**National Oceanography Centre, Southampton**

# Cruise Report No. 47

## RRS *Discovery* Cruise 341

08 JUL-13 AUG 2009

Porcupine Abyssal Plain time series site process study

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*ABSTRACT*

The Biological Carbon Pump (BCP) is a major feature of the global carbon transporting approximately 10GT C yr-1 from the ocean surface to the interior mainly via the sinking of particles with an organic component. The scale of the BCP requires good year-round measurements of its functioning. Moreover, the BCP's susceptibility to global change means that we need better information on how its climate sensitive elements function and how its poorly parameterised elements operate. These three requirements map directly onto the objectives of this cruise, which will be undertaken using Oceans 2025 funding at the Porcupine Abyssal Plain (PAP) site. The PAP site (47oN, 16.5oW) is the location of a time series of observations from surface to seafloor compiled by IOS, GDD and now NOCS over the last 20 years (Lampitt et al., 2001). A summary of these observations, together with descriptions of surface water biogeochemistry in the region from a cruise in 2005, is currently being published as a special issue of Deep-Sea Research II. The PAP site is close to the site of the JGOFS north Atlantic Bloom experiment and the French POMME programme and is a waypoint on the Atlantic Meridional Transect programme (SO1 in Oceans 2025). There is therefore a rich wealth of previous observations in which our 2009 observations can be grounded.

Objectives:
1) To recover and redeploy the PAP site observatory (Theme 10 of Oceans 2025)
2) To compile a vertical carbon budget for the PAP site with particular focus on the process of remineralisation in the mesopelagic (100 – 1000 m) and on the mechanisms leading to export from the upper ocean (Themes 2, 5 of Oceans 2025)
3) To quantify climate sensitive elements of the BCP at the PAP site, particularly the physical processes responsible for introducing nutrients to the upper water column, which combine to set the maximum level of export (Theme 2 of Oceans 2025)

Of these, 1) was partially successful, 2) was successful, 3) was unsuccessful.

*KEYWORDS*

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| Mark Coultas | Second Engineer |
| John Harnett | Third Engineer |
| Edin Silajdzic | Third Engineer |
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| David Hartshorne | Purser |
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LMGEM - Laboratoire de Microbiologie Géochimie et Ecologie marine, Marseille
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Narrative – Richard Sanders

*July 2009*

9th Sailed from Govan at noon following the pickup of Sarah Giering and James Hunter from Glasgow station

10th On passage

11th On Passage

12th On Passage

13th Work started with a CTD at the future French Mooring position for acoustic release test. The snowcatcher was deployed followed by another CTD. The weather blew up after the CTD was recovered and the rest of the day was lost.

14th Work resumed at 9.30. Nets, snowcatchers and Pelagras were deployed at the French mooring site then CTDs and finally SAPS

15th Biological work continued till dawn including the French CTD and the French drifter, then the IODA mooring was deployed. Unfortunately the line linking the release to the instruments parted and approx 700m parafil plus an acoustic release was lost. The remainder of the mooring was recovered. Subsequent tests showed that parafil is slightly negatively buoyant and hence the release can be fired safely some time towards the end of the cruise for recovery.

16th Aries was deployed around midnight, the French drifter recovered. More biological work ensued including Snowcatcher, CTD, SAPS. Finally Corer deployment 1 was undertaken which yielded 6 good cores.

17th More biological work was undertaken and then we embarked on Pelagra recoveries. All were rounded up in double quick time. The first three were found easily and the other two were slightly more problematic. We then returned to the core site for biological work and coring.

18th The corer was deployed, PAP 3 was deployed. The French drifter was recovered. The overnight Aries tow was abandoned due to CLAM problems which were fixed around 4am. Corer deployment 2

19th IODA was deployed again. This time the deployment was successful. 5 Pelagras were deployed at the core site. Aries was deployed x 2

20th DOMS was recovered. The shackle holding the main buoy to the chain had nearly worn through, the solar panels had nearly all been ripped away. The buoy was sitting low in the water. A number of points have to be addressed before a decision whether to redeploy can be made. We went off to start CTD survey.

21st CTD survey with occasional nets and snowcatchers

22nd CTD survey with occasional nets and snowcatchers

23rd CTD survey with occasional nets and snowcatchers plus SAPS for radiochemists

24th CTD survey with occasional nets and snowcatchers

25th CTD survey with occasional nets and snowcatchers

26th. The final day of the CTD survey. Bad weather prevented work after approximately 9am. Vessel hove to all day

27th. Pelagras began to signal their positions at approximately 4am. Two had been caught in a jet and moved a long way N and three had moved S. By breakfast the sea had abated enough to begin the retrieval process. We ran down to the northerly ones first, recovering the first by about 4PM after 2 failed attempts in which the trap went under the ship. The second was recovered in twilight at about 10PM. We then transited S overnight to look for the second group of traps.

28th. Three Pelagra recoveries were undertaken. The first at approximately noon, the second at approximately 6 after extensive searching and the third at approximately 10PM. Well coordinated shiphandling and deckwork meant that this difficult task was made to look much simpler that it actually was. We then transited to the coring site

29th A difficult day. The corer came up with only two poor quality cores. This was followed by a double ARIES tow, the second of which was brought inboard with the net detached from the codend cartridge. A shallow CTD was undertaken between the tows to allow a large bioluminescence experiment to be initiated. Following the second ARIES tow the Zubkov net was planned to be deployed. Unfortunately the acoustic current meter/ CTD unit which fires the closure mechanisms failed to respond to the computer and the cast was terminated. PAP3 mooring recovered. It came up in something of a tangle and hence the acoustic release was lost although the three traps were all recovered OK with their samples. Next five Pelagras were deployed for recovery on Sunday 2nd. The French CTD was then deployed but blew a fuse in the deck unit twice and the cast thus terminated.

30th This began bright and early with three CTD casts to collect biological samples. Following this the corer was deployed twice before the weather blew up at around 5PM. The first was successful, the second less so. During the day we conducted final trials on the DOMS toroid and came to the conclusion that the buoyancy available to keep the package out of the water was about 20% of the total buoyancy, possibly due to water ingress. Discussions with base lead to a decision not to redeploy.

31st Work began at around 9am and stretched out into the rest of the day with CTDs, both French and English, and the snowcatcher. At about 3PM the decision was made that it was too rough for ARIES to be deployed and so we deployed SAPS before trialling the Zubkov CTD incubator. Unfortunately this completely failed. Nets followed, then deep SAPS.

*August 2009*

1st The biological station continued with a regular and then the French CTD. The latter had been revived via a transplant of the titanium housed CTD unit from the trace metal CTD. The French drifter was deployed. Aries was deployed in the afternoon and then again in the evening.

2nd After Aries the French drifter was located visually and then the CTD deployed with the intention of drifter recovery thereafter. Unfortunately visual contact with the drifter was lost as the CTD came on board and the weather then blew up and mist came down. Meanwhile by 7am all Pelagras had signalled their positions. Weather downtime from approx 5.30am. By 8 am we had a firm position for the drifter and went off to find the buoy as the weather had come down. The first approach failed and the second resulted in a broken pellet line. The third approach succeeded and we recovered it at 11am. We then set course for the Pelagras in improving (just) weather. Two were sighted straightforwardly and brought in at 2PM and 3PM. The third proved more tricky to spot but was tracked down eventually. Finally two more were recovered between 8 and 10 PM. The biological station could then begin at the site of the last recovery with a French CTD.

3rd Nets and then two more CTDs ensued before the snowcatcher and finally SAPS were deployed. Five Pelagras were then deployed at the site of the last recovery and the vessel then departed for a mini CTD survey in the face of an inclement weather forecast. The weather did not blow up and the first station was occupied at 4PM. Further stations at about 7 and 10PM were occupied

4th A CTD at 3am was followed by a period of awkward confused swells and further CTD deployments were halted. Vessel still hove to at 2.15. Vessel still hove to at 6.47 the next morning. Wind had dropped and sea abated.

5th By noon the weather still had not improved enough for over the side work. Swell and wind were offset meaning station could not be kept. Fortunately the future weather is forecast to be benign. We started stations at about 1PM and then continued them overnight with further stations at approx 4, 7, 10, 1, 4.

6th Today was devoted to trace metal SAPS for Peter Statham and Chris Marsay, deployed off the zooplankton winch. A CTD for 234Th ensued before the hunt for Pelagra began. All five were recovered in 2.5 hours within 5 miles of each other. At one stage there were three showing their lights

as a fourth was recovered. We then steamed back to the French Mooring site and deployed the French CTD

7th The French IODA mooring was recovered today. This was a complex job because it had moved approximately five miles since deployment due to a light spare anchor being used, the original having been lost when the parafil parted. Fortunately it was just in range standing off the original site and the range decreased as we moved over the top of the original site. We fired the release and then headed off to find it. Triangulation lead to it being sighted just after lunch and it was recovered by teatime. A quick CTD for bioluminescence observations was undertaken and the Zubkov net deployed without its opening/closing device. We then headed for the site where all the Pelagras had been recovered to undertake a biological station to complement the biostation we had occupied immediately prior to the deployment. We towed Aries into the site to obtain a night profile of mesozooplankton biomass and then undertook CTD and SAPS casts overnight followed by two more CTDs.

8th At noon we redeployed ARIES to replicate the tow from the previous day during the day. Aries was on board by 6PM and we then set off for the core site. A shallow CTD for instrument calibrations was undertaken and the titanium CTD frame then brought down and assembled. At 10.30 pm we deployed the corer.

9th The day began well with the corer recovering 8 cores. We then transited to the French mooring location to recover the lost release. When we ranged the release it didn't reply coherently but it was clearly there. Intermittent mist meant that it was judged too risky to fire it given the minimal rewards recovering it would bring (no data or instruments were attached to the release) in the expectation that it would trigger despite not communicating sensibly, bearing in mind that the buoyancy package was only two spheres which would lead to it rising slowly and being difficult to spot. We therefore deployed the titanium CTD to 4000m with the hope that firing the release would be possible as the weather improved during the cast. This did not occur and at 10.30 am I took the difficult decision to abandon the French release in favour of obtaining a deep SAPS profile for biochemical analyses at the core site. A string of SAPS were deployed beginning at 12.30 pm and finishing at 7.30PM. A final CTD for bioluminescence experiments was undertaken and with that science at the PAP site ended to allow the core warp to be streamed at reduced speed and the ship departed for home.

10th On passage

11th On passage

12th On passage

13th Docked

Chronology of events D341

| Date | Time | Station number | Lat | Long | Equipment | Notes |
|---|---|---|---|---|---|---|
| 13/7/09 | 05.24 | 16476 | 49 02.3 | 16 28.9 | CTD | Full depth CTD for acoustic releases and sed trap preservatives |
| | 11.54 | 16477 | 49 02.6 | 16 27.8 | Snowcatcher | |
| | 12.54 | 16478 | 49 01.7 | 16 28.8 | CTD | |
| 14/7/09 | 09. 30 | 16479 | 49 01.8 | 16 29.2 | Bongo net | |
| | 09.42 | 16480 | 49 01.8 | 16 29.3 | Bongo net | |
| | 09.55 | 16481 | 49 01.8 | 16 29.5 | Bongo net | |
| | 10.24 | 16482 | 49 01.8 | 16 29.9 | Snowcatcher | |
| | 12.41 | 16483 | 49 02.1 | 16 30.0 | Pelagra | |
| | 13.08 | 16483 | 49 02.2 | 16 29.9 | Pelagra | |
| | 13.30 | 16483 | 49 02.3 | 16 29.9 | Pelagra | |
| | 13.48 | 16483 | 49 02.4 | 16 29.9 | Pelagra | |
| | 14.13 | 16484 | 49 02.6 | 16 30.0 | Pelagra | |
| | 14.34 | 16484 | 49 02.7 | 16 30.0 | Net | |
| | 15.23 | 16485 | 49 02.6 | 16 28.9 | Snowcatcher | |
| | 16.42 | 16486 | 49 02.6 | 16 28.9 | CTD | |
| | 21.20 | 16487 | 49 01.8 | 16 29.1 | SAPS | |
| 15/7/09 | 00.55 | 16488 | 49 01.0 | 16 31.5 | CTD | |
| | 03.12 | 16489 | 49 01.0 | 16 32.9 | French CTD | |
| | 07.33 | 16490 | 49 03.1 | 16 33.8 | French Drifter | |
| | 08.29 | 16491 | 49 03.8 | 16 33.5 | Snowcatcher | |
| | 08.42 | 16492 | 49 03.8 | 16 33.2 | Net | |
| | 09.42 | 16492 | 49 03.7 | 16 32.5 | Zubkov Net | |
| | 16.57 | 16493 | 49 02.5 | 16 29.3 | French Mooring | Mooring subsequently failed |
| 16/7/09 | 00.00 | 16494 | 49 02.0 | 16 28.1 | Aries | |
| | 07.40 | 16495 | 49 02.1 | 16 37.6 | French drifter recovery | |
| | 09.20 | 16496 | 48 58.5 | 16 24.9 | Snowcatcher | |
| | 10.00 | 16497 | 48 58.6 | 16 24.6 | CTD | |
| | 13.01 | 16498 | 48 58.2 | 16 24.0 | SAPS | |
| | 18.40 | 16499 | 48 50.4 | 16 29.9 | Megacorer | |
| | 23.53 | 16500 | 48 49.6 | 16 31.7 | Bongo net x 2 | |
| 17/709 | 02.42 | 16501 | 48 49.5 | 16 34.4 | CTD | |
| | 05.22 | 16502 | 48 50.2 | 16 35.8 | SAPS | |
| | 09.23 | 16503 | 48 49.4 | 16 34.9 | French drifter | |
| | 09.33 | 16504 | 48 49.6 | 16 34.6 | Zubkov Net | |
| | 12.20 | 16505 | 49 00.3 | 16 45.6 | Pelagra Recovery | Pelagra |
| | 13.32 | 16505 | 49 00.3 | 16 39.8 | Pelagra Recovery | Pelagra |
| | 14.42 | 16505 | 49 00.3 | 16 35.5 | Pelagra Recovery | Pelagra |
| | 15.30 | 16505 | 48 59.9 | 16 31.2 | Pelagra Recovery | Pelagra |
| | 19.07 | 16505 | 49 07.9 | 16 15.1 | Pelagra Recovery | Proceeded to core site |
| | 22.40 | 16506 | 48 50.7 | 16 29.3 | French CTD | CTD |
| 18/7/09 | 01.13 | 16507 | 48 50.6 | 16 29.5 | Corer | Corer |
| | 11.20 | 16508 | 48 51.6 | 16 40.5 | | French Mooring recovery |
| | 16.57 | 16509 | 48 59.9 | 16 29.2 | PAP3 | PAP3 deployment |
| Aries Overnight abandoned due to CLAM | | | | | | |
| 19/7/09 | 05.12 | 16510 | 48 59.8 | 16 30.6 | CTD | CTD |
| | 06.45 | 16511 | 48 59.1 | 16 30.6 | Net | Net |
| | 07.50 | 16512 | 48 58.5 | 16 30.4 | Net | Net |
| | 14.32 | 16513 | 49 02.2 | 16 29.9 | IODA | IODA Mooring |
| | 17.20 | 16514 | 49 01.3 | 16 30.9 | CTD | CTD |
| | 19.02 | 16515 | 49 01.1 | 16 30.9 | Pelagra deployment | Pelagra |
| | 19.30 | 16516 | 49 01.1 | 16 31.0 | Pelagra deployment | Pelagra |
| | 19.50 | 16517 | 49 01.1 | 16 31.1 | Pelagra deployment | Pelagra |
| | 20.18 | 16518 | 49 00.7 | 16 31.1 | Pelagra deployment | Pelagra |
| | 20.43 | 16519 | 49 00.3 | 16 30.9 | Pelagra deployment | Pelagra |
| | 22.00 | 16520 | 49 59.9 | 16 32.8 | ARIES | Aries |
| 20/7/09 | 02.48 | 16521 | 48 53.7 | 16 40.7 | ARIES | Aries |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 16.47 | 16522 | 49 04.3 | 16 22.9 | DOMS Mooring | DOMS |
| | 22.12 | 16523 | 48 32.9 | 17 10.8 | CTD | A6 |
| 21/7/09 | 00.50 | 16523 | 48 32.6 | 17 09.8 | CTD recovered | A6 |
| | 02.15 | 16524 | 48 43.8 | 17 10.8 | On station | A5 |
| | 02.35 | 16524 | 48 43.8 | 17 10.8 | CTD deployed | A5 |
| | 04.22 | 16524 | 48 43.6 | 17 11.0 | CTD recovered | A5 |
| | 05.25 | 16525 | 48 43.5 | 17 11.0 | Net deployed | A5 |
| | 05.55 | 16525 | 48 43.3 | 17 11.0 | Net recovered | A5 |
| | 07.00 | | 48 49.3 | 17 06.6 | Passage to A4 | |
| | 08.21 | 16526 | 48 54.6 | 17 10.7 | CTD deployed | A4 |
| | 09.43 | 16526 | 48 54.0 | 17 10.5 | CTD recovered | A4 |
| | 09.56 | 16527 | 48 53.3 | 17 10.4 | Snowcatcher | A4 |
| | 10.04 | 16527 | 48 53.7 | 17 10.4 | SC recovered | A4 |
| | 11.00 | | 48 56.7 | 17 10.8 | On passage to A3 | |
| | 12.50 | 16528 | 49 05.2 | 17 11.5 | CTD deployed | A3 |
| | 14.18 | 16528 | 49 04.4 | 17 12.3 | CTD recovered | A3 |
| | 16.15 | 16529 | 49 16.0 | 17 11.2 | CTD deployed | A2 |
| | 17.50 | 16529 | 49 16.1 | 17 12.0 | CTD recovered | A2 |
| | 18.02 | 16530 | 49 16.1 | 17 12.0 | Zubkov Net | A2 |
| | 18.33 | 16530 | 49 16.2 | 17 12.2 | Zubkov recovered | A2 |
| | 20.25 | 16531 | 49 26.9 | 17 10.9 | CTD deployed | A1 |
| | 21.49 | 16531 | 49 26.3 | 17 10.4 | CTD recovered | A1 |
| | 22.00 | 16532 | 49 26.2 | 17 07.7 | On Passage to B1 | B1 |
| | 23.05 | 16532 | 49 26.8 | 16 54.5 | CTD deployed | B1 |
| 22/7/09 | 00.34 | 16532 | 49 26.0 | 16 53.2 | CTD recovered | B1 |
| | 02.03 | 16533 | 49 16.1 | 16 54.6 | CTD deployed | B2 |
| | 03.40 | 16533 | 49 14.5 | 16 54.0 | CTD recovered | B2 |
| | 04.10 | 16534 | 49 14.0 | 16 53.8 | Net deployed | B2 |
| | 04.25 | 16534 | 49 13.8 | 16 53.8 | Net recovered | B2 |
| | 05.40 | 16535 | 49 05.2 | 16 34.7 | CTD deployed | B3 |
| | 06.50 | 16535 | 49 04.3 | 16 55.0 | CTD recovered | B3 |
| | | | | | | |
| | 08.12 | 16536 | 48 54.5 | 16 54.4 | CTD deployed | B4 |
| | 08.36 | 16536 | 48 54.5 | 16 54.4 | CTD recovered | B4 |
| | 08.36 | 16537 | 48 54.5 | 16 54.4 | Snowcatcher | B4 |
| | 09.47 | 16537 | 48 53.8 | 16.55.1 | Net deployed | B4 |
| | 09.53 | 16537 | 48 53.8 | 16.55.2 | Net recovered | B4 |
| | 11.26 | 16538 | 48 43.8 | 16 54.5 | CTD deployed | B5 |
| | 12.45 | 16538 | 48 43.3 | 16 54.5 | CTD recovered | B5 |
| | 14.09 | 16539 | 48 33.4 | 16 54.4 | CTD deployed | B6 |
| | 15.28 | 16539 | 48 32.9 | 16 55.1 | CTD recovered | B6 |
| | 15.45 | 16540 | 48 32.9 | 16 55.1 | Net deployed | B6 |
| | 16.30 | 16540 | 48 32.4 | 16 55.8 | Net recovered | B6 |
| | 18.07 | 16541 | 48 32.9 | 16 31.2 | CTD deployed | C6 |
| | 19.20 | 16541 | 48 32.3 | 16 39.5 | CTD recovered | C6 |
| | 20.55 | 16542 | 48 43.7 | 16 37.9 | CTD deployed | C5 |
| | 22.10 | 16542 | 48 42.9 | 16 38.1 | CTD recovered | C5 |
| | 23.48 | 16543 | 48 54.6 | 16 38.2 | CTD deployed | C4 |
| 23/7/09 | 01.13 | 16543 | 48 54.1 | 16 38.0 | CTD recovered | C4 |
| | 02.49 | 16544 | 49 05.3 | 16 38.2 | CTD deployed | C3 |
| | 04.20 | 16544 | 49 04.3 | 16 38.0 | CTD recovered | C3 |
| | 06.12 | 16545 | 49 04.0 | 16 37.9 | SAPs deployed (600 m) | C3 |
| | 09.16 | 16545 | 49 02.6 | 16 39.6 | SAPs recovered | C3 |
| | 10.58 | 16546 | 49 16.0 | 16 38.2 | CTD deployed | C2 |
| | 12.23 | 16546 | 49 15.0 | 16 38.3 | CTD recovered | C2 |
| | 12.25 | 16546 | 49 15.0 | 16 38.3 | Fault with CTD | C2 |
| | 12.58 | 16547 | 49 15.0 | 16 38.3 | CTD re-deployed | C2 |
| | 13.48 | 16547 | 49 14.0 | 16.38.5 | CTD recovered | C2 |
| | 15.25 | 16548 | 49 26.9 | 16 38.3 | On station C1 | C1 |
| | 15.30 | 16548 | 49 26.9 | 16 38.3 | CTD deployed | C1 |
| | 16.50 | 16548 | 49 27.0 | 16 37.8 | CTD recovered | C1 |
| | 18.02 | 16549 | 49 26.9 | 16 21.7 | CTD deployed | D1 |
| | 18.33 | 16549 | 49 27.0 | 16 21.5 | 1000 meters | D1 |
| | 19.18 | 16541 | 49 27.3 | 16 21.4 | CTD recovered | D1 |
| | 20.43 | 16550 | 49 16.2 | 16 21.6 | v/h on station | D2 |
| | 20.55 | 16550 | 49 16.2 | 16 21.5 | CTD deployed | D2 |
| | 22.19 | 16550 | 49 16.9 | 16 20.9 | CTD recovered | D2 |
| | 22.25 | 16551 | 49 16.9 | 16 21.1 | v/l on passage to D3 | D2 |
| | 23.45 | 16551 | 49 05.4 | 16 21.6 | v/l stopped on station | D3 |
| | 23.54 | 16551 | 49 05.4 | 16 21.6 | CTD deployed | D3 |
| 24/7/09 | 01.13 | 16551 | 49 05.4 | 16 21.4 | CTD recovered, proceeding to D4 | D3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 02.35 | 16552 | 48 54.7 | 16 21.7 | On station D2 | D4 |
| | 02.47 | 16552 | 48 54.7 | 16 21.7 | CTD deployed | D4 |
| | 04.15 | 16552 | 48 54.7 | 16 21.5 | CTD recovered | D4 |
| | 04.33 | 16553 | 48 54.8 | 16 21.5 | Plankton net deployed | D4 |
| | 04.50 | 16553 | 48 54.8 | 16 21.5 | Plankton net recovered | D4 |
| | 06.27 | 16554 | 48 43.9 | 16 21.7 | On CTD station | D5 |
| | 06.33 | 16554 | 48 43.9 | 16 21.7 | CTD deployed | D5 |
| | 06.59 | 16554 | 48 44.0 | 16 21.7 | 1000 meters | D5 |
| | 07.40 | 16554 | 48 44.3 | 16 21.3 | CTD recovered | D5 |
| | 09.05 | 16555 | 48 33.0 | 16 21.7 | v/h on station D6 | D6 |
| | 09.15 | 16555 | 48 32.9 | 16 21.7 | CTD deployed | D6 |
| | 10.31 | 16555 | 48 32.6 | 16 21.7 | CTD recovered; emergency drill | D6 |
| | 11.00 | 16555 | 48 32.6 | 16 21.7 | Drill complete; proceeding to E6 | D6 |
| | 12.20 | 16556 | 48 33.0 | 16 05.5 | On station E6 | E6 |
| | 12.28 | 16556 | 48 33.0 | 16 05.5 | CTD deployed | E6 |
| | 13.41 | 16556 | 48 32.8 | 16 05.9 | CTD recovered; proceeding to E5 | E6 |
| | 15.02 | 16557 | 48 43.9 | 16 05.4 | On station E5 | E5 |
| | 15.08 | 16557 | 48 43.9 | 16 05.4 | CTD deployed | E5 |
| | 16.38 | 16557 | 48 43.9 | 16 05.4 | CTD recovered | E5 |
| | 16.50 | 16558 | 48 44.4 | 16 05.6 | Zubkov net deployed | E5 |
| | 17.05 | 16558 | 48 44.4 | 16 05.6 | Zubkov net recovered | E5 |
| | 18.30 | 16559 | 48 54.8 | 16 05.3 | CTD deployed | E4 |
| | 19.00 | 16559 | 48 54.9 | 16 05.2 | 1000 meters | E4 |
| | 20.00 | 16559 | 48 55.0 | 16 04.7 | CTD recovered | E4 |
| | 21.11 | 16560 | 49 05.4 | 16 05.3 | v/l on station | E3 |
| | 21.14 | 16560 | 49 05.4 | 16 05.3 | CTD deployed | E3 |
| | 22.32 | 16560 | 49 05.0 | 16 04.9 | CTD recovered | E3 |
| | 22.50 | 16560 | 49 06.3 | 16 04.9 | v/l on passage to E2 | E3 |
| | 24.00 | 16561 | 49 16.3 | 16 05.3 | v/l on site E2 | E2 |
| 25/7/09 | 00.10 | 16561 | 49 16.3 | 16 05.3 | CTD deployed | E2 |
| | 01.30 | 16561 | 49 16.0 | 16 04.9 | CTD recovered; proceeding to E1 | E2 |
| | 02.47 | 16562 | 49 26.8 | 16 05.3 | On station E1 | E1 |
| | 02.54 | 16562 | 49 26.8 | 16 05.3 | CTD deployed | E1 |
| | 04.15 | 16562 | 49 27.6 | 16 03.9 | CTD recovered | E1 |
| | 04.30 | 16563 | 49 27.6 | 16 03.9 | Plankton net deployed | E1 |
| | 04.50 | 16563 | 49 27.8 | 16 03.9 | Plankton net recovered | E1 |
| | 05.00 | 16563 | 49 28.0 | 16 03.0 | To CTD station | E1 |
| | 06.10 | 16564 | 49 27.0 | 15 48.9 | On station for CTD | F1 |
| | 06.24 | 16564 | 49 27.2 | 15 48.7 | CTD deployed | F1 |
| | 06.46 | 16564 | 49 27.4 | 15 48.3 | 1000 meters | F1 |
| | 07.30 | 16564 | 49 27.9 | 15 47.8 | CTD recovered | F1 |
| | 09.00 | 16565 | 49 20.9 | 15 48.7 | v/l on passage to F2 | F1 |
| | 10.00 | 16565 | 49 16.3 | 15 48.3 | On station; weather bound | F2 |
| | 12.00 | 16565 | 49 15.9 | 15 45.6 | Hove to in weather | F2 |
| | 14.50 | 16565 | 49 13.7 | 14 43.6 | v/l returning to F2 | F2 |
| | 15.35 | 16565 | 49 16.1 | 15 48.8 | v/l back on station | F2 |
| | 16.00 | 16565 | 49 16 | 15 48 | No overside work | F2 |
| | 18.00 | 16565 | 49 14 | 15 48 | No overside work | F2 |
| | 20.00 | 16565 | 49 13 | 15 49 | Hove to adverse weather | F2 |
| | 24.00 | 16565 | 49 11.5 | 15 53.5 | Hove to in heavy weather | F2 |
| 26/7/09 | 04.00 | 16565 | 49 11.5 | 15 59.7 | Hove to in heavy weather | F2 |
| | 05.00 | 16565 | 49 11.0 | 16 01.5 | v/l motion too lively for overside work or equipment recovery | F2 |
| | 07.00 | 16565 | 49 09.4 | 16 04.9 | v/l motion too lively for overside work or equipment recovery | F2 |
| | 08.30 | 16566 | 49 09.4 | 16 04.9 | Proceeding to Pelagras | |
| | 12.00 | 16566 | 49 25 | 15 32.2 | Search for Pelagra | |

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|---|---|---|---|---|---|---|
| | 14.15 | 16566 | 49 24.1 | 15 33.5 | P4 sighted | |
| | 14.45 | 16566 | 49 24.1 | 15 33.5 | Recovery attempts abandoned due to weather | P4 |
| | 15.55 | 16566 | 49 23.7 | 15 33.8 | P4 recovered | P4 |
| | 16.15 | 16566 | 49 23.7 | 15 34.9 | Remain hove to; passage to P2 | |
| | 21.? | 16567 | 49 57.5 | 15 37.6 | On approach | P2 |
| | 21.47 | 16567 | 49 57.5 | 15 37.6 | Line on; buoy I/B | P2 |
| | 22.10 | 16568 | 49 57.8 | 15 39.9 | CTD deployed | CTD |
| | 23.14 | 16568 | 49 57.8 | 15 40.2 | CTD recovered | CTD |
| | 24.00 | 16568 | 49 57.7 | 16 41.5 | v/l awaiting deck work complete | |
| 27/7/09 | 00.40 | 16568 | 49 57.0 | 15 43.4 | v/l secure; proceeding towards pelagras | |
| | 02.00 | 16568 | 49 49.0 | 15 52.6 | On passage to pelagra | |
| | 09.00 | 16568 | 49 00.6 | 16 22.1 | v/l on passage to P5 | |
| | 11.50 | 16568 | 48 41.7 | 16 35.7 | Buoy sighted | P5 |
| | 12.17 | 16568 | 48 41.6 | 16 35.6 | P5 recovered | |
| | 12.30 | 16568 | 48 41.6 | 16 35.6 | Proceeding to P7 | |
| | 14.00 | 16568 | 48 28.9 | 16 32.9 | On passage to P7 | P7 |
| | 15.20 | 16568 | 48 16.6 | 16 26.7 | On location; search for P7 | P7 |
| | 18.47 | 16568 | 48 12.9 | 16 21.0 | P7 recovered | P7 |
| | 19.10 | 16568 | 48 13.0 | 16 21.9 | Next pelagra, P6 | |
| | 21.00 | 16569 | 48 28.4 | 16 18.9 | On passage to P6 | |
| | 22.00 | 16569 | 48 39.1 | 16 17.4 | Sighted | P6 |
| | 22.39 | 16569 | 48 39.1 | 16 17.4 | P6 recovered | P6 |
| | 23.44 | 16569 | 48 39.6 | 16 18.2 | Passage to core site | |
| 28/7/09 | 01.30 | 16570 | 48 50.5 | 16 29.9 | On location core site | |
| | 01.42 | 16570 | 48 50.5 | 16 29.9 | Corer deployed | Core |
| | 03.50 | 16570 | 48 49.6 | 16 28.5 | Corer at 4700; reduced to 10m/min | Core |
| | 03.56 | 16570 | 48 49.6 | 16 28.5 | Increase veer to 15 m/min | Core |
| | 04.20 | 16570 | 48 49.3 | 16 28.0 | On bottom at 5061m wire out; problems with scrolling on coring winch at 4550 m | Core |
| | 05.15 | 16570 | 48 49.3 | 16 28.0 | 4360m wire out | Core |
| | 05.27 | 16570 | 48 49.3 | 16 28.0 | Paying out 4307 m (wo) to remove gaps in the winch | Core |
| | 05.50 | 16570 | 48 48.2 | 16 27.3 | Stop at 4934 m (wo); commence recovery | Core |
| | 07.50 | 16570 | 48 47.0 | 16 27.2 | Corer recovered | Core |
| | 10.00 | 16571 | 48 59.0 | 16 29.7 | v/l stopped for deployment | Aries |
| | 10.20 | 16571 | 48 58.8 | 16 30.2 | Aries deployed | Aries |
| | 13.45 | 16571 | 48 59.6 | 16 41.9 | Aries recovered | Aries |
| | 14.23 | 16572 | 48 59.7 | 16 41.7 | CTD deployed | |
| | 14.56 | 16572 | 48 59.7 | 16 41.7 | CTD recovered | |
| | 15.43 | 16573 | 48 59.9 | 16 41.4 | Aries deployed | Aries |
| | 17.25 | 16573 | 49 01.0 | 16 45.8 | Scrolled at 1450m | Aries |
| | 19.05 | 16573 | 49 01.9 | 16 50.0 | Recovering Aries | Aries |
| | 19.10 | 16573 | 49 01.9 | 16 50.0 | Aries recovered | Aries |
| | 19.40 | 16574 | 49 01.8 | 16 49.9 | Zubkov net | Net |
| | 20.45 | 16574 | 49 01.1 | 16 50.2 | Net abandoned; move to deploy Pelagra | |
| | 21.12 | 16574 | 49 01.1 | 16 50.2 | Buoy O/B P2 | P2 |
| | 21.42 | 16575 | 49 01.4 | 16 50.1 | Buoy O/B P4 | P4 |
| | 22.00 | 16576 | 49 01.1 | 16 50.0 | Buoy O/B P5 | P5 |
| | 22.22 | 16577 | 49 01.1 | 16 50.0 | Buoy O/B P6 | P6 |
| | 22.41 | 16578 | 49 00.9 | 16 50.4 | Buoy O/B P7 | P7 |
| | 22.41 | 16578 | 49 00.9 | 16 50.4 | v/l preparing French CTD | CTD |
| | 23.22 | 16579 | 49 00.6 | 16 50.4 | CTD deployed | CTD |
| | 23.37 | 16579 | 49 00.5 | 16 50.6 | Problem CTD | CTD |

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|---|---|---|---|---|---|---|
| | | | | | recovered | |
| 29/7/09 | 00.44 | 16580 | 48 59.9 | 16 51.4 | CTD deployed | CTD |
| | 02.29 | 16580 | 48 59.0 | 16 52.7 | CTD recovered | CTD |
| | 03.06 | 16581 | 48 58.9 | 16 53.2 | Net deployed | Net |
| | 03.29 | 16581 | 48 58.9 | 16 53.2 | Net recovered | Net |
| | 04.15 | 16582 | 48 58.8 | 16 54.5 | CTD deployed | CTD |
| | 04.30 | 16582 | 48 58.8 | 16 54.5 | 1000 meters | CTD |
| | 05.22 | 16582 | 48 58.7 | 16 55.3 | CTD recovered | CTD |
| | 05.55 | 16582 | 48 58.7 | 16 55.3 | Swell building up; no overside work | |
| | 06.15 | 16583 | 48 58.8 | 16 55.9 | CTD deployed | CTD |
| | 06.55 | 16583 | 48 58.9 | 16.56.1 | 1000 meters | CTD |
| | 07.42 | 16583 | 48 58.9 | 16 56.4 | CTD recovered | CTD |
| | 08.58 | 16584 | 48 59.0 | 16 56.3 | SAP wt deployed | SAPs |
| | 09.05 | 16584 | 48 59.0 | 16 56.3 | (x2) SAP units deployed | SAPs |
| | 09.14 | 16584 | 48 59.0 | 16 56.3 | + (x2) SAP units deployed | SAPs |
| | 12.22 | 16584 | 48 49.2 | 16 56.5 | SAPs recovered; proceeding to PAP3 | SAPs |
| | 14.20 | 16585 | 48 58.6 | 16 27.8 | On station PAP3 | PAP3 |
| | 15.00 | 16585 | 48 58.2 | 16 27.2 | Release fired | PAP3 |
| | 15.40 | 16585 | 48 58.0 | 16 27.3 | PAP3 mooring sighted | PAP3 |
| | 16.12 | 16585 | 48 58.2 | 16 27.5 | Mooring recovery | PAP3 |
| | 16.30 | 16585 | 48 58.2 | 16 27.5 | Sediment trap recovered | PAP3 |
| | 17.00 | 16585 | 48 58.2 | 16 27.5 | Sediment trap recovered | PAP3 |
| | 17.40 | 16585 | 48 57.3 | 16 27.8 | Float recovered | PAP3 |
| | 17.45 | 16585 | 48 57.3 | 16 27.8 | All recovered | PAP3 |
| | 18.50 | 16586 | 48 56.8 | 16 27.4 | French CTD deployed | French CTD |
| | 19.06 | 16586 | 48 56.7 | 16 27.4 | French CTD recovered (not working) | French CTD |
| | 20.23 | | 48 50.6 | 16 29.5 | v/l stopped at core site for CTD or SAPs | SAPs |
| | 21.06 | 16587 | 48 50.4 | 16 29.9 | SAP wt deployed | SAPs |
| | 21.18 | 16587 | 48 50.4 | 16 29.9 | +1 SAP unit attached to 400m | SAPs |
| | 21.34 | 16587 | 48 50.4 | 16 29.9 | +1 SAP unit attached to 150m | SAPs |
| | 21.43 | 16587 | 48 50.4 | 16 29.9 | +1 SAP unit attached to 150m | SAPs |
| | 21.52 | 16587 | 48 50.4 | 16 29.9 | +1 SAP unit attached to 150 m | SAPs |
| | 22.01 | 16587 | 48 50.4 | 16 29.9 | +1 SAP unit attached to 150m | SAPs |
| | 24.00 | 16587 | 48 50.0 | 16 30.7 | v/l holding for SAPs | SAPs |
| 30/7/09 | 00.46 | 16587 | 48 49.9 | 16 30.8 | SAP recovery | SAPs |
| | 02.07 | 16587 | 48 49.3 | 16 30.8 | SAP recovered | SAPs |
| | 02.38 | 16588 | 48 49.9 | 16 30.7 | French CTD deployed | French CTD |
| | 02.39 | 16588 | 48 49.9 | 16 30.7 | CTD recovered due to fault | French CTD |
| | 03.19 | 16588 | 48 49.9 | 16 30.7 | CTD failed, deployment aborted | French CTD |
| | 03.20 | 16588 | 48 49.9 | 16 30.7 | Proceeding to coring site | |
| | 03.30 | 16588 | 48 50.7 | 16 30.0 | On location | Corer |
| | 03.40 | 16588 | 48 50.7 | 16 30.0 | Corer deployed | Corer |
| | 06.00 | 16588 | 48 49.6 | 16 28.6 | Stop at 4700m (wo) | Corer |
| | 06.37 | 16588 | 48 49.3 | 16 28.1 | On bottom 5041 m wo; 5051 wo up | Corer |
| | 09.28 | 16588 | 48 47.9 | 16 27.3 | Corer recovered | Corer |
| | 10.20 | 16589 | 48 47.9 | 16 27.3 | Snowcatcher deployed | Snowcatcher |
| | 10.26 | 16589 | 48 47.9 | 16 27.3 | Snowcatcher recovered | Snowcatcher |
| | 11.11 | 16590 | 48 47.9 | 16 27.6 | Corer deployed | Corer |
| | 13.29 | 16590 | 48 47.9 | 16 27.3 | Corer at 4700m; veering at 10m/min | Corer |
| | 13.53 | 16590 | 48 47.9 | 16 27.3 | Corer on seabed; 4998m wo | Corer |

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| | 15.38 | 16590 | 48 48.0 | 16 26.3 | Hauling stopped, crossed wire on drum | Corer |
| | 15.42 | 16590 | 48 48.0 | 16 26.3 | Fault cleared | Corer |
| | 16.40 | 16590 | 48 47.7 | 16 25.2 | Corer recovered | Corer |
| | 16.48 | 16590 | 48 47.7 | 16 24.8 | Weather deteriorating; no overside work | |
| | 18.30 | 16590 | 48 46.1 | 16 23.6 | Heavy swell | |
| 31/7/09 | 08.20 | 16591 | 48 50.4 | 16 29.8 | French CTD deployed | CTD |
| | 11.02 | 16592 | 48 49.7 | 16 30.1 | CTD recovered | CTD |
| | 11.52 | 16592 | 48 49.5 | 16 30.5 | CTD deployed | CTD |
| | 14.10 | 16592 | 48 49.2 | 16 30.8 | CTD recovered | CTD |
| | 15.00 | 16593 | 48 49.0 | 16 30.5 | Snowcatcher deployed | Snowcatcher |
| | 15.08 | 16593 | 48 49.0 | 16 30.5 | Snowcatcher recovered | Snowcatcher |
| | 15.27 | 16594 | 48 49.0 | 16 30.4 | SAPs deployed (150 m) | SAPs |
| | 18.30 | 16594 | 48 47.9 | 16.29.9 | SAPs recovered | SAPs |
| | 19.27 | 16595 | 48 47.5 | 16 30.3 | Zubkov CTD deployed (15 m) | Zubkov CTD |
| | 21.12 | 16595 | 48 46.3 | 16 30.5 | CTD recovered | Zubkov CTD |
| | 21.58 | 16596 | 48 45.9 | 16 30.9 | Giering net deployed | Net |
| | 22.12 | 16596 | 48 45.9 | 16 30.9 | Net deployed | Net |
| | 22.14 | 16596 | 48 45.9 | 16 30.9 | Net recovered | Net |
| | 22.24 | 16596 | 48 45.9 | 16 30.9 | Net deployed | Net |
| | 22.25 | 16596 | 48 45.9 | 16 30.9 | Net recovered | Net |
| | 22.31 | 16596 | 48 45.9 | 16 30.9 | Net deployed | Net |
| | 22.33 | 16596 | 48 45.9 | 16 30.9 | Net recovered | Net |
| | 23.08 | 16596 | 48 45.9 | 16 30.9 | Net deployed | Net |
| | 23.34 | 16597 | 48 44.9 | 16 31.4 | CTD deployed | CTD |
| 01/8/09 | 00.07 | 16598 | 48 44.8 | 16 31.7 | CTD recovered | CTD |
| | 00.52 | 16599 | 48 44.7 | 16 32.1 | SAPs deployed | SAPs |
| | 01.48 | 16599 | 48 44.6 | 16 32.3 | SAPs at 1000 m | SAPs |
| | 05.07 | 16599 | 48 44.1 | 16 32.5 | SAPs recovered | SAPs |
| | 05.22 | 16600 | 48 44.1 | 16 32.4 | Net deployed | Net |
| | 05.35 | 16600 | 48 44.1 | 16 32.4 | Net recovered | Net |
| | 05.38 | 16601 | 48 44.0 | 16 32.5 | Net deployed | Net |
| | 05.45 | 16601 | 48 43.9 | 16 32.4 | Net recovered | Net |
| | 05.48 | 16602 | 48 43.9 | 16 32.4 | Net deployed | Net |
| | 05.52 | 16602 | 48 43.9 | 16 32.4 | Net recovered | Net |
| | 06.15 | 16603 | 48 43 7 | 16 32.5 | Deployment French drifter | Drifter |
| | 07.26 | 16604 | 48 43.3 | 16 33.1 | CTD deployed | CTD |
| | 08.46 | 16604 | 48 42.5 | 16 33.2 | CTD recovered | CTD |
| | 09.23 | 16605 | 48 42.2 | 16 33.3 | Snowcatcher deployed | Snowcatcher |
| | 09.31 | 16605 | 48 42.2 | 16 33.3 | Snowcatcher recovered | Snowcatcher |
| | 10.08 | 16606 | 48 41.8 | 16 33.4 | French CTD deployed | CTD |
| | 13.32 | 16606 | 48 40.7 | 16 34.3 | CTD recovered | CTD |
| | 14.20 | 16607 | 48 40.7 | 16 35.1 | Aries deployed | Aries |
| | 18.10 | 16607 | 48 40.3 | 16 49.2 | Aries recovered | Aries |
| | 19.14 | 16608 | 48 40.5 | 16 46.5 | Aries deployed | Aries |
| | 22.45 | 16608 | 48 37.3 | 16 33.3 | Aries recovered | Aries |
| 02/8/09 | 01.30 | 16609 | 48 38.3 | 16 33.9 | CTD deployed | CTD |
| | 03.50 | 16609 | 48 38.2 | 16 33.7 | CTD recovered | CTD |
| | 10.54 | 16610 | 48 36.6 | 16 35.5 | French drifter recovered | Drifter |
| | 13.48 | 16611 | 48 47.0 | 16 51.4 | P6 recovered | P6 |
| | 15.00 | 16612 | 48 47.6 | 16 57.7 | P5 recovered | P5 |
| | 18.00 | 16613 | 48 54.8 | 17 01.9 | P4 recovered | P4 |
| | 21.07 | 16614 | 49 04.8 | 16 31.7 | P4 recovered | P2 |
| | 21.45 | 16615 | 49 03.4 | 16 26.4 | P7 recovered | P7 |
| | 22.28 | 16616 | 49 03.3 | 16 26.0 | French CTD deployed | CTD |
| 03/8/09 | 00.52 | 16616 | 49 02.2 | 16 26.0 | CTD recovered | CTD |
| | 01.32 | 16617 | 49 01.8 | 16 25.8 | Net deployed | Net |
| | 02.38 | 16617 | 49 01.5 | 16 25.9 | Net recovered | Net |
| | 03.00 | 16618 | 49 01.1 | 16 26.1 | CTD deployed | CTD |
| | 04.20 | 16618 | 49 00.2 | 16 25.7 | CTD recovered | CTD |

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| | 05.20 | 16619 | 48 39.6 | 16 25.5 | CTD deployed | CTD |
| | 06.55 | 16619 | 48 58.6 | 16 25.5 | CTD recovered | CTD |
| | 07.15 | 16620 | 48 58.3 | 16 25.0 | Snowcatcher deployed | Snowcatcher |
| | 07.20 | 16620 | 48 58.3 | 16 25.0 | SC recovered | Snowcatcher |
| | 08.09 | 16621 | 48 57.9 | 16 24.5 | SAPs deployed | SAPs |
| | 11.16 | 16621 | 48 55.8 | 16 23.4 | SAPs recovered | SAPs |
| | 12.02 | 16622 | 48 55.2 | 16 23.3 | P2 deployed | P2 |
| | 12.28 | 16623 | 48 55.1 | 16 23.3 | P4 deployed | P4 |
| | 12.51 | 16624 | 48 54.9 | 16 23.2 | P5 deployed | P5 |
| | 13.17 | 16625 | 48 54.8 | 16 23.2 | P6 deployed | P6 |
| | 13.42 | 16626 | 48 54.8 | 16 23.4 | P7 deployed | P7 |
| | 15.57 | 16627 | 48 43.8 | 16 05.4 | CTD deployed | CTD |
| | 17.15 | 16627 | 48 43.0 | 16 05.3 | CTD recovered | CTD |
| | 19.20 | 16628 | 48 43.8 | 16 21.6 | CTD deployed | CTD |
| | 20.32 | 16628 | 48 43.0 | 16 22.1 | CTD recovered | CTD |
| | 22.32 | 16629 | 48 43.8 | 16 37.8 | CTD deployed | CTD |
| | 23.43 | 16629 | 48 43.4 | 16 38.3 | CTD recovered | CTD |
| 04/8/09 | 01.45 | 16630 | 48 43.9 | 16 54.5 | CTD deployed | CTD |
| | 03.28 | 16630 | 48 43.4 | 16 54.8 | CTD recovered | CTD |
| | | | | | | Adverse weather conditions |
| 05/8/09 | 13.05 | 16631 | 48 54.8 | 16 54.4 | CTD deployed | B4 |
| | 14.52 | 16631 | 48 54.8 | 16 54.4 | CTD recovered | B4 |
| | 16.30 | 16632 | 49 05.4 | 16 34.5 | CTD deployed | B3 |
| | 17.50 | 16632 | 49 05.1 | 16 54.1 | CTD recovered | B3 |
| | 19.20 | 16633 | 49 05.2 | 16 37.9 | CTD deployed | C3 |
| | 20.43 | 16633 | 49 05.2 | 16 37.9 | CTD recovered | C3 |
| | 22.07 | 16634 | 49 05.3 | 16 22.1 | CTD deployed | D3 |
| | 23.45 | 16634 | 49 04.7 | 16 22.7 | CTD recovered | D3 |
| 06/8/09 | 01.22 | 16635 | 49 05.3 | 16 05.4 | CTD deployed | E3 |
| | 03.18 | 16635 | 49 04.2 | 16 05.3 | CTD recovered | E3 |
| | 05.00 | 16636 | 48 54.4 | 16 05.3 | CTD deployed | E4 |
| | 06.08 | 16636 | 48 53.8 | 16 05.9 | CTD recovered | E4 |
| | 08.48 | 16637 | 49 01.5 | 16 28.0 | SAPs deployed | SAPs |
| | 10.56 | 16637 | 49 00.1 | 16 27.5 | SAPs recovered | SAPs |
| | 11.10 | 16638 | 48 59.8 | 16 27.7 | SAPs deployed | SAPs |
| | 12.55 | 16638 | 48 59.8 | 16 27.7 | SAPs recovered | SAPs |
| | 13.19 | 16639 | 48 57.8 | 16 28.2 | SAPs deployed | SAPs |
| | 15.32 | 16639 | 48 55.9 | 16 29.9 | SAPs recovered | SAPs |
| | 15.48 | 16640 | 48 53.8 | 16 30.1 | CTD deployed | CTD |
| | 18.14 | 16640 | 48 33.0 | 16 32.7 | CTD recovered | CTD |
| | 18.35 | 16641 | 48 54.9 | 16 33.0 | Zubkov net deployed | Net |
| | 19.00 | 16641 | 48 54.9 | 16 33.4 | Zubkov net recovered | Net |
| | 21.48 | 16642 | 48 50.1 | 16 58.7 | Pelagra recovered | P4 |
| | 22.28 | 16643 | 48 47.1 | 17 01.8 | Pelagra recovered | P2 |
| | 23.36 | 16644 | 48 48.7 | 17 01.5 | Pelagra recovered | P5 |
| 07/8/09 | 00.00 | 16645 | 48 49.6 | 17 01.7 | Pelagra recovered | P6 |
| | 00.32 | 16646 | 48 50.6 | 17 03.0 | Pelagra recovered | P7 |
| | 03.09 | 16647 | 49 02.0 | 16 29.8 | Net deployed | Net |
| | 03.51 | 16647 | 49 01.5 | 16 29.5 | Net recovered | Net |
| | 04.15 | 16648 | 49 00.6 | 16 29.3 | French CTD deployed | French CTD |
| | 07.24 | 16648 | 48 58.9 | 16 29.3 | French CTD recovered | French CTD |
| | 09.17 | 16649 | 49 02.1 | 16 29.2 | IODA Transponder deployed | IODA |
| | 09.46 | 16649 | 49 02.1 | 16 28.9 | Transponder recovered | IODA |
| | 13.24 | 16649 | 48 56.3 | 16 32.6 | IODA recovery commenced | IODA |
| | 16.45 | 16649 | 48 54.1 | 16 32.6 | IODA onboard | IODA |
| | 17.08 | 16650 | 48 53.8 | 16 32.6 | CTD deployed | CTD |
| | 17.12 | 16650 | 48 53.7 | 16 32.6 | CTD recovered | CTD |
| | 17.27 | 16651 | 48 53.4 | 16 32.6 | Zubkov net deployed | Net |
| | 17.52 | 16651 | 48 53.1 | 16 32.5 | Zubkov net recovered | Net |
| | 19.40 | 16652 | 48 55.9 | 16 45.8 | Aries deployed | Aries |
| | 23.34 | 16653 | 48 48.7 | 16 57.5 | Aries recovered | Aries |
| 08/8/09 | 00.13 | 16654 | 48 48.5 | 16 58.2 | SAPs deployed | SAPs |
| | 03.27 | 16654 | 48 48.1 | 16 59.3 | SAPs recovered | SAPs |
| | 03.52 | 16655 | 48 48.1 | 16 59.3 | CTD deployed | CTD |

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| | 04.25 | 16655 | 48 48.0 | 16 59.4 | CTD recovered | CTD |
| | 04.37 | 16656 | 48 47.9 | 16 59.4 | Net deployed | Net |
| | 05.03 | 16656 | 48 47.9 | 16 59.3 | Net recovered | Net |
| | 05.17 | 16657 | 48 47.9 | 16 59.3 | SAPs deployed | SAPs |
| | 06.37 | 16657 | 48 47.5 | 16 58.9 | SAPs recovered | SAPs |
| | 07.07 | 16658 | 48 47.6 | 16 58.8 | CTD deployed | CTD |
| | 08.52 | 16658 | 48 47.5 | 16 59.1 | CTD recovered | CTD |
| | 10.08 | 16659 | 48 47.4 | 16 59.6 | CTD deployed | CTD |
| | 11.29 | 16659 | 48 57.1 | 16 59.8 | CTD recovered | CTD |
| | 12.04 | 16660 | 48 47.0 | 16 59.7 | Snowcatcher deployed | Snowcatcher |
| | 12.20 | 16660 | 48 47.0 | 16 59.7 | Snowcatcher recovered | Snowcatcher |
| | 14.02 | 16661 | 48 55.0 | 16 47.0 | Aries deployed | Aries |
| | 17.54 | 16661 | 48 48.6 | 16 58.7 | Aries recovered | Aries |
| | 20.24 | 16662 | 48 50.5 | 16 30.0 | CTD deployed | CTD |
| | 21.36 | 16662 | 48 50.7 | 16 30.4 | CTD recovered | CTD |
| | 22.28 | 16663 | 48 50.7 | 16 30.3 | Corer deployed | Corer |
| 09/8/09 | 01.16 | 16663 | 48 50.0 | 16 30.6 | Corer on seabed | Corer |
| | 03.42 | 16663 | 48 48.9 | 16 31.2 | Corer recovered | Corer |
| | 05.15 | 16664 | 49 02.0 | 16 29.4 | Mooring release site | Mooring release |
| | 07.12 | 16665 | 49 02.1 | 16 28.7 | CTD deployed | CTD |
| | 10.35 | 16665 | 49 01.0 | 16 28.9 | CTD recovered | CTD |
| | 12.35 | 16666 | 48 50.3 | 16 29.8 | SAPs deployment commences | SAPs |
| | 14.50 | 16666 | 48 48.2 | 16 29.4 | SAPs deployed | SAPs |
| | 19.40 | 16666 | 48 44.9 | 16 30.7 | SAPs recovered | SAPs |
| | 20.07 | 16667 | 48 44.5 | 16 31.2 | CTD recovered | CTD |
| | | | | | | END OF SCIENCE |

Nitrogen cycling

*Ian Brown, PML*

The objectives were to measure the assimilation of ammonia and nitrate, the regeneration of ammonium and the nitrification of ammonium to nitrate in surface waters at the PAP site focussing on vertical profiles of these N-cycling processes. Samples were collected by either filtration onto GF/F filters for analysis using a stable isotope mass spectrometer or onto SPE cartridges for analysis using HPLC and GCMS.

Samples were collected for:

$NH_4^+$ regeneration: Either micro/mesozooplankton excretion of $NH_4^+$ or bacterial degradation of dissolved organic N. The method does not separate the contribution from each of these processes. $NH_4^+$ regeneration rate changes with trophic status of the water mass. It also expresses diel variability in relation to DVM activity of zooplankton.

$NH_4^+$ oxidation: The first step of the nitrification process producing $NO_2^-$. This process may be an important source of nitrous oxide.

$NO_2^-$ oxidation: The second step of the nitrification process.

The combination of these experiments should provide a useful insight into N-dynamics within this region.

CTD's stations sampled:
16488, 16501, 16510, 16524, 16532, 16543, 16552, 16562, 16580, 16597, 16609, 16618, 16635 and 16655

Samples were taken for:

1. N-assimilation at 55% 33% 20% 7% and 1% sPAR. Using $^{15}N$-tecniques, the theoretical maximum rate of $NO_3^-$and $NH_4^+$ assimilation ($V_{max}$) and half saturation constant ($K_s$) will be determined.
2. $NH_4^+$ regeneration at 55% 33% 20% 7% and 1% sPAR. Using isotope dilution techniques the rate of $NH_4^+$ regeneration will be measured and used to correct $NH_4^+$ assimilation rate data.
3. Nitrification at 55% 33% 20% 7% and 1% sPAR

Delivery of results:
Results should be available within 6 months of receiving frozen samples.

Microbial processes using high pressure sampling systems

*Mehdi Boutrif & Christian Tamburini (LMGEM)*

Our main aim during this cruise was to estimate the role of prokaryotes in the degradation of the organic matter in the whole water column with a special emphasis in the meso- and upper bathypelagic waters.

To achieve this we used special high-pressure (HP) systems with common units known as high-pressure bottles (HPBs). These were fitted on a Sea-Bird Carousel with Niskin bottles (called thereafter HPSS for High Pressure Serial Sampler) in order to measure *in situ* prokaryotic activities. They were also used to simulate the pressure that attached microbes experience as they sink through the water column.

Hence, during D341 4 tasks were undertaken:

- Task 1 – Prokaryotic structure
- Task 2 – Activity in the whole water column
- Task 3 – SINking PArticles Simulation
- Task 4 – High-pressure bacteria cultivation from deep sediments

*Task 1 – Prokaryotic structure*

*Cast number 009, Station 16253 (20 July 09).*

Depth sampled: 5, 25, 50, 100, 200, 300, 500, 750, 1000, 2000, 3000 m. Different volumes of seawater were sampled. Formalin was added (2% final volume). A subsample was analyzed by flow cytometry by the Zubkov team. After an overnight incubation, samples were filtrated onto 0.2 µm for further analyses at the lab (CARD-FISH, prokaryotic cell counts, biovolume).

We sampled particles from PELAGRA at different depth: 50, 150 and 1000m. Further analyses on the RNA and DNA will be done to determine prokaryotes attached to particles.

We also sampled particles from SAPS at 150 and 1000m depth on 53µm-pore-size filters and GFF filters. Further analyses will be done in the lab.

Finally, we sampled seawater to determine free-living prokaryotes. The ultimate aim is to determine both prokaryotic communities (free-living and attached-to-particles).

*Task 2 – Prokaryotic activity under in situ conditions*

This task was closely related to the $IODA_{6000}$ mooring deployment.

Only 6 HPSS were done during the PAP D341 cruise reducing our chance to well validate the results obtained. To increase this, we have finally focused more our attention on the task 2.1 and 2.2.

*Task 2.1. Heterotrophic prokaryotic production (PHP with $^3$H-Leu) and Dark $CO_2$ Fixation (DCF)*

The aim of this task is to better estimate the PHP (under *in situ* conditions) in order to have a better estimate prokaryotic carbon demand (PCD) in meso- and bathypelagic waters. For such an aim, we:

determined PHP at the same level of $IODA_{6000}$ incubation: 10, 200, 500, 1000, 2000m-depth.

performed experiments to determine conversion factors for PHP with $^3$H-leucine: 500, and 2000m-depth.

sampled to do Micro-CARD-FISH analyses (further in the lab) in order to determine who do what in the meso- and bathypelagic waters.

Several profiles have been done during the PAP D341. Analyses have been done on board the ship. Interpretation of these analyses will be done later.

*Task 2.2. Labile vs semi-labile compounds degradation*

The aim of this task is to evaluate the capacity of meso- and bathypelagic prokaryotes to degrade semi-labile organic compounds. Indeed, the quality of the organic matter in both environments suggests that prokaryotes have to find their source of carbon and energy in the semi-labile pool of the organic matter. Hence, we have tested their capacities to use exopolysaccharides (EPS) in the meso- and bathypelagic waters. It was the first experiment done in meso- and bathypelagic waters in the Atlantic ocean under in situ pressure and temperature conditions. Several profiles have been done during the PAP D341. Analyses were done on board the ship. Interpretation of these analyses will be done later.

*Task 2.3. Ectoenzymatic activity (EEA): aminopeptidase (EAA), phosphatase (PA)*
The aim of this task was to estimate one of the preliminary and obligatory steps that prokaryotes use to degrade high molecular weight DOM to low molecular weight DOM. Fist attempts, in the deep-sea waters of Atlantic Ocean, have been done to determine the effect of pressure on these ectoenzymatic activities. First results obtained during the PAP cruise confirm our previous results in Mediterranean Sea (Tamburini et al., 2003, 2009), i-e., that aminopeptidase and phosphatase activities were higher under in situ pressure conditions than their decompressed counterparts.

Task 3 –PArticles Sinking Simulation (PASS)

2 experiments were done, one with the first deployment of the PELAGRA, the other with the second one.

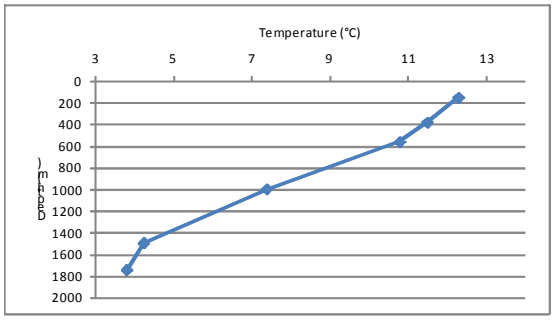
SINPAP#1 experiment:
The first sinking particles simulation experiment done at the PAP site was done with particles recovered from surface waters and incubated with natural prokaryotic assemblage recovered at 150m-depth. After splitting, particles were incubated over 5 days in 4 HPBs and 4 atmospheric bottles (ATM). Pressure was increased in order to simulate a fall of particles of 200m.d$^{-1}$ (for further details see Tamburini et al., 2009). Table 1 shows the days where we took one pair of HP and ATM bottles for sub-sampling. Sub-sampling has been done for further analyses in the laboratory (Bsi, DSi, DOC, POC, carbohydrates, lipids, PIC, DIC, TIC, PHP, TEP and oxygen consumption).

*Table 1. Depth simulated at the different time of sub-sampling during the SINPAP#1 experiment done on board the RSS Discovery during the PAP D341 cruise*

| Time (d) | Depth simulated (m) | Pressure (MPa) |
|---|---|---|
| Time 0 (26/07/09) | 150 | 1.5 |
| 1 | 350 | 3.5 |
| 2 | 550 | 5.5 |
| 3 | 750 | 7.5 |
| 5 | 1150 | 11.5 |

At the same time, we decreased the temperature in the water bath to simulate the decrease of temperature that particles and attached bacteria experience during their fall (Fig. 1).

*Figure 1. Temperature ramp during the SINPAP#1 experiment done on board the RSS Discovery during the PAP D341 cruise.*



Because of lack of communication, the first experiment was done using 150m-depth seawater with particles obtained in surface waters. So, this experiment would be consider more like a test than an experiment attempting to simulate the fall of particles through the mesopelagic waters.

SINPAP#2 experiment:
The second sinking particles simulation experiment done at the PAP site was undertaken with particles recovered at 50m-depth incubated with a natural prokaryotic assemblage recovered at 50m-depth.

After splitting, particles have been incubated during 5 days in 5 HPBs and 5 atmospheric bottles (ATM). Pressure was increased in order to simulate a fall of particles of 200m.d$^{-1}$. Table 2 shows the days where we have taken one pair of HP and ATM bottles for sub-sampling. Sub-sampling has been done for further analyses in the laboratory (Bsi, DSi, DOC, POC, carbohydrates, lipids, PIC, DIC, TIC, PHP, TEP and oxygen consumption).

*Table 2. Depth simulated at the different time of sub-sampling during the SINPAP#2 experiment done on board the RSS Discovery during the PAP D341 cruise*

| Time (d) | Depth simulated (m) | Pressure (MPa) |
|---|---|---|
| Time 0 (03/08/09) | 50 | 0.5 |
| 1 | 250 | 2.5 |
| 2 | 450 | 4.5 |
| 4 | 850 | 8.5 |
| 6 | 1250 | 12.5 |

At the same time, we have decreased the temperature in the water bath to simulate the decrease of temperature than particles and attached bacteria experience during their fall (Fig. 2).

*Figure 2. Temperature ramp during the SINPAP#2 experiment done on board the RSS Discovery during the PAP D341 cruise.*

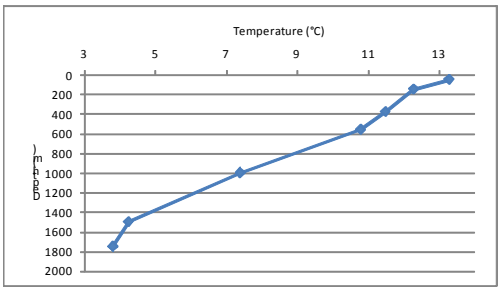



*Table 3. HPSS experiments undertaken during the PAP D341 cruise*

| Date | Number | Depth sampled | Activity done under in situ pressure conditions |
|---|---|---|---|
| 15/07/09 | HPSS01 – Station n° 16489 | 25, 500, 2000, 3000m | EPS degradation in triplicate<br>PHP in triplicate |
| 17/07/09 | HPSS02 – Station n° 16506 | 25, 500, 1000, 2000m | EAA activity in triplicate<br>EPA activity in triplicate<br>PHP in triplicate |
| 28/07/09 | HPSS03 – Station n° - Cast | | CTD failed |
| 29/07/09 | HPSS03 – Station n° 16588 - Cast | | CTD failed |
| 31/07/09 | HPSS03 – Station n° 16591- Cast 046 | 25, 150, 500, 1000, 2000m | EPS degradation in triplicate<br>Glu activity in triplicate<br>Dark CO2 fixation |
| 01/08/09 | HPSS04 – Station n° 16606- Cast 050 | 25, 500, 2000m | PHP in triplicate<br>EPA activity in triplicate<br>EPS degradation in triplicate |
| 02/08/09 | HPSS05 – Station n° 16616- Cast 052 | 50, 150, 2000m | PHP experiment to determine isotopic dilution in meso- and bathypelagic |

| | | | |
|---|---|---|---|
| | | | waters |
| 07/08/09 | HPSS06 – Station n° 16648- Cast 066 | 50, 150, 2000m | Dark CO2 fixation<br>Glu activity in triplicate<br>PHP in triplicate (in saturated and low concentration) |

Task 4 – Prokaryotic structure and activity (under *in situ* conditions)

This experiment was done using 900 ml of sediments recovered at the PAP site during the last coring. Sediments were then mixed with petroleum and incubated under high pressure (45 MPa), at 4°C and in anoxic conditions. The aim of this experiment is to attempt firstly isolation of hydrocarbonoclastic sulfato-bacteria and secondly to evaluate capacity of natural prokaryotic community from the sediments to degrade hydrocarbons under high pressure and low temperature conditions and in anoxic conditions, extreme conditions being an industrial interest. The incubation will be continued in the lab with further analyses.

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Dinoflagellate Bioluminescence

*Charlotte Marcinko, Stuart Painter (NOCS)*

The objectives of the D341 study were to (1) test new modifications made to the bench top bioluminescence instrument, GLOWtracka; (2) identify whether bioluminescent dinoflagellates are present at the Porcupine Abyssal Plain; (3) assess their horizontal and vertical distribution in the water column; (4) characterise the taxonomic composition of bioluminescent dinoflagellates. Experiments were also carried out to investigate variability in the bioluminescence signal recorded due to either natural controls or the sampling methods used. These experiments were designed to assess whether a circadian clock controls the activity of bioluminescence; investigate the affects of daytime light exposure upon night time bioluminescence and investigate the affects of flow speed through the instrument upon the bioluminescence signal.

To meet these objectives a total of 58 CTD casts have been sampled for stimulated bioluminescence and the presence (DNA) of the dinoflagellate luciferase gene. Lugols preserved samples have been collected at all corresponding stations, unless stated, which will be used for microscopic analysis. Measurements were consistently taken from near surface depths (typically 5 m) and a wider range of depths were sampled when water availability and time permitted.

Measurements of stimulated bioluminescence were taken using a GLOWtracka bathyphotometer manufactured by the Chelsea Technologies Group which has been modified for bench top use. Our bench top system is designed to provide measurements of stimulated bioluminescence, at a frequency of 1 kHz, from a constant flow of water. The voltage potential recorded can be converted into units of photons $cm^{-2}$ $sec^{-1}$ using a set calibration equation provided by the manufacturers. Specifically this apparatus was setup in such a way as to maximise the recording of light emission from any bioluminescent dinoflagellates species that may have been present in a water sample. All data from the instrument were recorded using Agilent VEE release 8.5 software and stored in a comma-separated variables (.csv) format. Data were stored using a standard file naming convention as follows 'disconnnnn_dddm_vl.csv' where 'nnnnn' was the RRS Discovery instrument deployment number followed by 'ddd' which represented the depth of the sample and 'v' which represented the sample volume.

Cruise D341 provided an opportunity to test modifications made to the bench top GLOWtracka instrument. These included the addition of a flowmeter to measure the flow rate through the instrument and a new larger sample settling chamber. The new settling chamber proved to be considerably more light tight than the original and thus the noise level of the signal was reduced. The larger chamber also made it possible to vary the volume of water sampled. Therefore, enabling the flow rate through the instrument to be varied by increasing or reducing the head of water in the chamber.

*Replicate Measurements*

Replicate measurements were made for 2 litre and 4 litre sample volumes in order to calculate the confidence interval in the bioluminescence measurements made (Table 4).

*Table 4 Sampling information for replicate measurements made for 2 litre and 4 litre sample volumes.*

| Station number | Depth (m) | Niskin Bottle Number | Day Of Year | Sample Volume (Litres) | Time Run through Instrument (GMT) | Number of Replicates Run |
|---|---|---|---|---|---|---|
| 16592 | 5 | 21,20,19 | 212 | 2 | 15:00 | 10 |
| 16592 | 5 | 21,20,19 | 212 | 2 | 23:00 | 10 |
| 16609 | 5 | 20,21,22 | 214 | 4 | 15:00 | 10 |
| 16609 | 5 | 23,24 | 214 | 4 | 23:00 | 10 |

*Flow Variation Experiments*

The affect of flow rate upon the bioluminescence signal was investigated by varying the sample volume run through the GLOWtracka. One, two, three and four litre volumes of water collected from the same depth on the same CTD cast were used for each experiment. The experiments were repeated three times (Table 5).

*Table 5. Sampling information for flow variation measurements made for 1, 2, 3 and 4 litre sample volumes.*

| CTD Cast Number | Depth (m) | Niskin Bottle Number | Day Of Year | CTD Sample Time (GMT) | Sample Volume (Litres) | Number of Replicates Run |
|---|---|---|---|---|---|---|
| 16514 | 5 | 17 and 18 | 200 | 18:30 | 1 | 3 |
| 16514 | 5 | 17 and 18 | 200 | 18:30 | 2 | 3 |
| 16514 | 5 | 17 and 18 | 200 | 18:30 | 3 | 3 |
| 16514 | 5 | 17 and 18 | 200 | 18:30 | 4 | 3 |
| 16568 | 5 | 15 and 16 | 207 | 23:15 | 1 | 3 |
| 16568 | 5 | 15 and 16 | 207 | 23:15 | 2 | 3 |
| 16568 | 5 | 15 and 16 | 207 | 23:15 | 3 | 3 |
| 16568 | 5 | 15 and 16 | 207 | 23:15 | 4 | 3 |
| 16618 | 5 | 23 | 215 | 04:20 | 1 | 1 |
| 16618 | 5 | 23 | 215 | 04:20 | 2 | 1 |
| 16618 | 5 | 23 | 215 | 04:20 | 3 | 1 |
| 16618 | 5 | 23 | 215 | 04:20 | 4 | 1 |

*Biological Sampling Stations*

Bioluminescence, DNA and microscopy data were collected from a number of over night biological stations which constituted several CTD casts to provide a wide range of biological measurements.

*Table 6. Overview of cast, niskin bottles and sample depths for measurements of bioluminescence and the collection of samples for molecular and microscopic analysis (those stations marked with * indicates no data for microscopy taken).*

| CTD Cast Number | Depth (m) | Niskin Bottle Number | CTD Sample Time (GMT) | Day of Year | Sample Volume (Litres) |
|---|---|---|---|---|---|
| 16477* | 5, 25 and 100 | 24, 22 and 14 | 15:00 | 194 | 2 |
| 16486* | 5, 35 and 125 | 16, 11 and 3 | 17:33 | 195 | 2 |
| 16488 | 6 and 32 | 23 and 12 | 02:07 | 196 | 2 and 4 |
| 16497* | 5, 25 and 50 | 24, 22 and 20 | 11:32 | 197 | 2 |
| 16510 | 6 and 35 | 24 and 15 | 06:10 | 201 | 2 |
| 16514 | 6 | 17 | 18:30 | 201 | 2 |

*CTD Survey 1*

Bioluminescence, DNA and microscopy data were collected from all CTD stations during the mesoscale survey which took place between day of year (DOY) 202 and 206 inclusive (Table 4). Samples that were collected from the CTD were stored in blacked out carboys within a darkened area of the constant temperature lab where the temperature was 16 ˚C whilst waiting to be run through the GLOWtracka.

*Table 7. Overview of CTD cast, niskin bottles and sample depths for measurements of bioluminescence and the collection of samples for molecular and microscopic analysis for mesoscale CTD survey 1.*

| Station Number | CTD Cast Number | Depth (m) | Niskin Bottle Number | CTD Sample Time (GMT) | Day of Year | Sample Volume (Litres) |
|---|---|---|---|---|---|---|
| A6 | 16523 | 5 and 25 | 21 and 19 | 18:30 | 202 | 2 |
| A5 | 16524 | 5 and 25 | 24 and 16 | 00:52 | 202 | 2 |
| A4 | 16526 | 5 and 25 | 14 and 13 | 04:04 | 202 | 2 |
| A3 | 16528 | 5 and 25 | 21 and 19 | 14:00 | 202 | 2 |
| A2 | 16529 | 5 and 25 | 23 and 21 | 17:47 | 202 | 2 |
| A1 | 16531 | 5 and 25 | 21 and 19 | 21:40 | 202 | 2 and 4 |
| B1 | 16532 | 5 and 25 | 21 and 19 | 00:35 | 203 | 2 and 4 |
| B2 | 16533 | 5 and 25 | 24 and 19 | 03:41 | 203 | 2 and 4 |
| B3 | 16535 | 5 and 25 | 23 and 19 | 06:48 | 203 | 2 and 4 |
| B4 | 16536 | 5 and 25 | 22 and 19 | 09:28 | 203 | 2 and 4 |
| B5 | 16537 | 5 and 25 | 21 and 19 | 12:45 | 203 | 2 and 4 |
| B6 | 16539 | 5 and 25 | 21 and 19 | 15:28 | 203 | 2 and 4 |
| C6 | 16541 | 5 and 25 | 21 and 19 | 19:19 | 203 | 2 and 4 |
| C5 | 16542 | 5 and 25 | 21 and 19 | 22:07 | 203 | 2 and 4 |
| C4 | 16543 | 5 and 25 | 22 and 16 | 01:13 | 204 | 2 and 4 |
| C3 | 16544 | 5 and 25 | 24 and 22 | 04:24 | 204 | 2 and 4 |
| C2 | 16546 | 5 and 25 | 23 and 21 | 12:25 | 204 | 2 and 4 |
| C1 | 16548 | 5 and 25 | 22 and 19 | 16:49 | 204 | 2 and 4 |
| D1 | 16549 | 5 and 25 | 22 and 19 | 19:17 | 204 | 2 and 4 |
| D2 | 16550 | 5 and 25 | 21 and 19 | 22:17 | 204 | 2 and 4 |
| D3 | 16551 | 5 and 25 | 23 and 21 | 01:13 | 205 | 2 and 4 |
| D4 | 16552 | 5 and 25 | 23 and 17 | 04:13 | 205 | 2 and 4 |
| D5 | 16554 | 5 and 25 | 23 and 19 | 07:40 | 205 | 2 and 4 |
| D6 | 16555 | 5 and 25 | 21 and 19 | 09:30 | 205 | 2 and 4 |
| E6 | 16556 | 5 and 25 | 22 and 20 | 13:42 | 205 | 2 and 4 |
| E5 | 16557 | 5 and 25 | 22 and 21 | 16:37 | 205 | 2 and 4 |
| E4 | 16559 | 5 and 25 | 23 and 21 | 19:55 | 205 | 2 and 4 |
| E3 | 16560 | 5 and 25 | 21 and 19 | 22:31 | 205 | 2 and 4 |
| E2 | 16561 | 5 and 25 | 22 and 20 | 01:31 | 206 | 2 and 4 |
| E1 | 16562 | 5 and 25 | 23 and 18 | 04:18 | 206 | 2 and 4 |
| F1 | 16564 | 5 and 25 | 23 and 19 | 07:27 | 206 | 2 and 4 |

*CTD Survey 2*

Bioluminescence, DNA and microscopy data were collected from all CTD stations during the second mesoscale survey which took place between day of year (DOY) 215 and 218 inclusive. As with CTD survey 1, samples that were collected from the CTD were stored in the constant temperature lab at 16 ˚C in continuous darkness whilst waiting to be run through the GLOWtracka. All Samples taken were run between the hours of 22:00 and 23:00 GMT.

*Table 8:Overview of stations, niskin bottles and sample depths for measurements of bioluminescence and the collection of samples for molecular and microscopic analysis for CTD survey 2.*

| Station Number | CTD Cast Number | Depth (m) | Niskin Bottle Number | CTD Sample Time (GMT) | Day of Year | Sample Volume (Litres) |
|---|---|---|---|---|---|---|
| E5 | 16627 | 5 | 23 | 17:16 | 215 | 2 |
| D5 | 16628 | 5 | 23 | 20:34 | 215 | 2 |
| C5 | 16629 | 5 | 23 | 23:44 | 215 | 2 |
| B5 | 16630 | 5 | 23 | 03:28 | 216 | 2 |
| B4 | 16631 | 5 | 23 | 14:52 | 217 | 2 |
| B3 | 16632 | 5 | 23 | 17:50 | 217 | 2 |
| C3 | 16633 | 5 | 24 | 20:42 | 217 | 2 |
| D3 | 16634 | 5 | 24 | 23:46 | 217 | 2 |
| E3 | 16635 | 5 | 22 | 03:19 | 218 | 2 |
| E4 | 16636 | 5 | 23 | 06:10 | 218 | 2 |

*Circadian Rhythm Experiments*

Results from CTD survey 1 indicated that there were significant differences between the bioluminescence of samples run through the GLOWtracka during daylight hours compared to those run through during hours of darkness. To investigate this and examine whether the bioluminescence

signal was being affected by the natural circadian rhythms of the organisms producing it, three 48 hour experiments were undertaken.

For the first experiment 100 litres of water were collected from CTD cast 16572 at 5 meters depth and a 2 litre sample was run through the GLOWtracka every hour from 16:00 GMT on DOY 208 until 16:00 GMT on DOY 210 (Table 9). Samples for microscopy analysis were taken every 4 hours throughout the 48 hour period and fixed with lugols solution. Water was kept in blacked out carboys within a darkened area of the constant temperature lab where the temperature was 16 ˚C whilst waiting to be run through the GLOWtracka. At the end of the 48 hours spare water was used in a short experiment to investigate the impact of exposure to light on the bioluminescence signal. Eight litres of water was placed in day light for a 7 hour period whilst another 8 litres was continued to be kept in darkness. Bioluminescence measurements were taken hourly from 21:00 (DOY 210) until 00:00 (DOY 211) from both the light exposed and the light deprived water. Preliminary results showed a higher bioluminescence signal in the light exposed compared to the light deprived samples. This was investigated further in the subsequent experiments.

*Table 9. Sampling information for first circadian rhythm experiment. Measurements made hourly for 48 hours*

| CTD Cast Number | Sample Number | DOY | Sample run Time (GMT) |
|---|---|---|---|
| 16572 | 1 | 208 | 16:08 |
| 16572 | 2 | 208 | 17:04 |
| 16572 | 3 | 208 | 18:03 |
| 16572 | 4 | 208 | 19:03 |
| 16572 | 5 | 208 | 20:07 |
| 16572 | 6 | 208 | 21:04 |
| 16572 | 7 | 208 | 22:12 |
| 16572 | 8 | 208 | 23:03 |
| 16572 | 9 | 209 | 00:04 |
| 16572 | 10 | 209 | 01:07 |
| 16572 | 11 | 209 | 02:05 |
| 16572 | 12 | 209 | 03:08 |
| 16572 | 13 | 209 | 04:08 |
| 16572 | 14 | 209 | 05:01 |
| 16572 | 15 | 209 | 06:01 |
| 16572 | 16 | 209 | 07:01 |
| 16572 | 17 | 209 | 08:03 |
| 16572 | 18 | 209 | 09:02 |
| 16572 | 19 | 209 | 10:04 |
| 16572 | 20 | 209 | 11:03 |
| 16572 | 21 | 209 | 12:04 |
| 16572 | 22 | 209 | 13:09 |
| 16572 | 23 | 209 | 14:02 |
| 16572 | 24 | 209 | 15:04 |
| 16572 | 25 | 209 | 16:05 |
| 16572 | 26 | 209 | 17:20 |
| 16572 | 27 | 209 | 18:03 |
| 16572 | 28 | 209 | 19:04 |
| 16572 | 29 | 209 | 20:02 |
| 16572 | 30 | 209 | 21:05 |

| | | | |
|---|---|---|---|
| 16572 | 31 | 209 | 22:04 |
| 16572 | 32 | 209 | 23:0 |
| 16572 | 33 | 210 | 00:04 |
| 16572 | 34 | 210 | 01:05 |
| 16572 | 35 | 210 | 02:06 |
| 16572 | 36 | 210 | 03:06 |
| 16572 | 37 | 210 | 04:04 |
| 16572 | 38 | 210 | 05:00 |
| 16572 | 39 | 210 | 06:02 |
| 16572 | 40 | 210 | 07:00 |
| 16572 | 41 | 210 | 08:00 |
| 16572 | 42 | 210 | 09:01 |
| 16572 | 43 | 210 | 10:06 |
| 16572 | 44 | 210 | 11:08 |
| 16572 | 45 | 210 | 12:03 |
| 16572 | 46 | 210 | 13:07 |
| 16572 | 47 | 210 | 14:04 |
| 16572 | 48 | 210 | 15:06 |
| 16572 | 49 | 210 | 16:16 |

For the second experiment 120 litres of water were collected from CTD cast 16650 at 7 meters depth and a 2 litre sample run through the GLOWtracka every hour from 17:30 GMT on DOY 219 until 17:30 GMT on DOY 221 (Table 10). As with the previous experiment, samples for microscopy analysis were taken every 4 hours throughout the 48 hour period and fixed with lugols solution. Ten litres of the water collected was placed in a simulated in situ incubator from sunrise (05:50 GMT) until sunset (20:40 GMT) on DOY 220 and exposed to 100% of the daily ambient light level. This water was run through the GLOWtracka every two hours from 19:30GMT (220) until 07:30GMT (221) in parallel with the 2 litre sample run every hour from the samples kept in continuous darkness.

*Table 10. Sampling information for second circadian rhythm experiment. Measurements made hourly for 48 hours (* indicates measurements also made from the light exposed sample).*

| CTD Cast Number | Sample Number | DOY | Sample run Time (GMT) |
|---|---|---|---|
| 16650 | 1 | 219 | 17:35:00 |
| 16650 | 2 | 219 | 18:30:00 |
| 16650 | 3 | 219 | 19:43:00 |
| 16650 | 4 | 219 | 20:35:00 |
| 16650 | 5 | 219 | 21:36:00 |
| 16650 | 6 | 219 | 22:34:00 |
| 16650 | 7 | 219 | 23:32:00 |
| 16650 | 8 | 220 | 00:38:00 |
| 16650 | 9 | 220 | 01:36:00 |
| 16650 | 10 | 220 | 02:34:00 |
| 16650 | 11 | 220 | 03:38:00 |
| 16650 | 12 | 220 | 04:38:00 |
| 16650 | 13 | 220 | 05:44:00 |
| 16650 | 14 | 220 | 06:40:00 |
| 16650 | 15 | 220 | 07:38:00 |
| 16650 | 16 | 220 | 08:32:00 |
| 16650 | 17 | 220 | 09:34:00 |
| 16650 | 18 | 220 | 11:31:00 |
| 16650 | 19 | 220 | 11:34:00 |

| | | | |
|---|---|---|---|
| 16650 | 20 | 220 | 13:35:00 |
| 16650 | 21 | 220 | 14:34:00 |
| 16650 | 22 | 220 | 15:35:00 |
| 16650 | 23 | 220 | 16:37:00 |
| 16650 | 24 | 220 | 17:40:00 |
| 16650 | 25 | 220 | 18:50:00 |
| 16650 | 26 | 220 | 19:36:00 |
| 16650 | 27 | 220 | 20:32:00 |
| 16650 | 28 | 220 | 21:30:00 |
| 16650 | 29 | 220 | 22:29:00 |
| 16650 | 30 | 220 | 23:29:00 |
| 16650 | 31 | 220 | 00:35:00 |
| 16650 | 32 | 221 | 01:33:00 |
| 16650 | 33 | 221 | 02:33:00 |
| 16650 | 34 | 221 | 03:36:00 |
| 16650 | 35 | 221 | 04:36:00 |
| 16650 | 36 | 221 | 05:33:00 |
| 16650 | 37 | 221 | 06:33:00 |
| 16650 | 38 | 221 | 07:33:00 |
| 16650 | 39 | 221 | 08:35:00 |
| 16650 | 40 | 221 | 09:35:00 |
| 16650 | 41 | 221 | 10:36:00 |
| 16650 | 42 | 221 | 11:35:00 |
| 16650 | 43 | 221 | 12:30:00 |
| 16650 | 44 | 221 | 13:31:00 |
| 16650 | 45 | 221 | 14:30:00 |
| 16650 | 46 | 221 | 15:34:00 |
| 16650 | 47 | 221 | 16:33:00 |
| 16650* | 48 | 220 | 19:43:00 |
| 16650* | 49 | 220 | 22:39:00 |
| 16650* | 50 | 221 | 01:40:00 |
| 16650* | 51 | 221 | 04:45:00 |
| 16650* | 52 | 221 | 07:42:00 |

A third experiment was carried out to improve the resolution of the light exposed measurements made in the second circadian rhythm experiment. Two hundred and forty litres of water were collected from CTD cast 16667 at 5 meters depth. Half the water collected was kept incubated on deck in constantly renewed surface water and exposed to 100% of the daily ambient light. Whilst the other half of the water collected was kept in continuous darkness at 16˚C. Two litre samples were run through the GLOWtracka from both sets of water in parallel every hour for 44 hours from 21:00GMT (DOY 221) until 17:00GMT (DOY 223). Light exposed and light deprived water was filtered to provide data for DNA analysis. Samples for microscopy analysis were also taken every 6 hours, from both the light exposed and light deprived water samples, throughout the 48 hour period and fixed with lugols solution.

*Light Exposure Experiment*

Seven water samples were exposed to differing light intensities for a full daylight cycle (i.e. sunrise 05:40 GMT to sunset 20:44 GMT) on day of year 213. Six samples exposed to 1%, 7%, 20%, 33% 55% and 100% of the ambient light level respectively were incubated in simulated in situ incubators (refer to Ian brown/PML section). The seventh sample, exposed to 0% of the ambient light level, was kept blacked out and in darkness in the constant temperature laboratory at 16 ˚C. Bioluminescence measurements from all samples were taken between the hours or 23:00 GMT and 00:00 GMT to investigate whether exposure to different light intensities affected stimulated night time bioluminescence. The experiment was conducted a total of three times with the two replicate experiments being carried out on DOY 215 and 218 where sunrise and sunset times were 05:42 (215), 05:47 (218) and 20:40 (215), 20:36 (218) respectively (Table 11).

*Table 11. Sampling information for light exposure measurements at 0%, 1%, 7%, 20%, 33%, 55% and 100% ambient light levels.*

| CTD Cast Number | Depth (m) | Niskin Bottle Number | CTD Sample time (GMT) | DOY | Light Level (%) | Sample Volume (Litres) |
|---|---|---|---|---|---|---|
| 16597 | 5 | 18 | 00:17 | 213 | 0 | 2 |
| 16597 | 5 | 18 | 00:17 | 213 | 1 | 2 |
| 16597 | 5 | 18 | 00:17 | 213 | 7 | 2 |
| 16597 | 5 | 18 | 00:17 | 213 | 20 | 2 |
| 16597 | 5 | 18 | 00:17 | 213 | 33 | 2 |
| 16597 | 5 | 18 | 00:17 | 213 | 55 | 2 |
| 16597 | 5 | 18 | 00:17 | 213 | 100 | 2 |
| 16618 | 5 | 24 | 04:20 | 215 | 0 | 2 |
| 16618 | 5 | 24 | 04:20 | 215 | 1 | 2 |
| 16618 | 5 | 24 | 04:20 | 215 | 7 | 2 |
| 16618 | 5 | 24 | 04:20 | 215 | 20 | 2 |
| 16618 | 5 | 24 | 04:20 | 215 | 33 | 2 |
| 16618 | 5 | 24 | 04:20 | 215 | 55 | 2 |
| 16618 | 5 | 24 | 04:20 | 215 | 100 | 2 |
| 16634 | 5 | 24 | 23:46 | 218 | 0 | 2 |
| 16634 | 5 | 24 | 23:46 | 218 | 1 | 2 |
| 16634 | 5 | 24 | 23:46 | 218 | 7 | 2 |
| 16634 | 5 | 24 | 23:46 | 218 | 20 | 2 |
| 16634 | 5 | 24 | 23:46 | 218 | 33 | 2 |
| 16634 | 5 | 24 | 23:46 | 218 | 55 | 2 |
| 16634 | 5 | 24 | 23:46 | 218 | 100 | 2 |

*Filtration for DNA*

Samples for DNA analysis were collected from all stations that bioluminescence measurements were made. Seawater was filtered through 12 µm polycarbonate membrane filters which were then stored at -80˚C dry. Samples for microscopy were collected from all stations unless stated otherwise and were fixed with 2% Lugol's iodine containing 10% glacial acetic acid. All analysis will be done at the National Oceanography Centre, Southampton, UK.

*Preliminary Results*

Early results indicate that the stimulated bioluminescence signal measured change over a diel cycle and that this change is controlled by endogenous circadian rhythms of the bioluminescent organisms. However, there is also evidence that the level of light the organisms are exposed to during the day may affect the maximum bioluminescence signal reached at night.

*Bioluminescence Data Processing*

Further processing and analysis of all these data will be carried out in the near future using custom based scripts written in MatLab (The MathWorks, Inc.) at the National Oceanography Centre, Southampton, UK.

Chlorophyll-*a*

*Stuart Painter, Nina Rothe (NOCS)*

Chlorophyll-*a* samples were taken from varying numbers of depth (at least 5) within the top 100 m of all stainless steel CTD casts. Exactly 250 mL of seawater were filtered on GF/F filters and chlorophyll-a was extracted in 10 mL 90% acetone for about 24 hours at 4 ºC. Measurements were made on a Turner Designs TD700 fluorometer following the Welschmeyer protocol. Fluorometer calibration was performed using a pure chlorophyll standard and serial dilution (Figure 1) but absolute calibration of the standard and fluorometer will be performed post cruise when the standard can be assessed spectrophotometrically. A new Turner solid standard (Red; Part No. 7000-94) was also purchased prior to the cruise and used throughout as a secondary check on the stability of the fluorometer.

Provisional chlorophyll concentrations were calculated as

Chl-a = (0.2667*F) * (v/V)

Where
F = sample fluorescence
v = acetone extraction volume (10 mL)
V = filtered sample volume (250 mL)

*Figure 3. Provisional chlorophyll fluorometer calibration*

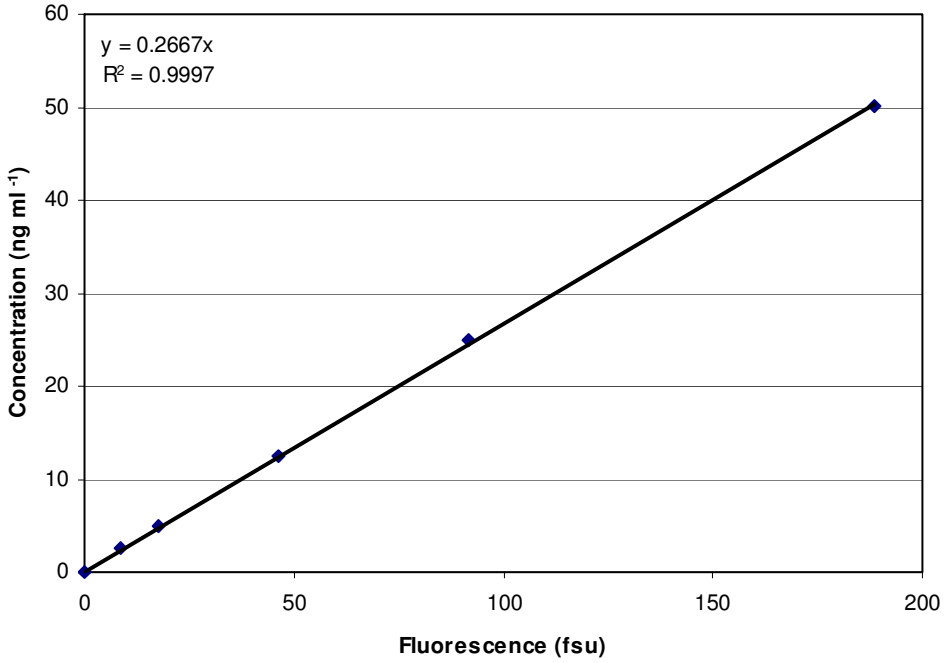


*Table 12. CTD samplinglog for chlorophyll analyses*

| Station Number (Survey) | Day of Year | Date | Niskins sampled | Sample Depth (m) |
|---|---|---|---|---|
| 16476 | 194 | 13/07/09 | 19, 20, 21, 22, 23, 24 | 100, 80, 60, 40, 20, 10 |
| 16478 | 194 | 13/07/09 | 14, 16, 18, 22, 24 | 100, 80, 50, 25, 5 |
| 16486 | 195 | 14/07/09 | 16, 15, 14, 13, 8, 7, 6, 5, 4, 3, 2 | 10, 15, 25, 35, 45, 55, 65, 75, 100,125,165 |
| 16488 | 196 | 15/07/09 | 23, 21, 18, 16, 12, 10, 9 | 6, 10, 18, 25, 32, 43, 64 |
| 16497 | 197 | 16/07/09 | 24, 22, 20, 18, 16, 14, 12, 10, 6, 4, 2 | 5, 25, 50, 80, 100, 150, 200, 300, 500, 750, 1000 |
| 16501 | 198 | 17/07/09 | 24, 22, 20, 18, 17, 12, 11, 8, 7 | 6, 10, 15, 18, 25, 32, 43, 64, 100 |
| 16510 | 199 | 18/07/09 | 24, 21, 19, 18, 17, 15, 12 | 6, 10, 15, 25, 35, 50, 80 |
| 16514 | 200 | 19/07/09 | 16, 13, 12, 11 | 6, 25, 30, 100 |
| 16523 (A6) | 202 | 21/07/09 | 21, 19, 17, 16, 15 | 5, 25, 50, 75, 100 |
| 16524 (A5) | 202 | 21/07/09 | 24, 16, 12, 10, 9 | 5, 25, 50, 75, 100 |
| 16526 (A4) | 202 | 21/07/09 | 14, 13, 12, 11, 10 | 5, 25, 50, 75, 100 |

| | | | | |
|---|---|---|---|---|
| 16528 (A3) | 202 | 21/07/09 | 21, 19, 17, 15, 14 | 5, 25, 50, 75, 100 |
| 16529 (A2) | 202 | 21/07/09 | 24, 22, 20, 18, 16 | 5, 25, 50, 75, 100 |
| 16531 (A1) | 202 | 21/07/09 | 21, 19, 17, 15, 13 | 5, 25, 50, 75, 100 |
| 16532 (B1) | 203 | 22/07/09 | 21, 19, 17, 15, 13 | 5, 25, 50, 75, 100 |
| 16533 (B2) | 203 | 22/07/09 | 24, 19, 14, 13, 12 | 5, 25, 50, 75, 100 |
| 16535 (B3) | 203 | 22/07/09 | 23, 19, 17, 15, 13 | 5, 25, 50, 75, 100 |
| 16536 (B4) | 203 | 22/07/09 | 22, 20, 18, 16, 14 | 5, 25, 50, 75, 100 |
| 16538 (B5) | 203 | 22/07/09 | 21, 19, 17, 15, 13 | 5, 25, 50, 75, 100 |
| 16539 (B6) | 203 | 22/07/09 | 21, 19, 17, 15, 13 | 5, 25, 50, 75, 100 |
| 16541 (C6) | 203 | 22/07/09 | 13, 15, 17, 19, 21 | 5, 25, 50, 75, 100 |
| 16542 (C5) | 203 | 22/07/09 | 22, 20, 18, 16, 14 | 5, 25, 50, 75, 100 |
| 16543 (C4) | 204 | 23/07/09 | 22, 16, 12, 11, 10 | 5, 25, 50, 75, 100 |
| 16544 (C3) | 204 | 23/07/09 | 24, 22, 20, 18, 16 | 5, 25, 50, 75, 100 |
| 16546 (C2) | 204 | 23/07/09 | 23, 21, 20, 17, 15 | 5, 25, 50, 75, 100 |
| 16548 (C1) | 204 | 23/07/09 | 22, 20, 17, 15, 14 | 5, 25, 50, 75, 100 |
| 16549 (D1) | 204 | 23/07/09 | 21, 19, 17, 15, 13 | 5, 25, 50, 75, 100 |
| 16550 (D2) | 204 | 23/07/09 | 22, 20, 18, 16, 14 | 5, 25, 50, 75, 100 |
| 16551 (D3) | 205 | 24/07/09 | 22, 20, 18, 15, 13 | 5, 25, 50, 75, 100 |
| 16552 (D4) | 205 | 24/07/09 | 23, 17, 12, 11, 10 | 5, 25, 50, 75, 100 |
| 16554 (D5) | 205 | 24/07/09 | 23, 18, 16, 15, 13 | 5, 25, 50, 75, 100 |
| 16555 (D6) | 205 | 24/07/09 | 22, 20, 18, 16, 14 | 5, 25, 50, 75, 100 |
| 16556 (E6) | 205 | 24/07/09 | 22, 20, 18, 15, 13 | 5, 25, 50, 75, 100 |
| 16557 (E5) | 205 | 24/07/09 | 22, 21, 19, 15, 13 | 5, 25, 50, 75, 100 |
| 16559 (E4) | 205 | 24/07/09 | 23, 21, 19, 18, 15 | 5, 25, 50, 75, 100 |
| 16560 (E3) | 205 | 24/07/09 | 21, 19, 18, 15, 13 | 5, 25, 50, 75, 100 |
| 16560 (E2) | 206 | 25/07/09 | 22, 20, 18, 15, 13 | 5, 25, 50, 75, 100 |
| 16562 (E1) | 206 | 25/07/09 | 23, 18, 11, 10, 9 | 5, 25, 50, 75, 100 |
| 16564 (F1) | 206 | 25/07/09 | 23, 21, 18, 15, 13 | 5, 25, 50, 75, 100 |
| 16568 | 207 | 26/07/09 | 1, 3, 4, 9, 10, 12, 13, 14, 18 | 250, 200, 175, 75, 50, 30, 20, 10, 5 |
| 16572 | 209 | 28/07/09 | 21, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1 | 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 |
| 16580 | 210 | 29/07/09 | 23, 20, 15, 8, 5 | 5, 9, 16, 29, 50 |
| 16582 | 210 | 29/07/09 | 24, 22, 20, 18 | 5, 10, 50, 80 |
| 16592 | 212 | 31/07/09 | 16, 15, 13, 11, 10 | 5, 25, 50, 75, 100 |
| 16597 | 213 | 1/08/09 | 19, 12, 9, 2, 1 | 5, 13, 22, 38, 60 |
| 16604 | 213 | 1/08/09 | 24, 21, 18, 15 | 5, 25, 50, 75 |
| 16618 | 215 | 3/08/09 | 22, 16, 12, 11, 5, 3, 2 | 5, 9, 13, 25, 38, 50, 100 |
| 16619 | 215 | 3/08/09 | 23, 21, 20, 19, 18, 16, 15 | 5, 25, 40, 50, 60, 80, 100 |
| 16627 (E5) | 215 | 3/08/09 | 23, 21, 18, 15, 13 | 5, 25, 50, 75, 100 |
| 16628 (D5) | 215 | 3/08/09 | 22, 20, 18, 16, 14 | 5, 25, 50, 75, 100 |
| 16629 (C5) | 216 | 4/08/09 | 23, 21, 19, 15, 13 | 5, 25, 50, 75, 100 |
| 16630 (B5) | 216 | 4/08/09 | 23, 21, 19, 15, 13 | 5, 25, 50, 75, 100 |
| 16631 (B4) | 217 | 5/08/09 | 23, 21, 19, 15, 13 | 5, 25, 50, 75, 100 |
| 16632 (B3) | 217 | 5/08/09 | 23, 21, 18, 15, 13 | 5, 25, 50, 75, 100 |
| 16633 (C3) | 217 | 5/08/09 | 24, 21, 18, 15, 13 | 5, 25, 50, 75, 100 |
| 16634 (D3) | 218 | 6/08/09 | 23, 21, 19, 16, 13 | 5, 25, 50, 75, 100 |
| 16635 (E3) | 218 | 6/08/09 | 22, 14, 10, 8, 6 | 5, 25, 50, 75, 100 |
| 16636 (E4) | 218 | 6/08/09 | 23, 21, 19, 16, 15 | 5, 25, 50, 75, 100 |
| 16640 | 218 | 06/08/09 | 24, 23, 21, 19, 16 | 5, 25, 50, 75, 100 |
| 16655 | 220 | 8/08/09 | 23, 16, 13, 8, 6, 3, 2, 1 | 5, 18, 25, 38, 42, 60, 75, 100 |
| 16658 | 220 | 8/08/09 | 24, 22, 20, 18, 16 | 5, 25, 50, 75, 100 |
| 16662 | 220 | 8/08/09 | 14, 13, 12, 11, 9, 7 | 5, 10, 20 ,30, 50, 75 |

Sediment Coring

*Nina Rothe (NOCS)*

Our goal for D341 was the continuation of the time-series at the Porcupine Abyssal Plain site by observing long-term changes in deep-sea communities in the Northeast Atlantic Ocean. The deep-sea floor is linked intimately to ocean surface processes and rapid, large-scale changes can occur in deep-sea ecosystems. For example, it has been suggested that the North Atlantic Oscillation affects the quantity and quality of carbon exported to the deep sea at the PAP site, which is reflected in changes in abundances observed in all components of the benthic community including meio, macro, and megafauna.

On this cruise, undisturbed sediment samples were obtained using a Megacorer. Samples were collected for macrofauna, metazoan meiofauna, and Foraminifera from five deployments (see Table 13). For each deployment, the corer was fitted with eight core tubes of 100 mm internal diameter by 400 mm long (Table 14). The objective was to collect a minimum of three cores for metazoan meiofauna and Foraminifera obtaining one core per deployment. For macrofauna one full sample consists of eight cores from one or two deployments.

*Table 13. Overview of megacore deployments on D341.*

| Station ID | Date of corer on seabed | Depth (m) | °N | °W |
|---|---|---|---|---|
| 16499 | 16/07/09 | 4809 | 48°49.55 | 16°30.47 |
| 16507 | 18/07/09 | 4808 | 48°49.51 | 16°29.95 |
| 16570 | 28/07/09 | 4808 | 48° 47.09 | 16°27.19 |
| 16588 | 30/07/09 | 4808 | 48°49.32 | 16°28.13 |
| 16590 | 30/07/09 | 4808.5 | 48°47.95 | 16°27.19 |
| 16663 | 08/08/09 | 4808 | 48°50.72 | 16°30.31 |

*Table 14. Station IDs and the number of core tubes deployed and processed after each recovery. F1-F3= Foraminifera samples 1-4; Meio1-4= Meiofauna samples 1-4; Macro1, 2 = Macrofauna samples 1and 2. Sediment height refers to the vertical span of the sediment sampled in each core tube.*

| Station ID | # of cores deployed | # of cores processed | Core IDs | Core description (sediment height) | Comments |
|---|---|---|---|---|---|
| 16499 | 8 | 4 | 1xF1, 1xMeio1, 2xMacro1 | F1: 42 cm, Meio1: 41 cm, Macro1: 39 and 40 cm | Little bioturbation |
| 16507 | 8 | 6 | 6xMacro1 | Macro1: 40cm, 42cm, 40cm, 42cm, 43cm, 40cm, 40cm | Medium bioturbation |
| 16570 | 8 | 2 | 1xF2, 1xMeio2 | F2: 47cm, Meio2: 30 cm | Little bioturbation |
| 16588 | 8 | 6 | 1xF3, 1xMeio3, 4xMacro2 | F3: 38cm, Meio3: 37cm, Macro2: 49cm, 50cm, 45cm, 50cm | Strong bioturbation |
| 16590 | 8 | 0 | - | - | Bad weather conditions |
| 16663 | 8 | 8 | 1xF4, 1xMeio4, 4xMacro2 | F4: 52cm, Meio4: 52cm, Macro2: 52cm, 51cm, 52cm, 51cm | Moderate bioturbation |

After each recovery, cores were selected for metazoan meiofauna, Foraminifera, and macrofauna based on an undisturbed sediment surface and a minimum sediment height between 10 and 20 cm. Sediment cores selected for meiofauna and Foraminifera were sectioned down to 5.0 cm in 0.5 cm and 1.0 cm intervals (Table 15). The bottom-water top sediment was first siphoned off and preserved. One core for each faunal group was sectioned down to 10 cm. All sediment was fixed in 10% buffered Formalin.

Macrofauna cores were also sectioned down to 5 cm in 1 and 2 cm intervals (Table 3). Prior to fixation, macrofauna samples were split using sieves with mesh sizes 500 µm and 300 µm. Each size group was consequently fixed in 10% buffered formalin.

*Table 15. Core sections for each faunal group sampled during D341. BWTS = Bottom-water top sediment*

| Core ID | Vertical span (cm) | Segment depth (cm) |
|---|---|---|
| Meiofauna + Foraminifera | BWTS | |
| | 0.0-0.5 | 0.5 |
| | 0.5-1.0 | 0.5 |
| | 1.0-1.5 | 0.5 |
| | 1.5-2.0 | 0.5 |
| | 2.0-3.0 | 1.0 |
| | 3.0-4.0 | 1.0 |
| | 4.0-5.0 | 1.0 |
| | 5.0-6.0 | 1.0 |
| | 6.0-7.0 | 1.0 |
| | 7.0-8.0 | 1.0 |
| | 8.0-9.0 | 1.0 |
| | 9.0-10.0 | 1.0 |
| Macrofauna | 0.0-1.0 | 1.0 |
| | 1.0-3.0 | 2.0 |
| | 3.0-5.0 | 2.0 |

Overall, four cores for both metazoan meiofauna and Foraminifera each were obtained from four independent deployments (F1-4, Meio1-4). In addition, two full sample sets for macrofauna were collected consisting of eight cores each and combined from four deployments (Macro1-2). One spare core was sectioned and frozen to be used for chemical analysis. In the laboratory at the National Oceanography Centre, Southampton, sediment samples will be stained and analyzed using light microscopy to assess abundance and diversity of meiofauna, Foraminifera, and macrofauna at the Porcupine Abyssal Plain.

CTD Survey 1

*Jennifer Riley (NOCS)*

The aim of the CTD survey *(Day of year 202 – 208)* was to map the spatial distribution of both physical and biological features around the PAP (Porcupine Abyssal Plain) site. The survey area was 100km$^2$ centred on the PAP site with station spacing of 20km. For a map of the survey area see section by Adrian Martin concerning CTD calibrations in this cruise report (Figure 36).

The survey commenced at grid point A6 and progressed northwards following a radiator pattern (as shown by the red arrows). Due to poor weather conditions the survey was unable to be completed. Data was only gathered up to point F1. Stations F2 to F6 (inclusive) were not sampled. At each station a CTD cast to 1000m was undertaken (unless otherwise requested). Physical measurements from the CTD deployments included:

- Temperature
- Pressure
- Conductivity
- Fluorescence
- Transmittance
- Oxygen
- Absorbance
- Photosynthetically Active Radiation (PAR)

An LADCP (Lowered Acoustic Doppler Current Profiler) was also attached to the CTD to take current measurements.

Niskin bottles were also fired at predetermined depths to sample for: Oxygen, Nutrients, Chlorophyll, Salinity, Particulate inorganic carbon, Particulate organic carbon, Biogenic silica, Chlorophyll pigments for analysis via HPLC, Bioluminescence, Lugols preserved samples.

The following tables document which stations were sampled and at what depths samples were taken from the CTD rosette

*Table 16. Samples taken from each station*

| Day of Year | Station | Oxygen | Nutrients | Chl | Salts | POC | PIC | BSi | HPLC | Bioluminescence | Lugols |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 202 | 16523 | x | x | X | x | X | x | x | X | x | x |
| 202 | 16524 | x | x | X | x | X | x | x | X | x | x |
| 202 | 16526 | x | x | X | x | X | x | x | X | x | x |
| 202 | 16528 | x | x | X | x | X | x | x | X | x | x |
| 202 | 16529 | x | x | X | x | X | x | x | x | x | x |
| 202 | 16531 | x | x | X | x | X | x | x | x | x | x |
| 203 | 16532 | x | x | X | x | X | x | x | x | x | x |
| 203 | 16533 | x | x | X | x | X | x | x | x | x | x |
| 203 | 16535 | x | x | X | x | X | x | x | x | x | x |
| 203 | 16536 | x | x | X | x | X | x | x | x | x | x |
| 203 | 16537 | x | x | X | x | X | x | x | x | x | x |
| 203 | 16539 | x | x | X | x | X | x | x | x | x | x |
| 203 | 16541 | x | x | X | x | X | x | x | x | x | x |
| 203 | 16542 | x | x | X | x | X | x | x | x | x | x |
| 204 | 16543 | x | x | X | x | X | x | x | x | x | x |
| 204 | 16544 | x | x | X | x | X | x | x | x | x | x |
| 204 | 16546 | x | x | X | x | X | x | x | x | x | x |
| 204 | 16548 | x | x | X | x | X | x | x | x | x | x |
| 204 | 16549 | x | x | X | x | X | x | x | x | x | x |
| 204 | 16550 | x | x | X | x | X | x | x | x | x | x |
| 205 | 16551 | x | x | X | x | X | x | x | x | x | x |
| 205 | 16552 | x | x | X | x | X | x | x | x | x | x |
| 205 | 16554 | x | x | X | x | X | x | x | x | x | x |
| 205 | 16555 | x | x | X | x | X | x | x | x | x | x |
| 205 | 16556 | x | x | X | x | X | x | x | x | x | x |
| 205 | 16557 | x | x | X | x | X | x | x | x | x | x |
| 205 | 16559 | x | x | X | x | X | x | x | x | x | x |
| 205 | 16560 | x | x | X | x | X | x | x | x | x | x |
| 206 | 16561 | x | x | X | x | X | x | x | x | x | x |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 206 | 16562 | x | x | X | x | X | x | x | x | x | x |
| 206 | 16564 | x | x | X | x | X | x | x | x | x | x |

*Table 17. Oxygen samples from each station*

| OXYGEN | | | |
|---|---|---|---|
| Station Number | Depth (m) | Niskin Bottle Number | Sample Volume (Litres) |
| D16523 | 5, 300, 500, 600, 750, 1000 | 21, 11, 8, 7, 6, 3 | n/a |
| D16526 | 5, 300, 500, 600, 750, 1000 | 14, 8, 6, 5, 4, 1 | n/a |
| D16529 | 1000 | 4 | n/a |
| D16532 | 5, 300, 500, 600, 750, 1000 | 22, 9, 8, 6, 4, 2 | n/a |
| D16535 | 300, 500, 600, 750, 1000 | 9, 7, 5, 3 | n/a |
| D16538 | 5, 300, 600, 750, 1000 | 22, 10, 6, 4, 2 | n/a |
| D16541 | 5, 300, 600, 1000 | 21, 9, 7, 5, 1 | n/a |
| D16544 | 5, 300, 500, 600, 750, 1000 | 23, 8, 4, 2, 1 | n/a |
| D16548 | 5, 300, 500, 600, 750, 1000 | 22, 10, 8, 6, 4, 2 | n/a |
| D16550 | 5, 300, 500, 600, 750 | 21, 9, 7, 5, 3 | n/a |
| D16552 | 5, 300, 500, 600, 750, 1000 | 23, 8, 7, 6, 4, 2 | n/a |
| D16555 | 5, 300, 500, 750, 1000 | 21, 9, 7, 3, 1 | n/a |
| D16557 | 5, 300, 500, 600, 750, 1000 | 23, 10, 8, 6, 4, 2 | n/a |
| D16560 | 5, 300, 500, 600, 650, 1000 | 22, 10, 8, 6, 4, 2 | n/a |

*Table 18: Bioluminescence and HPLC samples from each station*

| BIOLUMINESCENCE AND HPLC | | | |
|---|---|---|---|
| Station Number | Depth (m) | Niskin Bottle Number | Sample Volume (Litres) |
| 16523 | 5 and 25 | 21 and 19 | 2 |
| 16524 | 5 and 25 | 24 and 16 | 2 |
| 16526 | 5 and 25 | 14 and 13 | 2 |
| 16528 | 5 and 25 | 21 and 19 | 2 |
| 16529 | 5 and 25 | 23 and 21 | 2 |
| 16531 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16532 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16533 | 5 and 25 | 24 and 19 | 2 and 4 |
| 16535 | 5 and 25 | 23 and 19 | 2 and 4 |
| 16536 | 5 and 25 | 22 and 19 | 2 and 4 |
| 16537 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16539 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16541 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16542 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16543 | 5 and 25 | 22 and 16 | 2 and 4 |
| 16544 | 5 and 25 | 24 and 22 | 2 and 4 |
| 16546 | 5 and 25 | 23 and 21 | 2 and 4 |
| 16548 | 5 and 25 | 22 and 19 | 2 and 4 |
| 16549 | 5 and 25 | 22 and 19 | 2 and 4 |
| 16550 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16551 | 5 and 25 | 23 and 21 | 2 and 4 |
| 16552 | 5 and 25 | 23 and 17 | 2 and 4 |
| 16554 | 5 and 25 | 23 and 19 | 2 and 4 |
| 16555 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16556 | 5 and 25 | 22 and 20 | 2 and 4 |
| 16557 | 5 and 25 | 22 and 21 | 2 and 4 |
| 16559 | 5 and 25 | 23 and 21 | 2 and 4 |
| 16560 | 5 and 25 | 21 and 19 | 2 and 4 |
| 16561 | 5 and 25 | 22 and 20 | 2 and 4 |
| 16562 | 5 and 25 | 23 and 18 | 2 and 4 |
| 16564 | 5 and 25 | 23 and 19 | 2 and 4 |

*Table 19. Nutrient samples from each station*

| NUTRIENTS | | | |
|---|---|---|---|
| Station | Depth | Niskin | Volume Sampled |
| 16523 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 17, 16, 15, 14, 11, 8, 7, 6, 5 | 20 ml |
| 16524 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 24, 16, 12, 10, 9, 8, 7, 6, 5, 3, 1 | 20 ml |
| 16526 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 1 | 20 ml |
| 16528 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 17, 15, 13, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16529 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 23, 21, 19, 18, 17, 15, 13, 10, 8, 6, 4 | 20 ml |
| 16531 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 17, 15, 13, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16532 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 17, 15, 13, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16533 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 24, 29, 14, 13, 12, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16535 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 23, 19, 17, 15, 13, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16536 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 18, 15, 13, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16537 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 17, 15, 13, 11, 9, 7, 5, 3, 2 | 20 ml |
| 16539 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 17, 15, 13, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16541 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 17, 15, 13, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16542 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 21, 19, 18, 15, 13, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16543 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 22, 16, 12, 11, 10, 9, 8, 7, 5, 3, 1 | 20 ml |
| 16544 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 24, 22, 20, 18, 16, 12, 8, 4, 3, 2, 1 | 20 ml |
| 16546 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 23, 21, 20, 17, 15, 13, 11, 9, 7, 3, 1 | 20 ml |
| 16548 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 22, 19, 17, 15, 14, 11, 9, 7, 5, 3, 1 | 20 ml |
| 16549 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 22&21, 20&19, 18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |
| 16550 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 22&21, 20&19, 18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |
| 16551 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 22&21, 20&19, 18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |
| 16552 | 5, 15, 18, 25, 32, 43, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 24&23&22, 21&20,19, 18, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6&5, 4&3, 2&1 | 20 ml |
| 16554 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 24&23, 22&21&20&19&18, 16, 15&14, 13, 12&11, 10&9, 6, 5, 4&3, 2&1 | 20 ml |
| 16555 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 22&21, 20&19, 18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |
| 16556 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 23&22, 21&20, 19&18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |
| 16557 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 23&22, 21&20, 19&18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |
| 16559 | 5, 25, 50, 75, 100, 125, 150, 200, 300, 500, 600, 750, 1000 | 23, 22&21, 20&19, 18&16, 15&14, 13, 12&11, 10, 9&8, 7, 6, 5, 4&3, 2&1. | 20 ml |
| 16560 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 22&21, 20&19, 18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |
| 16561 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 23&22, 21&20, 19&18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |
| 16562 | 5, 15, 18, 25, 32, 43, 50, 75, 100, 150, 500, 600, 750, 1000 | 23, 20, 19, 18, 16&15, 14, 13&12, 11, 10, 9, 8, 6, 5, 4&3, 2&1 | 20 ml |
| 16564 | 5, 25, 50, 75, 100, 150, 300, 500, 600, 750, 1000 | 23&22, 21&20, 19&18, 16&15, 14&13, 12&11, 10&9, 8&7, 6&5, 4&3, 2&1 | 20 ml |

*Table 20. Table Chlorophyll samples from each station*

| CHLOROPHYLL | | | |
|---|---|---|---|
| Station | Depth | Niskin | Volume Sampled |
| 16523 | 5, 25, 50, 75, 100 | 21, 19, 17, 16, 15 | 250mls |
| 16524 | 5, 25, 50, 75, 100 | 24, 16, 12, 10, 9 | 250mls |
| 16526 | 5, 25, 50, 75, 100 | 14, 13, 12, 11, 10 | 250mls |
| 16528 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 250mls |
| 16529 | 5, 25, 50, 75, 100 | 23, 21, 19, 18, 17 | 250mls |
| 16531 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 250mls |
| 16532 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 250mls |
| 16533 | 5, 25, 50, 75, 100 | 24, 19, 14, 13, 12 | 250mls |
| 16535 | 5, 25, 50, 75, 100 | 23, 19, 17, 15, 13 | 250mls |
| 16536 | 5, 25, 50, 75, 100 | 22, 20, 18, 16, 14 | 250mls |
| 16537 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 250mls |
| 16539 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 250mls |
| 16541 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 250mls |
| 16542 | 5, 25, 50, 75, 100 | 21, 19, 18, 15, 13 | 250mls |
| 16543 | 5, 25, 50, 75, 100 | 22, 16, 12, 11, 10 | 250mls |
| 16544 | 5, 25, 50, 75, 100 | 24, 22, 20, 18, 16 | 250mls |
| 16546 | 5, 25, 50, 75, 100 | 23, 21, 20, 17, 15 | 250mls |
| 16548 | 5, 25, 50, 75, 100 | 22, 19, 17, 15, 14 | 250mls |
| 16549 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 250mls |
| 16550 | 5, 25, 50, 75, 100 | 22, 20, 18, 16, 14 | 250mls |
| 16551 | 5, 25, 50, 75, 100 | 22, 20, 18, 15, 13 | 250mls |
| 16552 | 5, 25, 50, 75, 100 | 23, 17, 12, 11, 10 | 250mls |
| 16554 | 5, 25, 50, 75, 100 | 23, 19, 16, 15, 13 | 250mls |
| 16555 | 5, 25, 50, 75, 100 | 22, 20, 18, 16, 14 | 250mls |
| 16556 | 5, 25, 50, 75, 100 | 22, 20, 18, 15, 13 | 250mls |
| 16557 | 5, 25, 50, 75, 100 | 22, 21, 19, 15, 13 | 250mls |
| 16559 | 5, 25, 50, 75, 100 | 23, 21, 19, 18, 15 | 250mls |
| 16560 | 5, 25, 50, 75, 100 | 21, 19, 18, 15, 13 | 250mls |
| 16561 | 5, 25, 50, 75, 100 | 22, 20, 18, 15, 13 | 250mls |
| 16562 | 5, 25, 50, 75, 100 | 23, 18, 11, 10, 9 | 250mls |
| 16564 | 5, 25, 50, 75, 100 | 23, 19, 16, 15, 13 | 250mls |

*Table 21. Salinity samples from each station*

| SALTS | | | |
|---|---|---|---|
| Station | Depth | Niskin | Volume Sampled |
| 16523 | 300, 600, 924, 922 | 11, 7, 2, 1 | n/a |
| 16524 | 500, 750, 1000 | 6, 3, 1 | n/a |
| 16526 | 5, 150, 300 | 1, 8, 9 | n/a |
| 16528 | 500, 750, 1000 | 7, 3, 1 | n/a |
| 16529 | 5, 100, 500, 750, 1000 | 23, 17, 10, 6, 4 | n/a |
| 16531 | 75, 500, 600 | 15, 7, 5 | n/a |
| 16532 | 300, 600, 1000 | 9, 5, 1 | n/a |
| 16533 | 500, 600, 1000 | 7, 5, 1 | n/a |
| 16535 | 25, 500, 1000 | 19, 7, 1 | n/a |
| 16536 | 25, 300, 1000 | 19, 9, 1 | n/a |
| 16537 | 300, 500, 1000 | 9, 7, 2 | n/a |
| 16539 | 50, 500, 1000 | 17, 7, 1 | n/a |
| 16541 | 25, 300, 1000 | 19, 9, 1 | n/a |
| 16542 | 25, 500, 750 | 19, 7, 3 | n/a |
| 16543 | 100, 750, 1000 | 10, 3, 1 | n/a |
| 16544 | 25, 150, 1000 | 22, 12, 1 | n/a |
| 16546 | No Salts | No salts | n/a |
| 16548 | 25, 300, 1000 | 19, 9, 1 | n/a |
| 16549 | 25, 500, 1000 | 19, 7, 1 | n/a |
| 16550 | 25, 500, 1000 | 19, 7, 1 | n/a |
| 16551 | 75, 600, 1000 | 15, 5, 1 | n/a |
| 16552 | 25, 300, 1000 | 17, 8, 1 | n/a |
| 16554 | 25, 300, 1000 | 19, 9, 1 | n/a |
| 16555 | 25, 500, 1000 | 20, 8, 2 | n/a |
| 16556 | 50, 750, 1000 | 18, 3, 1 | n/a |
| 16557 | 25, 750, 1000 | 21, 3, 1 | n/a |
| 16559 | 25, 500, 1000 | 21, 6, 1 | n/a |
| 16560 | 5, 150, 500 | 21, 12, 8 | n/a |
| 16561 | 25, 500, 1000 | 20, 7, 1 | n/a |
| 16562 | 25, 600, 1000 | 18, 5, 1 | n/a |
| 16564 | 25, 150, 1000 | 19, 11, 1 | n/a |

*Table 22. Lugols samples from each station for taxonomic analysis*

| LUGOLS | | | |
|---|---|---|---|
| Station | Depth | Niskin | Volume Sampled + lugols |
| 16523 | 5, 25, 50, 75, 100 | 21, 19, 17, 16, 15 | 100ml + 2ml |
| 16524 | 5, 25, 50, 75, 100 | 24, 16, 12, 10, 9 | 100ml + 2ml |
| 16526 | 5, 25, 50, 75, 100 | 14, 13, 12, 11, 10 | 95ml + 5ml |
| 16528 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 100ml + 2ml |
| 16529 | 5, 25, 50, 75, 100 | 23, 21, 19, 18, 17 | 95ml + 5ml |
| 16531 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 95ml + 5ml |
| 16532 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 100ml + 2ml |
| 16533 | 5, 25, 50, 75, 100 | 24, 19, 14, 13, 12 | 100ml + 2ml |
| 16535 | 5, 25, 50, 75, 100 | 23, 19, 17, 15, 13 | 95ml + 2ml |
| 16536 | 5, 25, 50, 75, 100 | 22, 20, 18, 16, 14 | 95ml + 5ml |
| 16537 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 100ml + 2ml |
| 16539 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 95ml + 2ml |
| 16541 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 95ml + 2ml |
| 16542 | 5, 25, 50, 75, 100 | 21, 19, 18, 15, 13 | 95ml + 2ml |
| 16543 | 5, 25, 50, 75, 100 | 22, 16, 12, 11, 10 | 95ml + 2ml |
| 16544 | 5, 25, 50, 75, 100 | 24, 22, 20, 18, 16 | 95ml + 2ml |
| 16546 | 5, 25, 50, 75, 100 | 23, 21, 20, 17, 15 | 95ml + 2ml |
| 16548 | 5, 25, 50, 75, 100 | 22, 19, 17, 15, 14 | 95ml + 2ml |
| 16549 | 5, 25, 50, 75, 100 | 21, 19, 17, 15, 13 | 95ml + 2ml |
| 16550 | 5, 25, 50, 75, 100 | 21, 19, 18, 15, 13 | 95ml + 2ml |
| 16551 | 5, 25, 50, 75, 100 | 22, 20, 18, 15, 13 | 100ml + 2ml |
| 16552 | 5, 25, 50, 75, 100 | 23, 17, 12, 11, 10 | 95ml + 2ml |
| 16554 | 5, 25, 50, 75, 100 | 23, 19, 16, 15, 13 | 95ml + 2ml |
| 16555 | 5, 25, 50, 75, 100 | 22, 20, 18, 16, 14 | 95ml + 2ml |
| 16556 | 5, 25, 50, 75, 100 | 22, 20, 18, 15, 13 | 95ml + 2ml |
| 16557 | 5, 25, 50, 75, 100 | 22, 21, 19, 15, 13 | 95ml + 2ml |
| 16559 | 5, 25, 50, 75, 100 | 23, 21, 19, 18, 15 | 95ml + 2ml |
| 16560 | 5, 25, 50, 75, 100 | 21, 19, 18, 15, 13 | 95ml + 2ml |
| 16561 | 5, 25, 50, 75, 100 | 22, 20, 18, 15, 13 | 95ml + 2ml |
| 16562 | 5, 25, 50, 75, 100 | 23, 18, 11, 10, 9 | 95ml + 2ml |
| 16564 | 5, 25, 50, 75, 100 | 23, 19, 16, 15, 13 | 95ml + 2ml |

*Table 23. Biogenic silica samples from each station*

| BIOGENIC SILICA | | | |
|---|---|---|---|
| Station | Depth | Niskin | Volume Filtered |
| 16523 | 5, 50, 300 | 21, 17, 11 | 0.59, 1, 1 |
| 16524 | 5, 50, 300 | 24, 12, 7 | 0.8, 1, 1 |
| 16526 | 5, 50, 300 | 14, 12, 8 | 1.9, 1, 1 |
| 16528 | 5, 50, 300 | 21, 17, 9 | 0.5, 0.968, 1 |
| 16529 | 5, 50, 300 | 23, 19, 13 | 1, 1, 1 |
| 16531 | 5, 50, 300 | 21, 17, 9 | 0.5, 1, 1 |
| 16532 | 5, 50, 300 | 21, 17, 9 | 1, 1, 1 |
| 16533 | 5, 50, 300 | 24, 14, 9 | 0.5, 1, 1 |
| 16535 | 5, 50, 300 | 23, 17, 9 | 1, 1, 1 |
| 16536 | 5, 50, 300 | 22, 18, 10 | 1, 1, 1 |
| 16537 | 5, 50, 300 | 21, 17, 9 | 0.4, 1, 1 |
| 16539 | 5, 50, 300 | 21, 17, 9 | 0.4, 1, 1 |
| 16541 | 5, 50, 300 | 21, 17, 9 | 0.4, 1, 1 |
| 16542 | 5, 50, 300 | 22, 18, 10 | 0.45, 1, 1 |
| 16543 | 5, 50, 300 | 22, 12, 8 | 0.5, 1, 1 |
| 16544 | 5, 50, 300 | 24, 20, 8 | 0.5, 1, 1 |
| 16546 | 5, 50, 300 | 23, 20, 11 | 0.35, 1, 1 |
| 16548 | 5, 50, 300 | 22, 17, 9 | 0.96, 1, 1 |
| 16549 | 5, 50, 300 | 21, 17, 9 | 0.4, 1, 1 |
| 16550 | 5, 50, 300 | 22, 18, 10 | 1, 1, 1 |
| 16551 | 5, 50, 300 | 22, 18, 9 | 0.35, 0.88, 1 |
| 16552 | 5, 50, 300 | 23, 12, 8 | 0.35, 0.75, 1 |
| 16554 | 5, 50, 300 | 23, 16, 9 | 0.5, 1, 1 |
| 16555 | 5, 50, 300 (all depths duplicated) | 22, 18, 10 | 0.36, 0.5, 1 1, 1, 1 |
| 16556 | 5, 50, 300 | 22, 18, 9 | 0.36, 0.5, 1 |
| 16557 | 5, 50, 300 | 22, 19, 9 | 0.4, 1, 1 |
| 16559 | 5, 50, 300 | 23, 19, 9 | 0.5, 1, 1 |
| 16560 | 5, 50, 300 | 21, 18, | 0.125, 1, 1 |

| | | | |
|---|---|---|---|
| 16561 | 5, 50, 300 | 22, 18, 9 | 0.19, 0.2, 0.25 |
| 16562 | 5, 50, 300 | 23, 11, 7 | 0.4, 1, 1 |
| 16564 | 5, 50, 300 | 23, 16, 7 | 0.4, 1, 1 |

*Table 24. Particulate inorganic carbon samples from each station*

| PARTICULATE INORGANIC CARBON | | | |
|---|---|---|---|
| Station | Depth | Niskin | Volume Filtered |
| 16523 | 5, 50, 300 | 21, 17, 11 | 0.64, 1, 1 |
| 16524 | 5, 50, 300 | 24, 12, 7 | 0.125, 1, 0.5 |
| 16526 | 5, 50, 300 | 14, 12, 8 | 0.5, 1, 1 |
| 16528 | 5, 50, 300 | 21, 17, 9 | 0.66, 1, 1 |
| 16529 | 5, 50, 300 | 23, 19, 13 | 0.5, 1, 1 |
| 16531 | 5, 50, 300 | 21, 17, 9 | 0.5, 1, 1 |
| 16532 | 5, 50, 300 | 21, 17, 9 | 1, 1, 1 |
| 16533 | 5, 50, 300 | 24, 14, 9 | 1.78, 1, 1 |
| 16535 | 5, 50, 300 | 23, 17, 9 | 0.5, 1, 1 |
| 16536 | 5, 50, 300 | 22, 18, 10 | 0.5, 1, 1 |
| 16537 | 5, 50, 300 | 21, 17, 9 | 0.4, 1, 1 |
| 16539 | 5, 50, 300 | 21, 17, 9 | 0.4, 1, 1 |
| 16541 | 5, 50, 300 | 21, 17, 9 | 0.4, 1, 1 |
| 16542 | 5, 50, 300 | 22, 18, 10 | 0.5, 1, 1 |
| 16543 | 5, 50, 300 | 22, 12, 8 | 0.4, 1, 1 |
| 16544 | 5, 50, 300 | 24, 20, 8 | 0.5, 1, 1 |
| 16546 | 5, 50, 300 | 23, 20, 11 | 0.4, 1, 1 |
| 16548 | 5, 50, 300 | 22, 17, 9 | 0.5, 1, 1 |
| 16549 | 5, 50, 300 | 21, 17, 9 | 0.4, 1, 1 |
| 16550 | 5, 50, 300 | 22, 18, 10 | 0.5, 0.7, 0.99 |
| 16551 | 5, 50, 300 | 22, 18, 9 | 0.35, 1, 1 |
| 16552 | 5, 50, 300 | 23, 12, 8 | 0.35, 0.75, 1 |
| 16554 | 5, 50, 300 | 23, 16, 9 | 0.4, 1, 1 |
| 16555 | 5, 50, 300 | 22, 18, 10 | 0.31, 1, 1 |
| 16556 | 5, 50, 300 | 22, 18, 9 | 0.3, 0.5, 1 |
| 16557 | 5, 50, 300 | 22, 19, 9 | 0.4, 1, 1 |
| 16559 | 5, 50, 300 | 23, 19, 9 | 0.452, 1, 1 |
| 16560 | 5, 50, 300 | 21, 18, | 0.34, 0.7, 1 |
| 16561 | 5, 50, 300 | 22, 18, 9 | 0.28, 0.66, 1 |
| 16562 | 5, 50, 300 | 23, 11, 7 | 0.4, 1, 1 |
| 16564 | 5, 50, 300 | 23, 16, 7 | 0.4, 1, 1 |

*Table 25. Particulate organic carbon samples from each station*

| PARTICULATE ORGANIC CARBON | | | |
|---|---|---|---|
| Station | Depth | Niskin | Volume Filtered |
| 16523 | 5, 50, 300 | 21, 17, 11 | 2, 2, 2 |
| 16524 | 5, 50, 300 | 24, 12, 7 | 1.615, 2, 2 |
| 16526 | 5, 50, 300 | 14, 12, 8 | 1.4, 2, 2 |
| 16528 | 5, 50, 300 | 21, 17, 9 | 1, 2, 2 |
| 16529 | 5, 50, 300 | 23, 19, 13 | 1, 2, 2 |
| 16531 | 5, 50, 300 | 21, 17, 9 | 1.19, 1, 2 |
| 16532 | 5, 50, 300 | 21, 17, 9 | 1, 2, 2 |
| 16533 | 5, 50, 300 | 24, 14, 9 | 1, 2, 2 |
| 16535 | 5, 50, 300 | 23, 17, 9 | 1, 2, 2 |
| 16536 | 5, 50, 300 | 22, 18, 10 | 2, 2, 2, |
| 16537 | 5, 50, 300 | 21, 17, 9 | 1, 2, 2 |
| 16539 | 5, 50, 300 | 21, 17, 9 | 1, 2, 2 |
| 16541 | 5, 50, 300 | 21, 17, 9 | 2, 2, 2, |
| 16542 | 5, 50, 300 | 22, 18, 10 | 1.88, 2, 2 |
| 16543 | 5, 50, 300 | 22, 12, 8 | 1, 2, 2 |
| 16544 | 5, 50, 300 | 24, 20, 8 | 1, 2, 2 |
| 16546 | 5, 50, 300 | 23, 20, 11 | 1, 2, 2 |
| 16548 | 5, 50 | 22, 17, 9 | 1, 2 |
| 16549 | 50, 300 | 21, 17, 9 | 2, 2 |
| 16550 | 5, 50, 300 | 22, 18, 10 | 1.9, 2, 2 |
| 16551 | 5, 50, 300 | 22, 18, 9 | 1, 2, 2 |
| 16552 | 5, 50, 300 | 23, 12, 8 | 1, 2, 2 |
| 16554 | 5, 50, 300 | 23, 16, 9 | 2, 2, 2 |
| 16555 | 5, 50, 300 | 22, 18, 10 | 1.41, 2, 2 |
| 16556 | 5, 50, 300 | 22, 18, 9 | 1, 2, 2 |
| 16557 | 5, 50, 300 | 22, 19, 9 | 1, 2, 2 |
| 16559 | 5, 50, 300 | 23, 19, 9 | 2, 2, 2 |
| 16560 | 5, 50, 300 | 21, 18, | 1.67, 2, 2 |

| | | | |
|---|---|---|---|
| 16561 | 5, 50, 300 | 22, 18, 9 | 1, 2, 2 |
| 16562 | 5, 50, 300 | 23, 11, 7 | 1, 2, 2 |
| 16564 | 5, 50, 300 | 23, 16, 7 | 1, 2, 2 |

*Sample Preparation, Preservation and Analysis:*

Sampling for POC, PIC and BSi was coordinated by Jennifer Riley (NOC).

*POC:* Each sample was filtered through at o.8µm pore size, 25mm diameter, ashed GFF filters, placed in a Petri dish and frozen at -20°c for later analysis.

*PIC:* Each sample was filtered through 0.4µm pore size, 25mm diameter, nucleopore polycarbonate membrane filters, rinsed with some slightly alkaline milliQ water, stored in a Petri dish and frozen at -20°c for later analysis.

*BSi:* Each sample was filtered through 0.4µm pore size, 25mm diameter, nucleopore polycarbonate membrane filters, stored in a centrifuge tube and frozen at -20°c for later analysis.

*Chlorophyll:* Each sample was taken and filtered through a 0.8µm pore size, 25mm diameter GFF filter. The sample was then digested in 10 mls of 90% acetone and analysed on board in the flourometer. Further calibrations will be done back at NOCS. (Sample co-ordination by Stuart Painter and Nina Rothe).

*HPLC*: Each sample was filtered through a 0.8µm pore size, 25mm diameter GFF filter. Once complete filters were folded, placed into cryo-vials and frozen in liquid nitrogen for later analysis. (Sample co-ordination by Nina Rothe and Konstas Kiriakoulakis).

*Oxygen* was sampled and analysed on board by the French group (Dominique Le Fevre and Anne Roberts) from Marseille.

*Nutrients:* These samples were processed by the NOCS group using the onboard autoanalyser. (Sample co-ordination was through Richard Sanders).

All other samples will be coordinated by the NOCS group for processing and analysis.

Sinking Marine Particles

*Jennifer Riley (NOCS)*

*The Marine Snow Catcher*

The objective of deploying the marine snow catcher during D341 PAP site cruise was to examine the relationship between particle sinking rates and the corresponding mineralogical composition, with respect to calcium carbonate and biogenic silica.

Sinking marine particles and aggregates were collected from the base of the mixed layer (approximately 50m). Each particle was:

1) Photographed to document each individual collected.
   (From these photographs, particle size can be determined and this later related to their composition. The size measurements will also enable a determination of the volume and mass to be calculated.)
2) Settled in a 1L glass measuring cylinder to determine the speed at which they sink.
   (Particles were introduced to the measuring cylinder using a Pasteur pipette and then timed sinking between the graduation marks on the glass. Each particle was then recovered where possible using the Pasteur pipette.)
3) Preserved for determination of its composition back in the lab.
   (Preservation used 5% buffered formalin either in bulk using brown medicine bottles or individually in ependorf tubes.)

To compliment this, supporting information about the biological states in the water column was also determined. Water samples were filtered for particulate organic carbon (POC), particulate inorganic carbon (PIC), biogenic silica (BSi) and coccolithophore counts. This data was collected to alongside every snow catcher deployment.

Samples for dissolved inorganic carbon (DIC) and alkalinity (TA) were also taken across the PAP site to provide an insight into how the geochemical conditions are influencing particle export.

*Table 26. Snow Catcher Deployments*

| Date (Day of Year) | Station # | Depth (m) | Lat. | Long. | # Particles collected | Photographed | Settling experiment | Preserved |
|---|---|---|---|---|---|---|---|---|
| 196 | 16491 | 50 | 49, 03.82 | 16, 33.00 | 85 | x | x | X |
| 197 | 16496 | 50 | 48, 58.5 | 16, 24.9 | 83 | x | x | X |
| 202 | 16527 | 50 | 48, 53.3 | 17, 10.4 | 91 | x | x | X |
| 203 | 16537 | 50 | 48 53.9 | 16 55.0 | 75 | x | x | X |
| 211 | 16589 | 50 | 48 47.9 | 16 27.3 | 32 | x | x | X |
| 212 | 16593 | 50 | 48 49.0 | 16 30.5 | 31 | x | x | X |
| 213 | 16605 | 50 | 48 42.2 | 16 33.3 | 28 | x | x | x |
| 215 | 16620 | 50 | 48 58.3 | 16 25.0 | 33 | x | x | x |
| 220 | 16660 | 45 | 48, 47.0 | 16, 59.7 | 70 | x | x | x |

The following tables show where samples were collected from and what was carried out.

*Table 27. Summary of samples taken directly from MSC*

| Date (Day of Year) | Station # | POC (Vol. sampled L) | PIC (Vol. sampled L) | BSi (Vol. sampled L) | Chlorophyll Vol. sampled L (Vial #) | Nutrients (Vol. sampled L) | Salinity (Bottle #; Crate #) |
|---|---|---|---|---|---|---|---|
| 196 | 16491 | 2 top only | 1 top only | 1 top only | 0.25 (10) | 0.02 | 41; 1022 |
| 197 | 16496 | 2 top only | 1 top only | 1 top only | 0.25 (7) | 0.02 | 06; 908 |
| 202 | 16527 | Unable to filter due to survey see site 16526 (A4) | | | | | |
| 203 | 16537 | Unable to filter due to survey see site 16536 (B4) | | | | | |
| 211 | 16589 | 2L top and base | 0.67L top, 0.59L base | 0.75L top and base | 0.25 (1) | 0.02 | 25; 01 |
| 212 | 16593 | 2L top and base | 0.5L top and base | 0.5L top and base | 0.25 (1) | 0.02 | 30; 01 |
| 213 | 16605 | 2L top and base | 1L top and base | 1L top and base | 0.25 (6) | 0.02 | 35; 01 |
| 215 | 16620 | 2L top and base | 0.5L top and base | 0.5L top and base | 0.25 (1) | 0.02 | 41; 01 |
| 220 | 16660 | 2L top and base | 0.5L top and base | 0.5L top and base | 0.25 (1) | 0.02 | 14; 367 |

*Table 28. Complementary POC samples taken from water column*

| Particulate Organic Carbon | | | | | | |
|---|---|---|---|---|---|---|
| Date (Day of Year) | Station # | Lat. | Long. | Niskin | Depth | Volume |
| 194 | 16478 | 49, 01.328 | 16, 28.377 | 24, 22, 20, 18, 16, 14, 12, 10, 8, 6 | 5, 25, 50, 80, 100, 150, 200, 300, 400 | All depths 2L |
| 197 | 16497 | 48 58.6 | 16 24.6 | 24, 22, 20, 18, 16, 14, 12, 10, 4 | 5, 25, 50, 80, 100, 150, 200, 300, 750 | All depths 2L |
| 210 | 16580 | 48 59.9 | 16 51.4 | 22, 18, 9, 5, 4, 3, 2, 1 | 54, 10, 25, 50, 75, 100, 300 | All depths 2L |
| 212 | 16592 | 48 49.5 | 16 30.5 | 18, 15, 13, 10 | 5, 25, 50, 100 | All depths 2L |
| 213 | 16604 | 48 43.3 | 16 33.1 | 24, 21, 18, 12 | 5, 25, 50, 100 | All depths 2L |
| 215 | 16619 | 48 39.6 | 16 25.5 | 24, 22, 18, 14 | 5, 25, 50, 100 | All depths 2L |
| 220 | 16658 | 48 47.57 | 16 58.95 | 24, 22, 20, 16 | 5, 25, 50, 100 | All Depths 2L |

*Table 29. Complementary BSi Samples taken from the water column*

| Biogenic Silica | | | | | | |
|---|---|---|---|---|---|---|
| Date (Day of Year) | Station # | Lat. | Long. | Niskin | Depth | Volume |
| 194 | 16478 | 49, 01.32 | 16, 28.37 | 24, 22, 20, 18, 16, 14, 12, 10, 8, 6 | 5, 25, 50, 80, 100, 150, 200, 300, 400 | 0.58, 0.56, 1, 0.989, 0.96, 1, 0.89, 0.83, 1 |
| 197 | 16497 | 48 58.6 | 16 24.6 | 24, 22, 20, 18, 16, 14, 12, 10, 4 | 5, 25, 50, 80, 100, 150, 200, 300, 750 | 0.5, 0.5, 1, 1, 1, 1, 1, 1 |
| 210 | 16580 | 48 59.9 | 16 51.4 | 22, 18, 9, 5, 4, 3, 2, 1 | 5, 10, 25, 50, 75, 100, 300 | 0.43, 0.39, 0.5, 1, 1, 1, 1 |
| 212 | 16592 | 48 49.5 | 16 30.5 | 18, 15, 13, 10 | 5, 25, 50, 100 | 0.5, 0.5, 0.5, 1 |
| 213 | 16604 | 48 43.3 | 16 33.1 | 24, 21, 18, 12 | 5, 25, 50, 100 | 0.5, 0.5, 1, 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 215 | 16619 | 48 39.6 | 16 25.5 | 24, 22, 18, 14 | 5, 25, 50, 100 | 0.5, 0.5, 0.5, 1 |
| 220 | 16658 | 48 47.57 | 16 58.95 | 24, 22, 20, 16 | 5, 25, 50, 100 | 0.5, 0.5, 0.5, 1 |

*Table 30. Complementary PIC Samples taken from the water column*

| Particulate Inorganic Carbon | | | | | | |
|---|---|---|---|---|---|---|
| Date (Day of Year) | Station # | Lat. | Long. | Niskin | Depth | Volume |
| 194 | 16478 | 49, 01.328 | 16, 28.377 | 24, 22, 20, 18, 16, 14, 12, 10, 8, 6 | 5, 25, 50, 80, 100, 150, 200, 300, 400 | 0.89, 0.945, 2, 2, 1, 1, 1, 1, 1 |
| 197 | 16497 | 48 58.6 | 16 24.6 | 24, 22, 20, 18, 16, 14, 12, 10, 4 | 5, 25, 50, 80, 100, 150, 200, 300, 750 | 0.39, 0.57, 1, 1, 1, 1, 1, 1 |
| 210 | 16580 | 48 59.9 | 16 51.4 | 22, 18, 9, 5, 4, 3, 2, 1 | 5, 10, 25, 50, 75, 100, 300 | 0.5, 0.45, 0.49, 1, 1, 1, 1 |
| 212 | 16592 | 48 49.5 | 16 30.5 | 18, 15, 13, 10 | 5, 25, 50, 100 | 0.5, 0.5, 0.5, 1 |
| 213 | 16604 | 48 43.3 | 16 33.1 | 24, 21, 18, 12 | 5, 25, 50, 100 | 0.5, 0.5, 1, 1 |
| 215 | 16619 | 48 39.6 | 16 25.5 | 24, 22, 18, 14 | 5, 25, 50, 100 | 0.5, 0.5, 0.6, 1 |
| 220 | 16658 | 48 47.57 | 16 58.95 | 24, 22, 20, 16 | 5, 25, 50, 100 | 0.5, 0.5, 0.5, 1 |

*Table 31. Complementary Coccolithophore Samples taken from the water column*

| Coccolithophores | | | | | | |
|---|---|---|---|---|---|---|
| Date (Day of Year) | Station # | Lat. | Long. | Niskin | Depth | Volume |
| 194 | 16478 | 49, 01.32 | 16, 28.37 | 24, 22, 20, 18, 16, 14, 12, 10, 8, 6 | 5, 25, 50, 80, 100 | 0.5 L all depths |
| 197 | 16497 | 48 58.6 | 16 24.6 | 24, 22, 20, 18, 16, 14, 12, 10, 4 | 5, 25, 50, 80, 100, 150, 200, 300, 750 | 0.1, 0.41, 0.5, 0.5, 0.5 |
| 210 | 16580 | 48 59.9 | 16 51.4 | 22, 18, 9, 5, 4, 3, 2, 1 | 5, 10, 25, 50, 75, 100 | 0.5 L all depths |
| 212 | 16592 | 48 49.5 | 16 30.5 | 18, 15, 13, 10 | 5, 25, 50, 100 | 0.5 L all depths |
| 213 | 16604 | 48 43.3 | 16 33.1 | 24, 21, 18, 12 | 5, 25, 50, 100 | 0.5 L all depths |
| 215 | 16619 | 48 39.6 | 16 25.5 | 24, 22, 18, 14 | 5, 25, 50, 100 | 0.5 L all depths |
| 220 | 16658 | 48 47.57 | 16 58.95 | 24, 22, 20, 16 | 5, 25, 50, 100 | 0.5L all depths |

*Table 32. Complementary DIC / TA Samples taken from the water column*

| DIC/TA | | | | | |
|---|---|---|---|---|---|
| Date (Day of Year) | Station # | Lat. | Long. | Niskin | Depths Sampled |
| 194 | 16478 | 49, 01.328 | 16, 28.377 | | 5, 25, 50, 80, 100, 200, 400 |
| 197 | 16497 | 48 58.6 | 16 24.6 | 24, 22, 20, 18, 16, 14, 12, 10, 4 | 5, 25, 50, 80, 100, 150, 200, 300, 750 |
| 210 | 16580 | 48 59.9 | 16 51.4 | | 5, 10, 25, 50, 75, 100, 150, 300 |
| 217 | 16631 | 48, 54.8 | 16, 59.7 | 1, 3, 7, 9, 11, 13, 19, 21, 23 | 1000, 750, 500, 300, 150, 100, 50, 25, 5 |
| 217 | 16634 | 49, 04.7 | 16, 22.7 | 5, 7, 9, 11, 13, 15, 19, 21, 23 | 600, 500, 300, 150, 100, 75, 50, 25, 5 |
| 220 | 16658 | 48 47.57 | 16 58.95 | 24, 22, 20, 16, 14, 13, 10, 8 | 5, 25, 50, 100, 150, 300, 450, 600 |

*Snow Catcher Sample Preservation*

After each deployment of the snow catcher the particles were sorted into categories on the basis of their appearance. A subset of each category was then used in a sinking experiment. The particles were recovered after the sinking experiment wherever possible and then preserved in bulk according to the categorisation. For the final 5 deployments the particles that were sunk were preserved individually in ependorf tubes. Those particles, which were not sunk, were preserved in bulk. Where there were low numbers of particles collected all were sunk and ten individually preserved. All of the samples preserved will be analysed for their compositional content (PIC, POC, and BSi) back at NOC.

*Filter Sample Preparation, Preservation and Analysis:*

*POC:* Each sample was filtered through at 0.8µm pore size, 25mm diameter, ashed GFF filters, placed in a Petri dish and frozen at -20℃ for later analysis.

*PIC:* Each sample was filtered through 0.4µm pore size, 25mm diameter, nucleopore polycarbonate membrane filters, rinsed with some slightly alkaline milliQ water, stored in a Petri dish and frozen at -20℃ for later analysis.

*BSi:* Each sample was filtered through 0.4µm pore size, 25mm diameter, nucleopore polycarbonate membrane filters, stored in a centrifuge tube and frozen at -20℃ for later analysis.

*Coccolithophores:* Each Sample was filtered through 0.5µm, 25mm cellulose nitrate (CN) filter, rinsed with a high pH solution, placed in a petri-slide holder and dried in an oven at 40ºc.

*DIC / TA:* Each sample was spiked with a 50µm supersaturated solution of mercuric chloride, the stoppers taped shut and stored in boxes for analysis on the VINDTA system back at NOC.

*Pelagra*

The objective of taking samples from the Pelagra deployments was to examine the flux of sinking particles below the mixed layer. This will hopefully enable an estimate to be made of how the sinking flux changes in terms of its composition and sinking velocity with depth. For each deployment the Pelagra sampled at 5 depths, 50m, 150, 300m, 450m and 600m.

For each Pelagra recovered approximately 30 aggregates were picked and sunk individually in a glass measuring cylinder. The remainder of the particles were separated into two splits. One for bulk preservation and the other for a larger settling velocity experiment. In this latter experiment the particles were introduced to a long (1.5m) column filled with water and left in it to settle to the bottom. At set time intervals, 2min, 4min, 6min, 8min, 12min, 14min, 16min, 32min, 64min and 128min samples were drained from the bottom tap and preserved in formalin for more detailed compositional analysis back at NOC.

Each particle that was individually picked was,

1) Photographed to document each individual collected.
(From these photographs, particle size can be determined and this later related to their composition. The size measurements will also enable a determination of the volume and mass to be calculated.)

2) Settled in a 1L glass-measuring cylinder to determine the speed they sink.
(Particles were introduced to the measuring cylinder using a Pasteur pipette and then timed sinking between the graduation marks on the glass. Each particle was then recovered where possible using the Pasteur pipette.)

3) Preserved for determination of its composition back in the lab (Preservation used 5% buffered formalin either in bulk using brown medicine bottles or individually in ependorf tubes.)

*Table 33. Summary of samples picked individually from Pelagra samples*

| Day of year | Station | Lat. | Long. | Pelagra No. | Depth (m) | No. photographed | No. individually sunk | Portion settled | Preserved. |
|---|---|---|---|---|---|---|---|---|---|
| 195 | 16483 | 49, 02.2 | 16, 29.9 | P5 | 280 | 96 | 61 | x | x |
| 195 | 16484 | 49, 02.2 | 16, 29.9 | P7 | 630 | 79 | 60 | x | x |
| 200 | 16515* | 49 01.1 | 16 30.9 | P2 | 50 | 21 | 6 | - | - |
| 200 | 16517 | 49 01.1 | 16 31.1 | P5 | 300 | 30 | 30 | x | x |
| 200 | 16518 | 49 00.7 | 16 31.1 | P7 | 600 | 30 | 30 | x | X |
| 200 | 16519 | 49 00.3 | 16 30.9 | P6 | 450 | 30 | 30 | x | X |
| 209 | 16578 | 49 00.9 | 16 50.4 | P7 | 200 | 30 | 30 | x | x |
| 215 | 16623 | 48 55.1 | 16 23.3 | P4 | 175 | 30 | 30 | x | x |
| 215 | 16624 | 48 54.9 | 16 23.2 | P5 | 300 | 30 | 30 | x | x |
| 215 | 16625 | 48 54.8 | 16 23.2 | P6 | 450 | 30 | 30 | x | x |
| 215 | 16626 | 48 54.8 | 16 23.4 | P7 | 600 | 30 | 30 | x | x |

* Sample had a jellyfish in it and so was immediately preserved with formalin. However this caused the particles to sink faster in the individual settling experiments due to the different density liquids. Therefore the experiment was abandoned.

n.b. For the first two Pelagra pots particles were not preserved individually but bulked together. The rest of the Pelagra samples had 30 individual particles picked out, photographed and sank, a subsample preserved as a bulk reference and a second subsample used in a larger settling velocity experiment.

CTD operations

*Peter Keen (Keen Marine Ltd, for NMFD Sensors & Moorings Group, NOCS).*

A total of 73 CTD casts were undertaken on the cruise, 67 of which used the stainless steel frame, 4 used a lightweight aluminium frame adapted to recover pressurised water samples from depth and 2 were conducted on a trace metal free titanium frame.

Casts were conducted for a variety of purposes though the majority formed part of two high spatial resolution surveys to acquire near synoptic physical and biological parameters of a small part of the study site. Casts that formed part of the surveys were invariably to 1000 metres. Both surveys were reduced in scope due to adverse weather.

*Stainless Steel CTD Frame*

The stainless steel frame configuration was as follows:

Sea-Bird 9/11 *plus* CTD System carrying 2 pairs of SBE 3p Temperature and 4c Conductivity sensors with a Digiquartz pressure sensor.
24 by 20L Ocean Test Equipment External Spring Water Samplers
Sea-Bird 43 Oxygen Sensor
Chelsea MKIII Aquatracka Fluorometer
Chelsea MKII Alphatracka 25cm path Transmissometer
Wetlabs BBRTD backscatter detector
Teledyne Benthos Altimeter
OED LADCP Pressure Case Battery Pack
RD Instruments Workhorse 300 KHz Lowered ADCP (downward-looking master configuration)

The pressure sensor is located 15cm from the bottom of the water samplers, and 132 cm from the top of the water samplers. This frame was used for the majority of casts

*Stainless Steel CTD Frame Deployment Notes*
CTD casts were all conducted in a standard fashion with logging beginning prior to the instrument package being lifted from the deck. Immediately on entry to the water the package would be taken to 10 metres to allow the pumps to start and the instruments to settle at which point it would be lifted to the surface, or as near as sea state allowed, and the taken to the casts maximum depth at a veering speed not exceeding 60m/min.
The first cast was the only full depth profile conducted and was also used to test three releases for mooring deployments later in the cruise.
The 20 L bottles showed a marked tendency to not seat properly on the bottom cap and it was normal for one or two to be leaking on recovery. This is partly a result of the design of the bottles and difficult to compensate for during their cocking. The bottle at position 17 consistently did not fire and was not programmed for use on any of the casts once it became apparent that this was an unserviceable problem with the seabird rosette system.
The ADCP battery pack failed on cast 21 resulting in no LADCP data being logged for this cast. The battery case and cables were replaced for the next cast (22). Cast 25 had to be repeated after it was noticed that the CTD operator had failed to remove the blanking tubes on the primary and secondary sensor pump outlets. As a result the bottles were sampled and Cast 26 is the repeated cast in the same location for physical parameters but with no water samples were collect. The LADCP was left running and the associated file (341_025.000) is a double profile with the second profile beginning at around 1300hrs.

*Lightweight Aluminium Frame*

The aluminium frame was provided by Christian Tamburini for use with his work and will be described more fully in other sections. The Seabird 9/11 *plus* CTD that was provided with it was not functioning due to a problem with the power supply and was replaced with the Titanium CTD unit from the 'trace metal' frame. Additionally this configuration used two SBE43 Oxygen sensors.

*Titanium CTD Frame*

The titanium frame configuration was as follows:

Sea-Bird 9/11 *plus* CTD System carrying a single pair of SBE 3p Temperature and 4c Conductivity sensors and a Digiquartz pressure sensor.
24 by 10L Ocean Test Equipment External Spring Water Samplers
Sea-Bird 43 Oxygen Sensor
Chelsea MKIII Aquatracka Fluorometer
Chelsea MKII Alphatracka 25cm path Transmissometer
Wetlabs BBRTD backscatter detector
Teledyne Benthos Altimeter

The pressure sensor is located 30cm from the bottom of the water samplers, and 119 cm from the top of the water samplers. This frame was used twice, once for trace metal sampling to a depth of 4000m and once to collect water for a bioluminescence experiment.

*Titanium CTD Deployment Notes*

The titanium CTD casts were conducted in accordance with standard deployment procedures as described for the Stainless Steel Frame deployment notes.
The titanium CTD cast was conducted at the end of the cruise and had been stored fully constructed under its own cover on the upper deck near the funnel. In retrospect this is not a satisfactory place to store this instrument and significant quantities of iron oxide were found to be on the exterior of the frame and bottles. Subsequent inspection suggests that this in all likelihood did not contaminate the samples in the bottles but the bottles will require acid washing prior to their next use. Specific contamination issues were noted as follows:

Bottom Cap: 24, 23, 22, 21, 20, 19, 18, 17, 11, 5, 3
Top cap 'O'-ring: 5
Taps: 24, 23, 22, 21, 14, 12, 1

It is recommended that the frame is not stored in this position again.

## $^{210}$Po-$^{210}$Pb profiles

*Maria Villa (University of Seville)*

*Scientific motivation*

$^{210}$Pb (T1/2 = 22.3 yr) and its daughter $^{210}$Po (T1/2 = 138.4 d) are natural particle reactive radioisotopes that can be used as tracers of particle cycling in the upper ocean. Both radioisotopes have a strong affinity for particles, but whereas $^{210}$Pb is only adsorbed on particle surfaces, $^{210}$Po is also bioaccumulated, being incorporated into the cytoplasm of some species of phytoplankton and bacteria. Its partitioning is similar to that of protein and sulphur within the cell. These differences result in $^{210}$Po being more efficiently removed from surface waters than $^{210}$Pb via sinking particles. Hence, disequilibrium between the two radionuclides occurs when biological activity is high. The degree of disequilibrium between $^{210}$Pb and $^{210}$Po and the dynamics of association to particles can be used to asses scavenging rates, export fluxes and remineralisation rates. POC contents measured in sinking particles will be used to convert $^{210}$Po fluxes into carbon fluxes. Those results are complementary to the export fluxes that are obtained from the disequilibrium between $^{234}$Th and $^{238}$U. $^{210}$Pb-$^{210}$Po disequilibrium has different characteristics than that of the pair $^{234}$Th-$^{238}$U. $^{234}$Th is attached to the surface of the particles, however, $^{210}$Po it is assimilated by the organic matter, thus it is expected that $^{210}$Po-$^{210}$Pb disequilibrium allow us to better estimate POC fluxes whereas $^{234}$Th will be used to estimate particle scavenging. Furthermore, the different half lives of $^{234}$Th (24d) and $^{210}$Po (138.4d) would allow us to study timescales ranging from several days ($^{234}$Th) to several months or a year ($^{210}$Po).

*Sampling methodology and sampling treatment on board*

Samples for $^{210}$Po and $^{210}$Pb analysis were collected from a stainless steel CTD rosette at several stations (see table 34). 5L water samples were collected from 10 to 15 depths between 5-1000m. The sampling pattern was focused between 0 and 500 m, where a significant disequilibrium between $^{210}$Po and $^{210}$Pb is expected. Samples were immediately acidified, spiked with $^{209}$Po and $Pb^{2+}$ as yield tracers and $Fe^{3+}$ carrier added. After 12 h of equilibration, the pH was adjusted to 8.5 with $NH_4OH$, and $Fe(OH)_3$ allowed to form and settle. The supernatant was carefully removed via siphoning and the precipitate transferred to 250-mL bottles and stored for its later treatment. The radiochemical analysis of these samples will be done at Universidad de Sevilla.

Seawater profiles of 5-15 depths (5-1000 m) for the $^{210}$Pb-$^{210}$Po work were collected from a total of 15 stations (9 high resolution and 6 low resolution profiles). A total of 164 samples were collected, including 3 blanks and 7 replicate samples to ensure reproducibility.

*Further work and scientific outcomes*

Once in the laboratory, in order to isolate $^{210}$Po and $^{210}$Pb and take it to an appropriate form for its proper measurement, radiochemical purification must be conducted. Afterwards, polonium will be plated onto silver discs and measured. For $^{210}$Pb determination, the plating solution will be stored for at least 6 months to allow for $^{210}$Po ingrowth and to permit determination of $^{210}$Pb by re-plating of the $^{210}$Po. Pb yields will be determined through measurement of stable Pb by ICP-OES. $^{210}$Po yields will be determined using radioactive $^{209}$Po as internal tracer. $^{210}$Po and $^{210}$Pb will be analysed at the University of Sevilla through alpha spectrometry using Canberra PIPS detectors. Decay corrections would be done to $^{210}$Pb and $^{210}$Po results before obtaining activity concentration in water. $^{210}$Po fluxes will be calculated from the disequilibrium between $^{210}$Pb and $^{210}$Po activities in each depth and integrating to all depths. The ratio $^{210}$Po/POC will be calculated from particles recovered from in-situ pumps and PELAGRA and $^{210}$Po export fluxes will be converted into POC, opal and calcite fluxes. The results will be complemented with the information obtained from $^{234}$Th fluxes (see $^{234}$Th/$^{238}$U section by Fred Le Moigne).

*Table 34: Station ID (RRS Discovery station number) with sampling time, position and samples taken.*

| Station ID | Date | Julian day | Latitude | Longitude | depth range | Number of samples |
|---|---|---|---|---|---|---|
| 16477 | 13/07/2009 | 194 | 49.20.86 N | 16.28.98 W | 5-1000m | 12 |
| 16497 | 16/07/2009 | 197 | 48.58.55 N | 16.24.48 W | 5-1000m | 11 |
| 16523A6 | 20/07/2009 | 201 | 48.32.73 N | 17.10.43 W | 5-1000m | 14 |
| 16544C3 | 23/07/2009 | 204 | 49.05.00 N | 16.38.15 W | 5-1000m | 16 |
| 16583 | 29/07/2009 | 210 | 48.58.79 N | 16.55.91 W | 5-1000m | 15 |
| 16592 | 31/07/2009 | 212 | 48.49.47 N | 16.30.50 W | 5-600m | 10 |
| 16619 | 03/08/2009 | 215 | 48.59.55 N | 16.25.5 W | 5-1000m | 15 |
| 16631B4 | 05/08/2009 | 217 | 48.54.61 N | 16.54.63 W | 5-150m | 5 |
| 16632B3 | 05/08/2009 | 217 | 49.05.38 N | 16.54.63 W | 5-150m | 5 |
| 16633C3 | 05/08/2009 | 217 | 49.05.38 N | 16.38.21 W | 5-150m | 4 |
| 16634D3 | 06/08/2009 | 218 | 49.05.38 N | 16.21.78 W | 5-150m | 6 |
| 16635E3 | 06/08/2009 | 218 | 49.05.38 N | 16.05.36 W | 5-150m | 5 |
| 16636E4 | 06/08/2009 | 218 | 48.54.61 N | 16.05.36 W | 5-150m | 5 |
| 16640 | 06/08/2009 | 218 | 48.55.00 N | 16.55.75 W | 5-1000m | 13 |
| 16659 | 08/08/2009 | 220 | 48.78.79 N | 16.99.79 W | 5-1000m | 15 |

Ammonium and macronutrients

*Peter Statham and Richard Sanders (NOCS)*

The work of the Plymouth Marine Laboratory personnel (Ian Brown) on board focused on the cycling of a variety of N species in the upper water column using N-15 tracers. In order not to add an excess of the isotopically enriched substrate it is important to know ambient concentrations of N species including ammonia, and so this measurement was carried out onboard.

The technique is based on the method of Holmes et al. (1999) in which ammonia reacts with OPA (orthophthalaldehyde) in a borate buffered solution in the presence of sulphite; the sulphite reduces interferences from amines. The fluorescent product was measured in a TD700 Turner fluorometer fitted with a near UV mercury vapour lamp, an interference excitation filter at 350nm and a 410-600 nm combination emission filter. The detailed protocol followed used slight modifications of the Holmes technique as recommended by Martin Johnson (UEA) and Stuart Painter (NOCS). The modified method used, 800 µL of the mixed reagent (made as in Holmes) per 10 mL of sample or standard, and after mixing the solution is allowed to stand for typically 3 hours at room temperature to allow the reaction to go to completion. Multiple blanks and standards as well as seawater fluorescence at the analytical wavelengths were determined. No detectable fluorescence above background was noted from the untreated seawaters and so no correction was applied. The detection limit of the method as used typically ranged from10-20 nM (3 sigma blank), and this was adequate for the sampled upper water column. All handling steps were done in a laminar flow hood fitted with an ammonia absorbing filter pack on the inlet which thus provided a low ammonia environment in which to work. Precision was improved by reusing the polystyrene diluvials in which the fluorescent product was formed. This infers there is a low level random contamination form the uncleaned diluvials. The calibration slope decreased gradually over he course of the cruise, and has been ascribed (S. Painter, pers comm.) to a gradual degradation of the OPA reagent.

During the cruise 10 profiles were measured and concentrations ranged from about 300 nM to less than detection limits. Although there were significant variations between profiles and often profiles were not sampled at high resolution, a general trend of highest concentrations in the surface waters with a frequent maximum at the base of the mixed layer was evident. Below are two example profiles from the main biogeochemistry station, profiles 16475 (Fig 4a) before and 16497 (Fig 4b) after a strong storm event with associated vertical mixing of the water column, and reduction in the magnitude and broadening of the ammonia maximum.

*Figure 4a. Ammonia profile 16475 before the first storm of the cruise*

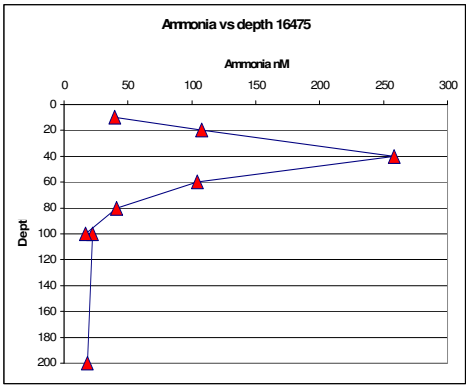


*Figure 4b. Ammonia profile after first storm event*

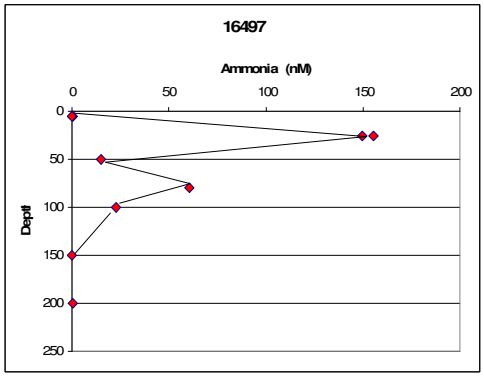


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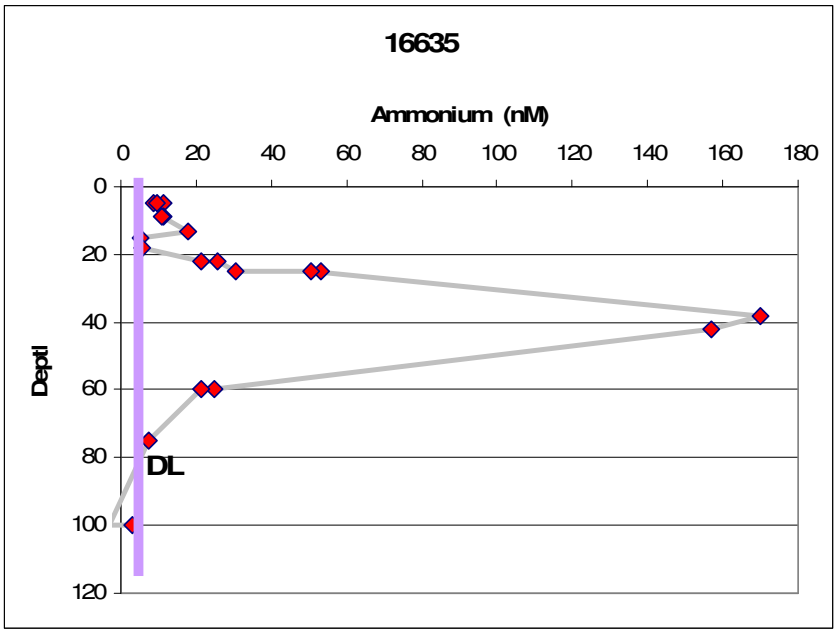
Figure 5 shows a detailed profile of ammonium structure in the upper water column, where the base of the mixed layer was at about 50m. An interpretation is the lowest ammonium in the mixed layer is just below the surface where productivity is expected to be highest and therefore any ammonium produced is rapidly taken up keeping concentrations low. Moving deeper into the water column, more detritus is accumulating and more recycling of ammonium occurs. This process seems to reach a maximum at the base of the mixed layer, in-line with other profiles where maxima occurred at a similar location. Below the mixed layer where the detritus is much less abundant, concentrations very rapidly fall to undetectable levels.

*Figure 5. Final profile of the cruise, when precision issues were better under control*

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*Reference:*

Holmes R.M., Aminot A., Kerouel R., Hooker B.A., and Peterson B.J. (1999) Can. J. Fish. Aquat. Sci. **56**, 1801-1808.

Macronutrients

Samples for the analysis of nitrate, phosphate and silicate concentrations were drawn from Niskin bottles on all CTD casts, stored at 4C and analysed within 24hrs of collection. Due to a shortage of manpower on the cruise the final numbers were not worked up on board – this should take place in June 2010.

D341 Doms Recovery

*Terry Edwards (NOCS)*

**The DOMS mooring was recovered on July 20th, the notes below were written following recovery to guide discussion over a possible redeployment. In the event no redeployment was undertaken.**

The idea was to approach the surface buoy from upwind to inspect and assess the best options. This took into account the relative position of the buoy and anchor. The sighting pass confirmed damage to the buoy and put the lifting bale at around level with the stb deck.

The idea was then to hook a 5T hook attached to the 3T deck winch cable directly into the bale and recover using the stb crane and ships wide block. The hook missed the top bale and became snagged on the ARGOS beacon brackets. It was then decided to hook the recover line so the 5T hook could be freed while keeping the buoy captive. The recovery line was eventually used to lift the buoy on board.

The chain was then stopped off. This proved quite difficult as using the stb crane to recover the buoy meant the tugger, stopper and buoy were all in the same line. We attempted to leave the chain connected to the buoy while the chain was tugged / stopped / tugged. However, it was noticed that the chain / buoy connection shackle was almost out so we reverted to the plan of mechanically and electrically disconnecting the chain and buoy. After this, it was relatively easy to pull the chain up with the 3T winch.

The first tugged length took the chain, wires and clamps through the block which didn't work well as the clamps snagged the block and it jumped heavily when it released. The procedure then changed to hauling the cable through the block until the chain reached the block then stop off. This worked well.

Frame came to the surface and was lifted out on stb crane. Swung forward and laid down on pallets. This was a bit awkward. But not too difficult. The wire was stopped off with 2 carpenters stops. This worked well, and the tail rope was connected through the DB winch.

The rope was tied through the encapsulated wire swage as it was too wide for a shackle. This arrangement destroyed the encapsulation but was otherwise effective.

The ship steamed to 0.5kts away from the anchor location as the wire was hauled in. The aim was to fire the release at 1.8NM from the anchor. Monitoring of the wire showed high tension so the release was fired at 1.7NM. 1127 GMT. The release was tracked until happy that it was ascending.

The procedure worked fairly well, the line came to the surface untangled.

After this, the recovery went as normal with only minor hitches when the drive arm on the drum reeler bent and had to be reinforced.

*Recommendations.*

Have wire from 3T winch go through the scrolling

3T winch should be more central
Grab recovery line on stb side to help get the hook in the lifting bale.

Disconnect chain from buoy immediately.

*Preliminary Report*

The section below is a copy of the preliminary report produced to focus attention on the 3 main issues that could prevent redeployment.

This report will concentrate only on the issues that will directly or seriously affect redeployment of the mooring and look at actions required and by whom. There are more minor issues, but not show stoppers.

It is well worth noting that the major problems are all at the top end, the frame, wire, rope and lower buoyancy are all in very good condition and no modifications are necessary. The rest of the buoy, wiring, radar reflector etc is all in A1 condition. If we can deploy until AMT then a top buoy refurbishment / repair / replacement should be possible, as a full recovery will not be necessary.

*Loss of solar panels.*

The loss of 3 solar panels and their mountings appears to be a function of the buoy design that allows water to flush through. Regardless, what we have now is one large panel and 3 old small units, 2 of which were intended for use with AIS.

The question is, would a combination of these allow a reduced instrument and comms capability, and if so, what is the best option? This should be considered with the fact that we now have a stand alone iridium beacon to fit to the unit, so position monitoring is not an issue.

Bear in mind also that only the microcats have inductive couplers now, so if no hub, then only CTD data can be real time. Note that the hub has begun to corrode quite badly, it may be necessary to coat it somehow.

**Action Jon and Richard to consult**

*Buoy / Chain Junction*

The shackle and bush arrangement is clearly not substantial enough or does not have the right characteristics for this type of installation. Strangely, this type of wear was not an issue on the 2007 deployment. It could be a function of the extra weight or drag of the larger instrument frame.
This is potentially a show stopper unless a new system can be devised.

Below is a picture of the worn shackle and pin. (Figure 6)

*Figure 6. Photograph showing erosion of threads in main shackle holding instrument frame to buoy*

So, how to attach a length of galvanized steel chain to a stainless steel eye in such a way that wear is reduced and movement is restricted?

**Action: Terry, Kevin , Sam and Darren to address this on ship any suggestions from anybody will be considered.**

We already have some ideas and will send them back as they shape up.

*Buoyancy*

The toroid appeared to be riding low in the water, if the buoy has taken on water, then a deployment is not possible. It sustained some minor damage on recovery, but I think this is repairable on board.

**Action, Terry and crew to test when weather allows, probably in the next day or 2.**

*Risk*

What level of equipment loss is acceptable?

Do we redeploy as a purely engineering exercise or not at all?

Do we deploy a sub set of instruments? (this will already be the case given the power constraint.).

Some thoughts that may be possible are;

Backup ropes from buoy to the frame, say 3 in case chain fails.

Planned inspection of top end by ships in area, JCR, AMT, ECOMAR passage or OFEG partners etc.

Of course, a risk assessment will be carried out for any system modifications.

**Action: Colin Day, Francis Mason, Richard Lampitt**

*Work Carried Out Aboard Ship*

The main problem appeared to be the connection between the chain and the buoy. This was improved by binding the first 50cm with 10mm polyester rope. The idea was to transmit some of the movement away from the first coupling. A CTD shackle was welded onto the buoy mounting plate after being connected to the chain making a permanent link. The whole thing was then covered with a 1m length of hydraulic hose and the top section filled with approx 25cm of polyurethane resin, injected using a silicone sealant gun.

This arrangement seemed fairly substantial and I am sure it would have lasted for several months, if not through the winter.

The power issue was worked around by adding 3 small 10W solar panels, 2 of which charged the main battery and one which charged the secondary battery which powered the radar reflector. The Sea-me control box and solar panel regulator were mounted in the battery box and bulkhead connectors fitted in the top cover.

A stand alone Iridium MELO beacon was added as an additional precaution.

Finally, extra buoyancy and weight tests were conducted which made us decide that a redeployment was not possible. Details below.

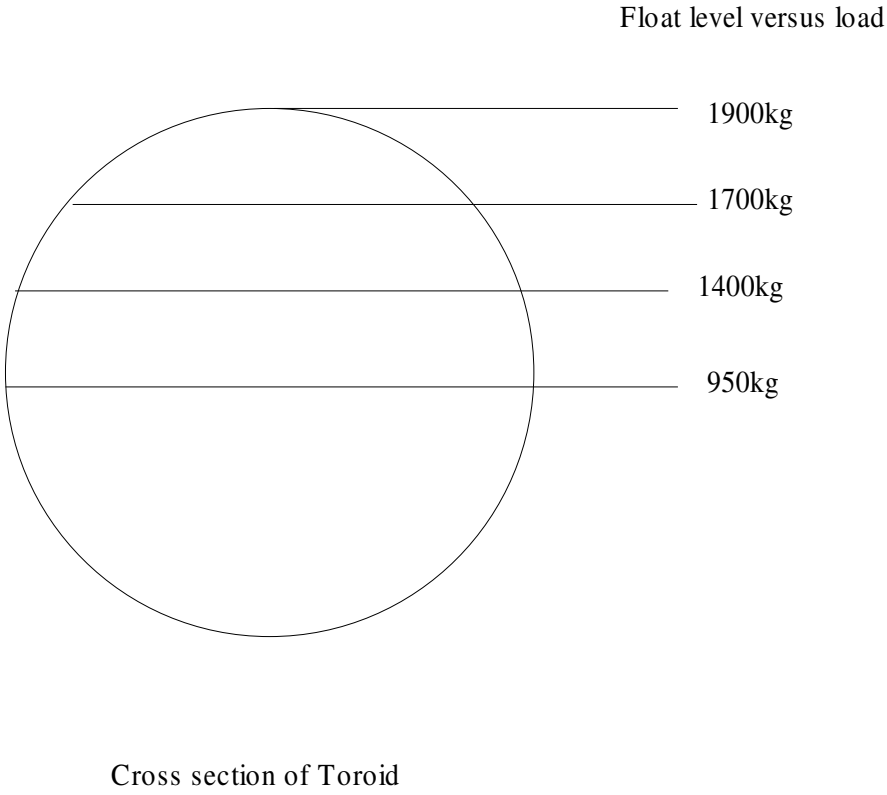
We conducted final weight and buoyancy calculations and used these together with a modeled toroid and images and film taken during recovery to conclude that the risk of a failure is too high to deploy.

Our methodology is below.

Weight (in air) of buoy + Frame + chain = 1700Kg
Displacement of toroid = 1900litres
Displacement of Battery pack = 300 litres

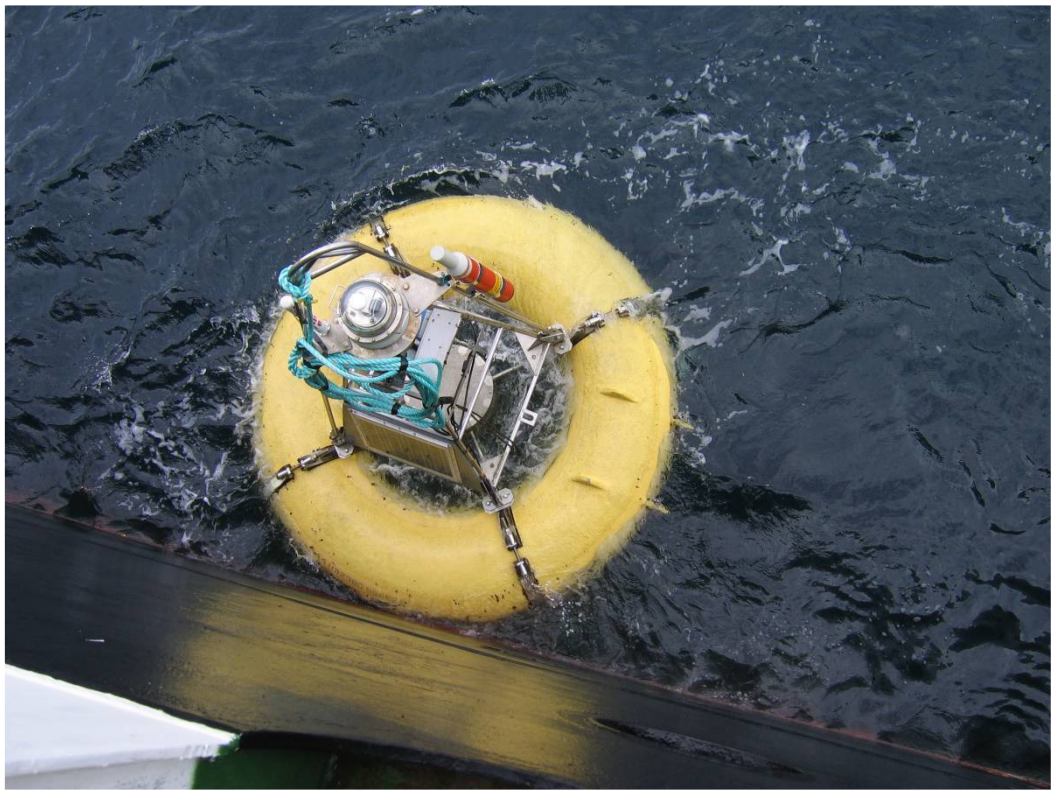
Therefore we have 500 kg of positive buoyancy. The diagram below shows float levels at various loads based on a modeled toroid.

*Figure 7. Schematic representation of water level on toroid as function of load*




The 500Kg of positive buoyancy should allow the buoy under load to float 100mm above the centre line, ie at the 1400Kg level. This is because of the extra 300Kg from the Battery pack. The image below demonstrates that the buoy is approximately at the 1700Kg level. Obviously, this is done at sea, and is therefore open to some interpretation, but video images and the float level indicated by biological growth back this up.

*Figure 8. Image of DOMS buoy on recovery*



This all means that we have around about 10% backup buoyancy available instead of a theoretical 20-25%. It does point to water ingress of the buoy, and this may be investigated at a future point, but we do not consider 10% adequate to risk a deployment of such a large installation in such a harsh environment.

Additional buoyancy added at the last deployment was dislodged and we do not have the resources on board to confidently add buoyancy to any element of the mooring.

Microbial community abundance, structure and dynamics

*Mike Zubkov, Ross Holland (NOCS)*

*The aim:* To study abundance, community composition and metabolic activities of dominant microbial groups within planktonic communities of the twilight zone and to assess the rates of their nutrient acquisition and metabolism.

*Objectives:*
1) To determine the spatial distribution, abundance and community structure of nano- and picoplankton in the twilight zone by flow cytometry.
2) To collect concentrated seawater samples for analysis of plankton community composition in the twilight zone using molecular approaches.
3) To estimate the turnover of dissolved organic nutrients and phosphorus using methionine, leucine and ATP tracers.
4) To determine composition and abundance of microplankton down to the twilight zone.

*2. Plankton community structure and abundance by flow cytometry.*

Seawater samples for flow cytometric analyses were collected from CTD bottles at stations and depths (Table 35) and 3.5 ml from each bottle sample were fixed with paraformaldehyde (PFA, final concentration 1%). Samples of 3.5 ml were left unfixed and unstained and were analysed live by flow cytometry within an hour of collection. Samples were analysed on a Becton Dickinson FACSCalibur (BD Biosciences, Oxford, UK) Analytical Flow Cytometer. Samples were analysed live unstained as well as fixed stained with SYBR Green I DNA stain. Three analysis protocols were used to resolve and enumerate populations of heterotrophic prokaryotes, picoplanktonic and nanoplanktonic algae and heterotrophic protists on bivariate dotplots of $90^{o}$ light scatter and green (DNA stain) fluorescence, orange fluorescence and red fluorescence.

Protocol 1 was used to analyse heterotrophic prokaryotes including cyanobacteria abundance and distribution in the stained sample on bivariate dotplots of $90^{o}$ light scatter (cell size index), red fluorescence (chlorophyll content) and orange fluorescence (phycoerythrin content) against green fluorescence (DNA content). Protocol 3 was used to analyse heterotrophic protists, picophytoplankton and nanophytoplankton groups in the stained sample on bivariate dotplots of red fluorescence and orange fluorescence against green fluorescence. Protocol 2 was used on the unstained sample to confirm or deny the assumption that autofluorescent cells can be as effectively enumerated using DNA stained samples as with unstained samples, without a loss of pigment leading to undercounting.

Protocol 1 was used to analyse all samples except those from CTD 16488.
Protocol 2 was used to analyse all samples without exception.
Protocol 3 was used to analyse all samples except those from CTDs 16475 and 16488.

A total of fourteen CTD profiles were analysed by flow cytometry as outlined below in Table 35, in addition bacterioplankton was enumerated in samples of interest to other cruise participants.

*Table 35. Table of bacterioplankton samples taken during cruise D341.*

| Discovery Station Number | D341 cruise Number | Date | Time, GMT | Bottle Number | Depth, m |
|---|---|---|---|---|---|
| 16475 | 1 | 13/07/2009 | 05:21 | 1 | 4800 |
| | | | | 4 | 2000 |
| | | | | 6 | 1500 |
| | | | | 8 | 1000 |
| | | | | 10 | 750 |
| | | | | 12 | 500 |
| | | | | 14 | 300 |
| | | | | 16 | 200 |
| | | | | 18 | 100 |
| | | | | 20 | 80 |
| | | | | 21 | 60 |
| | | | | 22 | 40 |
| | | | | 23 | 20 |
| | | | | 24 | 10 |
| 16488 | 4 | 15/07/2009 | 00:55 | 1 | 800 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | 2 | 800 |
| | | | | 3 | 800 |
| | | | | 4 | 800 |
| | | | | 5 | 800 |
| | | | | 6 | 800 |
| | | | | 7 | 800 |
| | | | | 8 | 800 |
| 16496 | 5 | 16/07/2009 | | 1 | 1000 |
| | | | | 3 | 750 |
| | | | | 7 | 500* |
| | | | | 9 | 300 |
| | | | | 11 | 200 |
| | | | | 13 | 150 |
| | | | | 15 | 100 |
| | | | | 17 | 80 |
| | | | | 19 | 50 |
| | | | | 21 | 25 |
| | | | | 23 | 5* |
| | SWAB.1 | 18/07/2009 | 13:30 | | 1* |
| 16510 | 7 | 19/07/2009 | 04:48 | 3 | 1000* |
| | | | | 4 | 900 |
| | | | | 5 | 750 |
| | | | | 6 | 600 |
| | | | | 7 | 500* |
| | | | | 8 | 400 |
| | | | | 9 | 300 |
| | | | | 10 | 200 |
| | | | | 11 | 100 |
| | | | | 12 | 80 |
| | | | | 13 | 50 |
| | | | | 15 | 35 |
| | | | | 19 | 15 |
| | | | | 20 | 10 |
| | | | | 22 | 6 |
| | SWAB.2 | 20/07/2009 | 12:40 | | 1* |
| 16526 | 11 | 21/07/2009 | 08:21 | 1 | 1000 |
| | | | | 3 | 1000* |
| | | | | 4 | 750 |
| | | | | 5 | 600 |
| | | | | 7 | 500* |
| | | | | 8 | 300 |
| | | | | 9 | 150 |
| | | | | 10 | 100 |
| | | | | 11 | 75 |
| | | | | 12 | 50 |
| | | | | 13 | 25 |
| | | | | 14 | 5 |
| 16535 | 17 | 22/07/2009 | 05:43 | 2 | 1000* |
| | | | | 4 | 750* |
| | | | | 6 | 600 |
| | | | | 8 | 500* |
| | | | | 10 | 300 |
| | | | | 12 | 150 |
| | | | | 14 | 100 |
| | | | | 16 | 75 |
| | | | | 18 | 50 |
| | | | | 20 | 25 |
| | | | | 24 | 5 |
| 16546 | 25 | 23/07/2009 | 11:02 | 2 | 1000 |
| | | | | 6 | 750* |
| | | | | 10 | 500 |
| | | | | 12 | 300 |
| | | | | 14 | 150 |
| | | | | 16 | 100 |
| | | | | 18 | 75 |
| | | | | 20 | 50 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | 22 | 25 |
| | | | | 24 | 5 |
| 16554 | 32 | 24/07/2009 | 06:30 | 2 | 1000 |
| | | | | 4 | 750 |
| | | | | 8 | 500* |
| | | | | 10 | 300 |
| | | | | 12 | 150 |
| | | | | 14 | 75 |
| | | | | 16 | 50 |
| | | | | 18 | 25 |
| | | | | 24 | 5 |
| 16564 | 40 | 25/07/2009 | | 2 | 1000 |
| | | | | 3 | 750 |
| | | | | 4 | 600 |
| | | | | 6 | 500 |
| | | | | 9 | 300* |
| | | | | 10 | 150 |
| | | | | 12 | 100 |
| | | | | 14 | 75 |
| | | | | 16 | 50 |
| | | | | 19 | 25 |
| | | | | 24 | 5 |
| | SWAB.3 | 26/07/2009 | 13:10 | | 1* |
| 16583 | 45 | 29/07/2009 | 06:17 | 1 | 1000* |
| | | | | 3 | 900 |
| | | | | 4 | 800 |
| | | | | 5 | 750 |
| | | | | 6 | 700 |
| | | | | 7 | 650 |
| | | | | 8 | 600 |
| | | | | 9 | 550 |
| | | | | 10 | 500 |
| | | | | 11 | 450 |
| | | | | 12 | 400 |
| | | | | 13 | 350 |
| | | | | 14 | 300 |
| | | | | 15 | 250 |
| | | | | 16 | 200 |
| | | | | 17 | 150 |
| | | | | 19 | 125 |
| | | | | 20 | 100 |
| | | | | 21 | 75 |
| | | | | 22 | 50 |
| | | | | 23 | 25 |
| | | | | 24 | 5 |
| 16592 | 47 | 31/07/2009 | 11:52 | 1 | 2000 |
| | | | | 3 | 600 |
| | | | | 4 | 500 |
| | | | | 5 | 400 |
| | | | | 6 | 200 |
| | | | | 7 | 150 |
| | | | | 8 | 125 |
| | | | | 9 | 100 |
| | | | | 11 | 75 |
| | | | | 13 | 50 |
| | | | | 15 | 25 |
| | | | | 17 | 5 |
| 16604 | 49 | 01/08/2009 | 07:25 | 2 | 1000 |
| | | | | 4 | 750 |
| | | | | 7 | 500* |
| | | | | 9 | 300 |
| | | | | 11 | 150 |
| | | | | 13 | 100 |
| | | | | 14 | 75 |
| | | | | 16 | 50 |
| | | | | 20 | 25 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | 24 | 5 |
| | SWAB.4 | 02/08/2009 | 14:59 | | 1* |
| 16619 | 54 | 03/08/2009 | | 1 | 1000 |
| | | | | 2 | 800 |
| | | | | 5 | 750* |
| | | | | 6 | 600 |
| | | | | 7 | 500 |
| | | | | 8 | 400 |
| | | | | 9 | 300 |
| | | | | 10 | 250 |
| | | | | 11 | 200 |
| | | | | 12 | 150 |
| | | | | 14 | 100 |
| | | | | 15 | 80 |
| | | | | 16 | 60 |
| | | | | 18 | 50 |
| | | | | 20 | 40 |
| | | | | 21 | 25 |
| | | | | 23 | 5 |
| 16636 | 64 | 06/08/2009 | 05:00 | 1 | 1000 |
| | | | | 3 | 750 |
| | | | | 5 | 600 |
| | | | | 7 | 500 |
| | | | | 11 | 300* |
| | | | | 12 | 150 |
| | | | | 14 | 100 |
| | | | | 16 | 75 |
| | | | | 19 | 50 |
| | | | | 21 | 25 |
| | | | | 23 | 5 |
| 16659 | 70 | 08/08/2009 | 10:08 | 1 | 1000 |
| | | | | 3 | 875* |
| | | | | 4 | 800 |
| | | | | 5 | 700 |
| | | | | 6 | 600 |
| | | | | 7 | 500 |
| | | | | 9 | 400 |
| | | | | 10 | 250 |
| | | | | 11 | 150 |
| | | | | 12 | 100 |
| | | | | 13 | 80 |
| | | | | 14 | 60 |
| | | | | 15 | 50 |
| | | | | 16 | 40 |
| | | | | 18 | 25 |
| | | | | 22 | 5 |

*2. Microbial cell collection for molecular analyses of phylogenetic composition of planktonic microbial communities.*

Seawater samples of 10-20L were collected from CTD bottles (Table 35, asterisks) and after prefiltration through 20µm to screen out larger organisms microbial cells were concentrated. The concentrates were frozen in liquid nitrogen and stored at -80℃ for further analyses ashore.

*3. Assessment of metabolic activities of dominant planktonic microbes in twilight zone.*

Seawater samples of 20L were collected from CTD bottles (Table 35, asterisks) and ambient concentrations and turnover rates of two amino acids, leucine and methionine, and ATP by total bacterioplankton were measured using isotopic dilution time-series bioassays. On four occasions (Table 35) samples were collected using a surface water acquisition bucket (SWAB) and used for bioassays to compare with microbial metabolic rates in the twilight zone. The samples collected were used for bioassay incubations within <1/2 hour of collection.

*4. PROgrammable Ocean Fractionation Net (PROOFNet) / FLOWCAM Trials.*

A novel method of collecting and size fractionating microplankton over a user-defined depth was trailed on D341. The Programmable Ocean Fractionation Net (PROOFNet) has a nested series of meshes of decreasing pore size, (180, 100, and 40µm) each with its own collection cod-end (Figures 9+10). The opening and closure of the meshes is controlled using a depth programmable operculum system. This enables the net to be opened and closed over a user-specified depth-range. Associated with the PROOFNet is a Nobska Velocity Meter which logs the inflow of water through the operculum in order to calculate the abundance and distribution of diverse microplankton groups over a specific depth range in the water column. The trials were conducted as detailed below in Table 36.

*Figures 9+10. PROOFNet being deployed*

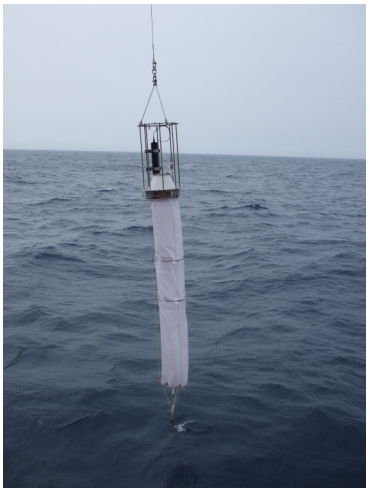


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*Table 36. Deployments of PROOFnet*

| Cast Date | Cast Time | Depth Range | Technical Notes |
|---|---|---|---|
| 14/07/2009 | 12:00 | 90m - 40m | Operculum function normal. No flow data recovered. User error. |
| 15/07/2009 | 08:00 | 90m - 40m | Operculum function normal. No flow data recovered. User error. |
| 17/09/2009 | 08:30 | 90m - 40m | Operculum opened. Flow data recovered. Unusual flow signal |
| | | | recorded after closure, electronic error suspected. |
| 19/07/2009 | 07:20 | 90 - 40m | Operculum opened. Flow data recovered. Unusual flow signal |
| | | | recorded after closure, electronic error confirmed. |
| | | | As the error occurs after operculum re-closure, flow data during |
| | | | open period assumed to be correct. |
| 21/07/2009 | 16:42 | 90m - surface | Operculum opened. Cast used as a control to confirm that |
| | | | closure on previous casts was effective. |
| 22/07/2009 | 15:26 | 90m - 40m | Operculum Opened. Flow data recovered. |
| 24/07/2009 | 16:15 | 90m - 40m | To minimise observed outflow of water (Possibly due to ship roll) |
| | | | from net, a faster net recovery was trialed (>10m/min). |
| | | | Operculum opened, but failed to close properly. After this |
| | | | deployment, velocity meter suffered electronic malfunction |
| | | | and was deemed irreparable on the ship. |
| 06/08/2009 | 20:00 | 100m - Surface | Net deployed without opening and closing mechanism. |
| 07/08/2009 | 20:00 | 100m - Surface | Net deployed without opening and closing mechanism. |

Samples were analysed using the FLOWCAM (*FLOW Cytometer And Microscope*) instrument, a fast-throughput system which images, classifies and enumerates organisms according to their individual morphologies.

*Preliminary observations*

Bacterioplankton community structure in the survey area was reasonably constant in terms of the flow cytograms of light scatter vs green fluorescence from stained DNA. Bacterioplankton abundance in the studied waters varied from 0.03 to 3.0 million cells $mL^{-1}$.

Scintillation counts were done on board the ship and a five fold range of rates of microbial activity was observed. Boiassayed concentrations of leucine in the water column studied ranged between 0.017-3.5 nM. Estimated turnover of leucine by bacterioplankton ranged between 6-570 hours. Detailed analysis of the rest of the collected tracer samples will be carried out after the cruise on low background scintillation counters back at the NOCS, because of the sensitivity limitations of the scintillation counter on board the ship. When completed, the data set will allow estimation of the rates of bacterioplankton metabolic activity and production as well as linking between bacterial function, composition, hydrological structure of the twilight zone.

During D341 dinoflagellates (e.g. C*eratium* spp. [Figure 11], *Noctiluca* sp.), tintinnids, acantharians, radiolarians, foraminifera, diatoms, colonial haptophytes (e.g. *Phaeocystis* sp.) and cyanobacteria (e.g. *Trichodesmium* sp. [Figure 12]) as well as copepods and their nauplii etc. were imaged and enumerated successfully using the FLOWCAM. Example images from D341 casts are presented below.

*Figure 11. Ceratium spp collected using PROOFnet and imaged using Flowcam.*

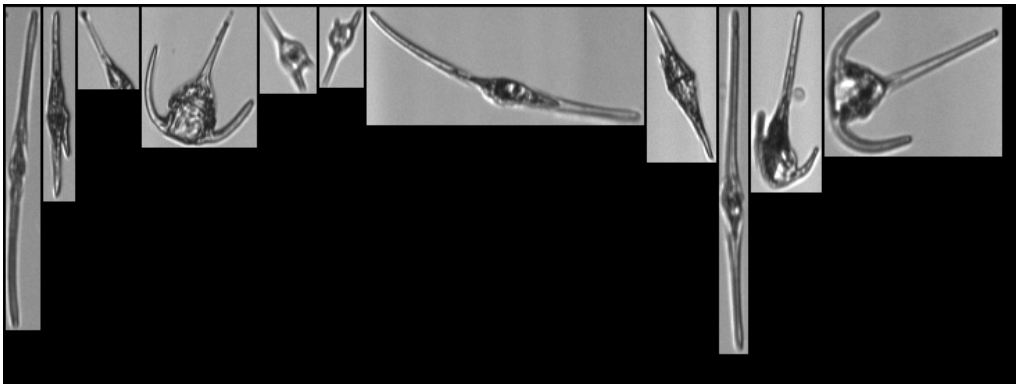
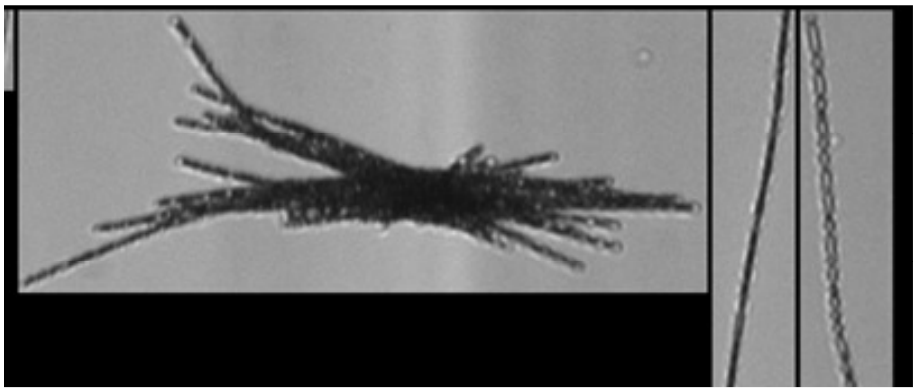


*Figure 12 Trichodesmium collected using PROOFnet and imaged using Flowcam*



D341 Moorings Report

*Terry Edwards (NOCS)*

*1. PAP 3 Deployment 17th July 2009*

Weather : F3, good vis, low swell, F3-4

*Table 37. Order of Events during PAP3 Deployment*

| Time | Equipment | S/N | Details |
|---|---|---|---|
| 1345 | Billings, light and pellet | X03-089 | |
| 1347 | 12 x 17" glass | | |
| 1400 | Parflux sed trap, 21 way | 12432-05 | |
| 1401 | Current meter, RCM8 | 9440 | |
| 1409 | Parflux sed trap, 21 way | 12432-04 | |
| 1503 | 10 x 17" glass | | |
| 1516 | Parflux sed trap, 21 way | 12432-06 | |
| 1517 | Current meter, RCM8 | | |
| 1527 | Release, AR861 | 828 | |

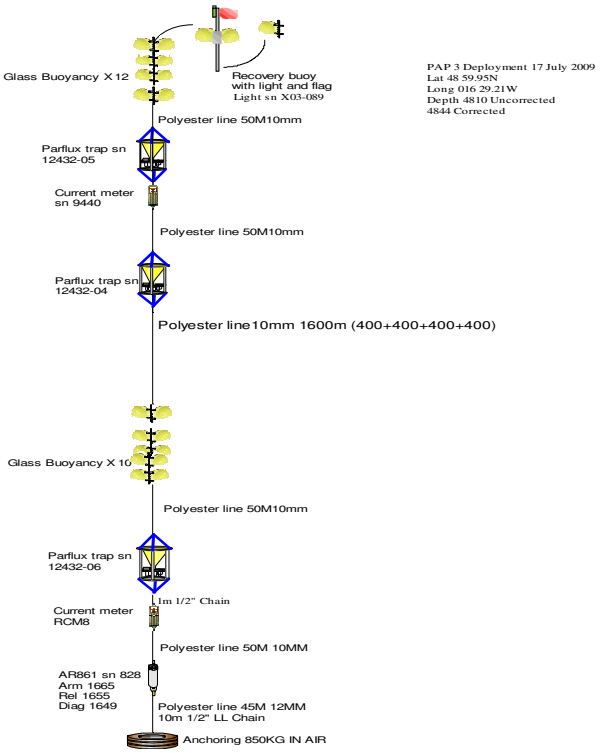
Release tracked to seabed at approx 80 m/min, Anchor position is given below

PAP 3 Deployment 17 July 2009
Lat 48 59.95N
Long 016 29.21W
Depth 4810 Uncorrected
4844 Corrected

Current meters set to 1 hour recording

The deployment went well, no problems. The traps were put in the water vertically using the 5m bridle extension.

*Figure 13. Diagram of PAP3 Deployment*



*2. IODA Deployment 1.*

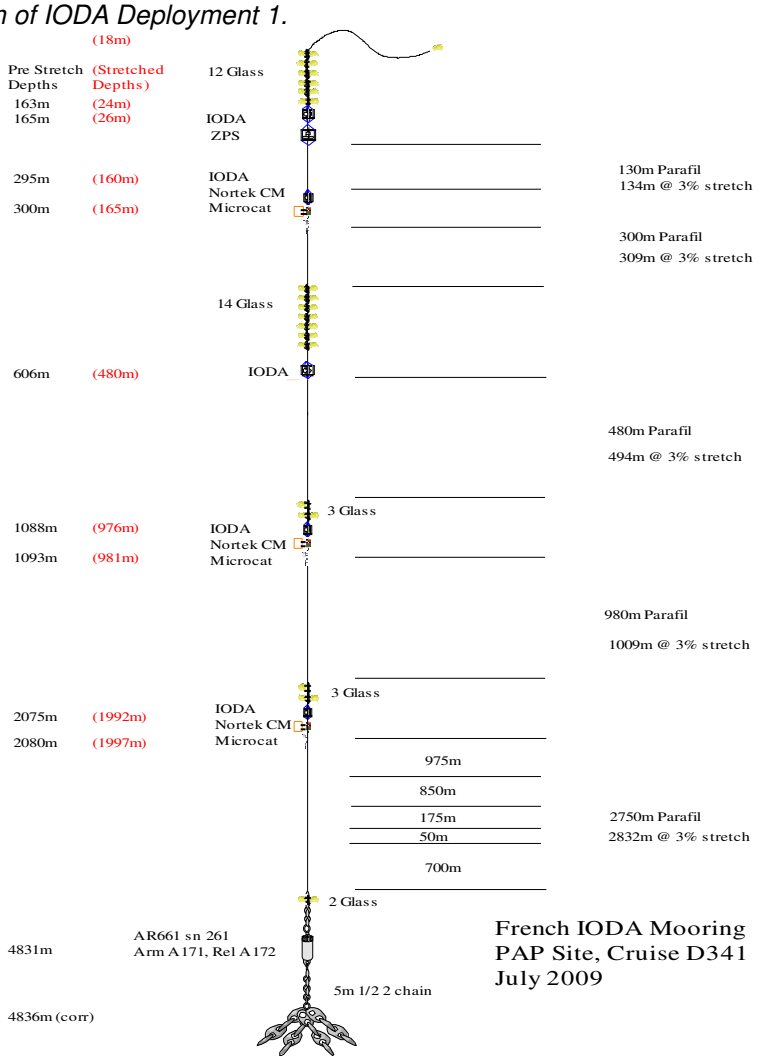
15th July 2009
Good vis, F3, low swell, sunny

The mooring was deployed without problems, anchor was released 1657 and triangulated. However, at 1900 the mooring elements were seen on the surface.

The stray line was grappled and the mooring recovered. The parafil termination 700m above the release had failed. Inspection showed that corrosion formed during storage that appeared to be surface only had in fact penetrated the termination and damaged the conical insert.

The release was lost with 700m of parafil and 2 17" spheres.

*Figure 14. Diagram of IODA Deployment 1.*




*3. IODA Deployment 2*

18th July 2009

New Parafil lines were prepared and several adjustments made to lengths in order to get the closest possible to depth required, around 30m. Stretch was considered and calculated for several percentages. In the end, the 2% figures were used. The actual deployment was slightly under 2% and the top CTD was at 40m for the first section of the deployment.

*Figure 15. Diagram of IODA Second Deployment.*

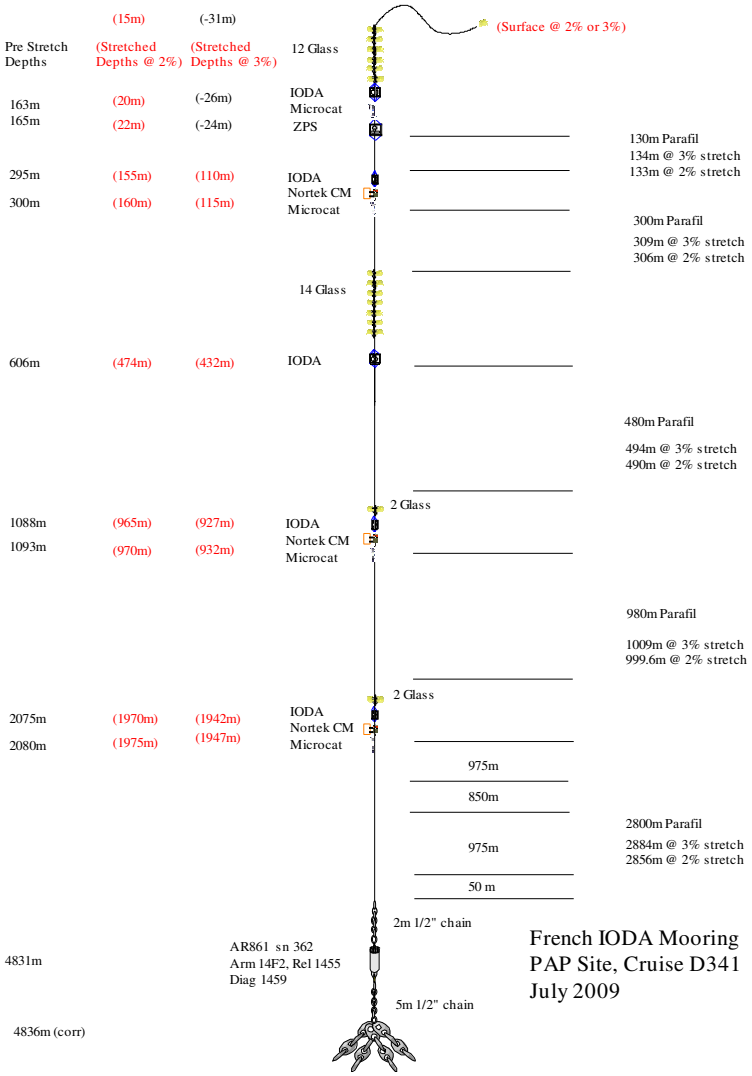



*Table 38. Order of Events for IODA 2 Deployment.*

| Time | Item | Serial Number | Notes |
|---|---|---|---|
| 1115 | 14 glass, IODA | 1 | |
| | SBE37 | 37085-3948 | |
| 1130 | IODA | 2 | |
| | SBE37 | 43007-4661 | |
| | Nortek CM | P20570-2 | |
| 1146 | IODA | 3 | |
| 1212 | IODA | 4 | |
| | SBE37 | 44431-5060 | |
| | Nortek CM | P20377-3 | |
| 1245 | IODA | 5 | |
| | SBE37 | 54518-6022 | |
| | Nortek CM | P22483 | |
| 1430 | Release, AR861 | 362 | |
| | | | |

The anchor was tracked. Initial rate as high as 80m/min but slowed to 25m/min close to the bottom.

Anchor position was 49º 01.875N, 16º 29.360W
Depth 4836 corrected.

*4. IODA Recovery*

7th July 2009
Wind F4, clear, vis good, bit of a swell

Start time 0825 GMT

The release was pinged from the ship standing approx 5 cables (1000m) downwind of anchor position. Initially, there were no comms and a decision was taken to fire. After a couple of attempts, a range of over 11000m was returned along with a release ok signal. This was initially taken as being a noise related spurious message. This was the only response received and after further attempts the ship repositioned and better ranges were obtained which confirmed the suspicion that the mooring had either been trawled or had dragged its anchor. The release was then triangulated and it became apparent that the release had actually fired at the initial communication. This was confirmed when 2 sets of range figures were received, one being a direct range and the other being a seabed reflection. The table below shows positions and ranges.

*Table 39. Ranges to anchor on IODA Recovery.*

| Time | Lat N | Long W | Range | Range | Range | Range | Range |
|---|---|---|---|---|---|---|---|
| 0837 | 49º 01.875 | 16º 29.360 | 11000 | | | | |
| 1015 | 49º 01.9 | 16º 29.3 | 10400 | | | | |
| 1055 | 48º 59.4 | 16º 31.9 | 9807 | 5965 | 9790 | 5952 | 5948 |
| 1135 | 48 º 47.86 | 16º 36.17 | 6041 | 9847 | 6005 | 9822 | 5975 |
| 1215 | 48 º 55.15 | 16º 34.07 | 4826 | 4822 | 4817 | | |

The glass packages were spotted on the surface at 48º 56.3N, 016º 32.6W.

Recovery started at 1325 and was complete at 1645.

*5. PAP 3 Recovery*

29th July 2009

Wind F5-6, clear, vis good, medium swell and choppy.

The conditions were on the good side of marginal, but given the prevailing conditions it was considered a good idea to attempt retrieval.

*Table 40. Order of Events*

| Time | Item | Serial Number | Notes |
|---|---|---|---|
| 1458 | Release fired | 829 | Good comms |
| 1540 | First glass sited | | |
| 1555 | Second glass sited | | |
| 1610 | Hooked stray line | | |
| 1618 | Billings on board | | |
| 1627 | Sed Trap on board | 12168-01 | |
| 1635 | Sed Trap on board | 11262-03 | |
| 1700 | Rope parted above second glass package | | |
| 1734 | Glass hooked after vessel repositions | | |
| 1746 | Sed Trap on board | 11262-02 | |
| 1750 | Release lost | | 829 |

The bottom section had become tangled and a large bight had formed. The rope appears to have chafed through in a couple of places resulting in the loss of the release.

PELAGRA - neutrally buoyant sediment traps (technical)

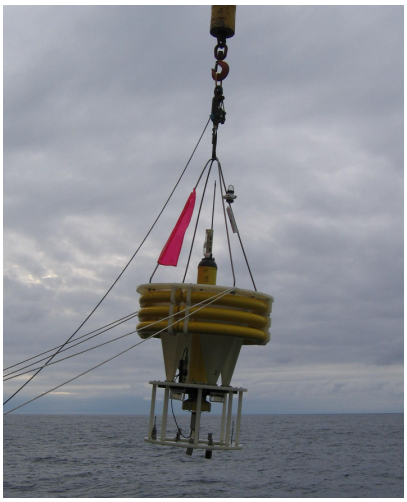
*Kevin Saw (NOCS).*

A total of five PELAGRA traps were available for D341. The broad strategy was to deploy all five traps simultaneously, each targeted at a particular depth: P2 50m, P4 150m, P5 300m, P6 450m and P7 600m. Four such multiple deployments were made making a total of twenty individual trap deployments.

Since their last science mission the traps have undergone some minor modifications:

- Several damaged GFRP collecting funnels were replaced.
- A through hole was provided in the base ring of each trap adjacent to the Idronaut CTD logger to improve water flow to the temperature probe and conductivity cell.
- The APEX sacrificial anodes were re-sited from the float top cap to the bottom cap in order to reduce the risk of zinc corrosion products entering the sample cups.
- Open-cell foam sealing rings were added to the upper face of the particle collection cup assemblies in order to close the existing 1mm gap and thus prevent small swimmers from entering the sample cups whilst they were closed.
- New, high-visibility marker flags made from *rip-stop* sailcloth were fitted adjacent to collecting funnel 1.
- The pressure sensors in all five Idronaut CTD loggers were upgraded from 500 dbar to 1000 dbar versions.
- All sensors, including the APEX SBE41 CTD, were re-furbished and re-calibrated.
- All traps were re-weighed and re-ballasted in the freshwater test tank at NOCS.

*Figure 16. Pelagra being deployed on D341*



*1. Deployment PAP1 (station 16483)*

Due to the various modifications and re-ballasting, this first set of deployments was designed as a trial but with a sampling period of 48 hours in order that any sample collected would be useful.

As P2 and P4 were targeted at depths shallower than the depressor weight release depth, depressor weights were not fitted. None of the traps stabilized at their intended depths. P4 and P6 went over-depth, released their emergency abort weights and returned to the surface for the entire deployment. P7 also went over-depth to approx. 1100m but its emergency abort weight should have been released at 970m so had not functioned correctly. This will be investigated on return to NOCS. P2 stabilized at 156m, P5 stabilized at 287m and P7 stabilized at 669m. Subsequent investigation revealed that all five traps were over-ballasted by c.159 grams. The capacity of the APEX buoyancy engine was insufficient to fully compensate for this and consequently the three traps that did stabilize did so deeper than intended.

It should be noted that P2, P5 and P7 were not stable for the initial part of the sampling period.

*2. Deployment PAP2 (stations 16515 - 16519)*

Deployment PAP2 was configured for a total sampling time of 132 hours. To compensate for the over-ballasting in deployment PAP1, the added ballast was reduced by 159 grams from that calculated by the ballast spreadsheets.

As P2 and P4 were targeted at depths shallower than the depressor weight release depth, depressor weights were not fitted and both remained at the surface until the sample pots opened; this behaviour had not been observed before. It was postulated that the air-space at the top of each sample cup was prevented from venting by the new foam sealing rings and the additional buoyancy was sufficient to prevent the traps from sinking (this is to be verified). Once the sample cups opened, the air was released and the traps sank.

Because the APEX buoyancy engine had already begun to reduce, P2 descended initially to 305m but recovered to stabilize at an average depth of 52m. It should be noted that P2 was unstable for the first 15 hours of sampling. P4 initially descended to 730m at which point its emergency over-depth release was triggered and it returned to the surface for the remainder of the deployment.

Any excess trapped air buoyancy in P5, P6 and P7 was overcome by the depressor weights and all three traps successfully stabilized close to their target depths: 312m, 449m and 565m respectively.

On deployment, funnel 1 on P5 was found to be cracked in several places. It is not clear how or when this occurred. There is no recollection that it was cracked on recovery of PAP1 so it is possible that it was damaged whilst on deck between deployments.

*3. Deployment PAP3 (stations 16574 - 16578)*

In order to overcome the trapped air problem, P2 and P4 were fitted with depressor weights this time. Additionally, funnels 3 and 4 on P2 were fitted with c.10mm square mesh baffle grids in order to reduce the ingress of jelly-fish which had heavily contaminated some previous samples. (These were fashioned from SAPS pre-filter grids). During deployments PAP3 and PAP4 sample cups 3 and 4 remained free from jelly-fish whilst sample cups 1 and 2 did not, so the grids appear to be effective and should be considered as a permanent modification.

Shortly after deployment it was discovered that an error had been made when compensating for the three less dense polypropylene sample cups that had replaced the standard polycarbonate cups. The error amounted to an under-ballast of c. 26 grams for P2 and c.214 grams for P4, P5, P6 and P7. Whilst this was insignificant for P2, it was felt that the other traps would not be able to achieve their target depths.

P2 did in fact stabilize at an average depth of 49m as planned.

Despite initially descending to 730m, P4 returned to the surface until the APEX buoyancy engine had reduced its volume to a minimum and stabilized at an average depth of 222m. It should be noted that P4 was unstable for the first 27 hours of sampling.

P5 descended to 208m where the depressor weight was released but thereafter behaved similarly to P4, only despite the APEX buoyancy engine reducing to minimum volume the trap remained at the surface. It is suspected that this was exacerbated by trapped air in the sample cups which was released when the sample cups opened. At this point the trap sank rapidly (approx. 3hrs) and stabilized at an average depth of 48m.

P6 behaved similarly to P4 only this time the combination of buoyancy engine reduction and released air was insufficient to sink the trap and it remained at or near the surface for more than half of its deployment. It did eventually stabilize at around 50m but it is unlikely that this trap will yield any useful sample.

P7 also returned to the surface after releasing its depressor weight at 218m. Rapid descent occurred once the sample cups opened and the trap stabilized at an average depth of 205m. It should be noted that P7 was unstable for the first 14 hours of sampling.

*4. Deployment PAP4 (stations 16622 - 16626)*

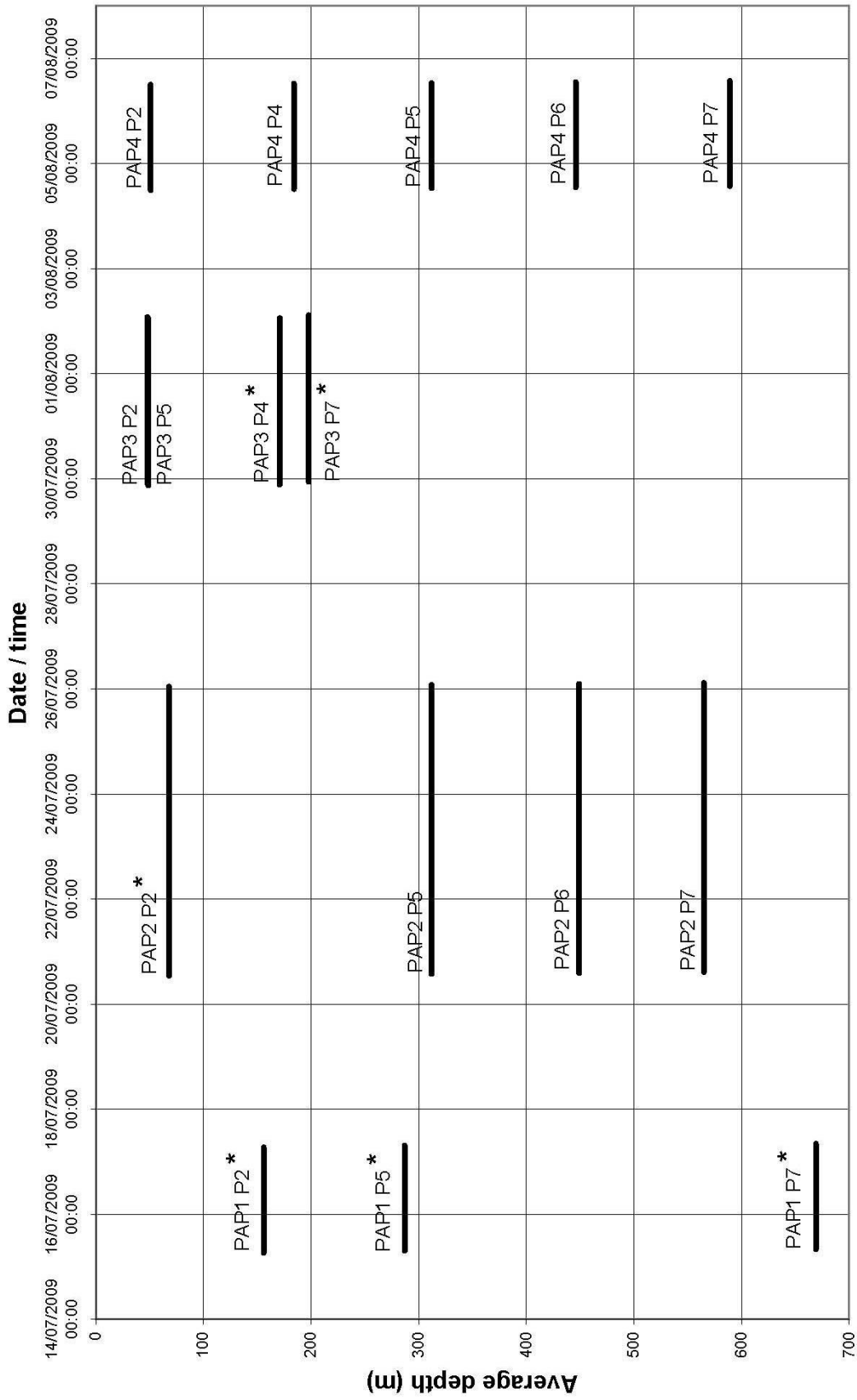
P2, P5, P6 and P7 performed perfectly and stabilized at average depths of 51m, 312m, 446m and 589m respectively. P4 descended initially to 470m but the APEX buoyancy engine recovered to stabilize at an average depth of 184m in good time for the sample cups to open.

Table 41 gives a summary of all of the deployments. Figure 17 illustrates temporal sampling coverage and figures 18 to 33 plot pressure against time for each deployment.

*Table 41. Deployment summary (all times GMT)*

| Trap code | Station (deployment) | Average sampling depth (m) | Sampling period (hr, commencing) | Deployment time | Deployment position | Surfacing time | Surfacing position |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| PAP1 P2 | 16483 | 156 | 48, 15.07.09 06:30 | 14.07.09 12:30 | 49º02.1N 16º30.0W | 17.07.09 07:08 | 49º04.4N 16º19.9W |
| PAP1 P4 | 16483 | - | - | 14.07.09 12:55 | 49º02.3N 16º30.0W | - | - |
| PAP1 P5 | 16483 | 287 | 48, 15.07.09 07:20 | 14.07.09 13:20 | 49º02.3N 16º30.0W | 17.07.09 08:08 | 49º01.4N 16º45.3W |
| PAP1 P6 | 16483 | - | - | 14.07.09 13:45 | 49º02.4N 16º30.0W | - | - |
| PAP1 P7 | 16483 | 669 | 48, 15.07.09 08:10 | 14.07.09 14:10 | 49º02.6N 16º30.0W | 17.07.09 09:33 | 49º01.1N 16º40.1W |
| PAP2 P2 | 16515 | 52 | 132, 20.07.09 13:00 | 19.07.09 19:00 | 49º01.2N 16º30.9W | 26.07.09 02:03 | 49º53.0N 15º54.1W |
| PAP2 P4 | 16516 | - | - | 19.07.09 19:25 | 49º01.1N 16º31.0W | - | - |
| PAP2 P5 | 16517 | 312 | 132, 20.07.09 13:50 | 19.07.09 19:50 | 49º01.1N 16º31.1W | 26.07.09 03:07 | 48º45.3N 16º41.6W |
| PAP2 P6 | 16518 | 449 | 132, 20.07.09 14:15 | 19.07.09 20:15 | 49º00.7N 16º31.1W | 26.07.09 03:35 | 48º38.5N 16º28.0W |
| PAP2 P7 | 16519 | 565 | 132, 20.07.09 14:40 | 19.07.09 20:40 | 49º00.3N 16º31.9W | 26.07.09 04:17 | 48º21.9N 16º36.6W |
| PAP3 P2 | 16574 | 49 | 76, 29.07.09 21:00 | 28.07.09 21:00 | 49º01.4N 16º50.2W | 02.08.09 01:42 | 49º06.8N 16º45.5W |
| PAP3 P4 | 16575 | 222 | 76, 29.07.09 21:25 | 28.07.09 21:25 | 49º01.4N 16º50.1W | 02.08.09 02:18 | 48º55.2N 17º09.9W |
| PAP3 P5 | 16576 | 48 | 76, 29.07.09 21:50 | 28.07.09 21:50 | 49º01.1N 16º50.0W | 02.08.09 01:50 | 48º48.0N 17º05.2W |
| PAP3 P6 | 16577 | - | - | 28.07.09 22:15 | 49º01.1N 16º50.0W | - | - |
| PAP3 P7 | 16578 | 205 | 76, 29.07.09 22:40 | 28.07.09 22:40 | 49º00.9N 16º50.4W | 02.08.09 03:33 | 49º08.5N 16º37.5W |
| PAP4 P2 | 16622 | 51 | 48, 04.08.09 12:00 | 03.08.09 12:00 | 48º55.2N 16º23.3W | 06.08.09 12:30 | 48º46.3N 17º00.6W |
| PAP4 P4 | 16623 | 184 | 48, 04.08.09 12:25 | 03.08.09 12:25 | 48º55.1N 16º23.3W | 06.08.09 13:05 | 48º47.8N 16º57.8W |
| PAP4 P5 | 16624 | 312 | 48, 04.08.09 12:50 | 03.08.09 12:50 | 48º54.9N 16º23.2W | 06.08.09 13:44 | 48º46.9N 17º01.0W |
| PAP4 P6 | 16625 | 446 | 48, 04.08.09 13:15 | 03.08.09 13:15 | 48º54.8N 16º23.3W | 06.08.09 14:23 | 48º47.5N 17º01.8W |
| PAP4 P7 | 16626 | 589 | 48, 04.08.09 13:40 | 03.08.09 13:40 | 48º54.8N 16º23.4W | 06.08.09 14:58 | 48º49.0N 17º04.7W |

*Figure 17. Temporal and vertical sampling coverage of PELAGRA on D341*




*(* Not stable for entire sampling period)*

*Figure 18. PAP1 P2, station 16483*

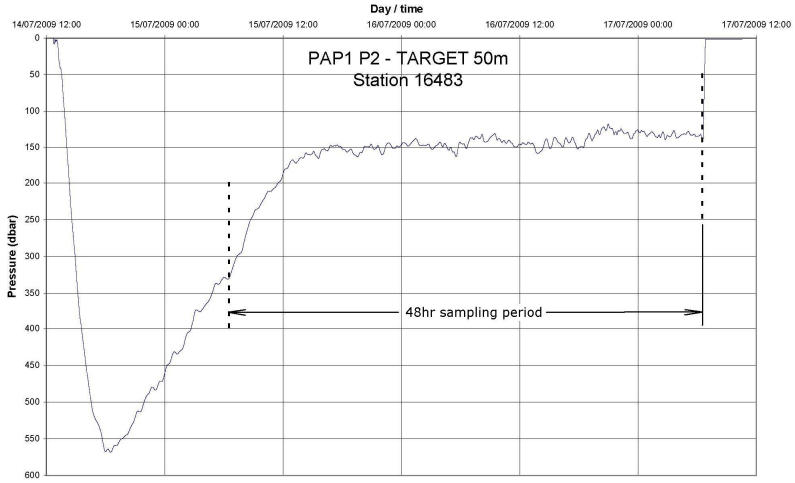



*Figure 19. PAP1 P5, station 16483*

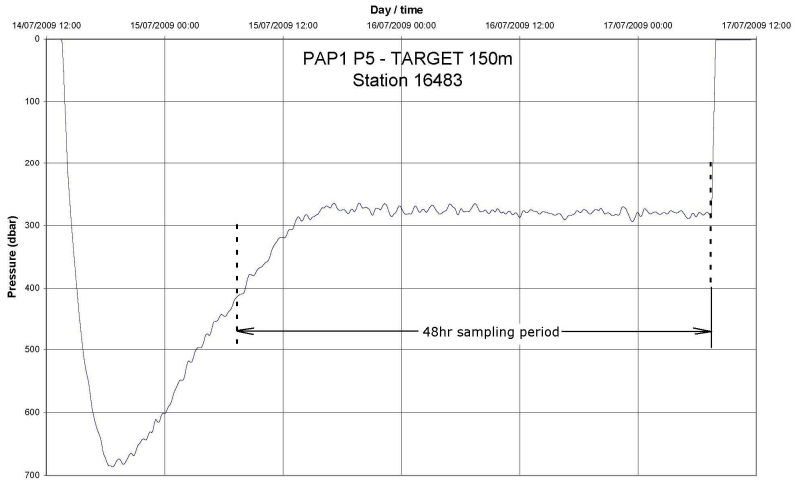



*Figure 20. PAP1 P7, station 16483*

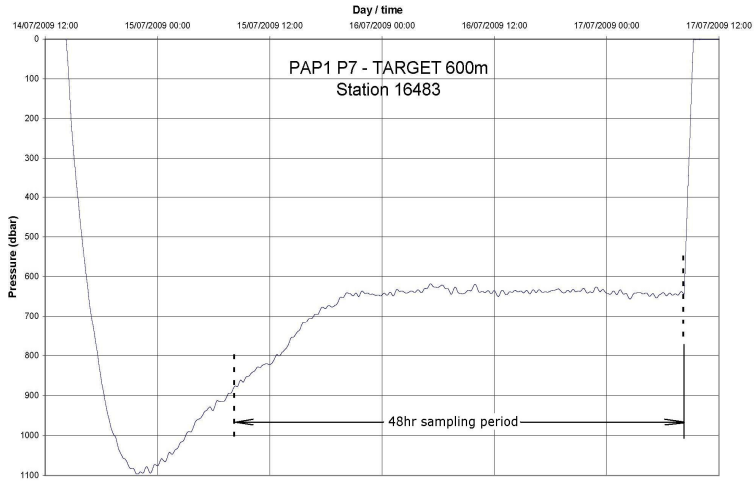


*Figure 21. PAP2 P2, station 16515*

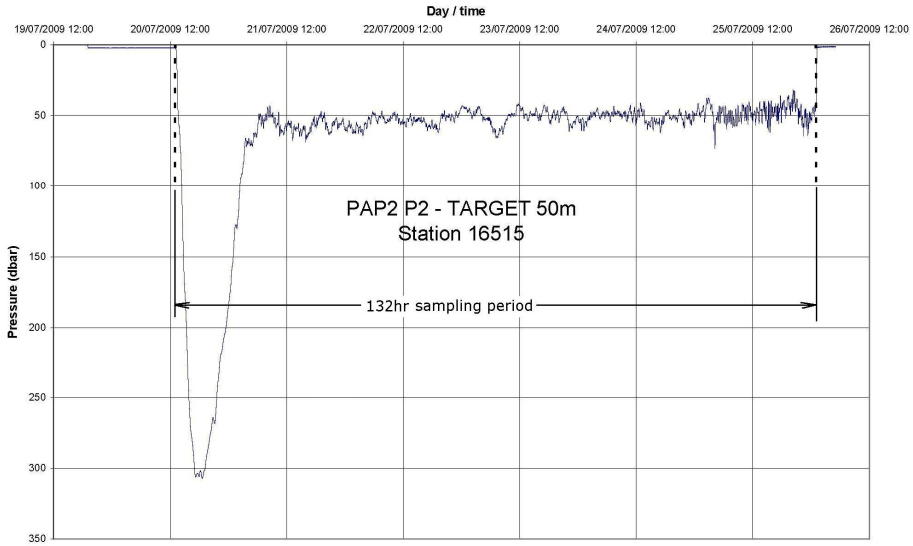



*Figure 22. PAP2 P5, station 16517*

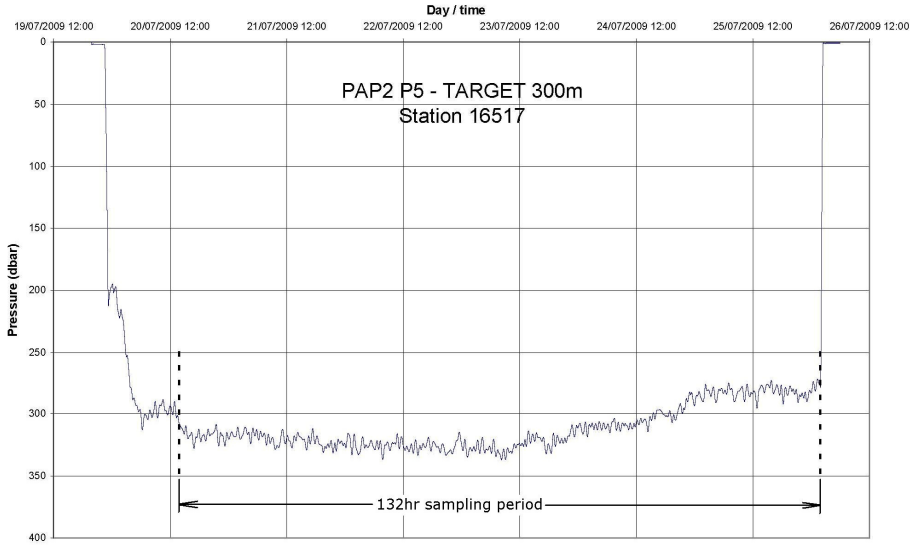



*Figure 23. PAP2 P6, station 16518*

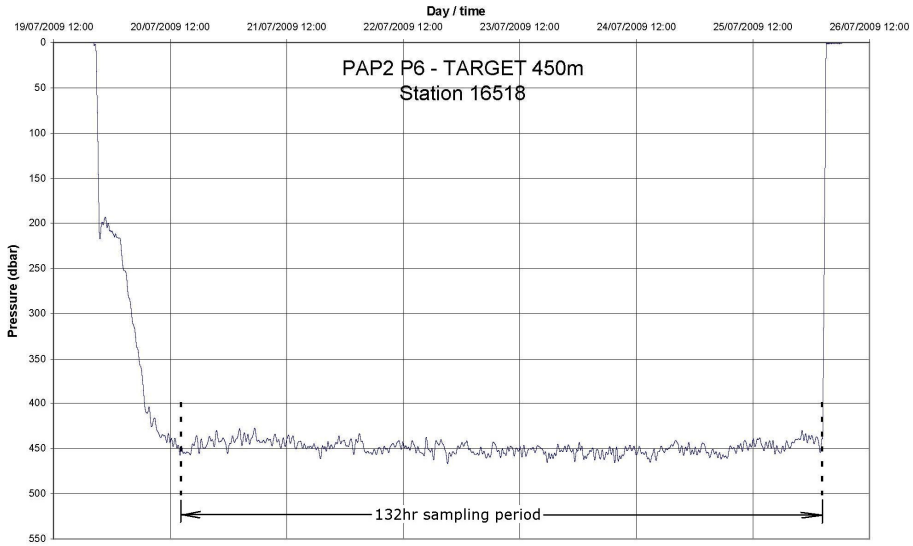


*Figure 24. PAP2 P7, station 16519*

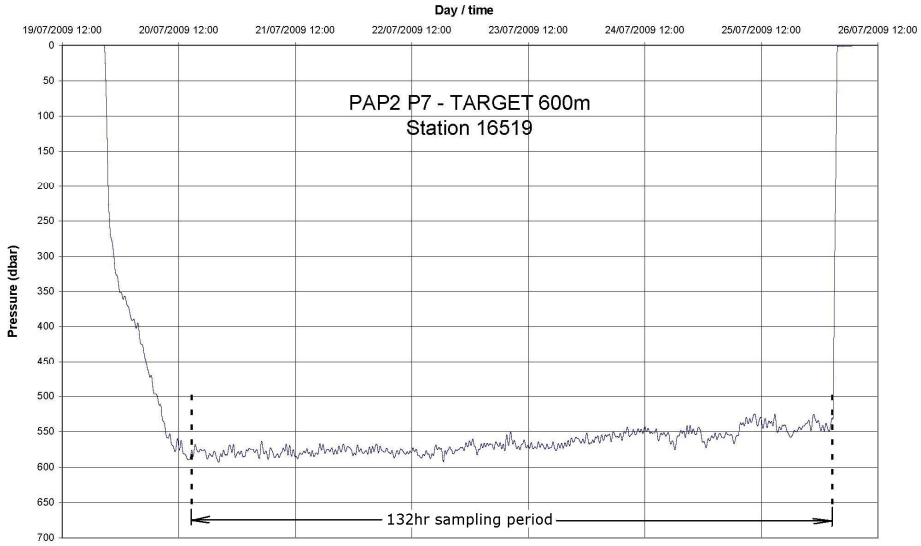



*Figure 25. PAP3 P2, station 16574*

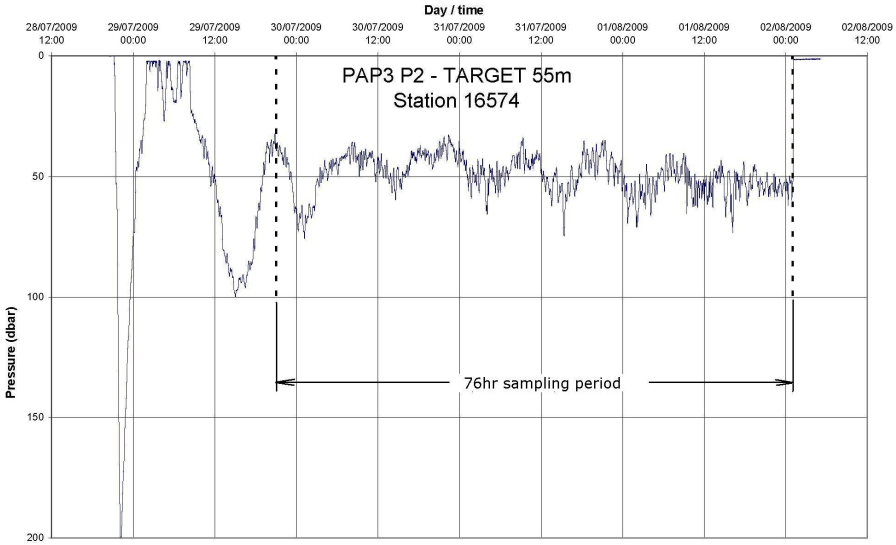



*Figure 26. PAP3 P4, station 16575*

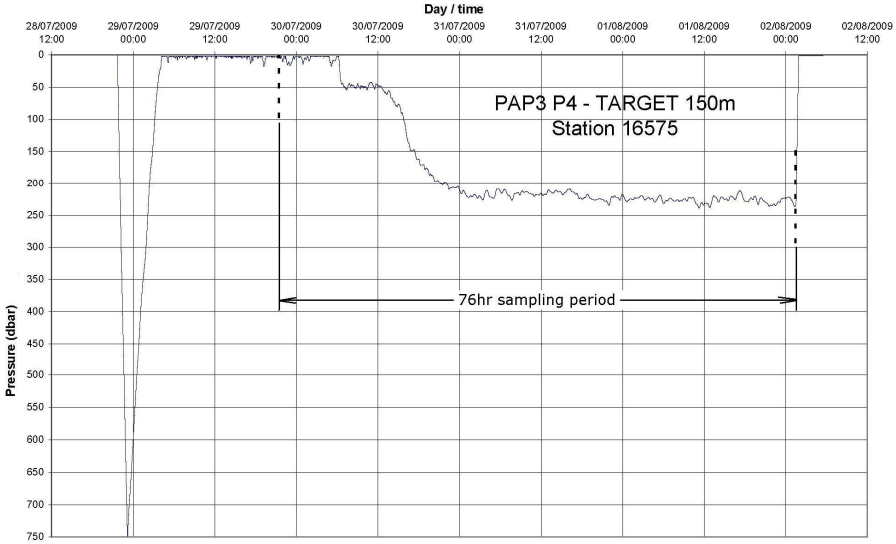


*Figure 27. PAP3 P5, station 16576*

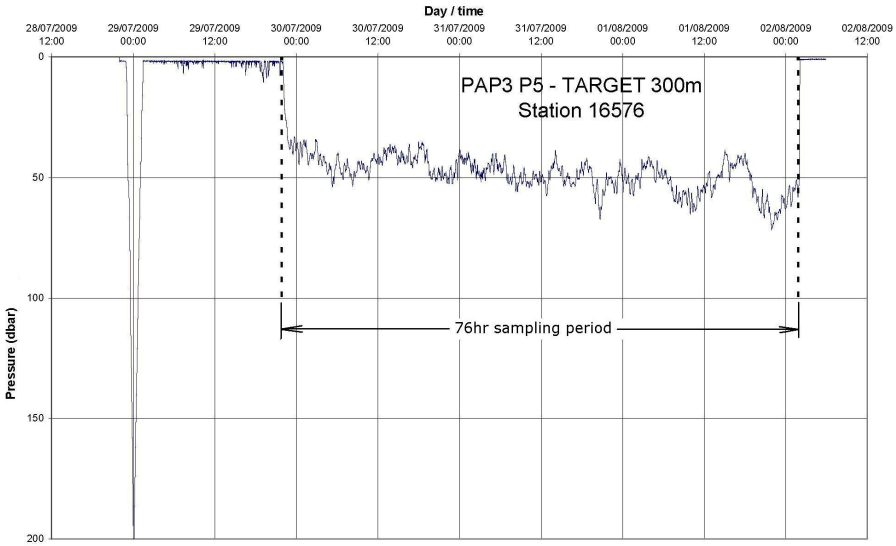



*Figure 28. PAP3 P7, station 16578*

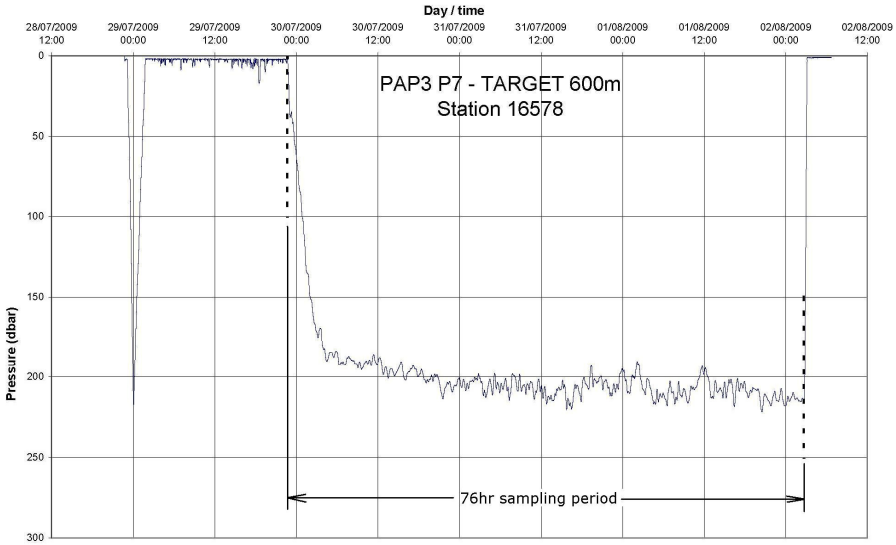



*Figure 29. PAP4 P2, station 16622*

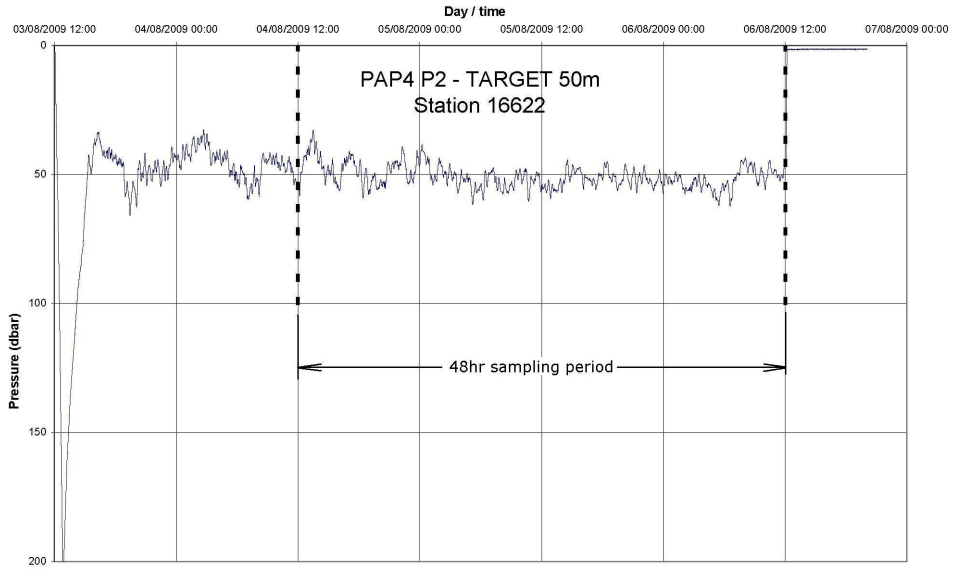


*Figure 30. PAP4 P4, station 16623*

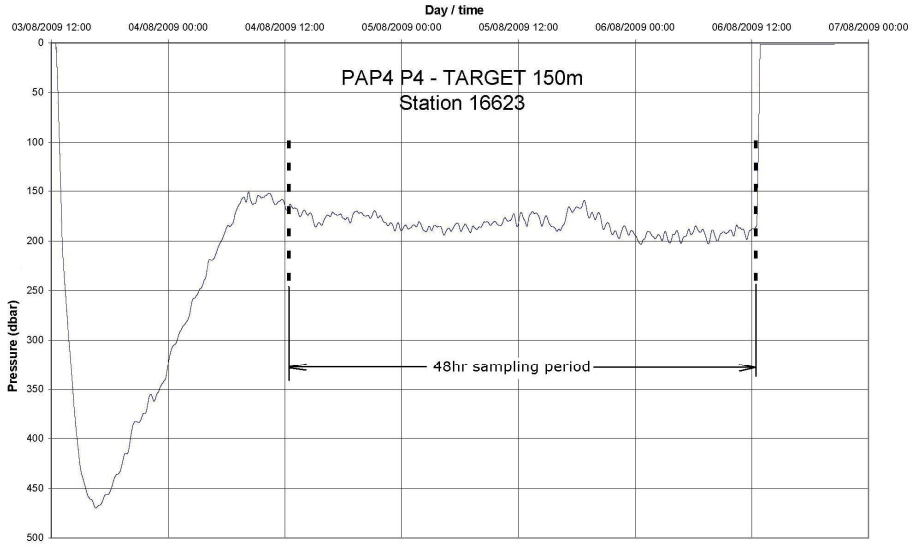



*Figure 31. PAP4 P5, station 16624*

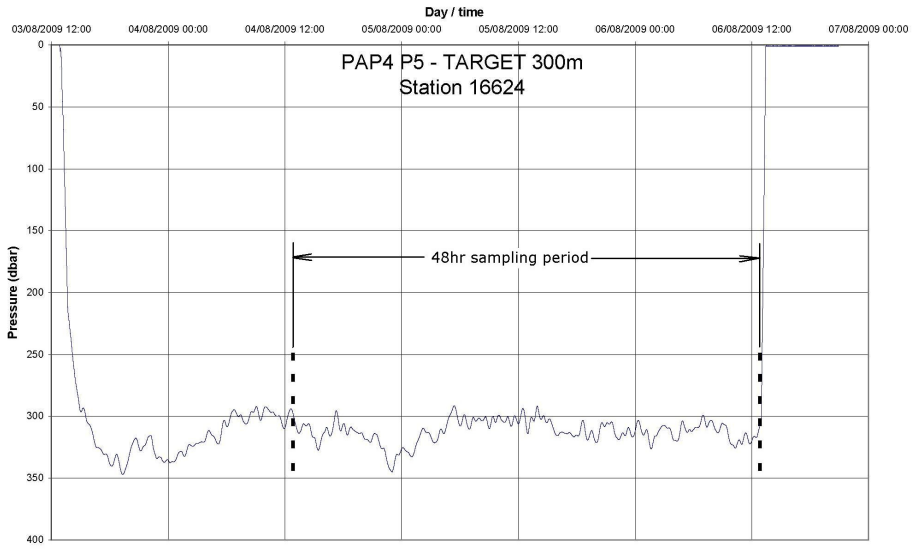



*Figure 32. PAP4 P6, station 16625*

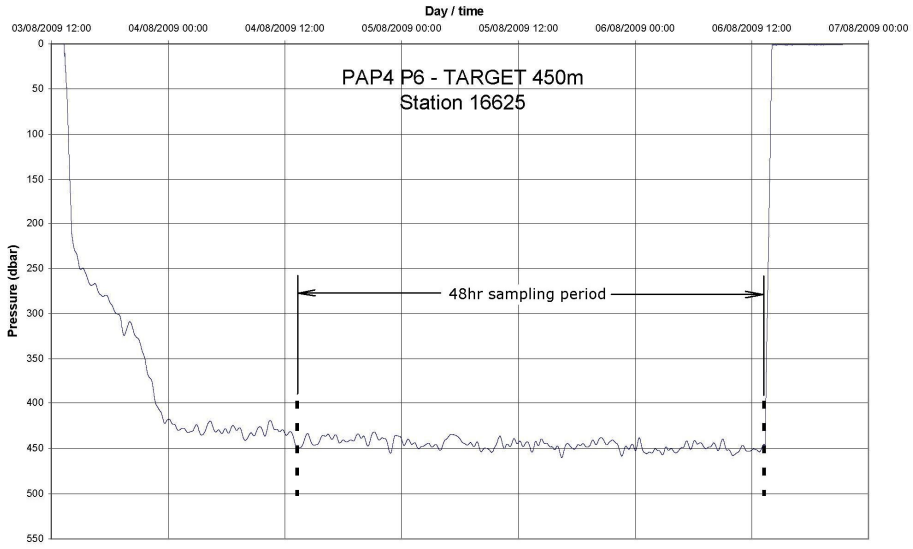
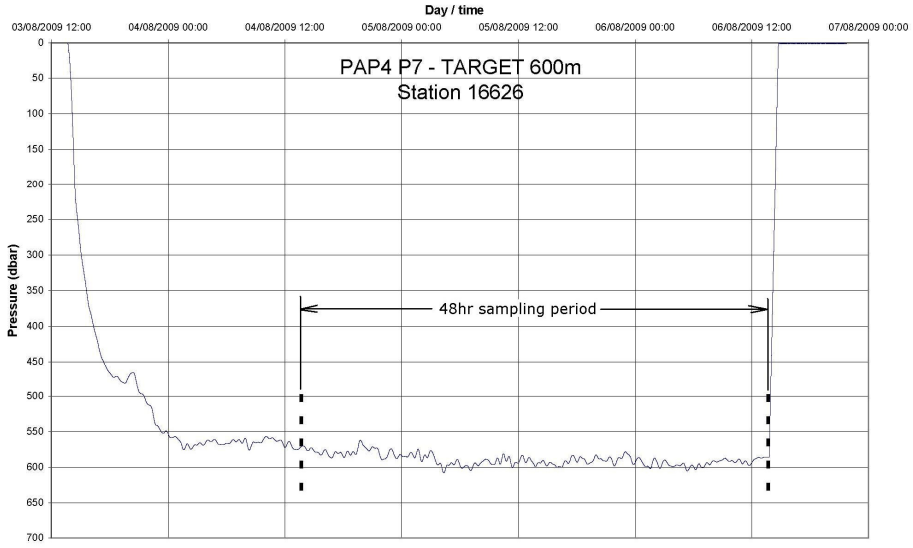


*Figure 33. PAP4 P7, station 16626*



## $^{234}$Th-$^{238}$U profiles

*Fred Le Moigne (NOCS)*

The Radioactive short-lived Thorium-234 ($^{234}$Th, t1/2=24,1d) can be used to estimate how much POC is exported into the deep ocean. $^{234}$Th is the daughter isotope of naturally occurring 238-Uranium ($^{238}$U, $t_{1/2}$ = 4.47 x $10^9$ y) which is conservative in seawater and is proportional to salinity in well oxygenated environments. Unlike $^{238}$U, $^{234}$Th is particle reactive in the water column. As particles with $^{234}$Th sink through the water column, a radioactive disequilibrium is formed between $^{238}$U and $^{234}$Th, which can be used to quantify the rate of carbon and biomineral export from the surface ocean. This is possible with the ratios of POC, PIC or BSi to particulate $^{234}$Th activity (Tsunogai et Minagawa, 1976) obtained from large volume samples (e.g. *in situ* pumps: SAPS).

*Sampling methodology and sampling treatment on board*

Samples for Thorium analysis were collected from a stainless steel CTD rosette at various stations (see table 42 and Figure 34). 10L water samples were collected from ten depths to 500m. The sampling distribution was focused between 0 and 300m where a significant export of particles are expected and thereby a disequilibrium between $^{234}$Th and $^{238}$U. $^{238}$U concentration is derived from salinity measurement and thus is not directly measured from seawater samples. Total $^{234}$Th is obtained by adding $KMnO_6$ (potassium permanganate), $MnCl_2$ (manganese dichloride) and concentrated ammonia ($NH_3$) to the 10L. Thorium is precipitated with $MnO_2$ within 8 hours. The formed precipitate is filtered onto 142mm 0.8µM polycarbonate filters. Afterwards, all the filters are folded the same way to maintain constant the counting geometry. The folded filters are then wrapped in mylar foil and counted in a Riso beta counter. Corrections are made for $^{234}$Th decay and $^{234}$Th in growth from $^{238}$U decay since sampling. Due to self-absorption of radiations through the filters efficiencies are <100%. To calibrate $^{234}$Th counting efficiency, mid water (2000m) samples were used, away from the surface ocean, coastal areas and seafloor nephleloid layers, where the secular equilibrium between $^{234}$Th and $^{238}$U is expected.

The ratios of POC, PIC or BSI to particulate $^{234}$Th activity will be obtained from particles from several depths sampled using SAPS and PELAGRAS (see SAPS and PELAGRAS part).

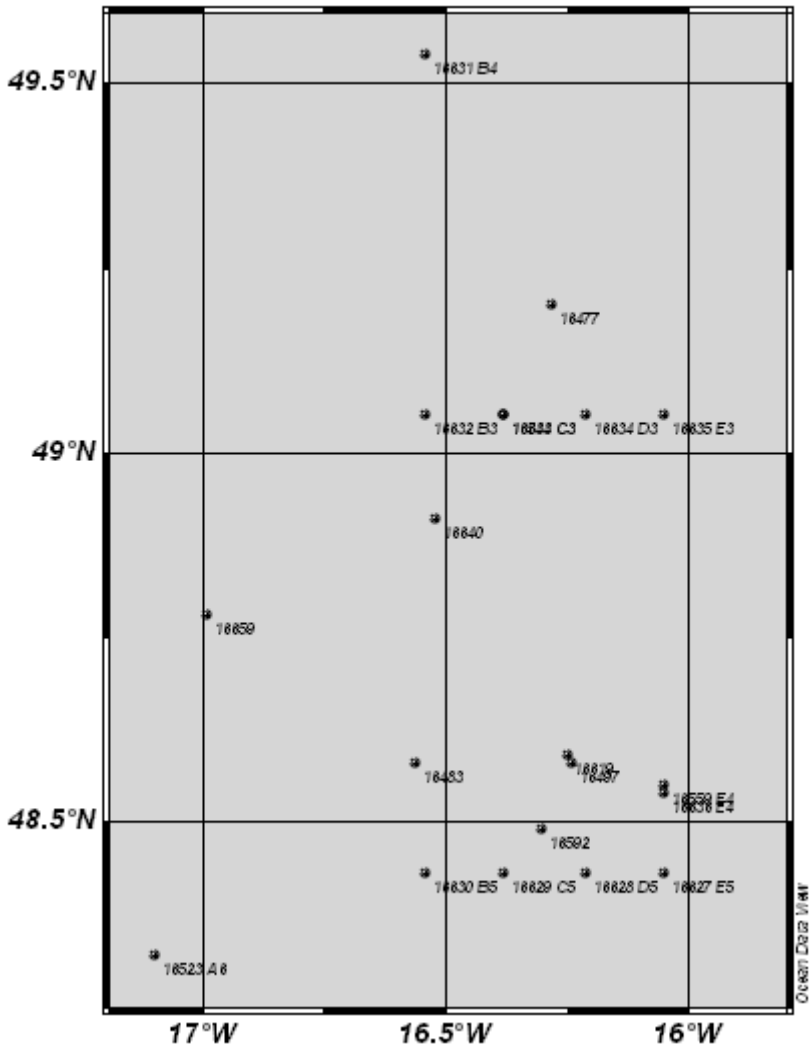
*Table 42: Station ID (RRS Discovery station number) with sampling time, position and samples taken.*

| Station ID | Date | Julian day | Latitude | Longitude | depth range | Number of samples |
|---|---|---|---|---|---|---|
| 16477 | 13/07/2009 | 194 | 49.20.86 N | 16.28.98 W | 5-400m | 7 |
| 16497 | 16/07/2009 | 197 | 48.58.55 N | 16.24.48 W | 5-750m | 10 |
| 16523A6 | 20/07/2009 | 201 | 48.32.73 N | 17.10.43 W | 5-350m | 10 |
| 16544C3 | 23/07/2009 | 204 | 49.05.00 N | 16.38.15 W | 5-400m | 10 |
| 16559E4 | 24/07/2009 | 205 | 48.55.86 N | 16.05.36 W | 5-400m | 10 |
| 16583 | 29/07/2009 | 210 | 48.98.12 N | 16.93.77 W | 5-400m | 10 |
| 16592 | 31/07/2009 | 212 | 48.82.23 N | 16.51.12 W | 5-600m | 10 |
| 16606 | 01/08/2009 | 213 | 48.98.12 N | 16.93.77 W | 2000m | 3 |
| 16619 | 03/08/2009 | 215 | 48.98.66 N | 16.42.52 W | 5-400m | 9 |
| 16627E5 | 03/08/2009 | 215 | 48.72.31 N | 16.08.72 W | 25-100 | 3 |
| 16628D5 | 03/08/2009 | 215 | 49.43.83 N | 16.21.78 W | 25-100 | 3 |
| 16629C5 | 04/08/2009 | 216 | 49.43.83N | 16.38.21 W | 25-100 | 3 |
| 16630B5 | 04/08/2009 | 216 | 49.43.83N | 16.54.63 W | 25-100 | 3 |
| 16631B4 | 05/08/2009 | 217 | 49.54.61 N | 16.54.63 W | 25-100 | 3 |
| 16632B3 | 05/08/2009 | 217 | 49.05.38 N | 16.54.63 W | 25-100 | 3 |
| 16633C3 | 05/08/2009 | 217 | 49.05.38 N | 16.38.21 W | 25-100 | 3 |
| 16634D3 | 06/08/2009 | 218 | 49.05.38 N | 16.21.78 W | 25-100 | 3 |
| 16635E3 | 06/08/2009 | 218 | 49.05.38 N | 16.05.36 W | 25-100 | 3 |
| 16636E4 | 06/08/2009 | 218 | 48.54.61 N | 16.05.36 W | 25-100 | 3 |
| 16640 | 06/08/2009 | 218 | 48.91.95 N | 16.52.62 W | 5-400m | 10 |
| 16659 | 08/08/2009 | 220 | 48.78.79 N | 16.99.79 W | 5-400m | 10 |

*Further work and scientific outcomes*

The results of $^{234}$Th will be corrected with two "background counting" in three and six month. The $^{238}$U results will be calculated from calibrated salinity measurments. Once corrected, the $^{234}$Th results will be integrated in order to obtain the $^{234}$Th fluxes (dpm $m^{-2}$ $d^{-1}$) to further extrapolate POC, calcite and opale export (mmol $m^{-2}$ $d^{-1}$) with POC/$^{234}$Th , PIC/$^{234}$Th and Bsi/$^{234}$Th ratio obtained from high volume collection of particulate matter (SAPS). The Thorium derived fluxes will be compaired and discuss regarding the fluxes obtained through $^{210}$Pb-$^{210}$Po desequilibrium as an alternative to calculate particle export. results (see $^{210}$Pb/$^{210}$Po section by Maria Villa).

*Figure 34: Station positions for $^{234}$Th sampling.*



Mid-water incubator

*Kevin Saw (NOCS)*

The mid-water incubator is a new instrument consisting of a rosette of 24 modified 20-litre Niskin bottles. Each Niskin bottle has been equipped with two fluid injection devices and an expansion bladder. Bottle firing and fluid injection is controlled by a purpose-built electronic timer system powered by one 24-volt Deep Sea Power and Light lead acid battery. The instrument is intended to be deployed on a long-term mooring to conduct *in situ* incubation experiments at depths of up to 6000m.

It was hoped that the incubator would be deployed on a mooring on D341. However, administrative issues and late delivery of the instrument prevented this. Instead, D341 provided an opportunity to carry out trial deployments suspended from the ship's CTD wire.

On-deck tests of the electronic control system early in the cruise highlighted an issue that prevented the syringes on bottles 1 and 2 from firing. Whilst this issue was not wholly consistent, it did appear to affect only bottles 1 and 2. The decision was taken to go ahead with a shallow deployment whilst accepting that some syringes may not fire.

In order to gain some insight into the effectiveness of fluid mixing within the closed bottles, the upper syringes were loaded with diluted blue food dye and the lower with yellow. A program was entered that would fire all 24 bottles and 48 syringes in the correct sequence at 1 minute intervals (5 minutes between bottle 1 and syringe 1) starting at 19:30 GMT. The incubator was deployed at 19:25 on 31 July 2009 from the CTD wire over the starboard gantry to a depth of 15m (station 16595). It was recovered to the deck at 21:10.

On recovery it was noted that nothing had fired except that bottle 1 had closed (although the top bung was not seated properly). Subsequent investigations on deck yielded the same result: bottle 1 fired but nothing else. In fact the problem appeared to be related to the real-time clock in the controller as after bottle 1 had fired the next trigger time had been reset to a time prior to the current time and so was ignored by the program.

Various updated versions of the controller firmware were supplied by colleagues at NOCS but none solved the problem. It was eventually concluded that the root of the problem most likely lay with the controller electronic hardware which is not repairable at sea; therefore no further sea-trials were conducted.

*Figure 35. Mid Water Incubator being deployed on D341*

Organic Biogeochemistry

*Kostas Kiriakoulakis (University of Liverpool)*

*1. Particulate sampling (SAPS and PELAGRA traps): Organic chemical analyses*

Particulate material from a range of water depths was collected using stand alone pumping systems (SAPS; Challenger Oceanic, Table 43). Often two size fractions were recovered. The small fraction (>53 µm) was usually collected on large (293 mm diam.) precombusted (400ºC; 4 h) GF/F filters (nominal pore size 0.7 µm). Each SAPS carried two stacked GF/F filters, the bottom one being used as a DOM-adsorption blank.

Occasionally small particles were collected on acid (10% HCL + 1% $H_2O_2$) cleaned Nylon mesh screens (pore size 1µm). Material was then rinsed with MilliQ water, filtered on a plastic rig through multiple precombusted (400ºC; 4 h) 25 mm GF/F filters and frozen at -80°C for the rest of the cruise. Larger particles were collected on acid (10% HCL + 1% $H_2O_2$) cleaned Nylon mesh screens (pore size 53 µm) that were positioned above the GF/F filters (or the smaller pore size Nylon screens). After recovery a similar procedure was carried out as for the smaller pore size Nylon screens (see above).

Non size fractionated particulate material was also collected at certain deployments (Table 43) on large GF/F filters as described above. On recovery the filters and/or the rinsed material was split between partners for a range of chemical analyses, namely radionuclides (see reports by Maria Villa and Fred LeMoigne) and/or pigment analysis (Denise Smythe-Wright, NOCS). The part of the GF/F filters that was allocated for organic geochemical analyses (i.e. organic carbon, nitrogen, lipid biomarkers, stable isotopes) was frozen at -80°C for the duration of the cruise.

Five or four SAPS units were used on the same deployment and the pumps were operated for 2 hours. Choice of depths was made to coincide with the depths of free-drifting (Pelagra) sediment traps when possible. These were usually 50, 150, 300, 450 and 600 m, although samples were also collected from the bottom of the twilight zone (1000 m) and in one deployment from 3000 and 4700 m (the latter two depths were chosen to coincide with the time series sediment traps that are moored in the PAP). Sinking particulate material from a range of water depths was also collected using five free drifting (Pelagra) sediment traps (Table 44). The preset depths were 50, 150, 300, 450 and 600 m although occasionally the traps malfunctioned and did not collect material from these depths (Table 44). Filtered, sterilised or deep (1000m) water with no preservative was used as a medium to collect the material, except the first deployment, when 0.5% $CH_3Cl$ was added in a concentrated brine solution that was used as a medium in that case (1/8 split with Chris Marsay). Occasionally large swimmers (jelly fish, shrimps etc.) were caught in the recipients. These were immediately removed on recovery and the sinking particles were filtered on a plastic rig through multiple precombusted (400ºC; 4 h) 25 mm GF/F filters and frozen at -80°C for the rest of the cruise.

On return to the laboratory particulate material collected on the filters will be freeze-dried and analysed for organic carbon, nitrogen, lipids and isotopes ($\delta^{13}C$ and $\delta^{15}N$).

*Table 43. Details of SAPS sampling*

| **Station** | **Date** | **SAPS depth** | **Volume pumped** | **Fractionated** | | | **split** |
|---|---|---|---|---|---|---|---|
| | | **m** | **L** | | **small fraction** | **large fraction** | |
| 16498 | 16/07/2009 | 50 | 896 | yes | GF/F | nylon 53 µm | half |
| 16498 | 16/07/2009 | 150 | 1462 | yes | GF/F | nylon 53 µm | half |
| 16498 | 16/07/2009 | 150 | 2300 | no | GF/F | | half |
| 16498 | 16/07/2009 | 600 | 623 | yes | GF/F | nylon 53 µm | half |
| 16498 | 16/07/2009 | 600 | 1362 | no | GF/F | | half |
| | | | | | | | |
| 16545 | 23/07/2009 | 50 | 2602 | yes | nylon 1µm | nylon 53 µm | quarter |
| 16545 | 23/07/2009 | 150 | 2083 | yes | nylon 1µm | nylon 53 µm | quarter |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16545 | 23/07/2009 | 350 | 1070 | no | GF/F | | half |
| 16545 | 23/07/2009 | 450 | 1326 | yes | GF/F (5.2g) | nylon 53 µm | half |
| 16545 | 23/07/2009 | 600 | 1351 | no | GF/F | | half |
| | | | | | | | |
| 16584 | 29/07/2009 | 50 | 1796 | yes | nylon 1µm | nylon 53 µm | quarter |
| 16584 | 29/07/2009 | 150 | 973 | yes | nylon 1µm | nylon 53 µm | quarter |
| | | | | | | | |
| 16587 | 29/07/2009 | 150 | 1402 | yes | GF/F | nylon 53 µm | half |
| 16587 | 29/07/2009 | 300 | 449 | yes | GF/F | nylon 53 µm | half |
| 16587 | 29/07/2009 | 450 | 1134 | no | GF/F | | half |
| 16587 | 29/07/2009 | 600 | 1435 | no | GF/F | | half |
| 16587 | 29/07/2009 | 1000 | 1251 | yes | GF/F (5.2g) | nylon 53 µm | half |
| | | | | | | | |
| 16594 | 31/07/2009 | 60 | 920 | yes | nylon 1µm | nylon 53 µm | quarter |
| 16594 | 31/07/2009 | 150 | 2164 | yes | nylon 1µm | nylon 53 µm | quarter |
| | | | | | | | |
| 16598 | 01/08/2009 | 150 | 1466 | yes | GF/F | nylon 53 µm | half |
| 16598 | 01/08/2009 | 300 | 1181 | yes | GF/F | nylon 53 µm | half |
| 16598 | 01/08/2009 | 600 | 588 | yes | GF/F | nylon 53 µm | half |
| 16598 | 01/08/2009 | 1000 | 1414 | no | GF/F | | half |
| | | | | | | | |
| 16666 | 09/08/2009 | 150 | 1479 | no | GF/F | | half |
| 16666 | 09/08/2009 | 600 | 589 | no | GF/F | | half |
| 16666 | 09/08/2009 | 3000 | 1271 | no | GF/F | | half |
| 16666 | 09/08/2009 | 4700 | 952 | no | GF/F | | half |

*Table 44. Details of Pelagra sampling*

| **Station** | **Date** | **Pelagra depth** | **split** | **medium** | **preservative** |
|---|---|---|---|---|---|
| **deployment** | **Deployment** | **m** | | | |
| 16483 | 14/07/2009 | 150 | 1/8. | brine | CH3Cl |
| 16483 | 14/07/2009 | 300 | 1/8. | brine | CH3Cl |
| 16483 | 14/07/2009 | 630 | 1/8. | brine | CH3Cl |
| 16515 | 19/07/2009 | 50 | half | filtered seawater | no |
| 16516 | 19/07/2009 | 150 did not work | no | filtered seawater | no |
| 16517 | 19/07/2009 | 300 | no | filtered seawater | no |
| 16518 | 19/07/2009 | 450 | no | filtered seawater | no |
| 16519 | 19/07/2009 | 600 | no | filtered seawater | no |
| 16574 | 28/07/2009 | 50 | half | sterilized water | no |
| 16575 | 28/07/2009 | 150 (did not work) | no | sterilized water | no |
| 16576 | 28/07/2009 | 300 (50 actual) | no | deep water | no |
| 16577 | 28/07/2009 | 450 (did not work) | no | deep water | no |
| 16578 | 28/07/2009 | 600 (200 actual) | no | deep water | no |
| 16622 | 03/08/2009 | 50 | no | deep water | no |

| | | | | | |
|---|---|---|---|---|---|
| 16623 | 03/08/2009 | 150 | no | deep water | no |
| 16624 | 03/08/2009 | 300 | no | deep water | no |
| 16625 | 03/08/2009 | 450 | no | deep water | no |
| 16626 | 03/08/2009 | 600 | no | deep water | no |

Two sediment cores (deployments: 16499 and 16663; see report by Nina Rothe) were collected using the NOCS mega corer and were frozen upon recovery, extruded when still frozen, wrapped in pre-combusted (400ºC; 4 h) foil and stored in -80ºC for the duration of the cruise. On return to the laboratory the cores will be sectioned down to 10 cm, freeze-dried and analysed for organic carbon, nitrogen, lipids and isotopes ($\delta^{13}C$ and $\delta^{15}N$).

*2. Particulate sampling for pigment (HPLC) and microscopic analyses (for Denise Smythe-Wright)*

Particulate material for pigment analyses (HPLC) from a range of water depths was collected using a CTD rosette (Table 45). Two litres of water for each depth was filtered on a plastic rig through a 25 mm GF/F filter and frozen at -80°C for the rest of the cruise. Additionally 95ml of water from the same depths was spiked with 2 ml of LUGOL solution in dark bottles and kept at room temperature for phytoplankton identification.

*Table 45. Details of filtered material for pigment and microscopy (for Denise Smythe-Wright)*

| Station | Date | Depth CTD | CTD bottle | Filtering | water (Lugol) | Lugol | Bottle |
|---|---|---|---|---|---|---|---|
| | | m | | volume (L) | (ml) | ml | Lugol |
| 16477 | 13/07/2009 | 400 | 6 | 2 | 95 | 2 | A9 |
| 16477 | 13/07/2009 | 300 | 8 | 2 | 95 | 2 | A8 |
| 16477 | 13/07/2009 | 200 | 10 | 2 | 95 | 2 | A7 |
| 16477 | 13/07/2009 | 150 | 12 | 2 | 95 | 2 | A6 |
| 16477 | 13/07/2009 | 100 | 14 | 2 | 95 | 2 | A5 |
| 16477 | 13/07/2009 | 80 | 16 | 2 | 95 | 2 | A4 |
| 16477 | 13/07/2009 | 50 | 18 | 2 | 95 | 2 | A3 |
| 16477 | 13/07/2009 | 25 | 22 | 2 | 95 | 2 | A2 |
| 16477 | 13/07/2009 | 5 | 24 | 2 | 95 | 2 | A1 |
| 16497 | 16/07/2009 | 400 | 6 | 2 | 95 | 2 | A18 |
| 16497 | 16/07/2009 | 300 | 10 | 2 | 95 | 2 | A17 |
| 16497 | 16/07/2009 | 200 | 12 | 2 | 95 | 2 | A16 |
| 16497 | 16/07/2009 | 150 | 14 | 2 | 95 | 2 | A15 |
| 16497 | 16/07/2009 | 100 | 16 | 2 | 95 | 2 | A14 |
| 16497 | 16/07/2009 | 80 | 18 | 2 | 95 | 2 | A13 |
| 16497 | 16/07/2009 | 50 | 20 | 2 | 95 | 2 | A12 |
| 16497 | 16/07/2009 | 25 | 22 | 2 | 95 | 2 | A11 |
| 16497 | 16/07/2009 | 5 | 24 | 2 | 95 | 2 | A10 |
| 16619 | 03/08/2009 | 5 | 24 | 2 | 95 | 2 | A19 |
| 16619 | 03/08/2009 | 25 | 22 | 2 | 95 | 2 | A20 |
| 16619 | 03/08/2009 | 50 | 20 | 2 | 95 | 2 | A21 |
| 16619 | 03/08/2009 | 100 | 18 | 2 | 95 | 2 | A22 |
| 16619 | 03/08/2009 | 150 | 16 | 2 | 95 | 2 | A23 |
| 16619 | 03/08/2009 | 200 | 14 | 2 | 95 | 2 | A24 |
| 16619 | 03/08/2009 | 300 | 12 | 2 | 95 | 2 | A25 |
| 16619 | 03/08/2009 | 400 | 10 | 2 | 95 | 2 | A26 |
| 16619 | 03/08/2009 | 600 | 6 | 2 | 95 | 2 | A27 |

Lowered CTD Sampling, Processing and Calibration

*Adrian Martin (NOCS)*

*Introduction*

In total 73 CTD profiles were completed on cruise D341 using NMEP equipment. Three of these profiles come from deployment of the HPSS equipment when fitted with an NMEP sea unit. An earlier two profiles arising from deployment of the HPSS equipment using a sea unit belonging to the HPSS group are not reported here. Of the 73 profiles discussed here, 52 were to 1000m. Of the remaining casts, 10 were shallower than 1000m and 11 were deeper. Just one, at 4800m, approached the full depth of the ocean at this location. Only one profile was obtained using the titanium frame. Table 1 gives a full list of all CTD profiles obtained using NMEP equipment on standard steel or titanium frames or on the HPSS frame.

*Sampling*

Water samples were taken from all CTDs in the following order; oxygen, DIC, everything else. CTD sampling depths varied according to water requirements. Full details can be found in either paper logs or in processed bottle files.

*CTD spatial surveys*

Two spatial CTD surveys were conducted during the cruise. The first took place from 2313 on 20/7/09 (jday 201) to 0645 on 25/7/09 (jday 206), comprised 31 stations (16523-16564) and covered an area 100km x 80km. The first survey was oriented in the manner shown because of evidence for a westward mean flow across the area, and the survey direction minimises errors arising from non-synoptic sampling. The second took place from 1623 on 3/8/09 (jday 215) to 0526 on 6/8/09 (jday 218), comprised 10 stations (16627-16636) and was restricted to the boundary of an area 60km x 40km. Figures 36 and 37 show both the location of stations composing each survey and the ship track between them. Both survey areas contained the central PAP site (49N 16.5w), shown in the figures as a diamond. Both surveys were also adversely affected by deteriorating weather: the first was cut short with the final leg (F1-F6) never completed; the second had to be adjusted to be completed in an active science period reduced by poor weather.

*Figure 36: First CTD spatial survey. For clarity, station names omit the S1 suffix used in Table 46. The diamond shows the position of the central PAP site (49N 16.5W).*

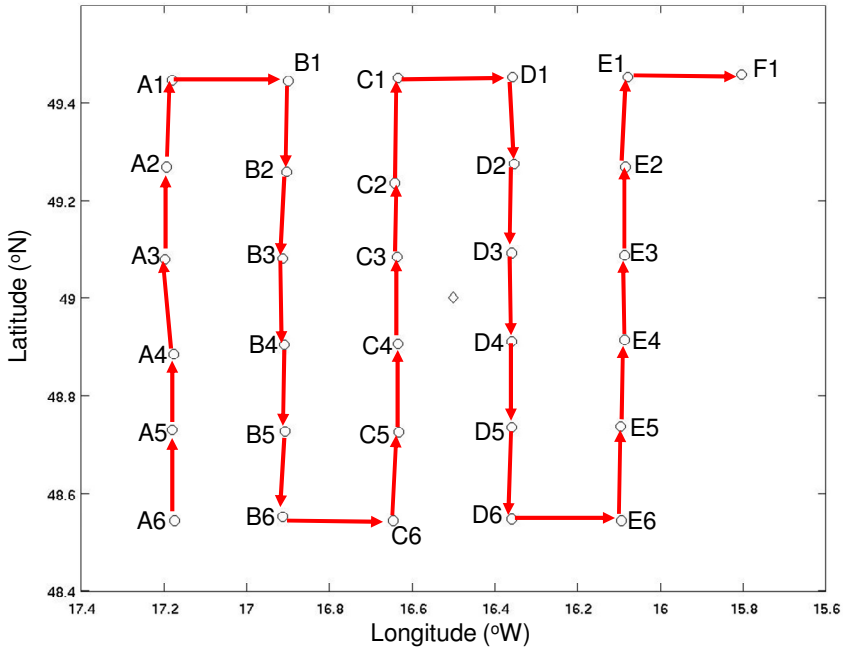
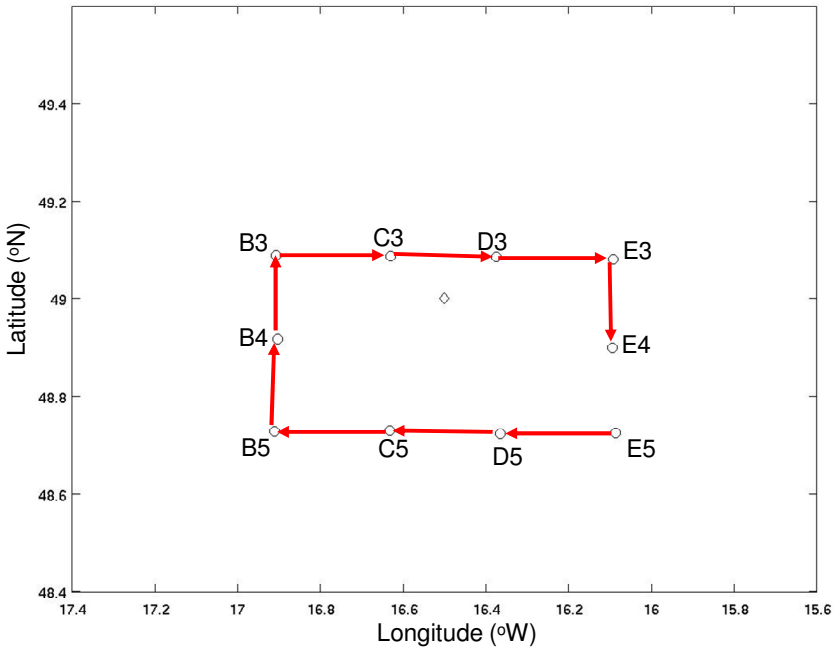


*Figure 37: second CTD spatial survey. For clarity station names omit the S2 suffix used in Table 46. The diamond shows the position of the central PAP site (49N 16.5W).*




*Processing*

The processing of SeaBird CTD data closely followed that of D321.) and D306. Those in turn are modified versions of the protocol adopted on P314 and D258, Marine Productivity I. Details can be found below.

Note that 6-digit CTD station numbers were used throughout the cruise – NDDDDD, where DDDDD is the Discovery number and N is a code letter denoting the type of CTD: a=steel ctd, b= titanium CTD. In addition, each CTD forming part of the mesoscale surveys was given a separate code denoting location in the survey – SqXY, where S denotes CTD survey, q denotes the survey number, X ranges from A (western-most) to F (eastern-most) and Y ranges from 1 (northern-most) to 6 (southern-most). All processed CTD files are named according to CTD station number and the code representing the type of CTD e.g. cta16210 for a steel CTD at station 16210. Table I shows CTD stations.

*Table 46. List of CTD stations carried out during D341 where 'combi' denotes deployment of NMEP sea unit on HPSS frame, 'a' corresponds to steel frame and 'b' corresponds to titanium frame.*

| CTD stn. | | Depth (m) | Date | jday | time | Latitude (N) | Longitude (W) | Cast type |
|---|---|---|---|---|---|---|---|---|
| 16476 | | 4800 | 13/7/09 | 194 | 0707 | 49 2.86 | 16 28.98 | a |
| 16478 | | 1000 | 13/7/09 | 194 | 1351 | 49 01.33 | 16 28.38 | a |
| 16486 | | 200 | 14/7/09 | 195 | 1703 | 49 02.49 | 16 28.73 | a |
| 16488 | | 800 | 15/7/09 | 196 | 0207 | 49 01.08 | 16 31.91 | a |
| 16497 | | 1000 | 16/7/09 | 197 | 1055 | 48 58.55 | 16 24.493 | a |
| 16501 | | 1000 | 17/7/09 | 198 | 0321 | 48 49.65 | 16 35.21 | a |
| 16510 | | 1000 | 19/7/09 | 200 | 0505 | 48 59.70 | 16 30.65 | a |
| 16514 | | 1000 | 19/7/09 | 200 | 1746 | 49 1.186 | 16 30.92 | a |
| 16523 | S1A6 | 3000 | 20/7/09 | 201 | 2313 | 48 32.73 | 17 10.43 | a |
| 16524 | S1A5 | 1000 | 21/7/09 | 202 | 0302 | 48 43.78 | 17 10.84 | a |
| 16526 | S1A4 | 1000 | 21/7/09 | 202 | 0920 | 48 53.09 | 17 10.64 | a |
| 16528 | S1A3 | 1000 | 21/7/09 | 202 | 1324 | 49 04.68 | 17 11.89 | a |
| 16529 | S1A2 | 1000 | 21/7/09 | 202 | 1747 | 49 16.12 | 17 11.66 | a |
| 16531 | S1A1 | 1000 | 21/7/09 | 202 | 2050 | 49 26.72 | 17 10.79 | a |
| 16532 | S1B1 | 1000 | 21/7/09 | 202 | 2335 | 49 26.59 | 16 54.03 | a |
| 16533 | S1B2 | 1000 | 22/7/09 | 203 | 0237 | 49 15.49 | 16 54.27 | a |
| 16535 | S1B3 | 1000 | 22/7/09 | 203 | 0607 | 49 04.84 | 16 54.80 | a |
| 16536 | S1B4 | 1000 | 22/7/09 | 203 | 0836 | 48 54.29 | 16 54.57 | a |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 16538 | S1B5 | 1000 | 22/7/09 | 203 | 1156 | 48 43.58 | 16 54.48 | a |
| 16539 | S1B6 | 1000 | 22/7/09 | 203 | 1435 | 48 33.16 | 16 54.77 | a |
| 16541 | S1C6 | 1000 | 22/7/09 | 203 | 1831 | 48 32.72 | 16 38.71 | a |
| 16542 | S1C5 | 1000 | 22/7/09 | 203 | 2118 | 48 43.47 | 16 37.90 | a |
| 16543 | S1C4 | 1000 | 23/7/09 | 204 | 0013 | 48 54.44 | 16 38.12 | a |
| 16544 | S1C3 | 1000 | 23/7/09 | 204 | 0318 | 49 05.00 | 16 38.15 | a |
| 16546 | These are bottles for 16547. No CTD data on 16546 due to technical slip. | | | | | | | |
| 16547 | S1C2 | 1000 | 23/7/09 | 204 | 1326 | 49 14.16 | 16 38.48 | a |
| 16548 | S1C1 | 1000 | 23/7/09 | 204 | 1558 | 49 27.00 | 16 38.10 | a |
| 16549 | S1D1 | 1000 | 23/7/09 | 204 | 1833 | 49 27.09 | 16 21.51 | a |
| 16550 | S1D2 | 1000 | 23/7/09 | 204 | 2123 | 49 16.46 | 16 21.24 | a |
| 16551 | S1D3 | 1000 | 24/7/09 | 205 | 0023 | 49 05.51 | 16 21.56 | a |
| 16552 | S1D4 | 1000 | 24/7/09 | 205 | 0318 | 48 54.66 | 16 21.54 | a |
| 16554 | S1D5 | 1000 | 24/7/09 | 205 | 0658 | 48 44.07 | 16 21.59 | a |
| 16555 | S1D6 | 1000 | 24/7/09 | 205 | 0940 | 48 32.87 | 16 21.62 | a |
| 16556 | S1E6 | 1000 | 24/7/09 | 205 | 1252 | 48 32.73 | 16 05.66 | a |
| 16557 | S1E5 | 1000 | 24/7/09 | 205 | 1539 | 48 44.18 | 16 05.77 | a |
| 16559 | S1E4 | 1000 | 24/7/09 | 205 | 1855 | 48 54.86 | 16 05.21 | a |
| 16560 | S1E3 | 1000 | 24/7/09 | 205 | 2142 | 49 05.21 | 16 05.17 | a |
| 16561 | S1E2 | 1000 | 25/7/09 | 206 | 0040 | 49 16.11 | 16 05.10 | a |
| 16562 | S1E1 | 1000 | 25/7/09 | 206 | 0326 | 49 27.07 | 16 04.76 | a |
| 16564 | S1F1 | 1000 | 25/7/09 | 206 | 0645 | 49 27.40 | 15 48.30 | a |
| 16568 | | 250 | 26/7/09 | 207 | 2227 | 49 57.81 | 15 40.01 | a |
| 16572 | | 100 | 28/7/09 | 209 | 1431 | 48 59.68 | 16 41.72 | a |
| 16580 | | 1000 | 29/7/09 | 210 | 0131 | 48 59.40 | 16 51.99 | a |
| 16582 | | 1000 | 29/7/09 | 210 | 0435 | 48 58.75 | 16 54.80 | a |
| 16583 | | 1000 | 29/7/09 | 210 | 0650 | 48 58.87 | 16 56.09 | a |
| 16591 | | 2000 | 31/7/09 | 212 | 0934 | 48 50.19 | 16 29.83 | combi |
| 16592 | | 2000 | 31/7/09 | 212 | 1244 | 48 49.34 | 16 30.67 | a |
| 16597 | | 60 | 31/7/09 | 212 | 2342 | 48 44.89 | 16 31.50 | a |
| 16604 | | 1000 | 1/8/09 | 213 | 0758 | 48 42.97 | 16 33.14 | a |
| 16606 | | 3000 | 1/8/09 | 213 | 1125 | 48 41.31 | 16 34.70 | combi |
| 16609 | | 2000 | 2/8/09 | 214 | 0224 | 48 38.19 | 16 33.85 | a |
| 16616 | | 2000 | 2/8/09 | 214 | 2331 | 49 02.87 | 16 26.14 | combi |
| 16618 | | 1000 | 3/8/09 | 215 | 0337 | 49 00.62 | 16 25.94 | a |
| 16619 | | 1000 | 3/8/09 | 215 | 0552 | 48 59.20 | 16 25.50 | a |
| 16627 | S2E5 | 1000 | 3/8/09 | 215 | 1623 | 48 43.39 | 16 05.23 | a |
| 16628 | S2D5 | 1000 | 3/8/09 | 215 | 1950 | 48 43.43 | 16 21.94 | a |
| 16629 | S2C5 | 1000 | 3/8/09 | 215 | 2259 | 48 43.75 | 16 37.90 | a |
| 16630 | S2B5 | 1000 | 4/8/09 | 216 | 0227 | 48 43.66 | 16 54.62 | a |
| 16631 | S2B4 | 1000 | 5/8/09 | 217 | 1341 | 48 55.09 | 16 54.22 | a |
| 16632 | S2B3 | 1000 | 5/8/09 | 217 | 1700 | 49 05.28 | 16 54.39 | a |
| 16633 | S2C3 | 1000 | 5/8/09 | 217 | 2042 | 49 05.21 | 16 37.89 | a |
| 16634 | S2D3 | 1000 | 5/8/09 | 217 | 2255 | 49 05.12 | 16 22.48 | a |
| 16635 | S2E3 | 1000 | 6/8/09 | 218 | 0200 | 49 04.81 | 16 05.59 | a |
| 16636 | S2E4 | 1000 | 6/8/09 | 218 | 0526 | 48 53.98 | 16 05.67 | a |
| 16640 | | 2000 | 6/8/09 | 218 | 1706 | 48 55.18 | 16 31.56 | a |
| 16648 | | 2000 | 7/8/09 | 219 | 0533 | 48 59.89 | 16 29.35 | combi |
| 16650 | | 10 | 7/8/09 | 219 | 1714 | 48 53.71 | 16 32.63 | a |
| 16655 | | 100 | 8/8/09 | 220 | 0359 | 48 48.04 | 16 59.32 | a |
| 16658 | | 2000 | 8/8/09 | 220 | 0748 | 48 47.57 | 16 59.03 | a |
| 16659 | | 1000 | 8/8/09 | 220 | 1034 | 48 47.27 | 16 59.80 | a |
| 16662 | | 250 | 8/8/09 | 220 | 2035 | 48 50.55 | 16 30.14 | a |
| 16665 | | 4000 | 9/8/09 | 221 | 0832 | 49 01.78 | 16 29.23 | b |
| 16667 | | 5 | 9/8/09 | 221 | 2000 | 49 44.55 | 16 31.10 | a |

*SeaBird Software processing (SBEDataProcessing-Win32)*

The calibrations applied to the raw data, by the SeaBird logging software prior to being stored in the files described below, can be found in the .CON file for each cast. All processing was carried out in \\discovery2ng\D341\ctd\ctd\D341StS\Data for the steel CTDs. Full pathnames should be used throughout though from now on \Data\raw and \Data are used here as shorthand for convenience.

The following steps were run on the binary 24Hz data. The input files were DDDDDN.dat, DDDDDN.BL, DDDDDN.CON and DDDDDN.HDR where DDDDD is the Discovery number and N denotes the type of CTD as described above. All input files were kept in \Data\raw with processed data being stored in \Data. A batchfile (D341Batch2.txt) was created in …\Data\raw for steel CTDs to process each raw file:

Datcnv /i%1\%2.DAT /c%1\%2.CON /p%1\DatCnv2.psa /o%1
Wildedit /i%1\%2.CNV /p%1\WildEdit2.psa /o%1

Filter /i%1\%2.cnv /p%1\Filter2.psa /o%1
Alignctd /i%1\%2.CNV /p%1\AlignCTD2.psa /o%1
Celltm /i%1\%2.CNV /p%1\CellTM2.psa /o%1
Loopedit /i%1\%2.CNV /p%1\LoopEdit2.psa /o%1
Bottlesum /i%1\%2.ROS /c%1\%2.CON /p%1\BottleSum2.psa /o%1
BinAvg /i%1\%2.cnv /p%1\BinAvg2.psa /o%1
AsciiOut /i%1\%2.1Hz.cnv /p%1\Ascii_Out2.psa /o%1

e.g to process raw file 176001.dat, execute sbebatch \\discovery2ng\D341\ctd\ctd\D341StS\Data\raw\D341Batch2.txt \\discovery2ng\D341\ctd\ctd\D341StS\Data\raw 176001

Note that all the above .psa filenames and that of the batch file contain the number 2 as this was a second version which incorporated the estimated oxygen time offset, described in AlignCTD below.

The steps carried out by the batch file were set up in the following manner (batch files for steel and titanium CTDs are identical except where indicated) and saved in the corresponding .psa files. Note that it is necessary to have a data file to work on to set the .psa file for each of these steps up.

Data conversion
This generates .cnv and .ros file
File setup
Program setup file DatCnv2.psu was created in \raw
Instrument config file: set to whatever you like – it is immaterial as overridden by batch file
Config. file: matched to input file.
Input dir: \raw
Input file: as instrument configuration file
Output dir: \raw
Name append: left blank (will automatically append .cnv)
Output file: left blank
Data setup
Process scans to end of file: yes
Scans to skip over: 0
Ouput format: ascii
Convert data from: upcast and downcast
Create file types: both bottle and data
Source of scan range data: .BL file
Scan range offset: 0sec
Scan range duration:
5sec for standard casts (chosen after discussion with Dave Teare on D306 – CTD exceedingly unlikely to move on again within 5sec of bottle firing)
Merge separate header file: No
Select output variables:
**Note:** temp2 and cond2 are the preferred sensors on the vane. The others (temp and cond) have a considerable lag (~5-10dbar) due to entrainment by the CTD frame. The names are swapped by ctd0 such that temp2 in the binary data becomes temp in the pstar version and vice versa (ditto for cond).
pressure (digiquartz) – dbar
temp 2 (ITS-90) – deg C
cond 2– mS/cm
temp (ITS-90) – deg C
cond – mS/cm
altimeter – m
oxygen (SBE43) – □mol/kg (2 sec window used)
temp difference, 2-1 (ITS-90) – deg C
cond difference, 2-1 – mS/cm
pot. temp (ITS-90) – deg C
fluor (Chelsea Aqua 3 Chl Con) – □g/l
Beam attenuation (Chelsea/Seatech/Wetlab)
Beam transmission (Chelsea/Seatech/Wetlab)

time elapsed - seconds
jday
latitude – deg
longitude – deg
PAR (downwelling) – $W/m^2$
PAR (upwelling) – $W/m^2$
oxygen voltage SBE43
oxygen SBE43 (dov/dt) (2 sec window used)
oxygen saturation – ml/l

WildEdit

Details as in P314 report (JTA)

File setup

Program setup file WildEdit2.psu was created in \raw
I/p dir and file, o/p name, dir and "appendation" as DataConversion

Data setup

standard deviations for pass 1: 1
standard deviations for pass 2: 2
scans per block: 10
keep data within this distance of mean: 0
Exclude scans marked bad: yes
Select WildEdit variables:
select all

Filter

Details as suggested in P314 report (JTA)

File setup

Program setup file Filter2.psu was created in \raw
I/p dir and file, o/p name, dir and "appendation" as DataConversion

Data setup

Low pass filter A: 0.03
Low pass filter B: 0.15
A should be applied to conductivity (1,2 and 1-2)
B should be applied to pressure

AlignCTD

Details as suggested in P314 report (JTA). A little more explanation might be helpful though on the subject of the oxygen advance. SeaBird recommend that the oxygen signal is advanced to give the best match between up and down casts. A program was written in Matlab to calculate the sum of squared differences between down and up casts. By applying this to a single cast run, through the SeaBird processing using different advances, a 3 sec advance was found to be the optimum one. This agrees with the findings of Jane Read on the preceding cruise D340 (pers. comm.). No attempt was made to take into account the further complication of primary T and conductivity sensors being on the vane when the oxygen sensor was on the base of the frame.

File setup

Program setup file AlignCTD2.psu was created in \raw
I/p dir and file, o/p name, dir and "appendation" as DataConversion

Data setup

Enter advance values
oxygen advanced 10sec, all others unaffected

CellTM

Details as suggested in P314 report (JTA)

File setup

Program setup file CellTM2.psu was created in \raw
I/p dir and file, o/p name, dir and "appendation" as DataConversion

Data setup

□=0.03
1/□=7
both applied to both temperature sensors

LoopEdit

Details as per Roger Reveille Cruise (Oct-Nov 2008) from Roz Pidcock via John Allen

File setup
Program setup file LoopEdit2.psa was created in \raw
I/p dir and file, o/p name, dir and “appendation” as DataConversion
Data setup
Minimum velocity type: fixed minimum velocity
Minimum CTD velocity (m/s): 0.05
Do not select ‘Remove Surface Soak’
Select ‘Exclude scans marked bad’

*BottleSum* (has been renamed from RosSum since P314)
Generates a .btl file
Details as suggested in P314 report (JTA)
File setup
Program setup file BottleSum2.psu was created in \raw
I/p dir and file, o/p name, dir and “appendation” as DataConversion
Config. filename doesn’t matter as over-ridden by batch file
Match to input file: yes
Data setup
Output min and max for averages variables: yes
All variables EXCEPT TIME to be averaged (also exclude scan count if it appears)
Derived variables to average:
none

BinAvg
Generates .1Hz.cnv file
Details as suggested in P314 report (JTA)
File setup
Program setup file BinAvg2.psu was created in \raw
I/p dir and file, o/p name, dir and “appendation” as DataConversion
Name append: .1Hz
Data setup
Bin type: time (seconds)
Bin size: 1 sec
Include no. scans per bin: no
Exclude scans marked bad: yes
Scans to skip over: 0
Cast to process: up and down

AsciiOut
Generates .1hz.asc file
File setup
Program setup file ASCII_Out2.psu was created in \raw
I/p dir and file, o/p name, dir and “appendation” as DataConversion
Data setup
Output header: yes
Lines/page: 60
Output data: yes
Exclude bad scans: yes
Columns labelled at top of file
Column separator: space
Julian days format: Julian days
Replace bad flag: -999.0

*Pstar processing*

Note that execs are slightly modified versions of those used on D321 which are in turn slightly tweaked versions of those from Poseidon 314. They appear to differ from those used on previous Discovery cruises (with the exception of D309) so care should be exercised to ensure the correct exec version is used for any subsequent reanalysis. Separate execs are used for steel and titanium CTDs due to the data being contained in different directories

*ctd0S and ctd0T* – translate the 24Hz SeaBird DDDDDN.cnv file into pstar format. Require the latitude and longitude of the bottom of the cast. These are entered manually from details on the CTD log-sheet but can be automatically checked and corrected later on. Output ctNDDDDD.24hz

*ctd1S and ctd1T* – after checking output of ctd0 with plxyed for spikes that may need to be removed before proceeding, ctd1S/T averages 24Hz data into 1Hz and derives salinity, potential temperature and density. It was noted that many of the casts had small spikes in both primary and secondary T and C sensors on the down cast, probably as a result of entrained water from slightly higher in the water column as this only was noticeable in the sharp gradient region of the seasonal thermocline. Output ctNDDDDD.1hz (and ctNDDDDD.10s)

*ctd2S and ctd2T* – require the user to first find the first in-water, deepest and last in-water datacycle using plxyed (with ctd1Hz.pdf) prior to use. These execs then extract data corresponding to full up and down casts (ctNDDDDD.ctu) and purely the downcast (ctNDDDDD.2db) averaged into 2db bins.

*sam0S and sam0T* – create a file, fir/fiNDDDDD, containing CTD data corresponding to the firing times of the bottles. It does so using the relevant .btl file in raw/. The resulting pstar file has both mean and standard deviation for all variables.

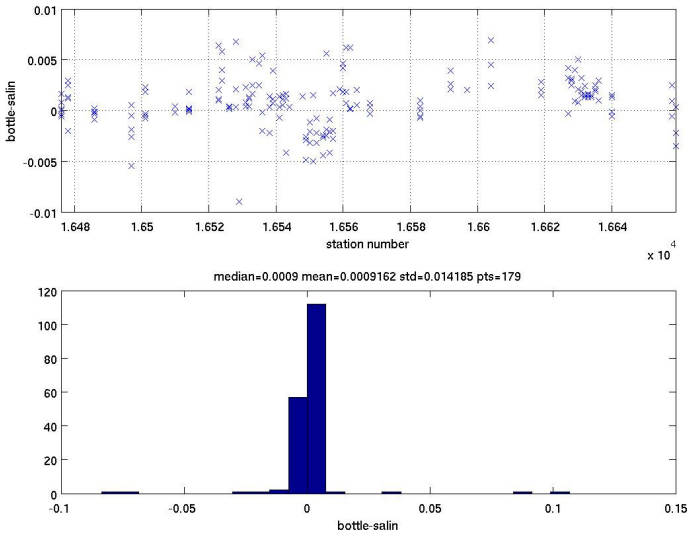
*sam1S and sam1T* – create a sample file, saNDDDDD, containing both CTD data at bottle firing depths but also with space for variables for which samples were taken e.g. oxygen, nutrients, chlorophyll. The list of sampled variables is contained in sam.names. Note is also made at this stage of the number of bottles fired on each cast to ensure the ascii sample file (see Salinometry section of report) has only this number of rows.

*Asciiexec/frasciiexec* – created ascii versions of ctNDDDDD.2db (as fulascNDDDDD.txt) and saNDDDDD (as botascNDDDDD.txt) for use buy ther scientists on cruise. The two versions of this program are for standard CTD (asciiexec) and for the French CTD when using NERC Sea Unit (frasciiexec).

*Salinity calibration and sensor issues*

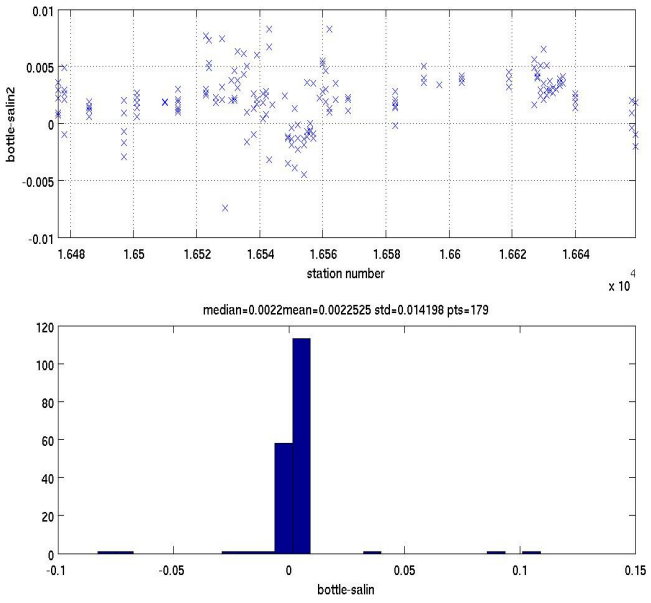
Salinity samples were taken on 56 of the 70 CTD profiles conducted using an NMEP frame and rosette. Figs 38 and 39 show differences between salinometer derived bottle sampled salinities and those derived from continuous CTD data. To remove outliers the differences between bottle and CTD estimated salinity were twice screened to exclude data-points outside 2 standard deviations of the mean. It is apparent that even this was not fully successful. For the primary sensor the mean offset is less than 0.001 psu. There is no trend with time but there is much variability throughout the cruise. In particular the periods of the two mesoscale surveys show the most scatter. There are two potential causes: first, the intensive nature of the survey required sampling by people both inexperienced in salinity sampling and also coming from different institutes which may have different protocols; second, the weather deteriorated during each survey so there is a potential rainwater signal for samples taken by less experienced samplers.

*Figure 38: Differences (psu) between bottle and primary CTD salinity sensor*




The same pattern is seen in residuals for the secondary salinity sensor. The mean residual is a ittle higher though at 0.0022 psu. Generally the residuals for both sensors are acceptable for a multidisciplinary exercise of this nature where there is not intent to infer subtle shifts in water mass characteristics. Further attention to specific remaining outliers and trends among samplers will hopefully reduce the standard deviation. This currently exaggerates the variability by virtue of the strong non-Gaussianity of residuals seen in the figures.

*Figure 39. Differences (psu) between bottle and secondary CTD salinity sensor*



Vessell Mounted ADCP (VM-ADCP) and navigation data

*John Allen, NOCS*

## *1. Introduction*

During the refit for RRS *Discovery* in March 2008, the original narrow band RDI 150 kHz Vessel-Mounted Acoustic Doppler Current Profiler (VM-ADCP) was replaced with an RDI broad band 150 kHz (Ocean Surveyor) phased array style VM-ADCP. This was in addition to the similar 75 kHz Ocean Surveyor instrument that had been in use in the forward ADCP housing since 2001.

The 150 kHz ADCP is mounted in the hull 1.75 m to port of the keel, 33 m aft of the bow at the waterline and at an approximate depth of 5 m. The 75 kHz ADCP is also mounted in the hull, but in a second water chest 4.15 m forward and 2.5 m to starboard of the 150 kHz well.

This section describes the operation and data processing paths for both ADCPs. The navigation data processing is described first since it is key to the accuracy of the ADCP current data. All integrated underway data were logged using the Ifremer TechSAS data logging system that has been gradually implemented on RRS *Discovery* for approximately 3 years. The extensive NMFSS scripts to read the netcdf format TechSAS file streams and create RVS data streams have been developed alongside the implementation of the system and most errors and wrinkles have been worked out. The 'live' RVS data format streams have overcome the problem discussed in some recent reports of insufficient significant figure resolution in position data using *nclistit*. Apparently these do not convert the netcdf format to RVS data format, instead, they log TechSAS broadcast messages independently.

## *2. Navigation*

The ship's primary position instrument was the GPS Trimble 4000 system. The positional accuracy for the GPS 4000 system was determined from the data recovered whilst tied up alongside in KGV docks, Govan. Standard deviation for positional accuracy was an incredible 1.045 m in latitude and 0.612 m in longitude, and some of this maybe due to heave in the mooring lines. In comparison, the Ashtech G12 navigation system was a little less accurate with standard deviation for positional accuracy of 2.000 m in latitude and 1.198 m in longitude.

Both navigations systems therefore had sufficient precision to enable the calculation of ship's velocities to better than 1 $cms^{-1}$, and therefore below the instrumental limits (~ 1 $cms^{-1}$) of the RDI ADCP systems. Using the GPS 4000 system as its primary navigation source, the NMFSS Bestnav combined (10 second) clean navigation process was operational on D341, however it returned a believable but spurious ship's track for approximately 10 hours whilst rounding the south-east corner of Eire on passage out to the PAP site. The cause of this problem with Bestnav was never identified and therefore the raw Trimble GPS 4000 data were taken as the master navigation source all cruise. In point of fact, the Trimble, Ashtech and Bestnav files streams matched perfectly for the rest of the cruise, and the largest gap in the Trimble GPS 4000 data stream was 91 seconds.

Navigation and gyro data were transferred daily from the RVS format file streams to pstar navigation files, e.g. abnv3401, gp434001 and gyr34001.

Scripts:
**navexec0**: transferred data from the RVS *bestnav* file to PSTAR, calculated the ships velocity, appended onto a cruise navigation file and calculated the distance run from the start of the file. Output: abnv3411

**gyroexec0**: transferred data from the RVS *gyrol* file stream to Pstar, a nominal edit was made for directions between 0-360° before the file was appended to a master file. Output: gyr34101

**gps4exec0**: transferred data from the RVS *gps_4kl* file stream to Pstar, edited out pdop (position dilution of precision) greater than 7 and appended the new 24 hour file to a master file. The master file was averaged to create an additional 30 second file and distance run was calculated and added to both. Output: gp434101 and gp434101.30sec

**gpsg12exec0**: transferred data from the RVS *gps_g12l* file stream to Pstar, edited out pdop (position dilution of precision) greater than 7, appended the new 24 hour file to a master file and distance run was calculated. Output: gpsg1234101

*3. Heading*

The ships attitude was determined every second with the ultra short baseline 3D GPS Ashtech ADU2 navigation system. Four antennae, 2 on the boat deck, two on the bridge top, measured the phase difference between incoming satellite signals from which the ship's heading, pitch and roll were determined.

The Ashtech data were used to calibrate the gyro heading information as follows:

**ashexec0**: transferred data from the RVS format file stream *gps_ash* to pstar.

**ashexec1**: merged the ashtech data from ashexec0 with the gyro data from gyroexec0 and calculated the difference in headings (hdg and gyroHdg); ashtech-gyro (a-ghdg).

**ashexec2**: edited the data from ashexec1 using the following criteria:

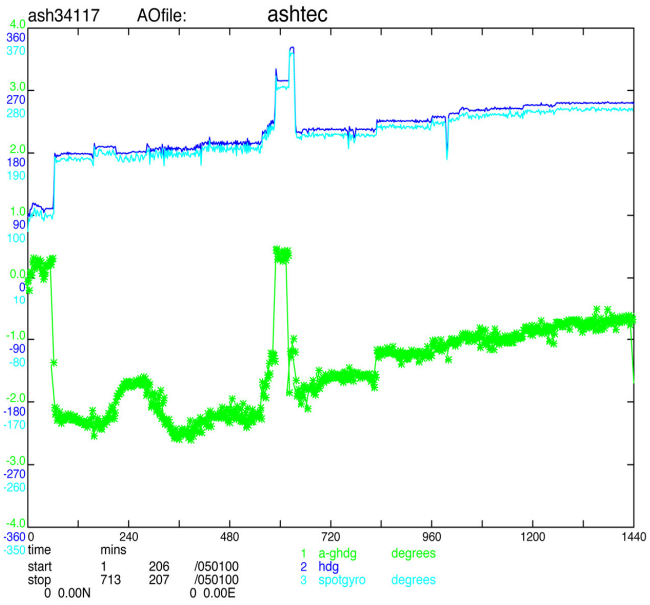
heading0 < hdg < 360 (degrees)
pitch -5 < pitch < 5 (degrees)
roll -7 < roll < 7 (degrees)
attitude flag -0.5 < attf < 0.5
measurement RMS error 0.00001 < mrms < 0.01
baseline RMS error 0.00001 < brms < 0.1
ashtech-gyro heading -7 < a-ghdg < 7 (degrees)

The heading difference (a-ghdg) was then filtered with a running mean based on 5 data cycles and a maximum difference between median and data of 1 degree. The data were then averaged to 2 minutes and further edited for

-2 < pitch <2
0 < mrms < 0.004

The 2 minute averages were merged with the gyro data files to obtain spot gyro values. The ships velocity was calculated from position and time, and converted to speed and direction. The resulting a-ghdg should be a smoothly varying trace that can be merged with ADCP data to correct the gyro heading. Diagnostic plots were produced to check this. During ship manoeuvres, bad weather or around data gaps, there were spikes which were edited out manually (plxyed, Figure 40).

*Fig. 40. Example of the edited onscreen daily heading data: gyro heading (light blue), Ashtech 3D-GPS heading (dark blue) and ashtech – gyro heading difference (green stars)*



Ashtech 3D GPS coverage was generally good. Gaps over 1 minute in the data stream are listed below. (Table 47)

*Table 47. Gaps in Ashtech data*

| |
|---|
| time gap : 09 186 15:52:18 to 09 186 15:53:30 (72 s) |
| time gap : 09 188 08:25:28 to 09 188 08:26:29 (61 s) |
| time gap : 09 192 13:03:56 to 09 192 13:04:57 (61 s) |
| time gap : 09 192 13:10:42 to 09 192 13:11:47 (65 s) |
| time gap : 09 203 21:06:41 to 09 203 21:08:16 (95 s) |
| time gap : 09 206 11:07:43 to 09 206 11:08:50 (67 s) |
| time gap : 09 217 01:50:40 to 09 217 01:51:42 (62 s) |
| time gap : 09 220 23:07:14 to 09 220 23:08:18 (64 s) |
| time gap : 09 223 20:48:59 to 09 223 20:50:14 (75 s) |

### *4. VM-ADCP data*

This section would normally describe the operation and data processing paths for both ADCPs fitted to RRS *Discovery*. However, before reaching the PAP study site, it was clear that the 75 kHz ADCP had ceased to provide any current data and very little return signal strength was being detected by either the transducers or the deck unit. Thorough diagnostic checks indicated potential problems with ADCP instrument itself, but email communication of the diagnostic results to RDI led the manufacturers to suggest that the deck unit would need to be repaired. Thus only the 150 kHz VM-ADCP was operable during this cruise.

Interestingly, our initial thoughts were that there might be air in the 75 kHz VM-ADCP housing. This is normally continuously bled through a small bleed valve to a stanchion pipe at deck level. Investigations showed that the bleed channel had indeed blocked up below the bleed valve. This blockage was cleared with high pressure air by the engineering staff, until water began to flow. Sadly, on this occasion, this did not solve the VM-ADCP problem and hence we began the diagnostic checks.

*150 kHz VM-ADCP data processing*
The RDI Ocean Surveyor 150 kHz Phased Array VM-ADCP was configured to sample over 120 second intervals with 100 bins of 4m depth and a blank beyond transmit of distance of 4m. The instrument is a broad-band phased array ADCP with 153.6 kHz frequency and a 30° beam angle.

Both deck units had firmware upgrades to VMDAS 23.17 after the March 2008 refit. Both control PCs ran RDI software VmDAS v1.46. Gyro heading, and GPS Ashtech heading, location and time were fed as NMEA messages into the serial ports of the both PCs and VmDAS was configured to use the Gyro heading for co-ordinate transformation. VmDAS logs the PC clock time, stamps the data (start of each ensemble) with that time, and records the offset of the PC clock from GPS time. This offset was applied to the data in the processing path before merging with navigation.

The 2 minute averaged data were written to the PC hard disk in files with a .STA extension, eg D341os150001_000000.STA, D341os150002_000000.STA etc. Sequentially numbered files were created whenever data logging was stopped and re-started. The software was set to close the file once it reached 100MB in size, though on D341 files were closed and data collection restarted daily such that the files never became that large. All files were transferred to the unix directories /data32/d341/os150/raw. This transfer included the plethora of much larger ping by ping data files, these can be useful in the event of major failure of the ship's data handling systems as they record all the basic navigation and ships heading/attitude data supplied by NMEA message.

The VM-ADCP instrument was configured to run in 'Narrowband' range over resolution mode. Bottom tracking was used until we left the continental shelf at the Porcupine sea bight. Bottom tracking was also used as we returned across the continental shelf south of Eire.

The VM-ADCP processing path followed an identical route to that developed in 2001 for the 75 kHz ADCP (RRS *Discovery* cruise 253). In the following script descriptions, "##" indicates the daily file number.

**s150exec0:** data read into Pstar format from RDI binary file (psurvey2). Water track velocities written into "adp" files, bottom track into "bot" files if in bottom track mode. Velocities were scaled to cm/s and amplitude by 0.45 to db. The time variable was corrected to GPS time by combining the PC clock time

and the PC-GPS offset. An offset depth for the depth bins was provided in the user supplied information (9 m for the 150 kHz instrument), this equated to the sum of the water depth of the transducer in the ship's hull (~5 m in RRS *Discovery*) and the blank beyond transmit distance used in the instrument setup (see earlier). Output Files: (adp341##.raw, bot341##.raw).

**s150exec1**: data edited according to status flags (flag of 1 indicated bad data). Velocity data replaced with absent data if variable "2+bmbad" was greater than 25% (% of pings where >1 beam bad therefore no velocity computed). Time of ensemble moved to the end of the ensemble period (120 secs added with pcalib). Output files: (adp341##, bot341##).

**s150exec2**: this merged the adcp data with the ashtech a-ghdg created by ashexec2. The adcp velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: (adp341##.true, bot341##.true).

**s150exec3**: applied the misalignment angle, ø, and scaling factor, A, to both files. Variables were renamed and re-ordered to preserve the original raw data. Output Files: (adp341##.cal, bot341##.cal).

**s150exec4gp**: merged the adcp data (both files) with the Trimble GPS 4000 navigation imported to pstar through gps4exec0 (gp434101). Ship's velocity was calculated from spot positions taken from the gp434101 file and applied to the adcp velocities. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from the gp434101.30sec file. Output Files: (adp341##.abs, bot341##.abs).

*5. 150 kHz VM-ADCP calibration*

A calibration of the 150 kHz VM-ADCP was achieved using bottom tracking data available from our transit through the Irish sea and across the continental shelf. Using long, straight, steady speed sections of standard two minute ensemble profiles over reasonably constant bottom depth the following calibrations for mis-alignment angle, $\phi$, and necessary amplification (tilt), A, were derived by comparing GPS derived component vectors of the vessel speed and direction with processed VM-ADCP bottom track determined component vectors of the vessel speed and direction:

***150 kHz:***

| | $\phi$ | A |
|---|---|---|
| mean | 1.530827714 | 1.001707899 |
| s.d | 0.11214429 | 0.002060111 |

These values were very similar to those on the immediately preceding RRS *Discovery* cruise D340.

*6. 150 kHz VM-ADCP initial data inspection*

The 150 kHz broadband VM-ADCP worked well throughout the cruise and had good range in 'narrowband' range over resolution mode. In Figure 41, we present the current vectors at 251 m for the 1st CTD period. An anti-cyclonic eddy like circulation can clearly be seen in the north-west corner of the survey region. This circulation correlates well with an eddy signal of increased surface chlorophyll concentration inferred from one of the rare ocean colour satellite images obtained during D341 (Figure 42).

*Figure. 41. VM-ADCP current vectors at 251 m depth for the 1st CTD survey period*

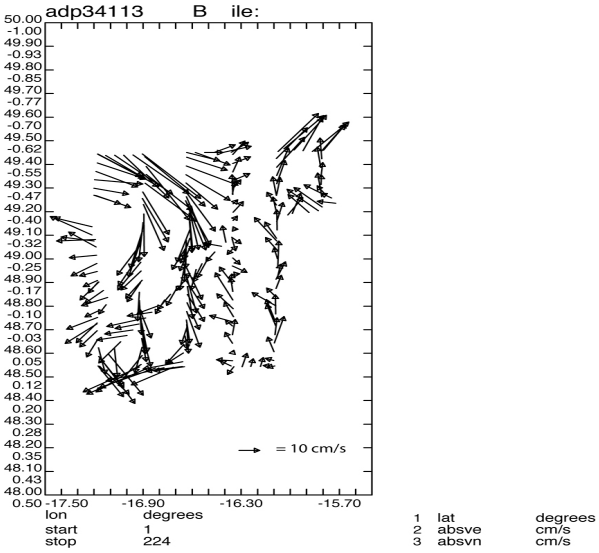
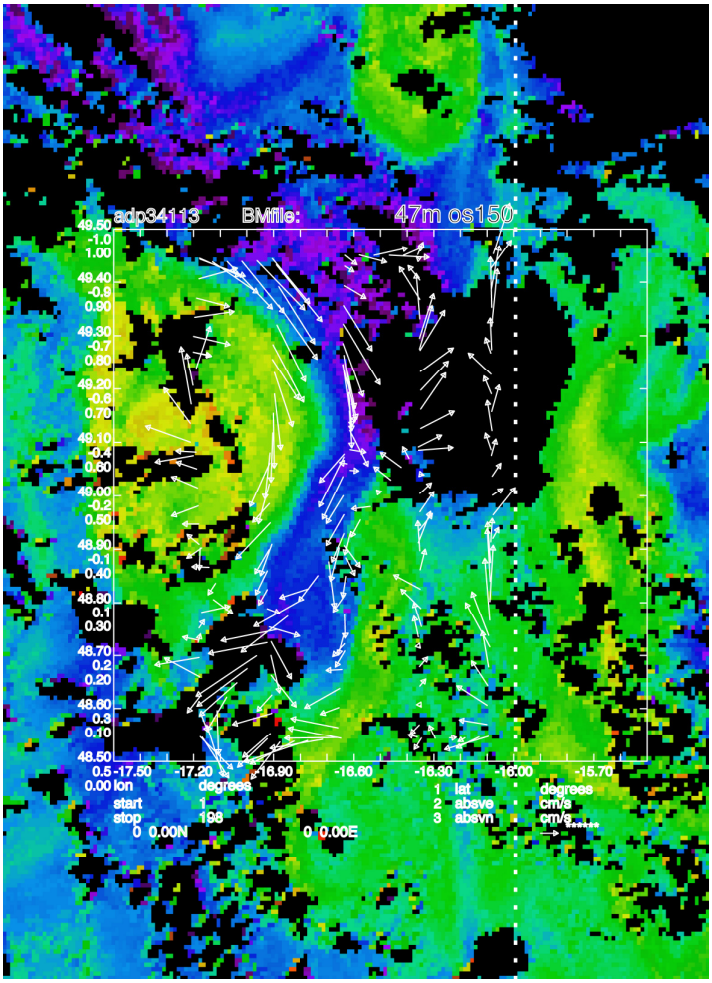



*Fig. 42. VM-ADCP current vectors at 47 m depth overlaid on one of the rare ocean colour satellite images for the 1st CTD survey period.*



Giering net and ARIES samples

*Sari Giering, (Then Aberdeen, now NOCS)*

*1. Background*

Zooplankton plays a major role in the biological carbon pump. They feed on phytoplankton and smaller organisms in the surface waters during night time and migrate downwards during day time. This daily vertical migration results in an active transport of carbon into depths through both respiration and excretion. The accurate quantification of mesozooplanktonic carbon consumption is essential for the understanding of the role of mesozooplankton in the pelagic biogeochemistry and the process of the biological carbon pump.

The quantity of zooplanktonic carbon transport is estimated using zooplankton metabolic rates such as respiration rates and carbon demand. Conventionally, zooplanktonic carbon demand (ZCD) is calculated on the base of size fractured biomass and water temperature (Ikeda, 1987). The animals are sampled from several discrete depth intervals and converted into zooplankton respiration (ZR) and ZCD using two equations:

$$\ln ZR = a_0 + a_1 \ln BM + a_2 T \,, \qquad (1)$$

where ln is the natural logarithm, ZR is the respiration rate (µL $O_2$ individual$^{-1}$ h$^{-1}$), BM is the body mass (mg dry weight, C, N, or P wt individual$^{-1}$), T is the habitat temperature (°C) and $a_0$, $a_1$ and $a_2$ are constants.

$$ZCD = \frac{ZR}{R \cdot AE}, \qquad (2)$$

where ZCD is measured in mg C m$^{-2}$ d$^{-1}$, ZR is the respiration rate converted into carbon equivalents (mg C m$^{-2}$ d$^{-1}$) after Al-Mutairi and Landry (2001), R is the fraction of assimilated carbon that is respired (~50%; Ikeda 1987), and AE is the fraction of carbon consumed that was assimilated (50-70%; Steinberg et al. 1997).

The zooplankton respiration model accounts for 84-96% of the variation in respiration rates. Therefore, additional feeding experiments are required to confirm the model output.

*2. Aries*

To estimate the carbon demand of the zooplankton between 0 – 1000 m depth, the mesozooplankton at the PAP zone was sampled using an Autosampling and Recording Instrumented Environmental Sampling System (ARIES). ARIES can take 110 samples from discrete depth intervals with a 200 µm net. Due to sample size the downcast samples are less useful for quantitative analysis; however they can be used for biogeochemical analysis. The upcast samples are quantitative and give a good representation of the zooplankton community at the sampled depth range. Using the equations described above, the samples will be converted into zooplankton carbon demand. ARIES was deployed at different daytimes to give a full cover of the daily vertical migration and a better understanding of the species involved in active vertical carbon transport.

*2.1 Aries Samples*

Eight ARIES deployments were conducted from 0 – 1000 m depth (Table 48). Individual ARIES cod-ends were carefully rinsed onto 200 µm mesh squares, which were folded and processed according to the cast. Downcast samples were wrapped in tin foil, labelled, put in polybags and stored at -70°C. Upcast samples were put into 30 mL glass vials containing 4% formaldehyde solution, labelled and stored. A total of 858 samples were taken: 443 downcast samples and 415 upcast samples. Furthermore, two 200 µm pop nets were placed on the ARIES main frame to collect an integrated sample over the entire depth range. One integrated sample was frozen, the other one preserved in 4% formaldehyde solution.

*Table 48. ARIES deployments*

| Station | Date | Position | | Time (hh:mm) | Duration (h:mm:ss) | Depth (m) | Distance (km) | Samples | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Total | Downcast | Upcast |
| 16494 | 16/07/09 | 49°01'9" N - 49°06'8" N | 16°28'2" W - 16°28'6" W | 00:51-03:30 | 2:39:00 | 1103.4 | 10.4 | 109 | 1 – 58 | 59 – 109 |
| 16520 | 19/07/09 | 48°59'8" N - 48°51'7" N | 16°32'6" W - 16°38'2" W | 21:22 – 01:01 | 3:38:51 | 1015.2 | 16.4 | 109 | 1 – 57 | 58 – 109 |
| 16521 | 20/07/09 | 48°53'7" N - 48°45'2" N | 16°40'7" W - 16°45'8" W | 02:49 – 06:28 | 3:39:03 | 1019.4 | 16.8 | 107 | 1 – 55 | 56 – 107 |
| 16571 | 28/07/09 | 48°58'6" N - 48°59'5" N | 16°30'8" W - 16°41'9" W | 10:31 – 13:41 | 3:10:08 | 1029.4 | 13.7 | 102 | 1 – 52 | 53 – 102 |
| 16607 | 01/08/09 | 48°40'7" N - 48°40'3" N | 16°35'1" W - 16°49'2" W | 14:21 – 18:00 | 3:38:41 | 1004.5 | 17.3 | 110 | 1 – 57 | 58 – 110 |
| 16608 | 01/08/09 | 48°40'5" N - 48°37'4" N | 16°46'5" W - 16°54'8" W | 19:10 – 22:09 | 2:59:02 | 1016.9 | 11.8 | 105 | 1 – 53 | 54 – 105 |
| 16652 | 07/08/09 | 48°55'9" N - 48°48'7" N | 16°45'8" W - 16°57'4" W | 19:39 – 23:29 | 3:49:48 | 1014.6 | 19.5 | 108 | 1 – 57 | 57 – 108 |
| 16661 | 08/08/09 | 48°55'0" N - 48°48'5" N | 16°47'0" W - 16°58'7" N | 14:04 – 17:48 | 3:44:19 | 1012.0 | 18.7 | 108 | 1 – 54 | 55 – 108 |

*3. Giering net*

To verify the estimates of the zooplankton carbon demand that have been calculated on the base of the ARIES samples, the feeding rate of the mesozooplankton species that were most dominant at the sample site was measured using bottle incubations.

*3.1 Seawater*

Seawater for the incubations was sampled from the Chorophyll α maximum depth directly before or after the animal's collection with 20 L Niskin bottles mounted on a 24-position rosette (Table 49). Salinity, temperature, and fluorescence were recorded at each station using a Sea-Bird CTD and the fluorescence data was used to estimate the Chl max depth. The seawater was filtered through a 200 µm mesh to remove smaller zooplankton and eggs, and siphoned with silicone tubing into 2.2 L glass incubation bottles. The water was carefully mixed throughout the filling process and filled little by little randomly into the bottles to provide homogeneity. Three replicates of 150 mL incubation water were preserved with 10 % of acidic Lugol's iodine as initial control. Six replicates of 1-2 L were filtered onto pre-combusted (450-500 °C, overnight) glass-fibre grade F (GF/G) filters (0.7 µm nominal pore size), and three replicates of 20 mL incubation water were frozen for biochemical analysis.

*3.2 Animals*

Animals were collected using a 200 µm WP2 net at night time from a depth of approximately 50m. Nets were deployed, veered until required depth, and hauled at approximately 1.5-2 m $min^{-1}$. Nets were rinsed with non-toxic seawater prior to unscrewing the cod-end. The cod-end was carefully emptied into a bucket filled with non-toxic seawater, rinsed and emptied again to retrieve remaining animals. Samples were diluted further to reduce zooplankton density. Animals were picked immediately or stored in a temperature controlled room at *in situ* temperature (SST) until further handling, however no longer than 12 h. After use, the net was washed thoroughly with hot freshwater, and hung to dry.

The selected animals were carefully transferred into the incubation bottles. Three control bottles were set up containing water only. All bottles were placed onto a temperature-controlled plankton wheel at *in situ* temperature (SST) and kept at ambient photoperiodic light. After 24 h, the animals were filtered out of the water and preserved in buffered formaldehyde solution (4%) for later identification. 150 mL of the incubation water was filled into medicine bottles containing 3 mL of acidified Lugol's iodine.

*3.3 Estimation of feeding rates*

The microplankton in the preserved incubation water samples will be analysed. Cells are identified and enumerated. The cell volume is determined, corrected for shrinkage induced by the preservation with Lugol's iodine, and converted to carbon (Strathmann 1967, Ohman & Runge 1994). Clearance and ingestion rates are determined, and feeding preferences are examined.

*3.4 Samples*

Nets were deployed at twelve stations and eight feeding experiments were carried out (Table 50). A total of 113 water samples were taken, five sets of pre-experimental animals were picked, 56 L water have been filtered onto 48 GF/G filter and frozen at -70°C, and eight sets of water samples (3 x 20 mL) were stored at -70°C.

Additional four stations were sampled for zooplankton community analysis (Table 4). Samples were taken from 45 m, 85 m and 135 m depth and split. One sub-sample was frozen for fatty acid analysis and one preserved in formaldehyde solution (4%) for identification and quantification purposes. Furthermore, four samples of the most abundant species at station 16617 were picked and frozen for fatty acid analysis.

*Table 49. CTD casts collecting water for feeding experiments*

| Station | Date | Position | | Cast | On deck (hh:mm) | Depth (m) |
|---|---|---|---|---|---|---|
| 16501 | 17/07/09 | 48°49'6" N | 16°35'2" W | 006 | 04:04 | 25 |
| 16510 | 19/07/09 | 48°59'9" N | 16°30'6" W | 007 | 05:59 | 25 |
| 16524 | 21/07/09 | 48°43'6" N | 17°10'9" W | 010 | 03:55 | 25 |
| 16535 | 22/07/09 | 49°04'3" N | 16°55'0" W | 017 | 06:44 | 25 |
| 16554 | 24/07/09 | 48°44'2" N | 16°21'3" W | 032 | 07:36 | 25 |
| 16564 | 25/07/09 | 49°27'8" N | 15°47'8" W | 040 | 07:23 | 25 |
| 16580 | 29/07/09 | 48°59'0" N | 16°52'6" W | 043 | 02:15 | 22 |
| 16597 | 31/07/09 | 48°44'7" N | 16°31'7" W | 048 | 23:51 | 29 |
| 16618 | 03/08/09 | 49°00'2" N | 16°25'6" W | 053 | 04:10 | 25 |
| 16659 | 08/08/09 | 48°47'4" N | 16°59'8" W | 068 | 10:08 | 25 |

*Table 50. WP2 net deployments for life samples*

| Station | Date | Position | | Time (hh:mm) | Depth (m) | Exp. | Date | Spp. (replicates) |
|---|---|---|---|---|---|---|---|---|
| 16480/1 | 14/07/09 | 49°01'8" N | 16°29'3" W | 09:30 – 10:04 | 100 | * | * | * |
| 16492 | 15/07/09 | 49°03'8" N | 16°33'2" W | 08:42 – 09:31 | 100 | * | * | * |
| 16500 | 17/07/09 | 48°49'6" N | 16°31'7" W | 23:53 – 00:26 | 50 | 1 | 17-18/07/09 | *Parapseudocalanus* (3), *Arcatia* (3), *Metridia* (3) |
| 16511 | 19/07/09 | 48°59'1" N | 16°30'6" W | 06:45 – 07:38 | 80 | 2 | 19-20/07/09 | *Parapseudocalanus* (3), *Arcatia* (3), *Metridia* (?) (3) |
| 16525 | 21/07/09 | 48°43'5" N | 17°11'0" W | 05:25 – 05:55 | 75 | 3 | 21-22/07/09 | Mixed spp., ≥500 µm (3) |
| 16534 | 22/07/09 | 49°14'0" N | 16°53'8" W | 04:10 – 04:25 | 75 | 4 | 22-23/07/09 | Mixed spp. (3,3) Influence of incubation water filter mesh size. |
| 16553 | 24/07/09 | 48°54'8" N | 16°21'5" W | 04:33 – 04:50 | 50 | 5 | 24-25/07/09 | Diff zooplankton spp. (1,1,4,2) |
| 16563 | 25/07/09 | 49°27'6" N | 16°03'9" W | 04:30 – 04:50 | 40 | * | * | * |
| 16581 | 29/07/09 | 48°58'9" N | 16°53'2" W | 03:06 – 03:29 | 40 | 6 | 29-30/07/09 | *Calanus* (1), *Arcatia* (5), *Metridia* (3) |
| 16596 | 31/07/09 | 48°45'9" N | 16°30'9" W | 21:58 – 22:12 | 60 | * | * | * |
| 16617 | 03/08/09 | 49°01'8" N | 16°25'8" W | 02:10 – 02:38 | 50 | 7 | 03-04/08/09 | *Parapseudocalanus* (3), *Arcatia* (5), *Calanus* (1) |
| 16656 | 08/08/09 | 48°47'9" N | 16°59'4" W | 04:37 – 05:03 | 50 | 8 | 08-09/08/09 | |

*Table 51. WP2 net deployments for community analysis*

| Station | Date | Position | | Time (hh:mm) | Depths (m) | | |
|---|---|---|---|---|---|---|---|
| 16596 | 31/07/09 | 48°45'9" N | 16°30'9" W | 22:05 – 22:25 | 45 | 85 | 135 |
| 16600-2 | 01/08/09 | 48°44'0" N | 16°32'4" W | 05:25 – 05:42 | 45 | 85 | 135 |
| 16617 | 03/08/09 | 49°01'8" N | 16°25'8" W | 01:32 – 02:10 | 45 | 85 | 135 |
| 16647 | 07/08/09 | 49°02'0" N | 16°29'8" W | 03:09 – 03:51 | 45 | 85 | 135 |

*4. References*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PELAGRA – neutrally buoyant sediment traps (scientific)

*Chris Marsay (NOCS)*

One of the main aims of cruise D341 was to measure the downward flux of carbon and other elements, with PELAGRA providing one of the tools for achieving this aim. It was hoped that from each deployment, measurements could be made of particulate organic and inorganic carbon in sinking material collected at each of the target depths, along with biogenic silica and trace metal concentrations.

*1. Brine preparation and other considerations*

Due to the desire for trace metal information from the sinking particulate material, precautions needed to be taken to minimise contamination of the sample pots both before and after deployment. To minimise the in situ concentrations of metals within the sample pots, the preparation of the poisoned brine involved partially freezing filtered seawater from 400m depth (collected in water >1000m deep) for several hours, then collecting the high salinity liquid fraction as the ice began to melt. MilliQ water was then added to the brine to reach a salinity of 40.5‰.

In addition chloroform, rather than the more commonly used formaldehyde, was chosen as a poison for the brine as it provided a cleaner option in terms of the trace metal concentrations. It was initially added to give a 0.5% (and therefore saturated) solution of chloroform, although on deployments 2-4 each sample pot had a further 1mL of chloroform added. This was done to maintain poison levels within the pot as diffusion to the overlying seawater gradually reduced the concentration.

Other precautions taken to reduce contamination included attaching and removing the sample pots immediately prior to and after deployment and otherwise keeping them capped when not in the trace metal van; all sample processing was carried out in the trace metal van, which has a filtered air supply. The use of chloroform as a poison meant that it was not possible to use the usual polycarbonate sample cups, as these are rapidly degraded by chloroform, and so polypropylene cups were used. Unfortunately, during the second deployment, five of the cups used (one on each trap; for particle sinking rate measurements) were polycarbonate and upon recovery the samples were partially lost through leakage out of the base of the cup.

As PELAGRA was not designed for trace metal work there is a slight potential for sample contamination, although modifications made to the design and setup were carried out to reduce this risk. Nevertheless, it was decided to run some process blanks to check for trace metal contamination of the sample pots. For the blanks, carried out during the first deployment, one cup filled with the same poisoned brine was programmed to remain closed for the duration of the deployment. Blanks were run on P2, P4 and P6.

*2. Sample treatment for core measurements*

For each PELAGRA trap, two of the four sample cups were typically combined to provide particulate material for the core measurements, although occasionally three of the cups were combined. Before combining, a photo was taken of the sample pots from each trap and their contents (see Figure 43). Following this, the first pot was emptied into a 4L bottle through a filter funnel topped with 350um mesh. After rinsing any remaining material out of the pot with poisoned brine (set aside before deployment), visible swimmers were then picked off the surface of the mesh and placed in a labelled glass vial. The mesh was then inverted and any remaining particulate material rinsed off into the 4L bottle. The reason for doing this is that a large proportion of the sinking flux was typically large, aggregated green-brown material which would be retained by the mesh. As this represents a significant fraction of the sinking particulate material it was desirable to keep it within the sample.

The procedure was then repeated for the second (and third, where appropriate) sample cup. Then the 4L bottle was capped with a modified cap, consisting of a length of tubing with a stopcock inline, and inverted. The other end of the tubing was connected to a motorised splitter, loaded with eight 500mL bottles, and with the splitter rotating and the 4L bottle contents kept mobile by gentle agitation, the stopcock was opened to drain the sample. In theory this would give eight splits of equal volume and composition. In practice, it was found that the sample volume typically varied by 10-20%, so split volumes were recorded.

The resulting eight splits were designated for the following analyses:

1. Trace metals – total metal content; filtered onboard
2. Trace metals – 2 step leach; filtered onboard
3. $^{234}$Th measurements – sample passed on
4. Pb/Po measurements – sample passed on
5. POC – some filtered onboard, others stored in fridge for filtration on land
6. BSi – some filtered onboard, others stored in fridge for filtration on land
7. PIC – to be filtered on land
8. spare

*Figure 43.: Example of PELAGRA pot contents*

*3. Other measurements*

Following the initial deployment (station 16483), one cup each from P5 and P7 was passed on for measurements of particle sinking rates, as described elsewhere. In all subsequent deployments cup 2 on each trap was designated for sample collection specifically for these measurements. These cups were also filled with chloroform-poisoned brine. Also, from deployment 2 onwards, cup 1 on each trap was used for collecting samples for organic chemical analyses. These cups were instead filled with either tap water or filtered seawater, and not poisoned. Further details on the organic chemical sampling are given elsewhere.

Cup 4 of PAP3 P2 was filled with non-poisoned brine to collect material for a solubilisation experiment. The idea was to study any changes in trace metal concentrations of the particulate material with time. To do this the cup contents were split eight ways and two of these splits filtered straight away. The remaining splits were kept at a temperature similar to that at the depth the sample was collected and filtered five days, twelve days and twenty days later.

Table 52 gives a summary of the measurements made from each deployment.

*4. Notes on deployments*

The first deployment, a trial run with only 48 hours of sampling time, was principally to test the performance of the traps following recent modifications (see technical report). However, the strategy of deploying two PELAGRA traps at 150m and two at 600m also offered the chance to observe any differences between traps deployed at the same depth. It was also used as an opportunity to carry out some process blanks. As noted in the technical report, P4 and P6 went over-depth early in the deployment and resurfaced, where they remained until recovery. These two samples were therefore not processed and this unfortunately removed the opportunity to compare traps deployed to the same depth.

Observations of the sample pots upon removal included the following:

- All three “blank” pots contained some visible particulate material, but considerably less than any of the sample pots
- P4 and P6 (at surface for the duration of the sampling period) pots contained several jellyfish between them, which were still alive.

- All sample pots contained particulate material consisting of fluffy green-brown aggregated material (marine snow) with varying numbers of dead swimmers of several species (see Figure 43). The presence of still-living jellyfish in P4 and P6 pots is ascribed partly to the possibility that the organisms entered the pots shortly before recovery and partly due to the chloroform being washed out of the pots due to greater wave action at the ocean surface.

The jellyfish observed in pots of P4 and P6 following deployment 1 were a common feature of deployments in the upper water column. Where jellyfish were found in the pots used for core measurements, they were removed with tweezers prior to combining pots. This unfortunately resulted in some particulate material also being lost, as it tended to stick to the jellyfish, but a record was kept of any time this was done. The third deployment had large numbers of other swimmers.

*Table 52. Summary of measurements made from PELAGRA deployments*

| PELAGRA deployment | Station | Measurements made | Notes |
|---|---|---|---|
| PAP1 P2 | 16483 | Cups 1, 2, 3 – core measurements<br>Cup 4 – process blank | Jellyfish |
| PAP1 P4 | 16483 | Cups 1-3 – not processed<br>Cup 4 – process blank | |
| PAP1 P5 | 16483 | Cups 1-3 – core measurements<br>Cup 4 - particle sinking measurements | |
| PAP1 P6 | 16483 | Cups 1-3 – not processed<br>Cup 4 – process blank | |
| PAP1 P7 | 16483 | Cups 1-3 – core measurements<br>Cup 4 – particle sinking measurements | |
| PAP2 P2 | 16515 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | Cup 2 partially dissolved by chloroform. |
| PAP2 P4 | 16516 | Not processed | |
| PAP2 P5 | 16517 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | Cup 2 partially dissolved by chloroform.<br>Jellyfish in pot 1 |
| PAP2 P6 | 16518 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | Cup 2 partially dissolved by chloroform. |
| PAP2 P7 | 16519 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | Cup 2 partially dissolved by chloroform. |
| PAP3 P2 | 16574 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cup 3 – core measurements<br>Cup 4 – solubilisation experiment | Jellyfish in pots 1 & 2.<br>Active swimmers in pot 4 |
| PAP3 P4 | 16575 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | |
| PAP3 P5 | 16576 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | Some active swimmers |
| PAP3 P6 | 16577 | Not processed | |
| PAP3 P7 | 16578 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | Large numbers of dead swimmers |
| PAP4 P2 | 16622 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | |
| PAP4 P4 | 16623 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | |
| PAP4 P5 | 16624 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | |
| PAP4 P6 | 16625 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | |
| PAP4 P7 | 16626 | Cup 1 – organic chemistry<br>Cup 2 – particle sinking measurements<br>Cups 3&4 – core measurements | |

For the second and later deployments, all five PELAGRA traps were deployed at different depths. The target depths were: P2 – 50m, P4 – 150m, P5 – 300m, P6 – 450m, P7 – 600m. Although the target depths were not always reached (see technical report) samples were still processed except where the trap had been floating at the surface during collection (PAP1 P4 & P6, PAP3 P6).

Mooring Sensors

*Thanos Grytzkalis-Papadopoulos (NOCS)*

*1. This section describes NOC sensor operations on the DOMS and the IODA6000 mooring. The objectives were as follows*

1. Recover the Deep Ocean Mooring System (DOMS) which has a frame equipped with instruments for monitoring of biogeochemical and physical properties. The sensors frame was deployed during cruise JC34T on 23/05/09. The instruments on the sensors frame were:
    a. Aandera Seaguard unit (219) equipped with a current meter (RCM), oxygen optode (4330) and a Cyclops fluorometer (2100990)
    b. ProOceanus $CO_2$ analyser(29-097-45)
    c. ProOceanus gas tension device GTD (29-099-15)
    d. ISUS nitrate sensor (59)
    e. NAS 3x nitrate analyzer (2672)
    f. Seabird Microcat CTD (4465)
    g. Wetlabs FLNTU fluorometer (269)
    h. Southampton Continuous Autonomous Water Sampler (SCAWS-Osmo Sampler)
    i. Control, telecommunication and data storage hub (NOCS made)

    The frame was deployed at 30m. A set of Microcat CTD and SCAWS was deployed at 100m and 1000m (microcat 4460 at 100m; microcat 3889 at 1000m).
2. Redeploy DOMS and include more sensors on the real time system.
3. Recover sediment traps (PAP3) mooring that is operating since 3/10/08.
4. Deploy sediment traps (PAP3).
5. Deploy/test McLane zooplankton sampler (ZPS) on a subsurface mooring line that will be deployed at the beginning of the cruise and recovered sometime near the end of the cruise. The mooring line will mainly support the in-situ oxygen dynamic autosampler ($IODA_{6000}$ – Marseille group).

*2. Deployment of the ZPS on the $IODA_{6000}$ subsurface mooring*

The $IODA_{6000}$ subsurface mooring was deployed on 15/7/09. The ZPS was scheduled to collect samples every 12 hours (1$^{st}$ sample 00:00:00 at 16/07/09). As a preservative, for the samples, a 5% buffered formalin-seawater solution was used (solution: 19 l of seawater were collected from 4,800 m, saturated with 100 g NaCl and 1 l of formalin buffered with borax was added). The ZPS was positioned below the first IODA instrument pack (IODA – Current meter – Seabird Microcat CTD SBE37 MP) aiming for a deployment depth between 40 and 50m (technical details of the mooring can be found on Terry Edward's mooring reports).

Deployment was successful and anchor was released at 17:00. However at 19:00 mooring floatation spheres were seen on the sea surface and the mooring was recovered. Examination indicated a corroded KEVLAR line connection. All instruments were recovered successfully apart from the acoustic release and 700m of parafill line (more details on Terry Edward's mooring report). None of the instruments recorded or sampled any data as they were programmed to start later than their recovery time.

After modifications the mooring was successfully redeployed on the 19/07/09. The ZPS was programmed in the same way (2 samples/d every 12 hours, 1$^{st}$ sample 20$^{th}$ July 00:00:00 and a maximum of 50 samples)

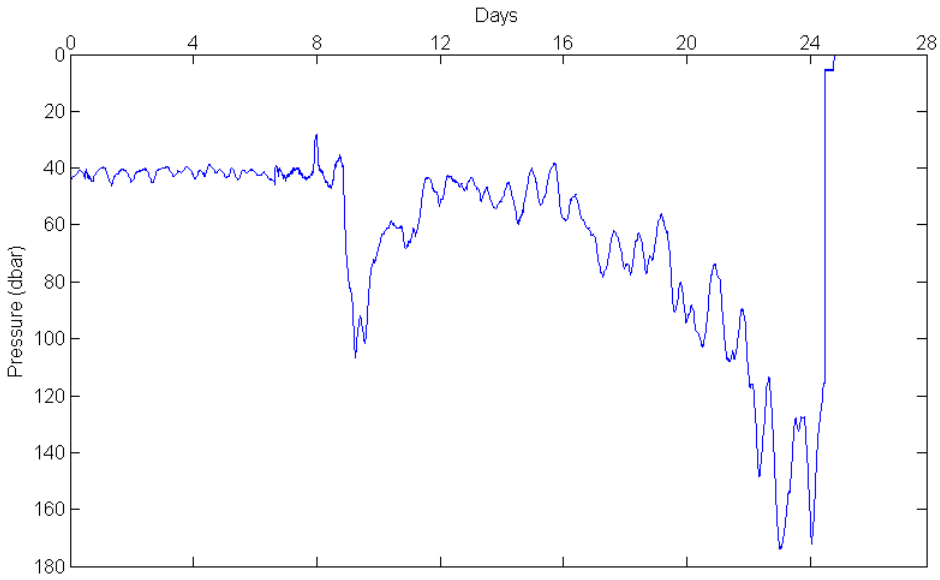
Anchor position: 49º 01.875N, 16º 29.360W;
Depth: 4836 (corrected).

*3. Recovery of the ZPS*

The ZPS and the IODA mooring were recovered on 07/08/09. The ZPS was on board at 13:45 p.m. It has operated according to its schedule collecting 38 samples in total. There were no indications of biofouling on any of the sampler's parts. Preservative was still left in the samples collection chamber as it was evident from the formalin smell. After recovery the preservative solution (5% formalin in seawater) was collected in a blood bag and the sampling mesh was recovered on one spool and stored in a container with 5% formalin. The mesh was kept under tension with a cable tie. The blood

bag and the samples container were stored at 4 $^0$C. The ZPS depth during deployment is presented in figure 44.

*Figure 44: ZPS deployment depth during D341*




*4. Sediment traps subsurface moorings – PAP3*

The PAP3 sediment traps mooring was deployed on 18/07/09. The sediment trap bottles were filled with 5% buffered formalin seawater one day before deployment. The deployment depths were as follows:

Trap LVII-A (S.Nr. 12432-05) and current meter RCM8 at 3000 m
Trap LVII-B (S. Nr. 12432-04) at 3000 m
Trap LVII-C (S. Nr. 12432-06) and current meter RCM8 at 100 m above sea bed.

Detailed sampling schedules of the sediment traps are on file D341 Sediment traps deployment schedule.xls. The current meters were set to record data every hour.

The deployment details are:

Latitude: 48$^0$ 59.59' N
Longitude: 16$^0$ 29.21'W
Depth : 4810m (u); 4844 m (c).

*5. PAP3 Recovery*

PAP3 (LIV deployment) mooring was recovered on 29/07/09. The mooring was released at 14:58 pm and the last sediment trap was on board at 17:46 pm.

The sediment traps were:

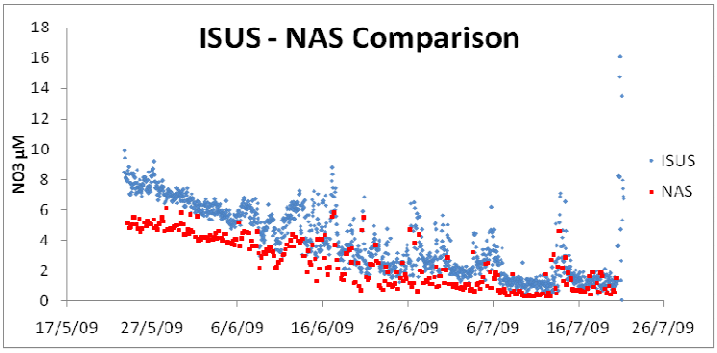
Trap LIV-A (S.Nr. 12168-01) and current meter RCM11 at 3000 m
Trap LIV-B (S. Nr. 11262-03) at 3000 m
Trap LIV-C (S. Nr. 11262-04) and current meter RCM11 at 100 m above sea bed.

All sediment traps worked according to their schedule. The carousel was at position 21 in all traps (still sampling). All sampling bottles were recovered, pH was measured and 1 ml of buffered formalin was added. Samples were stored at 4 $^0$C. The recovery files and sampling schedules were successfully downloaded from all three sediment traps.

*6. DOMS*

The DOMS was recovered on 20/07/09. Details on the condition of the buoy are on Terry Edwards 'DOMS recovery report'. The sensors frame and all the instruments on the mooring were in good condition. The only instruments that did not operate were the proOceanus $CO_2$ sensor and the proOceanus GTD sensor. All other instruments performed as expected. Data were downloaded successfully from all sensors. The sampling tubes from the three SCAWS samplers were sealed, frozen with liquid nitrogen and stored at the -70 $^0$C freezer. Further treatment of the samples and chemical analysis for nutrients will be performed in NOCS. Comparison between the ISUS $NO_3$ sensor and the NAS $NO_3$ analyzer is shown in figure 45.

*Figure 45. Comparison between ISUS-NAS at the PAP site (May - July 09)*




Comparisons between the Wetlabs FLNTU fluorometer and the Cyclops fluorometer are presented in figures 46 and 47.

*Figure 46: FLNTU - Wetlabs comparison during (May - July 09)*

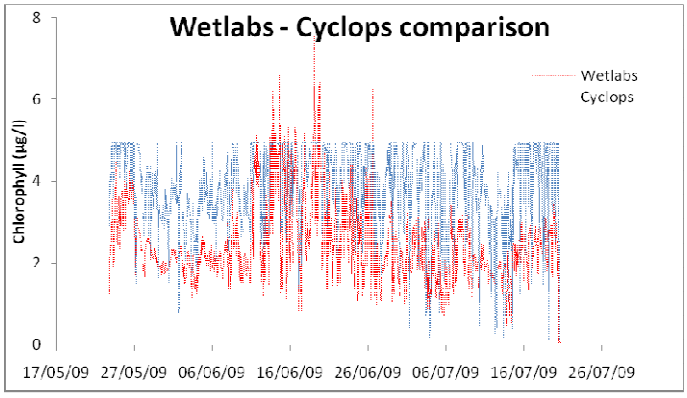
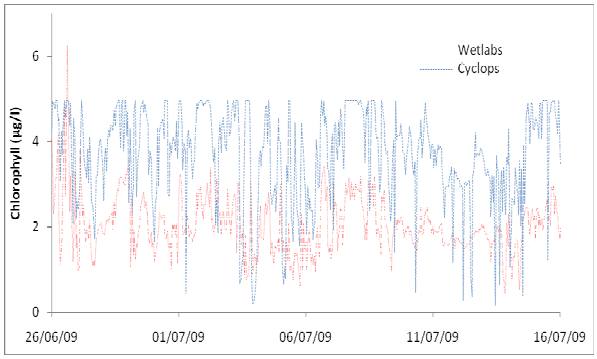
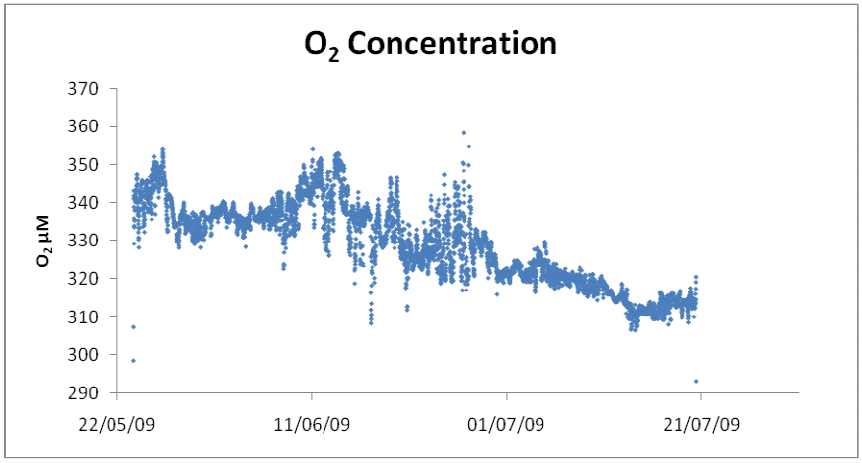



*Figure 47: Comparison between 26-06-09 and 16-07-09 where details are more evident*




Oxygen concentration variations (uncorrected for salinity and depth) during the DOMS trials deployment from the Aandera 4330 optode (Seaguard unit) are presented in figure 48.

*Figure 48: Oxygen concentration (uncorrected) at the PAP site (May-July 09).*




A post deployment calibration for ISUS 59, Wetlabs FLNTU (269) and the Seaguard 219 unit was performed on 8/8/09 (Station 16662). Analysis of the data and comparison will be performed in NOCS. Another CTD calibration cast (16555) was performed for the three Seabird Microcat CTD units.

*7. Deployment*

The DOMS was not redeployed due to serious technical issues that compromise the viability of the whole mooring structure in such hostile environment. More technical details on this matter can be found on Terry Edward's preliminary report for DOMS recovery and on Terry Edward's cruise report. However a calibration CTD cast (16568) was performed for the ISUS 60 unit, the wetlabs 238 FLNTU and the seaguard 217 unit. Results from some of the sensors are presented on figures 49 and 50.

*Figure 49. ISUS 60 calibration profile*

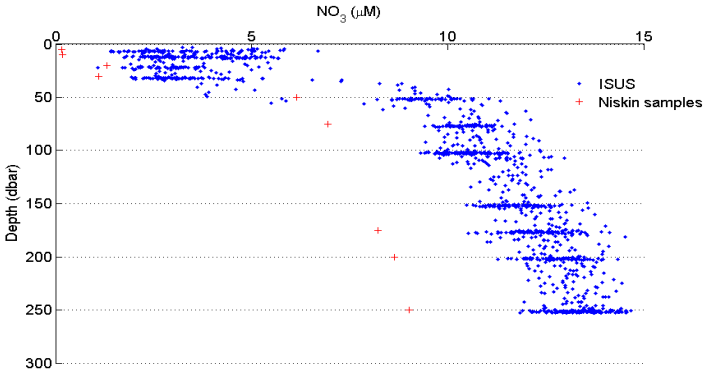
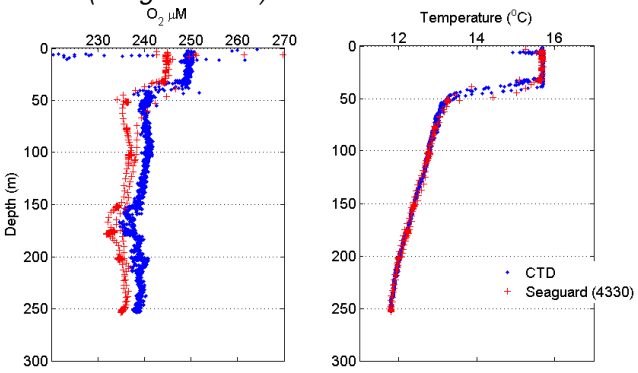



*Figure 50. Oxygen optode 4330 (seaguard 217) calibration cast*



Titanium CTD cast

*Peter Statham and Chris Marsay (NOCS)*

Dissolved Fe information is needed to complement the SAPS particle samples to allow the calculation of mixed layer inventories of Fe. Once particulate Fe fluxes have been calculated from the trace metal and Th-234 SAPS, this data can be used with the Fe inventories to calculate residence times of Fe in the mixed layer.

In order to provide dissolved Fe samples, a CTD cast was done using the titanium CTD fitted with 24 X 10L OTE bottles that have been modified for trace metal work. Modifications include use of epoxy coated external springs, coating of stainless ferrules, and fitting of PTFE taps. Samples were taken at depths from 4000m to the surface, with the emphasis on upper water column where the emphasis of the current study lies. Important depths sampled correspond to the depths of PELAGRA and SAPS deployments. Sample bottles were removed from the rosette and taken into the clean van, where samples were pressure filtered (nitrogen at about 0.5 bar) through a Sartobran 0.2µm filter cartridge. Additional samples were collected for nutrients and 5 salinity samples were also collected. Details of the sampling location and time are given in the following table:

*Table 53. Details of Titanium CTD deployment*

| Date | Lat | Long | Water depth | Stn. Number |
|---|---|---|---|---|
| 09 Aug. 2009 | 49º 01.778' | 16º 29.232' | 4810 m | 16665 |

Back in the laboratory at Southampton, dissolved Fe and other trace metals will be determined.

Trace-metal deployments of SAPS

*Chris Marsay (NOCS)*

SAPS for trace metal analysis were deployed on seven occasions - stations #'s 16487, 16502, 16584, 16594, 16621, 16637 & 16638 (one immediately after the other) and 16657. At each station, the aim was to deploy one SAPS just below the mixed layer and a second one hundred metres deeper. Where possible, a third was deployed within the mixed layer.

Some stations were shared with thorium SAPS, in which case two SAPS would be deployed at some of the depths (one for trace metals, one for carbon/thorium); others were devoted solely to trace metal sampling. The final three station numbers were carried out using a braided line, whereas all other deployments used the coring wire. Deployments are summarised in table 54.

Where possible, two size fractions were collected at each depth: >53 μm on a Nitex mesh and >1μm on a Sterlitech polycarbonate membrane. However, due to a limited number of 2nd filter inserts it was occasionally necessary to only load one filter in each holder. On these occasions, a 53μm filter was used for deployments below the mixed layer or a 1μm filter was used for mixed layer deployments.

Upon recovery of each SAPS, filters were immediately removed from their holders, folded, bagged and labelled. They were then transferred to the -20°C freezer for further processing and analysis back on land.

*Table 54. Trace metal SAPS deployments*

| Date | Time | Station # | Latitude | Longitude | Depths | Filters used | Pumping time |
|---|---|---|---|---|---|---|---|
| 14th July 2009 | 21:20 | 16487 | 49 01.8N | 16 29.1W | 25m<br>60m<br>160m | 1□m<br>53□m, 1□m<br>53□m | 120mins |
| 17th July 2009 | 05:22 | 16502 | 48 50.2N | 16 35.8W | 25m<br>50m<br>150m | 1□m<br>53□m, 1□m<br>53□m, 1□m | 120mins |
| 29th July 2009 | 08:58 | 16584 | 48 59.0N | 16 56.3W | 25m<br>50m<br>150m | 1□m<br>53□m, 1□m<br>53□m | 120mins |
| 31st July 2009 | 15:27 | 16594 | 48 49.0N | 16 30.4W | 60m<br>150m | 53□m<br>53□m, 1□m | 120mins |
| 3rd August 2009 | 08:09 | 16621 | 48 57.9N | 16 24.5W | 70m<br>150m | 53□m, 1□m<br>53□m, 1□m | 120mins |
| 6th August 2009 | 08:48 | 16637 | 49 01.5N | 16 28.0W | 150m | 53□m, 1□m | 90mins |
| 6th August 2009 | 11:10 | 16638 | 48 59.8N | 16 27.7W | 60m | 53□m, 1□m | 90mins |
| 8th August 2009 | 05:17 | 16657 | 48 47.9N | 16 59.3W | 25m | 53□m, 1□m | 60mins |

Oxygen consumption and evolution

*Dominique Lefèvre & Anne Robert (*LMGEM)

*1. Objectives*

The objective of the work was to measure biological fluxes of oxygen throughout the water column. Dissolved oxygen was determined via the Winkler method with a photometric detection of endpoint value (Williams & Jenkinson, 1982). In situ oxygen consumption and evolution rates were determined using the $IODA_{6000}$ (In situ Oxygen Dynamics Autosampler) autosampler developed by the LMGEM in collaboration with the CPPM (Centre de Physique des Particules de Marseille). Electron Transport System (ETS) Enzymatic determination of bacterial respiration was determined by measurement of Electron Transport System (ETS) with spectrophotometric determination (Packard, 1971).

*2. Sampling strategy*

1743 oxygen samples were analysed during the cruise. A daily calibration of the thiosulfate was performed and cross calibration was performed using reference standard $KIO_3$ (Osil, Iodate standard) at the beginning and end of the cruise, 75 ETS samples for 6 vertical profiles up to 2000m depth were collected. A mooring including 5 $IODA_{6000}$, 4 MicroCAT and 3 Aquadopp was deployed over 20 days

Vertical profiles of net community production were undertaken at 6 depths corresponding to 55%, 33%, 14%, 7%, 3% and 1% of surface PAR at 8 stations (D16524, 16533, 16543, 16552, 16567, 16580, 16635, 16655) for deck incubation and 8 depths (55%, 33%, 20%, 15%, 7%, 3%, 1% and 0.1% of PAR) at 3 stations (D16488, 16501 and 16597) for incubation on a drifter mooring line. The Vertical distribution of dissolved $O_2$ was measured at 23 stations to calibrate the SBE 43 sensor and to characterise the environment of the fixed moorings (i.e. PAP3, French mooring line)

Microbial respiration rates in euphotic layer was measured at 2 stations using seawater filtered at 0.6µm using an inverse filtration system.

Microbial respiration rates in meso and bathypelagic layers were measured at 4 depths (150, 500, 1000m and 2000 m) at 8 stations (16488, 16489, 16591, 16619 and 16659).

Vertical ETS profiles were carried out, with 13 depths sampled between 5 m and 2000m.

*3. Analysis and post-cruise processing, time required for full processing/analysis.*

Oxygen analysies were performed on board, Validated data will be made available at the end of2009. ETS samples are stored in liquid nitrogen and should be analysed in 2010. Validated data will be made available at the end 2010, $IODA_{6000}$, CTD-Seabird-microcat® and Current-meter-Aquadopp® data will be processed for mid 2010.

*3. Error and accuracy*

Accuracy of dissolved oxygen concentration determination for vertical profiles: 0.05 µmol $dm^{-3}$
Accuracy of the biological fluxes of dissolved oxygen by Winkler method : 0.2 µmol $O_2$ $dm^{-3}$ $d^{-1}$
Accuracy of the biological fluxes of dissolved oxygen using the $IODA_{6000}$ 0.4 µmol $O_2$ $dm^{-3}$ $d^{-1}$ (unpublished data)
Accuracy of ETS activity (0.001 µmol $O_2$ $dm^{-3}$ $h^{-1}$, Lefevre et al., 1996).

*4. References*

WILLIAMS P.J. LEB. & N.W. JENKINSON (1982). A transportable microprocessor-controlled precise Winkler titration suitable for field station and shipboard use. Limnol. Oceanogr. 27, 576-585.
Packard, T.T., 1971. The measurement of respiratory electron-electron-transport activity in marine phytoplankton. J. Mar.Res., 29: 235-244.
Lefèvre, D., M. Denis, C.E. Lambert, J.-C. Miquel, 1996. Is DOC the main source of organic matter remineralisation in the ocean water column? 'Journal of Marine Systems 7 (1996) 281-291