RRS JAMES CLARK ROSS
CRUISE REPORT – JR157

Glacial-Interglacial Sediment Transfer from the Antarctic Continent to Deep Ocean: A Shelf-Slope-Basin System Investigated Using the ISIS Remotely Operated Vehicle (ROV)

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1. CRUISE JR157 - MARGUERITE BAY, ANTARCTICA

1.1 Introduction: Aims and Achievements

Scientific Background

- The modern continental shelves around Antarctica have been overridden intermittently by ice sheets, which reached the shelf edge a number of times over the last few million years

- Marine sediments on the Antarctic continental margin contain a unique long-term and, sometimes, continuous record of past ice-sheet and environmental changes

- However, this record is complex in terms of both the process environment in which sediments are deposited and reworked, and in its palaeo-environmental interpretation

- Detailed imaging and sediment sampling using the instruments installed on the ISIS ROV will contribute to understanding the processes and timing ice-sheet retreat and sediment transfer on Antarctic margin

Aims of the Cruise

- To investigate the nature of sea-floor processes and the resulting depositional record by deploying geophysical instruments on the ISIS ROV, providing data with previously unprecedented spatial resolution

- To acquire supporting gravity cores, sub-bottom profiler and large-scale swath bathymetry from the JCR to provide a small- to large-scale sedimentary environmental context for the ISIS ROV data

- To better understand the nature of the sedimentary and biological processes and the interaction between them, and to enhance the interpretation of the unique modern and past environmental record held in sediments on the Antarctic continental margin

Study Area

The study area was the continental margin of the Antarctic Peninsula, encompassing the continental slope offshore of Marguerite Bay, the adjacent continental shelf, and a major fjord system (Bourgeois Fjord). The scientific party boarded the RRS James Clark Ross (JCR) in Montevideo and arrived offshore of the Antarctic Peninsula after a brief call into Port Stanley, Falkland Islands (Fig. 1.1). Cruise science then took place offshore of the Peninsula (Fig. 1.2), and the science party then disembarked at Rothera to be flown to Punta Arenas in Chile by Dash 7 aircraft.

Achievements

- The ISIS ROV conducted 16 dives during Cruise JR157, in water depths from 100 m to 3500 m. ROV surveys were selected to cover a variety of sedimentary environments from fjords, the continental shelf, and the continental slope offshore of Marguerite Bay, Antarctic Peninsula

- EM120 swath bathymetry and TOPAS sub-bottom profiler data collected from several parts of shelf, slope and fjord from the JCR

- Gravity cores, up to 7 m in length, also collected from JCR and push cores from Isis

Glacial landforms, sediments and environments, formed when ice last extended across the Marguerite Bay shelf at the Last Glacial Maximum, were surveyed by the ISIS ROV. Such features included:

- Glacial sedimentary bedforms, including drumlins and other streamlined features indicative of former ice streams

- Outer shelf and upper slope sedimentary environments featuring gullies and turbidite channels linked to sediment transfer down the continental slope

- Sediment drifts and their detailed sedimentology on lower slope and continental rise

- Subglacially-eroded bedrock channels on the inner shelf, indicative of past subglacial hydrological system

- Sediment ridges in front of tidewater glacier margins in an Antarctic Peninsula fjord system

Cruise Personnel and Collaboration

Cruise JR157 was funded through a NERC Antarctic Funding Initiative Grant (AFI06/14) to Julian Dowdeswell (SPRI), Rob Larter (BAS) and Gwyn Griffiths (NOC). However, before the cruise, it was agreed with Paul Tyler (NOC) and Andy Clarke (BAS) that their NERC Small Grant, on Antarctic biological observations with the Isis ROV (Cruise Report JR166), would be combined with our work into a single shipborne operation. This saved several days of ship time for scientific work rather than passage. It also resulted in very fruitful collaboration between the glacial geological and marine biological teams.

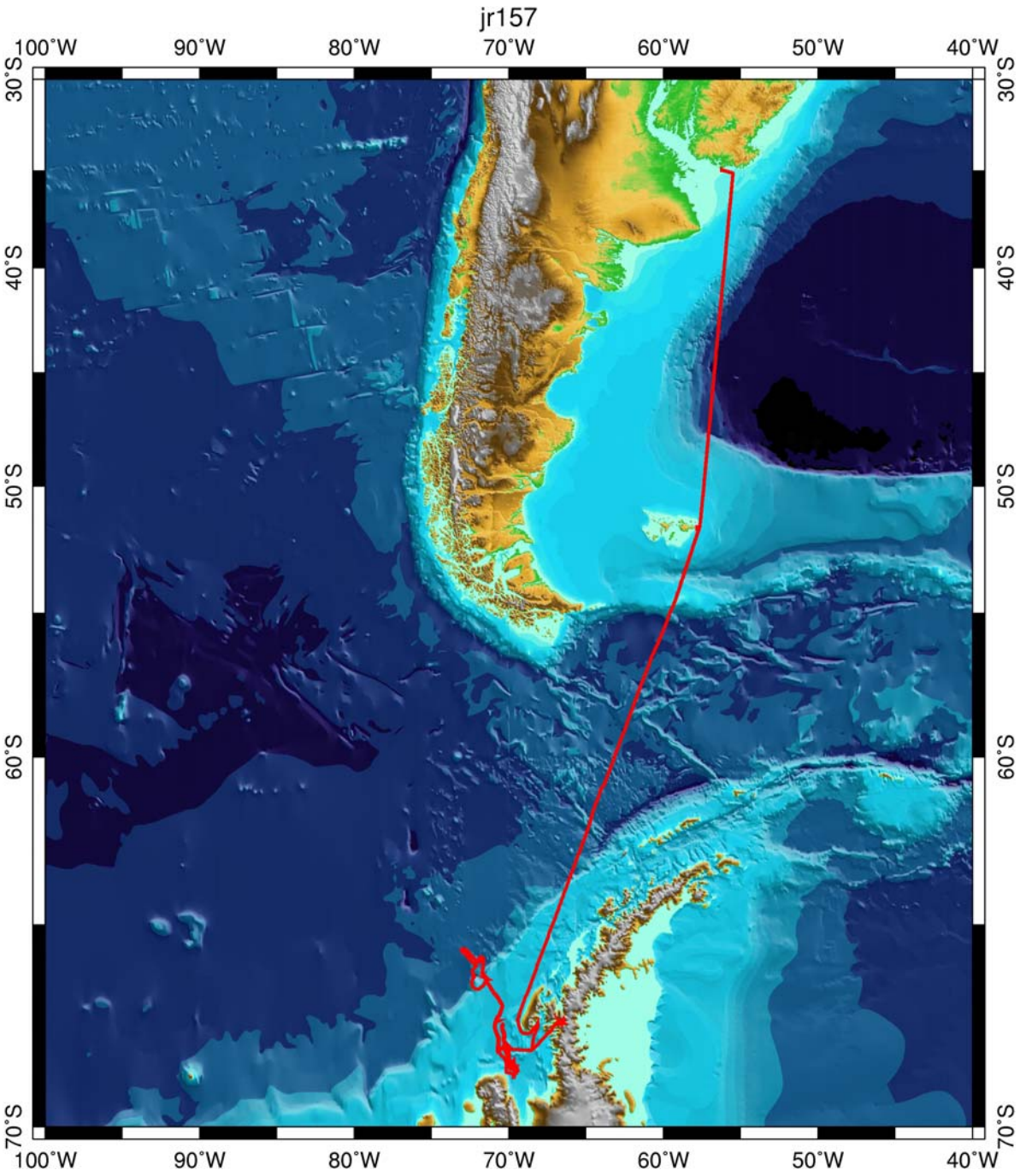

Figure 1.1. Ship track JCR Cruise 157 from Uraguay to Rothera via the study area (see Fig. 1.2)

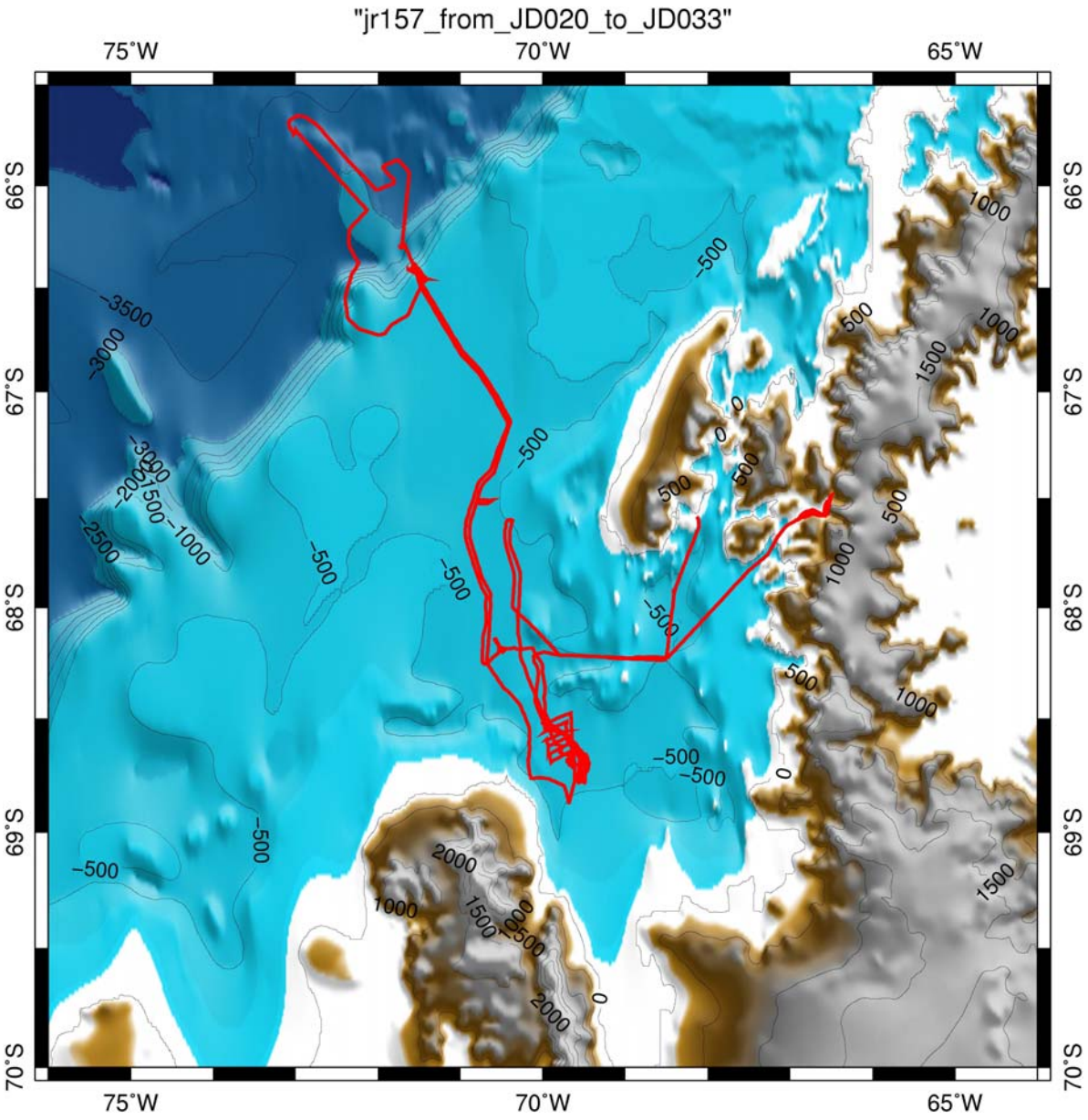

Figure 1.2. Map of cruise JR157 area in a fjord-shelf-slope marine sedimentary system, Marguerite Bay margin, Antarctic Peninsula

1.2 CRUISE PARTICIPANTS

Officers and Crew

Graham Chapman	Master
Robert Paterson	Chief Officer
Calum Hunter	2nd Officer
Douglas Leask	3rd Officer
John Summers	Deck Officer
Charles Waddicor	ETO (Comms)
David Cutting	Chief Engineer
Gerry Armour	2nd Engineer
Tom Elliott	3rd Engineer
Steve Eadie	4th Engineer
Doug Trevett	Deck Engineer
Nicholas Dunbar	ETO (ENG)
Hamish Gibson	Purser
George Stewart	Bosun
Marc Blaby	Bosun's Mate
Derek Jenkins	SG1
Lester Jolly	SG1
Christopher Solly	SGI
John MacLeod	SG1
Cliff Mullaney	SG1
Mark Robinshaw	MG1
Sidney Smith	MG1
Duncan MacIntyre	Chief Cook
Glen Ballard	2nd Cook
Cliff Pratley	Senior Steward
Jimmy Newall	Steward
Kenneth Weston	Steward
Derek Lee	Steward

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Jeff Evans	SPRI
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Gwyn Griffith	NOC
Paul Tyler	NOC
Sven Thatje	NOC
Emily Dolan	NOC
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SPRI, Scott Polar Research Institute, University of Cambridge
Durham, Department of Geography, Durham University
NOC, National Oceanography Centre, Southampton
ISIS , ISIS Team, National Oceanography Centre, Southampton

1.3 CRUISE NARRATIVE

Saturday 20 January, day 1
Departed Rothera at 08.00 and ISIS dipped in the water offshore for a buoyancy test. Proceeded about two hours steaming to first dive site. The aim was to recover a mooring that had failed to release acoustically. The ROV, equipped with cutters, was navigated to the site of the missing mooring and the remains of the weight and a limited amount of cable was found, but the mooring and its instruments were no longer attached. Isis was recovered at about 20.30 and ship steamed towards first scientific dive site (Dive 2), with ISIS being reconfigured en route.

Sunday 21 January, day 2
JCR swath towards tip of Alexander Island overnight, but met sea ice cover which meant that the first dive site, the submarine channel system, could not be reached. Diverted to second site, several hours to the north, and deployed ISIS at 12.00, configured for swath and cameras. Intermittent failure of Sonardyn navigation system during the rest of day meant that use of the swath system was restricted. However, camera transects over drumlins took place for remainder of afternoon and overnight, while navigation system problems were investigated. Weather calm with decreasing swell.

Monday 22 January, day 3
Weather calm all day with some fog and light snow showers in decreasing seas. Isis moved position to 20 m height above sea floor for swath transect around moat from about 07.00 until recovered in morning. A series of four 3 and 6 m gravity cores acquired around moat and top of drumlin and 4 miles to the North while Isis was being reconfigured for photographs and sampling. Isis launched at about 17.00 for a sea-floor sampling mission. Isis hauled in at about 01.00 after push core samples acquired and biological voucher specimens photographed and collected using vacuum system.

Tuesday 23 January, day 4
Core taken on mid shelf early morning to enable reconstruction of the Holocene sedimentary record. Then JCR swath along a transect to the outermost slope at the end of Marguerite Trough. Isis deployed at about 18.00. Began downslope tranverse across iceberg-scoured outermost shelf, across shelf edge and down a major gully. Isis configured with swath and cameras. Sonardyn navigation given better information throughout. Winds light all day with no sea ice at all.

Wednesday 24 January, day 5
Downslope traverse continued overnight. Oil warning brough ROV to surface about 08.00. Core taken in gully-mouth lobe while ROV being repaired. Only a few gravel clasts collected. ROV back in water at deepest point so far, 2130 m. Began upslope transect in afternnoon and continued overnight. Combining sections of 20 m height swath and 1-2 m height pohotographs of sea floor biology and geology.

Thursday 25 January, day 6
Completed upslope swath and photography transect just into iceberg scoured region inshore of the shelf edge above the gully. A 3-m gravity core was taken once Isis was recovered and while it was being reconfigured for sampling. The core, on a gully-mouth lobe, retrieved

about 25 cm of fine gravel. Isis launched again in the afternoon, and samples were taken at three sets of sites between 1800 and 1200 m in the gully. Isis was retrieved about 24.00.

Friday 26 January, day 7
JCR swath bathymetry was collected during an 8 hour transit to the start of Dive 7, on possible cold seeps. The swath track was set to fill in the margins of our existing swath data from the upper slope beyond Marguerite Bay. Dive 7 ended in late evening after photography and sampling of sea floor on drift sheet. Identified linear bedforms orientated parallel to current direction. JCR swath overnight, including bathymetry of a major channel system to location of Dive 8. Weather - light airs and intermittent fog.

Saturday 27 January, day 8
Deployed Isis at 08.30 for a run of cameras and sampling along the westward edge of a major channel system on the continental slope. Began in the channel at 3005 m depth and ran up to channel banks, which are formed by the margin of a major drift sheet. Spectacular photographs of channel margin – flat floor, to rippled floor, isolated detached blocks of friable laminated drift sand with dropstone, scree slope, cliff and then a flat top with minor sedimentary bedforms. Traversed this surface, which was about 70 m higher than the channel floor, and then turned east to come of down the cliffs again and onto the channel floor. Isis recovered and redeployed in late evening. Weather – light airs and intermittent fog.

Sunday 28 January, day 9
Isis in water at 00.00 for a run of swath data gathering over the deep-water channel and channel margin, planned on the basis of photography the previous day. Weather deteriorating and force 6-7 winds and building swell led to Isis recovery. Headed southwards across the shelf edge back into Marguerite Trough and Bay, to seek more sheltered waters for further Isis deployments.

Monday 29 January, day 10
Conditions much better further south, with light SE winds replacing strong northeasterly. In morning arrived at site of bedrock subglacial channel systems on the shelf NE of Alexander Island. Sea ice covered area selected site, so moved the ship northward to a further area of interest. Isis deployed with swath and cameras and undertook at long transect from NE to SW across a series of five deeply-incised channels and their interfluves. The channels were U shaped and with steep cliffs defining a very clear channel bed which was sediment covered.

Tuesday 30 January, day 11
Isis recovered early am and series of JCR swath tracks collected eastward of our existing swath coverage to extend the information and bathymetry we have about the extent and geometry of the whole channel system. Isis deployed again pm to begin a block of swath data in the channel system.

Wednesday 31 January, day 12
Isis recovered at 06.00 after collecting a block of swath data from former subglacial channel system and traversing along a channel. Also acquired spectacular photos of side walls and cliffs at base of channel, showing undercutting and fluvial erosional landforms. TOPAS survey of area to NW of main channel system in morning, gravity coring of this area in afternoon. Head northwards towards area of mega-scale glacial lineations on the mid-shelf in

increasing winds and swell. Broke off this northward passage in worsening weather during night when it became apparent that we would not be able to deploy Isis when on station.

Thursday 1 February, day 13
Ship changed course during the night to reach the entrance of Bougeous Fjord by 10.00. Proceeded up the 30 km long fjord during the day, in improving weather, undertaking the first swath survey. Approached Blind Bay in late afternoon and identified several sites for possible Isis deployment. However, winds gusting at times to 50 kts prevented an Isis dive, and instead a combination of JCR swath data collection and gravity coring was undertaken during the evening and overnight.

Friday 2 February, day 14
Gravity coring finished am. Weather calm and these good conditions allowed an Isis deployment with cameras and swath. The dive involved a transect with cameras to within about 150 m of the ice cliffs of Forel Glacier. The vehicle traversed a series of clearly identifiable landforms including a series of transverse and flow-parallel ridges about 3 m high, followed by a steep, boulder covered cliff close to the ice front. Isis was then recovered and a fault in the swath system was quickly rectified before a second dive involving the swath system proceeded overnight. Cores were taken between the two dives.

Saturday 3 February, day 15
The three legs of the Isis swath survey of what appears to be a recently deglaciated glacier forefield was completed successfully at about 11.00. Two box cores were taken followed by a JCR swath survey of the sea floor close to the margin of Perutz Glacier. About 15.00 a new Isis dive began on a transect from the central axis of Bouguois Fjord at about 600 m depth to the front of Llibourty Glacier. This dive was terminated rapidly by the implosion of the suction sampler, probably due to trapped air. A further dive was undertaken for photography and Isis was recovered from this in the early hours of Sunday. Conditions calm and ideal for survey work.

Sunday 4 February, day 16
A final dive with Isis took place to swath the area in front of Lliboutry Glacier. This dive was completed successfully by early afternoon. Five cores were then collected from locations proximal to Llibourty and Perutz glaciers. The remainder of the day was spent collecting swath bathymetry and TOPAS data from JCR in Bougeois Fjord.

Monday 5 February, day 17
JCR moored up at Rothera in the early hours to complete cruise JR157.

2. GEOPHYSICAL OPERATIONS – JCR SWATH AND TOPAS

2.1 EM120 Multibeam Swath Bathymetry and TOPAS Sub-Bottom Profiler

The Kongsberg-Simrad EM120 multibeam swath bathymetry system was operated throughout the cruise. Limited post-processing of the EM120 data (gridding and data filtering) was carried out using the Kongsberg-Simrad NEPTUNE post-processing software. The data coverage is shown below (ship track and TOPAS profiles are red lines and swath data are shaded around the lines). Earlier swath data coverage from cruises JR59 and 71 is included.

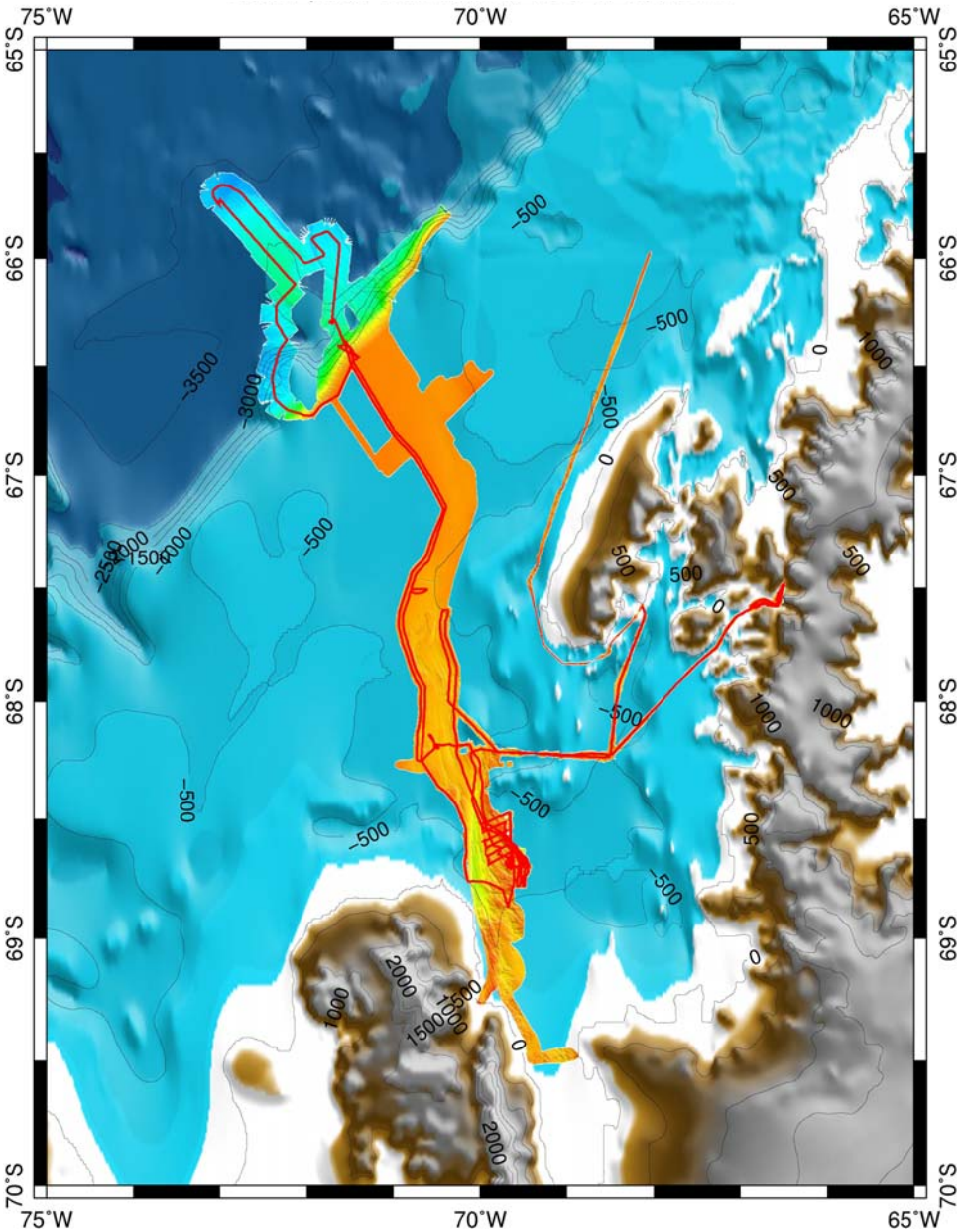


Figure 2.1. Coverage of EM120 swath bathymetry and TOPAS data on cruise JR157

The swath and TOPAS data were each recorded digitally throughout the cruise, but TOPAS data was also played out in near-real time on a chart recorder (see section 2.3).

2.2 EPC Chart Recorder

The EPC chart recorder worked without any problems throughout the cruise. TOPAS input to the EPC chart recorder was on Channel A. The settings used were: 0.5 second sweep; 0 delay; threshold 1/3 of a turn clockwise from the minimum setting; trigger level 0; gain generally about 8; sweep direction from left to right; print polarity +/- (centre setting). Chart settings: scale lines: on; take-up: on; mark/annotate: off (centre setting); chart drive: internal (centre setting), LPI was generally set to 75; contrast setting: centre. Ten-minute time marks and EM120 depths were automatically plotted on the paper roll.

2.3 Expendable Bathythermograph (XBT) System and Ocean Logger

Several XBT casts were made during JR-157 (see Table). Sound velocity profiles (SVP) obtained from the XBT deployments were input to the EM120 and used in the relevant surveys. The XBT system on the JCR worked well throughout the cruise. Individual SVP profiles were calculated from the XBT data by the system software, assuming a constant salinity. Salinity values were obtained from the Oceanlogger display (located in the UIC), and input to the XBT system software manually. The files (calculated sound velocity profiles) generated by the XBT system software were transferred to the swath bathymetry data processing workstation, and the data then imported into the swath data acquisition system across the network. Surface water temperature and salinity were alos recorded continuously during the cruise.

XBTs taken from the JCR on cruise JR157

XBT number	Date	Time	Latitude	Longitude	Water depth (m)	Salinity (psu)	Filename	ASVP filename
001	01-23-2007	18:34:14	66 48.83252	70 57.39041	497	33.7	T5_00001	jr157_xbt1.asvp
Failed	Failed	Failed	66 28.21094	72 20.55371			T5_00003	Failed
002	01-26-2007	07:23:04	66 26.59918	72 19.49121			T7_00004	jr157_xbt3.asvp
005	01-26-2007	11:41:25	65 46.06299	72 54.48623			T7_00006	jr157_xbt6.asvp
007	01-29-2007	11:15:42	68 48.88876	69 43.55957			T5_00007	jr157_xbt7.asvp
008	01-31-2007	15:44:53	68 28.76562	69 41.75195	660	32.3	T5_00008	jr157_xbt8.asvp
009	01-02-2007	14:14:00	67 35.05030'	66 50.83008'	654	32.7	T5_00009	jr157_xbt9.asvp

3. GEOLOGICAL OPERATIONS FROM THE JCR

Gravity cores (3 or 6 m barrel) and box cores were taken from JCR in the fjord-shelf-slope system offshore of the Antarctic Peninsula; in Bougois Fjord, and on the Marguerite bay shelf and upper slope (Fig. 3.1). Details of each core site are given in the tables below.

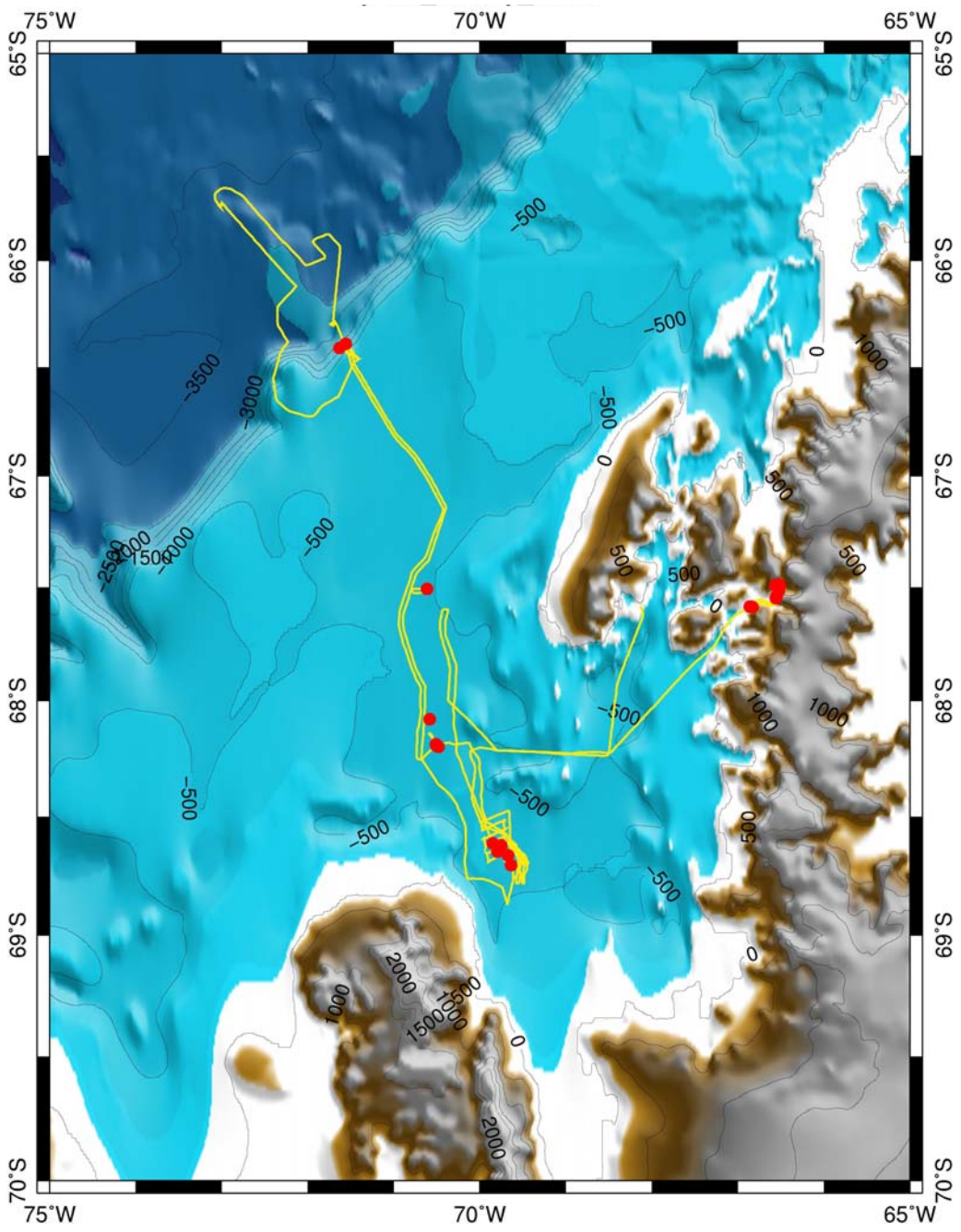


Figure 3.1. Sites of gravity and box cores of the Marguerite Bay margin during cruise JR157

Details of gravity cores collected in cruise JR157

Core Number	Water depth (m)	Latitude (S)	Longitude (W)	Recovery (cm)	Location
GC001	839	68 11.8124'	70 70.1836'	300	Moat of Drumlin, Inner Shelf
GC002	778	68 08.5074'	70 34.9208'	415	Holocene core, Inner Shelf
GC003	721	68 11.3200'	70 30.3700'	176	Crest of Drumlin, Inner Shelf
GC004	872	68 12.0097'	70 28.8792'	444	Moat of Drumlin, Inner Shelf
GC005	744	67 30.4945'	70 36.5867'	408	Holocene core, Inner Shelf
GC006	2187	66 23.4340'	71 33.3552'	Gravel. Core catcher sample	Mid Slope Gully system
GC007	2424	66 24.7360'	71 37.8400'	25	Mid Slope Gully system
GC008	623	68 42.4038'	69 38.2438'	210	Inner Shelf Channel
GC009	675	68 39.8985'	69 40.4904'	300	Inner Shelf Channel
GC010	767	68 38.9486'	69 47.5910'	334	Proximal to Mouth of Inner Shelf Channel
GC011	637	68 37.3609'	69 45.1440'	Core catcher Gravel clast only	Proximal to Mouth of Inner Shelf Channel
GC012	801	68 36.8237'	69 50.9231'	275	Distal to Mouth of Inner Shelf Channel
GC013	654	67 35.1880'	66 51.4890'	370	Inner-Middle Bourgeois Fjord
GC014	238	67 29.3712'	66 30.7824'	Core catcher Bag sample	Inner Blind Bay adjacent to Forel Glacier
GC015	268	67 29.5212'	66 33.9538'	Core catcher Bag sample	Inner Blind Bay
GC016	258	67 30.2401'	66 31.2890'	45	Middle Blind Bay
GC017	539	67 32.4094'	66 32.9265'	52	Outer Blind Bay
GC018	556	67 32.9214'	66 33.3051'	467	Outer Blind Bay
GC019	641	67 35.2506'	66 50.8051'	342	Middle Bourgeois Fjord
GC020	660	67 35.4046'	66 49.9797'	398	Middle Bourgeois Fjord
GC021	288	67 31.1383'	66 31.7051'	584	Middle Blind Bay
GC022	280	67 30.9979'	66 31.6407'	217	Middle Blind Bay
GC024	394	67 32.2594'	66 46.6056'	36	Bourgeois Fjord-Jones Channel
GC025	376	67 32.0957'	66 46.0885'	100	Bourgeois Fjord-Jones Channel
GC026	333	67 31.8367'	66 45.623'	230	Bourgeois Fjord-Jones Channel
GC027	204	67 35.8520'	66 36.3273'	289	Perutz Glacier - Ice-proximal

Details of box core taken on cruise JR157

Core Number	Water depth (m)	Latitude (S)	Longitude (W)	Recovery (cm)	Location	Comment
BC023	551	67 32.9332'	66 33.2715'	52	Middle Blind Bay	Very soupy muddy sediment

4. ISIS REMOTELY OPERATED VEHICLE OPERATIONS

4.1 Instruments and Deployment

The Isis Remotely Operated Vehicle (ROV) was equipped with a variety of sensors during cruise JR157 for both geological and biological use. The geological/geophysical applications of these sensors are dealt with in this report.

The deployment of the Isis ROV was from a 17 tonne gantry and winch system on the back deck of the JCR (Fig. 4.1). It is essential to make sure that appropriate shoreside crainage is available to lift the gantry and Isis onto the ship at the times of mobilisation and demobilisation.

Figure 4.1. The Isis ROV deployed in Antarctic waters from the back deck of the JCR

The Isis ROV was able to deploy several types of sensor (Fig. 4.2). For glacial marine geological work the following equipment was used:

- High-resolution swath bathymetry system - Mesotech MS2000
- Cameras – stills and video
- Instruments for collection of push cores/grabs from the sea floor (Fig. 4.3)

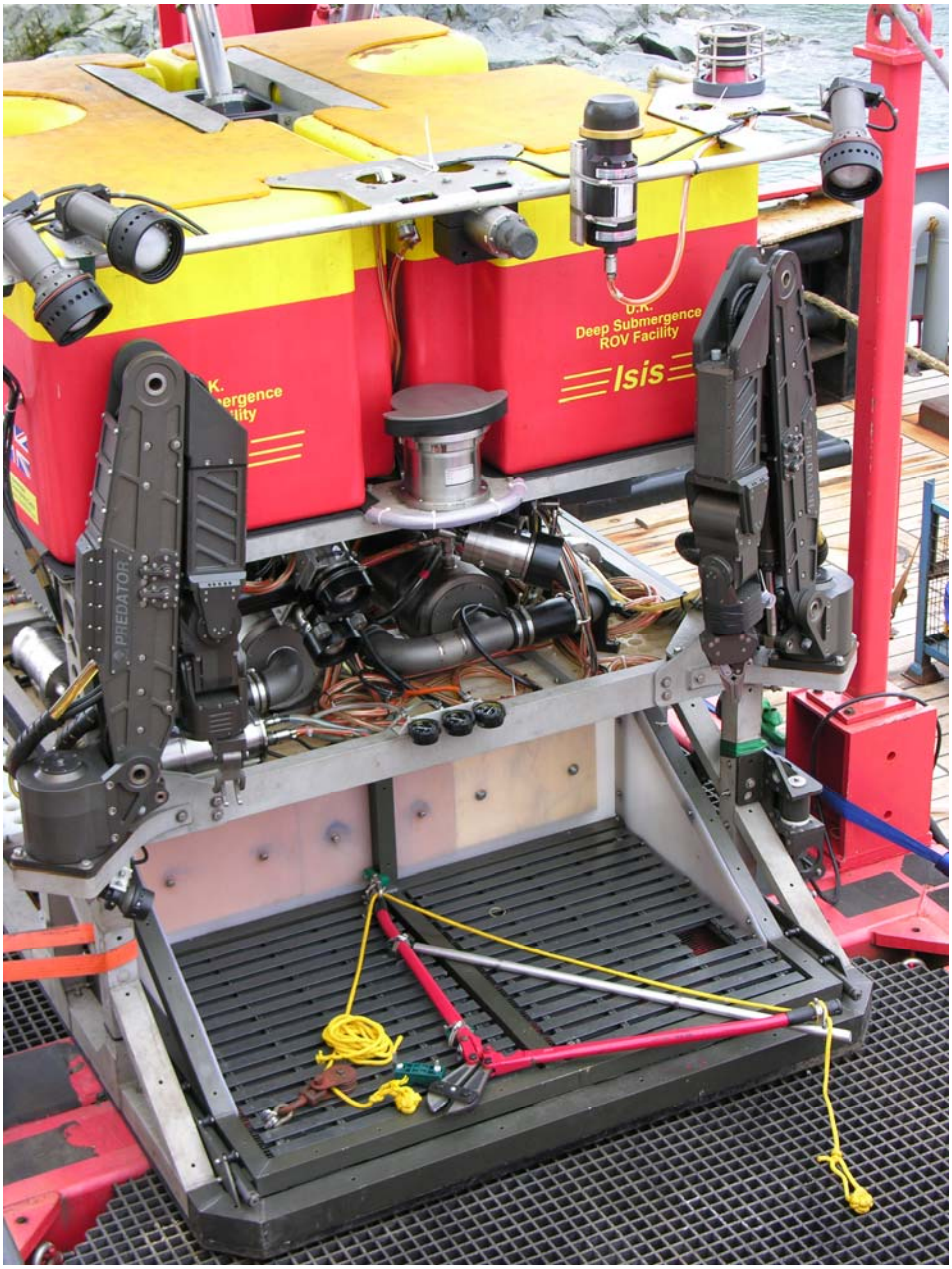


Figure 4.2. The Isis ROV, showing manipulator arms, cameras and lights.

Figure 4.3. Push core being taken of the sea floor using the manipulator arm of Isis

4.2 Dives and Environmental Targets for the Isis ROV

Several continental margin sub-environments were investigated using Isis during cruise JR157. They are given below together with the Isis dives associated with each:

1. Slope – sediment drifts, turbidite channels and gullies

- Gullies at the shelf edge – Dives 4 to 6
- Sediment waves in deep water – Dive 7
- Sediment drifts and channels - Dives 8 and 9

2. Shelf – streamlined landforms, subglacial channels
- Streamlined subglacial landforms; drumlins – Dives 2 and 3
- Former subglacial channel system in bedrock – Dives 10 and 11

3. Fjord – fjord floor, tidewater glacier margins
- Moraine ridges exposed by recent glacier retreat – Dives 12 to 16 (Dive 14 aborted)

The locations and times of each dive are given in Figure 4.4 and in the table below; the table includes both time off the deck and time at the sea floor. The logs of each dive are transcribed in Annex 1 and the tracks of Isis during swath and photographic dives are shown in Annex 2.

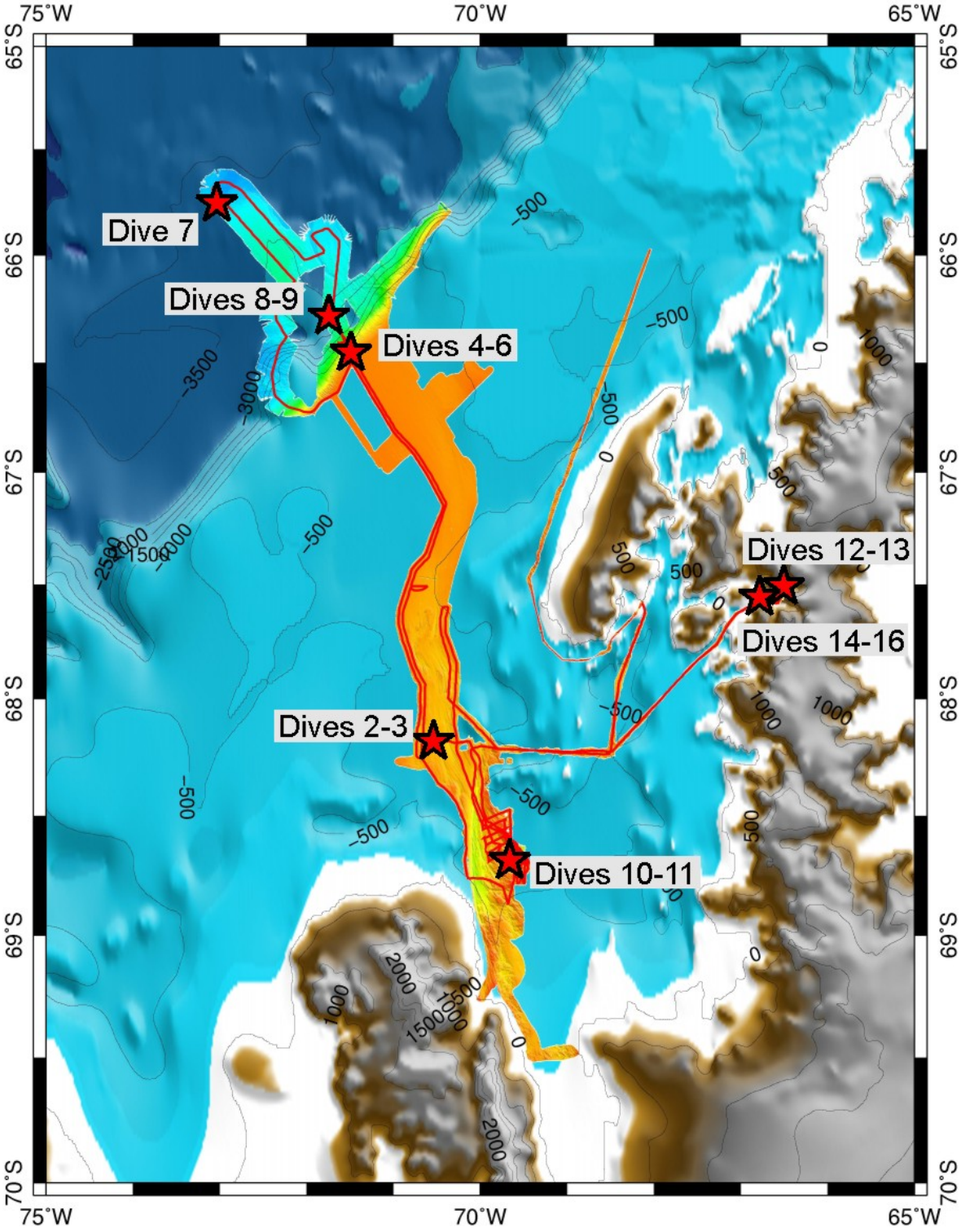


Figure 4.4. Locations of scientific dives of the Isis ROV on the Marguerite Bay margin

Table of Isis Dive times during its 16 deployments (Dive 1 was not a science dive)

Isis dive times for JR157

Dive No.	In water Jday	On Bottom Jday	Off bottom Jday	On surface Jday	Dive time Hours	Bottom time Hours
1	20.7514	20.8278	20.9417	20.9861	5.63	2.73
2	21.6736	21.7257	22.5660	22.6056	22.37	20.17
3	22.9556	23.0104	23.1632	23.3035	8.35	3.67
4	23.8924	23.9201	24.4250	24.4868	14.27	12.12
5	24.5972	24.6972	25.5882	25.6146	24.42	21.38
6	25.7493	25.8285	26.0778	26.1333	9.22	5.98
7	26.5153	26.6083	26.9833	27.1424	15.05	9.00
8	27.4938	27.5750	27.9347	28.0514	13.38	8.63
9	28.1472	28.2361	28.6306	28.7188	13.72	9.47
10	29.5729	29.5986	30.4625	30.4868	21.93	20.73
11	30.8694	30.8958	31.3514	31.3750	12.13	10.93
12	33.6528	33.6666	33.9549	33.9819	7.90	6.92
13	34.0965	34.1146	34.5326	34.5597	11.12	10.03
14	34.7757	Not reached	Not reached	34.8028	0.65	0.00
15	34.8507	34.8861	35.2375	35.2639	9.92	8.43
16	35.3222	35.3514	35.6764	35.6958	8.97	7.80
				Totals	**199.02**	**158.00**
			start first dive to end of last as % of total time		*55.49*	*44.05*

4.3 Photographs and Video data acquired from the Isis ROV

Two types of still image were acquired on dives where cameras were in operation. These were: (a) frame grabs from the video record, which are relatively low resolution; and (b) high resolution images from a digital stills camera. Each image is tagged with date and time, and each set of images is stored, in addition, by dive number.

In addition, video film was also recorded on these dives, and the tape list is tabulated by dive, below:

Isis Video Tape list for each dive site (location in Fig. 4.4)

Dive 1		
Dive 2		36
Dive 3	39	44
Dive 4	45	56
Dive 5	57	90
Dive 6	91	98
Dive 7	99	110
Dive 8	111	122
Dive 9	123	128
Dive 10	129	154
Dive 11	155	168
Dive 12	169	178
Dive 13	179	186
Dive 14	187	190
Dive 15	191	198
Dive 16	199	204

4.4 Core samples collected using the Isis ROV

Table giving details of the push cores and bag samples collected using the Isis ROV

Dive Number	Core Number	Water depth (m)	Latitude (S)	Longitude (W)	Recovery (cm)	Location
003	IC01		68 11.8140'	70 30.6320'	15	Drumlin and Drumlin Moat on Inner Shelf
	IC02		68 11.8140'	70 30.6320'	24	
	IC03		68 11.8140'	70 30.6320'	26	
	IC04		68 11.8140'	70 30.6320'	20	
006	IC05	1802	~66 24.3700'	~71 31.9000'	Bag sample	Gully-Channel System on Upper-Middle Slope
	IC06	1355	66 24.8740'	71 30.6760'	Bag sample	
	IC07	1254	66 25.0340'	71 30.1410'		
	Grab	1254	66 25.0340'	71 30.1390'	Rock - Bag sample	
007	IC08	3442	65 44.5890'	73 01.2870'	Paul Tyler	Distal part of Drift
	IC09	3442	65 44.5890'	73 01.2870'	Paul Tyler	
	IC10	3442	65 44.5890'	73 01.2870'	Paul Tyler	
	IC11	3442	65 44.5890'	73 01.2870'	11	
	IC12	3442	65 44.5890'	73 01.2870'	29	
	IC13	3440	65 44.6360	73 01.2470'	48	
	IC14	3440	65 44.6360	73 01.2470'	29	
	IC15	3440	65 44.6360	73 01.2470'	Paul Tyler	
008	IC16	3006	66 18.2810'	71 42.7720'	Bag sample	Side of Drift on Lower Slope and Channel System
	Grab	3007	66 18.1520'	71 43.1410'	Rock - Bag sample	
015	IC17	377			23	Bourgeois Fjord - Jones Channel
	IC18	377			14	
	IC19	377			25	
	IC20	377			16	
	IC21	377			14	

4.5 Swath bathymetry collected using the Isis ROV

Swath bathymetry was acquired using a Mesotech SM 2000 system on a number of dives:

Dive No.	In water Jday	On Bottom Jday	Off bottom Jday	On surface Jday	Dive time Hours	Bottom time Hours
2	21.6736	21.7257	22.5660	22.6056	22.37	20.17
4	23.8924	23.9201	24.4250	24.4868	14.27	12.12
5	24.5972	24.6972	25.5882	25.6146	24.42	21.38
9	28.1472	28.2361	28.6306	28.7188	13.72	9.47
11	30.8694	30.8958	31.3514	31.3750	12.13	10.93
13	34.0965	34.1146	34.5326	34.5597	11.12	10.03
16	35.3222	35.3514	35.6764	35.6958	8.97	7.80

Problems were encountered during the early deployments of the swath system, and it is likely that the later dives on JR157 will produce the highest quality swath imagery (Dives 13, 16). These problems related to several issues concerning the time-stamping on the SM2000 and the processing software that as used. The logs of each dive are transcribed in Annex 1 and the tracks of Isis during swath and photographic dives are shown in Annex 2.

All operations of the Isis ROV took place from the control centre mounted on the back deck of the JCR. The pilot and operators sit on the left, and the scientists on the right of the image in Figure 4.5

Figure 4.5. Isis operations cabin located on the back deck of the JCR

5. ANNEX – LOGBOOK RECORDS OF ISIS DIVES

ISIS dive logs for Dives 2-16 (Dive 1 was not a science dive), transcribed from the manual logbooks.

21.01.2007

DIVE 2
SWATH survey of crescentic moat on the blunt side of drumlin
16:10 Isis deployed 68:10.959S 70:31.008W d=820
17:25 isis at seabed
18:02 swath survey line started
18:26 swath stopped to chech data quality
18:40 recommence survey to WP2
18:54 isis stopped, tech problems
19:17 continuing to WP2
19:43 logging stopped, no nav from sonardyne
19:49 heading back to WP1, nav from doppler log
20:36 back on WP1, stop isis and continuing eastward
towards the crest of drumlin while sorting sonardyne out
21:21 reached crest of drumlin 68:10.987S 70:30.566W. Heading back west
21:51 back on WP1, continuing westward into the moat
22:01 close to max dept of moat... hanging around
22:10 turning 180 and moving west up the opposite slope of moat.
22:27 extensive videoing of a boulder
23:10 starting ascending along the opposite slope

22.01.2007

00:30 heading south along west of western moat of large drumlin
02:00 boulders and dropstones observed on the bottom
06:06 ship gps: 68:11.72S 70:31.49W
06:15 course alteration due to ice, heading c. 070
06:26 heading to 140
08:05 ship stopped tech problems
08:19 course change to 073
10:19 doppler reset
10:24 ISIS brought up to swath height and swath started
10:28 course to 058
11:00 come around to course 185 at WP8.
Discrepancy between sonardyne and dvl navigation
11:15 heading to WP9
11:18 tracking along the cliff
... navigation problems go on and on and on....

DIVE3
SAMPLING & VIDEO DIVE
22:50 ISIS in the water

23.01.2007

00:12 on the bottom 68:11.676S 70:30.584W ship
68:11.187S 70:30.727W d=853m
Lots of turns and moves in random direction while coring and filming

03:43 Survey end

DIVE4

SWATH survey (blue)

21:25 ISIS in water 66:27.6716S 71:24.5389W d=500m
22:05 ISIS at bottom 66:27.72S 71:24.428W
22:15 Heading for WP1, 57 m away
22:23 start of line
23:40 still on shelf 66:27.408S 71:25.273W d=480.6m

24.01.2007

00:49 strong SW current, isis struggling to stay on track
01:39 reached WP3 66:26.951S 71:26.839W d=551.2
03:39 Apparently ms2000 recording was not set earlier, except
the sounder was exporting "pre-processed" data
04:10 WP6
04:31 current pushing SW
04:37 DVL nav system set to CBL(?)
05:29 WP8
06:10 WP9
07:13 WP10
08:32 WP11 ship changing heding 5deg to port. ISIS 7m off-track
10:12 stop recording, recover isis at 66:24.290S 71:31.043W d=1424.3m

DIVE5

VIDEO & SWATH survey from WP14 to WP1 (red)

14:20 ISIS in water 66:23.4852S 71:32.9549W
16:44 ISIS on the bottom d=2131m
16:49 heading towards WP14
17:05 logging MS2000
17:11 very gravelly and poorly sorted seabed, Streaky dark patches with
large clasts along their paths and along the gully
17:48 on swath track, Starting swath survey 66:23.537S 71:32.878W
18:03 ship changing course
18:38 ISIS veered off-track. Stationary and trying to get back on track.
heading 108
18:47 back on track, heading 147 towards WP13, 66:23.6392S 71:32.691W
19:49 WP13
22:08 reached dive 4 cut-off point, continuing to WP11 at 2m off bottom
22:20 ISIS stopped, coarse bottom, strong current, lots of suspension

25.01.2007

00:17 End of transect
00:29 new transect, 50m off the previous line, 20m off-bottom
01:27 reached point 50m offset from WP10. End on sonar transect
transit to WP10 to start next camera transect

01:40 start of camera transect, going upslope.
03:03 end of camera run, d=1008m

03:12 heading from WP9 to WP8 to begin swath transect
03:29 doppler reset
04:06 WP8; sm2000 range reset to 75m
04:40 WP7

04:47 commencing camera run

very gravelly seafloor, locally clast clusters
05:30 WP6; end of camera run

05:38 heading for start point for swath run
05:50 starting offset line (6 to 5) to east
06:45 WP2; heading towards 3
06:58 coming around onto heading for WP4
08:32 WP6 66:26.444S 71:27.967W
08:41 WP7 66:24.444S 71:27.832W ISIS dives closer to seabed for bio-dive profile

08:45 Start Bio-profile
10:07 WP1-4; ISIS brought up to swath-height; end bio-profile SM2000 recording

10:22 WP8 66:26.633S 71:27.516W
10:26 ISIS stopped at WP8, waiting for ship
10:27 ship & isis moving towards WP9 (=1-3 offset by 50m); Swath recording
11:46 ??were heading to WP11, but WP12 & 13 added to level? to original WP1-1
12:14 WP10 (=50m offset from WP1-2)
isis heading 132@480m; heading to wp12
12:39 WP12

12:41 At seabed for bio camera run til 14:00
12:48 SM2000 stopped recording

14:52 isis leaving bottom
14:52 end; 66:27.5351S 71:24.8711W

DIVE6
CORING & BIO survey
17:59 isis in water 66:24.370S 71:31.9W d=1784
19:56 at seabed

26.01.2007

01:52 isis on way up; End dive6

DIVE7
BIO & GEO SAMPLING
12:22 isis in water 65:43.672S 72:59.561W d=3468m
14:36 isis on the bottom d=3477m; 3m off the bottom
19:08 Loop in the track, with the end in SW direction
19:58 start push coring
21:24 end coring
22:02 heading east along less rocky area with minor course changes
23:36 end of dive; ISIS off the bottom

27.01.2007

DIVE 8
Bio & geo sampling of channel, channel bank and drift sheet edge
11:51 isis in water, 66:18.448S 71:42.526W
13:45 Techsas record start
13:48 isis on bottom
14:02 start survey line 66:18.389S 71:42.532W

14:47 isis stop; starting push coring; 66:18.281S 71:42.772W d=3006
16:13 on the move again; large boulders
16:28 66:18.15S 71:43.088W
16:33 slump block & ice rafted debris, also scour around slump block
17:23 heading on after sampling
17:31 heading 302@2987m 66:18.117S 71:43.143W Possible scree field
17:39 crossed scarp, c.30m
18:16 heading 278 to WP3 and then NE to WP5. Out of boulder pavement area
18:50 heading 47 towards WP5
19:01 Gully into canyon 66:17.973S 71:43.372W d=2941; V-shaped
19:06 steep sloping canyon wall with stratification and gravel dropstones on face
19:20 traversed along edge of cliff.
fresh scar with talus 66:17.950S 71:43.338W 2945m
19:26 rippled seafloor area w. darker banding patches
19:45 possible folding
20:11 ISIS turning around to face canyon wall
20:54 narrow chutes in cliff face act as conduits to mass-wasting to produce tapering talus cones at their mouths
21:17 possible slump block
21:29 heading 49 towards WP5
21:41 turning to heading 090
21:44 back into channel. gravelly-sandy seafloor sediments
21:47 heading east d=3018
21:58 dimpled sandy-gravelly seafloor passes via a step to rippled seafloor
(barchan type)
22:26 End dive8. 66:17.671S 71:42.312W d=3017m

28.01.2007

DIVE9
SWATH survey of channel, channel bank and drift sheet edge
03:32 ISIS in water
05:50 Swath logging starts
05:53 Reached WP01
05:56 Heading to WP02
06:51 Ship adjusts course, swinging around to north
07:41 ISIS at WP02
12:07 at WP03
12:22 heading 287, 0.3kn
12:30 problem with heading (shows 188 instead of 288). ISIS turning to 019 course
to steer back c.50m to line
12:41 back on track, heading 288
14:47 220m to the end of line
15:08 end of swath d=2987m 66:17.706S 71:42.728W

29.01.2007

DIVE 10
13:45 ISIS in water 69:37.36S 68:39.238W d=530m
14:22 ISIS on the bottom. Starting video survey of subglacial meltwater system

30.01.2007

05:16 At WP(2?) 68:42.29S 69:41.02W
05:45 Start of Swath v=0.3kn, heading 96deg
06:40 Ship's heading adjusted to 115
ROV imaging sidewall of channel
07:21 SM2000 sv set to 1460m/s
07:33 imaging channel floor

07:39 TECHSAS RESTARTED. Last recorded data appears to be at 15:40 28.01.2007
*********Check if nav gap occurred in cdf**********

07:56 Heading changed to 060 to capture the channel wall
08:16 doppler lock on sidewall lost. Zigzagging back to NE to find wall
08:32 Ship's course to 120
08:55 turning to WP3, new heading 035
09:32 ISIS and ship stopped at WP3
09:38 Start moving towards WP4, heading 310
11:04 Stop for pressure drop
11:11 Stopped logging MS2000
11:41 ISIS on surface
12:15 Techsas stopped

DIVE 11
SWATH survey (and calibration)
21:30 ISIS on bottom, ca. 68:41.8S 69:40.2W
looking for calibration site, doing calibration tracks
23:29 Start swathing in the channel
23:45 Navigation crash
23:47 Sonardyne restarted and running again

31.01.2007

00:09 Swath shows undercutting on the port side
00:14 end of first survey line, starting to turn
00:21 starting second line, heading towards WP5
00:56 doppler lock lost, messing to acquire lock
01:02 Doppler lock back
01:09 end of second line
01:19 start of third
02:01 end of third, manuevering towards 4th
02:21 encoutered cliff on the way to WP4. Taking a plunge to investigate with cameras
68:41.674S 69:40.769W
03:38 breaking off channel to continue survey. GOOD FRAMEGRAB OF OVERHANG @ 03:47
04:07 swathing on line (not logging?)
04:17 heading to WP9
06:02 started recording ms1000(?)
06:43 navigation crash, stop to sort out
06:50 Swathing continues
07:09 Navigation green again
07:12 doppler lock gone, restart the system
07:14 messing...
07:42 ship & ISIS restarted along transect, ISIS 500m off trackline
08:08 pronounced channel bed - wall profile (on port side)
08:22 reached WP12
08:23 Stopped recording MS2000
08:26 end of line 68:41.096S 69:42.538W d=455m

09:01 TECHSAS stopped

02.02.2007 *JD033*

DIVE 12
Biological and video survey & coring
15:40 ISIS in water 67:30.5S 66:31.5W
22:55 End of dive 67:29.031S 66:29.911W

03.02.2007

DIVE 13
SWATH survey
02:29 66:31.51S 67:30.52S D=246m
03:01 Techsas started
03:44 speed up to 0.6kn
04:16 heading to 263
04:35 heading 025
06:09 momentary lost of bottom
06:16 ship stops due to ice ahead
06:22 navigation restart
06:27 nav ok 67:29.118S 66:30.02W
06:28 ship starting to turn around to go on parallel track back
06:32 doppler reset
06:49 ISIS on starboard track
07:33 ship altering course due to ice on starboard, isis ok.
09:03 ISIS a bit off-track, slight course change to come back on track
09:13 end of line, ISIS at WP6
09:14 changing heading to 310 towards WP3
09:23 ISIS at WP3. heading to WP4, new heading 025
09:25 doppler reset
09:29 ISIS/ship stopped, technical trouble on bridge
09:32 underway again
11:25 cusps on seabed on both sonars, locally two generations
11:52 ice in touch, reducing speed
12:10 ship stopping 66:30.12W 67:29.24S
12:22 ship stopped ISIS continues forward
12:36 steepening slope ahead
12:40 end of ISIS quest at 67:29.068S 66:29.961W D=175m
12:42 stop ms2000
13:17 ISIS on surface

DIVE 14
Crash dive
18:34 start
19:16 end

DIVE 15
CORING and VIDEO dive
20:25 ISIS in water
20:52 sonardyne up and running
21:16 ISIS on bottom 67:34.14S 66:48.853W D=595m

Moving around with lots of stops for coring and sampling

04.02.2007

06:20 ISIS recovered, End dive15

DIVE 16
SWATH dive
07:44 ISIS in water 67:32.5996S 66:47.1822W D=457m
08:26 Starting line, 0.6kn, heading 042 towards WP1
10:45 ISIS at WP1, continuing same direction to avoid ice
10:59 end of line, isis stops
11:09 doppler reset, continuing...
12:00 Problem with Techsas files other than cdf... No files appear have been recorded
for dives 14 and 15 either...
12:30 ship making evasive manoevres and slowing down. No effect for ISIS
13:40 slow to stop, hit ice square at stern
13:50 set course 132 to shifted WP2 (east offset)
13:52 stop due to ice
14:07 shifting further east due to ice
16:05 end of swath run near Lliboutry Glacier
16:07 ms2000 stopped 67:31.582S 66:44.865W d=286

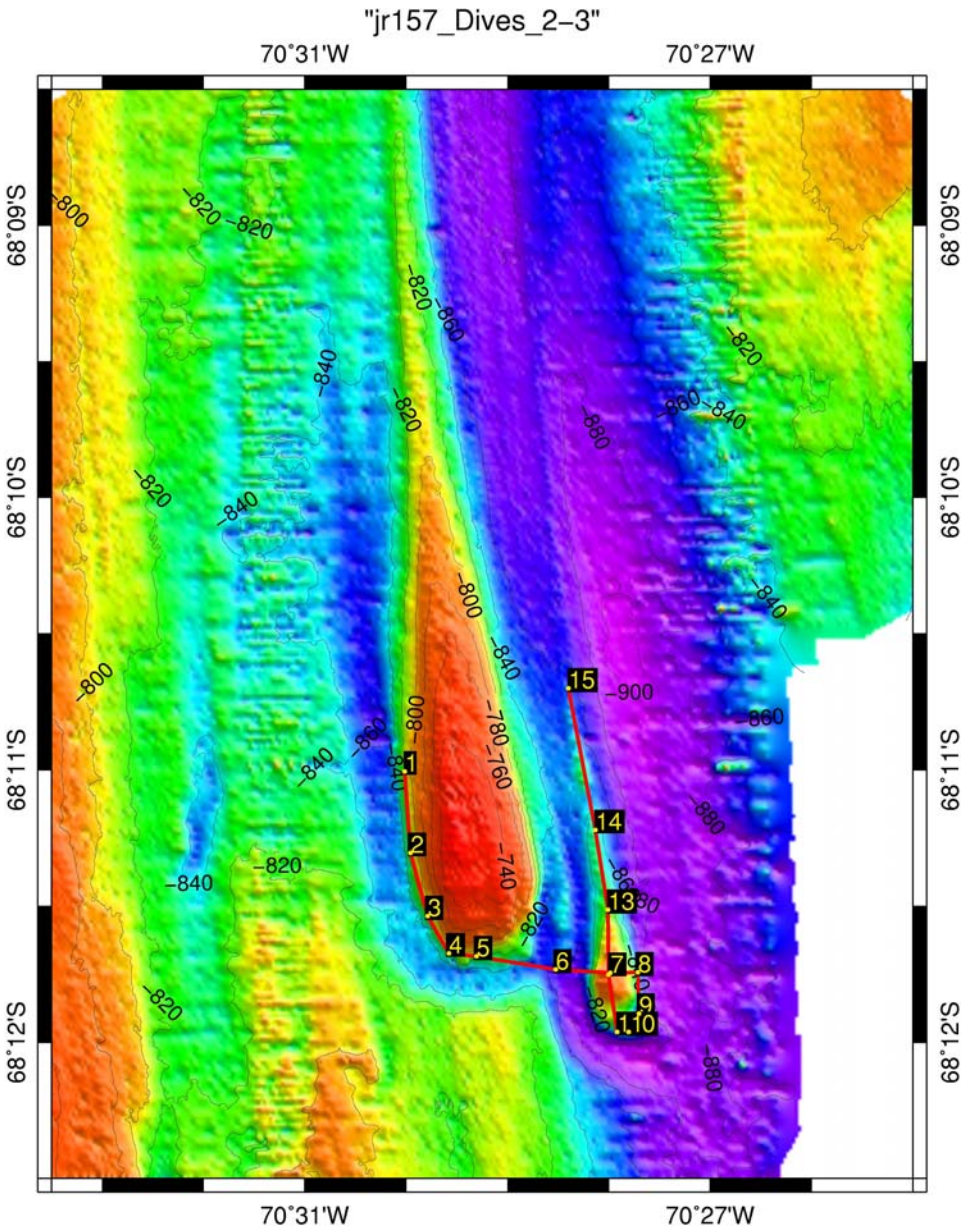
END

6. ANNEX – DETAILED MAPS OF ISIS DIVES

Note that tracks are approximate as navigation data have not been examined in full as yet.

DIVES 2 AND 3

Dive 2 swath survey and dive 3 cameras both in red

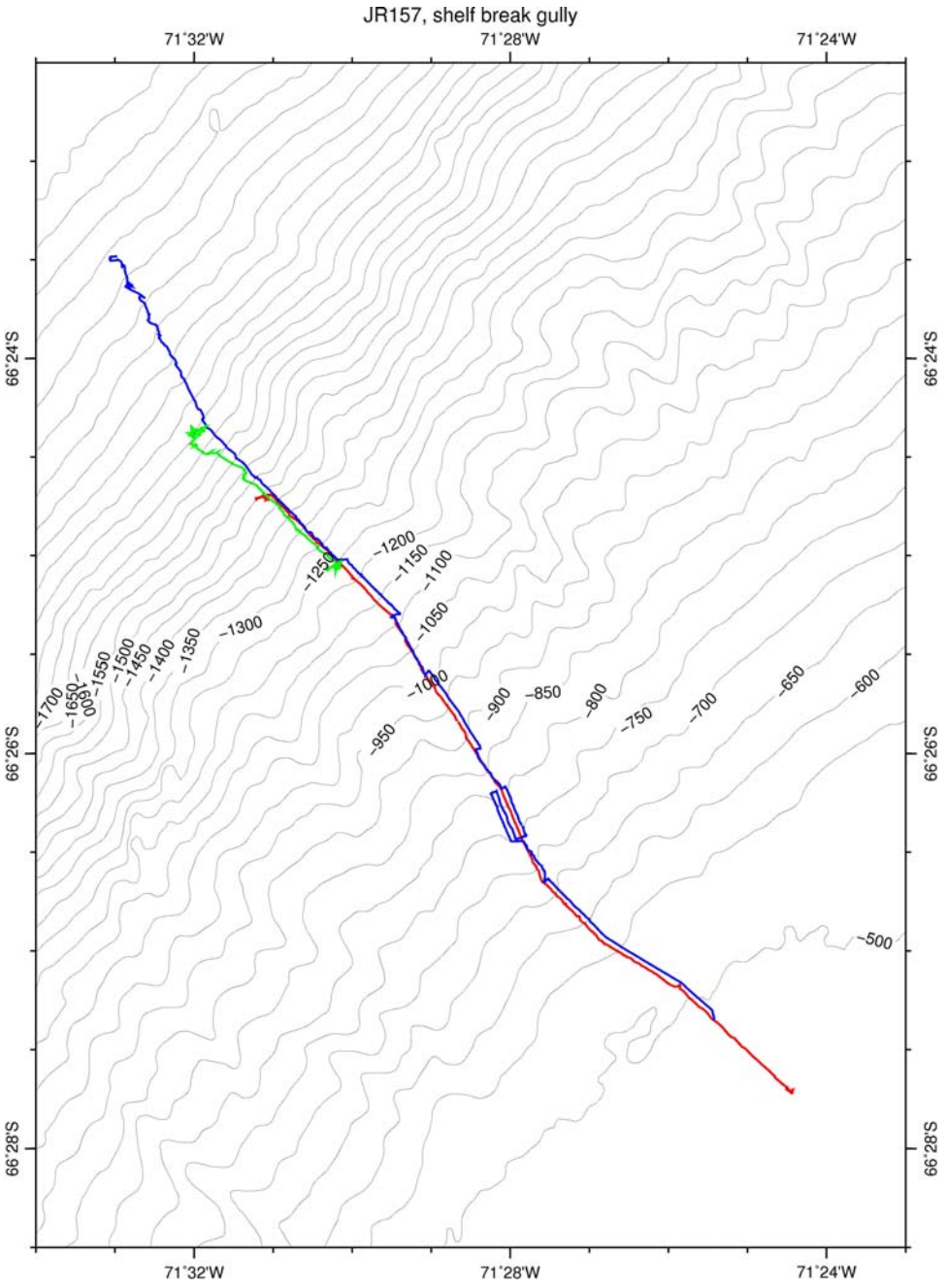


DIVES 4 TO 6

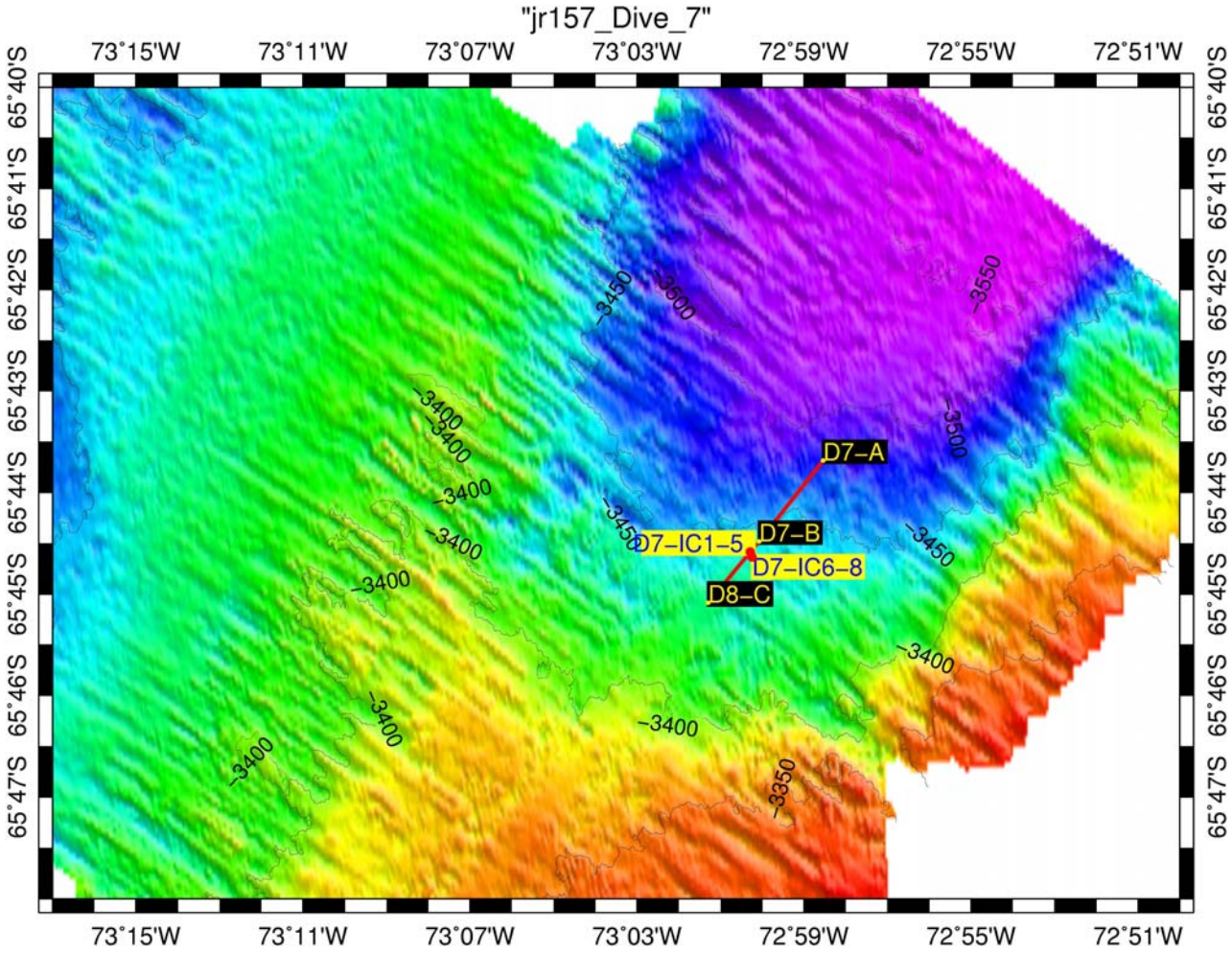
Dive 4 swath survey in blue

Dive 5 swath and video survey in red

Dive 6 coring and biological survey in green



DIVE 7

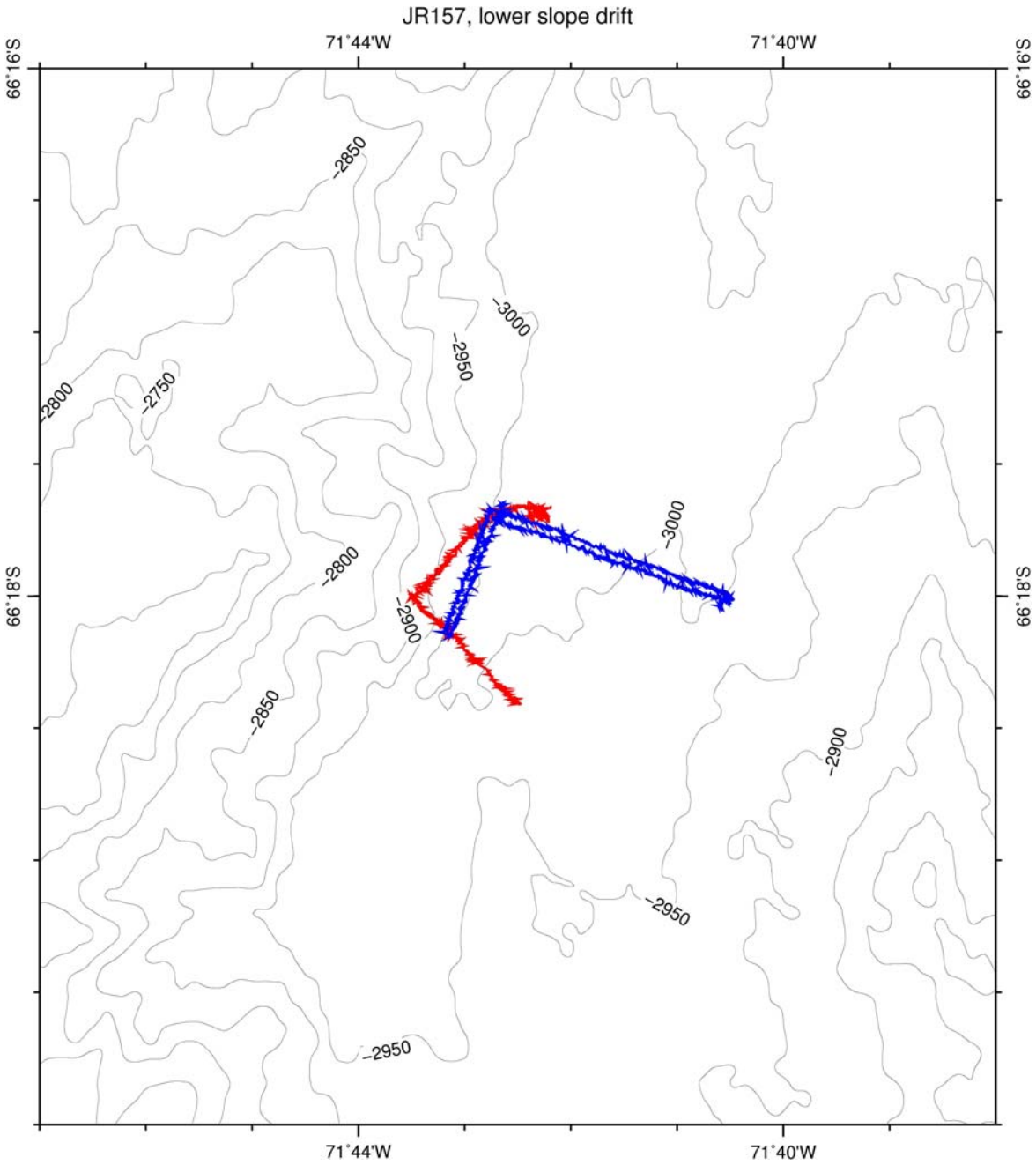

"jr157_Dive_7"
73°15'W
73°11'W
73°07'W
73°03'W
72°59'W
72°55'W
72°51'W
65°40'S
65°41'S
65°42'S
65°43'S
65°44'S
65°45'S
65°46'S
65°47'S
D7–A
D7–B
D7–IC1–5
D7–IC6–8
D8–C
-3400
-3450
-3500
-3550
-3350

DIVES 8 AND 9

Dive 8 geological and biological survey in red

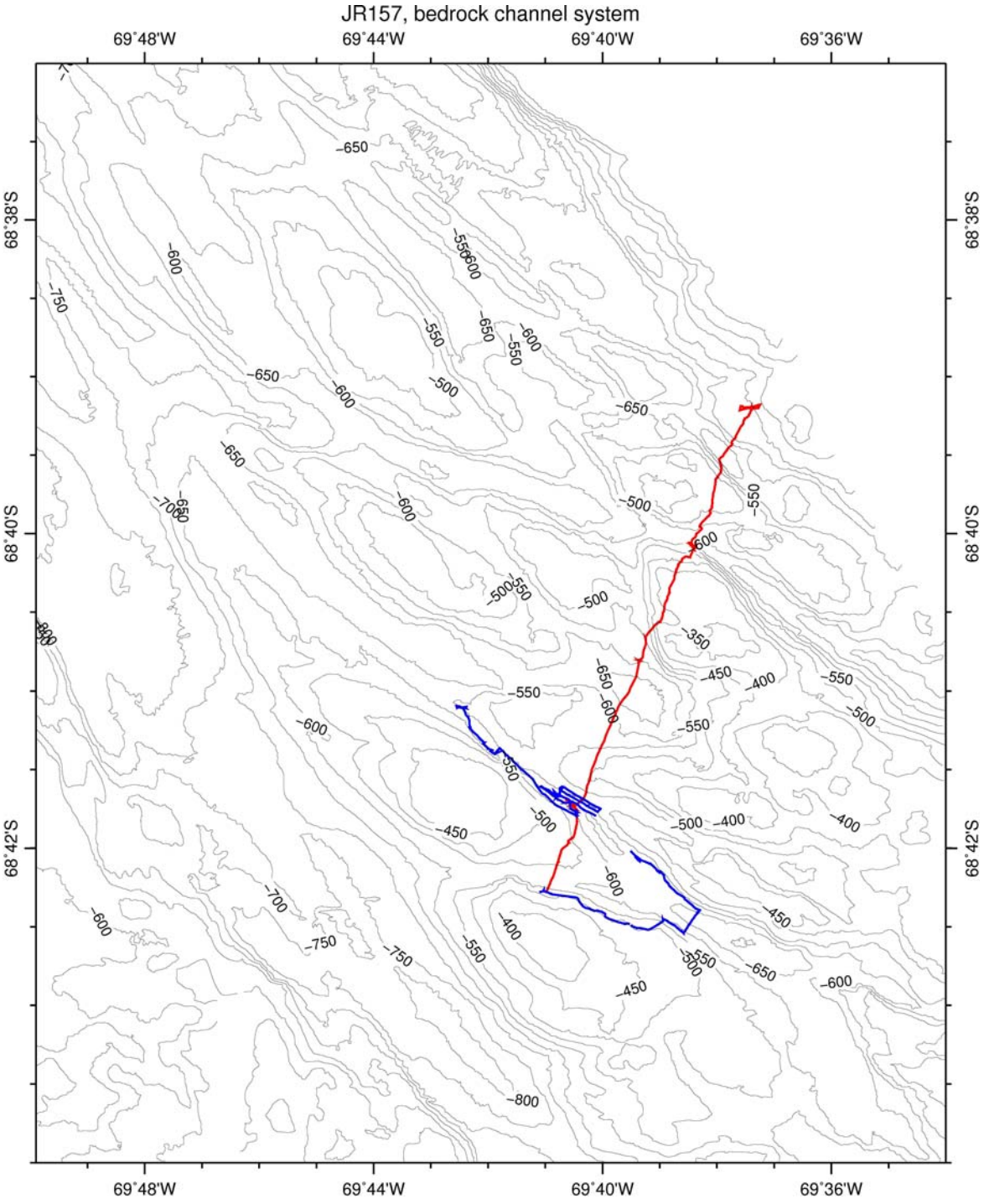
Dive 9 swath survey in blue

Note spikes in unprocessed navigation data



DIVES 10 AND 11

Dive 10 camera survey in red
Dive 11 swath survey in blue



DIVES 12 TO 16

Dive 12 and 13 camera and then swath surveys in black
Dive 14 aborted
Dive 15 cameras and sampling survey in yellow
Dive 16 swath survey in red