GEOLOGICAL SURVEY OF CANADA
OPEN FILE 4187

# Expedition report: MV *Anne S. Pierce*, 2000, German Bank, Scotian Shelf

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## 1. Introduction - *B.J. Todd*

### 1.1 Cruise overview

German Bank is located offshore southwestern Nova Scotia in the Gulf of Maine (Fig.1). Water depths range from less than 40 m to approximately 100 m. The bank has a rugged morphology, with areas of bedrock outcrop juxtaposed with basins filled with glacial and post-glacial sediments. A remarkable sequence of well-defined, parallel to sub-parallel southwest-northeast aligned moraines extends across the entire bank.

Geological Survey of Canada (Atlantic) (GSCA) cruise "2000 *Anne S. Pierce*" to German Bank took place from April 14-24, 2000 on board the 34.6 m-long MV *Anne S. Pierce* (Figs. 2, 3). The ship was mobilized and demobilized at the Deep Sea Trawler facility in Lunenburg, Nova Scotia.

The overall scientific objective of this cruise was to improve our understanding of the extent of exposed bedrock, the distribution of sediments and the glacial geomorphology on German Bank which, in turn, will lead to an improved interpretation of the geological history of the bank and the dynamics of modern sedimentation. Specific objectives of the cruise were to obtain acoustic geophysical data, sea floor sediment samples and seabed photographs. German Bank was previously surveyed using a Simrad 1000 multibeam system from the CCGS *Frederick G. Creed*. The multibeam data were collected and processed by the Canadian Hydrographic Service (CHS) in 1997, 1998 and 2000. The resulting bathymetric images were used for expedition planning and for the field survey.

The cruise was divided into two phases, the first phase being the geophysical survey, and the second phase being the sediment sampling and sea floor photography.

The *Anne S. Pierce* was operated under the direction of Captain Garth Hiltz; the captain and crew of the vessel ably assisted in the survey and the sampling (Table 1). Scientific staff are listed in Table 2.

### 1.2 Scientific equipment and layout

The layout of scientific equipment on board the *Anne S. Pierce* is illustrated in Figures 2, 4 and 5. The foredeck was not used and all survey equipment was located on the afterdeck.

On the port afterdeck was the Trackpoint II boom pivot location (Figs. 2, 4). When the ship was travelling to and from German Bank, the boom was kept in the horizontal position illustrated. On site, but before the geophysical survey was underway, the boom was lowered so that the Trackpoint II beacon was under the water surface. The beacon extended below the draft of the ship when the boom was vertical, as illustrated in Figure 2A.

The geophysical equipment (sidescan sonar and Huntec Deep Tow Seismic (DTS)) were deployed from the stern using an A-frame constructed expressly for this purpose by Clearwater Fine Foods Inc. (CFFI) (Figs. 2, 4, and photographs in Appendix 6.3). The sidescan was deployed from the port side of the stern and the Huntec DTS was deployed from the center of the stern. The winches were powered by a compressor secured to the deck forward.

Geological sampling was carried out from the stern using the A-frame to deploy a van Veen grab sampler and the Benthos sea floor camera.

This report is intended to provide a description of day-to-day activities on board the ship, to provide an overview of technical aspects of the equipment used, and to present a summary of the geophysical and geological data obtained during the *Anne S. Pierce* expedition to German Bank. In the following narrative account of the day-to-day activities (Section 2), reference is made to instrumentation and data which are fully described in later sections of this cruise report.

We thank Michael Li and Edward King, both of GSCA, for insightful reviews of this expedition report and for supporting its publication in PDF format.

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**Table 1: List of Clearwater personnel.**

| Title | Name |
|---|---|
| Captain | Garth Hiltz |
| Mate | John Langille |
| Chief Engineer | Byron Slauenwhite |
| Second Engineer | Gordon Langley |
| Cook | Laverne Greek |
| Deck Hand | Eric Robert |
| Deck Hand | Michael Weaver |

**Table 2: List of scientific personnel.**

| Title and duties | Name | Affiliation |
|---|---|---|
| Chief Scientist | Brian Todd | GSCA |
| Technologist (Sampling and photography) | Robert Murphy | GSCA |
| Technologist (Sidescan and recording systems) | Anthony Atkinson | GSCA |
| Technologist (Sampling and photography) | Steve MacCabe | GSCA |
| Technologist (Navigation) | Darrell Beaver | GSCA |
| Watchkeeper (Sidescan) | Peter Pledge | GSCA |
| Technologist (Huntec system) | Marty Uyesugi | GF |

GSCA: Geological Survey of Canada (Atlantic)
GF: Geoforce

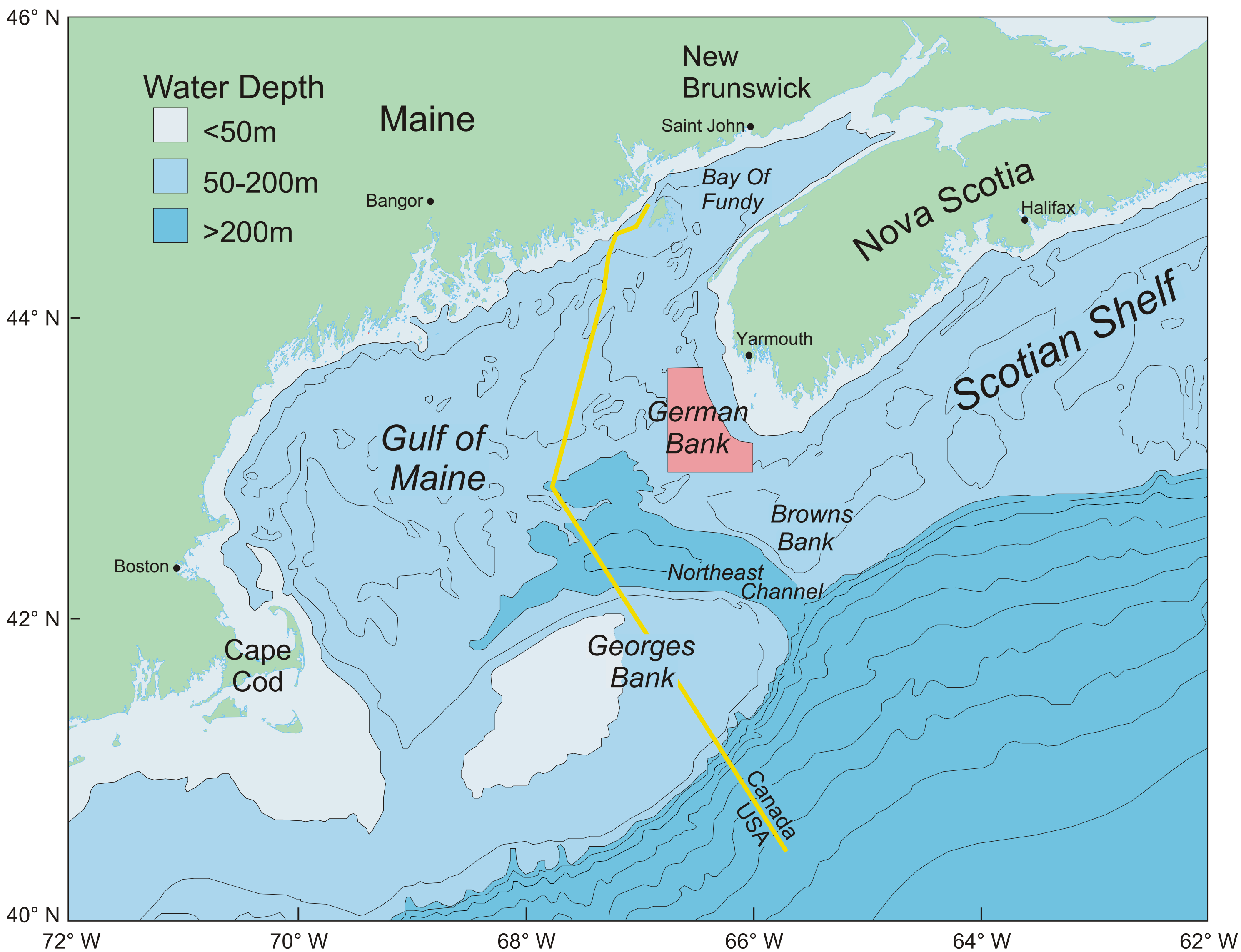


Figure 1. Location map of German Bank, southern Scotian Shelf.

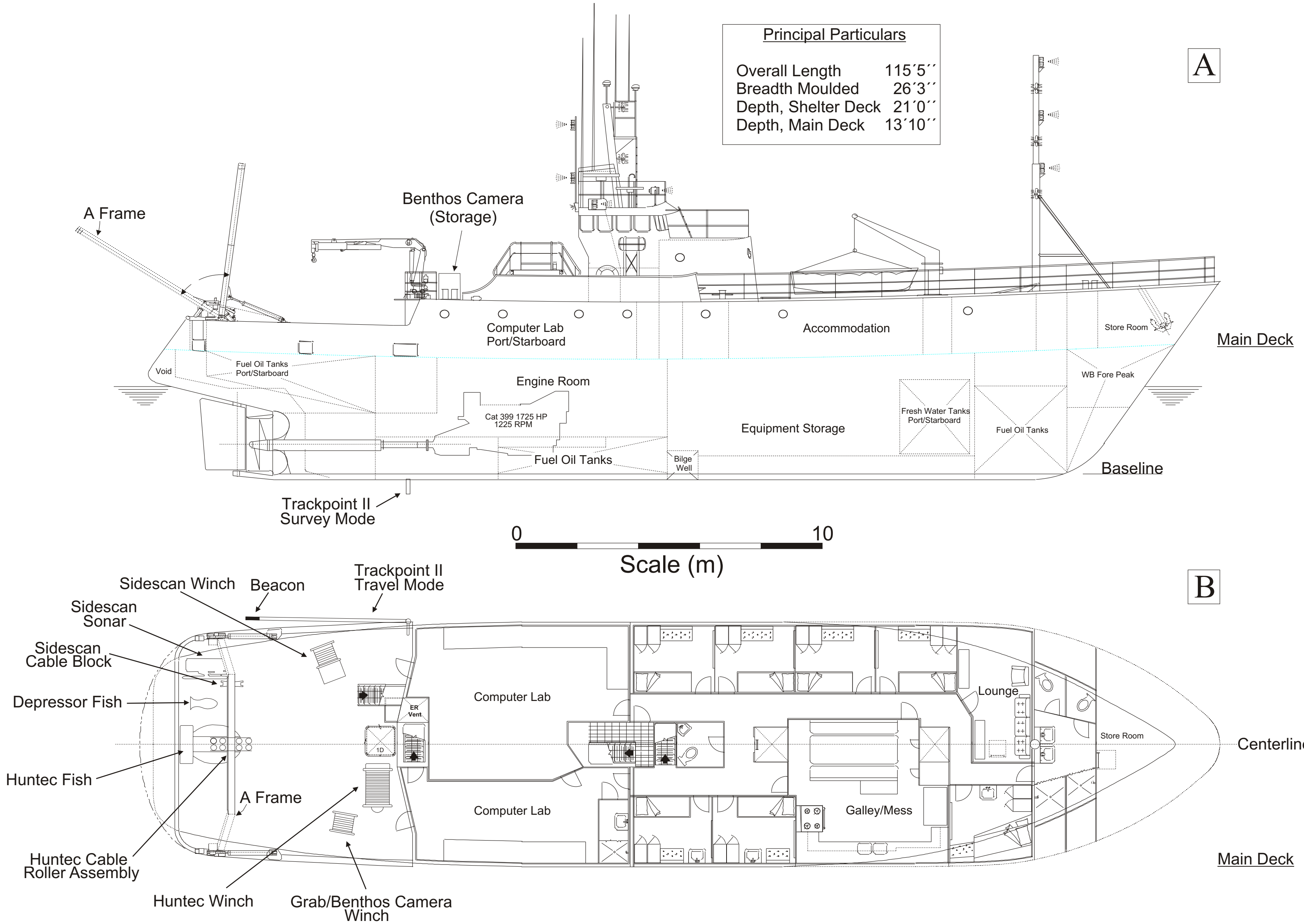


Figure 2. MV *Anne S. Pierce* (A) profile view, (B) plan view.


Figure 3. MV *Anne S. Pierce* at the Deep Sea Trawlers facility, Lunenburg, Nova Scotia.

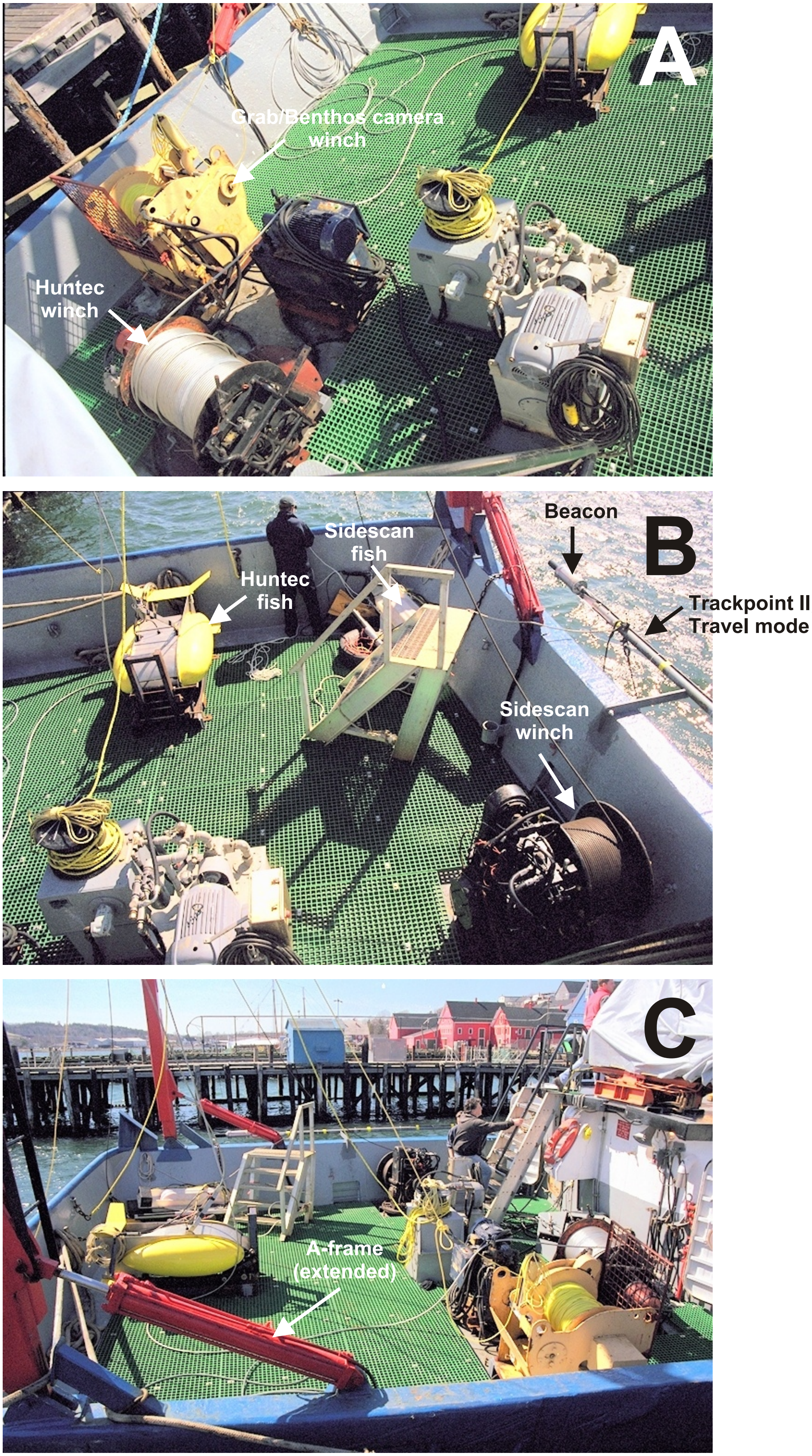


Figure 4. Afterdeck of the *Anne S. Pierce*. (A) Starboard side, (B) port side, (C) afterdeck.

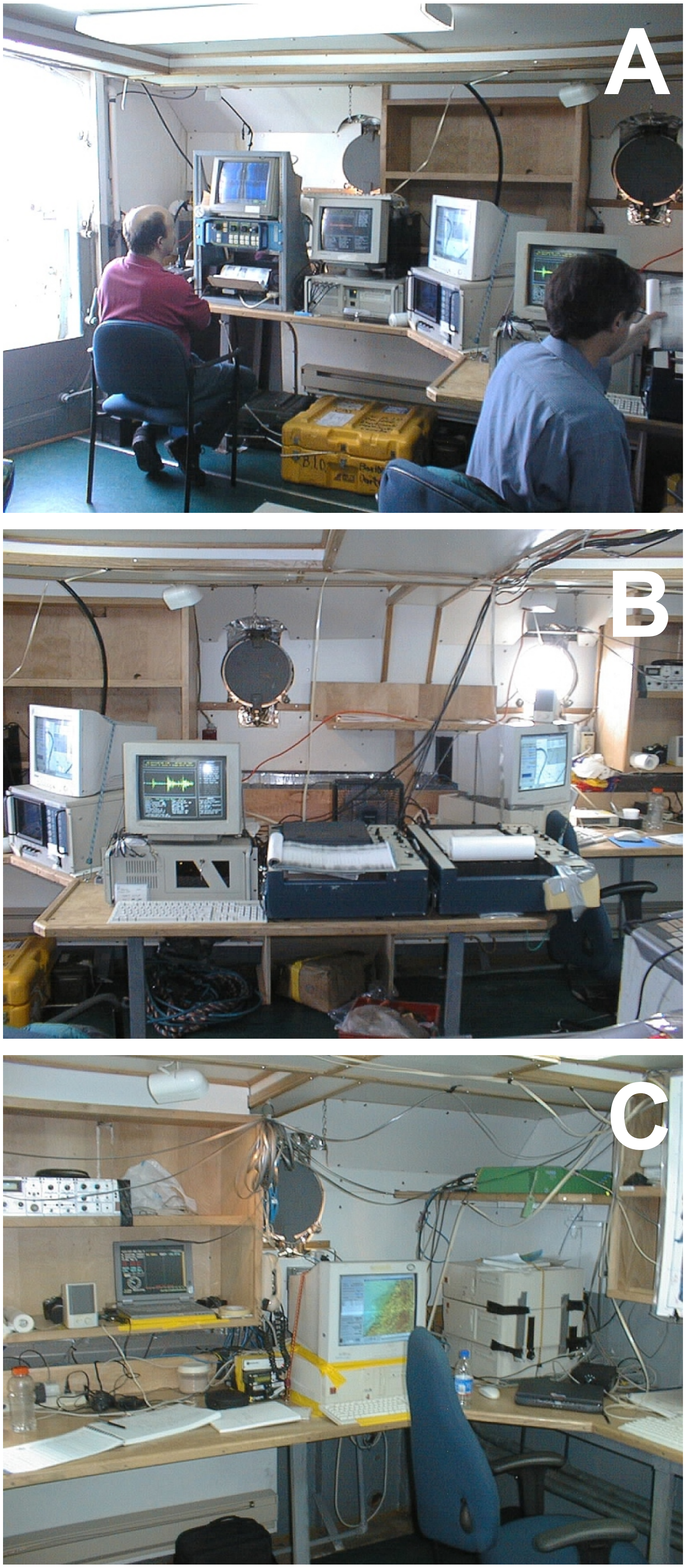


Figure 5. Computer lab of the *Anne S. Pierce*; images show an overlapping panorama from aft to fore (A to C). (A) Sidescan controls, (B) Huntec controls, (C) Navigation computers.

## 2. Cruise narrative - *B.J. Todd*

In this cruise narrative, all times are in Universal Time Coordinated (UTC) unless specified as Atlantic Standard Time (AST), which is three hours earlier than UTC (e.g. 1200 UTC is 0900 AST). Figure 6 shows the extent of the tracklines of the *Anne S. Pierce* on German Bank. The expedition map at a scale of 1:125,000 (Appendix 6.1) provides detailed ship's tracks and sample positions. Also depicted on this map are ships' tracks and sample sites from the *Hudson* 76-016 expedition. Line numbers referred to in the cruise narrative are labeled and day/times are shown.

**Thursday, April 13 Day 104**

The *Anne S. Pierce* was mobilized at Deep Sea Trawlers in Lunenburg.

**Friday, April 14 Day 105**

Mobilization of the ship continued at Lunenburg. The ship departed at 2000 (AST) after testing the geophysical equipment.

**Saturday, April 15 Day 106**

The ship arrived at German Bank at about 1000 (AST) after a very uncomfortable passage. The sea was too rough to deploy the geophysical survey equipment until the evening. Shortly after deployment on **line 100** at 2340, the sidescan sonar ceased to function and the instrument was recovered. The Huntec DTS continued to function.

**Sunday, April 16 Day 107**

The high seas moderated somewhat on Day 107. The sidescan remained inoperative but seismic surveying on **lines 100** to **104** was completed. **Line 100**, running to the west, was completed at 0146 and the ship altered course to the northwest on **line 101**. This line was oriented up the "valley" in the surrounding bedrock and crossed a number of prominent moraines. Course adjustments up the valley completed the line on a north heading. **Line 101** was completed at 0445 and the ship altered course to the northwest on **line 102**. This line ran to the northern edge of the multibeam survey area and was completed at 0852.

The ship altered course to the southeast and ran the short **line 103** until 0957. The ship altered course to the southwest and **line 104** was surveyed out into deep water of the Jordan Basin. At 0957, the ship altered course to the south on **line 105** and surveyed to the southern extent of the multibeam coverage. The sidescan sonar was deployed at 1450 but was retrieved with a flooded cable 10 minutes later. At 1805 on **line 105**, the Huntec EPC malfunctioned due to overheating. Surveying continued on **line 105** until 1850 when equipment was brought onboard and the ship headed to Shelburne to be re-supplied with working EPCs from GSCA.

**Monday, April 17      Day 108**

The ship arrived in Shelburne at 0130 (AST). Mike Gorveatt arrived with equipment at 1200 (AST) and the ship departed Shelburne at 1300 (AST). The sidescan was tested outside Shelburne Harbour and appeared to work. The ship then proceeded to German Bank.

**Tuesday, April 18      Day 109**

The Huntec survey on **line 100A** (re-survey of **line 100**) was initiated at 0157. The sidescan sonar record was very noisy; the instrument malfunctioned at 0245 and was retrieved. One of the Huntec replacement EPCs malfunctioned at 0247, and all the equipment was retrieved in order to service the sidescan sonar. The vessel maintained position while this work was done. The sidescan sonar was deployed once again at 0413, near where the survey had previously stopped. At 0449, the ship turned north to survey line **101A** (re-survey of line 101). The sidescan sonar malfunctioned at 0705. The sidescan was retrieved and the decision was made to use the Huntec DTS to investigate the shallow, granite outcrop on German Bank which had not yet been surveyed. **Line 111** was started near the end of **line 101A** at 0959. A short leg to the west was followed by a longer leg to the northwest. On this leg, the contact between granite outcrop and sediments was encountered at 1132. Overheating problems continued to plague the Huntec EPC recorders. **Line 111** concluded at 1306. After a turn to the south, **Line 112** was surveyed until 1434. The Benthos camera and van Veen grab sampler were transferred from the upper afterdeck to the lower afterdeck. Eight stations (grab samples, Table 5; Benthos camera, Table 6) on sites selected near **line 105** in the deep water, western portion of the multibeam survey area were sampled (see accompanying track chart). Sampling was suspended at 2100 due to high seas.

**Wednesday, April 19 Day 110**

Most of the day was passed waiting for the high seas to subside. In the afternoon, the ship proceeded to the northeast corner of the multibeam survey area to find calmer water in which to test the sidescan sonar. The sidescan tests were positive and the survey equipment was deployed and operational at 2116. **Line 113** was surveyed to the southwest from shallow to deep water, repeating **line 104** from Day 107. At 2345, the Huntec leak alarm was tripped and the instrument was offline until 2356. At 0053, the ship altered course to the south to **line 114**, repeating **line 105** from Day 107.

**Thursday, April 20 Day 111**

The night was very rough and uncomfortable, as well as hard on the equipment. **Line 104** was completed at 0642 and the ship turned to the east to begin **line 115** at 0650. At 0918, **line 104** was suspended due to the high sea state. The ship altered course to the northeast to **line 115A** to reduce the roll of the vessel. At 1325, the vessel altered course to the north on **line 116**, repeating **line 101** from Day 107. After a short distance, the ship altered course to the northwest to **line 117**, repeating **line 102** from Day 107. This line was completed at 1800 and the ship altered course to the southeast to begin **line 118** at 1807. This line repeats **line 103** from Day 107.

**Line 118** was completed at 1903 and the ship altered course to the south-southeast to **line 119**. Although the sea state was somewhat reduced in this northeast portion of the multibeam survey area, any west-east survey pattern was not possible due to excessive ship's roll. Therefore, a zigzag line survey pattern was established to work our way westward and southward. Quite a number of lobster trap buoys were encountered along this line. **Line 119** was completed at 2035 and the ship altered course to the northwest on **line 120**. This line was completed at 2332 and the ship altered course to the southeast on **line 121**.

**Friday, April 21 Day 112**

In the morning, the northern zigzag pattern was completed (**lines 121** to **125**) and the ship steamed south to the central part of the survey area to do another zigzag pattern northwest of the area of bedrock outcrop (**lines 126** to **135**).

**Saturday, April 22 Day 11**

**Line 136** transected moraines on the southern portion of the multibeam coverage. This line was completed at 0050 and the ship altered course to the northeast (**line 137**) to cross an area to the south of the multibeam coverage. The sidescan had been operational for some time, so the opportunity was seized to finally image the series of moraines on **lines 101** and **101A**. **Line 138** repeated these lines. **Line 139** to the southwest was completed as a tie to **line 111**. Finally, line 140 completed the survey at 0942.

High seas, and the prediction of even higher seas suggested that the prudent course of action was to declare the expedition complete and to *not* attempt bottom sampling. Our experience with the van Veen grab and the Benthos camera on day 109 had clearly demonstrated that the vessel was not suited for safe operations (for the instruments or the operators), given the tackle as it was arranged. This reasoning was relayed to the GSCA in Dartmouth; the situation was then discussed at length by GSCA with Clearwater in Lunenburg. Some hours later, a decision was reached between these two parties and the ship steamed for Lunenburg.

**Sunday, April 23 Day 114**

The ship reached the Deep Sea Trawler facility early on Sunday and the scientific staff departed. Easter Monday was a holiday and demobilization took place on Tuesday, April 25.

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## Table 3. *Anne S. Pierce* 2000 geophysical record inventory.

### A. HUNTEC DTS

| Survey Line | Start | | End | | Record Number | Comment |
|---|---|---|---|---|---|---|
| | Day | Time | Day | Time | | |
| 100 | 106 | 2318 | 107 | 0146 | 1 | EPC 9800: internal hydrophone array - upper; external streamer - lower<br>125 ms vertical scale for each channel, 750 ms fire rate<br>No data recorded from 2338.3-2350.1 |
| 101 | 107 | 0147 | 107 | 0445 | 2 | EPC 9800: internal hydrophone array - upper; external streamer - lower<br>125 ms vertical scale for each channel, 750 ms fire rate |
| 102 | 107 | 0445 | 107 | 0852 | 3 | same |
| 103 | 107 | 0852 | 107 | 0957 | 4 | same |
| 104 | 107 | 0957 | 107 | 1304 | 5 | EPC 9800: external streamer to 1203, then internal hydrophone array - upper; external streamer - lower<br>125 ms vertical scale for each channel, 750 ms fire rate |
| 105 | 107 | 1304 | 107 | 1805.6 | 6 | EPC 9800: internal hydrophone array - upper; external streamer - lower<br>125 ms vertical scale for each channel, 750 ms fire rate<br>EPC malfunctioned for remainder of line, from 1805.6 to 1850 |
| 100A | 109 | 157.5 | 109 | 0247 | 7 | EPC 8300: internal hydrophone array<br>125 ms vertical scale, 750 ms fire rate |
| | 109 | 157.5 | 109 | 0247 | 8 | same |
| 111 | 109 | 0959 | 109 | 1313 | 9 | EPC 8300: internal hydrophone array, with external streamer from 1014.5 to 1100.3 and 1147.5 to 1313<br>125 ms vertical scale, 750 ms fire rate |

| Survey Line | Start | | End | | Record Number | Comment |
|---|---|---|---|---|---|---|
| | Day | Time | Day | Time | | |
| 111 | 109 | 1059 | 109 | 1140.5 | 10 | EPC 8300: external streamer<br>125 ms vertical scale, 750 ms fire rate<br>EPC overheated and shut down |
| 112 | 109 | 1313 | 109 | 1434 | 11 | EPC 8300: external streamer<br>125 ms vertical scale, 750 ms fire rate |
| Test | 110 | 2118 | 110 | 2207 | 12 | Internal hydrophone array test |
| 113 | 110 | 2141.5 | 111 | 0052.5 | 13 | EPC 8300: external streamer<br>125 ms vertical scale, 750 ms fire rate<br>Huntec off from 2346-2356, leak alarm |
| 114 | 111 | 0052.5 | 111 | 0645 | 14 | EPC 8300: external streamer<br>125 ms vertical scale, 750 ms fire rate |
| 115 | 111 | 0645 | 111 | 0920 | 15 | same |
| 115A | 111 | 0920 | 111 | 1147.3 | 16 | same |
| | 111 | 1148.5 | 111 | 1324.5 | 17 | same |
| 116 | 111 | 1324.5 | 111 | 1359 | 18 | same |
| 117 | 111 | 1359 | 111 | 1803 | | |
| 118 | 111 | 1803 | 111 | 1851 | 19 | same |
| 119 | 111 | 1851 | 111 | 2040 | | |
| 120 | 111 | 2040 | 111 | 2336 | 20 | same |
| 121 | 111 | 2336 | 112 | 0224 | 21 | same |
| 122 | 112 | 0224 | 112 | 0530 | 22 | same |

| Survey Line | Start | | End | | Record Number | Comment |
|---|---|---|---|---|---|---|
| | Day | Time | Day | Time | | |
| 123 | 112 | 0530 | 112 | 0809 | 23 | same |
| 124 | 112 | 0809 | 112 | 1044 | 24 | same |
| 125 | 112 | 1044 | 112 | 1337 | 25 | same |
| 126 | 112 | 1337 | 112 | 1420 | 26 | same |
| 127 | 112 | 1420 | 112 | 1530 | | |
| 128 | 112 | 1530 | 112 | 1628 | | |
| 129 | 112 | 1628 | 112 | 1729 | | |
| 130 | 112 | 1729 | 112 | 1834 | | |
| 131 | 112 | 1834 | 112 | 1937 | | |
| 132 | 112 | 1937 | 112 | 2030 | | |
| 133 | 112 | 2030 | 112 | 2135 | 27 | same |
| 134 | 112 | 2135 | 112 | 2230 | | |
| 135 | 112 | 2230 | 113 | 001.25 | | |
| 136 | 113 | 001.25 | 113 | 0050 | 28 | same |
| 137 | 113 | 0050 | 113 | 0443 | | |
| 138 | 113 | 0443 | 113 | 0717 | 29 | same |
| 139 | 113 | 0717 | 113 | 0850 | 30 | same |
| 140 | 113 | 0850 | 113 | 0948.2 | | |

## B. SIMRAD MS 992 SIDESCAN

| Survey Line | Start | | End | | Record Number | Comment |
|---|---|---|---|---|---|---|
| | Day | Time | Day | Time | | |
| Test | 106 | 2240 | 106 | 2340 | 1 | Alden 9315 recorder, very poor record, 100 m range 120 kHz (upper), 330 kHz (lower) |
| Test | 107 ? | 1720 | 107 ? | 1805 | 2 | Poor record, 100 m range |
| Test | 108 ? | 2135 | 108 ? | 2205 | 3 | Off Shelburne, 100 m range |
| Test | 109 ? | 0155 | 109 ? | 0243 | 4 | 100 m range |
| 100A | 109 | 0413 | 109 | 0449 | 5 | 100 m range |
| 101A | 109 | 0449 | 109 | 0705 | | |
| 113 | 110 | 2015 | 111 | 0053 | 6 | Test at start of record |
| 114 | 111 | 0053 | 111 | 0335 | 7 | 100 m range to 0105, then 200 m range |
| | 111 | 0341 | 111 | 0645 | 8 | 200 m range |
| 115 | 111 | 0645 | 111 | 0930 | 9 | 200 m range |
| 115A | 111 | 0930 | 111 | 1325 | 10 | |
| 116 | 111 | 1325 | 111 | 1356 | 11 | 200 m range |
| 117 | 111 | 1356 | 111 | 1803 | | |
| 118 | 111 | 1803 | 111 | 1853 | 12 | 200 m range |
| 119 | 111 | 1853 | 111 | 2035 | | |

| Survey Line | Start | | End | | Record Number | Comment |
|---|---|---|---|---|---|---|
| | Day | Time | Day | Time | | |
| 120 | 111 | 2035 | 111 | 2333 | 13 | 200 m range |
| 121 | 111 | 2333 | 112 | 0220 | 14 | 200 m range |
| 122 | 112 | 0220 | 112 | 0534.75 | 15 | 200 m range |
| 123 | 112 | 0536.75 | 112 | 0806 | 16 | 200 m range |
| 124 | 112 | 0806 | 112 | 1041 | | |
| 125 | 112 | 1041 | 112 | 1335 | 17 | 200 m range |
| 126 | 112 | 1335 | 112 | 1420 | | |
| 127 | 112 | 1420 | 112 | 1528 | | |
| 128 | 112 | 1528 | 112 | 1628 | | |
| 129 | 112 | 1628 | 112 | 1727 | 18 | 200 m range |
| 130 | 112 | 1727 | 112 | 1834 | | |
| 131 | 112 | 1834 | 112 | 1937 | | |
| 132 | 112 | 1937 | 112 | 2031 | | |
| 133 | 112 | 2031 | 112 | 2135 | 19 | 200 m range |
| 134 | 112 | 2135 | 112 | 2227 | | |
| 135 | 112 | 2227 | 113 | 0000 | | |
| 136 | 113 | 0000 | 113 | 0050 | 20 | 200 m range |
| 137 | 113 | 0050 | 113 | 0440 | | |

| Survey Line | Start | | End | | Record Number | Comment |
|---|---|---|---|---|---|---|
| | Day | Time | Day | Time | | |
| 138 | 113 | 0440 | 113 | 0713.75 | 21 | 200 m range |
| 139 | 113 | 0715.7 | 113 | 0848 | 22 | 200 m range |
| 140 | 113 | 0848 | 113 | 0958.4 | | |

**Table 4: *Anne S. Pierce 2000* digital tape start and stop times.**

| Instrument | Tape Number | Start day/time | End day/time | File nos. | Lines | Mammoth Tape #40 File Nos. |
|---|---|---|---|---|---|---|
| Huntec DTS | 1 | 107 / 0014 | 107 / 0059 | 1 | 100 | 111 |
| | 2 | 107 / 0102 | 107 / 0204 | 1-4 | 100-101 | 113-116 |
| | 3 | 107 / 0208 | 107 / 0645 | 1-6 | 101-102 | 118-123 |
| | 4 | 107 / 0654 | 107 / 0755 | 1-2 | 102 | 125-126 |
| | 5 | 107 / 0820 | 107 / 1920 | 1-15 | 102-105 | 128-142 |
| | 6 | 109 / 0215 | 109 / 1433 | 1-9 | 100A-112 | 144-152 |
| | 7 | 110 / 2204 | 112 / 1335 | 3-57 | 113-125 | 154-210 |
| | 8 | 112 / 1338 | 113 / 0942 | 1-40 | 126-140 | 212-251 |
| | | | | | | |
| Sidescan* | 1 | 109 / 0215 | 109 / 0245 | 1 | 100A | 2 |
| | 2 | 109 / 0437 | 109 /0709 | 1-4 | 100A-101A | 4-7 |
| | 3 | 110 / 2204 | 111 / 1559 | 4-27 | 113-117 | 9-35 |
| | 4 | 111 / 1605 | 112 / 0530 | 1-21 | 117-122 | 37-57 |
| | 5 | 112 / 0537 | 113 / 0441 | 1-41 | 123-137 | 59-99 |
| | 6 | 113 / 0454 | 113 / 0942 | 1-9 | 138-140 | 101-109 |

✻ Note that the tape channels assignments for sidescan sonar tapes 1-3 and tape 4, files 1-8, are as follows:

1: 120 kHz starboard 2: 120 kHz port 3: 330 kHz port 4: 330 kHz starboard

For tape 4, files 9-21, and tapes 5 and 6, the channel assignment are as follows:

1: 120 kHz port 2: 120 kHz starboard 3: 330 kHz port 4: 330 kHz starboard

**Table 5. German Bank grab sample stations.**

| Station No. | Day/Time (UTC) | Latitude (°N) | Longitude (°W) | Water Depth (m) | Comments |
|---|---|---|---|---|---|
| 1 | 109/1557 | 43.39335 | 66.729725 | 160 | 2nd try at 109/1604, 43.392352 N, 66.730125 W; very little sediment, two vials filled, no photo taken |
| 2 | 109/1622 | 43.395242 | 66.731259 | 160 | same location as station 1; again two vials of sediment |
| 5 | 109/1822 | 43.374005 | 66.753134 | 124 | 1st try; one rock, no sediment<br>2nd try at 109/1829, 43.374339 N, 66.753893 W, gravel and sand |
| 6 | 109/1855 | 43.36319 | 66.745034 | 142 | mud with some sand, abundant macrofauna; located in "crater" |
| 8 | 109/2054 | 43.27292 | 66.708555 | 93 | 1st try: no sample, too much swell; 2nd try: same result |

**Table 6. German Bank Benthos camera stations.**

| Station No. | Start Day/Time (UTC) | Start Lat/Long | Stop Day/Time (UTC) | Stop Lat/Long | Water Depth (m) | Comments |
|---|---|---|---|---|---|---|
| 3 | 109/1716 | 43.396163<br>66.727760 | 109/1721 | 43.395417<br>66.727970 | ? | 14 photos |
| 4 | 109/1801 | 43.374312<br>66.753866 | 109/1807 | 43.374491<br>66.753002 | 155 | 13 photos |
| 7 | 109/1921 | 43.363723<br>66.744437 | 109/1927 | 43.363293<br>66.745054 | 121 | 22 photos |

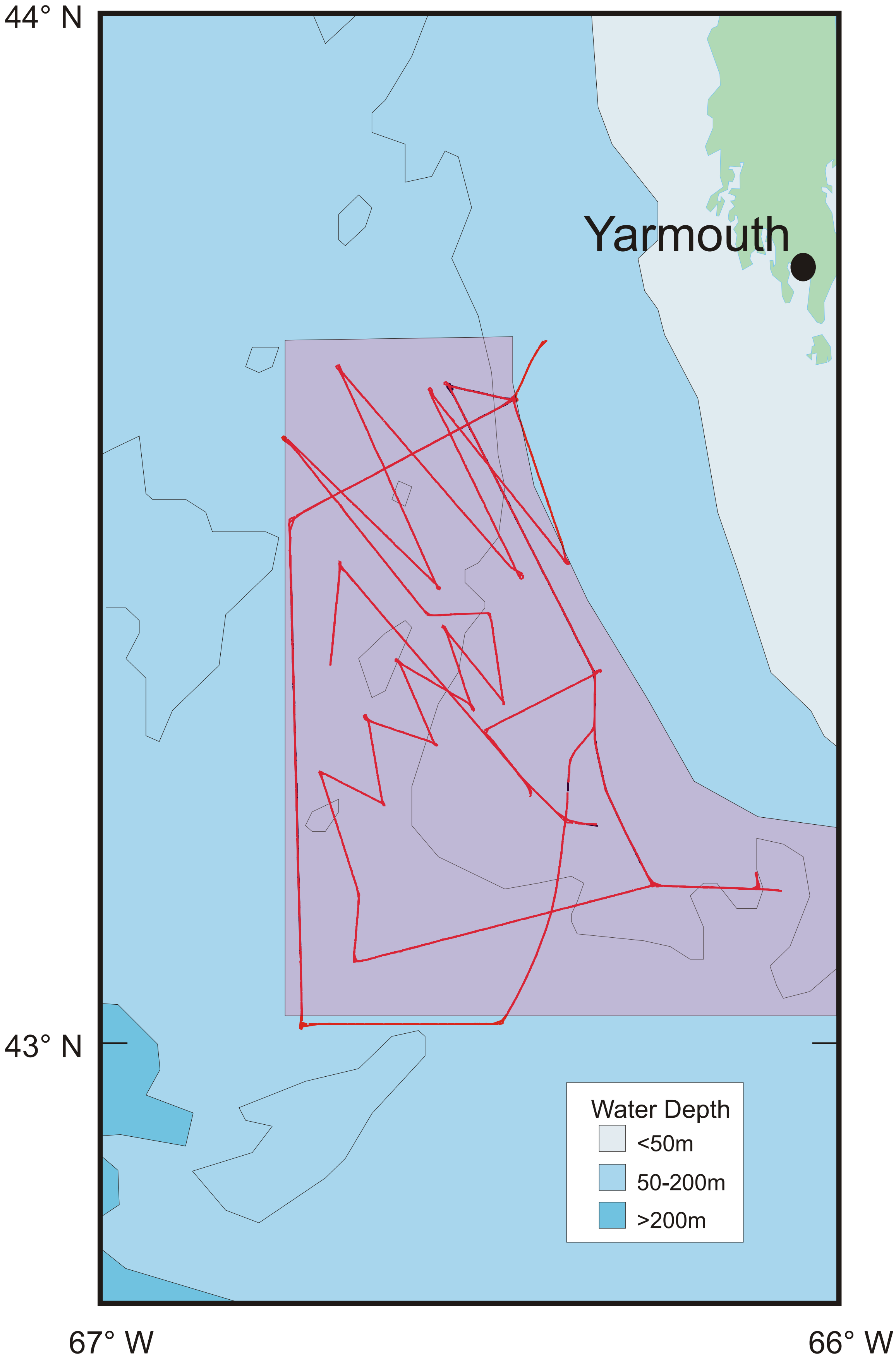


Figure 6. Simplified trackplot of *Anne S. Pierce* 2000, German Bank. Survey lines are shown in red. Extent of multibeam bathymetric coverage indicated by purple shading. The detailed trackplot in Appendix 6.1 includes line number designations, day/times and sample locations.

## 3. Navigation and positioning - *D.E. Beaver*

### 3.1 AGCNav and Regulus

Navigation during the 2000 *Anne S. Pierce* cruise to German Bank was accomplished using Regulus (with AGCNav backup logger) navigation computer programs which receive input via the serial port in the form of standard NMEA strings. The equipment used to generate the NMEA strings included POSMV and an ultra-short baseline acoustic positioning system (ORE Trackpoint II). All NMEA strings were fed into a Baytech multiplexer and then sent to a Black Box splitter. This signal was then fed to the AGCNav backup logger as well as to Regulus. The signal was also sent to the Huntec and sidescan sonar AGCDIG.

The following NMEA strings were used for positioning of the vessel and towed bodies, and were logged for post-processing:

- $INGGA: GPS time, latitude and longitude of the GPS antenna in the WGS-84 coordinate system, and various GPS satellite information fields
- $INHDT: Heading of vessel relative to true north
- $INVTG: Course over ground in degrees, speed over ground in knots
- $POREB: Proprietary string created by AGCNav which handles ORE Trackpoint II data including, towfish depth, slant range, and bearing
- $POREP: Created by AGCNav to display towfish position
- $SODBT: Depth below transducer in feet, meters, fathoms

Regulus was set up in the lab with a video split of the master station, meaning that it received the NMEA strings and displayed the vessel location (and the location of the two towed bodies). The AGCNav computer on the bridge was used solely as a backup.

The logging of the navigation data was done on one AGCNav laptop and on Regulus. AGCNav and Regulus have a file naming convention based on the ship's name, Julian day, and file number that day. An example would be ANNE109A.00E, where ANNE are the first four letters of the ship's name, 109 is the Julian day, and "A" means it was the first file created on day 109. Each day the navigation data was backed up from both logging computers onto CD-ROM on the master computer. The raw navigation files (.00E) were converted to files which contain only time, latitude and longitude (.00A) using ETOA file conversion software. The .00A files were then plotted using the program APLOT to view the navigation and to ensure that there were no data gaps. If data gaps were found, the data from the backup logger was used to fill the gaps. The navigation files are provided in Appendix 6.2.

## 3.2 ORE Trackpoint II

A 3° horizontal offset to starboard was entered into the Trackpoint based on the observed bias. Visual inspection during towfish deployment agreed with this adjustment. Two transponders were tracked simultaneously in ORE's Fish Track mode: one was fitted to the Huntec DTS (transponder 6, transmit frequency of 19 kHz and receive frequency of 22 kHz) and the other to the Simrad 992 sidescan sonar (transponder 3, transmit frequency of 17 kHz and receive frequency of 26 kHz).

## 4. Geophysical survey

### 4.1 Overview - *B.J. Todd*

Pre-cruise planning and daily refinement of the ship's geophysical survey tracks on the *Anne S. Pierce* cruise were based on careful study of the multibeam bathymetric and backscatter data provide by the Canadian Hydrographic Service. Targets and selected areas identified on these data sets were traversed by the ship using differential GPS for accurate navigation. The advantage that the multibeam data provides to enhance the usefulness of the conventional geophysical survey profiles cannot be overemphasized.

The objective of the geophysical survey was to collect regional geophysical survey lines across German Bank and to infill and augment data collected during the regional 1982 *Fogo Isle* cruise, and CSS *Dawson* 89-001 and CSS *Hudson* 92-01 cruises on northern Georges Bank. To this end, 1847 km of Huntec DTS and sidescan sonar data were collected (Fig. 6, Appendix 6.1). The data were output on graphic recorders (Table 3) and, simultaneously, digitally recorded (Table 4, Figure 7). Data were of medium to high quality, due to the changeable sea state during the survey period.

### 4.2 Sidescan sonar system - *A. Atkinson*

The sidescan sonar system used on the *Anne S. Pierce* was the Simrad MS992 neutral tow system. This system produced outstanding results even in rough weather. Data quality and quantity suffered in the early days of the cruise because of numerous flooded underwater splices and cable problems.

Records were displayed at a 200 metre range (100 m per channel) and every attempt was made to keep the tow vehicle close enough to the bottom to produce good acoustic shadows of bottom features. Fish height was ideally 18 to 25 metres above the seabed. Data was logged on an AGCDIG digital data logger. During the first day of the survey there was some experimentation with the vessel's tow speed. One night was spent jogging the vessel in and out of gear to try to keep the speed on line to about 4 knots. While this produced good imaging, it was hard to steer a straight course and the speed along track varied substantially. It was decided to run the subsequent lines at "idle speed" which translated to a steady speed between 5 and 6 knots, depending on the direction of the tidal currents.

Suggestions for improvement:

The same winch that was used on the *Hamilton Banker* 1999 expedition to Georges Bank was prepared for the *Anne S. Pierce* mission. When it was learned that the cable was too short to work in German Bank water depths of 170 meters another winch with a 600 metre cable had to be substituted.

Procedures for underwater splices used on this system are under review. All splices we attempted to use had been extensively used in the previous field season. Although they passed shallow water tests, they rapidly flooded at depth under real survey conditions. A more robust splicing system is being developed.

There were some minor power and ground problems with the ship's electrical system. Some of the Uninterruptible Power Supply's plugs had the large pin at high potential and the small pin at low potential. This is opposite to conventional wiring on land-based installations. Both pins should either be floating, or the large pin should be low and the small should be high. This could cause a "hot ground" in some survey equipment. Regular non-UPS plugs also had some problems. Plugs wired to the new panel seemed to produce noise on the equipment while the original plugs (old and tinged with paint) worked well.

Before the recording of file 8 on tape 4, the following data logger channel convention was used:

| Data Logger Channels | Simrad MS992 Channels Recorded |
|---|---|
| CH1 | Right 120 KHz |
| CH2 | Left 120 KHz |
| CH3 | Left 330 KHz |
| CH4 | Right 330 KHz |

After this file, the convention was switched to:

| Data Logger Channels | Simrad MS992 Channels Recorded |
|---|---|
| CH1 | Left 120 KHz |
| CH2 | Right 120 KHz |
| CH3 | Left 330 KHz |
| CH4 | Right 330 KHz |

## 4.3 Huntec Deep Tow System - *M. Uyesugi*

Equipment description - The PGC Huntec DTS system was used on this cruise (Tables 7, 8, 9; Fig. 7). The maximum power output of this system is 540 joules (30 mfd storage capacitance) with an ED10 F/C Boomer and multi tip sparker source. The internal single-element LC10 hydrophone was configured as Seismic #1. The externally-towed Benthos Mesh 15/10P streamer hydrophone was connected as Seismic #2 (Table 7).

The ED10 boomer source is depth-compensated and outputs a highly repeatable broadband pulse, capable of resolving 10 centimetres vertically. Peak output intensity is 118 db relative to 1 micro bar at 1 metre, with a pulse duration of 110 microseconds. The sparker source has twenty, # 22 awg, solid core tips. Sparker peak amplitude and pulse width are depth dependant.

The deck equipment consisted of a Huntec Model 1000 Oceanographic winch, which included a multi-way slip ring and a 305 metre, fourteen conductor, armoured tow cable. The winch was powered by the SSS 220 VAC, 25 HP hydraulic pump unit. The tow cable was handled by a 36 inch diameter roller cluster rigged on the centre position of the aft A-frame.

The lab instrumentation consisted of the Huntec Systems Console and DC high voltage power supply (PCU). The Systems Console houses the Bottom Motion Compensator circuits, the +24 volt fish supply, and modules for signal processing and tape outputs. The Huntec Mk III PCU provides DC power to the boomer in switchable ranges from 2 to 6 kilovolts.

Graphic display and signal processing - The two Huntec seismic channels were displayed on a EPC 9800 dual channel recorder. Seismic #1 (internal LC10 hydrophone) was processed by the systems console’s Adaptive Signal Processor (ASP) module and then displayed on Channel A of the EPC recorder. Seismic #2 (external streamer) was passed through a Krohn-Hite filter with a low pass setting of 3500 hertz, for display on Channel B of the EPC recorder.

Data recording - The Huntec signals were recorded on the AGCDIG unit #2: a digital, four channel logger with 8700 Exabyte tape drive (software version 2.33) (Table 7).

Equipment performance - The only Huntec system problem was a required retermination on

Day 285 after loss of external steamer signal made gear recovery necessary. It was noted that about ten outer strands of armour cable were broken. This may have occurred after snagging fishing gear on Day 281, combined with cable strumming.

AGCDIG - The AGCDIG program locked occasionally causing an increase in tape use.

Data quality - The boomer source was used exclusively during the survey. In general, Huntec data quality was good. Occasional cable strumming caused objectionable noise on the internal hydrophone channel. The external streamer had to be checked a couple of times resulting in the underwater E/O connectors being regreased to eliminate intermittent data.

Recommendations

1) The PGC winch should be modified for remote operation.
2) The fourteen-conductor armoured tow cable performed well, even after a snagged rope bent the cable severely at the towpoint. After several days, and significant cable strumming due to a lack of cable fairing, the tow cable had to be reterminated. At the conclusion of the survey, the tow cable had one broken strand in the outer armour; the cable should be reterminated and have cable fairing applied.
3) The intermittent external streamer did not need to be regreased after the retermination but the old streamer's E/O connection is worn and is suspect. The streamer's tail rope was cut off by the ship's prop and the tail rope and drogue were replaced. Damage to the streamer was not evident but replacing the E/O connection would be advisable.
4) The EPC 9800 had paper feed problems which were fixed by adjusting the machine.
5) Running the Huntec and sidescan systems on the same power pack is not advisable and data quality is compromised.
6) The roller cluster lost the top bolt on the starboard side and caused excessive wear on the large roller. The large roller should be removed, repaired and/or replaced.

4.4 Digital tape recording - *P.E. Pledge*

The AGCDIG for both sidescan and Huntec had only one problem. The DIG software often locked at the time of a file change (i.e. the automatic hourly change or manual change). The malfunction occurred more frequently on the Huntec DIG (unit #2). All of the serial data from the MUX going into AGCNav was also passed into DIG for logging. This did not appear to cause any problems. After each tape was removed, the "set clock" utility was executed and the drives were cleaned.

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**Table 7. Huntec DTS equipment.**

| Unit description | Serial Number |
| --- | --- |
| Tow Fish Body | PGC |
| ED10F/C Boomer Source | 2015 |
| MK5-2 Attitude Sensor Unit | N/A |
| S500 Energy Storage Unit | 1017 |
| Internal LC 10 Hydrophone | N/A |
| External Benthos 15/10P Streamer | 103 |
| Huntec Oceanographic Winch and Power Pack | --- |
| Roller Cluster 36" Dia. | --- |
| Systems Console | 102 |
| EPC 9800 Graphic Recorder | 104 |
| MK 3 Power Control Unit | 120 |
| Krohn-Hite 3550R Filter | N/A |
| AGCDIG Data Logger | #2 |

**Table 8. Equipment settings.**

| Parameter | Setting |
|---|---|
| Fire rate | 1.0 sec |
| PCU power setting | 4 kilovolts (240 joules) |
| ESU power setting | 30 microfarad (540 joules max.) |
| BMC (motion compensation) | Pressure Mode |
| Display Gain | Seismic #1- Adaptive.<br>Seismic #2- Max. EPC gain |
| Filter Setting - Internal<br>- External | Seismic #1 - 500 - 6000 hertz<br>Seismic #2 - 300 - 3500 hertz |
| Processor Gain (System Console) | 4 kV int. / 2 kV ext |
| DTS source | Boomer |
| AGCDIG sample rate | 60 to 110 microsecond |
| AGCDIG samples per channel | 4096 |
| AGCDIG base gain A/D board | 4 |
| EPC sweep speed | 125, 250, 500 microsecond |
| EPC print polarity | positive |

**Table 9. Data recording parameters.**

| AGCDIG Inputs | Description |
| --- | --- |
| Ch. #1 | Seismic #1 - Internal LC10 hydrophone |
| Ch. #2 | Seismic #2 - External Benthos 15/10P streamer |
| Trigger | Print delay trigger |

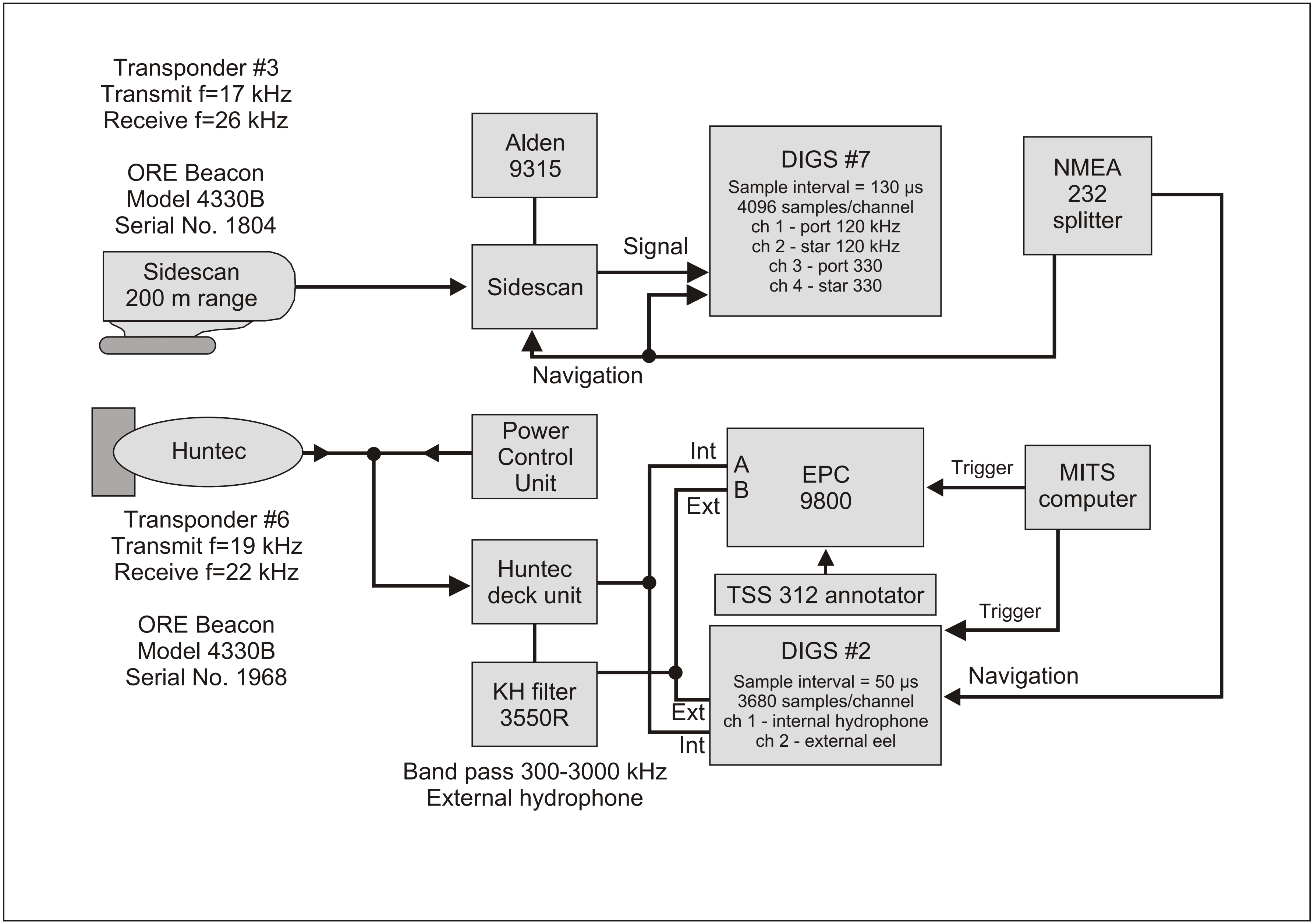


Figure 7. Schematic of Simrad sidescan sonar (upper) and Huntec DTS (lower) systems on the *Anne S. Pierce*.

## 5. Geological sampling - *B.J. Todd and R. Murphy*

A van Veen grab sampler with a capacity of approximately 0.01 $m^3$ was used to obtain samples from the sea floor (Table 5). The van Veen grab was deployed over the stern using the starboard winch and the A-frame. Five stations were attempted with material retrieved at four stations (see photos in Appendix 6.4). These sites were selected for sampling on the basis of the multibeam and/or geophysical information.

Sample volumes were not satisfactory. The van Veen was able to obtain only small volumes. This may have been exacerbated by rough sea conditions and strong currents; the angle of the winch cable was, more often than not, far off vertical. Therefore, the instrument may not have tripped on the sea floor in a manner most suited to sediment retrieval. As well, the winch speed was relatively slow and the van Veen impacted the seabed slowly. To ensure more complete sediment retrieval on future German Bank surveys, an IKU grab (which is much larger and heavier) is recommended, accompanied by a faster, dedicated winch.

The same deployment difficulties were experienced with the Benthos camera (Table 6). Photographs were obtained at three stations (see Appendix 6.5). The freeboard surrounding the afterdeck made deployment and retrieval somewhat dangerous for the operators and for the equipment. It is recommended that the Benthos camera not be deployed from the afterdeck of the *Anne S. Pierce* unless alterations are made to the vessel.