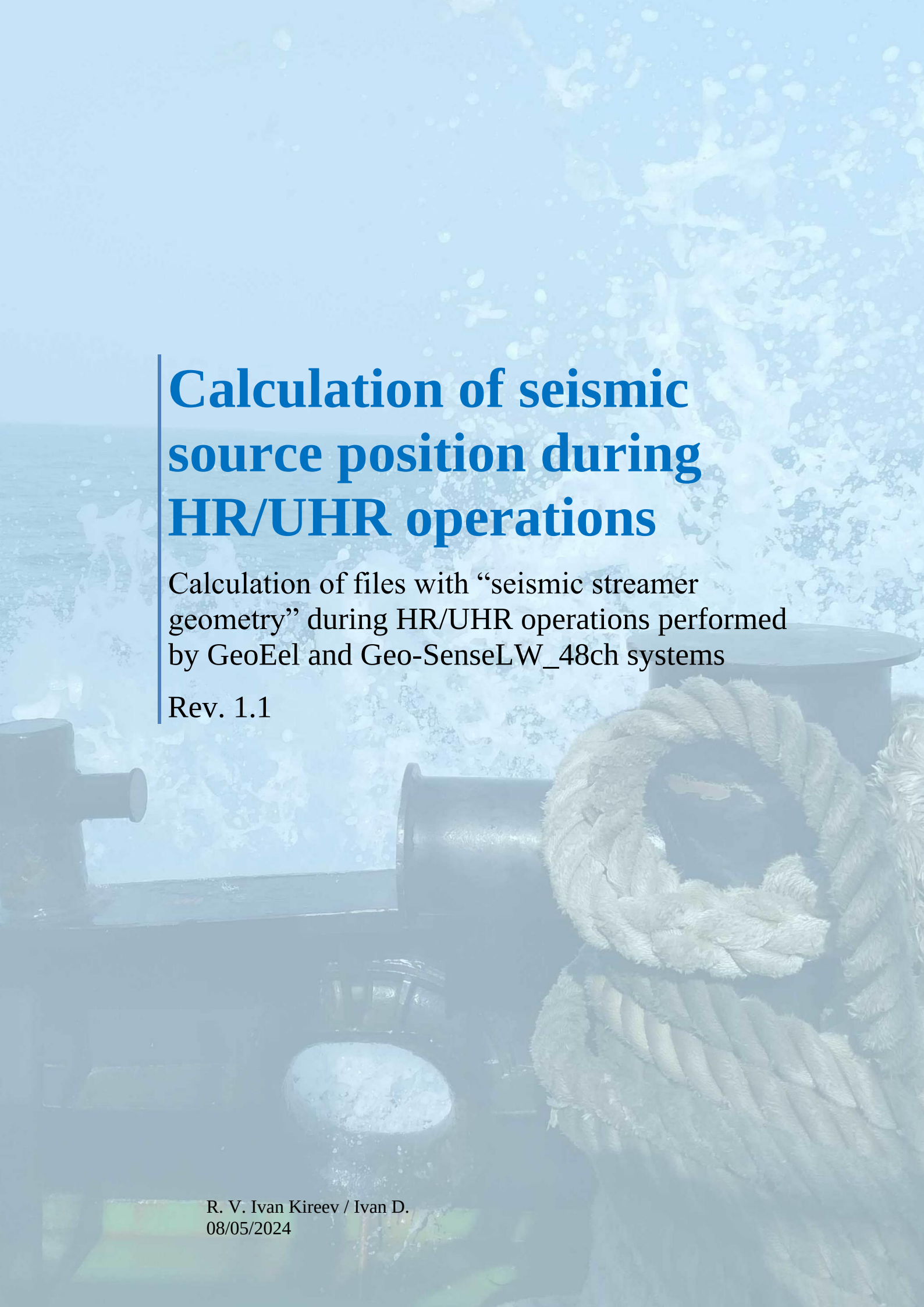

Calculation of seismic source position during HR/UHR operations

Calculation of files with “seismic streamer geometry” during HR/UHR operations performed by GeoEel and Geo-SenseLW_48ch systems

Rev. 1.1

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Contents

Revision History

Version	Date	Description of changes
1.0	2019-05-06	Document created // Ivan D.
1.1	2024-08-12	Document revised // Ivan D.

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Introduction

The paper describes two MatLab scripts calculating the towed seismic source coordinates at the moments of shots (i.e., the coordinates of seismic shot-points).

Logs from GeoEel and GeoSence (Geo-SenseLW_48ch) seismic stations as well as a navigation log with the seismic source towing point coordinates (recorded in QINSy after 1 second with a time stamp in UTC) are used for calculations. The calculation of the towed seismic source coordinates is performed as Layback (based on the towing point coordinates and the towing cable length). The coordinates of seismic shot-points are calculated by linear interpolation of the seismic source coordinates to the shot-time (the shot- time is recorded in the seismic station log and present in the "shot- command" navigation message transmitted to the seismic station).

Executing the scripts results in the following files:

-- a text file of P1/90 format containing coordinates of seismic excitation points;

-- a file with an AutoCad script for drawing seismic excitation points with signed FFID values (one needs to drag the file with the script into the AutoCad window);

-- a text file for loading into the "2D Marine Geometry Spreadsheet" (ProMax) a seismic streamer geometry assignment module.

Based on a file generated by scripts, the "2D Marine Geometry Spreadsheet" module calculates the geometry of a seismic streamer in the simplest way: by calculating the coordinates of seismic receiver groups relative to the coordinates of the seismic source shot- points, using a given direction.

To more accurately calculate the geometry of the seismic streamer, the calculation methodology can be improved. This will require additional data, for example:

-- position of the seismic source according to GPS data (a log from the cluster's GPS positioning system is required), which will facilitate obtaining the seismic excitation points coordinates with greater accuracy;

-- position of the end buoy according to GPS data (a log from the end buoy's GPS positioning system is required), which will facilitate obtaining the azimuth of the seismic streamer for each point in time and calculate the coordinates of seismic receiver groups more accurately;

-- values from the depth and direction controllers ("birds") for the seismic streamer, which will facilitate increasing the accuracy of the seismic receiver group coordinates calculation as well as their depth referencing.

1. gUhrGeoEel_GeomCreate script

1.1 Initial data

When operating the GeoEel seismic station, the following data is used to calculate the coordinates of seismic excitation points:

-- Log of navigation messages generated by the seismic station (the file is written to the seismic station hard disk);

-- A file with coordinates of the seismic source towing point exported from QINSy;

-- A file with coordinates and depths along MBES rays exported from QINSy (one can also use a pts file);

-- A sgy file recorded by the seismic station;

-- A text file with a header for P1/90 file.

Log of navigation messages generated by the seismic station

When performing seismic surveys, a line with the seismic source shot- time is sent to the GeoEel seismic station. The seismic station writes incoming lines to a log file; the log file name contains the postfix ".Nav" (for example, 0148_Seismic_Line_2.Nav.txt). The file contents example:

File: 103, $GPGGA,20190502,084731.92,-9,637334.83,5113283.19,37.1, 19:47:42.97

File: 104, $GPGGA,20190502,084734.47,-8,637339.03,5113288.90,37.1, 19:47:45.52

File: 105, $GPGGA,20190502,084737.07,-7,637341.95,5113292.64,37.1, 19:47:48.15

In the example above, the FFID values for the shot- points ("completed shot numbers") and the shot- time in UTC with an accuracy to the nearest hundredths of a second are bolded.

The FFID may not match the FIX number ("planned shot- numbers") received from navigation in the following cases: the seismic source was not ready for operation and the shot was missed; the navigation issued a "false" shot command (in this case, the "false" shot was missed due to the seismic source being unprepared for operation).

File with coordinates of the seismic source towing point

After a seismic profile is performed, navigation exports a file with the coordinates of the seismic source towing point in 1 second time step from QINSy. The file contents example:

20190502	084729.000	637331.96	5113279.43	35.79
20190502	084730.000	637333.40	5113281.30	35.79
20190502	084731.000	637334.83	5113283.19	35.78

The file will be used to calculate the Layback coordinates of the towed seismic source (based on the towing point coordinates and the towing cable length).

File with coordinates and depths along MBES rays

After a seismic profile is performed, navigation exports a file with coordinates and depths along MBES rays from QINSy. This file is necessary to calculate the sea depth under the seismic source, which is written to a P1/90 file. Depending on the requirements for P1/90, depth values can be “brought to zero mark” or contain the actual sea depth under the seismic source at the shot time (ignoring wave effects).

The file contents example:

```
637277.40    5113363.74    -78.06  1    1
637277.92    5113363.33    -78.06  2    1
637278.44    5113362.92    -78.03  3    1
```

Before running the gUhrGeoEel_GeomCreate script, the geophysicist prepares a directory containing seismic station logs and files exported from QINSy. File names consist of a "seismic profile name" (which is common to all files and varies for different seismic profiles) as well as postfixes and extensions (which are constant for each data type). The directory contents example is shown in ***Table 1.1*** below; files used by the script when calculating geometry are highlighted.

Table 1.1 Files contained in the GeoEel seismic profile directory

Seismic profile folder contents (created by GeoEel)	Description
0148_Seismic_Line_2.log	Log recorded by the GeoEel seismic station.
0148_Seismic_Line_2.Depth.txt	A file with the seismic streamer depth (according to a depth sensor installed on the streamer repeater), recorded by a seismic station.
0148_Seismic_Line_2.Gather1.sgy	File with a seismic section along the first seismic trace, recorded by a seismic station.
0148_Seismic_Line_2.Tension.txt	Log of streamer tension recorded by a seismic station.
0148_Seismic_Line_2.sgy	Seismic receiver recording sgy file recorded by a seismic station.
0148_Seismic_Line_2.Nav.txt	Log of navigation messages for each FIX, recorded by a seismic station.
0148_Seismic_Line_2_Bathy.txt	File with MBES ray coordinates and depths provided by navigation.
0148_Seismic_Line_2_tpSource.txt	File with seismic source towing point coordinates in 1 second provided by navigation

1.2 Calculation results

As a result of calculations (based on data contained in the “seismic profile directory”), the gUhrGeoEel_GeomCreate script creates the following files:

-- a file with FFID numbers and seismic source coordinates (three columns, tab delimiter);

-- a P190 file, including, among other things: coordinates of the seismic source shot point; FFIDs corresponding to seismograms in the sgy data file (excluding seismograms with noise recording); sea depths under the seismic source;

-- a text file with the “.geom” extension containing data to be loaded into the geometry table of the “2D Marine Geometry Spreadsheet” ProMax module;

-- a file with an AutoCad script for drawing the seismic source movement track and the coordinates of the shot points with signed FFIDs.

In ***Table 1.2***, there is an example of the file names and a description of the files created by the gUhrGeoEel_GeomCreate script.

Table 1.2 Files created by the gUhrGeoEel_GeomCreate script

File name	Description
0148_Seismic_Line_2_SrcFfidXY.txt	File with FFID numbers and seismic source coordinates (three columns, tab delimited).
0148_Seismic_Line_2_SrcFfidXY.scr	File with AutoCad script for drawing shot points with FFID numbers.
0148_Seismic_Line_2_Promax.geom	Geometry file to be loaded into the “2D Marine Geometry Spreadsheet” ProMax module.
0148_Seismic_Line_2.190	P1/90 file.

1.3 Script commands

To perform calculations, the operator sends the script a sequence of seven commands, described below.

0) Command: >> 0; gUhrGeoEel_GeomCreateScript;

Setting the initial parameters of the script operation. This command initializes the values of variables written in the script code, including the following ones:

-- the root directory name for the seismic profile with data files;

-- the main part of the file name containing the "seismic profile name" (an example is given in ***Table 1.1***);

-- the seismic source towing cable length;

-- depth of the seismic source;

-- azimuth to the seismic streamer end buoy from the seismic streamer towing point.

When lacking of the end buoy position data, the streamer azimuth can be approximately estimated as the direction opposite to the direction of the vessel diametric plane. To perform this, a file containing the seismic source towing point coordinates is viewed, in the last column of which the vessel's heading

(direction of the diametric plane) is recorded; the most common value in the profile is selected and 180 degrees is added (subtracted) to it.

1) Command: >> 1; gUhrGeoEel_GeomCreateScript;

Loading a navigation log (***Table 1.1***– 0148_Seismic_Line_2.Nav.txt) of the GeoEel seismic station (messages from navigation for each “planned shot point”).

2) Command: >>2; gUhrGeoEel_GeomCreateScript;

Loading a file with the towing point coordinates (***Table 1.1*** – 0148_Seismic_Line_2_tpSource.txt). Removing outliers from the seismic source towing point coordinates (performed in the outlier removal window) and calculating the towed seismic source coordinates using Layback (***Figure 1.1***).

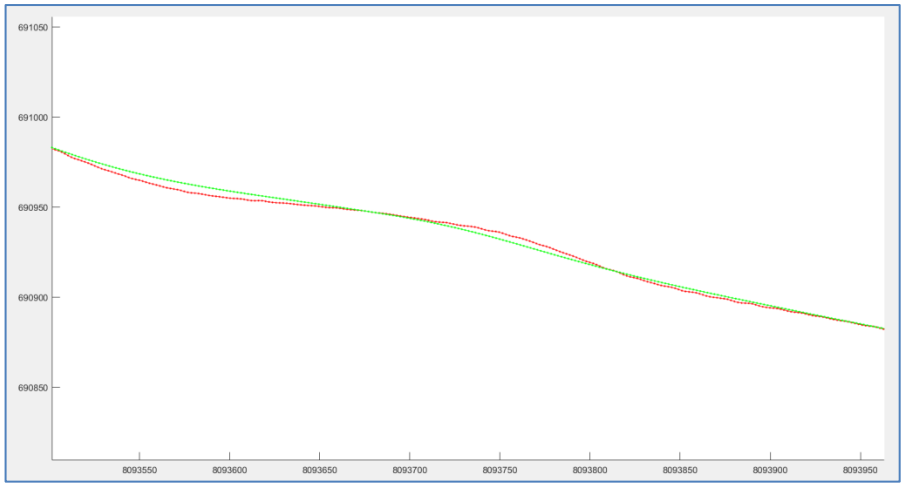

Figure 1.1 Calculation of the seismic source position based on Layback using the "Dragging" model (red line – the towing point position; green – the seismic source position)

3) Command: >>3; gUhrGeoEel_GeomCreateScript;

Checking FFID compliance in the sgy file (***Table 1.1*** – 0148_Seismic_Line_2.sgy) with the navigation message log file. The script removes FFIDs from shot points that are not in the sgy file.

A file with the coordinates of the shot points (***Table 1.2*** – 0148_Seismic_Line_2_SrcFfidXY.txt) and a file with an AutoCad script (***Table 1.2*** – 0148_Seismic_Line_2_SrcFfidXY.scr), which is intended for drawing shot points with FFID numbers, are written to the disk.

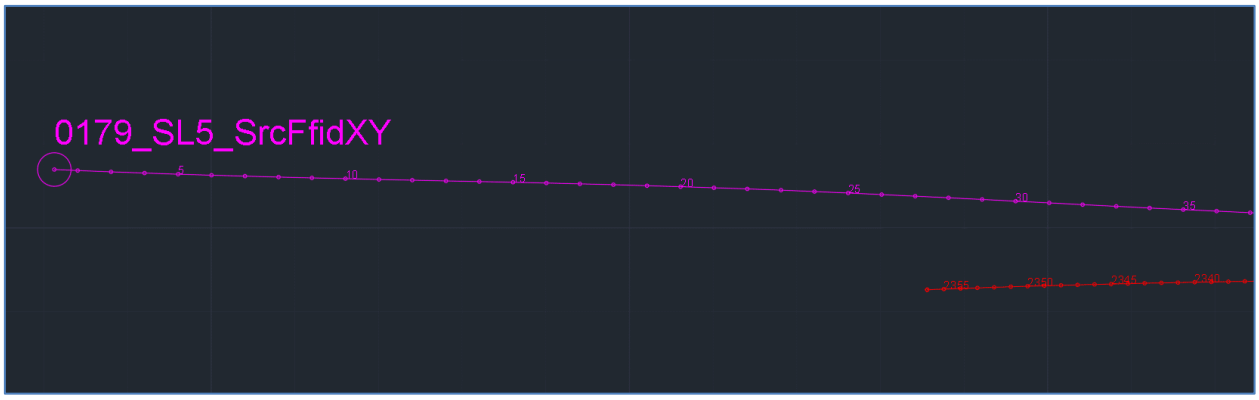

Figure 1.2 The shot points with FFID numbers drawing result in the AutoCad window

4) Command: >> 4; gUhrGeoEel_GeomCreateScript;

Loading a file with coordinates and depths using MBES rays (*Table 1.1* – 0148_Seismic_Line_2_Bathy.txt). Calculation of the sea depth under a seismic source at the moment of shot using triangulation.

5) Command: >> 5; gUhrGeoEel_GeomCreateScript;

Creating a file containing data to be loaded into the geomentry table of the "2D Marine Geometry Spreadsheet" ProMax module (*Table 1.2* – 0148_Seismic_Line_2_Promax.geom). The file contents example:

```
103 103 637311.8 5113253.3 78.2 3.0 103 216.0 84732 122 1 0.0
104 104 637315.5 5113258.1 78.2 3.0 104 216.0 84734 122 1 0.0
105 105 637319.2 5113262.9 78.2 3.0 105 216.0 84737 122 1 0.0
106 106 637323.0 5113268.0 78.2 3.0 106 216.0 84740 122 1 0.0
107 107 637326.8 5113272.9 78.2 3.0 107 216.0 84742 122 1 0.0
108 108 637330.6 5113277.9 78.2 3.0 108 216.0 84745 122 1 0.0
109 109 637334.4 5113282.9 78.2 3.0 109 216.0 84748 122 1 0.0
110 110 637338.1 5113287.9 78.2 3.0 110 216.0 84750 122 1 0.0
```

6) Command: >> 6; gUhrGeoEel_GeomCreateScript;

Uploading data to P1/90 file (*Table 1.2* – 0148_Seismic_Line_2.190). The file contents example (some header lines are removed):

```
H0100 Survey area               Testing survey, Aniva Bay
H0102 Vessel details            Ivan Kireev
H0103 Source details            Boomer AA301
H0202 Tape version              UKOOA P1/90
H2600 Water depth               Current sea surface by Echo Sounder
H2600....1.........2.........3.........4.........5.........6.........7.........8
S0180_SL5       11      1463112.58N1423051.34E 616148.45152957.3  33.1123112622
S0180_SL5       11      2463112.58N1423051.24E 616146.45152957.3  33.1123112623
S0180_SL5       11      3463112.58N1423051.15E 616144.45152957.2  33.1123112624
S0180_SL5       11      4463112.58N1423051.05E 616142.45152957.2  33.1123112625
```

2. gUhrGeoSense_GeomCreate script

2.1 Initial data

When operating the MultiTrace seismic station, the following data is used to calculate the coordinates of seismic excitation points:

-- Log generated by the MultiTrace seismic station (the file name example: 18661018.log);

-- A file with coordinates of the seismic source towing point exported from QINSy;

-- A file with coordinates and depths along MBES rays exported from QINSy (one can also use a pts file);

-- A sgy file recorded by the seismic station;

-- A text file with a header for P1/90 file.

Log generated by the seismic station

When performing seismic surveys, a line with the seismic source shot time is sent to the MultiTrace seismic station from navigation. The seismic station is configured so that after receiving the line, it detonates the seismic source. The seismic station records the data received from navigation into a log file. The file contents example:

FFID,1, SHOTID,1001, LINE,62, SN,18661018, TS,0.0, 01/05/2019 04:27:29.765
UTC,VESSEL_X,637640.960000000, VESSEL_Y,5113657.570000000, VESSEL_FIX,1219.0 00000000,
VESSEL_HDG,**41821.250000000**, VESSEL_AZI,0.000000000, VESSEL_FEA ,0.000000000,
VESSEL_SPEED,402460.403504188, VESSEL_GPSTIME,01/05/2019 04:27:27.178 UTC,
FFID,2, SHOTID,1002, LINE,62, SN,18661018, TS,500.0, 01/05/2019 04:27:30.666
UTC,VESSEL_X,637642.420000000, VESSEL_Y,5113667.320000000,VESSEL_FIX,119. 000000000,
VESSEL_HDG,**41824.460000000**, VESSEL_AZI,0.000000000, VESSEL_FEA ,0.000000000,
VESSEL_SPEED,1922.980426837, VESSEL_GPSTIME,01/05/2019 04:27:30.641 UTC,

In the example above, the FFID values for the shot points ("completed shot numbers") and the shot time in UTC with an accuracy to the nearest hundredths of a second are bolded.

The FFID may not match the FIX number ("planned shot numbers") received from navigation in the following cases: the seismic source was not ready for operation and the shot was missed; the navigation issued a "false" shot command (in this case, the "false" shot was missed due to the seismic source being unprepared for operation).

File with coordinates of the seismic source towing point

After a seismic profile is performed, navigation exports a file with the coordinates of the seismic source towing point in 1 second time step from QINSy. The file contents example:

20190501	041825.000	637646.09	5113673.31	28.39
20190501	041826.000	637646.97	5113674.76	28.46
20190501	041827.000	637647.77	5113676.28	28.61

The file will be used to calculate the Layback coordinates of the towed seismic source (based on the towing point coordinates and the towing cable length).

File with coordinates and depths along MBES rays

After a seismic profile is performed, navigation exports a file with coordinates and depths along MBES rays from QINSy. This file is necessary to calculate the sea depth under the seismic source, which is written to a P1/90 file. Depending on the requirements for P1/90, depth values can be "brought to zero mark" or contain the actual sea depth under the seismic source at the shot time (ignoring wave effects).

The file contents example:

637584.27	5113747.20	-78.28	1	1
637584.82	5113746.86	-78.29	2	1
637585.37	5113746.53	-78.31	3	1

637585.91 5113746.20 -78.33 4 1

Before running the gUhrGeoSense_GeomCreate script, the geophysicist prepares a directory containing seismic station logs and files exported from QINSy. Some of the files from the station are renamed or deleted. File names consist of a "seismic profile name" (which is common to all files and varies for different seismic profiles) as well as postfixes and extensions (which are constant for each data type). The directory contents example is shown in ***Table 2.1*** below; files used by the script when calculating geometry are highlighted.

Table 2.1 Files contained in the GeoSence seismic profile directory

Contents of the seismic profile folder being created by MultiTrace	Renamed files for geometry calculations	Description
18661018\		Seismogram files in MultiTrace seismic station format
18661019\		Seismogram files in MultiTrace seismic station format
SEG-Y\ 0126_Seismic_line_2.SEGY	SEG-Y\ 0126_Seismic_line_2.sgy	File with seismograms in sgy format
.devorder		Streamer segment numbers
18661018.GRIF		Seismic station service file
18661018.GRLI		Seismic station service file
18661018.log	0126_Seismic_line_2_LWStreamer.log	Seismic station log file for 18661018 streamer section
18661019.GRIF		Seismic station service file
18661019.GRLI		Seismic station service file
18661019.log	18661019.log	Seismic station log file for 18661019 streamer section
LAN_TRIGGER_LOG.log	0126_Seismic_line_2_LAN_TRIGGER_LOG.log	Log of navigation messages sent to the seismic station with reference to the station time.
name.txt		Seismic line name.
navigation.p190		P190 file generated by the seismic station (incorrect).
RAW_LOG-Input 0.log	0126_Seismic_line_2_RAW_LOG-Input 0.log	Log of navigation messages sent to the seismic station.
	0126_Seismic_line_2_tpSource.txt	File with coordinates and depths along MBES rays provided by navigation.
	0126_Seismic_line_2_Bathy.txt	File with seismic source towing point coordinates in 1 second provided by navigation

2.2 Calculation results

As a result of calculations (based on data contained in the “seismic profile directory”), the gUhrGeoSense_GeomCreate script creates the following files:

-- a file with FFID numbers and seismic source coordinates (three columns, tab delimiter);

-- a P190 file, including, among other things: coordinates of the seismic source shot point; FFIDs corresponding to seismograms in the sgy data file (excluding saismograms with noise recording); sea depths under the seismic source;

-- a text file with the ".geom" extension containing data to be loaded into the geometry table of the "2D Marine Geometry Spreadsheet" ProMax module;

-- a file with an AutoCad script, for drawing the seismic source movement track and the coordinates of the shot points with signed FFIDs.

In ***Table 2.2***, there is an example of the file names and a description of the files created by the gUhrGeoSense_GeomCreate script.

Table 2.2 Files created by the gUhrGeoSense_GeomCreate script

File name	Description
0126_Seismic_line_2_SrcFfidXY.txt	File with FFID numbers and seismic source coordinates (three columns, tab delimited).
0126_Seismic_line_2_SrcFfidXY.scr	AutoCad script file.
0126_Seismic_line_2_Promax.geom	Geometry file to be loaded into the "2D Marine Geometry Spreadsheet" ProMax module.
0126_Seismic_line_2.190	P1/90 file.

2.3 Script commands

To perform calculations, the operator sends the script a sequence of seven commands, described below.

0) Command :>> 0; gUhrGeoSense_GeomCreateScript;

Setting the initial parameters of the script operation. This command initializes the values of variables written in the script code, including the following ones:

-- the root directory name for the seismic profile with data files;

-- the main part of the file name containing the "seismic profile name" (an example is given in ***Table 2.1***);

-- the seismic source towing cable length;

-- depth of the seismic source;

-- azimuth to the seismic streamer end buoy from the seismic streamer towing point.

When lacking of the end buoy position data, the streamer azimuth can be approximately estimated as the direction opposite to the direction of the vessel diametric plane. To perform this, a file containing the seismic source towing point coordinates is viewed, in the last column of which the vessel's heading (direction of the diametric plane) is recorded; the most common value in the profile is selected and 180 degrees is added (subtracted) to it.

1) Command: >> 1; gUhrGeoSense_GeomCreateScript;

Loading the MultiTrace seismic station log containing data from navigation messages (***Table 2.1*** – 0126_Seismic_line_2_LWStreamer.log).

2) Command: >>2; gUhrGeoSense_GeomCreateScript;

Loading a file with the towing point coordinates (***Table 2.1*** – 0126_Seismic_line_2_tpSource.txt). Removing outliers from the seismic source towing point coordinates (performed in the outlier removal window) and calculating the towed seismic source coordinates using Layback.

3) Command:>>3; gUhrGeoSense_GeomCreateScript;

Checking FFID compliance in the sgy file (***Table 2.1***– SEG-Y\ 0126_Seismic_line_2.sgy) with the seismic station log file. The script removes FFIDs from shot points that are not in the sgy file.

A file with the coordinates of the shot points (***Table 2.2*** – 0126_Seismic_line_2_SrcFfidXY.txt) and a file with an AutoCad script (***Table 2.2*** – 0126_Seismic_line_2_SrcFfidXY.scr), which is intended for drawing shot points with FFID numbers, are written to the disk.

4) Command: >> 4; gUhrGeoSense_GeomCreateScript;

Loading a file with coordinates and depths using MBES rays (***Table 2.1*** – 0126_Seismic_line_2_tpSource.txt). Calculation of the sea depth under a seismic source at the moment of shot using triangulation.

5) Command: >> 5; gUhrGeoSense_GeomCreateScript;

Creating a file containing data to be loaded into the geometry table of the "2D Marine Geometry Spreadsheet" ProMax module (***Table 2.2*** – 0126_Seismic_line_2_Promax.geom). The file contents example:

```
1 1 637608.3 5113612.6 78.6 0.4 1 215.0 41821 121 1 0.0
2 2 637611.3 5113617.3 78.6 0.4 2 215.0 41824 121 1 0.0
3 3 637614.5 5113622.4 78.6 0.4 3 215.0 41828 121 1 0.0
4 4 637617.5 5113627.5 78.6 0.4 4 215.0 41831 121 1 0.0
5 5 637620.8 5113632.8 78.6 0.4 5 215.0 41835 121 1 0.0
6 6 637623.8 5113637.8 78.6 0.4 6 215.0 41838 121 1 0.0
```

6) Command: >> 6; gUhrGeoSense_GeomCreateScript;

Uploading data to P1/90 file (***Table 2.2*** – 0126_Seismic_line_2.190). The file contents example (some header lines are removed):

```
H0100 Survey area               Testing survey, Aniva Bay
H0102 Vessel details            Ivan Kireev
H0103 Source details            Boomer AA301
H0202 Tape version              UKOOA P1/90
H2600....1.........2.........3.........4.........5.........6.........7.........8
S0126_Seismic   11      1460943.89N1424656.53E 637608.35113612.6  78.6121041821
S0126_Seismic   11      2460944.05N1424656.67E 637611.35113617.3  78.6121041824
```

S0126_Seismic 11 3460944.21N1424656.83E 637614.55113622.4 78.6121041828

Appendix 1. gUhrGeoEel_GeomCreate script

```
%script gUhrGeoEel_GeomCreate;
key=ans;
ifkey==0,
RootDir='d:\001_RawData\0008_C_L_HR_14\';
NameZ='0008_C_L_HR_14';
NameP190Head='d:\001_RawData\P190_Header.txt';
SourceLayback=54.3;
SrcDepth=3;
StrAzimutz=198-180;
Nav.EllipParam=[6378137 0.0818191908426215];Nav.ProjForvFunc='gNavGeog2ProjUtm';Nav.ProjRevFunc='gNavProjUtm2Geog';Nav.ProjParam=[0 141 0.9996 500000
0];
 %LinePlan=gMapPLReadTxt('d:\001_RawData\Survey_lines.txt',1,'-b');
 %gMapPL2AcadExport('d:\001_RawData\Survey_lines.scr',LinePlan,[7 0],[5 100000],[6 0 1000000],2,0);
end;
ifkey==1,%//Z.GpsTime//Z.FFID
Log=gUhrGeoEel_NavLogRead([RootDir NameZ'.Nav.txt'],2);
Z.GpsTime=Log.GpsTime;Z.FFID=Log.SHOTID;Z.FIX=Log.FIX;
figure(1);plot(Z.FIX(1:end-1),diff(Z.FIX));
figure(2);plot(Z.FFID(1:end-1),diff(Z.FFID));
figure(3);plot(Z.FIX(1:end-1),diff(Z.FIX)-diff(Z.FFID));
end;
ifkey==2,
tmp=dlmread([RootDir NameZ'_tpSource.txt']);%read 1-second track for Source's TP
tmp(:,3)=[];
TP.GpsDay=gNavTime2Time('YMD2Dx',tmp(:,1)');TP.GpsTime=gNavTime2Time('HMS2Sd',tmp(:,2)');% %'DMY2Dx' 'YMD2Dx'
TP.GpsE=tmp(:,3)';TP.GpsN=tmp(:,4)';TP.Heading=tmp(:,5)';%L=find((TP.GpsE==0)|(TP.GpsN==0));TP=gFieldsRowSet(TP,length(TP.GpsDay),L,[]);
a=figure(100);axisequal;p=gMapPickHandleNan(TP.GpsE,TP.GpsN,a);pause;L=get(p,'UserData';close(a);
TP=gFieldsRowSet(TP,length(TP.GpsDay),~L,[]);
 %TP.GpsE=smooth(TP.GpsE,30,'loess')';TP.GpsN=smooth(TP.GpsN,30,'loess')';
EN=gNavLaybackOld([TP.GpsE;TP.GpsN;repmat(SourceLayback,size(TP.GpsE));repmat(0.1,size(TP.GpsE))],101);
 %EN(1,:)=smooth(EN(1,:),5,'loess');EN(2,:)=smooth(EN(2,:),5,'loess');%!! !!!!!!!!!!!!!!!!!!!!!!!!!!
cleartmp a p L;
end;
ifkey==3,%//Z.GpsE//Z.GpsN//Z.Heading//
Z.GpsDay=Log.GpsDay;%tmp=cumsum([0 diff(Z.GpsTime)<0]);Z.GpsDay=TP.GpsDay(1)+tmp;
t_Z=(Z.GpsDay-Z.GpsDay(1)).*24*3600+Z.GpsTime;
t_TP=(TP.GpsDay-Z.GpsDay(1)).*24*3600+TP.GpsTime;
Z.GpsE=interp1(t_TP,EN(1,:),t_Z,'pchip','extrap');
Z.GpsN=interp1(t_TP,EN(2,:),t_Z,'pchip','extrap');
Z.Heading=interp1(t_TP,TP.Heading,t_Z,'pchip','extrap');
[Z.GpsLat,Z.GpsLon]=feval(Nav.ProjRevFunc,Z.GpsE,Z.GpsN,Nav.EllipParam,Nav.ProjParam);
figure(105);axisequal;plot(Z.GpsE,Z.GpsN,'.');
cleartmp;
 %create file
dlmwrite([RootDir NameZ'_SrcFfidXY.txt'],[Z.FFID;Z.GpsE;Z.GpsN]','delimiter','\t','precision','%.8f');
PL=gMapPLReadTxt([RootDir NameZ'_SrcFfidXY.txt'],[2 2 3 1],'.');
gMapPL2AcadExport([RootDir NameZ'_SrcFfidXY.scr'],PL,[3 0 0 3 2],[0.2 1],[1 0 5 0],2,0);
 %stats
```

```
r=sqrt(diff(Z.GpsE).^2+diff(Z.GpsN).^2);AccDev=sum(r)-sum(6.25.*diff(Z.FIX));disp([mean( r) std(r) min(r) max(r) AccDev]);
clipboard('copy', [num2str(mean(r),'%f') char(9) num2str(std(r),'%f') char(9) num2str(min(r),'%f') char(9) num2str(max(r),'%f') char(9)
num2str(AccDev,'%f')]);
end;
ifkey==4,%//Z.SeaDepth//
bo=dlmread([RootDir NameZ'_Bathy.txt']);bott=scatteredInterpolant(bo(:,1),bo(:,2),bo(:,3),'linear','nearest');
Z.DepthSea=-bott(Z.GpsE,Z.GpsN);plot(Z.DepthSea,'.-');
end;
ifkey==5,%create file for PROMAX for Gun
 %MarkBlock; %TRC Geometry Sin//TraceHeader:SIN//Integer
 %Source; %Sin Geometry Source//TraceHeader:SOURCE//Integer
 %Station;%Sin Geometry Station//TraceHeader:SOU_SLOC//Integer
 %X;%Sin Geometry X_Coord//TraceHeader:SOU_X//Float
 %Y;%Sin Geometry Y_Coord//TraceHeader:SOU_Y//Float
 %DepthSea;%Sin Geometry Sea Depth//TraceHeader:SOU_H2OD//Float
 %SrcDepth;%Sin Geometry Depth//TraceHeader:DEPTH//Float
 %FFID;%Sin Geometry FFID//TraceHeader:FFID//Integer
 %StrmrAzmth;%Sin Geometry Azimuth//TraceHeader:none//Float
 %Time;%Sin Geometry Time//TraceHeader:none//Integer -- HHMMSS
 %Date;%Sin Geometry Date//TraceHeader:none//Integer -- Julian
 %SrcPattern;%Sin Geometry Pattern//TraceHeader:none//Integer
 %Static;%Sin Geometry Userstat//TraceHeader:none//Float
 %Z.FFID=Z.FFID(1):1:(Z.FFID(1)+numel(Z.FFID)-1);Z.FFID1=Z.FFID;
Z.SrcDepth=repmat(SrcDepth,size(Z.FFID));
Z.StrAzmth=repmat(StrAzimutz,size(Z.FFID));
Z.TimeHMS=round(gNavTime2Time('Sd2HMS',Z.GpsTime));
[~,Z.DateJulian]=gNavTime2Time('Dx2YDy',Z.GpsDay);
Z.SrcPattern=repmat(1,size(Z.FFID));
Z.Static=repmat(0,size(Z.FFID));
PmOut=[Z.FIX;Z.FIX;Z.GpsE;Z.GpsN;Z.DepthSea;Z.SrcDepth;Z.FFID;Z.StrAzmth;Z.TimeHMS;Z.DateJulian;Z.SrcPattern;Z.Static ];%-531500-5383000
[fId,mes]=fopen([RootDir NameZ'_GunPromax.geom'],'w');if~isempty(mes),error(mes);end;
fprintf(fId,'%6d %6d %10.1f %11.1f %8.1f %5.1f %7d %5.1f %6d %3d %2d %4.1f\r\n',PmOut);fclose(fId);
clearPmOut fId mes;
end;
ifkey==6,%create file P190 for Gun
[P190Head,~]=gP190Read(NameP190Head,2018);
Head.RecordId='S';Head.LineName=NameZ';
Head.Spare1=(' ')';Head.VesselId='1';Head.SourceId='1';Head.OtherId=' ';
Head.PointNum=Z.FFID;
Head.GpsE=Z.GpsE;Head.GpsN=Z.GpsN;Head.GpsLat=Z.GpsLat;Head.GpsLon=Z.GpsLon;
Head.WaterDepth=Z.DepthSea;
Head.GpsDay=Z.GpsDay;Head.GpsTime=Z.GpsTime;Head.Spare2=(' ');
gP190Write([RootDir NameZ'_Gun.190'],P190Head,Head,1,'NNMMMM');
end;

% mail@ge0mlib.com 05/01/2019
```

Appendix 2. gUhrGeoSense_GeomCreate script

```
%script gUhrGeoSense_GeomCreate;
key=ans;
ifkey==0,
RootDir='e:\2019_04_20_Tests\005_AA301&LW48ch\0180_SL5\';
NameX='0180_SL5';
NameP190Head='e:\2019_04_20_Tests\005_AA301&LW48ch\P190_Header.txt';
SourceLayback=34;
SrcDepth=0.2;
StrAzimutz=270-180;
Nav.EllipParam=[6378137 0.0818191908426215];Nav.ProjForvFunc='gNavGeog2ProjUtm';Nav.ProjRevFunc='gNavProjUtm2Geog';Nav.ProjParam=[0 141 0.9996 500000
0];
 %[m,dAng]=gNavReducingHeadingToProjUtm(52.212866,141.587076,Nav.EllipParam,Nav.ProjParam,1);
end;
ifkey==1,%//Z.CompDay//Z.CompTime//Z.GpsDay//Z.GpsTime//Z.FFID//Z.FIX//
Log=gUhrGeoSense_StreamerLogRead([RootDir NameX'_LWStreamer.log'],1);%read station Log-file
Z.GpsDay=Log.GpsDay;Z.GpsTime=Log.GpsTime;Z.FFID=Log.FFID;
end;
ifkey==2,%//Z.GpsE//Z.GpsN//Z.Heading//
tmp=dlmread([RootDir NameX'_tpSource.txt']);%read 1-second track for Source's TP
TP.GpsDay=gNavTime2Time('YMD2Dx',tmp(:,1)');TP.GpsTime=gNavTime2Time('HMS2Sd',tmp(:,2)');
TP.GpsE=tmp(:,3)';TP.GpsN=tmp(:,4)';TP.Heading=tmp(:,5)';%L=find((TP.GpsE==0)|(TP.GpsN==0));TP=gFieldsRowSet(TP,length(TP.GpsDay),L,[]);
a=figure(100);axisequal;p=gMapPickHandleNan(TP.GpsE,TP.GpsN,a);pause;L=get(p,'UserData';close(a);
TP=gFieldsRowSet(TP,length(TP.GpsDay),~L,[]);
EN=gNavLaybackOld([TP.GpsE;TP.GpsN;repmat(SourceLayback,size(TP.GpsE));repmat(1.5,size(TP.GpsE))],101);
EN(1,:)=smooth(EN(1,:),5,'loess';EN(2,:)=smooth(EN(2,:),5,'loess');%!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
cleartmp a p L;
t_Z=(Z.GpsDay-Z.GpsDay(1)).*24*3600+Z.GpsTime;
t_TP=(TP.GpsDay-Z.GpsDay(1)).*24*3600+TP.GpsTime;
Z.GpsE=interp1(t_TP,EN(1,:),t_Z,'linear','extrap');
Z.GpsN=interp1(t_TP,EN(2,:),t_Z,'linear','extrap');
Z.Heading=interp1(t_TP,TP.Heading,t_Z,'pchip','extrap');
[Z.GpsLat,Z.GpsLon]=feval(Nav.ProjRevFunc,Z.GpsE,Z.GpsN,Nav.EllipParam,Nav.ProjParam);
figure(105);plot(Z.GpsE,Z.GpsN,'.';axisequal;
cleartmp;
end;
ifkey==3,
 %delete dead FFID // files name is FFID 6th digits
dz=dir([RootDir'\SEG-Y\']);dz([dz.isdir])=[];fName=[repmat([RootDir'\SEG-Y\'],length(dz),1) char(dz.name)];Len=size(fName,1);
 fornn=1:Len,
fNameN=deblank(fName(nn,:));[~,Head0,~]=gSgyRead(fNameN,'',[]);
 ifnn==1,Head=Head0;else,Head=gFieldsRowAppend(Head,Head0,length(Head.MessageNum));end;
 end;
L=find([1 diff(Head.FieldRecord)]);FilesFFID=Head.FieldRecord(L);
fl_del=false(size(Z.FFID));forn=1:length(Z.FFID),ifall(Z.FFID(n)~=FilesFFID),fl_del(n)=true;end;end;disp('Deleted FFID:');disp(Z.FFID(fl_del));
Z=gFieldsRowSet(Z,length(Z.FFID),fl_del,[]);
 %clear dz fName FilesFFID fl_del n
dlmwrite([RootDir NameX'_SrcFfidXY.txt'],[Z.FFID;Z.GpsE;Z.GpsN]','delimiter','\t','precision','%.8f');
PL=gMapPLReadTxt([RootDir NameX'_SrcFfidXY.txt'],[2 2 3 1],'.');
```

```
gMapPL2AcadExport([RootDir NameX'_SrcFfidXY.scr'],PL,[3 0 0 3 2],[0.2 1],[1 0 5 0],2,0);
end;
ifkey==4,%//Z.SeaDepth//
bo=dlmread([RootDir NameX'_Bathy.txt']);bott=scatteredInterpolant(bo(:,1),bo(:,2),bo(:,3),'linear','nearest');
Z.DepthSea=-bott(Z.GpsE,Z.GpsN);plot(Z.DepthSea,'.-');
end;
ifkey==5,%create file for PROMAX
 %MarkBlock; %TRC Geometry Sin//TraceHeader:SIN//Integer
 %Source; %Sin Geometry Source//TraceHeader:SOURCE//Integer
 %Station;%Sin Geometry Station//TraceHeader:SOU_SLOC//Integer
 %X;%Sin Geometry X_Coord//TraceHeader:SOU_X//Float
 %Y;%Sin Geometry Y_Coord//TraceHeader:SOU_Y//Float
 %DepthSea;%Sin Geometry Sea Depth//TraceHeader:SOU_H2OD//Float
 %SrcDepth;%Sin Geometry Depth//TraceHeader:DEPTH//Float
 %FFID;%Sin Geometry FFID//TraceHeader:FFID//Integer
 %StrmrAzmth;%Sin Geometry Azimuth//TraceHeader:none//Float
 %Time;%Sin Geometry Time//TraceHeader:none//Integer -- HHMMSS
 %Date;%Sin Geometry Date//TraceHeader:none//Integer -- Julian
 %SrcPattern;%Sin Geometry Pattern//TraceHeader:none//Integer
 %Static;%Sin Geometry Userstat//TraceHeader:none//Float
Z.SrcDepth=repmat(SrcDepth,size(Z.FFID));
Z.StrAzmth=repmat(StrAzimutz,size(Z.FFID));
Z.TimeHMS=round(gNavTime2Time('Sd2HMS',Z.GpsTime));
[~,Z.DateJulian]=gNavTime2Time('Dx2YDy',Z.GpsDay);
Z.SrcPattern=repmat(1,size(Z.FFID));
Z.Static=repmat(0,size(Z.FFID));
 %PmOut=[Z.FFID;Z.FFID;Z.GpsE-531500;Z.GpsN-5383000;Z.DepthSea;Z.SrcDepth;Z.FFID;Z.StrAzmth;Z.TimeHMS;Z.DateJulian;Z. SrcPattern;Z.Static];
PmOut=[Z.FFID;Z.FFID;Z.GpsE;Z.GpsN;Z.DepthSea;Z.SrcDepth;Z.FFID;Z.StrAzmth;Z.TimeHMS;Z.DateJulian;Z.SrcPattern;Z.Static ];
[fId,mes]=fopen([RootDir NameX'_Promax.geom'],'w');if~isempty(mes),error(mes);end;
fprintf(fId,'%6d %6d %10.1f %11.1f %8.1f %5.1f %7d %5.1f %6d %3d %2d %4.1f\r\n',PmOut);fclose(fId);
clearPmOut fId mes;
end;
ifkey==6,%create file P190
[P190Head,~]=gP190Read(NameP190Head,2018);
Head.RecordId='S';Head.LineName=NameX';
Head.Spare1=(' ')';Head.VesselId='1';Head.SourceId='1';Head.OtherId=' ';
Head.PointNum=Z.FFID;
Head.GpsE=Z.GpsE;Head.GpsN=Z.GpsN;Head.GpsLat=Z.GpsLat;Head.GpsLon=Z.GpsLon;
 %Head.GpsE=Head.GpsE-531500;Head.GpsN=Head.GpsN-5383000;Head.GpsLat(:)=1;Head.GpsLon(:)=1;%!!!!!!!!!! !!!!!!!!!!!!!!!
Head.WaterDepth=Z.DepthSea;
Head.GpsDay=Z.GpsDay;Head.GpsTime=Z.GpsTime;Head.Spare2=(' ');
gP190Write([RootDir NameX'.190'],P190Head,Head,1,'NNMMMM');
end;

% mail@ge0mlib.com 05/01/2019
```