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**F.G. Creed Expedition 2006-047:  
Multibeam and sub-bottom profiler survey of the  
St. Lawrence Estuary, Matane-Baie Comeau**  
24 August – 03 September 2006



Geological Survey of Canada Open File 5471

2007

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## **GEOLOGICAL SURVEY OF CANADA**

OPEN FILE 5471

### **F.G. Creed Expedition 2006-047: Multibeam and sub-bottom profiler survey of the St. Lawrence Estuary, Matane-Baie Comeau, 24 August – 03 September, 2006**

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## Background

The St. Lawrence River drains the immense Great Lakes catchment area which supports a population of more than 20 million inhabitants. It acts as the principal discharge system flowing into the Atlantic via the Gulf of St. Lawrence. Moreover, the Gulf of St. Lawrence is one of the five priority areas of Canada's Oceans Action Plan, and for this reason, it is of primary importance to carry out surveys of the seabed in this area in order to answer the governmental priorities described in Canada's Ocean Strategy. The region has competing interests in fisheries, marine transport, delineation of cable and pipeline corridors, eco-tourism, as well as requests to conserve increasingly large areas of the seabed.

During 2005, a 1-year exploratory project was set up in order to conduct consultation with stakeholders and potential partners and set target areas, to compile and integrate in a GIS the existing data for the Gulf of St. Lawrence, and to gather new bathymetric data in the study area (Campbell *et al.*, 2005, Campbell *et al.*, 2006 and Bolduc *et al.* 2007, Campbell *et al.*, 2007). This survey is the second fieldwork component of the new "Geoscientific mapping of the St. Lawrence Estuary" project (project X44 of the Geoscience for Ocean Management II Program). The project will deliver digital products, such as charts, databases and interpreted reports of the morphology of the seabed and its sub-surface character, the benthic habitats, the geological risks and the potential resources indicators of fossil fuels, minerals and aggregates. This project will lay the groundwork used for effective marine management of the St. Lawrence Estuary.

The purpose of this survey was to extend multibeam and sub-bottom profiler data coverage in the area between Matane and Baie-Comeau, Québec.

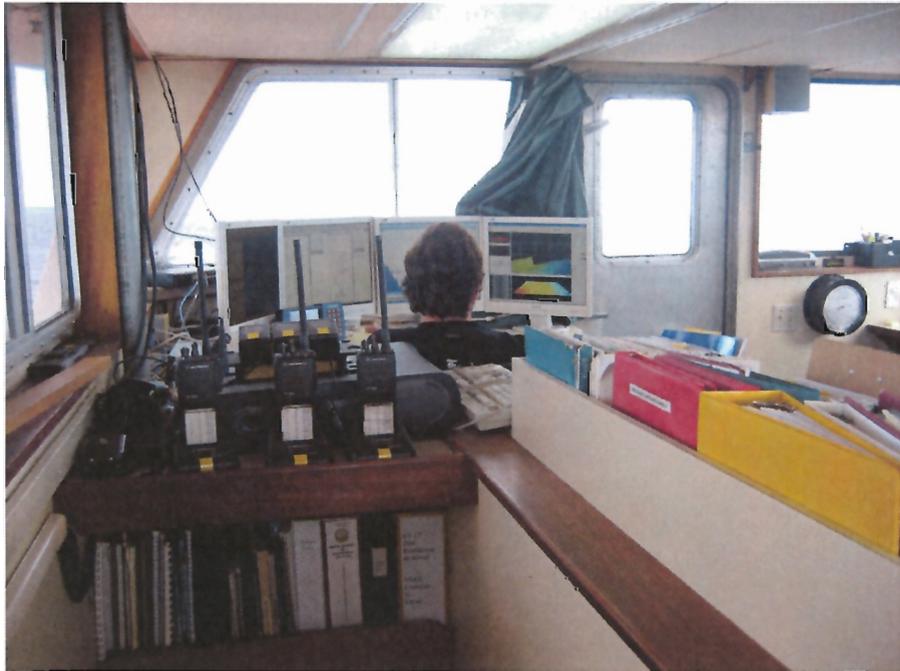
## Acquisition and Processing

The following equipment was used during survey Creed 2006-047:

- Simrad EM1002 multibeam bathymetry system
- Knudsen 320M echo sounder at both 3.5 kHz and 120 kHz
- Brooke Ocean Technology Moving Vessel Profiler MVP200
- Caris HIPS multibeam bathymetry data cleaning software running on Windows XP

### Multibeam Bathymetry

Multibeam bathymetric data were collected using a Simrad EM1002 multibeam bathymetry system mounted in the CCGS F.G.Creed's starboard sponson. The EM1002 system uses 95 kHz transducer with 111 beams at a beam width of  $2.0^\circ \times 2.0^\circ$ . The system provides a depth resolution of 1 cm with an accuracy of 5 cm RMS. Each beam ensonifies an area of approximately  $2.25 \text{ m}^2$  at 50 metres water depth. Simrad's Seafloor Information System software was used (*Figure 1*) for real time acquisition on a Windows XP workstation.



*Figure 1- Multibeam acquisition station on the Creed.*

Survey lines were run in a manner to generate 10-20% overlap in depths greater than 100 metres. During the survey, data were processed using version 6.0 of the HIPS data cleaning program (CARIS by Universal Systems Limited, Fredericton, NB) on a Windows XP workstation to remove spurious soundings, erroneous navigation data and to correct for tidal variations.

### Navigation

An Applied Analytics Corporation POS-MV (Positioning and Orientation System - Motor Vessel) 320 attitude sensing system with an integrated differential GPS navigation system was

used to determine position, heading and attitude of the vessel. RTK (Real Time Kinematic) signal was used to determine position and real time vertical offset from chart datum. The POS-MV system integrates data from an inertial measurement unit, differential GPS signals and RTK transmissions. Positional system accuracy 0.5 to 4 metres can be obtained using the phase differential of the GPS carrier frequency when using DGPS, and of 0.02-0.10 metres when using RTK. A heading aiding accuracy of  $0.1^{\circ}$  -  $0.5^{\circ}$  can be obtained from the raw GPS data. The predictive positioning algorithm Kalman Filter is used to improve the heading estimate to  $0.05^{\circ}$  -  $0.1^{\circ}$ . Vessel attitude is measured using an inertial measurement unit which also serves as Vessel RP (Reference Point) to provide an accuracy of  $0.0003^{\circ}$  for pitch, roll and heading. Tracks and survey lines were run with the Hypack navigation package

### **Knudsen 320M echo sounder**

Sub-bottom profiler data were collected with a Knudsen 320M sounder. The system was used to operate a 3.5 and 120 kHz transducer array installed in the port sponson. Data were stored in KEB (Knudsen Extended Binary) and ASCII format and viewed using the Knudsen Post Survey program.

### **Brooke Ocean Technology Moving Vessel Profiler MVP200**

Measurements of velocity of sound in the water column were made with a Brooke Ocean Technology Moving Vessel Profiler MVP200 equipped with an Applied Microsystems Limited Smart Probe SVP velocimeter. The system was used to provide data for correction of calculated water depths from the Kongsberg Simrad EM1002 multibeam bathymetry data.

## **Results**

### **Multibeam Bathymetry**

Acoustic backscatter intensity values and sounding values were acquired with the EM1002 system (Port and Starboard beams at  $55-65^{\circ}$  from Nadir). GPS tide, attitude, navigation and refraction edits were completed before being ok'd for cleaning. No deviations from what would be "normal" acquisition were observed. On one occasion, JD 242, there occurred a complete system lock up. Finally after a hardboot of the Kongsberg engine compartment UPS, acquisition was once again underway. The area covered for the survey is shown in *Figure 2*.

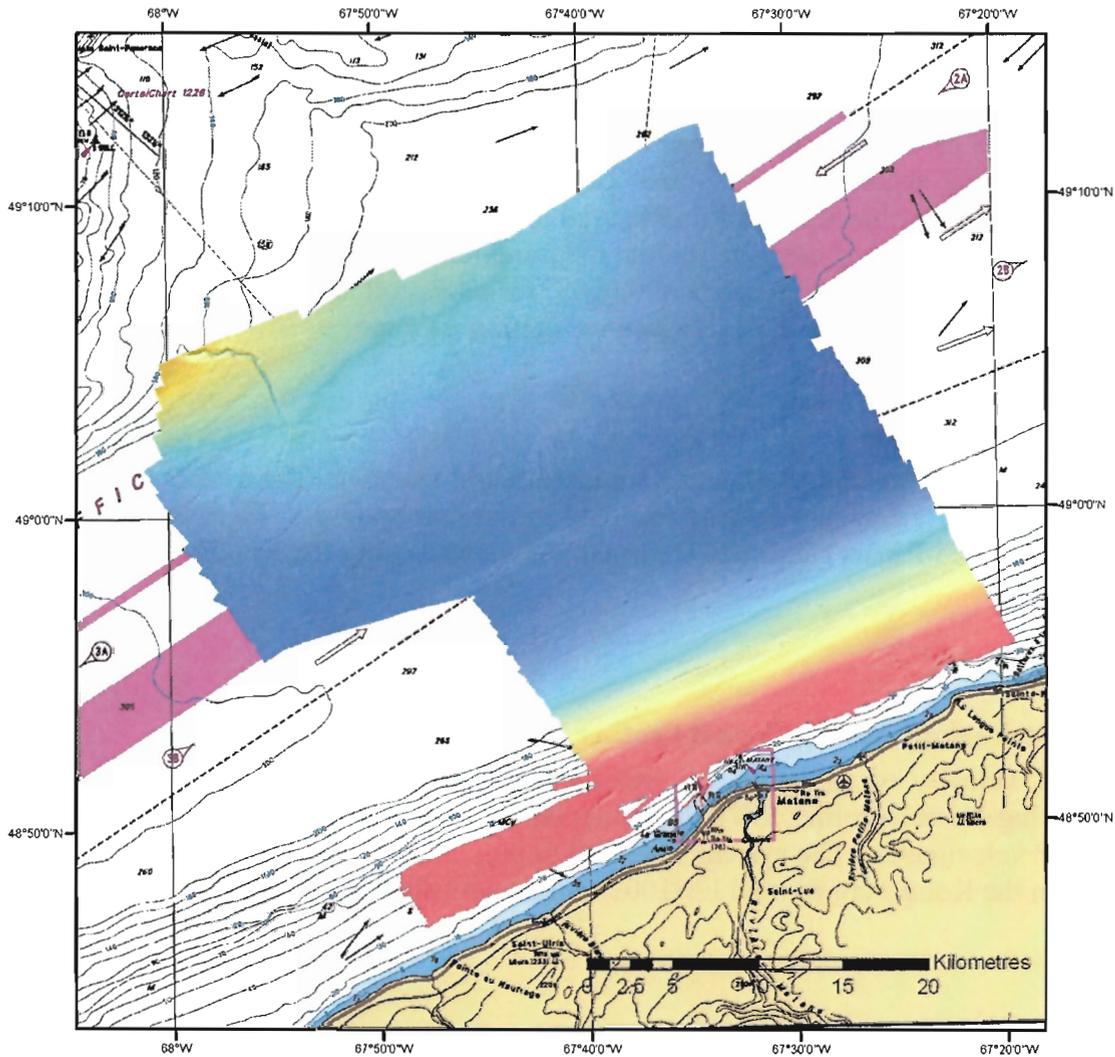


Figure 2- Multibeam data coverage for survey.

## RTK

A positioning array was set up on the rooftop of Centre Hospitalier de Matane where a UHF signal was broadcasted at 431.0 mhz. The configuration consisted of an RTK receiver using a DGPS solution for positioning. The system was run on batteries re-charged by solar panels. A variety of positioning problems were encountered while the survey was underway, mostly due to the inability of the UHF transmission reaching the vessel. This was due to atmospheric interference, inadequacy of amplitude or perhaps simple geometry. On several occasions the quality of the signal was so inadequate that lines startup had to be delayed, most of these occurred when the vessel was at > 35km range from the hospital.

## **Knudsen 320M Echo sounder**

Certain modifications were made to the system since the previous estuary survey.

*Background: it was discovered in late June (Bay of Fundy survey) that the improper installation of the echo sounder transducer contributed significantly to the amount of “noise” in the reception of 3.5 kHz soundings.*

Upon consultation with the chief engineer and the captain, a short term solution was agreed upon; this included adding seawater ballast to fill the air void directly beneath the transducer. The Creed flushed the ballast before transit to Québec. Upon arrival in Matane it was flooded for the purposes of this survey.

After consultation with notes by John Hughes Clarke’s CCGS Matthew trials in May, as well as talking to Mathieu Duchesne of GSCQ, we attempted to optimize the settings to show the clearest image of sub-bottom stratigraphy. The resulting settings were a display overlaying HF120 kHz with the 3.5 kHz data. No discernable data were picked up in the water column via the 120 kHz, but there were still issues of negligible noise in the water column from the installation. Settings were : AGC gain on, power 2, 6 ms chirp, TX blank, and sensitivity off, range adjusted as necessary. Penetration was in the order of 10-15 metres Bottom tracking was much improved. The gain was then decreased on the Knudsen to 25; the records were not as dark as with gain of 35, with some reduction in noise levels. Attempts to remove 20logR spreading loss gain resulted in very weak signals – basically no returns were visible with a gain of 30. After further experimentation, the pulse length was set for a 3 ms chirp to increase the shot rate, the power level set at 2, gain at 35, and a TVG of 20logR applied. Record quality is improved over those acquired with power level 1. Significant coherent noise is present on the records at all times.

## **Logistical comments**

The intention of the survey was to also include magnetic data from the towed Marine Magnetics sea spy magnetometer. Unfortunately due to transceiver communications issues encountered on the previous survey in the Bay of Fundy, the magnetometer remained in the shop at BIO for the duration of the survey. The magnetometer base station was set up at IML as per survey 2006-017 on August 23<sup>rd</sup> and remained logging ambient magnetics in the Mont-Joli area until August 31st. This will be archived but as yet has no utility. It is worth commenting that the quality of data logged at the base station was up to the standard of previous surveys with no issues of power or degradation of signal that were encountered at the first location in June 2005

## **Acknowledgements**

The captain and crew of the *CCGS Frederick G Creed* provided invaluable assistance with data collection. This project was jointly funded by Natural Resources Canada through the Geoscience

for Ocean Management program of the Earth Sciences Sector, and the Canadian Hydrographic Service of the Department of Fisheries and Oceans Canada. Financial contribution from Parks Canada Agency is gratefully acknowledged in return for an earlier survey within the limits of the Saguenay – St. Lawrence Marine Park.

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- Geological Survey of Canada Atlantic internet site at <http://gsca.nrcan.gc.ca>
- Knudsen Engineering Ltd. Post Survey software version 1.43 available at <http://www.knudsenengineering.com/ASP/Products/Products.asp>



**Appendix II- Activities**Creed St. Lawrence Estuary Simrad EM1002, Knudsen 3.5 & 120 kHz August 23,  
to September 03 2006-047

August22nd/JD234

13:00 local, leave Dartmouth en route for Matane QC, bringing magnetometer base station and all relevant peripherals. Tow fish is left behind in order to repair transceiver problem. Will be shipped to Mont-Joli when repairs complete.

18:00 Arrive Bathurst to overnight

JD235

10:00 local, leave Bathurst en route Matane,

11:00 stop in Campbellton to pick up surge protector and survey tape for base station

13:30 arrive Mont-Joli IML to set base station, meet Christine Deblonde and Louis Poliquin for assistance in base station setup. Set up station in lower pump house as per previous surveys, mag mounted about 10 metres south of pump house logging at 55000 nT excellent signal quality.

14:45 proceed to Matane, meet CCGS FG Creed, join Roger Côté, Stéphane Paquet and Christine Deblonde

JD236

10:30 UTC leave Matane to run patch test at a point across the river; winds >20 knts, clear skies, sea state- 1.5-2 m, rough going

12:23 Knudsen logging underway 3.5 and 120 kHz recording data

13:00 Turn back to Matane d/t sea state. No multibeam logging at all

14:32 Tied back in Matane, down d/t weather

15:00 Roger Côté troubleshooting problem with RTK station at Matane Hospital.

Engineer changing oil on main engines battery problems as well, RTK data being stamped with wrong year in NMEA string/fixed

JD237

10:30 Survey day 1; sea state 1 m clear skies, wind 10 knts

12:00 Standby d/t problem with ships batteries

12:45 Scott Hayward and Richard Boisvert leave for Rimouski to pick up replacement batteries for starboard engine

15:30 Return to Creed in Matane with new batteries

17:40 Creed underway leaving harbour breakwater at Matane, skies clear, wind 10-15 knts seas 1 m, heading to North Shore to perform patch test

20:12 Knudsen logging, multibeam logging

20:34 MVP cast

20:46 Patch test underway, SIS logging, patch test of 7 lines at Pointe des Monts NE Baie Comeau

22:10 Patch test complete, heading back to Matane

00:20 Tied in Matane

## JD238

- 10:05 Leave dock at Matane, skies clear, wind <10 knts, sea state <1 m, heading to area of shallow water SW of breakwater to begin lines
- 10:59 MVP cast
- 11:08 Multibeam logging underway running 15 km lines to the SW of Matane orientation SW and NE of Matane wharf
- 11:13 Knudsen logging on LF and HF channels, HF showing negligible data in shallow water, switching recording from stacked to overlaid.
- 00:44 Multibeam finished and sub-bottom stopped logging. 40 lines completed adjacent Matane.

## JD239

- 10:26 Leave dock in Matane for central channel, weather fair, sea state <1 m, wind 5 knts, heading NW 10 nautical miles
- 11:21 MVP cast
- 11:29 Knudsen on and logging
- 12:36 MVP cast line NE 283
- 22:56 Multibeam and Knudsen stopped logging, heading in for the night. 33 lines completed adjacent Baie Comeau
- 00:20 Tied alongside in Matane

## JD240

- 10:35 Leave dock in Matane for inshore lines NE of Matane, Roger Côté on board for the day, skies overcast, winds NE 20 knts, sea state 1 m.
- 10:58 MVP cast
- 11:05 Knudsen logging, still negligible results from high frequency chirper
- 20:15 Tied up in Matane waiting for furnace technician and fuel. 12 lines complete

## JD241

- 10:25 Leave dock in Matane for mid-channel lines, weather fair, sea state 1 m, overcast, wind 5 knts, 6 ms chirp power 2 on LF 3.5 kHz. 200 m range, 300 m water depth
- 10:53 MVP cast 90 m of water
- 10:55 Logging underway on Knudsen and MB system.
- 23:40 Tied alongside in Matane

## JD242

- 10:30 Leave dock in Matane for mid-channel lines, weather fair, sea state <1 m, sunny, wind 5 to 10 knts
- 11:25 MVP cast 300 m of water
- 11:30 Multibeam and Knudsen logging
- 14:30 SIS locks up, whole system rebooted including the Kongsberg UPS in engine room, finally inexplicably system works and we are back on line, approx down time 1 hour
- 22:45 Heading in to Matane
- 00:15 Tied up in Matane

## JD243

10:40 Leave Matane, Roger Côté on board for the day, skies slightly overcast, winds 5 knts, sea state <1 m, SIS problems, restarted 3 times before it would get a lock on bottom, single ping sent out and then a lock up

12:00 MVP cast

13:30 Reboot of POS, positioning problem.

21:00 Conversation with Bruce Wile, part for mag has arrived in Dartmouth  
Unlikely that it can be sent in time

23:15 Tied in Matane

23:30 Taking on fuel

## JD244

10:15 Leave Matane, sea state <1 m, skies overcast winds light from SE

11:38 MVP cast

14:00 Survey down d/t RTK degradation of signal. Roger Côté, going to re-position antennae in Matane, on standby

14:25 Back on line

14:55 Generator trips, ships gyro has no power, heading into Matane for technician

15:55 Arrive in Matane, technician at dock

16:30 Bruce Wile calls to confirm that the magnetometer has been repaired in Dartmouth

16:45 Ship powered down, batteries for gyro removed, Richard Boisvert and Stéphane Paquet head into Matane to find replacements

18:00 Batteries installed, gyro requires 3 hours to settle, survey complete for the day

## JD245

10:25 Leave Matane, sea state <1 m, skies clear winds 5 knts, NE

11:33 MVP cast

13:00 running lines in central traffic channel ENE - WSW direction

17:02 Generator trips, loss of ship's power

17:25 Back on line

00:10 Tied in Baie Comeau

## JD246

10:30 Leave dock in Baie Comeau, skies clear sea state 0, winds 5 knts from the east

11:43 MVP cast, running lines in subsea delta off Manicouagan river

17:15 Power off, rudder locked up - hard to port for 5 minutes

17:20 Engineer diagnosing situation

17:50 Heading to Matane, d/t traffic concerns if steering locks again on next power black out

21:20 Tied in Matane

