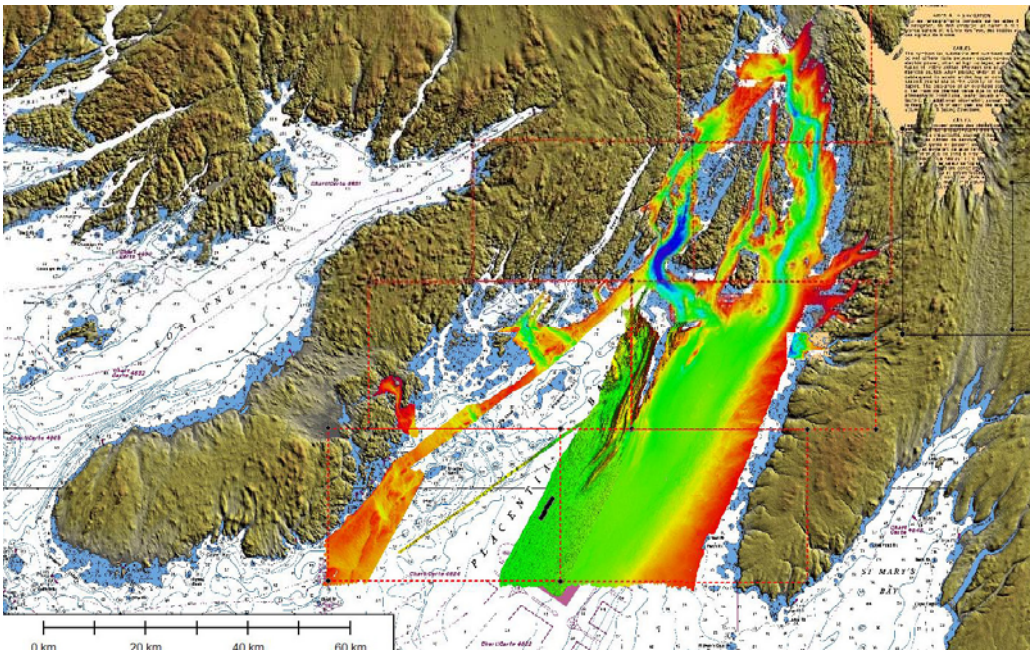
REPORT ON CRUISE *Matthew* 2005-020



Multibeam Sonar Surveys in Placentia Bay, Newfoundland, 19-29 July 2005

Geological Survey of Canada
Open File Report 5024

John Shaw, Mike Lamplugh, Glen King, Andrew Smith,
Darrell Beaver, and Angus Robertson

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2005

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J. Shaw, M. Lamplugh, G. King, A. Smith, D. Beaver, A. Robertson

2005

Available from
Geological Survey of Canada Atlantic
1 Challenger Drive (PO Box 1006)
Dartmouth, NS B2Y 4A2

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GENERAL INFORMATION

Vessel CCGS *Matthew*
Master Captain Lockyear
Dates 19 –29 July 2005
Areas of operation Placentia Bay, Newfoundland

GSC personnel	John Shaw	*GSC Atlantic*
	Darrell Beaver	*Multibeam launch surveys*
	Angus Robertson	*Multibeam operations*
CHS personnel	Michael Lamplugh	*CHS Hydrographer in Charge*
	Glenn Rodger	*CHS Hydrographer*
	Glen King	*CHS Hydrographer*
	Jon Griffin	*CHS Hydrographer*
	Andrew Smith	*CHS Hydrographer*
	Dave Sinnott	*CHS Hydrographer*
	Carmen Reid	*CHS Multibeam launch coxswain*
	Morley Wright	*CHS Electronic specialist*

CRUISE OBJECTIVES

This survey was undertaken as a collaborative venture between the Canadian Hydrographic Service and the Geological Survey of Canada, under the aegis of GSC Project X29. This project is part of the GSC's Geoscience for Ocean Management Program, and has the support of the interdepartmental Oceans Act Initiative that identified Placentia Bay, Newfoundland, as one of five large marine regions that should be the foci of inter-departmental research.

The survey was a continuation of multibeam mapping that commenced in 2004. The goal is to map Placentia Bay, Newfoundland, in support of the multi-agency Placentia Bay Information Seaway Project, and also in support of efforts to manage the marine resources of the bay. The scientific objective is to enhance our understanding of geological processes in the bay, including glacial history, sea-level history, modern processes, geological hazards including submarine landslides, and the presence of contaminants in marine sediments.

The tasks to be undertaken were:

- Use the Simrad EM-710 system on board CCGS *Matthew* to map an area of Placentia Bay adjoining the area surveyed in 2004 by CCGS *Creed* and CCGS *Matthew*.

- Use the EM-3002 system on board the survey launch CSL *Plover* to map shallow coastal waters in Placentia Roads.

CCGS *MATTHEW*

CCGS *Matthew* is an inshore hydrographic survey vessel with the following particulars:

Length overall	51.25 m
Breadth	10.50 m
Displacement (light)	745 tonnes
Displacement (loaded)	950 tonnes
Speed	12 knots
Range	4000 nautical miles
Crew	12 persons
Scientific staff	8 persons

SURVEY PROCEDURES

The vessel was used solely for multibeam surveys. Staff operated two-person eight-hour watches from 00:00 to 08:00, 08:00 to 16:00, and 16:00 to 24:00. The multibeam operator and the data processing person worked in the hydrographic control room adjacent to the bridge. The Moving Vessel Sound Velocity Processor was deployed by the crew and triggered using controls in the control room. The launch *Plover* was carried to Newfoundland aboard the *Matthew*, and dropped off at Placentia. It was operated independently by a CHS coxswain (Reid) and a GSC multibeam operator (Beaver). These staff stayed in Placentia.

SURVEY ACHIEVEMENTS

As usual, weather was the principal constraint on the survey. It limited surveys on 25th July and precluded surveys on 28th July. The coverage achieved was therefore less that the maximum possible, but was nevertheless very substantial. The area covered is shown on Figure 1.

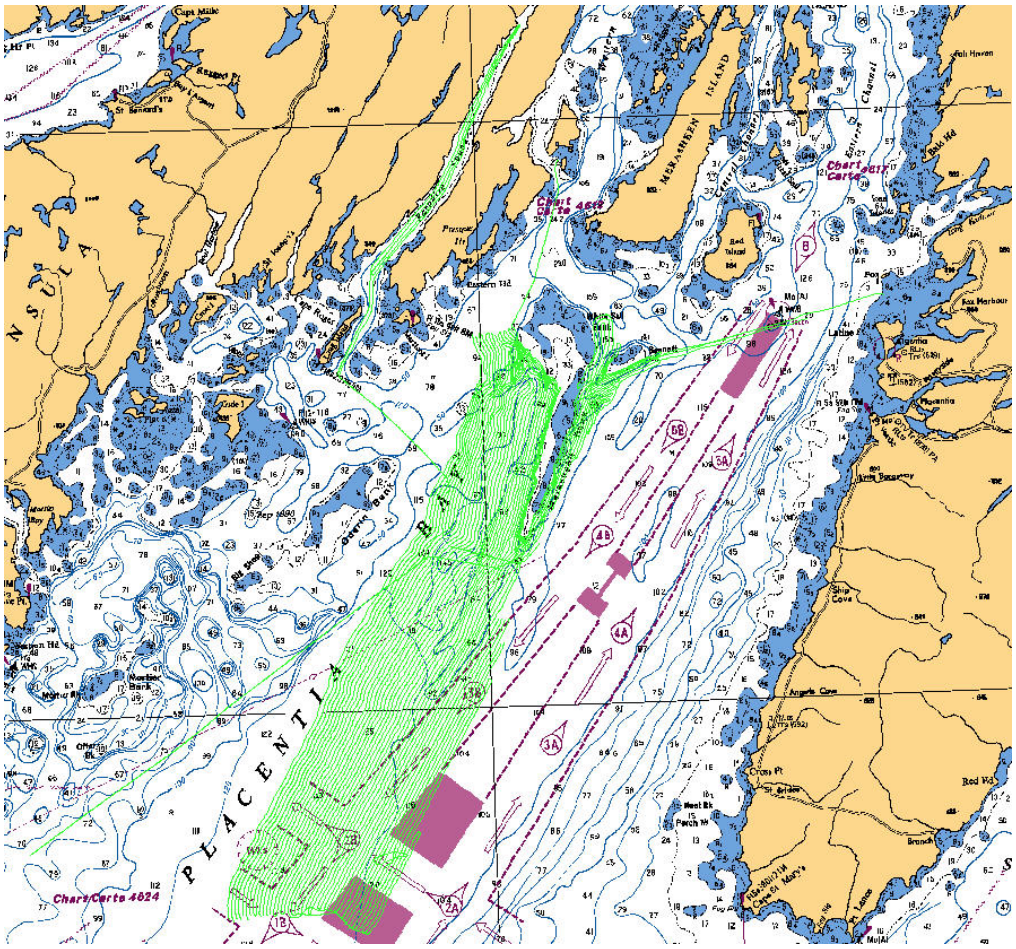

Figure 1: Ship's tracks for the survey. The tracks of the survey launch *Plover* are not shown.

CRUISE NARRATIVE

Note: Times are Atlantic Daylight Saving Time (i.e., Nova Scotia time), which is Z-3 hours.

Day 199 Monday 18 July

Beaver and Reid depart from the Bedford Institute of Oceanography (BIO) in a government vehicle, drive to North Sydney, and catch the Newfoundland ferry at about midnight. *Matthew* arrives in Placentia Bay and commences mapping.

Day 200 Tuesday 19 July

Beaver and Reid arrive at Port aux Basques in the early morning and drive to Placentia. CCGS *Matthew* conducts surveys in Placentia Bay.

Day 201 Wednesday 20 July

Shaw and Robertson fly from Halifax International Airport on Air Canada Flight 648 at 07:15. They arrive in St. John's, have breakfast in the airport, and hire a taxi to take them to Argentia where *Matthew* is tied up at the public wharf. They arrive at about 11:30. It is overcast and foggy with a light SW breeze. It is crew-change day. In the afternoon Beaver and Reid run test lines with the launch's multibeam system. After a lifeboat and safety familiarization exercise, the vessel departs Argentia in thick fog at 20:00 and begins line running soon afterwards, starting with L. 0080.

Day 202 Thursday 21 July

Line running continues in fair weather. It is foggy for most of the day, with slight swell and sea. Swell increases mid-afternoon and the fog clears. Several SVP casts are conducted in the afternoon. Sea conditions become slight during the night.

Day 203 Friday 22 July

The morning brings sunny conditions, with broken cirrus and a few patches of high altocumulus. Swell and sea are slight. Surveys are focused in the vicinity of Merasheen Bank. Late in the day, lines are run around shoals at the north end of the bank. In the early evening, long lines are run to fill a gap between this year's coverage and last year's. A slight to moderate sea arises in the late evening, then decreases. The sky is clear at sunset except for some cirrus. Shaw contacts *F.G. Creed* in the early evening and talks with Andre Roy who advises that P. Potter has left the vessel and that P. Girouard is expected to replace him.

Day 204 Saturday 23 July

Just after the start of the Julian Day, the system display in the control room crashes. After several attempts it is brought back to life, but all the accumulated coverage data are lost, making it difficult to run new lines. The vessel heaves to during the several failures, then continues line running. There is slight sea and swell overnight. The wind increases from the southeast, producing a few whitecaps. Surveys continue uninterrupted.

Day 205 Sunday 24 July

The morning brings overcast conditions, a slight sea and swell, no wind, and the usual thick fog. Surveys proceed without incident. Moderate rain begins in the mid-afternoon. Sea and swell increase in the evening.

Day 206 Monday 25 July

The wind becomes strong from the southwest overnight, and the sea increases accordingly. At 12:30 am the system becomes unstable. The line ends at 02:18 and a new project is started. However, the system will not ping. The system is on line by 03:18 am. Sunrise brings a clear blue sky and a strong southwest wind. Line running ends at 06:26 and the vessel heads towards Argentia in a heavy following sea. A large (15 m high and 45 m long) shipwreck was mapped during the night just outside a wreck circle on the chart. *Matthew* ties up at Argentia at 09:07. Charles Stirling (CHS, St. John's) meets the vessel and departs with Mike Lamplugh at 10:30, heading for St. John's. The wind continues to increase throughout the day, giving gusts up to 40 knots. In the afternoon, Shaw, A. Smith and G. King walk across to the Argentia tide gauge. King and Smith unload the data. They meet D. Beaver who has stopped surveying in Placentia Road because of the strong winds. Beaver reports on the work to date. Beaver comes to *Matthew* at 18:00, bringing images of the Placentia survey. The wind decreases very slightly and at dusk the air feels quite chilly. *Matthew* remains on one-hour notice for SAR (search and rescue) duties.

Day 207 Tuesday 26 July

Jon Griffin leaves the vessel at 06:45 and *Matthew* makes ready for departure from the wharf: a container vessel is arriving imminently. It is overcast with occasional light rain and a moderate SW wind. *Matthew* departs the wharf – the former fleet dock – at 07:00. *Matthew* crosses Placentia Bay in gale-force conditions, and starts line 018 (2nd project) into Paradise Sound at 10:10. There is very heavy swell at the start of the lines but it decreases as we make our way north. The day becomes foggy, with rain at times. The wind diminishes to about 15 knots in the mid-afternoon but then increases again. The swell is very heavy as we reach the south end of the lines. About 16:30 the wind has dropped, leaving a heavy swell. *Matthew* heads out to the middle of the bay to continue line running on the main grid.

Day 208 Wednesday 27 July

The swell remains heavy during the night, so that *Matthew* 'pounds' at times. Line running on the main grid continues, albeit at reduced speed (5-7 knots). Several new wrecks are spotted in the wreck area marked on the chart. The day is foggy, and sea conditions remain as before: a steep swell. Data quality is extremely poor on the lines running into the swell, and fair to very good on the opposite direction. Line running ends at 15:00 at which time *Matthew* heads toward Argentia. Telephone contact with the launch at about 14:00 establishes that the launch work has been completed, and the launch is alongside *F.G. Creed* at Argentia. *Matthew* arrives at the mouth of Argentia Harbour in thick fog and a stiffening southerly breeze at 19:00. *Matthew* drops anchor off Broad Cove Point and the launch *Plover* arrives, with Reid, Beaver, and Andre Roy, who collects the EM 710 data for further processing. Dave Sinnott and Andre Roy then leave, and the launch waits alongside *F.G. Creed* for Larry Norton, who has arrived on the ferry from North Sydney. By this time the SW to W wind is gusting to over 40 knots. Norton finally makes contact with *Matthew* at about 22:00. Captain Lockyer orders the launch to return

immediately due to the strong winds (maximum 43 knots) and the boat is brought aboard at 11:53.

Day 209 Thursday 28th July

With the wind unabated in the morning, and the vessel shrouded in thick fog, a decision is taken to fly the staff home rather than attempt surveys. At 12:30 Shaw, Rodger, Robertson, Smith, King and Griffin leave in the launch and are taken to the small craft wharf at the head of the harbour (near the former Fleet Repair Facility) where two CHS vehicles take them to the airport for flight to Halifax at 16:10 and 16:15. *Matthew* will attempt a passage to St. John's despite the strong winds.

DATA ACQUISITION AND PROCESSING

The following geophysical and sampling equipment was used for the surveys:

- Simrad EM-710 multibeam bathymetry system on board *Matthew*.
- Simrad EM-3002 multibeam bathymetry system on the launch *Plover*.
- Brooke Ocean Moving Vessel Sound Velocity Profiler (MVSVP) system.

Simrad EM-710 multibeam bathymetry: acquisition

The primary task of the survey was collection of multibeam bathymetry data using a Simrad EM-710 sounder. The transducer was mounted in the gondola on the port side amidships (gondola attached to the welded hull brackets). The system was operated from the survey control room adjoining the bridge. The setup comprised a Kongsberg Seafloor Information System (SIS) interface and a Regulus or Hypack navigation display.

Sound velocity profile casts were made using the Brooke Ocean Technologies Moving Vessel Sound Velocity Profiler (MVSVP). The profiler is mounted on the stern of the vessel on the port side. On the monitor screen in Figure 2 it is the stowed position. During operation a crew member starts the system, and the arm lifts the profiler out of the wooded stowage box. The arm then is swung 180 degrees, and the profiler is lowered into the water, and towed behind the vessel at a depth just above or equal to that of the transducer. The ship increases speed to about 8 knots or better. This enables the "fish" to rise to just below surface (depth approximately 1-2 m). The operator in the Hydrographic control room then triggers the system, sending the profiler to an assigned depth off the sea floor. The maximum depth attained during the cruise was about 220 metres. The profiler then automatically recovers to towing depth (just below surface at about 1.5-1.9 m) and can be either re-deployed for subsequent casts or recovered onboard. The profile graphs are viewed in the MVP monitor and the data are sent across the network to the Simrad computer. The file is edited as required and saved for importing and use in the SIS software. Draft measurements were made before leaving harbour, with the launch removed.

Figure 2: Monitor screen in the hydrographic control room showing the Brooke Ocean Technology Moving Vessel Sound Velocity Profiler (MVSVP) on the rear deck, port side.

Simrad EM-710 multibeam bathymetry: processing

Upon completion of each 15-minute line, the raw datagrams for each line were processed to remove erroneous soundings and navigation in the CARIS HIPS system (Hydrographic Information Processing System, version 5.4 by Universal Systems Limited, Fredericton, NB). First the raw datagrams for the line were converted. Then, with the project open, the data were inspected for navigation errors and then for yaw, roll, pitch and heave errors. Next, erroneous soundings were removed in SWATH EDIT. Then a zero tide was added and the data were merged. Data were backed up on DVD disks each evening after 21:00 local time (i.e., at the end of the Julian Day in UTC. Upon retrieval of data from the Argentia tide gauge, real tides were added and the data re-merged.

Simrad EM-3002 multibeam bathymetry

Multibeam bathymetric data were also collected using a Simrad EM3002 multibeam bathymetry system mounted in the CSL *Plover*. The EM-3002 system uses 300 kHz transducer with 254 beams with a beam width of 1.5^o x 1.5^o. The system provides a depth resolution of 1 cm with an accuracy of 5 cm RMS. Each beam insonifies an area of approximately 1.35 m^2 at 50 metres water depth. An Applied Analytics Corporation POS-MV 320 attitude sensing system with integrated differential GPS navigation system was used to position the vessel and determine the attitude. The system integrates data from an inertial measurement unit and differential GPS signals. A positional accuracy of 2-10 mm can be obtained using phase differential of the GPS carrier frequency. A heading aiding accuracy of 0.1^o - 0.5^o can be obtained from the raw GPS data. A Kalman filter is used to improve the heading estimate to 0.05^o - 0.1^o. Vessel attitude is measured using an inertial measurement unit to provide an accuracy of 0.0003^o for pitch, roll and heading. Survey lines were run at various spacing throughout the survey area to provide 200 percent coverage of the seafloor in water depths that ranged from 2 to 20 m. During the survey, data were processed using version 5.4 of the HIPS data-cleaning program (CARIS by Universal Systems Limited, Fredericton, NB) on a Windows NT workstation to remove spurious soundings

and navigation data and to correct for tidal variations. The system was deployed in conditions ranging from slight swell to very rough conditions (winds 40 knots).

Data Backup and Archive

Raw files were logged to the SIS computer during acquisition. From here they were copied to the networked TERA drive (specifically a volume in the server RAID). These data were then to be incrementally backed up on to an EXABYTE cartridge tape drive on a nightly basis, with a full backup occurring regularly. A Dell Poweredge 2650 was the server which controlled the network. Continuing problems with the Dell server and the EXABYTE tape drive necessitated a manual backup using DVDs.

Figure 3: Multibeam bathymetry launch CSL (Canadian Survey Launch) *Plover*.

Navigation

Positioning aboard the vessel was done with navigation software *Regulus* build 24659. The required computers were set up on the vessel prior to the mission departure from BIO. The primary computer was placed in the navigation room on the bridge deck and received differential GPS signals from the bridge receiver (*Magnavox*). The GPS feed consisted of position, course over ground and speed over ground. The navigation data along with the heading from the *Anschutz Kiel* gyro and depth below keel from the *ELAC LAZ 4400* echo sounder were combined through a *Baytec* multiplexer which fed the combined data to a line splitter for distribution over

the ship's RS-232 data distribution network. The video feed from this computer was split by a *VideoView* signal splitter in the navigation room and fed to the bridge.

GIS setup

There was no formal GIS setup nor was a person assigned to GIS support. The relatively inexpensive 'off-the-shelf' GIS program Global Mapper, running on a lap-top computer, proved invaluable for multiple tasks that might normally be assigned to the rather more expensive ARC product. For example, it was capable of importing Geotiffs, making their backgrounds transparent, and displaying them against BSB files (hydrographic charts). The ship's position and track at any time could be viewed when a navigation feed was plugged into the lap-top computer. Global Mapper was used to import .jpgs (e.g., the habitat map) and convert them rather easily into Geotiffs. Three-dimensional views could be made, and data could be exported in many formats.

Tides

Data from the gauge at Argentia were obtained after the survey. It will be used to apply real tides to the data during the next stage of cleaning under the supervision of Andre Roy.

SCIENTIFIC SUMMARY

Surveys on the west side of Placentia Bay by CCGS F.G. Creed

On the commencement of the survey at Argentia a geotiff was obtained from A. Roy showing the extent of *F.G. Creed* mapping to that day. The *Creed* multibeam – from Corbin Hd. to Presque Hr. – shows terrain heavily marked by drumlins, mostly indicating an ice flow to the southeast, i.e., offshore (Figures 4-6). The flow-line pattern shows some variability, particularly east of Jude Island. It is consistent with the concept of convergent flow into Placentia Bay from surrounding land areas, and also with the idea of strong topographic control upon flow direction. Note that on the Space Shuttle elevation data shown on Figure 3, drumlins are also present in the lowlands on the Burin Peninsula (dark gray area on Figure 4).

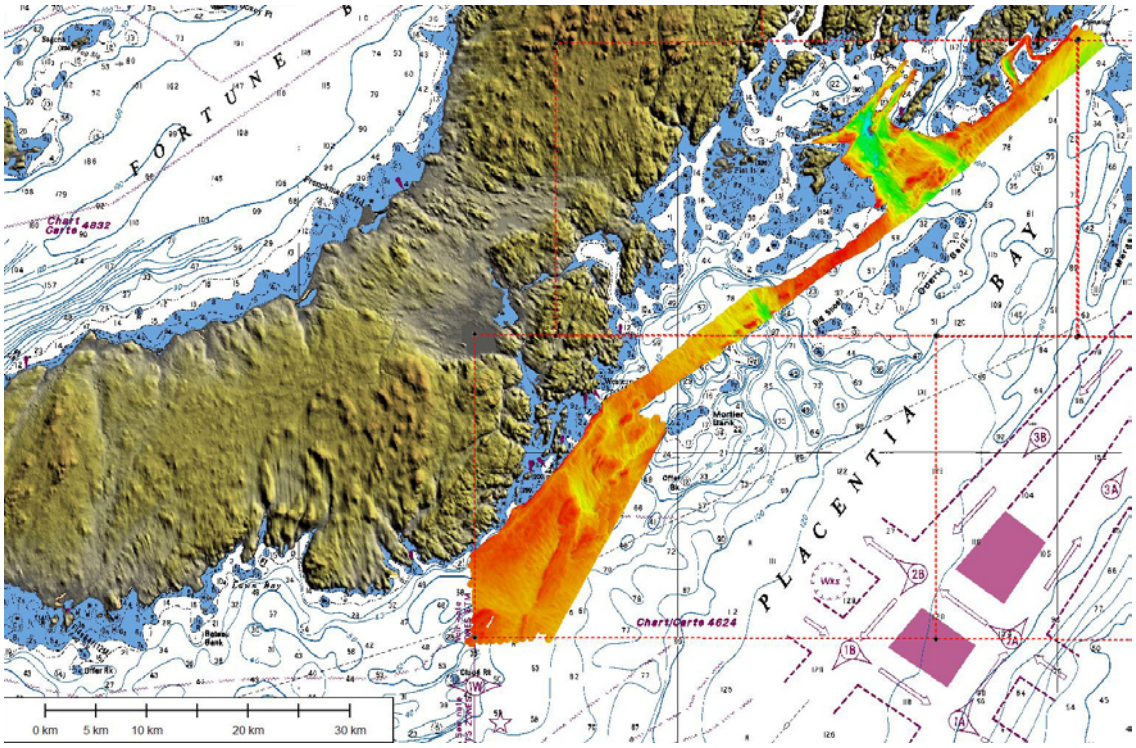

Figure 4: *F.G. Creed* surveys up to 19 July 2005 (JD 200).

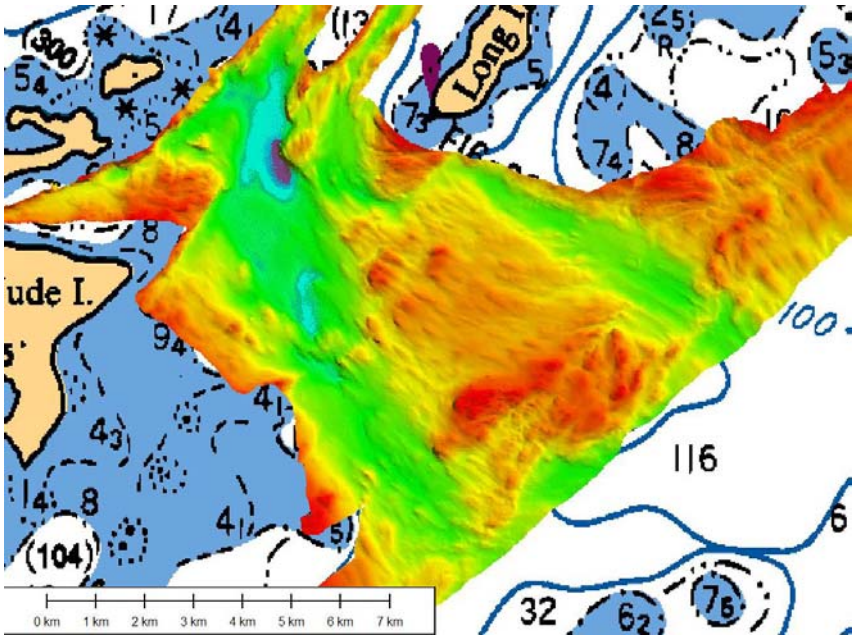

Figure 5: Enlarged view of part of the *Creed* surveys showing streamlined glacial bedforms near Jude Island. Note the variations in flow-line orientation.

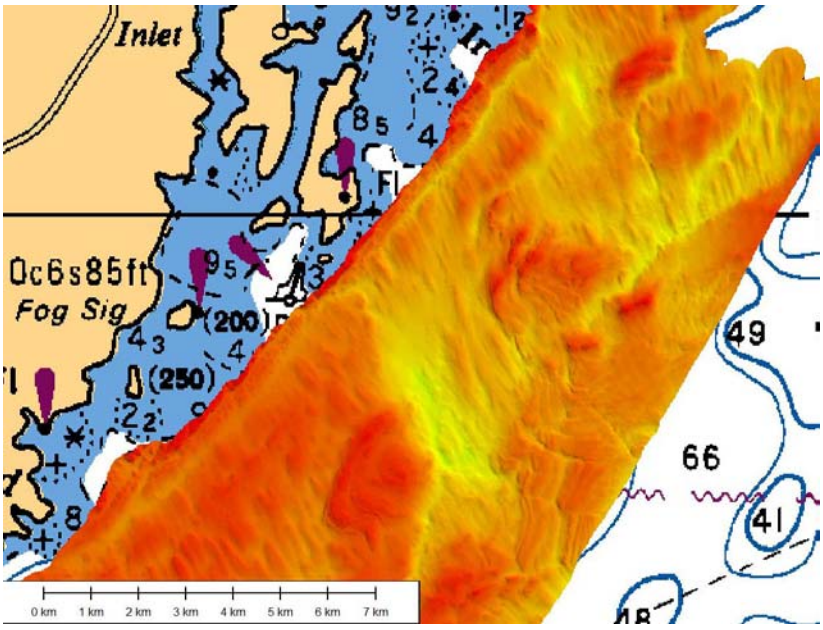

Figure 6: Enlarged view of the southern part of the *Creed* surveys showing streamline glacial bedforms that indicate flow of ice from the NNW.

Central Placentia Bay: Matthew surveys

The imagery resulting from the *Matthew* surveys is shown in Figure 7. The transit line run by *Matthew* on her entry to Placentia Bay shows fluted or drumlinised terrain (Fig. 8) with relief that varies up to a maximum of 40 m. This terrain is an extension of that seen on the *Creed* data. It appears that all the area east of the Burin Peninsula (including Mortier Bank and Oderin Bank), to depths of about 180 m, is comprised of a till sheet that has been drumlinised or fluted. It is probable that this fluted area is actually the extension into Placentia Bay of what Fader et al. (1982) mapped as the Burin Moraine. The marine geology of the central part of the bay, south of Merasheen Bank, appears to be relatively simple. The bedrock ridges (Figure 8) of the bank curve towards the southwest, and reduce in elevation. They disappear below a cover of Quaternary sediments, probably the usual sequence: Glaciomarine Mud (Downing Silt Formation) and Postglacial Mud (Placentia Clay Formation). Pockmarks occur in the postglacial mud. In the north of the coverage (Figure 9) they are mainly circular, but in the south (Figure 10) they are elongated, and up to 500 m long. A large shipwreck (Fig. 11) was mapped during Sunday evening. It is 15 m above the sea floor, 85 m long, and appears to be set into a scour depression that is 1-4 m deep. Subsequently a total of four possible wrecks was identified on the multibeam imagery within the wreck zone marked on the chart.

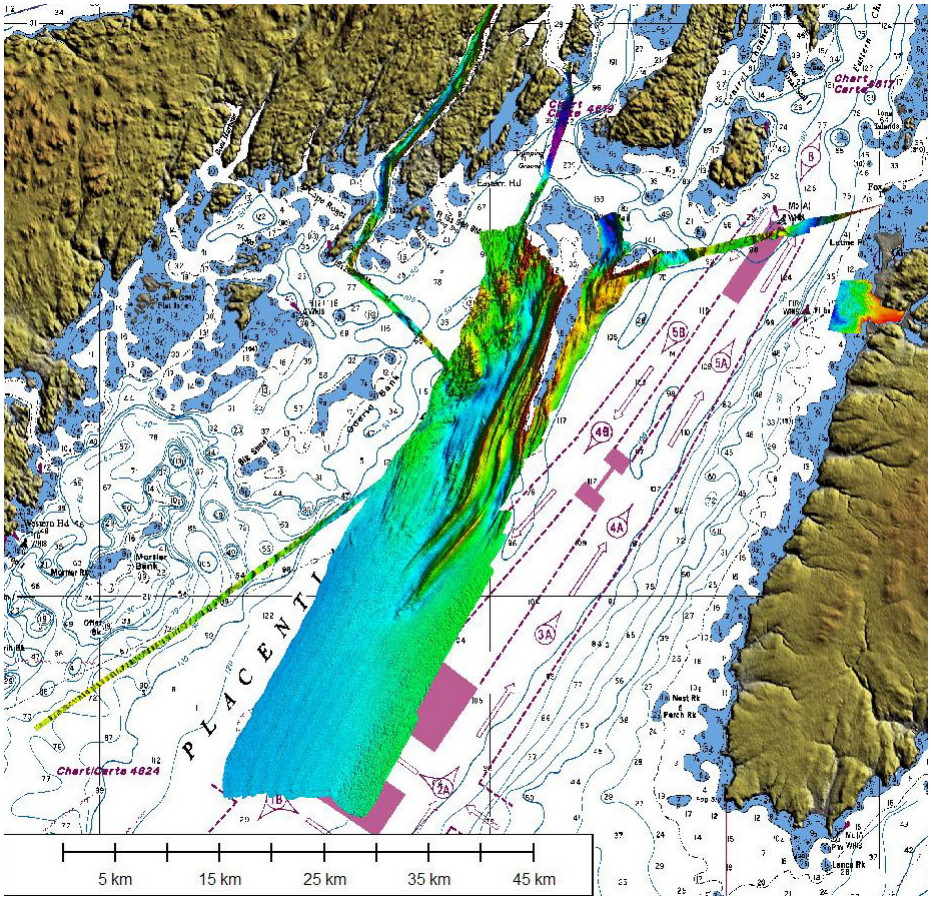

Figure 7: Image of the multibeam mapping by *Matthew* and *Plover*.

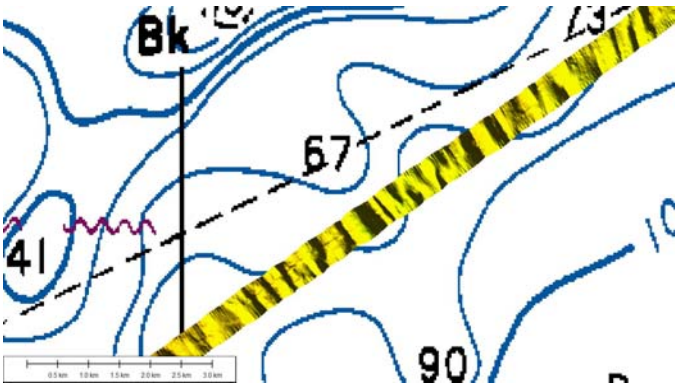

Figure 8: Fluted terrain on the *Matthew* transit line.

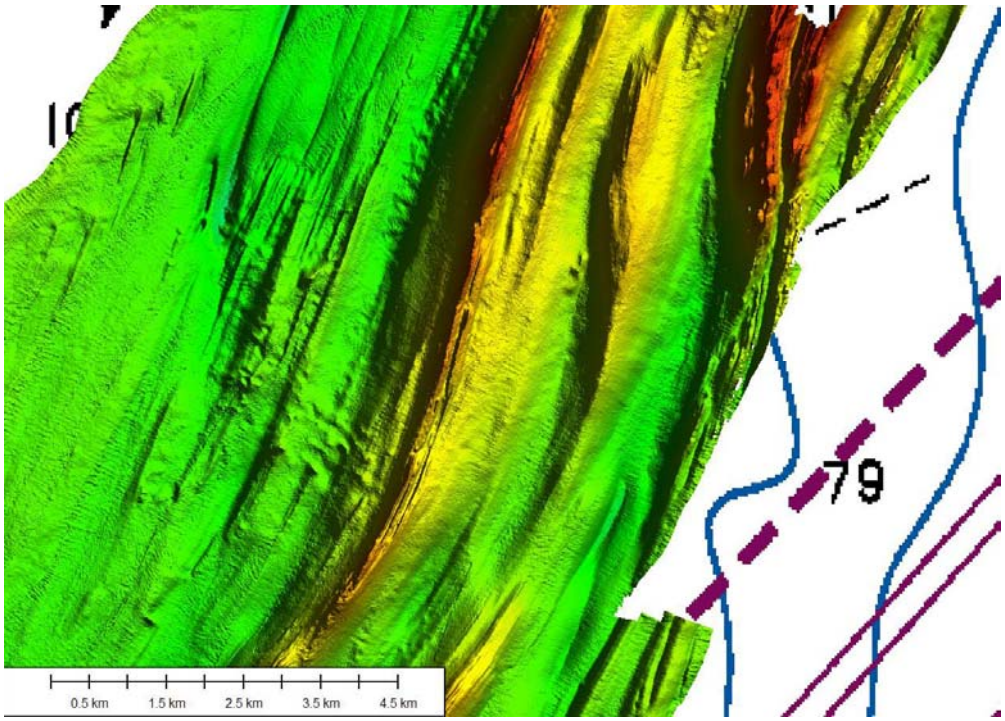

Figure 9: Bedrock ridges south of Merasheen Bank

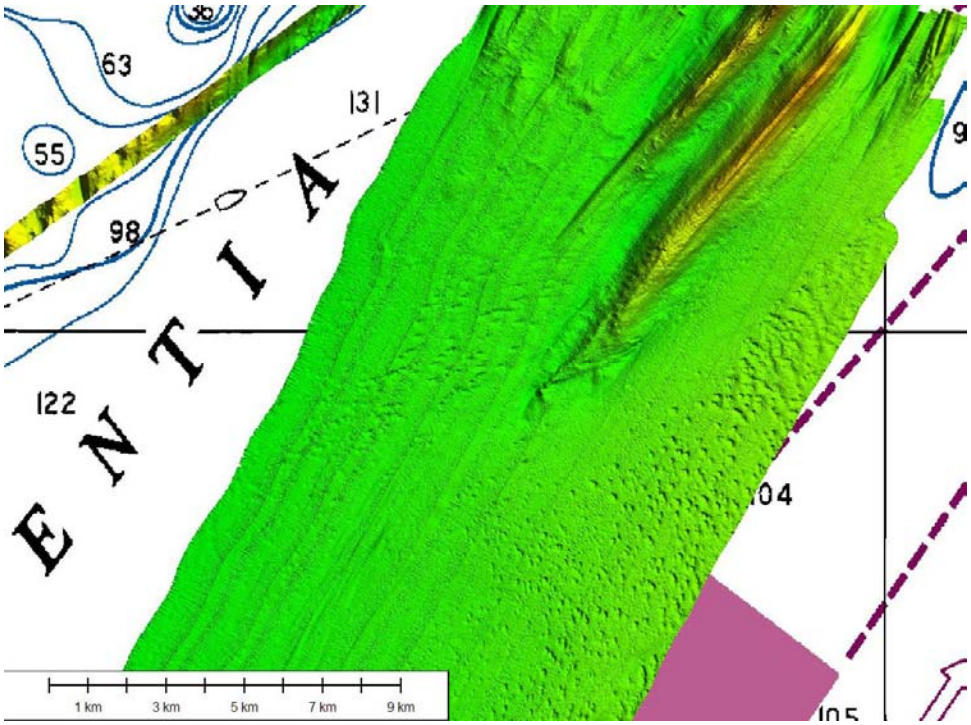

Figure 10: Pockmarks at the north end of the lines.

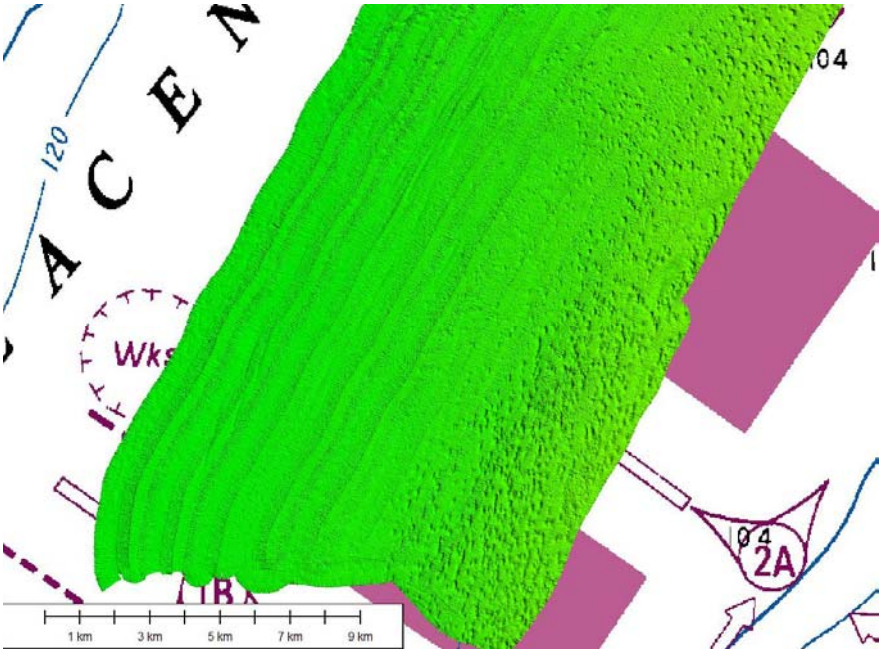

Figure 11: Elongated pockmarks at the south end of the lines.

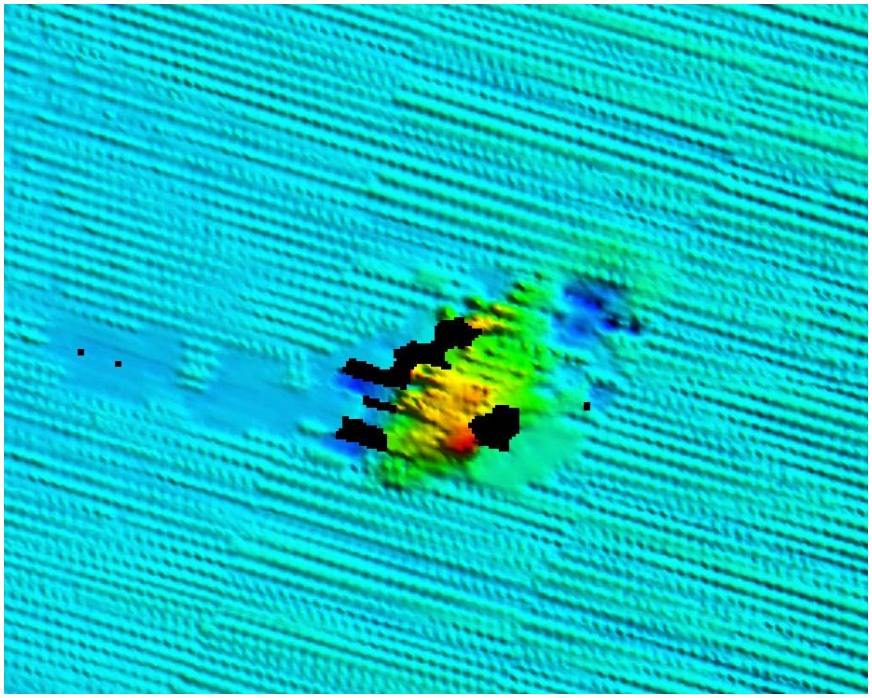

Figure 12: Shipwreck located at 46 53 14.78 N, 54 46 21.58W, water depth 235 m.

Placentia Road and the adjacent offshore area: Plover surveys

This area was surveyed with the EM- 3002 system on board the launch *Plover*. The new imagery is revealing in several respects. First, the offshore area is mainly hard bottom, probably mostly either till or postglacial gravel. On some of the shoals clusters of lag boulders can be seen. Elsewhere bedforms are visible. Gibralter Rock is actually only one of a number of isolated rocky knolls that protrude through the till and gravel in this offshore zone. Privécoeur Shoal appears to be a till shoal, and not a rocky one. Also, it is slightly farther west than it appears on the chart. The till shoal immediately seaward of Point Verde is a residual surface resulting from erosion of the glacial bluffs in this area. Less easily explained is the long narrow ridge extending seaward from the point of land northeast of the Point Verde Lighthouse. It is perhaps a residual structure composed of boulders and formed as a result of retreat of the headland and flanking gravel barriers.

In the inner part of the survey area – Placentia Roads - the most remarkable feature is the shoreface sand sheet that thickens towards the east, i.e., towards the gravel barrier beach at Placentia. This sand sheet has a smooth surface and lower backscatter than the adjacent offshore area.

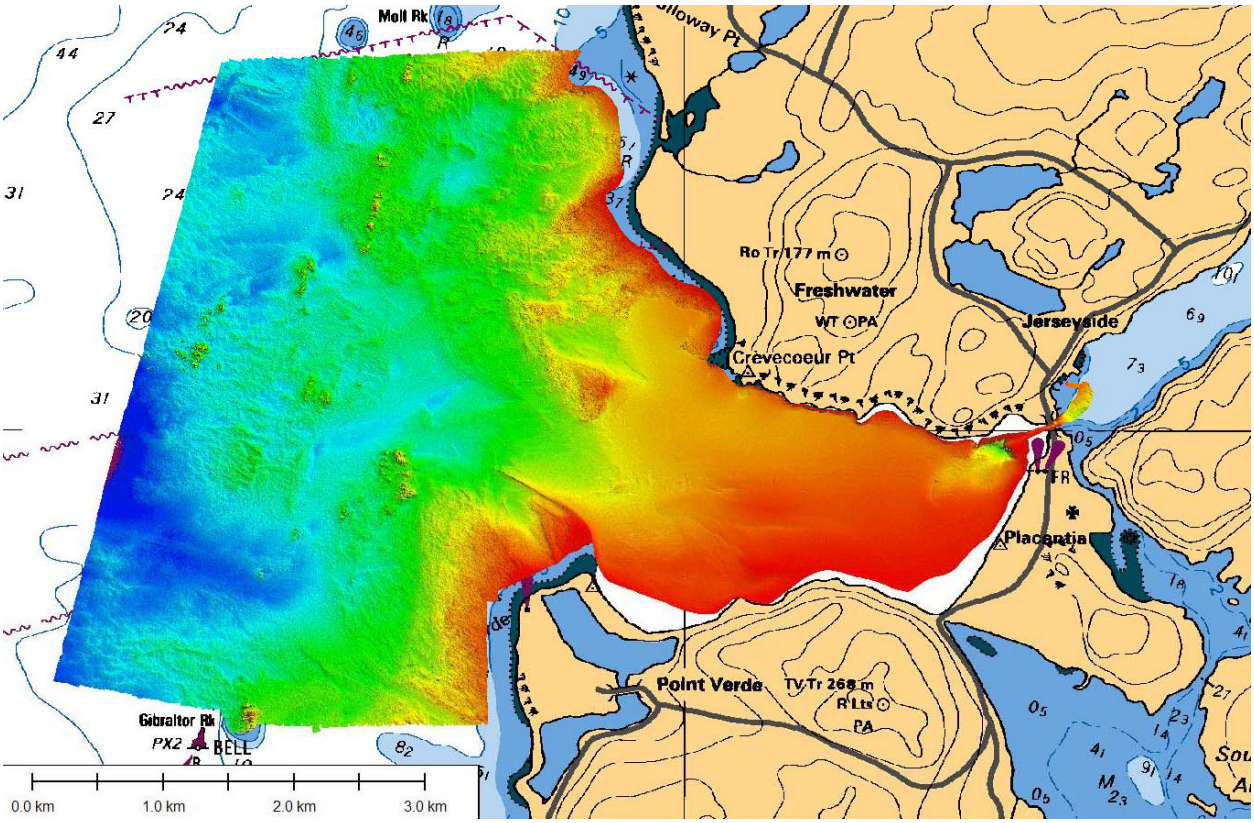

Figure 13: Multibeam image of Placentia Road and adjacent offshore areas. Background is Chart 4841.

ACKNOWLEDGEMENTS

We thank Captain Lockyer and the officers and crew of CCGS *Matthew* for their support during the survey. We also acknowledge Carmen Reid for his work on board the launch *Plover*, in conditions that were trying at times.

REFERENCES

Fader, G.B.J., King, L.H., and Josenhans. 1982. Surficial Geology of the Laurentian Channel and the western Grand Banks of Newfoundland. Marine Sciences Paper 21; Geological Survey of Canada paper 81-22. 37 p. and map.