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Cruise Report No. 22

RRS *James Cook* Cruise 71

29 APR – 12 MAY 2012

Porcupine Abyssal Plain: sustained ocean observation

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2013

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ABSTRACT

The objective of the PAP observatory is to provide high temporal resolution (hours) of an increasing number of variables which are relevant from the perspective of the biology, physics and chemistry of the upper water column, the midwater and the underlying seabed. These observations are made over a relatively small spatial scale (30km) in the open ocean over a very flat area of seabed at a depth of 4800m. The site has been under examination for over 20 years and during that time, substantial changes have been observed in the benthic environment. The intention is to sustain and enhance all of these observations in order that a deeper understanding is obtained into the processes which operate; in particular the responses to the changes which are currently taking place in the global environment.

The objective of the cruise was primarily to service the infrastructure required for continuous sustained observation, and to put these into context using observations from the ship which as yet cannot be carried out autonomously. The observatory comprises three autonomous platforms; (1) A moored meteorological buoy beneath which, at 30m depth, is a sensor frame carrying a wide range of sensors and samplers, (2) a sediment trap mooring with traps and current meters at 3000 and 4700m depth and (3) a Bathysnap benthic time lapse camera system. All of these were recovered and new or serviced platforms deployed for recovery after 12 months. The large amount of data are placed in the public domain as soon as quality checks have been completed. In addition to this various types of biological and biogeochemical sampling and experimentation was carried out in the water column and on the seafloor in their own right and to add value to the autonomous time series observations.

KEYWORDS

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8	MURREN	MICHAEL GERARD	3/E
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10	LUCAS	PAUL DERRICK	PCO
11	SMITH	STEPHEN JOHN	CPOS
12	LUCKHURST	KEVIN RAY	CPOD
13	ALLISON	PHILIP	POD
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22	PIPER	CARL	A/Stwd

1 Itinerary

In spite of some strong storms threatening to delay arrival, RRS *James Cook* slipped her moorings at Avonmouth only a few hours late at 1230h on 29th April for the start of a highly successful cruise to the sustained long term observatory over the Porcupine Abyssal Plain (PAP) (Fig.1). The remains of the storm provided some uncomfortable passage at the start, this soon abated however, and although we were somewhat constrained in the work we could do on arrival at PAP, hardly any time was lost to bad weather until the last few hours on site on 8th May.

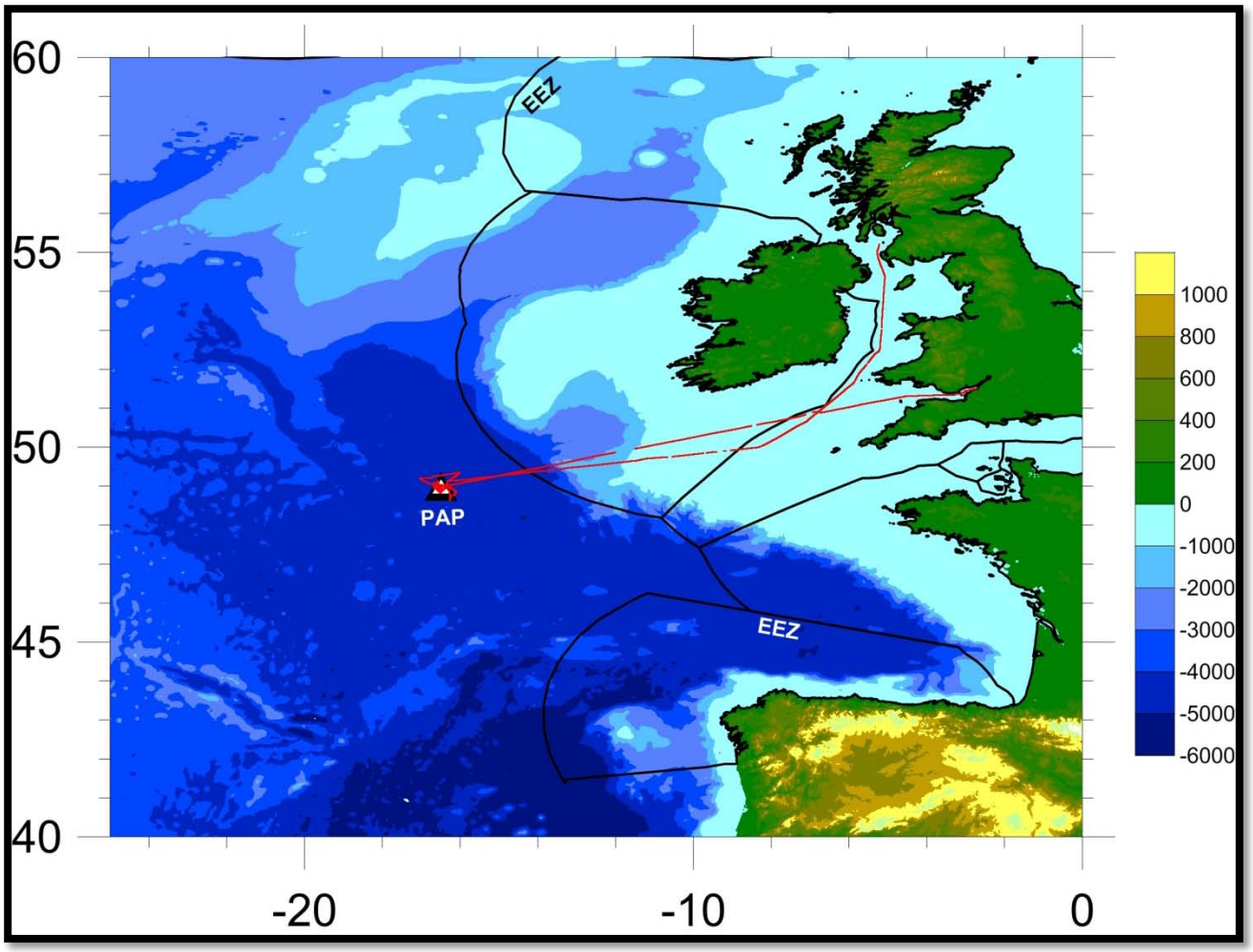


Fig. 1 Cruise Track (red) and Exclusive Economic Zone Boundaries (black).

2 Background & Objectives

The oceanic water column and the underlying seabed change on a variety of temporal and spatial scales. The objective of the PAP observatory is to provide high temporal resolution (hours) of an increasing number of variables which are relevant from the perspective of the biology, physics and chemistry over a

relatively small spatial scale (30km). The site has been under examination for over 20 years and during that time, substantial changes have been observed in the benthic environment. The intention is to sustain and enhance these observations in order that a deeper understanding is obtained into the processes which operate; in particular the responses to the changes which are currently taking place in the global environment.

The objective of the cruise was primarily to service the infrastructure required for continuous sustained observation, and to put these into context using observations from the ship which as yet cannot be carried out autonomously.

3 Infrastructure

3.1 PAP#1 Mooring (ODAS biogeochemical mooring)

Paul Provost & David Childs

From Sensors and Moorings Technical Report No. 2012

The purpose of the moorings exercise was to recover the PAP1 mooring and to redeploy an almost identical one using new or refurbished components.
The ODAS buoy, keel, chain, communications cables and sensor frame was replaced completely. All the recovered ropes were reused after inspection and measurement as no adverse wear had been observed. The only new rope to be used was to replace the lost 1000m between the release and the anchor.

3.1.1 PAP#1 Recovery

3.1.1.1 Operations Summary

The deck set-up for the ODAS buoy recovery used the following winches:

Ship fitted coring winch fed astern over the pendulum block of the aft gantry. Two Deck mounted (port and starboard) Lebus GP 5T winches with 16mm pennant wire. The winches were positioned diagonally towards the centre line aft. A Romica streamer winch with a 1.5T max put was used to wind in the mooring line.

The vessel approached the buoy stern-to and was hooked on the mast lifting lug at 13:32 on 2nd May 2012 using a 5t RH25 SeaCatch hook attached to the end of the core wire. The hook was controlled by a 5m aluminium pole which was withdrawn once the hook was attached securely. The load was taken on the wire and the buoy was lifted clear of the water and hauled up the transom of the vessel. At this point the safety rails were taken down.

Further steadying lines lead through the aft fairleads (panama leads) and wound around the vessel's mooring capstans were attached into the mast frame of the buoy. As recovery to deck commenced the steady-line winches took up the slack to prevent unwanted motion of the buoy. Before the keel of the buoy had cleared the transom the starboard line parted, there was no swing of the buoy however and it was further brought inboard.

Once the buoy was well inboard, but still remained suspended, the wires from the starboard and port deck winches was connected to the keel in the same position and hauled in to make the buoy vertical, allowing the chain to the frame to hang over the transom. The buoy was landed on deck and secured using pad eyes and ratchet straps (four off). The top of the chain, immediately below the buoy was stopped off using the port deck winch.

Using a sequence of lifts coordinated between the gantry Rexroff winches and the port deck winch, the chain suspending the instrument frame was recovered to deck and brought inboard (14:22). As the instrument frame was lifted from the water, the gantry was moved further outboard to prevent the frame (and instruments contained within) from being dragged up the transom of the vessel.

Once the instrument frame was on deck, the port deck winch was used to stop off the mooring rope allowing the pinned shackle, etc., to be broken.

The ODAS buoy and the frame were lifted clear of the aft deck to allow a pennant rope to be connected to the streamer winch for the rope recovery. The recovery of the mooring rope commenced at 15:30. Once 6 turns of mooring line were wound onto the main drum, the ship started to move forward at 0.5knts and the release was fired (15:38).

The winding in of the mooring continued and the subsurface floatation was recovered to deck at 16:45. At this point the 1271m of rope was wound off the drum and faked on the starboard deck. This was to allow the rope to be reversed, such that the top of the rope recovered first was removed and became the last part of the rope to be wound on for deployment. The streamer winch was capable of taking the 1271m rope plus three of the 1000m sections.

The remaining three 1000m sections were recovered and at each join the master link and shackle was inspected and measured. On the links, the minimum diameter measured was 34.3mm, the initial diameter had been 36mm, therefore these ropes were considered acceptable for re-use.

The release was recovered to deck at 21:18 (49^{0}00.8'N, 16^{0}20.2'W).

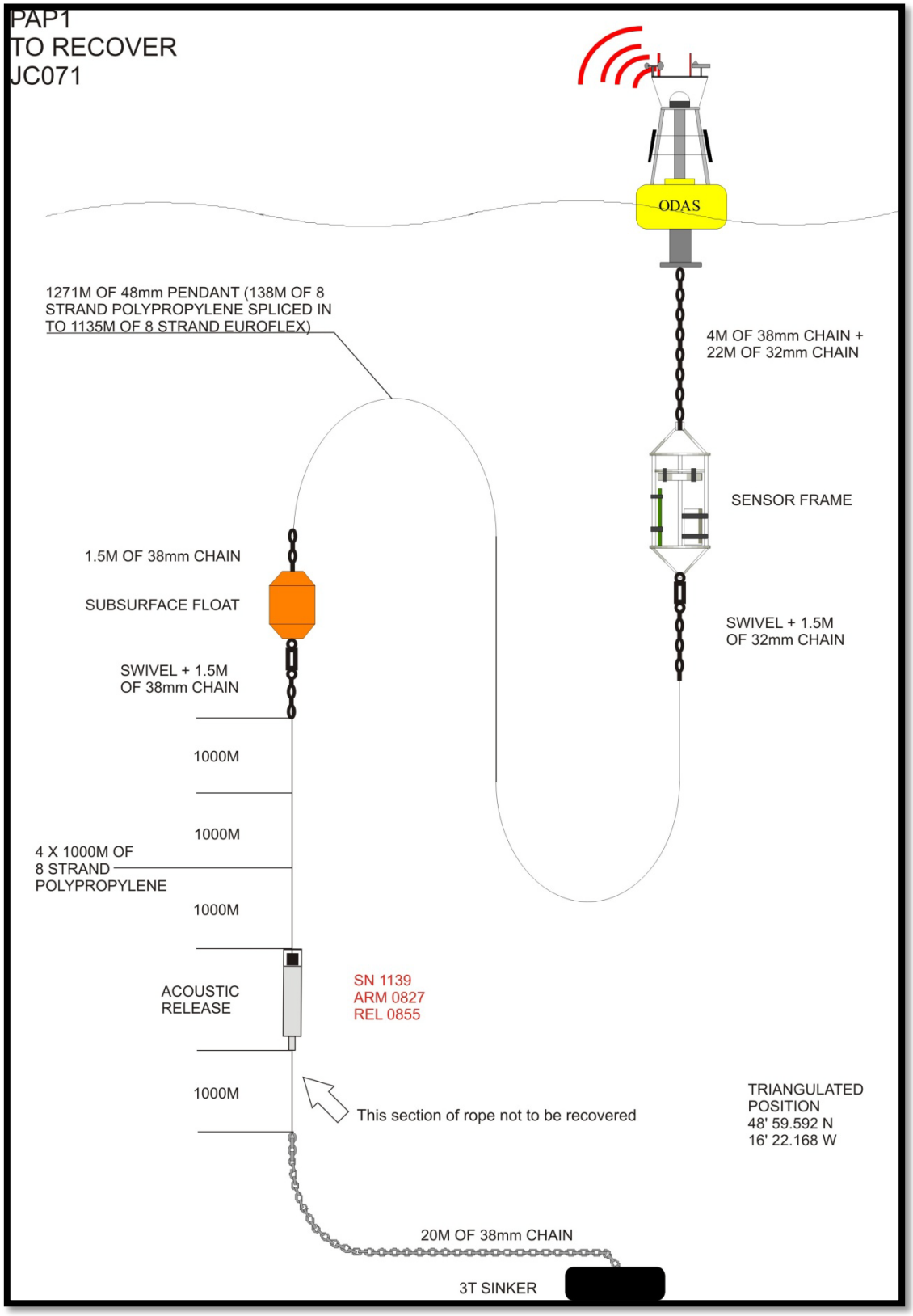


Fig.2 Diagram of recovered mooring.

3.1.1.2 Observations, Problems and Recommendations

During recovery, the use of large winches to control a load should be avoided. The control they offer is limited and the consequences of over-tensioning unpredictable. Consequently lighter, more controllable steady lines were used which afforded better control.

The recovered instrument frame was in good condition, and has been described in detail in a report produced by John Campbell from USL.

Video is available of the operation.

3.1.2 PAP#1 Deployment

3.1.2.1 Operations Summary

Prior to the commencement of deployment operations the 1271m of upper rope was wound in reverse of recovery onto the drum. The ship was positioned approximately 4.2nm away from the anchor position to allow for a sufficient run in to complete the mooring deployment.

The new buoy and sensor frame were positioned on the 'red zone' after working deck. A large SeaCatch hook (SWL 17t) was fitted to the end of the core wire and connected into the lifting eye of the buoy. The chain between the buoy and the frame was lowered over the transom in a bite hanging down, using a series of stopping off operations controlled by the two deck winches. Taking a few links at a time the chain was lowered over the transom.

Once the weight of the chain was on the keel of the buoy and the sensor frame, the buoy was lifted from the deck and floated outboard using hand controlled steadying ropes attached to the inside of the crane pedistals to prevent swing. The keel was dragged outboard by the weight of the mooring chain and this weight also prevented the keel from swinging side to side.

The gantry was luffed out and the buoy lowered into the water and released from the SeaCatch hook once afloat (16:10, 48^{0}59.3'N, 16^{0}16.2'W). The sensor frame was deployed following the release of the buoy from the starboard pedistal crane and a smaller SeaCatch release hook (16:20). The inboard (underside) weight of the frame was taken by the rope on the streamer winch and the crane payed out allowing the frame to invert and swing gently into the water. Once the load of the frame was on the mooring rope the release was activated and the mooring rope payed out with the ship moving forward

between 1 and 1.5knts. Once the top section of rope had been wound off the drum, the rope was stopped off using the deck winches. The remaining new 1000m section was wound onto the winch whilst the ship moved forward at 0.5knts. The subsurface buoyancy was connected in and deployed (17:33, $48^0$59.52'N, $16^0$17.89'W) and three further 1000m of rope was payed out. The release was inserted into the mooring (19:50) and the final 1000m of rope (which had been the top 1000m of rope under the subsurface on the previous deployment) was payed out and connected to the 20m of ground chain and 3000kg anchor.

The mooring was towed to 900m past the desired anchor position to allow for fallback. The sinker was released at 20:48 at $49^0$00.188'N, $16^0$23.189'W. After deployment the release was monitored to rest on the seabed using a TT801 deckunit. The buoy movement was monitored by the vessel's radar using target identification and the maximum speed of the buoy during sinker freefall was recorded as 2.2knts.

After triangulation the position of the release was judged to be $49^0$00.292'N, $16^0$22.580'W. The anchor fell back 765m at 75^0T.

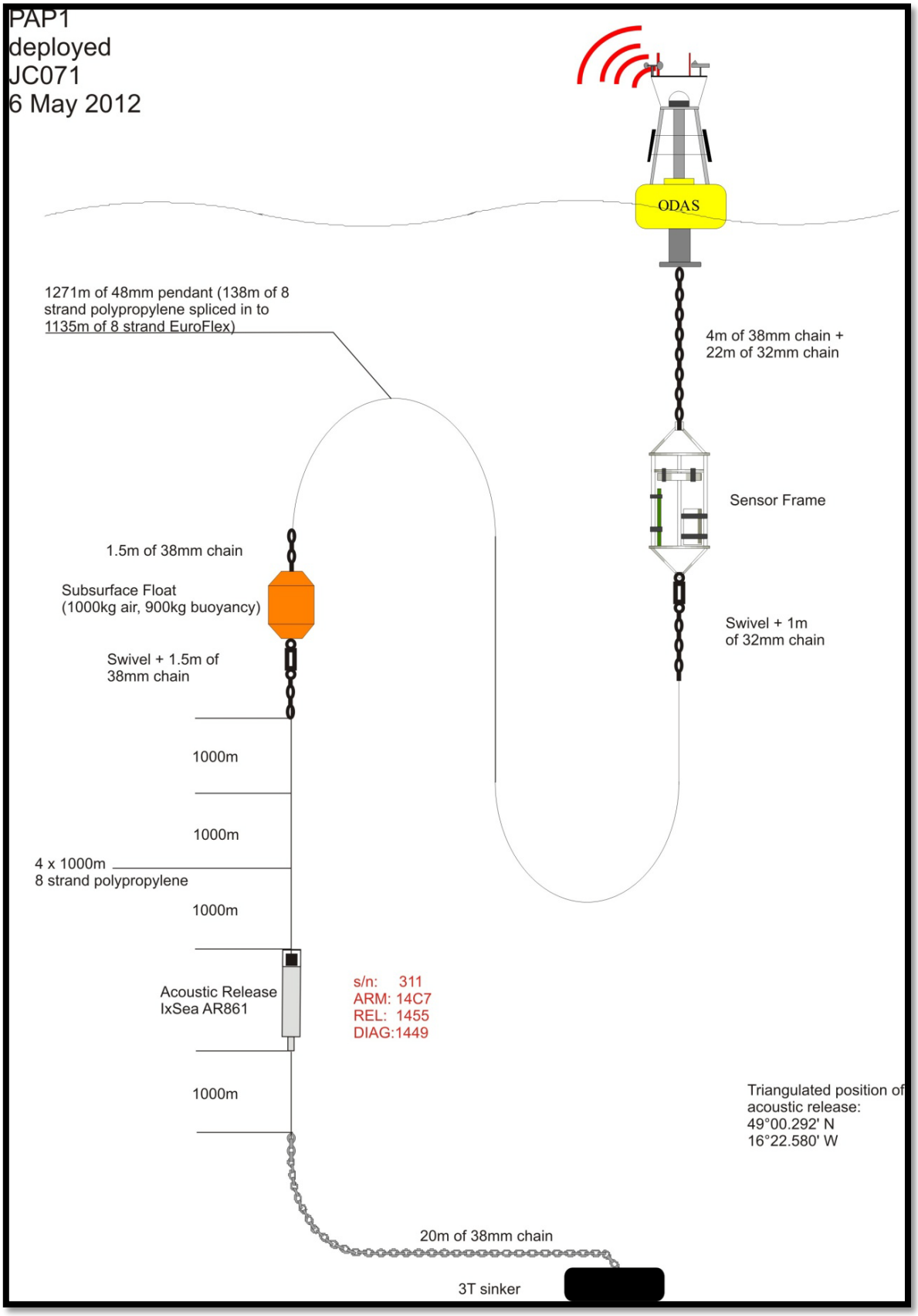


Fig. 3 Diagram of mooring deployed during cruise.

TYPE	:	**AR 861 B2S**	Date of Manufacture	:	**09#06/04**
S/N	:	**311**	Customer	:	**S.O.C.**
P/N	:	**392 9100**	Representative	:	**iXSea Ltd**
Function	:	**Acoustic Release**	Job file	:	**4P000112**
Modification	:		Customer approval	:	

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD

Reference	Rev	Function	S/N
392 2001	**3.0**	AR 8x1 board	**311**
		Firmware:	
		PROM (U6) - ET8_V2.2	
		FPGA (U38) - REC_V1.0/3.3V	
		PROM (U32) - EM_V1.0	
		FPGA (U33) - EM_V1.0/3.3V	

ELECTRONIC SPECIFICATIONS

Transmit width : **10** ms

Transmit level : **191** ± 4 dB ref 1µPa at 1 m

Pinger rate : **2** s

Pinger duration after release : **3** mn

FR0 = **09.0** kHz

FR1 = **10.5** kHz

CAF = **12.0** kHz

PINGER = **12.0** kHz

FUNCTIONAL SPECIFICATIONS

Function / Code	TT801/ TT701/ TT301	TT201	Sequence
ARM / RANGING	**14C7**	**N.A.**	⇒ CAF Lock-Out time = 4s Active time = 20s
<u>The following acoustic codes must be preceded by an ARM code</u>			
RELEASE	**1455**	**N.A.**	⇒ CAF ⇒ CAF
RELEASE WITH PINGER	**1456**	**N.A.**	⇒ CAF ⇒ CAF ⇒ PINGER
PINGER ON	**1447**	**N.A.**	⇒ CAF ⇒ PINGER
PINGER OFF	**1448**	**N.A.**	⇒ CAF
DIAGNOSTIC	**1449**	**N.A.**	⇒ CAF_1 ⇒ CAF_2

3.2 Telemetry System and Sensor Frame

Jon Campbell

The PAP telemetry system comprises a buoy telemetry electronics unit and a data concentrator hub in the sensor frame. Schematic drawings of these two units as configured for the latest deployment are shown at the end of this section.

Data are typically transmitted via the Iridium satellite system every 4 hours and are automatically displayed on the EuroSITES website: **http://www.eurosites.info/pap/data.php** Short status messages are also sent via the Iridium SBD (Short Burst Data) email system every 4 hours (typically). The SBD email system is also used to send commands to the buoy to change sampling intervals, disable/enable sensors and to vary other settings.

The buoy also houses an entirely separate system provided by the UK Met Office. This has its own Iridium telemetry system and a suite of meteorological sensors measuring wind velocity, wave spectra and atmospheric temperature, pressure and humidity. Data from these sensors are telemetered to the Met Office every hour.

3.2.1 Previous Deployment History

The system that was recovered used a Met Office K-series buoy and rope mooring that was originally deployed from the *RRS James Clark Ross* on cruise JR221 on 1st June 2010. The system was serviced aboard the *RRS Celtic Explorer* on cruise CE10005 on 19th September 2010, and again on cruise JC 062 on 29th July 2011.

Immediately after this last deployment, data were received from all sensors and this continued for the first month and a half. Table 1 (page 20) lists the sensors fitted for this deployment with salient points as follows:

a) 44 days after deployment the NAS-3X nutrient sensor stopped sending data and also stopped recording internally.
b) After 133 days the SeaBird SBE37-IMP stopped sampling though it continued to reply when interrogated. This was subsequently discovered to be caused by a low battery voltage.

c) The data from the Pro-Oceanus CO2-Pro sensor suddenly changed after 160 days, with the internal gas pressure readings showing a sudden drop. The unit continued to send data and with assistance from Pro-Oceanus it was possible to re-compute the CO2 data using the raw data and pressure readings from the GTD sensor.

d) The final and most serious problem of this deployment occurred after 211 days when the computer in the data hub began restarting, and a few days later stopped sending messages altogether. It was assumed that the most likely explanation for this would be a failure of the armoured cable connecting the hub to the buoy, but in fact it turned out that the hub had suffered water ingress.

The buoy controller and those sensors not dependent on the hub for power continued working until recovery, making this the most successful deployment to date. It is also worth noting that the buoy power supply functioned much better during this deployment, helped in part by the demise of the hub and hence the cessation of power-hungry CO_2 measurements (Fig. 6 shows a comparison of battery volts during the two deployments).

3.2.2 System Recovery and Inspection

- The Met Office buoy and NOC sensor frame were recovered on 2nd May 2012, 278 days after being serviced and redeployed on JC 062 (Figs. 4 and 5 show the buoy and frame during recovery). Due to the adverse weather conditions the top ring of the buoy mast made contact with the vessel's transom during recovery and was slightly damaged. The Satlantic radiometer sensor mounted on this ring was also dislodged but continued working even when dangling from its connecting lead.

- The buoy hull was once again fouled subject to heavy bio-fouling, but was superficially undamaged with the solar panels intact and relatively clean. The number of goose barnacles attached to the underside of the hull was far less than when the buoy was previously recovered in July 2011.

- The two armoured cables running down the chain to the sensor frame were also in good condition with no sign of damage.

- The sensor frame itself was in excellent condition with no damage, suggesting that the (much shrunken) sacrificial anodes had done a good

job. The sensors had also fared well, although the Bioshutters protecting the two radiometers appeared to have been left in the 'open' position when the hub failed, resulting in one shutter plate being lost. One of the 6 Star-Oddi miniature temperature/conductivity and pressure sensors that had been cable-tied to the chain was also lost.

- The polyurethane sheathed cable harnesses performed well with no signs of damage. The rubber cable connecting the ZebraTech wiper used to the clean the Cyclops fluorometer window to its battery pack had worn through in one point where it had chafed against a bolt. The Satlantic battery pack for the ISUS sensor was found to be loose in its clamps which had resulted in some minor damage to its casing.

- The only real casualty in the sensor frame was the data hub which was found to contain approximately a cupful of water. In attempting to find the source of the leak, attention first focussed on the O-rings but nothing conclusive was found. However, a careful examination of the penetrators revealed that in 3 out of the 9, the polyurethane moulding had separated from the stainless steel bulkhead allowing water into the cable (see Fig. 5). This in itself should not have caused a leak since the inner wires are potted into the stainless steel bulkhead. But these wires have PTFE sleeving which is difficult to bond to, and it appears that in at least one penetrator, water had crept along the outside of these wires and into the housing. The photo in Fig. 7 shows that penetrator 6 to be the likely culprit, and this was indeed the one exhibiting the worst moulding separation. The stainless steel bulkhead flanges had suffered quite bad corrosion on the faces in contact with the Delrin end caps.

3.2.3 Preparation of New Observatory

The Met Office provided a refurbished K-series buoy which they commissioned on board in Avonmouth. This had been fitted with two extra solar panels mounted behind the mast ladders, and the Met Office's new Axys Watchman data logger and telemetry system. The only other change was the addition of a SeaBird MicroCAT attached to the buoy keel and accessible through the inductive telemetry system.

The second sensor frame had been refurbished and strengthened at NOC, but it was necessary to add several additional cross beams in Avonmouth and these were welded in place by Rhys Roberts before the vessel sailed. Table 2 (page 21)

lists the sensors fitted for this deployment which include a Satlantic SeaFET pH sensor and a McLane Zooplankton Pumped Sampler.

The problems with the data hub recovered on 2nd May prompted some thought as to how to prevent a recurrence in the new hub. To protect the joints between the penetrator mouldings and the stainless steel, each one was wrapped with ScotchKote and self-amalgamating tape and some of the penetrators were re-oriented to reduce stress on the mouldings. The stainless steel flange faces were coated with Tectyl 506, a corrosion inhibitor.

The data hub itself is serial number 3 and was recently constructed to replace the unit lost during the September 2010 to July 2011 deployment. It incorporates an additional power supply as a backup for the SeaFET sensor, and the necessary software changes to accommodate the additional serial data stream. This hub was not fitted with accelerometer sensors due to shortage of time.

The buoy telemetry unit was swapped although the 'old' one was functioning correctly. The 'new' one incorporates minor software changes to handle data from the SeaFET sensor.

A description of the sensor calibrations and preparations is available elsewhere in this cruise report, but it is worth mentioning problems were experienced with the Aanderaa Seaguard unit (s/n 219). It was noted that the connector for the Turner Cyclops fluorometer was corroded and so the cable was swapped with the one from the freshly recovered Seaguard 217 which was not corroded. In the course of performing this swap it was discovered that the internal battery connector was badly corroded, possibly because it had been in contact with a small bag of silica gel. Once this connector had been disturbed the power connection to the Seaguard's computer became intermittent causing the computer to forget all its settings and software licence codes. The power connector was replaced and fortunately David Goldsmith at RS Aqua (supplier of the Seaguards) responded very promptly to an email requesting the necessary licence codes. The Seaguard was then configured by copying the settings from the other the other unit (s/n 217). Unfortunately in the haste to prepare this sensor for deployment, the anode was left off.

3.2.4 Deployment and Initial Performance

The PAP observatory was redeployed on the afternoon of 6th May in calm seas. Data telemetered to NOC from the buoy were accessed via FTP using the ship's

Internet connection and indicated that all the sensors were functioning. However, it quickly became apparent that there was a problem with the pressure sensor on the SBE37-IMP-DO MicroCAT sensor in the frame which was indicating a depth of only 1m instead of 30m. The most likely explanation is that one of the plastic clamps holding the unit in the frame was inadvertently placed over the small pressure port, sealing it from the outside pressure.

Another problem arose some two days after deployment at 13:05 on 9th May, when the Satlantic SeaFET sensor suddenly changed from scheduled, hourly sampling to continuous sampling. Unfortunately this sensor was powered from a dedicated battery pack and so there was no way of controlling it. It was estimated that sampling continuously would drain the battery pack in 2 – 3 months. Once the battery pack had run out it should be possible to restart the unit by powering it from the hub (hopefully causing it to) revert to scheduled sampling.

Fig. 4 PAP#1 ODAS Buoy just after recovery.

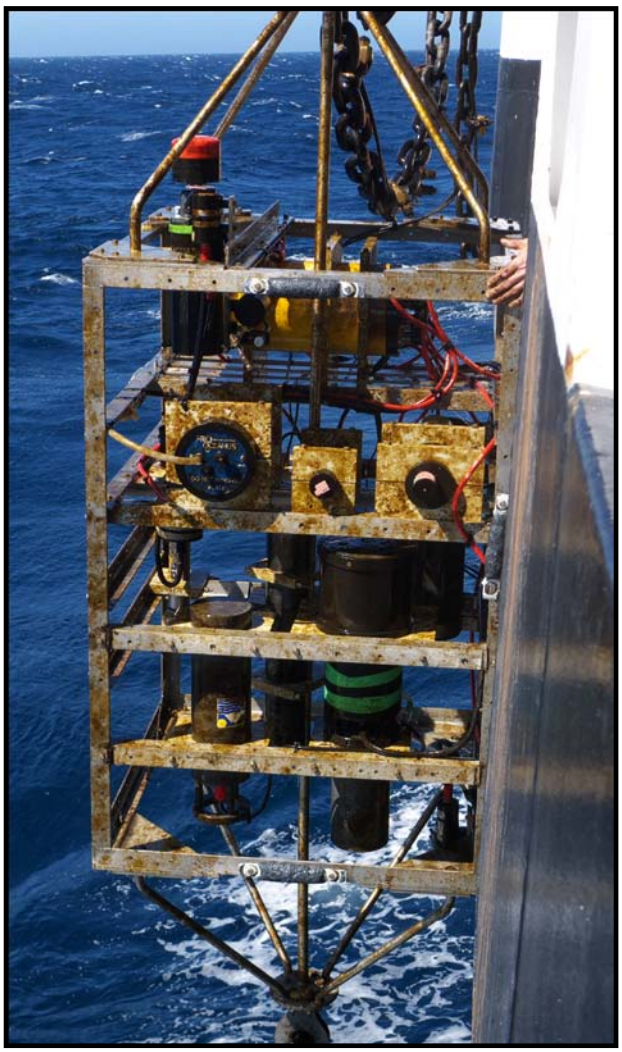


Fig. 5 PAP#1 sensor frame coming aboard after the 278-day deployment.

Fig. 6 Sensor frame anodes before and after deployment.

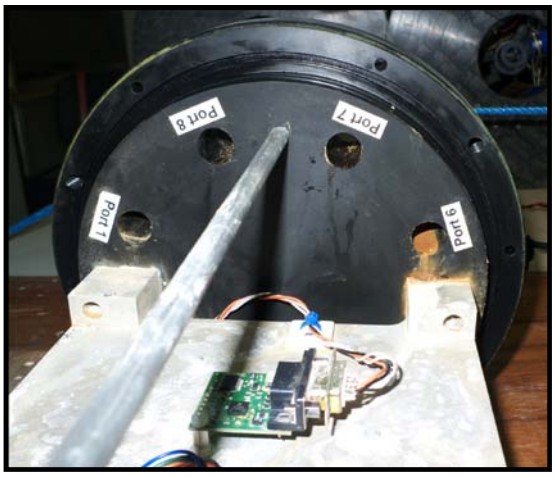


Fig. 7 Inside view of hub end cap showing likely leak through port 6.

Fig. 8 Penetrator 6 showing moulding separation from stainless steel bulkhead.

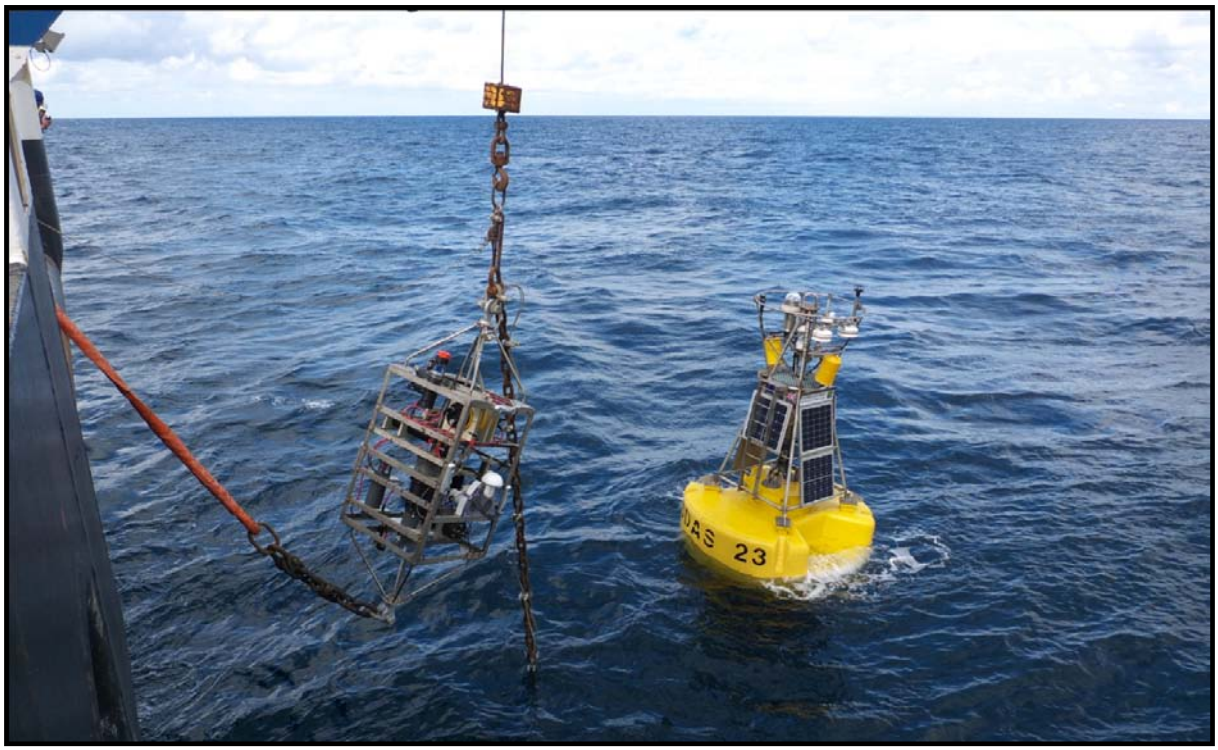


Fig. 9 Sensor frame being deployed shortly after the buoy.

PAP July 11 Configuration					
Sensor	**S/N**	**Internal sample interval**	**Offset from hour**	**Remote control sampling interval**	**Performance during 278-day deployment**
SeaBird SBE-37IMP-DO MicroCAT	9030	30 mins	0		No problems - recording when recovered
SeaBird SBE-37IMP MicroCAT	6917	15 mins	0		Stopped sampling after 133 days because of low battery voltage
WETLabs FLNTUSB	269	6 hours	0		No problems - recording when recovered
Satlantic ISUS V3	59	4 hours	0		No problems - recording when recovered
Aanderaa Seaguard	217	1 hour	0		No problems - recording when recovered, but CO2 optode was faulty when deployed
ZebraTech Wiper for Cyclops		6 hours			No problems - recording when recovered
NAS-3X	2675	24 hours			Stopped sampling after 44 days
NOC/SOES Osmo Sampler					Unknown at present as some capillary tubing was damaged
Satlantic OCR-507 ICSA (buoy)	201	None	17	1 hour	No problems - working when recovered
Satlantic OCR-507 ICSW	200	None	17	1 hour	Worked for 211 days until data hub failed
Satlantic OCR-507 R10W	95	None	17	1 hour	Worked for 211 days until data hub failed, Bioshutter plate missing when recovered
Pro-Oceanus CO2-Pro	29-097-45	None	19	12 hours	Worked for 211 days until data hub failed, but internal gas pressure sensor failed after 160 days
Pro-Oceanus GTD-Pro	29-099-15	None	19	12 hours	Worked for 211 days until data hub failed
Star-Oddi loggers	S5771	15 mins	0		No problems - recording when recovered
	S5772	15 mins	0		No problems - recording when recovered
	S5774	15 mins	0		No problems - recording when recovered
	S5775	15 mins	0		Lost
	S5777	15 mins	0		No problems - recording when recovered
	S5778	15 mins	0		No problems - recording when recovered

Table 1 Sensors fitted during July 2011 to May 2012 deployment

PAP May 2012 Configuration					
Sensor	**S/N**	**Internal sample interval**	**Offset from hour**	**Remote control sampling interval**	**Notes**
SeaBird SBE-37IMP-DO MicroCAT	9030	30 mins	0		Sensor re-batteried and reused from previous deployment. Pressure port covered by clamp
SeaBird SBE-37IMP MicroCAT (frame)	6915	15 mins	0		New sensor
SeaBird SBE-37IMP MicroCAT (buoy keel)	6916	15 mins	0		New sensor
WETLabs FLNTUSB	238	4 hours	0		Serviced by WETLabs
Satlantic ISUS V3	238	1 hour	20		New sensor
Satlantic SeaFET pH	8	1 hour	55		New sensor
Aanderaa Seaguard	219	1 hour	46		New CO2 sensor fitted. Anode not fitted
ZebraTech Wiper for Cyclops		6 hours			Fresh batteries
NAS-3X	2673	24 hours			
McLane ZPS					New sensor
Satlantic OCR-507 ICSA (buoy)	226	None	17	1 hour	New sensor
Satlantic OCR-507 ICSW	225	None	17	1 hour	New sensor
Satlantic OCR-507 R10W	102	None	17	1 hour	New sensor
Pro-Oceanus CO2-Pro	29-095-45	None	19	12 hours	Serviced by Pro-Oceanus
Pro-Oceanus GTD-Pro	29-100-15	None	19	12 hours	Serviced by Pro-Oceanus
Star-Oddi loggers	S5771	15 mins	0		Re-used from previous deployment
	S5772	15 mins	0		Re-used from previous deployment
	S5774	15 mins	0		Re-used from previous deployment
	S5777	15 mins	0		Re-used from previous deployment
	S5778	15 mins	0		Re-used from previous deployment

Table 2 Sensors fitted during May 2012 deployment

PAP Sensors CTD Calibrations/Comparisons					
Sensor	**S/N**	**Pre-deployment CTD**	**Date**	**Post-deployment CTD**	**Date**
SeaBird SBE-37IMP-DO MicroCAT	9030	JC062-CTD04	27-Jul-11	JC071-CTD02	03-May-12
SeaBird SBE-37IMP MicroCAT	6917	JC062-CTD04	27-Jul-11	JC071-CTD07	08-May-12
SeaBird SBE-37IMP MicroCAT (PAP3)	4460	JC062-CTD03	26-Jul-11	None	
WETLabs FLNTUSB	269	None		JC071-CTD07	08-May-12
Satlantic ISUS V3	59	JC062-CTD04	27-Jul-11	JC071-CTD07	08-May-12
Aanderaa Seaguard	217	JC062-CTD04	27-Jul-11	JC071-CTD07	08-May-12
Star-Oddi DST logger	S5771	None		JC071-CTD02	03-May-12
Star-Oddi DST logger	S5772	None		JC071-CTD02	03-May-12
Star-Oddi DST logger	S5774	None		JC071-CTD02	03-May-12
Star-Oddi DST logger	S5777	None		JC071-CTD02	03-May-12
Star-Oddi DST logger	S5778	None		JC071-CTD02	03-May-12
SeaBird SBE-37IMP MicroCAT (frame)	6915	None			
SeaBird SBE-37IMP MicroCAT (buoy keel)	6916	None			
WETLabs FLNTUSB	238	JC071-CTD02	03-May-12		
Satlantic ISUS V3	238	JC071-CTD02	03-May-12		
Aanderaa Seaguard	219	JC071-CTD02	03-May-12		

Table 3 Pre and post deployment sensor calibration CTDs

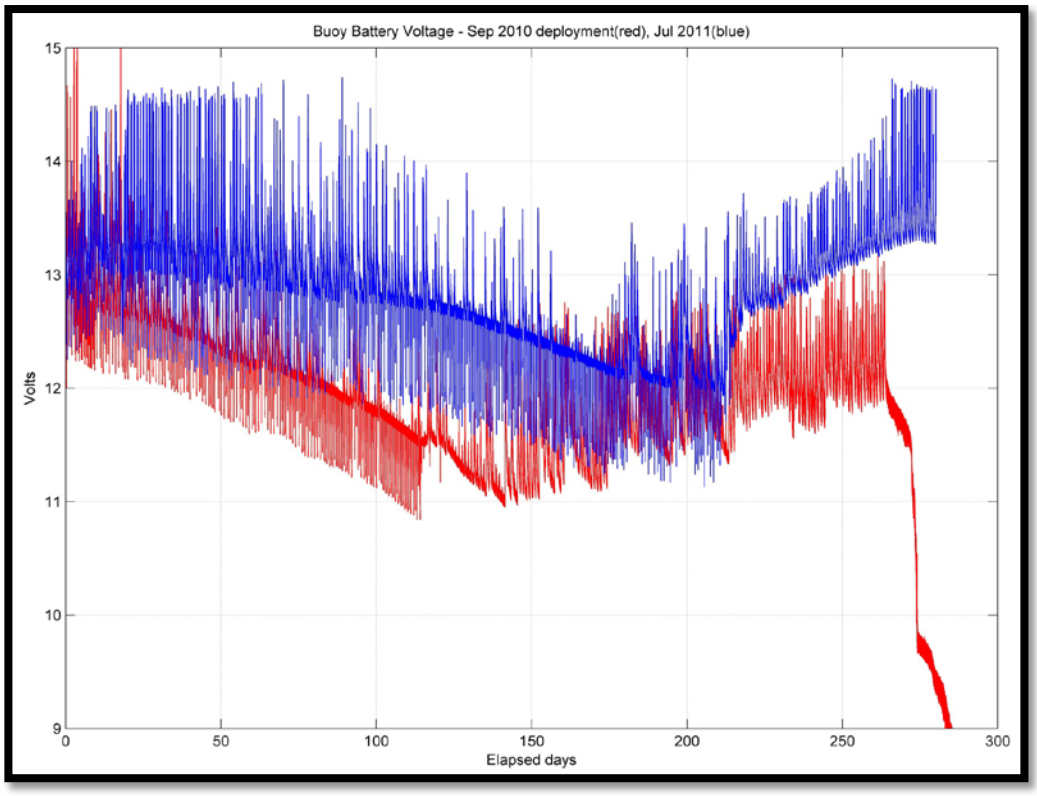


Fig. 10 Buoy battery voltage (daily average solar radiation) from previous two deployments; red: Sept. 2010 blue: July 2011.

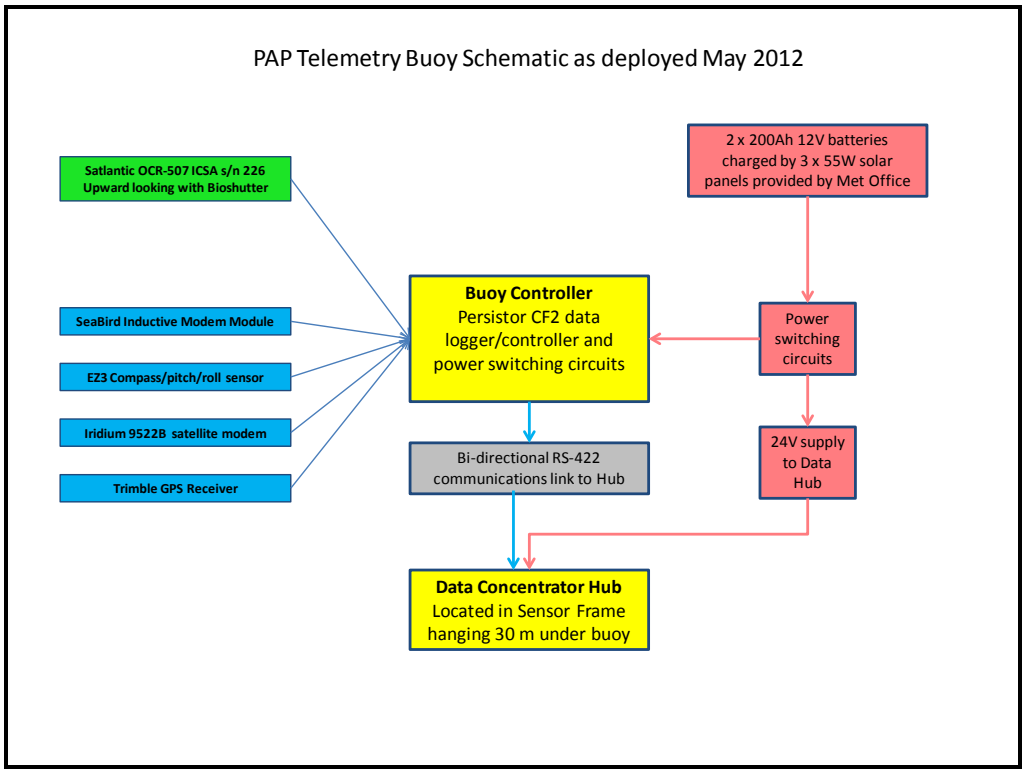


Fig. 11 Telemetry schematic.

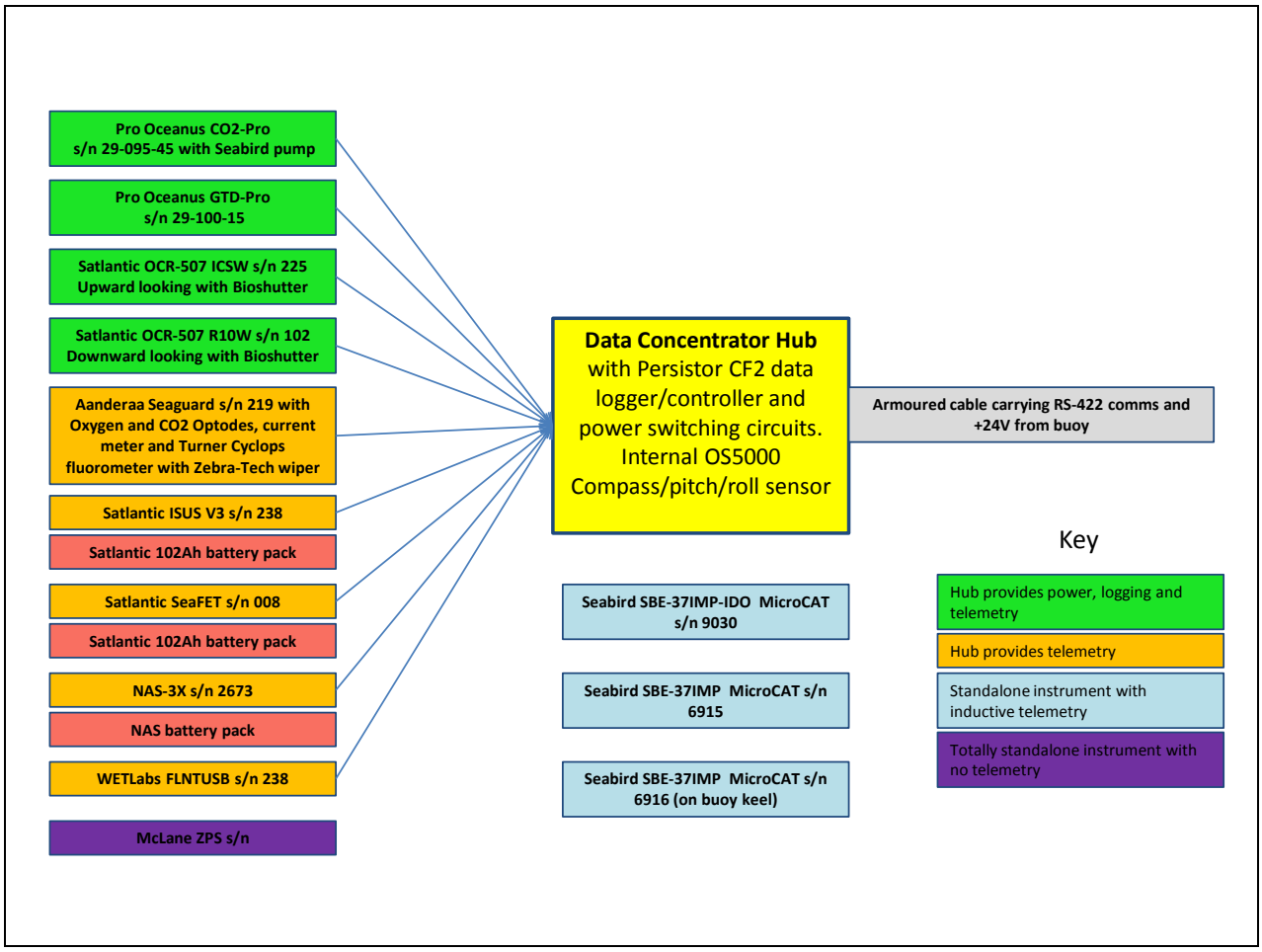


Fig. 12 PAP Sensor frame schematic as deployed May 2012.

3.3 In situ Sensors and Samplers

3.3.1 PAP1 Sensors Recovered

Manufacturer	Serial Number	Measurement
Wetlabs	FLNTUSB269	Fluorometer
MBARI-ISUS	059	Nitrate
NAS-3X	2675	Nitrate
NAS-3X Battery	2684	
Pro-Oceanus CO2-Pro	29-097-45	CO2
Pro-Oceanus GTD-Pro	29-099-15	Total Dissolved Gas Pressure
		xxxx
		Data Hub

Table 4

3.3.2 McLane ZPS

Corinne Pebody

The McLane Zooplankton Sampler was not deployed in 2011 as the instrument had been previously lost on a Eurosites partners mooring in the Mediterranean. A replacement (S/N 07) was delivered shortly before the cruise was mobilised, leaving no opportunity for any NOC-based testing. On unpacking onboard the communication blanking plug was found to be missing. Fortunately Jon Campbell had recovered a suitable plug from another instrument and was able to adapt it to fit the ZPS and the deployment could continue.

The ZPS is relatively simple to programme but it cannot be set into deployment mode until less than 12 hours prior to deployment. This is because once deployed the automatic back flush operates the pump every 12 hours. This pump would be damaged if it operated in air rather than water.

The quick disconnect system made it quick and easy to fill the reservoir to preserve the samples. Unfortunately the coupling failed to seal the formalin reservoir when disconnected, so the diluted formalin spilled onto the deck when the frame was tipped on to its side. Mark Hartman attached the second half of the disconnect system, but plugged it off with tubing and cable ties and taped it in

place to reduce movement (Fig. 13). This allowed the deployment a chance of sufficient preservative being retained both during deployment and for the next 10 months to effectively preserve the samples until 2013.

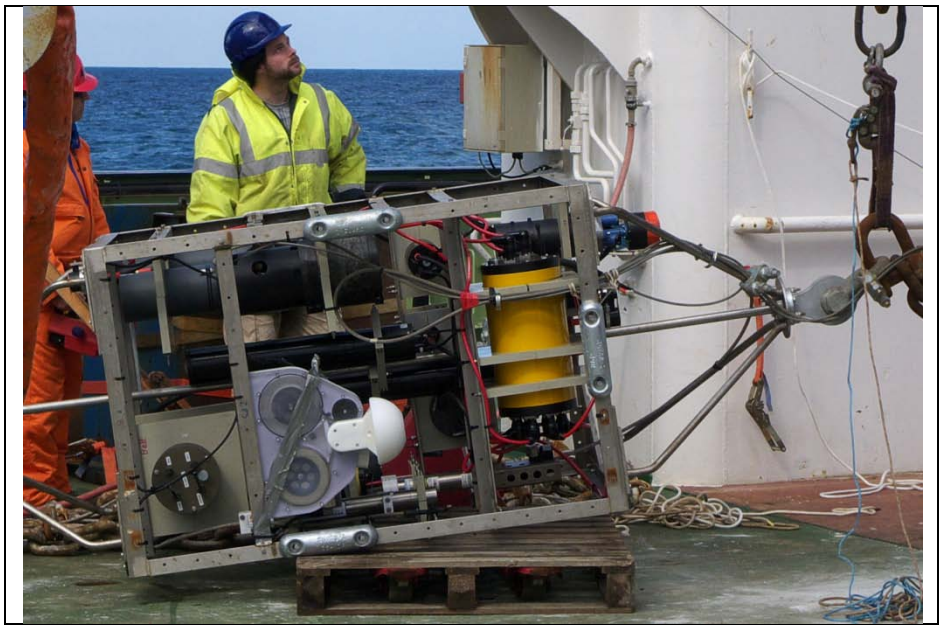


Fig. 13 ZPS on frame with obvious fix to the broken "quick disconnect".

3.3.3 Wetlabs Fluorometer

Mark Hartman

The unit S/N 269 was recovered and found to have been operating successfully despite being adapted in 2011. The 'jumper' plug had been damaged by the 2010/11 deployment and consequently the unit had to be connected by soldering before being redeployed. This was successful and the unit continued to record every 6 hours until its recovery. The copper cap worked well against 1 year's worth of bio fouling (Fig. 14).

Fig. 14 End of fluorometer showing bio fouling and patch to the right of the copper wiper which is completely clean.

The unit will be returned to wetlabs for service and repair. The replacement unit, S/N 238 was calibrated on ctd JC071 -061 and set to four hourly intervals until 2013. The "how to" document was updated and is attached as an appendix.

3.3.3.1 Sensor Post-Deployment Calibration

The following instruments had been deployed on the PAP1 Instrument frame during 2011-2012: Aanderaa Seaguard RCM SW 217, ISUS nitrate sensor (Serial no. 2675), Wetlabs fluorometer (Ser. No. FLNTUSB269) and Seabird Microcat CTD. They were mounted on the CTD frame during a 250m cast, (CTD 007). Bottle samples were taken for Oxygen, Chlorophyll and DIC samples; the Oxygen samples were analysed on board following the Winkler method; the remaining samples were returned to NOC for later analysis. Again high winds forced homogeneous mixing in the surface layers, although there was a distinct step in the temperature, salinity, fluorescence and the light transmission at 50 metres. Due to deteriorating weather, stops could not be taken above 50m and these samples were taken "on the fly".

3.3.3.2 Star-Oddi Pre-2012 and Post-2011 Deployment CTD

Star-Oddi DST CTDs are permanently sealed ceramic coated self logging sensors that were set to provide temperature, pressure and salinity readings every 15 minutes. 6 of these were mounted on the

PAP mooring in 2011; due to operational constraints 5 were placed on the chain between the surface buoy and the instrument frame and one was mounted on the instrument frame. 1 out of the 5 that were mounted on the chain was lost but considering the rough treatment they experience during deployment and recovery their placement within the cable securing brackets was seen to provide adequate protection. The surviving units provided data throughout the deployment with >80% battery life remaining. They were mounted on the 210m CTD 002 calibration cast with a sample interval of 10 seconds. This was reset to a 15 minute sampling routine for redeployment on the PAP1 mooring at nominal depths of 10, 15, 20, 25 and 50 metres.

3.3.3.3 NAS-3X Recovery

The NAS-3X is a wet chemistry nitrate sensor that uses a colorimetric technique to analyse the nitrate + nitrite concentration of a sample of seawater twice daily. It has two onboard standards 1µM and 10µM that are sampled weekly. The unit that was recovered from PAP1 had operated from 30/07/2011 00:03 to 11/09/2011 12:02 before it stopped transmitting data. On recovery the NAS was found to have considerable bio-fouling, particularly within the enclosed volumes where the chemical bags are housed, on the bags themselves and also around the syringe although it did not appear that the movement of the syringe shaft would have been impeded. Growth consisted primarily of light brown fibres several centimetres long that were well attached. These were similar in appearance to those attached to the mooring rope within 100m of the surface (Fig. 15).

Fig. 15 Growth of this type was also found on the internal spaces of the NAS-3X Sensor.

There was a severe kink in one of the tubes that feeds chemicals from bag to the syringe; it is currently unknown whether or not this would have created more of a drain on the power resources. The decay in the voltage of the NAS battery pack is well represented by a cubic regression (Fig. 16). The bags were disconnected from the manifold in order to clean the unit before being shipped to NOC; very little of the chemicals seemed to have been used.

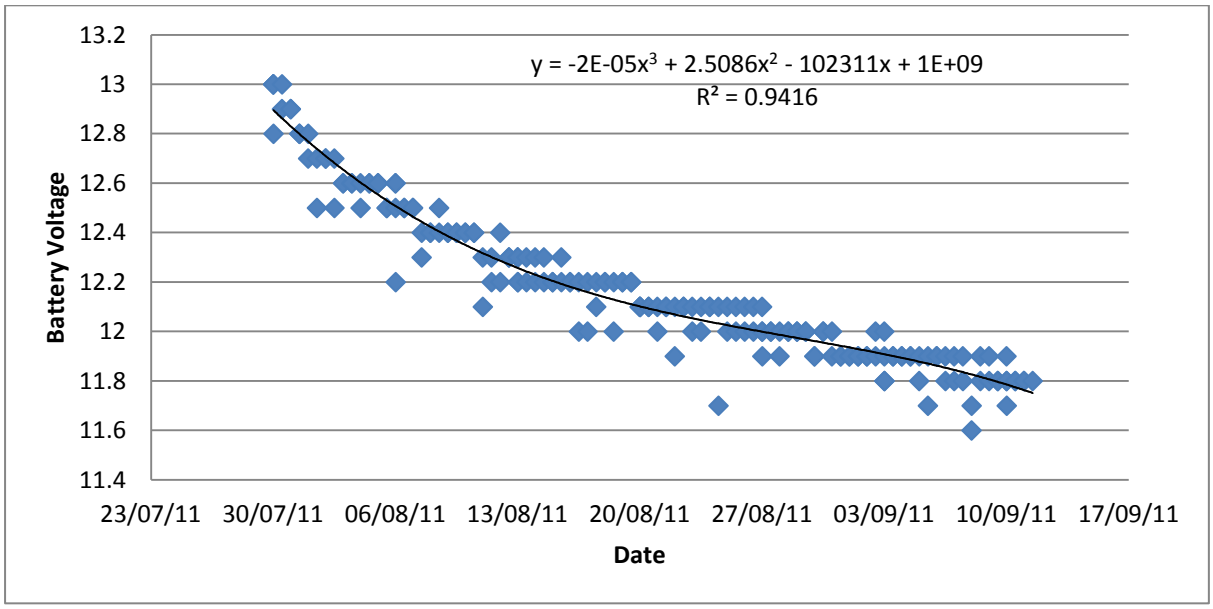


Fig. 16 Change in NAS battery voltage over time.

3.3.3.4 Sensor Pre-Deployment Calibration

The Aanderaa Seaguard RCM SW 219, ISUS nitrate sensor, Wetlabs fluorometer, 5 Star Oddi CTDs and Seabird Microcat CTD were mounted on the CTD frame on a 220 m cast (CTD 002) during which bottles were fired; Oxygen, Chlorophyll, nutrients and DIC (Dissolved Inorganic Carbon)/TA (Total Alkalinity) samples were extracted from 12 depths at 20 m intervals. The surface layers were extremely well mixed due to the strong winds experienced in the days leading up to the CTD cast and so there was not a great range in any of the observable parameters with depth.

3.3.4 PAP1 Sensors Deployed

Mark Hartman and Corinne Pebody

Manufacturer	Serial Number	Measurement
Wetlabs	FLNTUSB238	Fluorometer
MBARI-ISUS	238	Nitrate
NAS-3X	2673	Nitrate
NAS-3X Battery	2683	
Pro-Oceanus CO2	29-095-45	CO2
Pro-Oceanus GTD-PRO	29-100-15	Total Dissolved Gas Pressure
Mclane ZPS-7	12860-01	Zooplankton sampler
		Data Hub

Table 5

3.3.4.1 Preparation of NAS-3X Nitrate Sensor

The NAS-3X nutrient sensor was shipped from NOC in deployment ready state. When the instrument was powered on in the lab it immediately started its sampling routine. The script () was used for the 2012 deployment with a minor modification of 1/3 more pause macros inserted in order to set the instrument to sample twice daily.

Samples were taken of the two on-board nutrient standards for later analysis by auto-analyser at NOC, a sub sample of these was also offered up to the ISUS nitrate sensor prior to its pre-deployment CTD calibration. Care was taken to route the inlet and outlets so that they would not be pinched when the protective shroud was raised into place.

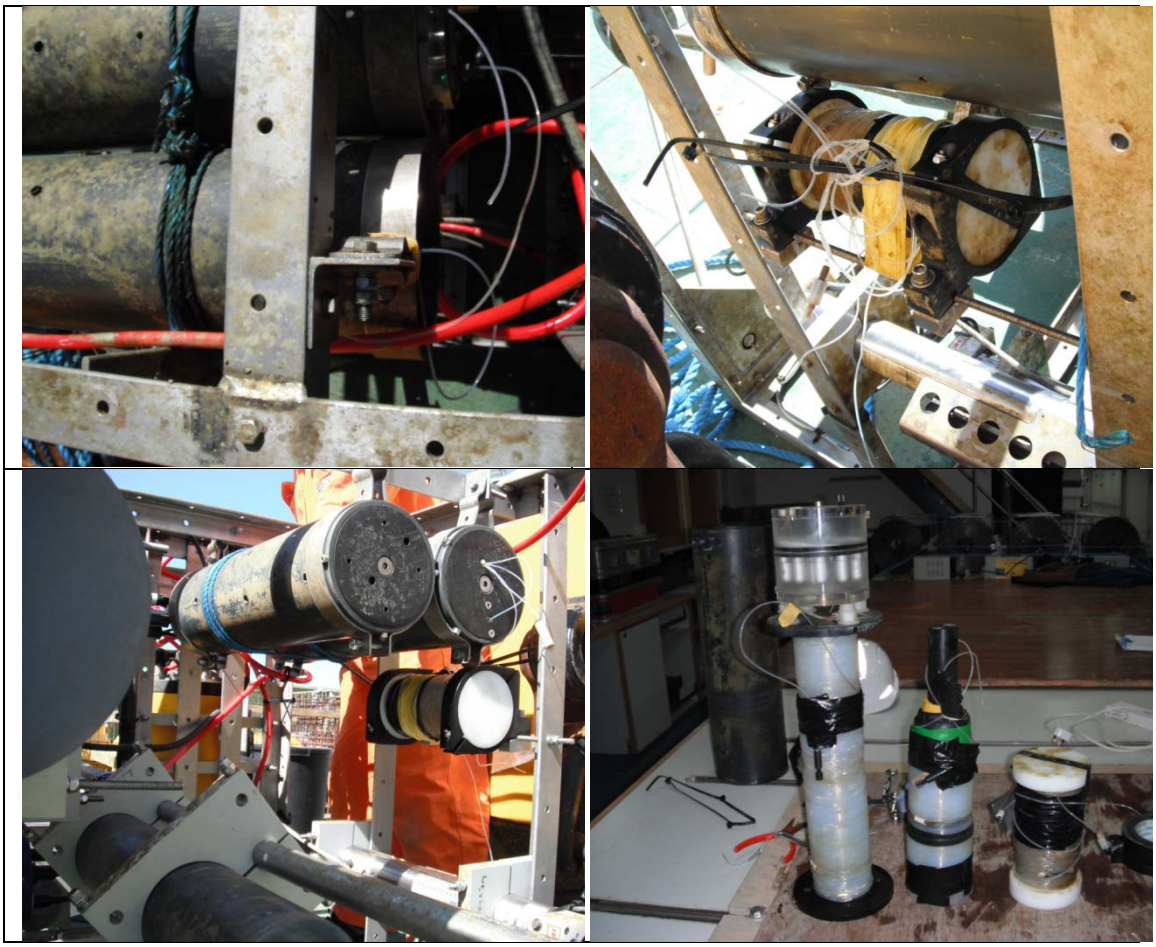
3.3.4.2 Seaguard Pre-Deployment Checks

Subsequent to the pre-deployment CTD both Seaguard units were immersed in a container fed by the ships non-toxic water supply in order to obtain a direct comparison of the two instruments. It was discovered however that the Cyclops-7 was not flashing and this was traced to corrosion in the Cyclops connector. Its appearance suggested that a previous sustained period of water ingress had caused at least one of the pin sockets in the fly lead to become unsalvageable. It was ultimately decided that the lead should be exchanged with the one from the recently recovered RCMSW217 unit as this was in good condition. Although most of the sensors are "plug and play" in operation the Cyclops fluorometer is hardwired into the uppermost circuit board of the Seaguard. The wiring differed between the units – it is thought that this was due to a change in the sensitivity. To access the soldered connection the topmost plastic cowl needed removing using a star drive attachment.

This revealed further corrosion contiguous to the internal power connector situated just below the top end cap. It was thought that this was attributable to the adjacent bag of silica gel as there were no signs of water internally. The connector was removed and replaced with the same from the recovered Seaguard 217. Owing to the lateness of these discoveries and the reversed decision of using the recovered Seaguard, the zinc anode was not attached to the 219 unit prior to its deployment. The unit was set to record at hourly intervals.

3.3.5 Recovery of the Osmotic Sampler

When the osmotic sampler was recovered from the PAP1 mooring frame its connecting tube was found to have separated between the two housings. The components were removed from the frame and any free ends of tubing were plugged with connectors. It was intended to flash freeze the contents with liquid nitrogen, but as the generator was not functioning this was not possible. The internal reels of tubing were placed in the -80°C freezer, the large thermal mass of the components caused the temperature of the freezer to rise to -60° C, fortunately after this the freezer temperature fell again.



Figs. 17 to 20 The recovered osmotic sampler.

3.3.6 Recovery of the Satlantic ISUS Nitrate Analyser

Fig. 21 Damage to copper sensor guard.

Fig. 22 Deterioration of pressure case coating.

The ISUS nitrate sensor recorded data internally from 29/07/2011 19:50 to 23/01/2012.

MilliQ water and Samples from the NAS-3X Serial No.2673 onboard standards were analysed by using the Satlantic software to generate a time series on 07.05.12

Start	finish	sample	ISUS reading / µM
		In air (no cleaning)	10
		In air (after cleaning)	8.5
		MilliQ water (0 µM)	1 ± 1
		NAS green Port (10µM)	-230
		NAS purple Port (1µM)	-200

Table 6

The large negative values were not expected and it remains to be seen whether the values logged by the ISUS ser no. 238 are also suspect.

3.3.7 Preparation of ISUS Nitrate Analyser for Deployment

Mark Hartman

The ISUS nitrate analyser arrived immediately prior to transportation to the ship. It was found that the new version of the bundled software would only operate on older laptops.

Communication was not established when using 64-bit PCs running Windows 7. Once running, the software was found to be easy to use. The ISUS was mounted on the CTD frame for CTD 002 and calibration through the analogue input channel of the Seabird CTD was established by Jon Campbell and Paul Provost. The unit was set to sample on continuous mode and wrote successfully to its internal memory; the data was later downloaded.

The ISUS was mounted vertically; sensor lowermost using chain clamps on a 0.9 m retort stand that was screwed down to the bench. Enough space was left underneath to introduce an HPLC vial over the sensor head. The vials were found to hold sufficient liquid to cover the optics without overflowing when they were filled with 2.2ml. A wooden block was drilled to take the diameter of the vials to a depth of 1cm and then chocked underneath to hold the upper surface of the wood against the sensor guard; this way the sample could be held in place hands free.

The ISUS software was used to generate a time series whilst a sample of MilliQ water was analysed, this fell within Satlantic's specifications of 0 ± 2 µM. Samples of the NAS-3X Serial No.2673 onboard standards were also analysed at the times given in the table below.

Start	finish	sample	ISUS reading / µM
13:22	13:24	MilliQ water (0 µM)	-2 ± 1
13:24:50	13:26:50	NAS Purple Port (10µM)	
13:27:30	13:29:50	NAS Purple Port (1µM)	

Table 7

3.3.8 Oxygen Measurement Summary

Mark Hartman

Both of the Aanderaa Seaguards used on the PAP1 mooring sensor frame; the returning (RCM217) and the outgoing (RCM219) were fitted with Oxygen optodes as well as prototype CO_2 optodes. Comparison with the Seabird oxygen sensor mounted on the CTD was made during two separate 250 metre casts. These can be seen on the timeline to have occurred in the afternoon/evenings of 3rd May and 8th May. Water samples from these two casts were collected

and analysed for their oxygen concentration using the Winkler titration method. The same analysis method was used on samples that were taken from the ships non-toxic water supply during the 6 hour period of a Swath Bathymetry survey on the 4th May. During the same period DIC / TA samples were also made. The non-toxic draws water from a depth of 5 metres.

From the 8th to the 9th May RCM217 was set to record at 30 second intervals while immersed in water flowing from the non-toxic system.

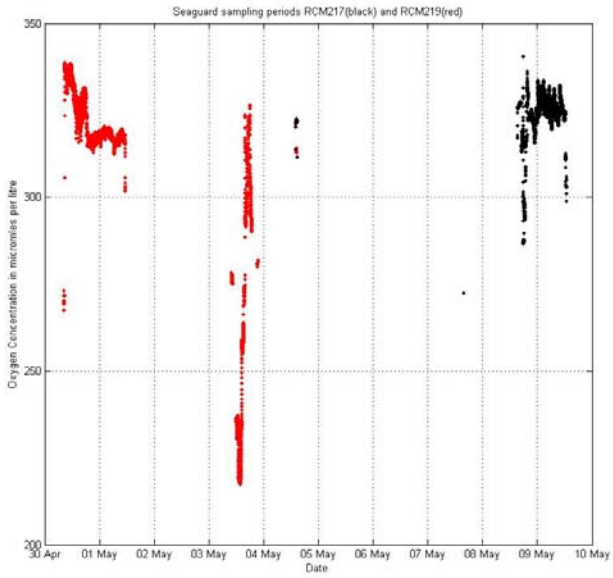


Fig. 23 Data collected from both Aanderaa Seaguards whilst onboard, including two CTD casts and some underway samples.

Fig. 24 Seaguard fed from non-toxic seawater supply at 6 litres per minute. Supply pipe positioned so that sea water passed by the sensor heads directly after leaving the pipe.

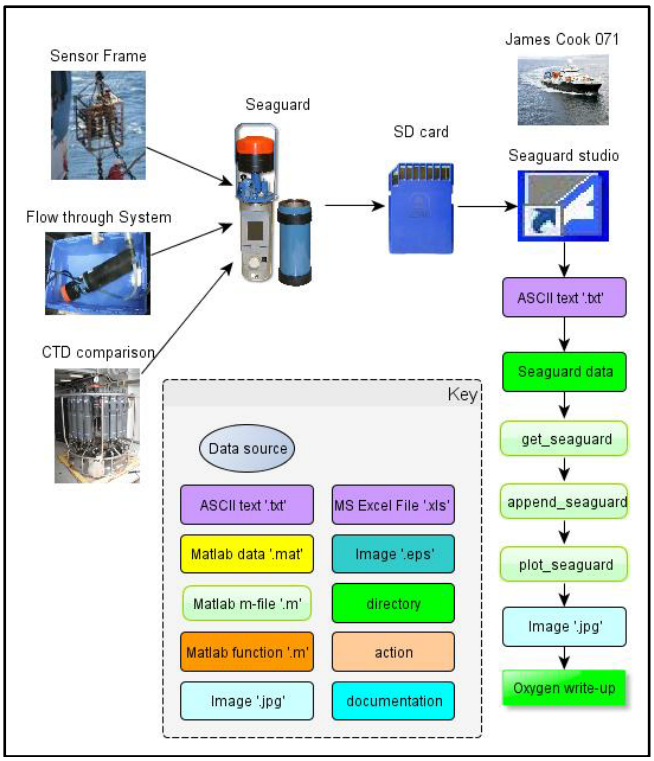


Fig. 25 Process flowchart.

Station	CTD	date	day	time	NISKIN	Depth/m	O2 uM/l
JC071_003	1	02/05/2012	123	08:20	5	3999	255.18
JC071_003	1	02/05/2012	123	08:20	5	3999	248.85
JC071_003	1	02/05/2012	123	09:14	10	1403	267.78
JC071_003	1	02/05/2012	123	09:14	10	1403	266.14
JC071_003	1	02/05/2012	123	09:51	17	126	274.64
JC071_003	1	02/05/2012	123	10:00	24	10	272.91
JC071_003	1	02/05/2012	123	10:05	non-toxic	5	272.26
JC071_003	1	02/05/2012	123	10:05	non-toxic	5	274.73
JC071_018	2	03/05/2012	124	16:27	5	170	273.03
JC071_018	2	03/05/2012	124	16:27	5	170	272.97
JC071_018	2	03/05/2012	124	16:48	9	130	255.87
JC071_018	2	03/05/2012	124	17:10	13	90	273.83
JC071_018	2	03/05/2012	124	17:30	17	50	277.35
JC071_018	2	03/05/2012	124	17:40	19	30	276.72
JC071_018	2	03/05/2012	124	17:40	19	30	273.78
JC071_018	2	03/05/2012	124	17:50	21	10	267.56
JC071_018	2	03/05/2012	124	17:50	21	10	278.29
JC071	Underway	04/05/2012	125	0.44444	N/A	5	279.12
JC071	Underway	04/05/2012	125	0.46458	N/A	5	273.56
JC071	Underway	04/05/2012	125	0.47986	N/A	5	286.32
JC071	Underway	04/05/2012	125	0.55069	N/A	5	263.78
JC071	Underway	04/05/2012	125	0.57917	N/A	5	272.02
JC071	Underway	04/05/2012	125	0.60278	N/A	5	273.35
JC071	Underway	04/05/2012	125	0.62569	N/A	5	273.59
JC071	Underway	04/05/2012	125	0.64236	N/A	5	277.58
JC071	Underway	04/05/2012	125	0.66319	N/A	5	283.81
JC071	Underway	04/05/2012	125	0.66319	N/A	5	290.53
JC071	Underway	04/05/2012	125	0.69236	N/A	5	280.50
JC071	Underway	04/05/2012	125	0.69236	N/A	5	284.46
JC071_061	7	08/05/2012	129	17:59	1	250	256.15
JC071_061	7	08/05/2012	129	17:59	1	250	252.58
JC071_061	7	08/05/2012	129	18:09	3	210	259.96
JC071_061	7	08/05/2012	129	18:19	5	190	251.59
JC071_061	7	08/05/2012	129	18:38	7	150	256.04
JC071_061	7	08/05/2012	129	18:40	9	130	264.94
JC071_061	7	08/05/2012	129	18:58	11	110	268.45
JC071_061	7	08/05/2012	129	19:08	13	90	271.72
JC071_061	7	08/05/2012	129	19:08	13	90	271.05
JC071_061	7	08/05/2012	129	19:18	15	70	269.13
JC071_061	7	08/05/2012	129	19:28	17	50	278.84
JC071_061	7	08/05/2012	129	19:35	23	10	

Table of Oxygen samples analysed on board JC071

Table 8 Summary of oxygen movements

3.3.9 Recovery of the Aanderaa Seaguard

Fig. 26 CO_2 and O_2 Optodes.

Fig. 27 Cyclops-7 and Zebratech wiper.

General condition of the Seaguard on recovery was good, there was some light fouling on the case. The CO_2 optode seemed to have a greater degree of fouling than the O_2 optode. The Zebra-tech wiper did a good job of keeping the face of the Fluorometer clean. The Lithium battery level throughout the deployment remained at 6.6V although the voltage at the terminals was 7.14V. Data were logged throughout the deployment from 29.07.11 13:00:00 to 02.05.12 21:00:00.

3.3.10 Preparation of Aanderaa Seaguard for Deployment

Mark Hartman

There are currently 2 Seaguard units available for the PAP1 deployment RCM SW217 and RCM SW219. The sensors attached to these include an Aanderaa Oxygen Optode, a prototype Aanderaa Carbon dioxide Optode and a Turner designs Cyclops 7 fluorometer together with current speed and direction. Software keys enable data output and logging data from the attached analogue sensors. (These should not generally be necessary but are listed below should the need arise). The Seaguard is enabled for data export so that it can telemeter data to the PAP1 hub for later transmission ashore. The instrument is configured by means of a touch screen that displays a windows based GUI. The following information is contained in the files Seaguard_RCM_SW_SN_219.pdf and seaguard_RCM_SW_SN_217.pdf.

Component	Serial No.	Component	Serial No.
Seaguard RCM SW	217	Seaguard RCM SW	219
Main Assembly 9340 DCS 4420 Oxygen Optode 4330 Cyclops-7 fluorescence Sensor	357 69 125 2100989	Main Assembly 9340 DCS 4420 Oxygen Optode 4330 Cyclops-7 fluorescence Sensor	360 77 151 2100990
License:		License:	
8033-2737-1723-4932	Analog Sensors	2399-5045-9418-7639	Analog Sensors
1386-4929-8419-7735	AADI Real-Time	4747-2567-1158-8918	AADI Real-Time

Table 9

3.3.11 Seaguard Configuration Instructions

"Switch the instrument on. If the screen goes immediately goes dark this suggests that the Seaguard is in logging mode. Tapping the screen brings up the brightness. On the bottom left corner of the screen adjacent to the pop up software keyboard select the Menu button. This displays the sub-menus in the table below. The sub-menus on the left side of the table are covered here".

Administrative Tools	**Active Programs**
Sensor Identification	**Programs**
System Configuration	**Show desktop**
Deployment Settings	
Recorder Panel	
Control Panel	

Table 10 Seaguard

1. Choose the ***Recorder Panel*** and if the instrument is logging press the ***Stop*** button and exit the ***Recorder Panel***.
2. Choose the ***Sensor Identification*** panel. Within this window this should be displayed:

System Parameters.	
Analog sensors / Chlorophyll	#2100989 or #2100990
CO2 optode 4797	#25 or #22
dcs	#69 or #77
optode sensor 4330	#125 or #151

Table 11

3. Save and exit ***the Sensor Identification*** panel.
4. Choosing the ***System Configuration*** window and ***Run Wizard*** displays the following 8 windows. Alter the settings to suit then

choose *Next* to move to the next window. Repeat for the ***Deployment Settings*** windows.

System Configuration		**Deployment Settings**	
Serial Port settings	**(1/8)**	**Deployment Settings**	**(1/6)**
Baud Rate	19200	Site Info	
Data Bits	8	Owner	NOCS
Stop Bits	1	Location	PAP
Parity	None	Geographic Position	49N16.5W
Flow Control	None	Vertical Position(m)	25
Incoming Communications	**(2/8)**	Reference	JC071-2012
Enable Commands	**Yes**	**Deployment Settings**	**(2/6)**
Enable Retransmit	**Yes**	Timing Method	
Enable Wakeup	**No**	Fixed Interval	1 hour
AD Channel Enable	**(3/8)**	Advanced Sequence	un-tick
Channel 1	No	Recording Start	
Channel 2	No	Start When Powered Up	Tick
Channel 3	No	**Deployment Settings**	**(3/6)**
Channel 4	Yes	Move required sensors into enabled sensors box.	
Output Settings	**(4/8)**	**Deployment Settings**	**(4/6)**
Enable Raw Data	Yes	Storage	
Enable Concentration	Yes	Store to Internal Storage	Yes
Enable Temperature	Yes	**Deployment Settings**	**(5/6)**
Enable HumidityComp	Yes	Common Settings	
Measurement Settings	**(5/8)**	Enable Serial Output	Yes
Ping Number	150	**Deployment Settings**	**(5/6)**
Sound Speed	1506.7 m/s	Owner	NOCS
Start Distance	0.50 m	Location	PAP_SITE
Cell Size	1.50 m	Geographic Position	49N16.5W
Operation Settings	**(6/8)**	Vertical Position	30m
Burst Mode	Tick	Reference	JC071_2012
Use Fixed Heading	Untick	Click **Finish** then **[X]**	
8tilt compensation	Tick		
Zpulse active	Tick		
Transducer Activation	**(7/8)**		
X-axis			
1 + 3 (normal)	Tick		
1			
3			
Y-axis			
2 + 4 (normal)	Tick		
2			
4			
Forward Ping Active	Tick		
Output Settings	**(8/8)**		
Enable air saturation	Yes		
Enable raw data	No	(was maybe set to yes on deployment 2012)	
Enable temperature	Yes		
Enable humidity comp	Yes		
Click **Finish** then **[X]**			

Table 12 Seaguard Configuration Settings

5. Select the ***Control Panel*** Window, then the ***Battery*** Icon by tapping it twice. The battery voltage displayed by the Seaguard. Select OK.
6. Select the ***SD Storage*** Icon to check the space remaining on the SD card. N.B. Ensure that prior to removing any files from the card that they are securely backed up to at least two locations on differing media, preferably a secure storage medium such as a file server. ***Erase*** files if no longer required or use another SD card. Once erased, ***Check Storage*** ensures that data can be written to the card.
7. Use Date/Time to set the Date and time as required. This will usually be the ship's time, GMT or UTZ. Exit the Control panel window.
8. In the ***Recorder Panel*****,** select the ***Setup*** tab to check that the timing intervals are correct; these can be changed if necessary By depressing the ***Recorder Deployment Settings*** button.
9. Press ***Record*****.** If the deployment is due to start within say one day then press ***Start now*****.** Alternatively, setting the start time and pressing ***Arm*** will set a delayed start.

3.4 PAP#3 (Sediment Trap Mooring)

Paul Provost

The intention was to recover the PAP3 sediment trap mooring deployed from the James Cook in July 2011 and redeploy with a very similar but new mooring.

All the recovered instruments were in good condition and in working order.

RCM11, s/n 524, showed no signs of damage, corrosion or fouling, and was continuing to sample. The instrument was stopped logging at 16:30 on 08/05/2012.

RCM11, s/n 425, showed no signs of damage, corrosion or fouling, and was continuing to sample. The instrument was stopped logging at 08:30 on 09/05/2012.

SeaBird Microcat SBE37IMP s/n 4460, showed no signs of damage, corrosion or fouling, and was continuing to sample. It was set to sample every 600seconds. The instrument was stopped logging at 09:45 on 07/05/2012.

Parflux sediment trap, s/n ML12432-02, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 15 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Parflux sediment trap, s/n 522, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 9 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Parflux sediment trap, s/n ML12432-06, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 15 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Acoustic release RT661, s/n 439, showed no signs of damage, corrosion or fouling and worked faultlessly. Communications through the drop keel transducer to the TT801, s/n 255, deck unit worked well and no lost or timed out transmissions occurred.

3.4.1 PAP#3 Recovery

3.4.1.1 Operations Summary

The deck setup for the mooring recovery used a Lebus GP 5T deck winch mounted well forward on the after deck with the mooring line with a long lead to a sheave suspended from the port aft pedestal crane. A chain stopper and boss hook was attached to the deck in the 'red zone for stoppering off the mooring. After recovery the mooring rope was wound off the winch drum into empty bins for storage.

The mooring was released at 07:03 on 5th May 2012 (48^{0}58.9'N, 16^{0}31.7'W) using an IXSEA TT801 connected through the single element transducer on the (raised) drop keel by a patch cable. The mooring was monitored during the buoyant ascent and a rate of

approximately 72 m/min was measured. The mooring was initially spotted at 07:50 with all the buoyancy packages visible approximately 30 minutes later.

On recovery, the recovery line was grappled from the starboard side of the vessel and hauled in first. The main buoyancy packages, sediment traps and current meters were recovered without incident. As the final sediment trap was lifted clear of the water, the lower buoyancy spheres immediately above the release were entangled with their rope around the trap. The Sediment trap was lifted inboard and the lines were separated and tied off to aid untangling the lines.

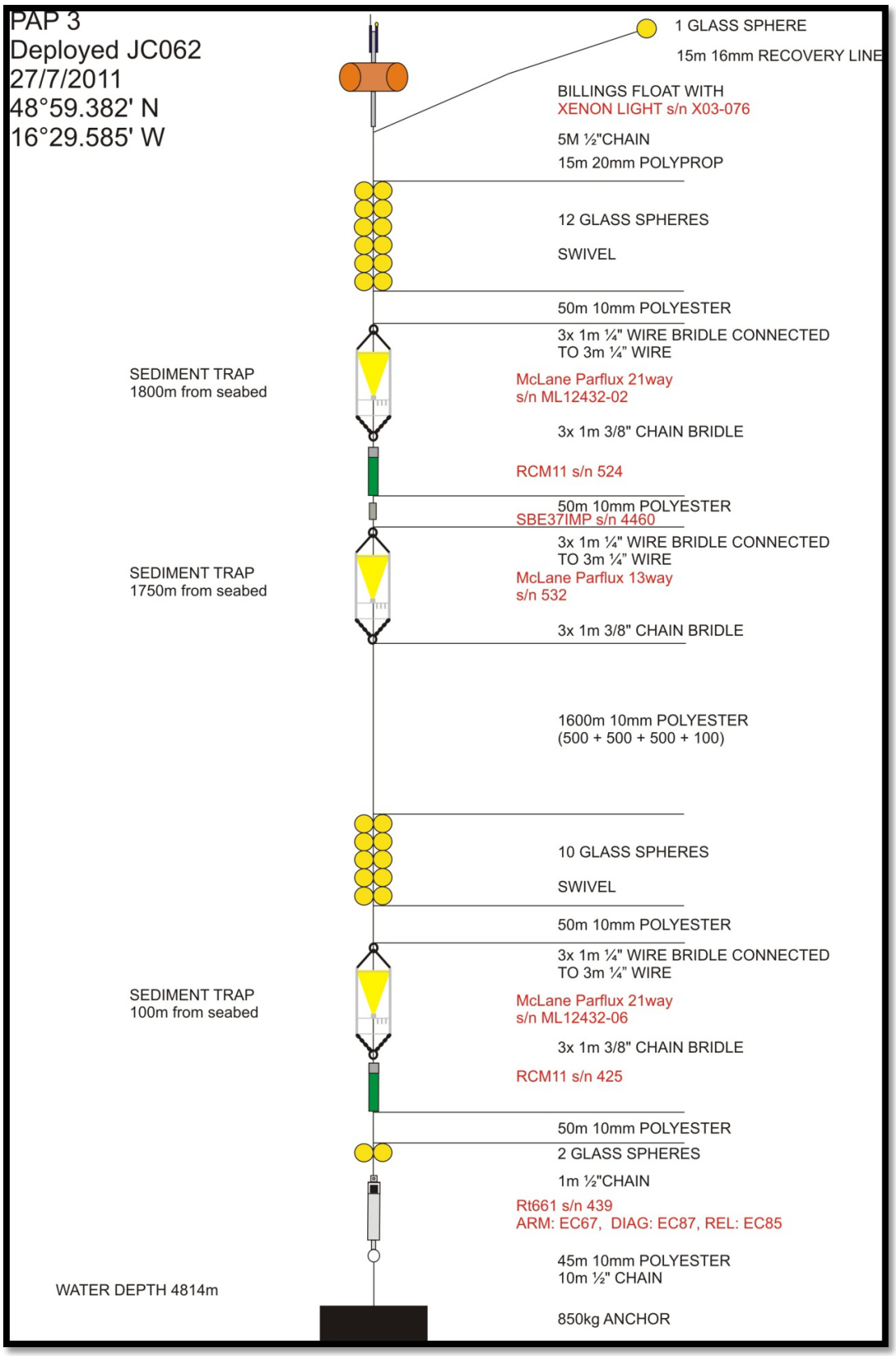


Fig. 28 PAP3 recovered mooring.

3.4.2 Observations, problems and recommendations

As previously stated, the only problem was observed on recovery of the mooring where the lower two 17" Benthos glass spheres supporting the acoustic release had become entangled with the sediment trap above. These two spheres had been placed there because on a couple a previous occasions at the PAP3 mooring, the release had been lost through as yet unidentified tangling/chaffing after the mooring anchor was released. The small effort in untangling the rope from the trap was justified in the safe recovery of all instrumentation, however as a result the bottom trap (ML12432-06) came inboard upside down with the loss of the sample from the open bottle.

3.4.3 Samples Collected

Corinne Pebody

The PAP 3 sediment trap mooring was recovered and deployed on 5th May and was inboard by 10:01. The third sediment trap at 100mab was brought in upside down and landed on its side consequently the sample on open hole was lost.

The bottles had good samples in. All were measured to estimate volume flux and 1ml of formalin was added to each.

Trap A – 3000m

Trap B – 3050m

Trap C – 100mab

Fig. 29 Recovered sediment trap sample cups.

3.4.4 PAP#3 deployment

3.4.4.1 Mooring Operations Summary

The deck setup for the mooring recovery used a Lebus GP 5T deck winch mounted well forward on the after deck with the mooring line, and a long lead to a sheave suspended from the port aft pedestal crane. A chain stopper and boss hook was attached to the deck in the 'red zone for stoppering off the mooring. For deployment the winch had the mooring ropes wound on prior deployment in an order that allowed the top of the mooring to be deployed first and streamed for an anchor last deployment.

The mooring operation commenced at 14:53 on 5th May (48^{0}58.0'N, 16^{0}30.7'W) when the first glass sphere was deployed from the deck. The mooring was deployed top first and streamed as the vessel approached the anchor release point. Due to the uniformity of the seabed, the exact deployment position was not critical, however a 1.5nm run in was allowed to the approximate anchor position. The mooring took 97 minutes to deploy but was towed for a further 55 minutes until 16:55 (48^{0}59.53'N, 16^{0}29.42'W) when the anchor was released, using a SeaCatch hook. The release was interrogated (using an IXSEA TT801 connected through the vessels single element transducer) as it fell to the seabed at an approximate descent speed of 80m/min. The anchor hit the seabed at approximately 17:35. Unfortunately continued ranging indicated that the release was returning to the sea surface. At 18:30, the buoyancy was spotted on the surface. Recovery of the PAP3 mooring commenced at 20:02 and was completed by 21:52. In order to aid deployment, the bottom 45m and extra 2 50m rope sections were added to the winch prior to the mooring recovery, this allowed the long section to be recovered

directly to the winch and be deployed without winding off and reversing the rope order.

On recovery the release was inspected and the IXSEA AR861 s/n 255 showed no signs of having being fired, although the release hook had been released. At the time of writing it is not clear how the release hook could have been released without the cam-latch having been activated. The two 17"glass spheres directly above the release had imploded.

The following day, the PAP3 mooring was deployed again, after having exchanged the acoustic release and replaced the imploded glass spheres.

The second deployment mooring operation commenced at 08:49 on 6th May (48^{0}58.7'N, 16^{0}27.6'W) when the first glass sphere was deployed from the deck. The mooring was deployed top first and streamed as the vessel approached the anchor release point. Due to the uniformity of the seabed, the exact deployment position was not critical, however a 1.5nm run in was allowed to the approximate anchor position. The mooring took 93 minutes to deploy and the anchor was released at 10:22 (48^{0}58.8'N, 16^{0}29.8'W) using a SeaCatch hook. The release was interrogated (using an IXSEA TT801 connected through the vessels single element transducer) as it fell to the seabed at an approximate descent speed of 80m/min. The anchor came to rest on the seabed at 11:18, and remained there.

The total distance that the vessel travelled on the 'tow-in' as the mooring was streamed was 3km at a bearing of 64^{0}T, with an average speed of just over 1 knot.

The mooring was deployed in an identical configuration to the PAP#3 mooring recovered on 5th May.

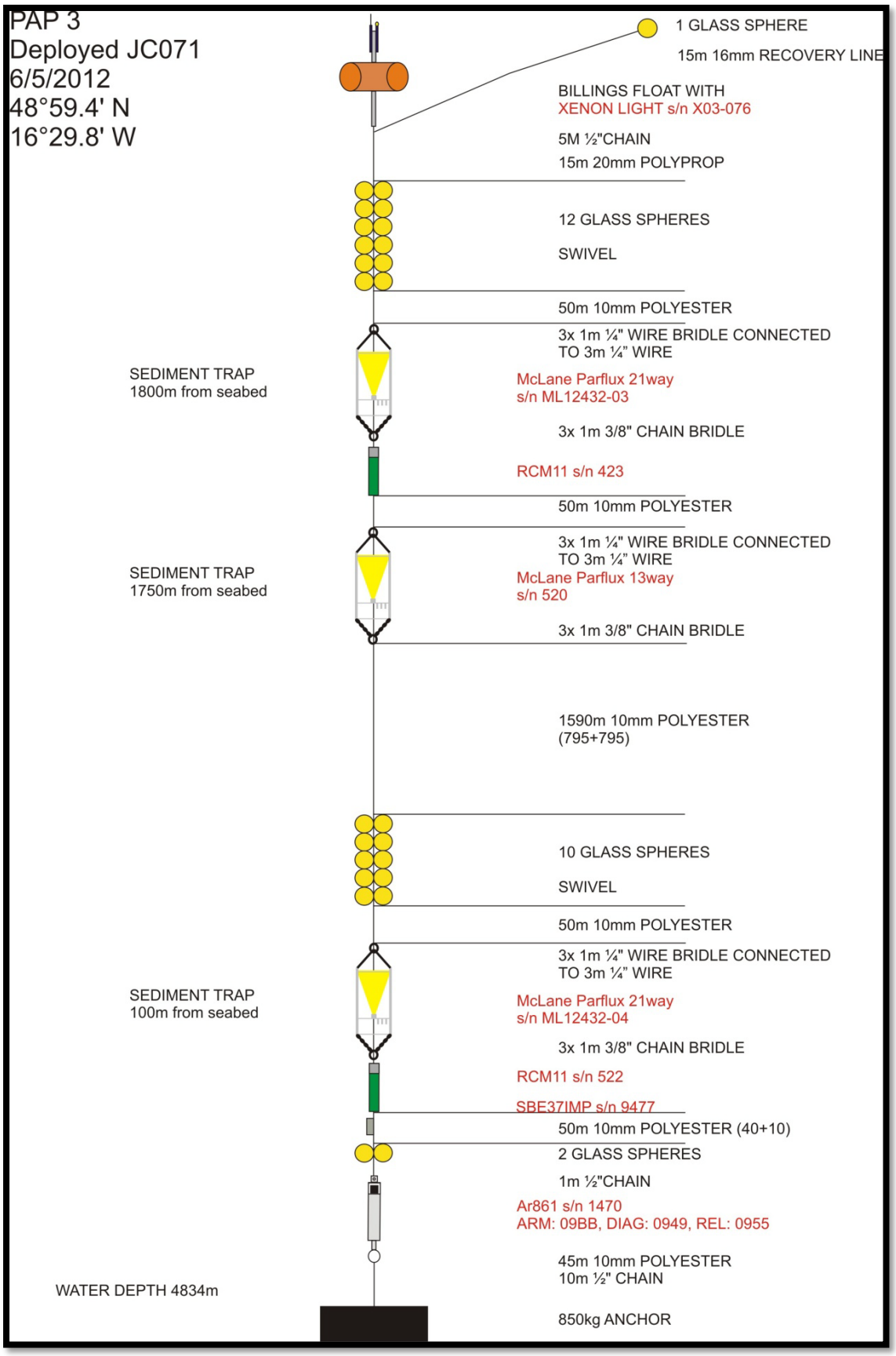


Fig. 30 PAP3 mooring deployed.

3.4.4.2 Instrument Set-Up

RCM11, s/n 423, had a fresh battery installed and the DSU had been erased and the time set to GMT. The instrument was started at 17:00 on 4th May 2012 with a 30 minute sampling frequency for 8 channels. The acoustic sampling was averaged at 300pings throughout the 30min sampling window. The temperature range was set to 'wide' and the conductivity to '0-74 ms/cm'.

RCM11, s/n 522, had a fresh battery installed and the DSU had been erased and the time set to GMT. The instrument was started at 17:00 on 4th May with a 30 minute sampling frequency for 8 channels. The acoustic sampling was averaged at 300pings throughout the 30min sampling window. The temperature range was set to 'wide' and the conductivity to '0-74 ms/cm'.

SeaBird Microcat SBE37IMP s/n 9477 (ID #05), had a fresh battery installed and the memory had been erased and the time set to GMT. The instrument was started at 12:00 on 5th May with a 30 minute (1800 seconds) sampling frequency.

Parflux sediment trap, s/n ML12432-03, had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling scheduled programmed (see below). During deployment the trap was not tilted or inverted.

Schedule Verification
Event 1 of 22 = 05/06/2012 12:00:00
Event 2 of 22 = 05/20/2012 12:00:00
Event 3 of 22 = 06/03/2012 12:00:00
Event 4 of 22 = 06/17/2012 12:00:00
Event 5 of 22 = 07/01/2012 12:00:00
Event 6 of 22 = 07/15/2012 12:00:00
Event 7 of 22 = 07/29/2012 12:00:00
Event 8 of 22 = 08/12/2012 12:00:00
Event 9 of 22 = 08/26/2012 12:00:00
Event 10 of 22 = 09/09/2012 12:00:00
Event 11 of 22 = 09/30/2012 12:00:00
Event 12 of 22 = 10/21/2012 12:00:00
Event 13 of 22 = 11/25/2012 12:00:00
Event 14 of 22 = 12/30/2012 12:00:00
Event 15 of 22 = 02/03/2013 12:00:00
Event 16 of 22 = 03/10/2013 12:00:00
Event 17 of 22 = 04/07/2013 12:00:00

Event 18 of 22 = 04/28/2013 12:00:00
Event 19 of 22 = 05/19/2013 12:00:00
Event 20 of 22 = 06/09/2013 12:00:00
Event 21 of 22 = 06/30/2013 12:00:00
Event 22 of 22 = 07/21/2013 12:00:00

Parflux sediment trap, s/n 520, had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling scheduled programmed. During deployment the trap was not tilted or inverted.

Schedule Verification

Event 01 of 14 = 05/06/12 12:00:00
Event 02 of 14 = 05/20/12 12:00:00
Event 03 of 14 = 06/03/12 12:00:00
Event 04 of 14 = 06/17/12 12:00:00
Event 05 of 14 = 07/01/12 12:00:00
Event 06 of 14 = 07/15/12 12:00:00
Event 07 of 14 = 07/29/12 12:00:00
Event 08 of 14 = 08/12/12 12:00:00
Event 09 of 14 = 08/26/12 12:00:00
Event 10 of 14 = 09/09/12 12:00:00
Event 11 of 14 = 05/19/13 12:00:00
Event 12 of 14 = 06/09/13 12:00:00
Event 13 of 14 = 06/30/13 12:00:00
Event 14 of 14 = 08/04/13 12:00:00

Parflux sediment trap, s/n ML12432-04, had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling scheduled programmed. During deployment the trap was not tilted or inverted.

Schedule Verification

Event 1 of 22 = 05/06/2012 12:00:00
Event 2 of 22 = 05/20/2012 12:00:00
Event 3 of 22 = 06/03/2012 12:00:00
Event 4 of 22 = 06/17/2012 12:00:00
Event 5 of 22 = 07/01/2012 12:00:00
Event 6 of 22 = 07/15/2012 12:00:00
Event 7 of 22 = 07/29/2012 12:00:00
Event 8 of 22 = 08/12/2012 12:00:00
Event 9 of 22 = 08/26/2012 12:00:00
Event 10 of 22 = 09/09/2012 12:00:00
Event 11 of 22 = 09/30/2012 12:00:00
Event 12 of 22 = 10/21/2012 12:00:00

Event 13 of 22 = 11/25/2012 12:00:00
Event 14 of 22 = 12/30/2012 12:00:00
Event 15 of 22 = 02/03/2013 12:00:00
Event 16 of 22 = 03/10/2013 12:00:00
Event 17 of 22 = 04/07/2013 12:00:00
Event 18 of 22 = 04/28/2013 12:00:00
Event 19 of 22 = 05/19/2013 12:00:00
Event 20 of 22 = 06/09/2013 12:00:00
Event 21 of 22 = 06/30/2013 12:00:00
Event 22 of 22 = 07/21/2013 12:00:00

Acoustic release AR861, s/n 1470, had fresh batteries installed and had been wire tested to 4835m.

AR861 s/n 1470 BUILD SHEET

Type **: OCEANO 2500 S-Universal** Date of Manufacture **: 20/01/2012**
S/N **: 1470** Customer **: NERC U.K.**
P/N **: 392 9100** Representative **:**
Function **: Acoustic Release** Job file **: B1 000115**
Modification **:** Customer Approval **:**
TECHNICAL SPECIFICATIONS
ELECTRONIC BOARD ELECTRONIC SPECIFICATIONS
Reference Rev Function S/N
392 2001 3.6 AR 8x1 board 1470
Firmware:
PROM (U6) - ET8_V2.2
FPGA (U38) - REC_V1.0/3.3V
PROM (U32) - EM_V1.0
FPGA (U33) - EM_V1.0/3.3V
Transmit width : **10** ms
Transmit level : **191** □□4 dB ref 1µPa at 1 m
Pinger rate : **5** s
Pinger duration after release : **3** mn
FR0 = **08.5** kHz
FR1 = **13.0** kHz
CAF = **12.0** kHz
PFR = **12.0** kHz
FUNCTIONAL SPECIFICATIONS
Function / Code TT301 / TT701 / TT801 Sequence
ARM / RANGING **09BB** ⇒□□AF Lock-out time = 4s
Active time = 20s
The following acoustic codes must be preceded by an ARM code
RELEASE **0955** ⇒□□AF ⇒□□AF
RELEASE WITH PINGER **0956** ⇒□□AF ⇒□□AF ⇒□PFR
PINGER ON **0947** ⇒□□AF ⇒□PFR
PINGER OFF **0948** ⇒□□AF
DIAGNOSTIC **0949** ⇒□□AF_1 ⇒□□AF_2
MECHANICAL SPECIFICATIONS
Safe Working Load (SWL) = 2.5 T Release Load (RL) = 2.5 T Test Load (TL) = 5.0 T

3.4.4.3 Observations, problems and recommendations

No problems noted.

3.5 Bathysnap (Benthic Time Lapse Camera System)

Brian Bett and Henry Ruhl

Bathysnap is a long-term time-lapse camera system designed to record the abundance and behaviour of deep-sea megabenthos and variations in their seafloor environment (*Lampitt and Burnham, 1983; Bett, 2003*[1]). Objectives for RRS *James Cook* cruise 071 where: (a) to recover a Bathysnap system deployed on the Porcupine Abyssal Plain during RRS *James Cook* cruise 062 (stn: JC062-119: 49° 00.36'N 016° 26.93'W, 10:00 UTC, 21st August 2011); and (b) to redeploy the system for recovery in summer 2013.

3.5.1 Recovery of JC062-119

Recovery was successfully achieved on 3rd August 2012. Acoustic communications with the release unit (Ocean-Ixsea s/n 332) were somewhat difficult using the NMFD TT801 deck unit, but were more readily achieved with the deepseas group TT300 deck unit (an old release preferring and old deck unit. The mooring was released at 12:30 UTC and had an estimated ascent rate of 45-50 $mmin^{-1}$. The Bridge reported radio signals from the mooring at 14:10 UTC and sighted the mooring five minutes later (apparent ascent rate 48.5 $mmin^{-1}$). The mooring was fully recovered to deck by 15:00 UTC and appeared to be in good condition with no obvious damage (the extreme outboard end of the main mooring line was damaged in the block in the very last stage of recovery.

The Bathysnap camera system (Imenco SDS1210) had recorded 768 good seafloor images at nominal eight-hour intervals, the first at 12:05 UTC 21st August 2011 the last at 04:41 3rd May 2012 (note 36-minute timing drift during deployment). The recovered photographs

1 Lampitt R.S. and Burnham M.P. (1983). A free fall time lapse camera and current meter system 'Bathysnap' with notes on the foraging behaviour of a bathyal decapod shrimp. *Deep-Sea Research* **30**:1009-1017,
Bett BJ (2003) Time-lapse photography in the deep sea. *Underwater Technology* **25**: 121-127.

appear to be of good quality, capturing many of the more abundant members of the Porcupine Abyssal Plain megabenthos (Fig. 31). The images record a variety of behaviours and faunal activity including: (a) a 'wandering anemone', a burrowing anemone that relocates between burrow openings (Fig. 32), as previously recorded during a short-term Bathysnap deployment in 2011 (stn. JC062-045) and (b) 'volcano mound' formation.

The first photograph recorded appears to show two 'volcano mounds', a third mound formed during the course of the deployment (Fig. 33). Mound formation was initiated by three sediment bulging events (as opposed to sediment expulsion), mound building then progressed through 11 fluidised sediment expulsions at near-regular intervals (eight at 24-hour intervals and one each at 16- and 32-hour intervals; Fig. 34). Similar chains of volcano mounds have been observed on the Cape Verde Abyssal Plain (*Bett et al., 1995*[2]) where they were clearly produced by echiuran words. No proboscis activity or spoke marks were observed in the present case nor any other indication of the identity of the mound former. Echiurans are a significant component of the mega-infauna of the porcupine Abyssal Plain, and have previously been recorded by Bathysnap (*see Bett & Rice, 1993*[3]). A potential alternative for the mound former would be a molpadiid holothurian, again a significant component of the mega-infauna of the Porcupine Abyssal Plain.

2 Bett BJ, Rice AL, Thurston MH (1995) A quantitative photographic survey of "spoke-burrow" type Lebensspuren on the Cape Verde Abyssal Plain. *Internationale Revue der Gesamten Hydrobiologie* **80**: 153-170.

3 Bett BJ, Rice AL (1993) The feeding behaviour of an abyssal echiuran revealed by *in situ* time-lapse photography. *Deep-Sea Research I* **40**: 1767-1779.

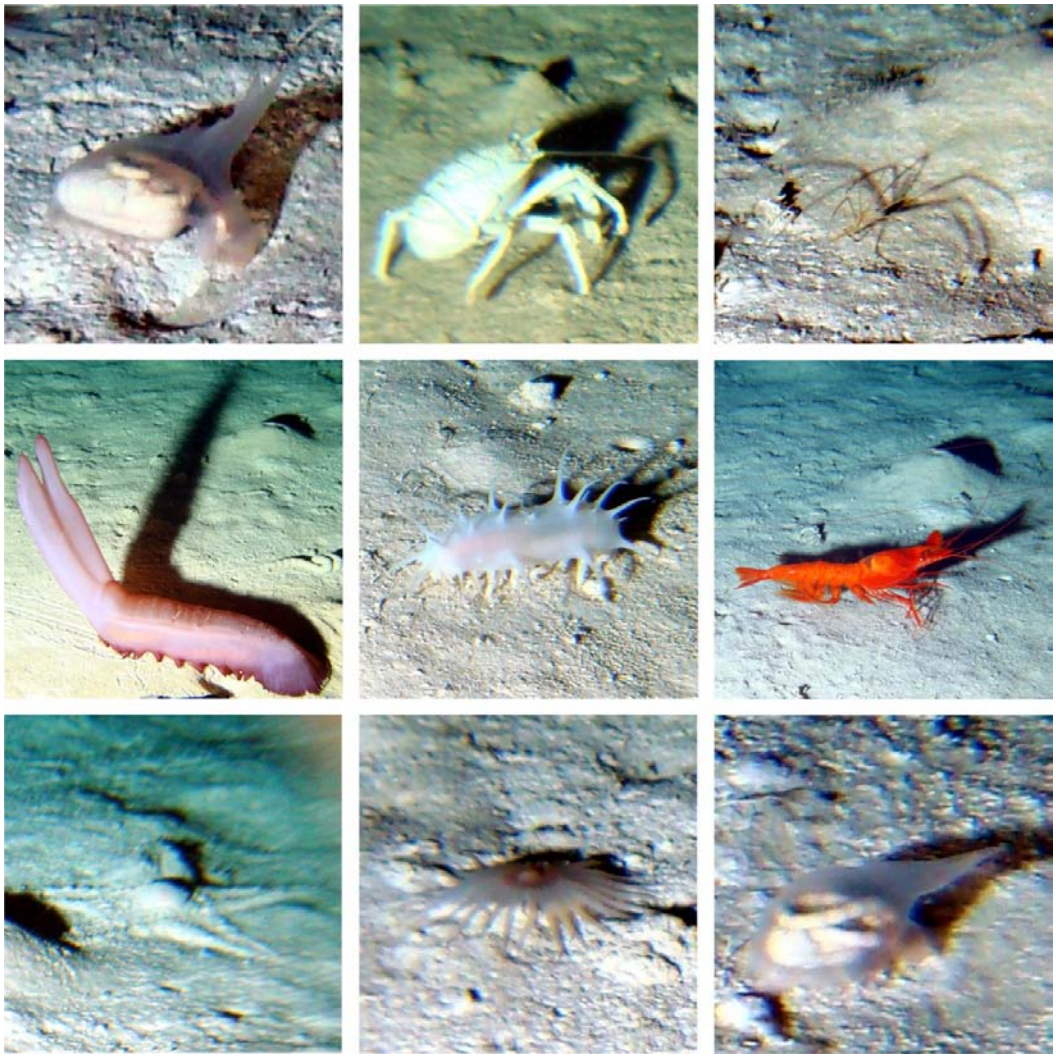


Fig. 31 Example images from Bathysnap JC062-119. Left-right, top-bottom: Amperima (sea cucumber); Munidopsis (squat lobster); Colossendeis (giant sea spider); Psychropotes (sea cucumber); Oneirophanta (sea cucumber); Plesiopenaeus (prawn); asteroid (burried starfish); actinarian (sea anemone); Amperima (sea cucumber).

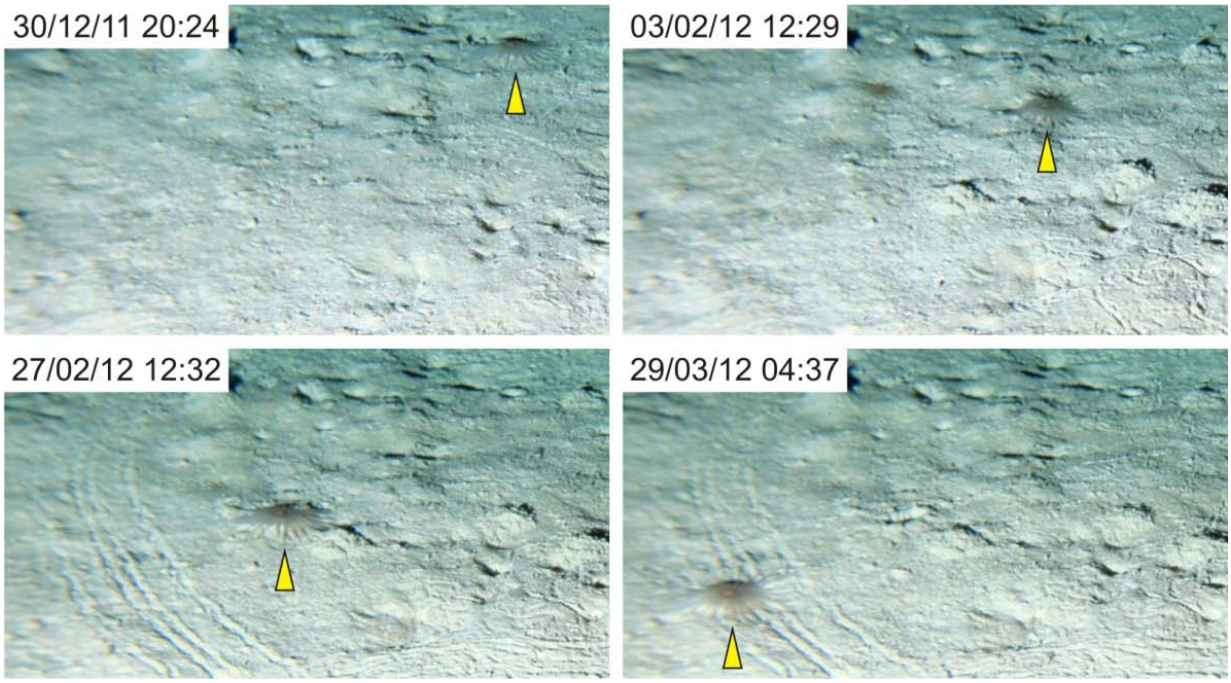


Fig. 32 'Wandering anemone' sequence from Bathysnap JC062-119. Yellow arrows indicate the changing position of burrowing anemone (presumed to be the same individual).

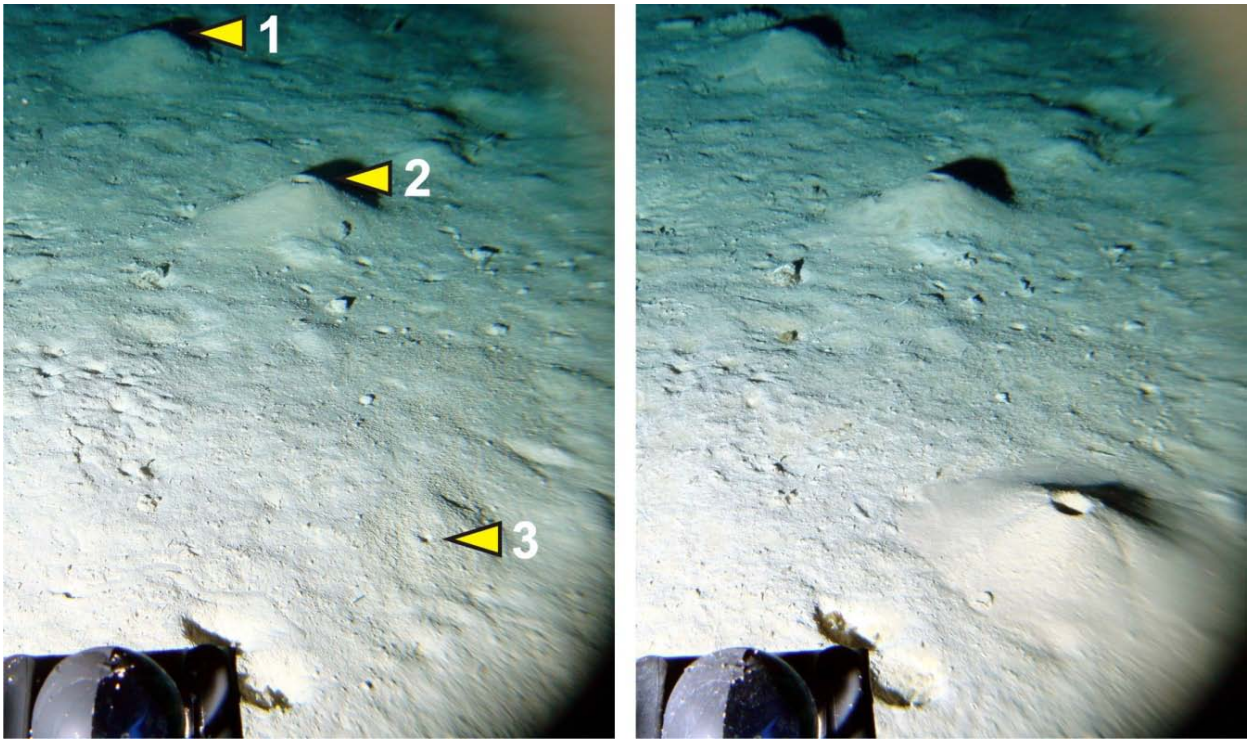


Fig. 33 'Volcano mound' formation sequence from Bathysnap JC062-119. Yellow arrows indicate positions of three volcano mounds, mound three forming during the course of the deployment (left image 21/08/11 12:05, right image 20/10/11 12:14).

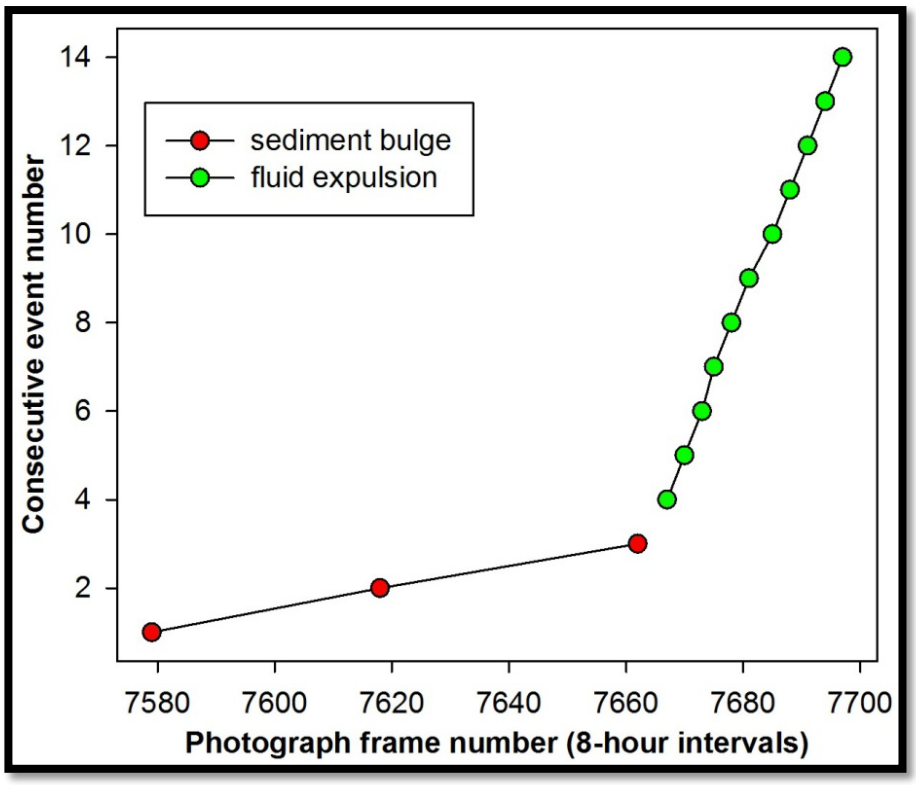


Fig. 34 'Volcano mound' formation time sequence from Bathysnap JC062-119. Three sediment bulge events were followed by 11 fluid expulsion events.

3.5.2 Deployment

Bathysnap was redeployed as station JC071-043 on 6th May. The mooring consisted of the following (Fig. 35):

- seabed frame with acoustic release (Oceano 2500 S-Universal, s/n 1186, AR 8x1 board, ARM 0875, RELEASE ARM+0855, RELEASE WITH PINGER ARM+0856, PINGER ON ARM+0847, PINGER OFF ARM+0848, DIAGNOSTIC ARM+0849)
- 50m white braid rope
- Four yellow benthos spheres on 3m chain, swivel each end
- 20m blue polyprop rope
- Dan buoy of two yellow benthos spheres carrying weighted mast with xenon strobe (Novatech ST-400A, s/n x03-088, auto daylight off, double burst flash), radio beacon (Novatech RF-700A1, s/n x03-86, Channel 72, 156.625 MHz,

2-sec on, 4-sec off), and a yellow flag

- 20m blue polyprop rope
- Lazy float (yellow benthos sphere)

The Bathysnap camera (Imenco SDS1210) was set-up as follows:

- manual mode; 12M pixel; record mode normal; colour mode normal; ISO 200; Multi-metering; focus 3m; white balance for flash; flash level 0; red eye off; contrast 0; sharpness 0; steady shot off.
- SDS timer set at 08:00 intervals (initiated at 05:50 6th May 2012).

Recovery is intended for summer 2013 – cruise not yet programmed.

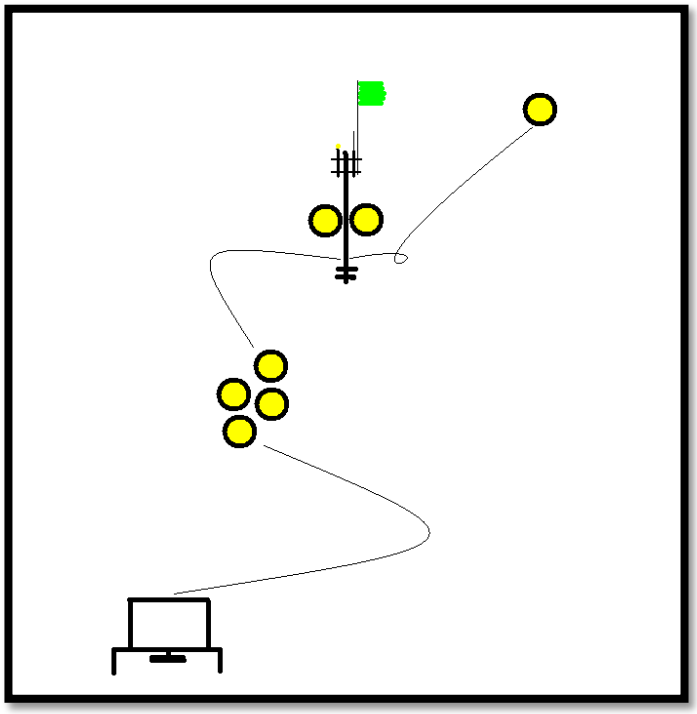


Fig. 35 Mooring sketch for Bathysnap system deployed as station JC071-043.

4 Biological sampling

4.1 Amphipods

Brian Bett

The amphipod trap used during RRS *James Cook* cruise 071 is a comparatively new design, having been previously used on the 2010 ECOMAR cruise and the previous Porcupine Abyssal Plain cruise (JC062), and represents a development of the DEMAR trap used formerly (IOS / SOC). The seabed frame carries four separate double-parlour traps (Fig. 36), two located close to the seafloor (traps 1 and 3) and two about 1-metre above bottom (traps 2 and 4). The trap was deployed on a simple mooring as follows:

- seabed frame with four traps and acoustic release
- 50m braid rope
- Five yellow benthos spheres on 3m chain, swivel each end
- 20m polyprop rope
- Dan buoy of two yellow benthos spheres carrying weighted mast with xenon strobe, radio beacon, and a flag
- 20m polyprop rope
- Lazy float (yellow benthos sphere)

Two deployments were successfully completed

Station	Date	Depth (m corr.)	Latitude	Longitude	Soak time
JC071-020	4 May 2012	4847	49 00.29 N	016 26.98 W	17 hours
JC071-034	5-7 May 2012	4846	48 57.85 N	016 30.12 W	40 hours

Table 13 Deployments of amphipod trap

In each case, all traps were baited with a well defrosted and scored mackerel. On recovery the catch from each trap was preserved separately in ethanol in 1-litre UN plastic jars for return to NOC.

By comparison to the preceding cruise (JC062), catches appeared to be small and lacking in large *Eurythenes gryllus*.

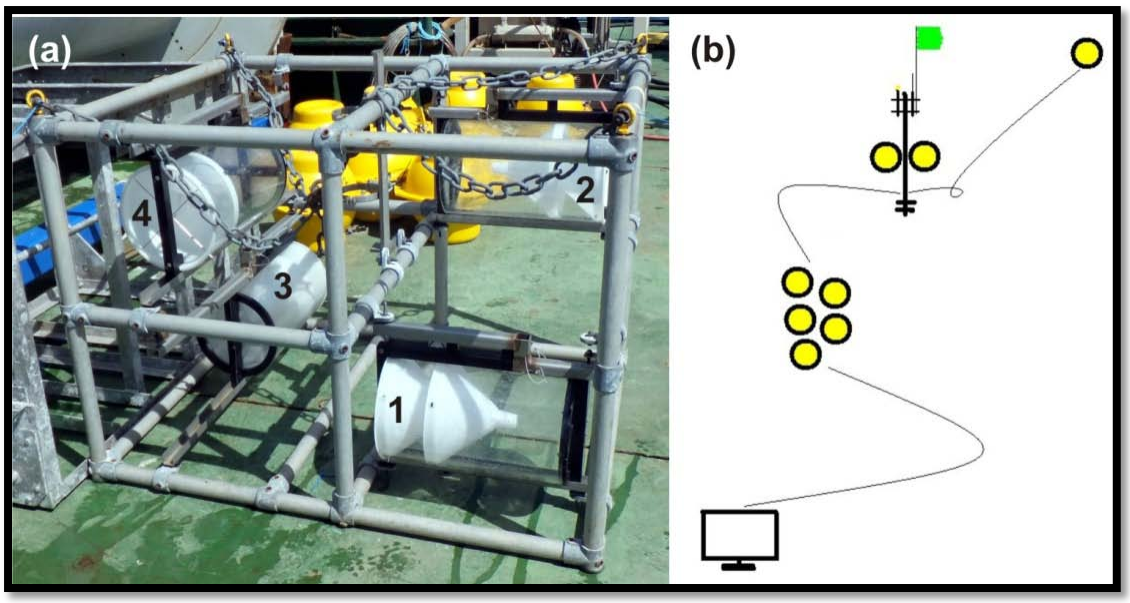


Fig. 36 Amphipod trap (a) Seabed frame showing locations of individual traps (b) Mooring sketch for amphipod trap as deployed during RRS James Cook cruise 071.

4.2 Megacore

Henry Ruhl, Brian Bett and Sara Cregeen

The DeepSeas group Megacore (*Bowers & Connelly design; Gage & Bett, 2005*[4]) was employed during RRS *James Cook* cruise 071. For all five deployments it was fitted with eight 10cm diameter coring units and two extra lead ballast plates (in addition to its standard ballast load). Deployments were monitored with an NMFD-supplied 2-second 10kHz pinger. Acoustic traces were displayed on the Simrad EK500 oceanographic echo-sounder, which generally performed well. The five deployments were carried out at the 'PAP central' location and returned core samples as follows:

Station	Date (2012)	Latitude (DD MM.MM)	Longitude (DDD MM.MM)	Depth (m corr.)	Cores (from 8)	Length (median cm)
JC071-013	03 May	48 49.99	016 30.50	4843	7	39.5
JC071-025	04 May	48 50.00	016 30.50	4846	6	39
JC071-028	05 May	48 50.00	016 30.50	4843	6	40.5
JC071-040	06 May	48 50.00	016 30.50	4846	6	39.5
JC071-071	07 May	48 50.00	016 30.50	4842	4	43

4 Gage JD, Bett BJ (2005) Deep-sea benthic sampling. In: Eleftheriou A, McIntyre A, editors. Methods for the study of marine benthos 3rd ed. Oxford: Blackwell Publishing. pp. 273-325.

Corer performance was somewhat below expectation in terms of numbers of cores returned. All coring units appeared to be functioning well and free running on their support pins. In all cases the safety clips were out at recovery and all failures were complete failures to fire. The bottle screws on the head guides were eased fractionally (c. 2mm) in both axes after JC071-028, but to no improvement. Prior to this cruise the top plates of the frame and damper cylinder were strengthened to cope with additional ballast load. It is possible this modification and / or the subsequent reassembly of the corer has tightened / restricted the descent of the coring head – this will be further investigated ashore.

The cores recovered were generally very uniform in profile and typical of the PAP central location (Fig. 37). About 24cm of light brown sediment overlies a 3cm thick darker brown layer (thought to be tubidite) with a light cream-coloured clay below. The cores were sampled for macrobenthos and prokaryotes as detailed below.

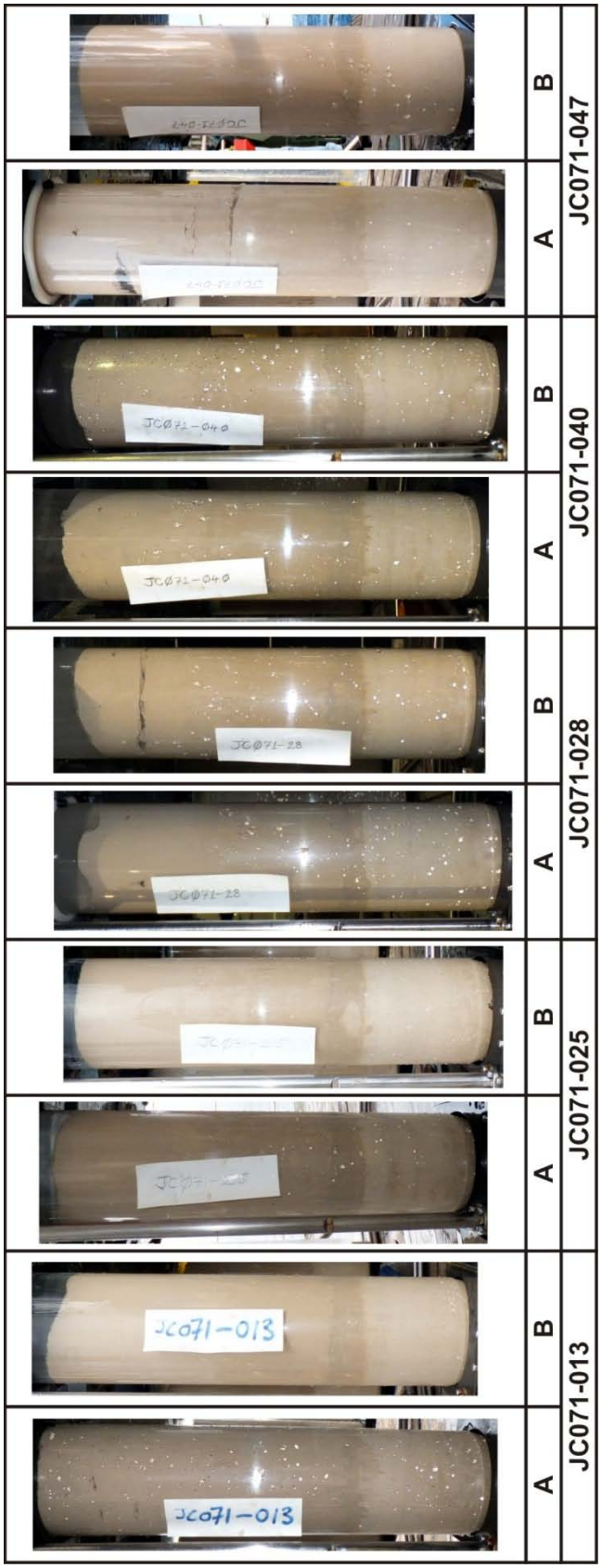


Fig. 37 Representative core profiles from five Megacore deployments (station numbers as indicated) at the 'PAP central' site during RRS James Cook cruise 071.

4.2.1 Macrobenthos

Macrobenthos samples were collected by Megacore during RRS *James Cook* cruise 071 these will contribute to time-series studies of the standing stocks and compositions of this element off the abyssal plain fauna. For each available core, the top layer water was siphoned through a 300 micron sieve, the sieved material concentrated and washed into the 0-1 cm sampling container. The core was then sliced into 0-1, 1-3, 3-5, 5-10 and 10-15 cm layers, each slice was bulk preserved in 10%, borax buffered, formalin (<5% Formaldehyde) in 500 ml or 1.5 l UN certified hazardous materials containers.

4.3 Prokaryotic Community Structure

Sara Cregeen, Henry Ruhl and Markus Moeseneder

The purpose of this study is to investigate the community structure and gene and cell abundances of the water column and sediment prokaryotes at the Porcupine Abyssal Plain. The community structure will be analysed using a Denaturing Gradient Gel Electrophoresis approach where the microbial community is represented by the differential banding pattern of PCR-amplified gene fragments that are separated on an acrylamide gel. Gene abundances, determined through quantitative PCR, will provide information about *in situ* microbial activity. Finally, direct cell counts will show organism abundances at the site. Sampling was divided into sediment core collection and water column filtration. All samples were given a unique continuous number.

4.3.1 Sediments

4.3.1.1 Method

A total of 5 megacorer drops were undertaken, using an 8-tube arrangement (10 cm diameter tubes). Two of these tubes were used for prokaryotes.

Upon arrival on deck of the ship, duplicate push cores were immediately sliced off in a cold room at 4°C. Between slices, all equipment for slicing was cleaned with 70% ethanol before sampling

each sediment horizon. Sediment cores were sampled in the following intervals: 0-1, 1-2, 2-3, 3-5, 5-10, 10-15 cm. Slices were immediately stored in sterile sampling bags at -80˚C.

4.3.1.2 Analysis

A full 1.5ml Eppendorf tube of wet sediment was used as a measurement for flow cytometry analysis, with a duplicate tube stored at -80 ˚C for weight determination in the lab. The content of the tube was emptied into a 15ml tube and 4230 µl of 1x PBSP buffer (see below) was added. The samples were then fixed with 270 µl 0.2 µm filtered 37% formaldehyde (final conc. 2%). The samples were vortexed at the highest speed for 15 min and left at room temperature for 45 min. After incubation, the samples were centrifuged at 1000 x rpm for 5 min to collect the sediment. The supernatant was transferred into a 5 ml cryotube and stored at -80˚C (tubes were kept upright in the cryo-rack until frozen).

1x PBSP buffer (1L):

8g	NaCl	Sodium Cloride (130mM final)
0.2g	KCl	Potassium Chloride (2.7mM final)
1.44g (10mM)	Na2HPO4	Disodium Hydrogen Orthophosphate
0.24g (2mM)	KH2PO4	Potasium Dihydrogen orthophosphate
2.23g	Na4P2O7 *10H2O	Sodium Pyrophosphate (5mM)

4.3.2 Water Column

4.3.2.1 Method

A total of 12 depths were collected at three CTD stations. The depths represented a vertical profile from the seabed to the surface and were as follows: 10 meters above seafloor (mabsf), 30 mabsf, 50 mabsf, 100 mabsf, 1750 mabsf, 1800 mabsf, 950 m, 500 m, 125 m, 80 m, 25 m, 10 m. Ten litres from each depth was filtered through a two-stage filtration system using a peristaltic pump (see Fig. 38). The first filtration was through a 1.2 um pore size GF/C filter, where all particulate matter (with attached bacteria) and larger microbes (such as planktonic eukaryotes) were collected. Free-living bacterial

cells remained in the filtrate of the GF/C filter. These were then collected on a 0.2 um pore size Sterivex filter.

Fig. 38 Two-stage filtration system set up with four samples being processed at the same time.

The filtration system was set up before any CTD sampling was done and all tubing and Jerry cans were soaked with 0.1 N HCl overnight before use. If more samples were being processed, and soaking with 0.1N HCl was not possible, the Jerry cans and the tubing were rinsed with water from the respective sampling depth, before the water was filtered onto the filters. The water samples from the CTD were collected in 10 l and 25 l Jerry cans and stored at 4 ˚C before filtration, which was done immediately. A total of 4 samples were processed at a time, with the filtered water passing first through the GF/C filter and then through the Sterivex filter. Filtered water was collected in 5l (for measurement of the final volume filtered per sample) Jerry cans and the final filtrate was discarded. The GF/C filters were taken from their filter holder with forceps (cleaned with 70% Ethanol) and put in a sterile 1.5 ml Eppendorf tube. Any remaining liquid in Sterivex filters was removed by pushing air though the Sterivex filter with a 50 ml syringe. The Sterivex filter (including its casing) was put in a small sterile sampling bag. Both filters were then stored at -80 ˚C.

4.3.2.2 Flow Cytometry Analysis of the Prokaryotic Community

A total of 4230 ml of seawater was added to a 5 ml cryo-tube and fixed with 270 µl 0.2 µm filtered 37% formaldehyde (final conc 2%). The samples were mixed by inverting the tubes and then left at room temperature for 60 min. Tubes were then stored at -80˚C (tubes were kept upright in the cryo-rack until frozen).

Station number	Date	Longitude (˚N)	Latitude (˚W)	Depth (m)	Activity	Samples
JC071-003	020512	48.9680	16.2694	4837	CTD-1	24 (filtr.)*
						12 (FC**)
JC071-013	030512	48.8333	16.5082	4842	CORER-1	12 (sed. ***)
						12 (FC)
JC071-019	030512	49.0230	16.4541	4833	CTD-3	24 (filtr.)
						12 (FC)
JC071-025	040512	48.8334	16.5553	4843	CORER-2	12 (sed.)
JC071-028	050512	48.8334	16.5082	4843	CORER-3	12 (sed.)
						12 (FC)
JC071-040	060512	48.8333	16.5083	4846	CORER-4	12 (sed.)
						12 (FC)
JC071-047	070512	48.8333	16.5083	4842	CORER-5	12 (sed.)
						12 (FC)
JC071-055	080512	49.1146	16.3383	4840	CTD-6	24 (filtr.)
						12 (FC)

* Filtrations samples – 12 GF/C filters and 12 Sterivex filters.

** FC – flow cytometry samples

*** Two sets of six sediment horizons.

Table 15 List of locations and number of samples taken for prokaryotiv community structure analysis

4.4 Zooplankton Sampling

Corinne Pebody

The WP2, 200µm net was lowered to 200m then brought up at approx. 10 m/min. The port quarter deck winch was used and this has no speed indicator so the rate was therefore controlled by eye. On recovery the net was hosed down with filtered seawater and emptied into a white bucket. Samples were then either, transferred to a 1 litre bottle and preserved by adding formalin to about 5%.

Alternatively the sample was sieved through initially 200 and 50µm mesh and later an initial 500 µm mesh. Samples were transferred to cryo vials and stored in the -80°C freezer. Further analysis will be carried out at NOC. On the second midnight sampling, the net was torn, probably by being dragged under the hull by the current. A spare net was attached to the hoop and the cod ends changed over and restrung. Three midnight and two noon pairs were successful and will be help bench mark the ZPS samples on its recovery.

Sample id	Date	time	lat	long	comments
JC071-016	03/05/2012	12:10 – 12:35	49.000567 – 49.00579	16.457956 – 16.458002	Sample preserved in formalin
JC071-017	03/05/2012	12:45 – 13:21	49.00569 – 49.000565	16.457978 – 16.457993	Sample filtered through 200µm and 50 µm mesh and frozen at -80°C.
JC071-021	03/05/2012	23:33 – 23:45	49.006274 - 49.006238	16.448703 – 16.448680	Sample preserved in formalin
JC071-022	04/05/2012	00:01 – 00:14	49.006283– 49.006287	16.448680 – 16.448677	Sample filtered through 200µm and 50 µm mesh and frozen at -80°C.
JC071-027	04/05/2012	22:12 – 22:24	48.833369– 48.833349	16.508015 – 16.507993	Net ripped, probably dragged underneath hull as line was running underneath on recovery.
JC071-045	06/05/2012	23:47 – 00:33	48.993426 - 48.993413	16.329105 – 16.329096	Sample preserved in formalin
JC071-046	07/05/2012	01:00 – 01:30	48.996557– 49.000661	16.327181 – 16.320900	Sample filtered through 500µm, 200µm and 50 µm mesh and frozen at -80°C.
JC071-053	08/05/2012	02:03 – 02:31	49.346542 - 49.346440	16.004923 – 16.004856	Sample preserved in formalin
JC071-054	08/05/2012	02:36 – 03:03	49.346465– 49.346443	16.004842 – 16.004838	Sample filtered through 500µm, 200µm and 50 µm mesh and frozen at -80°C.
JC071-056	08/05/2012	12:46 – 13:14	49.114695 - 49.114706	16.338355 – 16.338351	Sample preserved in formalin
JC071-057	08/05/2012	13:18 – 13:28	49.114716– 49.114699	16.338357 – 16.338375	Sample filtered through 500µm, 200µm and 50 µm mesh and frozen at -80°C.

Table 16 Zooplankton samples collected with WP2 net

5 Biogeochemistry

5.1 Dissolved Inorganic Carbon and Phytoplankton Community Structure

Denise Smythe-Wright, Aaron Daniel and Kerstin Kroeger

5.1.1 Objective

The purpose of this work was to collect samples for plant pigment analysis, the identification and enumeration of phytoplankton using a combination of analytical methods (viz, light and scanning electronic microscopy and flow cytometry) and for dissolved inorganic carbon analysis. There were four primary objectives to the work:

- To collect pigment data for the calibration and validation of a new tool for primary productivity measurements being developed under the EU project PROTOOL (see FRRF section).

- To study the relationship between phytoplankton and carbon chemistry in the ocean.

- To investigate the relationship between individual plant pigments and phytoplankton groups to better classify phytoplankton (possibly even to species level) using pigment ratios.

- To study the movement of pigments and their degradation products throughout the water column and to assess their potential as a food source to the benthos.

5.1.2 Methodology

Underway samples were collected in UK national or international waters from the ships sea water supply at two -hourly intervals along transects to and from the PAP site and on an ad hoc basis along transects between the individual mooring and benthic sites. Samples were also collected along the tracks of the multibeam surveys. A list of the underway stations is given in Table 17.

In addition, samples were collected at up to 12 depth levels at 7 CTD stations; details of these are given in Table 18. There were also 3 SAP deployments for pigment studies (see SAP section).

5.2 Plant Pigments and Phytoplankton Community

Water samples were collected directly from the non-toxic supply or directly from the 10L Niskin bottles into plastic 10L containers. Each sample was then divided for

- *Plant pigment analysis:* 2 L of water were filtered through 25 mm GFF filters (underway samples in duplicate). The filters were placed in cryovials and flash frozen with liquid nitrogen before being transferred to a -80°C freezer.
- *Light microscopy identification and enumeration:* 100 ml transferred to. an amber glass bottles containing 0.4 ml of lugols iodine solution.
- *Flow cytometry identification and enumeration:* 1.8 ml pipetted into a cryovial containing 0.2 ml of 20% paraformaldehyde solution as a preservative. These samples were then stored at -20°C
- *Coccolithophore enumeration by SEM:* between 200 - 500 ml (sufficient to give colouration) filtered through 25mm 0.8µm membrane filters, which were placed in petri dishes and allowed to air dry before storage.

5.3 Dissolved Inorganic Carbon

Samples were collected directly from the non-toxic supply or from the 10L Niskin bottles into special ground glass topped glass bottles using a small length of narrow bore tubing inserted into the bottom of the bottle. Care was taken to ensure that no gas bubbles were present in the sample by first inverting the bottle and revolving it slowly while returning it to an upright position. Once filled the bottle was flushed from the bottom with three times its volume before inserting the glass stopper. The sample was then opened in a fume hood and 2.5 ml of seawater removed and 50 uL of mercuric chloride added by gently placing the pipette tip below the surface and expelling the liquid. A small amount of silicone grease was placed on the stopper before it was replaced and sealed into the bottle with tape.

Station No	date	time	lat	long
JC071 -001:1	01/05/2012	08.00	49° 19.9'	14° 39.9'
JC071 -001:2	01/05/2012	10.00	49° 13.3'	15° 13.3'
JC071 -001:3	01/05/2012	12.00	49° 07.1'	15° 44.5'
JC072 -001:4	01/05/2012	14.00	49° 01.0'	16° 15.4'
JC071 -001:5	01/05/2012	16.00	49° 03.0'	16° 20.7'
JC071 -001:6	01/05/2012	18.00	49° 03.0'	16° 20.7'
JC071 -001:7	01/05/2012	20.00	49° 00.98'	16° 17.23'
JC071 -001:8	01/05/2012	22.00	48° 43.40'	16° 15.42'
JC071 -004:1	02/05/2012	00.00	48° 42.52'	16° 14.81'
JC071 -004:2	02/05/2012	02.00	48° 46.80'	16° 08.29'
JC071 -004:3	02/05/2012	06.00	48° 58.10'	16° 16.2'
JC071 -004:4	02/05/2012	12.00	49° 00.60'	16° 22.7'
JC071 -014:1	03/05/2012	00.00	49° 00.92'	16° 19.59'
JC071 -014:2	03/05/2012	20.00	49° 01.38'	16° 27.25'
JC071 -023:1	04/05/2012	08.30	48° 50.00'	16° 30.4'
JC071 -023:2	04/05/2012	10.30	48° 55.1'	16° 34.6'
JC071 -023:3	04/05/2012	11.30	49° 03.6'	16° 34.0'
JC071 023:4	04/05/2012	12.30	49° 07.9'	16° 35.55'
JC071 023:5	04/05/2012	13.10	49° 02.3'	16° 34.5'
JC071 023:6	04/05/2012	13.55	48° 58.7'	16° 40.7'
JC071 023:7	04/05/2012	14.23	48° 56.3'	16° 38.5'
JC071 023:8	04/05/2012	14.55	48° 59.1'	16° 33.7'
JC071- 023:9	04/05/2012	15.25	49° 01.65'	16° 39.24'
JC071 023:10	04/05/2012	15.55	48° 58.44'	16° 28.66'
JC071 023:11	04/05/2012	16.30	48° 54.9'	16° 34.44'
JC071 -041:1	06/05/2012	08.30	48° 58.74'	16° 27.73'
JC071 -041:2	06/05/2012	09.25*	48° 59.97'	16° 28.47'
JC071 -041:3	06/05/2012	12.00	49° 03.27'	16° 27.23'
JC071 -041:4	06/05/2012	14.00	48° 59.32'	16° 23.91'
JC071 -041:5	06/05/2012	18.30	48° 59.76'	16° 19.78'
JC071 -051:1	07/05/2012	16.00	48° 57.57'	16° 30.73'
JC071 -052:1	08/05/2012	23.00	49° 09.07'	16° 01.12'
JC071 -062:1	09/05/2012	01:00	49° 10.14'	15° 48.05'
JC071 -062:2	09/05/2012	03.00	49° 11.99'	15° 34.79'
JC071 -062:3	09/05/2012	05.30	49° 14.19'	15° 15.03'
JC071 -062:4	09/05/2012	07.00	49° 16.03'	14° 54.32'
JC071 -062:5	09/05/2012	09.00	49° 18.63'	14° 35.11'
JC071 -062:6	09/05/2012	11.00	49° 08.59'	14° 21.84'
JC071 -062:7	09/05/2012	12.00	49° 23.11'	13° 54.24'
JC071-063:1	10/05/2012	09.00	50° 00.26'	08° 18.12'
JC071 -063.2	10/05/2012	11.00	50° 12.84'	07° 52.92'
JC071 -063.3	10/05/2012	13.00	50° 26.37'	07° 29.63'
JC071 -063:4	10/05/2012	15.00	50° 40.14'	07° 04.56'
JC071 -063:5	10/05/2012	17.00	50° 56.49'	06° 44.58'

JC071 -063:6	10/05/2012	19.00	51° 12.52'	06° 24.75'
JC071 -063:7	10/05/2012	21.00	51° 25.60'	06° 05.40'
JC071 -063:8	10/05/2012	23.00	51° 44.90'	05° 49.16'
JC071 -064:1	11/05/2012	01.00	52° 05.41'	05° 34.28'
JC071 -064:2	11/05/2012	03.00	52° 21.88'	05° 21.05'
JC071 -064:3	11/05/2012	05.00	52° 36.14'	05° 11.80'
JC071 -064:4	11/05/2012	07.00	52° 49.86'	05° 10.64'
JC071 -064:5	11/05/2012	09.00	53° 06.03'	05° 08.06'
JC071 -064:6	11/05/2012	11.00	53° 26.58'	05° 08.58'
JC062 -064:7	11/05/2012	13.00	53° 49.93'	05° 06.73'
JC062 -064:8	11/05/2012	15.00	54° 10.36'	05° 05.39'
JC062 064:9	11/05/2012	17.00	54° 31.21'	05° 07.03'
JC062 064:10	11/05/2012	19.00	54° 52.82'	05° 15.51'
JC062 064:11	11/05/2012	20.15	55° 05.47'	05° 15.01'

* nutrient sample only

Table 17

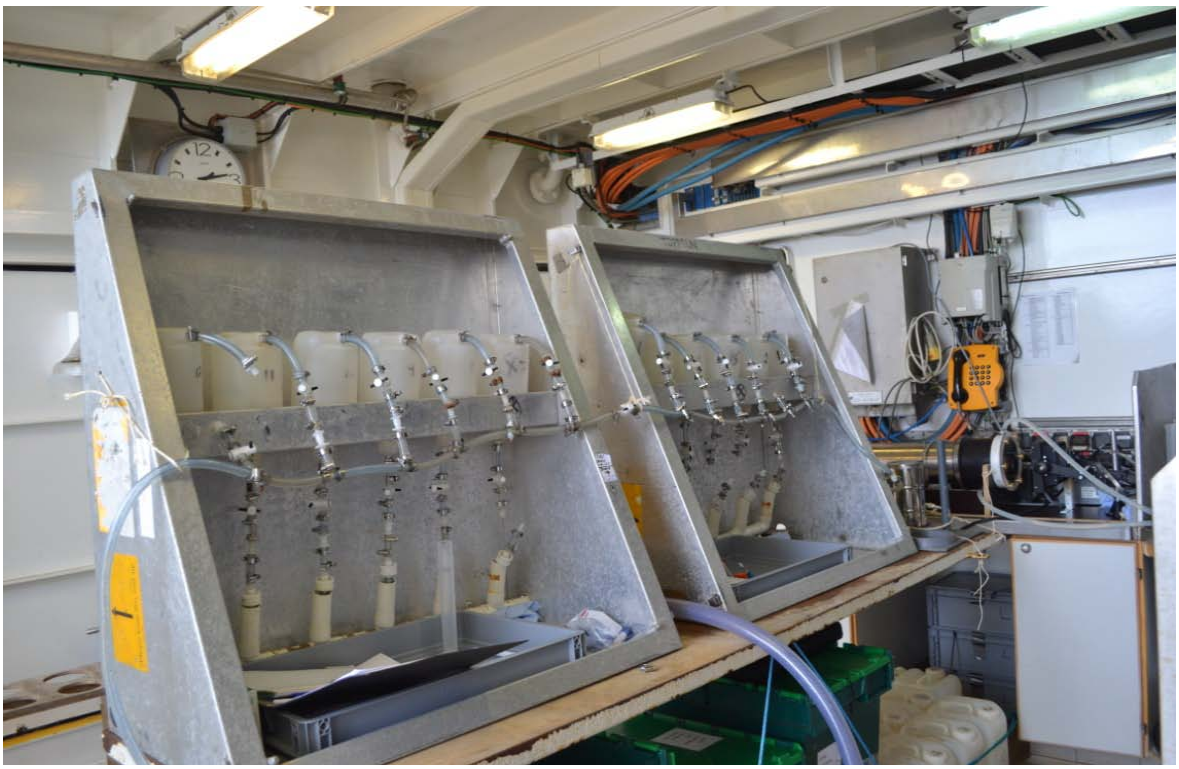


Fig. 39 Filtration rig.

						SAMPLES					
STATION	**DATE**	**CTD on deck TIME (GMT)**	**LONGITUDE**	**LATITUDE**	**NUMBER OF DEPTHS SAMPLED**	**HPLC**	**SEM**	**LIGHT MICROSCOPE**	**FLOW CYTOMETRY**	**DIC**	**TOTAL SAMPLES COLLECTED**
JC071-003	2/05/2012	10:05	16°16.16	48°58.08	7	7	7	7	7	7	35
JC071-018	3/05/2012	17:55	16°27.24	49°01.38	12	12	8	12	12	12	56
JC071-026	4/05/2012	20.45	16°27.17	49°00.48	12	12	4	6	6	12	40
JC071-036	5/05/2012	18:46	16°28.89	49°00.28	16	11	4	9	9	15	48
JC071-055	8/05/2012	11:35	16°20.30	49°06.88	11	3	0	3	3	11	20
JC071-061	8/05/2012	19:35	16°19.77	49°06.97	12	12	3	9	9	6	30

Table 18

5.4 Carbon Flux Derived Using ^{210}Po

María Villa-Alfageme

5.4.1 Scientific Motivation

^{210}Pb ($T_{1/2}$ = 22.3 yr) and its daughter ^{210}Po ($T_{1/2}$ = 138.4 d) are natural particle reactive radioisotopes that can be used as tracers of particle cycling in the upper ocean (Cochran and Masque, 2003). 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 (Fisher et al., 1983) and bacteria (Cherrier et al., 1995; La Rock et al., 1996); its partitioning is similar to that of protein and sulphur within the cell (Fisher et al., 1983; Stewart and Fisher, 2003a, b; Stewart et al., 2005). For this reason ^{210}Po is more efficiently removed from surface waters than ^{210}Pb via sinking particles. Hence, disequilibrium between the two radionuclides occurs when biological activity is mesurable and downward ^{210}Po fluxes can be calculated and converted to POC fluxes using the ratio POC/^{210}Po in particles.

During JC071, ^{210}Po downward fluxes will be calculated to assess the strength of downward export of particulate matter. Subsequently POC/^{210}Po ratios measured in sinking particles (*See SAPS report*) will be used to obtain POC fluxes from 210Po fluxes.

210Po fluxes obtained from to ^{210}Pb and ^{210}Po disequilibrium differ from the ^{234}Th fluxes from ^{234}Th-^{238}U disequilibrium in several ways: First, ^{234}Th is attached to the surface of the particles, on the contrary ^{210}Po is also 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. Study timescales are different, going from several days (^{234}Th) to several months (^{210}Po) due to the different half lives of ^{234}Th (24d) and ^{210}Po (138.4d). Finally, due to ^{210}Po longer half-life and its highest affinity with carbon, ^{210}Po-^{210}Pb disequilibrium occurs from 0 to 500-600m, allowing us to quantify carbon fluxes in deeper depths (down to 400m) than using ^{234}Th method (~150 m).

Finally, the measurement of radioactive ^{210}Po-^{210}Pb pair in the water column provides a novel method by which it is be possible to obtain the

depth variation of the velocities of the sinking particles through the water column.

5.4.2 Sampling Summary

Samples for ^{210}Po and ^{210}Pb analysis were collected from a stainless steel CTD rosette at several stations (Table 19). 5L water samples were collected from 10 to 13 depths between 5-4000m. The sampling distribution was focused between 0 and 500 m, where the most significant disequilibrium between ^{210}Po and ^{210}Pb is expected.

Seawater profiles of 10-13 depths (5-4000 m) for the ^{210}Pb-^{210}Po work were collected from 4 stations. A total of 50 samples were collected, including 3 blanks and 4 replicate samples to ensure reproducibility.

STATION #	DEPTHS (m)	Sampling date	LAT (N)	LON (W)
JC07103	10 25 50 80 135 200 650 1400 2000 3030 4000	01/05/2012	48º 53.080	16º 16.165
JC07118	10 30 90 150 210 500 950 3013 4000 4713	03/05/2012	49º 1.382	16º 27.245
JC07136	5 10 30 50 90 110 200 400 600 800 1000 1500	05-05-2012	48º 29,391	16º 28.894
JC07155	5 10 50 70 90 125 150 200 500 950 2000 3014 4000	08-05-2012	49º 6,882	16º 20,303

Table 19 Station ID, coordinates, sampling date and depths sampled

5.4.3 Pre-treatment On Board

Samples were immediately acidified, spiked with radioactive 209Po, stable Pb2+, as yield tracers, and Fe3+ carrier added. After 6 h of equilibration, the pH was adjusted to 8.5 with NH4OH, 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.

5.4.4 Further Work

Once in the laboratory, in order to isolate 210Po and 210Pb and take it to an appropriate form for its proper measurement, radiochemical purification of polonium must be conducted. Afterwards, polonium will be plated onto silver discs and measured.

For 210Pb determination, the plating solution will be stored for at least 6 months to allow for 210Po ingrowth and to permit determination of 210Pb by re-plating of the 210Po.

Pb yields will be determined through measurement of stable Pb by ICP-OES. 210Po yields will be determined using radioactive 209Po as internal tracer.

210Po and 210Pb will be analysed at the Universidad de Sevilla through alpha spectrometry using Canberra PIPS detectors. Decay corrections would be done to 210Pb and 210Po results before obtaining activity concentration in water.

5.4.5 Scientific Outcomes

^{2}10Po fluxes will be calculated from the disequilibrium between 210Pb and 210Po activities in each depth and integrating to depths 50, 150 and 400m.

SAPS pumps were deployed for every 210Po-210Pb water depth profile (see SAPS report). 210Po and 210Pb, together with POC in particles, will be measured in the particles collected from in-situ pumps.

The ratio 210Po/POC in sinking particles can be then calculated and 210Po export fluxes will be converted into POC fluxes.

210Po and 210Pb will be also measured in PELAGRA samples to obtain 210Po/POC data.

Those results will be used:

- For an assessment of the strength of downward export of particulate matter.
- To compare POC fluxes using POC/^{210}Po ratios from SAPS and PELAGRA. The objective is to use both particle collection methods to obtain complementary information about the sinking of ^{210}Po and POC.
- To model ^{210}Po and ^{210}Pb concentration in depth profiles using a one-box model and the computed results will be used to better understand the ^{210}Po behaviour in the twilight zone. This will provide information of the attenuation of the particle flux through the twilight zone.
- To calculate particle sinking velocities variation with depth in the sampled profiles.
- The final aim is to use this parameter to analyse the attenuation of the particle flux through the twilight zone, e.g. measuring the contribution of slow sinking particles to the flu and their changes with depth.

5.5 SAPS Deployment

María Villa-Alfageme and Denise Smythe-Wright

Long Lat	Collection date	Station number	depths (m)	Type of mesh	Splits
49º 00.86 16º 20.02	3/05/2012	JC07109	50	1µm NITEX	5/8 Po-Pb, 3/8POC,
				53µm NITEX	5/8 Po-Pb, 3/8POC,
		JC07111	500	1µm NITEX	5/8 Po-Pb, 3/8POC,
				53µm NITEX	5/8 Po-Pb, 3/8POC
		JC07112	1000	1µm NITEX	5/8 Po-Pb, 3/8POC,
				53µm NITEX	5/8 Po-Pb, 3/8POC,
48º 57.878 16º 31.719	5/05/2012	JC07132	200	1µm NITEX	5/8 Po-Pb, 3/8POC,
				53µm NITEX	5/8 Po-Pb, 3/8POC,
		JC07133	400	1µm NITEX	5/8 Po-Pb, 3/8POC,
				53µm NITEX	5/8 Po-Pb, 3/8POC
49º 06.88 16º 20.28	8/05/2012	JC07158	200	1µm NITEX	5/8 Po-Pb, 3/8POC,
				53µm NITEX	5/8 Po-Pb, 3/8POC,
		JC07159	400	1µm NITEX	5/8 Po-Pb, 3/8POC,
				53µm NITEX	5/8 Po-Pb, 3/8POC,

Table 20 POC and ^{210}Po-^{210}Pb SAPS

During the JC071, deployments for Standing alone pumping system (SAPS) were performed. Three SAPS were deployed per cast. Generally two were devoted for ^{210}Po and derived carbon fluxes (Maria Villa-Alfageme) and one for pigment work (Denise Smythe-Wright) as summarised in Tables 20 and 21. SAPS pumping time was set as 90min except for those that were deployed at 1000-4000m, where the time was set to 120 min. This allowed a filtration volume from 500 to 2000L. After recovery, particles were rinsed off the mesh on POC-^{210}Po devoted SAPS and split in two portions for subsequent ^{210}Po-^{210}Pb and POC analysis onshore. ^{210}Po and ^{210}Pb and POC will be analysed at University de Sevilla. Pigment SAPS filters were frozen and stored for later analysis by HPLC at NOC.

Long Lat	Collection date	Station number	depths (m)	Type of mesh	Splits
48º 57.57 16º 30.73	7/05/2012	JC07120	1000	1µm GF/F	No splits
		JC07121	2500	1µm GF/F	
		JC07122	4000	1µm GF/F	
48º 57.878 16º 31.719	5/05/2012	JC07131	500	1µm GF/F	
49º 06.88 16º 20.28	8/05/2012	JC07158	200	1µm GF/F	

Table 21 Pigment SAPS

5.6 Automated Measurements of Phytoplankton Photosynthetic Activity

Jacco Kromkramp and Greg Silsbe

5.6.1 Introduction

The contribution of the NIOZ team to the JCO71 cruise is within the framework of the FP7 EU funded project PROductivity TOOLs (PROTOOL). The aim of this project is to develop an automated primary production platform which can be used on research ships and on ships of opportunity. PROTOOL developed 3 pieces of hardware: 1) an automated active fluorometer to measure the photosynthetic activity, 2) a reflectance setup

(above surface hyperspectral reflectance) to measure water quality parameters (chlorophyll *a* and the diffuse light attenuation coefficient k_d) and 3), an absorption meter (OSCAR) to measure absorption by water constituents, including phytoplankton. The aim of the measurements during the JC071 cruise was to see if the PROTOOL modules work in Case 1 waters, and to obtain automated estimates of primary production with discrete measures of carbon fixation. For this reason C-fixation measurements were made 3 times a day.

Previous measurements made on the Baltic, and during the JC062 cruise showed that phytoplankton photosynthetic activity was highly regulated. Automated photosynthetic rapid light curves (RLC) showed an up regulation of the maximum rate of photosynthetic electron transport (ETR_{max}) which peaked around solar noon, and a decrease in the photosynthetic efficiency (α_{ETR}) during the day, especially on sunny days. During this cruise, initial analysis on our measures, demonstrated the pattern occurs as well (Fig. 43). Because flowthrough RLC measurements are novel, checks were carried out to see if the same pattern occurred in discrete measurements. To do this, hourly samples were taken from the non toxic flow through (NTFT) water supply, and RLCs were performed on these discrete samples using a FastTracka-II equipped with a FastAct light source.

5.6.2 Methods

Automated Rapid Light Curves on the non-toxic water supply were made using a PC controlled LED light source (SLC3500, Photon Systems International) which was fitted with red and white LED. Unfortunately the white LED's could not be PC controlled for an unknown reason, hence only the red LEDs were used in the rapid light curves. In 9 steps of 30 sec each the intensity was increased to approx. 900 µmol photons m^{-2} s^{-1}, followed by another 30 seconds of darkness. This irradiance sequence was repeated continuously. The FastTracka-I was fitted with a custom made cuvet with a transparent window facing the LED panel. The volume of the cuvet was 1350 ml and was hooked up to the non-toxic water supply with a flow rate of ~2.1 L min^{-1}, meaning that after 30 sec 55% of the volume had been replaced by new water and that after 1 min only 9% of the original sample was present. Hence, the RLC were not influenced by the light history

generated by the RLC itself and the measured photosynthetic quantum efficiencies are thus mainly the result of *in situ* conditions.

The settings of the FastTracka-I were as followed: 8 acquisitions were averaged, the saturation flash time was instrument setting 1 and the flash delay time was instrument setting 4). The photomultiplier was set at autogain. From the measured minimum (F_o) and maximum fluorescence (F_m) the maximum quantum efficiency of photosystem II is calculated (corrected for background fluorescence using filtrate) as:

$$F_v/F_m = (F_m-F_o)/(F_m-F_{background})$$

In the presence of actinic light, the effective PSII quantum efficiency was calculated as:

$$\Delta F/F_m' = (F_m'-F)/(F_m'-F_{background})$$

Where F and F_m' are the minimum and maximum fluorescence in actinic light (our red LED light). From $\Delta F/F_m'$ and the actinic irradiance E the relative rate of PSII electron transport can be calculated (it is relative because it is based on incident and not absorbed light):

$$rETR = E \times \Delta F/F_m'$$

The parameters $rETR_{max}$ and α_{ETR} describe the shape of the RLC and are calculated as (Silsbe & Kromkamp, in press):

$$rETR = rETR_{max} (1-\exp(-E/E_k))/E,$$

where $E_k = rETR_{max} /\alpha_{ETR}$; this parameter describes the approximate irradiance where photosynthesis switches from being light limited to being light saturated, and is often used as an index of high or low light acclimated cells.

RLC on discrete samples were measured with the FastTracka-II fitted with the FastAct accessory. Here, a RLC was performed on the same sample. The FastAct was temperature controlled, so the RLCs were performed at *in situ* temperatures. nother major difference was that the FastAct used blue light (470 nm peak intensity), hence for comparison of absolute rates a correction has to be done for the differences in light colour between both systems. This required not only knowledge about the spectral

characteristics of the light sources used (which is known), but also of the optical absorption cross section (i.e. the absorption coefficient of the algae per mg chl*a*). For this reason, 250 ml water samples were filtered onto 25 mm Whatmann GF/F. The filters were stored at -80 ^{o}C, and the absorption characteristics will be determined later at the NIOZ lab.

Fig. 40 Set-up for 13C-incubations.

Fig. 41 3 TriOS Ramses Sensors mounted on side of ship.

13C-incubations were performed on 250 samples taken from the NTFT at 8:00, 12:00 and 16:00 h and were incubated in 250 ml tissue culture bottles for 3 h at *in situ* temperatures at irradiance 2x E_k and $E_k/2$ (Fig. 40). To 250 ml 1 ml of a $NaH^{13}CO_3$ was added, assuming a 10% DIC enrichment (assuming a natural DIC concentration of 2.1 mM). After the incubation the samples were filtered onto 25 ml GF/F filters and stored at -20 ^{o}C, until analysis at the NIOZ lab.

Hyperspectral reflectance was measured using a combination of 3 TriOS Ramses sensors: 1 irradiance sensor looking at the zenith, one radiance sensor measuring the water leaving radiance (Lu) and one radiance sensor measuring the sky (Lsky) (Fig.41). Both Lu and Lsky were measured at a 40^{o} angle. The measurements were made every 15 min using the raster function of the TriOS MSDA software. The measurements were started on the 6th May. The sensors were mounted on the deck above the bridge of the ship. The irradiance sensor was moved upward in order to minimize shade/reflection from the white satellite antenna behind it (arrow).

OSCAR absorption measurements. The OSCAR is an absorption meter which makes use of the point source integrating cavity principle. Basically it is an integrating sphere with a perfect white diffuse wall, and diffuse Lambertian light source in its centre and a spectroradiometer fitted to the cavity wall. The OSCAR is still a prototype, and was just in flow through during this cruise, but because some files were missing, the measurements only started on the 7th May. Contact between the sensor itself and the IPS401 unit was lost regularly, making the instrument not too reliable at the moment.

5.6.3 Preliminary Results

Fig. 42 shows an example of the dynamic behavior in phytoplankton chlorophyll synthesis. When surface irradiance increases, the fluorescence measured with the surfmet system (measuring the flow through water supply) showed a near mirror image, although hysteresis in the signal was visible: the decrease in the fluorescence was slower than the rise and the minimum was reached after the irradiance had reached at maximum at solar noon. The bottom panels shows that he decrease in the fluo signal is caused by a decrease in the PSII quantum efficiency: de dynamics in F_v/F_m were similar to the changes in the fluo signal, indicating that

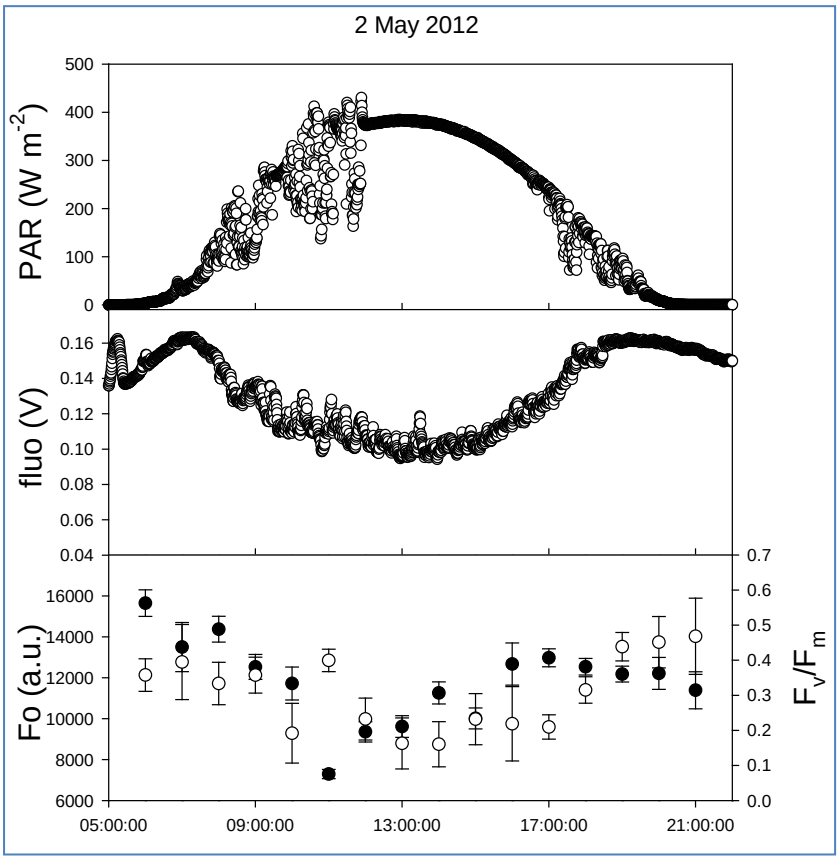


Fig. 42 PAR data (top), fluorescence signals of the surfmet system (middle) and Fo and F_v/F_m data from discrete measurements (bottom panel).

the decrease was not due to a decrease in phytoplankton biomass, but were the result of non-photochemical quenching (NPQ) of fluorescence, a process that is the result of a photoprotection mechanisms (qE), possible photodamage (qI) and state transitions (qT), but we believe qE, driven by the xanthophyll cycle is the most important process (see below).

Fig. 43 below shows the results from the discrete rapid light curves from 4 days at the PAP sight measured during JC071. The blue points correspond to maximum electron transport rates (ETR_{Max}) and the red lines correspond to light limited electron transport ($\square_{ETR}$). This data demonstrates that phytoplankton dynamically adjust their photosynthetic apparatus over the course of a day, consistent with previous measures made in the PROTOOL project in the Baltic and North Seas and on a previous NOC cruise (JC062). This data demonstrates an up regulation of ETR_{max} peaks around solar noon and is coincident with a decrease light limited photosynthetic efficiency (αETR).

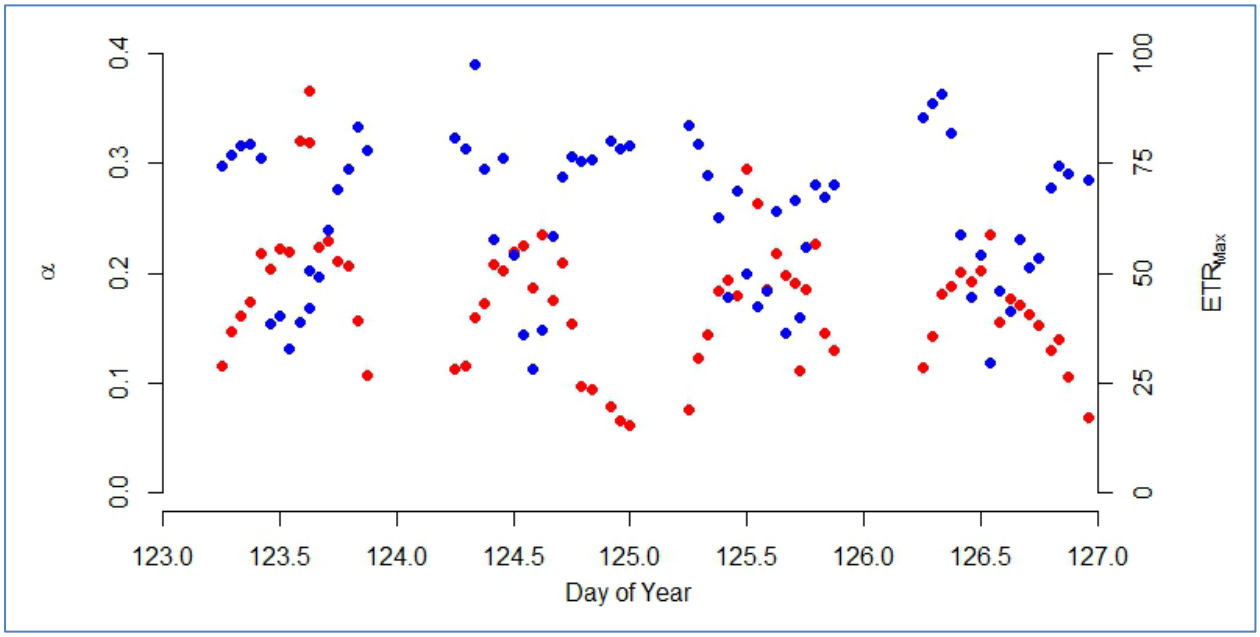


Fig. 43 Discrete rapid light curves measured during JC071 showing diurnal variations in light limited electron transport rates (a) and maximum electron transport rates (ETR_{MAX}).

We studied recovery kinetics of F_v/F_m by following the change in F_v/F_m at an irradiance of 19 µmol photons m^{-2} s^{-1}, initiated after the completion of the RLC. Fig 3 gives an example of such a recovery phase. The recovery

follows an exponential increase, and from the graphs it is difficult to say if it is biphasic or monophasic. In the former case, recovery will consist of a population of fast (qE relaxation) and slow recovery (qI recovery = PSII repail, likley involving *de novo* D1 protein synthesis), whereas if the recovery can be adequately described by a single exponential rise, qE relaxation will be the most likely explanation. Model 1 describes recovery of F_v/F_m ($\Phi_{II,t}$) as a single exponential rise to a maximum with rate constant to:

Model 1: $$\Phi_{II,t} = (\Phi_{II,0} - \Phi_{II,\infty}) * e^{-k*t} + \Phi_{II,\infty}$$

Whereas Model 2 describes recovery of the PSII efficiency using a 5 model parameter where P_{fast} and P_{slow} are the fast and slow recovering populations with their rate constant k_{fast} and k_{slow} respectively $\Phi_{II,0}$ and $\Phi_{II,t}$ are the initial and final value for the PSII quantum efficiency.

Model 2: $$\Phi_{II,t} = \Phi_{II,0} + P_{fast}(1 - e^{-k_{fast} \cdot t}) + P_{slow}(1 - e^{-k_{slow} \cdot t})$$

An initial analysis based on r^2 values shows that both model perform equally well, and that according to model 2 the fluorescence kinetics are dominated by a minority ~10%) of fast reacting PSII units. For simplicity we show the results in the daily kinetic parameters of model 1 in Fig. 44.

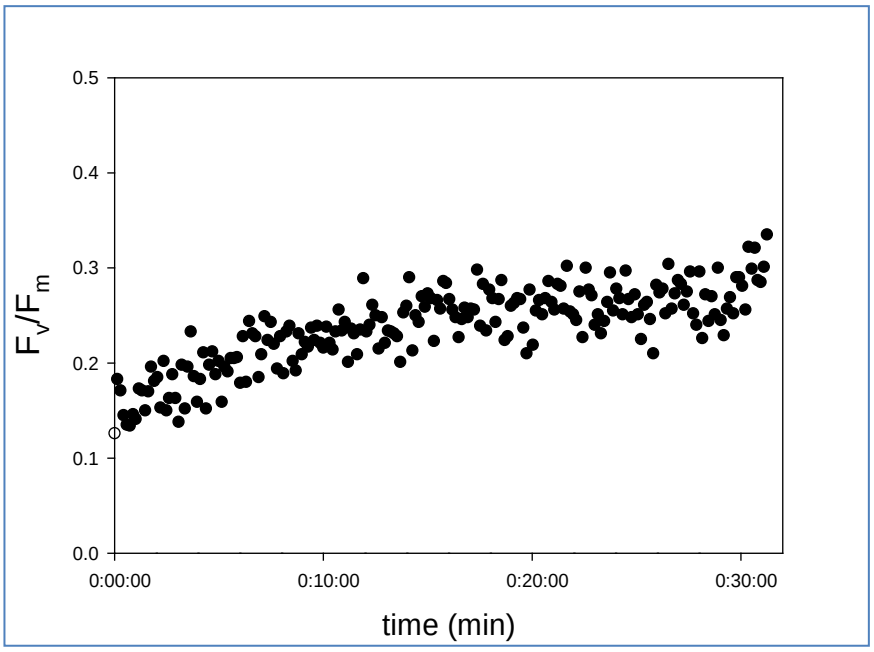


Fig. 44 Example of recovery kinetics at an irradiance of 19 µmol photons m^{-2} s^{-1}. Sample of 2 May, 14:00h. The data here are not corrected for background fluorescence.

This graph shows clearly that after recovery of Fv/Fm the values are stable. The fact that the values are so low is caused by the fact that they have not been corrected yet for background fluorescence. This does not influence the rate constant *k*. The initial F_v/F_m, the result of 30 sec

of dark acclimation after the completion of a RLC is higher during the night than during the day, hence the difference in F_v/F_m ($\Delta F_v/F_m$) is larger during the day. This means that the 30 sec dark acclimation period is not sufficient to reach full relaxation. Interestingly, the rate constant for recovery is high during the night and decreases during the day. This suggests that relaxation slows down during the day, which might indicate that qI might be induced during the day. The fact that this is not picked up in model 2 might have to do with the noise in the recovery data.

6 Acoustic Surveying of the Seafloor

6.1 EM120 (Multibeam Echosounder and Sub-bottom Profiler)

Swath bathymetric mapping and chirp sediment profiling were carried out on an opportunistic basis during the cruise.

Two multibeam surveys were carried out to extend bathymetric coverage of the greater PAP area (Fig. 45):

- SE area survey (JC071-002, 21:59 1st May – 03:22 2nd May)
- NW area survey (JC071-051, 20:59 7th May – 01:48 8th May)

A multibeam and chirp profiler survey of the prospective AESA (Autonomous Ecological Surveying of the Abyss) project large-scale survey area was also undertaken (JC071-024 13:07-16:31 4 May). Three lines were run through six waypoints as follows (see Fig. 47):

Line	Start WP	Start time	End WP	End time
3	6	13:07	5	13:50
2	4	14:20	3	15:22
1	2	15:52	1	16:31

Table 22

At time of writing the swath bathymetry had not been processed, but should provide a good base map for the planning of Autosub6000 missions during the forthcoming *RRS Discovery* cruise 377/8. Sub-bottom profiler results are shown in Fig. 48, these will be combined with similar SBP data

acquired during RRS *James Cook* Cruise 062 to further study the occurrence of 'abyssal plain faults' (see e.g. *Buckley & Grant, 1985*[5]) tentatively identified during the latter cruise.

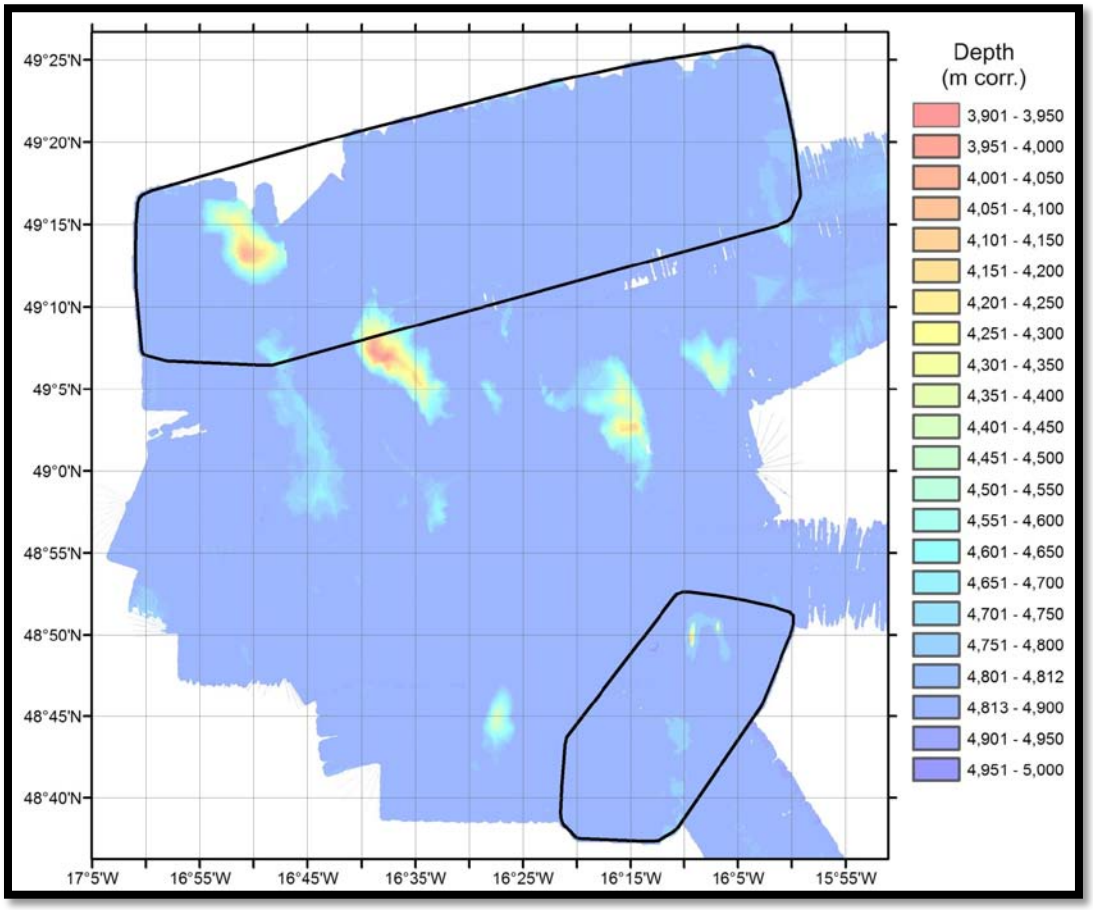


Fig. 45 Multibeam bathymetry surveys carried out: NW area (JC071-051), SE area (JC071-002).

5 Buckley, D.E., Grant, A.C., 1985. Faultlike features in abyssal plain sediments: possible dewatering structures. Journal of Geophysical Research 90: 9173-9180.

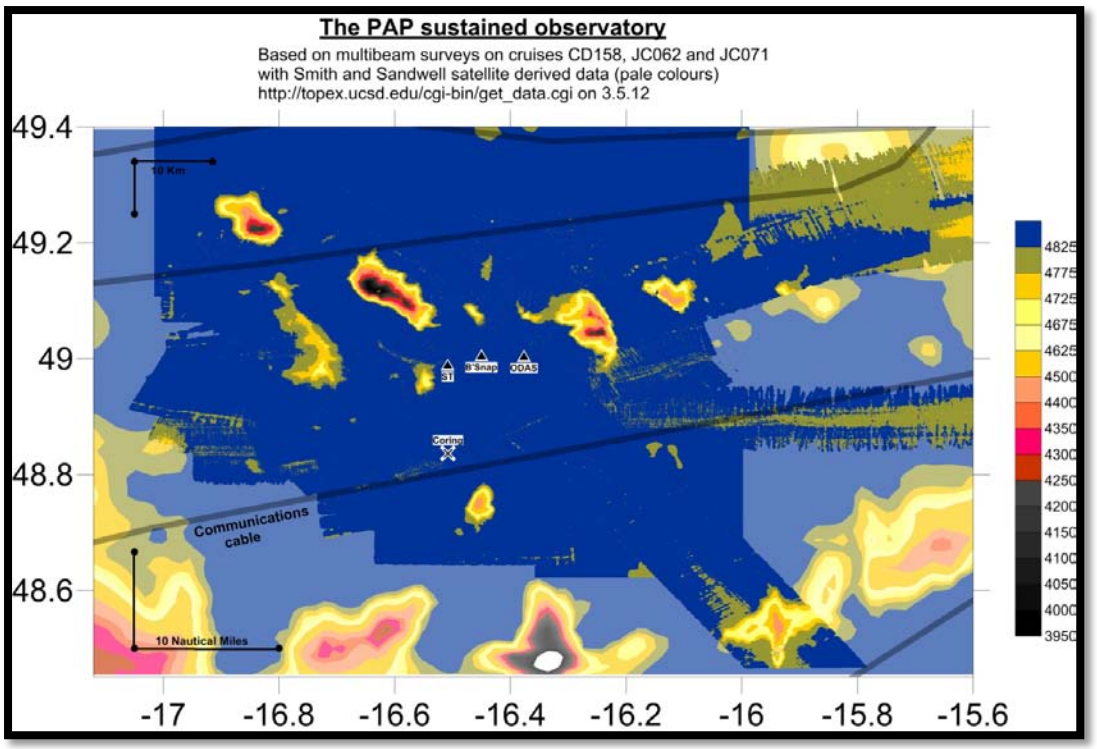


Fig. 46 Bethymetry of area after multibeam survey.

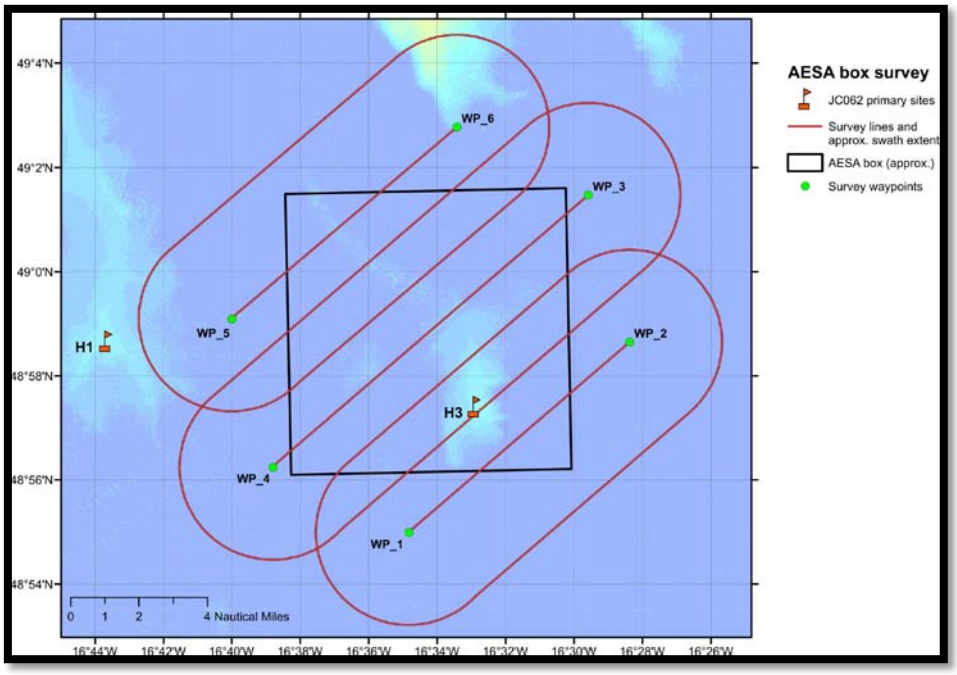


Fig. 47 Multibeam and chirp profiler survey of the 'AESA box's carried out. (Note the survey was run in reverse order, i.e. WP6 to WP1).

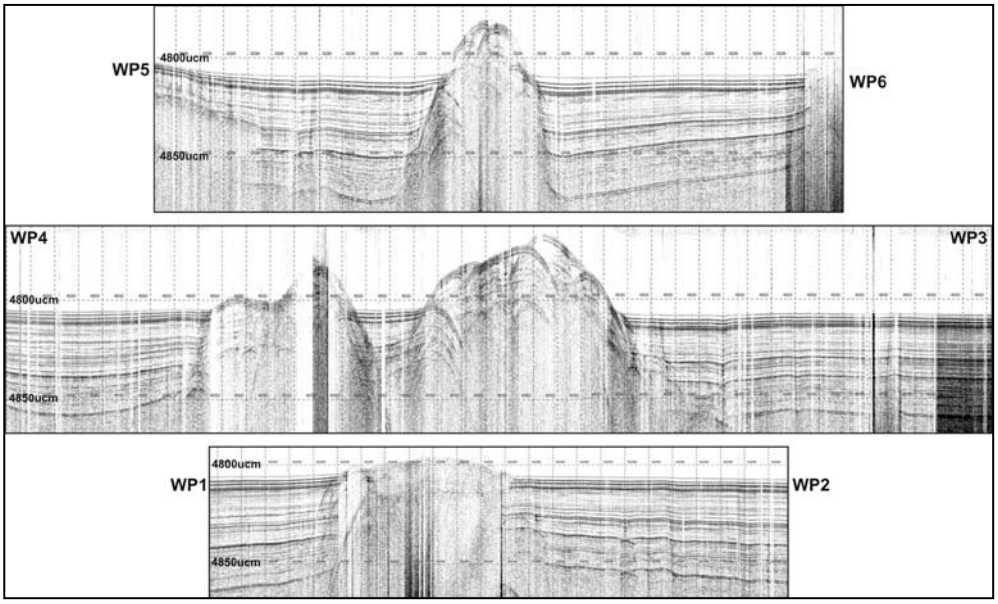


Fig. 48 SBP-120 survey lines through the 'AESA box's carried out during RRS James Cook cruise 071. (See Fig. bjb9 for locations and horizontal extents).

7 Trials of PELAGRA (Neutrally Buoyant Sediment Trap)

Sam Ward

The aim of JC071 for the PELAGRA's was to rectify the issues which were experienced during D369 to traps P5, P7 and P8. These issues were:

- Faulty hydrostatic depressor releases
- Faulty hydrostatic emergency abort releases

Due to these faults, limited ballast information was gained from deployments for P5, P7 and P8 on D369. Ballast information is essential and required for future cruises when the PELAGRA's will be expected to deliver sediment samples in 2013.

Fig. 49

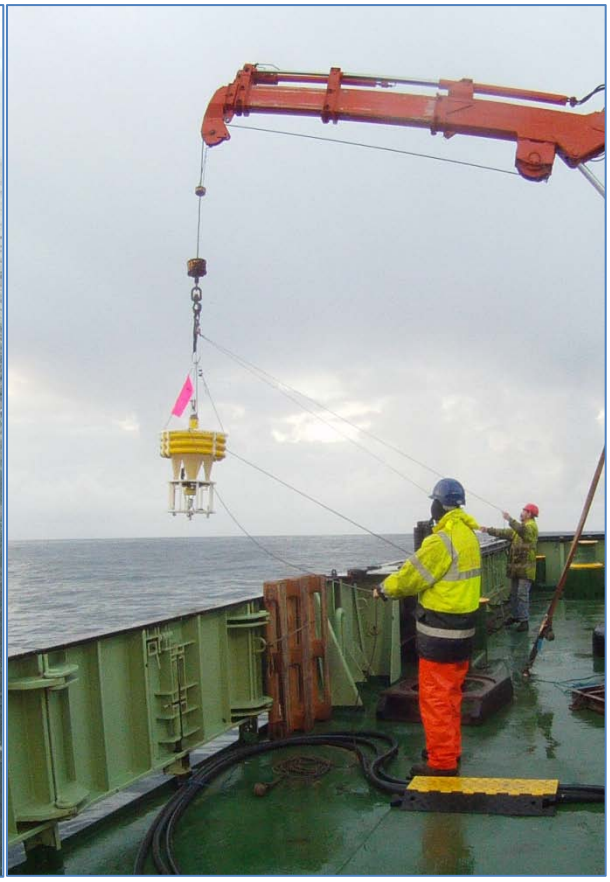


Fig. 50

7.1 Deployment and Recovery Positions

	PELAGRA Trap Number	Deployment Date and Time	Deployment position (Long)	Deployment position (Lat)	Recovery Date and Time	Recovery Position (Long)	Recovery Position (Lat)
Deployment 1	P5	02/05/2012 22:38	49° 00.8' N	16° 20.2' W	04/05/2012 02:44	49° 06.1' N	16° 39.7' W
	P7	02/05/2012 23:10	49° 00.9' N	16° 20.3' W	04/05/2012 02:05	49° 06.1' N	16° 39.7' W
	P8	02/05/2012 23:36	49° 00.9' N	16° 19.98' W	04/05/2012 12:23	49° 04.6' N	16° 39.7' W
Deployment 2	P5	05/05/2012 19:04	49° 00.3' N	16° 28.9' W	08/05/2012 05:19	49° 10.6' N	16° 14.5' W
	P7	05/05/2012 19:32	48° 59.7' N	16° 29.5' W	08/05/2012 06:24	49° 08.9' N	16° 16.7' W
	P8	05/05/2012 20:04	48° 59.9' N	16° 29.9' W	08/05/2012 07:15	49° 06.8' N	16° 20.3' W

Table 23

7.2 Deployment One

P5

Depth: 350 m
Sampling period: 4 hours
Stabilization period: 20 hours
Down time: 24 hours
Sink time: 181 minutes
Target Temp: 11.46
Target Sal: 35.524
Ballast added: 3.3 kg

P5 Deployment One Information:

Due to ballast data which was gathered during D369 it was estimated that P5 was 345 grams too heavy. Because of this information from the previous cruise, 345 grams was subtracted from the ballast calculations for this deployment. P5 stayed on the surface as it was under- ballasted.

P7

Depth:	350 m
Sampling period:	4 hours
Stabilization period:	20 hours
Down time:	24 hours
Sink time:	169 minutes
Target Temp:	11.46 °c
Target Sal:	35.524
Ballast added:	3.609 kg

P7 Deployment One Information:

Due to ballast data from D369, 150 grams was subtracted from P7. On deployment one P7 came to the surface after dropping its depressor weight as it was under ballasted. Even though P7's sink time ended when it was at 130m depth it could not pump its self back down to its target depth quick enough due to the rate in which it was ascending. See the depth plot below for "P7 Deployment 1, 350m".

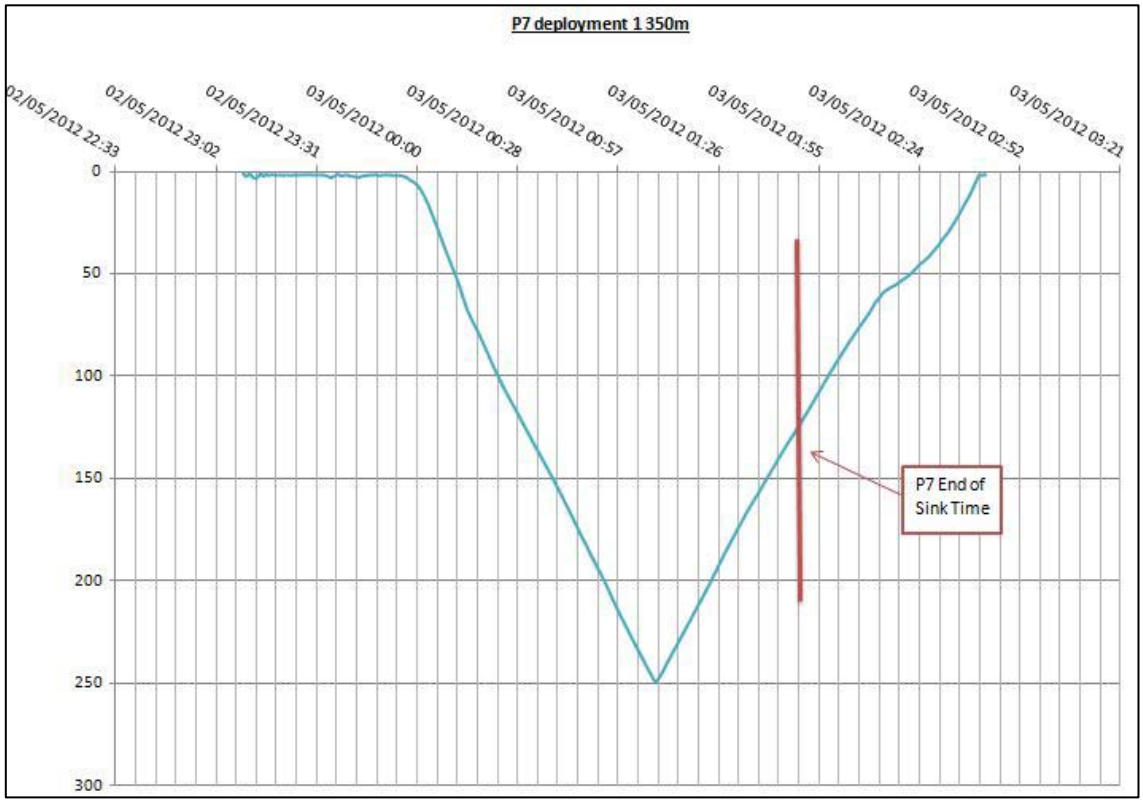


Fig. 51

P8

Depth:	350 m
Sampling period:	4 hours
Stabilization period:	20 hours
Down time:	24 hours
Sink time:	180 minutes
Target Temp:	11.46 °c
Target Sal:	35.524
Ballast added:	3.787 kg

P8 Deployment One Information:

P8 had a successful deployment; it had 150 grams subtracted from the ballast calculations due to ballast data which was collected from D369.
See depth plot below for "P8 Deployment 1, 350m".

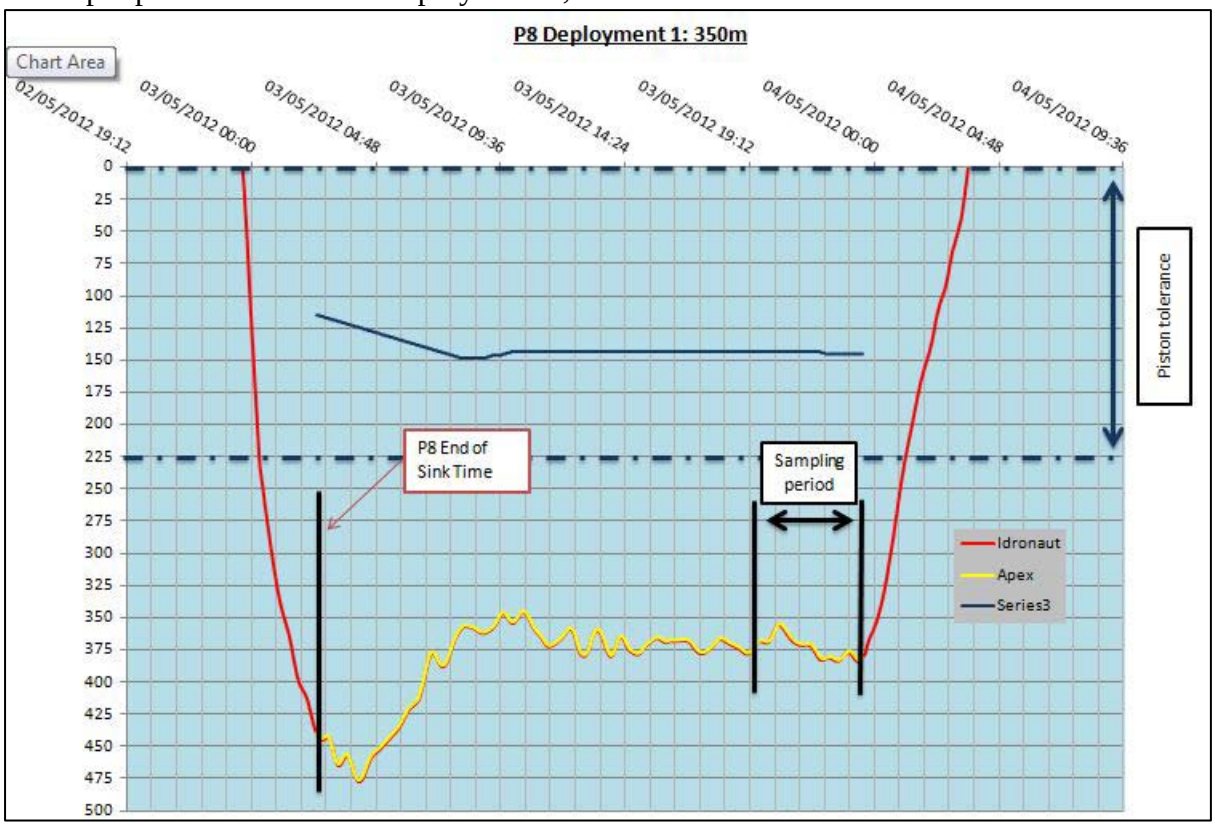


Fig. 52

7.3 Deployment Two

P5

Depth:	350 m
Sampling period:	24 hours
Stabilization period:	24 hours
Down time:	48 hours
Sink time:	180 minutes
Target Temp:	11.46 °c
Target Sal:	35.524
Ballast added:	3.495 kg

P5 Deployment two Information:

As P5 was under ballasted for deployment one, only 150 grams was subtracted from its ballast weight for deployment two (instead of the 345 grams estimated previously). P5 was under ballasted again and stayed on the surface.

P7

Depth:	350 m
Sampling period:	24 hours
Stabilization period:	24 hours
Down time:	48 hours
Sink time:	169 minutes
Target Temp:	11.46 °c
Target Sal:	35.524
Ballast added:	3.759 kg

P7 Deployment two Information:

P7 had a successful deployment, it had nothing subtracted from it ballast calculations.

See the depth plot below for "P7 deployment 2, 350m".

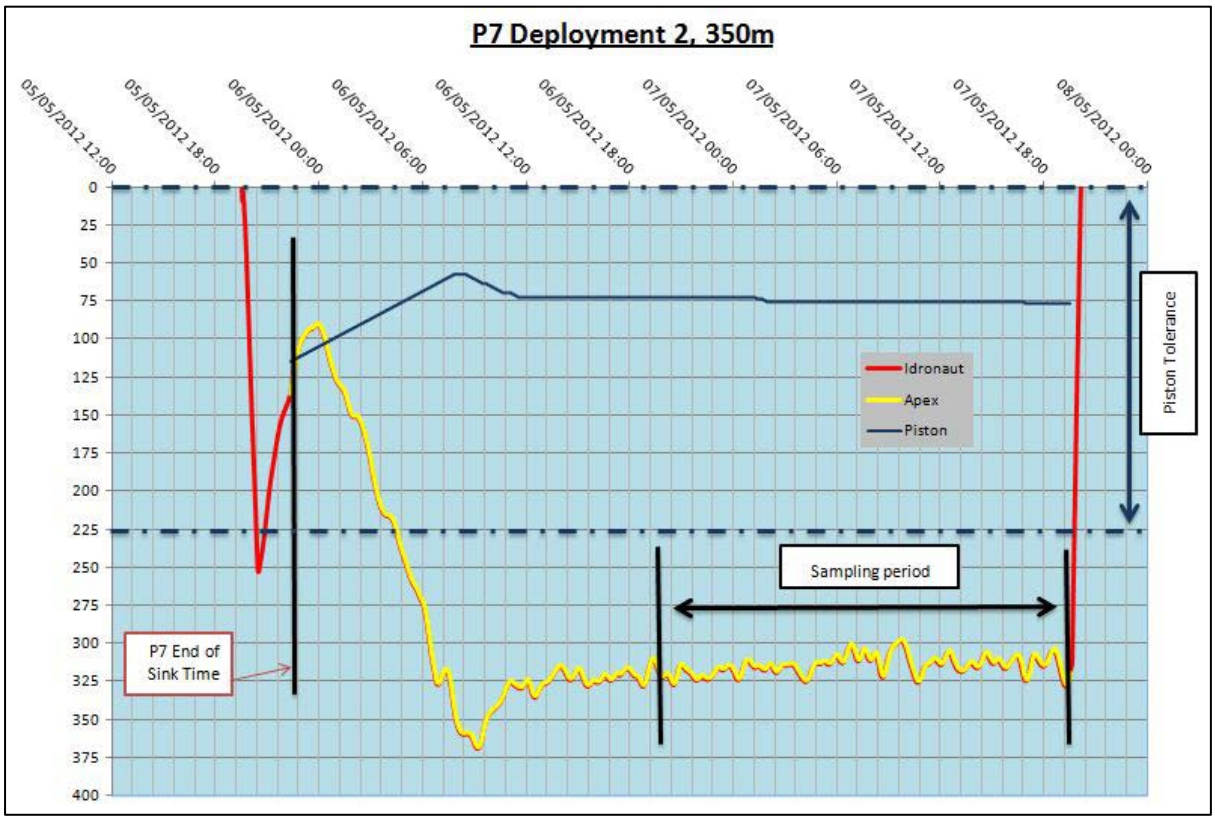


Fig. 53

P8

Depth:	350 m
Sampling period:	24 hours
Stabilization period:	24 hours
Down time:	48 hours
Sink time:	181 minutes
Target Temp:	11.46 °c
Target Sal:	35.524
Ballast added:	3.787 kg

P8 Deployment two Information:

P8 had a successful deployment, it was probably around 40 grams lighter as its emergency release weight fell off during deployment and another had to be added quickly in order for the mission to go ahead.

See the depth plot below for "P8 deployment 2, 350m".

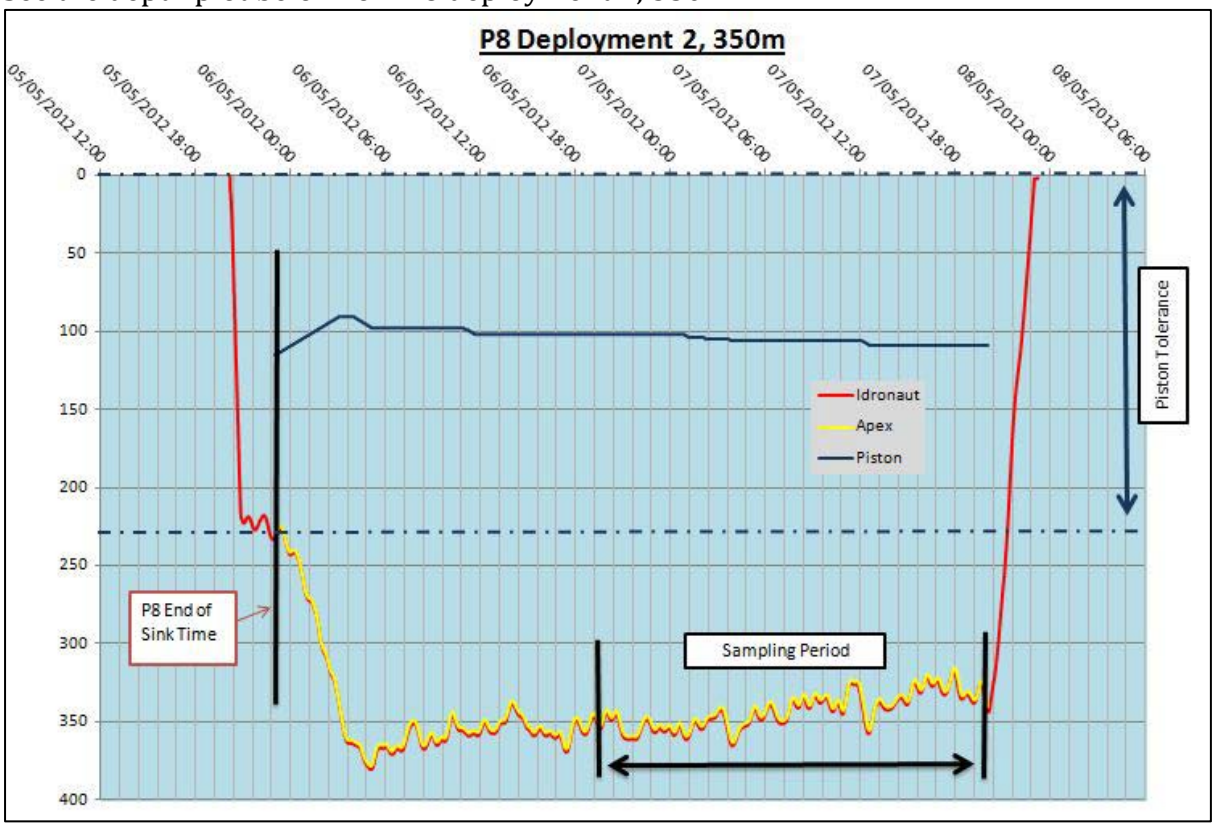


Fig. 54

Maintenance required for PELAGRA traps:

P7 needs the connector for the motor replacing as well as one of the lead ends due to damage caused in deployment preparation.

Deployment and recovery suggestions:

- Stronger cable ties (small) for release and emergency release weights as they tend to snap during entry on deployment
- External battery pack for the PELAGRA laptop so to avoid using 240v on deck when programming floats

Development suggestions:
To replacing or modifying the existing PELAGRA apex floats to gain a larger buoyancy bladder. By doing this the bladders buoyancy range would be more forgiving and the traps would not need to be ballasted so finely.

7.4 Conclusion

From the ballasting data collected throughout JC071 both P7 and P8 are ready for scientific use. P5 will need a trial deployment were it may be worth adding another M24 nut (96.6 grams) to the depressor weight; this would be to get the trap down to depth. It may also be worth subtracting 0.75 grams to the ballast calculation weight. P2, P4 and P6 were not been used on JC071, but as they had 5 deployments on D369 which were all successful with a good quality of samples, it is assumed that they should be trouble free when they are next needed for use.

8 Station list

James Cook Cruise 71

Station Log

Deployment	Recovery	Station	Cast	Time GMT			Start position		Finish position		Uncorrected	Activity	Contact person
Date	Date (If different		(if CTD)	Start	BOTTOM	End	Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)	sea floor		
"May 2012"	from deployment)										depth (m)		
1st		JC071-001		08:00		23:59						Underway water sampling	Smythe-Wright
2nd		JC071-002		21:59		22:55	48.727987	16.256431	48.632963	16.266025		Multibeam survey	Bett
2nd				02:18		03:22	48.713446	16.246861	48.859284	16.088999			
2nd		JC071-003	1	06:22	07:50	10:03	48.968017	16.269417	48.96800	16.269467	4812	CTD to 4600m	Smythe-Wright
2nd		JC071-004		00:00								Underway water sampling	Smythe-Wright
2nd		JC071-005		12:00		22:00	49.013533	16.369817				Recover PAP 1 buoy (deployed JC062-099) on deck at 13:36	Provost
2nd	4th	JC071-006		22:37	02:44		49.014123	16.335265	49.101939	16.675127		PELAGRA P5 deploy	Ward
2nd	4th	JC071-007		23:10	02:05		49.014333	16.334220	49.074414	16.658183		PELAGRA P7 deploy	Ward
2nd	4th	JC071-008		23:35	12:27		49.014461	16.333317	49.133091	16.586201		PELAGRA P8 deploy	Ward
3rd		JC071-009		00:12		04:12	49.015483	16.326381	49.015462	16.326418	4816.02	SAPS 1000m Pumps on 02:00 off 03:00	Villa
3rd		JC071-010										SAPS 500m Pumps on 02:00 off 03:00	Villa
3rd		JC071-011										SAPS 200m Failed to pump	Villa
3rd		JC071-012										SAPS 50m Pumps on 02:00 off 03:00	Villa
3rd		JC071-013		06:03	08:14		48.833359	16.508287				Megacore	Ruhl
3rd		JC071-014		00:00	23:59							Underway water sampling	Kromkamp
3rd		JC071-015		12:30		15:00	49.000570	16.457947				Bathysnap recovery From station JC62-0119	Bett
3rd		JC071-016		12:10	12:23	12:35	49.000567	16.457956	49.000579	16.458002		Zooplankton net SOG=0.85	Pebody

3rd		JC071-017		12:45	12:56	13:21	49.000569	16.457978	49.000565	16.457993		Zooplankton net SOG=1.16	Pebody
3rd		JC071-018	2	15:42	13:55	17:55	49.023067	16.454100	49.023000	16.454067		CTD to 250m Sensor calibration and water	Smythe-Wright
3rd		JC071-019	3	18:58	20:28	22:23	49.023067	16.454100	49.023117	16.454100		CTD to 4600m Water samples	Smythe-Wright
3rd		JC071-020		22:57			49.004833	16.449667			4847	Deploy Amphipod trap	Bett
3rd	4th	JC071-021		23:33	23:45	00:01	49.006274	16.448703	49.006283	16.448680	4819.2	Zooplankton net SOG=1.02	Pebody
4th		JC071-022		00:01	00:14	00:31	49.006283	16.448680	49.006287	16.448677		ZooplanktonNet	Pebody
4th		JC071-023		00:00								Underway water sampling	Smythe-Wright
4th		JC071-024		13:19	13:50		49.046167	16.557000	48.984833	16.666833		Subbottom Profiling	Bett
				14:20	15:22		48.937333	16.646667	49.024500	16.493167			
				15:52	16:31		48.977500	16.486667	49.916500	16.580500			
4th		JC071-025		05:42	07:46		48.833402	16.555339				Megacore	Ruhl
4th		JC071-026	4	20:05	20:16	20:45	49.008033	16.452817	49.008033	16.452833		CTD to 250m	Smythe-Wright
4th		JC071-027		22:12	22:24	22:39	48.833369	16.508015	48.833349	16.507993		Zooplankton net	Pebody
4th	5th	JC071-028		23:02	01:00	03:00	48.833379	16.508295			4843	Megacore	Ruhl
5th		JC071-029										Underway Sampling	Smythe-Wright
5th		JC071-030		08:32		10:02	48.989483	16.492700				PAP3 Recovery(JC062-018)	Provost
5th		JC071-031		11:50		13:20	48.964634	16.528652	48.964654	16.528636		SAPS500m pump on, pump off times	Villa
5th		JC071-032										SAPS400m	Villa
5th		JC071-033										SAPS 200m	Volla
5th		JC071-034		14:18			48.964079	16.502082				Amphipod Trap Deployment 15:44(eta)	Bett
5th		JC071-035		15:53		16:55	48.979545	16.500992	48.992736	16.489829		PAP3 Deployment	Provost
5th		JC071-036	5	17:20	17:52	18:46	49.004800	16.481567	48.004767	16.481550		CTD to 1500	Smythe-Wright

5th	8th	JC071-037		19:04		07:15	49.004939	16.482031	49.148619	16.278929		PELAGRA P5	Ward
5th	8th	JC071-038		19:32		05:19	48.995408	16.491425	49.176796	16.241725		PELAGRA P7	Ward
5th	8th	JC071-039		20:04		06:25	48.999956	16.497797	49.148619	16.278929		PELAGRA P8	Ward
5th	6th	JC071-040		23:10	01:10	01:44	48.833354	16.508332				Megacore	Ruhl
6th		JC071-041										Underway Sampling	Smythe-Wright
6th		JC071-042		08:49		10:22	48.978460	16.462262	48.990145	16.508332		PAP3 re-redeployment	Provost
6th		JC071-043		11:47			49.006167	16.450167				Bathysnap deployment: submerged time and position	Bett
6th		JC071-044		16:10		20:48	48.988710	16.270694	49.003171	16.386735		PAP1 deployment: triangulated position 49.004867, 16.376333	Provost
6th	7th	JC071-045		23:47	00:00	00:33	48.993426	16.329105	48.993413	16.329096		Zooplankton net	Pebody
7th		JC071-046		01:00	01:10	01:30	48.996557	16.327181	49.000661	16.320900		Zooplankton net	Pebody
7th		JC071-047		03:08	05:15		48.833333	16.508333			4842	Megacore	Ruhl
7th		JC071-048		14:20		16:20	48.958952	16.511527	48.960045	16.512744	4813	SAPS 4000m pumps on 14:20, pumps off 16:20	Villa
7th		JC071-049										SAPS 2500m pumps on 14:20, pumps off 16:20	Villa
7th		JC071-050										SAPS 1000m pumps on 14:20, pumps off 16:20	Villa
7th	8th	JC071-051		20:59		22:01	49.200000	17.000000	49.200000	16.800000		Underway Sampling Lines 80 and 83-84	Seddon
				22:40		01:48	49.250000	16.655000	49.344833	16.013333			
8th		JC071-052										Underway sampling	Smythe-Wright
8th		JC071-053		02:03	02:16	02:31	49.346542	16.004923	49.346440	16.004856		Zooplankton net	Pebody
8th		JC071-054		02:36	02:49	03:03	49.346465	16.004842	49.346443	16.004838		Zooplankton net	Pebody
8th		JC071-055	6	07:00	09:44	11:35	49.114717	16.338333	49.114683	16.338350		CTD to 4000m	Smythe-Wright
8th		JC071-056		12:46	12:56	13:14	49.114695	16.338355	49.114706	16.338351		Zooplankton Net	Pebody
		JC071-057		13:18	13:28	13:39	49.114716	16.338357	49.114699	16.338375		Zooplankton Net	Pebody

		JC071-058										SAPS 400	Villa
		JC071-059		15:30		17:00	49.114651	16.33835	49.11470	16.338263		SAPS 200	Villa
		JC071-060										SAPS 200	Villa
		JC071-061	7	17:40		19:35	49.114717	16.338000	49.11623	16.32953		CTD to 250m Sensor calibration and water	Smythe-Wright
9th		JC071-062		00:00		12:00						Underway Sampling	Smythe-Wright
10th		JC071-063		09:00		23:59						Underway Sampling	Smythe-Wright
11th		JC071-064		00:00		20:20						Underway Sampling	Smythe-Wright

9 Appendix "How to…" for Wetlabs ECO-FLNTUSB Fluorometer

Susan Hartman

9.1 Introduction

The Wetlabs FLNTUSB fluorometer measures backscattering at 700nm wavelength and chlorophyll fluorescence at 455 and 685nm. Current models are only rated to 300m.

Caution: **do not move the bio wiper with your finger, even though it is very tempting!!! This voids the warranty. Leave the end cap on as much as possible.**

It is essential to perform a calibration profile prior to deployment of the equipment onto a mooring so that fluorescence output can be compared with chlorophyll measurements from filtered seawater. A second calibration dip on recovery is also very useful.

Setting up at sea

You will need: fluorometer and manual, cable, 9v battery, and pc equipped with a serial port (RS232) which has ecoview or a hyperterminal software installed (note: Windows 7 PC's do not have hyperterminal Alternatively you can use Tera Term). Y ou will also need the dev and cal files specific to the instrument. Ensure you have files for instruments both to be deployed and recovered. Initial Equipment set up

- Record and clear calibration dip data prior to deployment to optimise memory.

- Ensure the instrument is attached to the mooring such that the beam is unobstructed (30° cone).

9.2 Programming

9.2.1 Using ECO View (Recommended)

ECO View is the software developed from Wetlabs to set up fluorometers. For a very detailed function of the software and the full potentials of it please refer to the manual (ecoviewj.pdf).

Below there is a concise description of the steps for setting up the fluorometer via the ECO View software.

- Connect the fluorometer with the PC via the serial cable (RS232)
- Open the ECOView Software
- On the top right corner of the window select the “Select COM port” button and select the appropriate port (RS 232 port is usually port 1) baud rate 19200. Upload appropriate dev file if requested.
- Apply power to the instrument using preferably a 9V battery, or via a power supply. If a power supply is used make sure that the voltage does not exceed 9 V. Alternatively you can power the sensor using the short circuit power plug (“magic plug”).
- When power is applied you should here the wiper turn and a blue light is emmited by the sensor. If not then on the “Meter Set Up” tab click the Start Data button and you should here the wiper turning and the blue light emitted from the sensor.
- Quickly select the “Raw Data” tab to see the output of the sensor.
- Switch back to “Meter Set Up” tab and click “Stop Data”, this should stop the instrument working and the wiper should return to its original position.
- Select the “Raw Data” tab where at the end of the tab window you can see the instruments set up. The various abbreviations are:
    - Avg: Sampling rate. According to the manual if set to 28 the sampling rate will be 1 Hz. This is modified by the Set Avg/ Data Rate button.
    - PKT: Number of samples taken during operation. Set to 0 for continuous mode. For deployment mode set 8 or 10.

- SET: Number of Cycles. This should be set to 0 and kept as such for both the calibration dip and the deployment.
- INT: Interval between which the sensor is on sleep mode in HHMMSS. This takes into account the operational time of the sensor, ie end of one sampling event to the beginning of the next sampling event. This means that if the sampling rate is at 1 Hz, the number of samples is 10 and the interval is set to 1 hour then the sensor will operate every 1 hour and 10 seconds FROM THE MOMENT THE SENSOR WAS POWERED UP.
- REC: 1 indicates that the sensor is internally logging 0 it's not. It's crucial that before any deployment this is set to 1.

- **Downloading data:** TIP: Change the Data Rate (e.g. Set it to 20 approx. 4Hz) in order to speed up the transfer. Select the "Transfer Data" tab and press the "Receive Data" button. A pop up window will ask you where you want to save the data and provide a name for the file. **NOTE: It may be that long file names are not accepted and you will not be able to transfer the data. Use concise and descriptive names for the new files.** When the transfer has completed, verify that the new file is stored and saved and after that erase the data from the sensors Flash memory to free space. When you have finished with "Data Transfer/ Clear Memory", do not forget to change the sampling rate to 1 Hz.

- **Setting up the instrument for calibration:ie continuous use**
  - Set / get time and date stamp (first make sure the pc is correct and in GMT if appropriate) → Press Store to Flash button

- Set Avg / Data Rate: 28 → press Set Avg / Data Rate button → Press Store to Flash button
- Set Number of samples: 0 → press Set Number of Samples → press Store to Flash button
- Set Number of Cycles: 0 → press Set Number of Cycles → press Store to Flash button
- Set Cycle Interval: Leave as is (since the number of cycles is 0 the interval is not applied).
- If the Turn logging On button appears then press it. If the sensor is in logging mode then this button should be indicating Turn Logging Off, WHICH YOU DO NOT PRESS. In any case before you disconnect the sensor check it's status by switching it on for 3-5 seconds and making sure that REC is 1 and not 0.
- Finally click the start data button, prior to deployment and add the magic jumper plug at the time at which you want it to start sampling.

- GENERAL COMMENT ON CHANGING ANY PAPAMETER: When you change the value of any parameter on the "Meter Setup" tab you should first press the associated button. When you've changed that then a yellow sign on the top right corner of the EC View window will appear reminding you that the change is not stored to Flash memory. Press the "Store to Flash" button and the yellow reminder should disappear. If it's still visible then you should start the sensor (Start Data button), let it sample for a few seconds (3 – 5) and then press stop data. When you switch to the "Raw Data" tab you should check

the status of the sensor where you can identify whether any changes you've made were stored to the Flash memory.

- Select the "Meter Setup" tab, press the Get RAM Setup button and use print screen to capture the settings. Open a word document and just press paste to transfer to image to the doc.
- Setting up the instrument for mooring long term deployment:
    - Set Avg / Data Rate: 28 → press Set Avg / Data Rate button → Press Store to Flash button
    - Set Number of samples: Usually 8 not more than 10→ press Set Number of Samples → press Store to Flash button. Whatever number you choose you should take it into account to compute the Cycle interval.
    - Set Number of Cycles: 0 → press Set Number of Cycles → press Store to Flash button
    - Set Cycle Interval: equaps smapling frequqncy – sampling time so, if an hourly interval is required then type 005952 for a set number 8 or 005950 for a set number 10 (if every 2 hours is required then 015952, etc) → press Set Cycle Interval → press Store to Flash button.
    - If the Turn logging On button appears then press it. If the sensor is in logging mode then this button should be indicating Turn Logging Off, if this is the sign DO NOT PRESS the button as it will change the setting to not logging. In any case before you disconnect the sensor check it's status by switching it on for 3-5 seconds and making sure that REC is 1 and not 0.
- Select the "Meter Setup" tab, press the Get RAM Setup button and use print screen to capture the settings. In the same document as the one

you've used for the previous print screen image, press paste to transfer to image to the doc

- Finally click the start data button, prior to deployment and add the magic jumper plug at the time at which you want it to start sampling.

GENERAL COMMENT: If the sensor is on a scheduled mode then it is not possible to communicate between the sampling intervals. If this is necessary then disconnect the sensor from any power supply and let it rest for 10 – 20 seconds. Connect the instrument with the ECO View software, establish connection, apply power and quickly press "Stop Data". This should allow you to communicate with the sensor as normal.

9.2.2 Using Hyperterminal

To programme for a calibration dip:

Attach cable to fluorometer and to laptop through serial, RS232 port.

Attach 9volt power (battery, power supplu, "magic plug"). This should 'wake up' instrument and you should see the light flashing through the end cap.

Using hyperterminal, com1, 19200 baud rate (use com 4 for the pap laptop)

In hyperterminal window press !!!!! to wake up the instrument (either as you apply power or as the data scrolls to the screen).

$mnu takes you to the present menu and will list the following:

AVE - set to 28 for 1 second readings ($AVE 28, nb hyperterminal needs a space)

PKT - set to 0 for the calibration and 10 for the mooring deployment ($PKT 0)

SET - keep as zero otherwise it will only do a few runs ($SET 0)

REC - set to 1 to record the data ($REC 1)

INT time interval as 00:00:00, (hh:mm:ss) doesn't matter what you use for the calibration dip but set it to 01:59:52 for the mooring deployment ($INT 015952)

DAT – date - for calibration cast, set to match ctd. For deployment, set to GMT.

CLK - clock - for calibration cast, set to match ctd. For deployment, set to GMT.

Mem - this should be cleared after the calibration cast so should read 0 ($EMC)

If making any changes, press dollar and the above abbreviation then a space and the changed value. After a return the modified menu will appear.

Use $sto to store the settings, otherwise it will revert to previous settings

For the calibration cast set the clock and date to match the CTD ($dat and $clk) and set $ave to 25 and $pkt to zero. Set $rec to 1 to record the data.

Remove the 9volt battery prior to deployment.

After the cast use $get to get the data, view copy and back up to disk. Get the depths from the CTD profile to match on tim.

Use $emc to erase the memory to optimise memory available for deployment.

For the deployment set the clock and date as above. Set the interval ($int) to 01:59:52 and the $ave to 25 and $pkt to 10 so that we will get 10 1-second readings every 2 hours when the instrument wakes up.

9.3 Positioning

To ensure that the instrument does not detect reflections from other objects a 30° cone must be kept clear for at least 1m in front of the windows. For the calibration profile it may be preferable to mount the instrument at the base of the CTD looking downwards. For the CTD

calibration, start the sensor as late as possible and near to CTD in the water time.

For the mooring deployment, start the sensor on the clock (e.g. 09:00:00, not 09:14:23), but as near to the mooring deployment time as possible.

At the end of a calibration profile or mooring deployment clean off instrument gently and return to the Marine Equipment Pool at National Oceanography Centre, Southampton for battery replacement. The bio-wiper will also need maintenance. Clean it with a scourer to remove the green and replace of the wiper, with a gap equivalent to 8 sheets of paper for maximum efficiency.

9.4 Data Processing

An example of the data file produced:

date	time	chl ref	chl signal	NTU ref	NTU signal	thermistor	pressure
7/7/05	1:05:56	1231	1592	1614	4117	10114	408

Chlorophyll is calculated as the scaling factor * (output – Dark counts). The scaling factors and clean water offset (CWO) (now called dark counts) are on the calibration sheets and summarised in the table below. Unit 179 does not have a pressure sensor but for the others **pressure** is calculated from (output x slope) + intercept (also on the calibration sheets and in the table below. For each sensor final pressure is calculated by subtracting the minimum value (presumed on deck value) from the in-situ value.

unit	Chl scale factor	Chl Dark counts	Press slope	Press intercept
179	0.0127	55	not	fitted
237	0.0127	54	0.061	-11.01
238 (from11/11)	0.0120	50	0.032	0.68

268	0.0127	55	0.061	-21.14
269	0.0125	51	0.059	-18
270	0.0121	55	0.059	-21.35

9.5 Wetlabs Fluorometer Check List

VERY IMPORTANT: Make sure that you have the power short plugs that will allow the instrument to operate autonomously.

Instrument: keep protective cover for instrument if possible.

Cables: test cable includes 5 legs, power interface module, auxiliary analogue out connector, DB-9 serial interface connector, six-socket in-line connector plugs.

CD of the sensor which has the sensors engineering, files, the correction factors, manuals and ECO View software (Nb: The software on the CD might not be the most updated one…check on line for latest versions).

9 volt battery.

Users guide: ECO FLNTUSB, ECO View Host software.

Mounting bracket for the CTD rosette.

Spare parts: Whole sheet of bits but must send hex keys, .050in and 3/32-in.

NB: Pack with foam, not chips or bubble wrap.

Use with **laptop** with **Serial port and hyperterminal.**