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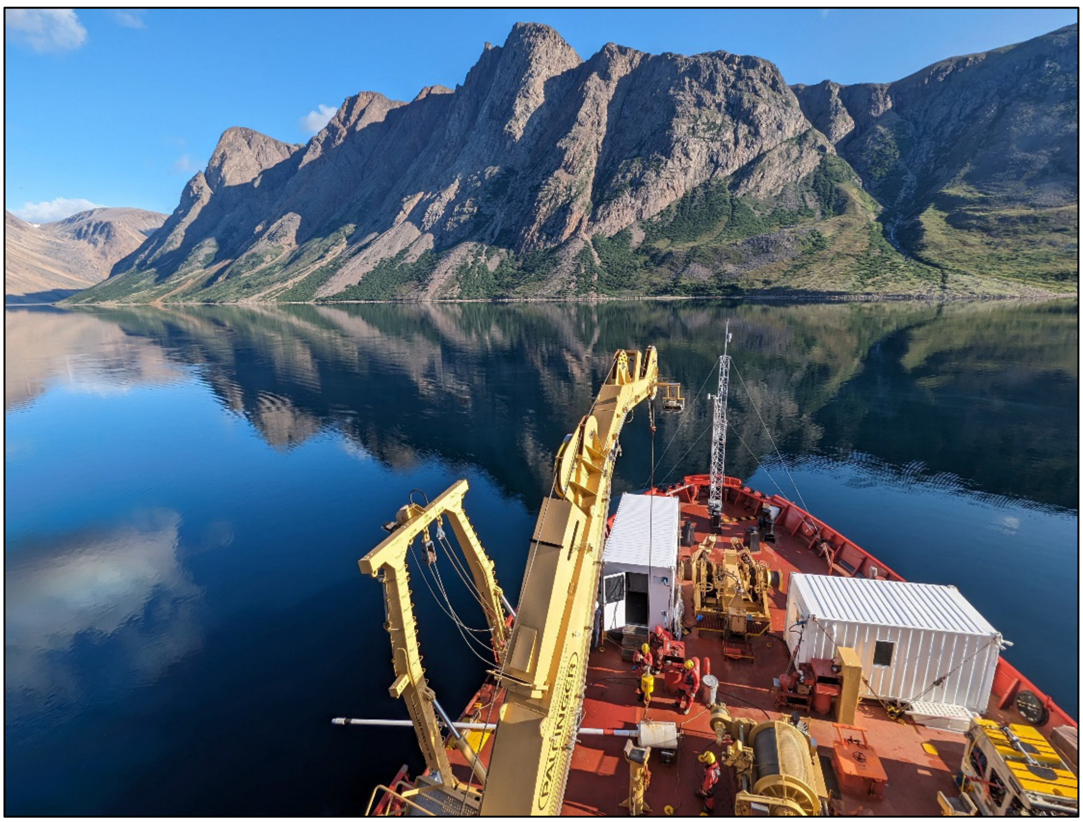
CCGS *Amundsen* 2023804: Seabed mapping and marine geohazards in Nunatsiavut, Newfoundland and Labrador and Baffin Bay, Nunavut



L. Broom, R. Bennett, A. Normandeau, S. Hayward, and M. Atkinson

2024

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CCGS *Amundsen* 2023804: Seabed mapping and marine geohazards in Nunatsiavut, Newfoundland and Labrador and Baffin Bay, Nunavut

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Acknowledgments
We would like to thank the Captain of the CCGS *Amundsen* Pascal Pellerin and the ship's officers and crew. We thank *Amundsen* Science, Chief Scientists Rodd Laing and David Coté, and the entire science and technical crew. We also thank the Nunatsiavut Government for permission to work in their marine territories.

1. Background

The 2023 research program on the CCGS *Amundsen* aimed at coalescing research within the Labrador Sea and Baffin Bay Ecosystems to fully support Nunatsiavut's Imappivut Marine Planning Initiative and the Torngat Area of Interest Feasibility Assessment. NRCan along with its partners and stakeholders in this project, have been collecting and gathering all the seabed data available on the Labrador Shelf to provide bathymetric and surficial geology maps, two important components of NRCan's Marine Geoscience for Marine Spatial Planning (MGMSP) program. MGMSP conducts research on the marine geology of Canada's continental shelves. On the Canadian East Coast, the program focuses mainly on the Scotian Shelf and the Newfoundland and Labrador Shelf. On the Labrador Shelf, research is being conducted to support both the Nunatsiavut government's and Fisheries and Oceans Canada's decision-making on the use of the seabed. Therefore, high-resolution seabed mapping and ground-truthing of seabed sediment provide the data necessary to develop the base map for properly managing seabed use.

In Baffin Bay, the work conducted on the CCGS *Amundsen* supported the Public Safety Geoscience (PSG) program of NRCan. The Baffin Bay activity of PSG conducts research to improve the understanding of geological processes and hazards (geohazards) in Baffin Bay to support stakeholder decisions on the use of offshore areas and provide northern communities with better knowledge for improving public safety. For the 2023804 expedition, research was focused on Southwind fiord, which was established in 2018 as a natural site to characterize and monitor marine geohazards in nearshore Baffin Island (Normandeau et al., 2018, 2021a, b).

2. Objectives

1. Characterize and constrain the timing of submarine landslide deposits in Northern Labrador fiords utilizing gravity cores.
2. Run experimental deployment of the GAVIA autonomous underwater vehicle (AUV) over areas with potential coral/sponge habitat to determine if they can be resolved by the AUV bathymetry and sidescan imagery.
3. Characterize turbidity current processes in the glacierized Southwind fiord and understand the seabed recovery of an iceberg-induced landslides.

3. Participants

Four participants from Natural Resources Canada (NRCan) and one participant from the University of New Brunswick (UNB) contributed to the NRCan operations of the 2023804 expedition. Alexandre Normandeau executed the planning of the 2023 stations and provided onshore scientific support. The field team included Robbie Bennett, Scott Hayward, Laura Broom and Margaret Atkinson (Table 1).

Table 1: Natural Resources Canada and University of New Brunswick participants onboard the 2020804 CCGS *Amundsen* Expedition.

First name	Last name	Organization	Role
Alexandre	Normandeau	Natural Resources Canada	Research Scientist
Robbie	Bennett	Natural Resources Canada	Physical Scientist
Laura	Broom	Natural Resources Canada	Physical Scientist
Scott	Hayward	Natural Resources Canada	Technologist
Margaret	Atkinson	University of New Brunswick	MSc. Student

4. Summary of Activities

2023804 was conducted during leg 1 of the 2023 *Amundsen* Science Expedition onboard the CCGS *Amundsen*. This was a multidisciplinary cruise that began on July 13, 2023 and ended on August 10^{th}, 2023. NRCan participants completed 22 stations (Table 8; Figure 1):

1. 5 giant gravity core deployments
2. 16 box core deployments
3. 3 Autonomous Underwater Vehicle (AUV) deployments

In addition, NRCan participants helped with the collection of multibeam bathymetry data and 3.5 kHz sub-bottom profiles during the entire leg.

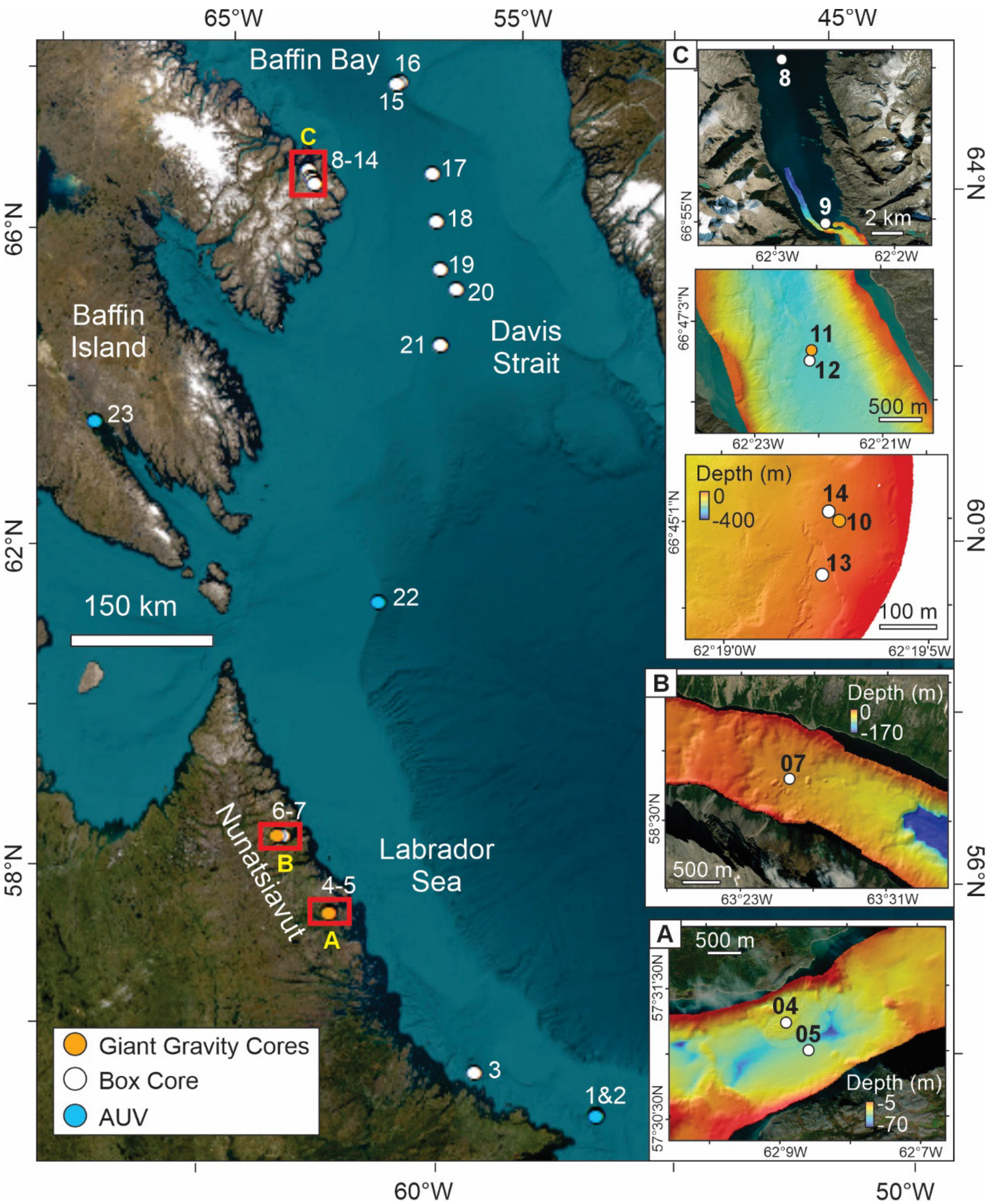

Figure 1: NRCan's station locations during 2023804. World imagery basemap from: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

5. Equipment and Procedures

5.1 Multibeam echosounder: Kongsberg EM304 30kHz

In 2022, *Amundsen* Science installed a Kongsberg EM304 30kHz multibeam echosounder to upgrade from the previous system. The ship was also equipped with a POSMV V5 inertial motion unit (IMU). This system was utilized by NRCan during Leg 1 to collect a repeat multibeam survey of inner Southwind Fiord and to fill in data outside of the fiord.

5.2 Sub-bottom profiler: Knudsen 3260 3.5kHz

The sub-bottom profiler system installed on the *Amundsen* is a Knudsen 3260. It acquires sub-bottom profiles at 3.5 kHz to image the sub-seafloor stratigraphy.

5.3 Coring

Giant Gravity Core

For the giant gravity corer stations, the piston corer was deployed as a gravity corer. This set up was used because it performs well in soft sediments (mud) and is faster to deploy which is valuable during multidisciplinary cruises. The set up involved installing the 9m-long corer without the trigger weight core and trip arm and the piston. The giant gravity corer system includes three 3 m long barrels attached by couplings and a 2000 lb core head (Figure 2). Inside of the barrels was nine meters of core liner and a butterfly valve was fitted to the top of the liner in place of the piston.

Figure 2: Gravity coring system ready for deployment onboard the CCGS *Amundsen*. Photograph by L. Broom. NRCan photo 2023-319.

In total, there were five deployments of the giant gravity coring system (Table 8). Three deployments were in the Labrador Sea including Okak Bay and Saglek Fiord and two deployments were in Southwind Fiord, Baffin Bay (Figure 3).

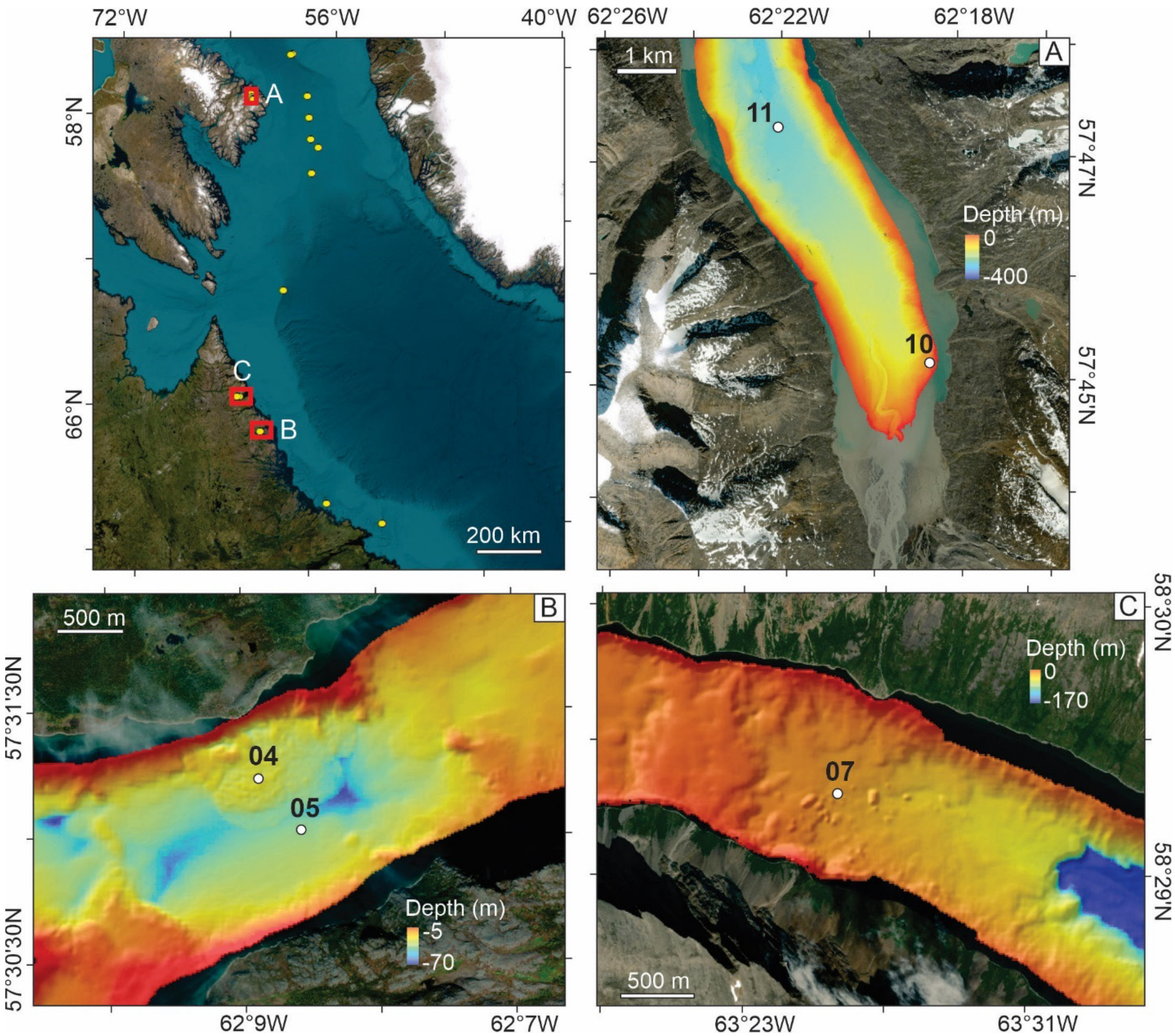

Figure 3: NRCan's gravity core stations for leg 1 of the 2023 *Amundsen* expedition including: A) Southwind Fiord, B) Okak Bay, and C) Saglek Fiord. World imagery basemap from: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

When the gravity core is retrieved, the plastic liners are taken apart, beginning with the base. Each liner is three meters long and as they are recovered on deck, they are cut into 1.5 m sections, fitted with end caps and taken into the lab for documentation and preliminary processing (Figure 4). If the core cutter or catcher recovered sediment, then the material was extruded into a separate piece of core liner for archiving.

Figure 4: Image shows the gravity core system on deck and Margaret Atkinson (UNB) and Scott Hayward removing the core cutter from the bottom barrel. Photograph by L. Broom. NRCan photo 2023-320.

On board processing of the cores consisted of taking shear strength measurements and a constant volume subsample from the top and/or bottom of core sections where the material was suitable. Shear strength measurements were taken using a torvane that was inserted into the sediment at the bottom/top of the core liner and turned at a constant rate until the sediment failed. This measurement is used to help calibrate the shear strength measurements that will be taken along the length of the core at NRCan. Constant volume samples were collected using a cylinder of known volume which will be analysed for bulk density at NRCan. This measurement will help calibrate the bulk density measurements taken along the length of the core at NRCan. Suitable sediment for these procedures is undisturbed mud. Sand, soupy mud or core disturbance will make the measurements unsuitable. The cores were then resealed with tape, the ends were covered with wax and the cores were stored upright in a refrigerated container. These cores will be taken back to NRCan for further processing.

Box Core

The box corer (Figure 5) was deployed and subsampled 16 times by NRCan during the 2023804 *Amundsen* expedition (Figure 1; Table 8). For NRCan's stations, the box core was subsampled by inserting a liner into the sediment (Figure 6). Once the push core was inserted, the excess sediment was removed from the box corer with shovels, and the core was capped with endcaps, taped, sealed with wax and stored upright in the refrigerated container.

Figure 5: Deployment of the box core system in Saglek Fiord, Labrador Sea. Photograph by L. Broom. NRCan photo 2023-321.

Figure 6: Example of push core subsampling from box core station 0012.Photograph by L. Broom. NRCan photo 2023-322.

5.4 Autonomous Underwater Vehicle (AUV)

The AUV used during this cruise was a Gavia, manufactured by Teledyne Marine (Figure 7). It is approximately 12.5’ in length and weighs 325 lbs. The main sensors on the AUV are: 1) an EdgeTech 2205 bathymetric sonar that collects side scan sonar and multibeam-like bathymetry at ~15 cm resolution; and 2) a sub-bottom profiler which operated between 12 – 23 kHz that is capable of imaging the upper 10 to 15 m of soft sediment. The Gavia AUV is a fully autonomous vehicle that does not receive corrections from the operator while on a mission.

The AUV is programmed with a mission plan using a laptop computer (or tablet) that is connected through its own wifi network. The AUV is deployed from the foredeck of the *Amundsen* using the starboard crane (Figure 8) and then towed to the mission site using a fast rescue craft (FRC). When at the appropriate release point, the AUV is untied from the FRC and activated using a ruggedized tablet connected via the AUV’s wifi network.

Figure 7: Photo of the Gavia AUV on deck. Photograph by L. Broom. NRCan photo 2023-053.

Figure 8: Photo of the deployment of the Gavia AUV during leg 1. Photograph by L. Broom. NRCan photo 2023-323.

Three AUV missions were conducted during leg 1 of the 2023 *Amundsen* expedition. These missions were conducted at Joey's Gully, Hatton Basin, and Inner Frobisher Bay (Figure 9; Figure 10; Figure 11). Unfortunately, the AUV was not able to collect data at Joey's Gully and Hatton Basin due to technical and environmental difficulties. The AUV mission in Frobisher Bay was successful and traveled 19 km collecting bathymetric sonar and sub-bottom profiler data.

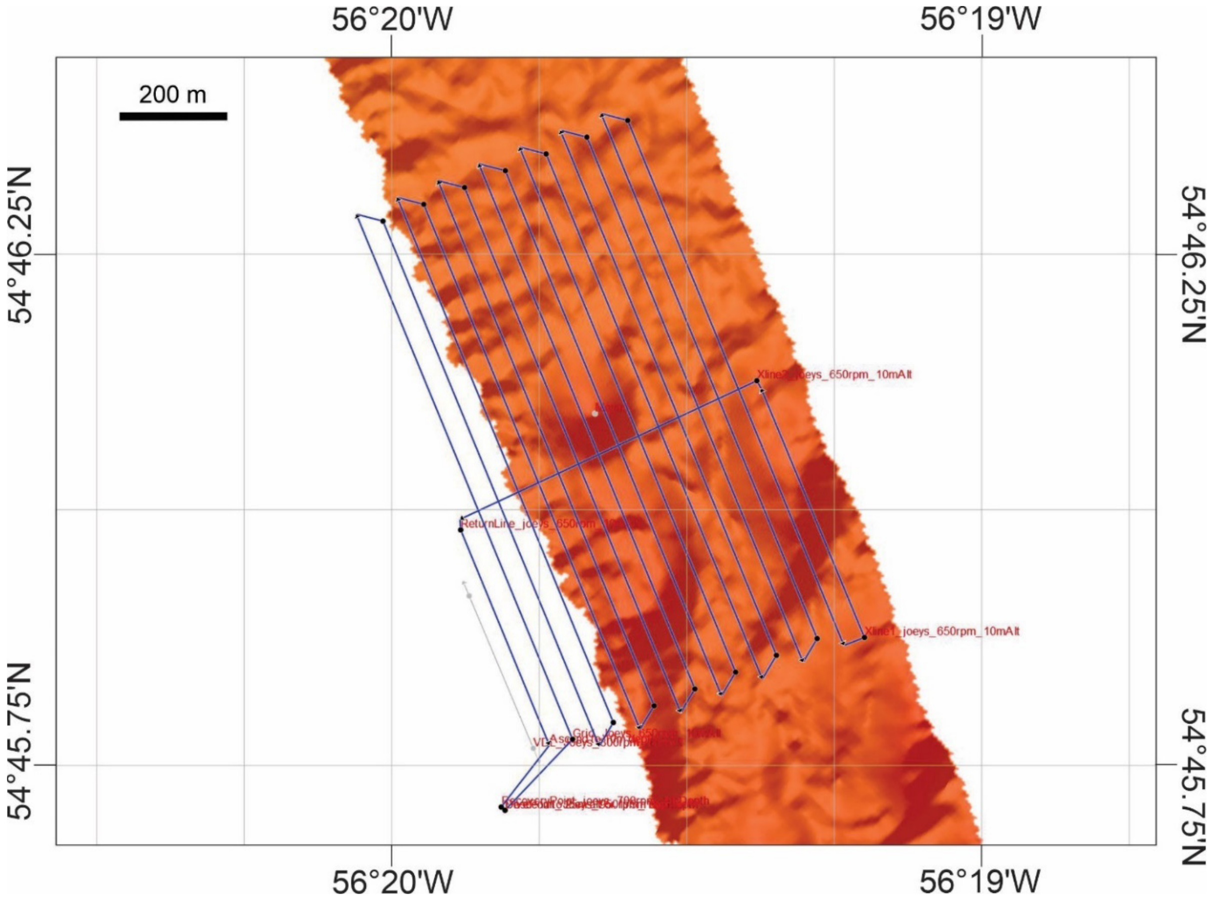

Figure 9: Planned AUV mission in Joey's Gully, Labrador Sea.

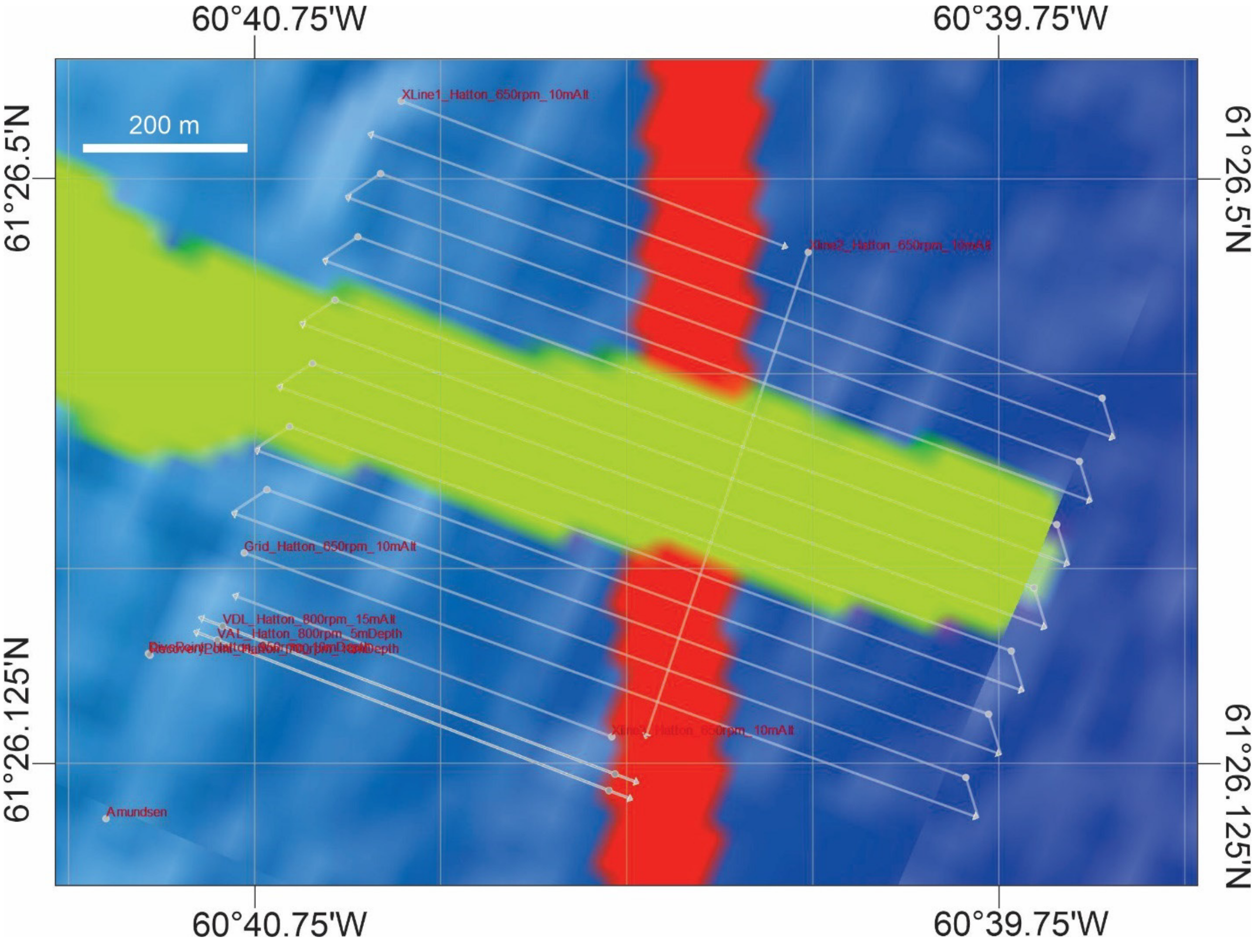

Figure 10: Planned AUV mission at Hatton Basin (green line is the track of a previous ROV dive; the red line is the location of a trawl line.

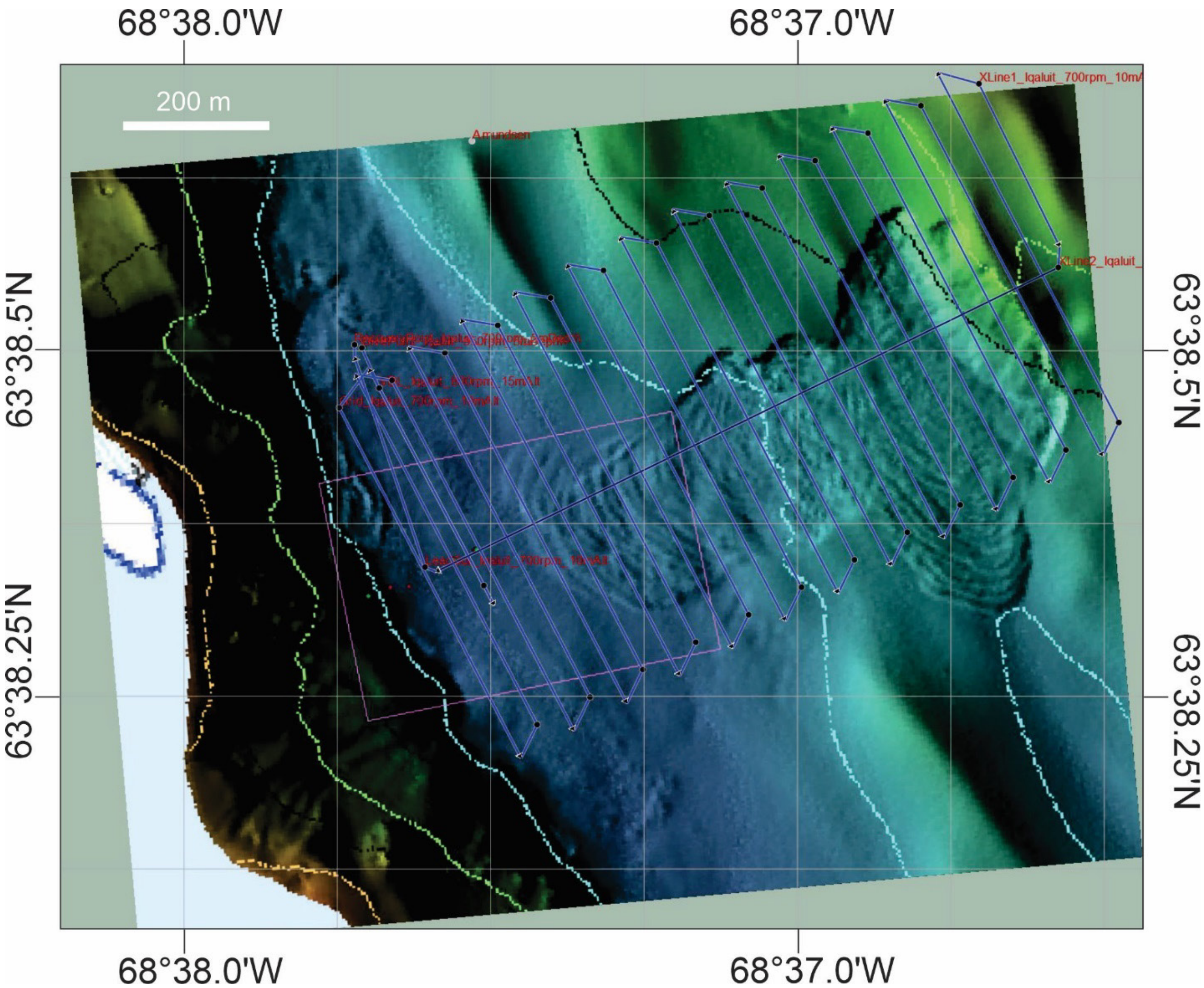

Figure 11: Planned AUV mission in Frobisher Bay near Iqaluit

6. Preliminary Results

6.1 Labrador Fiords, Nunatsiavut

Two gravity cores were successfully collected from Okak Bay, Labrador Sea. Core 0004 was collected inside of a submarine landslide deposit observed in multibeam bathymetric data, and core 0005 was collected downslope of the landslide deposit in undisturbed sediments (Figure 3). Core 0004 was collected at 64 meters below sea level (mbsl) and recovered 2 m of sediment (Table 2). Core 0005 was collected downslope of the submarine landslide at 70 mbsl and recovered 6.6 m of sediment. Constant volume samples and shear strength measurements were taken from the ends of each core section where possible (Table 3; Table 4). In Saglek Fiord, Labrador Sea, a gravity core was deployed at a site that appeared in the multibeam as a blocky deposit, interpreted as a potential submarine landslide. The core was retrieved from 91 m water depth and recovered only 25 cm of sediment. The material consisted of pebbly material. The seabed is likely coarse grained and not conducive to gravity coring.

Table 2: Gravity core stations

Station	Depth (m)	Total Length (cm)	Location	Comments
0004	64	207.5	Okak Bay	Inside submarine landslide
0005	70	662.5	Okak Bay	Downslope of submarine landslide
0007	91	25	Saglek Fiord	Inside submarine landslide. Recovered material was very rocky – lots of pebbles.

Table 3: Constant volume sampling for giant gravity core (GGC) stations during leg 1.

Station	Type	Section	Top/Base	Sampler ID	Bottle ID	Comments
0004	GGC	A/B	Top	A2	A481	Some visible sand partings.
0005	GGC	A/B	Top	A2	A482	
0005	GGC	B/C	Top	A2	A483	
0005	GGC	C/D	Top	A2	A485	
0005	GGC	D/E	Top	A2	A484	Sandy – a couple of small voids at top of sampler.

Table 4: Shear strength measurements for giant gravity core (GGC) stations during leg 1.

Station	Type	Section	Top/Base	Torvane used	Reading
0004	GGC	A/B	Top	L	0.22
0005	GGC	A/B	Top	L	0.54
0005	GGC	B/C	Top	L	0.25
0005	GGC	C/D	Top	L	0.53

6.2 Southwind Fiord

Coring stations

In Southwind Fiord, Baffin Bay, two gravity cores were collected (Figure 3; Table 5). Core 0010 targeted undisturbed sediments adjacent to a submarine landslide deposit. It was deployed at 211 mbsl and recovered 2.5 m of sediment. Core 0011 targeted the depocenter for turbidity current processes in the fiord. It was taken to determine if there was a record of sediment accumulation since that last core was taken in 2019. It was deployed at 180 m water depth and recovered 1.4 m of sediment. When core 0011 was being recovered, the winch wire caught on the core barrel. The coring system had to be relowered to the seabed to untangle the wire. This was effective and the core was successfully recovered, although the bottom of the sample might have been disturbed when it was lowered back to the seabed.

Table 5: Giant gravity core stations from Southwind Fiord, Baffin Bay.

Station	Depth (m)	Total Length (cm)	Location	Comments
0010	211	246.5	Southwind Fiord	Outside of 2018 landslide target.
0011	180	138	Southwind Fiord	Depocenter target. Winch wire caught on core barrel during retrieval. Core had to be lowered back to seabed, so sample disturbance is possible.

Five box cores were collected in Southwind Fiord primarily in collaboration with Christopher Algar from Dalhousie University to investigate the biogeochemistry of the top tens of centimetres of sediment and integrate these results with the physical properties of the sediment where applicable (Table 6; Figure 12). A push core was subsampled from each box core for processing and archiving at NRCan (Figure 18).

Table 6: Box core stations listing the push core subsamples from Southwind Fiord, Baffin Bay.

Station	Depth (m)	Subcore Type	Subcore name	Core Length (cm)	Location	Comments
8	389.9	Push	A	42.5	Southwind Fiord, Baffin Bay (SW2)	One push core collected
9	117.8	Push	A	20.5	Southwind Fiord, Baffin Bay (SW3)	One push core collected
12	179.8	Push	A	23	Southwind Fiord, Baffin Bay (SW5)	Depocenter site. One push core collected
13	37.1	Push	A	30	Southwind Fiord, Baffin Bay (SW7)	Outside landslide deposit. One push core collected
14	41.4	Push	A	29	Southwind Fiord, Baffin Bay (SW8)	Inside landslide deposit. One push core collected

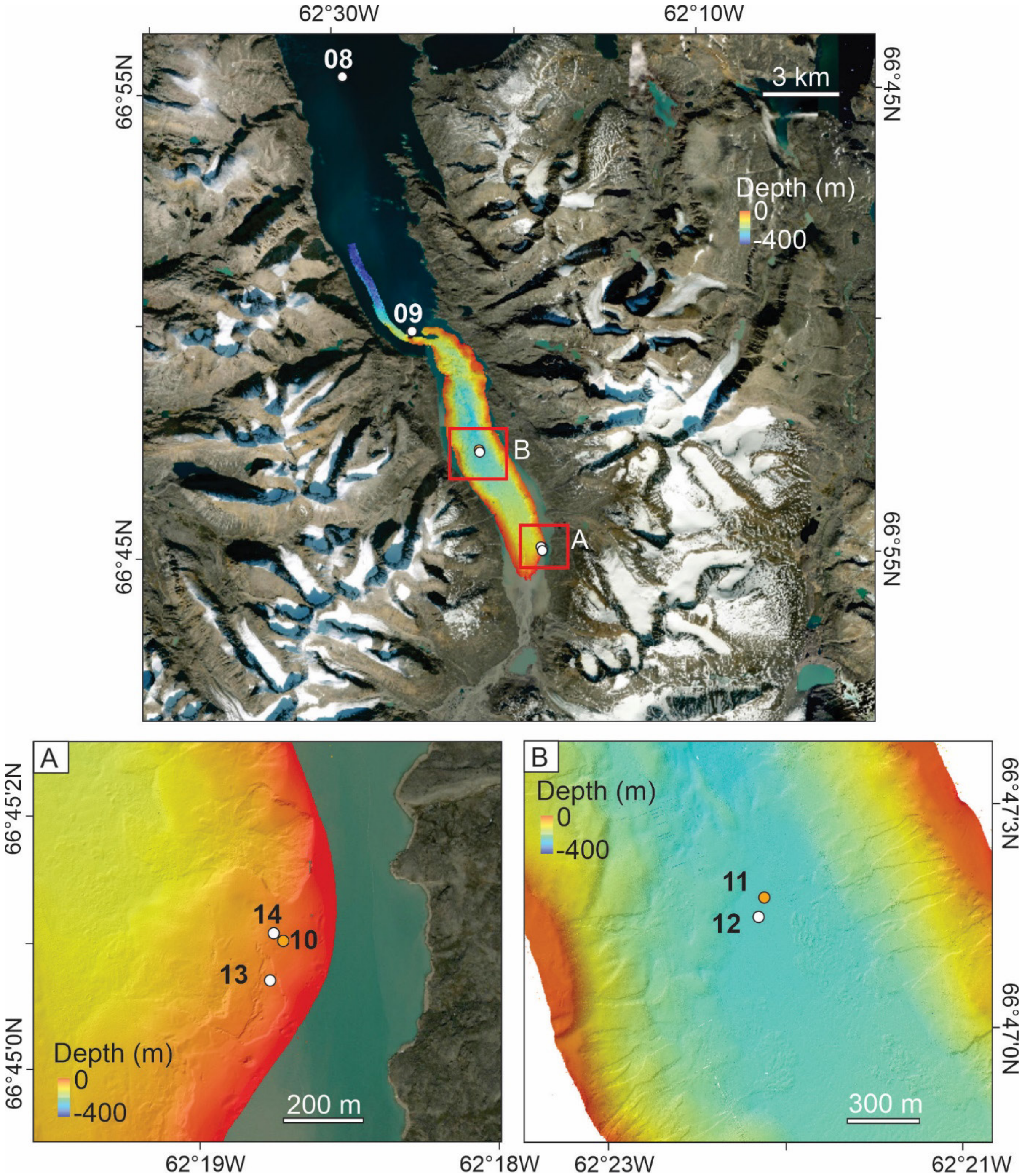

Figure 12: Giant gravity core and box core stations in Southwind Fiord, Baffin Bay. World imagery basemap from: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

Multibeam Bathymetric data

Planned and opportunistic multibeam bathymetric data were collected in Southwind Fiord, Baffin Bay (Figure 13). Repeat mapping of the inner fiord was completed to visualize if any changes to the seabed were present, including potential new submarine landslides (Figure 14). None were observed in the preliminary data compared to 2019 survey. Multibeam bathymetric data were also collected in the middle and outer part of the fiord (Figure 15; Figure 16). Sea ice conditions limited the data quality of the outer fiord data set (Figure 16). This data will be further processed back at NRCan.

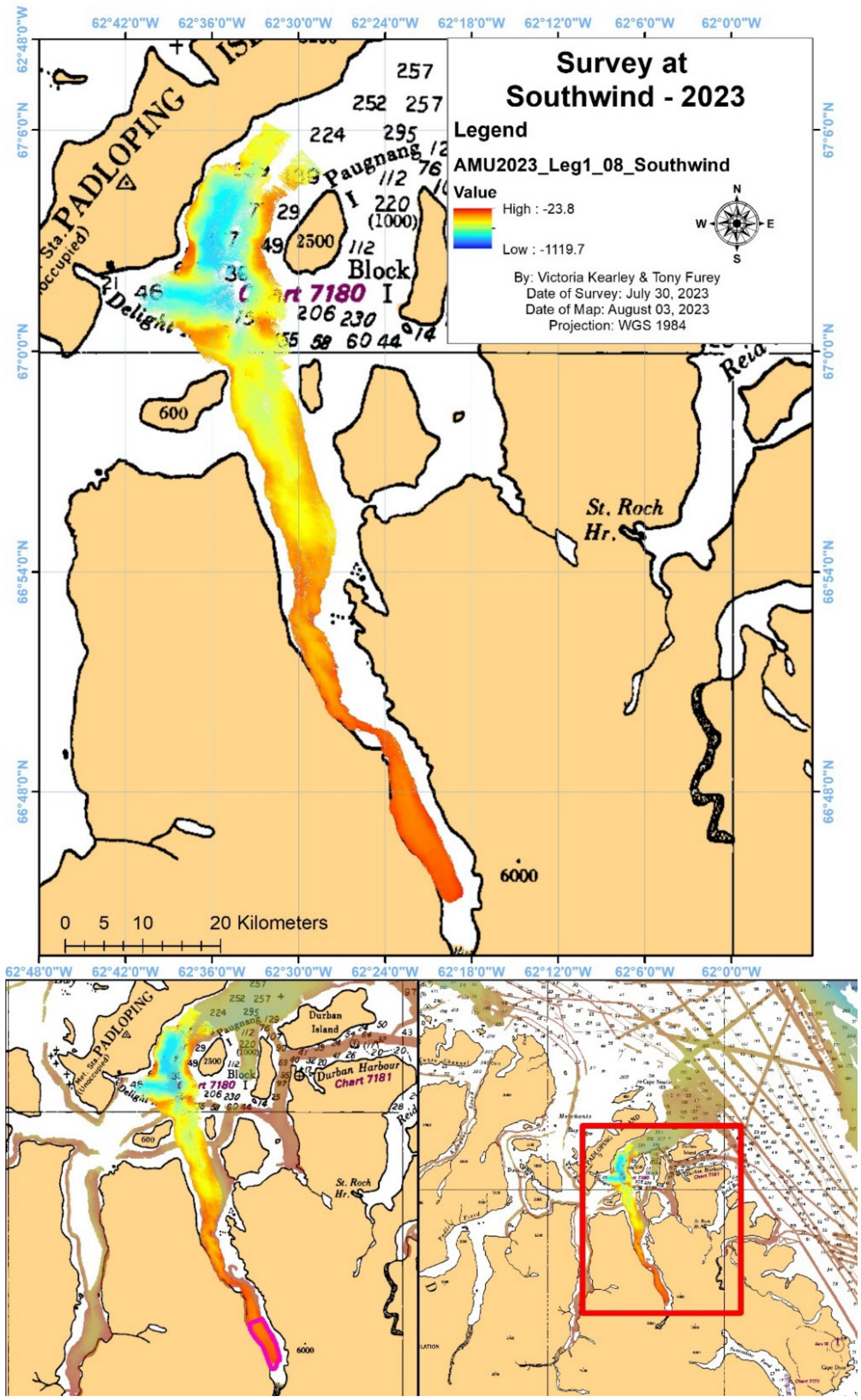

Figure 13: Multibeam bathymetric data coverage for Southwind Fiord, Baffin Bay acquired during 2023804. Maps produced by Victoria Kearley and Tony Furey.

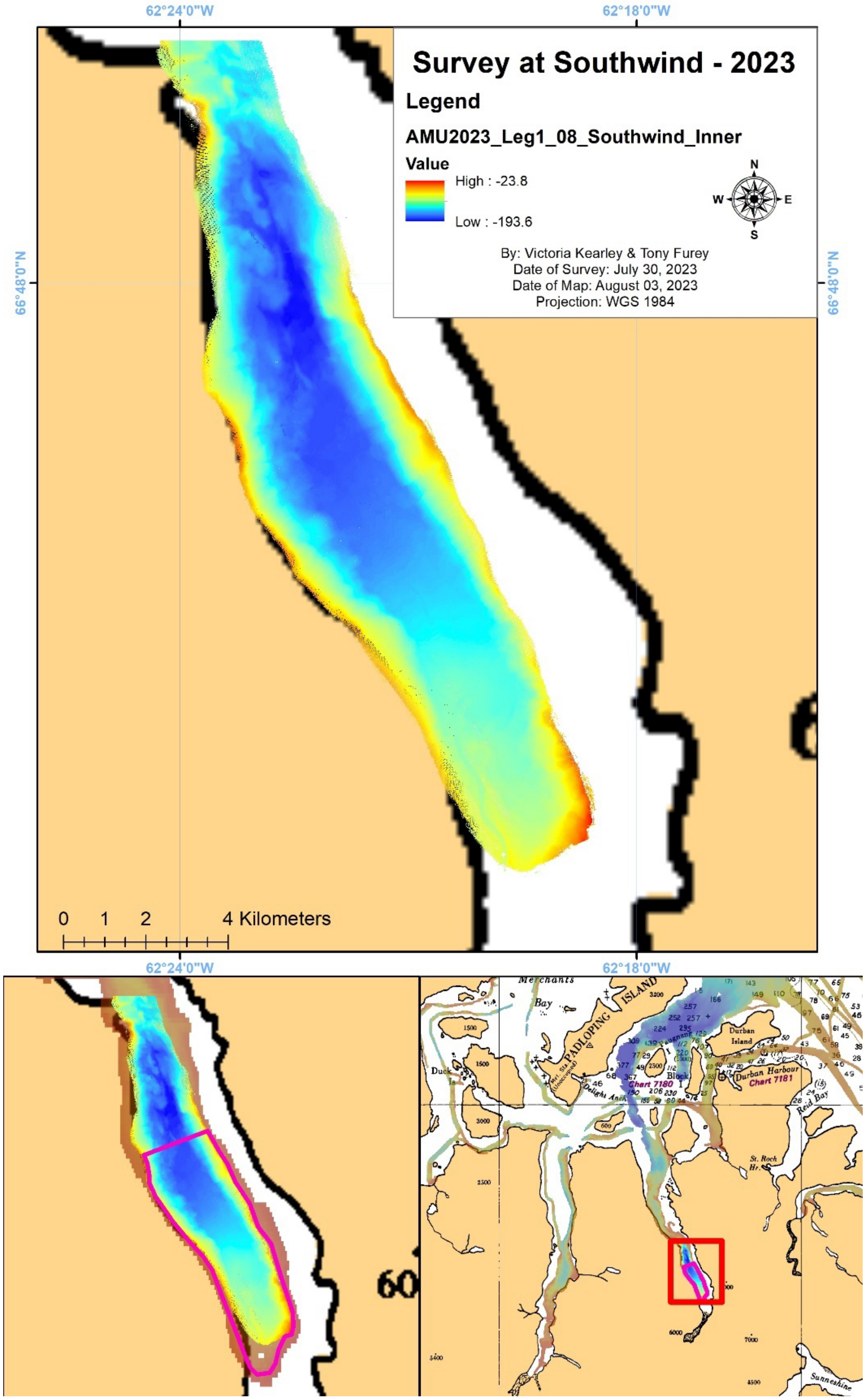

Figure 14: Multibeam bathymetric data coverage for the inner portion of Southwind Fiord, Baffin Bay acquired during 2023804. Red polygon shows where the priority area for repeat mapping. Figure produced by Victoria Kearley and Tony Furey.

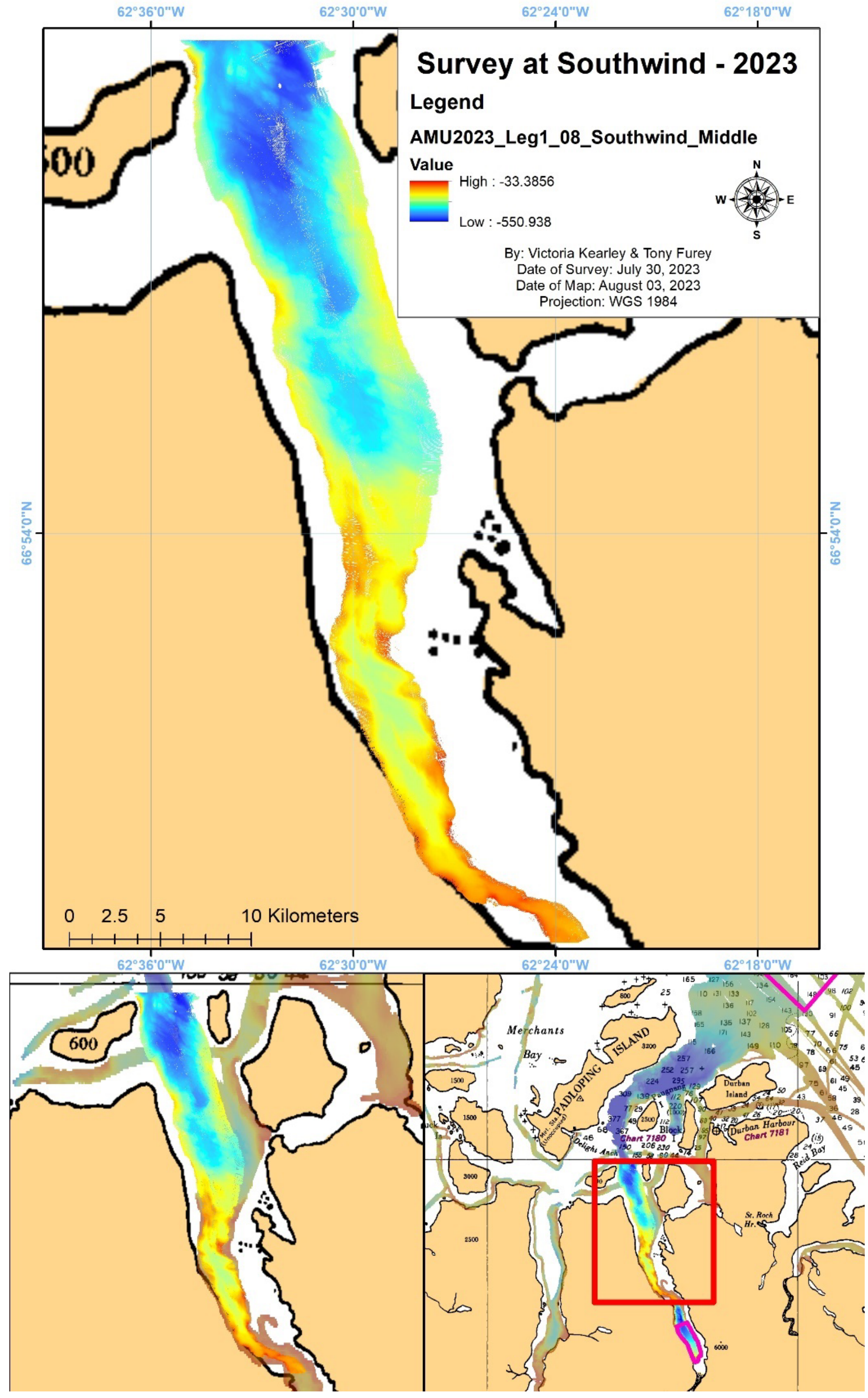

Figure 15: Multibeam bathymetric data coverage for the middle portion of Southwind Fiord, Baffin Bay acquired during 2023804. Figure produced by Victoria Kearley and Tony Furey.

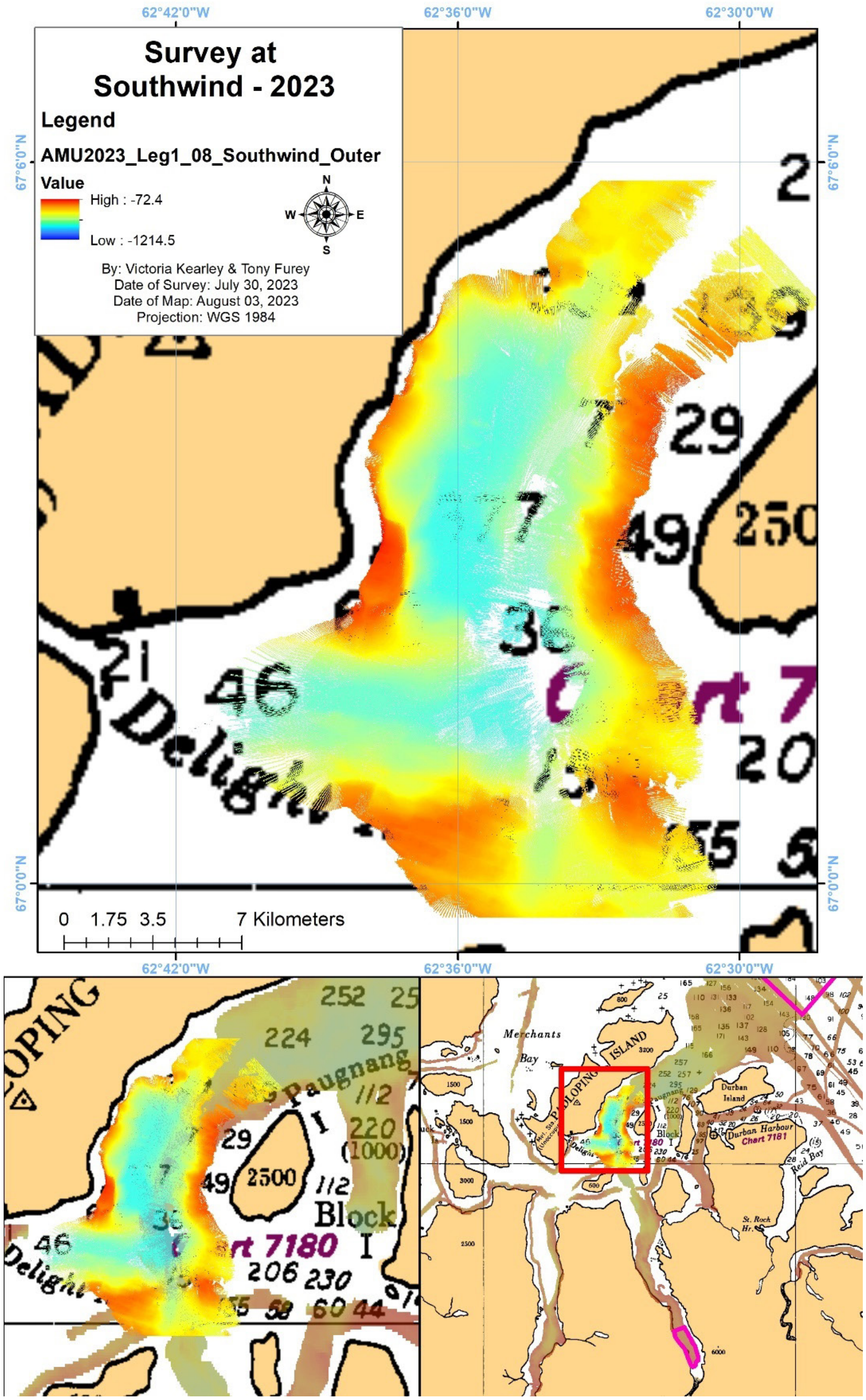

Figure 16: Multibeam bathymetric data coverage for the outer portion of Southwind Fiord, Baffin Bay acquired during 2023804. Figure produced by Victoria Kearley and Tony Furey.

6.3 Additional Box Core stations

A total of 10 other box core stations were sampled by NRCan in collaboration with other institutions onboard 2023804 of the *Amundsen* Science expedition (Table 7;Figure 18; Figure 19). Push cores that were sub-sampled from all stations with appropriate recovery are to be processed and archived at the NRCan. These box cores were collected from the Joey's Gully, Makkovik Hanging Gardens and Saglek Fiord in the Labrador Sea, and from Disko Fan and Davis Strait in Baffin Bay.

Table 7: Additional box core stations subsampled by NRCan.

Station	Depth (m)	Subcore type	Subcore name	Core Length (cm)	Location	Comments
0001	137.8	-	-	0	Joey's Gully, Labrador Sea	Box core only recovered a couple of small cobbles. Suspect the bottom was rocky.
0003	703.4	Push	A	36.5	Makkovik Hanging Gardens, Labrador Sea	
0006	240.7	Push	A	48	Saglek Fiord, Labrador Sea	Soupy mud. Push collected taken in collaboration with Chris Algar (Dalhousie University) to be archived by NRCan
0015	553.9	Push Push	A B	16.5 17.5	Disko Fan, Baffin Bay, BB1B_600	Push cores collected in collaboration with Maxime Geoffroy (Marine Institute) to investigate otoliths, to be archived by NRCan
0016	895.1	Push Push	A B	27 21	Disko Fan, Baffin Bay	Push cores collected in collaboration with Maxime Geoffroy (Marine Institute) to investigate otoliths, to be archived by NRCan
0017	808.9	Push Push	A B	26.5 26	Davis Strait, Otolith 3	Push cores collected in collaboration with Maxime Geoffroy (Marine Institute) to investigate otoliths, to be archived by NRCan
0018	508.3	Push Push	A B	40 35	Davis Strait, Otolith 4	Sediment was dense with sponge spicules throughout. Push cores collected in collaboration with Maxime Geoffroy (Marine Institute) to investigate otoliths & sponge spicules to be archived by NRCan

Station	Depth (m)	Subcore type	Subcore name	Core Length (cm)	Location	Comments
0019	504.3	Push Push Push	A B C	25 22 25	Davis Strait, Otolith 5	Few sponge spicules noted in top few cm of box core. Push cores collected in collaboration with Maxime Geoffroy (Marine Institute) to investigate otoliths & sponge spicules to be archived by NRCan
0020	573.8		A	40	Davis Strait, DS2	Push core collected in collaboration with Chris Algar (Dalhousie University) to be archived by NRCan
0021	610.6		A	32	Davis Strait, DS3	Push core collected in collaboration with Maxime Geoffroy (Marine Institute) to investigate otoliths, to be archived by NRCan

6.4 AUV Dives

The AUV was not able to collect data at Joey's Gully or Hatton Basin. The Joey's Gully dive was in about 140 m water depth. The AUV dove to the programmed altitude (10 m above the seabed) and aborted the mission soon after it reached this depth due to a "failed to track depth" error. This dive plan was using a newly developed diving program in the Gavia software (called Ascent/Descent actions) that has not produced consistent results. At this point in the expedition, all dives were switched to a different diving program in hopes of getting more consistent diving behavior (called Vertical Descent Lines or Vertical Ascent Lines).

The Hatton Basin dive was in about 650 m water depth to the east of Hudson Strait. The AUV was unable to dive to the programmed altitude due to very strong currents in the area (the ROV dive at this site was also unsuccessful due to the currents). When reviewing the diagnostic data from the dive, the AUV dove to about 450 m water depth but was unable to maintain the desired speed or heading. This led to significant position errors, and the Gavia cut power to its thruster and performed an unpowered ascent to the surface. When the AUV arrived at the surface, it took a GPS fix and attempted to dive again. The Gavia dove to about 500 m, but the currents caused the same issues as the first attempt, so the AUV did another unpowered ascent to the surface and aborted the mission.

The Inner Frobisher Bay dive was planned to map a site previously observed by an ROV and to image a portion of a nearby slope failure. This dive was in about 140 m water depth. The AUV conducted a successful mission that was about three hours in duration and collected ~19 line kilometres of geophysical data (Figure 17). The western portion of the survey area was previously investigated by the Department of Fisheries and Oceans (DFO) using an ROV. The ROV video showed the presence of sponges in this area so the main purpose of this dive was to see if the AUV could resolve the sponges. The AUV data have been shared with DFO for further analysis regarding the presence of sponges. A slope failure near the DFO sponge area that was previously mapped with a conventional surface multibeam system was remapped by the AUV. The AUV bathymetric data showed a considerable improvement in resolution of the slope failure (Figure 17).

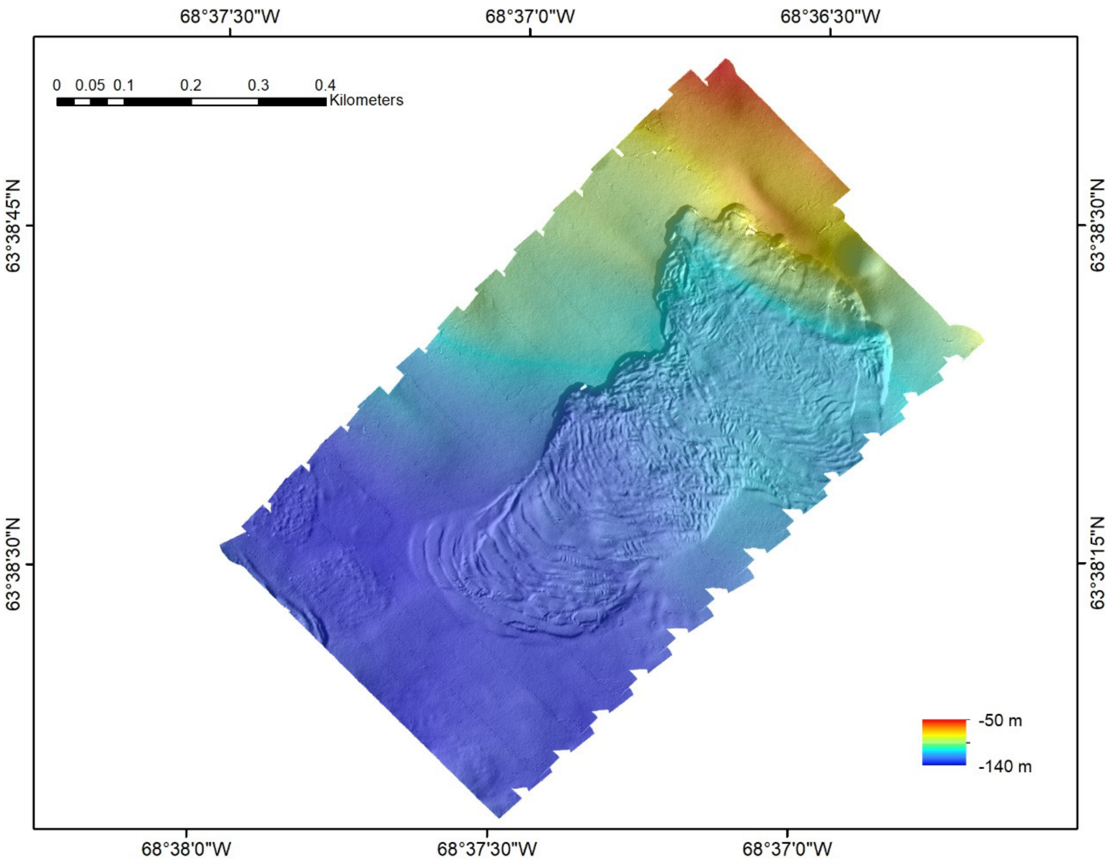

Figure 17: AUV bathymetric data in Inner Frobisher Bay

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8. Appendices

Appendix A: Station Summary

Table 8: NRCan and stations during leg 1 of the 2023 *Amundsen* Expedition.

Time (UTC)	Amundsen Station ID	NRCan Stn ID	Latitude	Longitude	Activity	Event	Depth (m)
2023/07/15 19:03:48	Joey's Gully	0001	54.7671368	-56.3280718	Box Core	Bottom	137.8
2023/07/15 18:41:15	Joey's Gully	0001	54.7685478	-56.3276153	Box Core	Bottom	134.8
2023/07/15 21:32:51	Joey's Gully	0002	54.7575080	-56.3270285	AUV	Recovery	134.3
2023/07/15 20:55:01	Joey's Gully	0002	54.7593737	-56.3260930	AUV	Deployment	129.8
2023/07/18 00:28:41	Makkovik Hanging Gardens	0003	55.4336408	-58.9433882	Box Core	Bottom	703.4
2023/07/21 11:16:13	Okak Bay	0004	57.5204550	-62.1480705	Gravity Core	Bottom	64.0
2023/07/21 13:06:16	Okak Bay	0005	57.5169133	-62.1428528	Gravity Core	Bottom	69.6
2023/07/22 08:44:20	North Arm	0006	58.4833333	-63.2191180	Box Core	Bottom	240.7
2023/07/22 11:15:41	North Arm	0007	58.4883655	-63.3721275	Gravity Core	Bottom	91.3
2023/07/30 05:32:24	SW2	0008	66.9226873	-62.4900620	Box Core	Bottom	389.9
2023/07/30 08:09:56	SW3	0009	66.8306782	-62.4295318	Box Core	Bottom	117.8
2023/07/30 07:40:54	SW3	0009	66.8292505	-62.4278477	Box Core	Bottom	86.7
2023/07/30 13:59:36	SW9	0010	66.7527830	-62.3119530	Gravity Core	Bottom	36.9
2023/07/30 16:47:21	SW10	0011	66.7883083	-62.3684640	Gravity Core	Bottom	179.8
2023/07/30 22:27:55	SW5	0012	66.7875997	-62.3689900	Box Core	Bottom	179.8
2023/07/30 23:15:31	SW7	0013	66.7519007	-62.3126303	Box Core	Bottom	37.1
2023/07/31 00:00:27	SW8	0014	66.7529092	-62.3123542	Box Core	Bottom	41.4
2023/08/01 07:53:28	BB1B_600	0015	67.9917192	-59.3750933	Box Core	Bottom	553.9
2023/08/01 11:16:51	Disko Fan	0016	67.9708863	-59.5046017	Box Core	Bottom	895.1
2023/08/02 08:38:00	Otolith 3	0017	66.7997842	-58.4859132	Box Core	Bottom	808.9
2023/08/02 11:24	DS1	N/A	66.25728	-58.2972	Box Core	Bottom	625.8

Time (UTC)	Amundsen Station ID	NRCan Stn ID	Latitude	Longitude	Activity	Event	Depth (m)
2023/08/02 20:46:32	Otolith 4	0018	66.1994828	-58.4967143	Box Core	Bottom	508.3
2023/08/03 08:04:27	Otolith 5	0019	65.5993298	-58.4978438	Box Core	Bottom	504.3
2023/08/03 21:55:03	DS2	0020	65.3349683	-58.0167712	Box Core	Bottom	573.8
2023/08/04 15:20:02	DS3	0021	64.6477755	-58.6032630	Box Core	Bottom	610.3
2023/08/04 14:42:51	DS3	0021	64.6484325	-58.6031017	Box Core	Bottom	610.6
2023/08/05 12:28:39	HB AUV	0022	61.4325402	-60.7060933	AUV	Deployment	540.0
2023/08/09 17:02:16	-	0023	63.6477622	-68.6227770	AUV	Deployment	55.0
2023/08/09 13:41:57	-	0023	63.6472503	-68.6244128	AUV	Recovery	55.0

Appendix B: Box core photos

Figure 18: Images from box core stations 0006, 0012, 0013 and 0014, 0015 and 0016.

Figure 19: Images from box core stations 0017,0018, 0019, 0020, 0021.