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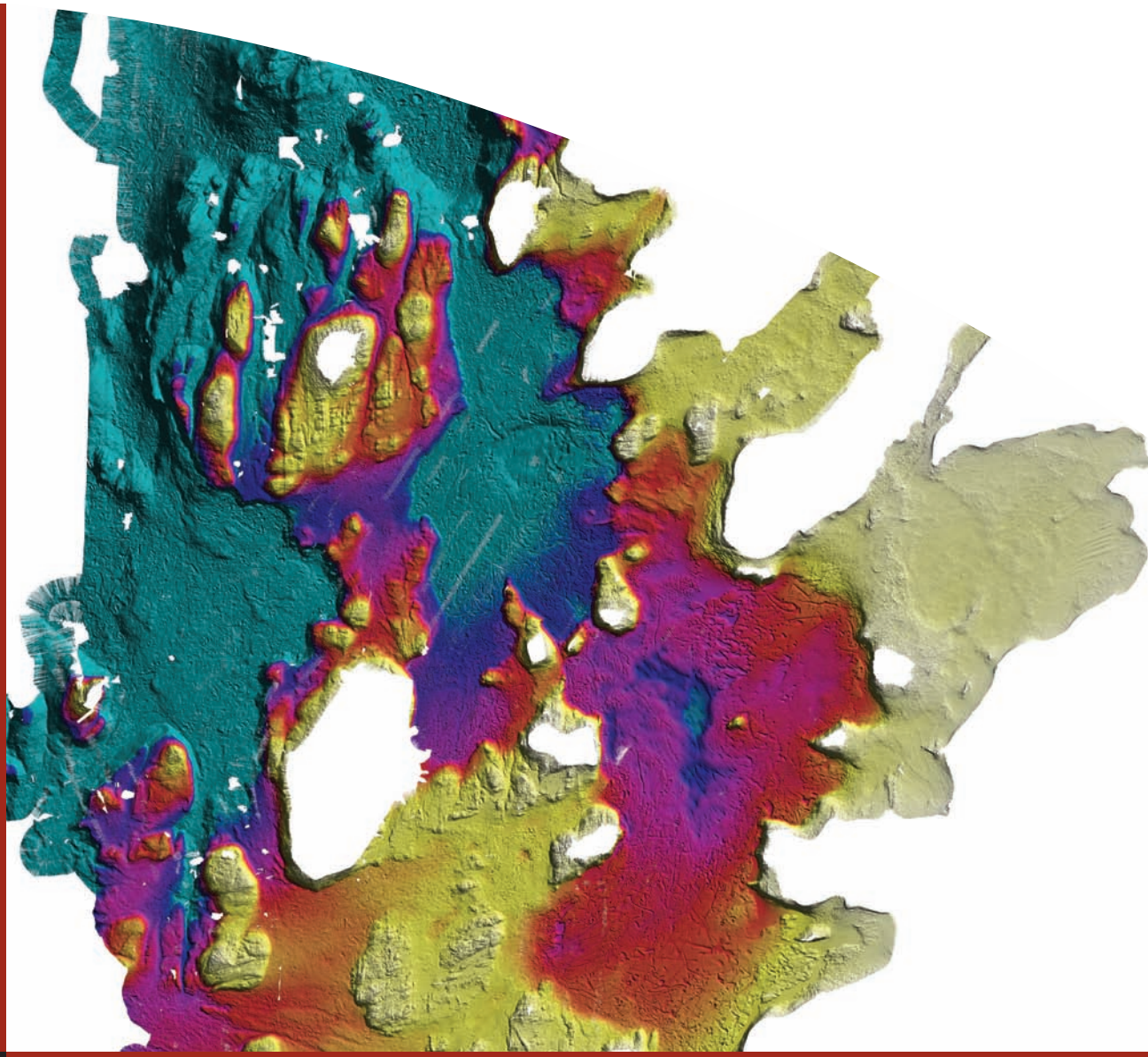

Coastal Seabed Mapping Survey, Vestfold Hills, Antarctica, February-March 2010 (AAS 2201) – Post Survey Report

GEOSCIENCE AUSTRALIA
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by

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Australian Government
Geoscience Australia

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Executive Summary

From February to March 2010, Geoscience Australia (GA) conducted a multibeam sonar survey of the coastal waters of the Vestfold Hills in the Australian Antarctic Territory. The survey was conducted jointly with Australian Antarctic Division (AAD) and the Deployable Geospatial Survey Team (DGST) of the Royal Australian Navy. The survey was aimed primarily at understanding the character of the sea floor around Davis Station to better inform studies of the benthic biota and the possible impacts of the Davis sewage outfall. DGST were involved to ensure that the bathymetric data could be used to update and extend the nautical charts of the Davis area.

The survey was conducted using GA's Kongsberg EM3002D multibeam echo sounder and C-Nav Differential GPS system mounted on the AAD work boat *Howard Burton*. Sixteen under water videos were also collected using the GA Raytech camera system and 3 grabs were also collected to compliment an intensive sampling program by AAD divers and a sampling program conducted in the 1990's by University of Tasmania (Franklin, 1996).

An area of 42 km^2 was surveyed intensively immediately off Davis and additional survey lines were run to Long Fjord in the north and to Crooked Fjord and the Sørsdal Glacier in the south. The main survey area had between 150% and 200% coverage as the seabed was esonified from opposing angles to resolve and provide detail to the numerous features of the seafloor such as rocky reefs, iceberg scours, boulders, anchor chain drag marks and grounded icebergs. The new high resolution data provided detailed maps of sea bed morphology and texture classification to complement sample data. Sixteen video transects were collected and 3 grab samples collected in water too deep for the Australian Antarctic Division Diving program.

New high resolution bathymetric grids have been prepared for scientific use and further processing for hydrographic charting is ongoing. A new sea floor geomorphic map has been prepared using the multibeam data, preliminary video and sampling data.

Introduction

The Davis coastal seabed mapping survey was a joint project undertaken by Geoscience Australia with Australian Antarctic Division and the Australian Hydrographic Service (Royal Australian Navy) between the 25 January and 29 March 2010. The objectives of the survey were as follows:

- Provide multibeam bathymetry of the coastal region of the Vestfold Hills around Davis Station, Antarctica, to aid the understanding of sea bed character, benthic habitats, provide a basis for hydrodynamic modeling of water movement around Davis, and to update and extend the navigational charts of the region
- Collect sea floor towed-video footage to assist with interpretation of sea bed character and benthic habitats
- Collect sediment samples to ground truth the acoustic data
- Collect sidescan sonar data to compliment the multibeam bathymetry and backscatter and improve hazard identification

The project was a component of Australian Antarctic Science (AAS) Project 2201 – Natural Variability and Human Induced Change on Antarctic Nearshore Marine Benthic Communities, whose project Leader was Dr Martin Riddle of the Australian Antarctic Division. The Hydrographic Charting was also under the auspices of Australian Antarctic Division non-Science Project 3259, Hydrographic Charting of Antarctic Waters. Project AAS 2201 also had a party undertaking a biological survey using scuba diving in the area so consultations were held to determine survey priorities.

The GA contribution to the project comprised the EM3002 multibeam sonar, the Raytech under water video system and the sediment grabs and operational support. GA also contributed geological interpretation of the data. The Royal Australian Navy Deployable Geospatial Support Team (DGST) conducted single beam surveys in very shallow areas and deployed tide gauges.

Personnel

Geoscience Australia
Philip E O'Brien, geologist and science leader
Ian Atkinson, multibeam system engineer and vessel manager
Royal Australian Navy Service Deployable Geospatial Survey Team (DGST)
Lt Comd Ross Bowden, hydrographic survey leader
PO Dean Forrest
LS Jade Paddison
AS Steven Swanson

REGIONAL SETTING

Davis is situated on the coast of the Vestfold Hills, one of the largest ice-free areas on the East Antarctic coast with an area of 400 km^2 (Fig. 1a, b). It lies between 68^o 21'S and 68^o 41'S and 077^o 49'E and 78^o 35'E. Its coastline is a complex of small rocky islands and fjords with water depths from 0 to 160 m in the deepest places (Long Fjord). Islands and hills on the mainland reach elevations of up to 60 m in the coastal zone rising to 156 m inland near the edge of the ice sheet. The only hydrographic survey of the region (chart AUS 602) shows water depths from 0 to around 169 m.

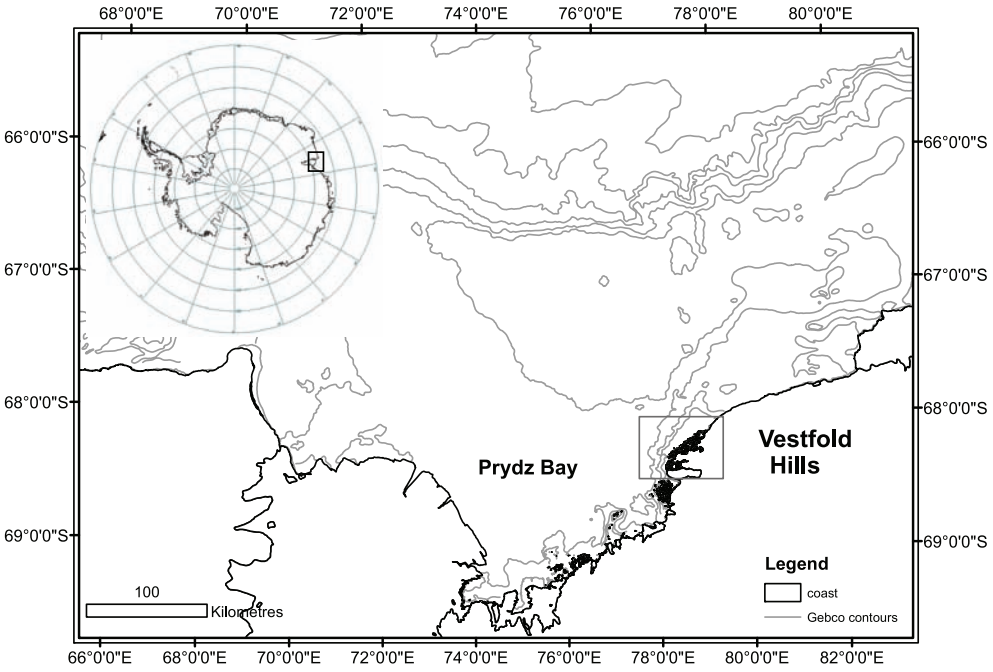

Figure 1a: *Location of the Vestfold Hills in East Antarctica on the eastern side of Prydz Bay*

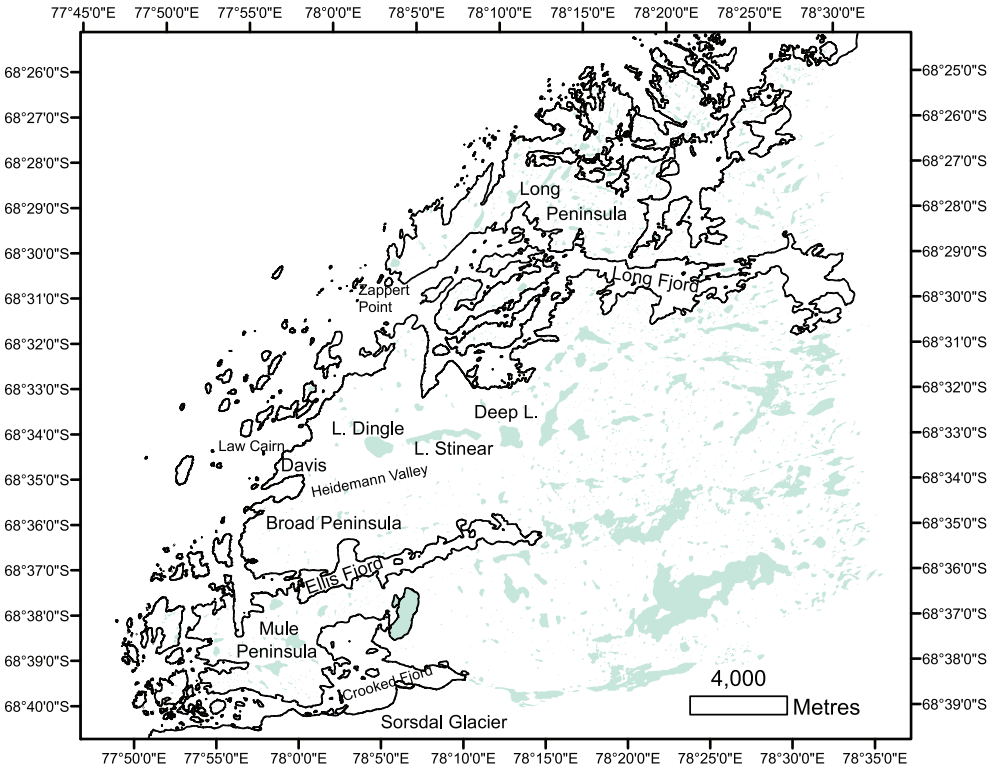

Figure 1b: *Vestfold Hills place names mentioned in the text*

GEOLOGY

The Vestfold Hills are composed of a basement of Archean gneiss intruded by Palaeo-Proterozoic dolerite dykes (Tingey, 1991). The basement is cut by a number of joint and fault sets. The Vestfold Hills are surrounded by younger Precambrian metamorphic rocks north and south and westwards by the Phanerozoic Prydz Bay Basin (Stagg, 1985; Tingey, 1991). The eastern extent of the Vestold Hills block is unknown because it is obscured by the ice sheet. The Vestfold Hill form an elevated plateau surrounded by deeper basement. The Sørsdal Glacier has cut a trough at least 300 m deep along the southern side and the sea floor drops to depths of 300-700 m in the Svenner Channels to the west (O'Brien and Leitchenkov 1997). The depth of basement beneath the ice sheet to the north and east of the Vestfold Hills is poorly known.

Younger sediments are scattered across the Vestfold Hills. The oldest Cenozoic units are Pliocene diatomaceous deposits at Marine Plain. They represent a phase of shallow marine sedimentation from 4.1-4.5 Ma under conditions 1.6^{o}-3^{o}C warmer than today (Harwood et al., 2000). Glacial deposits of slightly younger age have been identified in Heidemann Valley. Colhoun et al., (2010) concluded that the till in a trench excavated in 1997 was between 2.6-3.5 Ma. Identification of younger tills and other glacial sediments has relied on ^{14}C and cosmogenic dates which suggest parts of the Vestfold Hills close to the present ice edge were glaciated during the last glacial cycle and deglaciated between 9 ka and 12 ka (Fabel et al., 1995).

Marine sediments are found along major valleys in the form of Holocene bouldery diatom-bearing sands that form low relief plains within the valleys and benches around Lake Dingle, Stinear and Deep Lake (Fig. 2: Zhang and Peterson, 1984). Modern beaches are found at Davis, along the coast between Davis and Law Cairn and at the head of Heidemann Bay.

Figure 2: *Bench of Holocene marine sediments, southern side of Lake Dingle, Vestfold Hills*

CLIMATE

The climate at Davis is cold-polar with Mean Maximum Temperature of -7.4^{o}C and a Mean Minimum Temperature of -13^{o}C. Snowfall is low with a mean annual precipitation of 70.5 mm water equivalent. Mean wind speeds vary from 17 km hr^{-1} to 26 km hr^{-1} though maximum gusts of 206 km hr^{-1} have been recorded (Bureau of Meteorology, 2010). The sea is covered with sea ice for most of the year. Freezing takes place intermittently from the end of February and break-out typically takes place in December. Break-out occurs progressively from south to north in response to prevailing winds from the north-east and the geometry of the coast. This gradational change has a major impact on marine communities.

SURVEY DESIGN

The survey was planned using a set of areas designated by number based roughly on priority as defined in consultation with Australian Antarctic Division (Fig. 3). The primary survey objective was to obtain data for a detailed bathymetry grid and sea floor characterization in the area around Davis to better understand the sea floor environment and to allow assessment of the impact of the Davis sewage outfall. The Australian Hydrographic Service also nominated some areas of interest for shoal investigations. Plans were modified during the survey in response to weather conditions and priorities. The daily survey narrative is contained in Appendix 1.

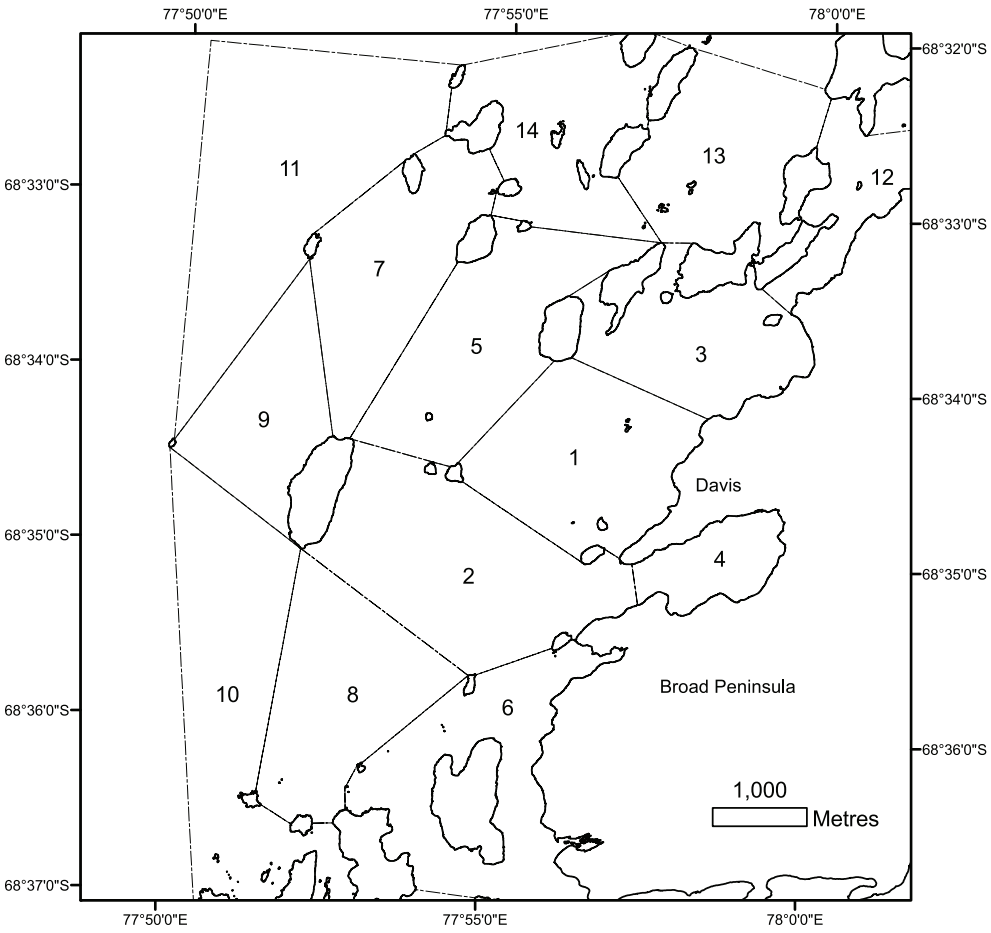

Figure 3: *Survey area off Davis with priorities assigned (numbered 1 to 14)*

EQUIPMENT

Vessel
The survey was conducted on the Australian Antarctic Division workboat *Howard Burton*. The *Howard Burton* is 8.5 m long and is equipped with twin outboard motors and a moonpool, through which the multibeam transducers could be raised and lowered. The vessel was also equipped with an electric winch to handle the coaxial cable for the sidescan sonar and underwater video system. Vessel details and layout are contained in Appendix 2.

Multibeam Sonar
The multibeam sonar was a dual head Konsberg EM 3002D. The system has a nominal frequency of 300 kHz. The motion reference unit was a Applanix PosMV 320 coupled with Auxiliary high precision C-Nav 2050R corrected GPS system. C-Nav is used for differential corrections and measuring vertical height above the geoid. However, for the seabed mapping project, bathymetry was levelled to Lowest Astronomical Tide using predicted tides for the Davis tide gauge. Details of the system are presented in Appendix 2.

Sound Velocity Profiler
Sound velocities were measured using a Applied Microsystems SV plus2 sound velocity profiler which was battery powered and deployed on rope. Locations of the profiles are presented in Appendix 2.

Tides
Predicted tides provided by the Australian Antarctic Data Centre were used to correct the bathymetry soundings back to a chart datum (lowest astronomical tide for this survey). DGST also deployed 2 tide gauges during the survey to check the accuracy of the predicted tide.

Sidescan
The sidescan sonar system was a 325 kHz C-Max towfish with maximum swath width of 150 m. However, after arriving at Davis it was decided not to use the sidescan sonar system because floating ice, complex bathymetry and the presence of current meters and sediment trap moorings in the survey area made it highly likely that the tow fish would be lost.

Towed Camera
Sea floor videos were collected using a Raytech towed camera that provided real time images on the deck unit and a tape recording of the video against time to tie the video to the navigation system. A hardwired error in the deck unit meant that tape time equalled Universal Time minus 5 minutes 30 seconds. The logged GPS file was subsequently reformatted to give a spreadsheet of UTC, tape time and locations which was then converted into an ArcGIS shape file for plotting.

Single Beam Echosounder
DGST also used their single beam echo sounder equipment on Inflatable Rigid Boat to survey very shallow areas such as Heidemann Bay and several shoal areas where the water depths and presence of boulders made multibeam acquisition hazardous.

SURVEY TIME

Out of 39 days at Davis, 19 survey days were possible. Eight days were lost when winds exceeded the boat operating limit of 25 knots, seven days were required for equipment installation, station inductions and field safety training, and four days for pack up and cargo operations prior to the ship

arriving to return the party to Hobart. One day was lost when the station doctor supervised a medical evacuation. Boat operations are not permitted when there is no doctor on station. By 12 March, ice conditions were restricting access to un-surveyed areas.

DATA PROCESSING

Multibeam data were loaded into CARIS HIPS & SIPS, merged with the True Heave from the motion sensor unit and corrected using the predicted tides. The tidal predictions proved accurate with only occasional evidence of "stitch marks" between survey lines that might have been caused by differences between predicted and actual tides. However, the few stitch marks present are most likely the result of local sound velocity anomalies.

A CARIS BASE surface was prepared for each day's data using a swath angle weighted method. Data were then edited to remove major spikes and bad swaths. Icebergs generated large groups of vertical to overhanging soundings which were removed by hand (Fig. 4). After cleaning in line editor, a new BASE surface (Bathymetry Associated with Statistical Error surface) was calculated and examined for anomalies which were then examined in SUBSET editor and further cleaned. The final BASE surface was then recomputed. The DGST processed further to include observed tides, TPE (Total Propagated Error) and the calculation of a CUBE (Combined Uncertainty and Bathymetry Estimator) surface.

In addition to occasional bad swaths and other noise, bad data stemmed from excessive water depths, steep slopes and rapid turns to avoid ice and shoals. Steep slopes and depths limiting multibeam acquisition (> 300 m deep) were especially common near the Sørsdal Glacier. The range capabilities of the EM3002D are dependant on the environment but are in the order of 200-250 m in cold waters, however, some plausible bottom returns were recorded in water as deep as 260 m. In poorly mapped areas, beams angles were commonly extended to horizontal (90°) to look for uncharted shoals. This also produced noise in the outer beams but was necessary for safety and obstacle detection.

Across most of the survey area, data coverage between 150% and 200% were achieved. The best sea floor imagery was produced by 200% coverage where sharp features such as boulders were ensonified from both sides. Gaps exist where icebergs remained during the survey, over shoals that were too shallow to traverse and the occasional gap in line coverage caused by the complexity of line layout imposed by the narrow seaways and floating ice. The BASE surface displayed herein contains lines of small gaps that correspond to the nadir of the multibeam system. These gaps result from the distance between beams being larger than the beam widths and the multibeam system running in equidistant mode (Appendix 2). A continuous surface could be calculated by increasing the grid size but at the cost of fine detail.

UNUSUAL FEATURES

Icebergs produced vertical to overhanging surfaces which were edited out (Fig. 4). They sometimes feature a trench in front of the ice face which is sometimes spurious. The trench appears because the sound bounces off the ice onto the sea floor and is reflected back to the transducer. The longer ray path produces an apparent depression (Fig. 5). Boulders are common features of the Vestfold Hills landscape (Fig. 6) and are also prominent submarine features. Like icebergs, they commonly have spurious soundings in front of the boulder produced by the ray path reflecting off the sea floor. These possible spurious soundings were inspected and edited out when deemed erroneous during data cleaning.

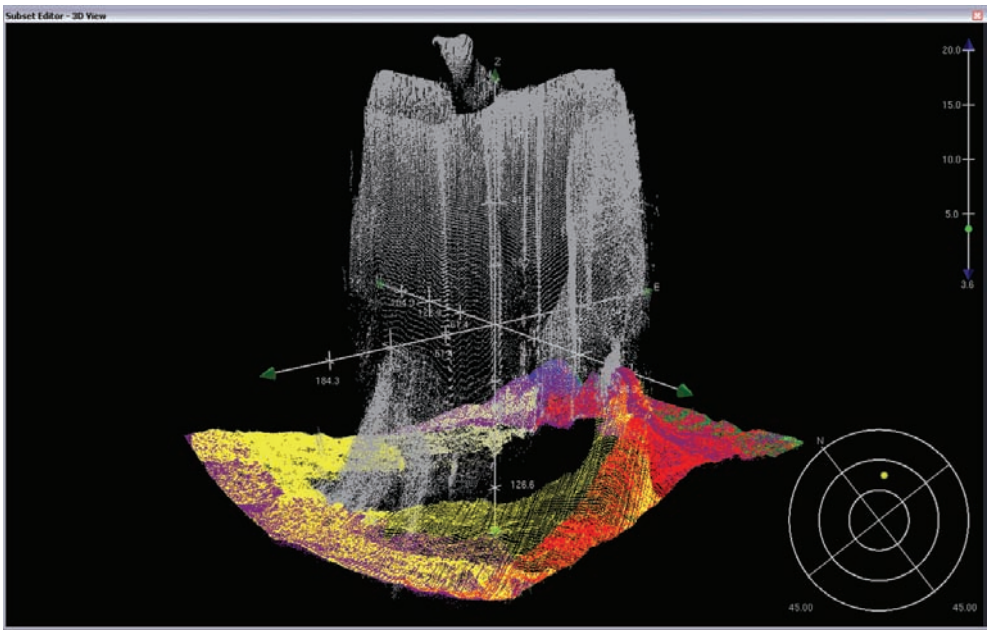

Figure 4: *Soundings from an iceberg near Davis. Coloured soundings are valid sea bed soundings and are part of the BASE surface while grey soundings are from the iceberg and have been made inactive*

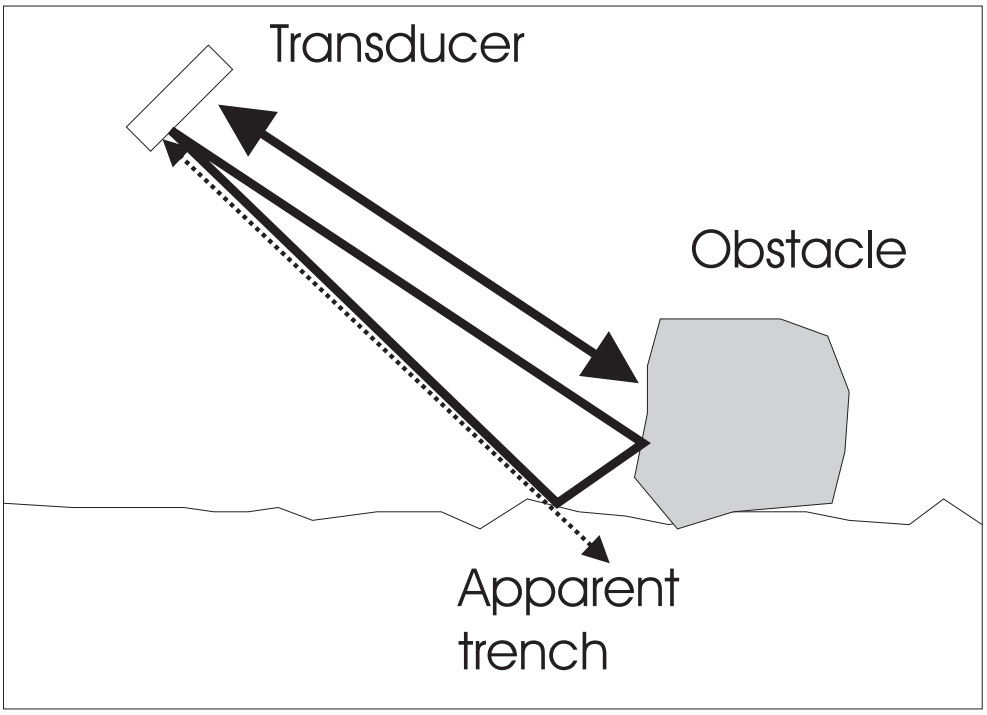

Figure 5: *Ray paths (solid lines) for echo sounder pings reflecting off a large boulder. The longer ray path that hits the seafloor appears as a sounding from a trench in front of the boulder (dashed line)*

Figure 6: *Large boulders on the surface of the Vestfold Hills similar to those imaged by the multibeam data. The largest boulder is about 3 m in diameter. These boulders are thought to be glacially transported*

Macroalgae (*Himathothalus* and *Iridea*) are a dominant feature of the Vestfold Hills marine environment. They are particularly abundant on areas of rocky sea floor. Multibeam data show vertical strings of reflectors above these areas around the Vestfold Hills which were initially interpreted as vertical stands of macroalgae. However, both algae lie flat on the sea floor, unlike the kelp found in temperate waters which *Himanthothalus* resembles and macroalgae is commonly transparent to sonar, especially at the frequency of the EM3002D system. The reflectors were usually left in the data unless they clearly affected the BASE surface. Examination of the data in SUBSET editor show clouds of points sitting about 1-1.5 m above the BASE surface on rocky outcrops in places. A more likely explanation for these clouds of reflectors is provided by the observation of abundant gas bubbles generated by the algae in sunny conditions (M.Riddle, pers. comm. 2010). Gas bubbles can provide strong point reflectors because they resonate at certain sound frequencies determined by bubble size (Clay and Medwin, 1977). This phenomena is particularly apparent over methane seeps (Rollet et al., 2006). A gas bubble origin for these reflectors can explain the observation that they typically show a gap between the base of the cloud and the sea bed. The reflectors originate from the gas bubbles changing size as they ascend through the water and dissolve, so they reach an optimum target strength at roughly the same distance from the sea floor. If they were stands of vertical algae, they would be continuous with the bed.

VIDEO TRANSECTS

The Raytech video camera was deployed via a frame on the stern of the workboat and recorded on the deck unit against tape time which is UTC minus 5 minute 30 sec. Locations were logged by recording GPS coordinates on a portable computer and the multibeam unit as a back-up. Spreadsheets of video transect start and end points are included in Appendix 3.

OTHER DATA

Sediment samples were collected from the area as part of an Antarctic Cooperative Research Centre PhD project in 1993/1994 (Franklin 1996). Additional samples were collected using the GA mini-shipeck grab and the AAD diving program collected 400 push core samples. Grab samples locations and data from Franklin (1996) are listed in Appendix 4. The AAD program also deployed sediment traps and current meters in the Davis area. Their locations are listed in Appendix 4.

Results

MULTIBEAM

A total of 42 km^2 of multibeam were collected. The core area around Davis was mapped almost completely (Fig. 7). Transects were run further afield; to the Sørsdal Glacier and Crooked Fjord, Laternula Inlet and Ellis Fjord to the south and to Long Fjord and Zappert Point to the north. Attempts to extend coverage of Long Fjord were thwarted by sea ice growth late in the campaign. Hydrographic aspects of the multibeam survey are detailed in a report to the Australian Hydrographic Service (HI468).

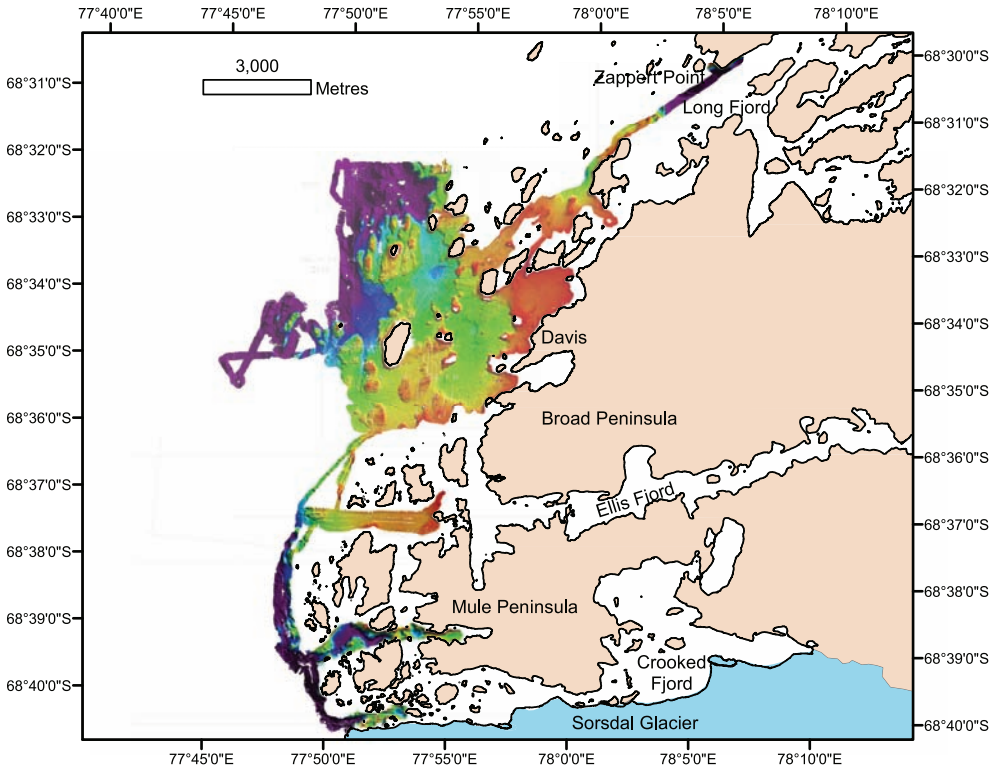

Figure 7: *Multibeam coverage of the Vestfold Hills nearshore zone collected in February to March 2010*

VIDEO

Sixteen videos were recorded, mostly in the Davis area and one transect was run in Crooked Fjord at the southern- most limit of the survey area (Fig. 8a, b). The plan to collect a track in Long Fjord was prevented by ice. Video transect CAM09 experienced a failure of the logging computer so the way points shown are those logged on field data sheets. Video quality was variable and affected by abundant phytodetritus in the water column. Adjustments were made to the light diffusers and the weighting of the video during the survey to improve video quality. The last few recordings were run under improved visibility which set in during the last few days of the survey, possibly in response to low temperatures inhibiting phytoplankton growth.

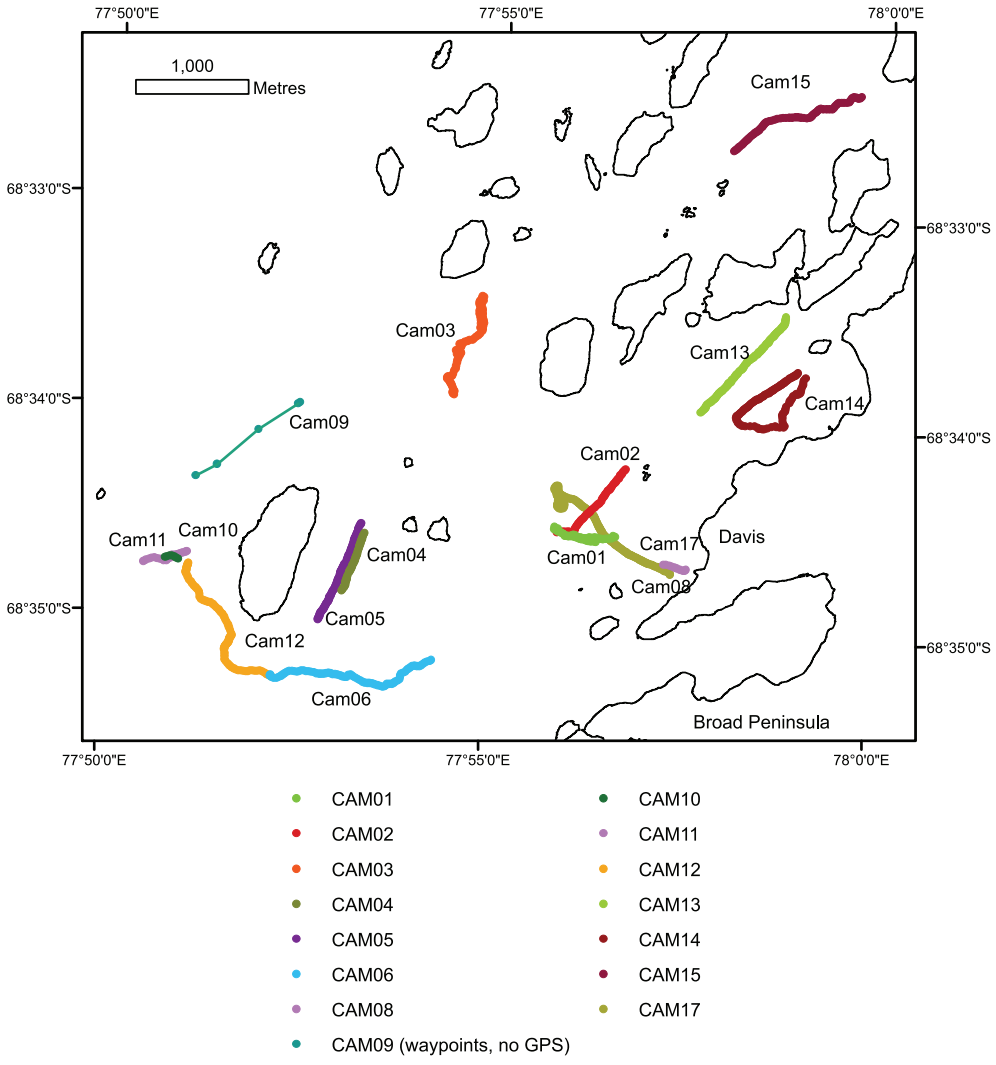

Figure 8a: *Video transects collected in the area immediately around Davis.*

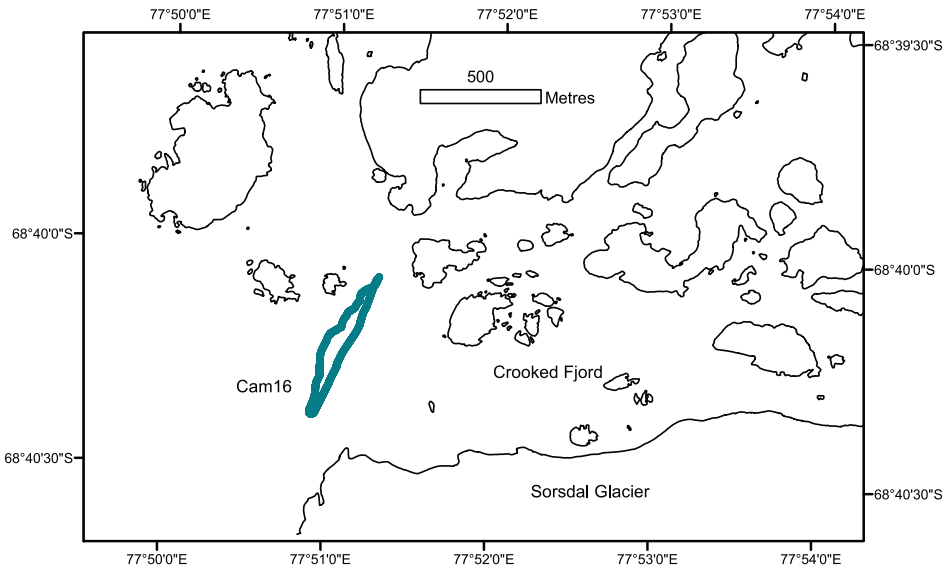

Figure 8b: *Video transect (CAM16) from Crooked Fjord adjacent to the Sørsdal Glacier collected in the area immediately around Davis*

SEDIMENT DATA

Sediment sample locations are shown in Fig. 9. Preliminary examination of the sediments collected as part of the survey reveals that sediments are muddy sand to sandy mud consistent with the data reported in Franklin (1996).

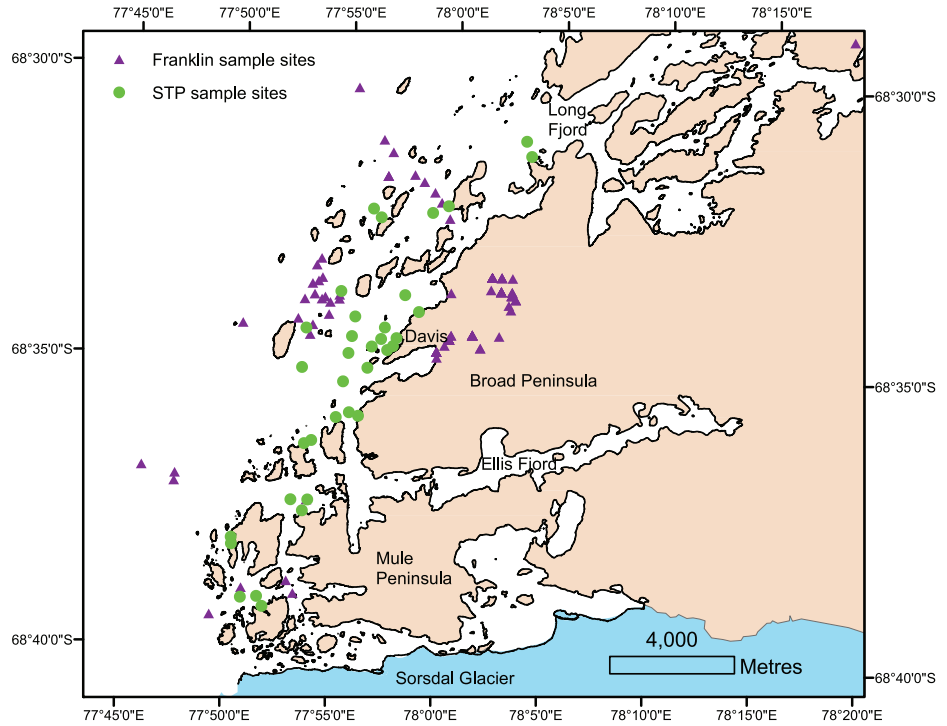

Figure 9: *Sediment samples from the AAD sampling program 2009/10 (STP) and Franklin (1996)*

GEOMORPHIC FEATURES AND HABITATS

The geomorphology and habitats presented here are based on interpretation of the multibeam data and a preliminary assessment of the other data sets. The area around Davis has been mapped for geomorphic units (Fig. 10) whereas areas to the north and south have not because of discontinuous multibeam coverage.

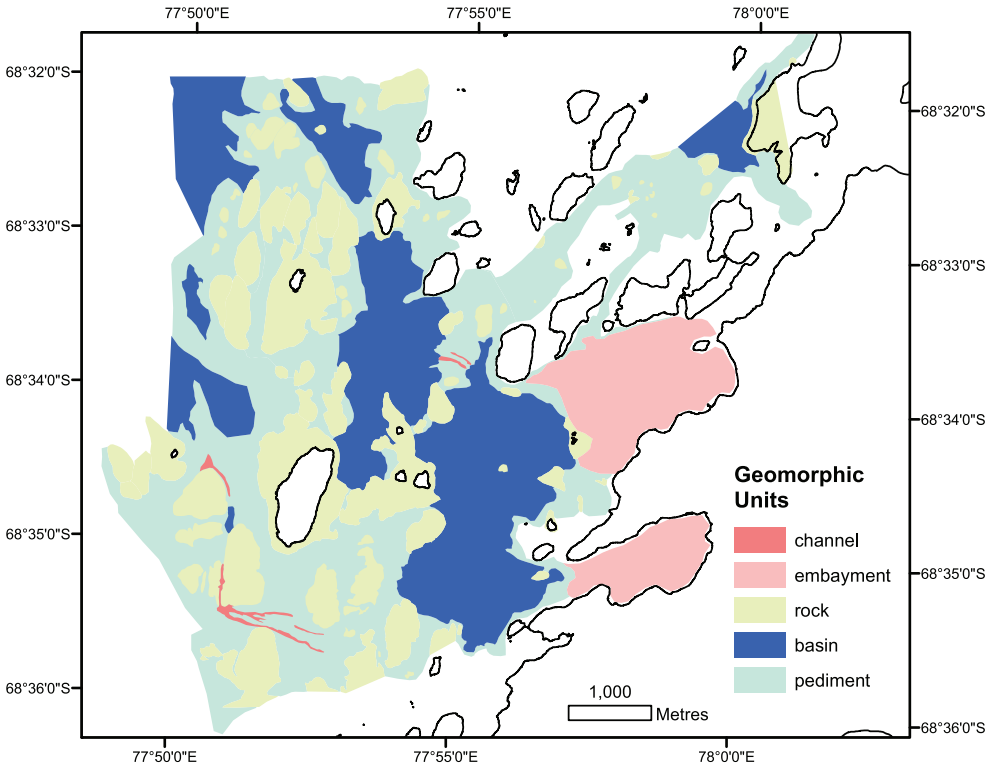

Figure 10: *Geomorphic units of the sea floor in the Davis area based on multibeam bathymetry data. Elongate deeps are found in Long Fjord and Laternula Inlet, outside the area of this figure*

Bedrock outcrops – Within the multibeam data, bedrock outcrops stand up above the surrounding sea floor as rounded hills and knolls with fine and medium scale roughness (Fig. 11). Joint planes and faults are commonly visible in the topography (Fig. 11). Bedrock outcrops range in depth from 0 to 25 m.

Sediment-floored depressions - Between islands and bedrock outcrops are basins floored with sediment (Fig. 12). These basins vary from 5 to 45 m in the Davis area and are typically floored with olive grey to green muddy fine sand to sandy mud. The mud component lacks cohesion and is probably mostly siliceous phytodetritus. Ice keel scours are abundant ranging from enclosed, rounded wallow marks 30 m across and 2 m deep, through meandering tracks. Sets of radial tracks only a few meters across around Anchorage patch are almost certainly ship anchor drag marks. The predominant direction of larger scours is north to south and NNW to SSE, and probably reflects oceanic circulation in Prydz Bay (Nunes Vaz and Lennon, 1994). Many narrow scours are oriented from NE to SW, indicating wind-driven sea ice as the cause.

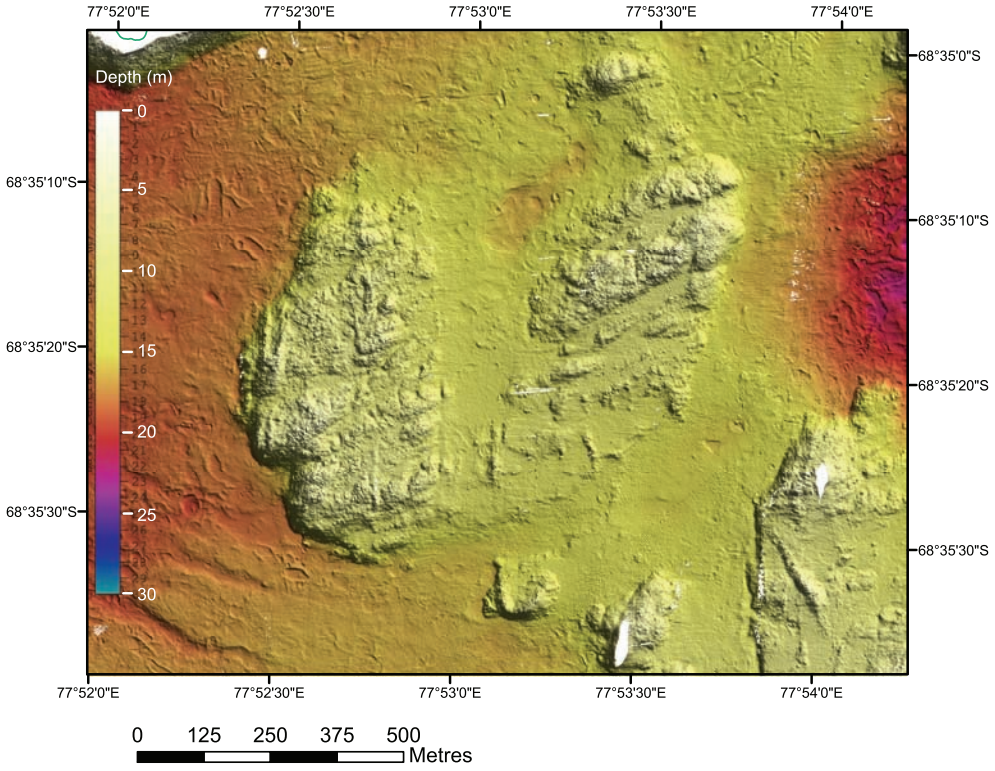

***Figure 11**: Shaded image multibeam data showing a bedrock hill off Davis. Data are a 0.75 m BASE surface. Gently sloping areas surrounding the bedrock hills are mapped as pediments*

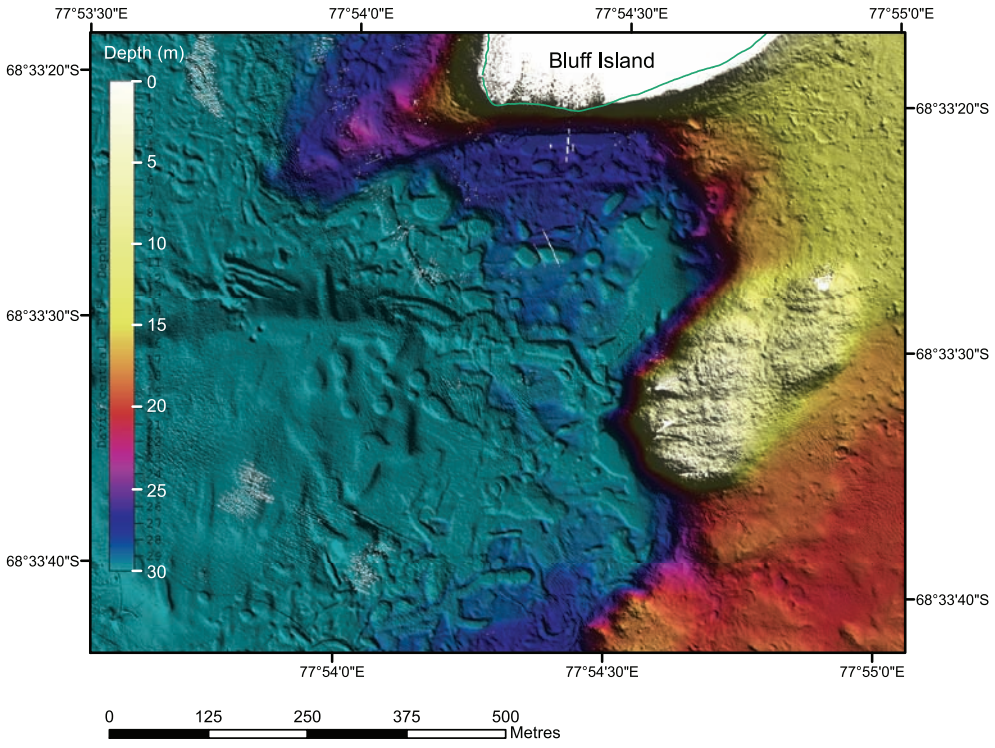

***Figure 12**: Shaded multibeam image of a sediment filled depression with abundant iceberg scours*

Pediments – The transition between bedrock outcrops and sediment-floored depressions are areas that are gently sloping with thin sandy sediment cover, probably on shallow bedrock. Slopes are lower than the sides of rocky hills and the surfaces may undulate, possibly reflecting underlying near-surface bedrock. Pebbles are common in these areas. Iceberg scours are present in some areas but others lack apparent scours, possibly because the sediments are too coarse to retain well defined scour topography. These areas most closely resemble pediments seen in many arid areas. A pediments is defined as "a plain of eroded bedrock, (which may or may not be covered with thin veneer of alluvium) in an arid area, developed between mountain and basin areas" (Whitten and Brooks, 1972). Though the areas off Davis are unlikely to have alluvial cover, their morphology, bedrock outcrops and thin sediment quite closely resemble typical pediments.

Channels – Channels wrap around several areas of bedrock such as the unnamed bank between Gardner Island and Keuken Island, Barrat Island and Anchorage Patch (Fig. 13). These channels are floored with muddy sand and videos across one channel show benthos consistently leaning south, the direction of prevailing currents (Nunes Vaz and Lennon, 1994). Other, narrower channels that resemble drainage features occur in a few places, running down slope from high points to low and at an angle to the probable prevailing current direction. These channels are modified by iceberg scours (Fig. 13). In other settings, these channels may be relict fluvial features, however, the area has a history of glacial rebound since the Last Glacial Maximum so it is unlikely the channels were exposed. Also, their persistence in spite of ice scour suggests recent activity, though modification by scours suggests that this activity is intermittent.

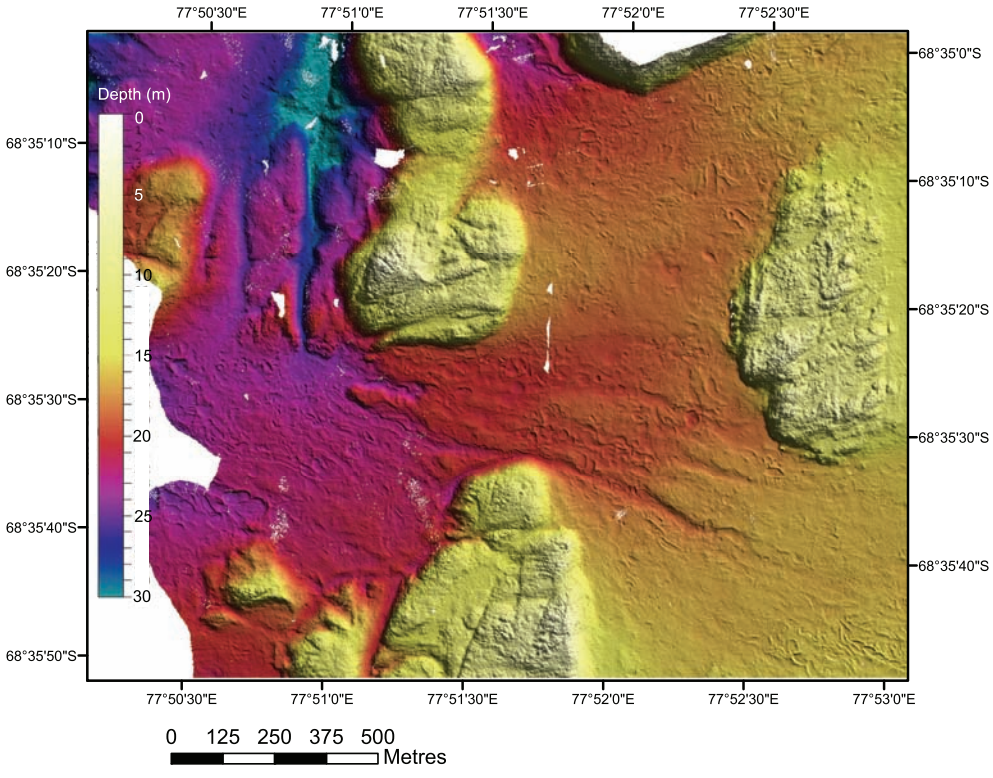

Figure 13: *Shaded multibeam image of sea floor channels near Davis*

Enclosed embayments – Some shallow areas <10 m deep are enclosed by peninsulas or islands that protect the sea floor from scouring by drifting ice. These area (Heidemann Bay, Airport Beach embayment) exhibit a relatively smooth sea floor but with abundant large boulders (Fig. 14). These boulders are probably relics of past glaciation (Colhoun et al., 2010). The sea floor between boulders is typically muddy sand with areas of current ripples and, in Airport Beach embayment, linear sediment ridges and gutters, suggesting current activity.

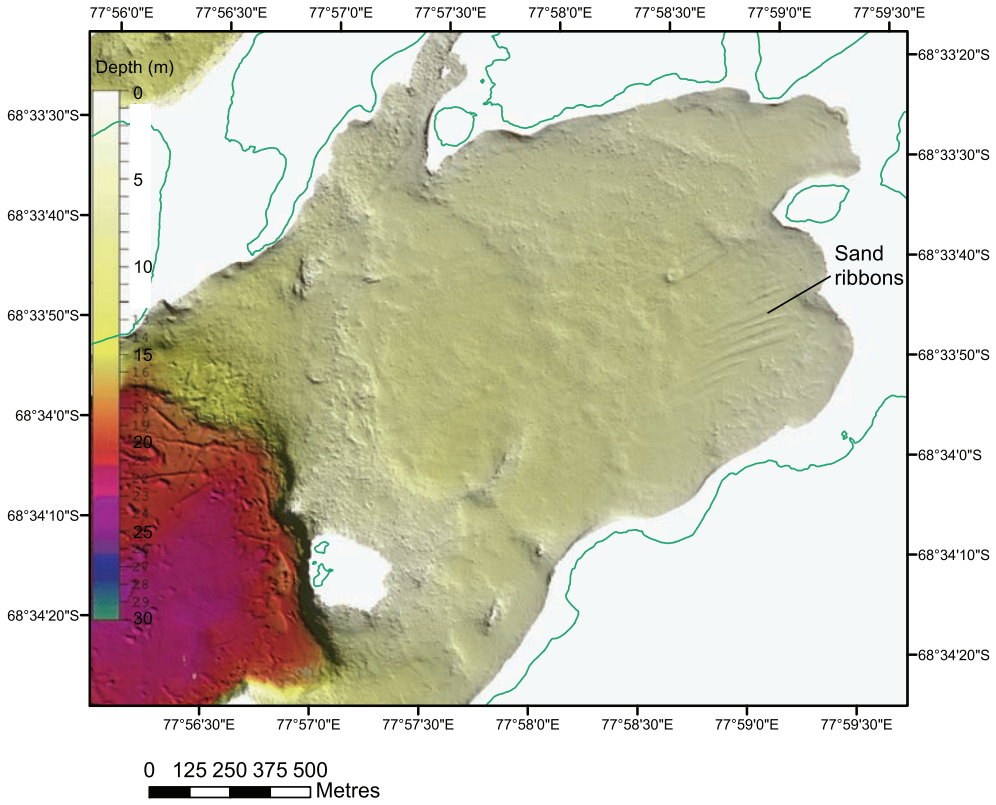

Figure 14: *Shaded multibeam image of an enclosed embayment north of Davis (Airport Beach). Speckled appearance is caused by many large boulders on the sea floor. Ribbons of rippled sand are also present*

Elongate deeps – Several deeply incised valleys were partly mapped. Complete mapping was not possible because water depths were close to the depth capability of the EM3002D. The trough of the Sørsdal Glacier is over 300 m deep. Other valleys were found in Long Fjord where depths of 160 m were encountered with very steep sides suggesting glacial erosion. The entrance to Laternula Inlet also exceeded 50 m in depth. The deep basins typically have smooth, sedimentary floors with some evidence of mass movement. Long Fjord, near Zappert Point, displays gullies, probably formed by sediment gravity flows (Fig. 15) whereas Laternula Inlet features lobate sediment bodies on the northern side, possibly formed as small turbidite fans (Fig. 16).

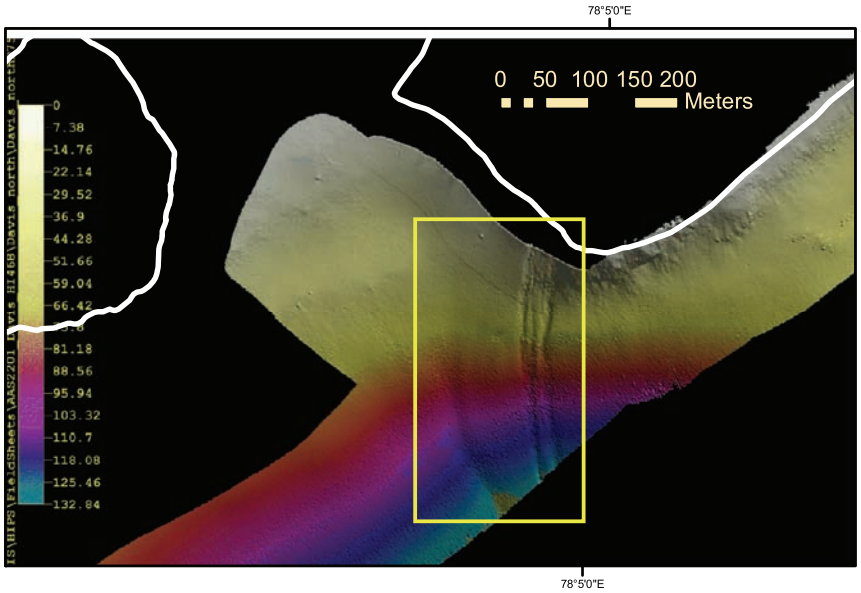

Figure 15: *Shaded bathymetry image of gullies (in box) on the northern side of Long Fjord, Zappert Point. The gullies are probably formed by landslides or density flows from melting snow*

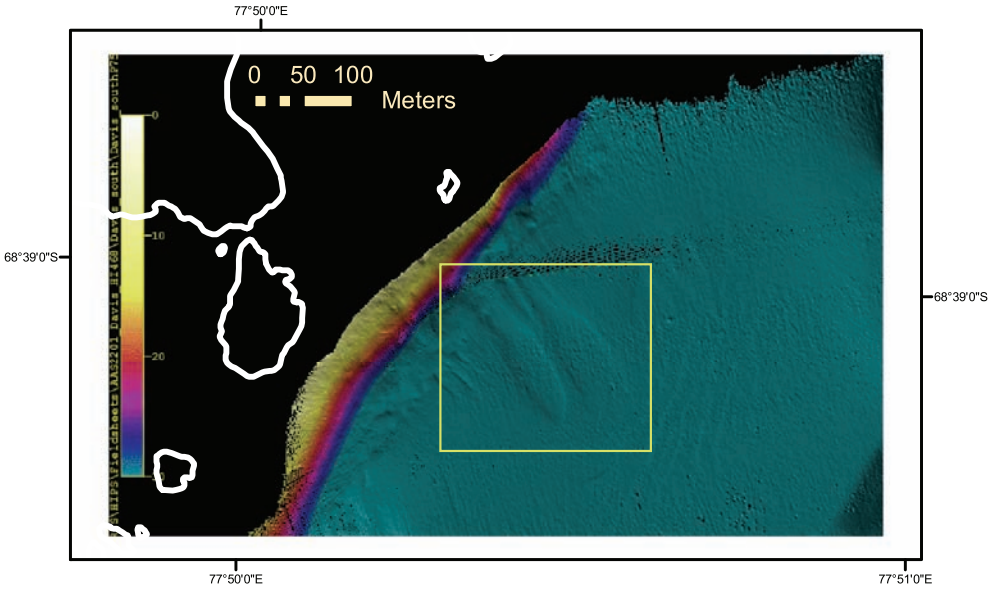

Figure 16: *Shaded bathymetry image of sediment lobes in Laternula Inlet. The lobes may form as turbidite deposits of debris flows*

Conclusions

The 2009/2010 Davis multibeam survey was highly successful in providing new insights into sea floor environments and processes along the Vestfold Hills coastline. The data will also allow expansion of the charted areas around Davis, though no major inaccuracies were found in the existing charts. Multibeam and video data have been lodged with GA, multibeam data with AHS and a 4m bathymetric grid provided to Australian Antarctic Division.

Acknowledgements

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Appendix 1: Survey Narrative

Table 1: Daily survey narrative (all dates in 2010)

DATE	SURVEY ACTIVITIES
25 Jan – 5 Feb	Transit. *RSV Aurora Australis* departed Hobart 1700 EAST. Arrived Davis anchorage at 1400 Local time (UTC +3) 5 February.
6-Feb	Party disembarked 0900 Davis time for station inductions and settling in. RV *Howard Burton* unloaded 1700
7-Feb	Equipment installation on HB.
8-Feb	Equipment installation on HB plus field survival training.
9-Feb	Equipment installation on HB plus field survival training.
10-Feb	Equipment installation on HB plus field survival training.
11-Feb	Field survival training and HB preparations. Winds building to >35 knots.
12-Feb	High winds. No surveying.
13-Feb	High winds. No surveying.
14-Feb	High winds. No surveying.
15-Feb	HB deployed 0830 via crane. System calibration till 1400. Survey area 1 and 5 till 1730.
16-Feb	High winds. No surveying. Data processing.
17-Feb	HB deployed and retrieved via trailer 0830. Surveying areas 2, 1 and 4.
18-Feb	High winds. No surveying. Data processing.
19-Feb	HB deployed 1030 after winds dropped earlier then anticipated.
20-Feb	HB deployed 0830. Surveyed Davis anchorage area.
21-Feb	HB deployed 0830. Surveyed Davis anchorage area.
22-Feb	HB deployed 0900. Video work, Davis anchorage area.
23-Feb	HB deployed 0830. Video work, Gardner Island area till 1230. Inflatable Rigid Boats (IRBs) deployed 1330 for single beam survey of Davis beach and Gorman and Torkler Rocks till 1700.
24-Feb	HB deployed 1100 after station meeting. Surveyed south of Davis including Crooked Fjord, Laternula Inlet and Ellis Fjord.
25-Feb	HB deployed 0900. Surveyed parts of areas 12,13 and 14 between Anchorage, Bluff and Plough Islands.
26-Feb	IRB survey of Heidemann Bay, Area 3 and passages between Anchorage, Trigwell and Flutter Islands.
27-Feb	High winds. No surveying. Data processing.
28-Feb	HB deployed 0900. Surveyed Area 3 and channel between Trigwell and Flutter Island.
1-Mar	HB deployed 0830. Surveyed areas 3 and 11.
2-Mar	High winds. No surveying. Data processing.
3-Mar	HB deployed 0830. Surveyed Area 11.
4-Mar	HB deployed 0830. Surveyed Area 11.
5-Mar	DGST surveyed wharf and boat ramp. No boating operations while the doctor was off station for a medical evacuation.
6-Mar	HB deployed 0900. Videos collected for Area 3 and near Plough Island. Multibeam traverse from Plough Island to Zappert Point on Long Fjord and return.
7-Mar	HB deployed at 1330 because of ice on the boat ramp. Multibeam to the Sørsdal Glacier and return with a video collected in Crooked Fjord.
8-Mar	High winds, snow, no surveying.
9-Mar	High winds, no surveying.

10-Mar	HB deployed 0900. Area 11 completed, some infill lines in Area 2.
11-Mar	HB deployed 0900. Some infill lines completed before the multibeam was retracted to avoid abrasion by newly formed ice. Three sediment grabs collected in Area 5. Attempts to sample Area 3 prevented by thick ice.
12-Mar	HB deployed 0900. Some infill lines collected in Area 5 but ice restricted access to preferred survey areas. Video collected across wreck and Davis anchorage area.
13-Mar	HB deployed 1100 for final calibration runs. Completed 1315.
14-19 Mar	Equipment removed for return to Australia. Data processing and pack up.
19-29 Mar	Transit to Hobart.

Appendix 2: Equipment

R.V. HOWARD BURTON METADATA

Figure 17: *Set up on the RV Howard Burton. Transducer heads were attached mechanically to the motion reference unit and the whole trolley lowered into the moonpool and locked in place. Video winch sat aft of the moonpool trolley with the video deployed on the aft davit*

MULTIBEAM SYSTEM COMPONENTS

Sonar System

Kongsberg EM3002D Sonar system – dual sonar heads with associated processing unit.

Port Head Serial No: 547 operated at 293 kHz
Starboard Head No: 548 operated at 307 kHz
Set degree of overlap between heads 0°
Looking up angle set per head during operation was 95° or less depending on seabed terrain, depth and resolution required.
Beams per head 160.

Depth determination precision specified by manufacturer is 5cm RMS.
Seafloor Information Software (display and control): 3.6.5

Processing Unit and Sonar Heads Software Versions as follows:

Date Time Ser. No.

2010.03.09 12:05:36.863 547
EM3002
HCT: 2.0.9 060126
BSP67 Master: 2.0.0 080912
BSP67 Slave: 2.0.0 080912
PU: 2.0.13 091019
Head: 547

2010.03.09 12:05:57.471 548
EM3002
HCT: 2.0.9 060126
BSP67 Master: 2.0.0 080912
BSP67 Slave: 2.0.0 080912
PU: 2.0.13 091019
Head: 548

Important notes regarding soundings

On Days 2010_46 & 2010_48 the system was operated in Equiangular mode all other days the system was operated in Equidistant mode.

Installation

The sonar heads were installed looking Port and Starboard, aft of centre of the boat in a moonpool. The Inertial Measurement Unit (IMU) was mechanically fixed to the sonar heads directly above on a rigid moonpool trolley.

The sonar head and IMU trolley system was daily winched down the moonpool and locked down in a fixed and known position.

The mechanical relationship between the sonar heads and the IMU was accurately machined. Thus all offsets and angles measured were constant and not affected by the daily winching and lockdown procedure of the moonpool trolley.

Motion Referencing System

Applanix PosMV 320 coupled with Auxiliary high precision C-Nav 2050R corrected GPS system.

Applanix PosMV 320 consists of:

Inertial Measurement Unit (IMU)
Model: MV V4
Serial: 2578

Processing unit incorporating two GNSS receivers and two seperate Applanix system GNSS antennas.
Model: LN200
Serial: 66
Firmware: POS MV V4 4.22

Manufacturers Specifications:

Roll, Pitch accuracy:	0.02° (1 sigma with DGNSS)
Heave accuracy:	5cm or 5% (whichever is greater) for periods of 20s or less
Heading accuracy:	0.02° (1 sigma) with a 2m antenna baseline.
Position accuracy:	as per C-Nav 2050R
Velocity accuracy:	0.03 m/s

Auxillary GPS:

C-Nav 2050R with high gain satellite correction signal antenna.
LBM serial No: 3076
Firmware version: 5.1.13
Manufacturers Specification: accuracy position (H) <10cm (V)<15cm
User

EM3002 system component offsets

Sonar Head installation parameters applied in the EM3002 Processing Unit.
Locations are in relation to the **Reference Point** which is exactly between head centres.

X is positive in the forward direction,
Y is positive in the Starboard direction,
Z is positive in the downward direction.

Reference point (Ref)	X = 0.00	Y = 0.00	Z = 0.00
Port Sonar Head	X = 0.00	Y = -0.208	Z = 0.00
Starboard Sonar Head	X = 0.00	Y = 0.208	Z = 0.00

Angles are measured up from the horizontal, rotation Port up is positive, Pitch bow up is positive, Heading rotation to starboard from for' ward is positive. Angles as corrected post calibration (Post-patch test settings):

Port Sonar Head	Roll + 40.10°	Pitch 0.50°	Heading 0.00°
Starboard Sonar Head	Roll - 40.00°	Pitch 0.50°	Heading 0.00°

Waterline offset

Centre of EM3002 heads to water surface Z = -0.70

Positioning and Motion Referencing installation parameters applied in the PosMV Processing Unit.

Locations in relation to the Reference Point which is exactly between head centres.

X is positive in the forward direction,
Y is positive in the Starboard direction,
Z is positive in the downward direction.

Ref to Inertial measurement Unit	X = 0.00	Y = 0.00	Z = -1.405
Ref to Primary GNSS Antenna (Port)	X = 0.996	Y = -0.873	Z = -4.149
Ref to Auxiliary GNSS Antenna (Stbd)	X = 0.996	Y = 0.027	Z = -4.149

Base Line Vector for Port – Starboard GNSS Antenna post GAMS calibration
X = 0.004 Y = 1.799 Z = 0.024
Accuracy of locations < 2cm

Sound Velocity Profiler

Applied Microsystems SV plus2 sound velocity profiler – battery powered and deployed on rope.

Manufacturer Specifications:	SV	accuracy +/- 0.05ms^{-1}
	Temperature	accuracy +/- 0.05deg C
	Pressure Sensor	accuracy +/- 0.05FS (0-500m)

Table 2: Sound velocity profile locations (days are in Julian Days 2010)

JULIAN DAY		SVP	LATITUDE	LONGITUDE	DATE/TIME
Day	46	SVP1	68 33.9S	77 54.3E	UTC 15/02/2010 05:34
Day	48	SVP2	68 35.70809S	77 52.35424E	UTC 17/02/2010 09:38
Day	50	SVP3	68 33.53920S	77 53.95111E	UTC 19/02/2010 07:10
Day	55	SVP4	68 39.66S	77 49.05E	UTC 24/02/2010 07:35
Day	55	SVP5	68 37.23S	77 52.78E	UTC 24/02/2010 11:30
Day	59	SVP6	68 34.37051S	77 56.76738E	UTC 28/02/2010 05:08
Day	60	SVP7	68 34.20293S	77 48.10628E	UTC 1/03/2010 07:35
Day	62	SVP8	68 33.06696S	77 50.68312E	UTC 3/03/2010 06:33
Day	66	SVP9	68 36.54672S	77 49.63726E	UTC 7/03/2010 09:09
Day	69	SVP10	68 34.38503S	77 56.81365E	UTC 10/03/2010 04:41
Day	71	SVP11	68 34.227S	77 56.4462E	UTC 12/03/2010 04:54

Sound Velocimeter – continuous

Valeport MiniSVS 50mm sound velocity sensor was mounted directly behind the sonar heads in a clear flow of ambient water delivering a continuous real-time sound velocity.
Manufacturers Specifications: Accuracy 0.06ms^{-1} Stability 0.006ms^{-1}

Positions

All positions are derived from the Global Navigational Satellite System in **WGS84**. The C-Nav system was set up over a survey mark (Station D5) and position logged for 36 hours. Variations in horizontal position were less than 8 cm over the 36 hours.

Appendix 3: Video navigation data

Table 3: Start and finish coordinates, time and depth during underwater video deployments

VIDEO		LATITUDE	LONGITUDE	UTC	DEPTH	TAPE
01CAM01	Start	-68.57619	77.93967	7:27:00	-20.48	7:21:30
	Finish	-68.57591	77.94486	7:49:30	-16.33	7:44:00
02CAM02	Start	-68.56975	77.94687	8:46:01	-19.61	8:41:01
	Finish	-68.57558	77.93164	9:16:00	-22.17	9:11:00
03CAM03	Start	-68.56491	77.90763	9:41:00	-26.72	9:35:30
	Finish	-68.56481	77.90752	9:41:30	-27.69	9:36:00
04CAM04	Start	-68.57633	77.88989	9:25:01		9:19:31
	Finish	-68.58137	77.88487	9:50:59		9:45:29
05CAM05	Start	-68.57546	77.88903	10:00:01		9:54:31
	Finish	-68.58368	77.88037	10:50:59		10:45:29
06CAM06	Start	-68.58802	77.87073	11:10:30	-18.14	11:05:00
	Finish	-68.58607	77.90601	11:48:30	-20.80	11:43:00
08CAM08	Start	-68.57811	77.95978	4:13:30	-4.03	4:08:00
	Finish	-68.57774	77.95441	4:18:00	-5.27	4:12:30
09CAM09	Start	-68.56615	77.8746	4:40:00	-24.6	4:34:30
	Finish	-68.57244	77.85255	5:32:45		5:27:15
10CAM10	Start	-68.57901	77.84918	5:52:30	-37.99	5:47:00
	Finish	-68.57906	77.84684	5:55:30	-19.00	5:50:00
11CAM11	Start	-68.57848	77.85110	6:13:00	-38.48	6:07:30
	Finish	-68.57947	77.84153	6:24:00	-19.71	6:18:30
12CAM12	Start	-68.57940	77.85187	6:54:30	-35.97	6:49:00
	Finish	-68.58809	77.87142	7:37:30	-18.10	7:32:00
13CAM13	Start	-68.55763	77.97917	5:33:00	-4.20	5:27:30
	Finish	-68.56552	77.96156	6:22:00	-8.14	6:16:30
14CAM14	Start	-68.56202	77.98235	6:58:00	-5.32	6:52:30
	Finish	-68.56172	77.98403	7:49:30	-4.54	7:44:00
15CAM15	Start	-68.54174	77.98207	9:34:30	-12.60	9:29:00
	Finish	-68.54465	77.96616	9:53:30	-6.38	9:48:00
17CAM17	Start	-68.57285	77.93199	7:16:03	-22.57	7:10:33
	Finish	-68.57853	77.95659	7:52:17	-4.11	7:46:47

Appendix 4: Sediment samples

Table 4: Grab samples collected using the mini Shipeck grab deployed from the Howard Burton

SURVEY	STATION	GRAB	LATITUDE	LONGITUDE	DESCRIPTION
AAS2201	17	GR01	-68.56345	77.85545	Dark olive, grey-green muddy sand, polychaete tubes, gastropods
AAS2201	18	GR02	-68.56935	77.8581	Olive grey-black sandy mud, mottled, polychaete tubes, holothurians
AAS2201	19	GR03	-68.59145	77.8658	Olive grey sand, bivalve fragments

Franklin (1996) contains tabulated sample information including descriptions and grains size analyses however the thesis table displays only 2 decimal places on the coordinates therefore we list the more precise coordinates stored at GA. Sample data should be obtained from the thesis.

Table 5: Sediment samples from Vestfold Hills nearshore area from Franklin (1996)

NUMBER	LONGITUDE	LATITUDE	DEPTH
93006	78.33431667	-68.41251667	96.77
93007	78.32048333	-68.41003333	102.90
93009A	78.31180000	-68.40745000	98.39
93011	78.30341667	-68.40508333	107.10
93012	78.29895000	-68.40285000	99.68
93013	78.29500000	-68.40288333	102.26
93019	78.27716667	-68.40391667	122.58
93027	78.23438333	-68.43195000	27.00
93031	78.21431667	-68.41796667	101.00
93032	78.21010000	-68.41710000	124.00
93033	78.20725000	-68.41593333	121.00
93034	78.20418333	-68.41408333	86.00
93035	78.20130000	-68.41238333	88.00
93036	78.20071667	-68.41020000	69.00
93037	78.19398333	-68.40838333	95.00
93038	78.18845000	-68.40681667	110.00
93039	78.18648333	-68.40591667	110.00
93040	78.18193333	-68.40470000	85.00
93047	78.90581667	-68.49783333	104.00
93048	78.90915000	-68.49895000	105.00
93050	77.92158333	-68.50478333	105.00
93054	77.94303333	-68.51943333	43.00
93055	77.95060000	-68.52293333	35.00
93057	77.96833333	-68.52916667	27.00
93058	77.97595000	-68.53105000	38.00
93059	77.98471667	-68.53395000	42.00
93060	77.99030000	-68.53670000	22.00
93061	77.99736667	-68.54126667	13.00
93063	77.83845000	-68.57361667	59.00
93069	78.30833333	-68.48500000	42.00
93070	78.32000000	-68.45833333	45.00

93071	78.34666667	-68.46000000	43.00
93072	78.04852941	-68.56666667	0.00
93073	78.04681373	-68.56540541	0.00
93074	77.99191176	-68.58126126	0.00
93075	77.99754902	-68.57774775	0.00
93076	78.00245098	-68.57468468	0.00
93077	78.00245098	-68.57468468	0.00
93080	78.02585784	-68.57801802	0.00
93081	78.02585784	-68.57801802	0.00
93082A	78.05196078	-68.56369369	0.00
93083	78.05196078	-68.56369369	0.00
93084	78.05196078	-68.56369369	0.00
93085	78.03235294	-68.56117117	0.00
93088	77.00000000	-68.00000000	0.00
93089	77.00000000	-68.00000000	0.00
93090	77.00000000	-68.00000000	0.00
93091	77.00000000	-68.00000000	0.00
93092	77.00000000	-68.00000000	0.00
93093	77.00000000	-68.00000000	0.00
93095	77.00000000	-68.00000000	0.00
93096	77.00000000	-68.00000000	0.00
93097	77.00000000	-68.00000000	0.00
93101	77.94753333	-68.52983333	20.00
93101A	77.94753333	-68.52983333	20.00
93102	77.94750000	-68.52983333	21.00
93103	77.89816667	-68.55416667	21.00
93104	77.89466667	-68.55616667	33.00
93107	77.89966667	-68.56583333	31.00
93108	77.89383333	-68.56450000	30.00
93109	77.88616667	-68.56600000	29.00
93111	77.88166667	-68.57166667	28.00
93112	77.89333333	-68.57333333	0.00
93113	77.90633333	-68.56666667	28.00
93114	77.90583333	-68.57016667	29.00
93115	77.89166667	-68.57616667	29.00
93116	77.91333333	-68.56566667	30.00
93117	77.89183333	-68.56150000	30.00
93118	77.89650000	-68.56066667	30.00
93119	77.89950000	-68.55966667	29.00
93120	77.91333333	-68.56450000	27.00
93121	77.90216667	-68.56516667	29.00
93122	77.00000000	-68.00000000	23.00
93123	77.00000000	-68.00000000	27.00
93124	77.00000000	-68.00000000	24.00
93125	77.00000000	-68.00000000	24.00
93126	77.00000000	-68.00000000	22.00
93131.1	77.78983333	-68.61745000	50.00
93132	77.82175000	-68.65761667	76.00
93134	77.84593333	-68.64968333	56.00
93136	77.88136667	-68.64708333	14.00
93137	77.88715000	-68.65066667	37.00
93142	77.89440000	-68.62366667	9.00

93146	77.78943333	-68.61970000	57.00
93150	77.76333333	-68.61550000	60.00
94001	77.00000000	-68.00000000	0.00
94002	77.00000000	-68.00000000	0.00
94003	77.00000000	-68.00000000	0.00
94004	77.00000000	-68.00000000	0.00
AL15	77.00000000	-68.00000000	14.50
AL25	77.00000000	-68.00000000	25.00
Challenger	79.80000000	-65.70000000	3050.00
DH1-000	78.00103333	-68.57590000	0.00
DH1-010	78.00103333	-68.57590000	0.00
DH1-020	78.00103333	-68.57590000	0.00
DH1-030	78.00103333	-68.57590000	0.00
DH2-015	78.00103333	-68.57590000	0.00
DH2-053	78.00103333	-68.57590000	0.00
DH2-060	78.00103333	-68.56253333	0.00
DH2-100	78.00103333	0.00000000	
DH2-110	78.00103333	-68.57590000	0.00
DH2-130	78.00103333	-68.57590000	0.00
DH2-150	78.00103333	-68.57590000	0.00
DH2-170	78.00103333	-68.57590000	0.00
DH2-180	78.00103333	-68.57590000	0.00
DH2-210	78.00103333	-68.57590000	0.00
DH2-230	78.00103333	-68.57590000	0.00
DH2-250	78.00103333	-68.57590000	0.00
DH3-000	78.04885000	-68.56253333	0.00
DH3-050	78.04885000	-68.56253333	0.00
DH3-070	78.04885000	-68.56253333	0.00
DH3-090	78.04885000	-68.56156667	0.00
DH3-110	78.04885000	-68.56253333	0.00
DH3-120	78.04885000	-68.56253333	0.00
DH3-130	78.04885000	-68.56253333	0.00
DH3-145	78.04885000	-68.56253333	0.00
DH3-150	78.04885000	-68.56253333	0.00
DH3-160	78.04885000	-68.56253333	0.00
DH3-180	78.04885000	-68.56156667	0.00
DH3-200	78.04885000	-68.55753333	0.00
DH3-210	78.04885000	-68.56156667	0.00
DH4-000	78.04035000	-68.56156667	0.00
DH4-070	78.04035000	-68.56156667	0.00
DH4-080	78.04035000	-68.56156667	0.00
DH4-100	78.04035000	-68.56156667	0.00
DH4-120	78.04035000	-68.56156667	0.00
DH4-130	78.04035000	-68.56156667	0.00
DH4-140	78.04035000	-68.56156667	0.00
DH4-150	78.04035000	-68.56156667	0.00
DH4-160	78.04035000	-68.56156667	0.00
DH4-180	78.04035000	-68.56156667	0.00
DH4-200	78.04035000	-68.55753333	0.00
DH4-220	78.04035000	-68.55753333	0.00
DH4-240	78.04035000	-68.55753333	0.00
DH4-250	78.04035000	-68.57436667	0.00

DH4-270	78.04035000	-68.55753333	0.00
DH4-290	78.04035000	-68.55753333	0.00
DH5-000	78.03273333	-68.55753333	0.00
DH5-020	78.03273333	-68.55753333	0.00
DH5-050	78.03273333	-68.55753333	0.00
DH5-060	78.03273333	-68.55753333	0.00
DH5-080	78.03273333	-68.55753333	0.00
DH5-090	78.03273333	-68.55753333	0.00
DH5-100	78.03273333	-68.55753333	0.00
DH5-120	78.03273333	-68.55753333	0.00
DH5-140	78.03273333	-68.55753333	0.00
DH5-160	78.03273333	-68.55753333	0.00
DH5-180	78.03273333	-68.55753333	0.00
DH5-200	78.03273333	-68.55753333	0.00
DH6-000	78.01916667	-68.57436667	0.00
DH6-020	78.01916667	-68.57436667	0.00
DH6-050	78.01916667	-68.57436667	0.00
DH6-060	78.01916667	-68.57436667	0.00
DH7-080	78.01916667	-68.57436667	0.00
DH7-090	78.01916667	-68.57436667	0.00
DH7-100	78.01916667	-68.57436667	0.00
DH7-120	78.01916667	-68.57436667	0.00
DH7-140	78.01916667	-68.57436667	0.00
DH8-000	77.99146667	-68.57960000	0.00
DH8-020	77.99146667	-68.57960000	0.00
DH8-060	77.99146667	-68.57960000	0.00
DH8-070	77.99146667	-68.57960000	0.00
DH8-080	77.99146667	-68.57960000	0.00
DH8-100	77.99146667	-68.57960000	0.00
GR01	77.51966667	-66.72416667	803.00
GR02A	77.80633333	-68.43116667	179.00
GR03	77.64000000	-68.57333333	388.00
GR03B	77.64000000	-68.57333333	388.00
GR04	77.51166667	-68.70333333	707.00
GR05	77.27183333	-68.67233333	538.00
GR06	77.16666667	-68.81666667	760.00
GR07	76.89350000	-68.91200000	700.00
GR08	76.80416667	-68.78200000	798.00
GR09	76.74433333	-68.71016667	820.00
GR10	76.71666667	-68.65533333	775.00
GR11	76.54716667	-68.01233333	460.00
GR12	76.58800000	-67.35450000	318.00
GR13	76.31050000	-66.96933333	330.00
GR14	75.18500000	-68.96666667	740.00
GR15	74.52150000	-68.61450000	667.00
GR16	74.20866667	-68.45166667	665.00
GR17	73.57383333	-68.94433333	792.00
GR18	75.87550000	-68.18466667	695.00
GR19	76.09966667	-69.22800000	548.00
GR20	73.49700000	-66.99533333	490.00
GR21	72.00083333	-66.53500000	1030.00
GR22	72.00816667	-68.47416667	509.00

GR23	72.25050000	-68.10266667	788.00
GR24	70.49933333	-68.50966667	1060.00
GR25	72.26866667	-66.87983333	532.00
GR26	69.39666667	-66.61416667	1435.00
GR27	69.29616667	-66.82366667	907.00
GR28	69.22050000	-66.91483333	512.00
GR29	68.84700000	-67.04650000	200.00
GR30	68.19566667	-67.51516667	460.00
GR31	65.42300000	-67.26950000	110.00
GR31-Ca	65.42300000	-67.26950000	110.00
GR32	65.10233333	-67.41966667	1057.00
GR33	64.66050000	-66.84050000	1520.00
GR34	62.74000000	-66.55966667	1882.00
GR35	63.16000000	-55.86716667	434.00
S111	68.91666667	-67.01666667	396.00
S112	68.91666667	-67.01666667	396.00
S113	68.91666667	-67.01666667	396.00
S114	68.91666667	-67.01666667	396.00
S141	71.06766667	-67.89683333	487.00
S142	71.06766667	-67.89683333	487.00
S143	71.06766667	-67.89683333	487.00
S144	71.06766667	-67.89683333	487.00
S151	71.06933333	-67.46083333	429.00
S152	71.06933333	-67.46083333	429.00
S153	71.06933333	-67.46083333	429.00
S154	71.06933333	-67.46083333	429.00
S271	72.01666667	-68.00000000	300.00
S272	72.01666667	-68.00000000	300.00
S273	72.01666667	-68.00000000	300.00
S282	72.18333333	-68.38333333	504.00
S283	72.18333333	-68.38333333	504.00
S284	72.18333333	-68.38333333	504.00
S301	73.51033333	-68.56416667	760.00
S302	73.51033333	-68.56416667	760.00
S304	73.51033333	-68.56416667	760.00
S321	73.64666667	-67.54966667	566.00
S322	73.64666667	-67.54966667	566.00
S323	73.64666667	-67.54966667	566.00
S431	75.02700000	-67.46633333	456.00
S432	75.02700000	-67.46633333	456.00
S433	75.02700000	-67.46633333	456.00
S434	75.02700000	-67.46633333	456.00
S441	75.00666667	-67.98833333	540.00
S442	75.00666667	-67.98833333	540.00
S443	75.00666667	-67.98833333	540.00
S444	75.00666667	-67.98833333	540.00
S451	75.94000000	-68.51283333	646.00
S452	75.94000000	-68.51283333	646.00
S453	75.94000000	-68.51283333	646.00
S481	76.45983333	-68.49150000	620.00
S482	76.45983333	-68.49150000	620.00
S501	76.55883333	-67.53616667	356.00

S502	76.55883333	-67.53616667	356.00
S503	76.55883333	-67.53616667	356.00
S504	76.55883333	-67.53616667	356.00
S511	76.38883333	-67.06166667	335.00
S512	76.38883333	-67.06166667	335.00
S513	76.38883333	-67.06166667	335.00
S514	76.38883333	-67.06166667	335.00
S621	77.85266667	-68.04816667	544.00
S622	77.85266667	-68.04816667	544.00
S623	77.85266667	-68.04816667	544.00
S624	77.85266667	-68.04816667	544.00
T071	78.22400000	-67.03000000	612.00
T072	78.22400000	-67.03000000	612.00
T073	78.22400000	-67.03000000	612.00
T081	77.34366667	-67.34383333	550.00
T082	77.34366667	-67.34383333	550.00
T083	77.34366667	-67.34383333	550.00
T111	74.43333333	-66.96666667	249.00
T113	74.43333333	-66.96666667	249.00
T114	74.43333333	-66.96666667	249.00
T221	72.36666667	-67.45000000	330.00
T222	72.36666667	-67.45000000	330.00
T223	72.36666667	-67.45000000	330.00
T224	72.36666667	-67.45000000	330.00
T231	72.56666667	-66.96666667	434.00
T232	72.56666667	-66.96666667	434.00

Table 6: Sample and mooring sites investigated by the AAD Dive program. Site labels are as follows:
BRUV – Baited Underwater Video sites.
CM – Current meter sites
ST – sediment trap sites
STP – Sewage Treatment Plant study sites, including baseline sites remote form the outfall.

SITE	LAT	LONG	DATE	TIME	HEIGHT
BRU23R	-68.5912	77.87945	03/17/2010	16:25:16	0.3
BRUV01	-68.5778	77.94897	03/17/2010	16:25:16	6.4
BRUV10	-68.5792	77.94638	03/17/2010	16:25:16	-2.1
BRUV12	-68.5680	77.94521	03/17/2010	16:25:16	-1.5
BRUV13	-68.5715	77.94075	03/17/2010	16:25:16	2.4
BRUV14	-68.5784	77.95920	03/17/2010	16:25:16	-26.2
BRUV15	-68.5882	77.94356	03/17/2010	16:25:16	-4.0
BRUV16	-68.5896	77.87903	03/17/2010	16:25:17	-1.2
BRUV17	-68.5193	78.06693	03/17/2010	16:25:17	-4.6
BRUV19	-68.5235	78.05664	03/17/2010	16:25:17	-10.1
BRUV2	-68.5962	77.92562	03/17/2010	16:25:17	-7.0
BRUV20	-68.5712	77.93927	03/17/2010	16:25:17	-3.0
BRUV23	-68.5904	77.89702	03/17/2010	16:25:17	9.1

BRUV25	-68.5440	77.98014	03/17/2010	16:25:17	0.9
BRUV26	-68.5886	77.94541	03/17/2010	16:25:17	3.4
BRUV3	-68.5847	77.93984	03/17/2010	16:25:17	1.2
BRUV6	-68.5836	77.86403	03/17/2010	16:25:17	-7.3
BRUV9	-68.5493	77.96652	03/17/2010	16:25:18	-1.2
CM1	-68.5779	77.95755	03/17/2010	16:25:18	0.0
CM2	-68.5740	77.96051	03/17/2010	16:25:18	0.0
CM3	-68.5729	77.94856	03/17/2010	16:25:18	0.0
CM4	-68.5774	77.94158	03/17/2010	16:25:18	0.0
CM5	-68.5831	77.91917	03/17/2010	16:25:18	0.0
CM6	-68.5644	77.89624	03/17/2010	16:25:18	0.0
ST1	-68.5785	77.95940	03/17/2010	16:25:21	0.0
ST10	-68.5850	77.93891	03/17/2010	16:25:21	0.0
ST11	-68.5980	77.92174	03/17/2010	16:25:21	0.0
ST12	-68.6236	77.89085	03/17/2010	16:25:21	0.0
ST13	-68.6516	77.85199	03/17/2010	16:25:21	0.0
ST14	-68.5404	77.98123	03/17/2010	16:25:21	0.0
ST2	-68.5797	77.95417	03/17/2010	16:25:21	0.0
ST3	-68.5766	77.96027	03/17/2010	16:25:22	0.0
ST4	-68.5734	77.95085	03/17/2010	16:25:22	0.0
ST5	-68.5766	77.94633	03/17/2010	16:25:22	0.0
ST6	-68.5790	77.93976	03/17/2010	16:25:22	0.0
ST7	-68.5761	77.92326	03/17/2010	16:25:22	0.0
ST8	-68.5705	77.92512	03/17/2010	16:25:22	0.0
ST9	-68.5809	77.92096	03/17/2010	16:25:22	0.0
STP0	-68.5783	77.96133	03/17/2010	16:25:22	-2.7
STP1	-68.5782	77.95882	03/17/2010	16:25:22	0.0
STP10A	-68.5844	77.94405	03/17/2010	16:25:22	4.6
STP10B	-68.5843	77.94868	03/17/2010	16:25:22	7.3
STP10D	-68.5850	77.95738	03/17/2010	16:25:23	-20.4
STP14A	-68.5401	78.00311	03/17/2010	16:25:23	4.0
STP14B	-68.5470	77.98402	03/17/2010	16:25:23	-1.2
STP15A1	-68.5229	78.07274	6/3/2010	14:11:55	0.0
STP15A	-68.5230	78.07335	03/17/2010	16:25:23	-4.3
STP15B	-68.5287	78.06077	03/17/2010	16:25:23	2.4
STP15C	-68.5310	78.03938	03/17/2010	16:25:23	-2.4
STP15E	-68.5192	78.08167	03/17/2010	16:25:24	4.9
STP16	-68.5680	77.96387	03/17/2010	16:25:24	-4.6
STP17	-68.5894	77.92060	03/17/2010	16:25:24	0.0
STP2	-68.5787	77.95321	03/17/2010	16:25:24	-1.8
STP3	-68.5763	77.95908	03/17/2010	16:25:24	4.3
STP4	-68.5765	77.94931	03/17/2010	16:25:24	-2.1
STP6	-68.5806	77.94276	03/17/2010	16:25:24	-0.6

STP8	-68.5728	77.93175	03/17/2010	16:25:24	5.2
STP10C	-68.5861	77.93542	6/3/2010	14:11:55	-12.8
STP12A	-68.6180	77.89181	6/3/2010	14:11:55	2.7
STP12B	-68.6181	77.87595	6/3/2010	14:11:55	0.9
STP13A	-68.6551	77.86362	6/3/2010	14:11:55	-6.7
STP14	-68.5436	78.01036	6/3/2010	14:11:55	0.0
STP5	-68.5736	77.95215	6/3/2010	14:11:56	1.2
STP7	-68.5767	77.94503	6/3/2010	14:11:56	-2.7
STP9	-68.5828	77.91915	6/3/2010	14:11:56	-1.8
STP 11A	-68.5991	77.92100	7/3/2010	12:02:40	-9999.0
STP 11B	-68.5957	77.93320	7/3/2010	12:07:28	-9999.0
STP 13B	-68.6481	77.85883	7/3/2010	12:09:54	-9999.0
STP 12	-68.6271	77.89031	7/3/2010	12:13:55	-9999.0
STP 15D	-68.5196	78.06595	03/23/2010	15:19:19	-9999.0