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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 ARA05C 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 ARA05C 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.

Twenty multichannel seismic (MCS) lines representing 998 line-km of seismic data and 19,962 shot points were collected from September 2 to September 13, 2014 (Figure 1 and Table 1; Jin et al., 2016). The seismic source was positioned 31.25 m behind the ship's stern, towed 6 m beneath the sea surface, and triggered every 50 m. Lines ARA05C-SS-1 to ARA05C-SS-10 were shot with a seismic source that consisted of an airgun array of two 250 in^3, two 200 in^3, two 90 in^3, and two 60 in^3 Sercel G-Gun II for a total source volume of 1200 in^3. During the acquisition of line ARA05C-SS-11, one of the two 250 in^3 airguns experienced misfires. Therefore, it was turned off and subsequent lines were collected with a total source volume of 950 in^3. Seismic arrivals were recorded using a 1.5 km-long streamer that consisted of a 60 m-long lead-in cable, 50 m-long head stretch, ten 150 m-long solid state active sections including twelve receiver groups spaced by 12.5 m, and a tail buoy deployed at the end of a 50 m-long cable. Seven birds were mounted on the streamer, at 150 m or 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 sample rate of 1 ms over a trace length of 10,000 ms. The navigation was provided by the GPS antenna of the ship and positions were recorded for every shot point in separate ASCII files.

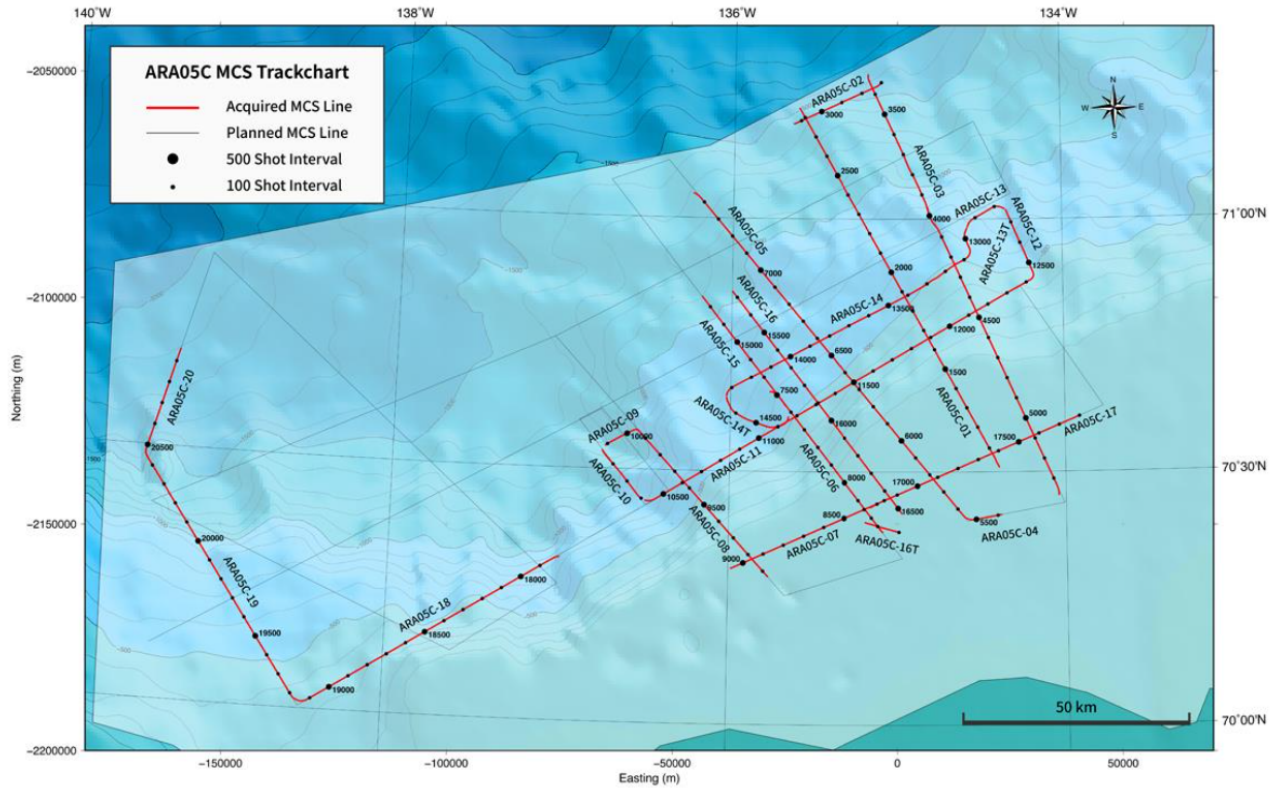

Figure 1: Overview of the ship track and seismic lines for Expedition ARA05C. (Jin, et al., 2016)

Table 1. Seismic acquisition field log. (Jin, et al., 2016)

Line Name	SOL (Start of Line)							EOL (End of Line)							FGSP	LGSP
	SP	Date	Time	Latitude (- / South)		Longitude (- / West)		SP	Date	Time	Latitude (- / South)		Longitude (- / West)			
ARA05C-SS-01	1001	2014-09-02	03:03:33	70.509576	70 30.5746	-134.395013	-134 23.7008	2850	2014-09-02	13:00:52	71.220395	71 13.2237	-135.605767	-135 36.3460	1003	2848
ARA05C-SS-02	2862	2014-09-02	14:18:35	71.187900	71 11.2740	-135.636357	-135 38.1814	3307	2014-09-02	16:42:51	71.273987	71 16.4392	-135.090929	-135 05.4557	2865	3273
ARA05C-SS-03	3308	2014-09-02	17:27:01	71.285447	71 17.1268	-135.180022	-135 10.8013	5380	2014-09-03	04:16:51	70.451241	70 27.0745	-134.043227	-134 02.5936	3344	5324
ARA05C-SS-04	5381	2014-09-03	05:57:10	70.415626	70 24.9376	-134.384226	-134 23.0536	5531	2014-09-03	06:45:22	70.406747	70 24.4048	-134.577830	-134 34.6698	5381	5498
ARA05C-SS-05	5532	2014-09-03	06:45:52	70.406990	70 24.4194	-134.579712	-134 34.7827	7463	2014-09-03	17:04:32	71.048464	71 02.9078	-136.250708	-136 15.0425	5555	7432
ARA05C-SS-06	7468	2014-09-08	01:10:35	70.657397	70 39.4438	-135.763156	-135 45.7894	8285	2014-09-08	05:44:07	70.379485	70 22.7691	-135.080881	-135 04.8529	7510	8148
ARA05C-SS-07	8286	2014-09-08	07:25:12	70.446023	70 26.7614	-135.064814	-135 03.8888	9063	2014-09-08	11:35:00	70.306539	70 18.3923	-135.989311	-135 59.3587	8290	9063
ARA05C-SS-08	9065	2014-09-08	13:35:37	70.292619	70 17.5571	-135.766219	-135 45.9731	9960	2014-09-08	18:25:31	70.577150	70 34.6290	-136.567480	-136 34.0488	9162	9946
ARA05C-SS-09	9961	2014-09-08	18:26:16	70.576860	70 34.6116	-136.570113	-136 34.2068	10114	2014-09-08	19:16:26	70.543596	70 32.6158	-136.744754	-136 44.6852	9972	10114
ARA05C-SS-10	10118	2014-09-08	19:23:32	70.535492	70 32.1295	-136.756053	-136 45.3632	10407	2014-09-08	20:59:25	70.439994	70 26.3996	-136.507125	-136 30.4275	10120	10377
ARA05C-SS-11	10412	2014-09-08	21:02:18	70.438443	70 26.3066	-136.496304	-136 29.7782	12449	2014-09-09	07:47:47	70.893278	70 53.5967	-134.178805	-134 10.7283	10430	12440
ARA05C-SS-12	12450	2014-09-09	07:48:04	70.893705	70 53.6223	-134.179345	-134 10.7607	12762	2014-09-09	09:25:10	71.019158	71 01.1495	-134.346122	-134 20.7673	12460	12762
ARA05C-SS-13	12763	2014-09-09	09:26:20	71.020067	71 01.2040	-134.349923	-134 20.9954	12952	2014-09-09	10:31:57	70.982579	70 58.9547	-134.578023	-134 34.6814	12775	12952
ARA05C-SS-13T	12954	2014-09-09	10:32:47	70.981506	70 58.8904	-134.579338	-134 34.7603	13091	2014-09-09	11:20:54	70.921106	70 55.2664	-134.587996	-134 35.2798	12955	13091
ARA05C-SS-14	13092	2014-09-09	11:21:12	70.920873	70 55.2524	-134.589187	-134 35.3512	14339	2014-09-09	17:50:02	70.646218	70 38.7731	-136.024463	-136 01.4678	13102	14284
ARA05C-SS-14T	14340	2014-09-09	17:50:59	70.644922	70 38.6953	-136.024162	-136 01.4497	14636	2014-09-09	19:49:28	70.610046	70 36.6028	-135.652660	-135 39.1596	14340	14636
ARA05C-SS-15	14637	2014-09-09	20:05:05	70.630287	70 37.8172	-135.671902	-135 40.3141	15262	2014-09-09	23:13:18	70.845205	70 50.7123	-136.184159	-136 11.0495	14640	15262
ARA05C-SS-16	15263	2014-09-10	00:19:42	70.854576	70 51.2746	-135.998226	-135 59.8936	16543	2014-09-10	07:07:52	70.412333	70 24.7400	-134.959218	-134 57.5531	15266	16540
ARA05C-SS-16T	16594	2014-09-10	07:35:24	70.380833	70 22.8500	-134.986491	-134 59.1895	16762	2014-09-10	08:28:23	70.400726	70 24.0436	-135.197376	-135 11.8426	16598	16760
ARA05C-SS-17	16764	2014-09-10	10:01:05	70.429910	70 25.7946	-135.158416	-135 09.5050	17803	2014-09-10	15:36:11	70.610116	70 36.6070	-133.907749	-133 54.4649	16701	17803
ARA05C-SS-18	17804	2014-09-13	00:57:01	70.322537	70 19.3522	-136.991595	-136 59.4957	19152	2014-09-13	08:06:52	70.014033	70 00.8420	-138.474672	-138 28.4803	17840	19152
ARA05C-SS-19	19153	2014-09-13	08:07:18	70.014184	70 00.8510	-138.476272	-138 28.5763	20462	2014-09-13	14:58:31	70.480590	70 28.8354	-139.459768	-139 27.5860	17159	20434
ARA05C-SS-20	20463	2014-09-13	14:58:49	70.480947	70 28.8568	-139.460021	-139 27.6013	20961	2014-09-13	17:39:11	70.692451	70 41.5470	-139.299194	-139 17.9516	20480	20874

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, 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 of the attenuation of low frequency ship noise with a low-cut Butterworth filter with a low-cut stop and a low-cut pass of 5 and 8 Hz respectively. 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 with 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) to attenuate high-frequency random noise. Moreover, amplitudes were rescaled using a short time-window (250 ms) automatic gain control scaling to increase the amplitude of the late arrivals. 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. Data were then 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 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 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 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 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).

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 .

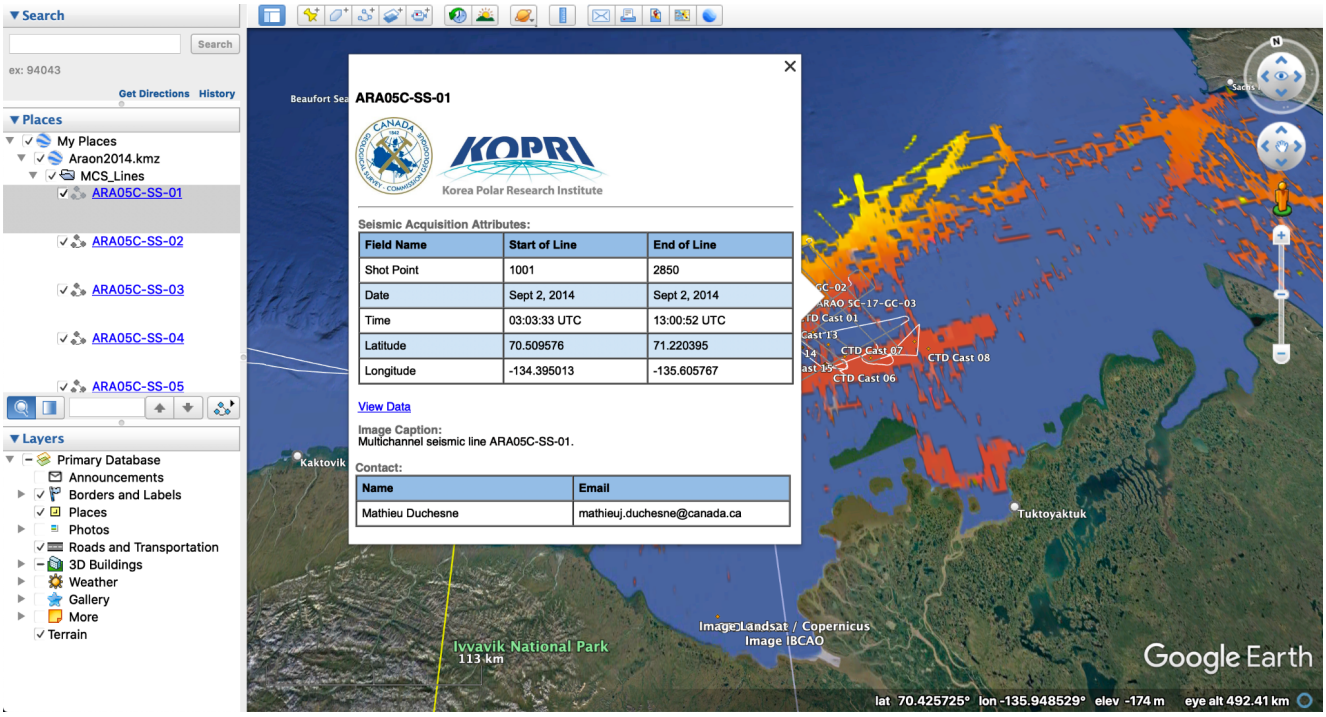

Figure 2: KMZ file displayed in Google Earth showing the information bubble corresponding to the selected 2-D multichannel seismic line. Also shown are the bathymetric data and the navigation tracklines of the survey vessel.

Data Download

The data discussed in this Open File can be downloaded from the '2014 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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