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Summary

This Geological Survey of Canada Open File provides summary information about the 2-D multichannel seismic data collected in the Canadian Beaufort Sea during the marine research expedition ARA08C onboard the Ice-breaker Research Vessel Araon. The acquisition geometry, the processing used to generate the brute stacks, and the loading information of the SEG-Y files are described in detail.

Sommaire

Ce Dossier Public de la Commission Géologique du Canada fournit des informations sommaires sur les données sismiques multitraces 2-D acquises dans la partie canadienne de mer de Beaufort lors de l'expédition de recherche marine ARA08C à bord du brise-glace de recherche Araon. La géométrie d'acquisition, le traitement utilisé pour générer les sections sommées ainsi que les informations de chargement des fichiers SEG-Y sont décrits en détail.

Data Acquisition

Seismic data were collected onboard the icebreaker research vessel (IBRV) Araon as part of a research collaboration outlined in a Memorandum of Understanding between the Department of Natural Resources of Canada and the Korea Polar Research Institute.

Twelve multichannel seismic (MCS) lines representing 890 line-km of seismic data and 35,496 shot points were collected from August 31 to September 4, 2017 (Figure 1 and Table 1; Jin et al. (2018)). The seismic source was positioned 31.25 m behind the ship's stern, towed 6 m beneath the sea surface, and triggered every 25 m. Seismic source consisted of an airgun array formed by two 210 in^3 Sercel's Generator Injectors for a total source volume of 420 in^3. Seismic arrivals were recorded using a 1.75 km-long streamer that consisted of 150 m-long lead-in cable, 50-m long head-stretch, ten 150 m-long solid state active sections including 12 receiver groups spaced by 12.5 m, and a tail buoy deployed at end of 50 m-long cable. Six birds were mounted on the streamer, at 300 m intervals, to ensure a constant depth of 6 m. The nearest and the farthest offsets were respectively located 85 m and 1572.5 m behind the source. Shot files were recorded in SEG-D format at a sample rate of 1 ms over a trace length of 8000 ms. The navigation was provided by the GPS antenna of the ship and positions were recorded for every shot point in separate ASCII files.

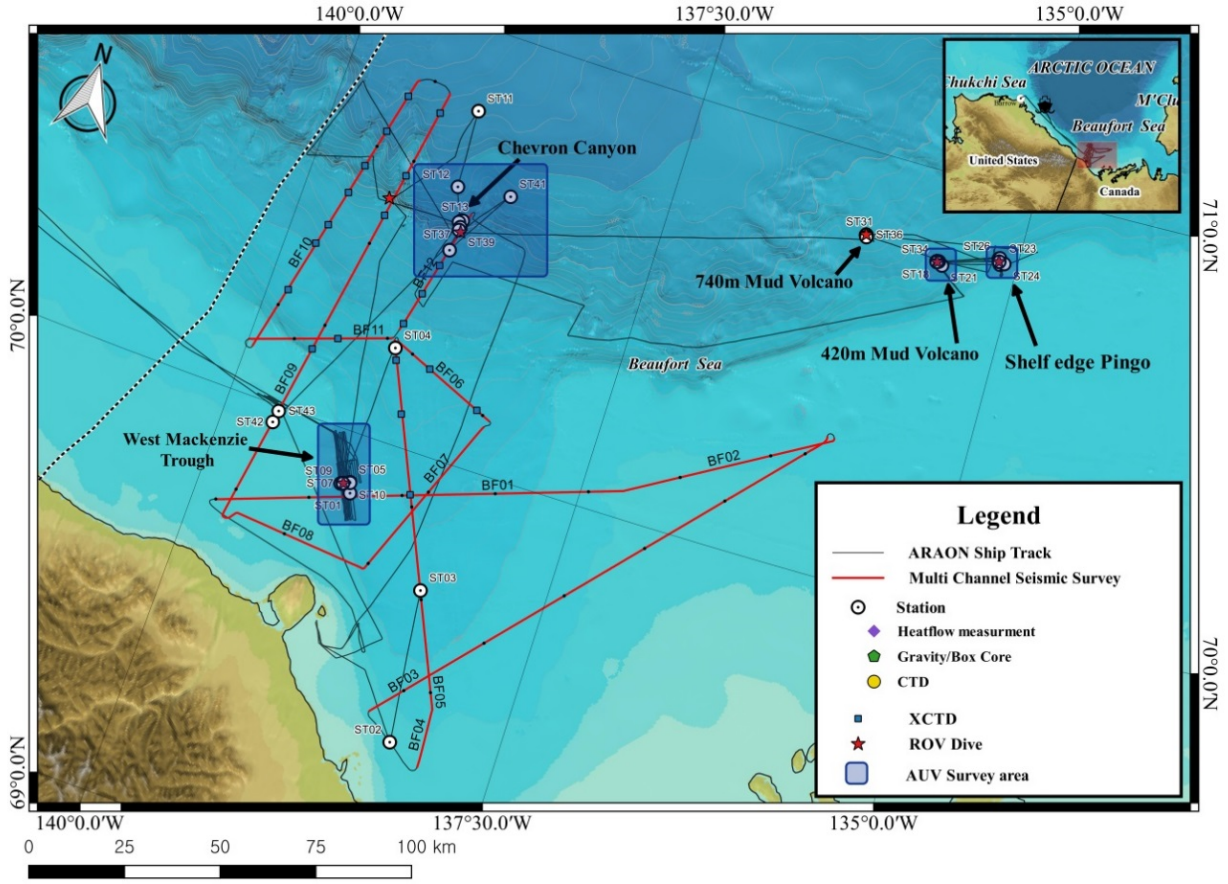

Figure 1: Overview map of the ship track, seismic lines, sampling stations, ROV dives and AUV survey areas for Expedition ARA08C. (Jin et al. (2018)

Table 1. Seismic acquisition field log. (Table 2.2; Jin, et al. (2018))

Line Name	Start of Line					End of Line					First Good Shot Point	Last Good Shot Point	Length (km)
	Shot Point	Date	Time	Latitude	Longitude	Shot point	Date	Time	Latitude	Longitude			
BF01	1998	2017.08.31	07:50	69°43.9492'N	139°52.2262'W	6373	2017.08.31	20:08	70°03.9800'N	137°12.8722'W	2021	6373	106.90
BF02	6374	2017.08.31	20:08	70°03.9716'N	137°12.9813'W	8705	2017.09.01	03:05	70°19.5895'N	135°55.3687'W	6374	8651	57.13
BF03	8707	2017.09.01	03:25	70°19.3148'N	135°58.2346'W	14428	2017.09.01	20:15	69°23.6800'N	138°23.7659'W	8775	14413	139.96
BF04	15182	2017.09.01	22:48	69°18.2646'N	137°58.9085'W	15819	2017.09.02	00:41	69°26.7426'N	138°00.5723'W	15240	15801	15.52
BF05	15820	2017.09.02	00:42	69°26.7854'N	138°00.6151'W	19796	2017.09.02	12:20	70°14.0947'N	139°02.4036'W	15820	19786	97.03
BF06	19797	2017.09.02	12:41	70°14.0573'N	139°00.4899'W	21089	2017.09.02	16:30	70°07.5377'N	138°14.6725'W	19813	21084	31.56
BF07	21090	2017.09.02	16:53	70°06.1594'N	138°16.6670'W	23071	2017.09.02	22:54	69°42.3256'N	138°44.3987'W	21105	23054	48.36
BF08	23072	2017.09.02	22:54	69°42.2804'N	138°44.5509'W	24690	2017.09.03	03:53	69°42.9769'N	139°45.6140'W	23148	24542	40.78
BF09	24691	2017.09.03	03:54	69°42.9953'N	139°45.6079'W	29820	2017.09.03	19:03	70°49.5177'N	139°14.8411'W	24771	29794	125.31
BF10	30160	2017.09.03	20:13	70°49.6779'N	139°29.2177'W	33515	2017.09.04	06:15	70°06.6840'N	139°57.5006'W	30228	33514	82.09
BF11	33516	2017.09.04	06:47	70°07.4476'N	139°59.5814'W	35051	2017.09.04	11:13	70°14.2267'N	139°03.9393'W	33594	35045	37.50
BF12	35052	2017.09.04	11:35	70°15.8733'N	139°02.0927'W	36496	2017.09.04	15:58	70°34.3468'N	138°49.3588'W	35110	36496	35.29

Data Processing

Shot files were first converted from SEG-D to SEG-Y (revision 1) format (Norris and Faichney, 2002), then resampled from 1 ms to 2 ms for data reduction. Resampling did not alias the data since the seismic energy recorded was between 5 and 120 Hz and thus significantly beyond the 500 Hz Nyquist frequency of the original sampling rate of 1 ms. Only the first 5000 ms of data were processed given that no coherent reflected arrivals are generally present between 5000 and 8000 ms. The following step consisted in the application of a low-cut Butterworth filter (low-cut stop: 5 Hz, low-cut pass: 8 Hz) to attenuate the low frequency noise of the ship. The geometry of the survey was then edited so each recorded trace was registered with shot and receiver locations. Shot and receiver positions were computed by assuming a straight receiver configuration having an arbitrary origin of x=0 m and y=0 m, since the streamer was not equipped with acoustic positioning transceivers for measuring ranges between each channel and the survey vessel. The geometry editing resulted in a common mid-point (CMP) bin size of 6.25m x 6.25m. For the purpose of the velocity analysis, traces were sorted as CMP gathers. CMP gathers were filtered using an Ormsby bandpass filter (10-30-80-100 Hz) and amplitudes were rescaled using a short time-window (250 ms) automatic gain control scaling to respectively attenuate high-frequency random noise and increase the amplitude of the late arrivals. Then a velocity analysis was conducted every 1000 CMPs using super-gathers that included 10 bins to increase the signal-to-noise ratio. Velocities were manually picked on semblance gathers calculated for RMS velocities ranging from 1300 to 4500 m s^{-1} using a 5 m s^{-1} increment. Afterwards, data were sorted as CMP gathers and corrected for normal moveout using 100% of the root-mean

square velocity field and by applying a stretch mute factor of 100%. Finally, brute stacks were generated by stacking the CMPs. Stacked sections were output as SEG-Y files following the SEG-Y revision 1 Data Exchange Format.

SEG-Y File Loading Information and Navigation

The loading information of the brute stacks is contained in the textual header (Extended Binary Coded Decimal Interchange Code (EBCDIC) encoding) of each SEG-Y file. To preserve the level of precision in the latitude/longitude positions of each shot point in the trace headers while still conforming to the SEG-Y revision 1 standards, both arc-seconds and decimal degree coordinates are included within the trace headers. To accomplish this, the values presented in units of arc-seconds were placed in the expected byte locations in the trace headers. The values presented in units of decimal degrees were placed in alternate byte locations in the trace headers, as shown in Table 2. Note that all relevant byte locations are specified in the text header of each SEG-Y file. Finally, the trace to shot point relationship is 8, and the first good trace is specified in the EBCDIC header of each file.

Table 2. Byte locations of SEG-Y loading information and navigation included in trace headers

Data Type	**Trace Header Byte Location**	**Trace Header Byte Description**
Trace Number	1-4	Trace sequence number within line
Shot Point Number	17-20	Energy source point number; used when >1 trace is recorded at the same surface location
Number of Samples	115-116	Number of time samples of the trace
Sample Interval	117-118	Sample interval in microseconds of the trace
Latitude (Arcseconds)	77-80	Source coordinate -Y
Longitude (Arcseconds)	73-76	Source coordinate -X
Scale (Arcseconds)	71-72	Scalar applied to coordinates specified in Trace Header bytes 73-88 to give the real value (positive = multiplier; negative = divisor)
Coordinate Unit (Arcseconds)	89-90	Coordinate units (2 = seconds of arc)

Latitude (Decimal Degrees)	85-88	Group coordinate -Y
Longitude (Decimal Degrees)	81-84	Group coordinate -X
Scale (Decimal Degrees)	65-68	Water depth at group (note that for scale values: positive = multiplier; negative = divisor)
Coordinate Units (Decimal Degrees)	61-64	Water depth at source (note that for coordinate units: 3 = decimal degrees)

Conversion to JPEG2000

For each brute stack, a corresponding JPEG2000 file is released. The SEG-Y files were converted to JPEG2000 format using the SegyJp2 software developed by the Geological Survey of Canada (Courtney, 2007). JPEG2000 is an image compression standard that allows for improved compression over the JPEG standard while achieving a higher resolution (Taubman and Marcellin, 2002). With these files, SEG-Y data can be efficiently encoded with 100,000's of traces without undue system resource allocation. JPEG2000 files also allow for a framework for embedding value-added interpretations to accompany the data.

Each SEG-Y file was compressed to 10% of its original size using a maximum bit depth of 16 bits per sample. No filtering was applied to the traces and a 100% clipping factor was used, preventing the removal of outliers from the data during compression.

The SEG-Y trace and textual file headers cannot be retrieved directly from the JPEG2000 files; however the trace information is retained in the JPEG2000 file, encoded as XML and stored directly in the file. This can be restored by converting the file back to SEG-Y format.

KMZ File

The Google Earth KMZ file displays SEG-Y location data and 3-D projections of the 2-D multichannel seismic data alongside the navigation trackline of the survey vessel (Courtney, 2013). Information about these data can be viewed by selecting an item from the side pane or on the map (Figure 2).

The seismic data includes survey lines overlain by 3-D projections, transit lines, and test lines. Selecting a survey line will open a pop-up containing information about the seismic acquisition attributes and a link to view an image of the data.

Bathymetric data having a spatial resolution of 100 m is also displayed in the KMZ file, and was sourced from the Canadian Hydrographic Service Non-Navigational Bathymetric Data Portal: https://open.canada.ca/data/en/dataset/d3881c4c-650d-4070-bf9b-1e00aabf0a1d .

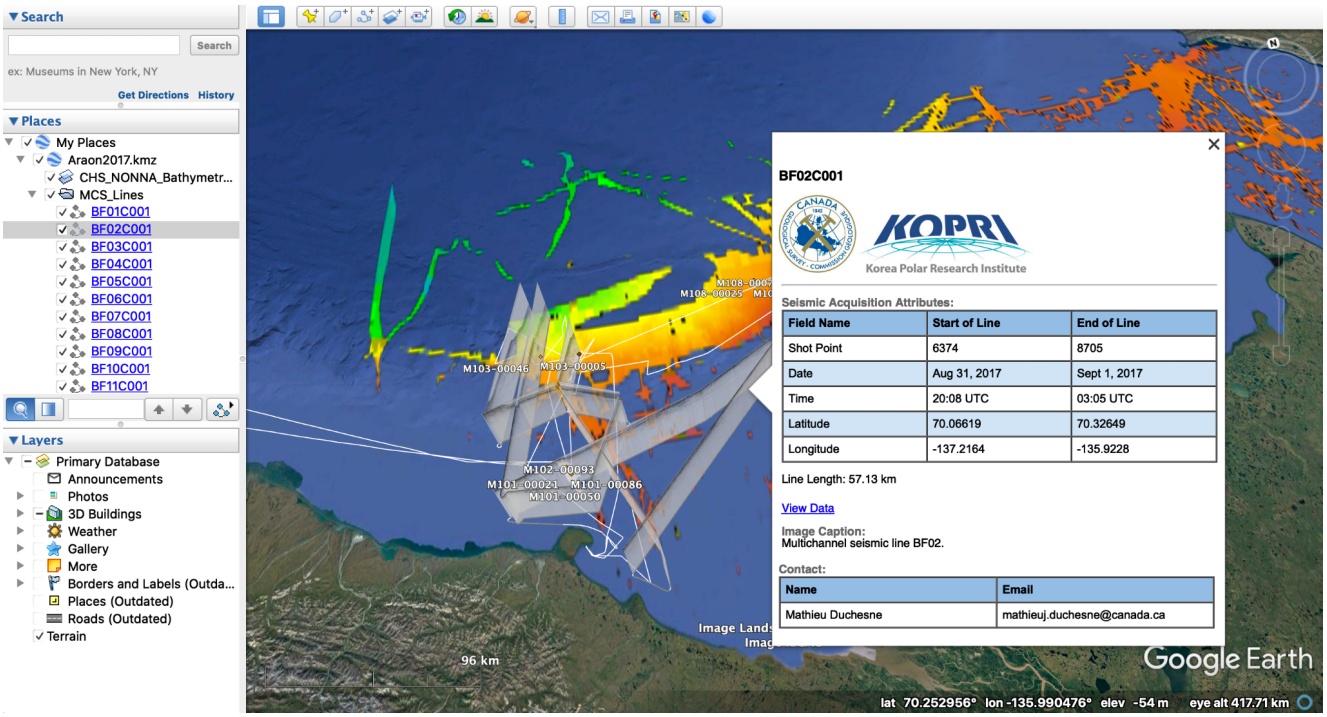

Figure 2: KMZ file displayed in Google Earth showing the information bubble corresponding to the selected 2-D multichannel seismic line. Also shown are the 3-D projections of the seismic data, the bathymetric data, and the navigation trackline of the survey vessel.

Data Download

The data discussed in this Open File can be downloaded from the '2017 Araon' directory at: https://ftp.maps.canada.ca/pub/nrcan_rncan/raster/marine_geoscience/Seismic_Reflection_Digital/ . In order to convert the JPEG2000 files back into SEG-Y format, the SegyJp2 tool (Courtney, 2007) can be used. This tool, alongside those used to create and view JPEG2000 files, can be found in the 'Tools/NRCAN Windows 10 Software' directory at the above link.

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