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:** 22 May 2012 **TO:** 9 June 2012

SCIENCE CRUISE NUMBER: 2012-12 **SHIP'S PATROL NUMBER:** 12-03

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Desirée Dillman (UVic)	Michael Arychuk (IOS)
Aria Hahn (UBC)	Michael Bentley (CWS/EC)
Jennifer Keene (NOAA)	Seth Bushinsky (UW)
Wendy Richardson (IOS)	Michael Craig (NOAA)
Marie Robert (IOS)	Dave Janssen (UVic)
Christina Schallenberg (UVic)	Roger P. Kelly (URI)
Nina Schuback (UBC)	Brendan Mackinson (URI)
	Hugh Maclean (IOS)
	Kyle Simpson (IOS)
	Doug Yelland (IOS)

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 (2012-12) was a success from beginning to end, despite a few patches of rough weather. All stations were visited, all casts performed, the mooring work was done without any mishaps, the deployed Argo float for the University of Washington (UW) worked well, and we even managed to recover another UW float that had been deployed last February.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section. Deploy two MetOcean floats for IOS, one Iridium float for University of Washington (UW), three weather data drifting buoys for Environment Canada, and recover one Iridium float for UW. Perform a drifting sediment trap experiment. Recover NOAA mooring PA-005 and deploy mooring PA-006 at Station P.

DAYS ALLOCATED: 18 **DAYS OF OPERATION:** 17

DAYS LOST DUE TO WEATHER: only a few hours.

SAMPLING:

- The Line P survey was 100% successful. All planned stations were visited and all planned profiles got done, although one station had to be revisited on the way back. The drifting sediment trap experiment went very well as did all the mooring work.
- Two MetOcean floats were deployed for DFO/IOS, one at P16 and the second at P21. We are unsure at this time if the floats are functioning properly or not. One Iridium float was deployed at P26 for the University of Washington/Applied Physics Lab and it seems to be functioning properly. One Iridium float deployed for UW last February at Station Papa was recovered ~30 miles NE of P17. Three weather data drifting buoys were deployed for Environment Canada.
- The set-up for the *in-situ* pumps, using the same winch as the bongos, worked well. The Multiple Plankton Sampler (MPS or Multinet) was used at 5 stations. Even though the surface NOAA buoy was located in the middle of the aft-deck it was still relatively easy to use the MPS.
- Because the Trace Metal container occupied some winch pads, the drifting sediment traps had to be deployed and recovered using the capstan. This operation went rather smoothly.
- 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 (2 different sensors).
  3) From the Rosette: **DFO-IOS:** dissolved oxygen, salinity, nutrients, DMS, DMSP, chlorophyll, HPLC, DIC, Alk, pH – **UBC (Hahn, Schuback):** 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), Methane, DMSO, DMSOp – **UW (Bushinsky):** Oxygen, O^{17}, ONAr (Oxygen, Nitrogen, Argon), DIC, DOC, Noble gases, salinity – **City Uni. NY, URI, BIOS (Kelly, Mackinson):** Thorium, polonium, total chlorophyll, 5µm chlorophyll, total HPLC, 5µm HPLC, FCM, µplankton, primary production.
  4) From the pump/Trace Metal X-Niskins: **DFO-IOS, UVic (Simpson, Schallenberg, Janssen, Dillman):** Iron (Dissolved and Total dissolved, three different treatments), Fe (II), Zinc.
  5) **DFO-IOS (Yelland) and City Uni. NY (Kelly):** Zooplankton using vertical net hauls (Bongos and MPS).

RADIOISOTOPE USE:

The following radioisotopes were used in the Rad-Van: ^{14}C-bicarbonate. Wipe tests were done in all appropriate areas of the ship every seven days and upon completion of the studies. The lab was decommissioned at the end of the cruise. For more information see page 13.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

There seems to be a problem with the fluorometer on the thermosalinograph (TSG). The values are constantly negative. There is also a problem with the flow coming to the lab. It is hard to say if the filter between the

manifold and the TSG is the problem, but the flow is constantly either changing or stopping. Finally the "new position" window on the TSG kept saying "NO" even when a new position was recorded.

There is also a problem with the pCO_2 flow indicator. The flow written on the screen is different than the flow actually measured.

SUCCESSES [SCIENTIFIC]:

The new laser printer in the lab worked wonderfully with our waterproof paper to make the rosette log sheets. Printing the rosette logs appropriate for each cast is really a good way to go.

The new long (4500m) Kevlar line allowed us to finally get a Trace Metal profile all the way to the bottom at Station Papa.

As usual it was good doing the Line P cruise back-to-back with the La Perouse cruise; less equipment had to be loaded at the beginning of the cruise. Thanks to Doug Yelland for loading the Rad-Van on his cruise even though it was not needed.

The trace metal container used to have power issues when on the ship. This got fixed just prior to sailing and it seems that everything is working well now.

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

There was a problem, once again, with the hydro winch (Hawboldt 1076-01). This winch has had issues for many cruises in a row now, and after spending a long time in the winch shop getting fixed we still had issues at the beginning of the cruise. These issues caused us to re-visit a station on the way back. Neither the spooling nor the counter fitted on the winch were working. Thanks to Vaughn for taking the counter from another winch and setting it up on the hydro winch so that at least we knew to what depth we were going. We spent a lot of money on the new Kevlar line, and we regularly have 1-3 people on board who are here solely to get Trace Metal data using that winch. It is imperative that either the Hawboldt 1076-01 winch gets fixed or that another winch gets set-up in its place.

The internet access was very poor on the way to station Papa, and was not working at all on the way back. We have become used to relying on this system to make offloading and travel plans (back to other agencies) at the end of cruises. It was really unfortunate that this system was not working. Also, when it WAS working, there were still many useful websites that were blocked; for example www.microsoft.com. Often drivers or updates are required on our computers and were not available during this cruise. The best example is the Virus Definition updates in order to protect our computers.

SUCCESSES [SHIP]:

The mooring work went really well. During recovery of PA-005 the buoy did not go near the sides or the top of the A-frame at any time.

The DP system on the bridge worked very well during deep Go-flo casts in the chains. Previously the Kevlar had a tendency to end up under the ship, which would result in about 150m of the new Kevlar line needing to be cut. Once the DP system was used, the Kevlar line was "up-and-down" and protected from the ship.

Thanks to Captain Corfield for using both engines when leaving Station Papa in order to recover the UW Argo drifter during the day time. Since we had to be back earlier than our allocated time in order for the next group to do all their work, we could not afford to wait until the next morning to recover the float. With both engines on, we managed to get to the float position by dinner time and recover right after dinner. Thanks!

DELAYS [OTHER THAN WEATHER]:

None

SAFETY CONCERNS:

None.

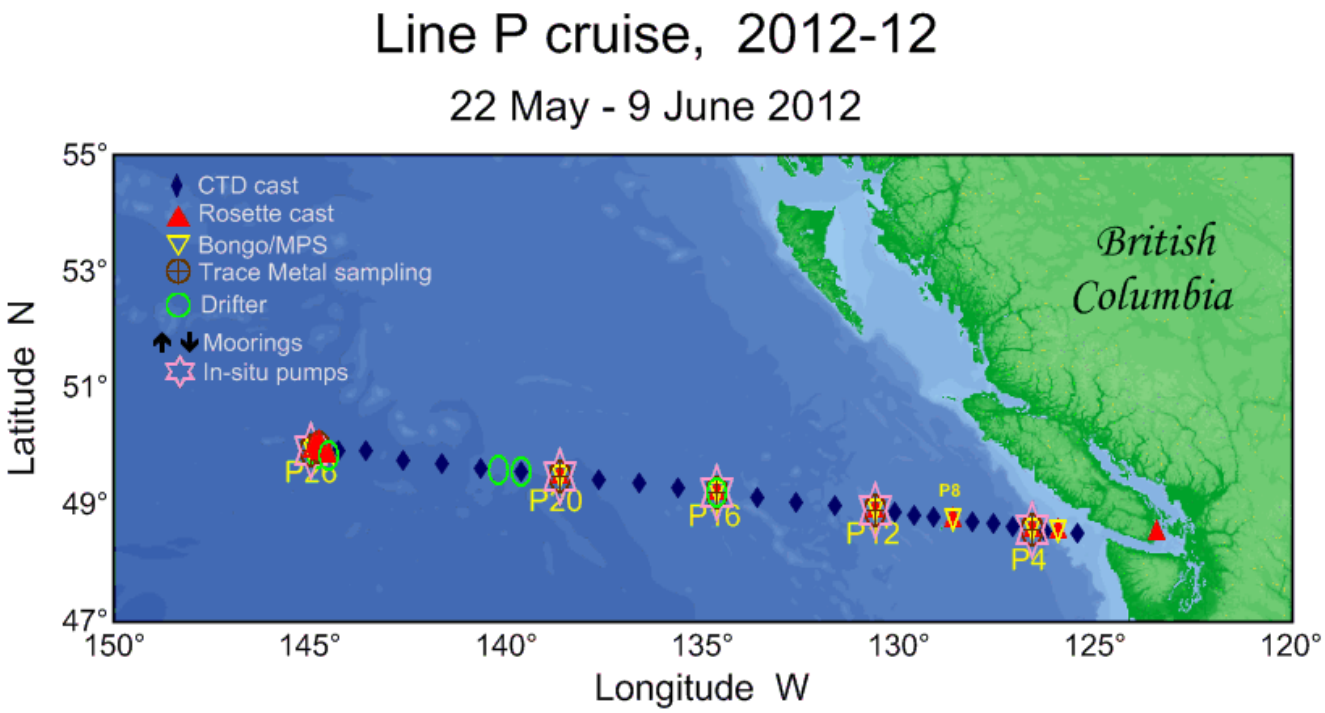
HAZARDOUS OCCURRENCES:

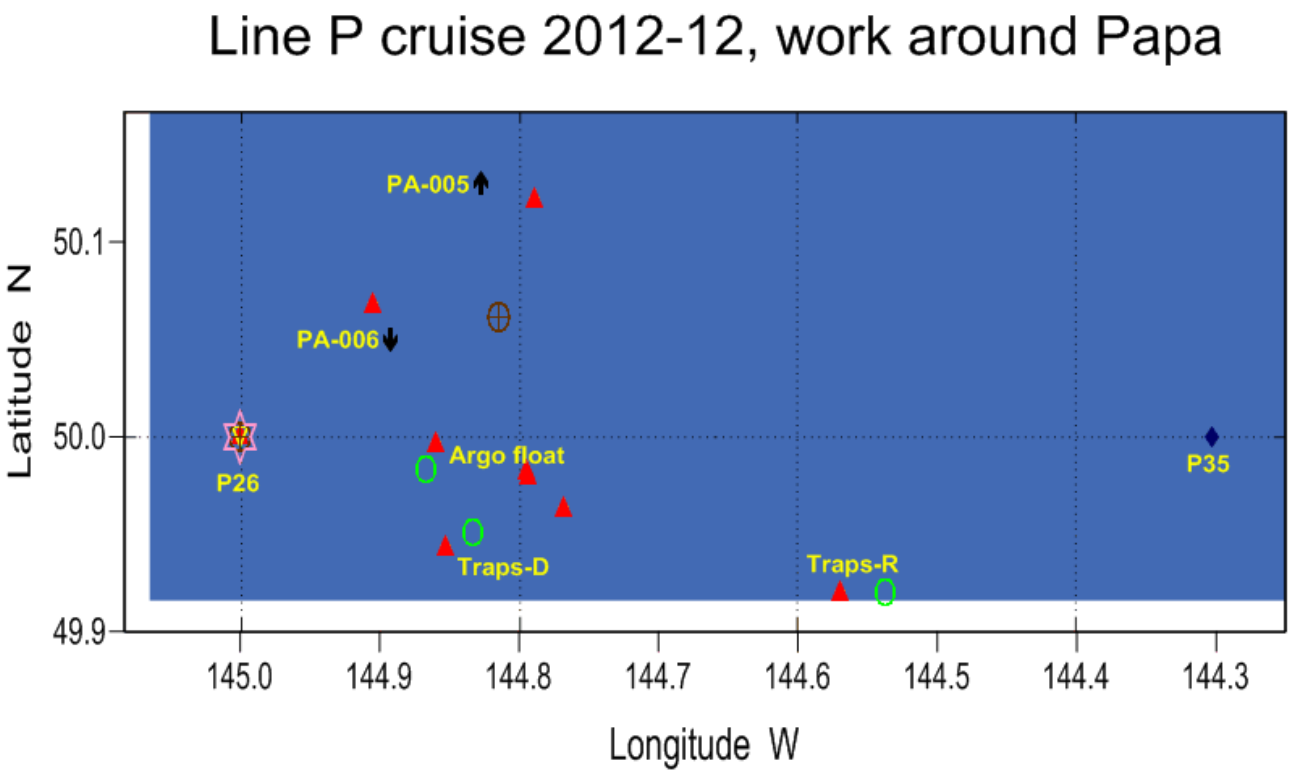
None involving scientific personnel.

EVENT LOG:

Tuesday 22 May:	Start loading the ship at IOS around 1400.
Wednesday 23 May:	Safety meeting. Fire and boat drill. Leave IOS around 1400. Do the Saanich Inlet cast, leave for P1 around 1600. Science meeting.
Thursday 24 May:	Stations P1 to P4.
Friday 25 May:	Stations P4 to P8.
Saturday 26 May:	Stations P9 to P12.
Sunday 27 May:	Stations P12 to P14.
Monday 28 May:	Stations P15 to P16.
Tuesday 29 May:	Stations P16 to P19.
Wednesday 30 May:	Station P20.
Thursday 31 May:	Stations P20 to P23.
Friday 1 June:	Stations P24 to P35. Arrive at Papa in the afternoon. Deploy drifting sediment traps. Deploy UW Iridium float. Th-Po and Papa deep cast. MPS.
Saturday 2 June:	Deploy NOAA mooring PA-006. UBC, Light, DMS, ONAr, mooring and float calibration casts.
Sunday 3 June:	Recover NOAA mooring PA-005. Go-flo casts and pumping. ONAr, mooring and float calibration casts. Bongos.
Monday 4 June:	Cesium casts. Th-Cs cast. Recover drifting sediment traps. Start heading east.
Tuesday 5 June:	Recover UW Iridium float ~30 nm NE of P17.
Thursday 7 June:	Rosette, Go-flo and pumping at P4.
Friday 8 June:	Arrive at IOS and offload.

CRUISE TRACK:





SUMMARY/FINAL COMMENTS:

- Many thanks to everyone at IOS who have helped make this cruise a success: Janet, Nina, Kenny, Glenn … your help is always greatly appreciated!
- Thanks to Captain Corfield for using both engines when we left Papa so that we could recover the UW Iridium float and still be at IOS earlier than allocated in order for the following program to have more days to do their work.
- Special thanks to Vaughn for getting the hydro winch to a state where we could use it! Thanks also to the whole engineering group for constantly adjusting the "tank schedule" around our sampling schedule, as well as trying to fix the flow issues to the thermosalinograph.
- Big, heartfelt "thank you" to the entire deck crew for their constant help with our equipment, from carrying the Go-flos from the chains to the trace metal container to almost doing the bongos on your own!
- Thanks to the smokers for always using the smoking lounge and not smoking on deck!
- Finally, a VERY special thank you to Kerri and her fantastic crew for cooking such wonderful meals, yet again, as well as looking after us so perfectly. You guys must have a great time in the galley; we can taste it every single meal!

Marie Robert and the science team.

- All NOAA mooring gear was safely deployed and successfully recovered. Project PI Meghan Cronin sends her sincere thanks to the captain and crew of the TULLY, and to IOS, for the continued partnership, hard work, and cooperation that make this ocean reference station mooring at Station P possible.

Jennifer Keene and Michael Craig

- I really appreciated the time the crew, officers and scientist took to explain their own work to me. I learned much more than I anticipated. I am truly fortunate to have had the opportunity to participate in the cruise.

- 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.

Aria Hahn

- Big thanks to all the deck crew for their help, to the engineers for jury-rigging the winch, and to the officers for keeping the wire angle in check!

The Trace Metal gang (Christina, Dave, Desirée, Kyle).

- Thanks to the officers and crew of the John P. Tully for a successful cruise. Thanks and appreciation to the Bosun and deck crew for assistance securing our equipment on the weather decks and with the careful deployment of our sampling gear. We would also like to thank Marie Robert for a fine job with cruise planning and the science watch-standers for their sampling assistance. Thanks to Mike Arychuk for assistance with inter-cruise chemical storage and handling. We'd also like to thank Darren Tuele, Wendy Richardson, and Hugh Maclean for help during pre- and post-cruise operations.

Pat Kelly and Brendan Mackinson

- We would like to thank the crew of the John P. Tully, the scientists from IOS, and the rest of the science crew for all of their help on this cruise. None of the science done at sea is the work of only one person and these Line P cruises are great examples of the collaboration and cooperation necessary to get things done.

Seth Bushinsky

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

The weather during this Line P cruise was quite cold. Of course the cruise started about 10 days earlier than the regular Line P sailing time; despite this fact it is rare to see some snow falling offshore in June! The temperature profile along Line P shows these cold temperatures quite well when compared to the June 2011 temperature profile (Figure 1). Possibly because of these colder temperatures at the surface, the levels of dissolved oxygen were also much lower than a year ago. They were comparative to February levels with the maximum value not reaching 6.8 ml/l (Figure 2), whereas a year ago values of 7.3 ml/l were attained.

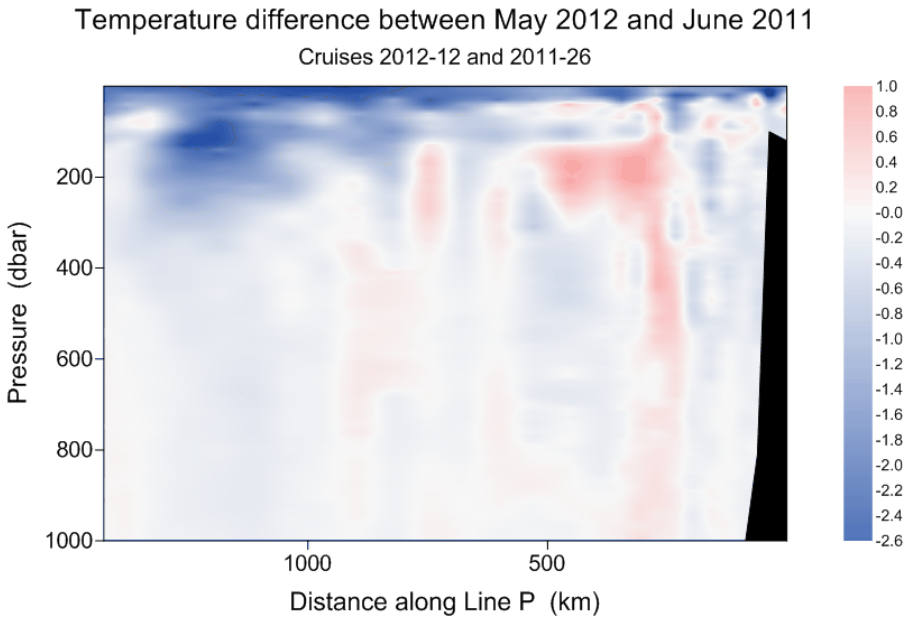


Figure 1: Difference of temperature between May 2012 and June 2011 showing this year's cold waters, mainly at the surface (unprocessed data).

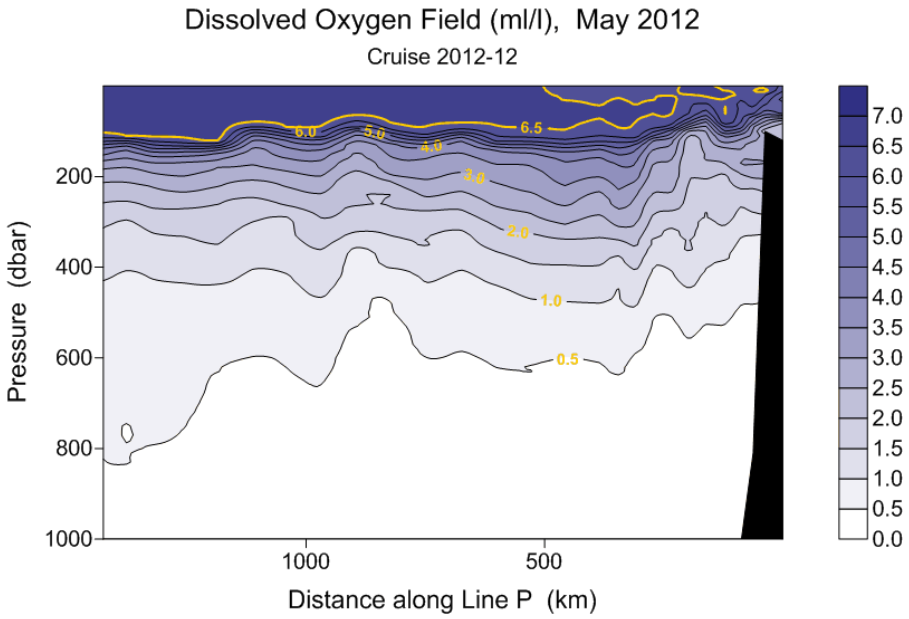


Figure 2: Dissolved Oxygen field in ml/l along Line P in May 2012. The maximum value during this cruise only reached 6.87 ml/l (unprocessed data).

NOAA mooring operations – Jennifer Keene, Michael Craig, NOAA.

Summary of NOAA Mooring Operations

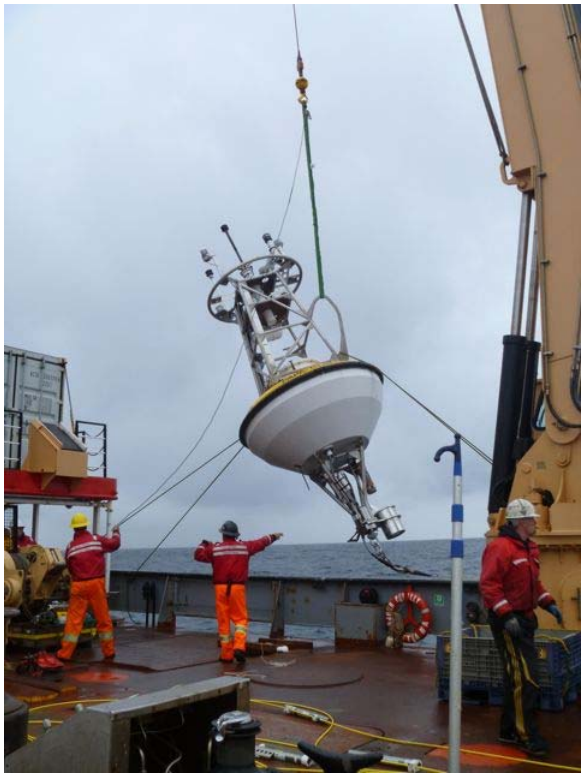
Anchor Location	Mooring ID	Operation	Date
50° 3'N, 144° 53.5'W	PA006a	Deploy	2 June 2012
50° 7.8'N, 144° 49.6'W	PA005a	Recover	3 June 2012

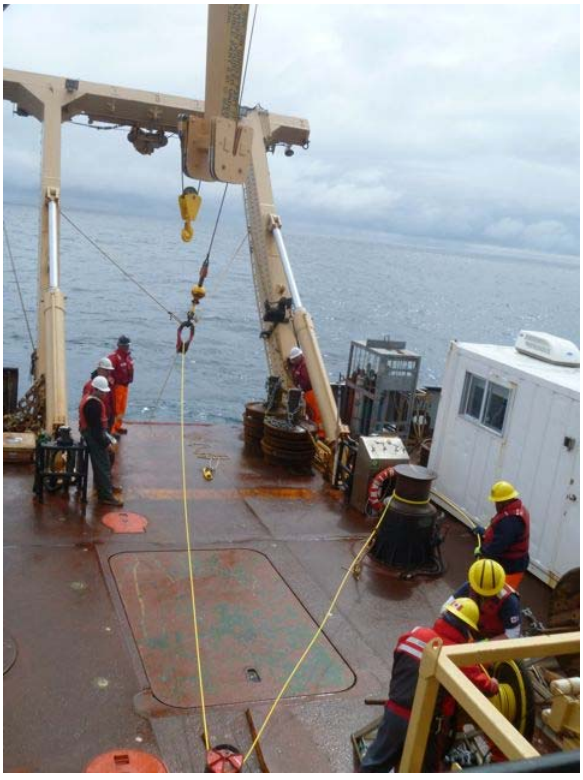
All NOAA mooring gear was safely deployed and successfully recovered. Project PI Meghan Cronin sends her sincere thanks to the captain and crew of the TULLY, and to IOS, for the continued partnership, hard work, and cooperation that make this ocean reference station mooring at Station P possible.

DEPLOYMENT OF PA006:

Deployment of the PA006a mooring began at 18:25 UTC on Saturday, June 2. Operations began about 3NM up wind and current of the desired anchor drop site. The buoy was deployed over the starboard side, using a 24' strap, basketed with one end to the release hook, and the other to the crane hook. Instruments were pre-attached to the top 80m of nilspin, which was flaked out on deck. This wire was passed over the rail by hand as the buoy paid out aft.

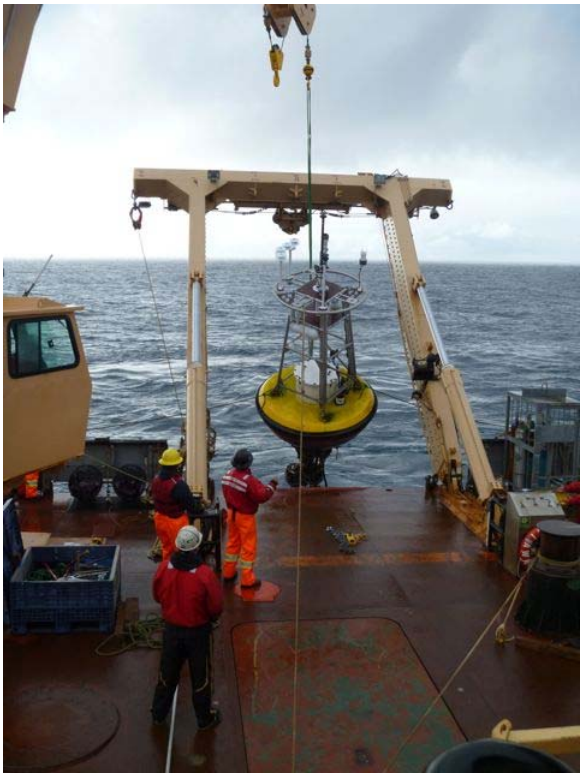
The rest of the deployment was then performed through a block in the crane hook, positioned in the center of the A-frame. Remaining instruments were attached to 300m of wire rope, on the outboard side of the block. Once the wire was fully deployed, the remainder of the mooring nylon was allowed to payout freely as the ship steamed toward the anchor drop location. The anchor was dropped at 50° 3.09'N, 144° 54.05'W. At fly-by, the buoy was resting at 50° 2.94'N, 144° 52.93'W. Operations went smoothly, and the mooring was towed for 1:18 before anchor drop at 22:21 UTC, for a total deployment time of 3:56.





RECOVERY OF PA005:

The release command was first sent at 14:45 UTC on Sunday, June 3, for the recovery of the PA005a mooring. All depth sounders were turned off, the ship repositioned and declutched, and the spare deck set was tried. After an hour of trying, though definite confirmation of release was never received, it was decided to proceed with recovery.



A small boat was used to attach the working line and tag lines. The boat towed the buoy to the ship, for lifting with the crane, through the fully extended A-frame. Two tag lines went to either side of the aft deck of the ship, plus one to the capstan. The small boat also tended a line, to keep the buoy away from the stern of the ship. The buoy was brought in slowly and safely and set on deck, until it could be disconnected from the mooring, repositioned and secured. While positioning the buoy on deck before disconnecting from the mooring, the temperature sensor at 5m depth on the wire was dragged over the transom.

Once the buoy was securely onboard, the small boat was recovered. The remainder of the mooring line was then recovered through a block on the crane hook, positioned in the center of the A-frame, similar to the deployment setup. Instruments were removed from the wire on the outboard side of the block. All line was powered in by the capstan, and hand spooled onto reels. The release was brought on board at 20:40 UTC, for a total recovery time of 5:55.

Zooplankton sampling – Doug Yelland, DFO/IOS.

Zooplankton sampling on this cruise was very successful, with 12 Bongo Vertical Net Hauls completed (5 for the University of Rhode Island), and 5 MPS (Multiple Plankton Sampler) VNHs (25 samples) completed. There were some issues with attaining the correct depth as we were using a very heavy wire due to deck space limitations and the counter was misreading on the ship's roll (the wire would lose contact with the sheave). Fortunately, we were testing an RBR depth recorder and were able to measure the exact depth of each cast (shallower than 750m) so the errors were corrected. A lighter cable and sheave, and perhaps even more weight at the bottom could have helped. The MPS was not outputting text data to the computer so we had to operate it from the deck unit but this didn't cause any great issues, all flow readings were recorded manually. The MPS is a very useful tool for determining depth of various life-stages of copepods in particular.

Aria Hahn UBC Line P – June 2012

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), nitrous oxide (N_2O) measurement using Gas Chromatography Mass Spectrometry.
2) 15mL seawater samples were taken per depth to count the number of cells per millilitre using Flow Assisted Cytometry.
3) 15mL seawater samples were taken for hydrogen sulfide (H_2S) quantification an indicator of anaerobic respiration – **P4 ONLY**.
4) 1L seawater samples (at 16 depths) for high resolution bacterial DNA and sequencing were filtered.
5) Samples were taken and preserved using *glyTE* for single cell DNA analysis.

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) Gas samples were taken for later dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), argon (Ar), nitrous oxide (N_2O) measurement using Gas Chromatography Mass Spectrometry.
3) Samples were taken and preserved using *glyTE* for single cell DNA analysis.
4) 15mL seawater samples were taken for hydrogen sulfide (H_2S) quantification an indicator of anaerobic respiration.
5) 15mL seawater samples were taken per depth to count the number of cells per millilitre using Flow Assisted Cytometry.

Comments:
I really appreciated the time the crew, officers and scientist took to explain their own work to me. I learned much more than I anticipated. I am truly fortunate to have had the opportunity to participate in the cruise.

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 once again in future cruises.

Gas samples were taken, in duplicate at all depths at stations P4, P8, P12, P16, P20 and P26. Additionally, gas samples were also taken in duplicate at the 4 UBC depths at P4, P12 and P26.
Flow Assisted Cytometer has been already performed for all samples at UBC. 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. DNA 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).

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.

Trace metal sampling – Christina Schallenberg, Dave Janssen, Desirée Dillman (Cullen lab, UVic); and Kyle Simpson (DFO/IOS).

Participants: *Kyle Simpson (IOS), Dave Janssen (UVic), Christina Schallenberg (UVic) and Desiree Dillman (UVic)*

At all major stations, sampling from GOFlo and XNiskin bottles and a Teflon pump was undertaken at 15 to 27 discrete depths per station, to a maximum depth of 4000 m. Bottles and pump tubing were mounted on Kevlar line, with deployment taking place in the “chains” on the starboard side of the ship. Sampling from GOFlo bottles was undertaken in a container on the aft deck where a HEPA filter continuously cleaned the air of particles. Sampling from the pump was done in a flow bench with HEPA filter in the wetlab, and the XNiskins were sampled without any further precautions in the wetlab.
Samples from bottles were filtered with PALL AcroPak 0.2 µm filters and pumped samples were filtered with a Millipore Opticap cartridge filter (0.22 µm). Some samples were acidified at sea, with the majority awaiting acidification in the laboratory on shore.
Samples are stored in thoroughly acid-cleaned LDPE bottles and the following trace metals will be measured in the laboratory: total dissolved iron, total iron, and zinc. Extra sample volumes were taken for archiving and may be analyzed for additional trace metals in the future.

Trace metal analysis on board
Zinc, Dave Janssen (UVic)
Filtered samples for dissolved zinc were collected at the five major stations as described above and analyzed using the fluorescence based flow-injection method described by Nowicki et al. (1994). Depths were selected to give higher resolution in surface waters and the oxygen minimum zone. Previous lab and preliminary cruise work suggested that the choice of nitric acid rather than hydrochloric acid for sample acidification may positively influence the analytical signal. Therefore, a duplicate set of samples was collected at each station to compare the acids if continuing work suggests this may be influential. Samples analyzed at sea were acidified using hydrochloric acid to pH = 1.7 at least 24 hours prior to analysis. The remaining samples will be acidified in the lab using either hydrochloric or nitric acid and analyzed using the same fluorescence based method.
Iron(II), Christina Schallenberg (UVic)

At all major stations, filtered samples were drawn from GOFlo bottles as soon as they were secured in the container. Samples were filtered as described above and were brought to the flow bench in the main lab within a minute of filtration to be analyzed for iron(II). Likewise, pumped samples were analyzed within 1 minute of filtration. Iron(II) was detected with the luminol method combining the experimental set-up of Hansard et al. (2009) with the chemistry as described by Croot and Laan (2002). Samples were not acidified prior to analysis and were pumped directly into the flow cell without an injection valve. Care was taken to maintain a stable light field in the flow bench during measurements as the luminol reagent was found to be extremely sensitive to changes in light intensity.

Dust incubation experiment

Christina Schallenberg (UVic)

At Station P20, an incubation experiment was carried out to investigate the influence of glacial flour (dust) on the growth and photosynthetic capacity of phytoplankton native to the Northeast Pacific Ocean. Water was collected with the Teflon pump at P20, and 5 different treatments plus a control were incubated in polycarbonate bottles on the Heli deck for 6 days. Over the course of the experiment, repeat measurements of iron(II), variable fluorescence (Fv/Fm) and chlorophyll were made. At the end of the incubation, subsamples were filtered for trace metal analysis in the lab, and the bulk of the incubation volume was filtered for HPLC analysis.

Big thanks to all the deck crew for their help, to the engineers for jury-rigging the winch, and to the officers for keeping the wire angle in check!

References:
J.L. Nowicki et al. (1994). Analytica Chimica Acta 66: 2732-2738.
P.L. Croot, P. Laan (2002). Analytica Chimica Acta 466: 261-273.
S.P. Hansard et al. (2009). Deep-Sea Res. I 56: 1117-1129.

POC production, POC export and POC-^{210}Po-^{234}Th interactions in relation to plankton community structure in the subarctic NE Pacific

PI's: Gillian Stewart, City University of New York, Queens College, Flushing NY USA
Bradley Moran, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI USA
Michael Lomas, Bermuda Institute of Ocean Sciences, St. George, BERMUDA

2012-12 June Line P Cruise Participants:
Roger P. Kelly, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI USA
Brendan Mackinson, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI USA

OBJECTIVES and BACKGROUND

The overarching goal of this collaborative project is to investigate the relationship between variability in plankton community structure with variability in POC production, POC export and POC-^{210}Po-^{234}Th interactions in the subarctic NE Pacific.

This study is motivated by the need to illuminate the role of euphotic zone ecosystem processing in predicting the eventual fate of export flux in the mesopelagic. The project will provide a mechanistic understanding of the processes controlling the production and export of POC and associated elements in the upper subarctic Pacific. Specifically, we will investigate and directly test hypotheses on ecosystem processes that link variability in plankton community structure to variability in particle production, export, and POC-^{210}Po-^{234}Th interactions in the upper ocean. We anticipate that outcomes from field work at Line P in conjunction with laboratory experiments will demonstrate strong and consistent relationships between planktonic food webs and the rates of carbon, ^{210}Po, and ^{234}Th packaging, sinking, and remineralization. Further, the information gathered will guide future use of radionuclide tracers, including mechanistic justifications for which tracer to use, when and where to use each tracer, as well as insight into the specific aspect of carbon that ^{210}Po and ^{234}Th are tracing. This project is relevant to several national and international research programs. These include: GEOTRACES, which is focused on the global-ocean distribution of trace elements and isotopes in seawater; and IMBER, which is focused on the structure and functioning of ocean ecosystems. This project will also build upon the results of earlier process studies at OSP including SUPER (Subarctic Pacific Ecosystem Research, Miller 1993), VERTEX (VERTical EXchange, Martin et al. 1987) and the Canadian JGOFS study.

SAMPLING:

At 5 major stations (P4, P12, P16, P20, and P26) two discrete rosette/CTD casts were made to collect seawater for our measurements. One cast was made for ^{234}Th and ^{210}Po samples, tripping bottles at 13 depths, of which 12 were fixed depths (5, 10, 20, 30, 50, 75, 100, 150, 200, 300, 400, 500m) and 1 was the chlorophyll maximum (DCM). The DCM was chosen based on observation of the instrument traces (fluorometer, transmissometer), which varied at each station but generally ranged between 40-60m. When no discernable fluorescence peak was observed, a depth near the midpoint of the surface mixed layer was selected. The second cast was for phytoplankton community structure and primary productivity samples. 7 depths were selected based on PAR light levels (100%, 50%,30%,17%,9%,5%,1%). Water samples were processed on board (described below) for later analyses at respective PI laboratories.

Phytoplankton structure profiles were measured from 7 depths based on PAR light levels.

Fluorometric chlorophyll – 400-500ml filtrations each for "total" (GF/F filters, nominally 0.7µm) and >5 µm (polycarbonate membrane filters) size fractions in duplicate, stored in -80°C.
HPLC pigments – 400-500ml filtrations each for "total" (GF/F filters, nominally 0.7µm) and >5 µm (polycarbonate membrane filters) size fractions, occasional duplicates, stored in -80°C.
Flow Cytometry – 4ml samples preserved with 200 µl paraformaldehyde, stored in -80°C.
Preserved microplankton – 200ml samples preserved with 10ml buffered formalin and 1 ml alkaline lugols solution, stored in the dark at room temperature.

Thorium profiles were measured on 12 depths (DCM, 1, 10, 20, 30, 50, 75, 100, 150, 200, 300, 500m). 4L samples were pH adjusted with 8 drops 28% NH_4OH then 25 µl 0.2M $KMnO_4$ and 10 µl 1 M $MnCl_2$ to form a MnO_2 precipitate which was collected on GM/F filters. The filters were stored frozen (-20C) and brought to URI-GSO for analysis by direct beta counting.

Polonium profiles were measured on a subset of 10 depths. Whole-rosette bottle samples (10.1 L) were drained into 10L carboys. Samples were pH adjusted with HNO_3 then spiked with 25 µl ^{210}Po tracer, 1 ml Pb standard and 5-8 ml $FeCl_3$. Samples were pH adjusted again with NH_4OH, oxidized with 1 ml $NaCrO_4$, and pH increased to 9-10 with more NH_4OH. Samples were allowed to precipitate for at least 10-12 hours. Samples were decanted to ~1L and transferred with most of the precipitate to LDPE bottles.

Cesium profiles were measured on 9 depths (1, 50, 100, 150, 200, 300, 400, 500, 600m). Large-volume (50 L) samples were collected on two rosette casts at P4 and P26, and extracted onto KCFC (potassium cobalt ferrocyanide) ion-exchange resin at ~ 300 ml/min. The resin was then rinsed with 100 ml of milli-q water, then sealed for radiometric analysis at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia.

***In-situ* pumps** were deployed at each station for collection of size-fractionated particles. Three McLane and one Challenger pump were deployed for 4 hours (0.5 hour delay, 3.5 hour pump time) to sample particles (>53, 53-10, 10-1 µm nitex screens) at 30, 50, 100, and 200 m. Upon recovery, the nitex screens were rinsed and sonicated to extract the particles, which were then filtered onto precombusted GF/F filters for organic carbon, thorium, polonium, and pigment analysis.

Sediment traps were deployed near P26 and allowed to drift freely for ~3 days. They were abandoned to complete science objectives at other locations while their position was monitored by ARGOS transmissions which were received by ships email. The traps were deployed with filtered seawater brine (~80 ppt), and collected particles at 30, 50, 100, 150, and 200 m. Upon recovery, the trap tubes were allowed to stand for ~1hr to allow the brine layer to stabilize, at which time the top layer of seawater was siphoned off and discarded. All four trap tubes from a given depth were combined, and sub-samples were collected for particulate organic carbon, thorium, polonium, and pigment analysis. Swimmers were picked from filtered samples.

Summary table of samples collected on 2011-01 Line P cruise by URI-BIOS-CUNY•QC group.

Samples were collected at P4, P12, P16, P20, and P26

Sample	P4	P12	P16	P20	P26
Total Chlorophyll	11	11	11	11	11
5 µm Chlorophyll	11	11	11	11	11
Total HPLC	11	11	11	11	11
5 µm HPLC	11	11	11	11	11
Preserved Microplankton	4	4	4	4	8
Primary Production	7	7	X	7	7
Total Cesium	8	X	X	X	8
Total ^{234}Th	12	12	12	12	24
Total ^{210}Po	11	11	11	11	11
Bongo Tow	2	2	2	2	2
In-situ pumps	4	4	4	4	4
Sediment Traps	X	X	X	X	10

RADIOISOTOPE USE:

The following radioisotope was used in the Rad-Van: $H^{14}CO_3$. This isotope was used to measure rates of primary productivity at different light levels at P4, P12, P20, and P26 by Nina Schuback (UBC). Wipe tests were conducted in the beginning and at the end of the cruise inside the rad van and on the doors and handrails leading to the heli deck. Furthermore, wipe tests inside the rad van were conducted after each experiment. Before the filtrate was disposed via the "hot" rad van drain, additional wipe tests were made to prove that the radioisotope waste had been properly acidified, ventilating C^{14} to the atmosphere. The drain was checked afterwards for contamination. There were no incidences to report with any level of contamination. The daughter stock left after the last experiment was disposed along with the waste produced.

RADIATION VAN REPORT:

The IOS radiation van was easy to work in. The floor space is good and the bench height is comfortable to work on. There is plenty of bench space and drawers. Unfortunately the heating system could not be connected, which made the van a little cold to work in at times.

SUMMARY/FINAL COMMENTS:

Thanks to the officers and crew of the John P. Tully for a successful cruise. Thanks and appreciation to the Bosun and deck crew for assistance securing our equipment on the weather decks and with the careful deployment of our sampling gear. We would also like to thank Marie Robert for a fine job with cruise planning and the science watch-standers for their sampling assistance. Thanks to Mike Arychuk for assistance with inter-cruise chemical storage and handling. We'd also like to thank Darren Tuele, Wendy Richardson, and Hugh Maclean for help during pre- and post-cruise operations.

ONAr, ARGO and mooring – Seth Bushinsky (University of Washington)

On this cruise we deployed a SeaBird CTD package and a SAMI pH sensor on the PAPA mooring and recovered the same from the old mooring. The CTD packages measure temperature, salinity, oxygen through both a Seabird 43 and Aandaeraa optode, total gas pressure from a Gas Tension Device, and fluorescence and backscatter using a Wetlabs ECOFLNTUS. To both calibrate these sensors and provide data for mixed layer export models we took discrete water samples of oxygen, ONAr (Oxygen, Nitrogen, and Argon), alkalinity, dissolved inorganic carbon, and salinity. Additionally, ^{17}O was measured to estimate biological production.

In addition to the mooring work, we deployed an ARGO float modified to support two oxygen optodes. These optodes are designed to measure oxygen in both the water and the air. The amount of oxygen in the air is essentially constant, allowing us to calibrate the oxygen measurements every time the float surfaces and sticks an optode into the air.

We also recovered another modified ARGO float that had malfunctioned and was at risk of sinking. Craig McNeil at the University of Washington's Applied Physics Lab designed this ARGO float to measure the total gas pressure in the water, which would allow the calculation of the pressure of nitrogen in the water. Unfortunately, sometime after deployment the float was damaged and had to stay at the surface, waiting for someone like us to pick it up. After several tries and a lot of effort by the crew of the Tully we managed to get the float on board so that it can be fixed and modified back in Seattle.

A successful recovery. Photo courtesy of C. Schallenberg

The transport of carbon from the atmosphere into the ocean plays a major role in controlling the carbon dioxide content of the atmosphere. This flux is driven both by physical absorption and biological production. The amount of biologically produced carbon that is exported to the deep ocean can be measured by making precise oxygen measurements. These oxygen measurements, coupled with measurements of the biologically inert gases nitrogen and argon, allow distinction between physical processes that affect gas saturation from biological production and consumption of oxygen. The discrete measurements taken on this cruise, coupled with the high-resolution data collected from the mooring allows us to estimate carbon export and work towards constraining the carbonate system at PAPA.

We would like to thank the crew of the John P. Tully, the scientists from IOS, and the rest of the science crew for all of their help on this cruise. None of the science done at sea is the work of only one person and these Line P cruises are great examples of the collaboration and cooperation necessary to get things done.

Carbonate Studies – Mike Arychuk, Marie Robert and Kyle Simpson: Carbonate Studies

Four aspects of the carbonate system were measured on the 2012-12 expedition to OSP. Both pH and underway continuous automated pCO2 are measured onboard the Tully. Samples for Dissolved Inorganic Carbon (DIC) and Total Alkalinity (TA) are collected, preserved and returned to the shore-based lab for analysis.

1) pCO2

The pCO2 system was run using the seawater loop system from roughly station P2 up until Juan de Fuca strait. This is the first time the pCO2 system has been run since it was damaged in a flood at IOS. The unit performed well with the exception of the flow meter that measures the seawater flow rate. The digital output of the flow meter was flawed often reading at its maximum level regardless of flow. Finally near the end of the cruise the flywheel became stuck and thus the flow rate was recorded as zero from that point on.

2) DIC/alkalinity sampling

DIC/alkalinity samples were collected in 500ml bottles and preserved with 100ul of $HgCl_2$ at all major stations on line P. Stoppers were greased with Apeizon grease and tapped closed with electrical tape. One

duplicate was collected at each station between 1000 and 3000m as well as a duplicate bottle tripped at one of the deeper depths.

A calibration cast was conducted at P22 on the way to OSP (5 bottles for DIC/TA were tripped at 2000m and each sampled in triplicate). Station P26 was sampled in duplicate for DIC/TA if required. Sampling was carried out by a variety of personnel.

3) pH

Seawater pH was analyzed at major line P stations using the Agilent (HP) spectrophotometer and the m-cresol purple technique of Clayton and Byrne. Cells (100mm cylindrical glass) were filled directly from Niskins. They were stabilized at 25°C using a constant temperature bath and an aluminium block. A temperature controlled cell holder was also used to maintain sample temperature at 25°C during analysis, although this cell holder seems to have far less effect on seawater temperature than does the air temperature. Profiles consistent with DIC/TA depths were collected from all major line P stations as well as a calibration cast at P22 where 5 Niskins were each sampled in triplicate.

As usual, the pH system was set up in temperature controlled lab. The lab temperature remained relatively stable throughout the trip. The temperature of the seawater in the cells was measured after each analysis to confirm the temperature. Sample collection and analysis was carried out by Kyle Simpson .