GEOLOGICAL SURVEY OF CANADA
OPEN FILE 6826

Cruise Report, 2010003PGC, CCGS Vector, 18–22 June 2010

P.R. Hill

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GEOLOGICAL SURVEY OF CANADA –PACIFIC

CRUISE REPORT

Vector
18–22 June 2010

SCIENCE CRUISE NUMBER: 2010003PGC

SHIP'S PATROL NUMBER: 10-02

NAME OF SHIP/PLATFORM: CCGS *VECTOR*

SURVEY AREA/AREA OF OPERATION: Sand Heads, Southern Strait of Georgia

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Cruise Objectives

- Recover, maintain and deploy VENUS equipment using Oceanic Explorer ROV.
- Conduct ADCP measurements of currents and backscatter.
- Collect CTD profiles and water samples for suspended sediment concentration.
- Collect grab samples for benthic fauna.

Scientific Personnel

Phil Hill (NRCan)
Kim Picard (NRCan)
Korhan Ayranci (SFU)
Megan Jamer (SFU)
Glenn Costello (Canpac)
Daniel Cormany (Canpac)
Craig Dawe (Canpac)
Paul Macoun (UVic)

Schedule Variance

The expedition was originally scheduled for June 18-23, but because of mechanical problems with the anchor capstan, Coast Guard requested a one-day reduction in the expedition length. This was accommodated by returning directly to IOS and shipping the ROV back to the mainland by truck. One night's non-critical sampling was also lost.

Equipment Performance, Results and Data Sets

1. Oceanic Explorer ROV

The Oceanic Explorer is a 25 HP Electro-Hydraulic Remotely Operated Vehicle operated by Canpac Divers Inc. of North Vancouver, B.C. It has multiple cameras and two manipulator arms. The ROV was loaded on board Vector from the Island Tug and Barge wharf at Berry Point, Burnaby and unloaded at IOS. The Oceanic Explorer was deployed from the aft deck with no major problems. Several problems were encountered and overcome in preparing the ROV, notably with the ballast and hydraulics systems. Once deployed, problems were encountered with the navigation system due to the lack of a stable gyro feed to the Trackpoint positioning system, resulting in ambiguity in positioning. This ambiguity and the lack of visibility placed great importance on the sector scanning sonar for locating the DDL instrument platform. On the first dive, the sonar head was incorrectly oriented so that the results were confusing. Once corrected, the DDL platform was quickly located using the sonar.

Figure 1. Recovering the Oceanic Explorer ROV (Photo by Korhan Ayranci).

The Delta Dynamics Laboratory (DDL) instrument platform was successfully unplugged from the VENUS network and recovered intact. Although the original plan was to service and re-program the instruments for re-deployment as an autonomous platform, time did not allow this to happen, nor for other VENUS nodes to be examined. No data sets were generated by these activities.

The Canpac personnel showed great expertise in using the ROV manipulator arms to release and recover the DDL. However, the time required for problem-solving did not permit the re-deployment of the DDL platform in autonomous mode as originally planned.

2. Navigation

All positioning data for the ship were collected using the ship's GPS and logged through PGC's Regulus system. Both raw and processed navigation data are included in *Data Set 1 Navigation*. The following files types are included:

Raw:

Vect1xx.txt	Raw	GPS stream.

Processed:

2010003PGC nav elements_processed.xls		Stations and Line SOL/EOL
Vectxxx_Process1.xls	Lat,	Long, Nav Elements

3. ADCP

A Teledyne-RDI 300kHz Acoustic Doppler Current Profiler (ADCP) provided by Richard Dewey of the University of Victoria was mounted on the port side just below the hull. Positioning information was taken from the ship's GPS. An external compass provided by Dewey did not appear to work, so the input to the ADCP was not enabled and the directional information depended on the instrument compass.

ADCP profiles were run along transects during the major ebb phase of the tide. The ADCP records continuous profiles of the horizontal and vertical components of current velocity and backscatter intensity. The data were recorded onto an NRCan laptop. In general, the ADCP functioned well. There was a brief problem when the WinADCP program would not start, but this occurred because the internal memory of the ADCP was full. Clearing of the memory resolved the issue.

ADCP profiles were measured both autonomously and in conjunction with CTD and turbidity casts and water sampling. The list of profile lines is provided in Table 1 and the line locations are shown in Figure 2. An example of the data is shown in Figure 3.

The uncorrected backscatter intensity profiles show a strong surface plume, as expected, but also more complex structure in the mid-water and near bottom regions (Fig. 3; bottom). Some of the profiles appear to have unreasonable directional changes in the currents (Fig. 4). Review of the navigation data indicates that these anomalous sections correspond to intervals when the ship was manouevring to avoid traffic, an unavoidable consequence of operating in the marine traffic lanes or to do CTD casts. The instrument compass appears to have an inadequate response time to respond to sudden changes in course.

The ADCP data were output using the VmDas software provided by RDI and are included in *Data Set 2 ADCP*. VmDas generates a number of files for each record.

Data files produced by VmDas during data collect mode has the following filename format (from VmDas User Manual): DeployName000_000000.Ext, where:

DeployName is a user-entered name for the deployment (up to 128 characters)

000 is the deployment number (changes with each stop/restart)

000000 is the file sequence number, which is incremented when the specified maximum file size is reached

Ext is the file extension, and reflects the type of data in the file.

The file extensions have the following meaning:

.ENR Raw ADCP data file

.LTA ADCP (plus NAV) data that has been averaged using the long time period specified in the Options, Edit Data Options, Averaging tab.

.STA ADCP (plus NAV) data that has been averaged using the short time period specified in the Options, Edit Data Options, Averaging tab.

.ENS ADCP data after having been screened for received signal strength indicator (RSSI) and correlation by VmDas, or adjusted by the customer via a User Exit. Also has NAV records merged into the ensembles from the .NMS file.

.ENX ADCP single-ping data (plus NAV) after having been bin-mapped, transformed to Earth coordinates, and screened for error velocity, vertical velocity, and false targets. This data is ready for averaging.

.N1R, .N2R Raw NMEA data files - text files; includes ADCP time stamps with the following format: $PADCP,eeeee,yyyymmdd,hhmmss,-nnnnn.nn<CR><LF> Where:
eeeee = ADCP ensemble number
yyyymmdd = Year, Month, Day (date of ADCP ping)
hhmmss.ss = Hour, minute, seconds.hundredths (Time of ADCP ping)
-nnnnn.nn = (signed) PC clock offset from UTC in seconds; includes time zone difference).
The .N1R extension is used for single-port NMEA data collection, or for GPS position data (Nav) in dual-port collection mode. The .N2R extension is used for Roll/Pitch/Heading (RPH) data collection when using two serial ports for NMEA data collection.

.NMS Binary format NAV data file after having been screened and pre-averaged.

.VMO The option settings used for collecting the data (text file).

.VMP The option settings used for reprocessing the data (text file).

4. CTD and Alec Turbidity Sensor

A Seabird-19 internally recording CTD was deployed from the forward starboard side hydro winch at stations in the river mouth and plume of the Fraser River (Fig. 5). Niskin bottles were deployed at the same time. The data were recorded onto an NRCan laptop using Seabird software. No problems were encountered with the instrument. However, the internal clock time of the instrument recorded into the data files was not synchronized with the GPS navigation time. Users are referred to Table 2 where the following times were noted from the shipboard navigation system:

- **Start**: when CTD was placed in the surface water. Typically, the instrument was held at the surface to stabilize for a few minutes before being lowered. The instrument was then typically lowered in several stages as Niskin bottles were added to the wire at intervals.
- **Bottom/Messenger:** when the messenger was deployed to close the Niskin bottles. This is the time at which the samples were taken. Both terms are retained to remain consistent with the shipboard log.
- **2nd messenger**: in some cases, the first deployment of the messenger failed to trigger the bottles, so a second one was sent to ensure closure.

- **End:** when the CTD instrument arrived at the surface and was lifted out. The upward movement of the instrument was similarly conducted in stages to allow for removal of the Niskin bottles.

The CTD data files are included in *Data Set 3 CTD.* The Seabird-19 instrument records raw files in hexadecimal format (2010003PGC_STNx.hex) , which are then converted into engineering units in separate files (2010003PGC_STNx.cnv). The converted data were then read into Excel spreadsheets, which are also provided in a single file (2010003PGC_allstations.xls). Example CTD profiles are shown in Figure 6.

A JFE Avantech (Alec) Compact CLW turbidity sensor was attached to the CTD frame and turbidity values were logged separately. Because the clock in the Alec meter was not synchronized with the Seabird CTD, the clock times between the two instruments differ. Re-synchronization was computed by re-sampling the Seabird data to reduce them from half-second to two-second intervals and then iteratively finding the best fit correlation between the recorded Seabird and Alec temperature sensors. R^2 values exceeding 0.99 were generally obtained.

The Alec turbidity data are included in *Data Set 4 Alec Turbidity* as Excel files (2010003PGC_STN x_Alec.xls). An example is provided in Figure 7.

5. Water Sampling for Suspended Sediment Concentrations

Water samples were collected using 1.8 litre Niskin bottles from the forward starboard side hydro winch in conjunction with the CTD and turbidity profiles. Two of the six Niskin bottles were inoperable but for the water depths and scientific objectives, four bottles were sufficient. Strong currents at most sites produced high wire angles, introducing significant errors in the depth measurements.

The volume of water obtained was measured and the water samples were transferred to plastic containers for filtering ashore. The measured suspended sediment concentrations from the water samples are listed in Table 3. Details of the analysis are included in *Data Set 5 SSC*.

6. Grab Sampling (SFU)

SFU students took samples for benthic macrofauna on an opportunity basis using a VanVeen grab sampler. The latch on the sampler almost broke off on one deployment requiring a repair of the weld, which was carried out by the ship's engineer. Samples were destructively processed on board and so were not entered into the GSC sample inventory. For more information on these samples, please contact Dr Shahin Dashtgard, Department of Earth Sciences, Simon Fraser

University, 8888 University Drive, Burnaby, B.C. V5A 1S6; phone: (778) 782-5492; fax: (778) 782-4198; email: sdashtga@sfu.ca.

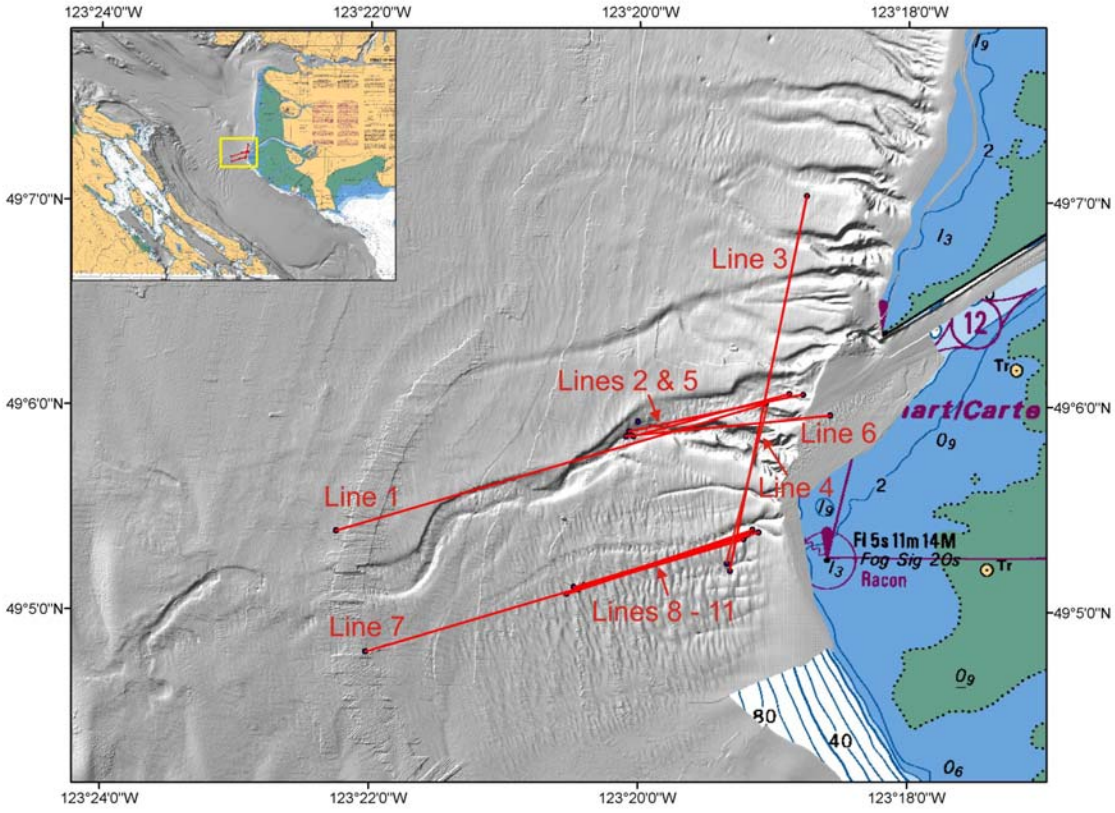

Figure 2. Location of ADCP profiles based on start and end points. The actual track lines are more complex due to strong currents and traffic avoidance in the river mouth area.

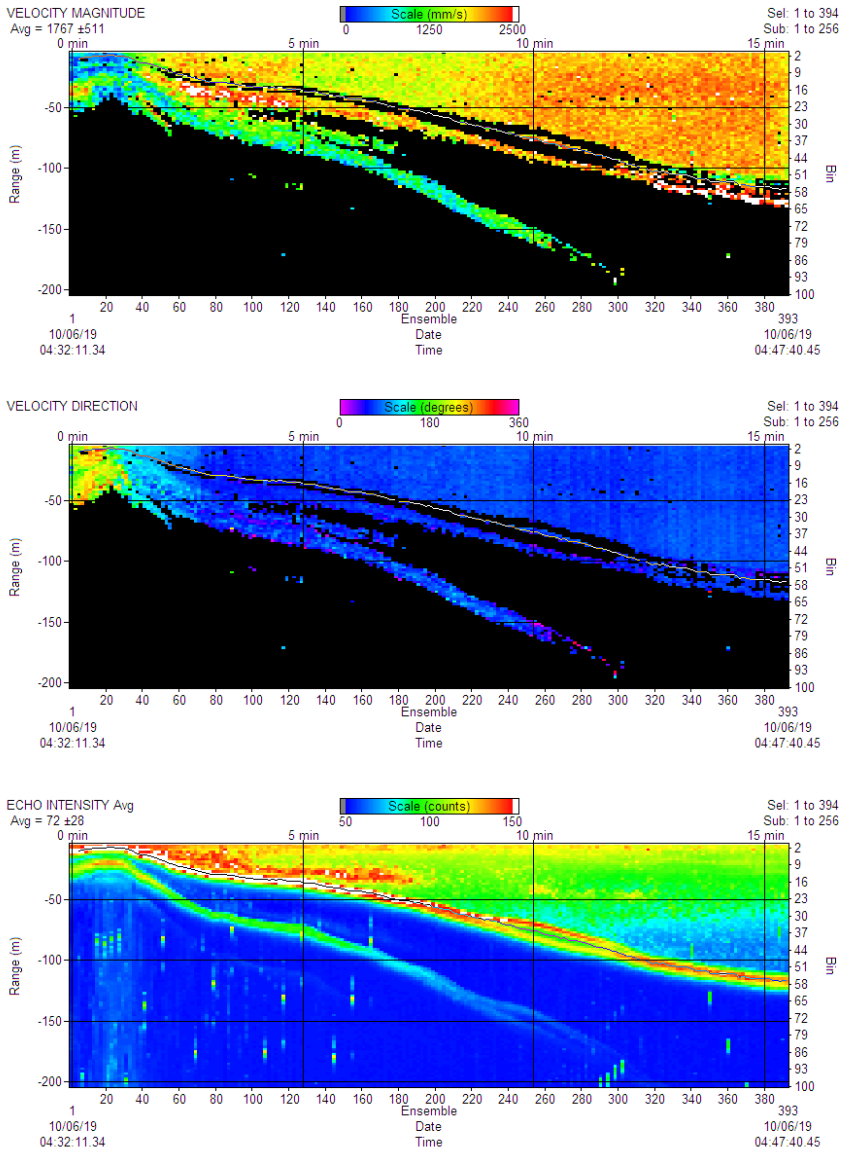

Figure 3. Examples of ADCP profiles (Line 2, June 19). Top: current speed; Middle: Current Direction; Bottom: Backscatter Intensity.

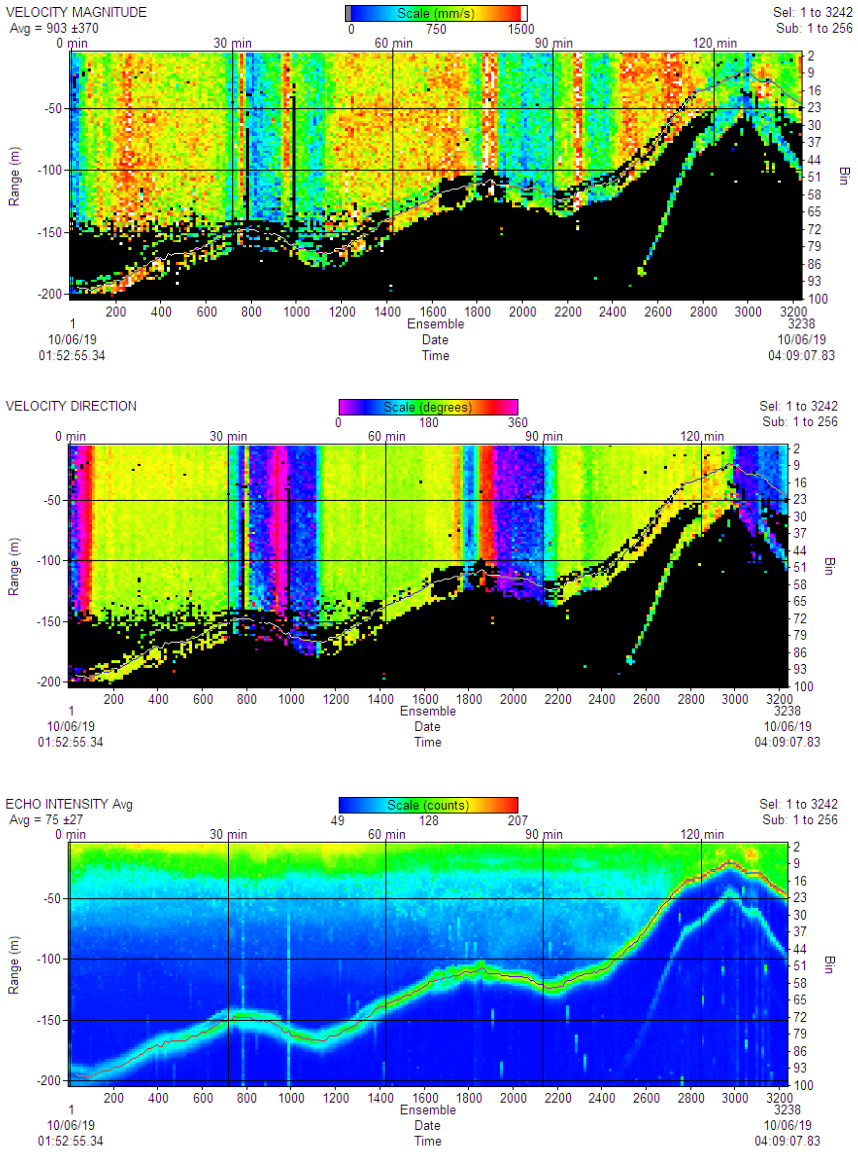

Figure 4. Example of ADCP profile data with anomalous directional information (Stations 1-4, June 19).

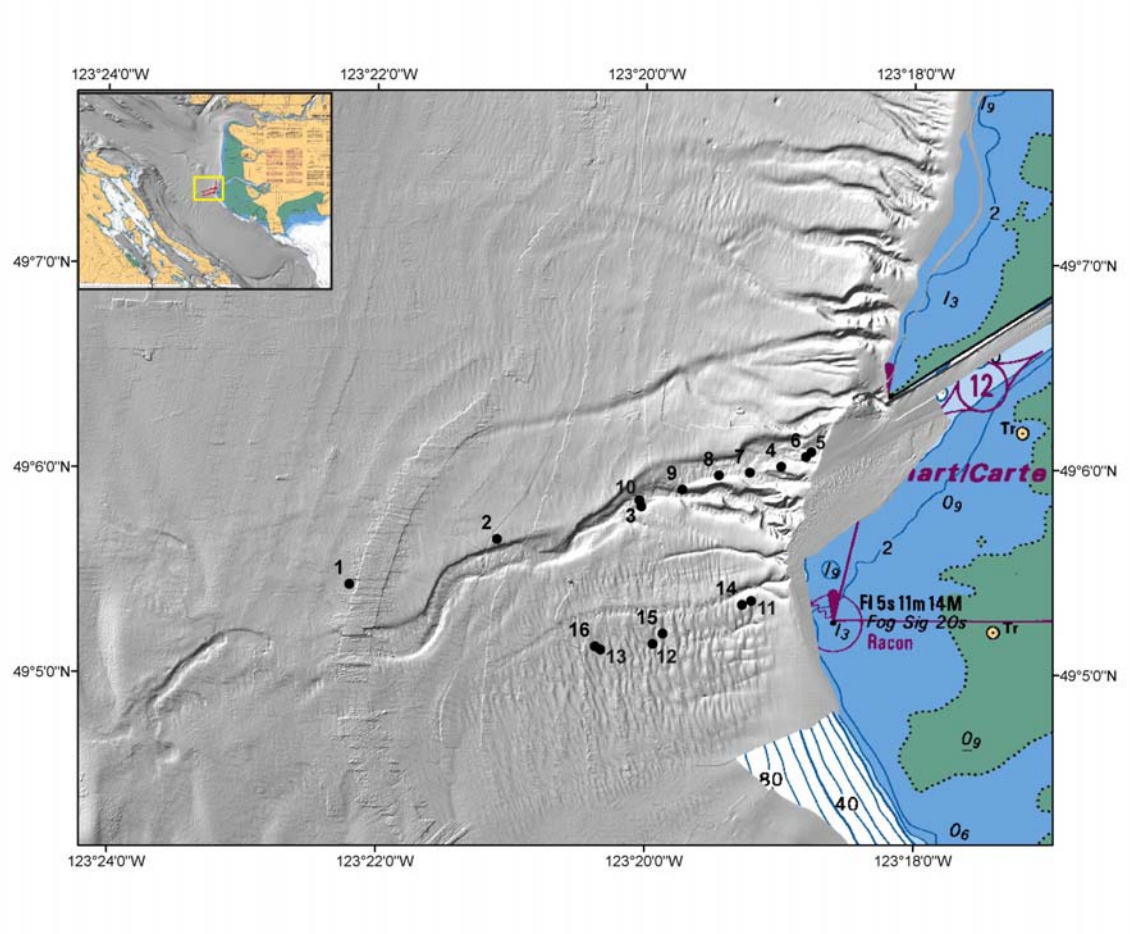

Figure 5. Locations of CTD stations. The plotted locations represent the position at which the CTD attained maximum depth and the Niskin bottles were triggered.

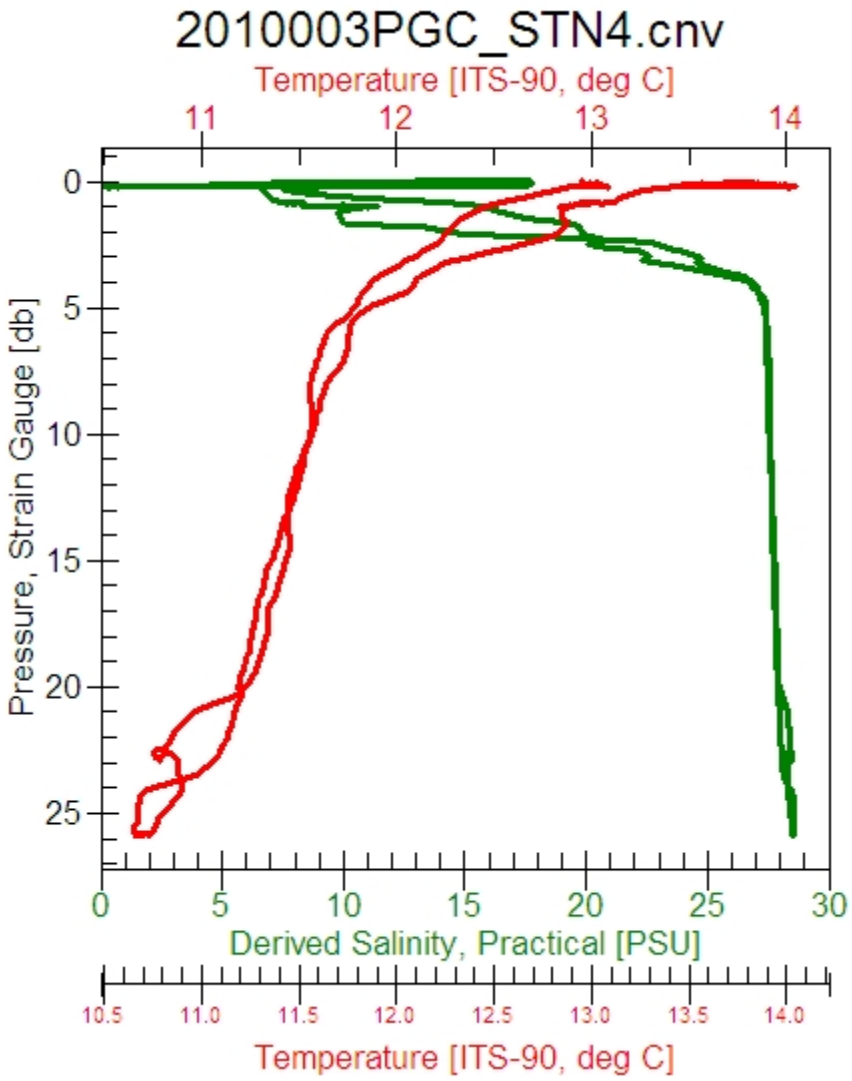

Figure 6. Example of CTD data from Seabird 19 (Station 4).

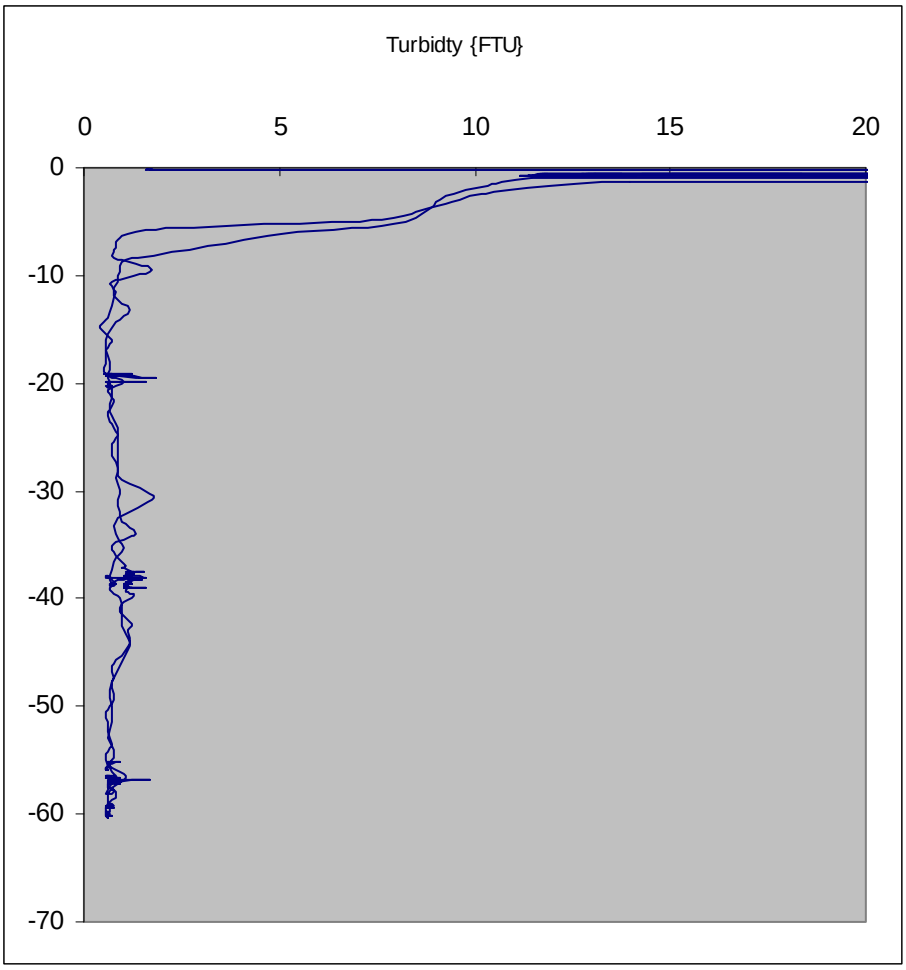

Figure 7. Example of turbidity profile, Station 15.

Acknowledgements

The help of all the following was much appreciated:

- Captain Mike Corfield, Bosun Rob White and the officers and crew of the CCGS Vector.
- Richard Dewey (U. Vic) provided and installed the ADCP instrument.
- Paul Macoun coordinated the ROV operations before and during the expedition. He also got up in the early hours one morning to troubleshoot the ADCP.
- Gwyn Lintern prepared the Alec turbidity instrument and conducted shipboard calibrations. He also stood by for two days, prepared to turn around instrumentation from the DDL platform, in vain as it turned out.
- Kim Picard helped with cruise preparation and filtered water samples in the lab after the cruise.
- Scott Rose prepared the CTD instrument.
- Hugh Maclean prepared the Niskin bottles.
- Steve Romaine advised on water property measurements and facilitated equipment loans from DFO.
- Peter Neelands helped with quality control of navigation data and preparation of this Open File.

Table 1. ADCP profile lines

Line	Date	UTC	Latitude	Longitude	Depth (m)	WinADCP Files
2010003PGC_ADCP_SOL1	19-06-2010	8:55:42	49.089813	-123.3708	196	ADCP009
2010003PGC_ADCP_EOL1	19-06-2010	11:06:41	49.10024	-123.31755	47	
2010003PGC_ADCP_SOL2	19-06-2010	11:35:06	49.101018	-123.31469	34	ADCP010
2010003PGC_ADCP_EOL2	19-06-2010	11:47:28	49.097601	-123.33398	122	
2010003PGC_ADCP_SOL3	20-06-2010	8:06:56	49.117168	-123.3126	53	ADCP013
2010003PGC_ADCP_EOL3	20-06-2010	8:43:32	49.086618	-123.32196	71	
2010003PGC_ADCP_SOL4	20-06-2010	8:51:08	49.087215	-123.32235	76	ADCP014
2010003PGC_ADCP_EOL4	20-06-2010	9:07:02	49.098745	-123.3334	122	
2010003PGC_ADCP_SOL5	20-06-2010	9:26:08	49.097978	-123.33451	113	ADCP015
2010003PGC_ADCP_EOL5	20-06-2010	9:47:27	49.100945	-123.31297	14	
2010003PGC_ADCP_SOL6	20-06-2010	10:02:46	49.099299	-123.3096	13	ADCP016
2010003PGC_ADCP_EOL6	20-06-2010	11:15:33	49.097572	-123.33487	121	
2010003PGC_ADCP_SOL7	21-06-2010	9:24:55	49.07995	-123.36711	199	ADCP030
2010003PGC_ADCP_EOL7	21-06-2010	10:03:05	49.089233	-123.3203	38	
2010003PGC_ADCP_SOL8	21-06-2010	10:06:49	49.0898	-123.31845	40	ADCP031
2010003PGC_ADCP_EOL8	21-06-2010	11:13:55	49.08541	-123.34002	143	
2010003PGC_ADCP_SOL9	21-06-2010	11:23:57	49.085094	-123.34079	138	ADCP033
2010003PGC_ADCP_EOL9	21-06-2010	11:52:28	49.090014	-123.31919	42	
2010003PGC_ADCP_SOL10	21-06-2010	11:54:12	49.089503	-123.32004	41	ADCP034
2010003PGC_ADCP_EOL10	21-06-2010	12:50:07	49.085286	-123.3413	145	
2010003PGC_ADCP_SOL11	21-06-2010	12:53:41	49.084712	-123.34217	144	ADCP035
2010003PGC_ADCP_EOL11	21-06-2010	13:55:32	49.089643	-123.3197	42	

Table 2. CTD and Turbidity Stations

Station	Date	UTC	Latitude	Longitude	Depth (m)
2010003PGC_STN1	19-06-2010	8:47:07	49.09055	-123.36994	196
2010003PGC_STN2_Start	19-06-2010	9:29:02	49.09478	-123.35000	153
2010003PGC_STN2_Bottom	19-06-2010	9:33:23	49.09426	-123.35168	164
2010003PGC_STN2_End	19-06-2010	9:38:55	49.09235	-123.35347	168
2010003PGC_STN3_Start	19-06-2010	10:17:29	49.09782	-123.33205	118
2010003PGC_STN3_Bottom	19-06-2010	10:22:05	49.09696	-123.33379	121
2010003PGC_STN3_End	19-06-2010	10:24:38	49.09645	-123.33468	125
2010003PGC_STN4_Start	19-06-2010	11:02:09	49.10099	-123.31397	34
2010003PGC_STN4_Bottom	19-06-2010	11:04:53	49.10023	-123.31643	34
2010003PGC_STN4_End	19-06-2010	11:06:41	49.10024	-123.31755	47
2010003PGC_STN5_Start	20-06-2010	10:16:58	49.10220	-123.30915	13
2010003PGC_STN5_Messenger	20-06-2010	10:22:31	49.10142	-123.31270	25
2010003PGC_STN5_End	20-06-2010	10:26:51	49.10102	-123.31531	40
2010003PGC_STN6_Start	20-06-2010	10:45:46	49.10242	-123.30754	13
2010003PGC_STN6_Messenger	20-06-2010	10:52:41	49.10103	-123.31335	28
2010003PGC_STN7_Start	20-06-2010	11:15:33	49.10096	-123.31338	33
2010003PGC_STN7_Messenger	20-06-2010	11:25:16	49.09972	-123.32031	58
2010003PGC_STN7_End	20-06-2010	11:29:14	49.09981	-123.32175	68
2010003PGC_STN8_Start	20-06-2010	11:39:53	49.10003	-123.32019	48
2010003PGC_STN8_Messenger	20-06-2010	11:47:01	49.09950	-123.32415	82
2010003PGC_STN8_End	20-06-2010	11:51:20	49.09947	-123.32532	85
2010003PGC_STN9_Start	20-06-2010	12:18:00	49.09941	-123.32280	74
2010003PGC_STN9_Messenger	20-06-2010	12:26:30	49.09834	-123.32869	101
2010003PGC_STN9_End	20-06-2010	12:31:37	49.09891	-123.33024	106
2010003PGC_STN10_Start	20-06-2010	12:41:51	49.09736	-123.32946	100
2010003PGC_STN10_Messenger	20-06-2010	12:50:37	49.09746	-123.33399	121
2010003PGC_STN10_End	20-06-2010	12:56:23	49.09757	-123.33487	122
2010003PGC_STN11_Start	21-06-2010	10:09:37	49.08912	-123.31948	39
2010003PGC_STN11_Messenger	21-06-2010	10:16:24	49.08929	-123.32010	55
2010003PGC_STN11_End	21-06-2010	10:21:17	49.08812	-123.32104	70
2010003PGC_STN12_Start	21-06-2010	10:32:35	49.08751	-123.32936	106
2010003PGC_STN12_Messenger	21-06-2010	10:40:29	49.08643	-123.33174	117
2010003PGC_STN12_2ndmessenger	21-06-2010	10:42:48	49.08578	-123.33231	120
2010003PGC_STN12_End	21-06-2010	10:47:50	49.08640	-123.33330	122
2010003PGC_STN13_Start	21-06-2010	10:58:22	49.08595	-123.33616	130
2010003PGC_STN13_Messenger	21-06-2010	11:06:05	49.08529	-123.33878	140
2010003PGC_STN13_End	21-06-2010	11:11:30	49.08528	-123.33928	140

2010003PGC_STN14_Start	21-06-2010	11:57:23	49.08980	-123.31906	48
2010003PGC_STN14_Messenger	21-06-2010	12:03:12	49.08898	-123.32124	63
2010003PGC_STN14_End	21-06-2010	12:07:03	49.08863	-123.32229	72
2010003PGC_STN15_Start	21-06-2010	12:17:22	49.08755	-123.32900	104
2010003PGC_STN15_Messenger	21-06-2010	12:23:46	49.08661	-123.33105	114
2010003PGC_STN15_End	21-06-2010	12:27:29	49.08647	-123.33219	116
2010003PGC_STN16_Start	21-06-2010	12:38:19	49.08528	-123.33727	132
2010003PGC_STN16_Messenger	21-06-2010	12:44:12	49.08557	-123.33943	140
2010003PGC_STN16_End	21-06-2010	12:48:07	49.08530	-123.34046	144

Table 3

Suspended Sediment Concentrations

Stn	Water Depth	Suspended Sediment Concentration
	m	g/l
05-01	Surface	0.0216
06-01	1	0.0221
06-02	8	0.0087
06-03	14	0.0081
07-01	1	0.0172
07-02	11	0.0105
07-03	18	0.0287
07-04	25	0.0107
08-01	1	0.0155
08-02	35	0.0285
08-03	60	0.0091
08-04	75	0.0128
09-01	1	0.0216
09-02	55	0.0041
09-03	75	0.0090
09-04	95	0.0085
10-01	1	0.0201
10-02	45	0.0084
10-03	80	0.0088
10-04	115	0.0067
11-01	1	0.0165
11-02	23	0.0060
11-03	35	0.0073
11-04	47	0.0120
12-01	1	0.0118
12-02	61	0.0065
12-03	96	0.0016
12-04	131	0.0153
13-01	1	0.0201
13-02	48	0.0046
13-03	93	0.0855
13-04	138	0.0143
14-01	1	0.0157
14-02	29	0.0103
14-04	59	0.0162
15-01	1	0.0179
15-02	20	0.0071
15-03	40	0.0078
15-04	60	0.0077
16-01	1	0.0156
16-02	21	0.0090
16-03	41	0.0069

16-04	61	0.0078
Check 1		3.0700
Check 1		2.9500
Check 1		4.0833
Check 2		3.2720
Check 3		2.1846
Check 4		0.3604
Check 5		0.1640
Check 6		0.0482

Chief Scientists Log

All times in local PDST

June 18

13h00	A-frames and winches being loaded. Serious problem with anchor capstan. Requested by Paddy Murphy to shorten cruise to 4 days if possible. Canpac Divers contacted and will ship ROV back from Sidney by flatbed. Now plan to return by 08h00 on June 22.
18h15	Departed IOS. Weather warm, sunny light breeze. Heading for Sand Heads.

June 19

01h00	Approaching Sand Heads. Deploying ADCP pole. Problems setting pole into rest in the dark.
01h30	ADCP running. Preparing for CTD station.
04h50	Four CTD stations (2010003_CTD_STN1 to 4) with ADCP running throughout (called 2010003PGC_ADCP Line 1) and one straight ADCP transect completed (Line 2). Files for this day saved into a single folder for the day.
05h00	Heading to Berry Point
08h00	Arrived Berry Point (Island Tug and Barge). Barge has tio be moved before Vector can dock.
09h00	Vector at dock. Loading Canpac Divers ROV and equipment.
13h00	Underway to Sturgeon Bank.
15h30	Preparing to grab sample.
16h15	Bosun remarking on inadequate set-up for sieving mud. Use sieving tables, probably available at IOS. Crew jury-rigging a table. Processing sample took over 1 hr, so Korhan assessing a different approach,.
23h30	Successful completion of grb stations. Latch of Van Veen grab has failed twice. Ship's engineer has welded it back on. Need to inform Greg.

June 20

01h00	ADCP pole successfully deployed, this time without problem. Running ADCP lines at Sand Heads.
03h10	Preparing to do CTD and water sampling
06h00	Completed five CTD and water sampling stations at river mouth.
08h00	Gwyn Lintern aboard using Zodiac. Starting ROV operations.
13h00	Ballast and hydraulics problems require repairs. Starting grab sampling.
18h00	Test dive with ROV.
18h30	Second test dive. Hydraulics working but problems remain. Heading to Sand Heads to drop Gwyn off.
20h45	Grab sampling.

June 21

00h50	Last grab sample on deck. Heading to Sand Heads.
02h24	Starting ADCP Line 6.
06h45	Completed 3 ADCP profiles and 6 CTD stations with Niskins.
08h00	Gwyn brought aboard by Zodiac.
10h00	Mooring deployed near DDL.
13h00	ROV successfully deployed. Problems finding DDL at coordinates provided.
15h40	ROV brought up to re-position scanning sonar. Going back down.
18h00	DDL successfully recovered.
19h00	Gwyn returned to shore by Zodiac.
21h00	Grab sampling.

June 22

04h30	Completed grab sampling. Heading to IOS.
09h15	At IOS wharf.
11h15	PGC unloading completed.