

F.G. CREED EXPEDITION 2006-017



Multibeam, magnetometer and sub-bottom profiler survey of the St. Lawrence Estuary north of Cacouna and Matane, May 6th to June 4th 2006

Geoscientific Mapping of the St. Lawrence Estuary

Geological Survey of Canada Open File #5427

2007



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Table of Contents

Staff	3
NRCan-RNCan.....	3
CHS-SHC	3
Acknowledgements	3
Introduction	4
Survey Objectives	4
Daily Log	6
Preliminary Results	19
Technical Summary	22
<i>Survey Vessel:</i>	22
<i>Multibeam System, Simrad EM1002:</i>	23
Data acquisition and processing	23
<i>Knudsen 320 M sub-bottom profiler</i>	25
<i>SeaSpy Marine Magnetometer</i>	26
Procedures for Sea-Spy Magnetometer deployment during this survey	26
Issues	29
<i>Magnetometer Base Station at IML:</i>	31
References-	32

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Michael Furlong	Geo-spatial Technologist	May 6- May 24
Paul Fraser	Remote Sensing Scientist	May 24 - June 4
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CHS-SHC

Roger Côté	Project Mgr: Data Acquisition.	May 6- May 23
David Brisson	Hydrographer	May 6- May 25
Stephane Paquet	Hydrographer	May 24- June 4

Acknowledgements

We would like to thank the officers and crew of the F.G. Creed (Figure 1) for their professionalism, their willingness to try new equipment and the excellent hospitality and cuisine. We would also like to thank the staff at Institut Maurice-Lamontagne (IML) for facilitating the installation of the station magnetometer and for allowing occasional access to check the status of the instrument.



Figure 1- Survey vessel, CCGS F.G. Creed at the dock in Rimouski.

Introduction

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 the St. Lawrence, and to gather new bathymetric data in the study area (Campbell et al., 2005, Campbell et al., 2006 and Bolduc et al. 2006). This survey is the first field work component of the new "Geoscientific mapping of the St. Lawrence Estuary" project (project X44 of the Geoscience for Ocean Management II Program) and will capitalize on the work carried out in 2005-06. The project will deliver digital products, such as charts, databases and interpreted reports of the morphology of the seabed, the 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.

Survey Objectives

The objective of this survey was to increase coverage of the St. Lawrence Estuary from 30 m water depth and deeper. It was also the first field trial of the new sub-bottom profiler installed on the Creed earlier in the spring. The field activities collected over 1200 km² of multibeam bathymetry and backscatter (Figure 2) as well as coincident sub-bottom profiler and magnetometer data in the Estuary between the Saguenay River, including the area upstream from the Saguenay River but within the limits of the Saguenay – St. Lawrence Marine Park, and Pointe-des-Monts, with full coverage from the deepwater portion of the estuary to 30 metres water depth.

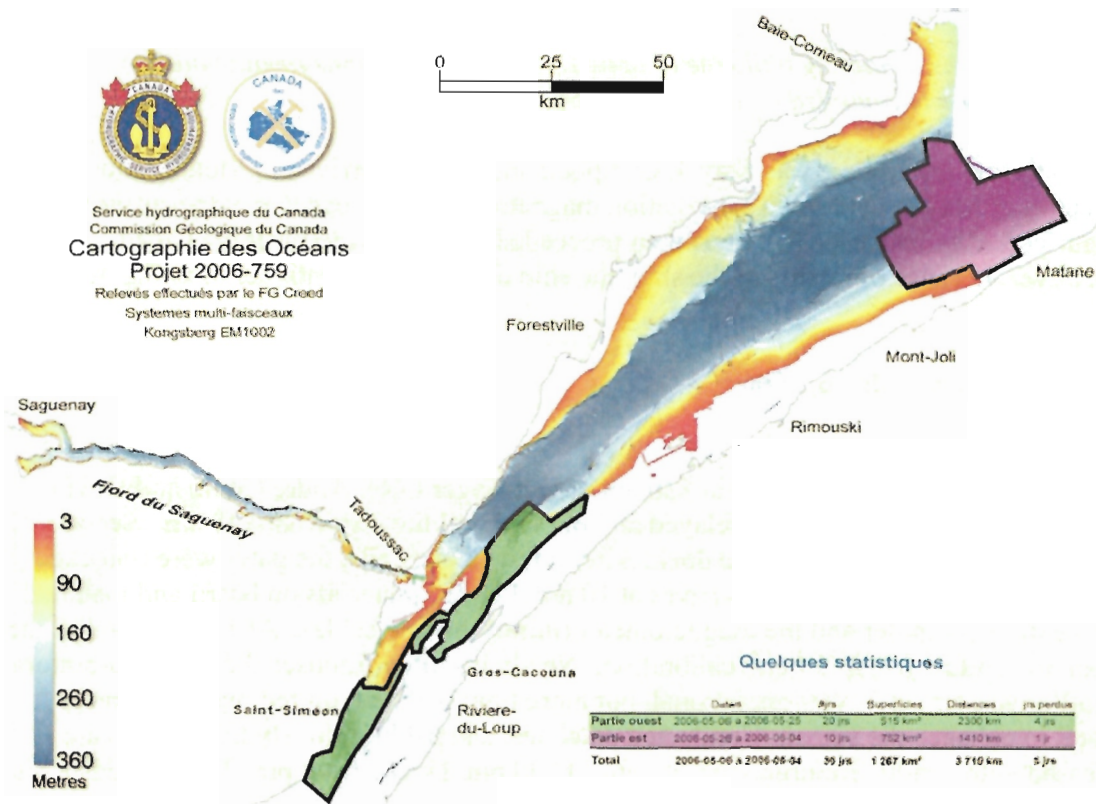


Figure 2- Shaded relief imagery of multibeam coverage in the St. Lawrence Estuary. Coloured areas are data collected up to 2005 and the areas outlined in black are new data collected during this survey. (Image courtesy of Roger Côté, CHS)

Daily Log

The daily log is a running dialogue of activities and observations throughout the expedition and is compiled on a day to day basis.

Note- Original start date was May 4. Campbell and Furlong arrived in Mont-Joli on the evening of May 2. On May 3rd the station magnetometer was installed at the Institut Maurice LaMontagne (IML). Staff then proceeded to Cacouna to meet the Creed. However, because of repairs to the ship, the ship did not arrive until the morning of May 6th.

JD 126, Saturday May 6, 2006

Start of Survey

- Arrive at the dock at Cacouna at 830 am. Meet Roger Côté, André Godin and David Brisson at dock. The Creed is delayed an hour and will not arrive until 10 am. Security gates did not allow access to the dock. After a few phone calls, the gates were unlocked and access was granted. Creed arrives at 10 am. Loaded materials on board and installed processing computer and the magnetometer (minus the tow cable). At 130 pm we left the dock to conduct patch test and calibration. Newly installed Knudsen 3.5 kHz sub-bottom profiler was tested. It was operational, but more time will be required once the survey starts to enhance the signal. Conducted patch test and calibration. Hydrographers are pleased with results. Returned to Cacouna at 730 pm. Docked at 9 pm. The Creed is a bit cramped with a total of 9 persons onboard.

JD 127, Sunday May 7, 2006

Survey Lines 000-032

- Sailed from Cacouna at 7 am. Steamed to just west of Isle Verte and conducted velocity cast. Winds high in the morning (20kts), tapering off in the afternoon. Collected high quality bathymetry data with very little refraction or survey artifacts. Surveyed over several large bedforms and circular mounds. Sub-bottom profiler penetrates to subsurface reflector at least 15 m deep over a lenticular, acoustically transparent interval. Otherwise, the seabed appears hard with little penetration. There was significant ringing in the 3.5 kHz data early in the day which decreased in the afternoon so may have been a function of the seastate. Returned to Cacouna in the early afternoon so André Godin could disembark (lost 1 hour of data collection). Continued to survey until 7 pm, then returned to Cacouna.

JD128, Monday May 8, 2006

Survey lines 033-058

- Sailed from Cacouna at 630. Steamed to north of Isle Verte and conducted velocity cast. Collected good quality data. At 630, stopped surveying and steamed to Tadoussac.

- Campbell disembarks in the morning in order to drive to IML and pick-up magnetometer cable, some materials for Coast Guard for the ship, and to check the

station magnetometer. Arrives at IML at 915 am. The station magnetometer is operating and appears to have had no down time since installation. After picking up materials, it was decided that the ship would dock in Tadoussac that evening and so the remainder of the day was spent switching vehicles and transiting to Tadoussac.

JD129, Tuesday May 9, 2006
Survey lines 059-086

- Sailed from Tadoussac at 630 am. Steamed to where survey finished the previous day, just north of Isle Verte. Collected good quality bathymetry data for half the day, then lost RTK signal and had to move to the southwest.

- In the morning, installed magnetometer cable and performed deck test. Deployed the magnetometer at 10 am. The instrument experienced some communication difficulties with both the navigation serial port and the magnetometer serial port. It appears that Windows creates a hardware conflict when the computer is powered up with incoming data streams from the com ports. The solution appears to be detaching all devices before booting the computer.

- In the late afternoon, ship was called to assist the CCGS Tracy to retrieve a beached buoy on Isle Verte. Conducted bathy survey near the shore to allow close access for the Tracy.

- Returned to Cacouna at 7pm.

JD130, Wednesday May 10, 2006
Survey lines 87-119

- Sailed from Cacouna at 615. Headed back towards area from previous day, near Isle Verte. Conducted velocity cast and deployed magnetometer. Left early to try to collect some data before the wind became too strong.

- Communication problems were encountered once again with the magnetometer. The problem appears related to Windows, and a device conflict appears when the logging computer is booted while active devices (either the GPS or the magnetometer) are attached to the serial port. The solution appears to be to power down then magnetometer, disconnect the com ports, boot the computer, then power up the magnetometer and connect the com ports.

- Collected good quality data in the morning. In the afternoon the weather deteriorated and we moved to the southwest. Sub-bottom data was o.k. with some sub-surface penetration where the geology allowed.

- Returned to Cacouna at 6 pm. Andrée Bolduc arrives and will sail the following day.

JD131, Thursday May 11, 2006

Survey lines 120 – 145

- Sailed from Cacouna at 6:30. Conducted velocity cast and deployed magnetometer.
- Andrée Bolduc arrives in the morning and spends the day on board to check on the project progress and assist with processing the data.
- Strong wind forced relocation to another area part way through the day. The waves were manageable in this new area and surveying continued.
- First officer conducted familiarity tour of the Creed today.
- The sub-bottom profiler was not integrating the ships heave into the calculations, resulting in poor data acquisition. We determined that the baud rate must be set to 19200 on COMM port 2. After this the data quality improved.
- Since Cacouna is 1.5 hr drive from IML, Stéphane Paquet from CHS at IML checks to see if the magnetometer base station is functioning properly.
- Returned to Cacouna at 5:15pm. Calvin and Andrée depart ship at 6pm for Québec City.

JD 132, Friday May 12, 2006

- Previous evening the cook had a medical issue arise, which needed attention at a clinic. Captain decided he would not sail with less than 4 crewmembers. Spent the day at Cacouna port until a fourth crew member was onboard. As a result it was decided that Roger would drive cook to the nearest clinic at 7am, then Roger and David drove to Tadoussac to attend to their tide gauge. Mike stayed on board to continue cleaning data. Maurice (cook) returned to the ship at 9:45am.
- Magnetometer base station is checked to see if it was functioning properly.

JD 133, Saturday May 13, 2006

Survey lines 146 - 175

- Roger and David setup a RTK station at Cacouna. Steamed to the start of the first line at 8:30am. At 9:15 we conducted the velocity cast, deployed the magnetometer, and started collecting sub-bottom data.

- Due to a problem with the sub-bottom profiler, the ship heave was not being calculated, which can cause some error in the output. As it is Saturday, there is no one we can call to try to get this fixed. Luckily there is no heave today, and the water is calm, so we'll keep collecting data as is.

- At around 3pm the magnetometer fish got some seaweed tangled on its fin, causing the cable to twist up very tightly, very quickly. The magnetometer was brought back in for repair, which was not possible on the deck. The repairs needed to be done on the wharf; therefore no more magnetometer data was collected for the remainder of the day. The repairs went well and the magnetometer was fully functional.

(Note: the data logging was not stopped until the magnetometer was detached from the cable, so the data for the last 10-15 minutes should be disregarded.)

- Docked at Cacouna at 7pm.

JD 134, Sunday May 14, 2006

Survey lines 176 - 212

- Left Cacouna at 7 am, and conducted velocity test and deployed magnetometer shortly after. Winds are light today, the magnetometer is working well after repairs to the tow cable, and the sub-bottom profiler is collecting good data.

- We surveyed a shipwreck this morning at 48°00'03.29" N, 69°38'35.76" W . Both the multibeam and magnetometer data for the wreck looked great.

- Magnetometer tow cable became twisted once again due to seaweed becoming attached to fin. Luckily it was noticed very quickly and was not as bad as the previous day. The magnetometer was brought on deck mid-morning, repaired on the ship, then redeployed at 11:30am. It worked fine.

- Last line of the day was finished at 6:15. Magnetometer was brought in, and we started steaming to Tadoussac for the night.

JD 135, Monday May 15, 2006

Survey lines 213 - 242

- Left Tadoussac at 6am. Reached starting location at 7am, where we conducted velocity test, deployed magnetometer and began the sub-bottom profiler. The first hour of magnetometer data had no GPS coordinates attached.

- The magnetometer was pulled on deck at 12:15 for transit to another location. Due to a problem with the sub-bottom profiler, the data was not logging until this time.

- We are doing a small survey of the mouth of the Saguenay River, and the captain has requested that we keep the magnetometer on board until it is finished due to increased traffic in this area. Conducted a second velocity cast at 1:40 pm near Tadoussac. Turned off the sub-bottom profiler while surveying the mouth of the Saguenay River because a good reading was not possible.
- Crew conducted safety drill in the afternoon consisting of fire drill, lifejackets and lifeboats drill.
- Returned to port at Tadoussac at around 6pm. Roger, Mike, & David went to Baie-Sainte-Catherine to dismantle and retrieve the GPS station.
- Someone from CHS at IML went to the magnetometer base station to check if it was functioning properly.

JD 136, Tuesday May 16, 2006
Survey lines 243 - 263

- Roger and David set out at 5:30am to set up a new GPS station at Saint-Siméon. The Creed left port at Tadoussac at 6:15 and steamed to Saint-Siméon to pick them up at the dock. After a short steam, we conducted a velocity test, deployed the magnetometer, and started collecting sub-bottom data. We are still not getting the ship heave info incorporated into the sub-bottom software. We hope to get someone on board to repair it Wednesday or Thursday.
- Someone from CHS at IML went to the magnetometer base station at the end of the day to check if it was functioning properly. They made a backup copy of all data collected so far (JD 123 – 136).
- Retrieved magnetometer at 6 pm.
- Tied up in Cacouna in preparation for tomorrow's crew change.

JD 137, Wednesday May 17, 2006
Coast Guard Crew Change

- Spent the entire day tied up in Cacouna for crew change. Mike, David, and Roger spent the day processing data.

JD 138, Thursday May 18, 2006
Calibration and Repairs to Multibeam System

- The first mate had a family emergency, and had to leave the ship first thing in the morning. A search is underway for a replacement crewmember. In the meantime we will sail short one crewmember.
- André Godin (CHS) and Ted Chapman (Kongsburg) met us at the Cacouna dock at 7am and came aboard for the day to help fix our multibeam system. So far the data collected has had a lot of error in it, so some parts were replaced and the system tuned, and it is now collecting better data.
- André brought Mike the backups of the magnetometer data. Looks good.
- Left Cacouna at 7am and steamed to the mouth of the Saguenay River to run test lines. The weather was bad and the waves large, and this area was fairly sheltered and provided a descent area to use for calibration.
- Collected some sub-bottom data for the first part of the test run. Bad weather and the local geography eventually decreased the data quality. Due to this plus the fact that we were going in circles, the echo sounder was shut off.
- Magnetometer data was not collected today. After finishing working in the Saguenay river area, the LRK GPS base station was moved to the Cacouna dock. Today's survey area was out of range of this station, so we had to switch to a differential GPS system (POSMV). This system has only 5m accuracy (compared to the 1cm accuracy LRK system we have been using), and outputs its navigation strings differently. The magnetometer software would not accept as input this navigation data due to the different strings. Therefore, although we towed the magnetometer, we could not synchronise the magnetometer data to the GPS, making it impossible to collect any useable data. In the future, if this GPS system must be used, we will need to find a way to either alter the output navigation strings to feed into the magnetometer system, or alter the magnetometer software to accept the alternate navigation string format.
- Returned to Cacouna at 2pm, at which time Ted and André disembarked. Mike, Roger, and David continued to process data for the remainder of the day.

JD139, Friday May 19, 2006
No Data Collected (Weather)

- Steamed out of Cacouna at 7am to head to start of survey for the day. High winds and very large waves forced us to turn around at 8:40am. We arrived back at Cacouna at 11am. No surveying was conducted. Mike, Roger, and David spent the day processing data onboard.

JD 140, Saturday May 20, 2006

Survey Lines 266 - 293

- Steamed out of Cacouna at 6:45am to head to start of survey for the day. Performed a velocity cast at 7:30am, then deployed the magnetometer and started collecting sub-bottom data. Winds light with not much heave.
- Echo Sounder still not tracking the ship heave. The solution to getting this to work is to turn off the computer, restart the Knudsen 320, then restart the computer. Set COMM port 2 as a TSS1 connection with a Baud rate of 19200. Once we got it working (at around the start of second line of the day) we started recording data.
- Retrieved the magnetometer at 8pm and steamed to Saint-Siméon to tie up for the night so that Roger and David could check their GPS station. Conditions were too rough there, so we went to Cacouna instead. Tied up at Cacouna around 10:15pm.

JD 141, Sunday May 21, 2006

Survey Lines 294 - 324

- Steamed out of Cacouna at 6:30am to head to start of survey for the day. Performed velocity cast and then started collecting data around 8am.
- Our GPS signal coming from Cacouna is getting weaker as we move further away, so a relay station must be set up. We brought in magnetometer at 3:30 to drop David off at Saint-Siméon so he can go set up the relay station.
- Re-deployed magnetometer at 5pm and continued surveying.
- Brought in magnetometer at 7:16pm, turned off Echo sounder, and headed to Saint-Siméon to pick up David. Picked up David at 8pm, and tied up at Cacouna at 9:45pm.
- Magnetometer base station still being check everyday by Stéphane Paquet (CHS / IML)

JD 142, Monday May 22, 2006

Survey Lines 325 - 361

- Left Cacouna at 6:45am to head to start of survey for the day. Performed velocity cast, then magnetometer in the water at 8:45, collecting sub-bottom data.
- Magnetometer was retrieved at 12:17pm to perform a velocity cast, and then redeployed at 12:35pm. The GPS signal relay station set up last night isn't working because of a peninsula cutting out between the source and the relay.
- Magnetometer lost its GPS signal at 1:03pm because we had to switch to the POSMV GPS system due to being out of range of the GPS base station. This is necessary to

survey 5 lines, which are out of range. Unfortunately the output string of this system isn't compatible with the SeaLink, as discussed on JD138. We attached David's personal GPS system (Garmin ETREX) to the computer and set the system to receive its GPS signal from that. This system has a resolution of 5-10m. We continued logging data in this method at 1:27pm. Pressure for the magnetometer had to be set while in the water since we didn't retrieve it during this blackout period. Pulled in gear at 4:30

- Tied up at Saint-Siméon to retrieve GPS station at 5pm. Steamed to Cacouna and tied up at 8 pm.

JD 143, Tuesday May 23, 2006
Survey Lines 355 - 367

- Stéphane Paquet came aboard this morning to join the survey. He will be replacing Roger, who will leave tonight. David left the Creed at 7:30 am to go set up a new GPS base station and collect the relay station.

- Left Cacouna at 8:30 am to head to start of survey for the day. This morning we will be filling in the holes from the lines, which were discarded due to poor quality. Performed velocity cast at 9:05 am, then deployed the magnetometer and started collecting data.

- Took magnetometer out of the water at 10:40 am. We are going beyond our GPS signal range, so we must go set up a new base station. Steaming to Les Escoumins.

- Turned off sub-bottom at 11:45 am and tied up at Les Escoumins. Left Les Escoumins at 2 pm. Performed velocity cast at 2:30 pm, then put magnetometer in the water and started recording sub-bottom.

- Finished last line at 6:50 pm. Retrieved magnetometer and stopped logging sub-bottom data. Returned to Cacouna at 7:30 pm

- Calvin Campbell, Paul Fraser, and Philippe-Xavier Normandeau join the ship. Roger leaves.

JD 144, Wednesday May 24, 2006
Survey Lines 368 to 398

- Left Cacouna at 7:00 am to start surveying for the day. Performed velocity cast and deployed magnetometer. Philippe and Paul were trained to process multibeam using Caris HIPS. Collected data for Survey Lines 368 to 398

- Finished the last line for the day at 5:30. Recovered the magnetometer and steamed to Cacouna. Calvin Campbell and Mike Furlong left the Creed to travel back to BIO.

JD 145, Thursday May 25, 2006

Survey Lines 399 to end of survey Estuaire-ouest.

- Sailed from Cacouna at 6:45 am. Started logging 3.5 kHz sub-bottom data at 7:15 am. Performed velocity cast at 7:45 am. Deployed magnetometer and started collecting data at 8:00 am. Finished collecting data and recovered magnetometer at 5:10 pm to begin the steam to Rimouski where we will dock for the night.

JD 146, Friday May 26, 2006

No Survey Lines Collected

- Sailed from Rimouski at 7:25 am to investigate a shipwreck that was found in previous data. Roger is back on board with two guests from CHS. Started logging the sub-bottom profiler at 7:15 am. Made a couple of multibeam passes over the wreck at 8:15 am then turned towards Rimouski to drop off our visitors. Stopped logging sub-bottom data at 9:10 am.

- Tied up in Rimouski at 9:15 am. The ship remained tied up in Rimouski for the rest of the day to take on fuel and supplies.

- Stéphane and Paul drove from Rimouski to Cacouna at 10:00 am to move the vehicles back to Rimouski. They arrived back in Rimouski at 12:30.

- Stéphane and Paul left Rimouski at 1:30 pm to drive vehicles to Matane where we will be docking for the remainder of the survey. They returned to Rimouski at 4:00.

- Philippe spent the afternoon processing data.

JD 147, Saturday May 27, 2006

Survey Lines 1 – 26 in a new project (Estuaire – est)

- Sailed from Rimouski at 6:30 am to steam toward the eastern portion of the survey area. Today will be the first day of collection in this area. Started logging sub-bottom data at 7:30 am but had problems getting the heave corrections.

- Performed a velocity cast at 8:15 am. There were problems getting the profiler to dive deep enough to get a reliable profile. The problem was caused by erroneous soundings from the ship's sounder. The sounder would return depths that were much less than the actual water depth which would cause the safety mechanism on the profiler to stop the descent. After turning off the safety, a good velocity profile was achieved by manually lowering the profiler.

- Deployed the magnetometer and started collecting magnetic and multibeam data at 8:50 am. Passed over a shipwreck at approximately 4:00 p.m. with no noticeable spike in the magnetic data. Recovered the magnetometer and stopped logging data at 6:15 pm. Started steaming towards Matane where we will tie up for the night. Tied up in Matane at 7:50 pm.

JD 148, Sunday May 28, 2006

Survey Lines 27 - 56

- Sailed from Matane at 6:30 am to steam toward start of survey for the day. Started logging sub-bottom profiler at 6:50 am, performed sound velocity cast at 8:00 am, and deployed magnetometer and started collecting data at 8:15 am.

- Passed over the shipwreck from JD 147 with a noticeable spike in the magnetic data and on the sub-bottom profile. Recovered the magnetometer at 12:00 pm to remove seaweed from the fins that was causing the tow cable to twist. Redeployed and started logging again at 12:05 pm.

- Recovered the magnetometer at 3:15 pm to perform another velocity cast. Magnetometer was back in the water and logging at 3:30 pm. Passed over another shipwreck at 3:40 pm with a strong response on the magnetometer and a spike on the sub-bottom profile.

- GPS timed out on the magnetometer at 6:25 pm. The time was resynchronized and logging was started again. Recovered magnetometer and stopped collecting data at 7:00 pm to start steaming towards Matane. Tied up in Matane at 8:00 pm.

JD 149, Monday May 29, 2006

Survey Lines 57 – 82

- Sailed from Matane at 6:30 am and started logging sub-bottom profiler at 6:50 am. Performed velocity cast at 7:20 am. Deployed magnetometer and started logging data at 7:30 am.

- Magnetometer timed out from GPS time at 7:55.

- Recovered magnetometer to perform another velocity cast at 8:00 am. The magnetometer was redeployed and logging again at 8:15. At this time we were having GPS positioning problems so the boat circled for five minutes until the problem was solved. Started collecting data again at 8:20.

- At 9:53 am the magnetometer timed out again and was recovered to remove some seaweed from the fins. After some problems with time synchronization logging was started again at 10:10 am

- At 1:15 pm the magnetometer was recovered and the survey was stopped due to problems with the GPS base station at Matane. There had been problems throughout the morning and someone from IML in Mont-Joli was sent to investigate. The problem was with the solar panel which was not charging the batteries properly.
- At 2:50 pm the problem was solved and data collection started again.
- At 6:30 pm the magnetometer was recovered and at 6:55 pm the logging was stopped on the sub-bottom profiler. Tied up in Matane at 7:15 pm

JD 150, Tuesday May 30, 2006
Survey Lines 83 – 112

- Sailed from Matane at 6:30 am and started logging sub-bottom profiler data at 6:55 am. A velocity cast was done at 7:30 am. Magnetometer was deployed and data logging was started at 7:40 am.
- Magnetometer was recovered at 8:25 am and another velocity cast was conducted. The magnetometer was logging again at 8:40 am. At 10:47 am multibeam collection was stopped to allow the batteries in the GPS base station to be changed (solar panel is still not working). Data collection was started again at 10:53 am
- The magnetometer was brought on board and logging was stopped for the day at 6:00 pm to start the steam back to Matane. The logging was stopped on the sub-bottom profiler at 6:40 pm and we tied up in Matane at 7:15 pm.

JD 151, Wednesday May 31, 2006
Coast Guard Crew Change Day

- Today was crew change day so no data was collected. Stéphane, Phillipe, and Paul spent the day on board cleaning data. The data from days 148 – 150 have some refraction problems.

JD 152, Thursday June 1, 2006
Survey Lines 113 – 130

- This morning we waited at the dock for a technician to come to check out an apparent problem with the stabilization system of the ship. After it was checked and given the OK, we sailed from Matane at 11:20 am.
- Roger Côté on board today with Bruce McGowan from CHS in Dartmouth. Roger will be showing Bruce the systems on board as Bruce will be the hydrographer for the Bay of Fundy cruise.

- Started logging the sub-bottom profiler at noon and we stopped at 12:15 pm to perform a velocity cast. Started collecting magnetometer data at 12:35 pm.
- Experienced problems with the network throughout the day today. At 4:40 everything was shut down so that the network router could be reset. This seemed to solve the problem.
- Stopped collecting multibeam data at 6:50 pm. At this time the magnetometer was recovered and we stopped logging sub-bottom data as well. Steamed to Matane and tied up there at 8:00 pm.

JD 153, Friday June 2, 2006
Survey Lines 131 - 158

- Sailed from Matane at 6:40 am and started logging sub-bottom data at 6:50 am. At 8:45 am we stopped for a velocity cast and to deploy the magnetometer. Started logging magnetometer data at 8:10 am. There was another problem with the network this morning so everything was shut down and the router was reset. There were no further problems throughout the day.
- At 4:40 pm there was a problem with a large piece of driftwood caught at the bow of the ship, so the magnetometer was brought on board so the ship could maneuver to try to remove the wood. The magnetometer was back in the water and logging again at 4:55 pm.
- Stopped collecting data for the day at 6:10 pm and the magnetometer was brought on board at this time. The sub-bottom profiler logged until 6:20 pm.
- The magnetic data was very interesting today as there was a steep gradient between very low data values at the Eastern end of our survey lines and very high values at the western end. Collected good sub-bottom profiler data today with penetration better to a strong reflector at 10m below an acoustically transparent layer. Although the system appeared to be getting good heave corrections throughout the day, the data seemed to be negatively affected by the roll of the vessel at times.

JD 154, Saturday June 3, 2006
Survey Lines 159 - 188

- Today we sailed from Matane at 6:30 am and started logging the sub-bottom profiler at 7:00 am. The magnetometer was deployed and logging began at 7:55 am. There was no velocity cast performed at this time as we were in the same area as yesterday and the water temperatures were the same. We started the day by running a check line of multibeam data across the data from yesterday to help with the correction of the

refraction problems. There are problems with the multibeam acquisition computer this morning as it is intermittently not displaying the data that is being collected.

- At 8:50 am stopped collecting multibeam data to restart the acquisition computer. We were back online again at 9:00 am. At 9:30 am stopped again as the problems with the CPU continued. Stéphane was able to get the acquisition computer going again after multiple restarts and we were collecting data again at 10:00 am

- At 1:00 we recovered the magnetometer to perform a velocity cast. There was a problem with the winch on the MVP, which caused some delay. The magnetometer was back in the water at 1:45 pm.

- We stopped logging all data at 7:30 pm and started the steam to Matane. At this point the moving vessel profiler is still not in operation so Stéphane is looking at using the manual velocity probe for tomorrow's survey.

- We collected some good quality sub-bottom data today with penetration of better than 10 m in the morning survey area. In the afternoon we moved to a new area and there was little penetration. The morning magnetic data contained the same very low data values that we saw yesterday.

JD 155, Sunday June 4, 2006

Survey Lines 189 - 218

- Sailed from Matane at 6:30 am. We will not be conducting a velocity cast this morning as the moving vessel profiler is still not operational and we are missing software for the manual velocity probe.

- Started logging the magnetometer and sub-bottom data at 7:00 am. At 9:05 am the magnetometer was recovered as the ship had gotten tangled in some fishing gear. At 9:20 am the ship was free and we started collecting multibeam again. It was decided that we would not re-deploy the magnetometer while we surveyed in this area as there was a lot of fishing gear around. Stéphane decided we would move towards the North Shore and survey there instead to avoid the fishing gear. The magnetometer was back in the water and logging at the new location at 10:15 am.

- At 11:05 am there were problems with the ship's GPS. It is independent of the GPS for the multibeam system but it needed to be solved. The GPS was restored and we were underway at 11:50 am.

- We surveyed until 6:30 pm at which point the magnetometer was recovered and we started the steam towards Matane. We stopped logging the sub-bottom profiler data at 7:00 pm and arrived in Matane at 7:40 pm.

- Demobbed vessel and drove back to Halifax. End of survey.

Preliminary Results

The following pages illustrate the preliminary results of multibeam bathymetry and towed magnetometer surveys (Figures 3 and 4).

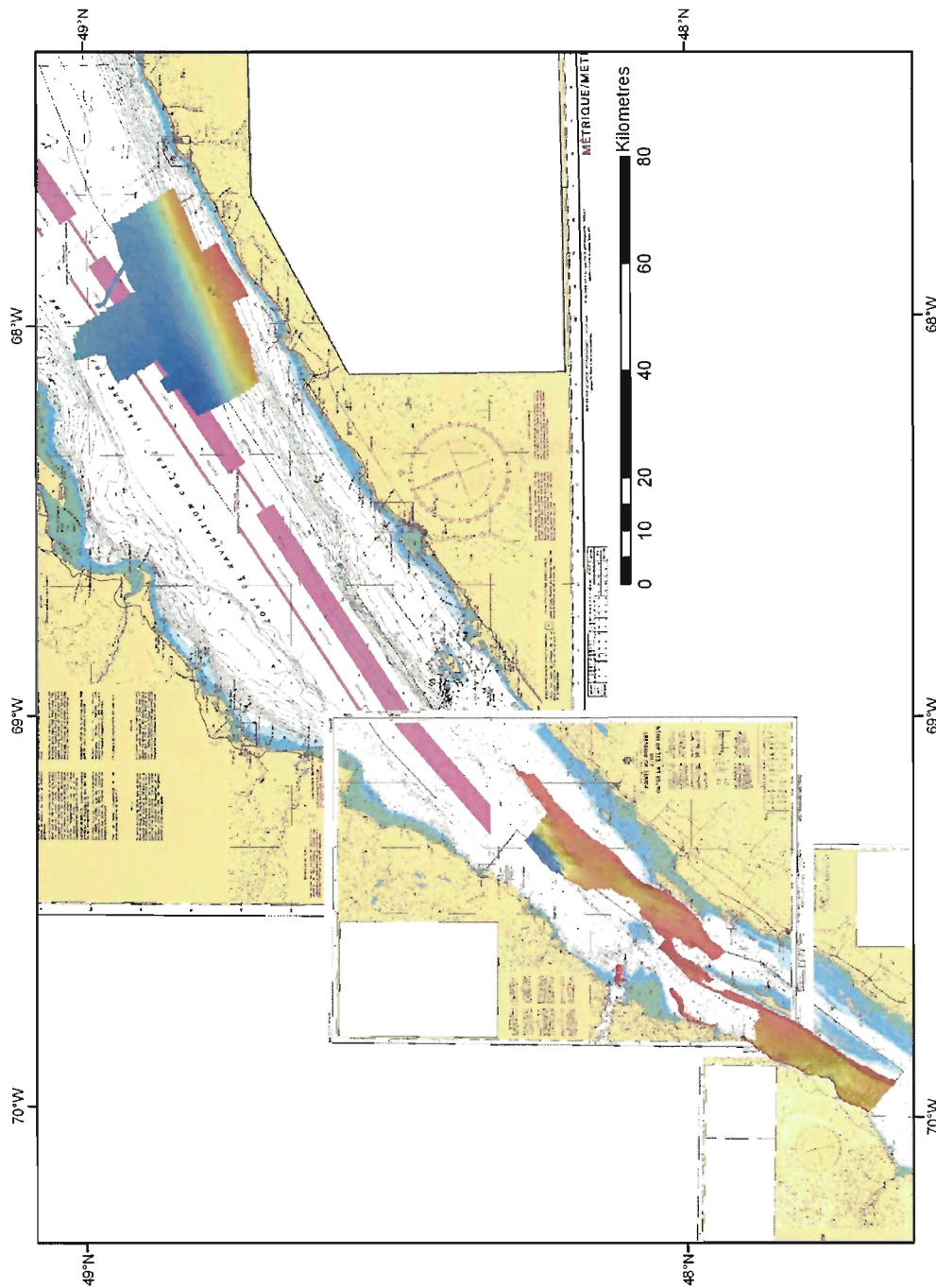


Figure 3- Shaded relief DEM of the multibeam bathymetry collected during the survey. Water depths range from ~340 m on the channel floor (dark blue) to <30 m on the banks (red).

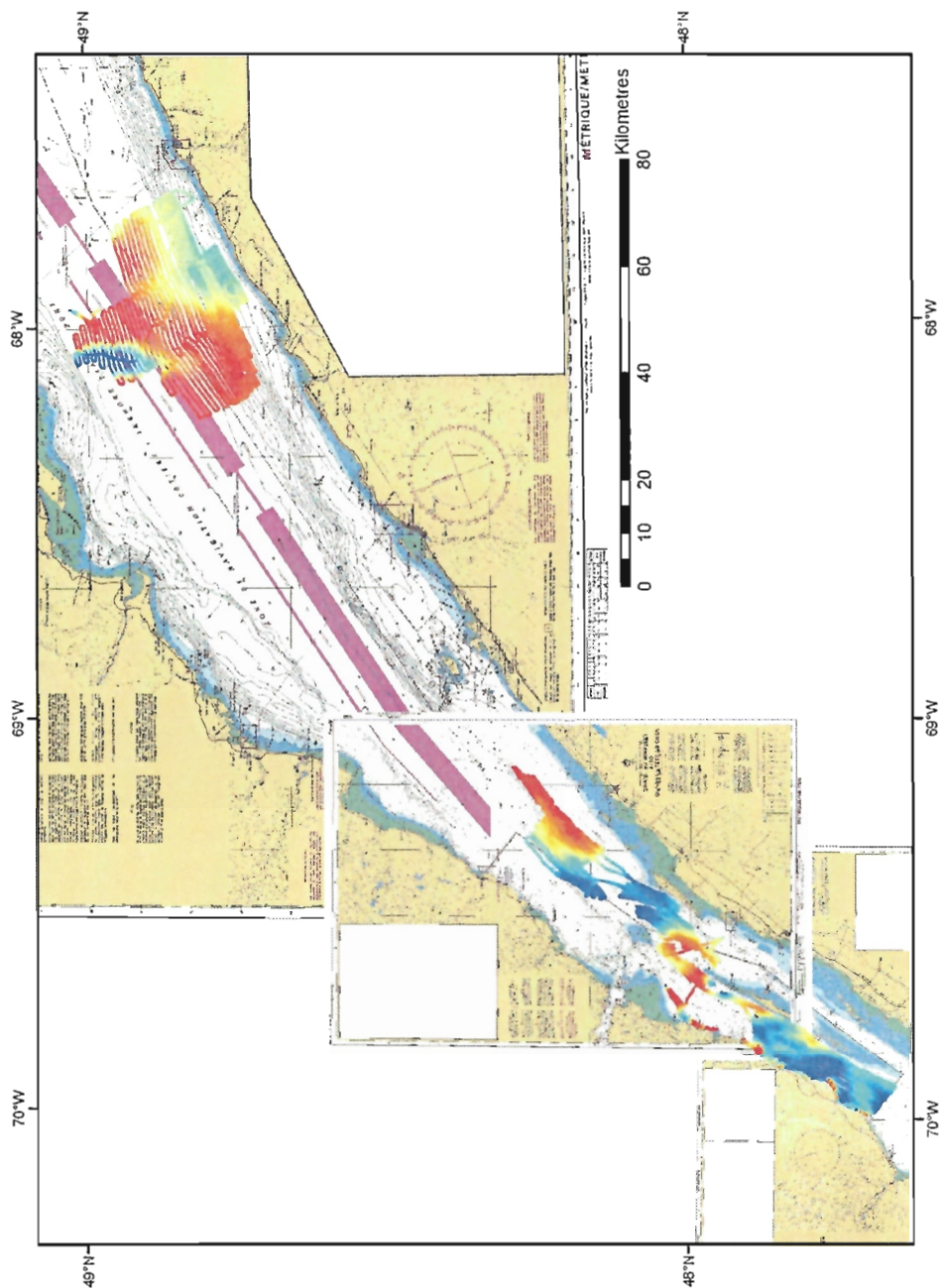


Figure 4- Along-track presentation of towed magnetometer data. Warm colours indicate higher values and cool colours indicate lower values. Note, no magnetometer data was collected during the last two days of the survey.

Technical Summary

Survey Vessel:

The vessel used in this survey was the *CCGS F.G. Creed* (Figure 5). The vessel is operated by the Canadian Coast Guard. She is a twin-hulled SWATH (Small Water Area Twin Hull) vessel built in 1988. She is 20.4 m long and 9.75 m wide and can accommodate 4 ship's crew (Captain, Engineer, First Mate, and cook) as well as 5 scientific staff. The vessel has a data processing lab aft which has space for several workstations. She is equipped with a Simrad EM 1002 multibeam echosounder, a BOT MVP100 moving vessel profiler, a Knudsen 320M sub-bottom profiler and has a large aft deck for her size which can accommodate other oceanographic equipment, such as the marine magnetometer in the case of this survey.



Figure 5- CCGS F.G.Creed

Multibeam System, Simrad EM1002:

EM 1002 multibeam echosounder is a short to medium range, high resolution echosounder with 111 narrow beams of 2 x 2 degrees, and a sounding accuracy that satisfies the requirements for IHO S-44 order 1 surveys. The 95 kHz operating frequency is robust for pollution and particles in the water, resulting in a range performance in combination with resolution and accuracy which is attractive for many applications. The swath coverage of the EM 1002 Multibeam echosounder is up to 7.5 times the distance from the transducer face to the seabed, or a maximum of approximately 1200 meters (depending upon conditions). The sounding pattern is stabilized for the ships roll movements, and the sounding pattern can be selected as equiangular or equidistant on the bottom. On the Creed, the positioning may come from various sources. The Pos/MV is the primary positioning system and uses differential corrections from the Coast Guard DGPS network (Rivière-du-Loup, 300.0 kHz in this survey area). For the purpose of this survey, independent RTK positioning was used with a base station that was relocated occasionally to improve signal quality. The advantage of RTK positioning is a precision of a few centimeters in the 3 axes (xyz). The z component is very useful as it records the water level during surveying in areas far away from any tide gauges.

Data acquisition and processing

Multibeam data acquisition on the Creed is controlled on the bridge (Figure 6). This allows for easy communication between the hydrographer and the captain. During this survey, there was one workstation on the bridge for acquiring data and another for quality control. Within the lab on the main deck, there was one primary (“multifonction”) workstation and two secondary processing workstations that worked on data stored on the “multifonction” station over the ship’s network (Figure 7). Software included Simrad SIS acquisition software and Caris HIPS/SIPS (v. 5.4) processing suite.



Figure 6- Bridge configuration onboard the Creed.

The following steps were used during onboard processing:

1. Once a line was completed, the .all file was copied from the acquisition computer on the bridge to the “multifonction” workstation in the lab.
2. The line was converted to Caris HDCS format (conversion wizard).
3. The line was loaded into Caris HIPS.
4. GPS tide was calculated.
5. Navigation data processed. Remove spikes and errors from speed/distance/course made good data.
6. Attitude data processed. Removed spikes from heave/pitch/roll and GPS tide data.
7. Apply tide corrections. Mainly used GPS tide data. Measured tide may be applied back at office where the GPS tide was poor quality.
8. Merge file (compute and interpolate depths/positions and apply water level, refraction coefficients, etc.).
9. Swath editor to remove severe sounding anomalies.
10. Create fieldsheet and render a shaded relief image of the data.
11. Subset editor. Systematically edit sounding data to remove spikes.
12. Refraction editor, where needed to remove refraction errors from the data.
13. At the end of each day, a fieldsheet of the entire day was created and a shaded relief image was rendered. A mosaic of the sidescan data (backscatter information) was produced.

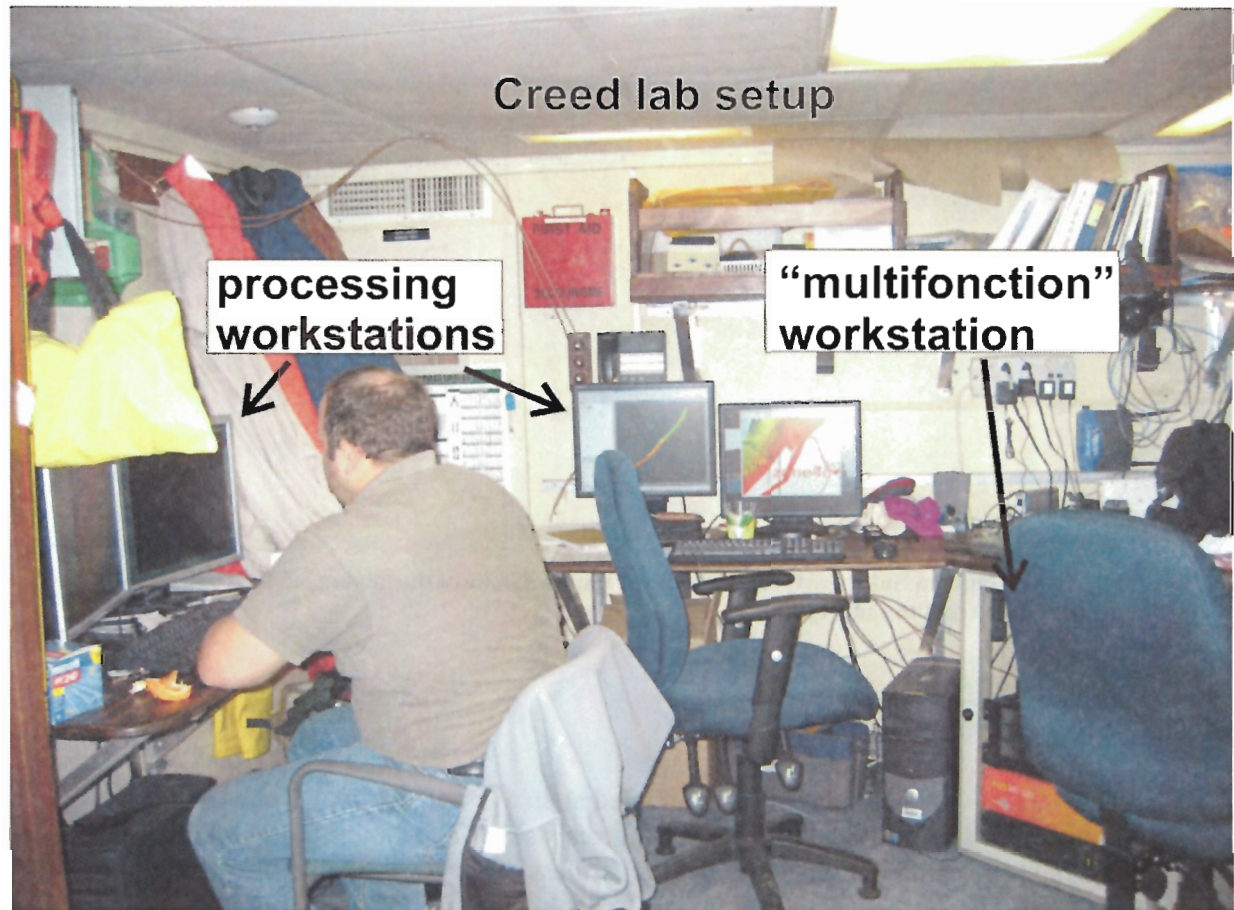


Figure 7- Lab configuration.

Knudsen 320 M sub-bottom profiler

This was the first survey to use the new Knudsen 320 M sub-bottom profiler installed on the Creed during the spring of 2006. The system was used to operate a 3.5 transducer array installed in the port sponson. Data were stored in KEB (Knudsen Extended Binary) and Knudsen's extended SEG-Y format. The data were viewed onboard using Knudsen Post Survey program. Data acquisition was integrated with the POS-MV vessel motion unit in order to correct for vessel motion in real time. This worked approximately 75% of the time, however the data string from the POS-MV unit was often lost. Half-way through the survey the data collected to that point were brought back to the office for closer inspection in Kingdom Suite (Figure 8). Signal enhancement was performed in real-time by the acquisition software. There were a number of options and generally automatic gain control gave the best results. There was a lot of noise at times in the data, with ringing apparent throughout. On a subsequent survey, it was discovered that the transducer was not mounted flush to the hull, but that there was an air space between the transducer and the hull in the ballast tank when the tank was not flooded. Flooding of the ballast tank improved the signal considerably.

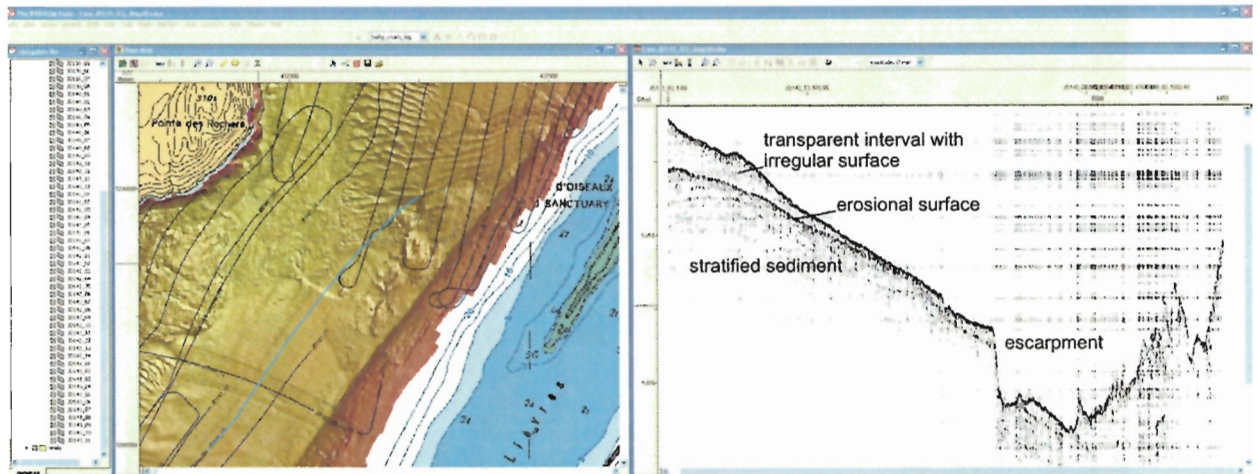


Figure 8- Kingdom Suite (TM) seismic interpretation software displaying 3.5 kHz sub-bottom profiler data from the survey.

SeaSpy Marine Magnetometer:

The SeaSpy Magnetometer fish was towed at an average depth of 1 m below the sea surface at a speed of 10-12 kts in varying sea states. The system uses Overhauser sensors and measures ambient magnetic field regardless of survey direction or orientation with the field. The system requires 2 people to deploy the fish (~20 kg), but is rather low maintenance once it is deployed. All preliminary field observations show data quality as excellent.

Procedures for Sea-Spy Magnetometer deployment during this survey

1. Tow point on Fish- 60m of cable measured on wharf (3 times vessel length)- Using Samson braid rope, created tow point (braided, clamped and taped).
2. Tow point on Vessel- Approximately 2 m of Samson braid rope tied to aft-port cleat. Tow points connected by two small shackles and a quick release shackle (Figure 9).
3. Spool- 60 m *cable* wrapped loosely around port cleats (Figure 10), wooden spool on aft quarter/bridge-deck, deck lead to lab through conduit. Deck lead to adapter to small black input box. Black input box output splits to COM port input and power supply. (See manual for more details).

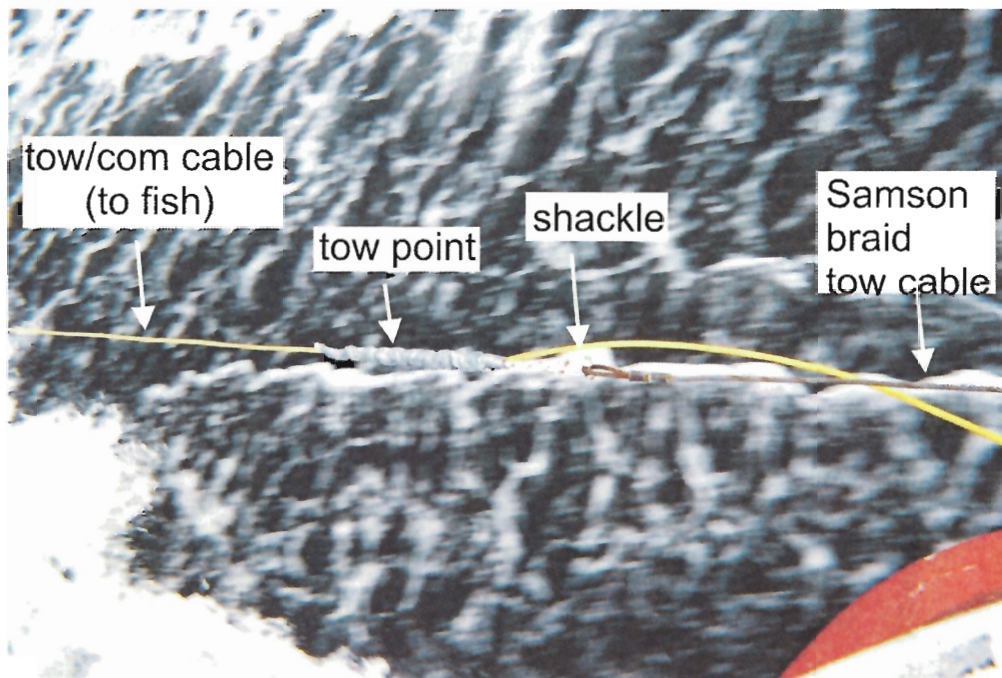


Figure 9- Magnetometer tow point in action.

4. Setup GPS input. Software accepts standard NMEA navigation input from a COM port. Software requires baud rate, parity, etc. to be set. In this case it was a baud rate of 9600 and no parity. Navigation was updated at 10 Hz.

5. Determine layback. In this case approximately $3 \times \text{Vessel Length (60m)} + \text{Vessel DGPS/RTK offset (7.5m)} + \text{Towpoint (1m)} = 68.5\text{m}$

5. Deployment Procedures- Slowed to deployment speed of 2-4 kts. Before deploying, startup SeaLINK software. Check that GPS data is streaming in the GPS window. Press the “sync GPS” button to sync the computers clock to the GPS. In the command window, enter “p” to zero pressure the depth sensor on the tow fish. Set the cycle rate (usually 1 or 2 Hz). Press the “append GPS values button” to attach position information to the file. Enter the calculated layback. Fish lowered over top of railing on the side of vessel with person 1 holding tension on fish. Wraps were taken off cleats by person 2 as to not tangle cable or transfer tension to deck. Tow point on last wrap handled by person 1 while person 2 pulls wire cable over railing and shackles the rope tow point to wire cable. Tension was then slowly released by person 1. Note two additional wraps were left on deck cleats as safety back up. Once fish is deployed, press the logging button on the acquisition computer to begin logging. Bring ship to survey speed (10-12 kts) (Figure 11).

6. Retrieval Procedures- Slowed to recovery speed of 2 to 4 kts. Person 1 hand recovers fish while person 2 neatly wraps the tow cable on deck (not tight around cleats). When tow fish is along side, bring fish on board carefully, ensuring that the fish does not impact

the hull. Removed composite nose piece and using potable water (starboard side of the Creed) rinsed thoroughly brass connector and body of the fish, replaced nose piece and secured fish to railing. Note, corrosion takes place fairly quickly when the saltwater, fresh air and brass are all in contact, it is important to rinse the fittings after each retrieval, however it is not necessary to break the brass seal during this process, the o-rings provide the true seal.



Figure 10- Setup of magnetometer while on deck.

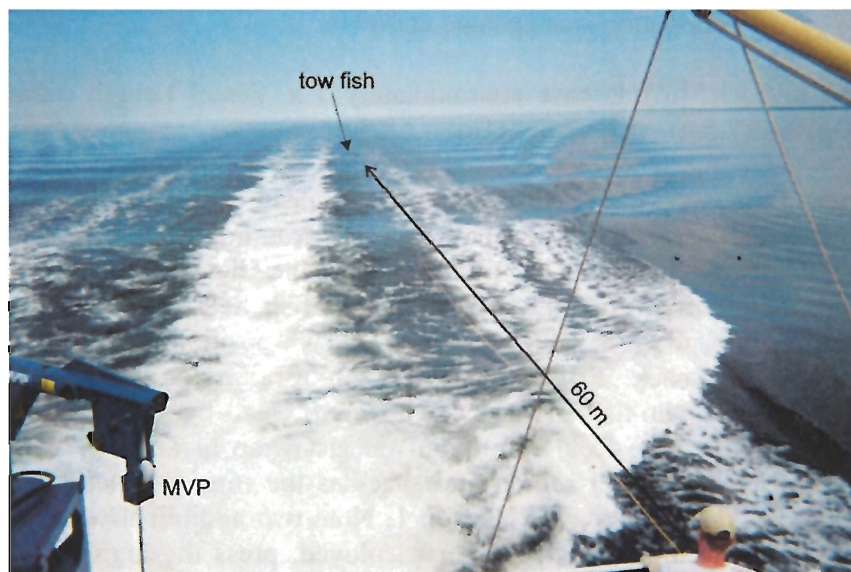


Figure 11- Setup of magnetometer while acquiring data.

SeaLink setup and magnetometer software configuration

- Requirements – System Windows 95 or higher with two available com ports.
- The Magnetometer requires both a Serial connection to the towfish and a real-time NMEA navigation string from DGPS.
- A cycle rate of 1 to 2 hz is desirable on the magnetometer at 12 kts, 1 Hz gives reading ~ every 20 metres, 2 Hz every 10 m.
- Magnetometer Baud 9600 string com1.
- GPS Baud 9600 10hz NMEA string com2.

Issues

- No valid navigation string found, program restarted/rebooted until com port found.
- No valid magnetometer com link, Windows OS interpreted magnetometer com port as a plug and play mouse. Power disconnected from magnetometer until windows completed reboot, power reconnected and program initiated.
- The pressure sensor provided erroneous calculations of depth throughout the cruise, sometimes showing fish above surface of the water. Fish could be observed under most conditions riding 60m aft and .5m or greater, below the surface.
- No ability to configure the “x” or “z” offset of the Magnetometer is provided with the sealink software, due to the MVP mounting aft centre, it was necessary to deploy magnetometer approximately 3m to the Port of the RP, giving an overall error of positioning +/- 6m instead of the usual DGPS corrected positioning of +/- 3m. Primary corrections received from Coast Guard DGPS station in Rivière-du-Loup (300 Khz) and RTK reference stations.
- During the Creed 2006-017 survey the magnetometer tow cable developed a twist during survey operations. The reason appears to be seaweed which wrapped around the fins on the tow fish thus affecting the hydrodynamics of the towed body (Figure 12). The cable can become severely twisted in a short period of time, so regular half hour checks of the tow cable condition were performed while surveying. If severe twisting occurs (Figure 13), care must be taken not to kink the tow cable.



Figure 12- Seaweed wrapped around the fins of magnetometer towfish.

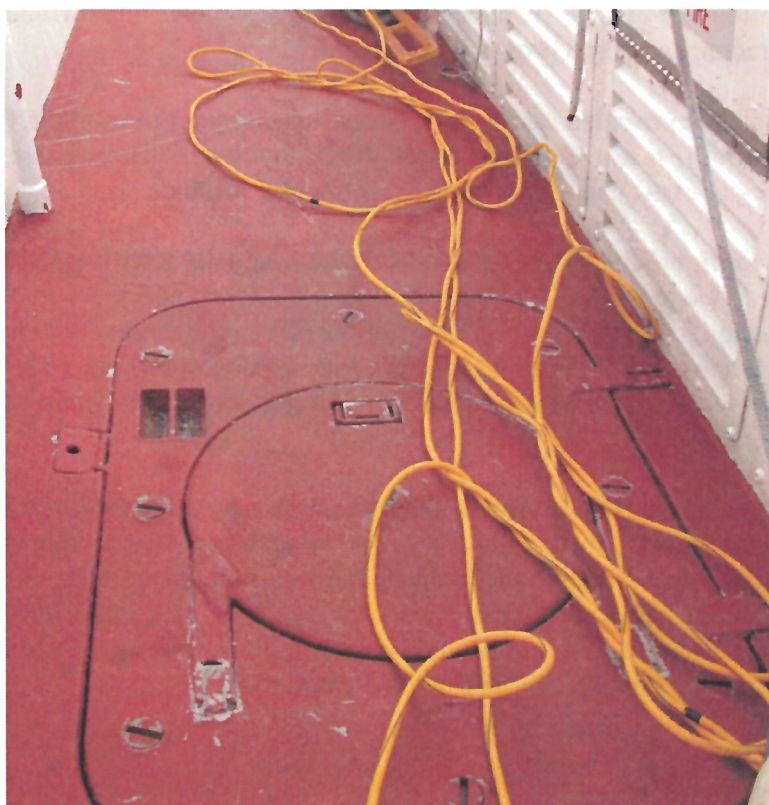


Figure 13- Twisted tow cable on deck.

Magnetometer Base Station at IML:

Base station was installed at IML using the same location as surveys 2005-066 and 2005-075 (Figure 14). The sensor was setup in an open grassy area away from the pump house and the GPS antenna was installed on a temporary mast (soccer goal post) (Figure 15). Over the winter, a new laptop was purchased to log the base station data and it, along with the GPS, and other electronics were setup inside the pump house and power supply was provided from a wall socket. Except for some communications errors between the laptop and the sensor, the setup of the station magnetometer was successful with readings in the 55 000 nT range with variance of less than 30 nT over a 1 hour period.



Figure 14- Station magnetometer setup location on the IML campus for this survey.

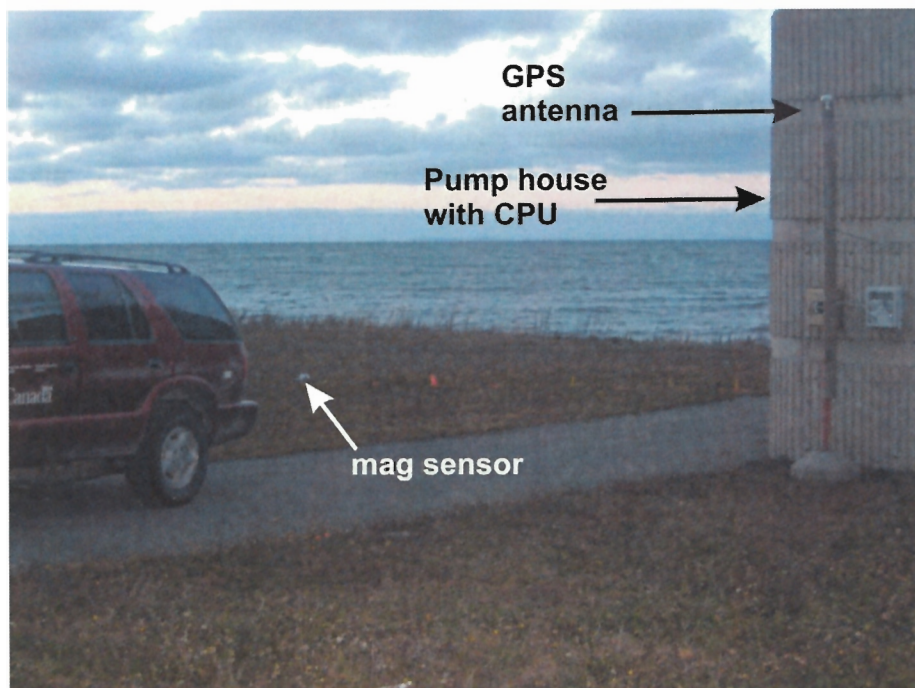


Figure 15- Station magnetometer configuration outside of pump house during this survey.

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2007: F.G. CREED EXPEDITION 2005-075: Multibeam and magnetometer survey of the St. Lawrence Estuary west of Rimouski, October 27th to November 28th 2005, GSC Open File Report 5390

