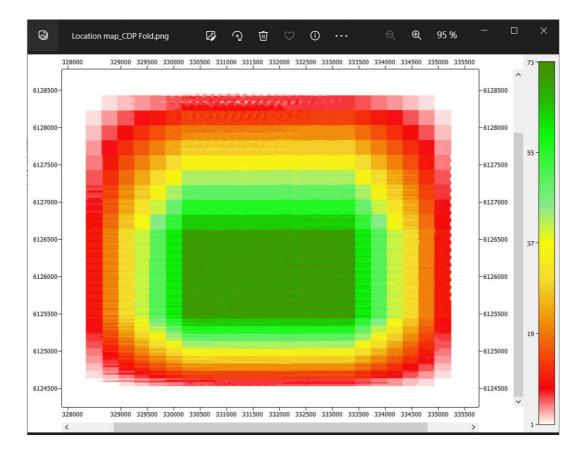
the Save Image icon on the toolbar:



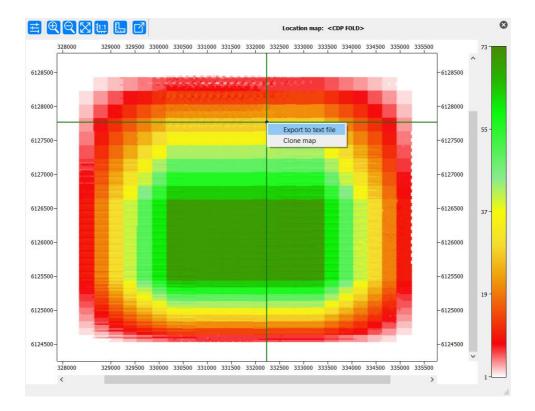
In the standard Windows File Save... dialog select image format, location and file name:

ate modified 7.03.2023 18:57 7.03.2023 18:58	Type File folder File folder	Size	2
7.03.2023 18:57 7.03.2023 18:58	File folder	Size	
7.03.2023 18:58			
	File folder		
	The folder		
2.03.2023 12:49	File folder		
7.03.2023 18:58	File folder		
7.03.2023 18:58	File folder		
7.03.2023 18:58	File folder		
7.03.2023 18:58	File folder		
2.03.2023 12:03	File folder		
	7.03.2023 18:58 7.03.2023 18:58 7.03.2023 18:58	.03.2023 18:58         File folder           .03.2023 18:58         File folder           .03.2023 18:58         File folder	.03.2023 18:58 File folder .03.2023 18:58 File folder .03.2023 18:58 File folder

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 at 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:

· • • 🖡	« Da	ata (D:) > Attrib_and_Interactive_QC >	× ×	Ö	🔎 Sea	rch Attrib_and_Inter	active.
Organize 🔹 New	/ folde	er				•	?
🧢 This PC	^	Name	Date	modifie	d	Туре	1
🧊 3D Objects		.props	17.03	.2023 18	:57	File folder	
📃 Desktop		📕 Area1	17.03	.2023 18	:58	File folder	
Documents		📕 Data	02.03	.2023 12	:49	File folder	
Downloads		📕 db.#root	17.03	.2023 18	:58	File folder	
Music		DB_SAVE	17.03	.2023 18	:58	File folder	
Pictures		LOGS	17.03	.2023 18	:58	File folder	
_		MISC	17.03	.2023 18	:58	File folder	
🚼 Videos		📕 tmp	02.03	.2023 12	:03	File folder	
📞 Windows (C:)	-11	errlog	24.02	.2023 13	:30	Text Document	
🧅 Data (D:)	~	<					>
File name:	Loca	tion map_CDP fold					
Save as type:	*.txt						

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>):

_	ion map_CDP fold	d_cdps - Notepad Help				-		×
ILINE	NO	XLINE_NO	CDP	CDP_X	CDP_Y	<cdp< td=""><td>FOLD&gt;</td><td>^</td></cdp<>	FOLD>	^
77	385	3850077 33315	6.1957	6126438.	.1536	70		
77	386	3860077 33316	8.6957	6126438.	.1536	70		
77	387	3870077 33318	1.1957	6126438.	. 1536	70		
77	388	3880077 33319	3.6957	6126438.	.1536	70		
77	389	3890077 33320	6.1957	6126438.	.1536	70		
77	390	3900077 33321	8.6957	6126438.	.1536	70		
77	391	3910077 33323	1.1957	6126438.	.1536	70		
77	392	3920077 33324	3.6957	6126438.	.1536	69		
77	393	3930077 33325	6.1957	6126438.	.1536	70		
77	394	3940077 33326	8.6957	6126438.	.1536	70		
77	395	3950077 33328	1.1957	6126438.	.1536	70		
77	396	3960077 33329	3.6957	6126438.	.1536	70		
77	397	3970077 33330	6.1957	6126438.	.1536	70		
77	398	3980077 33331	8.6957	6126438.	.1536	69		
77	399	3990077 33333	1.1957	6126438.	.1536	70		
77	400	4000077 33334	3.6957	6126438.	.1536	70		
77	401	4010077 33335	6.1957	6126438.	.1536	70		
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