Regional Operations Centre
Canadian Coast Guard – Pacific

PACIFIC REGION CCG VESSEL - POST CRUISE REPORT
Line P Program – Fisheries and Oceans Canada

NAME OF SHIP/PLATFORM: John P Tully

DATE: **FROM:** 5 February 2013 **TO:** 19 February 2013

SCIENCE CRUISE NUMBER: 2013-01 **SHIP'S PATROL NUMBER:** 12-11

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Emily Braithwaite (volunteer)	Michael Arychuk (IOS)
Tamara Fraser (IOS)	Mark Belton (Volunteer)
Marie Robert (IOS)	Glenn Cooper (IOS)
Jill Sutton (U. Berkeley)	Sam Kheirandish (UBC)
	Hugh Maclean (IOS)
	Kyle Simpson (IOS)
	Todd Wood (U. Berkeley)

AREAS OF OPERATION: North East Pacific, Line P, Station P.

INTRODUCTION/PROGRAM BACKGROUND: Line P is a long standing program which surveys a 1400 km long section 3 times annually. Data has been collected along this line since 1956 and shows evidence of the impact of climate variability on ocean productivity. It is the only Canadian long time-series that allows scientists to monitor climate changes in the Pacific Ocean. It is also the best opportunity for other programs (e.g. Universities) to do research in the Pacific since the Line P data give them background as well as current water properties.

This cruise (2013-01) went quite well despite being only 14 days and in February! All stations were visited and all casts performed, although some stations had to be done on the return leg. We deployed 3 MetOcean drifters for DFO/IOS, two Iridium floats for Jim Bishop at the Lawrence Berkeley National Lab in Berkeley, CA, two Iridium floats for the University of Washington (UW) and two weather data drifting buoys for Environment Canada.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section. Deploy drifters for DFO/IOS, University of California – Berkeley, and University of Washington (UW); and two weather data drifting buoys for Environment Canada.

DAYS ALLOCATED: 14 **DAYS OF OPERATION:** 14

DAYS LOST DUE TO WEATHER: roughly a day.

SAMPLING:

- The Line P survey was 100% successful. All planned stations were visited and all planned profiles got done, although some stations had to be done on the way back.
- Two Carbon Explorer profiling floats were deployed at station PAPA. Their purpose is to collect daily profiles of PIC, POC and CTD data. It is anticipated that they will remain operating at this location for several months.
- Two Iridium floats were deployed at P26 for the University of Washington and seem to be functioning properly. Two weather data drifting buoys were deployed for Environment Canada.
- Three MetOcean floats were deployed for DFO/IOS at P12, P18 and P26. Unfortunately we have to wait 10 days before we know if they are functioning properly.
- Extra sensors (two C-Star transmissometers and a turbidity sensor) were added to our CTD for the University of California – Berkeley.
- The samples collected include:
  1) Underway: **IOS**: Thermosalinograph (Temperature, Salinity, Fluorescence), acoustic sounder.
  2) "E-data" from CTD: Pressure, Temperature, Conductivity, Dissolved Oxygen, Transmissivity, Irradiance, Fluorescence (only one sensor), Turbidity (Bishop's sensor).
  3) From the Rosette: **DFO-IOS:** dissolved oxygen, salinity, nutrients, DMS, DMSP, chlorophyll, HPLC, Dissolved Inorganic Carbon (DIC), Alkalinity, pH – **UBC (Kheirandish):** dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), argon (Ar), nitrous oxide (N_2O), number of cells per millilitre, bacterial genomic (DNA, RNA) – **UW (Fraser for UW):** ONAr (Oxygen, Nitrogen, Argon) – **U. Berkeley (Wood, Sutton):** Particulate Inorganic Carbon (PIC).
  4) From the pump/Trace Metal Go-Flos: **DFO-IOS (Simpson):** Fe (III) filtered and un-filtered, salinity, nutrients.
  5) **DFO-IOS (Galbraith):** Zooplankton using vertical net hauls (Bongos) to 250 m and 1000 m.

RADIOISOTOPE USE:

No radioisotope was used during this cruise.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

We had to reterminate the rosette wire at Station P17 on the way out. The rosette fell a metre or so during a previous deployment which probably resulted in a weakening of the wire. At P17 the wire broke just past the winch during deployment. Fortunately the rosette was still locked in the LARS head when the wire broke.

We lost some nutrients samples in the cold room when they all went flying during bad weather.

The Milli-Q water maker went dry three times. Scientists have to bring more MQ water on board and use the maker as back-up, or **at the very least** consult with other scientists before using too much water and be very careful to not entirely drain the tank as that creates problems with the filters.

The acoustic sounder was not set to recording until a few days into the cruise.

The PCO2 system encountered a blockage that prevented the second level of the calibration standard to be analyzed. This occurred at the beginning of the cruise and although the location of the blockage was located, it could not be fixed due to the inability to access the location without a complete dismantelling of the instrument. It was determined that the instrument continue to run without level two of the calibration curve and the data manually be re-calculated upon return to the lab.

The bongo winch should always be used on Pad I instead of on Pad F. The steeper angle would help the sheave to turn better, and it would be less dangerous for people to trip on the wire when not it use or get caught in the bight during a downcast.

The thermosalinograph computer crashed after the last station of the cruise. Hopefully we will be able to recover the files.

SUCCESSES [SCIENTIFIC]:

We had two volunteers on board who worked really hard, learned quickly and were awesome!

PROBLEMS [SHIP'S EQUIPMENT/OPERATIONS/PLATFORM SUITABILITY]:

One ship router got reset at some point before the cruise, causing problems by assigning 'wrong' IP addresses to different computers. This caused problems with the communication between computers. Thanks to Doug Yelland for sending us instructions on how to at least 'put a patch' on the problem for the duration of this cruise. It is important that this issue gets resolved before the next scientific cruise.

We had a few problems with the CTD winch losing power at the beginning of a few casts.

SUCCESSES [SHIP]:

We had to give up time for shaft work the first day we got the ship, but we were allowed to load a day before the official beginning of the cruise so it all worked well.

Normally, this section would be included within the trace metal sampling section, but given the success of the A-Frame extension, it warranted its own section. From the science personnel's perspective, the new boom extension to the boat-deck A-frame performed beyond expectations. It allowed the operator to move the trace metal Kevlar rope toward and away from the ship to avoid contamination / abrasion that can occur when wire angles are difficult to maintain due to inclement weather. It also made deploying and retrieving the go-Flo / X-Niskin bottles much easier and safer as the wire could be brought very close to the Chains and so in most cases this could be accomplished with only one person (i.e. a second person wasn't required to hold the rope). This became even more important as we were obligated to use a full harness and fall arrest while working from the chains and a second person (not involved with the deployment) was required to attach and disconnect the harness in order to keep the sampling trace metal clean. We would like to thank Shave Lovelace for his suggestion of extending the A-frame in order to protect our equipment and sample quality as well as CCG for bringing this extension from a concept to a reality.

Kyle Simpson

DELAYS [OTHER THAN WEATHER]:

Half-day at end of cruise for shaft work.

SAFETY CONCERNS:

None.

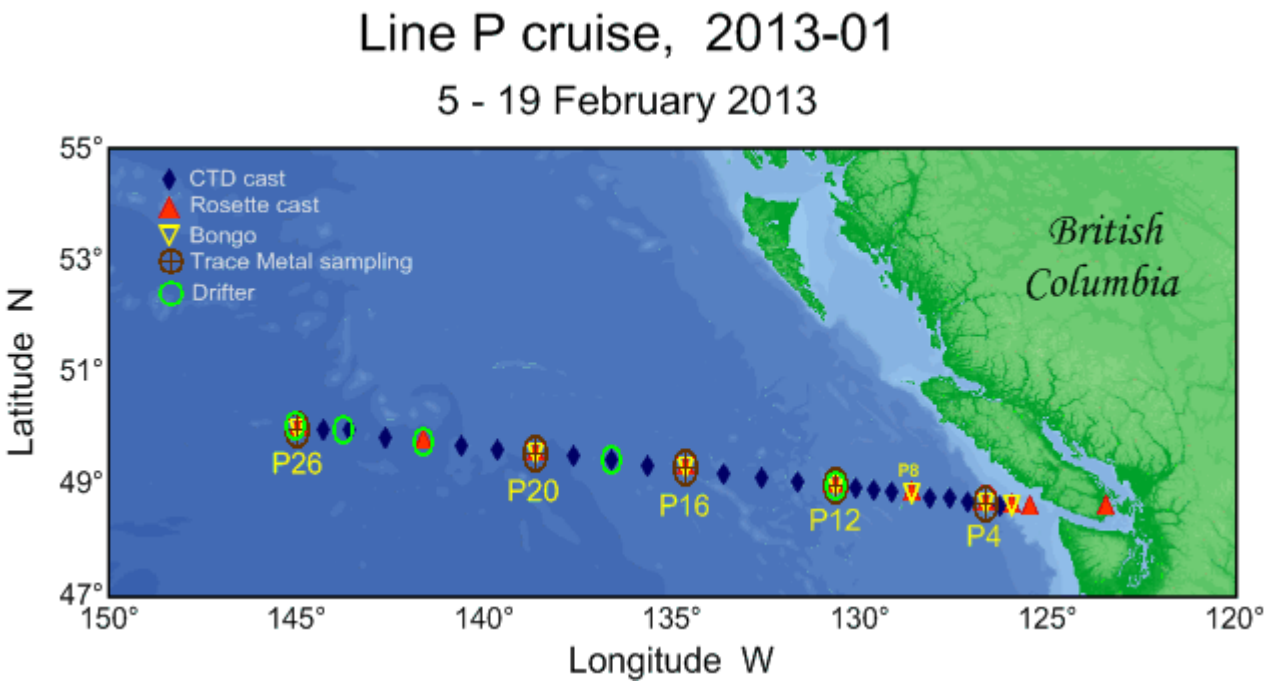
HAZARDOUS OCCURRENCES:

None involving scientific personnel.

EVENT LOG:

Monday 4 February:	Start loading the ship at IOS around 1000.
Tuesday 5 February:	Safety meeting at 1300. Leave the jetty around 1800. Saanich Inlet cast. Leave for P1 around 2000.
Wednesday 6 February:	Stations P2 to P5. Skip P1 (weather) and P4 (timing and weather).
Thursday 7 February:	Stations P6 to P10.
Friday 8 February:	Stations P11 to P13.
Saturday 9 February:	Stations P14 to P16.
Sunday 10 February:	Stations P18 to P19. Skip P17 (re-termination) and P20 (timing and weather).
Monday 11 February:	Stations P21 to P23. Skip P24 to P35 (weather). Deploy EC weather drifter.
Tuesday 12 February:	Station P26. Deploy all drifters.
Wednesday 13 February:	Stations PA-006, P35 to P24. Deploy EC second weather drifter.
Thursday 14 February:	Station P20.
Friday 15 February:	Station P17.
Sunday 17 February:	Station P4, P1.
Monday 18 February:	Arrive at IOS and offload.

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- Many thanks to everyone at IOS who have helped make this cruise a success: Doug, Janet, Kelly, Kenny, Marty, Moira, Nina, Scott, Wendy … your help is always greatly appreciated!
- Thanks to the engineering group for constantly adjusting the "tank and burn schedule" around our sampling schedule.
- Thanks to Captain Gronmyr for his help with weather maps and stations planning!
- And finally a big heartfelt thank you to the entire crew for another successful and pleasant cruise! As usual all the work – and more! – was accomplished with lots of enthusiasm. See you all in June!

Marie Robert and the science team.

- We would like to thank Kyle Simpson, Michael Arychuk, Emily Braithwaite, Todd Wood, and Mark Belton for assisting in sampling, poisoning, and sealing the [DIC] samples.

Glenn Cooper

- I would like to thank Mark Belton, Emily Braithwaite, Glenn Cooper, Tamara Fraser, Hugh Maclean, Todd Wood and the winch crews, for their help with the work from the chains.

Kyle Simpson

- We wish to thank the Tully crew for their assistance and excellent work throughout the cruise. Thanks to Marie Robert and the scientists onboard for their help on deck and in the lab.

Sam Kheirandish

Greetings,

Just want to say a big thank you to everyone involved in the Line P February 2013 cruise. Everyone from the crew, officers and scientific staff were very friendly, helpful, professional and accommodating. It was an absolute pleasure to participate.

Thanks again,

Mark Belton

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

The offshore conditions were very different between February 2013 and what they were a year ago. This can mainly be seen by comparing the salinity levels and the dissolved oxygen values between the two cruises (2012-01 and 2013-01). Figure 1 shows the salinity conditions in February 2012 on the left and February 2013 on the right, displayed on the same scale. This year's waters were fresher (0.2 psu) from the surface to about 80 dbar pretty much all along Line P.

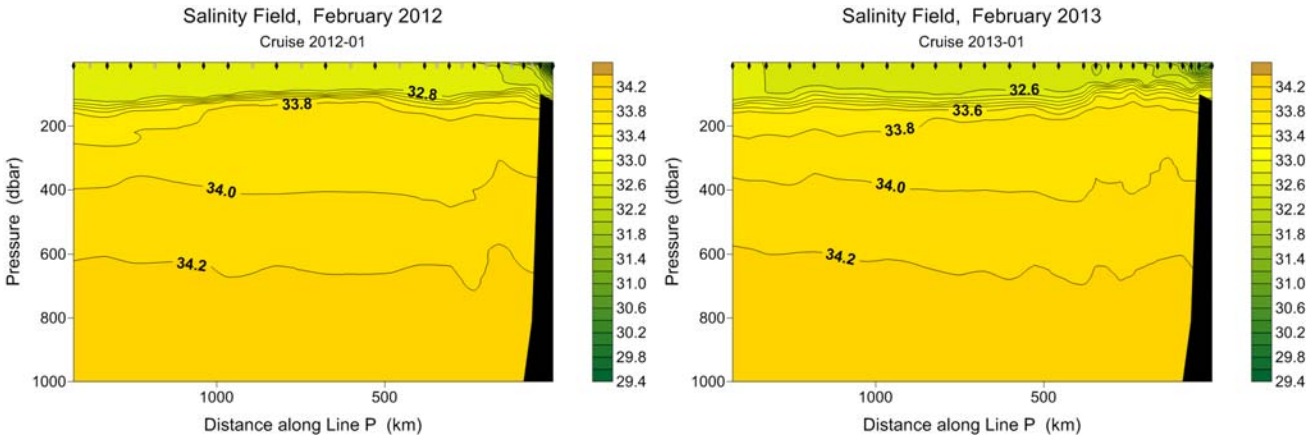


Figure 1: Salinity along Line P in February 2012 on the left and February 2013 on the right.

The dissolved oxygen values were also quite different from last year to this year. There was a lot more oxygen dissolved in the offshore surface waters this year, as can be seen in figure 2. Please note that these data are all **un**processed.

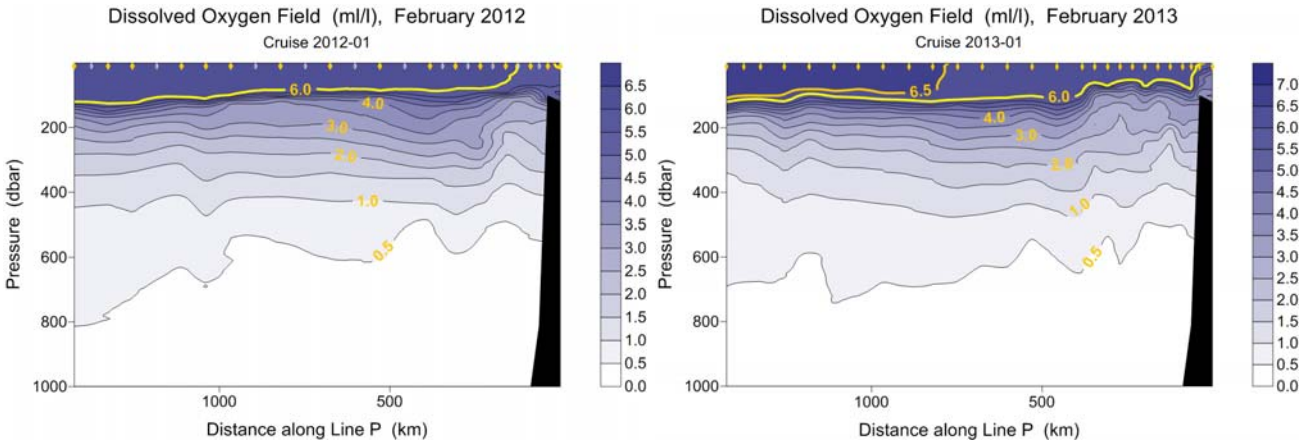


Figure 2: Dissolved oxygen (ml/l) along Line P in February 2012 on the left and February 2013 on the right.

Seawater pH analysis – Glenn Cooper, DFO/IOS.

Seawater pH was determined using the spectrophotometric method developed by Clayton and Byrne (Deep Sea Research, 1993) following the procedures of Dickson *et.al* 2007 Guide to best practices. Seawater was collected directly into 10cm path length glass cuvette. Meta-cresol purple (mCP) was used as the indicator dye and was validated prior to the cruise at the Institute of Ocean Sciences. All samples were collected and analyzed aboard by Glenn Cooper. The following stations were sampled: P01, P02, P04, P12, P16, P20, and

P26. One triplicate was taken at P02 station, for all other casts 2 triplicates were taken to determine precision for the overall cruise. Inter and intra Niskin calibration was performed at P23, whereby 5 Niskins were closed at 2000m and triplicates were analyzed from each Niskin. Precision for the entire cruise is estimated to be ± 0.0003 pH units.

A recent article by Lui *et al* (Environ. Sci & Tech. 45.11, 2011) found that m-cresol purple indicator dye from various manufactures contained small amounts of impurities which absorb light at the same wavelengths used to determine sample pH. The impurities present in the indicator dye can significantly affect the accuracy of pH measured using this method. Lui was able to purify mCP and recharacterized its physical and chemical properties. We obtained a small amount of Lui's purified dye and compared it with our indicator dye (Anachemica Lot# 780322) used on this and previous Line P cruises. Samples were collected from various depths and stations (P8, P15, P18 and P25), representing the entire pH range typically seen on the Line P cruise. Six samples were drawn from each Niskin and divided. Half of the samples were analyzed with the purified mCP and the other half with our mCP dye. Salinity samples were also taken from the same Niskins. By comparing the results from the purified mCP to the Anachemica mCP, the goal is to generate an offset so as to further increase the accuracy of our system. I would like to thank Marie Robert for allowing me to collect extra samples during the cruise in order to complete this task.

Dissolved Inorganic Carbon and Alkalinity Sampling – Glenn Cooper, DFO/IOS.

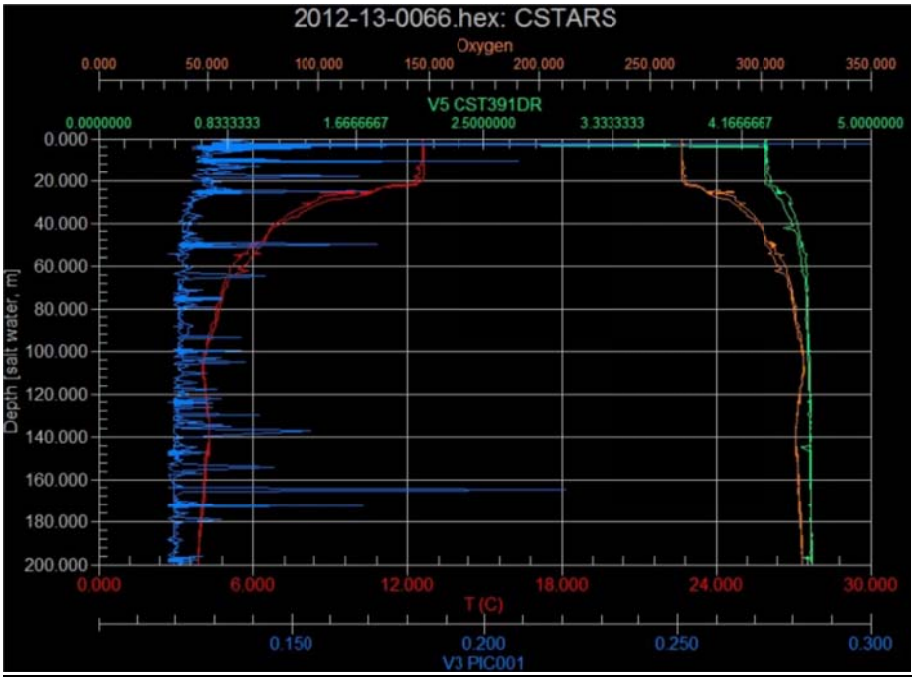
Dissolved inorganic carbon and alkalinity (DIC/Alk) samples were collected by Kyle Simpson at P01, P02, P04, P12, P16, P20, and P26. One set of replicates was taken at each station. An extra set of samples were taken for archiving at P26. DIC/Alk was also taken at the calibration cast (P23). Sea water was collected into 500ml glass bottles and overfilled with one and a half volumes. Samples were poisoned with 100 µl of saturated mercuric chloride. Bottles were sealed with greased glass ground stoppers and kept in place with electrical tape. Samples were stored in a 4^{o}C cooler until off loaded. We would like to thank Michael Arychuk, Emily Braithwaite, Todd Wood, and Mark Belton for assisting in sampling, poisoning, and sealing the samples.

PIC Sensing – Todd Wood and Jill Sutton, University of California – Berkeley.

Objective: The goal of this project was to measure the Particulate Inorganic Carbon (PIC) content of the North Pacific Ocean along Line P. These observations will be used to calibrate a PIC sensor designed by James Bishop (University of California, Berkeley), which currently is in the final stages of development. The PIC sensor measures calcium carbonate ($CaCO_3$), which is mainly formed by coccolithophores. These phytoplankton use $CaCO_3$ to make protective casings. Thus, $CaCO_3$ forms in areas of high productivity.

Much of this particulate carbon is ultimately lithified on the ocean floor, making it an important carbon sink. The sensor uses a polarized laser and a cross polarized receiver. When calcium carbonate enters the beam path, it changes the plane of polarization, and the signal increases. The sensor was mounted on the Rosette, along with a transmissometer and turbidity sensor. Profiles were taken all along P. At major stations, 1 liter water samples were collected. These samples were filtered using a small volume direct filtration system, and the Supor membrane disc filters were saved for later analysis.

Below is an example of a PIC profile. This profile is from station PAPA from an earlier voyage. The blue line indicates the PIC sensor readings. The spikes are most likely caused by large organisms, but the trend shows high levels of PIC, especially near the surface, as is expected.



Trace metal (Iron) Sampling – Kyle Simpson, DFO/IOS.

The trace metal clean hood for pumping was set up in the wet lab, with tubing run from the Teflon pumping system to the "chains" in the breeze way when needed. The clean hood was used for all pumped samples taken from 10m 25m and 40m. X-Niskins were used for samples taken at 75m, 100m, 150m, and 200m and Go-Flo's were used to sample 300m, 400m, 800m and 1000m . All samples, for both unfiltered and filtered (0.2um Opti cartridge) and bulk seawater sampling were collected into acid cleaned polyethylene containers.

The Zodiac was used for surface / subsurface sampling at station P26 only.

Sampling was focused on the major Line-P stations (see table below). Labile and dissolved iron analysis are to be completed on shore at a later date.

I would like to thank Mark Belton, Emily Braithwaite, Glenn Cooper, Tamara Fraser, Hugh Maclean, Todd Wood and the winch crews, for their help with the work from the chains.

Sampling Summary for Fe profiles:

Depth	P04	P12	P16	P20	P26
0m					X
5m					
10m	X	X	X	X	X
25m	X	X	X	X	X
40m	X	X	X	X	X
75m		X	X	X	X
100m		X	X	X	X
150m		X	X	X	X
200m		X	X	X	X
300m		X	X	X	X
400m		X	X	X	X
600m					
800m		X	X	X	X
1000m		X	X	X	X

Sam Kheirandish UBC Line P – February 2013

Objectives:
Describe the taxonomic and metabolic diversity of the bacterial communities involved in the cycling of major nutrients and gases along Line P, focusing on the communities in the Oxygen Minimum Zone.

Sampling summary:
At 5 stations (P4, P12, P16, P20, P26)

1) Gasses samples were taken for later dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), argon (Ar) and nitrous oxide (N_2O) measurement using Gas Chromatography Mass Spectrometry.
2) 15 ml seawater samples were taken per depth to count the number of cells per millilitre using Flow Assisted Cytometry.
3) 15 ml seawater samples were taken for hydrogen sulfide (H_2S) quantification an indicator of anaerobic respiration.
4) 1 litre seawater samples (at 16 depths) for high resolution bacterial DNA and sequencing were filtered.
5) Samples were taken and preserved with GlyTE to perform single cell DNA analysis (SAGs).

Additionally, at 3 major stations, (P4, P12, and P26) the following were sampled at four depths across the oxygen minimum zone.

1) Large volumes (20l) per depth were filtered to create genomic libraries of the bacterial communities.
2) 2l seawater samples (at 16 depths) for high resolution bacterial RNA and sequencing were filtered.
3) Gas samples were taken for later dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), argon (Ar) and nitrous oxide (N_2O) measurement using Gas Chromatography Mass Spectrometry.
4) Samples were taken and preserved with GlyTE for SAGs at P4 and P12.
5) 15ml seawater samples were taken for hydrogen sulfide (H_2S) quantification an indicator of anaerobic respiration.
6) 15ml seawater samples were taken per depth to count the number of cells per millilitre using Flow Assisted Cytometry.

Comments:
All our lab objectives for this cruise were successfully fulfilled. The work area distribution was very convenient for our sampling needs and we will try to use the same setup in future cruises.
Gas samples were taken, in triplicate at all depths at stations P4, P8, P12, P16, P20 and P26. Additionally, gas samples were also taken in triplicate at the 4 UBC depths at P4, P12 and P26.
Samples were taken at 16 depths from the IOS casts (P4, P8, P12, P16, P20) and 4 depths for the UBC casts (P4, P12 and P26). Hydrogen Sulfide quantification has been already performed for all samples at UBC.
We wish to thank the Tully crew for their assistance and excellent work throughout the cruise. Thanks to Marie Robert and the scientists onboard for their help on deck and in the lab.