Import-export Z using SES Convert and Silas

Z (tides) export settings when working with SES Convert and when loading seg-y files into Silas software

Rev. 1.1

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Contents

Some of the conclusions may not be fine! Please use this document only in conjunction with document C02_05 to avoid errors.

1 Introduction

Most manuals and handovers including the ones for Z values (“tides”) is a combination of checkboxes set for conversion with SES Convert and when importing into Silas, shown in *Figure 1* (pay attention to red circles).

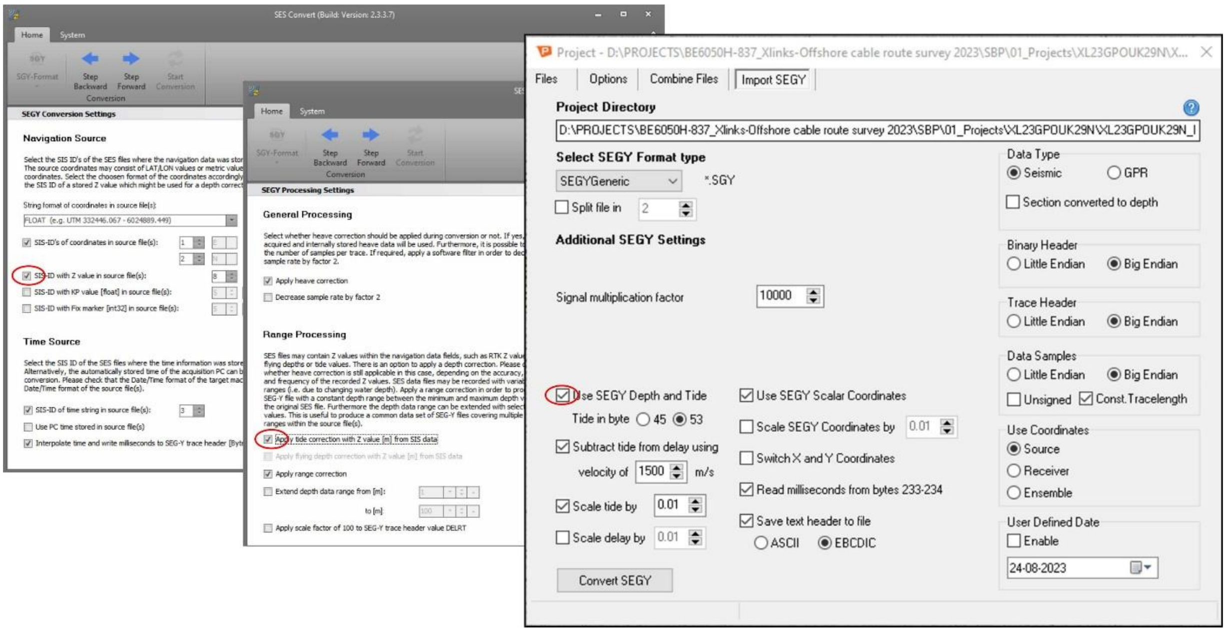


Figure 1

The use of such a combination of checkboxes by the processor (if its “transfers” them from instructions without understanding the meaning) leads to double application of Z (“tides”) to seismic data. The constant component will be compensated by shifting the seismic-bottom towards the MBES-bottom in Silas (*Figure 2*). However, the additional “curvature” introduced by the double use of tides will not be compensated for.

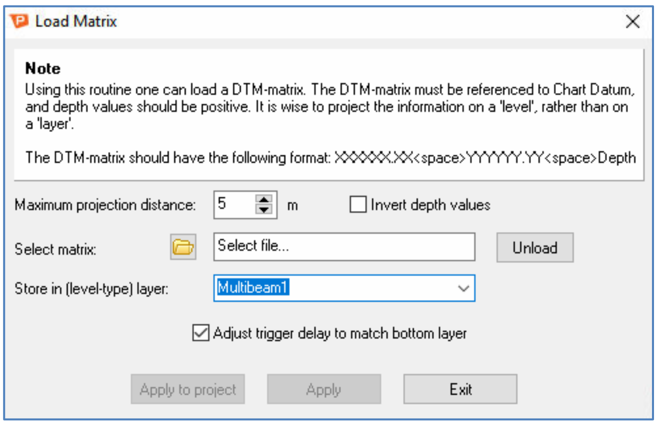


Figure 2

The following software versions were used when writing the text:
-- SES Convert 2.3.3.7,
-- Silas V3.11.1.0 (x64).

2 Checkboxes for Z, when exporting from SES Convert

When performing a survey using the Innomar equipment (SES2000), a string containing the "tide" value (hereinafter referred to as Z) is sent to the on-line software. In this example, this string is presented in SIS-ID 8. When converting data from the native SES2000 format to seg-y, there are two main options to include Z in data exported. The checkboxes corresponding to these options are marked with red circles in *Figure 3*.

The first checkbox (**"SIS-ID with Z..."**, upper in the figure) confirms that it is necessary to read Z and specifies the SIS-ID number from which Z will be read in centimeters. The value is written to the seg-y headers, in bytes 53-56 and 57-60, the values are varied from trace to trace. Values in bytes 69-70 are always 1 (scale for Z).

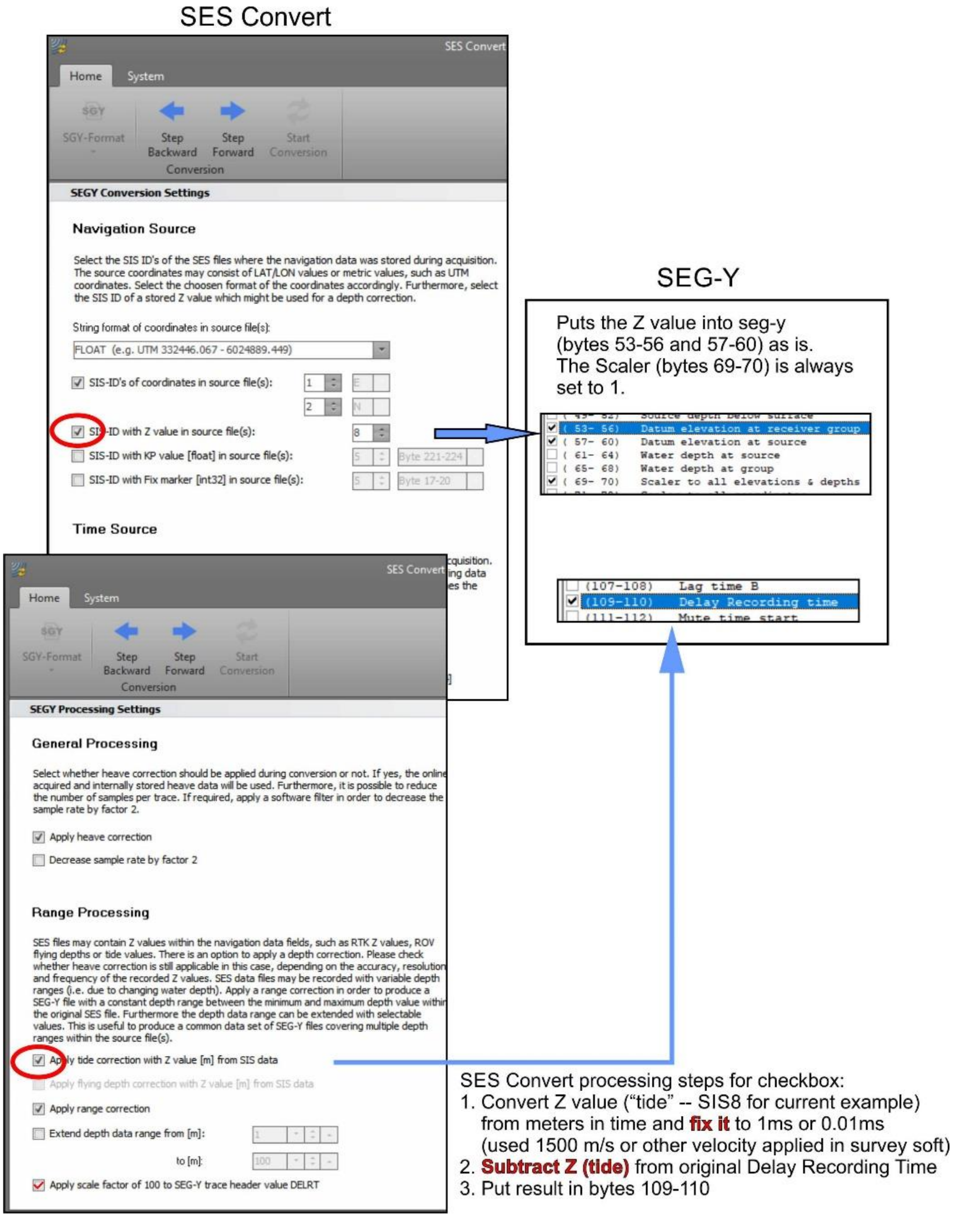


Figure 3

The second checkbox (**"Apply tide correction with Z value…"**) confirms that it is necessary to apply the Z value to the seismic traces. In this case, the "Delay Recording time" value for each trace is changed. The checkbox located below **"Apply range correction"** saves the file so that the Delay Recording time value is set to the same for the entire file (for all seismic traces), and each seismic trace is "shifted within the seismogram" by the required number of samples (a "hypertrophied" example of a shift in seismic traces is shown in *Figure 4*).

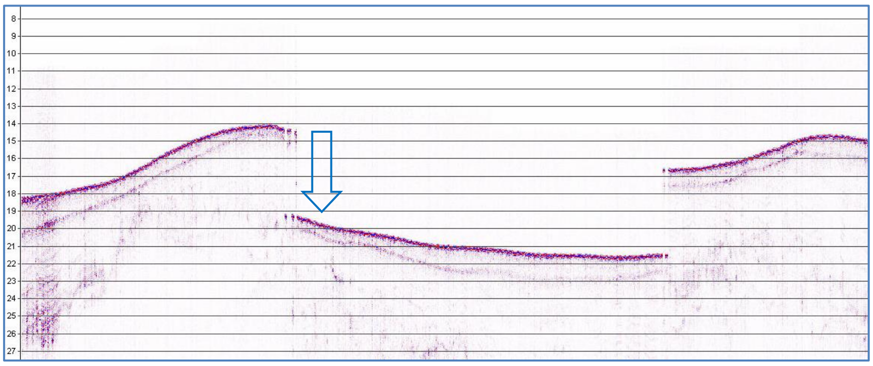


Figure 4

We will name settings of export in accordance with check boxes marked with red circles (*Figure 3*):

-- the “off_off” will correspond to the case when both checkboxes are cleared, that is, Z values are not written to seg-y;

-- the “on_off” will correspond to the case when the first checkbox is checked and the second is cleared, that is, in seg-y, in bytes 53-56 and 57-60, the Z values are written as “Elevation”;

-- the “on_on” will correspond to the case when both checkboxes are set, that is, in seg-y, in bytes 53-56 and 57-60, the Z values are written as “Elevation”, and the Z values are written in “Delay Recording time”.

The **“Apply scale factor of 100 to...”** checkbox, located below and marked with a red tick, allows you to save Delay Recording time with an accuracy of 0.01 (sets the multiplier to 100). It is recommended always to check this checkbox to avoid rounding errors. As an example, *Figure 5* shows fragments of exported files with the “off_off” settings, displayed in SeiSee. When rendered in SeiSee, the seismogram is displayed without the “Delay Recording time” values applied.

The fragment on the left corresponds to an export with a multiplier of 100 (Delay value = 14.61ms); the fragment on the right corresponds to an export with a multiplier of 1 (Delay=14ms). The Delay difference between fragments is 0.61ms and the seismic traces should be “shifted within the seismogram” by this amount. However, as can be seen from the figure, the general shift value is 0.78ms. This can be explained by the not entirely correct operation of the algorithm due to rounding errors - rounding is probably carried out not only at the last step, but also somewhere in the intermediate stage of calculations.

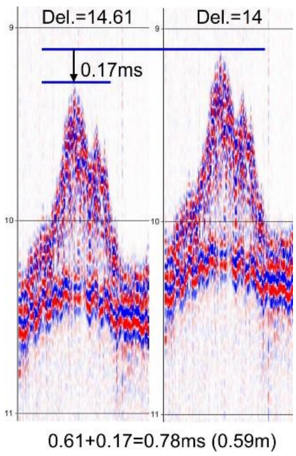


Figure 5

It is recommended to check the “Apply scale factor of 100 to...” checkbox. In older versions of SES Convert (for example, 2.3.2.9) this checkbox is missed.

3 Effect of checkboxes "Apply tide correction with Z value..." and "Apply range correction"

Let's look at the effect of the "Apply tide correction with Z value..." and "Apply range correction" checkboxes in more detail. To do this, we exported the example file twice, with "on_off" and "on_on" settings. The results output in SeiSee are shown in *Figure* 6 (when viewing in SeiSee, the seismogram is displayed without the "Delay Recording time" values applied). Also shown in *Figure* 6 is a graph of changes in the Z value ("tides"), which can be approximately interpolated by a linear function with a difference between the initial and final values of 7 centimeters.

Let's draw a straight line (green) on both seismograms between identical points selected on the bottom surface (identical for both seismograms). To assess the change in angle, we copied the line from the upper seismogram to the lower one. The difference between the edges of the line will be 0.098ms, which when recalculated for a speed of 1500m/s will give 7.35cm. That is, a "shift of seismic traces" is applied to the second seismogram so that the difference between the initial and final values is close to 7 centimeters.

Let's calculate the time/distance shift between the initial values of the seismograms. The difference between identical points selected on the bottom surface at the beginning of the seismograms is 0.36ms, then the value of the time shift between identical points (taking into account Delay) can be calculated as: 14.61+0.36-13.28=1.69ms. At a speed of 1500m/s this will be 1.27m, which is close to the value of 1.29m (the difference is due to the error of the "graphical" method of searching for identical points that we used).

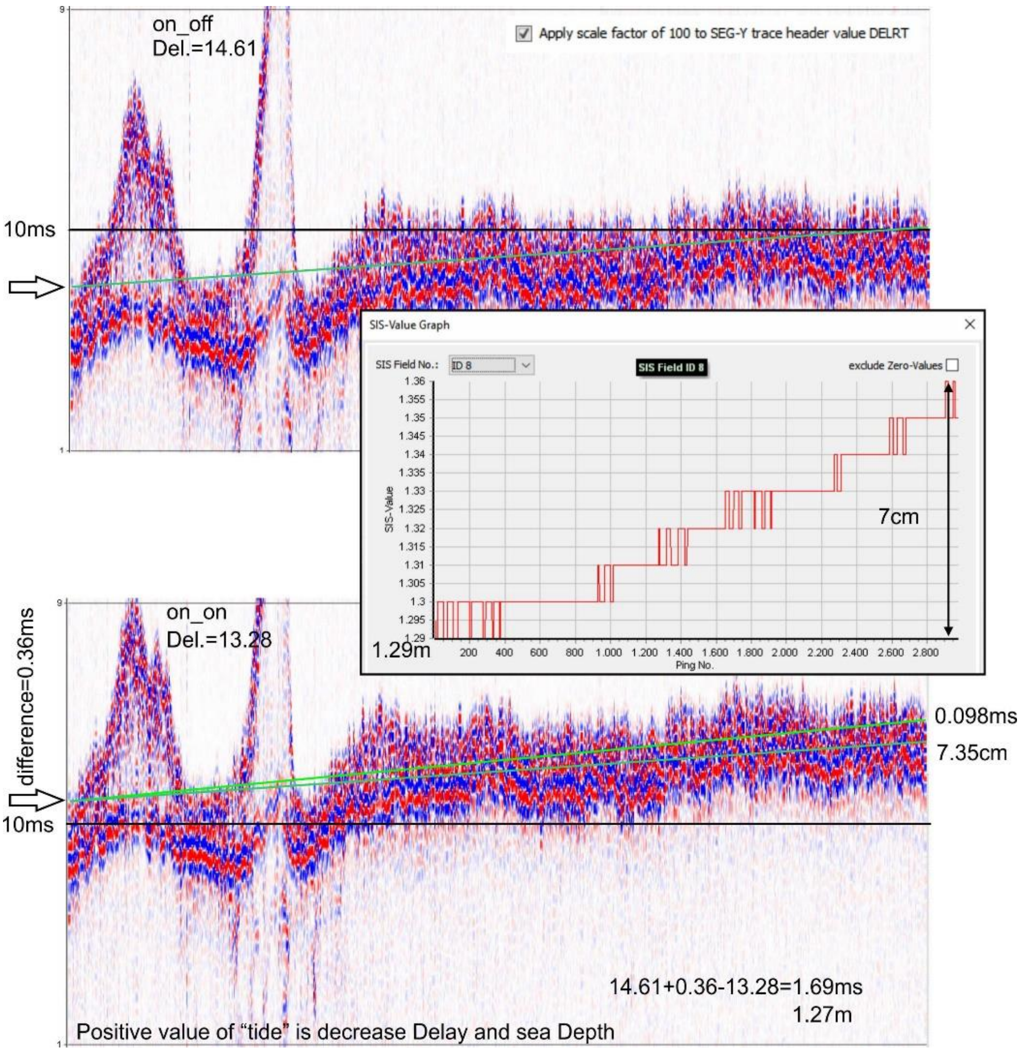


Figure 6

When performing calculations, SES Convert probably uses the sound speed saved in the converted file. There is some ambiguity here, since the sound speed of 1500m/s was used when recording the files in on-line software, and the text header of the converted seg-y file says “Sound Velocity: 1505 m/sec”.

When applying the Z value (“tides”), a positive Z value corresponds to “upward rise of the seafloor” or “decreasing thickness of the water layer.” That is, the Z axis is directed “down” (toward the center of the Earth).

4 Seg-y import into Silas

When importing files into Silas, both Elevation values (bytes 53-56 of the seg-y headers, checkbox **"Use SEGY Depth and Tide"**) and Delay values are used (Figure 6). At the same time, the Delay value is always used (its use cannot be "disabled"). Despite the inscription **"Subtract tide from delay using velocity of"** (Figure 6), subtraction of "tide" for seismic traces is not actually performed; "tide" values are applied not to the seismogram (seismic trace shift), but to the depth-lines (visual curvature and shift of the marker lines for depth in the seismogram view window of Silas software).

If export using SES Convert was carried out using the "on_off" settings, then the Z values can be read from bytes 53-56. At the same time, Silas allows you to set the speed of sound used in the conversion and **"Scale tide by"**, which allows you to convert values from centimeters to meters. At the same time, in the Silas window with a seismogram, the applied Z values are displayed in the "form" of the depth-lines (the word "form" is not entirely correct, see explanations in *Displaying tides in Silas from bytes 53-56 seg-y*).

If export using SES Convert was carried out using the "on_on" settings, then the Z values will be automatically read from Delay in Silas. In the corresponding checkbox we need to set the scale for Delay. In this case, the depth-lines will remain strictly horizontal, and the Z values will be contained in the shift of the seismic traces themselves (which was performed by SES Convert).

If export using SES Convert was carried out using the "on_on" settings, and import into Silas is carried out by reading bytes 53-56, then the Z value will be applied twice - in the shift of seismic traces and in the applied Z values.

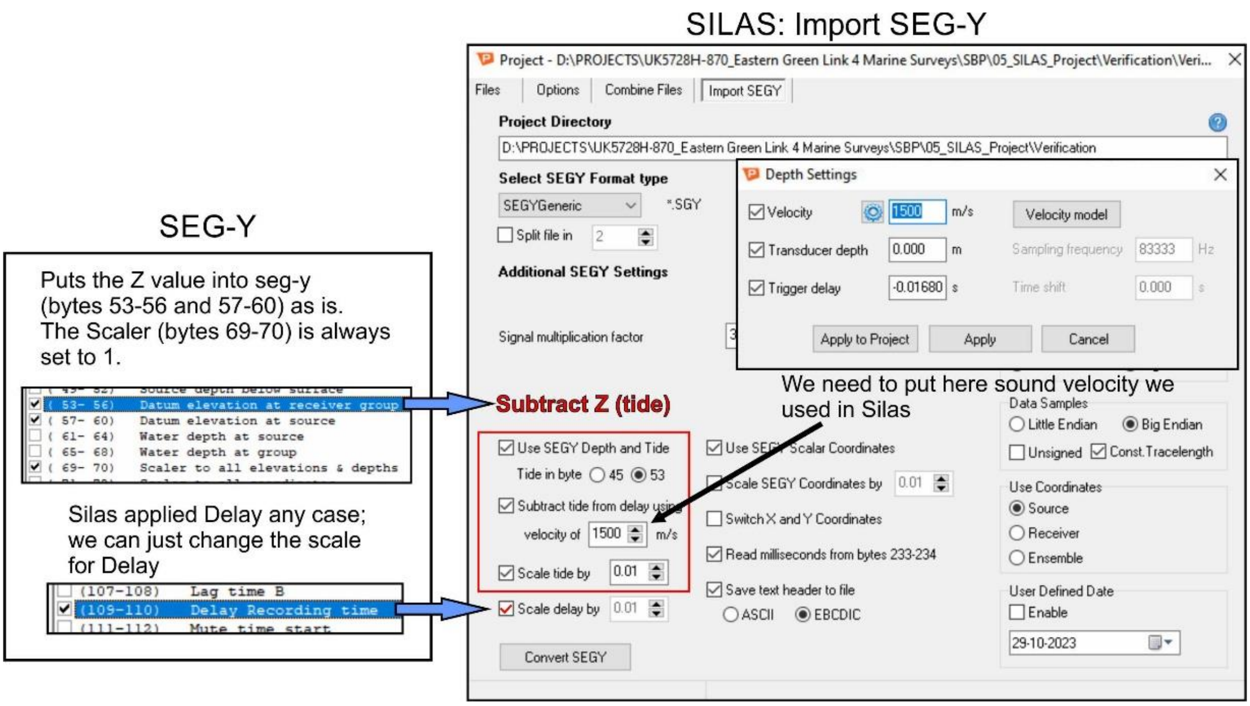


Figure 7

The described patterns, when imported into Silas with the "Scale delay by 0.01" checkbox set, are shown in *Figure 8*. The top row of pictures corresponds to the display of the seismic section in the depth scale. The "off_on" settings correspond to import into Silas with the checkbox disabled for bytes 53-56 of data exported using the "on_on" settings. The second and third pictures are "raised" by approximately 1.3 meters relative to "off_off", which corresponds to the correction made by Z. For the fourth picture, the Z value is applied twice.

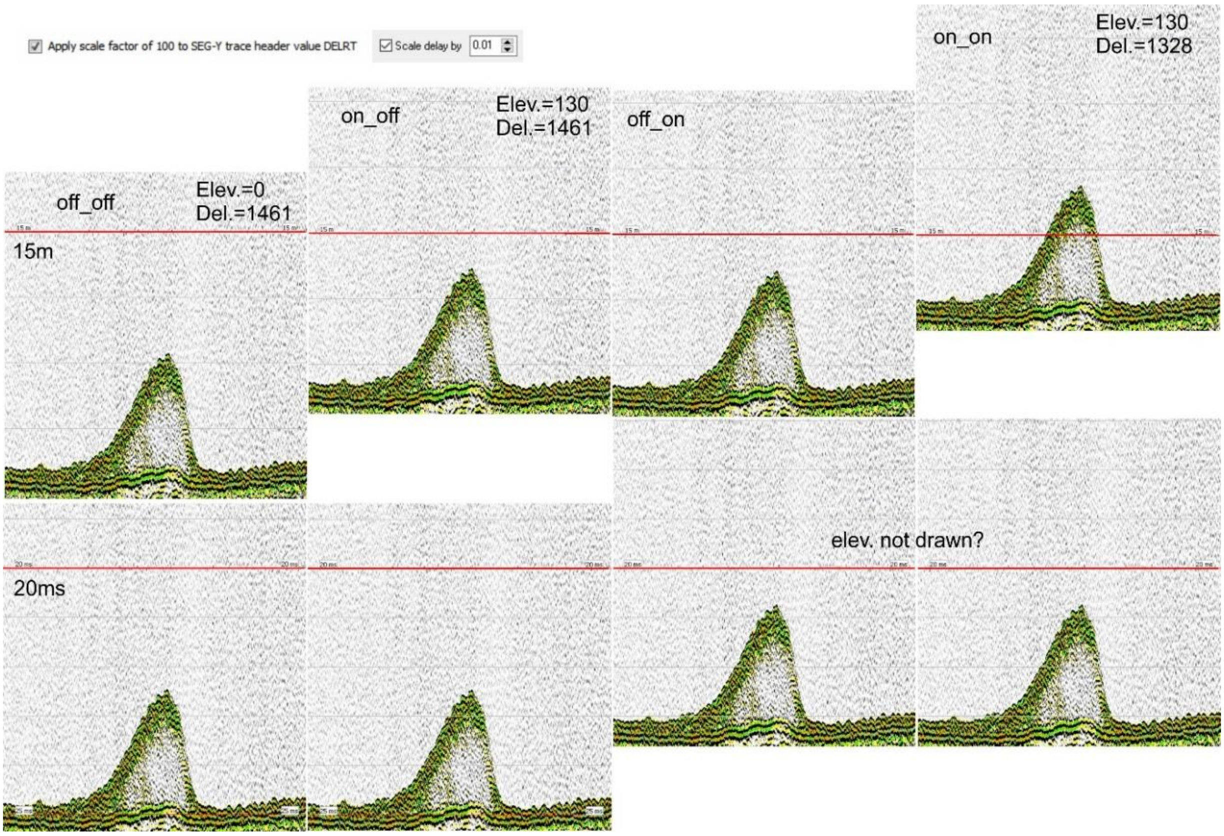


Figure 8

The bottom row of pictures corresponds to the display of the seismic section in the timescale. In this case, the Elevation value is not applied to draw time-lines.

We will get a different result for import with the "Scale delay by" checkbox disabled – *Figure 9* (if the "Apply scale factor of 100 to..." checkbox was not selected in SES Convert).

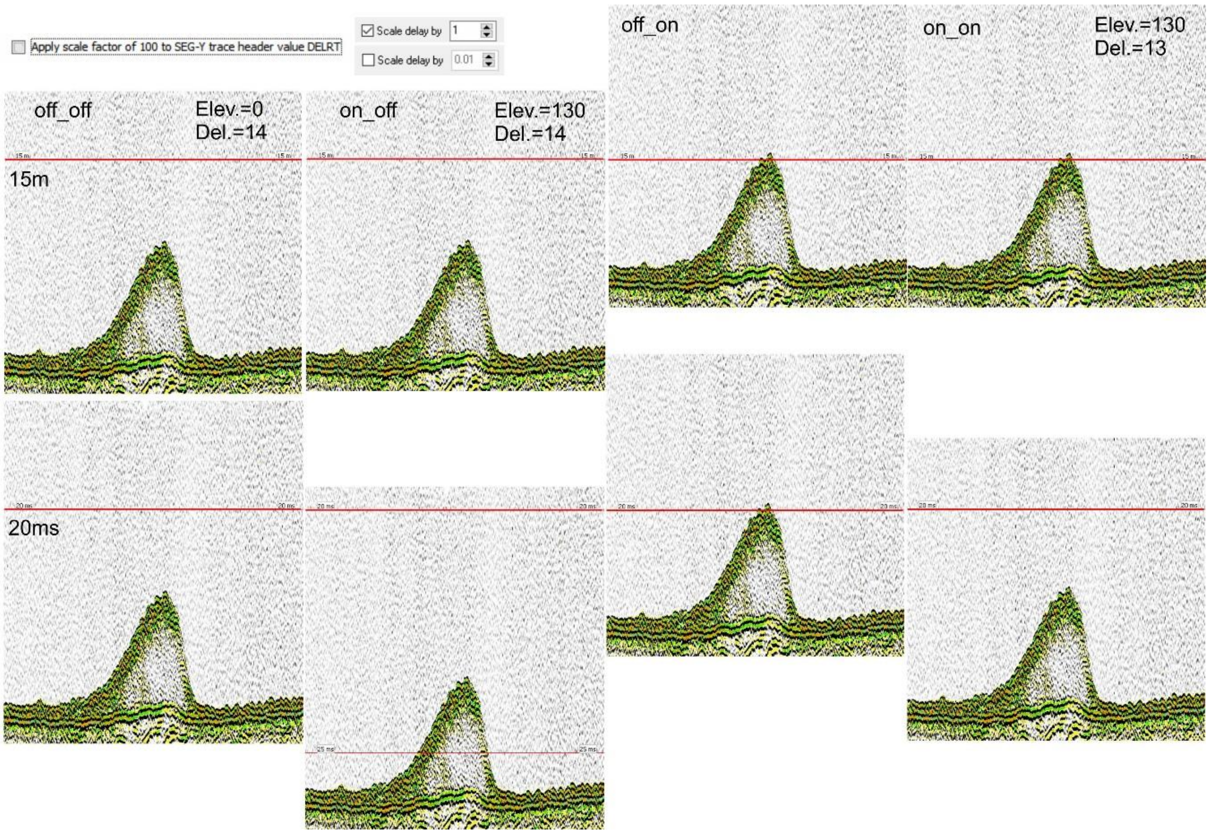


Figure 9

The top row of pictures (*Figure 9*) corresponds to the display of the seismic section in the depth-lines. At the same time, the Elevation values do not change the position of the depth marks (although, with “Scale delay by 0.01” enabled, they changed it). The bottom row of pictures corresponds to the display of the seismic section in the timescale. In this case, the Elevation values are applied to the time-lines with the opposite sign (that is, a positive Z value “lowers” the seabed or increases the thickness of the water layer). Due to this, the fourth picture “remains in place” - the section moves down according to Elevation and rises due to the shift of seismic traces performed by SES Convert.

The reason for this difference in display when loading files with the “Scale delay by 0.01” checkbox set (*Figure 8*) or cleared (*Figure 9*) is not clear. Since the seg-y files look the same for both cases (except the multiplier applied to Delay), the reason is probably the implementation of data loading procedures in the Silas software code. It is recommended always to check the “Apply scale factor of 100 to...” checkbox so that the image displayed in the Silas depth axes corresponds to the applied Z values.

To check, we export to seg-y all the seismic sections from which *Figure 8* and *Figure 9* were prepared, with the settings shown in *Figure 20*. Then we take the same point on the bottom surface for all seismic sections and calculate the “reflection time” considering Delay value. The calculation results are shown in the table below. From the table, the following conclusions can be drawn:
-- For the “off_off” settings with “Scale delay by 0.01” and “Scale delay by not set” the reflection time is different (0.79ms), which corresponds to the “rounding error” shown in *Figure 5*;
-- For “Scale delay by 0.01” all times in the exported files correspond to the tide values that were applied to them;
-- For “Scale delay by not set” the times in the exported files do not correspond to the applied tides. It seems that the constant value from Delay does not affect the reflection time value. The resulting values correspond to the depth-lines in *Figure 9*;
-- The difference between identical points at the beginning and end of the seismogram d(tide), calculated by analogy with that shown in *Figure 6*, was about 7 cm (with single application of tides) and about 14 cm (with double application of tides). That is, the “increment” for tides is applied correctly for all cases/files.

	off_off	**on_off**	**off_on**	**on_on**
Scale delay by 0.01	24.86ms 18.65m d(tide)=0m	23.15ms 17.36m (d=1.29m) d(tide)=0.07m	23.18ms 17.38m (d=1.27m) d(tide)=0.07m	24.86ms 16.10m (d=2.55m) d(tide)=0.14m
Scale delay not set	24.07ms 18.05m d(tide)=0m	24.10ms 18.08m (d=-0.03m) d(tide)=0.07m	22.28ms 16.71m (d=1.34m) d(tide)=0.07m	22.31ms 16.73m (d=1.32m) d(tide)=0.14m

The results of comparing the Delay values in the seg-y for importing and in Silas (the settings window is shown in *Figure 21*), immediately after importing, are shown in the table below. The table confirms that Delay values are imported/calculated *possibly* incorrectly in Silas when importing tides from bytes 53-56 with “Scale delay by not set” settings due to “mean value of tides” subtract from Delay as write in *Figure 7* and *above*; see Trigger delay values in the Table below.

	off_off	**on_off**	**off_on**	**on_on**
Scale delay by 0.01	Segy=14.61ms Silas=-0.01461s	Segy=14.61ms Silas=-0.01461s	Silas=-0.01328s	Segy=13.28ms Silas=-0.01328s
Scale delay not set	Segy=14 ms Silas=-0.014s	Segy=14 ms Silas=-0.01575s	Silas=-0.01300s	Segy=13 ms Silas=-0.01475s

The first option for export-import is an option with the following state of the checkboxes in SES Convert (*Figure 10*):

-- "SIS-ID with Z…" – ON,

-- "Apply tide correction with Z value…" – OFF,

-- "Apply range correction" – ON,

-- "Apply scale factor of 100 to…" – ON;

and in Silas:

-- "Use SEGY Depth and Tide" – ON, "Tide in byte" – 53, "Subtract tide from delay using velocity of" – 1500 m/s, "Scale tide by" – 0.01,

-- "Scale delay by" -- 0.01.

This import-export will correspond to the second picture in the first row in *Figure 8*. This option allows you to measure the speed of sound in water from 1500 m/s to the current one, which is used in the speed model in Silas. Z values will appear in Silas as curved depth-lines.

The second option for export-import seems to be the one with the following state of the checkboxes in SES Convert (*Figure 11*):

-- "SIS-ID with Z…" – ON,

-- "Apply tide correction with Z value…" – ON,

-- "Apply range correction" – ON,

-- "Apply scale factor of 100 to…" – ON;

and in Silas:

-- "Use SEGY Depth and Tide" – OFF,

-- "Scale delay by" -- 0.01.

This import-export would correspond to the third picture in the first row in *Figure 8*. However, this option does not allow you to measure the speed of sound in water when applying Z (in fact, applying Z to seismic traces is done in SES Convert).

After performing the procedure of combining the "seismic bottom" with the "MBES bottom", all images on the depth scale will be shifted by a constant value and will be displayed correctly except for the case with double Z application (export from SES Convert with the "Apply tide correction" checkbox selected with Z value…" and loading into Silas with "Use SEGY Depth and Tide" set).

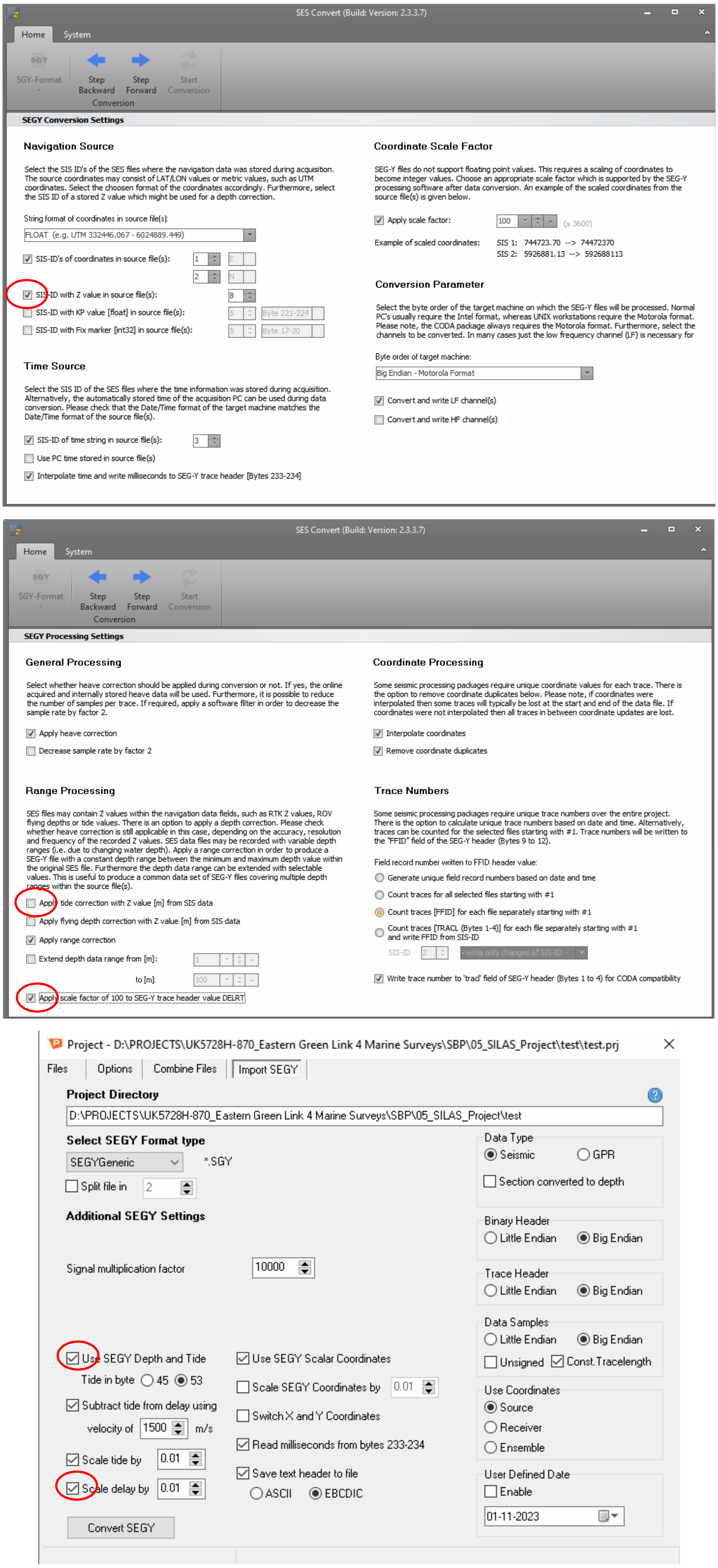
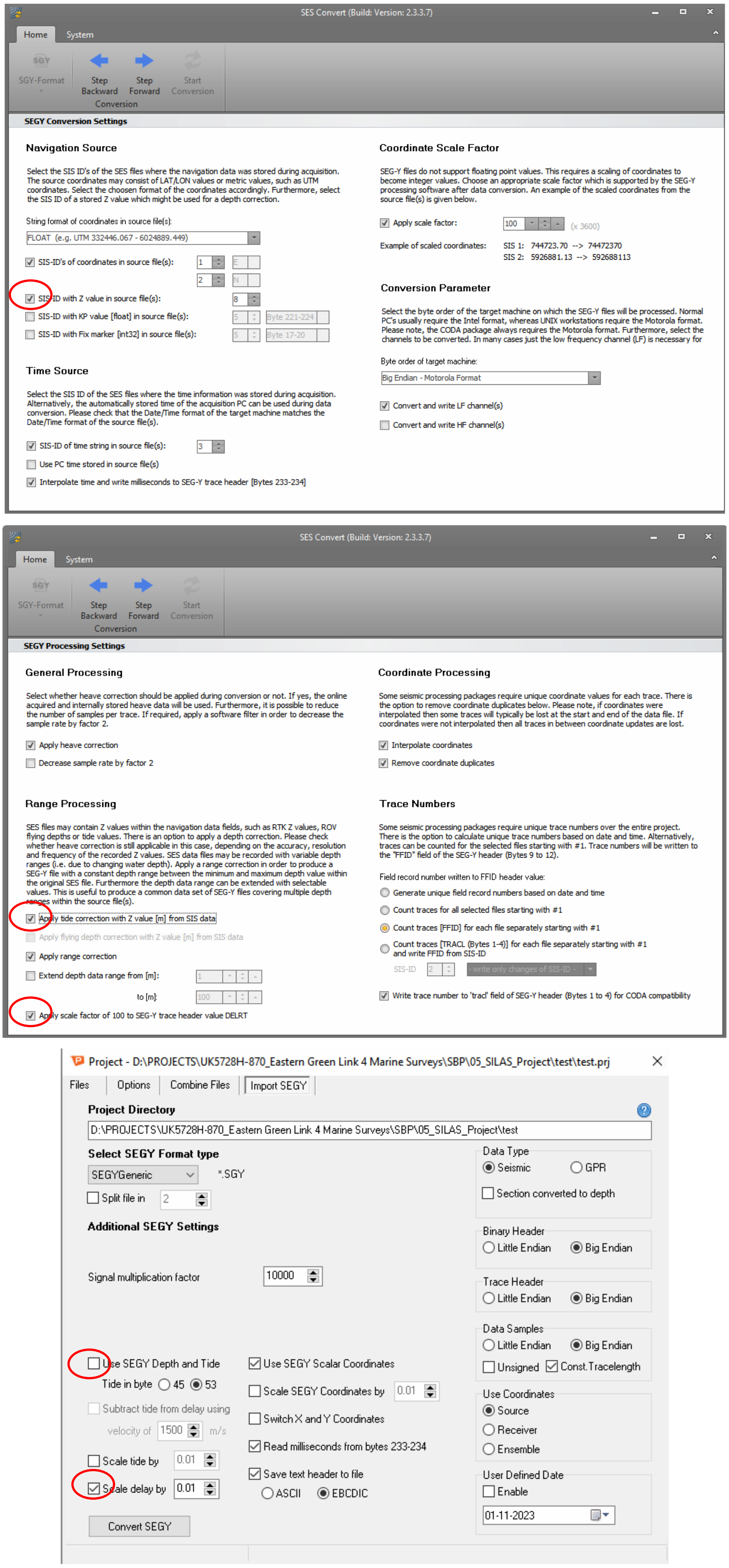

SES Convert (Build: Version: 2.3.3.7)
Home
System
SGY-Format
Step Backward
Step Forward
Start Conversion
Conversion
SEGY Conversion Settings
Navigation Source
Select the SIS ID's of the SES files where the navigation data was stored during acquisition. The source coordinates may consist of LAT/LON values or metric values, such as UTM coordinates. Select the choosen format of the coordinates accordingly. Furthermore, select the SIS ID of a stored Z value which might be used for a depth correction.
String format of coordinates in source file(s):
FLOAT (e.g. UTM 332446.067 - 6024889.449)
SIS-ID's of coordinates in source file(s):
SIS-ID with Z value in source file(s):
SIS-ID with KP value [float] in source file(s):
SIS-ID with Fix marker [int32] in source file(s):
Byte 221-224
Byte 17-20
Time Source
Select the SIS ID of the SES files where the time information was stored during acquisition. Alternatively, the automatically stored time of the acquisition PC can be used during data conversion. Please check that the Date/Time format of the target machine matches the Date/Time format of the source file(s).
SIS-ID of time string in source file(s):
Use PC time stored in source file(s)
Interpolate time and write milliseconds to SEG-Y trace header [Bytes 233-234]
Coordinate Scale Factor
SEG-Y files do not support floating point values. This requires a scaling of coordinates to become integer values. Choose an appropriate scale factor which is supported by the SEG-Y processing software after data conversion. An example of the scaled coordinates from the source file(s) is given below.
Apply scale factor:
100
(x 3600)
Example of scaled coordinates:
SIS 1: 744723.70 --> 74472370
SIS 2: 5926881.13 --> 592688113
Conversion Parameter
Select the byte order of the target machine on which the SEG-Y files will be processed. Normal PC's usually require the Intel format, whereas UNIX workstations require the Motorola format. Please note, the CODA package always requires the Motorola format. Furthermore, select the channels to be converted. In many cases just the low frequency channel (LF) is necessary for
Byte order of target machine:
Big Endian - Motorola Format
Convert and write LF channel(s)
Convert and write HF channel(s)
SES Convert (Build: Version: 2.3.3.7)
SEGY Processing Settings
General Processing
Select whether heave correction should be applied during conversion or not. If yes, the online acquired and internally stored heave data will be used. Furthermore, it is possible to reduce the number of samples per trace. If required, apply a software filter in order to decrease the sample rate by factor 2.
Apply heave correction
Decrease sample rate by factor 2
Range Processing
SES files may contain Z values within the navigation data fields, such as RTK Z values, ROV flying depths or tide values. There is an option to apply a depth correction. Please check whether heave correction is still applicable in this case, depending on the accuracy, resolution and frequency of the recorded Z values. SES data files may be recorded with variable depth ranges (i.e. due to changing water depth). Apply a range correction in order to produce a SEG-Y file with a constant depth range between the minimum and maximum depth value within the original SES file. Furthermore the depth data range can be extended with selectable values. This is useful to produce a common data set of SEG-Y files covering multiple depth ranges within the source file(s).
Apply tide correction with Z value [m] from SIS data
Apply flying depth correction with Z value [m] from SIS data
Apply range correction
Extend depth data range from [m]:
to [m]:
Apply scale factor of 100 to SEG-Y trace header value DELRT
Coordinate Processing
Some seismic processing packages require unique coordinate values for each trace. There is the option to remove coordinate duplicates below. Please note, if coordinates were interpolated then some traces will typically be lost at the start and end of the data file. If coordinates were not interpolated then all traces in between coordinate updates are lost.
Interpolate coordinates
Remove coordinate duplicates
Trace Numbers
Some seismic processing packages require unique trace numbers over the entire project. There is the option to calculate unique trace numbers based on date and time. Alternatively, traces can be counted for the selected files starting with #1. Trace numbers will be written to the "FFID" field of the SEG-Y header (Bytes 9 to 12).
Field record number written to FFID header value:
Generate unique field record numbers based on date and time
Count traces for all selected files starting with #1
Count traces [FFID] for each file separately starting with #1
Count traces [TRACL (Bytes 1-4)] for each file separately starting with #1 and write FFID from SIS-ID
Write trace number to 'tracl' field of SEG-Y header (Bytes 1 to 4) for CODA compatibility
Project - D:\PROJECTS\UK5728H-870_Eastern Green Link 4 Marine Surveys\SBP\05_SILAS_Project\test\test.prj
Files
Options
Combine Files
Import SEGY
Project Directory
D:\PROJECTS\UK5728H-870_Eastern Green Link 4 Marine Surveys\SBP\05_SILAS_Project\test
Select SEGY Format type
SEGYGeneric
*.SGY
Split file in
2
Additional SEGY Settings
Signal multiplication factor
10000
Data Type
Seismic
GPR
Section converted to depth
Binary Header
Little Endian
Big Endian
Trace Header
Little Endian
Big Endian
Data Samples
Little Endian
Big Endian
Unsigned
Const.Tracelength
Use SEGY Depth and Tide
Tide in byte
45
53
Subtract tide from delay using
velocity of
1500
m/s
Scale tide by
0.01
Scale delay by
0.01
Convert SEGY
Use SEGY Scalar Coordinates
Scale SEGY Coordinates by
0.01
Switch X and Y Coordinates
Read milliseconds from bytes 233-234
Save text header to file
ASCII
EBCDIC
Use Coordinates
Source
Receiver
Ensemble
User Defined Date
Enable
01-11-2023

Figure 10



SES Convert (Build: Version: 2.3.3.7)
Home
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SGY-Format
Step Backward
Step Forward
Start Conversion
Conversion
SEGY Conversion Settings
Navigation Source
Select the SIS ID's of the SES files where the navigation data was stored during acquisition. The source coordinates may consist of LAT/LON values or metric values, such as UTM coordinates. Select the choosen format of the coordinates accordingly. Furthermore, select the SIS ID of a stored Z value which might be used for a depth correction.
String format of coordinates in source file(s):
FLOAT (e.g. UTM 332446.067 - 6024889.449)
SIS-ID's of coordinates in source file(s):
SIS-ID with Z value in source file(s):
SIS-ID with KP value [float] in source file(s):
SIS-ID with Fix marker [int32] in source file(s):
Byte 221-224
Byte 17-20
Time Source
Select the SIS ID of the SES files where the time information was stored during acquisition. Alternatively, the automatically stored time of the acquisition PC can be used during data conversion. Please check that the Date/Time format of the target machine matches the Date/Time format of the source file(s).
SIS-ID of time string in source file(s):
Use PC time stored in source file(s)
Interpolate time and write milliseconds to SEG-Y trace header [Bytes 233-234]
Coordinate Scale Factor
SEG-Y files do not support floating point values. This requires a scaling of coordinates to become integer values. Choose an appropriate scale factor which is supported by the SEG-Y processing software after data conversion. An example of the scaled coordinates from the source file(s) is given below.
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100
(x 3600)
Example of scaled coordinates:
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SIS 2: 5926881.13 --> 592688113
Conversion Parameter
Select the byte order of the target machine on which the SEG-Y files will be processed. Normal PC's usually require the Intel format, whereas UNIX workstations require the Motorola format. Please note, the CODA package always requires the Motorola format. Furthermore, select the channels to be converted. In many cases just the low frequency channel (LF) is necessary for
Byte order of target machine:
Big Endian - Motorola Format
Convert and write LF channel(s)
Convert and write HF channel(s)
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System
SGY-Format
Step Backward
Step Forward
Start Conversion
Conversion
SEGY Processing Settings
General Processing
Select whether heave correction should be applied during conversion or not. If yes, the online acquired and internally stored heave data will be used. Furthermore, it is possible to reduce the number of samples per trace. If required, apply a software filter in order to decrease the sample rate by factor 2.
Apply heave correction
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Apply flying depth correction with Z value [m] from SIS data
Apply range correction
Extend depth data range from [m]:
to [m]:
Apply scale factor of 100 to SEG-Y trace header value DELRT
Coordinate Processing
Some seismic processing packages require unique coordinate values for each trace. There is the option to remove coordinate duplicates below. Please note, if coordinates were interpolated then some traces will typically be lost at the start and end of the data file. If coordinates were not interpolated then all traces in between coordinate updates are lost.
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Field record number written to FFID header value:
Generate unique field record numbers based on date and time
Count traces for all selected files starting with #1
Count traces [FFID] for each file separately starting with #1
Count traces [TRACL (Bytes 1-4)] for each file separately starting with #1 and write FFID from SIS-ID
SIS-ID
- write only changes of SIS-ID -
Write trace number to 'tracl' field of SEG-Y header (Bytes 1 to 4) for CODA compatibility
Project - D:\PROJECTS\UK5728H-870_Eastern Green Link 4 Marine Surveys\SBP\05_SILAS_Project\test\test.prj
Files
Options
Combine Files
Import SEGY
Project Directory
D:\PROJECTS\UK5728H-870_Eastern Green Link 4 Marine Surveys\SBP\05_SILAS_Project\test
Select SEGY Format type
SEGYGeneric
*.SGY
Split file in
2
Additional SEGY Settings
Signal multiplication factor
10000
Use SEGY Depth and Tide
Tide in byte
45
53
Subtract tide from delay using
velocity of
1500
m/s
Scale tide by
0.01
Scale delay by
0.01
Convert SEGY
Use SEGY Scalar Coordinates
Scale SEGY Coordinates by
0.01
Switch X and Y Coordinates
Read milliseconds from bytes 233-234
Save text header to file
ASCII
EBCDIC
Data Type
Seismic
GPR
Section converted to depth
Binary Header
Little Endian
Big Endian
Trace Header
Little Endian
Big Endian
Data Samples
Little Endian
Big Endian
Unsigned
Const. Tracelength
Use Coordinates
Source
Receiver
Ensemble
User Defined Date
Enable
01-11-2023

Figure 11

5 Displaying tides in Silas from bytes 53-56 seg-y

As we said above that the value of bytes 53-56 ("tides") is displayed in the form depth-lines. Partly it is not true; let's try to explain by using *Figure 12*, *Figure 13* and *Figure 14*.

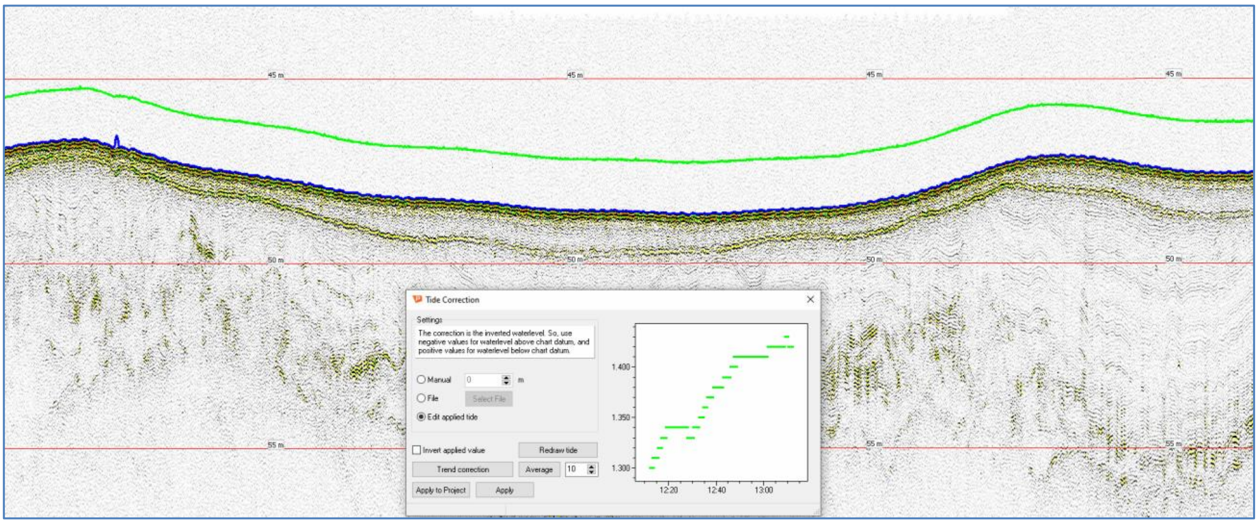

Figure 12

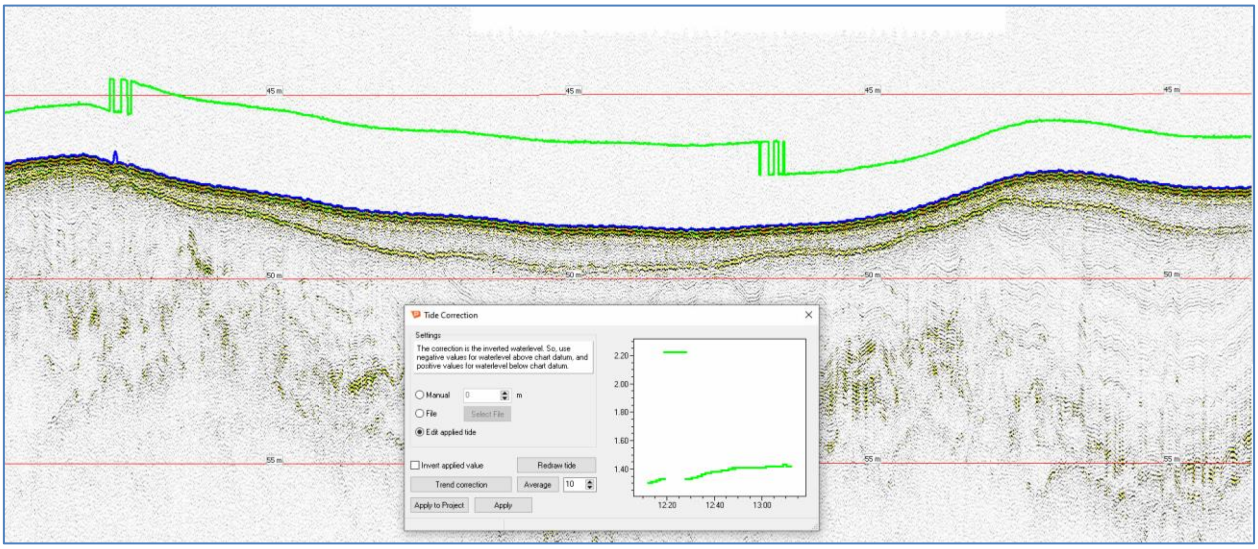

Figure 13

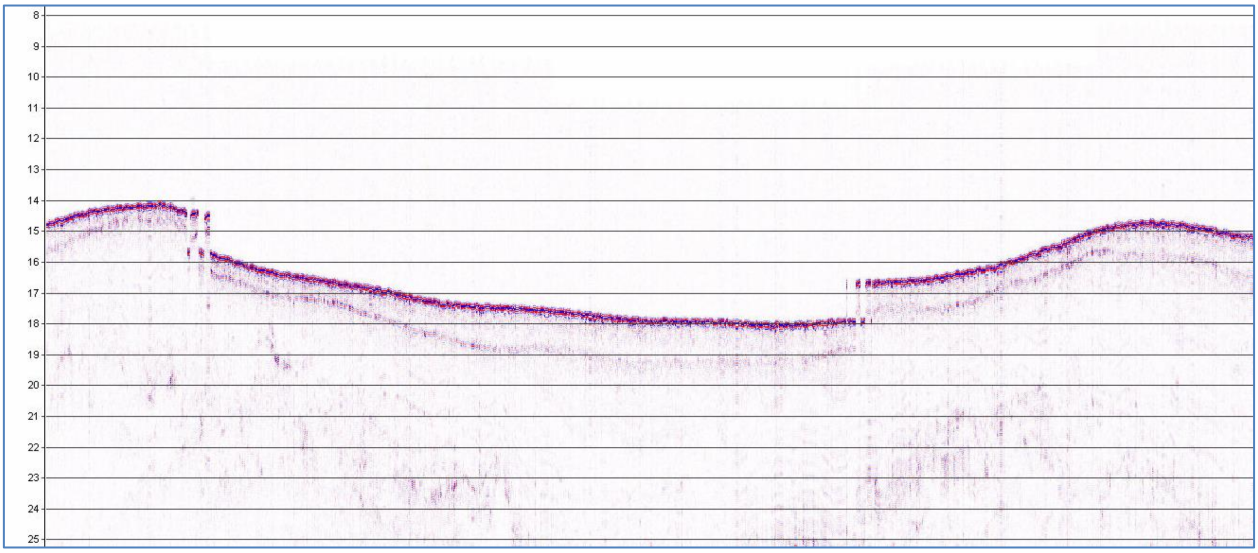

Figure 14

Bytes 53-56 ("tides") are visualized simultaneously in two "ways":

1) A long-period trend is calculated, which is displayed on the seismic section in depth-lines. For the current version of Silas, this trend is displayed as linear (*Figure 15*; depth-lines are angled). For previous versions of Silas, a sine-like shape of depth-lines was encountered;
2) Short-period variations of "tides" are not displayed in the form of depth-lines on a seismic section. They can be seen either on the tide graph or on the loaded bathymetry graph. *Figure 12* shows the tide plot, seismic section and MBES bottom. In *Figure 13* we have intentionally introduced a "shift" for the section of tide; this "shift" was displayed on the tide chart and in the shape of the MBES-bottom (we must re-load MBES-bottom to see any changes). The seismic section in *Figure 13* remains unchanged. *Figure 14* shows the result of exporting from Silas to a seg-y file with settings shown in *Figure 20*. In this case, the value of the tides was added to the seismic section, and was displayed as a "downward" shift of seismic traces ("tide" values were added to Delay).

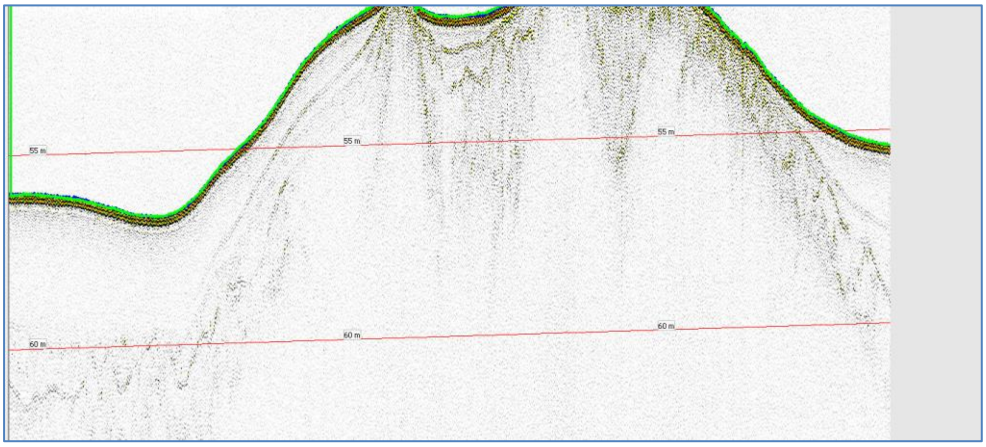

Figure 15

6 Trend correction

If the tide chart is complicated by spikes (as in *Figure 13*), then it can be corrected manually by removing these "spikes" (the change of the editing mode type is done by double-clicking in the window with tide graphs). If the tide chart is incorrect (does not carry any useful information), then we can use the "trick" with matching the trend of the seismic bottom with the bathymetric bottom. To do this you will need to perform the following steps:

1) Manually set the tide value to 0 (*Figure 16***);
2) In this case, probably, at the edges of the survey line, the MBES-bottom will be shifted relative to the SBP-bottom due to the "tidal trend" (*Figure 17*);
3) Use "Trend correction", with the settings shown in *Figure 18*. The filter length was chosen by us to be 300 points, strong "relief features" (points highlighted in red) were removed manually;
4) The trend calculated as a result of calculations, for the difference between the "tides" (set to 0) and the MBES-bottom, is shown in *Figure 19*. The same figure shows a comparison of the MBES-bottom and SBP-bottom at the edges of the profile. The shift that took place in *Figure 17* has disappeared.

** It should be noted that the SBP-bottom with "zero tides" matched well with the MBES-bottom (*Figure 16* not includes constant shift of about 1 meter as presented for *Figure 12*). Moreover, this case occurs quite often. It is possible that the constant shift is already subtracted somewhere during intermediate calculations. In this case, the export with "Scale delay not set" described *above* will be more correct. Although the reason for this data behavior is unclear.

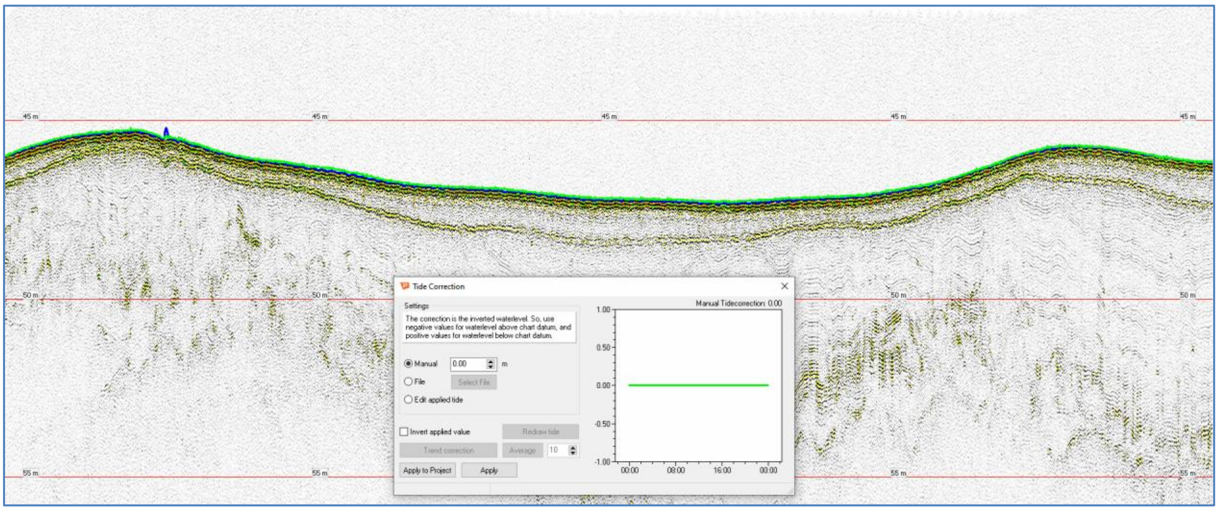

Figure 16

Figure 17

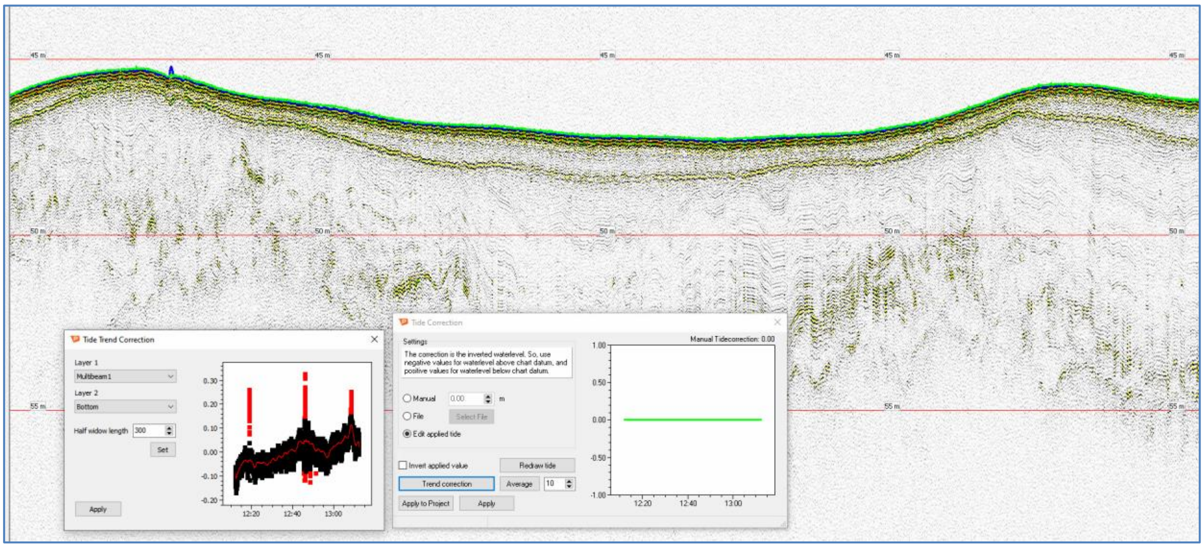

Figure 18

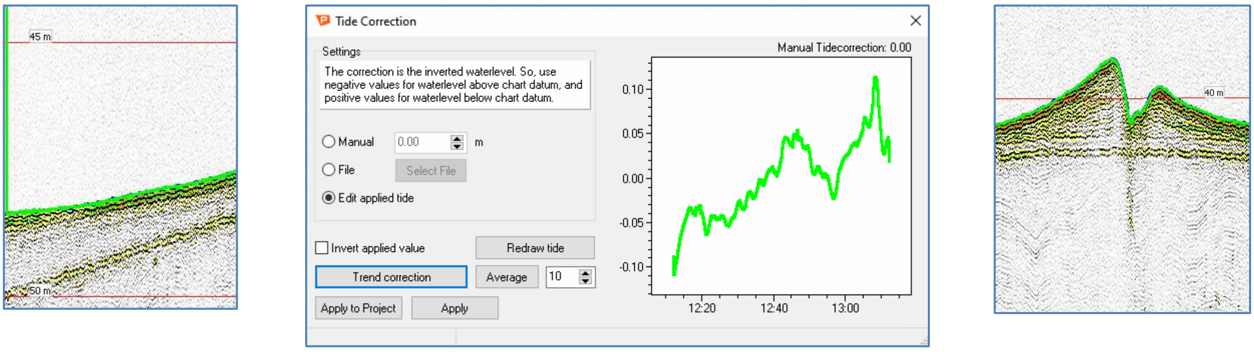

Figure 19

7 Export seg-y from Silas

When exporting to seg-y from Silas software, the values of bytes 53-56 will always contain 0. The corresponding checkboxes (*Figure 20*) allow:

-- recalculate the Z (“tide”) values to time (using the speed of sound in water) and subtract them from Delay,

-- write the Delay value to the exported file (or not write it).

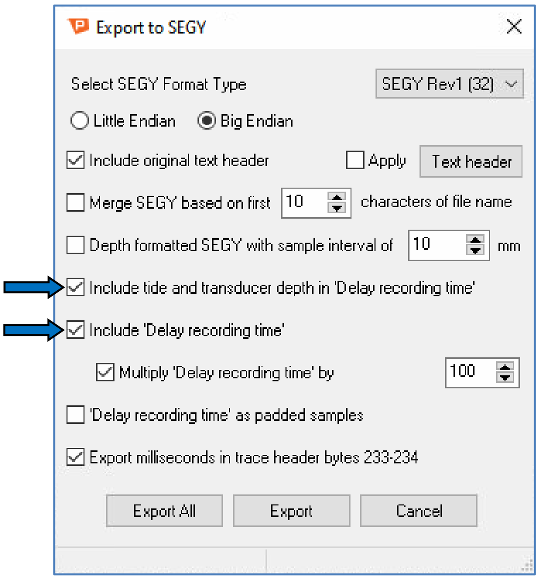

Figure 20

Conclusion

Checkboxes in **SES Convert**:

-- "Apply tide correction with Z value..." recalculates the Z values from depth to time and subtracts them from the Delay value;

-- "Apply range correction" transforms the data in such a way ("shifts" the seismic traces on the seismogram; a "hypertrophied" example of a shift in seismic traces is shown in *Figure 4*) that each seismogram (file) will correspond to one Delay value.

When setting the "Apply tide correction with Z value..." checkbox, there is no need to read tides when loading seg-y into Silas (set the "Use SEGY Depth and Tide" checkbox), since this will lead to double application of tides.

It looks like **Silas** works with the following data structure:

-- The seismogram is read in Silas with a single Delay value, which is displayed in the "Depth Settings" window under the name "Trigger delay" (*Figure 21*). This Delay value can be changed by shifting the seismic-bottom towards the MBES-bottom in Silas (*Figure 2*);

-- It is preferable to import seg-y with the "Scale delay by 0.01" checkbox set, because this gives a correct import of the Delay value from seg-y to Silas (see explanations to *Figure 8* and *Figure 9*) and probably corresponds to a more correct export from SES Convert (*Figure 5*);

-- Z values (called "tides" in Silas) are read from bytes 53-56 (Elevation) seg-y, visually these values are displayed as a "shift" of the depth-line marks on the seismogram and features on the MBES-bottom (*Figure 13* and *Figure 15*);

-- We can view the tide values in the Silas "Tide Correction" window; tide values are displayed simultaneously for all loaded lines. If multiple lines with different tide processing are loaded, multiple tide lines will be displayed, as shown in *Figure 22*. To view or process the tide values for one line, you need to remove all other lines from the project;

-- When exporting data from Silas, values in bytes 53-56 (Elevation) seg-y are not written (always set to 0), however, Z (tide) values can be subtracted from Delay by setting the appropriate checkbox in the export window (*Figure 20*).

When you load data with a "foreign conversion" into Silas, the first question should be - was the "Apply tide correction with Z value..." checkbox set in SES Convert during conversion? The "Use SEGY Depth and Tide" checkbox depends on this.

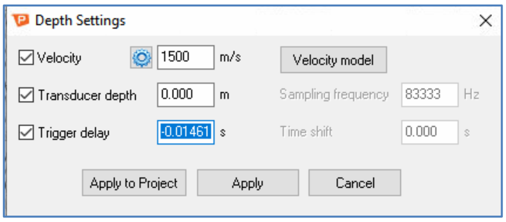

Figure 21

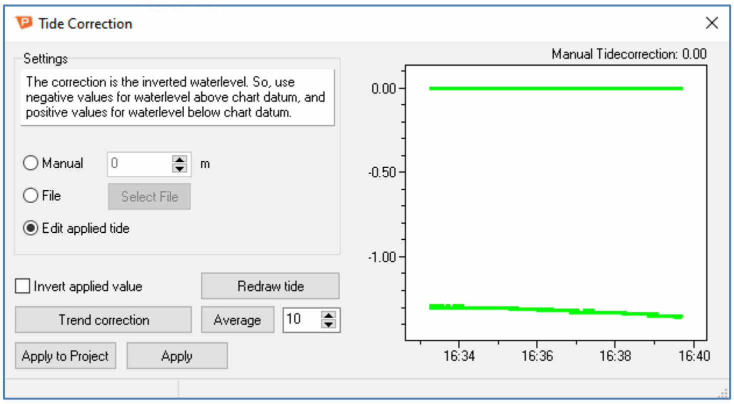

Figure 22