BOFS 'STERNA 92'
CRUISE REPORT

RRS JAMES CLARK ROSS 02
26/11/92 - 18/12/92

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CONTENTS

LIST OF TABLES.

LIST OF FIGURES.

ACKNOWLEDGEMENTS.

It goes without saying that this cruise, which represented the largest number of British oceanographers ever deployed on a single ship, could not have been carried out without the efforts of a large number of people, many of whom did not take part in the seagoing. To all those who were involved, we all, and particularly I, extend a very warm 'thank you'.

It is with great pleasure that we thank all the ship's officers and crew for their dedication, professionalism, humour and help throughout the cruise. Special thanks go to:

The Master, Captain N.A. Beer, and all the deck officers, for ensuring a safe passage through 'troubled waters', and who constantly had our requirements as their highest priority;

First Officer Jerry Burgan who, with deck bosun Robbie and the entire deck department, gave the best possible service for all the deck operations;

Chief Engineer John Donnelly* and the engineering department for their constant attention to our needs, and who were responsible for some extraodinary engineering at the end of the cruise which enabled the cruise to end on time;

Chief Steward Ken Olley, and all in the catering department for their wonderful work catering for so many, under sometimes very trying conditions - it is an old saying that "an army marches on its stomach", we "marched" very well indeed!

Finally, for the ship's side, it has to be said that the cruise could not have been carried out without the efforts of John Summers (Scientific Bosun) and Simon Wright (Deck Engineer). Both contributed so much to the cruise that it is impossible to detail. They worked long and arduous hours, with constant good humour and absolute dedication; it was an honour to sail with them.

Much praise must also be given for our other 'shipmates'. The seagoing technical support provided by Simon Watts (RVS) and Paul Woodroffe (BAS) was exemplary, as was the computing support provided by Paul Duncan (RVS) and Graham Butcher (BAS). The service provided was outstanding. And I cannot express enough gratitude to Alan (Doc) Milne our medical officer whose professional skills were tested to the full. His stoicism was sublime, and a wonderful example.

Many people helped 'behind the scenes' and we thank them all. This was a unique cruise in that it was the first use of a BAS managed ship for STAP science. This enevitably meant that there were no previous experiences on

which to call for many of the 'procedures'. However, through great efforts from personnel at RVS, Barry (Dr. C.Fay, C. Adams and I. Innes) and BAS HQ, Cambridge (F. Curry, J. Hall and R. Chin) the potential difficulties did not materialise. On the organisation side we are also indebted to the hard work of Linda King (BAS, Cambridge) and Miriam Booth (BAS, Stanley, FI).

We all received a lot of help from our 'home institutions' prior to the cruise and during it. In most cases I do not know who these people are, but in particular we thank Carol Turley, Brian Bayne and Angie Smith (PML) for their help in keeping families informed. There were also a number of colleagues who had an important and continuing input to the scientific objectives, particularly Eugene Murphy (BAS) and the whole of the BOFS community.

We also received much help and moral boosting from David Turner and his colleagues on board the *RRS Discovery*. It was heartening indeed to hear David's voice during our regular radio 'skeds', and it was comforting to know that there was another ship out there somewhere, with friends on board, when so far from home.

We are indebted to Malcolm Woodward for his work in organising the logistics for this cruise. This not only involved the work for the *James Clark Ross*, but also the *Discovery*. This was a mammoth task well done.

Finally, I would like to add my personal thanks to all my 'shipmates'. It was a genuine pleasure and honour to sail with such good company. The support I received was outstanding. Although the cruise did not go as smoothly as we all would have liked (in more ways than one!), a tremendous job was done because of their enthusiasm and dedication. To them all I offer my gratitude and best wishes for 'smooth seas'.

Nicholas J.P. Owens
Plymouth Marine Laboratory
March 1993.

*Sadly, John Donnelly became seriously ill at the end of the cruise, and has since died; we extend our sincere condolences to his family and colleagues.

1. SUMMARY AND OVERVIEW

1.1 INTRODUCTION

This cruise was part of the two ship (including RRS *Discovery*), final field-work phase of the UK oceanographic community study BOFS (Biogeochemical Ocean Flux Study). The main task of the *James Clark Ross* was to provide detailed rate and process data within the wider survey work carried out by *Discovery*, and to take advantage of the ship's ice-breaking capabilities to provide a platform for work within heavy ice conditions. This two ship model had been successfully used within BOFS in the North Atlantic, and followed in the illustrious path of the two-ship programmes carried out (predominantly in the Scotia Sea) by *Discovery* 1 and *William Scoresby* during the *Discovery expeditions* of the 1920's.

The programme was designed to examine biogeochemical conditions and processes in relation to a seasonally-induced retreating ice-edge. The Bellingshausen Sea region was chosen primarily because it offered the best liklihood (based on satellite data archives) of a rapid and even ice-retreat. The area also provided an opportunity to examine a very understudied region of the Southern Ocean.

Apart from the wide range of scientific activities (detailed in later sections) the cruise was notable for a number of reasons. Although this was the second scientific cruise for the ship, it represented the most severe test to date in terms of duration, numbers of scientists, capability for scientific operations in ice, and diversity of operations. This cruise also was the first use of the *James Clark Ross* under the newly introduced policy of utilisation of the ship by the 'STAP' community.

1.2 OBJECTIVES

To evaluate the magnitude and variability of biogeochemical fluxes (particularly carbon and nitrogen), during early summer in the South East Pacific sector of the Southern Ocean, with emphasis on rates and processes in the marginal ice zone.

Within this broad objective four specific objectives were identified:

1. To determine ocean-atmosphere exchanges of radiatively active gases, and the factors influencing such fluxes, over a wide latitudinal range.

2. To investigate the interactions between the biological, chemical and physical processes that control carbon fluxes in the euphotic zone.

3. To assess the impact of sea-ice on biogeochemical fluxes, in order to estimate the importance of climatic feedback effects.

4. To determine the export of biogenic material from the upper ocean and its subsequent fate.

1.3 SUMMARY ITINERARY

21 Oct. - 26 Oct. Preparation for sailing - Stanley, Falkland Is.

26 Oct. - 31 Oct. Passage South (survey work).

31 Oct. - 1 Nov. Echo sounding calibration (King George Is) & sampling (Deception Is).

1 Nov. - 4 Nov. Passage North to FI's (medical evacuation).

4 Nov. - 8 Nov. Passage South (survey work).

8 Nov. - 9 Nov. Faraday Base relief.

9 Nov. - 13 Nov. Passage into Bellingshausen Sea (survey work).

13 Nov. - 14 Nov. Shakedown Ice-station 'F'.

14 Nov. - 18 Nov. Ice-station 'G'.

18 Nov. - 20 Nov. Passage North for *Discovery* rendezvous.

20 Nov. *Discovery* rendezvous and intercalibration.

20 Nov. - 23 Nov. Passage North to FI's (medical evacuation).

23 Nov. - 29 Nov. Passage South to Bellingshausen Sea.

29 Nov. - 30 Nov. Ice-station 'H'.

30 Nov. - 3 Dec. Ice-edge station 'I'.

3 Dec. - 6 Dec. Open water station 'J'.

6 Dec. - 9 Dec. Open water station 'K'.

9 Dec. - 13 Dec. Passage to Rothera, via Palmer & Faraday.

13 Dec. - 14 Dec. Rothera Base relief.

14 Dec. - 18 Dec. Passage North to FI's.

19 Dec. Cruise ends.

1.4 SCIENTIFIC ACHIEVMENTS - SUMMARY.

Figure 1 shows the cruise track for the entire cruise. Data were obtained along a number of transects from surface pumped supplies for temperature, salinity, chlorophyll concentrations and nutrients, together with extensive use of the Undulating Oceanographic Recorder (details can be found in the individual reports below). Figure 2 shows the positions, and period of occupancy, of six stations (including a preliminary 'shakedown' station) occupied for a variable number of days to examine details of biogeochemical fluxes within the overall objectives. All the stations were located approximately along the 85º meridian. Stations F, G and H were situated within solid pack-ice which enabled a significant amount of on, and under-ice activities to be carried out. Station I was situated immediately seawards of a distinct ice-edge. Stations J and K were in open water, with little or no obvious influence from ice.

The original plan of occupying a single station to examine the temporal development of an ice-edge associated bloom could not be carried for two reasons.

First, the severe restrictions on time. As can be seen from the summary itinerary, and detailed below, there was a requirement for the ship to make two unscheduled return passages to the Falkland Islands for medical evacuations. These resulted in a loss of seventeen days of station occupancy time. This loss, together with two-three days lost due to bad weather on passages, and the requirement to depart the working area one day early for logistical requirements, significantly restricted the amount of work possible.

Second, the conditions actually observed. It had been hypothesised from previous observations, primarily for Arctic regions but with some scant evidence from the Weddell Sea, that an intense algal bloom would be observed associated with density induced stratification at the retreating ice-edge. On first entering the ice-field (approx. 66º 30'S - 12 Nov.) a marked chlorophyll maximum was observed, in accord with expectations. However, it became apparent from subsequent transects that this feature was maintaining its approximate geographic position, despite a rapid retreat of the ice-edge. There were no indications for the initiation and development of an algal bloom associated with the retreating ice. It was considered that the best information on biogeochemical rates in the area would be obtained by examining a range of contrasting conditions. Thus the programme was modified, and the series of stations outlined above, from within ice to the (eventually) open-water chlorophyll maximum, was examined. The relationship between the intense chlorophyll maximum, which was relatively restricted in its latitudinal axis but longitudinally extensive, and the seasonal ice cover is currently not known, but may have been associated with a large scale oceanographic frontal feature. This is currently under investigation.

Whilst on station a wide range of measurements were made:

1). Ice structure and its relationship with light attenuation, light penetration and algal biomass.
2). Within-ice microbial communities and rates of production/grazing.
3). Water column structure and nutrient and particulate characterisation and distributions.
4). Within ice and water column determinations of selected biogases.
5). Water column microbial and algal biomass/pigment/biomarker signatures and production.
6). Size fractionated phytoplankton production, respiration and nitrogen assimilation.
7). Distributions and populations of zooplankton and krill, and faecal pellet production.
8). Characterisation of sedimenting particles and surface sediment characterisation.

Despite the limited availability of time, significant advances were made in all aspects of the above.

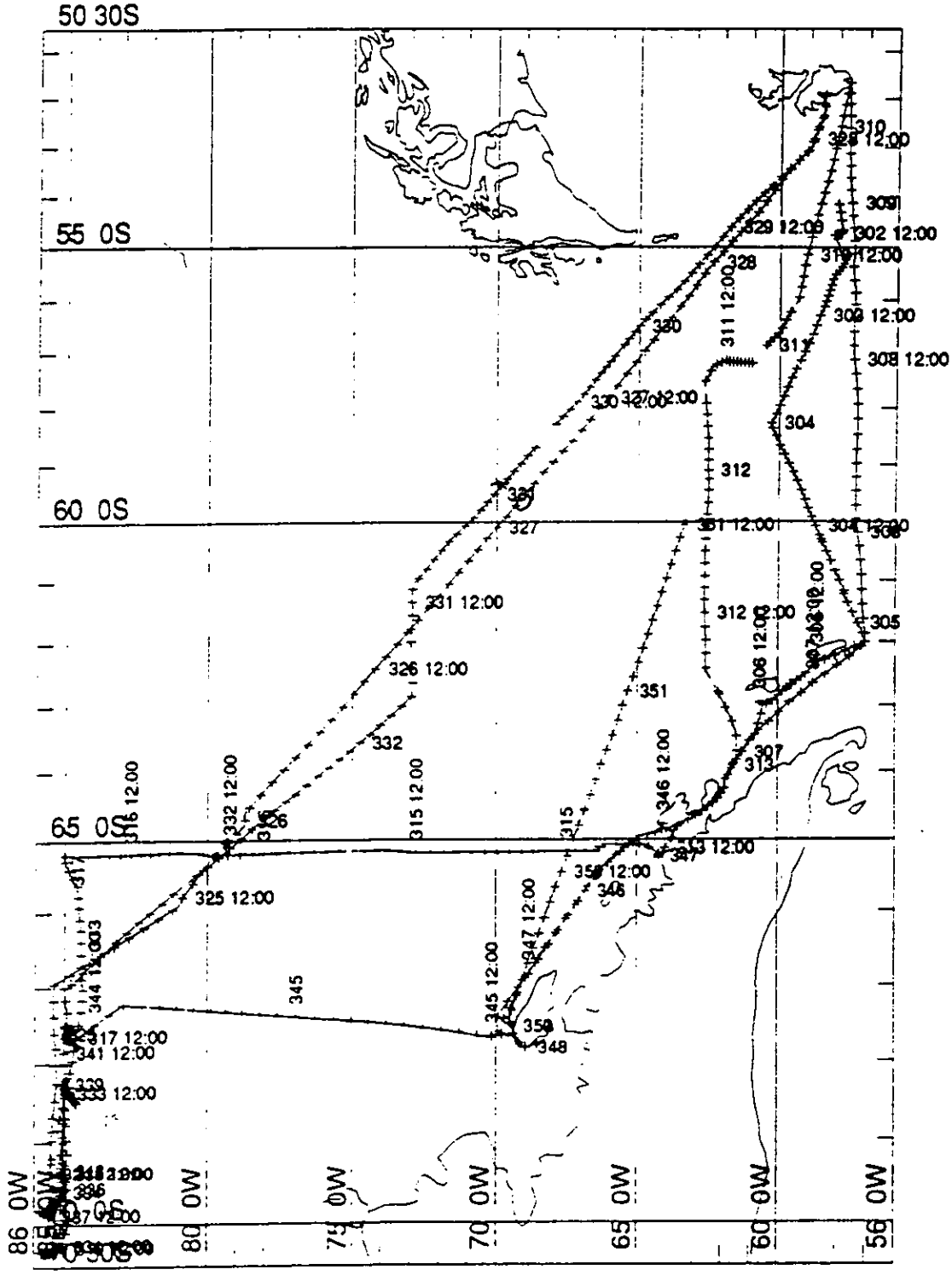
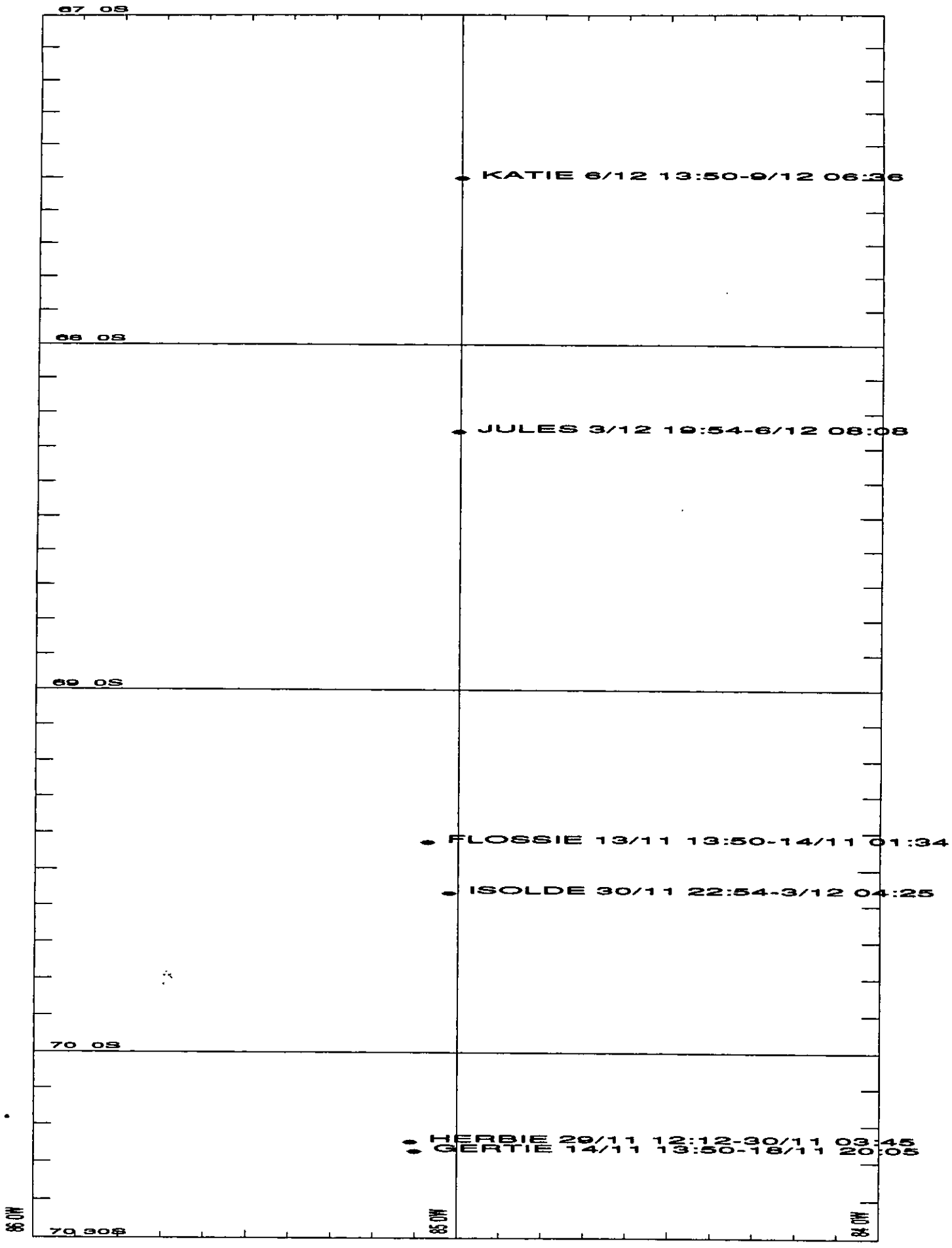


Figure 1. Cruise track of *James Clark Ross* during the Southern Ocean BOFS cruise.

Figure 2. ***RRS James Clark Ross*** **02 Station Positions and start & end times.**



2. NARRATIVE AND SCIENTIFIC LOG

2.1 NARRATIVE - DIARY.

[This diary was written during the cruise as a non-technical description for transmission to the UK for a variety of users. It is thus necessarily simplistic, 'non-scientific', and rather prosaic (!), however, it is a useful record of the wider context of the cruise. The Scientific Log (page 181) should be referred to for specific information about technical activities].

19th October to 26th October.
The expedition got off to a good start with staff travelling to the Falklands via 'RAF airlines' over a variety of dates, all finally arrived by the 23rd October. The earlier travellers (including myself) had made a start on unloading over 15tons of scientific equipment, which had travelled on the ship from the UK, when she left in September. The flight is long (18hours) but with a stopover for refueling at the British/American base on Ascension island. Refuelling not only for the plane, but also an opportunity for a much needed beer! Very strange sensation leaving Britain on a cold autumn night to arrive on an island just south of the equator. The journey is completed on arrival at the Falklands by a lecture on the different types of mines etc to be found when walking around, even quite close to Stanley!

Work on the RRS James Clark Ross (JCR) went well. Many visits by local people, the BAS ships are a familiar sight in Stanley, indeed BAS used to be known as the Falkland Islands and Dependencies Survey. Notable visit by the Governor of the Falklands, David Tatham and his wife - tea on board with Captain, Chief Officer and self. Followed up on Friday 23rd by invitation (taken up by most PML scientists) for cocktails at Government House - the empire still exists out here!! Occasional forays into Stanley by scientists to visit post-office, people learn to write letters a lot more in these far flung corners. Now also a satellite phone link, although expensive about £6 per minute - concentrates the mind! Weather throughout generally very pleasant, windy but sunny most of the time. Solid work unpacking all equipment and getting scientific instruments working and tying equipment down in the ship's laboratories - after all we were about to sail into the world's stormiest seas.

26th - 30th October.
Departed Falklands 26th 0600. Refueled at RN refuelling base at Mare Harbour. Visit to ship by Rear-Admiral Neil Rankin, Chief of Forces Falkland Islands, before sailing. Set off on over 850 mile passage across the Drake Passage - notorious piece of water South of Cape Horn - to Antarctic Peninsula. Very rough passage, Force 8 and above for most of the time. Three and a half days of very heavy rolling. Large amounts of water on deck. Some deck container laboratories flooded. Large numbers of people sea-sick, however, we still achieved a great deal of survey work monitoring conditions between the Falklands and the Antarctic Peninsula. About 2/3rds across the Passage, we crossed what is known as the Antarctic Convergence, which is a boundary between 2 water types in the Southern ocean, to the South is the cold Antarctic water, and it is like going through a door. One hour you can be out on deck wearing normal outdoor clothing, and the next you are reaching for the thermal underwear! Bird life, albatrosses and other Antarctic birds suddenly increase, and you are left in no doubt where you are. Outside temperatures now down to -4deg C, with ice and snow on deck. Still rough, but work continuing over the 24h day.

31st October
Scenery now spectacular. Inside the relative haven of a group of Islands known as the South Shetland Is. and the Antarctic continent, area known as the Bransfield Strait. Seas much calmer. Islands, some, many thousands of feet high, covered in snow and ice, glaciers falling into the sea. Icebergs at last, plus smaller pieces of ice known as 'bergy bits'- mostly hidden under water, almost undetectable by radar, but sufficiently large to make a nasty hole in an ordinary ship. JCR takes them all in her stride. Anchored in a sheltered anchorage known as Potter Cove to the South of King George Is. Spectacular

scenery, only a couple of hundred yards from a vertical ice-cliff. Came here for calm water to calibrate some echo-sounders. Sparkling day, blue-skies, but relatively mild at about 0deg C. Courtesy visit to Argentine research base (Jubany Base) nestling beneath a spectacular rock peak known as the Three Brothers. They don't get too many casual visitors to these parts! Very hospitable visit, entertained to lunch. Work on echo-sounders continued throughout the day. Visit reciprocated by some to the ship during the afternoon. Left for overnight steam to Deception Island. Marvellous scenery, never really got dark.

1st November

Sailed into Port Foster, Deception Island. Island is an active volcano, where once upon a time the rim of the volcano collapsed letting in the sea. To enter you sail through a gap only a couple of hundred yards wide, Sheer icy cliffs hundreds of feet high to either side. Some charts describe the gap as Neptunes Bellows, others the gates of Hell. 'Once inside, the 'harbour' is about a 4 miles in diameter, almost circular. Extraordinary place, like being inside a very white china tea-cup, however, it is bizarre to think that one is sitting on a ship in a volcano. There has been recent eruptions, as recently as 2 years ago. Fierce wind, in excess of 60kts at time - freezing cold. Air temperature not too bad, about zero, but nasty wind-chill. Sun out, dazzlingly bright with all the ice and snow. Came to measure some particular gases important in the greenhouse effect (methane and nitrous oxide) dissolved in the water - excellent results. Departed in the evening, needing to dodge a couple of ice-bergs that had taken up residence in the entrance. Sad news regarding some personal matters from 2 on board required that we turn around and go all the way back to the Falklands!. Very gloomy atmosphere indeed on board.

2nd - 4th November.

Fortunately the return passage was relatively calm. Scientists and ship's staff resigned to the return, these things happen, and with the distances involved, it is inevitable that a great deal of time will be lost.

4th - 7th November.

Re-departed Falklands pm 4th. Planned to repeat the work carried out on the original passage, so the journey was not entirely fruitless from a scientific point of view. However, weather conditions particularly fierce, worse than the original passage, extremely uncomfortable on board - ship did 34degree roll on one occasion - under such conditions one wonders if it is going to stay upright. Sea-sickness returned. Unable to use any of the scientific instruments for a period of over 18hours, indeed the ship was unable to follow the track we intended to make, hove-to. Not good for all on board, already somewhat down from having to make the long journey north and back again. By the end of the 7th, thankfully back in the Bransfield Strait again, and in calm waters, with the scenery, ice, birds, and a few whales (not many up to now).

8th November

Passage continued down Bransfield Strait, into Gerlache Strait and through the Neumayer and Lemaire Channels. This area is known as 'Kodak crack'!!. Completely indescribable scenery. Narrow twisting channels a hundred yards or so wide. Vertical cliffs, splattered in snow and ice, Unbelievably beautiful. The guys who discovered these channels, in wooden sailing ships were amazing. Even at a relatively near distance of a mile or so, the channels look like solid walls of rock. However, as one crashed through sea-ice (frozen sea, rather than ice-bergs which come from glaciers, or the continental ice-sheet), the first of the trip so far (the JCR has a purpose built ice-strengthened hull), the routes through became more obvious. The reason for coming this way was to relieve the BAS base called Faraday, a long established research outpost in the Argentine Island group. Faraday is a permanent base requiring men to overwinter, and we were to be the first ship in of the present Antarctic summer. Our main role, since we were to be working in the area, was to provide them with much needed fuel, and other stores. Faraday was reached mid-morning. JCR was 'parked' gently into solid 'fast-ice' a couple of hundred yards opposite the small collection of wooden buildings. 'Mooring' in this way was to prove a very much easier way of getting a pipeline to them and provided a good way of moving other stores by man-hauled sledge.

Remained at Faraday all day. Absolutely gloriously clear weather. Indescribably beautiful. Divers took the opportunity to practice various under-ice diving techniques - skills which we would need when the main work started.

Work relieving the base continued to 2000.

9th - 12th November.
Remained in our ice-mooring until 0600 of the 9th. Work completed by 1100. A course was now set out into the Bellingshausen Sea, our main area of work. This is in fact a southerly extension of the South Pacific - but palm trees are rather scarce around here!

First part of the passage was through heavy broken pack-ice 'littered' with numerous ice-bergs. Wind rose strongly during morning, but the sea was strangely calm because of the presence of the ice. Finally broke out of the ice into open water. Became rough again! Followed a direct W course at 65S latitude for just over 2 days, working throughout mapping biological and chemical conditions. Strangely devoid of much bird and other animal (mammals) life. Rather grey, chilly days - very dull following the sparkling days around the islands.

Turned due South mid-afternoon of the 11th.

Met our first pack at 66degS. it seems an awful long time and way to come to at long last meet this. Monitoring all the time as we sail, Science continues 24hours a day with watches being kept to cover the hours between 2000 and 0800. Nights rapidly becoming brighter and shorter by the day. Getting colder again, well below freezing at midday, quite a lot of snow around on the decks. Extraordinarily bright.

13th November.
Now into much heavier pack-ice, 'Open water' becoming scarcer and the ice floes becoming much bigger. These are just the conditions we needed. Crossed the Antarctic circle (66deg 33minutes South latitude) at 0015. Rammed the JCR into a large floe (1-2km long by 1km wide) early in the morning. Two intrepid scientists put 'ashore' by crane to test the surface. Ok for working on, so preliminary tests carried out all day. Involved cutting holes in the ice with a chain-saw with a 50inch blade! Divers down collecting samples, all reported the amazing beauty of it all. Fortunately we have underwater cameras with us, so the non-divers can get some impression of what it is like. All tests of equipment and chemical methods worked well. Left this trial site during late evening and crashed our way further South.

14th - 18th November.
Arrived at a perfect location just south of 70 degrees South. An unbroken expanse of solid pack-ice, over 2m thick in places. Although solid, the sea-ice is not flat. It is peppered with small ridges between 1 and 5m high - pressure ridges, which are formed by the power of the wind pushing smaller sections of ice over each other. The effect is stunning; wherever you look there are the most wonderfully strange shapes and features. It makes travelling difficult however. Fortunately, we have a motorised ski-doo (a petrol driven sledge) which we use to pull a Nansen sledge. This is the most beautiful of structures, named after the famous explorer. It is about 10feet long, of the most intricate interwoven wood and runners, all bound together with thongs. Its most useful characteristic is that it flexes over all the humps and hollows, rather than bumping. This is our main mode of transport, apart from people power, for carrying heavy equipment onto the ice. The technique of 'mooring' a ship under such circumstances is amazing. Full power is selected from the engines and the ship drives straight at the ice. It thuds into it, sending huge blocks this way and that and eventually she comes to a juddering halt! By maintaining the occasional turn of the propeller the ship is snug in a cradle of ice.

We stayed like this for four days, with science carrying on at a frantic pace, 24hours a day. A large number of experiments were carried out and many dives completed. This was a place of amazing, almost surreal beauty. We had 24hours of full daylight, indeed it was necessary to wear the snow-glasses at midnight, even on days when the sun was not out. We had 2 out of the 4 days when we saw the sun throughout the day. It is necessary to really pull the blinds down in your cabin and convince yourself that it is night-time; a very strange experience, 24hours of sunshine. Very necessary to wear a lot of sun protection; the reflected glare was fierce. The constant daylight makes it relatively easy to work long, difficult hours. Some of the work on the ice is very physically demanding.

Quite a lot of wildlife around - utterly fearless, seals, penguins and a few whales. The seals seemed particularly interested in our sledges!

Work proceeded exceptionally well. Some of it was hampered by a spell of particularly cold weather, below minus 10 C, seawater samples

all frozen are rather difficult to do chemical analyses on! Very uncomfortable working on the deck of the ship, or on the ice under such conditions. The beauty of the place made up for it all though. Life in the ship is fine, however, although some people take to it better than others. A walk on the ice is good therapy, as long as you don't get too worried about the fact that you are walking on frozen seawater over 600m deep!

The work had progressed so well at this first location, and the situation was so unusual that the Captain, on behalf of the ship's company challenged me, on behalf of the scientists to a tug of war on the ice before leaving! Scientists 3 ship's company 0! Mind you, there were nearly twice as many scientists in the team than ship's company.

Reluctantly left this location late afternoon on the 18th. It is difficult to comprehend that we were not leaving land. A very strange experience. As mentioned above, surreal, impossible to describe.

Our intentions were to move slightly further North to investigate conditions where the ice was not so solid.

Monitored conditions throughout the night in the seawater as we crashed and bumped our way through solid ice. Breaking ice 'cracking cubes' as the deck officers call it, is an amazing experience. The closest thing I have previously experienced is turbulence in a jumbo-jet, although we are in a ship which is nearly 100m long! The power of this vessel is awesome, like a hot knife through butter. Occasionally, the ice defeated us, but after a good run-up and a second or third attempt we usually bashed our way through. On a couple of occasions we were temporarily stuck - no way out ahead or astern! However, after a few minutes of full power, with a lot of crashing about we smashed our way out. Yet another monumental experience. I have run out of adjectives and superlatives to describe these experiences.

19th November.
Morning (although when does that start down here, when the sun never goes away?) saw us still 'cracking-cubes'. The ice was not as strong as further south, but still remains fairly impressive.

Radio contact with our colleagues on the RRS Discovery, about 600miles north of us, out in open water. They were having a rough time of it in 50knot winds and very heavy seas. Some damage reported on the ship. For us still in the ice, it was not like being at sea at all, very little motion as such, just the juddering and shaking. I spoke with David Turner, chief scientist on the Discovery, and we decided it would be best if we did the rendezvous earlier rather than later (because of medical problem with one of the crew), so the day was spent monitoring conditions as we went North, and they did likewise but moving South. Expected meeting sometime during the afternoon of the 20th. It will be good to see old friends and colleagues from Plymouth in this remote part of the world. Strange really, here we are, almost at the other end of the world and we will meet up with people we bump into every day at work in Plymouth!

20th November
Crossed the Antarctic circle northwards about 0500, sampling having been stopped earlier about midnight to make best possible speed to meet Discovery. Medical situation on board now considered to be urgent.

Fast progress made to Disco, she loomed up out of the mist at 1300. Doctor, Paul Woodroffe and I transferred by rubber boat under rather hazardous conditions of heavy swell. Great to see so many familiar faces. Intercalibration exercise started and continued throughout the afternoon.

Mighty blow dealt when we had to make the decision to take on the crewman from Disco, and make all speed to the Falklands. It seems as if this cruise is fated! All on board devastated, Over 1100 miles to Stanley, minimum time to complete round trip - 6 days, leaving very little time for us to carry on our work when we return. It is unbelievable that we have been out here for so long and achieved so little, it will be difficult to keep up moral and get everybody going again.

Meeting (2000) with all scientists to explain the situation. No complaints. Doctor explained the medical implications. Blood transfusions carried out during the night.. Volunteers very forthcoming, Good supply built up over the evening. Tea given up for Guinness!

Course set for Stanley ca. 1900, full speed.

Saturday 21st November.
Awoke late!! to find us making good progress NE to Stanley. Total distance to run about 1100 miles. ETA weather permitting Monday pm.

Extremely quiet and subdued on board. Most seemed resigned to the situation, and fairly cheerful considering everything.

Fortunately, the weather was kind, with a relatively flat sea. Bright, occasional sun and mist. Very good speed, averaged 15.8kts for the previous 24hours. Proper sunset, now that we were well north of the Antarctic circle. Exceptionally quiet evening. Very few scientists around - all coping with the disappointment in different ways.

Sunday 22nd November.
Another quiet day! Sea exceptionally calm - we were lucky. Sunshine and blue sea and skies, warm enough for shirt sleeves on deck. We could have been anywhere but the Bellingshausen Sea.

Contacted Disco during evening, radio-link rather weak. They had managed to achieve very little during the period since leaving them because of bad weather. Fast speed maintained overnight, strange to see so much darkness again, even if it is relatively short lived. UK is so dark at this time of year!

Monday 23rd November.
Sea calmer and calmer, balmy weather. Entered Mare Harbour (RN 'Port' on the Falklands) 1300. There is nowhere to tie up alongside here; instead we picked up a mooring for refuelling. Transferred patient and Doc. ashore by boat for hospitalisation of patient. Small party ashore to NAAFI to restock with goodies - nuts, mints, chewing gum etc. Inward mail on board, also opportunity to get mail out. Fine afternoon refuelling, and waiting for Doc. to return. Nice to see relatively green land again; also fine, fresh land smells.

Departed Mare Harbour 1800, full speed towards SE. Fine weather still. Good passage overnight, pitching gently into a low swell from the west. Drake Passage for the fifth time!

Tuesday 24th November.
Swell increased overnight with wind now a brisk W, but we still managed to make full speed. Scientists still quiet. Warm outside still and midday saw us about 80 miles S of Cape Horn.

Weather worsened steadily as the day wore on. Swell increased from W - NW. Seasickness returned. I was somewhat surprised at this given the amount of time we have been at sea.

A governor on one of the main engines failed during the afternoon. This reduced our power by about 2/3rds to a half, resulting in a reduction in ship's speed to about 11-12kts. (I have to say that at this point I wondered what sort of test was being set us). Reasonably comfortable night, but swell beginning to make itself rather obvious.

Wednesday 25th November.
Fine, bright morning, reasonable progress being made back to work area. Spoke to David twice today, they are obviously bouyed up by their results, working what seems to be the ice-edge bloom, but I wonder? They have been to 68S, but not seen any ice yet - obviously moved a long way since we were last there. Meetings of sub-groups and whole scientific party to decide best course of action.

Sea got quite bouncy as the day proceeded, a number of the scientific party down, this 5th crossing of the Drake Passage is proving to be as much of a trial as all the other odd-numbered crossings.

Thursday 26th November.
Sea and swell increased considerably overnight. Most found it very difficult to sleep. Starting to ship 'green water' over the quarter. Containers wet again, although no damage reported. We had to alter course to S to prevent further wetness encroaching on board. Some very heavy rolls during the day - up to 39degrees! Labs. holding together well. Very trying morning, and surprised it isn't sandwiches for lunch. The catering department deserve all the credit they can get under such conditions. Everybody's patience sorely tested today. The hope is for better weather to the South, although the reports from the Disco. during the morning suggest otherwise - Quote from Disco R/O - 'we are rolling around like a cow'!!

Weather brightened considerably during the PM. The sun came out and with the sea and spray produced a wonderful show. Although the weather was not really any better its

amazing how it always seems it when the sun is out.

Very uncomfortable night, heavy rolls commonly in the high 30degrees, a lot of water around on decks - banned from going outside (again). Very few people able to sleep.

Friday 27th November.
Weather continued to deteriorate during early hours. Spectacular (!!) 42degree roll around 0300 re-arranged a good many things, including some lab. equipment, although nothing serious.

Later morning brought no improvement. Everybody getting exceptionally weary of the excessive motion, difficult to walk around etc - quite a lot of seasickness around. Its amazing that food can still be cooked under these conditions. Galley scuppers unable to empty properly - leaving the galley deck awash with goodness knows what! Crashes from various serving hatches, there goes another pile of dishes!

Heard from AM Disco call they were fairing not a lot better, plus some problems with one of their gantries. Crossed Antarctic circle again just after lunch, marginal improvement in swell, and a decrease in the wind, so some prospects of improvement. Finally (2330) made 67S; 85W - our starting point for our run S into the ice; what a haul it has been. Joy of joys! deployed UOR at midnight - back to work at last, watches for overnight sampling started.

Saturday 28th November.
Through a combination of the change in course, and a slight improvement in the weather the rolling was almost instantly better; for those not working there should be some heavy sleeping tonight! We sighted Disco. about 0100 @ about 5 miles, now back in nearly full 24h daylight. Had a good chat with David over the VHF, obviously things much improved for them also, but still with problems with gantry.

The later morning turned out to be marvellous weatherwise, blue skies and seas with a lot bergs around. Came across a band of ice later in the morning which caused a few hearts in mouths since we were still towing the UOR. The sea got flatter, the sky bluer and a definite chill now in the air - just below zero. Hadn't seen so many people up and around for quite a few days. Spirits now much better after the roughness of the last few days, also the prospect of serious work helped I am sure. Very definite ice-edge encountered around 1600. Did some sampling before bashing back into it. Decided to head for a position close to original ice-station, now not very far away - only about 40 miles. Wonderful sunshine again, with spectacular ice scenery. We all had to find our sunglasses again! Carried on 'cracking cubes' overnight, monitoring as we went.

Sunday 29th November.
Arrived at station 'Herbie' 0800, very close to original 'Gertie' - its been a long time since we were last here! Things had changed quite a lot, with the floes now much smaller. Unfortunately, given the relatively rotten nature of the ice, access was by crane only - none of this - 'I'm just popping out for a walk business'.

Fortunately, there was clear water astern, so we were able to sample using the CTD and nets off the stern. Wonderful sight of Minke whales, only a few feet away in our 'pool'. Good day's work carried out, on and under-ice activities proceeded particularly well. A great day. Decided to turn the remaining days work into a series of stations from this baseline to the high activity way to the north. A cold day, with a keen wind and little sunshine. Continued sampling etc until just past midnight then left.

Monday 30th November.
Northbound! Progress through the ice very slow because of the relative lack of power, also the nature of the ice, which had closed in leaving no leads at all, just large floes and 'porridge' between. Continued throughout the morning bashing North. Wonderful ice scenery, but people a little edgy because of slow progress.

Finally broke out of ice at 2000, established station 'Isolde' (Wagner fans take note) on ice edge. Gentle roll, just enough to remind us that we were at sea! Work started right away and continued throughout the night.

Tuesday 1st December.
JCR's 2nd Birthday!! - Launched 2 years ago today. Bright breezy morning, not cold but wind increased all day to 45kts. Wonderfully calm in behind the breakwaters (!) of ice bands and bergs. Swell built during day, sure

sign of bad weather somewhere - we found out where when in contact with Disco - they had been hove-to for the last 24hours!

A good full day's work, hardly any time at all without some bit of gear over the side. Pre-dinner cocktails to toast the JCR, also coincided with Graham Shimmield's birthday. Started series of 6 CTD's at 2330 for phytoplankton incubation rigs.

Weather improved and calmed during the day, however, nowhere near as magical as at our furthest south stations. Still very bright in the 'wee small hours'.

Wednesday 2nd December.
Deployed incubation rigs 0130 in a gentle swell, with a rising sun (not that it ever went down) and an increasingly blue sky. Very busy day, with folks working around the clock, sleeping when they could.

Late on during the day, heavy snow resulted in the most wonderful effect on the sea surface. There was no wind, the sea was a jet black between the ice-floes, and the snow flakes which fell did not melt when they hit the sea. The result was little patches of white flower-like discs, just like lily pads- quite magical.

Fortunately the krill 'fishers' were successful tonight - they have had very little luck up to now.

We had difficulty finding the rigs, however, we found one eventually around midnight.

Thursday 3rd December.
Recovered first rig (sediment trap) without too much difficulty, however, second nowhere to be seen. Started box search. Very difficult conditions at times, with poor visibility in heavy snow showers. Regrettably called off search at 0700 and started passage to next station about 90 miles to the north.

Surface sampling, and UOR, done on transect. Still calm but murky with heavy snow showers. This was the last ice we were to see in the study area. Arrived at new station mid-pm and moved into the station work again. Deployed new sediment trap rig and made sure of being able to find it again by adding a wonderful array of 'visual aids' - including a helium filled weather balloon!! Might catch on. Lively Met.Obs. meeting today, preceded by a short carol singing session! Rest of the day filled by overside activities - CTD's, SAPS and zooplankton nets, which continued through the night. Disco. passed within a mile on a southerly leg towing Sea-Soar. It is somehow comforting to know that there are friends out there, buzzing around all working towards the same goals.

Made radio contact with Round the World Yachts, about 500miles to the North of us. We gave them weather information and sent best wishes from the PML sailing fraternity. Calm, peaceful evening and night - although of course still 24h light.

Friday 4th December.
Bad news from Disco. this morning about loss of Sea-Soar. Having been in a similar position myself on more than one occasion, I can well imagine what people are feeling like on her. There are two emotions when such a thing happens. One is the financial implications and the considerations for the future, but a more immediate one is the severe hole that such a loss makes to the scientific programme. Loss felt badly on board JCR too.

Arranged for transfer of UOR and Ian for the afternoon. Fortunately the weather was somewhat better than when we last transferred people and equipment, and it all went well. This was also the opportunity to do the trade in eggs for wine! I think we did well since Mike Harding (Master on Discovery) keeps a good cellar! Rather grey, murky day - very different from the sparkling days when in the ice.

Work carried on continuously, ranging across the board of all sampling activities. 2330 sampling for phytoplankton work repeated again.

Saturday 5th December.
Early morning sampling continued, and rigs deployed by 0130. An interesting arrangement this time, with a long string of ropes and bouys needed because of the loss of various vital bits of equipment off the previous one. These early morning sessions are always lively. Quite a number of people are involved in them, and there is invariably loud music being played in one lab. or another. Still very grey, rather miserable weather, however, with little wind around, conditions on board are very easy for working.

Busy day for most, with some not getting much sleep at all. Heavy snow in the late afternoon, plenty for the Met.Obs. people to talk about! Started lying quite thickly around on the decks - very seasonal.

Sunday 6th December.
Manoeuvred to pick up rigs just after midnight. Sadly, there was a loss of both sediment traps, and UCNW's oxygen rig - this was a severe blow. The condition of the wires (new 8mm) suspending the traps was amazing - it looked as if it had been shredded. There was no evidence of damage as such to where the oxygen rig had been attached. We could not imagine what had caused such damage, but we tentatively suggested that it could be caused by whales. Certainly, whales had been frequently seen 'playing' around the rigs. We'll never know for sure.

Relocated during the morning 60miles further N to our final station - 'Katie' at 67 30'S. Deployed new trap arrangement on arrival - and hoped that we would see it all intact following the two day deployment. Fabulous, bright sunny morning, with blue skies and sea and just enough breeze to make a few white horses. A little swell, but nothing much to bother us - one of those days that make seagoing so worthwhile!

Moved into the cycle of station activities again, sadly for the last time. Hopeful that it would be a successful station.

Contact with Disco. suggested that they would join us on Monday, and, weather permitting, a transfer back of 'Professor' (as we affectionately call him) Bellan; his skills as Met. observer have been missed! More importantly, we really need to have his sensor packages back for sampling on Monday.

'Fishing' for krill continued all night without a lot of success. These open ocean stations are difficult places for the krill people.

Monday 7th December.
Early morning unfortunately saw the wind and swell build up. Not uncomfortable on board, but making the prospect of small boat work unlikely.

Unfortunately problems with one of the winches delayed sampling activities during the morning.

8th December.
Deployed incubation rigs and tied them to sediment traps, we did not want a repeat of the previous loss. The weather in the morning was not much better than the previous day, but it was decided to go and collect the Prof. While we were waiting we had made up a 20' long banner with the words - "Welcome Home Prof." in dayglo pink. We froze solid out on deck, holding this up during a blizzard or two. We also managed to acquire some out of date flares, so when finally the boat transfer occurred, it was accompanied with much frantic waving, ship's hooter sounding and fireworks. I don't think they quite knew what was happening on Disco! Needless to say Ian was delighted.

Once the transfer was over, the Disco. made a very close approach to allow us all to say goodbye, and with much hooting from both ships she quickly disappeared North, to complete her transect and then Chile. Nice moment, considering we were something like 8500 miles from home.

Work continued during the day with an air of urgency. We had a major success by combining SAPS deployment with a box-core simultaneously. A huge saving in wire time since we were in over 4000m of water, and that's a lot of winding. Weather improved for us during the day - we were indeed fortunate, in fact, we were extremely fortunate for all the open water stations.

Air of expectancy about the place now that the main work was virtually at an end.

9th December.
The God's did not continue to smile on us, however, because on retrieving the rigs in the early hours of the morning, we discovered that the traps had been torn away again. Fortunately, the Langdon rigs were OK. We came to the conclusion that the whale theory was probably not on, and that the stresses and strains on the rigs, under what were still arduous, moderate swell conditions, were just too much for the type of rig we were using. Sad loss of data, but it could have been a lot worse.

Wonderful sunny morning. We had planned to leave immediately after some krill fishing following the rig recovery, however, there was still a sting in the tail. On departure,and about to tow the UOR, some hydraulic lines were

broken which put the aft gantry out of commission, and thus prevented the UOR from being towed. Were these problems destined to dog us throughout?

Anyway finally left for Passage to Rothera at 0800. About 400 mile passage, but with a lot of unknown ice conditions to get through. Very fine early part of the passage, calm sea. UOR recovered when out of the work area, final recovery greeted with a toast on the after-deck - at least were bringing this one home!!

Evening quiet, despite it being Phil Boyd's birthday - small rather subdued party held without the birthday boy present!

10th December

Came across the ice mid-morning and within half a mile of getting into it we were stuck! Unfortunately it was very sticky, complete cover stuff, and without the power of the 4th engine, the Jolly red giant just couldn't make it. After several attempts in different directions, there was nothing for it, but to change plans and abandon (almost certainly) Rothera. This caused a few long faces because we were looking forward to this.

However, events took a rapid and dramatic turn, when we were informed by Cambridge that the Rothera call was priority, At this stage it was not known how this would influence the itinerary. Several communications were sent backwards and forwards. It was evident at this point that a few battles were going to be fought.

Once back in open water we made very good progress North, during a very fine afternoon and night. Some very nice bergs around.

11th December

Arrived Palmer station (US - mostly biological work base) 0800. Opportunity for a rapid exchange of scientists. I didn't make the visit myself, but all reported a very good atmosphere about the base. It is certainly in a rather attractive position, situated on a rocky bluff with ice-ramps to either side, and a large ice-slope up to a flat plateau. Remarkably, just as we arrived, the BAS twin-otter flew in onto the ice ski-way, carrying the spare part for the engine. This would certainly be necessary if we were to stand a chance at making Rothera.

The commitment of BAS to the relief of Rothera was confirmed during the morning by word that our flights on the 19th had been cancelled!

The cargo work (boxes left a few weeks earlier by RRS Bransfield for Faraday, but unable to deliver because of severe ice-conditions) was completed by 1200 and we continued on our whistle-stop tour of the Peninsular again. Sad it was such a short visit because the Palmer crowd were an extremely nice bunch indeed.

Wonderfully, our route S to Faraday took us through the Lemaire Channel again!! Clouds obscured the highest tops, but it was another dose of sensory overload again!

Faraday was reached by 1630 - only round the corner, and the cargo work started immediately. Unfortunately unable to get ashore because of the lack of time.

Throughout this time the engineers had been working on the spare part for the engine. Unbelievably, it was the wrong part. Amazingly, however, they had managed to fabricate one working part out of the old part and the new unsuitable one. It was a great feat of engineering involving sheaving a shaft with such a tight fit that one part had been placed in a minus 60C freezer, and the other heated to enable to be fitted. Without the part, Rothera would have been an impossibility it was thought.

Set off for Faraday and called meeting to explain the now confirmed situation. The news of the priorities, the uncertainty of the ice-conditions, and the cancellation of the flights did not go down well. However, it is not overstating the case, that the majority of people took it with the philosophical attitude that had been called upon several times already on this cruise.

12th December

Passage south, back to Rothera continued well throughout the night and into the morning. Lovely calm weather again - amazing for down here.We hit the ice-edge at 1300, and immediately slowed. Hard to gain any progress into the ice, but it was done by going backwards and forwards. At one point, only one mile was done in an hour. At the point of entering the ice we were about 50 miles from Rothera, so doing 1 mile in an hour was not a good prospect!! Fortunately, we knew, from the plane which returned to Rothera, and

which did a 'recce' flight for us, that there was only about 15 miles of the stuff.

We pressed on during the afternoon, and by about 2000 we were out of the worst of it. Finally, we hit open water - a shore lead of sorts- inside the ice, and the job was done apart from about 6 miles of fast ice, up against the coast.

The views of the land developed very dramatically during the late afternoon, islands, mountains, ice etc. Absolutely tremendous place. We approached the fast ice at about 2200 and hardly noticed a change in speed. The fast ice was about half a metre thick, and could have been our downfall, however, the jolly red giant, made mince-meat of it. Progress was so good that we 'parked' for a few hours in the middle of nowhere during the night, so that we arrived at Rothera at a sociable hour.

Sunday 13th December.
Arrived at Rothera first thing, and the work started immediately. What an incredible place. Unlike all the other places we have visited, there is now a quay here, and a hard runway. The whole place resembled a major construction site. There were vehicles of all shapes and sizes ready for us, 'Tonka Toys' was one description - very apt, but also somehow very incongruous in all this beauty.

Masses of cargo shifted throughout the day, with scientists putting in a hard days work in both the hold and at the base. All managed to get a bit a free time. A visit to the dogs was the number one thing to do, and what a great joy it was to see them.

Work continued apace all day, finishing at 2100. A tough day for all involved. Weather was quite amazing, almost warm. Sadly, rather cloudy but the effect of the fjord like situation, with ice cliffs and mountains all around that most mountaineers can only dream about was utterly stunning. A few base personnel entertained on the ship, but otherwise a quiet night.

Monday 14th December.
Work started early again with the cargo. Some involvement from scientists, but most occupied with filling containers with gear. Again a very warm day (about +3C) with almost a drizzle in the air, but which came and went as a light snowfall on occasions. Cranes working all morning, unloading all sorts of stuff, including 800 barrels of aviation fuel; a long job when they are shifted four at a time from the hold with a crane.

Weather improved as the day moved on - certainly nice enough to realise what a unique position this base is in. Most were able to get an hour or two ashore up towards a very fine peak, or wander around amongst the snow, ice and rocks.

Some of the divers managed a dive, right next to the ship, at the end of the runway. All reported the most magnificent scenes: eg. feather stars bigger than dinner plates etc. The Diving officer who had done many dives in the Antarctic, had never before seen such sights, and concluded that the place probably warranted the status of SSSI.

Managed to bash a few golf balls around before we left, our furthest South golfing. Sadly, we didn't get around doing this at station Gertie all those weeks ago at 70 and a bit south. Still, Rothera is not a bad place to hit a ball or two!!

Left with the customary hooting at 1500. Rather a sad occasion for the ship and the base really, with no time for socialising.

Progress made initially through the fast ice was superb. All that remained was how long would it take us to get out of the pack ice. The answer would determine when it was that we would get home.

In the event we really cracked on at a superb pace. There were many occasions when we were stopped, which required the now customary backwards and forwards business, but overall we made great progress. News of our success at the Rothera relief had been relayed to Cambridge, who had managed to reinstate our flights on the 19th. This news greeted with great relief.

Got out of the ice by the evening, so 'plain sailing' from now on!! Fortunately, when we got out of the ice the weather was good to us - nice smooth seas, and gentle winds, just a gentle swell from the west, just enough to remind us that we were really at sea.

15th - 18th December.
Not a lot to report here, apart from a magnificent passage back to Stanley. The

weather just go calmer and calmer! There were a few gentle tilts to remind us that we were in the Drake passage, but basically, a passage of no wind, largely blue sea and sky - quite magic. Little by little the Antarctic disappeared, even the Convergence area which effectively delimits the area was not really noticed; a little fog perhaps, but that's about all. All on board, now much more relaxed with the prospect of an arrival at Stanley on time.

Arrived Stanley early AM 18th. Packing continued all day, with departure set for early AM 19th.

19th December - 21st December.

First flight to Ascension Is. Ok, however, 24h delay required on island because of problems with plane. Final arrival UK early 21st.

3. SHIP, EQUIPMENT & LOGISTICS.

General.

Given that the *James Clark Ross* had previously carried out only one relatively short scientific cruise there were relatively few problems. This is a magnificent ship, and it was a pleasure to sail on her. I am convinced that she will become a highly sought after platform for science in the very near future.

No difficulties were encountered over the potential overlap of management function between BAS and RVS. The pre-cruise meeting where the scientists, senior ship's officers RVS and BAS management had an opportunity to meet together was a very valuable excercise and must be a requirement for future cruises.

It is vital that RVS and BAS agree on the numbering of cruises. This was RVS JCR cruise 03, and BAS JCR cruise 02!!

Given their far wider experience and contacts I would recommend that BAS organise transportation of personnel to the Falklands (as was the case on this cruise). Communications between the ship and UK were excellent via BAS, but less reliable via RVS. The BAS organised personal air-letter facility was a generous facility and much appreciated.

Some difficulties were encountered over communications to home institutes when changes to the ship's programme occurred. This came about because of the diverse affiliations of the scientists. Neither the responsibility (nor the information to accomplish it) for disemination of 'urgent' information other than to 'first contacts' (via the BAS personal message facility) had been agreed in advance. This can be easily overcome for future cruises by ensuring that either BAS or RVS (whichever takes the responsibility) has the necessary information. The large number of BAS scientists on board, and the requirement for the ship to carry out BAS logistics ensured that communications were largely as usual for the ship, and thus not a problem for most scientists. The situation will inevitably arise when this is not the case (say for Arctic work). It is essential that a clear policy is decided in this event.

Winches, deck operations etc.

The major problem, which was never fully resolved, related to difficulties with the 10 tonne traction winch (the 30T winch was not required). There were three seperate problems. (See also Deck Engineer's report - page ??).

1. Impracticality of using hydrographic wire. No attempt was made to use this wire. This decision was based on extensive discussions prior to the cruise which suggested that the time required to continually change wires, coupled with the potential for damage to be caused to the conducting wire made the operation of the hydrographic wire untenable. Whether these difficulties will be overcome during the refit of winches is unknown, however, a traction winch system for a hydrographic wire would seem to be a major overspecification.

A 'portable' drum winch (RVS SAPS winch) was provided in place of the hydrographic winch. Some problems were encountered initially with the installation of this (see Deck Engineer's report). Once operational, problems were encountered through lack of suitable wire-out facilities and lack of an operational spooling mechanism. Whilst these were not insurmountable, their absence resulted in a very cumbersome operation. The winch was sited on the stbd. side, outboard of the CTD hangar for the majority of the cruise. This made operation of the CTD difficult, and potentially hazardous for personnel and equipment. The RVS support technician has stated that he would not operate under a similar arrangement again. I support this view. On occasions the SAPS winch was operated over the stern gantry, and apart from the difficulty of blocked vision of the winch operator because of the containers (a problem common for all over-stern operations), this worked smoothly.

A permanent, hydrographic winch is a major requirement. The facility to operate this over the stern gantry when necessary (see below) is an important requirement.

2. Unreeving of conducting wire. This was a serious problem at the start of the cruise, which resulted in significant delays, and potential hazard for equipment. Althouth the problem was largely overcome this was a constant insecurity throughout the cruise. It is unacceptable that the smooth running of a winch is considered a 'bonus', yet this is how it became seen. There was always an element of doubt about whether the winch operation would run smoothly. This also had the practical difficulty of requireing the full attention of both a winch driver and the deck engineer, who spent a considerable amount of time 'in residence' in the winch room. Given the sometimes 24h operation of the winch this required considerable dedication to duty. Damage was caused to the conducting wire due to this occasional unreeving resulting in the need for retermination.

3. Hydraulic oil spillages. This was a constant problem throughout the cruise requireing the constant attention of the Deck Engineer. I got the impression that the problems were worse at cold temperatures, however, this is unsubstatiated. The spillages of oil clearly have (unknown) implications on the 'clean' chemical measurements made.

Other difficulties encountered were problems with hydraulic oil leakage from the stern gantry. The consequences on measurements are unknown. Also, the leakages made working off the deck extremely hazardous because of slippery decks.

Continual problems were encountered with the snagging of the conducting wire on the large coring block located on the stbd. gantry. This frequently knocked off grease cannisters (dangerous for those below), and on one occasion damaged the wire which necessitated re-termination.

The operation of the Gillson winch for towing the UOR was a success, despite the lead being not quite perfect. The lack of spooling gear on the winch was a minor inconvenience, requireing a jury rig. More permanent arrangements are necessary for the future use of towed bodies. There were no cleats available for use on the afterdeck, this should be rectified.

Other deck operations ran smoothly. The wide side-deck, and ship's manouverability were excellent. Visibility from the bridge and stbd. from the winch operator console were excellent. As noted above, visibility was restricted aft from the winch console because of the containers. It is difficult to suggest how this could be overcome if there is a requirement for containers.

The arrangement of the winch operator and the CTD operator is excellent. Communications between deck, winch and bridge were best carried out through the use of portable VHF radios.

As noted in the acknowledgements, the deck bosun and deck engineer were vital to the success of the science. I firmly believe that ship's staff who's role is scientific support is an excellent arrangement, and their occupancy of scientific berths is a small price to pay for the expertise.

Difficulties were encountered in sampling within solid ice. Our original hope was that sufficient space would be created around the side of the ship to enable the normal use of CTD, water bottles etc. This was possible only if 'off ship' activities were not required. Where there was a requirement to 'moor' the ship solidly in ice, over stern sampling was the only option. Successful deployments of all gear over the stern gantry, however, this was only possible because of the flexibility of re-reeving the wires required. It is important to ensure that if a separate hydrographic winch arrangement is devised, this must have the flexibility to be deployed through both the starboard and stern gantries.

Serious difficulties were encountered in the use of the uncontaminated seawater supply when working ice through the blockage of the intakes. This seriously hampered scientific operations. Our only alternative was to halt the ship when in leads. This was far from ideal, and the continual start-stop operation led to a reduction in quality of the supply for many requirements and instruments. This problem must be addressed. A similar problem occurred with the drinking water supply intakes.

Laboratories.

All laboratory space (and more) was used to the full. The facilities in the laboratories, benches, cupboards etc. are good. Because of the size of the ship, there was a tendency for those mainly working in the UIC room to become polarised from those mainly working in the main deck laboratories. It is difficult to see how this can be overcome.

The requirements for space on the cruise was such that scientific operations were carried out in both the scientific workshops. The special needs of a gamma-spectrometer (see report from Graham Shimmield - page ??) required the use of the scientific hold. This cruise could not have been carried out without the use of four laboratory containers. These containers worked well, with a full suite of facilities. Occasional iceing up of drains was a problem. Apart from the problems with vision outlined above, the presence of the containers caused only minor inconveniences of space. Access to the containers was barred on occasions because of bad weather. One container suffered severe flooding, however, this was due to the design and poor condition of this container.

A continual annoyance and difficulty in the laboratories was the number of doors that had to be negotiated with equipment and samples. The small size of some of the laboratories caused difficulties with temperature control (both these aspects are dealt with in some of the individual reports). Both problems tended to be overcome by the tying back of doors. Obviously this is not good practice but it was the easiest solution. Occasional difficulties were experienced with the biological laboratory which is a natural through-route into and out of the main laboratory.

The ship's piped gas supply was unusable. This was due to the inadequacy of the laboratory outlets in which the rubber gaskets had perished. It is doubtful if these would have been of sufficient quality even if operational. The problem was overcome by piping individual gas lines into the laboratory. Although untidy, this was a perfectly adequate solution, and the favoured operation for some users since all parts are provided and can be quality checked (e.g. leak tested) by the end-user. Given adequate outside storage for gas bottles this is no more of a hazard than inbuilt piped supplies, indeed it could be argued that it is safer since all parts can be leak tested; this is not the case for built in supplies. Given the large number of users of gas, individual supplies would have been required even had the ship's system been operational.

The deionised water supply was not of sufficient quality for some uses.

Overall, despite extremely heavy use the laboratory facilities were excellent. It was felt by some that they were overcrowded (see below), however, the majority of users were very satisfied with the laboratory accommodation.

Hotel facilities.

The descision to sail with so many scientists had been the subject of considerable debate prior to sailing.

The majority of fears had centred on the sharing of cabins, particularly the pullman cabins. With the exception of some individuals, the sharing of cabins, including the pullmans was considered satisfactory. Even given the several long passages made on this cruise most people used their cabins only for sleeping. Whilst this general satisfaction was not shared by all, and I am well aware that I had a large and pleasant cabin, it is true to say that the majority of people would be prepared to take part in a JCR cruise under similar circumstances again. In the majority of cases the size of the 'public spaces' made up for the difficulties of lack of space, thus generally allaying the potential sense of claustrophobia. While

I am not suggesting that this number of scientists should be seen to be the norm for the JCR, I strongly believe that it would be an unnacceptable misuse of a resource to discount this possibility for the future. A number of individual reports refer to the cabin accommodation. The provision of showers outside the cabins would be desirable for those sharing cabins (even the large cabins) in the future.

As noted above, some scientists felt that the numbers of scientists was too many for the scientific accommodation. However, this was not a general feeling, and the majority were very satisfied with the arrangements. Certainly almost all available space was utilised, and some spaces were used for purposes beyond their original design (e.g. a workshop was permanently used for the servicing of the towed body instrument - however, this did not exclude its primary use as a general workshop). My own impression was that the scientific accommodation was more than adequate for the numbers, indeed I was pleasantly surprised that so many could be accommodated, however, as noted previously the four laboratory containers were essential.

Difficulties in the catering facilities were anticipated. Undoubtably the large number of scientists proved to be an unnaceptable burden for the original number of catering staff. This problem was, I believe, largely overcome by the recruitment of an extra-hand, and was made possible because of the unexpected gaining of a scientist berth. It is not for me to comment further on this, except to say that I was pleased that this was did ease the considerable work load of the catering department.

While the saloon was clearly under pressure, the 'rolling' arrangements adopted for breakfasts and lunches worked well. The two sitting arrangement for dinner also worked extremely well. It is difficult to see how other arrangements might work. A suggestion has been made to abandon the use of the 'coffee lounge'. I personally would not recommend this since this proved to be highly useful in speeding up the vacancy of the saloon. It also provided an obvious 'no smoking' area. Some difficulties were experienced over the provision of vegetarian food. However, the majority of people were highly complementary about the standard and variety of the food.

The bar/lounge area was well used(!) and much liked, and its size allowed many different activities to be pursued simultaneously. Although perhaps not strictly a 'hotel facility' the library/conference room was well used as a general office and quiet room, as well as a meeting room. I am not aware over any conflicts of interests in the use of this space. The sauna and gym were very heavily used, and a superb facility.

Logistics.

As noted in the acknowledgements, the hard work of many people ensured that the logistics of moving so many people and their equipment went extremely smoothly, and no difficulties were encountered. Stanley proved to be an adequate mobilisation/demobilisation port.

Questions were raised during the cruise about the consequences of combining BAS logistics with STAP time. The logistics carried out on this cruise did not inconvenience the science, indeed the opportunity to visit BAS bases was seen by

most as a highlight of the cruise. The difficulties encountered at the end of the cruise through the priority requirement for logistics work did cause personal problems for some. The need for medical evacuations (and the heavy time penalty) that so severely impinged on this cruise cannot ever be wholly overcome, and must be accepted as a consequence of working in remote areas.

4. SCIENTIFIC ACTIVITIES

4.1 SIZE-FRACTIONATED PRIMARY PRODUCTION - PHIL BOYD.

1) OBJECTIVES

To investigate the temporal development of the phytoplankton bloom associated with the marginal ice zone (MIZ).

To place the time series data set obtained within a spatial context by linking, via a simple bio-optical model, *in situ* primary productivity measurements, photosynthetic characteristics, PAR and Kd with the dataset of a co-worker on RRS Discovery.

To attempt to examine the relationship between phytoplankton size spectra, community structure and the vertical flux of material from the surface layers.

To input the data set into a cruise database to be used in conjunction with a Southern Ocean model currently being developed at BAS.

2) METHODS

a) Water column processes

Size fractionated *in situ* primary production using the ^{14}C technique and three size classes - 0.2*u*m-2*u*m, 2*u*m -20*u*m and >20*u*m.
Determination of the photosynthetic characteristics of the phytoplankton within the above size classes using an artificial light gradient incubator and the ^{14}C technique.
Analyses of chlorophyll and phaeopigments for the above phytoplanktonic size fractions and total chlorophyll (>0.2um) using 90% acetone extraction/ fluorometric assay.
Preservation of phytoplankton samples using Lugols.
Deployment of drifting sediment traps at 150m and 300m.

b) Sea Ice processes

In situ ice algal incubations were performed using the ^{14}C technique and fractionation using the above size classes. Cores of sea ice (approx 100mls volume when melted) were obtained from the underside of the ice by divers using hand corers. The cores were then put in perspex incubation chambers, innoculated, and placed in a incubator which floated against the underside of the ice. This method is a departure from the JGOFS protocol, formulated by Dieckmann and Bathmann (AWI), in which sea ice samples are allowed to melt in large volumes of sterile sea water over a period of up to 24h prior to conducting physiological experiments. In the present study, the distribution of the ^{14}C label through the ice core was assessed using the addition of a fluorescent dye to a core in an additional chamber.

3) EXPERIMENTAL PROGRAMME

a) Transect work

This involved the routine collection of samples from the ships non-toxic sea water supply. The samples were analysed for chlorophyll and phaeopigments in order to calibrate the ships Turner flow through fluorometer. In addition, this data was used to give "real time" information on changes in chlorophyll concentrations along the transect, in particular while steaming through brash ice as the signal from the fluorometer was noisy under these conditions. Water samples for phytoplankton counts were taken concurrently with those for chlorophyll. See Table 1 for details of the transects.

b) Station work

When the ship was on station, samples were taken over a range of depths in order to obtain vertical profiles of chlorophyll concentrations and phytoplankton cell densities. A number of rate process measurements were made when on station. Tables 2a and 2b contain a summary of the measurements made and how samples were obtained.

4) PRELIMINARY RESULTS

Transect data

a) Chlorophyll data

The surface transects (Table 1) from approx 66 30' S to 70 00'S on each occasion revealed a prominant peak in chlorophyll concentration centred around 67 30'S (Fig. 1). This feature appeared to be geographically consistent, being characterized by a sharp N boundary (67 00'S) while the S edge of the chlorophyll peak showed more variation (67 30'S - >68 00' S).

b) Phytoplankton data

The relatively high chlorophyll concentrations associated with the feature centred on 67 30' S permitted light microscopy (without sedimentation) of the Lugols stained samples. These microscopic observations revealed a diatom dominated assemblage within the chlorophyll peak. The main diatom species noted were *Thalassiosira, Rhizosolenia, Corethron* and *Asterionella.* Photomicrographs were taken of the dominant phytoplankton.

Station data

c) *In situ* primary production

A series of *in situ* productivity experiments were performed at several stations (Table 2a) using samples from 6/7 depths from 2m to 75m depending on the light field. On one occasion (Station I) the *in situ* rig was not relocated and after an extensive search was assumed to have been sunk by ice action. Rates of primary production obtained from surface samples ranged from <5 ug C l^{-1} d^{-1} to > 30 ug C l^{-1} d^{-1} for stations G and K respectively. In general the partitioning of production between the three size fractions showed that the >20um fraction was the dominant size class, contributing > 70% to total production. These data will be compared and contrasted with concurrent *in situ* measurements of oxygen evolution /respiration and nitrogen transformations using the ^{15}N technique.

Two *in situ* ice algal incubations were performed at station G in conjunction with microzooplankton grazing experiments/counts. Primary production in the ice algal samples was > 50 times greater than noted in the surface waters under the sea ice. The ice algal data revealed high spatial variability in the rates of

primary production. However, as each filter obtained for primary production estimates was split in two, biomass normalized production rates could be calculated. Normalization of the data revealed substantially less spatial variability in the production rates. Thanks to the divers, dive hole "navigators" who cut/dug the dive hole and to Carol R for running tCO_2 analyses on ice melt samples.

d) Chlorophyll measurements

High spatial variability was also noted for the chlorophyll concentrations obtained from analyses of the sea ice cores. Values ranged from < 1 ug l^{-1} to > 15 ug l^{-1}. Water column chlorophyll concentrations were low at G and H being < 0.2 ug l^{-1}, but generally increased from south to north reaching values of > 2ug l^{-1} at station K. Size fractionated chlorophyll data revealed that the majority of the autotrophic biomass was in the > 20um. fraction. Chlorophyll standards were distributed to co-workers on the RRS Discovery and JCR and a cast of samples for chlorophyll analyses was exchanged between ships during the rendez-vous of the 20th November. The chlorophyll data from the level 1 casts will be used to calibrate the CTD Chelsea fluorometer.

e) P:i characteristics

Preliminary examination of the data obtained from p:i experiments suggested that values of Pb max were low, being < 0.5ug C ug $Chla^{-1}$ h^{-1} at G, H and I. Values of around 1 ug C ug $Chla^{-1}$ h^{-1} were noted for Pb max at J and K. As the data has yet to be curve fitted, no information on alpha is available at present. An intercalibration p:i experiment was carried out, using a common water sample, with a co-worker on RRS Discovery during a rendez-vous station on 20th November.

f) Sediment traps

I assisted Graham Shimmield with 4 deployments of drifting sediment traps. The traps were deployed for periods of 2-4d. Recovery of the traps at J and K was unsuccessful, however they were successfully recovered and material was collected at G and I. Examination of the contents of the traps suggested low material flux. Several faecal strings (500*u*m) were observed by microscopy and photographed. Amphipods, and large copepods were also noted.

g) Phytoplankton samples

No samples from the water column profiles have so far been analysed in detail. Microscopic examination of fixed ice algal samples revealed an assemblage dominated by pennate diatoms such as including *Nitzchia* species.

5) DATA FORMAT

a) Transect and vertical profile chlorophyll data - Excel spreadsheet.
b) *in situ* and p:i primary production data - hard copy output from Beckmann scintillation counter.
c) fixed phytoplankton samples-hand written notes and photomicrographs.
d) sediment trap material - on preserved filters and photomicrographs. It is hoped to have a) and b) on the database at BODC by March /April '93. The fate of c) and d) have yet to be discussed.

6) PRELIMINARY CONCLUSIONS

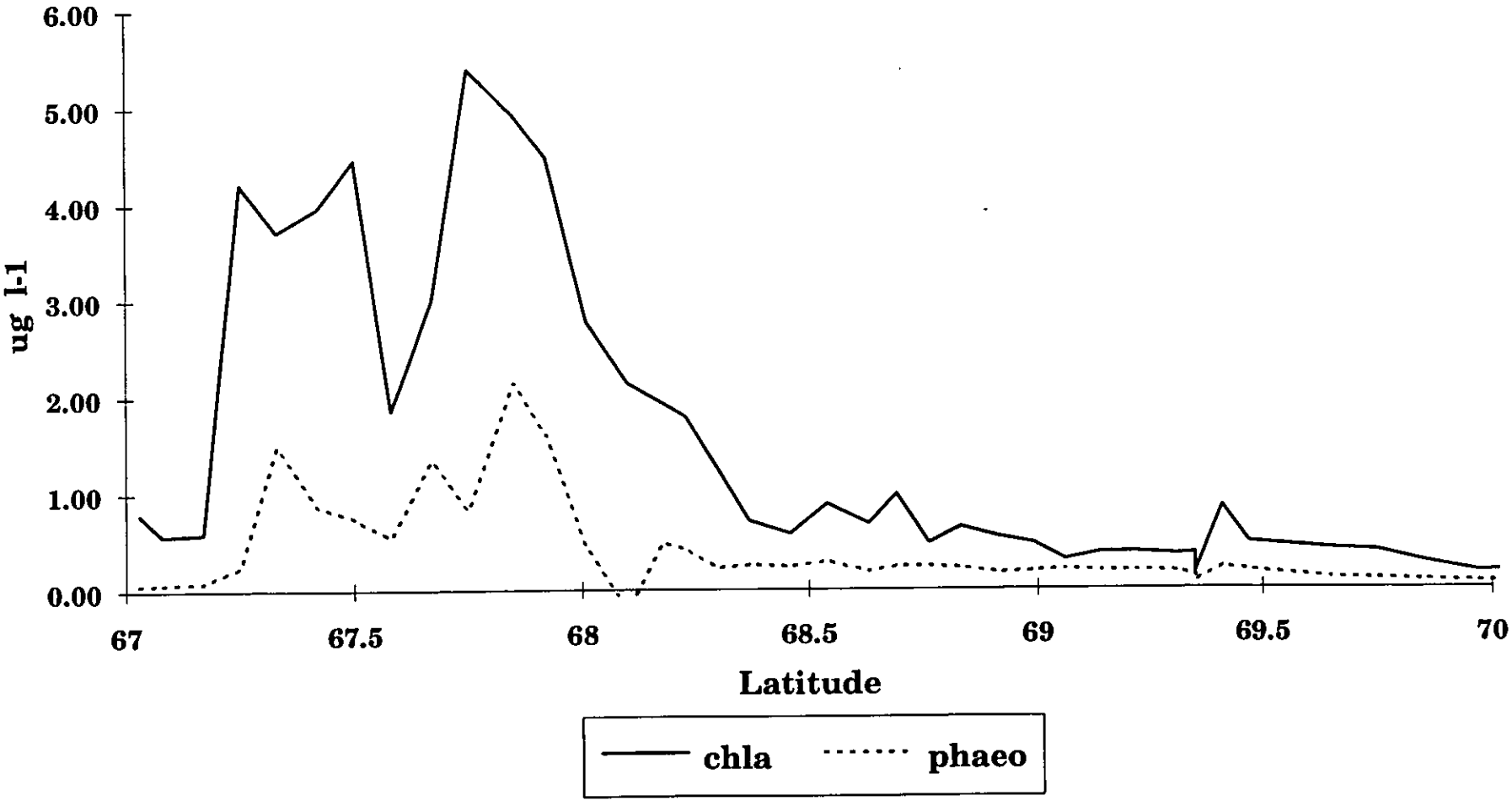
a) From the observations on phytoplankton biomass and production there appears to be little evidence of the development of a phytoplankton bloom associated with the MIZ during the present study.

b) The higher surface chlorophyll concentrations centred on 67 30'S may be indicative of a region where a bloom has developed. The spatial extent of this feature and the processes constraining the N and, in particular, the S boundary are of considerable interest.

c) This offshore region of high chlorophyll was observed in a water column with a mixed layer depth of > 70m. The development of this bloom is of interest: rates of primary production per unit biomass were low at station K and a light profile obtained at this station suggested that the 0.01% Io depth was around 40m. Analysis of the data on photosynthetic characteristics of the phytoplankton at this station may assist in understanding some of these observations.

d) The loss of 15d obviously curtailed and compromised the programme. The preliminary findings of this cruise suggest that the Bellingshausen Sea has a research potential which merits further attention.

TRANSECT N-S ALONG 85W TO ICE JD 333/334



UNDERWAY TRANSECTS (SAMPLES FOR CHLA'S/ LUGOLS TAKEN)

TRANSECT	JD START	TIME GMT	LAT (S)	LONG (W)	JD FINISH	TIME GMT	LAT(S)	LONG (V
DRAKES PASSAGE 1	302	2000h	54 60'	58 05'	305	0100h	061 51'	57 06'
DRAKES PASSAGE 2	310	1200h	55 08'	59 04'	313	1800h	62 47'	62 07'
W TRANSECT ALONG 65S	316	0300h	65 11'	79 19'	316	2000h	65 16'	85 00'
S TRANSECT ALONG 85W	316	2100h	65 23'	84 52'	318	0000h	69 20'	85 01'
S-N TRANSECT "G" TO DISC	324	0048h	70 06'	85 31'	325	0300h	66 56'	85 22'
N-S TRANSECT TO ICE	333	0246h	67 02'	84 58'	334	0852h	70 05'	85 07'
S-N TRANSECT "I" TO "J"	338	1030h	69 40'	85 10'	338	1930h	68 17'	85 00'
S-N TRANSECT "J" TO "K"	341	0810h	68 17'	84 41'	341	1200h	67 57'	85 00'

STATIONS

STATION	JD START	JD FINISH	LAT	LONG	VERT CHLA	VERT LUGOLS	ICE CHLA	ICE LUGOLS	14C IN SITU	14CICE IN SITU	14C P:I	SED TRAP
GERTIE	320	325	70 19'	85 13'	Y	Y	Y	Y	Y	Y	Y	Y
HERBIE	334	336	70 14'	85 64'	Y	Y	Y	Y			Y	
ISOLDE	336	338	69 34'	84 58'	Y	Y			Y (NR)		Y	Y
JULES	338	341	68 30'	85 02'	Y	Y			Y		Y	Y(NR)
KATIE	341	344	67 29'	85 00'	Y	Y			Y		Y	Y(NR)
I TO J	338	338	69 00'	85 02'	Y	Y					Y	
J TO K	341	341	68 06'	85 00'	Y	Y					Y	

(NR DENOTES NOT RECOVERED)

CTD/CAST NOS

STATION	JD START	JD FINISH	VERT CHLA	VERT LUGOLS	ICE CHLA	ICE LUGOLS	I4C IN SITU	14CICE IN SITU	14C P:I	SED TRAP
GERTIE	320	325	10	10	DIVER	DIVER	11	DIVER	17	
HERBIE	334	336	30	30	DIVER	DIVER			24 ?	
ISOLDE	336	338	36	36			39		44	
JULES	338	341	52/53	52/53			56		62	
KATIE	341	344	69	69			72		78	
I TO J	338	338	49	49					49	
J TO K	341	341	66	66					66	

4.2 NUTRIENT ANALYSES. - E.M.S. WOODWARD and M.J. WHITEHOUSE

Objectives

1.To characterise the spatial and temporal variation in the distribution of nutrients in relation to physical and biological parameters during a phytoplankton bloom associated with the summer sea ice retreat.
2. To chacterise the surface nutrient concentrations across the Polar and Sub-Antarctic frontal systems, in relation to other chemical, biological and physical parameters
3. To commission and field test a innovative new nanomolar ammonium analysis system.

Methods

Discrete samples for dissolved nutrient analysis were filtered through a 0.45um filter and measured using a Chemlab Segmented Flow Analyser (Whitehouse and Woodley 1987). Particulate samples taken for biogenic silicon analysis were filtered onto a 0.4um filter, dried and stored for analysis back at Cambridge (Paasche 1980).
A Technicon 6-channel autoanalyser was used for continuous and semi-continuous sample analysis of nitrate, nitrite, ammonium, phosphate, silicon, and urea.
On-line water was obtained from the ships uncontaminated sea water system, pumped from under the hull amidships. Samples were filtered through a 0.45um membrane filter.
See Nutrient analysis techniques, EMS. Woodward, Plymouth Marine Laboratory, January 1992.
The nanomolar technique is from RD. Jones, 1992.

Stations

Nitrate, nitrite, ammonium, phosphate and dissolved silicon were measured on samples taken from CTD casts 2, 7, 10, 18, 23, 24, 26, 28, 30, 35, 36, 45, 48, 49, 51, 52, 53, 54, 61, 65, 66, 69, 77, 79.

Nitrate, nitrite, ammonium, phosphate and dissolved silicon were measured on samples obtained with an under-ice pump system - 13 Nov, 15 Nov, 16 Nov. Samples were also taken for biogenic silicon analysis.

Additional biogenic silicon samples were filtered from CTD casts 10, 36, 53, 77.

Discovery intercalibration - 20 Nov (CTD 27 - JCR)

Pumped versus CTD water bottle comparison - 13 Nov (CTD 7)

Continuous surface analysis, and semi-continuous discrete sample analysis carried out during the following times:

FROM	TO	COMMENTS
28/10/92 (1340)	31/10/92 (0100)	1st Drakes Passage
5/11/92 (1300)	7/11/92 (1855)	3rd Drakes Passage
11/11/92 (2350)	12/11/92 (2330)	Open sea to ice run.
13/11/92	13/11/92	Pump profile at Flossie, to 51 meters.
16/11/92		Incub rig samples
17/11/92		Deep CTD (500m)
20/11/92		Intercalibration with RRS Discovery
28/11/92 (0240)	29/11/92 (1152)	Flossie to Gertie
29/11/92		CTD for DR
2/12/92		Incub rig samples. Also deep CTD, 48
3/12/92 (0958)	3/12/92 (2106)	Isolde to Jules
4/12/92		Urea for level 1 CTD, and 500m CTD.
5/12/92		Incub rig samples.
6/12/92 (0756)	6/12/92 (1345)	Jules to Katie
8/12/92		Incub rig samples. Deep CTD (4000m) for Urea.

Data status

The discrete nutrient analyser chart recorder output will be analysed during January 1993.
The 6-channel analyser was logged every 5 seconds by the main ship computer, this will be archived at BODC, and the data will be worked up here and at PML.
Nanoammonium data is in chart recorder form, and this will be digitised at PML.

Results to date

The continuous transect for the first crossing of the Drake passage is shown in the attached figures. The structures in nutrients, salinity, temperature and fluoresence can be clearly seen particularly for the Polar and sub-antarctic fronts. This data is still in its primary stage of screening.
The low level ammonium system was finally fully operational on 1/12/92, and was used successfully to measure the ammonium concentrations from a variety of water column profiles, particularly the deep CTD's where the ammonium levels were as low as 20-30 nanomolar.

A standard calibration is shown in the attached figure.The sensitivity of the conventional colorimetric system is at best 0.1uM (100nM)

Cruise conclusions.

Most of this is said in the PSO's reports, a feeling of frustration at what could have been achieved given even a little less bad luck.
Ship, officers and crew were excellent. Generally one of the friendliest and most helpfull group of officers I have sailed with in over 50 cruises.
WE WILL RETURN !!!

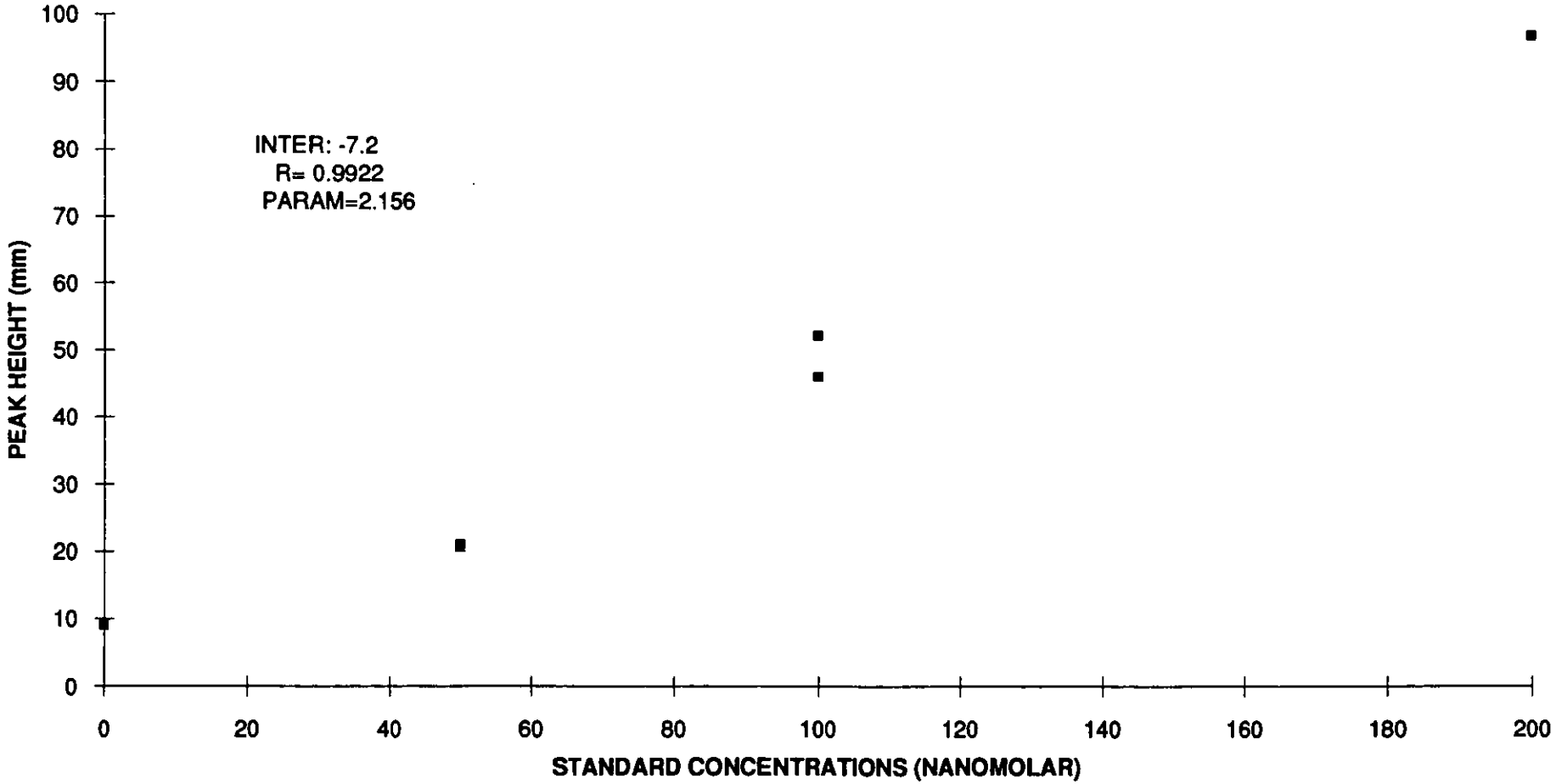
References

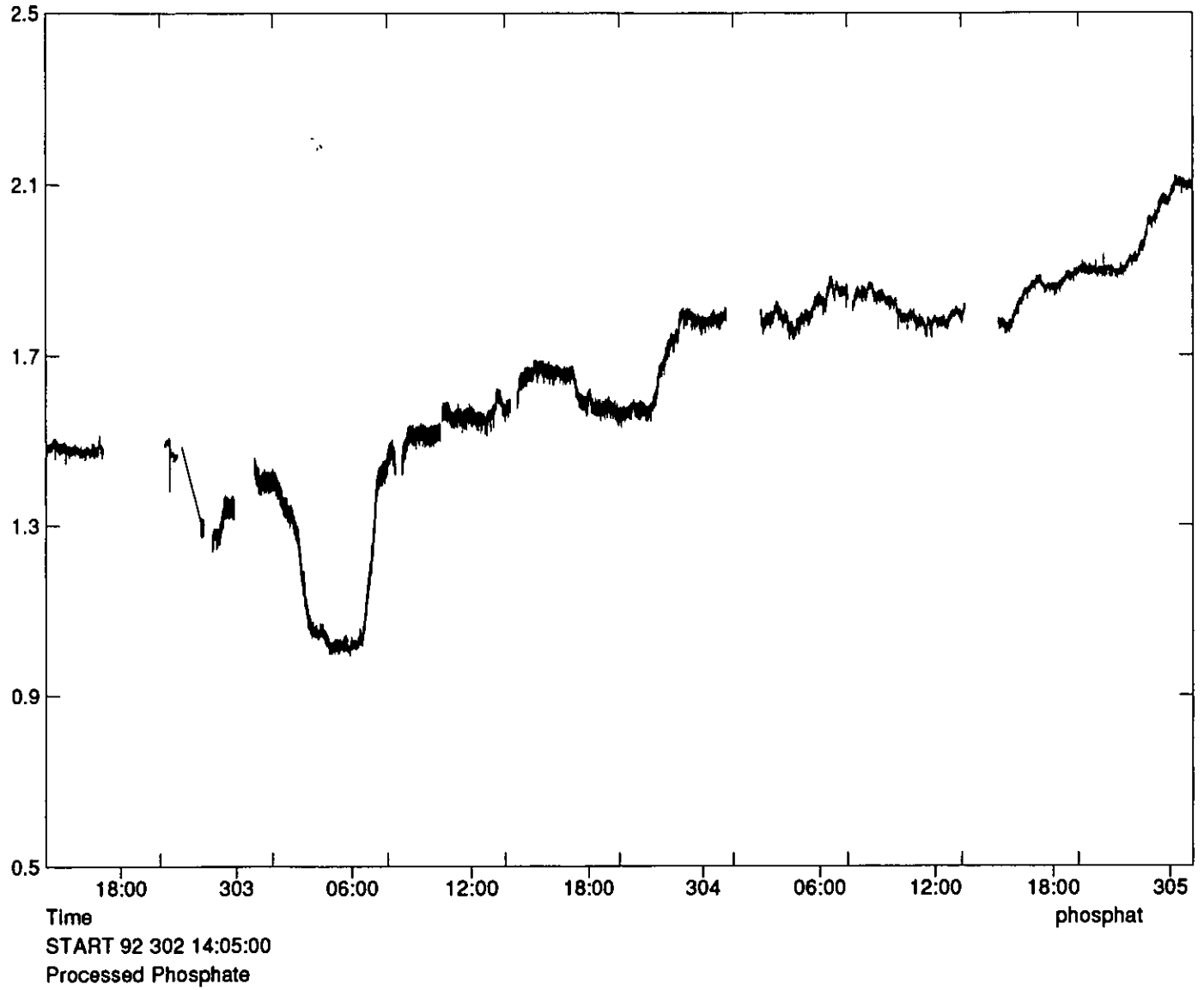
Jones, R.D., 1991. An improved fluorescence method for the determination of nanomolar concentrations of ammonium in natural waters. Limnology and Oceanography., 36(4), 1991, 814-819.
Paasche, E. 1980. Silicon content of five marine plankton diatom species measured with a rapid filter method. Limnol. Ocean., 25 (3): 474 - 480.

Whitehouse, M.J. & V.R. Woodley. 1987. Automated Seawater Nutrient Analysis. pp. 41. Cambridge, British Antarctic Survey.

Woodward, E.M.S., 1992. . Nutrient Analysis Techniques. Plymouth Marine Laboratory.

NANOMOLAR AMMONIUM CALIBRATION.

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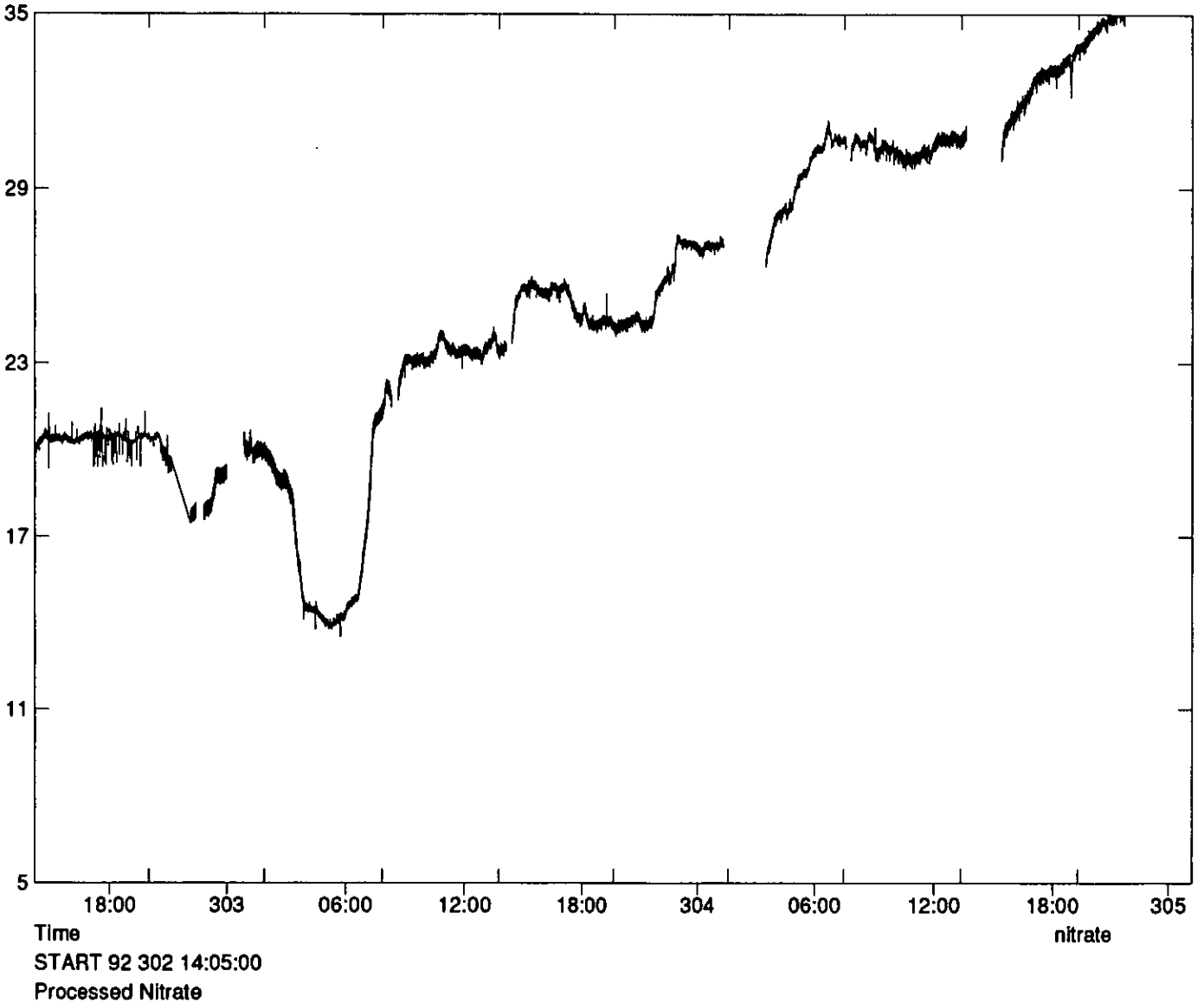
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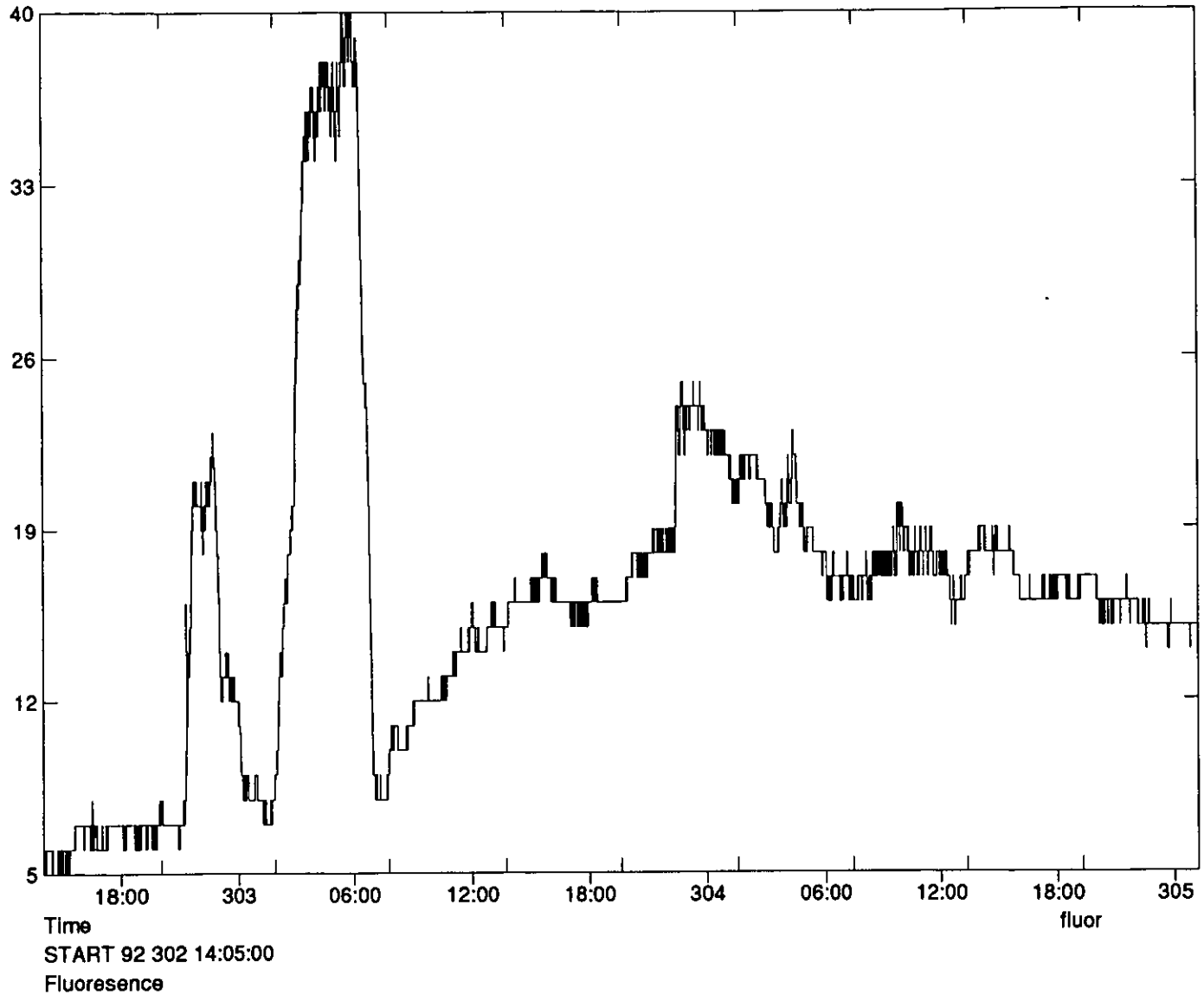
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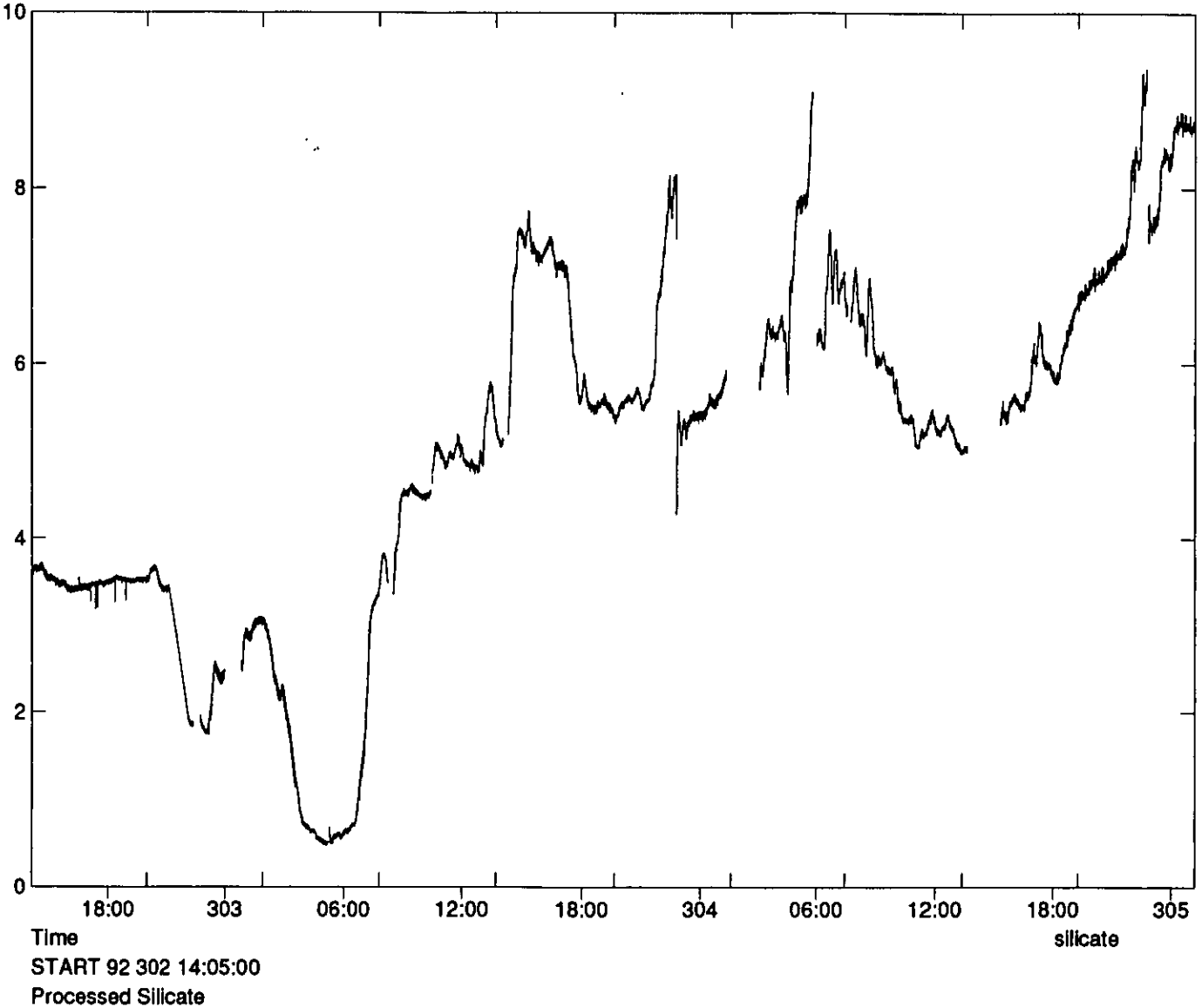
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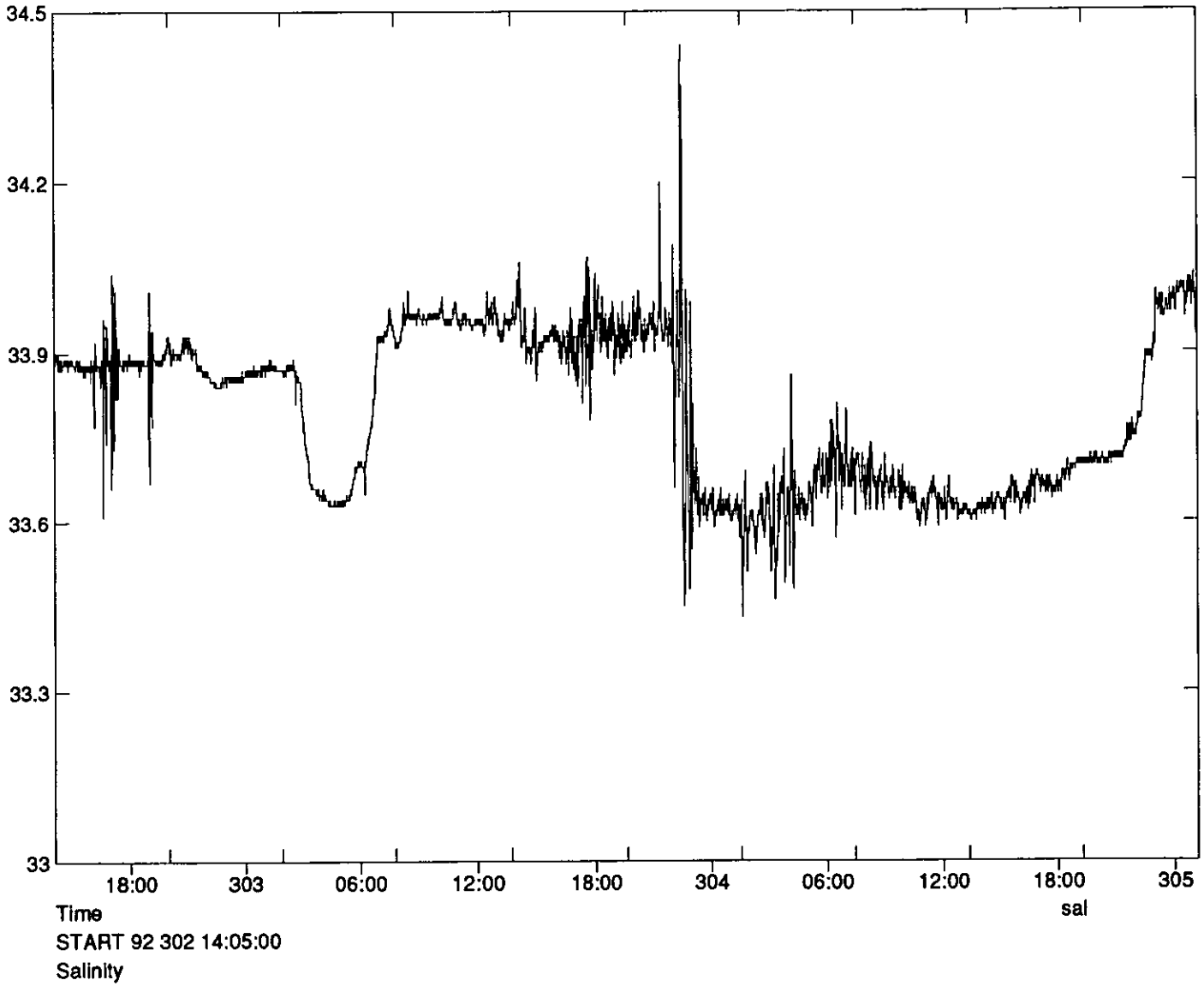
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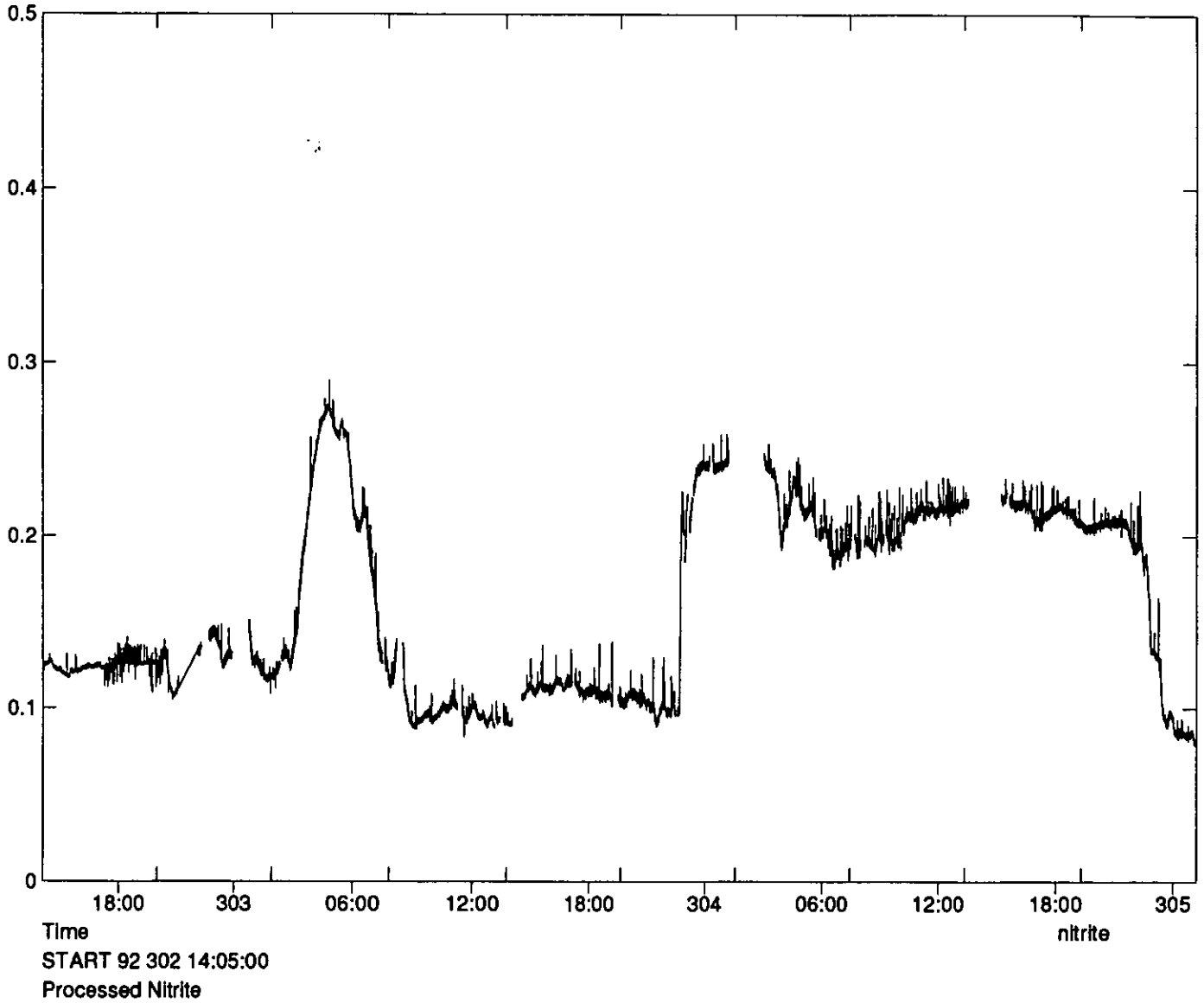
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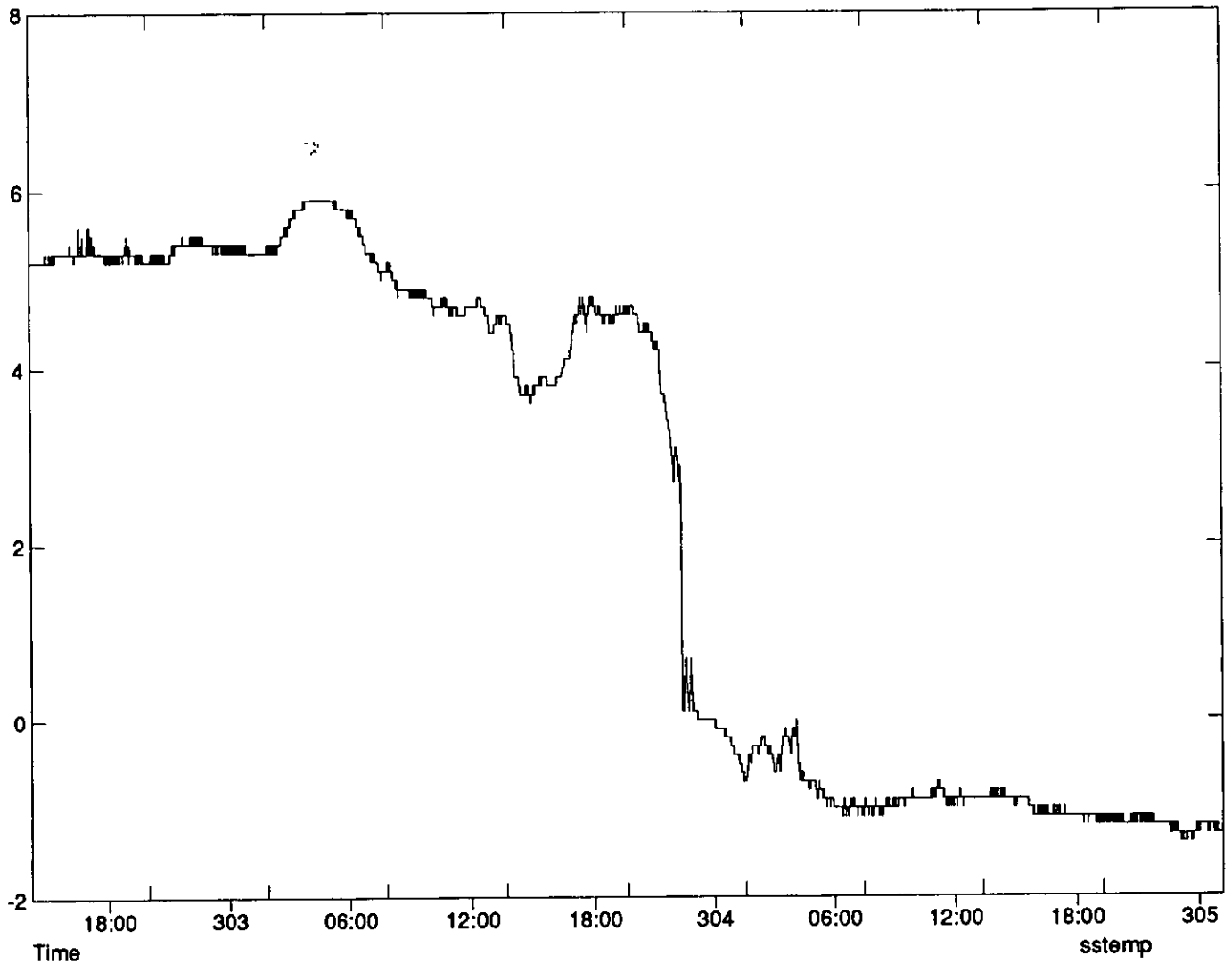
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4.3 ICE PHYSICS. E. ALDWORTH and S. WELLS.

1. Objectives

A study of the snow and ice characteristics during the spring melt at various locations within the Bellingshausen Sea, November - December 1992. These investigations are intended to form a basis or to be used as ancillary data in conjunction with remote sensing applications and experiments to determine light penetration through ice and snow cover over the sea surface. (see N. Fenton report).

Observations in the form of a standard ice watch and iceberg count will be made when appropriate.

2. Methods

The original intention was to select a location for the ice station in the pack ice and then make observations and measurements as the ice edge retreated in time, past the ship. In reality, it was necessary to speed up the process by moving the ship from the pack ice to stations successively closer to the ice edge.

At each ice station the main activities were ice coring and snow measurements. These were supplemented by ice thickness and temperature measurements where possible.

In addition it was possible to deploy heave-tilt measuring apparatus, a weather station, an Argos buoy and two radar reflectors at the station (G) within the pack ice. Unfortunately, this was the only station which was safe enough for the deployment of this equipment.

Briefly, the procedure at each station is to set up various transects, usually 30m. in length and take measurements at 5m. intervals. It was necessary to coordinate these with the diving requirements for the optical work, for example a north-south orientation and depending on ice thickness, wherever it was possible to cut the dive hole.

3. Stations

Samples and measurements were collected at stations F,G,H and I. Diagrams showing general layout and position of stations G and H are given in Figures 1 and 2. All times are given in GMT.

Station F [13th November 69 42S 85 07W] It was intended this should be used as a 'shakedown' station.What started out by being quite a large floe, approximately 200m. diameter turned out to be fairly rotten ice which cracked and disintegrated rather rapidly, decreasing in size by the minute. The general area around consisted of hummmocky floes, some possible small ridges, but mostly bergy bits and drifting snow. The cores from the transect confirmed that the floe consisted mainly of compacted snow and rotting ice, which was difficult to extract from the corer in one piece and not suitable for analysis.

Station G [14th-18th November 70 16S 85 06W] The initial survey revealed no serious holes or soft patches on what appeared to be a substantial area of pack ice. It was heavily ridged in places with snow cover varying from 10cm. to deep drifts of up to 1.0m. near the ridges. Site plan in Fig. 1.

In order to maximise the opportunities for sampling it was decided to carry out a snow experiment in a different area since it was necessary to wait until the dives were completed before the surface work on the transects could commence. The snow transect S1 was selected close to a ridge heavily covered with drifting snow. The transect extended 15m. with a sondage dug out at the 10m.position. The first set of readings commenced at 20.24hrs. on the 14th and carried through until 11.00hrs. on the 18th. It was hoped to collect four sets of readings each day but initial problems with the snowfork and the necessity for recharging the battery at more frequent intervals than had been anticipated meant that these had to be reduced. A thermistor was set into the snow and ice just beside the 15m. position. Temperature measurements using a probe were recorded just below the snow surface at each of the transect points at the same times as the snowfork measurements were recorded. In the sondage a similar set of measurements were recorded both vertically at 5cm. depths and horizontally at 10cm. intevals on all three sides of the pit. From the sondage there appeared to be two distinct layers of snow with air pockets in lenses separating the layers. The separation interface was quite brittle as if it had melted as a surface and then refrozen prior to a fall of fresh snow on the upper level. This type of layer building was observed on the morning of the 17th, when a fresh overnight fall of fine powdery snow had redrifted filling up most of the pit, creating a unique opportunity to take measurements of both the old and the new snow sections.

At the snow/ice interface was a fairly deep slush layer 5-10cm. thick which did not refreeze even overnight. Since the sondage was close to the ridge it was decided to clear an area of snow from the ice surface in order to be able to use the profilometer to obtain surface roughness measurements of the ice. This was not successful due to the ice composition which in all areas tended to slush at the surface.

An ice core was taken at each of the four locations and ice thicknesses measured. These gave ice thickness measurements between 3.0 - 4.0m., covered by snow thickness of 30 -70cm.

Snow tube and snow scoop samples were taken from close to the thermistor probe for later laboratory analysis.

Two core samples were taken from transects T1, T2, T3 and T4 at 5m intervals except in the case of T1 where they were taken at 2.5m intervals. For each transect there were 2 x 6 cores some of which have been analysed for salinity and chlorophyll, the remainder will be analysed for structure.

The two radar reflectors were deployed at distance of about 430m. from the ship using the sledge and the skidoo, at positions R1 70 19.31S 85 26.45W and R270 19.29S 85 26.88W between 23.00 and 24.00 hrs on 16th November. The final adjustments of angles and levelling were made prior to the ERS_1 pass on 17th November.

The Argos buoy was deployed at 70 19.00S 85 24.99W at approximately 23.50 on the 16th November.

Station H [29th November 70 15.19S 85 10.55W] This ice station was quite different in many ways from station G. The floe was fairly large and broken along one edge in order to anchor the ship's bow to the floe. There were a couple of cracks but nothing serious. A few discernible low ridges covered with a reasonably heavy layer of snow crossed the floe randomly. The site was set out with two 30m. transects and a dive hole was cut at the end nearest to the ship. One transect was used for the ice optics work and the other for the snow measurements. Cores and ice thickness measurements were taken from both. The snow appeared to be compacted into a series of hard layers in parts ranging in depth from 30 -55 cms., with a slush layer at the snow/ice interface of 5 - 20cms. The ice thickness over both transects ranged between 50 and 200 cms. Thermistors were set into the snow, ice and water at locations 2 and 4 on the snow transect.

Station I [2nd December 69 50.13S 85 50.97W] This ice station was located at the ice edge and access to the floes was achieved by using small boats for 'pancake hopping'. Cores and ice thickness measurements were taken arbitrarily usually from the centre of the floe and snow measurements taken along the longest diameter at 0.5m. intervals. The floe sizes were approximately 7m x 9m, 6m x 7m, 5m x9m and 8m x 10m. the cores were approx 1.0m in length and the snow cover varied between 10 - 50 cms. Most of the floes were rotting at the edges and on the underside.

4. Results

An example of the data obtained from the snow measurements is given in Figures 3 to 8. Snow cover and sea ice exhibit a complicated dielectric behaviour mainly because they tend to be inhomogeneous. The initial permittivity values are indicative of this. Snow wetness, depth and density results require further analysesbefore any detailed or general comments can be made.

Sea ice is largely an anisotropic material and found to be a mixture of ice, brine pockets, air bubbles and other impurities including algae. It was interesting to observe that the brown ice, an indicator of algae, did not always appear on the underside of ice blocks, some of the cores had sections of discoloration in the middle. However, it was noticeable during the ice watch that many of the pancake floes had a layer of brown ice at the snow/ice interface. This was almost certainly due to flooding, refreezing and then often quite heavy snowfalls. In general the snow cover in the Bellingshausen sea tended to be consistently deep. The ice was more complicated, a tentative suggestion is that melting first year ice in the Bellingshausen sea may be divided into two types:

1)water saturated blue ice including the shallow melt ponds often seen on pancakes.

2) white ice which consists of a thick layer of drained ice underlain by blue ice

ice, this was observed frequently during coring on the larger floes.

Data from the snow experiments plus salinity and temperature measurements will be available on 3.5" floppy disks once the calibrations have been made shortly after return to UK. The results from the core analysis will not be available until June/July 1993.

Unfortunately, the ESA receiving station, at O'Higgins on the peninsula, did not start receiving data until twelve hours after the overflight we were hoping to catch. The team at O'Higgins had been delayed by bad weather.

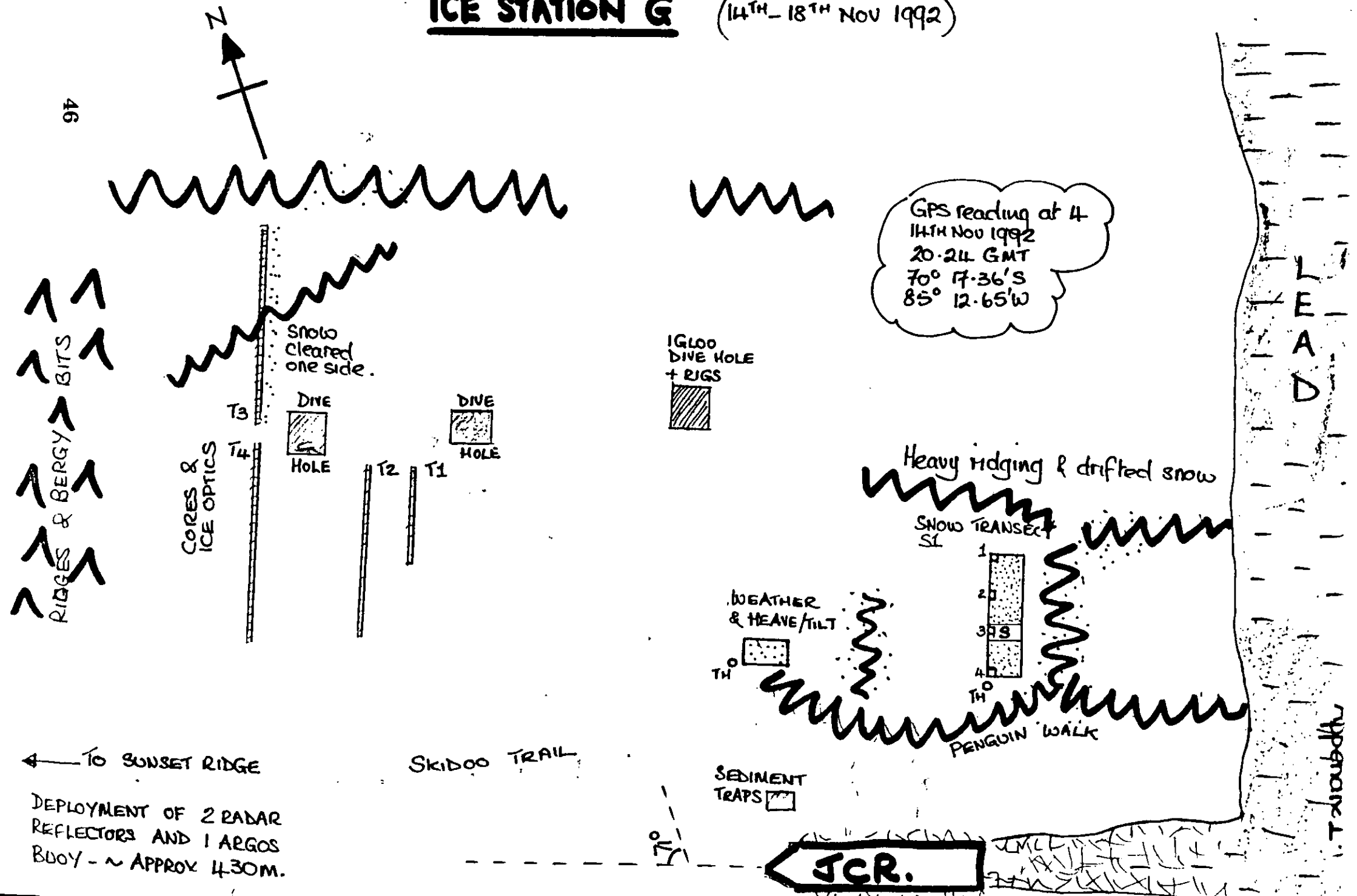
The Argos buoy started transmitting immediately. It drifted westwards for a couple of days and then south and east. The data and detailed track should be available shortly.

5. Conclusions

Many useful and interesting general observations were made but the limited time available, five and a half days on the ice, was not nearly sufficient to complete our proposed programme of work.

It would be extremely useful to return to this area for a longer period of study and experiments, starting well before the ice melt and continuing through to the summer open water.

ICE STATION G (14TH – 18TH NOV 1992)



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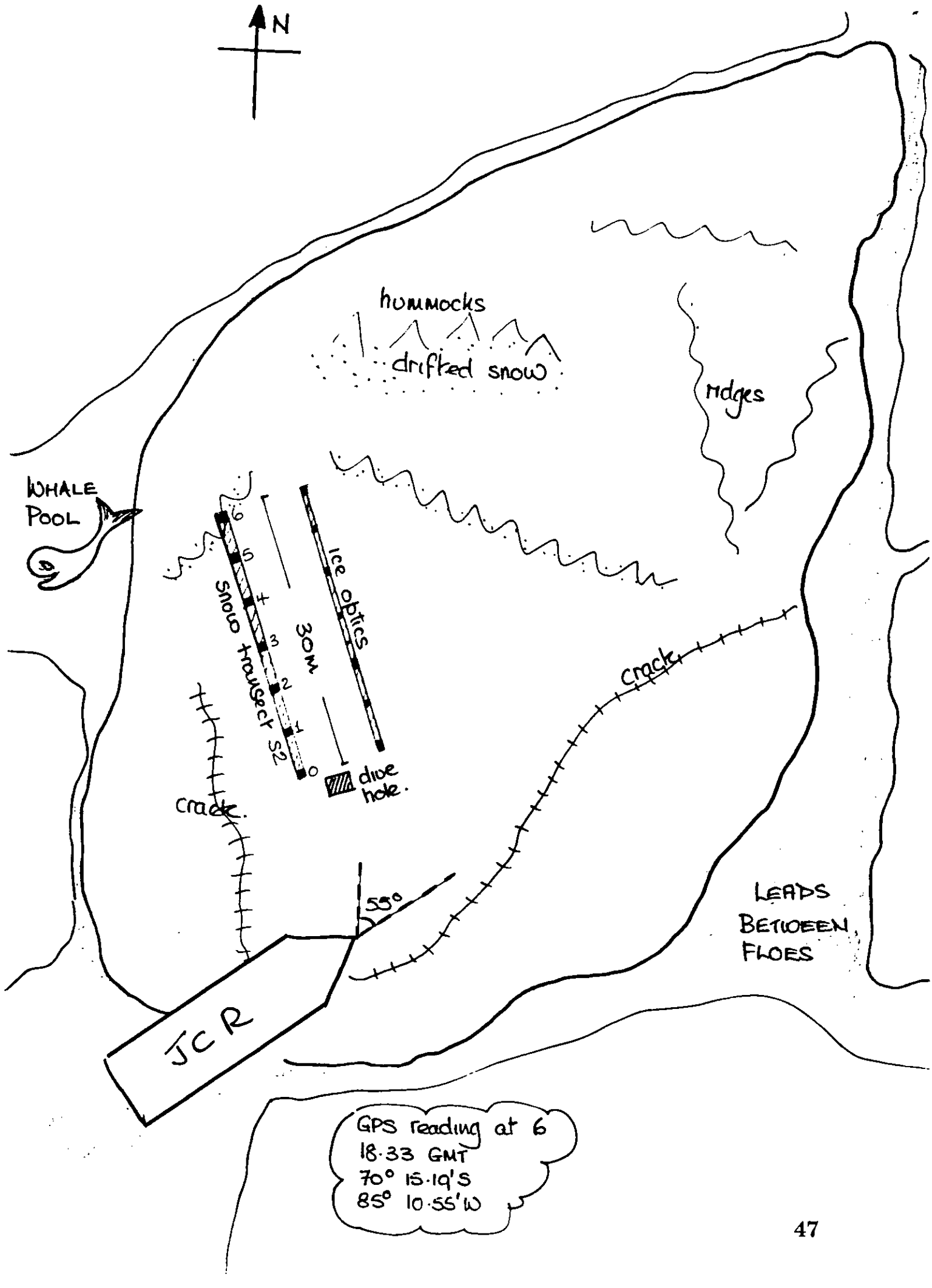

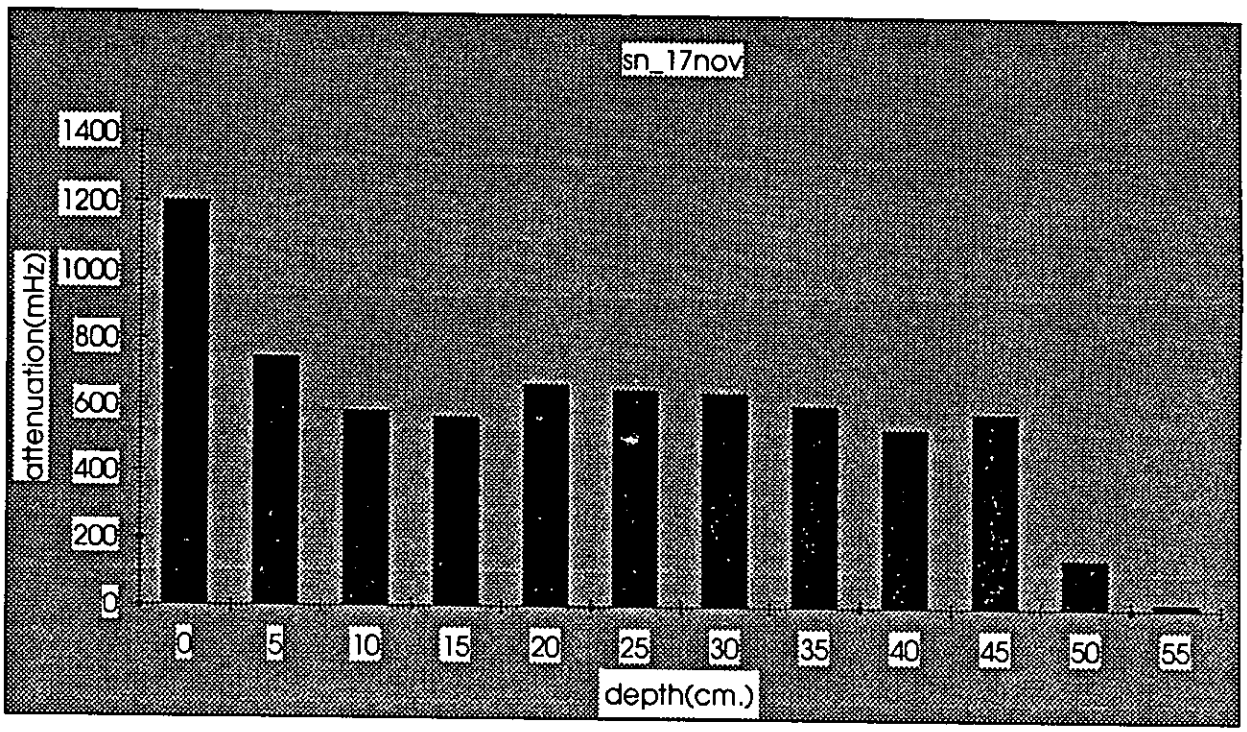
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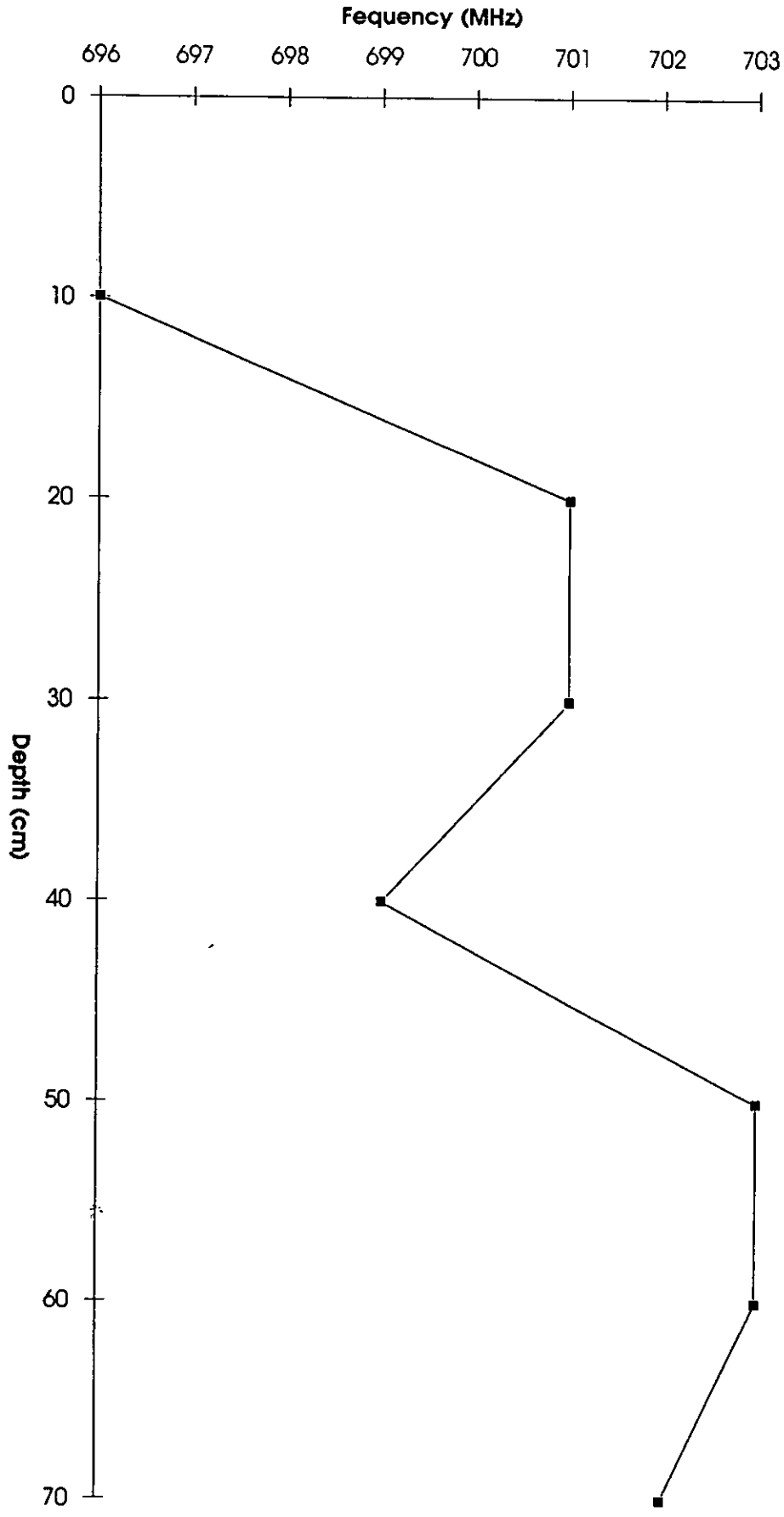
55
depth(cm.)


Fequency (MHz)
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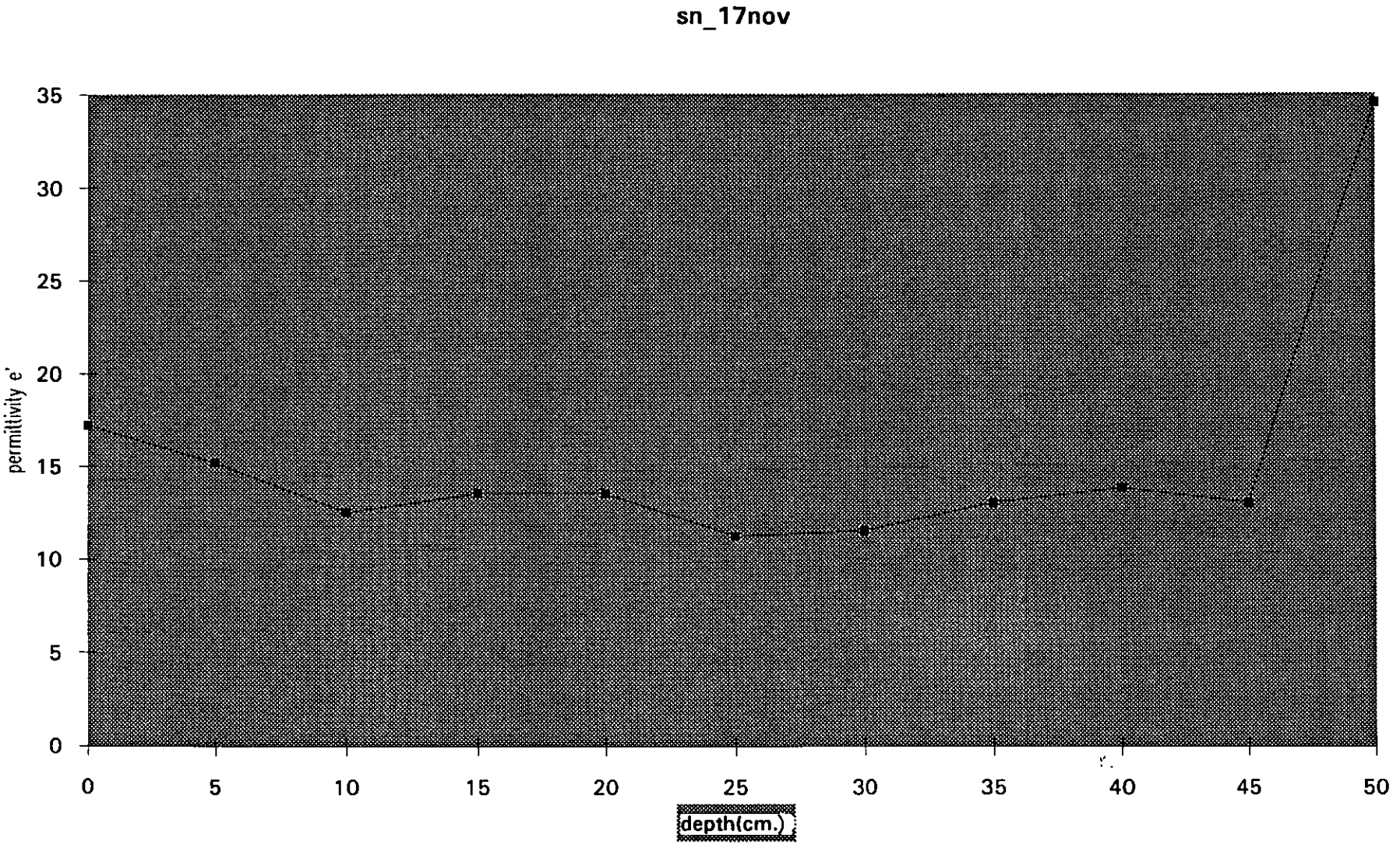
Depth (cm)

Nov-16

APPENDIX II .3



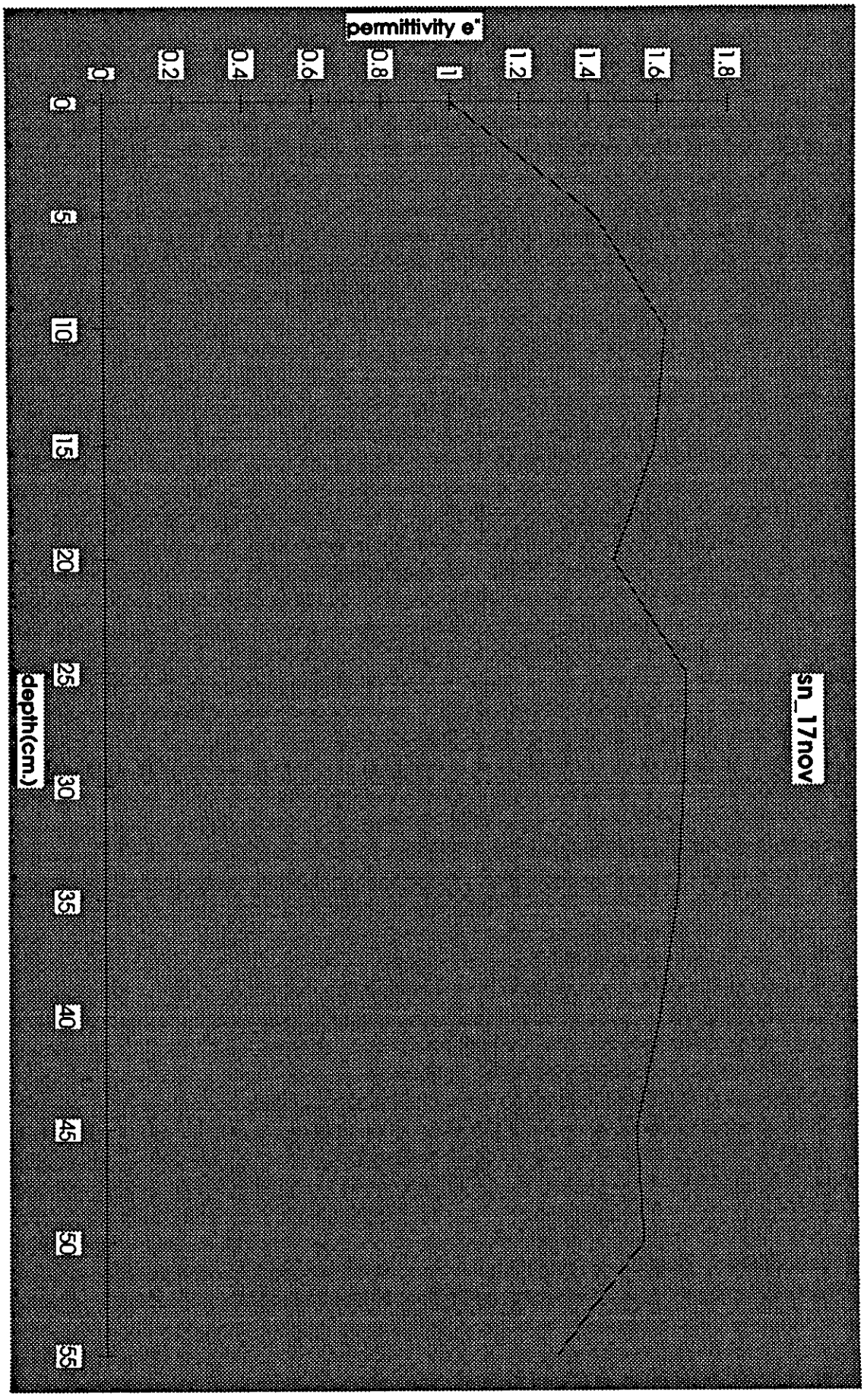
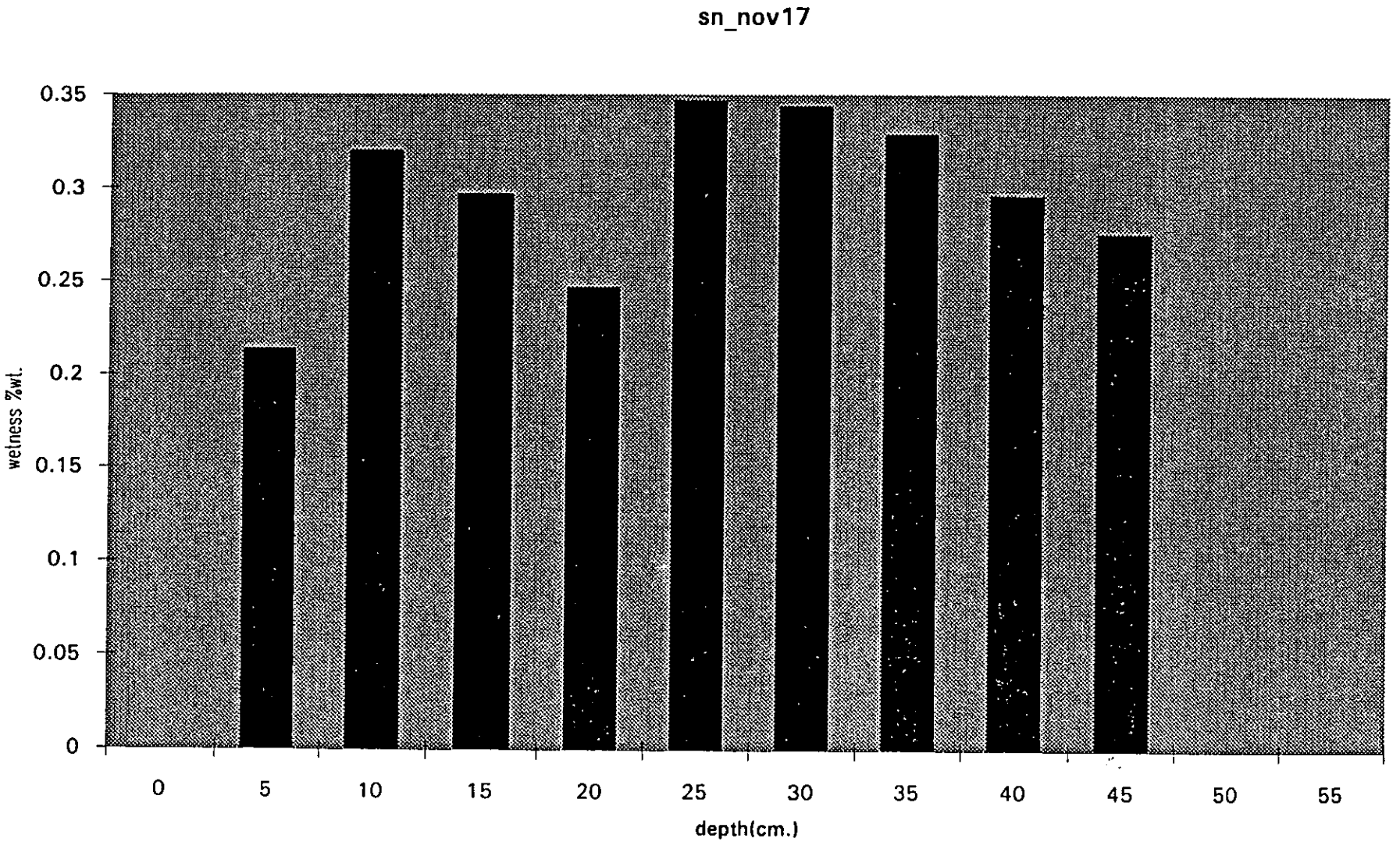


Chart7

Page 1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welness %wt.
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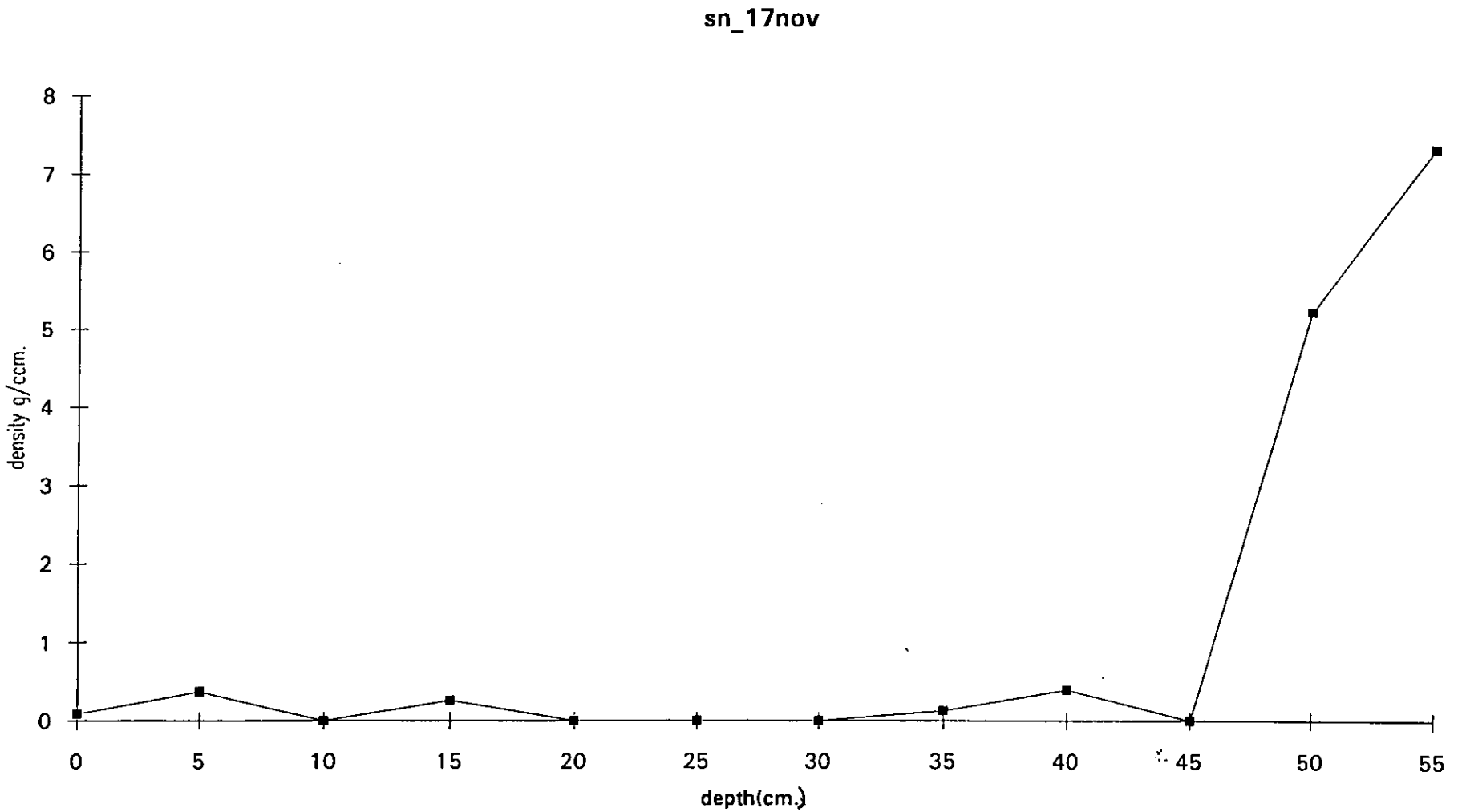
15
20
25
30
35
40
45
50
55
depth(cm.)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40
45
50
55
depth(cm.)

4.4 UNDER-ICE OPTICS - N. FENTON.

Objectives

The objective of the project is to relate light transmission through sea ice to the vertical physical structure of the ice, and the biological processes occurring within the ice. The results obtained will be used to construct a bio-optical descriptive model of light transmission through sea ice.

Methods

1) Data were collected at the two ice stations, G and H. 30 m Transects were layed out in a north-south direction on the surface of the ice, and similar transect was layed out beneath the same ice. Four transects were completed at G and one at H.

2) Using a modified version of the, Undulating Oceanographic Recorder (UOR), irradiance measurements were taken at 5 m intervals (stations) along the underwater transect. At the same time incident irradiance was measured at the surface with a Spectron SE590. After the dive the Spectron was used to measure reflectance at the surface stations, from this albedo will be determined at a later date.

3) At the surface stations measurements were taken of snow thickness, snow conductivity and ice thickness, and two ice cores were collected. One core was kept intact to look at ice fabric at a later date, the other was cut into 10 cm sections and melted for salinity and chlorophyll concentration measurements.

Preliminary Results

The data collected with the UOR and that collected with the Spectron are not directly comparable. Figures 1 and 2 show the irradiance data in their present form. Figure 1 is a typical profile of incident surface irradiance measured between 400nm and 1000nm. Irradiance varied with time due to change in cloud cover and sun angle, but no major differences were seen in the spectral distribution of the profile. Figure 2 shows a UOR plot for Photosynthetically available radiation (PAR), (courtesy of Ian Bellan, Plymouth Marine Laboratory). The irradiance at stations along a transect and between transects were highly variable. Whether this is due to the differences in the physical and biological properties of the ice, or to change in surface irradiance is impossible to say at the present time.

The incident irradiance data will be integrated over PAR (400- 700nm) to compare with the PAR sensor of the UOR, and corrections applied so as to compare with the wavelengths of the UOR. Until this process is carried out, it is not possible to relate light transmission through the ice to the physical structure of the ice or the chlorophyll concentration present in the ice. It is hoped that this process will be completed within the next three months.

Chlorophyll concentrations within the ice generally increased towards the bottom, although banding of high and low chlorophyll also occurred. Chlorophyll data is still in fluorescence units, but will be in units of mg chlorophyll l^{-1} soon after Christmas. All irradiance data collected is stored on computer disc.

Data may be obtained from Dr. Nicola Fenton at either Scott Polar Research Institute (SPRI) or British Antarctic Survey (BAS) until May 1995, thereafter Dr. Peter Wadhams at SPRI or Dr. Julian Priddle at BAS.

I would like to thank everyone who helped with the ice coring, it would not have been possible without you. To Ian Bellan for his construction of the diver operated UOR and subsequent data handling. Also to those who helped with the diving, particularly my diving 'buddy' Rick Price. A special thankyou to Steve Wells who has been invaluable and makes a great flask of tea!

FIGURE 1. INCIDENT SURFACE IRRADIANCE

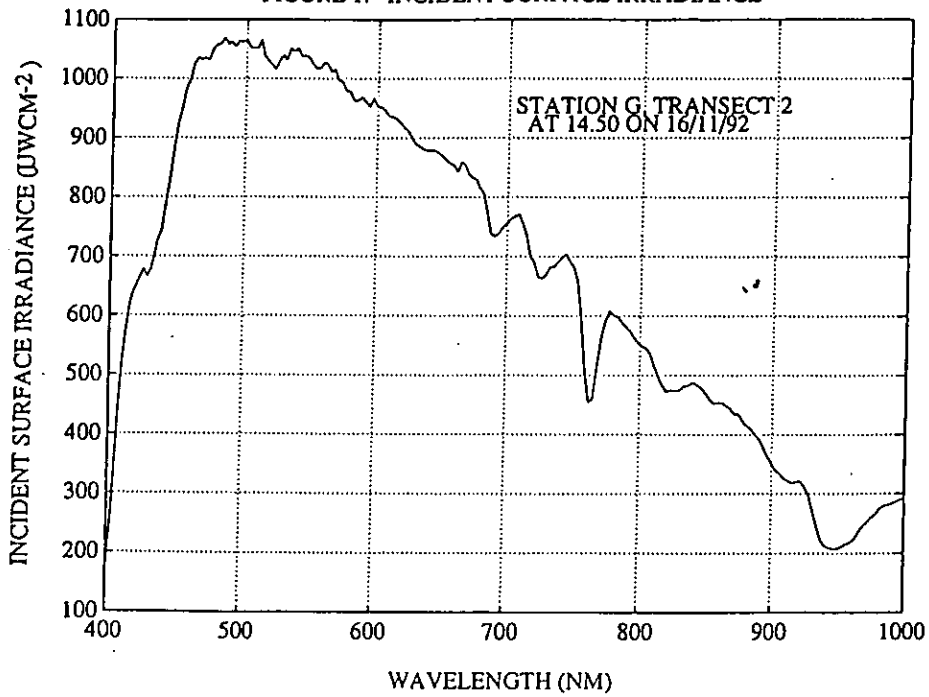
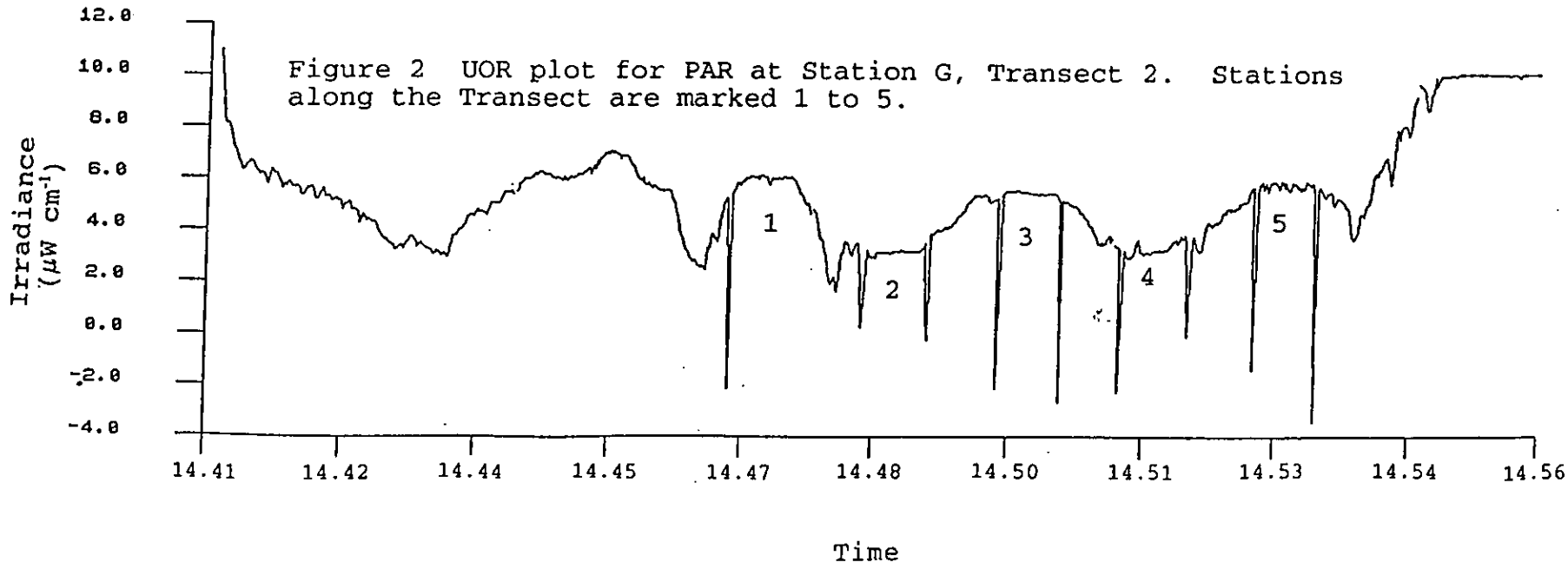


Figure 2 UOR plot for PAR at Station G, Transect 2. Stations along the Transect are marked 1 to 5.



4.5 PHYTOPLANKTON NITROGEN ASSIMILATION. - S.J. BURY.

INTRODUCTION: BROAD OBJECTIVE

The main objective of the work was to assess the impact of the ice sheet, and changes associated with the melt of that ice, on the phytoplankton community, in terms of nitrogen assimilation and nitrogen cycling within the euphotic zone.

Specifically, the interest in the marginal ice zone (MIZ) area lies in the fact that current data show that although most of the Southern Ocean exhibits consistently high nitrate concentrations and relatively low productivity (Priddle *et al.*, 1986) measurements of nitrogen assimilation indicate that the system as a whole is highly dependent on reduced nitrogen species (Collos, 1982; Glibert *et al.*, 1982; Olson, 1980; Owens *et al* 1981; Probyn and Painting, 1985; Smith, 1991). This produces low 'f' ratios, where 'f' is a measure of the proportion of total production supported by nitrate.

The ammonium story is an interesting one. Koike *et al.* (1986) and Owens *et al.* (1991) have shown that most of the ammonium uptake is associated with the less than 20μ size fraction. High ammonium concentrations are known to suppresss the utilisation of nitrate, but as yet this is poorly investigated in the field (Jacques, 1991). Physiologically, high concentrations of ammonium have been shown in laboratory experiments to have multiple effects on nitrate uptake, including inhibition of membrane transport, inhibition of nitrate reductase and repression of nitrate reductase synthesis (Syrett, 1981). This requires further field investigation. In addition, Smith and Nelson (1990) note that there are high relative preference indices for ammonium whenever the ambient ammonium concentrations are less than 0.3μmol indicating that where Antarctic phytoplankton are living at concentrations below this value they are able to rapidly increase their rate of ammonium uptake in response to increased availability. In areas where the presence of large passing krill swarms and/or high abundances of copepods may locally rapidly increase ammonium concentrations this is a significant observation in terms of the nitrogen budget, potential phytoplankton growth rates and organic matter flux from the euphotic zone.

It was the aim of this cruise to try and investigate the reduced nitrogen species story further, particularly in the context of changing conditions during the retreat of an ice sheet. This was to be done by in situ uptake measurements and onboard deck incubations to investigate specific phenomena mentioned above.

SPECIFIC OBJECTIVES

1. To measure the uptake of nitrate, ammonia, urea and a suite of dissolved free amino acids (DFAA) in phytoplankton using in situ ^{15}N incubations.

2. To measure the simultaneous uptake of carbon and nitrogen by carrying out ^{13}C assimilation experiments in the same bottles as the ^{15}N experiments and to compare these uptake rates to those measured by ^{14}C (Phil Boyd).

3. To determine respiration rates during the incubation period from ^{13}C isotope dilution experiments.

4. To carry out experiments to determine the effect of ultraviolet light on the uptake of nitrate, ammonium, urea, DFAA and carbon.

5. To measure ammonium regeneration rates over the in situ 24 hour period of incubation.

6. To determine the concentrations of DFAA produced/utilised during the 24 hour incubation.

7. To determine the concentrations of nitrate reductase naturally present in the waters sampled for incubation experiments (Nitrate reductase is the enzyme which enables phytoplankton to utilise nitrate).

8. To investigate the influence of increasing concentrations of ambient ammonium on the suppression of nitrate uptake by means of ammonium additions and $^{15}NO_3$ uptake measurements using on deck incubators.

9. To measure concentration changes of nitrate reductase during the above ammonium addition experiments pre- and post-incubation.

10. To carry out Michaelis-Menten kinetic experiments using nitrate, ammonium, urea and DFAA substrates in on deck experiments.

11. During location in the ice to carry out ^{15}N uptake measurements on water samples immediately below the ice and on melted ice samples using JGOFS procedures of melting.

METHODS

1. The determinations of uptake rates of nitrate, ammonium, urea and DFAA constitute part of the suite of *in situ* productivity measurements and were carried out in conjunction with the ^{14}C (Phil Boyd) and oxygen and carbon (Carol Robinson) productivity measurements. Water samples were taken at 6 depths down to the 0.1% light level using CTD water bottles in a series of 3 consecutive casts and water was pooled from each depth into acid-cleaned and rinsed 60 l carboys. Water was first removed for oxygen productivity, then for ^{14}C measurements and finally for nitrogen uptake experiments.

   Nitrogen uptake was measured using the stable isotope ^{15}N in the form of $^{15}NaNo_3$, $^{15}NH_4Cl$, $CO(^{15}NH_2)_2$ and a ^{15}N algal mixture of DFAA. Spikes were added to 2.4l polycarbonate bottles to 10% of the ambient nutrient concentrations where these had previously been measured (Thanks to Mick Whitehouse and Malcolm Woodward for numbers provided). DFAA additions were the exception to this as there was no available on board analysis. 200 µmoles l^{-1} (Kirchman *et al*, 1989; Tupas and Koike, 1990) was taken as an upper limit for DFAA concentrations in the Antarctic and additions were made to 10% of this value.

^{14}C, oxygen, carbon, and ^{15}N productivity bottles were all incubated on the same *in situ* rig for a 24 hour period. Post incubation, ^{15}N samples were filtered through 47 mm GF filters and size fractionated into > and <20μ using 20μ silk meshes, in line with ^{14}C measurements. Filters were immediately dried and prepared for analysis of particulate and atom % nitrogen on the Europa Roboprep Triple Collector Mass Spectrometer.

2. ^{13}C in the form of $NaH^{13}CO_3$, was added to each of the nitrogen species bottles adding 5% of the expected ambient concentration (100 μmol C l^{-1} spike concentration). In addition a dark ^{13}C incubation was carried out at each depth. Filters were fumed for 2 mins over concentrated HCl to remove organics before drying. Particulate and atom % carbon can be analysed simultaneously on the same sample as the nitrogen values using a dual C and N isotope program on the Europa Mass Spectrometer.

3. For all surface samples for each nitrogen species the filtrate from t=0 and t=24 samples was frozen in 5 ml aliquots to enable later determination of dissolved ^{13}C content pre-and post-incubation. From these values and using isotope dilution calculations it should be possible to determine respiration rates during the bottle incubations.

4. 500 ml FEP UV transparent bottles were used to investigate the effect of UV light on the uptake of all 4 nitrogen substrates in surface samples only. ^{13}C was added to all bottles. Unfortunately all UV transparent bottles were lost on the first rig deployment when the productivity rig could not be relocated. There is therefore no data available for UV experiments.

5. NH_4 regeneration rates were measured using an isotope dilution technique which requires the measurement of dissolved $^{15}NH_4$ in 60 mls of the filtrate from t=0 and t=24 incubated productivity rig samples. Regeneration rates were measured at all incubated depths.

   A new technique for measurement of NH4 regeneration rates was employed which has only been previously tested in its primitive form once in the field. The technique was subsequently refined in the laboratory and will hopefully prove to be successful! The ammonium is complexed using a modification of the Solarzano indophenol blue method (ref?) and a method developed by Mantoura and Woodward (ref?) where DTT is used in place of sodium hypochlorite, lower concentrations of phenol are used and a borate buffer replaces the conventional oxidising solution. An internal dichloroindophenol sodium salt standard was added to the complexed solution, the ph was taken down to 6.0 and the NH_4 was extracted using Empore extraction discs. Samples were then dried off and will be transported back to SURRC for final elution and determination on a GC/MS by Tom Preston.

6. The concentrations of DFAA will be determined in each of the regeneration experiment bottles from the filtrates of both t=0 and t=24 incubations. This

includes NH_4 regeneration samples at all depths and nitrate, ammonium, urea and DFAA samples at the surface. 5 ml of the filtrate was taken from each sample and immediately frozen for later analysis at SURRC.

7. Samples were taken from each depth of incubation for nitrate reductase analysis. Samples were size fractionated into < and > 20µ and between 200-800 mls were filtered through 25 mm GF filters immediately after sampling. The filters were placed in 1.5 ml centrifuge tubes, 1 ml of plasmolysis buffer was added to crack open the cell walls, release the nitrate reductase and preserve the enzyme, and samples were then frozen at -20°C. Laboratory analysis of these samples will take place after consultation with Charles Hipkin and Kevin Flynn at the University of Swansea.

8/9. The effect of increasing concentrations of ammonium on nitrate assimilation was investigated by adding unlabelled ammonium sulphate from 10m water sample split into 9 x 2.41 polycarbonate bottles. The final ammonium concentrations ranged from ambient (0.1-0.6 µmol l^{-1} depending on the station) to a maximum expected ambient value in the Antarctic of 8 µmol l^{-1}. $^{15}NO_3$ and $NaH^{13}CO_3$ were then added to each bottle to 10% and 5% of the respective ambient concentrations. Nitrate reductase samples were taken both pre- and post-incubation. Samples were incubated for a period of 12 hours in on deck incubators. After incubation samples were processed in the same way as the *in situ* rig incubations.

10. Michaelis-Menten experiments were carried out for each of the nitrogen substrates to enable V_{max} and K_t values to be calculated. These data will be used to investigate kinetics of uptake and to input values into models being developed by Eugene Murphy at BAS. A water sample was taken from 10m and, with the exception of nitrate, ^{15}N additions were made to 25, 50, 100, 500, 1000 and 5000% of ambient concentrations. The nitrate kinetics experiment was complicated by the fact that ambient concentrations were already very high (<30µmol l^{-1}) and therefore it would not be possible to obtain values at the lower end of the Michaelis-Menten curve. As a result of this additions of $^{15}NO_3$ were made to 10, 25, 50, 100, 150 and 500% of ambient concentrations. All samples were incubated in on deck incubators for a period of 12 hours.

11. Whilst located in the ice, experiments were carried out on the water (immediately in contact with the ice by diving operations (Station Gertie) and on ice samples subsampled from dive hole ice blocks (Station Gertie revisited/Herbie?).

    Water Samples: Using divers, triplicate water samples were taken for each of the nitrogen substrates in 2.41 polycarbonate bottles. Bottles were passed up to the surface where they were spiked and were then passed back to the divers so they could be positioned for incubation under the ice for 24 hours. Samples were processed in the same way as the rig incubations.

Ice Samples: Two types of ice samples were sawn off a 0.7 m thick block of ice extracted from the diver hole: one from the base of the ice zone which looked clear, and one from the centre of the block immediately below the compacted snow zone, which had a brown colouration. These samples were thawed out into 11 of filtered seawater at a temperature of 1°C following JGOFS protocol. the samples took 48 hours to thaw after which each sample was divided into 10 x 125 ml bottles and replicates of ^{15}N nitrate, ammonium, urea, DFAA (into which ^{13}C was added to each) and dark ^{13}C bottles were set up. Samples were incubated in on deck incubators under filters appropriate to the ice thickness cover for a 24 hour period. In addition, subsamples of the ice were thawed out into dry vessels at room temperature in the dark for Chl a analysis (Phil Boyd) and HPLC pigment analysis (Ray Barlow).

PRELIMINARY RESULTS TO DATE (15.12.92)/ FORM OF DATA

There are no real results to report to date with the exception of the following:

HPLC analysis of the clear and brown ice samples by Ray Barlow showed that both samples had a very similar community structure which consisted predominantly of diatoms (<95%, which was also confirmed by microscopy (Ray Leakey)). There was an indication from both methods that dinoflagellates were also present in small amounts. The brown sample had more than 10 times the amount of diatoms than the clear sample.

Mass spectrometry analysis has been carried out on the ^{15}N filters from 3 out of the 14 experiments in total. This data is recorded as a printout and also on a pc disc which can be read directly into Excel or Lotus. The data is produced in raw format as total beam, µmol N (and C), and atom % and these values have to be converted to nitrogen and carbon assimilation data. It will take approximately three months to complete the samples analyses and to subsequently calculate uptake rates.

Eyeballing data analysed on the mass spectrometer so far, which consists of samples taken at station Gertie on the first visit, it is obvious that we are right on the limit of detection due to the small amount of material on the filters. The uptake rates for all nitrogen species are almost non-existent, although even within the constraints of low sample detection the atom % values for ammonium are higher than those for nitrogen at similar µmol N values, indicating that ammonium uptake is supporting what little productivity is present despite the high nitrate values at this station (32 µmol N l^{-1}) and low ammonium values (approximately 0.1 µmol l^{-1}). This confirms findings already in the literature (see Introduction).

SAMPLE PROCESSING TO COMPLETE (APPROXIMATE TIME REQUIRED FOR ANALYSIS)

1. Mass Spectrometry analysis of 11 Experiments for ^{15}N and ^{13}C uptake rates (PML: 2 months).
2. Analysis of nitrate reductase samples (PML: 1 month).

3. Analysis of ammonium regeneration isotope dilution samples (SURRC: 1 month).
4. Analysis of DFAA concentrations in regenerated experiment samples (SURCC: 1 month).
5. Analysis of dissolved ^{13}C isotope dilution samples (SURCC: 1 month).

Total analysis time required = 6 months. Estimated time for data processing = 3 months. Results from most experiments should be ready in approximately 1 year from now. Nitrate and ammonium uptake data should be available from about May 1992.

CONCLUSIONS/ASSESSMENT OF CRUISE SUCCESS

Given the restrictions imposed on the cruise due to two medivacs we seem to have had a reasonably productive end to the cruise. It was disappointing that due to time restrictions we were unable to carry out a time series survey strategy, however the differing productivity conditions encountered during the alternative transect programme provided enough varying conditions to enable a useful suite of Michaelis-Menten and ammonium inhibition of nitrate uptake experiments to be carried out and hopefully this should provide the modellers with the data that they require. The number of *in situ* rig incubations carried out was a fraction of those originally planned, but at least we managed to get three in different ice and open water conditions to compare varying oceanographic and phytoplankton community regimes. It was very unfortunate that all the UV transparent bottles were lost in the second rig incubation, but compared to Langdon oxygen rigs, sediment trap and SEASOAR losses this is but small fry and is probably best hushed up for fear of ridicule from other quarters!

SUGGESTIONS ON HOW TO IMPROVE ACTIVITIES ON THE JCR

Better footing grippage on the aft deck for deployment of gear
More tying off points for equipment on the aft deck

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Solorzano

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ACKNOWLEDGEMENTS

Thanks to Phil, Carol, Nicko, Andy and Duncan for help with the deployment of rigs; to Mick and Malcolm for supplying nutrient data; to Phil for carrying out chlorophyll analyses; and to the two Rays for help with identifying the ice phytoplankton communities. A big thank you to all the officers and crew on board the JCR who made the cruise an absolute pleasure and were always there to help.

Sarah Bury: Experiment Sampling Details

Expt No.	Station Name	Date	CTD No.	Depths Sampled	Details of Experiment
1	Gertie	16.12.92	11,12,13	5,10,15,20,25,30	Rig #1: Under Ice Rig Incubation
2	Gertie	16.11.92		0	Diving Under ice water Incubation
3	Disco	20.11.92		0,27	Discovery Intercalibration
4	Herbie	29.11.92	29	10	Ammonium inhibition of Nitrate Expt 1
5	Herbie	29.11.92		10	Michaelis-Menten Expt 1
6	Herbie	29.11.92		ICE	Ice Incubation Expt
7	Isolde	30.11.92	34	10	Michaelis-Menten Expt 2
8	Isolde	2.12.92	39,40,41	2,10,15,20,30,50	Rig #2 Rig Lost
9	Jules	3.12.92	50	10	Michaelis-Menten Expt 3
10	Jules	5.12.92	56,57,58	2,10,15,20,30,50	Rig #3
11	Jules	5.12.92	GoFlo	10	Ammonium inhibition of Nitrate Expt 2
12	Katie	6.12.92	68	10	Michaelis-Menten Expt 4
13	Katie	7.12.92	GoFlo	10	Ammonium inhibition of Nitrate Expt 3
14	Katie	8.12.92	72,73,74	2,10,15,20,30,50	Rig #4

4.6 PHYSICAL OCEANOGRAPHY. - C. SYMON.

Objectives

To characterise the physical oceanographic environment of the Bellingshausen Sea Marginal Ice Zone at spatial and temporal scales relevant to the biological and chemical components of the cruise.

Methods

Changes in vertical and horizontal water structure on a transect between closed pack ice to open water were examined using data from the CTD, ADCP and thermosalinograph. The variation in structure was examined specifically for the top 250 m of water and placed in the context of large scale water movements and process using full depth CTD profiles. Retrospective satellite imagery will be used to examine fluctuations in the position of the ice edge during the cruise.

Status and Availability of Data

ADCP - ADCP data was logged continuously on the level C system during the cruise (except when the ship was alongside at Port Stanley or during the intermittent visits to Antarctic bases). The ADCP was operated in 'bottom tracking mode' in water of < 250 m depth and out of bottom tracking mode (using one of several types of reference levels for screen display) in water of > 250 m depth. In bottom tracking mode data were generated in 4 m bins over 5 minute periods. Out of bottom tracking mode the vertical resolution changed to 8 m and the sample period increased to 15 minutes. In open water, data quality was generally very good to depths of between 200 to 300 m. The maximum depth over which data were good varied according to ship speed and sea state. When the ship was stationary good data were available to 300 m (occasionally more) - at speeds over 14 knots data quality was poor (or non-existent if the sea state was also high). When the ship was in ice, data quality was often poor (probably due to ice under the ship - observed by divers). The data held on the level C system are raw uncalibrated data. They uncalibrated ADCP data will be calibrated during post processing ashore.

CTD - All (ish) CTD data were logged to the level C system. These data have been corrected for the instrument calibrations carried out before the cruise but have not yet been corrected for the *in situ* temperature (reversing thermometers) and salinity (autosal) measurements made by Simon Watts. Plots of temperature against depth, salinity against depth, density against depth, fluorescence against depth and temperature against salinity have been made for every CTD profile of > 100 m (CTD's 02, 06, 08, 10, 16, 18, 19, 23, 24, 26, 27, 28, 29, 30, 31, 34, 35, 36, 38, 43, 45, 47, 48, 49, 50, 51, 52, 53, 54, 56, 61, 63, 65, 66, 67, 68, 69, 70, 72, 77, 78, 79). Although these profiles are based on uncalibrated data the plots use the same temperature, salinity, density, fluorescence and depth scales throughout and provide a good indication of broad changes in water column structure.

Thermosalinograph - All thermosalinograph data were logged on the level C system. These data have been corrected for instrument calibrations but have not

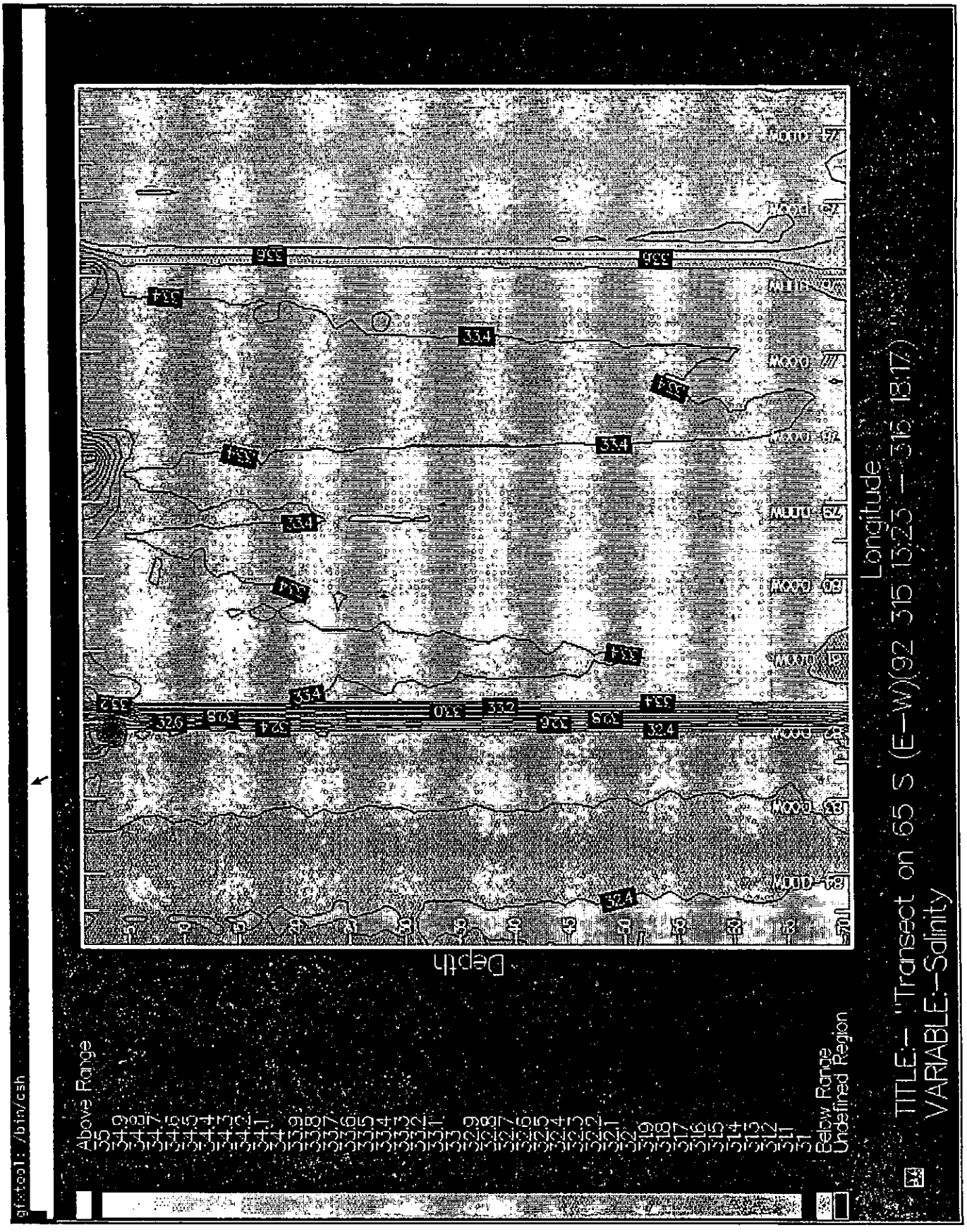
yet been calibrated using the routine salinity samples taken and analyzed by Simon Watts. Data are not available for the periods when the water intake became blocked by ice (most of the time when the ship was moving through the ice) or biological material such as krill (only occasionally and in open water). Plots are available for temperature, salinity and fluorescence against latitude or longitude (depending on the direction of the ship - usually east-west or north-south). While the ship was stationary (on station) temperature, salinity and fluorescence were plotted against time.

Additional Information - Coloured contour plots of temperature, salinity and fluorescence against latitude or longitude have been made for the UOR profiles - either singularly or as composites (if there are more than one UOR tow per transect).

Preliminary Results -

(i) opportunist transects. Several opportunist transects were made while the ship was on the way to the Bellingshausen Sea Marginal Ice Zone; two across the Scotia Sea between the Falkland Islands and the Antarctic Peninsula (both north-south), one along 65°S (east- west) and two along 85°W (north-south and south-north). Data were routinely obtained from the ADCP, UOR and thermosalinograph, with additional biological and chemical measurements on certain sections of the transects. Across the Scotia Sea the positions of the Subantarctic Zone (north of the Subantarctic Front), the Subantarctic Front (~ 56°S), the Polar Frontal Zone (between the Subantarctic Front and the Polar Front), the Polar Front (about 58°S) and the Antarctic Zone (south of the Polar front) were clearly evident in the UOR and thermosalinograph profiles (particularly in the temperature field) and were associated with marked chemical (particularly nutrients) and biological changes (chlorophyll concentration and species changes). The southerly UOR transects show strong variation in the salinity field and this appears to be associated with variation in the chlorophyll levels. On the east-west transect across 65°S the water is mixed to at least 60 m (the vertical extent of the UOR tows) and salinity decreases with increasing distance from the Antarctic Peninsula (*ie* increasing with distance from the sea-ice, as expected) (Fig. 1). There are marked discontinuities in the salinity field at 76°W and, more strongly, at 82°W. These fronts appear to delimit a region of higher chlorophyll levels (Fig. 2). Similar features were evident on the north-south transect along 85° with discontinuities in the salinity field at 67°15'S and 68°10'S (Fig. 3) delimiting a region of very high chlorophyll concentrations (Fig. 4). This appears to be a region of upwelling. At the southerly end of the 85°W transect mixed layers decreased to about 50 m (Fig. 3).
(ii) MIZ transect - A transect between the most southerly ice station; Station G (complete pack) to Station K (open water) showed strong variation in water structure. Data were obtained from the ADCP, thermosalinograph and 7 CTD profiles (6 full depth, 1 to 250 m). CTD contour plots showing the temperature, salinity and fluoresence fields over the upper 250 m between about 70°45'S to 67°45'S show the classic MIZ structure; a deep mixed layer of about 100 m at the ice edge with downwelling of higher salinity water from brine rejection, changing with distance from the ice edge to a region of fresher surface water mixed to about 50 m (Fig. 5). High chlorophyll levels occur in the relatively shallow surface mixed layer to the north of the ice edge (Fig. 6).

FIG 1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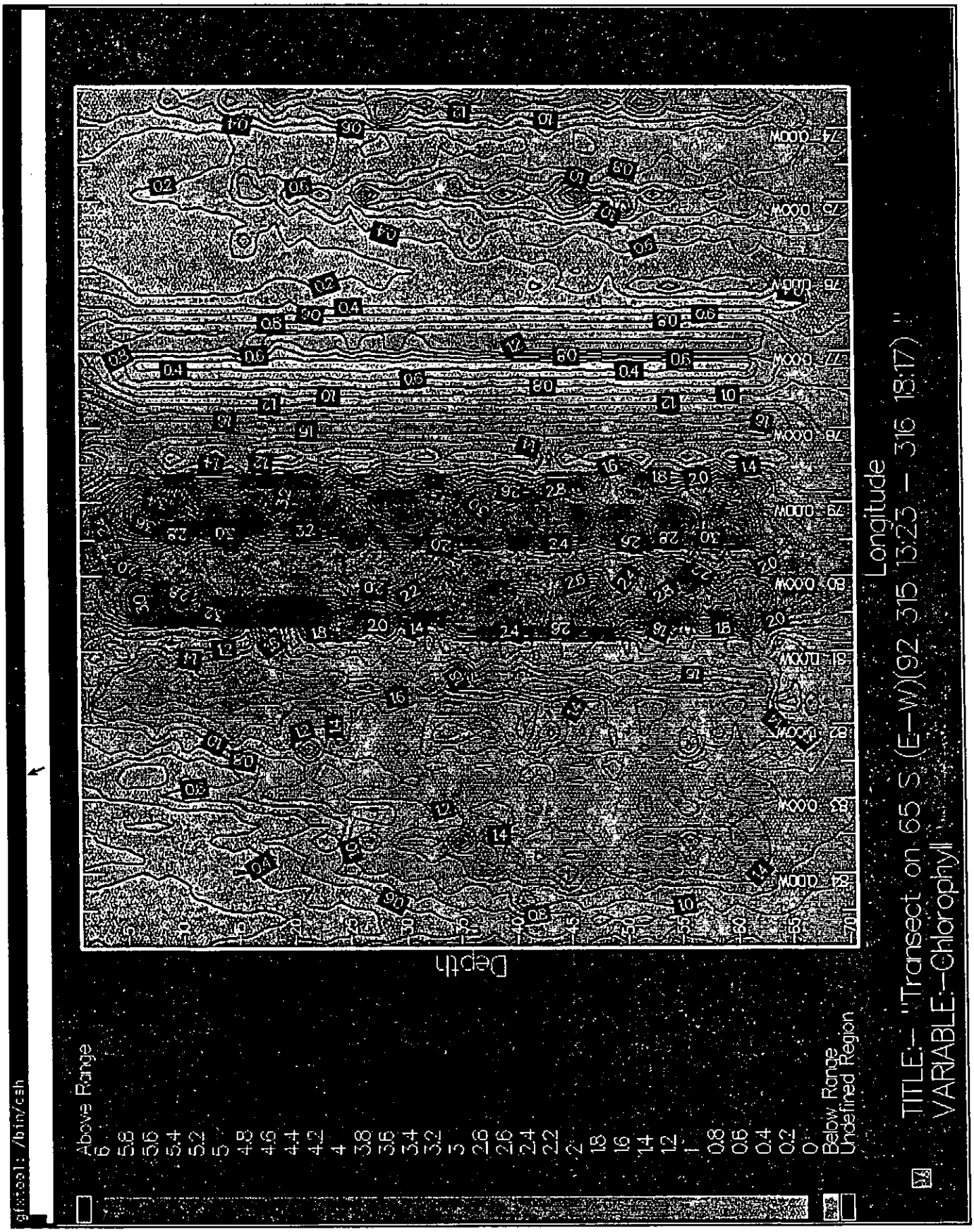
Undefined Region
Depth
Longitude

FIG 2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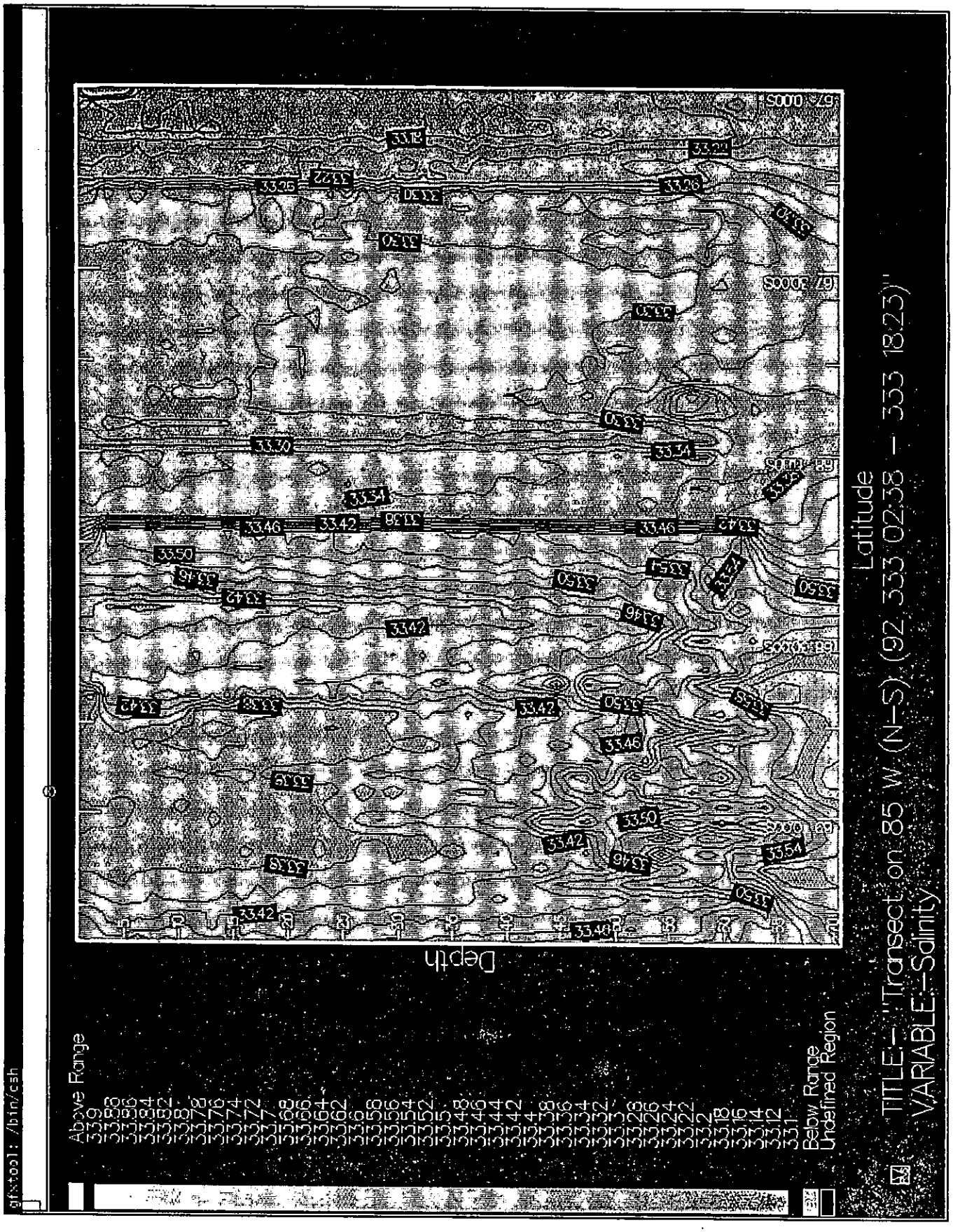
Depth
Longitude

FIG 3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Depth
Latitude
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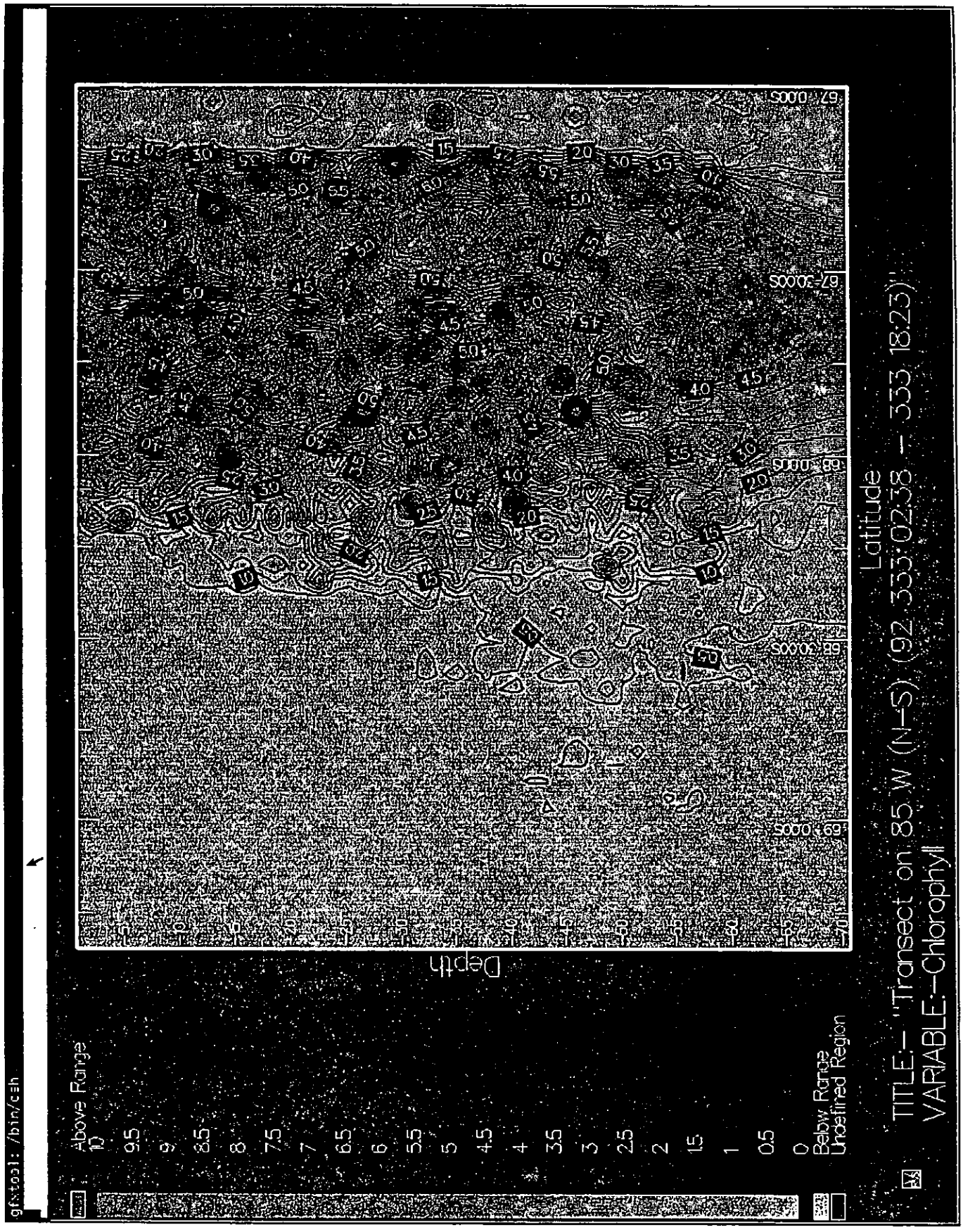
VARIABLE= Salinity

FIG 4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Depth
Latitude
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VARIABLE:-Chlorophyll

FIG 5

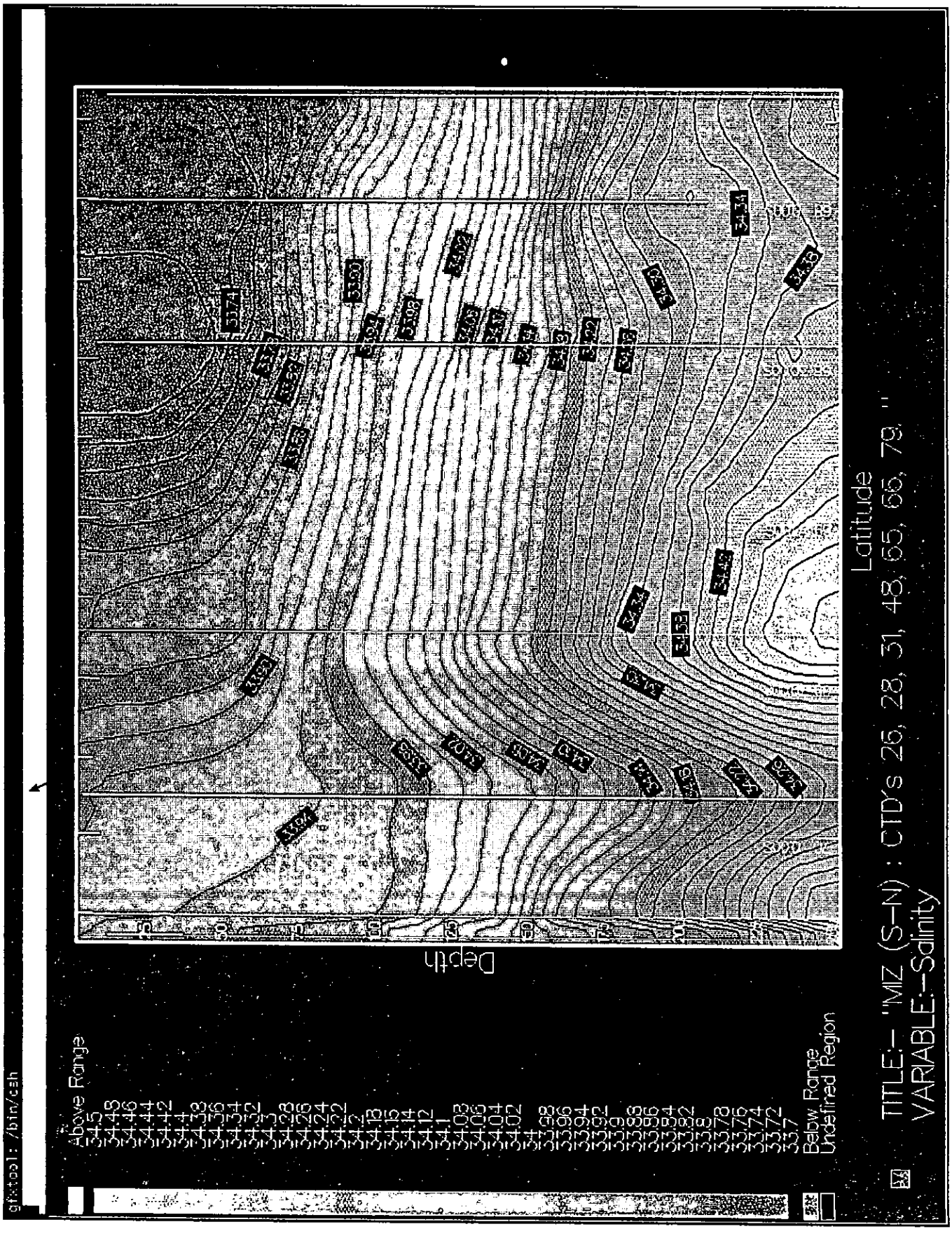
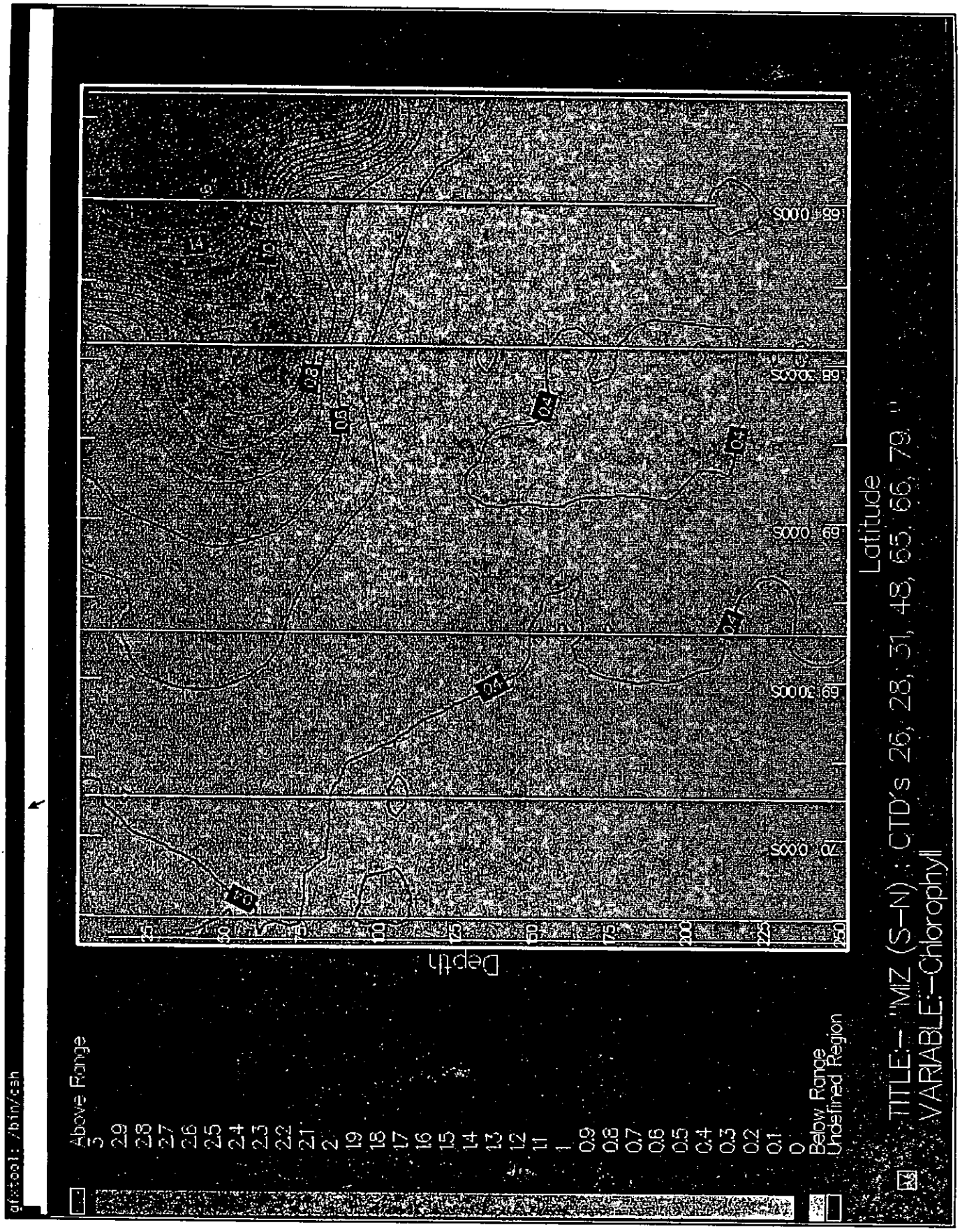

gfxtool: /bin/csh
Above Range
Below Range
Undefined Region
TITLE:- 'MIZ (S-N) : CTD's 26, 28, 31, 48, 65, 66, 79, ''
VARIABLE:-Salinity
Depth
Latitude

FIG 6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Above Range
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Below Range
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TITLE:- "MIZ (S-N) : CTD's 26, 28, 31, 48, 65, 66, 79 "
VARIABLE:-Chlorophyll
Depth
Latitude
S000 .69
S000 .68

4.7 PIGMENT BIOMARKERS. - R.G. BARLOW.

OBJECTIVES

1) To investigate the distribution of chlorophyll and carotenoid pigments in the water column and in the ice in order to determine the chemotaxonomic composition of the phyto biomass in relation to prevailing environmental conditions.

2) Measure phaeopigment concentrations to assess the degree of chlorophyll breakdown with respect to zooplankton grazing and other degradative processes.

SAMPLING PROGRAMME

1) Underway transect studies.
Drake Passage and along 85W north to south; see Table 1 for details.

2) Level 1 CTD.
Stations F, G, H, I, J & K.
Depths for station F were 2, 10, 20, 30, 40, 51 metres.
Depths for stations G to K were 2, 10, 20, 30, 40, 50, 75, 100, 125, 150, 200 metres.
2 litres filtered for each depth.
3) Ice cores.
Full length ice cores at stations G, H, & I.
SCUBA diver ice cores from the base of the ice at station G; 100ml cores at 5m, 10m & 15m along Nicky Fenton's optics transect.

4) SAP samples.
see Tim Fileman's report.

METHODS

1) Water column samples were drawn from CTD casts; see above.

2) Underway samples were taken from uncontaminated sea water supply.

3) Full length ice cores were taken with the aid of a motorized ice corer and then cut into 10-20 cm sections prior to melting in the dark. Small cores from the base of the ice were withdrawn using small hand held corers.

4) All water column and melted ice samples were filtered onto 25mm GFF filters and immediately frozen.

5) Frozen filters were extracted in acetone and analysed by reverse phase high performance liquid chromatography. Pigment separation and quantitation was achieved using a binary solvent system and a linear gradient, with chlorophylls and carotenoids being detected by absorbance at 440nm. Phaeopigments were monitored by fluorescence at 405nm excitation and 670nm emission.

6) Calibration of the liquid chromatograph was performed with authentic standards (chlorophylls *a* and *b*) and well characterized microalgal cultures from the Plymouth Culture Collection.

DATA STATUS

1) All samples, except for SAP samples and ice core H, were analysed on board the JCR and the rawdata archived on PC and printouts. SAP samples and ice core H will be analysed at PML.

2) Partial workup of some of the key pigment data has been undertaken (see Results) but most of the data processing has still to be completed. This will probably take 4-6 months.

3) Data will be available through personal contact and the BOFS data base.

RESULTS

A number of chlorophyll and carotenoid pigments were detected in the ice and in the water column of the Bellingshausen Sea and an example of an absorbance chromatogram is presented in Fig.1. The following broad chemotaxonomic scheme indicates the relationship between pigment biomarkers and algal classes:

All algae	*Chlorophyll a*
Diatoms	Chlorophyll c_1, Chlorophyll c_2, *Fucoxanthin*
Dinoflagellates	Chlorophyll c_2, *Peridinin*
Prymnesiophytes	Chlorophyll c_2, Chlorophyll c_3, 19'-Butanoyloxyfucoxanthin, *19'-Hexanoyloxyfucoxanthin*
Green algae	*Chlorophyll b*, Lutein, a-Carotene
Cryptophytes	Chlorophyll c_2, *Alloxanthin*, a-Carotene
Diatoms, Dino's, Prym's	Diadinoxanthin, b-Carotene
Chlorophyll degradation	Phaeophorbides, Phaeophytins

The pigments in *italics* are the principal pigment signatures of the particular classes of interest and are used, in conjunction with chlorophyll *a* in mathematical analysis, to assess the proportion of each class contributing to the phyto biomass.

Some selected preliminary results are presented in Figs.2-4. Fig.2 shows the pigment composition of two full length ice cores from stations G and I. For ice core G it may be noted that the highest concentrations of chlorophyll *a* and fucoxanthin were measured in sections 3 and 4 in the lower half of the core. Very low levels of 19'-hexanoyloxyfucoxanthin were also monitored in each section. In contrast, the ice core at station I had the highest concentrations of chlorophyll *a* , fucoxanthin and 19'-hexanoyloxyfucoxanthin in the upper half of the core in section 2. A decreasing trend in the levels of these pigments was observed from section 2 through to section 6 at the bottom. Traces of chlorophyll *b* were also detected in each section of ice core I.

Chlorophyll *a*, fucoxanthin and 19'-hexanoyloxyfucoxanthin were also the dominant pigment markers in the water column and Figs.3 & 4 illustrate the

depth profiles of these pigments. Very low levels of chlorophyll *a* were measured at station G (6-95 $ng.l^{-1}$) but there was a progressive increase in chlorophyll concentrations at each successive station from G through to K (Fig.3), with levels of 2000-2500 $ng.l^{-1}$ being detected in the upper 75m at station K. Fucoxanthin was the most prominent accessory pigment at the six stations, while 19'-hexanoyloxyfucoxanthin was the next most significant (Fig.4). It is interesting to note, however, that at station I (ice edge), 19'-hexanoyloxyfucoxanthin concentrations were slightly greater than fucoxanthin in the upper 50m, while at stations J and K, 19'-hexanoyloxyfucoxanthin levels in the upper 75m (50-100 $ng.l^{-1}$) were much lower than those of fucoxanthin (200-1300 $ng.l^{-1}$) (Fig.4).

Although none of the phaeopigment data has been processed yet, observation of the chromatograms indicates that the proportion of phaeophorbides and phaeophytins relative to chlorophyll *a* was very low in the upper 100m of the water column. Between 100 and 200m, however, there was a considerable increase in phaeopigments with respect to chlorophyll *a*.

CONCLUSIONS

Considering the constraints of the scientific progamme, it appears that the results obtained in this study were very satisfactory in meeting the broad objectives of the investigation. Overall, the pigment signatures indicated that diatoms were the most prominent components of the algal biomass, both in the ice and in the water column, but prymnesiophytes also made a significant contribution. Green algae and cryptophytes were found to minor components of the microalgal community. Once the pigment data processing has been completed, it will be important to relate the pigment concentrations to environmental parameters such as temperature, salinity, irradiance and nutrients in order to assess the effects of changing environmental conditions on the constituents of the algal community.

ACKNOWLEDGEMENTS

Sincere thanks to Nick Owens and Malcolm Woodward for their hard work and excellent organisation of the cruise; and to Nick Beer and his officers and crew for their superb support and enthusiasm.

TABLE 1

UNDERWAY TRANSECT STUDIES

DRAKE PASSAGE TRANSECT

Date	Time (local)	Long W	Lat S	Temp	Vol fil (l)
	1015	57.9	54.71	5	2
28-Oct	2302	57.84	55.31	5.4	2
	0358	58.25	55.69	5.3	2
29-Oct	0900	58.62	56.29	4.7	2
	1200	58.99	56.82	3.7	2
	1600	59.58	57.45	4.6	2
	2000	60.12	58.11	0.1	2
	2400	59.96	58.67	-0.6	2
	0400	59.36	59.3	-1	2
30-Oct	1000	58.6	60.23	-0.9	2
	1600	62.56	58.12	3.6	2
6-Nov	1700	62.53	58.33	1.7	2
	1710	62.53	58.37	0.9	2
	1730	62.52	58.44	0.2	2

TRANSECT ALONG 85W

Date	Time (local)	Long W	Lat S	Temp	Vol fil (l)
	1900	84.72	65.53	-0.7	2
11-Nov	2200	84.52	65.93	-1.6	2
	0100	84.43	66.4	-1.5	2
12-Nov	0400	84.41	66.87	-1.6	2
	0730	84.46	67.41	-1.7	2
	1004	84.67	67.83	-1.7	2
	1335	84.92	68.36	-1	2
	1545	84.94	68.68	-1.4	2
	1900	84.89	69.14	-1.6	2

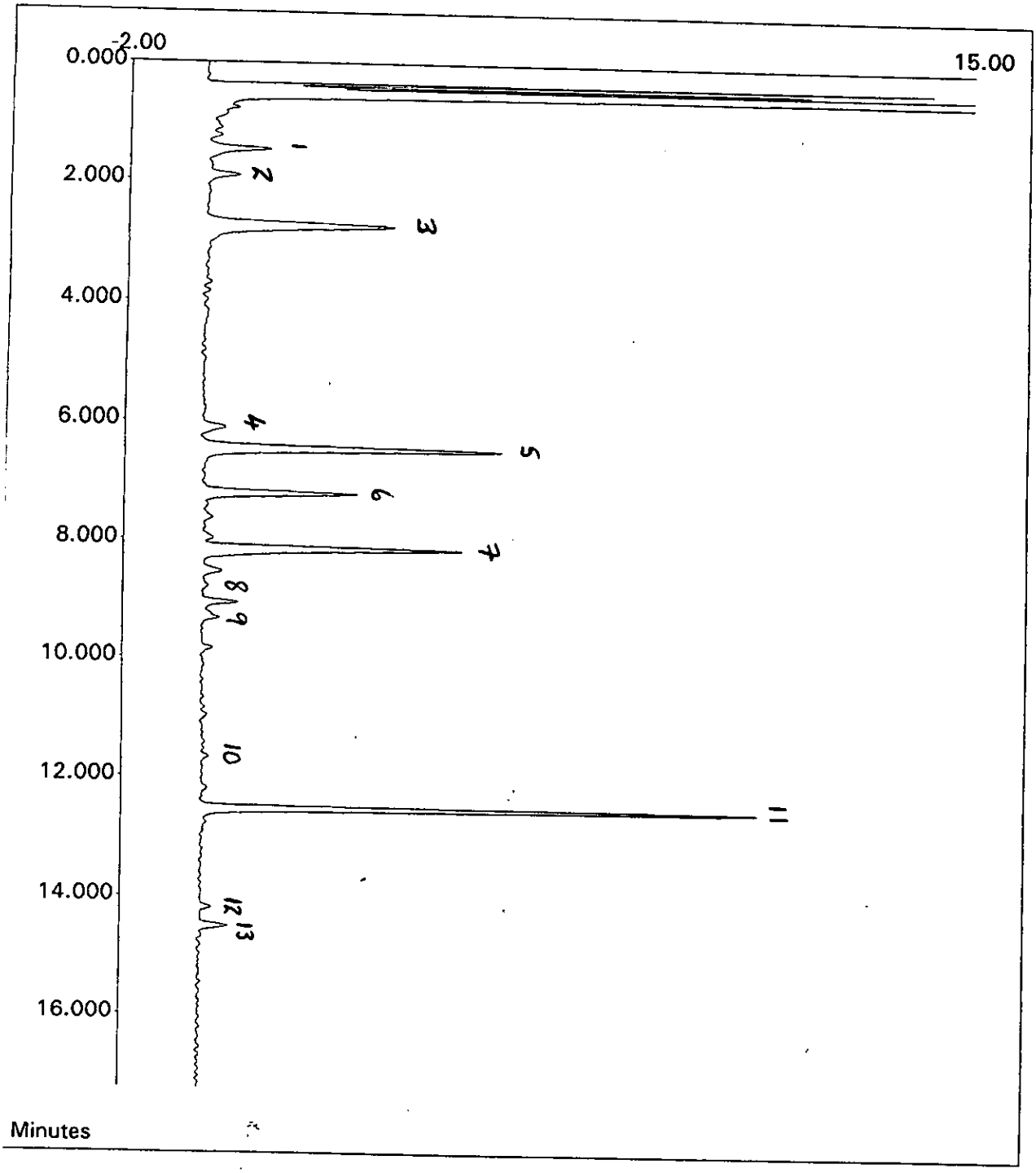
Figure legends

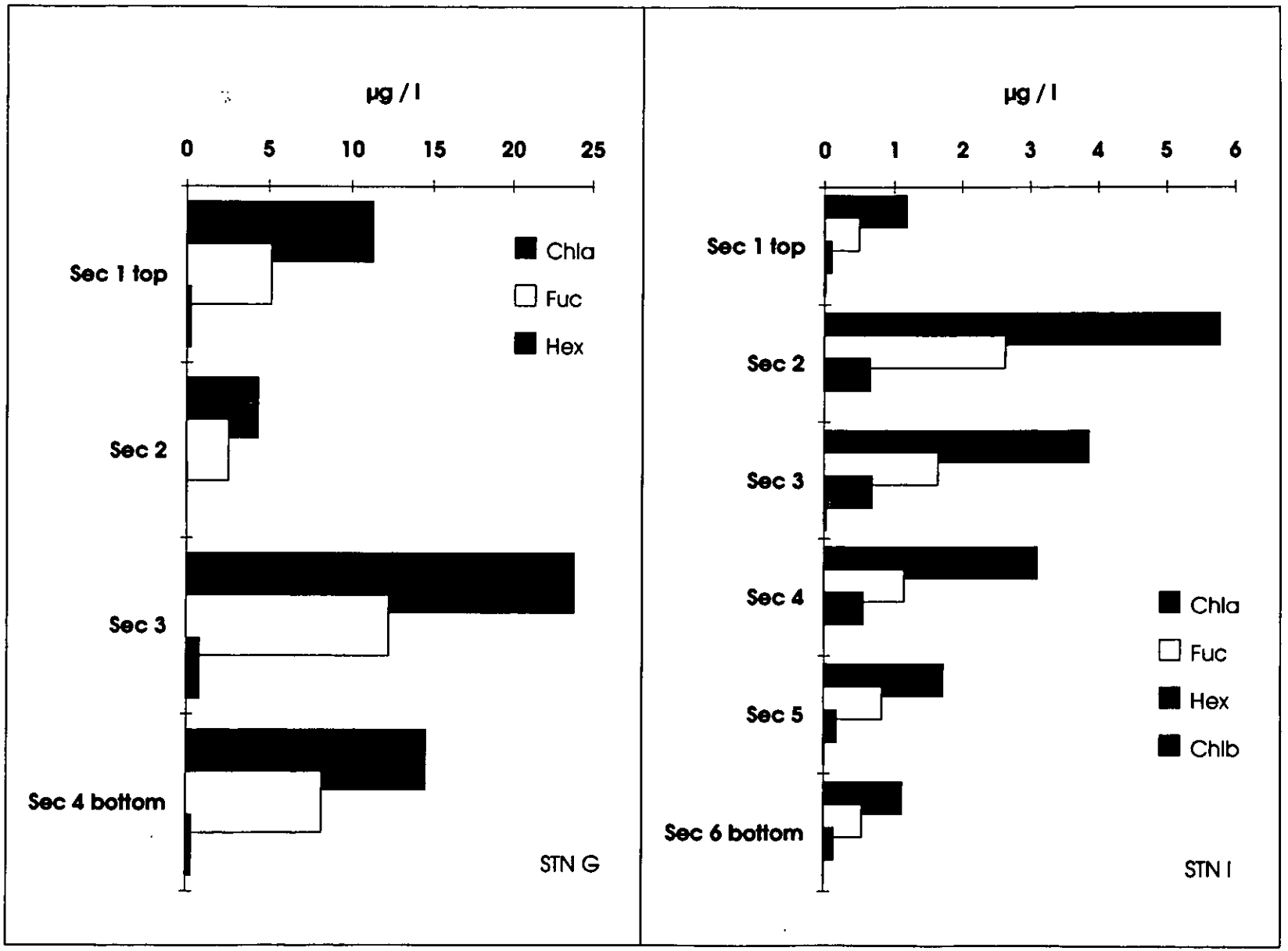
Fig.1. Absorbance chromatogram of a surface sample in the Bellingshausen Sea. Pigment identities are: 1) chlorophyll c_3; 2) chlorophyllide *a*; 3) chlorophyll c_1c_2; 4) 19'-butanoyloxyfucoxanthin; 5) fucoxanthin; 6) 19'-hexanoyloxyfucoxanthin; 7) diadinoxanthin; 8) alloxanthin; 9) lutein; 10) chlorophyll *b*; 11) chlorophyll *a*; 12) a-carotene; 13) b-carotene.

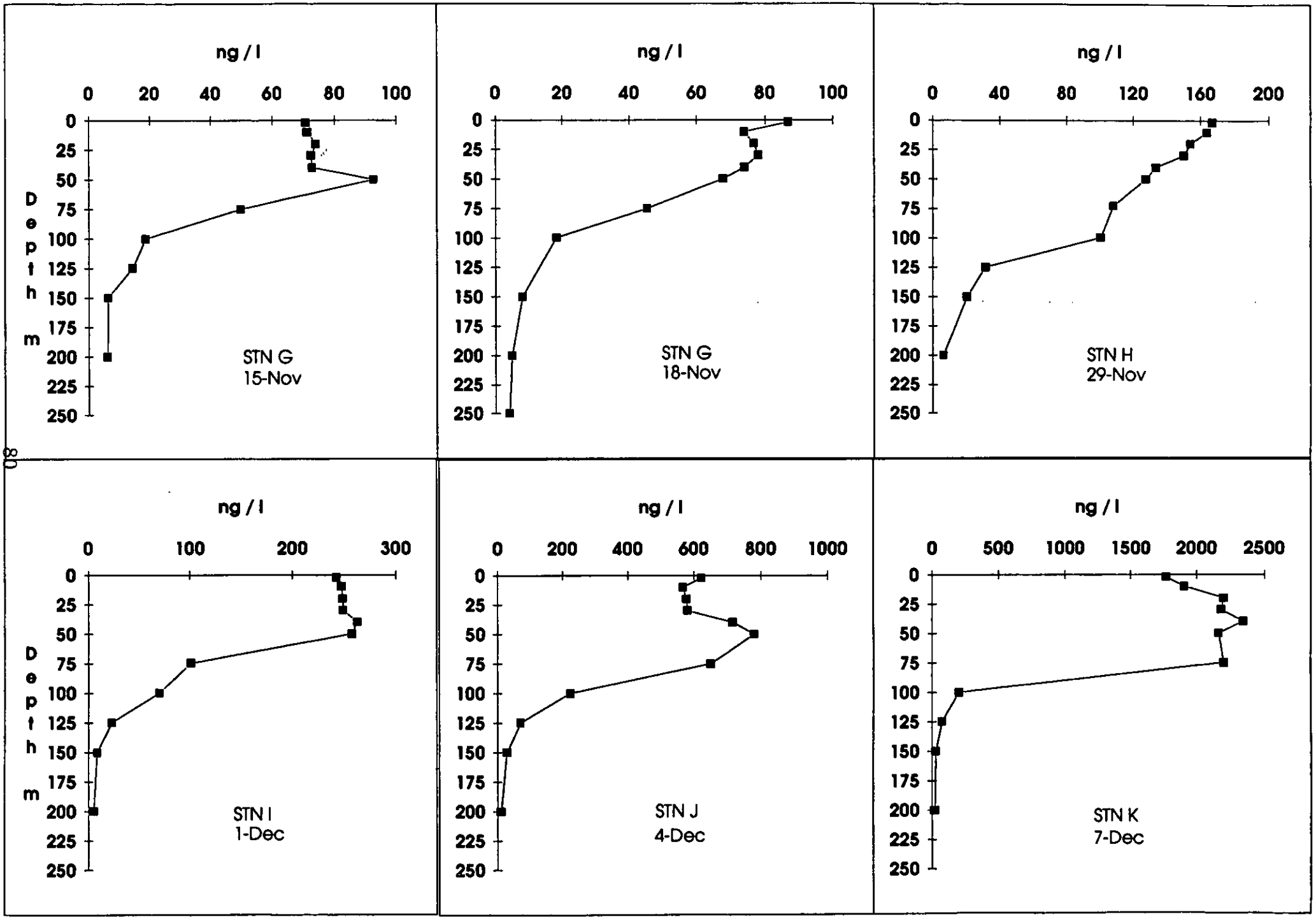
Fig.2. Pigment distribution in full length ice cores from stations G and I. Core G was cut into four 20cm sections and core I into six 15cm sections. Pigment identities are: Chla-chlorophyll *a*; Fuc-fucoxanthin; Hex-19'-hexanoyloxyfucoxanthin; Chlb-chlorophyll *b*.

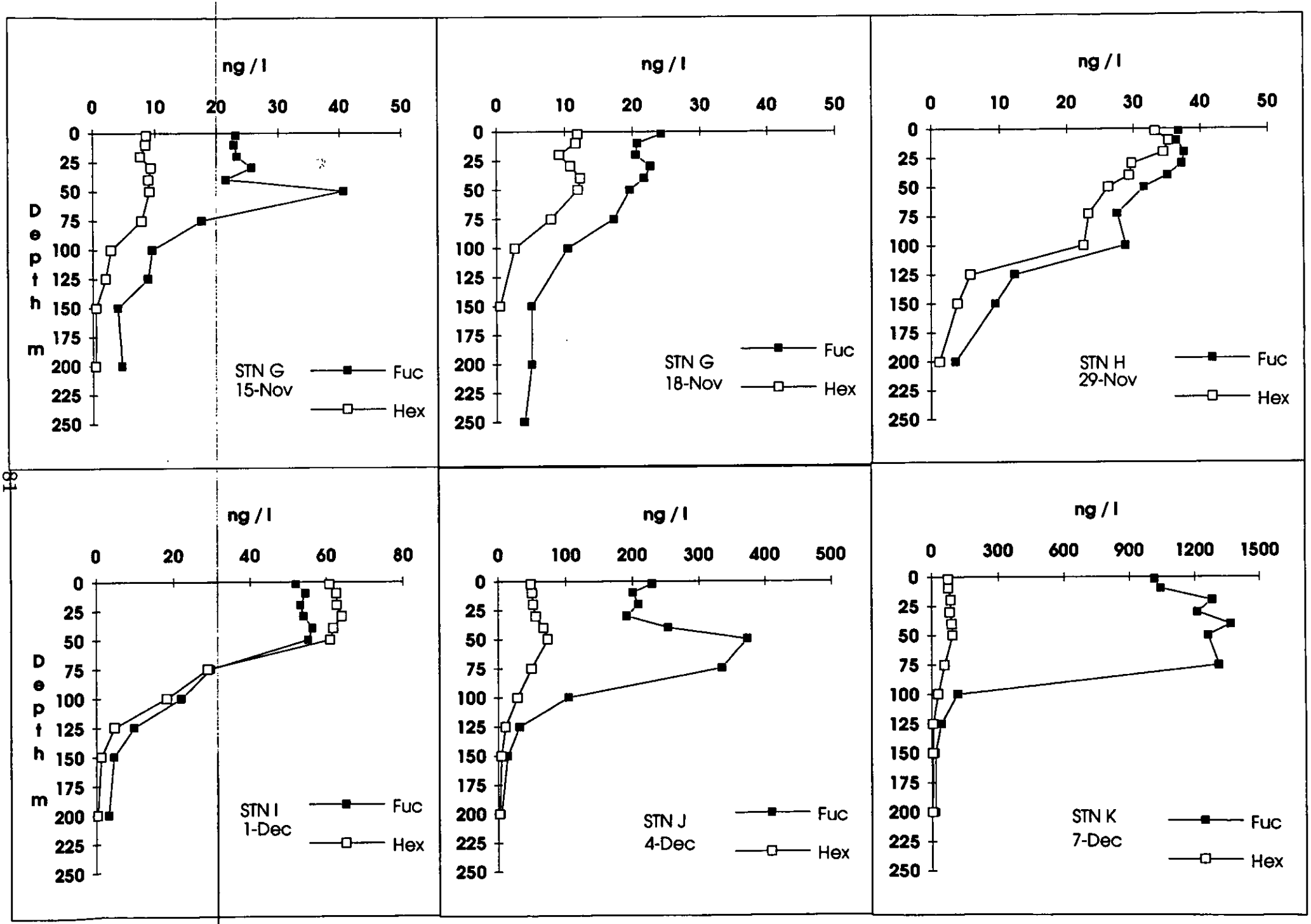
Fig.3. Depth profiles of chlorophyll *a* for stations G to K in the Bellingshausen Sea marginal ice zone. Note change in concentration scale.

Fig.4. Vertical profiles of fucoxanthin (Fuc) and 19'-hexanoyloxyfucoxanthin (Hex) for stations G to K. Note change in concentration scale.


2.00
0.000
15.00
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
1
2
3
4
5
6
7
8
9
10
11
12
13
Minutes


µg / l
0
5
10
15
20
25
Sec 1 top
Sec 2
Sec 3
Sec 4 bottom
Chla
Fuc
Hex
STN G
µg / l
0
1
2
3
4
5
6
Sec 1 top
Sec 2
Sec 3
Sec 4
Sec 5
Sec 6 bottom
Chla
Fuc
Hex
Chlb
STN I


ng / l
0 20 40 60 80 100
Depth m
0 25 50 75 100 125 150 175 200 225 250
STN G
15-Nov
ng / l
0 20 40 60 80 100
0 25 50 75 100 125 150 175 200 225 250
STN G
18-Nov
ng / l
0 40 80 120 160 200
0 25 50 75 100 125 150 175 200 225 250
STN H
29-Nov
ng / l
0 100 200 300
Depth m
0 25 50 75 100 125 150 175 200 225 250
STN I
1-Dec
ng / l
0 200 400 600 800 1000
0 25 50 75 100 125 150 175 200 225 250
STN J
4-Dec
ng / l
0 500 1000 1500 2000 2500
0 25 50 75 100 125 150 175 200 225 250
STN K
7-Dec


ng / l
0 10 20 30 40 50
Depth m
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STN G
15-Nov
Fuc
Hex
ng / l
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STN G
18-Nov
Fuc
Hex
ng / l
0 10 20 30 40 50
0 25 50 75 100 125 150 175 200 225 250
STN H
29-Nov
Fuc
Hex
ng / l
0 20 40 60 80
Depth m
0 25 50 75 100 125 150 175 200 225 250
STN I
1-Dec
Fuc
Hex
ng / l
0 100 200 300 400 500
0 25 50 75 100 125 150 175 200 225 250
STN J
4-Dec
Fuc
Hex
ng / l
0 300 600 900 1200 1500
0 25 50 75 100 125 150 175 200 225 250
STN K
7-Dec
Fuc
Hex

4.8 HYDROCARBONS AND CHLOROPIGMENTS. - G. CRIPPS.

SAMPLING AND METHODS

Box core samples frozen for later analysis in the UK.

Faecal pellets from krill (*Euphausia superba*) collected from animals in filtered seawater for gut evacuation and animals 'caged' in a continuous flow from the non-toxic supply - to mimic feeding in natural conditions (cf lab work in UK).

The non-toxic supply was also used to sample surface particulates and seawater (dissolved fraction).

Suspended particulate samples were taken from all depths using stand alone pumps (SAP).

Sediment traps were deployed at 150 and 300 m - no material collected save several pieces of glass, an amphipod and a lump of putty.

Zooplankton were collected using vertical nets (for copepoda) and RMT net deployments (for krill). Most samples were frozen for later analysis in the UK. One sample of krill at H was dissected for gut content analysis.

Samples were either homogenised or 'sonicated' in neat acetone followed by spinning down in the centrifuge. The resulting liquor was either analysed for pigments or partitioned into hexane for hydrocarbons (or both in some cases). Hydrocarbon samples (neutral lipid fraction) were purified using small silica columns before analysis by capillary GC. The chloropigments were analysed by HPLC with fluorescence and UV absorbance detection.

Hydrocarbon methodology

Filter discs were extracted with 100% acetone using a sonic probe. The resulting mixture was then spun down in the centrifuge. The supernatant liquor (3ml) was removed, diluted with water (3ml) and extracted with hexane (2ml). The hexane extract (neutral lipid fraction) was evaporated under a stream of nitrogen to 100 æl. The aliphatic fraction of the extract was then isolated by LC on a silica column (SeppaK) - eluted with 2ml hexane. The remainder of the neutral lipid fraction was left on the column and stored in the -60 freezer for later analysis in the UK - sometime???

The aliphatic extract was then evaporated to a small volume as above (25 - 100 æl) and analysed by capillary GC with FID and on-column injection. The column was 30m SE-54 and temperature programmed from 60 - 300 over 60 minutes. See attached chromatogram of a typical SAP sample.

Peak i.d.

15.5 min - nC16 alkane
17.0 min - nC17 alkane
18.7 min - nC18 alkane
36.6 min - Phthalate
41.8 min - nC29 alkane

SAMPLING REGIME

STATION	BOX CORE	FAECAL PELLETS	NON TOXIC	SAP	SED TRAP	ZOOP.
F			X	X		
G	X	X	X	X	x	X
H		X	X	X	x	X
I	X	X	X	X		X
J			X	X		X
K	X	X	X	X		X

Further work was carried out in transit - faecal pellet experiments and sampling surface particulates from the non - toxic supply. There was an additional SAP at Deception Island. In addition to the cruise programme, seawater and limpets were sampled at Faraday Base as part of a hydrocarbon monitoring programme following a small spill of diesel earlier this year.

PRELIMINARY RESULTS

Aliphatic hydrocarbons

There were detail differences in the distributions of n- alkanes with depth at stations G I J, in particular the proportion of the C14 - C18 compounds compared to the C24 - C32 compounds. The distributions were similar at all depths at H & K - suggesting a single source for these compounds compared to a number at G I & J. At Deception Island, although there was little organic material on the SAP filter, the alkanes appeared to be of biogenic origin with a similar distribution to H & K

A straight chain alkene with six double bonds (a marker for diatoms) was found in the sea-ice algae at G. The chromatogram (figure 1) shows seven main components, the first five are the C14 - C18 n-alkanes followed by the C21:6 n-alkene and squalene (a precursor in the synthesis of cholesterol). In larger algae (>20 æm) from the water column there was a greater proportion of the C24 - C32 n-alkanes than for algae <20 æm. The distribution of alkanes in the dissolved fraction was similar that of suspended particulates.

N-alkanes in faecal material from krill reflected the distribution in algae but did not have significant proportions of other aliphatic compounds such as alkenes and isoalkanes except for pristane. Pristane was found in high proportion in all zooplankton but is present in low levels in phytoplankton. Larger species (>20 æm) had the highest proportion of pristane. The ratio of pristane to the C17 n-alkane in faecal material from krill was similar to that for the algae on which the animals had been feeding (Table 1).

BAS 01223 61188 (Fax)

0·45 µm Nuclepore.

20 µm nylon

Table 1. Pristane / C17 n-alkane ratio for microalgae and krill faecal pellets.

STATN	SAMPLE	PRISTANE/n-C17 RATIO
H	ALGAE	0.07
H	FAECAL PELLET	0.30
G	FAECAL PELLET	2.25
I	FAECAL PELLET	1.81
K	<20 æm ALGAE	0.11
K	>20 æm ALGAE	1.60

n.b. The C17 n-alkane is the hydrocarbon with a retention time which is closest to pristane.

Pigments

Pigment profiles of krill faecal pellets confirmed earlier lab observations - well fed krill only degrade chlorophyll in algae to a limited extent. The proportion of chlorophyll a was reduced in the faecal material, but only traces of degradation products were detected. When krill are held in filtered seawater they produce faecal material which was 90% degraded to pheophorbide a.

Algae from the surface water were fractionated at 20 æm from stations K & J. Hexanoylfucoxanthin was only found in the small fraction (< 20 æm) and neofucoxanthin only in the larger species. The proportions of chlorophyll a and c were similar for both sizes.

Starved copepods were found to contain two dominant pigments; these were probably astaxanthin and canthaxanthin. Feeding copepods had all the pigments from the larger diatoms - this may be contamination in the vertical net rather than an indication that copepods eat large diatoms. The pigments found in the sea-ice algae were typical of diatoms.

Due to sensitivity problems with the BAS HPLC, SAP samples were not analysed.

POST MORTEM

Achievements were disappointing, only about 33% of work planned was completed. This was largely due to circumstances out of our control and equipment not performing as well as expected (HPLC).

All chromatographic data is stored on disk with Unicam Chemstation software in Windows 3.0. Present data needs further processing and collection of data will not be complete until autumn 1993. (n.b. instrumentation and samples will not be available again until May).

Obviously the cruise was overloaded with personnel. This made work in the labs very difficult at times, due to lack of space and restricted access to services such as the non-toxic supply. In some cases lab safety was compromised. The attitude of some towards other peoples work was at times disappointing (normal cruise paranoia ??). I feel we should have had watch leaders on duty

round the clock when on station not just during the transects. Watch leaders would responsible for coordinating deck work and liaise with the deck crew and the bridge. An event log would have been useful and a complete record of cruise activities. The watch leader system and event logger have worked well for BAS in the past. The gas lines in the lab were a complete disaster - I shall be communicating with the personnel concerned when I return to BAS.

I realise this has been a very difficult cruise to organise and the loss of a senior scientist (JP) early in the trip did not help. The ships officers were of the usual high standard. The deck crew were always helpful and worked well considering most of them had no experience of a scientific cruise. There was a lot of problems with the deck equipment (winches, gantry etc.) and special commendation must go to the deck engineer for the long hours and hard work despite floods of hydraulic fluid.

Reanalysis 1 Sample : 1 21:57 Sat Dec 12 1992

Run Type : Unknown

File Description	Date	Name
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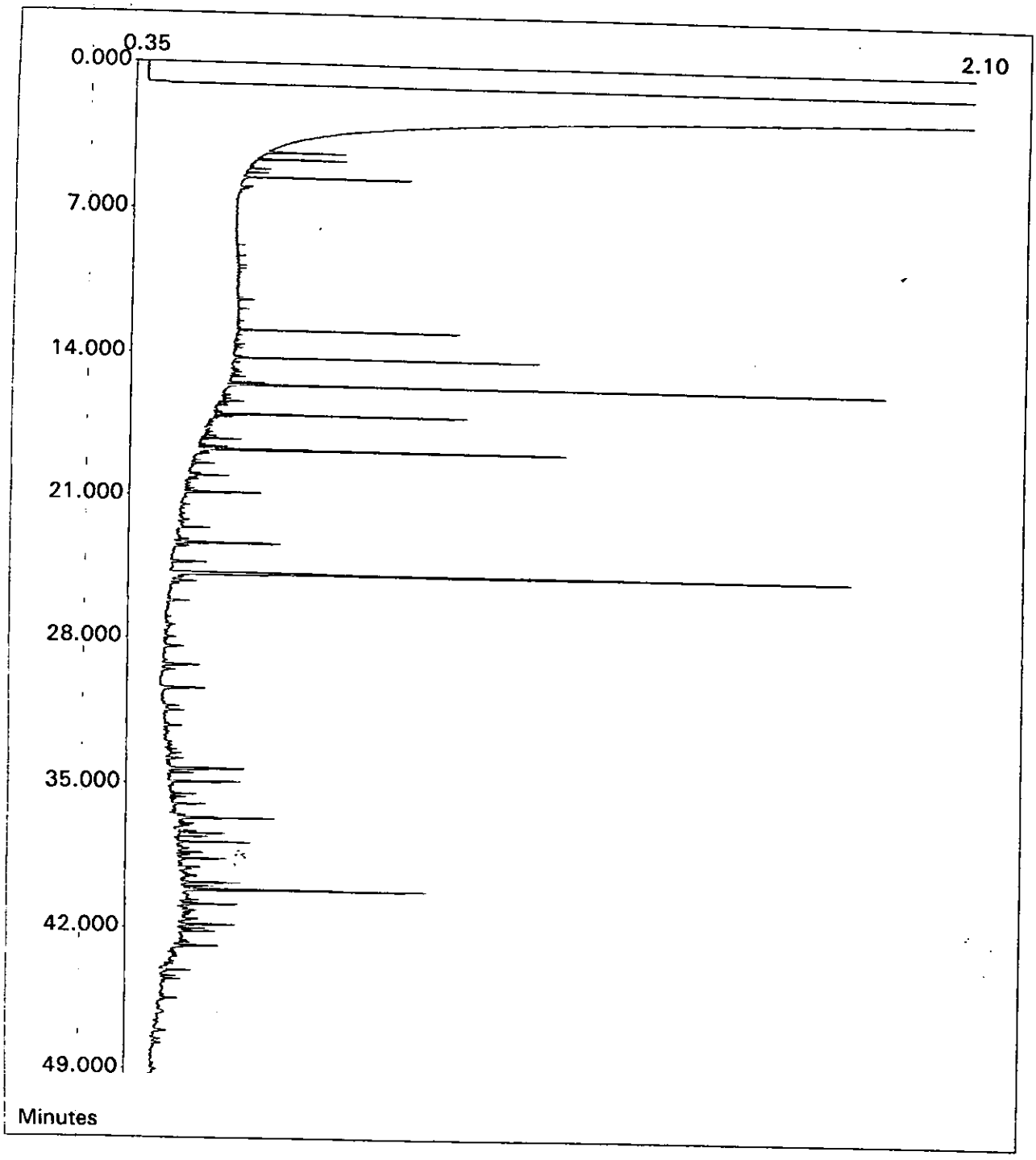
Method:	20:51 Sat Dec 12 1992	C:\4880\METHODS\DIAGS
Raw Data:	05:34 Tue Dec 01 1992	C:\4880\RAWDATA\ALWAT.012

Mode : Manual Response Factors : Replace

Sample Name : ICE ALGAE STA. G

Scale : 1.0000000 Sample Amount : 1.0000000

Comment:



No Peaks detected

4.9 STAND ALONE PUMPS. T. FILEMAN.

OBJECTIVES

1. *Organic Geochemistry*:

a) To measure the concentrations of particulate organic carbon (POC) and nitrogen (PON), pigments, amino acids, carbohydrates, lipids and hydrocarbons down the water column in order to characterise the organic component of the particulate material. This characterisation will be used to assess the fate and fluxes of these organic biomarkers with respect to the sedimentation and degradation processes of the carbon cycle.

b) To collect samples of surface water particulates for long-chain alkenones and alkyl alkenoate determinations along a transect from the Falkland Islands to the Bellingshausen Sea. Alkenone and alkenoate abundances and distributions have been shown to correlate with source organisms and water temperature. This sampling is being carried out to complement an existing data set for Maureen Conte at Bristol University.

2. *Radionuclides*:

Measurement of both suspended and sinking particulate nuclide/carbon ratios in order to quantify the flux of organic matter through the water column. This to be accomplished by simultaneous collection of particulate and dissolved radionuclides from a variety of depths using stand alone pumps.

METHODS

Large volume in-situ filtration using four Challenger Oceanic SAPs each fitted with an improved Fileman/Conte filter housing and two radionuclide scavenger cartridges. Particulate material, for biogeochemistry and radionuclide determinations, was removed on ashed (450°C) 293mm Whatman GF/F filters. Filters were subdivided using stainless-steel cutters of various sizes and the residual filter (56%) used for radionuclide determinations. Table 1 shows all the analyses being carried out on SAPs filter subsamples. Dissolved nuclides were removed on MnO_2-coated polypropylene cartridges ("scavengers").

Table 1: SAPs Analyses

Name	Institute	Subsample Size	Analysis Type
Tim Fileman	PML	6 x 22mm	Amino Acids
Tim Fileman	PML	6 x 22mm	Carbohydrates
Tim Fileman	PML	3 x 22mm	POC/PON
Ray Barlow	PML	6 x 22mm	Pigments
Maureen Conte	OGU, Bristol Univ.	5 x 59mm	Lipids
Geoff Cripps	BAS	1 x 59mm	Hydrocarbons
Graham Shimmield	Edinburgh Univ.	1 x 59mm	Metals
Graham Shimmield	Edinburgh Univ.	Residual	Radionuclides

RESULTS

All main stations were sampled at depths of 20, 50, 100 and 200 metres. It was not possible to complete full depth profiles at each station, in fact only two were completed. Table 2 shows all relevant data on the SAPs deployments. Table 3 shows all the information on the underway sampling carried out for Maureen Conte.

CONCLUSIONS:

All biogeochemical analyses to be carried out back in the UK. More detailed information on radionuclides can be obtained from the cruise report written by Graham Shimmield and George Ritchie.

Acknowledgments:

I would like to thank Graham Shimmield for all his assistance with the SAPs. Also a big THANKYOU to all the officers and crew on the JCR for all their enthusiasm and help throughout the cruise. A most enjoyable cruise.

Table 2: Data on SAPs deployments.

SAP Cast #	Station	Date	Depth (m)	Lat. °s	Lon. °w	Volume Pumped (litres)			
						Total	59.4mm	22.2mm	Residual
1	Deception	1/11/92	140	62.97	60.64	533.3	23.58	3.28	299.34
2	Flossy	13/11/92	1500	69.43	84.96	419.6	18.55	2.58	235.52
2	Flossy	13/11/92	1500	69.43	84.96	641.5	28.36	3.95	360.07
2	Flossy	13/11/92	1500	69.43	84.96	881.8	38.98	5.43	494.95
2	Flossy	13/11/92	1500	69.43	84.96	425.9	18.83	2.62	239.06
3	Gurtie	15/11/92	20	70.29	85.25	824.4	36.45	5.07	462.73
3	Gurtie	15/11/92	50	70.29	85.25	563.4	24.91	3.47	316.23
3	Gurtie	15/11/92	100	70.29	85.25	288.7	12.76	1.78	162.05
4	Gurtie	16/11/92	200	70.31	85.28	440.8	19.49	2.71	247.42
4	Gurtie	16/11/92	350	70.31	85.28	839.3	37.11	5.16	471.10
4	Gurtie	16/11/92	500	70.31	85.28	790.4	34.94	4.86	443.65
5	Herbie	29/11/92	20	70.28	85.32	600.6	26.55	3.70	337.11
5	Herbie	29/11/92	50	70.28	85.32	853.8	37.75	5.25	479.23
5	Herbie	29/11/92	100	70.28	85.32	756.8	33.46	4.66	424.79
5	Herbie	29/11/92	215	70.28	85.32	686.6	30.35	4.23	385.39
6	Isolde	30/11/92	20	69.59	84.99	628.8	27.80	3.87	352.94
6	Isolde	30/11/92	50	69.59	84.99	831.8	36.77	5.12	466.89
6	Isolde	30/11/92	100	69.59	84.99	815.4	36.05	5.02	457.68
6	Isolde	30/11/92	210	69.59	84.99	1033.8	45.70	6.36	580.27
7	Julian	3/12/92	20	68.25	85.05	257.5	11.38	1.58	144.53
7	Julian	3/12/92	50	68.25	85.05	282.2	12.48	1.74	158.40
7	Julian	3/12/92	100	68.25	85.05	348.6	15.41	2.15	195.67
7	Julian	3/12/92	200	68.25	85.05	482.9	21.35	2.97	271.05
8	Katie	6/12/92	20	67.51	84.99	354.2	15.66	2.18	198.81
8	Katie	6/12/92	50	67.51	84.99	456.9	20.20	2.81	256.46
8	Katie	6/12/92	100	67.51	84.99	497.1	21.98	3.06	279.02
8	Katie	6/12/92	200	67.51	84.99	666.1	29.45	4.10	373.88
9	Katie	8/12/92	500	67.7	84.79	831.2	36.75	5.12	466.55
9	Katie	8/12/92	1500	67.7	84.79	813.6	35.97	5.01	456.67
9	Katie	8/12/92	3000	67.7	84.79	1298.1	57.39	7.99	728.62
9	Katie	8/12/92	3900	67.7	84.79	941.8	41.64	5.80	528.63

Table 3: Underway Sampling for Lipids

Sample No.	Julian Da	Date	Time (Z)	Lat. °s	Lon. °w	Temp. °C	Volume Filtered (litres) Lipids	POC	Pigments
UW1	302	28/10/92	11:43	54.71	57.90	5.00	6	3 x 2	2
UW2	303	29/10/92	2:02	55.31	57.84	5.40	8	3 x 1	2
UW3	303	29/10/92	6:58	55.70	58.25	5.30	8.6	3 x 1	2
UW4	303	29/10/92	12:07	56.29	58.62	4.70	8	3 x 1	2
UW5	303	29/10/92	15:00	56.82	59.00	3.70	8	3 x 1	2
UW6	303	29/10/92	21:36	57.45	59.58	4.60	8	3 x 1	2
UW7	303	29/10/92	23:10	58.11	60.12	0.10	8	3 x 1	2
UW8	304	30/10/92	3:03	58.67	59.96	-0.60	8	3 x 1	2
UW9	304	30/10/92	7:00	59.30	59.36	-1.00	7.9	3 x 1	2
UW10	304	30/10/92	12:57	60.23	58.60	-0.90	8	3 x 1	2
UW11	311	6/11/92	3:00	57.09	60.74	2.90	8	3 x 1	2
UW12	311	6/11/92	20:00	58.33	62.54	1.70	8	3 x 1	2
UW13	311	6/11/92	20:15	58.38	62.53	0.30	8	3 x 1	2

4.10 RADIONUCLIDE AND CARBON FLUX STUDY. - G. SHIMMIELD and G. RITCHIE.

OBJECTIVES

In order to quantify the rates of carbon cycling in the upper ocean it is important to be able to identify geochemical tracers of carbon or nutrient uptake and export. For the estimation of particle formation and export flux on time scales of days to weeks, associated with plankton blooms, appropriate radionuclide tracers include ^{234}Th, ^{210}Po and ^{210}Pb with respective half-lives of 24 days, 138 days and 22 years. Each of these nuclides is "particle reactive" becoming adsorbed or incorporated into the biogenic detritus formed within the euphotic zone. Due to the variation in half-life and biogeochemistry of these three nuclides, measurement of the dissolved and particulate radioactivity (analogous to concentration) allows comparison of different aspects and scales of the carbon dynamics in the upper water column.

The source term for the three nuclides is ^{238}U which occurs at almost constant activity in seawater (^{238}U = 0.0686 x salinity ‰). Through α and β/γ decay a variety of nuclides of different half-lives are formed, each with different biochemical behaviour. This is known as the natural U-decay series. By comparing the inventories of parent / daughter isotope pairs (^{238}U/^{234}Th and ^{210}Pb/^{210}Po) within the water column it is possible to calculate both the residence time and vertical flux of particulate material using simple mass-balance concepts and steady-state assumptions of production and decay of the radionuclides. However, adoption of a time-series approach to sample collection within a biologically-evolving water mass allows the application of non steady-state models which can give a much more realistic budget for the rate of change of new production with time. Both approaches require the radionuclide fluxes to be converted to meaningful carbon fluxes through the application of a nuclide/organic carbon ratio. Only a few such measurements are available in the literature, usually collected from sediment trap studies. This is potentially the greatest source of uncertainty in this approach to quantification of the upper ocean carbon cycle. In the approach used on this cruise we decided to attempt measurement of both suspended and sinking particulate nuclide/carbon ratios through sample collection by stand-alone pump (SAP) and free-floating sediment trap (further detail below). Furthermore, box-core samples from the same stations would allow the integration of ^{210}Pb fluxes over the last century or so, in order to estimate the degree of scavenging effectiveness operating in the Bellingshausen Sea, and to quantify the flux of organic matter to the seafloor.

In summary, the objectives of the radionuclide study were:

1. To collect particulate and dissolved ^{234}Th, ^{210}Po and ^{210}Pb samples from a variety of water depths at a (time) series of stations in the marginal ice zone.
2. To measure the short-lived ^{234}Th isotope by shipboard high-resolution gamma-spectroscopy.

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[1] Marine Geosciences Unit, Department of Geology & Geophysics, University of Edinburgh, West Mains Road, Edinburgh, EH9 3JW

3. To collect suspended and sinking biogenic detritus for the measurement of radionuclides, pigments, POC and PON.
4. To use the variety of isotopes and their respective half-lives to constrain the rate of change of biological and physical processes operating on the time scale of days to weeks in the marginal ice zone.
5. To obtain independent measurement of the euphotic zone export fluxes without the complications and assumptions inherent with the use of sediment traps in the upper water column.
6. To characterise the benthic carbon flux, and the scavenging effectiveness of sinking particles in the Bellingshausen Sea, through measurements taken from a depth profile within a sediment core.

METHODS

Sample collection for the radionuclide study employed a variety of techniques:

1. Large volume filtration using stand-alone pumps. For the shipboard gamma-spectroscopy used in the determination of ^{234}Th in excess of 500 litres of seawater is required for analysis. Particulate material was removed on large diameter GF/F glassfibre Whatman filters (foil-fired prior to use). Dissolved nuclides were removed on MnO_2-coated would polypropylene cartridges ("scavengers").
2. Laboratory filtration of 25 litres of seawater collected using the CTD rosette system for 210Po and 210Pb isotopes. Particulate material was removed on 0.45 µm cellulose acetate membrane filters, and the dissolved nuclides collected by APDC coprecipitation.
3. Underway continuous sampling from the ship's non-toxic seawater supply using a similar configuration of particulate filter and scavengers employed on the SAPs.
4. Sediment core sampling using the RVS box-corer, and subsampled with acetate liner and core extrusion into 1 and 2 cm sliced intervals (for ^{210}Pb analysis only).
5. Sediment traps using the single collector, cone-shape design produced by the SMBA, Oban. The rig comprised two traps set at 150m and 300m depth, with surface buoyancy and a dan-buoy.

Further details on the sample collection methodology may be found in the appropriate sections.

Shipboard radiochemistry

$^{210}Pb/^{210}Po$ Determinations

By the use of a compressed air pump approximately 25 litres of water were filtered through a 142mm diameter, 0.45µm cellulose ester filter to remove particulates. The filters were then stored at 0°C for processing ashore. The filtered water was acidified with 40ml of HCl and spiked with ^{208}Po (5dpm) and ^{206}Pb (0.5 ml, 2000ppm) yield tracers. The sample was then allowed to equilibrate for at least two days. The radiotracers and the spikes were then precipitated out by the addition of 10mg Co (as cobalt nitrate) and

APDC. After about 30 minutes the green precipitate was removed by filtering through a 150mm GF/D filter again using the compressed air pump. These filters were also stored for processing ashore.

^{234}Th Determinations

Large volumes (up to 3000l) of seawater were pumped firstly through a 293mm GF/F filter to remove particulates. It then passed through two manganese dioxide covered cartridges, arranged in series, to strip out the dissolved ^{234}Th. The relative amounts of ^{234}Th on the cartridges provides a means of determining the efficiency of recovery of the dissolved ^{234}Th. The particulate sample is then placed on the gamma radiation detector and the ^{234}Th activity in the particulate phase determined directly. The geometry of the cartridges is not suitable for presentation to the gamma detector and so they require to be processed as follows. Firstly a 1.5l solution of 0.1M HCl and 0.02M HO.NH_3Cl was prepared. It was then pumped (by means of a peristaltic pump) to totally immerse the cartridge and allowed to soak for 2 minutes. The solution was then circulated for 30 minutes. A second 1.5l solution of 0.1M HCl was then also circulated for 30 minutes and finally 1.5l of distilled water circulated for 15 minutes. The three solutions were combined and had 25mg of iron added (as $FeCl_3$) and finally 50 ml of NH_3. The precipitate (containing the ^{234}Th) was then gravity filtered onto a 150mm GF/D filter which was stored in a sample bag and counted on the gamma detector.

Shipboard spectroscopy analysis for ^{234}Th was performed for the first time on a UK research vessel. Using a high-purity, 38% efficient, germanium detector connected to a cryogenic cold-head assembly (EG&G Ortec Electricool system), 12 hour counts on dissolved and particulate samples were performed. Data collection and analysis was carried out using EG&G Maestro and Omnigam software running on a 386 PC. A 152Eu low-activity source was used for energy calibration between 15 keV and 1400 keV; for effciency standardisation a mixed-nuclide, low activity solution from the National Physical Laboratory was spiked onto appropriate filters. This provided a suitable approximation for the efficiency response for the detector whilst at sea - further detailed calibration in the shore-based laboratory will be required to confirm the activities quoted below. Sample collection from deep in the water column was carried out in order to attempt effciency calibration using a sample where ^{234}Th/^{238}U was expected to be in equilibrium.

The location of the counting equipment, dictated by the weight of the lead shielding, in the forward scientific hold was far from ideal. Many days were spent tracing electrically and mechanically-induced microphonics that caused severe degradation of the gamma spectrum. Important points to note include: (a) severe vibration from the thrusters and winch room, (b) poor shielding of the power supplies in the hold (they are NOT on the lab supply, despite ambiguous labelling), (c) vicinity of electrically-noisy pumps associated with the ship's fresh water supply system.

STATION LIST

The following sample collections were carried out during the cruise:

Station	Date	Latitude	Longitude	Device	Code #	Comments
Deception	1 Nov 92	62 58.0'S	60 38.55'W	SAP	1	Shakedown station
Flossie	13 Nov 92	69 25.64'S	84 57.37'W	SAP	2	Test for Th-234 counting efficiency
Gertie	15 Nov 92	70 16.4'S	85 05.6'W	CTD	8	Pb/Po radionuclides (deep)
Gertie	15 Nov 92	70 16.4'S	85 05.6'W	CTD	9	Pb/Po radionuclides (shallow)
Gertie	15 Nov 92	70 16.4'S	85 05.6'W	Non-toxic	1	On-line filtration for Th-234
Gertie	17 Nov 92	70 19.58'	85 44.25'W	Non-toxic	2	On-line filtration for Th-234
Gertie	15 Nov 92	70 29.4'S	85 25.6'W	SAP	3	Shallow cast
Gertie	16 Nov 92	70 31'S	85 28'W	SAP	4	Deep cast
Gertie	14 Nov 92	70 17.41'S	85 12.71'W	Box-core	1	620 m depth
Herbie	29 Nov 92	70 15.02'S	85 7.32'W	Non-toxic	3	On-line filtration for Th-234
Herbie	29 Nov 92	70 15.26'S	85 10.69'W	CTD	31	Pb/Po radionuclides (deep)
Herbie	29 Nov 92	70 15.26'S	85 10.69'W	CTD	32	Pb/Po radionuclides (shallow)
Herbie	29 Nov 92	70 16.5'S	85 19.0'W	SAP	5	Shallow cast
Isolde	30 Nov 92	69 34.79'S	84 59.54W	Non-toxic	4	On-line filtration for Th-234
Isolde	30 Nov 92	69 35.6'S	84 59.4'W	SAP	6	Shallow cast
Isolde	1 Dec 92	69 34.7'S	84 59.5'W	CTD	37	Pb/Po radionuclides (shallow)
Isolde	1 Dec 92	69 34.7'S	84 59.5'W	CTD	38	Pb/Po radionuclides (deep)
Isolde	1 Dec 92	69 41.34'S	85 10.50'W	Box-core	2	1837 m depth
Julian	3 Dec 92	68 15.82'S	85 01.11'W	Non-toxic	5	On-line filtration for Th-234
Julian	3 Dec 92	68 15.1'S	85 03.0'W	SAP	7	Shallow cast
Julian	4 Dec 92	68 15.82'S	85 01.11'W	CTD	54	Pb/Po radionuclides (deep)
Julian	4 Dec 92	68 15.82'S	85 01.11'W	CTD	55	Pb/Po radionuclides (shallow)
Julian	5 Dec 92	68 27.5'S	84 40.0'W	Box-core	3	3827 m depth (no core)
Katie	6 Dec 92	67 29.87'S	84 59.96'W	Non-toxic	6	On-line filtration for Th-234
Katie	6 Dec 92	67 30.6'S	84 59.1'W	SAP	8	Shallow cast
Katie	7 Dec 92	67 36.68'S	84 56.31'W	CTD	70	Pb/Po radionuclides (deep)
Katie	7 Dec 92	67 36.68'S	84 56.31'W	CTD	71	Pb/Po radionuclides (shallow)
Katie	9 Dec 92	67 41.7'S	84 47.2'W	SAP	9	Deep cast
Katie	8 Dec 92	67 41.70'S	84 47.57'W	Box-core	4	4100 m depth

RESULTS

Preliminary radionuclide results from shipboard gamma-spectroscopy. Total 234Th activities are probably too low and require recalibration from measured salinity values. The reported errors are based on one-sigma counting statistics.

Depth *metres*	Th-234 particulate *dpm/l*	Th-234 error	Th-234 dissolved *dpm/l*	Th-234 error	Th-234 total *dpm/l*	Th-234 error
Station Gertie						
20	0.03	0.044	1.58	0.058	1.61	0.07
50	0.18	0.083	1.50	0.109	1.68	0.14
100	0.03	0.192	1.41	0.208	1.44	0.28
200	0.06	0.092	1.52	0.122	1.58	0.15
350	0.19	0.061	1.39	0.080	1.59	0.10
550	0.29	0.041	1.68	0.071	1.97	0.08
Station Herbie						
20	0.15	0.048	1.25	0.073	1.40	0.09
50	0.12	0.048	1.69	0.068	1.81	0.08
100	0.10	0.047	1.61	0.075	1.71	0.09
200	0.09	0.058	1.51	0.065	1.59	0.09
Station Isolde						
20	0.17	0.071	1.51	0.098	1.68	0.12
50	0.10	0.062	1.61	0.090	1.71	0.11
100	0.09	0.060	1.62	0.070	1.71	0.09
210	0.16	0.061	1.43	0.063	1.59	0.09

DATA FORMAT

The shipboard γ-spectroscopy data is backed up on a PC awaiting final post-cruise calibrations. Stations Julian and Katie will be counted for ^{234}Th activity on return to the UK. These samples should be complete by mid January.

For ^{210}Po and ^{210}Pb the analytical period is much longer. On return, the particulate and dissolved samples will be subject to complete dissolution, autodeposition, and α-spectroscopy using the Edinburgh 16-detector system. This will provide a total ^{210}Po analysis which includes the ^{210}Pb-supported contribution. Following this initial stripping of ^{210}Po, the samples are stored for at least 6 months to allow ^{210}Po ingrowth towards the ^{210}Pb activity. Final analysis should be complete within one year after the cruise. It should be noted that funds for

this project (staff salary) only extend to the end of March 1993. All radioanalytical data will be made available through the BODC data centre in the normal way.

PRELIMINARY CONCLUSIONS AND CRUISE ASSESSMENT

The unfortunate set of circumstances affecting this cruise had a major impact on the radiochemistry programme. The experimental concept was based around a time-series evolution of a water mass in which melting sea ice triggers and sustains major phytoplankton and attendant zooplankton growth. This would allow the application of non-steady state numerical models for the quantification of export flux with time. To our knowledge, no such experiment has been carried out in the Southern Ocean using natural radiotracers.

The reorganised programme allowed us to complete a transect off the continental shelf and into the deep Bellingshausen Sea. Due to the proximity of the shelf and slope, it is expected that continental margin boundary scavenging effects will dominate the vertical structure of the observed profiles (particularly for ^{210}Pb), rather than any *in situ* biology. Nevertheless, this will be an original data set for this area of the ocean. Previous studies around Antarctica for natural radionuclides have concentrated on the northern Weddell Sea and Ross Sea with some data from the Bransfield Strait.

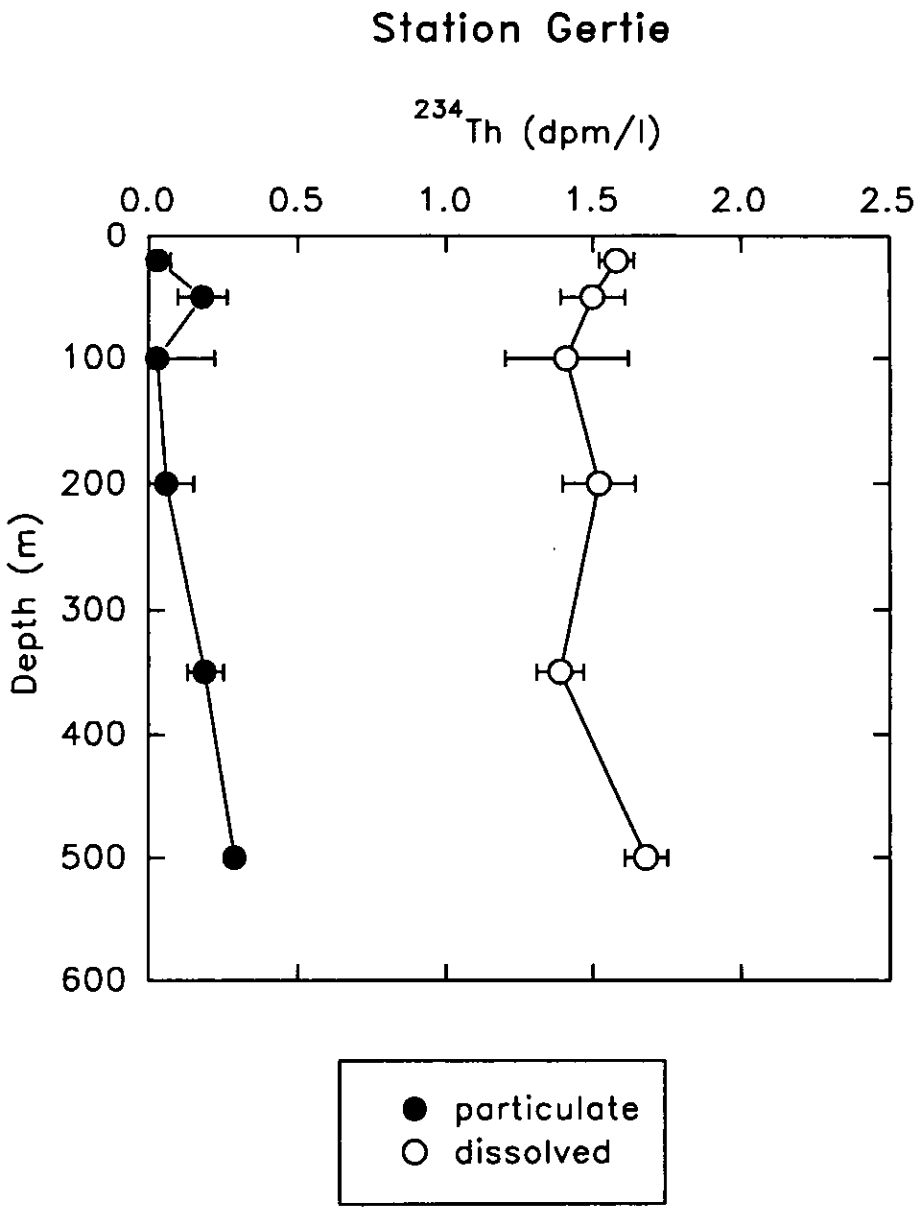
Due to the compression of available science time, the profiles did not extend over the desired depth range. In addition the 2-3 day turnaround time between stations resulted in a backlog of samples for shipboard counting. This results in poorer analytical accuracy as the available excess radioactivity for ^{234}Th decays away with a half-life of 24 days. Although the SAPs worked well, the total volume available for analysis very rarely exceeded 1000 l. Further consideration should be given to increasing the pumped volume to improve the analytical precision and accuracy of short-lived natural isotopes.

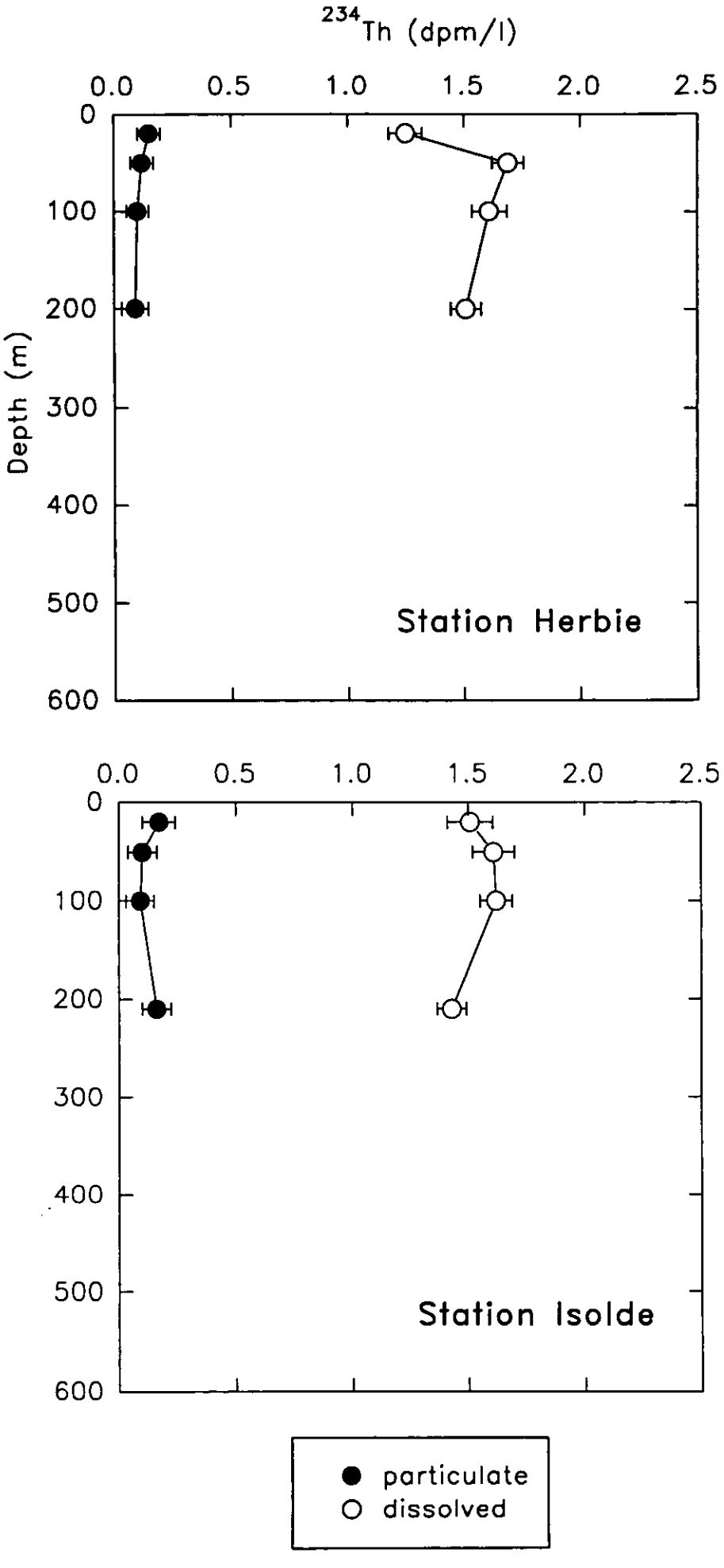
FURTHER COMMENTS

Many scientists will have commented on the status of the shipboard facilities and sampling equipment. We concur with many of these sentiments, but would also like to add that the professionalism and dedication of the officers and crew of the *James Clark Ross* provided the best possible platform for science work to be completed. Our thanks to them all.

Final words concern the relationship between Institutes and HEI personnel at sea. The gulf seems to be widening rather than reducing when BOFS was at it's acme. Given the huge investment made by several groups to participate in this expedition, the logistical requirements dictated by BAS need to be very carefully evaluated. Futhermore, potential participants need to be very clear about procedures that will be adopted during the duration of the cruise. I think the opportunity for University lecturing staff to take part in winter

cruises of 2-month duration, given the uncertainties and vagaries of Antarctic operations, will be very limited. The possibility of scientific personnel change-over via the Rothera air transport facility should be carefully evaluated in this context.


Station Gertie
234Th (dpm/l)
0.0
0.5
1.0
1.5
2.0
2.5
0
100
200
300
400
500
600
Depth (m)
particulate
dissolved


234Th (dpm/l)
0.0
0.5
1.0
1.5
2.0
2.5
0
100
200
300
400
500
600
Depth (m)
Station Herbie
Station Isolde
particulate
dissolved

4.11 MODERN COCCOLITH ASSEMBLAGES. - G. RITCHIE.

(Contact: Dr. Dick Kroon, Dept. Geology and Geophysics, University of Edinburgh, West Mains Road, Edinburgh. EH9 3JW.)

OBJECTIVES

To determine the relationship between water mass, sea surface temperature and coccolith assemblages with reference to their paeleoceanographic significance.

METHODS

Two litres of sea water from the non-toxic supply were filtered through 47mm, 0.8 micron Nuclepore filters by the use of a Venturi pump. They were then stored in petri slides at -20°C.

SAMPLING

Samples were taken at approximately three hour intervals over the periods listed below:

Transect 1. Drake Passage/Antarctic Convergence
from 10.00 29/10 to 22.20 30/10.

Transect 2. Drake Passage/Antarctic Convergence
from 19.40 4/11 to 13.15 7/11.

Transect 3. Transect into ice
from 16.50 11/11 to 18.50 12/11.

Transect 4. Drake Passage
from 11.13 24/11 to 11.51 25/11.

Transect 5. Transect out of ice to cphyll max
daily 1/12, 2/12, 5/12, 8/12.

ASSESSMENT

With samples being collected over a wide range of surface temperatures (from 6.1 to -1.2°C) the original objectives have been satisfied. Also with two transects across the Antarctic Convergence being sampled an indication of the temporal variability of the features being studied may be possible.

COMMENTS

Labs tended to be too warm. The lab display with the position, temp etc could be more reliable and a screen dump facility would be useful (perhaps with CTD bottle firing depths). However overall this is an excellent ship to work and live on and many thanks to all officers and crew for helping to make it so.

4.12 COMMUNITY PRODUCTION AND RESPIRATION, C. ROBINSON and D.H. PLUMMER.

The following four objectives were chosen during cruise planning:

1) To determine the magnitude and temporal sequence of net community production and respiration in the marginal ice zone during the Austral Spring, using in vitro and in situ measurements of TCO_2 and O_2
2) To determine the influence of environmental factors such as light, nutrients, vertical mixing and sea ice on net community production and respiration
3) To examine the balance between net and primary production in relation to the size distribution of metabolism and community structure
4) To establish how well current coupled physical/biological models can account for the observations of net community production and respiration

When the original cruise schedule of a forty day time series of measurements, sampled at a single geographical position whilst the ice edge receded, was changed to become a transect of four two-day stations, the objectives of this project were duly modified to accommodate a spatial rather than temporal study. Estimates of net community production determined from in situ changes in dissolved oxygen, total dissolved inorganic carbon, $d^{13}C$-POC and $d^{13}C$-DIC (Hilary Kennedy, UCNW) could not be undertaken. An assessment of whether the data collected may successfully be used to compare coupled physical/biological models and so achieve objective 4, has yet to be completed.

Sample collection and analysis can be divided into the following categories:
a) Underway measurements
b) Depth profiles
c) In situ incubations of in vitro samples
d) Fractionated respiration
e) Autonomous in situ rig deployments + diving
f) Opportunistic sampling

Underway measurements

Forty-three discrete samples were collected from the non-toxic seawater supply at approximately one hour intervals during the transect south between 09:00 05/11/92 and 16:30 12/11/92, for the determination of dissolved oxygen by automated Winkler titration. Normally four replicates were analysed.

Total dissolved inorganic carbon (DIC or TCO_2) was measured using the automated coulometric titration system developed during the BOFS programme. The system is calibrated with standard solutions of sodium carbonate prior to the cruise and checked at frequent intervals during the cruise against JGOFS reference seawater standards (A.Dickson; SIO, La Jolla). 1540 continual TCO_2 samples were analysed from the non-toxic seawater supply between the following times (GMT)

13:19 28/10/92 - 01:18 31/10/92 : south from Stanley
12:12 05/11/92 - 19:10 07/11/92 : south from Stanley
13:31 11/11/92 - 22:17 12/11/92 : south to Stn. Gertie
20:24 14/11/92 - 03:07 15/11/92 : on Stn. Gertie
15:27 15/11/92 - 21:25 15/11/92 : on Stn. Gertie
00:52 20/11/92 - 03:41 20/11/92 : Stn. Gertie to RRS Discovery
01:22 28/11/92 - 09:16 29/11/92 : south to Stn. Herbie
13:13 29/11/92 - 03:35 30/11/92 : Stn. Herbie to Stn. Isolde

11:51 03/12/92 - 20:41 03/12/92 : Stn. Isolde to Stn. Julian
08:40 06/12/92 - 13:54 06/12/92 : Stn. Julian to Stn. Katie

Twenty two discrete samples were collected from the non-toxic supply at approximately 4 hour intervals during the two transects south and transferred to RRS Discovery for the determination of total alkalinity (photometric titration: Susan Knox, PML). An estimate of pCO_2 along this transect should therefore be possible using the concomitant alkalinity and TCO_2 measurements.

A reduction in precision of the dissolved oxygen measurements was attributed to degassing of the non-toxic supply (previously a header tank has been incorporated into the pumped seawater supply), there were also unavoidable problems with cavitation in the large swell, and blockage due to ice. However, a comparison between TCO_2 measured from a Niskin fired at 10m on the CTD at the same time as samples were analysed from the non-toxic (intake at 8m) suggests that if any degassing did occur the effect on the TCO_2 data was within the precision of the measurements.

The underway data still requires processing and correcting to calibrated in situ salinity, however preliminary plots reveal a gradual increase in TCO_2 and decrease in dissolved oxygen % saturation as the ship travelled southwards through the ice. Such changes were accredited to increasing gas solubility with decreasing temperature and the sampling of 'old' or 'mature !' seawater which had lost contact with the atmosphere for at least one year.

Depth profiles

Water was collected from a rosette of eleven 10 litre Niskins on the CTD for determination of the depth distribution of dissolved oxygen and TCO_2. These data will be corrected for in situ temperature and salinity, once the CTD sensors are calibrated. The Winkler determined dissolved oxygen data will be used to calibrate the oxygen electrode on the CTD (Roy Lowry, BODC). The following 12 CTD's were sampled :

#2	Deception Island	01/11/92	O_2	5-150m
#10	Stn. Gertie	15/11/92	TCO_2, O_2	5-200m
#19	Stn. Gertie	17/11/92	TCO_2, O_2	10-600m
#24	Stn. Gertie	18/11/92	O_2	5-200m
#12203/1	RRS Discovery intercomparison	20/11/92	TCO_2	2-250m
#27	RRS Discovery intercomparison	20/11/92	TCO_2	2-250m
#30	Stn. Herbie	29/11/92	TCO_2, O_2	5-200m
#36	Stn. Isolde	01/12/92	TCO_2, O_2	5-200m
#48	Stn. Isolde	02/12/92	TCO_2, O_2	700-1380m
#52,#53	Stn. Julian	04/12/92	TCO_2, O_2	2-150m
#67	Stn. Katie	06/12/92	TCO_2	5-100m
#77	Stn. Katie	07/12/92	TCO_2, O_2	5-200m

In situ incubations of in vitro samples

Water samples were collected and incubated for 24hr on a drifting in situ productivity rig for determination of gross and net community production and respiration, as estimated by changes in dissolved oxygen and dissolved inorganic carbon.

The in situ rig consisted of six dexion cubes suspended at 2, 10, 15, 20, 30 and 50m on 8mm wire beneath a doughnut buoy. Each cube held in vitro samples for determination of plankton production from changes in oxygen and DIC, uptake of ^{14}C, ^{13}C and ^{15}N. At station Gertie the rig was manhandled through a hole in the ice, whilst at subsequent open water stations the doughnut buoy was connected to a Dahn buoy with radar reflector and direction finding beacon. Unfortunately this

dexion rig was lost at station Isolde, and so replaced by six aluminium racks specifically manufactured to hold 2 litre polycarbonate bottles, again placed at 2, 10, 15, 20, 30 and 50m on 8mm wire. The mode of deployment and exposure of these racks restricted deployment of the glass bottles required for oxygen and carbon determinations. ^{14}C samples were attached to a separate rig connected to the first at the surface. Many thanks to the team (especially Andy Rees, Malcolm Woodward and Nick Owens) who organised and executed the rig deployments and recoveries.

The number of in situ productivity rig deployments (four, as detailed below) was restricted by the revised cruise schedule. This situation was further exacerbated by freezing of all samples at station Gertie, loss of the rig at station Isolde and loss/breakage of sample bottles from the rigs deployed at stations Julian and Katie.

Stn. Gertie	16-17/11/92	O_2, TCO_2	frozen samples
Stn. Isolde	02-03/12/92	O_2, TCO_2	lost at sea
Stn. Julian	05-06/12/92	O_2	2,10,15,20,30,50m
Stn. Katie	08-09/12/92	O_2,TCO_2	2,10,15,20,30,50,75m

Productivity data still require checking and error analysis, however preliminary results show net community production at station Julian to be 3-4 umol O_2/L.day down to 20m, reducing to 1-2 umol O_2/L.day at 50m, respiration was always less than 1 umol O_2/L.day. At station Katie, where chlorophyll levels were ca. 2.5 ug/L, net community production decreased from surface values of 3-5 umol O_2/L.day to -1.5 umol O_2/L.day at 50m, respiration peaked between 15-30m (3-4 umol O_2/L.day), decreasing towards the surface and at depth (1-2 umol O_2/L.day).

Fractionated respiration

In order to determine the size distribution of respiration, water samples were fractioned by gravity through Nucleopore filters prior to a 24hr incubation in the dark. Despite the dark incubator being situated in the cold room (0°C +/- 1°C) and connected to a continuous supply of surface seawater, the lowest incubation temperature achieved was -0.4°C i.e. in situ temperature +/- 1°C. Concomitant fractioned samples were collected by Ray Leakey for characterisation of the microheterotroph community present, and by Duncan Plummer for bacterial biomass and activity. Details of the seven fractionation experiments completed are given below.

#				
#	Stn. Gertie	18/11/92	5, 10m	whole, <2um, <0.8um
#31/2	Stn. Herbie	29/11/92	10, 50, 100m	whole
#44	Stn. Isolde	01/12/92	10, 30m	whole, <18um, <2um
#60	Stn. Julian	05/12/92	10, 30m	whole, <18um, <2um, <0.8um
#67	Stn. Katie	06/12/92	30m	whole, <18um, <2um, <0.8um
#68	Stn. Katie	07/12/92	50m	whole, <18um, <2um
#76	Stn. Katie	08/12/92	10, 30m	whole, <18um, <2um, <0.8um

All data is almost in its final form, requiring only error analysis. Community respiration was not detectable at stations Gertie or Herbie, at station Isolde the ca. 3 umol O_2/L.day community respiration did not pass the 18um filter. At station Julian community respiration was <1 umol O_2/L.day, and again confined to the large size fractions, whereas at station Katie, up to a third of the ca. 3 umol O_2/L.day community respiration measured could be attributed to the <0.8um fraction.

Autonomous in situ rig deployments and dives

An autonomous in situ rig (Langdon Rig) comprising incubation modules suspended at two depths on a 8mm wire were deployed on the following occasions:,

06:00 16/11/92 - 18:00 18/11/92	Stn. Gertie	5 & 10m
23:30 30/11/92 - 04:00 03/12/92	Stn. Isolde	5 & 30m

21:00 03/12/92 - 03:00 06/12/92	Stn. Julian	10 & 30m (30m lost)
15:00 05/12/92 - 05:00 09/12/92	Stn. Katie	10 & 30m

Each module comprises 1) a perspex incubation chamber containing temperature, PAR and dissolved oxygen sensors, 2) ambient temperature and oxygen sensors, 3) a motor enabling the incubation chamber to open and close, and 4) the circuitry and batteries required to operate the motor, collect and store data from the various sensors, and if necessary relay selected data via satellite. The modules were programmed to flush with ambient seawater at the same time that water was collected to be incubated on the in situ productivity rig, hence a comparison of the two estimates of net community production may be made. Calibration of the oxygen electrodes was effected by Winkler titration of samples collected alongside the modules, either by SCUBA or CTD. Details of the dives planned and undertaken to this end are given below. A full description of the diving protocol is given elsewhere in this report. Special thanks to Rick Price and the other divers, boathandlers and linesmen without whom these activities could not have taken place.

31/10/92	Potters Cove	Familiarisation : -2°C
08/11/92	Faraday Base	Familiarisation : roped under ice
13/11/92	Faraday Base	Practise Niskin and ^{15}N sampling protocol
15/11/92	Stn. Gertie	Collect Langdon Rig calibration samples
17/11/92	Stn. Gertie	Collect Langdon Rig calibration samples
02/12/92	Stn. Isolde	Cancelled
05/12/92	Stn. Julian	Cancelled
08/12/92	Stn. Katie	Cancelled
11/12/92	Faraday Base	Collect ice samples for TCO_2 analysis
13/12/92	Rothera Base	Benthic ecology

Opportunistic sampling

Calculation of the uptake of ^{14}C by phytoplankton requires a knowledge of the ambient DIC concentration. The DIC concentration of melted and partially melted ice samples used in ^{14}C uptake experiments (Phil Boyd, Steve Archer) was therefore analysed. A strong gradient of DIC(>500 umol/L) from seawater slush to freshwater ice was observed, while samples of surface freshwater ice, discoloured with algae, contained less than one fifth of the DIC normally found in surface seawater possibly indicating carbon limitation.

Similarly a precise measurement of the ^{13}C-DIC spike added to ^{13}C uptake experiments (Sarah Bury) will reduce the overall error of the estimate. Spikes made up to an expected concentration of 2200 umol C/L gave a measured concentration of 1900 umol C/L., possibly indicating degassing through the plastic containers.

4.13 DIMETHYL SULPHIDE AND DIMETHYLSULPHONIOPROPIONATE. S. TURNER.

OBJECTIVES

The overall objectives for the two-ship BOFS Southern Ocean cruises were
(i) to determine surface water concentrations of dimethyl sulphide (DMS) in order to assess its sea-to-air flux.
(ii) to determine the concentrations of dimethylsulphoniopropionate (DMSP), the algal precursor of DMS.

Open ocean surface mapping would be done on board RRS Discovery, covering a box grid which would be repeated and thus give some indication of any temporal changes. RRS James Clark Ross would make water column measurements along a transect into the ice and subsequently monitor changes as the ice retreated and algal productivity increased.

METHODS

Water samples were obtained from the ships' non-toxic supply for surface data during transit and from CTD water bottles for depth profiling on station. Samples were analysed as rapidly as possible to minimise storage artefacts, although several hours were required to complete depth profile samples. Measurements were made of DMS and DMSPp (particulate) and DMSPd (dissolved), the latter being operationally defined as DMSP that passes through a Millipore AP25 depth filter. DMSP samples were hydrolysed at high pH to produce DMS, and all three moities determined using a purge-and-trap method, followed by flame photometric gas chromatography.

SAMPLING ACTIVITIES (JCR only)

i) Depth profiles: CTD # 10, 19, 20, 30, 36, 49, 52, 53, 67
ii) Ice cores: stations G and I (station H core to be returned to UK for analysis)
iii) Discovery Intercalibration for DMS and DMSP
iv) DMSPp size fractionation
v) Surface transects: julian day and GMT
   a) 303: 18.40 to 304: 23.10
   b) 310: 12.00 to 312: 17.00
   c) 315: 17.50 to 317: 18.40
   d) 324: 00.48 to 314: 19.04
   e) 333: 02.46 to 333: 15.00

PRELIMINARY RESULTS

Figure 1 shows the results of two transects along 85 W for DMS and DMSPp. Changes in concentration are in general agreement with variations in chlorophyll 'a', with an overall decrease moving south, from brash ice to almost complete ice cover. Concentrations of DMS were below analytical detection limits south of 69.3 . Figure 2 shows the depth profiles for DMSPp at 70 S (CTD 10, 15/11/92) and 68.85 S (CTD 67, 6/12/92). The profile at 70 S is comparable with the most southerly transect sample, but it is clear that significant changes had occurred in DMSPp concentrations between 28th Nov. and 6th Dec. as levels had increased by about 4-fold. Six depth profiles were made between 70 S and 68.85 S which generally showed a progressive increase in surface DMSPp concentrations as the stations became more northerly. All the profiles show a subsurface maximum at 10m, with a second maximum at 40 to 50m, below which concentrations decreased dramatically.

Analyses of 2 ice cores (total DMS and DMSP) showed very high concentrations relative to those in the underlying water (approx 50 to 200-fold) and variation in concentration was observed down the ice cores.

Size fractionation analysis for DMSPp (>25um, <25>10um, <10>1um) at St. Jules, showed that the majority of the DMSPp occurred in the <10um size fraction.

The results of the intercalibration exercise with RRS Discovery have not yet been compared.

DATA FORMAT

Preliminary results, recorded on paper, require final calibration and computer archival, but should be available to the ship communities by Feb. 1993.

PRELIMINARY CONCLUSIONS

There are very few published data for DMS and DMSP in the Southern Oceans, but some workers have found very high concentrations of DMS. However, as spatial and seasonal factors are highly significant, it is difficult to make comparisons with the current results. Nevertheless, very high concentrations were not found (except in the ice) and the levels are not inconsistent with those of the N. hemisphere in late winter and early Spring.

Although this cruise has been beset by a myriad of problems (ship's logistics and mechanics: this 'group' suffering GC baseline - 'tilting' interference thereby causing a poor detection limit and having only one operator), a limited amount of interesting and novel data has been produced. Further insight will be gained when these data are related to chlorophyll 'a', HPLC pigments and algal species distribution. Originally it was hoped that investigation of Spring bloom development using a lagrangian approach might have been possible, however there were always too many unknown factors, therefore, the results from the 85 W transect and series of profiles will have to stand as a current 'best attempt'.

Fig. 1

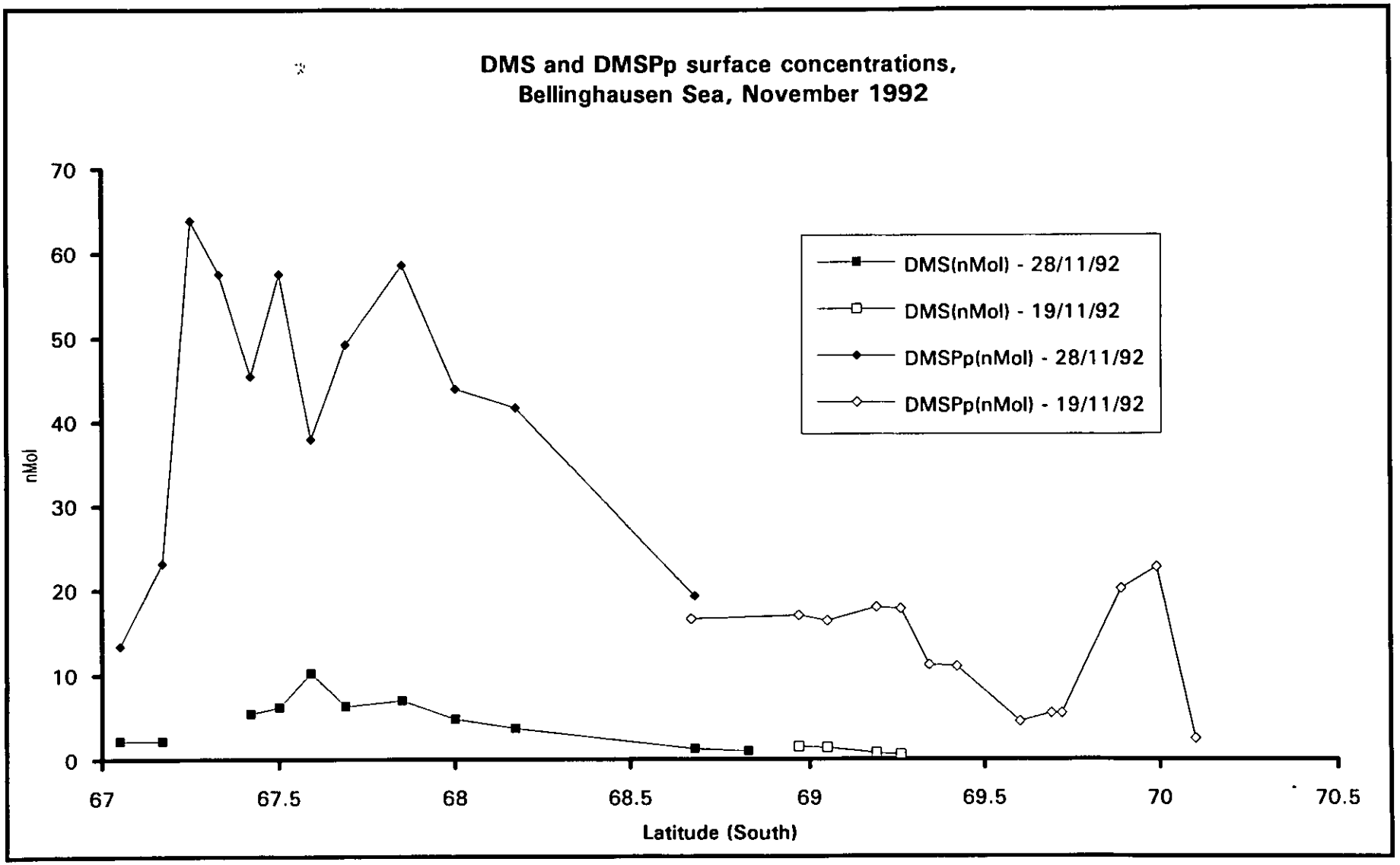
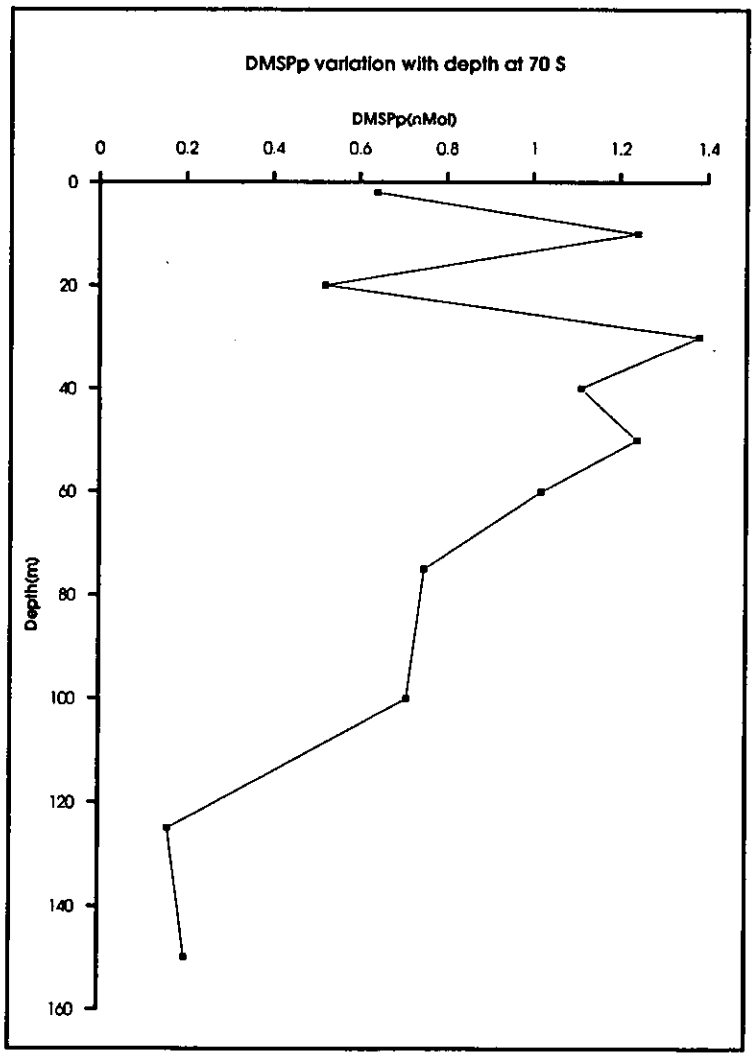
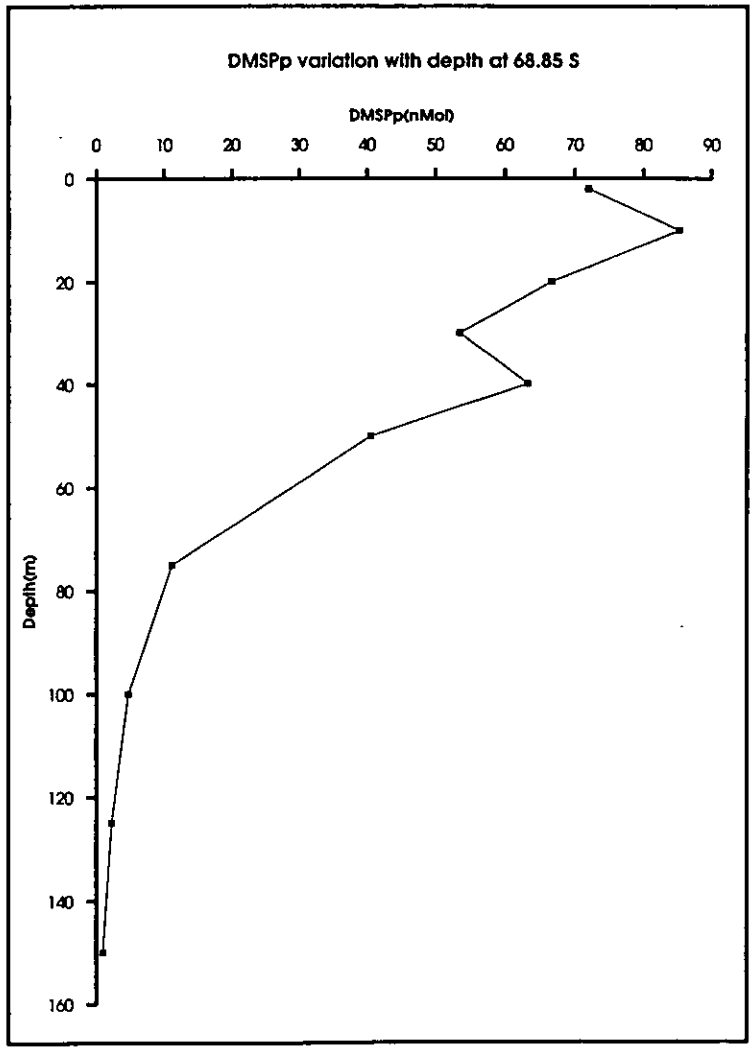

DMS and DMSPp surface concentrations,
Bellinghausen Sea, November 1992
DMS(nMol) - 28/11/92
DMS(nMol) - 19/11/92
DMSPp(nMol) - 28/11/92
DMSPp(nMol) - 19/11/92
nMol
0
10
20
30
40
50
60
70
67
67.5
68
68.5
69
69.5
70
70.5
Latitude (South)

FIG. 2


DMSPp variation with depth at 70 S
DMSPp(nMol)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth(m)
0
20
40
60
80
100
120
140
160


DMSPp variation with depth at 68.85 S
DMSPp(nMol)
0
10
20
30
40
50
60
70
80
90
Depth(m)
0
20
40
60
80
100
120
140
160

4.14 METHANE AND NITROUS OXIDE. - A.P. REES.

OBJECTIVES

As radiatively active gases both having contributary effects on climate change, it is desirable to be able to estimate the air-sea flux budget for as much of the world's oceans as possible.

Both gases have natural and anthropogenic sources, with the seas capable of acting as source or sink depending on relative physical and biological conditions. The very low temperatures experienced in the southern ocean and downwelling associated with deep water formation could be expected to provide sink conditions, with waters being undersaturated relative to atmospheric equilibrium. In contrast, high productivity levels previously associated with phytoplankton blooms within the MIZ and at the ice edge could be expected to result in production of both gases as previously reported in temperate and tropical waters (Ward et al.,1987 and Law and Owens,1990).

The aims of this study were to estimate a budget of both methane and nitrous oxide for the study area in relation to conditions associated with the ice retreat with the onset of the austral summer, and to determine conditions both physical and biological likely to control production or consumption processes.

METHODS

Vertical profiles using water collected from the ctd rosette and surface transects using the ships non-toxic supply were carried out, an inter comparison of the two was also made to determine the viability of data collected from the non-toxic supply. The analysis procedure involved addition of saturated mercuric chloride solution to inhibit further microbial action, prior to temperature equilibration at 25°C. A headspace equilibrium technique using an electron capture detector and flame ionisation detector gas chromatographs connected in series, allowed the analysis of both gases on a single sample.

Bacterial oxidation is one of the processes likely to be responsible for a reduction from equilibrium of methane concentrations. At two of the stations occupied, experiments to determine the amount of methane being removed by this pathway were undertaken. After incubation with ^{14}C labelled methane, samples were filtered to allow determination of ^{14}C incorporated into the particulate material and that oxidised to CO_2 was collected on GF/F filters treated with phenylethylamine after addition of conc. sulphuric acid to the filtrate.

At all stations close collaboration was made with Duncan Plummer, who was involved in determination of bacterial production rates and cell counts. It is hoped that these will be particularly important in final interpretation of the data.

Table 1. Date and position of vertical profile stations

Date	JD	Station	Position	CTD No.	Depth (m)	CH_4	N_2O	CH_4 oxidn
1/11/92	306	Deception	62 58.05'S 60 38.55'W	2	0-150	y	y	n
13/11/92	318	Flossie	69 25.59'S 85 04.42'W	7	0-50	y	y	n
16/11/92	321	Gertie	70 16.45'S 85 07.56'W	15	0-30	y	y	n
17/11/92	322	Gertie	70 16.45'S 85 07.56'W	17	10-600	y	y	y
29/11/92	334	Herbie	70 14.8'S 85 06.50'W	30	0-200	y	n	n
1/12/92	336	Isolde	69 38.80'S 85 05.00'W	36	0-200	y	y	n
				48	700-1380	y	y	n
4/12/92	339	Jules	68 18'S 84.56'W	52	0-300	y	y	y
				53				
				54				
				65	1000-3775	y	y	n
7/12/92	342	Katie	67 40'S 84 52'W	69	0-200	y	y	n
				79	1000-3000	y	y	n

Table 2. Surface transect positions

Date start	Time start	Position start	Date end	Time end	Position finish	No. samples	CH_4	N_2O
5/11/92	1300	55 20.83'S 59 08.99'W	7/11/92	1800	62 47.92'S 62 07.16'W	22	n	y
11/11/92	2000	65 16.64'S 85 00.73'W	12/11/92	2200	69 08.38'S 84 53.74'W	12	y	y
19/11/92	0048	70 06.9'S 85 31.27'W	20/11/92	0030	67 30.08'S 85 21.82'W	8	y	y
28/11/92	0630	67 35.41'S 84 53.70'W	29/11/92	0649	69 58.44'S 85 06.35'W	14	y	y

PRELIMINARY RESULTS

Methane data have been calculated, as percentage saturation relative to atmospheric concentration (mean value over the duration of the cruise of 1.672ppm) at all of the vertical profiles - although not all depths, Fig 1. Deception Island values where an order of magnitude greater than at all other stations being greatly oversaturated, this is attributed at present without further evidence to be associated with volcanic activity. At all of the subsequent stations waters at all depths in the surface 200m were found to be undersaturated ranging from approximately 20-80%. At present there is no obvious trend in moving along the transect from full ice to open water conditions. However a large difference was noted between stations Gertie and Herbie (same geographic position), the degree of undersaturation decreasing between the two dates - 12 days.

No data are available at present for methane from the surface transect and for Nitrous oxide from either the vertical profiles or the surface transect. This at the moment is in it's roughest form as notes in lab book and as integrator output. It is thought that a period of 6-8 months is necessary to complete all further analysis. The data presented above is not complete and requires correcting for baseline drift (experienced at the last two stations, after problems with one of the g.c.s), further updating will also be performed as the calibration of ctd data is confirmed.

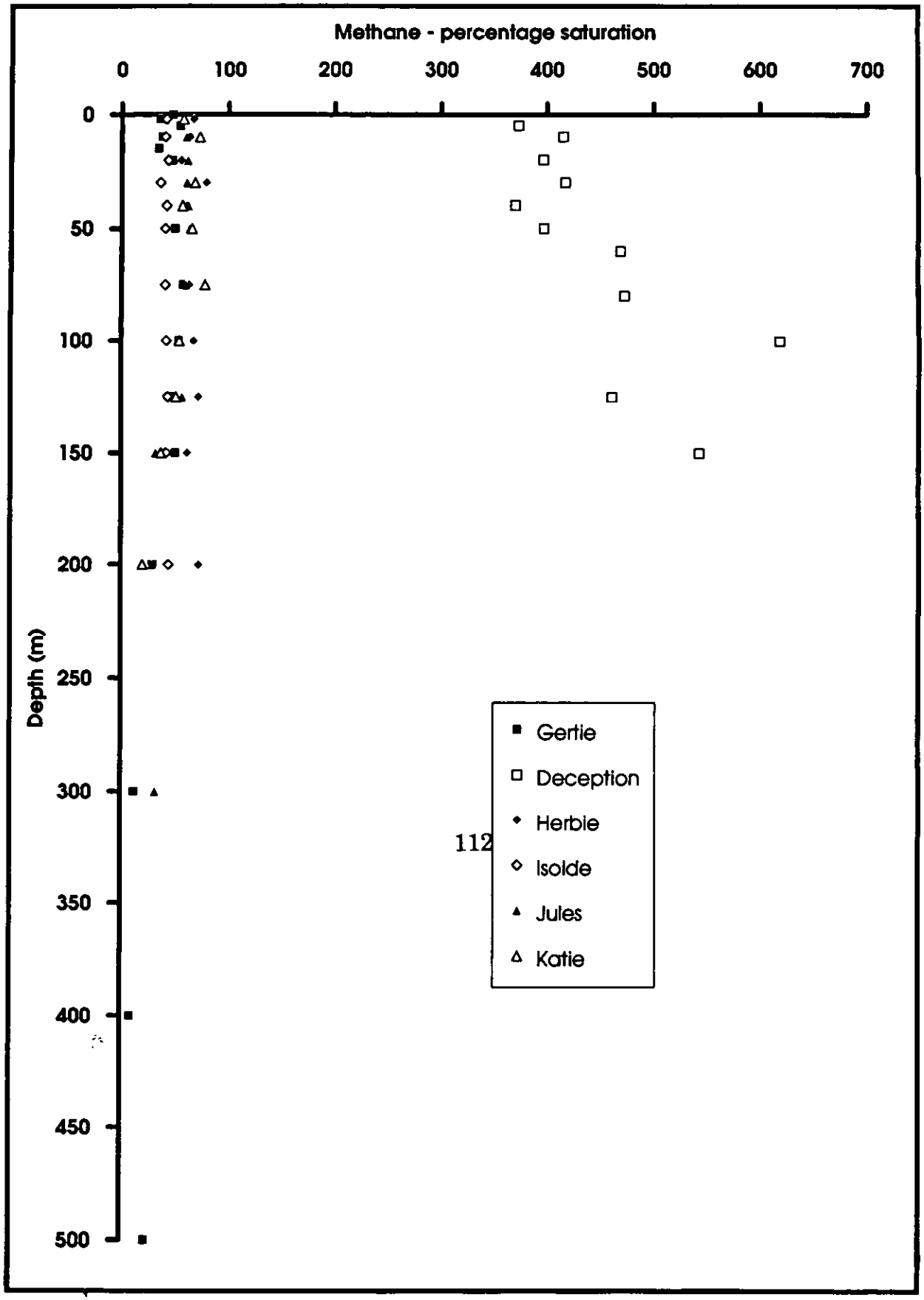
PRELIMINARY CONCLUSIONS

As no data are yet available for nitrous oxide it is not possible to comment, on the study area and of it's possible degree of saturation. It is apparent that the area is acting as a sink to methane, during conditions of full ice cover and for a time after the ice retreat, without further time series studies it is not possible to state at this time as to whether this is the general condition at all times or whether production processes do occur later during the summer period.

References:

Ward, B.B., Kilpatrick, K.A., Novelli, P.C., and Scranton M.I. (1987) Methane oxidation and methane fluxes in the ocean surfacelayer and deep anoxic waters. Nature 327,226-229.

Law, C.S. and Owens, N.J.P. (1990) Denitrification and Nitrous Oxide in the North Sea. Netherland Journal of Sea Research. 25, 65-74


Methane - percentage saturation
0
100
200
300
400
500
600
700
0
50
100
150
200
250
300
350
400
450
500
Depth (m)
Gertie
Deception
Herbie
Isolde
Jules
Katie

4.15 MICROBIAL PROCESSES. - S. ARCHER, P. BURKILL, E. EDWARDS, R. LEAKEY and D. PLUMMER.

OBJECTIVES

The broad objective of our group's research was to investigate the role of microheterotrophs in the flux of phytogenic carbon across the Marginal Ice Zone (MIZ). The microheterotrophs investigated consisted of the bacteria and microzooplankton (protozoa and metazoa < 200 µm in size) communities. The objectives involved studies of the a) ice and b) pelagic surface mixed layer communities and these, together with the fluxes measured, are shown in Figure 1.

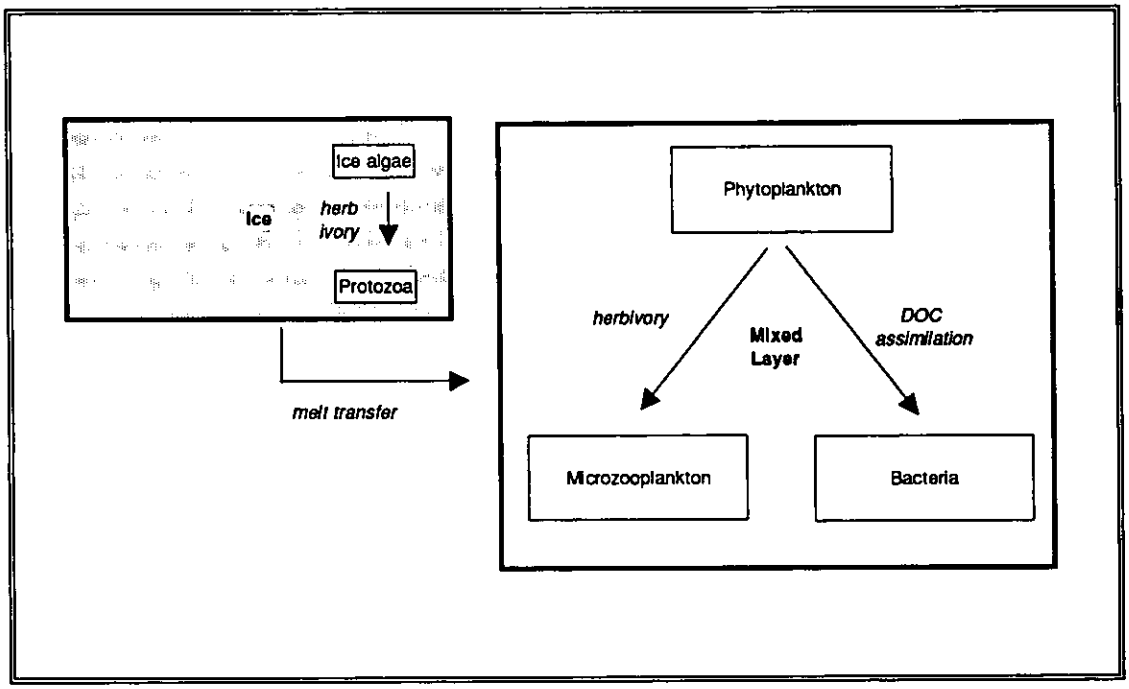


Figure 1: Conceptual model of microbial cycling pathways in the MIZ, showing the state and rate variables of interest.

A) ICE STUDIES

Ice Studies were conducted at stations Gertie, Herbie and Isolde where the biomass of ice protozoa (Section 1) and their herbivory (Section 2) were studied, as shown in Table 1.

Station	Transect	Latitude (°S), Longitude (°W)	Date	Sample Type	Measurement[a]
Gertie	1	70°19'S, 85°13'W	15 Nov	Bottom ice	2
Gertie	2	70°18'S, 85°17'W	17 Nov	Surface Core	1
Gertie	2	70°18'S, 85°17'W	17 Nov	Bottom Ice	1
Gertie	2	70°18'S, 85°17'W	17 Nov	Ice/Water Interface	1
Herbie	5	70°15'S, 85°06'W	29 Nov	Surface core	1
Herbie	5	70°15'S, 85°06'W	29 Nov	Ice/Water Interface	1
Isolde	none	69°38'S, 85°05'W	01 Dec	"Slush Ice"	2
Isolde	6	69°56'S, 85°23'W	02 Dec	Surface Core	1
Isolde	none	69°56'S, 85°23'W	02 Dec	Bottom Ice	1
Isolde	none	69°56'S, 85°23'W	02 Dec	Ice/ Water Interface	1
Isolde	none	69°56'S, 85°23'W	02 Dec	Bottom ice	2

Table 1: Details of Ice Experiments carried out
a: 1: Biomass Studies, 2: Grazing Experiments

1) Biomass Studies (Ray Leakey and Steve Archer)

The objective of this research was to determine the abundance and biomass of the sympagic microbial community. To achieve this samples were collected from up to 3 locations along a transect at each station as follows: (a) 100 ml ice volume from all depth horizons within the ice (surface ice core samples), (b) 100 ml ice volume from the bottom ice (diver held ice corer), and (c) 500 ml water volume from the sea-ice/water interface including opportunistic collection of algal strands (diver bottle collections). The ice samples were melted in 0.2 μm filtered sea-water at a ratio of 1:4 to preserve fragile forms (JGOFS protocol). Samples were fixed as follows:

(a) 0.4% Lugol's iodine solution for microplankton (ciliate, dinoflagellate and diatom) taxonomy, abundance and biomass.
(b) 0.3% Glutaraldehyde for bacteria and nanoplankton (autotrophic and heterotrophic flagellate) taxonomy, abundance and biomass.
(c) 2% hexamine buffered Formaldehyde to distinguish autotrophic components of the microplankton community.
(d) 9% Bouin's solution to determine ciliate taxonomy by silver staining.
(e) 20% Karnovsky's solution for analysis of ciliate mixotrophy by electron microscopy.

Glutaraldehyde fixed samples were stained, filtered onto polycarbonate filters and slides prepared. All samples were then stored frozen (slide samples) or cool (water samples).

Preliminary analysis of ice samples revealed an extremely abundant microbial population with all major groups represented. These included a diatom community dominated by small pennate forms, and a ciliate community comprising many taxa not normally abundant within the water column. Preliminary analysis of sea-ice/water interface samples revealed much lower abundances of all major groups, except where algal strands (comprising long chains of large pennate and centric

diatoms) grew. Full post-cruise analysis awaits return of the samples to the UK in May. It is anticipated that sample analysis will take 4 months thereafter.

2) Grazing Experiments (Steve Archer)

The objective of this research was to quantify herbivory by sympagic protozoa. This work represents a novel approach, involving autoradiography. Although autoradiography has been used previously to determine species specific carbon uptake in phytoplankton, it has not been used to study carbon flow through the microbial community. The research is still at an early stage of development.

Assessment of sympagic protozoan grazing rates were undertaken on bottom ice and "slush ice" samples. A direct approach employed autoradiography to follow ^{14}C flux through a three compartment system (water, algae and protozoa), in order to provide grazing rate information. In addition, autoradiography was employed to estimate primary production rates of individual species of phytoplankton.

Bottom ice samples were collected using SCUBA and a hand held ice corer (29 mm i.d., 210 mm length) and transferred to perspex incubation chambers of similar size. Care was taken to maintain *in situ* temperature and light conditions. 5 μCi ^{14}C was added to each end of the incubation chambers and the chambers relocated under the ice surface. Incubation times were 2-h for grazing experiments and 24-h for primary production studies. Ice samples (100 ml) were then melted in 0.1% Lugol's iodine solution in filtered sea-water (400 ml). "Slush ice" samples were collected from the surface. Incubations were carried out on deck at ambient temperature and light levels for 2-h. Samples were melted in equal volumes (500 ml) of 0.1% Lugol's iodine solution. Subsamples were prepared for track autoradiography, the remainder preserved for return to U.K.

Application of autoradiography to microplankton presents a number of special problems. These include loss of radioisotope on fixation, and drying and production of preparations of adequate optical quality. Despite this, encouraging results from this cruise confirmed that carbon uptake could be observed in single sympagic phytoplankton cells using track autoradiography. However, further work in the U.K. is required to assess ^{14}C loss in delicate taxa. It is anticipated that analysis will take 6 months.

Two general comments:

a) It is important to point out the crucial role played by the Diving Officer (Rick Price) in enabling our ice work to be undertaken. This would have been difficult or impossible without his expertise and help.

b) We wish to stress the importance of other groups being able to SEE what they are studying in both ice and pelagic samples

B) PELAGIC STUDIES

A series of integrated studies were carried out to quantify the fate of phytogenic carbon by herbivorous microzooplankton and bacterial production within the surface

mixed layer. Microzooplankton communities were sampled (Section 1) and their grazing assessed by a variety of techniques. These involved dilution (Sections 2 and 3), algal uptake (Section 4) and autoradiography (Section 5) experiments. The impact of bacteria on phytogenic carbon was assessed by measurements of bacterial production integrated with the other measurements (Section 7). In addition some size-fractionated microzooplankton biomass measurements were carried out in conjunction with respiration studies of Dr C Robinson (Section 6).

Many samples and water for experiments were obtained using CTD casts (Level 1 and other specialised casts) and these are detailed in Table 2.

Station	CTD cast #	Latitude (°S), Longitude (°W)	Date; Time (GMT)	Depth (metres)	Measure-ments[a]
Deception	2	62°58'S, 60°38'W	11 Nov: 05:30	2-60	1l
Deception	3	62°58'S, 60°38'W	11 Nov; n.i.	10	2,4
Flossie	7	69°29'S, 85°04'W	13 Nov; n.i.	2-50	3
Gertie	10	70°19'S, 85°13'W	15 Nov; 20:19	2-200	1,3,7
Gertie	11,12,13	70°18'S, 85°17'W	16 Nov; 02:25	2-30	7
Gertie	14	70°18'S, 85°17'W	16 Nov; 05:15	10	2,3,4,5,7
Gertie	15	70°18'S, 85°17'W	16 Nov; 06:30	2-30	1l,f,e,3,7
Gertie	19	70°20'S, 85°45'W	17 Nov; 17:30	10-600	7
Gertie	24	70°19'S, 85°43'W	18 Nov; 11:34	2-250	3,7
Gertie	25	70°19'S, 85°43'W	18 Nov; 13:36	5-20	1l,f,e,2,3,7
Herbie	30	70°15'S, 85°06'W	29 Nov; 17:00	2-200	1l,f,e,3,7
Isolde	36	69°38'S, 85°05'W	01 Dec; 14:39	2-200	1,3,7
Isolde	39,40,41	69°28'S, 85°43'W	02 Dec; 02:30	2-50	7
Isolde	42	69°49'S, 85°23'W	02 Dec; 04:28	10	2,3,4,5,7
Isolde	43	69°56'S, 85°23'W	02 Dec; 06:00	2-200	1l,f,e,3
Isolde	44	69°49'S, 85°23'W	02 Dec; 07:18	10 & 30	6
Isolde	48	69°52'S, 85°40'W	02 Dec; 19:23	700-1390	7
I-J	49	69°00'S, 85°02'W	03 Dec; 14.25	2-200	1l,f,e,7
Jules	52/53	68°18'S, 84°56'W	04 Dec; 17:15	2-200	1,7
Jules	56,57,58	68°21'S, 84°24'W	04 Dec: 02:23	2-30	7
Jules	59	68°21'S, 84°24'W	05 Dec; 04:45	40	2,3,4,5,7
Jules	60	68°21'S, 84°24'W	05 Dec; 05:47	10 & 30	6
Jules	65	68°26'S, 84°42'W	05 Dec; 18:20	1-3.8km	7
J-K	66	68°00'S, 85°00'W	06 Dec; 10:12	2-200	1l,f,e,7
Katie	68	67°29'S, 85°00'W	07 Dec; 00:15	10	5
Katie	68	67°29'S, 85°00'W	07 Dec; 00:15	50	6
Katie	69	67°36'S, 84°56'W	07 Dec; 18:00	2-200	1l,f,e,7
Katie	72,73,74	67°38'S, 84°54'W	08 Dec; 02:36	2-75	7
Katie	75	67°38'S, 84°54'W	08 Dec; 04:20	30	1,2,3,4,5,7
Katie	76	67°30'S, 84°54'W	08 Dec; 06:10	10 & 30	6

Table 2: Details of CTD casts used.
(a: 1: Microzooplankton abundance, biomass and composition (l: Lugol's; f: formaldehyde: e: epifl prep), 2:Dilution Grazing Expts, 3: Flow cytometry analyses, 4: FLA uptake Grazing Expts, 5: Autoradiography Grazing Expts, 6: Size fractionated biomass, 7: Bacteria Production.

1) Microzooplankton Biomass Studies (Elaine Edwards)

The objective of this work was to determine the abundance, biomass and composition of microzooplankton in the pelagic zones at each station. The methods used involved the collection of whole water samples from CTD depth profiles. These were fixed in:

a) 1% acid Lugols iodine for subsequent determination of total microzooplankton biomass and species composition.
b) 2% formaldehyde for the enumeration and identification of plastidic and aplastidic ciliates.
c) 0.3% glutaraldehyde stained with DAPI and proflavin and filtered onto 0.4 μm polycarbonate filters, placed onto a microscope slide and frozen for enumeration of autotrophic and heterotrophic nanoflagellates by fluorescence microscopy.

Full details of samples taken are shown in Table 2. The above samples will be analysed back in the lab using inverted microscopy and image analysis. It is estimated that analysis of all samples should be complete by the end of 1993, however some preliminary results will be available earlier.

Apstein net hauls were carried out at all stations from depths down to 100 metres. Details are shown in Table 3. The Apstein used was fitted with a 20 μm mesh net and allows qualitative assessment of the larger and less delicate of the microzooplankton (eg. the tintinnids and large heterotrophic dinoflagellates) together with larger phytoplankton cells. Live samples collected were observed using an inverted fluorescence microscope fitted with Normarski interference contrast. A video has been made of live cells including ciliates, dinoflagellates and other phytoplankton cells that will help in future identification work and image analysis.

Date	Time (local)	Depth
13/11/92	11:00 hr	100m
15/11/92	13:00 hr	50m
18/11/92	12:45 hr	50m
29/11/92	13:30 hr	50m
4/12/92	13:00-13:30 hr	100 & 50m
7/12/92	11:15 hr	50m

Table 3: Details of Apstein Net hauls taken.

In the Apstein net hauls, there was a definite increase in both the phytoplankton and microzooplankton populations in the top 50 metres of the water column as we headed northwards. At station 'Jules' & 'Katie', long chain-forming diatoms were most abundant, with some dinoflagellates, such as the large *Protoperidinium antarctica,* present. Tintinnids also became much more abundant. A detailed

description of both phytoplankton and microzooplankton assemblages is given in Table 4.

Stations 'Flossie' -'Isolde'		Station 'Jules' & 'Katie	
Phytoplankton community	Microzooplankton community	Phytoplankton community	Microzooplankton community
Diatoms:-	**Tintinnids**:-	**Diatoms**:-	**Tintinnids**:-
Corethron sp.	*Laachmaniella* sp.	*Asteromphallus sp.*	*Cymatocylis* spp
Dactyliosolen like *Eucampia* sp.	*Cymatocylis sp.*	*Chaetoceros* sp.	*Laachmaniella* sp
Navicula sp.	**Other ciliates**:-	*Corethron* sp	*Salpingella* sp
Nitzschia sp.	*Leegardiella* like	*Coscinodiscus* sp.	*Codonellopsis* spp
Odontella sp	*Lacrymaria* like	*Dactyliosolen*	**Other Ciliates**:-
Biddulphia sp		*Eucampia* sp.	*Euplotes* like sp.
Proboscia sp.	Radiolarians	*Navicula* sp.	*Leegardiella* like sp.
Rhizosolenia sp.	Acantharians	*Nitzschia* sp.	*Strombidium* sp.
Few dinoflagellates:-	Foraminiferans	*Rhizosolenia* sp.	Other holotrichs
Protoperidinium sp.		*Thalassiosira* sp.	
Gymnodinium sp		*Thalassiothrix* sp.	Radiolarians
Gyrodinium sp		Dinoflagellates:-	Acantharians
		Protoperidinium spp	Foraminiferans
		Gymnodinium spp	
		Gyrodinium spp	Heterotrophic dinoflagellates

Table 4: Dominant genera of phytoplankton and microzooplankton in 20 μm Apstein net hauls.

2) Dilution Grazing Experiments (Elaine Edwards)

Microzooplankton grazing experiments using the dilution technique of Landry & Hassett (1982) were carried out at all stations in conjunction with primary productivity and bacterial productivity experiments. Water was collected by CTD from a depth closest to the chlorophyll maximum when present. Details are shown in Table 5.

All experiments were run over a period of 24 hours. Where possible incubation of experimental bottles was carried out *in situ*. Chlorophyll concentration was estimated by fluorometry and further sub-samples analysed by flow cytometry (Section 3). At stations 'Jules' & 'Katie', size-fractionated experiments were carried out using 0.2, 2 and 18 μm polycarbonate filters.

Date	Station	Position	Incubation	Depth
1/11/92	Deception		Incubator	10 m
16/11/92	"Gertie"	70° 18' S 85° 17' W	Incubator & *in situ*	10 m
18/11/92	"Gertie"	70° 19' S 85° 44' W	Incubator	20 m
2/12/92	"Isolde"	69° 49' S 85° 23' W	Incubator & *in situ* (lost)	10 m
5/12/92	"Jules"	68° 21' S 84° 24' W	Incubator & *in situ*	40 m
8/12/92	"Katie"	67° 38' S 84° 54' W	Incubator & *in situ*	30 m

Table 5:Dilution Grazing Experiments

Preliminary results suggest that there was little or no grazing at Station 'Gertie', but at 'Isolde', the microzooplankton were found to be grazing 10% of the total phytoplankton chlorophyll per day. Results from subsequent experiments are still in note form and remain to be fully calculated. However, there is a suggestion that grazing rates showed an increase at stations 'Jules' & 'Katie'. This was particularly notable on the smaller phytoplankton. All grazing data should be analysed by the end of March 1993.

Note: Use of non-toxic water supply for microzooplankton sampling.
A short investigation was carried out to determine the effects of the non-toxic water pump on microzooplankton. Although it was found that most dinoflagellates were not significantly affected, only 10% of the total number of ciliates in the water at 8 metres (compared to that collected by CTD water bottle at the same depth) were present. Therefore the non-toxic supply in its current state is not a suitable method for microzooplankton sampling.

3) Flow Cytometry Analyses (Peter Burkill)

The objective of this research was to quantify microzooplankton herbivorous flux and to determine whether the microzooplankton were selecting phytoplankton of a particular size and biochemical composition. All measurements were made on dilution experiment bottles described in Section 2 (see Table 5). Mixed-layer vertical profiles of phytoplankton were also characterised by flow cytometry.

A FLUVO II flow cytometer was borrowed from Dr V Kachel (Max-Planck Institut fuer Biochemie, Munich) for this cruise. The instrument was set up with a orifice of diameter 100 μm and length 80 μm for measuring particles in the range ca 2 to 40 μm by electrical impedance. The cytometer also measured cellular chlorophyll fluorescence (>650 nm) and phycoerythrin fluorescence (570 nm) derived from a Hg burner (470-500 nm). The instrument was adapted for the cruise to handle high flow rates, and 3 ml of sample were typically analysed at a rate of 450 μl/min (ie 10 times normal EPICS rates). The instrument generally performed well; however on 19th November, the computer failed to find DOS on the hard disk and this required

reformatting and the software reinstalling. The cause of this remains unknown and no damage appears to be sustained. A second, and more serious, problem was the short life of the Hg burners used for sample irradiation. Although these were rated for at least 200 hours each, the Osram bulbs lasted for only 18-36 hours. The 5 bulbs brought were used by 8 December. Fortunately a spare bulb was loaned by the Mesozooplankton Group allowing work to continue. The reason for the short duration of the bulbs may have been due to faulty manufacture or to a fault in the burner ignition box.

The short life-span of the burners placed a limit on the number of samples that could be analysed. A priority was given to the grazing experiments and after 'Isolde' no further vertical profiles were carried out.

Cytometric data are held on computer disk and some data analysis has already been carried out. This suggests that there is variability between replicates and the causes of this have to be determined before any definitive statements can be made. However at Station 'Gertie', pooled replicates were used to assess grazing, and the results are shown in Figure 2

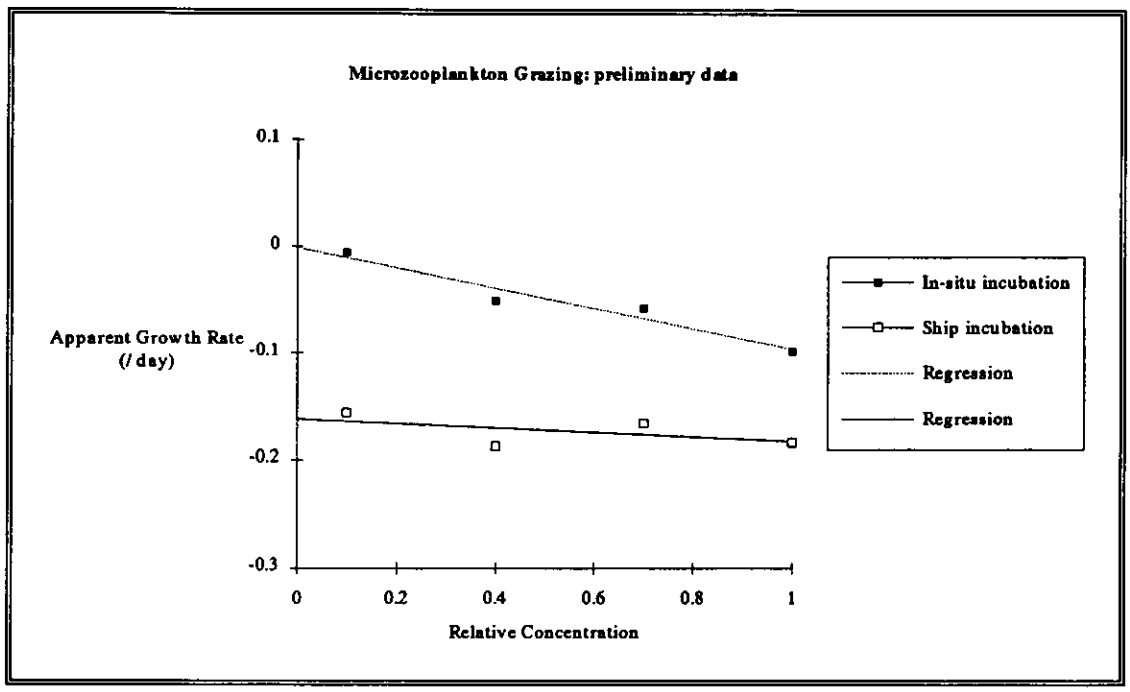


Figure 2: Microzooplankton Grazing Experiment at Ice Station 'Gertie': very preliminary data.

The data suggest that the microzooplankton may be grazing the phytoplankton at extremely low rates turning over 2% day^{-1} (incubator result) or 9% day^{-1} (*in situ* result). These results also suggest that the phytoplankton are reducing in concentration at a rate of 0.1% per day.

Data work up from disk will be carried out in the laboratory and will take at least 6 months.

4) Fluorescently Labelled Algae Grazing Experiments (Ray Leakey)

The objective of this research was to quantify taxon-specific protozooplankton herbivory. This was achieved by quantifying the uptake of fluorescently labelled nanophytoplankton by protozoa in natural water samples. Cultures of two species of flagellate algae of contrasting size were chosen, *Dunaliella tertiolecta* (~10 μm diameter) and *Chlorella stigmataphora.* (~4 μm diameter), and stained with the fluorochrome, DTAF. Pelagic samples were then inoculated with the stained algae and incubated for 0, 10, 20 40, and 80 minutes under ambient conditions. Samples were fixed and stored for preliminary analysis on ship, and for full post-cruise analysis. Results from a shake-down experiment at Deception Island revealed that grazing by ciliate protozoans on 10 μm algae was low (total population clearance rate = 2 ml of water litre^{-1} hr^{-1}). Preliminary observations at Station 'Gertie' also revealed low population grazing rates for both 4 μm and 10 μm algae. Further results await full post-cruise analysis after samples return to the UK in May. It is anticipated that 2-3 months will be required to analyse the samples.

5) Autoradiography Grazing Experiments (Steve Archer)

The objective of this research was to compare autoradiographic information on grazing rates and species specific primary production within the sea ice (see Sectioan A 1 above) and water column. In addition, this allows calibration of grazing rates obtained using autoradiographic methods with values observed employing standard techniques (see 2 and 4 above).

Grazing experiments on pelagic samples (500 ml) involved simulated *in situ* incubations and a time series of 1-, 2- and 3-h. Incubations over 24-h *in situ* were carried out for primary production studies. ^{14}C concentrations used per 500 ml were 5 μCi for primary production studies and 10-20 μCi for grazing experiments. Subsamples were immediately prepared for autoradiography to minimise and to act as controls for radioisotope loss. The remainder samples were fixed in 0.4% Lugol's iodine solution for return to U.K.

As stated previously, autoradiographic methods are still under development and further experimental and analytical work is required to support these experiments. Initial results are encouraging and include observation of beta tracks emerging from a number of species of diatom. It is anticipated that 6 months will be required to analyse the samples.

6) Size Fractionated Biomass for Respiration Studies (Ray Leakey in collaboration with Carol Robinson)

The objective of this research was to quantify the abundance and biomass of heterotrophs responsible for respiratory oxygen demand within different size fractions of plankton. Samples were collected from unfractioned water and water fractioned at <0.8, <2.0 and <18 μm and used for dark respiration determinations. The samples were then fixed and slides prepared for post-cruise

analysis of pico-, nano- and microheterotroph abundance and biomass on return to the UK in May. It is anticipate that 1 month will be required to complete analysis.

7) Bacterial abundance, biomass and productivity (Duncan Plummer).

The objectives of this research were to measure bacterial abundance, biomass and productivity at each station in relation to the following:

a) JGOFS Coe Measurements (Level 1) at all depths
b) Production Rig samples - all depths
c) Samples as required for the Microbial Processes Group
d) Samples used for the Biogenic Gas Group.

The sampling and experimental methods used were baed on JGOFS Report No 6 on 'Core Measurements and Protocols'. For bacterial production, the ^{3}H thymidine incorporation method was used. Replicate aliquots (4 + blank) were filtered at three time intervals during the incubation (90, 180 & 360 minutes). This allowed both the linearity of thymidine incorporation to be verified and improves the precision of the method as the data can be analysed using regression methods.

Bacterial abundance and biomass measurements will be made on samples obtained at the same time for production estimates. These were preserved in 2% particle fee formaldehyde and stored in glass vials. Abundance will be determined by epifluorescence microscopy using acridine orange as a fluorochrome.

For most profiles, duplicate samples were collected for one depth to test the precision of estimates.

A list of the stations worked is shown in Table 2.

As the analysis of samples, and hence interpretation of results, is to be performed back in the laboratory, there is little to report here. the original intention of using the shipboard scintillation counter was abandoned due to its poor performance. Using the "Efficiency Standard Precision Check" of the instrument on a set of certified standards, an unacceptable precision was indicated. Thus the vials will be counted on return to Plymouth. Samples for bacterial enumeration and biomass measurements will also be analysed back in Plymouth.

If it is accepted that the revised scientific programme was a success, then the bacterial part of the study must be considered successful. During the 5 stations, 96 samples were collected for bacterial examination. However, conclusions can only be drawn after analysis of the samples.

4.16 ZOOPLANKTON. - A. ATKINSON, R. HARRIS, H. HILL, D. ROBINS and J. WATKINS. (in association with A. Bedo and P. Ward).

Work on the cruise was seriously affected by three major factors. Firstly, the need for medical evacuation of one member of the group at the start of the cruise. Secondly, the change in overall cruise plan, from a 40 day time-series study, to a 10 day transect along four stations. Thirdly, the extremely low abundance (and absence of) zooplankton and krill at some stations, which made some experimental procedures difficult, or impossible.

The following report summarizes activities in relation to the seven original objectives in the Zooplankton Group cruise proposal, *"Upper ocean biogeochemistry in the south east Pacific sector of the Southern Ocean: an integrated programme of zooplankton research"*

1) **ZOOPLANKTON INGESTION RATES AND FECAL PELLET PRODUCTION:** quantification across the size spectrum, concentrating on small copepods, Appendicularia, mesozooplankton (using JGOFS "Level 1" protocols) and krill.

Gut evacuation experiments were carried out for 27 of the 0-50m net hauls, which will enable copepod grazing rates to be estimated using gut fluorescence. At each of the stations grazing experiments were conducted with selected dominant mesozooplankton grazers. These involved incubating the animals in seawater (and at station G also in melted ice algae) and preserving water samples before and after the experiment. Microscope counts of plant and animal food items will be completed in Cambridge. The aims of these experiments were threefold. 1) to provide an independent estimate of grazing rates; 2) to determine the diets of both small and large species before the main spring bloom; 3) to determine the efficiency with which small copepods, large copepods and small euphausiids ingest the large, bloom forming diatoms.
It was not practicable to collect faecal pellets in quantity on this cruise, but they were obtained from the incubation experiments. It is hoped that laboratory measurements can be made of their dimensions and sinking rates.

2) **BIOCHEMICAL COMPOSITION AND PARTICLE SIZE DISTRIBUTION OF NATURAL PARTICULATE MATERIAL:** characterisation of, and the fecal pellets produced by zooplankton feeding on it, with special emphasis on the <10 mm size fraction.

A full suite of particulate samples (GF/F, and size-fractionated) were obtained for phytoplankton identification (Lugol and formalin, Table 1), chlorophyll analysis (Turner Designs Fluorometer, Table 2), CHN analysis (Carlo Erba, Table 3), and selected biochemical parameters (Protein, Carbohydrate and Lipid, Table 4). Reduced

manpower, and the low levels of particulate material at most stations, limited the collection of size fractionated samples.

Electronic particle sizing was carried out with a Coulter Multisizer ; this technique also determines particle concentrations and volume. The Multisizer analysed particulate material within a dynamic size range of 1 - 180μm, expressing all particle diameters as an 'Equivalent Spherical Diameter' (ESD). Profiles for each of the main stations were obtained either over 7 depths (0-100m) or as a limited (3 depth) profile (0-50m). Data from the Multisizer are routinely presented as the size distribution of particle volume (expressed in 'parts per million' - ppm). They may be used as 'Total Particle Volume' (TPV) or sub-divided into relevant size fractions to investigate and display within water column structure and between station variability. The preliminary data shows a general trend of increasing particle abundance and TPV from the under ice station to the open ocean (northerly) station. It also shows significant within station variability from one vertical profile to another.

Additional information on the characteristics of the natural particulate assemblages (1 to ~100μm) was gathered using a Becton Dickinson *FACSort* flow cytometer. This instrument can rapidly identify the presence of auto-fluorescing pigments, such as chlorophyll, within individual particles and relate this to other parameters such as light scatter signals for the same particle; thus allowing particles of a similar nature to be classified into sub-populations. The objectives for using this instrument were two fold: Firstly, as it is the first of a new generation of 'bench top' instruments, to test its suitability for use at sea; secondly, having proved its satisfactory ship-board performance, to characterise the chlorophyll containing cells within the particulate assemblages at each station in order to identify sub-population structure. This in turn can be used to identify within station and between station variability, as well as relating particle structure to potential grazer abundance.

At selected times and depths natural particulate assemblages were incubated with Fluorescein Diacetate to investigate the 'viability' of the phytoplankton cells, those that were metabolizing give a characteristic fluorescence. Preliminary results show the vast majority (~90%+) of chlorophyll containing cells in the top 50 metres to be alive.

The flow cytometer was also used to investigate whether there was a significant selective uptake of small particles by dominant herbivorous zooplankton at the MIZ. Using uniquely fluorescing beads of 2.33μm and 0.49μm the flow cytometer was used to monitor concentrations over periods of 24 hours.

A complete listing of Multisizer and AFC analyses is given in Table 5.

3) **ASSIMILATION EFFICIENCY:** assessment using the biogenic silica technique for a range of biochemical components, concentrating on estimating *in situ* pigment degradation.

(It was not possible to address this objective due to low zooplankton abundance, low rates of faecal pellet production, and reduced manpower).

4) **RESPIRATION AND EXCRETION:** measurement of rates of representatives of various size fractions of zooplankton to determine carbon requirements for metabolism.

(Reduced manpower meant that no respiration or excretion experiments could be attempted)

5) **MESOZOOPLANKTON COMMUNITY:** definition of the composition, vertical distribution and ontogenetic development during the ice edge retreat using JGOFS "Level 1" mesozooplankton protocols.

At the five stations, G, H, I, J and K, 20, 4, 20, 28 and 20, respectively, vertical net hauls wer completed with a 200 μm "Z-net" to monitor the seasonal development of the mesozooplankton. The hauls were in discrete depth horizons; 0-50 m, 50-250 m and 250- 600 m and spanned the diel cycle, so that both seasonal and vertical migration could be elucidated. Many of the catches were preserved in formaldehyde, but subsamples were also size fractionated using JGOFS "Level 1" protocols (>2000, 2000-1000, 1000-500, 500-200 μm fractions, Table 6) for determination of carbon and nitrogen content. At sites G, J and K, 100-200 individual copepods of the dominant stages and species were sorted for CHN analysis (Table 7). These data will be combined with the abundance counts to assess the biomass dominance of selected species and stages.

Sufficient material was collected on this short cruise for about two years labwork at BAS Cambridge, so full results will be available later. Preliminary observations are summarised here. Within the sea ice at site G, it was surprising to find extremely high numbers of harpacticoid copepods. Biomass estimates of these will be compared to that of the plankton. The latter were mainly at overwintering depths, below 250 m. Within the top 50 m *Oithona* spp. and *Calanus propinquus* were the major species, and the latter at least was actively feeding. A clear spatial and temporal transition was evident as we moved northward out of the ice, with the increased abundance of the predominantly subantarctic species *Rhincalanus gigas* and a migration of zooplankton up into the top 250 m (stations J and K).

6) **GROWTH AND FOOD INTAKE FOR DIFFERENT SIZES OF KRILL:** measurement during spring melting of the ice edge and investigation of spatial and temporal variation in carbon export through the relationship of fecal pellet production to timing of feeding and position of krill in the water column.

Kill growth and moulting were assessed by carrying out a series of instantaneous growth rate (IGR) experiments. Individual krill were held at ambient temperature in 1.2 l containers in the cool room. Animals were inspected every 12 hours over a 4 day period, moulting animals were removed and preserved for measurement of growth increment. Moult rate and intermoult period were determined from the proportion of krill moulting during the experimental period.

Fecal pellet production experiments were carried out to determine the gut passage time and amount of carbon excreted. Animals were placed in 5 l containers immediately after capture and then animals and faecal pellets were sampled serially over a 12 hour

period. Faecal pellets were placed on pre-weighed aluminium foil boats. All the samples were frozen at -60 øC.

Whole animals were frozen at -60 øC for later estimation chlorophyll a content by means of whole animal gut fluorescence. Animals were starved and then frozen to provide a measure of background fluorescence.

Table 8 shows the activities worked at each of the stations during the study. Table 9 shows the acoustic data collected during the study period.

7) **DISTRIBUTION OF KRILL:** definition in relation to the ice edge, phytoplankton and mixed layer depth, and investigation of swarm structure in relation to krill density, water-column structure and presence of sea ice, and estimation of the relative quantities of krill under ice, at the ice edge and in open water (using acoustic observations from RRS Discovery)

Net hauls, diving and light trapping were employed for capturing live krill for ship-board experiments. Net hauls for live krill were usually targeted on a swarm or concentration of krill detected with the echo-sounder. The duration of such hauls was kept to the minimum possible to ensure the least possible damage to the krill. A hand-held net made from an RMT8 liner was used to capture krill while diving. At the ice stations 12 volt search lights were used to attract krill to a hole in the ice at night.

On board live krill were kept in large tanks with a through flow of sea water from the uncontaminated supply.

An EK500 scientific echo-sounder, operating at frequencies of 120 and 38 kHz provided information of krill distribution over the depth range 10-250 m. The sounder system was operated both while the ship was on station and during all transects.

Samples were collected using a large (4 m2 mouth opening) vertical net when the ship was working ice stations. A multiple opening and closing RMT8 net system was used to take samples when the ship was in open water. For distribution studies with the latter net, depth horizons of 10-50, 50-150 and 150-250 m were sampled as upward oblique hauls with each net sampling for approx 20 min.

The distribution of krill and other zooplankton under the ice and at the ice edge was assessed by visual observations of divers, underwater diver-held video, 16 mm cine film and 70 mm Camera Alive photogrammetric cameras.

Krill were observed both acoustically and visually under the ice. On leaving Faraday, at the beginning of the cruise, the ship passed through a zone of pack ice. Large numbers of krill were seen on floes overturned by the ship. Occasionally krill were seen in the same way in the Bellingshausen, but on numerous occasions there was no sign of any krill associated with the ice as the ship overturned floes. Some krill were found at all the ice stations, however, distribution was quite patchy and abundance was low. Thus at station Gertie, continuous sampling produced no krill for the first three days.

On the last day krill were sighted for the first time by divers and at the same time krill were caught in vertical net hauls. In contrast, krill were abundant at station Herbie (see diving observations). At the ice edge station acoustic searches for krill revealed very few swarms present in the water column.
An acoustic search covering several miles on either side of the ice edge revealed 5 swarms occurring under the ice and one swarm just at the ice edge. Unfortunately bad weather prevented sampling until the following day. At the two open water stations krill abundance was low, only one catch of live krill was obtained at station Isolde and no live krill were taken at station Katie. At the last two stations, Isolde and Katie, a persistent but diffuse layer was observed on the echo-sounder between the surface and 50 m on the echo-sounder. Net samples taken through this layer contained salps, Thysanoessa sp. and large copepods.

Krill caught under the ice were small juveniles about 25-30 mm total length. In contrast krill caught at the open water stations (Isolde & Jules) were large (fig.) adults. Some females had attached spermatophore sacks but there were no gravid females.

Krill were observed during dives at stations Gertie, Herbie and Isolde. At station Gertie a single swarm was observed on the last day. Unfortunately when we returned to film the swarm only one or two isolated individuals were found. At station Herbie krill were found all around the dive site, animals were seen feeding under the ice as well as swimming at least 5 m below the ice. On a second dive 6 hours later most of the krill had disappeared, although a small aggregation was found feeding in a crevice about 30 m from the dive hole. Video and cine film of the feeding was shot by Rick Price, however, there was a problem on the normally reliable photogrammetric system and no 70 mm photographs were taken.

Krill swarms in the oceanic Bellingshausen Sea were relatively infrequent compared to shelf areas covered during the cruise. Krill were observed feeding under the ice while the phytoplankton concentrations in the water column were extremely low. It is possible that krill therefore play a significant role in carbon transport well before the ice melts or moves away and the pelagic systems can swing into action.

Overall success of the cruise

Of the original cruise objectives, the characterisation of particulate material, and the composition and ontogenetic development of the mesozooplankton were thoroughly addressed. Sampling was also sufficiently intensive to monitor diel vertical migration and feeding periodicity at all stations except H. In addition valuable zooplankton incubation experiments were achieved. These should provide useful information on both feeding behaviour and feacal pellets.

The unfortunate departure of Alain Bedo and the absence of Peter Ward from the cruise meant a critical shortage of manpower. Partly because of this and partly through lack of sampling time, iI was unable to attend to the secondary objectives of measuring, assimilation, and respiration or excretion rates of zooplankton.

Both under the ice and in open water large amounts of time were spent trying to find fishable concentrations of krill. At several stations krill were finally sampled successfully just prior to the ship moving to another location. This illustrated well the inherent problem of trying to find concentrations of a mobile, patchily distributed organism in a multi-disciplinary study based on geographically fixed stations. Thus the quantity and occasions on which live krill were sampled fell well below that necessary to achieve our experimental objectives. On the other hand the increased number of transects steamed has resulted in much more acoustic data. An analysis of these data in conjunction with UOR, ADCP and sea surface parameters will be very interesting and useful although may not contribute directly to the main aims of BOFS.

The abbreviated nature of the cruise, and the decision to opt for a spatial transect approach, obviously prevented us from monitoring a true seasonal progression. Its impingement on the zooplankton work was twofold. Firstly we could not study the development of a single community, and it will be hard to separate temporal from spatial events. Secondly we could not get to grips with how the ice and its biota actually affected the zooplankton. The response of copepods to food shortage and then bloom, on the time scale we were able to measure it, could have occured in any oceanic area. Nevertheless, as a series of spot measurements, this cruise was a useful starter, especially in the context of on-going BAS studies in this and related environments.

From a BOFS/JGOFS viewpoint the results achieved were disappointingly limited, despite the good efforts of those on board. On the basis of the data obtained on JCR 003 it will be very difficult advance models of the role of mesozooplankton and krill in carbon flux during the seasonal "retreat" of the marginal ice zone in the Bellingshausen Sea.

Deck work would be considerably safer if the aft bulwark was painted with non-slip deck paint. To haul in the codends of nets it was frequently necessary to stand on the lowered bulwark. It was difficult to remain upright when this was wet or covered with hydraulic oil(as often happened).

Date	Time	Lat	Long	CTD #	Depth	Sample #
15/11/92	2019	70o18'S	85o13'W	10	2	9000
15/11/92	2019	70o18'S	85o13'W	10	10	9001
15/11/92	2019	70o18'S	85o13'W	10	20	9002
15/11/92	2019	70o18'S	85o13'W	10	30	9003
15/11/92	2019	70o18'S	85o13'W	10	50	9004
15/11/92	2019	70o18'S	85o13'W	10	75	9005
15/11/92	2019	70o18'S	85o13'W	10	100	9006
16/11/92	1032	70o18'S	85o17'W	16	2	9007
16/11/92	1032	70o18'S	85o17'W	16	50	9008
16/11/92	1032	70o18'S	85o17'W	16	20	9009
17/11/92	'0954	70o20'S	85o37'W	18	2	9010
17/11/92	'0954	70o20'S	85o37'W	18	20	9011
17/11/92	'0954	70o20'S	85o37'W	18	50	9012
18/11/92	'0946	70o18'S	85o47'W	23	2	9013
18/11/92	'0946	70o18'S	85o47'W	23	20	9014
18/11/92	'0946	70o18'S	85o47'W	23	50	9015
29/11/92	1238	70o14'S	85o06'S	29	2	9016
29/11/92	1238	70o14'S	85o06'S	29	20	9017
29/11/92	1238	70o14'S	85o06'S	29	50	9018
1/12/92	'0959	69o38'S	85o05'W	35	2	9032
1/12/92	'0959	69o38'S	85o05'W	35	10	9033
1/12/92	'0959	69o38'S	85o05'W	35	20	9034
1/12/92	'0959	69o38'S	85o05'W	35	30	9035
1/12/92	'0959	69o38'S	85o05'W	35	50	9036
1/12/92	'0959	69o38'S	85o05'W	35	75	9037
1/12/92	'0959	69o38'S	85o05'W	35	100	9038
2/12/92	'0956	69o51'S	85o26'W	45	2	9039
2/12/92	'0956	69o51'S	85o26'W	45	20	9040
2/12/92	'0956	69o51'S	85o26'W	45	50	9041
3/12/92	1447	69o00'S	85o02'W	49	2	9042
3/12/92	1447	69o00'S	85o02'W	49	20	9043
3/12/92	1447	69o00'S	85o02'W	49	50	9044
4/12/92	1158	68o18'S	84o59'W	51	2	9045
4/12/92	1158	68o18'S	84o59'W	51	10	9046
4/12/92	1158	68o18'S	84o59'W	51	20	9047
4/12/92	1158	68o18'S	84o59'W	51	30	9019
4/12/92	1158	68o18'S	84o59'W	51	50	9020
4/12/92	1158	68o18'S	84o59'W	51	75	9021
4/12/92	1158	68o18'S	84o59'W	51	100	9022
5/12/92	'0942	68o23'S	84o50'W	61	2	9024
5/12/92	'0942	68o23'S	84o50'W	61	20	9025
5/12/92	'0942	68o23'S	84o50'W	61	50	9026

6/12/92	1012	68o00'S	85o00'W	66	2	9027
6/12/92	1012	68o00'S	85o00'W	66	20	9028
6/12/92	1012	68o00'S	85o00'W	66	50	9029
6/12/92	1600	67o29'S	85o00'W	67	2	9030
6/12/92	1600	67o29'S	85o00'W	67	20	9031
6/12/92	1600	67o29'S	85o00'W	67	50	9048
8/12/92	'0630	67o39'S	84o54'W	77	2	9049
8/12/92	'0630	67o39'S	84o54'W	77	10	9050
8/12/92	'0630	67o39'S	84o54'W	77	20	9051
8/12/92	'0630	67o39'S	84o54'W	77	30	9052
8/12/92	'0630	67o39'S	84o54'W	77	50	9053
8/12/92	'0630	67o39'S	84o54'W	77	75	9054
8/12/92	'0630	67o39'S	84o54'W	77	100	9055

JAMES CLARK ROSS 1992 CHLOROPHYLL DATA LOG

Date	Time	Lat	Long	CTD #	Depth	Vol filt	Reps	Size fract	Number	vol ext
16/11/92	1032	70o18'S	85o17'W	16	2	250	2	Tot	1	20
16/11/92	1032	70o18'S	85o17'W	16	2	250	2	"	2	20
16/11/92	1032	70o18'S	85o17'W	16	2	250	2	<20um	3	20
16/11/92	1032	70o18'S	85o17'W	16	2	250	2	"	4	20
16/11/92	1032	70o18'S	85o17'W	16	2	250	2	<2um	5	20
16/11/92	1032	70o18'S	85o17'W	16	2	250	2	"	6	20
16/11/92	1032	70o18'S	85o17'W	16	50	250	2	Tot	7	20
16/11/92	1032	70o18'S	85o17'W	16	50	250	2	"	8	20
16/11/92	1032	70o18'S	85o17'W	16	50	250	2	<20um	9	20
16/11/92	1032	70o18'S	85o17'W	16	50	250	2	"	10	20
16/11/92	1032	70o18'S	85o17'W	16	50	250	2	<2um	11	20
16/11/92	1032	70o18'S	85o17'W	16	50	250	2	"	12	20
16/11/92	1032	70o18'S	85o17'W	16	20	250	2	Tot	13	20
16/11/92	1032	70o18'S	85o17'W	16	20	250	2	"	14	20
16/11/92	1032	70o18'S	85o17'W	16	20	250	2	<20um	15	20
16/11/92	1032	70o18'S	85o17'W	16	20	250	2	"	16	20
16/11/92	1032	70o18'S	85o17'W	16	20	250	2	<2um	17	20
16/11/92	1032	70o18'S	85o17'W	16	20	250	2	"	18	20
17/11/92	'0954	70o20'S	85o37'W	18	2	250	2	Total	19	20
17/11/92	'0954	70o20'S	85o37'W	18	2	250	2		20	20
17/11/92	'0954	70o20'S	85o37'W	18	20	250	2	Total	21	20
17/11/92	'0954	70o20'S	85o37'W	18	20	250	2		22	20
17/11/92	'0954	70o20'S	85o37'W	18	50	250	2	Total	23	20
17/11/92	'0954	70o20'S	85o37'W	18	50	250	2		24	20
18/11/92	'0946	70o18'S	85o47'W	23	2	250	2	Total	25	20
18/11/92	'0946	70o18'S	85o47'W	23	2	250	2		26	20
18/11/92	'0946	70o18'S	85o47'W	23	20	250	2	Total	27	20
18/11/92	'0946	70o18'S	85o47'W	23	20	250	2		28	20
18/11/92	'0946	70o18'S	85o47'W	23	50	250	2	Total	29	20
18/11/92	'0946	70o18'S	85o47'W	23	50	250	2		30	20
29/11/92	1238	70o14'S	85o06'S	29	2	250	2	Total	31	20
29/11/92	1238	70o14'S	85o06'S	29	2	250	2		32	20
29/11/92	1238	70o14'S	85o06'S	29	20	250	2	Total	33	20
29/11/92	1238	70o14'S	85o06'S	29	20	250	2		34	20
29/11/92	1238	70o14'S	85o06'S	29	50	250	2	Total	35	20
29/11/92	1238	70o14'S	85o06'S	29	50	250	2		36	20
1/12/92	'0959	69o38'S	85o05'W	35	2	250	2	Total	37	20
1/12/92	'0959	69o38'S	85o05'W	35	2	250			38	20
1/12/92	'0959	69o38'S	85o05'W	35	10	250	2	Total	39	20
1/12/92	'0959	69o38'S	85o05'W	35	10	250			40	20
1/12/92	'0959	69o38'S	85o05'W	35	20	250	2	Total	41	20
1/12/92	'0959	69o38'S	85o05'W	35	20	250			42	20
1/12/92	'0959	69o38'S	85o05'W	35	30	250	2	Total	43	20
1/12/92	'0959	69o38'S	85o05'W	35	30	250			44	20
1/12/92	'0959	69o38'S	85o05'W	35	50	250	2	Total	45	20
1/12/92	'0959	69o38'S	85o05'W	35	50	250			46	20
1/12/92	'0959	69o38'S	85o05'W	35	75	250	2	Total	47	20

1/12/92	'0959	69o38'S	85o05'W	35	75	250			48	20
1/12/92	'0959	69o38'S	85o05'W	35	100	250	2	Total	49	20
1/12/92	'0959	69o38'S	85o05'W	35	100	250			50	20
2/12/92	'0956	69o51'S	85o26'W	45	2	250	2	Total	51	20
2/12/92	'0956	69o51'S	85o26'W	45	2	250			52	20
2/12/92	'0956	69o51'S	85o26'W	45	20	250	2	Total	53	20
2/12/92	'0956	69o51'S	85o26'W	45	20	250			54	20
2/12/92	'0956	69o51'S	85o26'W	45	50	250	2	Total	55	20
2/12/92	'0956	69o51'S	85o26'W	45	50	250			56	20
3/12/92	1447	69o00'S	85o02'W	49	2	250	2	Total	57	20
3/12/92	1447	69o00'S	85o02'W	49	2	250			58	20
3/12/92	1447	69o00'S	85o02'W	49	20	250	2	Total	59	20
3/12/92	1447	69o00'S	85o02'W	49	20	250			60	20
3/12/92	1447	69o00'S	85o02'W	49	50	250	2	Total	61	20
3/12/92	1447	69o00'S	85o02'W	49	50	250			62	20
4/12/92	1158	68o18'S	84o59'W	51	2	250	2	Total	63	20
4/12/92	1158	68o18'S	84o59'W	51	2	250			64	20
4/12/92	1158	68o18'S	84o59'W	51	10	250	2	Total	65	20
4/12/92	1158	68o18'S	84o59'W	51	10	250			66	20
4/12/92	1158	68o18'S	84o59'W	51	20	250	2	Total	67	20
4/12/92	1158	68o18'S	84o59'W	51	20	250			68	20
4/12/92	1158	68o18'S	84o59'W	51	30	250	2	Total	69	20
4/12/92	1158	68o18'S	84o59'W	51	30	250			70	20
4/12/92	1158	68o18'S	84o59'W	51	50	250	2	Total	71	20
4/12/92	1158	68o18'S	84o59'W	51	50	250			72	20
4/12/92	1158	68o18'S	84o59'W	51	75	250	2	Total	73	20
4/12/92	1158	68o18'S	84o59'W	51	75	250			74	20
4/12/92	1158	68o18'S	84o59'W	51	100	250	2	Total	75	20
4/12/92	1158	68o18'S	84o59'W	51	100	250			76	20
5/12/92	'0942	68o23'S	84o50'W	61	2	250	2	Total	77	20
5/12/92	'0942	68o23'S	84o50'W	61	2	250			78	20
5/12/92	'0942	68o23'S	84o50'W	61	20	250	2	Total	79	20
5/12/92	'0942	68o23'S	84o50'W	61	20	250			80	20
5/12/92	'0942	68o23'S	84o50'W	61	50	250	2	Total	81	20
5/12/92	'0942	68o23'S	84o50'W	61	50	250			82	20
5/12/92	'0942	68o23'S	84o50'W	61	2	250	2	Total	83	20
5/12/92	'0942	68o23'S	84o50'W	61	2	250			84	20
5/12/92	'0942	68o23'S	84o50'W	61	20	250	2	Total	85	20
5/12/92	'0942	68o23'S	84o50'W	61	20	250			86	20
5/12/92	'0942	68o23'S	84o50'W	61	50	250	2	Total	87	20
5/12/92	'0942	68o23'S	84o50'W	61	50	250			88	20
6/12/92	1600	67o29'S	85o00'W	67	2	250	2	Total	89	20
6/12/92	1600	67o29'S	85o00'W	67	2	250			90	20
6/12/92	1600	67o29'S	85o00'W	67	20	250	2	Total	91	20
6/12/92	1600	67o29'S	85o00'W	67	20	250			92	20
6/12/92	1600	67o29'S	85o00'W	67	50	250	2	Total	93	20

6/12/92	1600	67o29'S	85o00'W	67	50	250			94	20
8/12/92	'0630	67o39'S	84o54'W	77	2	100	2	Total	95	20
8/12/92	'0630	67o39'S	84o54'W	77	2	100			96	20
8/12/92	'0630	67o39'S	84o54'W	77	10	100	2	Total	97	20
8/12/92	'0630	67o39'S	84o54'W	77	10	100			98	20
8/12/92	'0630	67o39'S	84o54'W	77	20	100	2	Total	99	20
8/12/92	'0630	67o39'S	84o54'W	77	20	100			100	20
8/12/92	'0630	67o39'S	84o54'W	77	30	100	2	Total	101	20
8/12/92	'0630	67o39'S	84o54'W	77	30	100			102	20
8/12/92	'0630	67o39'S	84o54'W	77	50	100	2	Total	103	20
8/12/92	'0630	67o39'S	84o54'W	77	50	100			104	20
8/12/92	'0630	67o39'S	84o54'W	77	75	100	2	Total	105	20
8/12/92	'0630	67o39'S	84o54'W	77	75	100			106	20
8/12/92	'0630	67o39'S	84o54'W	77	100	100	2	Total	107	20
8/12/92	'0630	67o39'S	84o54'W	77	100	100			108	20

JAMES CLARK ROSS 1992 CHN SAMPLE DATA LOG

Date	Time	Lat	Long	CTD #	Depth	Vol	replicates	#	SF
15/11/92	2019	70o18'S	85o13'W	10	2	500	2	7000	Total
15/11/92	2019	70o18'S	85o13'W	10	10	500	2	7001	Total
15/11/92	2019	70o18'S	85o13'W	10	20	500	2	7002	Total
15/11/92	2019	70o18'S	85o13'W	10	30	500	2	7003	Total
15/11/92	2019	70o18'S	85o13'W	10	50	500	2	7004	Total
15/11/92	2019	70o18'S	85o13'W	10	75	500	2	7005	Total
15/11/92	2019	70o18'S	85o13'W	10	100	500	2	7006	Total
16/11/92	1032	70o18'S	85o17'W	16	2	500	2	7007	Total
16/11/92	1032	70o18'S	85o17'W	16	2	500	2	7008	<20um
16/11/92	1032	70o18'S	85o17'W	16	2	500	2	7009	<2um
16/11/92	1032	70o18'S	85o17'W	16	50	500	2	7010	Total
16/11/92	1032	70o18'S	85o17'W	16	50	500	2	7011	<20um
16/11/92	1032	70o18'S	85o17'W	16	50	500	2	7012	<2um
16/11/92	1032	70o18'S	85o17'W	16	20	500	2	7013	Total
16/11/92	1032	70o18'S	85o17'W	16	20	500	2	7014	<20um
16/11/92	1032	70o18'S	85o17'W	16	20	500	2	7015	<2um
17/11/92	'0954	70o20'S	85o37'W	18	2	500	2	7016	Total
17/11/92	'0954	70o20'S	85o37'W	18	20	500	2	7017	Total
17/11/92	'0954	70o20'S	85o37'W	18	50	500	2	7018	Total
18/11/92	'0946	70o18'S	85o47'W	23	2	500	2	7019	Total
18/11/92	'0946	70o18'S	85o47'W	23	20	500	2	7020	Total
18/11/92	'0946	70o18'S	85o47'W	23	50	500	2	7021	Total
29/11/92	1238	70o14'S	85o06'S	29	2	500	2	7021	Total
29/11/92	1238	70o14'S	85o06'S	29	20	500	2	7022	Total
29/11/92	1238	70o14'S	85o06'S	29	50	500	2	7023	Total
1/12/92	'0959	69o38'S	85o05'W	35	2	500	2	7024	Total
1/12/92	'0959	69o38'S	85o05'W	35	10	500	2	7025	Total
1/12/92	'0959	69o38'S	85o05'W	35	20	500	2	7026	Total
1/12/92	'0959	69o38'S	85o05'W	35	30	500	2	7027	Total
1/12/92	'0959	69o38'S	85o05'W	35	50	500	2	7028	Total
1/12/92	'0959	69o38'S	85o05'W	35	75	500	2	7029	Total
1/12/92	'0959	69o38'S	85o05'W	35	100	500	2	7030	Total
2/12/92	'0956	69o51'S	85o26'W	45	2	500	2	7031	Total
2/12/92	'0956	69o51'S	85o26'W	45	20	500	2	7032	Total
2/12/92	'0956	69o51'S	85o26'W	45	50	500	2	7033	Total
3/12/92	1447	69o00'S	85o02'W	49	2	500	2	7034	Total
3/12/92	1447	69o00'S	85o02'W	49	20	500	2	7035	Total
3/12/92	1447	69o00'S	85o02'W	49	50	500	2	7036	Total
4/12/92	1158	68o18'S	84o59'W	51	2	500	2	7037	Total
4/12/92	1158	68o18'S	84o59'W	51	10	500	2	7038	Total
4/12/92	1158	68o18'S	84o59'W	51	20	500	2	7039	Total
4/12/92	1158	68o18'S	84o59'W	51	30	500	2	7040	Total
4/12/92	1158	68o18'S	84o59'W	51	50	500	2	7041	Total

4/12/92	1158	68o18'S	84o59'W	51	75	500	2	7042	Total
4/12/92	1158	68o18'S	84o59'W	51	100	500	2	7043	Total
5/12/92	'0942	68o23'S	84o50'W	61	2	500	2	7044	Total
5/12/92	'0942	68o23'S	84o50'W	61	20	500	2	7045	Total
5/12/92	'0942	68o23'S	84o50'W	61	50	500	2	7046	Total
6/12/92	1012	68o00'S	85o00'W	66	2	500	2	7047	Total
6/12/92	1012	68o00'S	85o00'W	66	2	500	2	7048	Total
6/12/92	1012	68o00'S	85o00'W	66	2	500	2	7049	Total
6/12/92	1600	67o29'S	85o00'W	67	2	500	2	7050	Total
6/12/92	1600	67o29'S	85o00'W	67	2	500	2	7051	Total
6/12/92	1600	67o29'S	85o00'W	67	2	500	2	7052	Total
8/12/92	'0630	67o39'S	84o54'W	77	2	250**	2	7053	Total
8/12/92	'0630	67o39'S	84o54'W	77	10	250**	2	7054	Total
8/12/92	'0630	67o39'S	84o54'W	77	20	250**	2	7055	Total
8/12/92	'0630	67o39'S	84o54'W	77	30	250**	2	7056	Total
8/12/92	'0630	67o39'S	84o54'W	77	50	250**	2	7057	Total
8/12/92	'0630	67o39'S	84o54'W	77	75	250**	2	7058	Total
8/12/92	'0630	67o39'S	84o54'W	77	100	250**	2	7059	Total

JAMES CLARK ROSS 1992 PARTICULATE BIOCHEMISTRY SAMPLE LOG

Date	Time	Lat	Long	CTD #	Depth	Vol	Reps	#	SF
16/11/92	1032	70o18'S	85o17'W	16	2	500	6	7007	Total
16/11/92	1032	70o18'S	85o17'W	16	2	500	6	7008	<20um
16/11/92	1032	70o18'S	85o17'W	16	2	500	6	7009	<2um
16/11/92	1032	70o18'S	85o17'W	16	50	500	6	7010	Total
16/11/92	1032	70o18'S	85o17'W	16	50	500	6	7011	<20um
16/11/92	1032	70o18'S	85o17'W	16	50	500	6	7012	<2um
16/11/92	1032	70o18'S	85o17'W	16	20	500	6	7013	Total
16/11/92	1032	70o18'S	85o17'W	16	20	500	6	7014	<20um
16/11/92	1032	70o18'S	85o17'W	16	20	500	6	7015	<2um
1/12/92	'0959	69o38'S	85o05'S	35	2	500	6	7024	Total
1/12/92	'0959	69o38'S	85o05'S	35	10	500	6	7025	Total
1/12/92	'0959	69o38'S	85o05'S	35	20	500	6	7026	Total
1/12/92	'0959	69o38'S	85o05'S	35	30	500	6	7027	Total
1/12/92	'0959	69o38'S	85o05'S	35	50	500	6	7028	Total
1/12/92	'0959	69o38'S	85o05'S	35	75	500	6	7029	Total
1/12/92	'0959	69o38'S	85o05'S	35	100	500	6	7030	
4/12/92	1158	68o18'S	84o59'W	51	2	500	6	7037	
4/12/92	1158	68o18'S	84o59'W	51	10	500	6	7038	
4/12/92	1158	68o18'S	84o59'W	51	20	500	6	7039	
4/12/92	1158	68o18'S	84o59'W	51	30	500	6	7040	
4/12/92	1158	68o18'S	84o59'W	51	50	500	6	7041	
4/12/92	1158	68o18'S	84o59'W	51	75	500	6	7042	
4/12/92	1158	68o18'S	84o59'W	51	100	500	6	7043	
8/12/92	'0630	67o39'S	84o54'W	77	2	250	6	7053	
8/12/92	'0630	67o39'S	84o54'W	77	10	250	6	7054	
8/12/92	'0630	67o39'S	84o54'W	77	20	250	6	7055	
8/12/92	'0630	67o39'S	84o54'W	77	30	250	6	7056	
8/12/92	'0630	67o39'S	84o54'W	77	50	250	6	7057	
8/12/92	'0630	67o39'S	84o54'W	77	75	250	6	7058	
8/12/92	'0630	67o39'S	84o54'W	77	100	250	6	7059	

Date	Time	Lat	Long	CTD #	Depth	afc	multi	expt
13/1/92	1200				2	afc	multi	
					10	afc	multi	
					20	afc	multi	
					30	afc	multi	
					50	afc	multi	
15/11/92	2019	70o18'S	85o13'W	10	2		multi	
15/11/92	2019	70o18'S	85o13'W	10	10		multi	
15/11/92	2019	70o18'S	85o13'W	10	20		multi	
15/11/92	2019	70o18'S	85o13'W	10	30		multi	
15/11/92	2019	70o18'S	85o13'W	10	50		multi	
15/11/92	2019	70o18'S	85o13'W	10	75		multi	
15/11/92	2019	70o18'S	85o13'W	10	100		multi	
16/11/92	1032	70o18'S	85o17'W	16	2		multi	
16/11/92	1032	70o18'S	85o17'W	16	10		multi	
16/11/92	1032	70o18'S	85o17'W	16	20		multi	
16/11/92	1032	70o18'S	85o17'W	16	30		multi	
16/11/92	1032	70o18'S	85o17'W	16	50		multi	
16/11/92	1032	70o18'S	85o17'W	16	75		multi	
16/11/92	1032	70o18'S	85o17'W	16	100		multi	
17/11/92	'0954	70o20'S	85o37'W	18	2		multi	
17/11/92	'0954	70o20'S	85o37'W	18	20		multi	
17/11/92	'0954	70o20'S	85o37'W	18	50		multi	
18/11/92	'0946	70o18'S	85o47'W	23	2	afc	multi	
18/11/92	'0946	70o18'S	85o47'W	23	20	afc	multi	
18/11/92	'0946	70o18'S	85o47'W	23	30	afc		
18/11/92	'0946	70o18'S	85o47'W	23	50	afc	multi	
18/11/92	'0946	70o18'S	85o47'W	23	75	afc		
18/11/92	'0946	70o18'S	85o47'W	23	100	afc		
29/11/92	1238	70o14'S	85o06'S	29	2	afc	multi	
29/11/92	1238	70o14'S	85o06'S	29	20	afc	multi	
29/11/92	1238	70o14'S	85o06'S	29	30	afc	multi	
29/11/92	1238	70o14'S	85o06'S	29	50	afc	multi	
29/11/92	1238	70o14'S	85o06'S	29	75	afc	multi	
29/11/92	1238	70o14'S	85o06'S	29	100	afc	multi	
1/12/92	'0959	69o38'S	85o05'W	35	2	afc	multi	
1/12/92	'0959	69o38'S	85o05'W	35	10	afc	multi	
1/12/92	'0959	69o38'S	85o05'W	35	20	afc	multi	
1/12/92	'0959	69o38'S	85o05'W	35	30	afc	multi	
1/12/92	'0959	69o38'S	85o05'W	35	50	afc	multi	
1/12/92	'0959	69o38'S	85o05'W	35	75	afc	multi	
1/12/92	'0959	69o38'S	85o05'W	35	100	afc	multi	
2/12/92	'0956	69o51'S	85o26'W	45	2	afc	multi	nbeads
2/12/92	'0956	69o51'S	85o26'W	45	20	afc	multi	
2/12/92	'0956	69o51'S	85o26'W	45	50	afc	multi	

3/12/92	1447	69o00'S	85o02'W	49	2	afc	multi	
3/12/92	1447	69o00'S	85o02'W	49	20	afc	multi	fda
3/12/92	1447	69o00'S	85o02'W	49	50	afc	multi	
4/12/92	1158	68o18'S	84o59'W	51	2	afc	multi	
4/12/92	1158	68o18'S	84o59'W	51	10	afc	multi	
4/12/92	1158	68o18'S	84o59'W	51	20	afc	multi	
4/12/92	1158	68o18'S	84o59'W	51	30	afc	multi	
4/12/92	1158	68o18'S	84o59'W	51	50	afc	multi	
4/12/92	1158	68o18'S	84o59'W	51	75	afc	multi	fda
4/12/92	1158	68o18'S	84o59'W	51	100	afc	multi	
5/12/92	'0942	68o23'S	84o50'W	61	2	afc	multi	
5/12/92	'0942	68o23'S	84o50'W	61	10	afc	multi	
5/12/92	'0942	68o23'S	84o50'W	61	20	afc	multi	
5/12/92	'0942	68o23'S	84o50'W	61	30	afc	multi	
5/12/92	'0942	68o23'S	84o50'W	61	50	afc	multi	
5/12/92	'0942	68o23'S	84o50'W	61	75	afc	multi	beads
5/12/92	'0942	68o23'S	84o50'W	61	100	afc	multi	
6/12/92	1012	68o00'S	85o00'W	66	2	afc	multi	
6/12/92	1012	68o00'S	85o00'W	66	20	afc	multi	
6/12/92	1012	68o00'S	85o00'W	66	50	afc	multi	
6/12/92	1600	67o29'S	85o00'W	67	2	afc	multi	
6/12/92	1600	67o29'S	85o00'W	67	20	afc	multi	
6/12/92	1600	67o29'S	85o00'W	67	50	afc	multi	
8/12/92	'0630	67o39'S	84o54'W	77	2	afc	multi	
8/12/92	'0630	67o39'S	84o54'W	77	10	afc	multi	
8/12/92	'0630	67o39'S	84o54'W	77	20	afc	multi	
8/12/92	'0630	67o39'S	84o54'W	77	30	afc	multi	
8/12/92	'0630	67o39'S	84o54'W	77	50	afc	multi	
8/12/92	'0630	67o39'S	84o54'W	77	75	afc	multi	
8/12/92	'0630	67o39'S	84o54'W	77	100	afc	multi	

Date	Time	Lat	Long	CTD #	Depth	Split	SF	Net	#
16/11/92	1250	70o17'S	85o17'W	16	600-230	0.125	2000-1000um	BAS	1
16/11/92	1250	70o17'S	85o17'W	16	600-230	0.125	1000-500um	BAS	2
16/11/92	1250	70o17'S	85o17'W	16	600-230	0.125	500-200um	BAS	3
16/11/92	1340	70o17'S	85o17'W	16	250-0	0.5	2000-1000um	BAS	4
16/11/92	1340	70o17'S	85o17'W	16	250-0	0.5	1000-500um	BAS	5
16/11/92	1340	70o17'S	85o17'W	16	250-0	0.5	500-200um	BAS	6
16/11/92	1340	70o17'S	85o17'W	16	50-0	0.5	2000-1000um	BAS	7
16/11/92	1340	70o17'S	85o17'W	16	50-0	0.5	1000-500um	BAS	8
16/11/92	1340	70o17'S	85o17'W	16	50-0	0.5	500-200um	BAS	9
17/11/92	'0337	70o20'S	85o37'W	18	600-250	0.25	>2000	BAS	10
17/11/92	'0337	70o20'S	85o37'W	18	600-250	0.25	2000-1000um	BAS	11
17/11/92	'0337	70o20'S	85o37'W	18	600-250	0.25	1000-500um	BAS	12
17/11/92	'0337	70o20'S	85o37'W	18	600-250	0.25	500-200um	BAS	13
17/11/92	'0337	70o20'S	85o37'W	18	250-50	0.25	>2000um	BAS	14
17/11/92	'0337	70o20'S	85o37'W	18	250-50	0.25	2000-1000um	BAS	15
17/11/92	'0337	70o20'S	85o37'W	18	250-50	0.25	1000-500um	BAS	16
17/11/92	'0337	70o20'S	85o37'W	18	250-50	0.25	500-200um	BAS	17
17/11/92	'0437	70o20'S	85o37'W	18	50-0	0.25	2000-1000um	BAS	18
17/11/92	'0437	70o20'S	85o37'W	18	50-0	0.25	1000-500um	BAS	19
17/11/92	'0437	70o20'S	85o37'W	18	50-0	0.25	500-200um	BAS	20
18/11/92	'0400	70o18'S	85o47'W	23	600-0	0.33	>2000um	BAS	21
18/11/92	'0400	70o18'S	85o47'W	23	600-0	0.33	2000-1000um	BAS	22
18/11/92	'0400	70o18'S	85o47'W	23	600-0	0.33	1000-500um	BAS	23
18/11/92	'0400	70o18'S	85o47'W	23	600-0	0.33	500-200um	BAS	24
18/11/92	'0400	70o18'S	85o47'W	23	250-0	0.33	2000-1000um	BAS	25
18/11/92	'0400	70o18'S	85o47'W	23	250-0	0.33	1000-500um	BAS	26
18/11/92	'0400	70o18'S	85o47'W	23	250-0	0.33	500-200um	BAS	27
18/11/92	'0400	70o18'S	85o47'W	23	50-0	0.33	2000-1000um	BAS	28
18/11/92	'0400	70o18'S	85o47'W	23	50-0	0.33	1000-500um	BAS	29
18/11/92	'0400	70o18'S	85o47'W	23	50-0	0.33	500-200um	BAS	30
18/11/92	'0400	70o18'S	85o47'W	23	250-0	0.25	>2000u m	WP-2	31
18/11/92	'0400	70o18'S	85o47'W	23	250-0	0.25	2000-1000um	WP-2	32
18/11/92	'0400	70o18'S	85o47'W	23	250-0	0.25	1000-500um	WP-2	33
18/11/92	'0400	70o18'S	85o47'W	23	250-0	0.25	500-200um	WP-2	34
29/11/92	1500	70o14'S	85o06'W	29	600-250	0.25	2000-1000um	BAS	35
29/11/92	1500	70o14'S	85o06'W	29	600-250	0.25	1000-500um	BAS	36
29/11/92	1500	70o14'S	85o06'W	29	600-250	0.25	500-200um	BAS	37
29/11/92	1500	70o14'S	85o06'W	29	250-60	0.27	2000-1000um	BAS	38
29/11/92	1500	70o14'S	85o06'W	29	250-60	0.27	1000-500um	BAS	39
29/11/92	1500	70o14'S	85o06'W	29	250-60	0.27	500-200um	BAS	40
29/11/92	1500	70o14'S	85o06'W	29	50-0	0.23	2000-1000um	BAS	41
29/11/92	1500	70o14'S	85o06'W	29	50-0	0.23	1000-500um	BAS	42
29/11/92	1500	70o14'S	85o06'W	29	50-0	0.23	500-200um	BAS	43
1/12/92	'0715	69o38'S	85o05'W	35	250-50	0.30	2000-1000um	BAS	44
1/12/92	'0715	69o38'S	85o05'W	35	250-50	0.30	1000-500um	BAS	45
1/12/92	'0715	69o38'S	85o05'W	35	250-50	0.30	500-200um	BAS	46

1/12/92	1500	69o38'S	85o05'W	35	600-250	0.30	>2000m	BAS	47
1/12/92	1500	69o38'S	85o05'W	35	600-250	0.30	2000-1000um	BAS	48
1/12/92	1500	69o38'S	85o05'W	35	600-250	0.30	1000-500um	BAS	49
1/12/92	1500	69o38'S	85o05'W	35	600-250	0.30	500-200um	BAS	50
1/12/92	1500	69o38'S	85o05'W	35	250-50	0.2	>2000m	BAS	51
1/12/92	1500	69o38'S	85o05'W	35	250-50	0.2	2000-1000um	BAS	52
1/12/92	1500	69o38'S	85o05'W	35	250-50	0.2	1000-500um	BAS	53
1/12/92	1500	69o38'S	85o05'W	35	250-50	0.2	500-200um	BAS	54
1/12/92	1500	69o38'S	85o05'W	35	50-0	0.17	2000-1000um	BAS	55
1/12/92	1500	69o38'S	85o05'W	35	50-0	0.17	1000-500um	BAS	56
1/12/92	1500	69o38'S	85o05'W	35	50-0	0.17	500-200um	BAS	57
2/12/92	'0600	69o51'S	85o26'W	45	600-250	0.18	2000-1000um	BAS	58
2/12/92	'0600	69o51'S	85o26'W	45	600-250	0.18	1000-500um	BAS	59
2/12/92	'0600	69o51'S	85o26'W	45	600-250	0.18	500-200um	BAS	60
2/12/92	'0600	69o51'S	85o26'W	45	250-50	0.18	2000-1000um	BAS	61
2/12/92	'0600	69o51'S	85o26'W	45	250-50	0.18	1000-500um	BAS	62
2/12/92	'0600	69o51'S	85o26'W	45	250-50	0.18	500-200um	BAS	63
2/12/92	'0600	69o51'S	85o26'W	45	50-0	0.18	2000-1000um	BAS	64
2/12/92	'0600	69o51'S	85o26'W	45	50-0	0.18	1000-500um	BAS	65
2/12/92	'0600	69o51'S	85o26'W	45	50-0	0.18	500-200um	BAS	66
2/12/92	1500	69o51'S	85o26'W	45	600-250	0.24	>2000m	BAS	67
2/12/92	1500	69o51'S	85o26'W	45	600-250	0.24	2000-1000um	BAS	68
2/12/92	1500	69o51'S	85o26'W	45	600-250	0.24	1000-500um	BAS	69
2/12/92	1500	69o51'S	85o26'W	45	600-250	0.24	500-200um	BAS	70
2/12/92	1500	69o51'S	85o26'W	45	250-65	0.2	2000-1000um	BAS	71
2/12/92	1500	69o51'S	85o26'W	45	250-65	0.2	500-200um	BAS	72
2/12/92	1500	69o51'S	85o26'W	45	50-0	0.2	2000-1000um	BAS	73
2/12/92	1500	69o51'S	85o26'W	45	50-0	0.2	1000-500um	BAS	74
2/12/92	1500	69o51'S	85o26'W	45	50-0	0.2	500-200um	BAS	75
3/12/92	'0250	69o00'S	85o02'W	49	600-250	0.18	>2000m	BAS	76
3/12/92	'0250	69o00'S	85o02'W	49	600-250	0.18	2000-1000um	BAS	77
3/12/92	'0250	69o00'S	85o02'W	49	600-250	0.18	1000-500um	BAS	78
3/12/92	'0250	69o00'S	85o02'W	49	600-250	0.18	500-200um	BAS	79
3/12/92	'0305	69o00'S	85o02'W	49	600-250?	0.2	>2000m	BAS	80
3/12/92	'0305	69o00'S	85o02'W	49	600-250	0.2	2000-1000um	BAS	81
3/12/92	'0305	69o00'S	85o02'W	49	600-250	0.2	1000-500um	BAS	82
3/12/92	'0305	69o00'S	85o02'W	49	600-250	0.2	500-200um	BAS	83
3/12/92	'0338	69o00'S	85o02'W	49	250-50?	0.14	>2000m	BAS	84
3/12/92	'0338	69o00'S	85o02'W	49	250-50?	0.14	2000-1000um	BAS	85
3/12/92	'0338	69o00'S	85o02'W	49	250-50?	0.14	1000-500um	BAS	86
3/12/92	'0338	69o00'S	85o02'W	49	250-50?	0.14	500-200um	BAS	87
3/12/92	1035	69o00'S	85o02'W	49	50-0?	0.2	>2000m	BAS	88
3/12/92	1035	69o00'S	85o02'W	49	50-0?	0.2	2000-1000um	BAS	89
3/12/92	1035	69o00'S	85o02'W	49	50-0?	0.2	1000-500um	BAS	90
3/12/92	1035	69o00'S	85o02'W	49	50-0?	0.2	500-200um	BAS	91
3/12/92	1043	69o00'S	85o02'W	49	50-0?	0.22	>2000m	BAS	92
3/12/92	1043	69o00'S	85o02'W	49	50-0?	0.22	2000-1000um	BAS	93

3/12/92	1043	69o00'S	85o02'W	49	50-0?	0.22	1000-500um	BAS	94
3/12/92	1043	69o00'S	85o02'W	49	50-0?	0.22	500-200um	BAS	95
3/12/92	1400	69o00'S	85o02'W	49	600-250	0.2	2000-1000um	BAS	96
3/12/92	1400	69o00'S	85o02'W	49	600-250	0.2	1000-500um	BAS	97
3/12/92	1400	69o00'S	85o02'W	49	600-250	0.2	500-200um	BAS	98
3/12/92	1400	69o00'S	85o02'W	49	250-50	0.25	2000-1000um	BAS	99
3/12/92	1400	69o00'S	85o02'W	49	250-50	0.25	1000-500um	BAS	100
3/12/92	1400	69o00'S	85o02'W	49	250-50	0.25	500-200um	BAS	101
3/12/92	1400	69o00'S	85o02'W	49	50-0	0.13	2000-1000um	BAS	102
3/12/92	1400	69o00'S	85o02'W	49	50-0	0.13	1000-500um	BAS	103
3/12/92	1400	69o00'S	85o02'W	49	50-0	0.13	500-200um	BAS	104
7/12/92	'0110	67o39'S	84o54'W	77	250-50	0.18	2000-1000um	BAS	105
7/12/92	'0110	67o39'S	84o54'W	77	250-50	0.18	1000-500um	BAS	106
7/12/92	'0110	67o39'S	84o54'W	77	250-50	0.18	500-200um	BAS	107
7/12/92	1500	67o39'S	84o54'W	77	600-250	0.18	>2000m	BAS	108
7/12/92	1500	67o39'S	84o54'W	77	600-250	0.18	2000-1000um	BAS	109
7/12/92	1500	67o39'S	84o54'W	77	600-250	0.18	1000-500um	BAS	110
7/12/92	1500	67o39'S	84o54'W	77	600-250	0.18	500-200um	BAS	111
7/12/92	1500	67o39'S	84o54'W	77	250-0	0.25	>2000m	BAS	112
7/12/92	1500	67o39'S	84o54'W	77	250-0	0.25	2000-1000um	BAS	113
7/12/92	1500	67o39'S	84o54'W	77	250-0	0.25	1000-500um	BAS	114
7/12/92	1500	67o39'S	84o54'W	77	250-0	0.25	500-200um	BAS	115
7/12/92	1500	67o39'S	84o54'W	77	50-0	0.25	>2000m	BAS	116
7/12/92	1500	67o39'S	84o54'W	77	50-0	0.25	2000-1000um	BAS	117
7/12/92	1500	67o39'S	84o54'W	77	50-0	0.25	1000-500um	BAS	118
7/12/92	1500	67o39'S	84o54'W	77	50-0	0.25	500-200um	BAS	119
8/12/92	'0050	67o39'S	84o54'W	77	250-50	0.13	>2000	BAS	120
8/12/92	'0050	67o39'S	84o54'W	77	250-50	0.13	2000-1000um	BAS	121
8/12/92	'0050	67o39'S	84o54'W	77	250-50	0.13	1000-500um	BAS	122
8/12/92	'0050	67o39'S	84o54'W	77	250-50	0.13	500-200um	BAS	123
8/12/92	'0030	67o39'S	84o54'W	77	250-50	0.25	>2000	BAS	124
8/12/92	'0030	67o39'S	84o54'W	77	250-50	0.25	2000-1000um	BAS	125
8/12/92	'0030	67o39'S	84o54'W	77	250-50	0.25	1000-500um	BAS	126
8/12/92	'0030	67o39'S	84o54'W	77	250-50	0.25	500-200um	BAS	127
8/12/92	1350	67o39'S	84o54'W	77	500-230	0.182	>2000	BAS	128
8/12/92	1350	67o39'S	84o54'W	77	500-230	0.182	2000-1000um	BAS	129
8/12/92	1350	67o39'S	84o54'W	77	500-230	0.182	1000-500um	BAS	130
8/12/92	1350	67o39'S	84o54'W	77	500-230	0.182	500-200um	BAS	131
8/12/92	1640	67o39'S	84o54'W	77	50-0	0.25	>2000	BAS	132
8/12/92	1640	67o39'S	84o54'W	77	50-0	0.25	2000-1000um	BAS	133
8/12/92	1640	67o39'S	84o54'W	77	50-0	0.25	1000-500um	BAS	134
8/12/92	1640	67o39'S	84o54'W	77	50-0	0.25	500-200um	BAS	135

19/11/92 STATION G

	1	2	3	4	5	6	7	8	9	10	11	12
A	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F
B	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV
C	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
D	Rg V	38 VI oth	55 C oth	21 Mic							Rg VI F	Rg VI F
E	Cp V	Cp V					10 Mic					
F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
G	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV
H	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F

9/12/92 STATION K1

	1	2	3	4	5	6	7	8	9	10	11	12
A	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
B	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
C	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F
D												Cp VI F
E	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F
G	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V
H	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F

Stippled cells : copepods from 0-50m haul 0630 — Un-stippled :250-50m haul 0620

9/12/92 STATION K2

	1	2	3	4	5	6	7	8	9	10	11	12
A	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
B	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
C	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
D	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Mg VI F	Mg VI F
E	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
G	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Ca V	Ca V	Ca V
H	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F

5/12/92 J1

	1	2	3	4	5	6	7	8	9	10	11	12
A	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
B	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V
C	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F		Rg V	Rg V
D	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
E	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Rg V	Rg V	Cp V	Cp V	Cp V	Cp V	Cp V	Cp V
G	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V
H	Ca VI F	Ca VI F	Ca VI F	Rg V	Rg V	Rg V	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F

6/12/1992 J2

	1	2	3	4	5	6	7	8	9	10	11	12
A	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
B	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V
C	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F
D	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
E	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Rg VI F	Cp VI F	Cp VI F	Cp VI F
G	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V
H	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F

J1 1750 250-50m — J2 0745 250-50m

Ca = Calanoides acutus — Cp Calanus propinquus

Rg = Rhincalanus gigas — Mg Metridia gerlachei

JAMES CLARK ROSS 1992 INDIVIDUAL COPEPOD CHN SAMPLES

19/11/92 STATION G

	1	2	3	4	5	6	7	8	9	10	11	12
A	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F
B	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV
C	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
D	Rg V	38 VI oth	65 C oth	21 Mic							Rg VI F	Rg VI F
E	Cp V	Cp V					10 Mic					
F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
G	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV	Ca IV
H	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F

9/12/92 STATION K1

	1	2	3	4	5	6	7	8	9	10	11	12
A	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
B	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
C	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F
D												Cp VI F
E	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F
G	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V
H	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F

Stippled cells : copepods from 0-50m haul 0630 — Un-stippled :250-50m haul 0620

9/12/92 STATION K2

	1	2	3	4	5	6	7	8	9	10	11	12
A	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
B	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
C	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
D	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Mg VI F	Mg VI F
E	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
G	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Ca V	Ca V	Ca V
H	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F

5/12/92 STATION J1

	1	2	3	4	5	6	7	8	9	10	11	12
A	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
B	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V
C	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F		Rg V	Rg V
D	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
E	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Rg V	Rg V	Cp V	Cp V	Cp V	Cp V	Cp V	Cp V
G	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V
H	Ca VI F	Ca VI F	Ca VI F	Rg V	Rg V	Rg V	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F

6/12/1992 J2

	1	2	3	4	5	6	7	8	9	10	11	12
A	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F	Rg VI F
B	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V	Rg V
C	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F
D	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
E	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F	Mg VI F
F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Cp VI F	Rg VI F	Cp VI F	Cp VI F	Cp VI F
G	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V	Ca V
H	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F	Ca VI F

J1 1750 250-50m — J2 0745 250-50m

Ca = Calanoides acutus
Rg = Rhincalanus gigas
Cp = Calanus propinquus
Mg = Metridia gerlachei

Table 8: Krill activities at Sterna 92 stations

Station	dive	nets; date time (Z) type V=vertical, R=RMT8	acoustics *	experiments	live krill
Flossie	1	921113 2147-2203 V	yes	none	12
Gertie	1	921116 0115-0140 V 921116 1437-1451 V 921116 2156-2200 V 921116 2229-2242 V 921116 2245-2304 V 921117 0545-0602 V 921117 1650-1659 V 921118 0300-0040 V 921118 0353-0413 V	no **	gut fluorescence	none
Herbie	2	921129 1415-1432 V 921129 1442-1455 V 921130 0219-0228 V 921130 0248-0335 V	yes	gut fluorescence	none
Isolde	1	921201 0826-0847 V 921201 0908-0924 V 921202 2150-2300 R 921202 2315-0025 R 921203 0041-0125 R	on station, transect, krill search	gut fluorescence IGR (200 krill)	>1000
Jules	0	921204 0530-0537 R 921204 0815-1007 R 921205 0104-0158 R 921205 0725-0808 R 921205 0832-0917 R 921206 0111-0156 R 921206 0612-0704 R	on station, krill search	gut fluorescence IGR (200 krill) faecal pellets (180 krill)	>500
Katie	0	921207 0411-0455 R 921208 2220-0008 R 921209 0810-0920 R 921210 0733-0827 R	on station, krill search	gut fluorescence	none

* - times of acoustic transects and data run are shown in Table 9.
** - although acoustic data were collected at this station it is likely that ice beneath the transducer invalidated the results.

Table 9: Acoustic data collected on STAP BOFS cruise

File name	Size (K)	Start time (Z)	End time (Z)
28oct92.dat	7	921028 1446	921028 1543
29oct92.dat	36	921029 1519	921029 2055
30oct92.dat	7	921030 1219	921030 1332
30oct_2.dat	27	921030 1514	921030 1956
30oct_3.dat	58	921030 2225	921031 0802
31oct92.dat	47	921031 2111	921101 1012
5nov92.dat	101	921105 1240	921106 1148
6nov92.dat	281	921106 1716	921107 1652
7nov92.dat	40	921107 1655	921107 2005
7nov_2.dat	204	921107 2007	921108 1316
9nov92.dat	209	921109 1831	921110 1208
10nov92.dat	417	921110 1210	921111 1138
11nov92.dat	75	921111 1149	921111 1805
11nov_2.dat	72	921111 1928	921112 1135
12nov92.dat	57	921112 1140	921113 0026
15nov_g1.dat	38	921115 1947	921115 2252
18nov92.dat	206	921118 2009	921119 1319
19nov92.dat	47	921119 1322	921119 1721
19nov_2.dat	1772	921119 1726	921120 1617
20nov92.dat	220	921120 2228	921121 1327
21nov92.dat	44	921121 1329	921121 1709
21nova.dat	25	921121 1714	921121 1800
21novb.dat	266	921121 1802	921122 0227
22nov_1.dat	591	921122 0229	921122 1203
22nov_2.dat	145	921122 1205	921122 1424
22nov_3.dat	213	921122 1426	921122 1709
22nov_4.dat	658	921122 1711	921123 0118
22nov_5.dat	850	921123 0120	921123 1148
26nov_1.dat	1294	921126 2259	921127 2300
27nov_1.dat	675	921127 2302	921128 1133
28nov_1.dat	319	921128 1135	921128 1609
28nov_2.dat	201	921128 1611	921128 1827
28nov_3.dat	595	921128 2041	921128 0300
29nov_1.dat	153	921129 0314	921129 0457
29nov_2.dat	1704	921129 0505	921129 1732
29nov_3.dat	2711	921129 1732	921129 2345
30nov_1.dat	816	921130 0447	921130 1403
30nov_2.dat	930	921130 1405	921130 2224
30nov_3.dat	926	921130 2226	921201 0936
1dec_1.dat	239	921201 0941	921201 1406
1dec_2.dat	1321	921201 2053	921202 0148
3dec_t.dat	29	921203 0623	921203 0654
3dec_t2.dat	686	921203 0702	921203 1945
rmt1.dat	501	921202 2108	921203 0618
4dec_rmt.dat	1589	921204 0402	921204 1140
4dec_rm2.dat	570	91205 0033	921205 0306
5dec_rm2.dat	327	921206 0116	921206 0244
5dec_rmt.dat	477	921205 0715	921205 0924
6dec_1.dat	315	921206 0245	921206 0733
6dec_2.dat	151	921206 0735	921206 1003
6dec_3.dat	452	921206 1005	921206 1621
6dec_4.dat	746	921206 1720	921207 0144
6dec_5.dat	283	921207 0155	921207 0500
7dec_1.dat	659	921207 0623	921207 1347
7dec_2.dat	126	921207 1602	921207 1724
7dec_3.dat	406	921207 1726	921208 0145
7dec_4.dat	244	921208 0217	921208 1009
8dec_1.dat	526	921209 0626	921209 0837
9dec_trn.dat	799	921209 0147	921210 1047
9de_uor2.dat	708	921209 1726	921210 0124
9dec_uor.dat	1167	921209 0837	921209 1715
10dec_3.dat	653	921210 1639	911211 0001
10dec_4.dat	247	921211 0009	921211 0255
11dec_1.dat	720	921211 0257	921211 1027

145

krillen N = 65

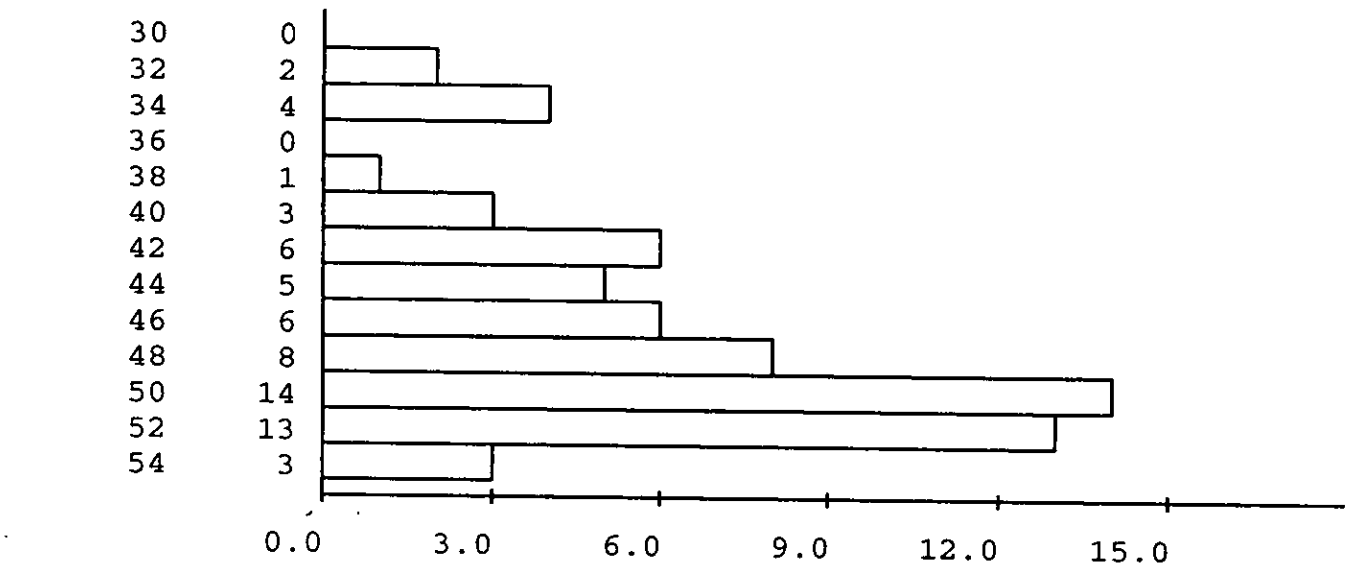


Fig. 1

4.17 UNDULATING OCEANOGRAPHIC RECORDER. - I. BELLAN.

Twenty UOR tows were completed on JCR and five Tows aboard Discovery.

The sensors fitted to the UOR were as follows

Depth, temperature, conductivity, chlorophyll, dissolved oxygen, transmission, salinity, PAR, light meters - 412D & U; 443D & U; 490D & U; 510 D & U; 555D & U; 632D & U and 683U.

Most tows undulated 2 - 65 x 4000m collecting 4 sec data point from the above sensors and creating reflectance files for the 6 pairs of light meters.

Time plots were produced on an IBM PC, and calibrated data downloaded on the level C, from which depth contour plots were produced.

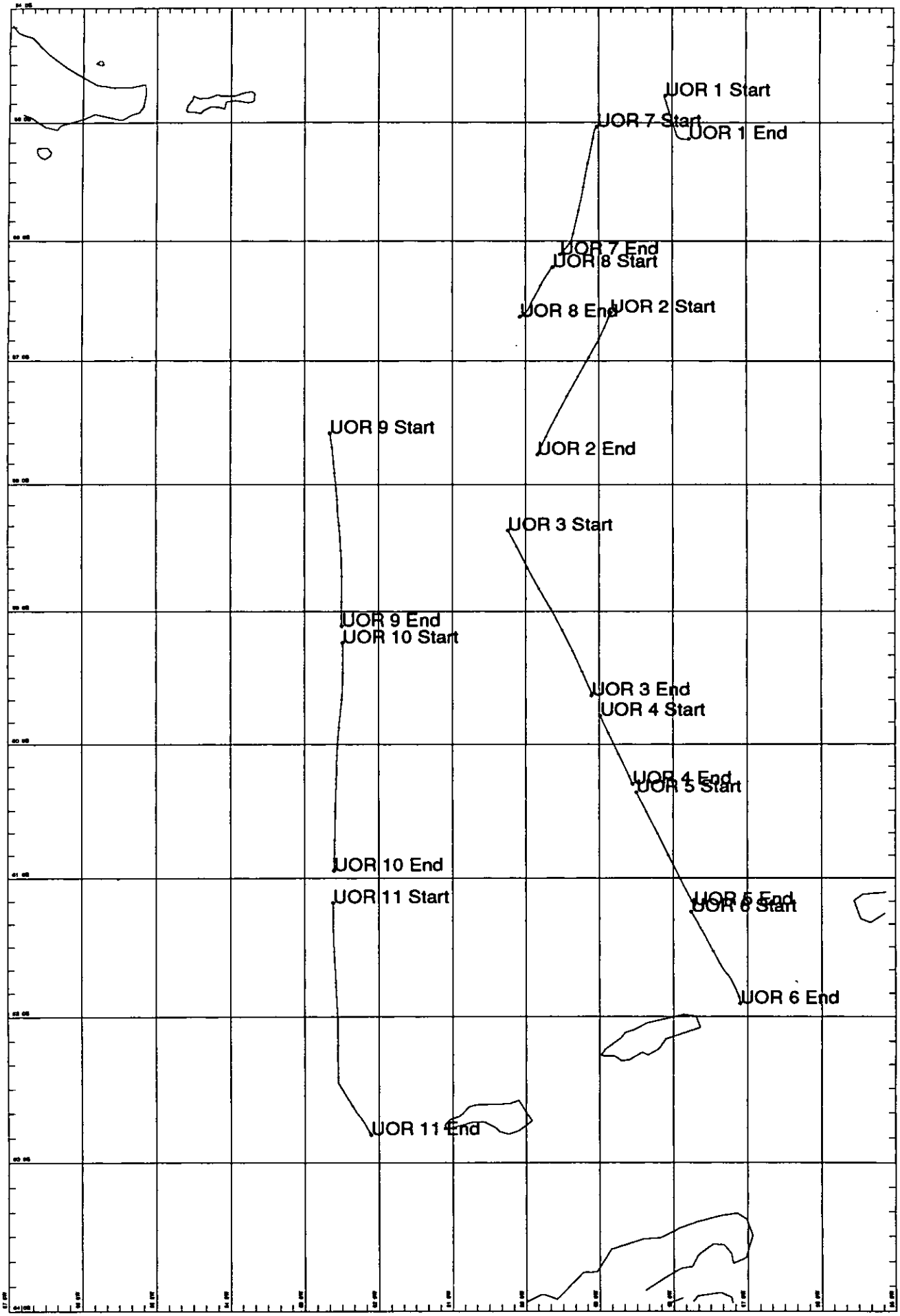
Towing operations worked smoothly on JCR, with no problems of deployment or recovery. This was made easier and safe for the UOR with the stern gantry so far aft of the ship. Even in rough seas no collision occurred.

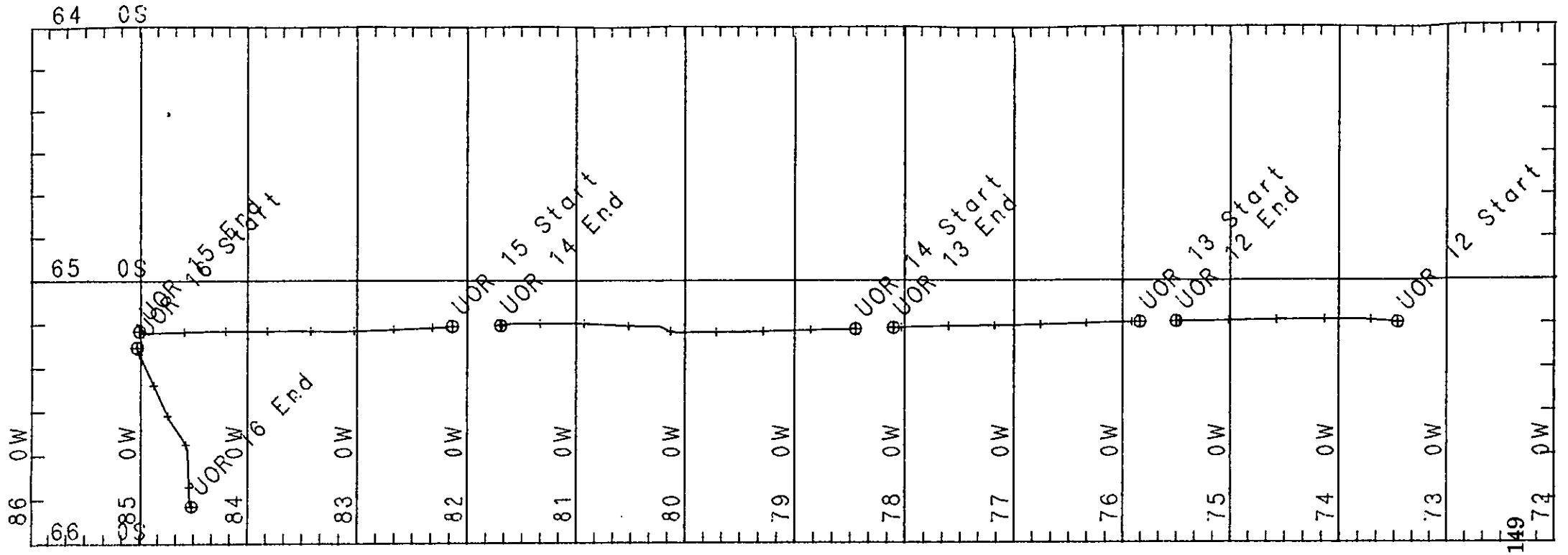
Although the Gilson winch deployment worked well, a dedicated winch with spooling would have been more useful, and reduced wear and tear on the cable.

Two risky operations occurred. The first on JCR, towing through the ice on tow 18, and the 2nd, when the wire jumped the sheave on Discovery and jammed in the block.

Twenty-two vertical profiles with a variety of combinations of sensors and light meters were carried out. Seven hand-held deployments of sensors through the ice were also carried out.

The following figures show the positions and numbers of UOR tows. See Appendix 4. for the UOR tow list.


UOR 1 Start
UOR 7 Start
UOR 1 End
UOR 7 End
UOR 8 Start
UOR 8 End
UOR 2 Start
UOR 9 Start
UOR 2 End
UOR 3 Start
UOR 9 End
UOR 10 Start
UOR 3 End
UOR 4 Start
UOR 4 End
UOR 5 Start
UOR 10 End
UOR 11 Start
UOR 5 End
UOR 6 Start
UOR 6 End
UOR 11 End



RVS MERCATOR PROJECTION

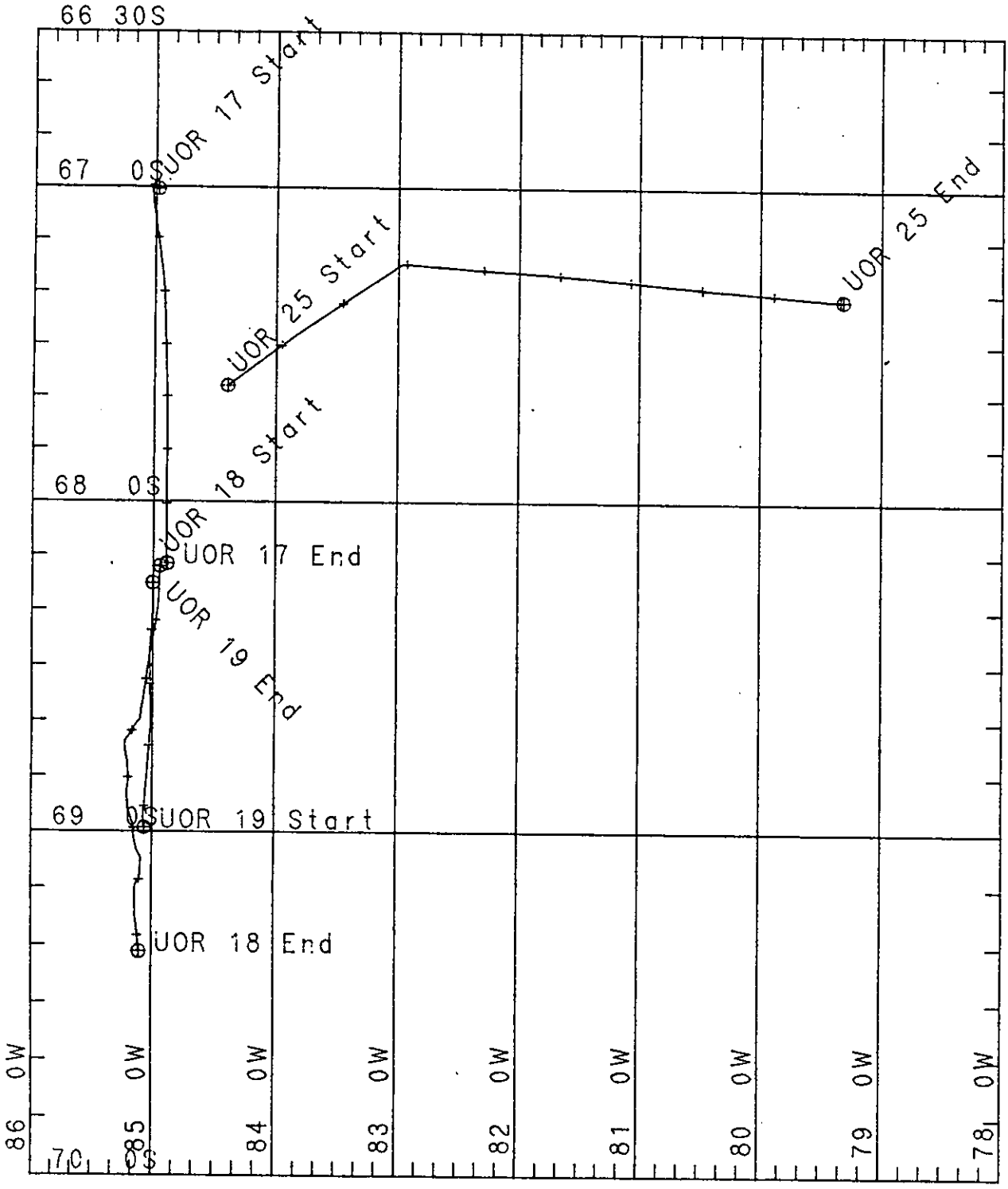
GRID NO. 2

—Track plotted from bestnav

SCALE 1 TO 2358940 (NATURAL SCALE AT LAT. -65)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE -65

UOR Tows off the Antarctic Peninsula, STERNA '92



MERCATOR PROJECTION

GRID NO. 3

SCALE 1 TO 2091184 (NATURAL SCALE AT LAT. -63)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE -63

4.18 DIVING OPERATIONS. - R. PRICE.

Introduction:

This report summarizes the equipment and methods used to enable the diving aspect of the cruise to be carried out safely and efficiently and contains a precis of the type of work undertaken by the diving contingent. Details are provided of the problems encountered and how they were resolved. A list of dive data is included and there is a note about special dive sites encountered. One site in particular should be considered for designation as an S.S.S.I.

Equipment:

Standard SCUBA equipment was used, particular attention being paid to the choice of a regulator suitable for Antarctic conditions. Poseidon 5000 or 500 regulators were chosen because of previous experience with these in both Antarctic and Arctic waters. These regulators were used on both the primary and pony cylinders. The primary cylinders were AP Valves 12.2 L, 232 Bar and the pony cylinders were Faber 3 L, 232 Bar.

The buoyancy aids used were mainly Buddy Commando Profile Buoyancy Compensators (B.C.), but a Scubapro Custom Black B.C. and a Buddy Arctic lifejacket were also used.

Six divers used neoprene drysuits, five made by Northern Divers, and one by Otter Watersports. The remaining three divers wore membrane suits, two of these were made by "Polar Bears". There seemed to be little difference between the two types so long as suitable underclothing was worn. On balance, less complaints about feeling cold after a dive were made by those wearing neoprene suits.

One diver used a"Spare Air" instead of a pony and this was tested on one dive at station "Gertie" and performed perfectly. On reflection, because of the small endurance of "Spare Air" and the need to return horizontally to the dive hole as well as ascending, it would be prudent to use pony cylinders when diving under the ice.

Although gloves were worn by three divers, and were adequate in keeping the hands warm, the remainder used mitts. Some of the latter were specially made by the divers out of 8mm. neoprene.

A two man, twin chamber, recompression chamber fed by three 47.2 L cylinders was located in the "Tween Deck" hold and was always ready for use whenever diving was being undertaken.An oxygen supply was rigged up to administer oxygen to any potential patient. This was fed by one 47.2 L cylinder with a second as reserve. The air bank could be charged from the Bauer Mariner compressor used for charging the diving cylinders. (There was also a diving

doctor on board to oversee the use of the chamber if it was required for therapeutic use).

A skidoo and Nansen sledge were provided for taxiing the dive team to and from the dive site when conditions were suitable (only at Ice Station "Gertie" on this cruise).

A Stihl 084 AV chainsaw with a 48" guide bar and chain was used to prepare the dive holes.

Regulator Protection:

The interstage pressure was reduced from 12.5 to 11.5 Bar to reduce the risk of a free flow occurring. The second stage was also set on the harder to inhale setting of the two possible settings. All the regulators had environmental protection caps fitted and these were filled with a 50:50 mixture of glycerine and distilled water. The easiest way to fill these was found to be as follows:

1. Place the regulator with the pressure sensing port uppermost and fill the port with neat glycerine, taking care to exclude all the air by pouring a thin stream in slowly. By doing this the glycerine will remain in place, excluding air, for the rest of the filling operation when the regulator is tilted.
2. Keeping the regulator as level as possible put on the cap.
3. Raise up the edge of the cap with a blunt instrument such as the handle of a pair of forceps. Insert a rigid tube attached to a syringe filled with diluted glycerine.
4. Tip the regulator to exclude the air as inject glycerine until glycerine spills out and regulator is now "upside down". It takes about 35 ml. of glycerine to fill the cap. Remove the tube and attach the plastic cable clip.

Care of the Equipment:

Because of the danger of freshwater freezing in the regulators, direct feeds, dump valves etc., it was essential to thoroughly dry everything before the next dive. The second stage could easily be partially stripped after washing to facilitate drying. If two dives were planned on the same day then the equipment would not be rinsed between dives.

Due to the hardening of "O"-rings at low temperatures, the air supply was always turned on in the warm before taking the equipment outside.

Methods:

Boats were used at the ice edge and once a suitable location had been found the anchor was thrown onto a suitable floe to prevent the boat from moving at a different rate to the ice.

The boatman then acted as linesman for the divers who worked under the pack ice as they had under the fast ice. The ice edge was tightly packed pack ice with no areas of open water. It was prudent to therefore treat these dives as true "under ice" dives. Even had the pack been loose and had there been no wind, it would still have been prudent to use lines to the divers.

When working on floes where the ship had to stay alongside the floe, a crane and special bridle were used to transfer the divers and equipment onto the ice. The equipment was stowed on the net in the centre of the bridle and the divers stood on the outside. The dive hole was cut as close as possible to the "Landing Zone" in these instances. If the ship could penetrate very large floes without them cracking up then a gangway was lowered onto the ice and access was quicker and easier. Equipment could then be carried down in stages to a waiting sledge. The dive sites could be any distance from the ship in this instance.

A hole large enough to accommodate two to three divers was cut and this usually involved making three cuts with the chain saw in one direction and a further four at right angles to produce six blocks. If the blocks proved to be unmanageable they were either cut again or split with a pick axe. One block was then pushed under the ice with an ice chisel to facilitate the removal of the remaining blocks.

The system used for roping the divers was to have one diver on the main line to the tender and the other diver, or divers, would be attached to a second or third line running along the main line. This gives the second diver the freedom to travel along the main line to untangle the rope, return or collect items to or from the surface etc., without disturbing the first diver. The ropes were attached to the diver's harness with a bowline and the clip on the end of the rope was then attached to the line for extra security. If the harness was joined together by a clip, as on the Buddy B.C.s, then the clip on the end of the rope was always attached to a loop on the B.C. Should the harness clip have come undone during a dive then the rope would still have been firmly attached to the diver. Finally, the free end of the rope was always attached securely to either the linesman, sledge or skidoo.

A very basic signalling system was used. This involved one pull to let out more line, two pulls to take in slack and three or more pulls to indicate an emergency and to pull in the divers quickly. To enable this to work though, the line had to be kept reasonably taught.

Problems:

Very few problems were encountered. The main cause for concern was that, for some reason, a total of twelve High Pressure hoses blew and had to be scrapped. These were not all from the same source and the cause has yet to be identified. Minor leaks from direct feed hose connections occurred occasionally but a strip down and "O"-ring replacement or cleaning was all that was required.

If a diver had to make two or more visits to the surface, the second stage would feed ice and water along with the air on descent but, although unpleasant, it would generally clear after half a dozen deep exhalations once in clear water under the dive hole.

At several stations there was a $\frac{1}{2}$ kt. current running which presented problems when carrying equipment and the divers sometimes had to rest after the occasional struggle. The linesman was aware of the current and that help would sometimes be required on the return to the dive hole.

Dive Sites of Special Note:

In general, there was very little life evident under the ice, predominantly ctenophores. There was an abundance of benthic life at the first shake down station on Grotto Is. at Faraday. However, although that site was, in the D.O.'s opinion, an exceptionally rich and varied habitat, this paled into insignificance when compared to the site at the S.W. end of the runway at Rothera Point.

The variety, size and abundance of the benthic communities there was quite extraordinary and justifies a further investigation with a view to designating the area as an S.S.S.I.

Recommendations:

Should a similar cruise be undertaken in the future it would be advisable to adher to similar equipment and methods outlined in this report. The regulators and methods for diving under the ice are those used at the B.A.S. base at Signy Is. and are tried and tested and are reliable as they could be under the extreme conditions that the divers work under.

It is also essential to carry a good stock of spares and a couple of complete sets of diving equipment in case of loss or failure. Ideally this should include at least one spare dry suit in useable condition.

A heated changing room come drying room which could be dedicated to the divers use would also be advantageous, both to the divers and to the rest of the ship's company.

A skidoo and sledge are invaluable when working on solid ice away from the

ship and on this cruise the combination also proved to be of great value to other scientists as a cargo carrier.

It proved to be very difficult to recharge the air banks for the recompression chamber as this was sited in the forward, No.2, hold. To avoid having to disconnect and move the cylinders so that the existing charging hose could reach the compressor up on the main deck, a new hose should be obtained. This should have a fitting for the "A" clamp of the compressor at one end and a male fitting for the 47.2 L air cylinder at the other. A length of 15 m. of hose would be sufficient.

Finally, it would be advisable to have at least one member of the dive team who has had experience of diving under the ice and is familiar with all aspects of this demanding task.

Conclusion:

Considering a total of 56 dives were undertaken, of which 47 were under the ice, there were remarkably few problems. Both the divers and their equipment performed well and there were no incidents worth reporting here. Considering only the D.O. had had previous under ice experience it is worth recording how easily and confidently the other divers undertook this exacting type of diving. All the divers thoroughly enjoyed their experiences and they will remember this cruise as a highlight in their diving careers.

Acknowledgements:

Although there were usually enough "spare" divers to help carry equipment and line for the working divers, there were inevitably times when outside help had to be sought. Thanks are due to most people on board who helped with the hole preparation and lugging kit around etc., but special thanks are due to Steve Wells who worked like a Trojan out on the ice. I should also like to thank the scientists, and the divers in particular, for their help and support in making my job a little easier and for making the whole cruise so pleasant and unforgettable.

Appendix.

List of Divers, Experience and Work Description:

Sarah Bury: BSAC Advanced Diver, 1980. 350+ dives. ^{15}N uptake by phytoplankton. Measurement of uptake rates of nitrate, ammonia, urea and dissolved free amino acids by phytoplankton in ice samples and in water immediately under the ice.

Carol Robinson: BSAC 3rd. Class Diver, 1984. 2nd. Class, 1986. HSE Part IV, 1991. 400 + dives. Calibration of in situ O_2 instrument, Langdon Oxygen Rig.

Jon Watkins: BSAC 3rd. Class Diver, 1975. Advanced Diver, 1992. 75 dives. To look for krill under the ice and to sample and observe. Use of 70 mm. stereoscopic camera system to photograph swarms of krill.

Helen Hill: BSAC 3rd. Class, 1982, Advanced, 1992. 200 dives. Assist Jon Watkins.

Nicky Fenton: BSAC Advanced Diver, 1992. 68 dives. Use of a modified Undulating Oceanographic Recorder (UOR) to measure light transmission through the sea ice along a transect.

Steve Archer: BSAC Advanced Diver, 1991. 300 + dives.

Ray Leakey: BSAC Advanced Diver, 1992. 109 dives. Joint work with Steve. Microbial sea ice Level 1 abundance and biomass estimations along sea ice transect involving water and ice collection from ice and ice/water interface. Microbial rate measurements in sea ice involving ice collection from sea ice and transfer to in-situ incubation rig. Activities for other groups involving ice collection.

Julian Priddle: BSAC 3rd. Class Diver, 1970. Advanced Diver, 1992. 200 + dives. Assistant Principle Scientific Officer.

Rick Price: BSAC 3rd. Class Diver, 1974. HSE Part IV, 1984. Diving Officer. 500 + dives. As a freelance wildlife cameraman to carry out some filming for a new B.B.C. T.V. series about Antarctica called "Life in the Freezer".

Dive Data:

Type of Dive.	Location.	No. of Dives.
Shake down	Potter Cove	4
" "	Faraday	8
" "	Bellingshausen Sea	4
Working	Ice Station "Gertie"	24
" "	" " " "Gertie II"	6
" "	" " " "Isolde", ice edge	2
Recreational	Mare Harbour, F.I.	3
" " "	Faraday	2
" " "	Rothera	3
	Total:	56 (plus 2 chamber dives)

Depth Range: 2 - 28 m.
Dive Duration Range: 2 - 80 mins.
Avr. Dive Time: 25 mins.
Total Under Ice Dives: 47
Total Work Dives: 32

Individual Dive Totals:

Alan Milne (Doctor)	2	(Chamber dives)
Rick Price	22	
Ray Leakey	22	
Steve Archer	20	
Nicky Fenton	11	
Carol Robinson	10	
Jon Watkins	11	
Sarah Bury	8	
Helen Hill	6	
Julian Priddle	2	

Total Individual Dives: 114

Total Man-Hours spent underwater: 48 hrs. 26 mins.

N.B. A dive was recorded as being a separate dive if the diver stayed on the surface for longer than a minute, any less and the dive counted as the same dive.

Photographic Record of the Cruise:

16 mm. cine film was shot for the B.B.C. and is B.B.C. copyright. The B.B.C. agreed to copy any underwater material onto tape for internal use by B.A.S. scientists. Some of this material was of krill feeding off the ice so perhaps Jon Watkins at B.A.S. could be contacted for further information.

The D.O. also shot some Hi-8 video of underwater activities and some of the flora and fauna. This material is the D.O.'s copyright and any enquiries should be directed to him at his home address:
19, Abbey Court, Denbigh, Clwyd, N.Wales, LL16 3HU.

Dive Log Sheets:

Full dive details are available from Martin White, Institute Diving Officer, B.A.S., Cambridge. Dive Reference Numbers for this cruise are: JCR 1/92 to JCR 58/92.

Species Recorded for Rothera Pt. Dive Site:

Most life was around 15 - 20 + m. Ice scour prevented growth above 7 m.
Groups of ascidians, 10 - 15 cm. tall.
Nemertine worms.
Holothurians, 20 - 30 cm. tall.
Crenoids (Feather Star), 30 cm. diameter.
Anemonies, 10 - 15 cm. diameter, 20 cm. tall.
Pycnogonid nyphon.
Nacella.
Hargagifer, large numbers.
Echinoderms. Hundreds of small (3 - 5 cm. diameter) sea urchins. Abundance of small red starfish and larger (20 cm. diameter) white starfish. Red spotted cushion starfish.
Clumps of Desmarestia weed, no Antarcturus noticed amongst this.
White tentacles of tube worms in abundance.
Encrusting sponges and "soft corals".
~~Small groups of polyps, like tiny sea anemonies.~~
Brittle stars in abundance.
Large yellow nudibranchs (?), 5 - 10 cm. in diameter.
Other unidentified species in abundance.

4.19 CTD OPERATIONS. - S. WATTS.

CTD OPERATION

Seventy nine casts were completed during the cruise and with the exception of :
a) The rosette sampler mechanism only allowing eleven bottles.
b) The oxygen sensor expiring after about the sixteenth cast. (It was then replaced and functioned well for the remainder of the cruise.)
the system worked very well.

Calibration

The CTD calibration proved to be very steady through out the cruise. The temperature offset was generally <+/-0.02mC compared with the reversing thermometers and +0.09 offset in salinity compared with samples measured on the autosal.

The autosal was also checked during an intercalibration exercise with RRS Discovery ,this showed an error of less than 2ppm between the two ships. (table 3).

However keeping the autosal's temperature steady proved to be very difficult (due to the extreme ambient temperatures) which made it unusable for long periods.

The pressure sensor showed a 2m offset during the cruise.

In air laboratory calibrations for the light meters,transmissometer and fluorometer have also been included. (Table 4)

Data

The CTD data has been logged on two systems :
a) ABC system (see Paul Duncan).
b) EG&G CTD PC logging program.

Two meter ASCII pressure averaged files for most casts (apart from when casts were repeated in a short time period) upto 250m and five meter averages for every cast cast over 250m have been produced from the PC. Also bottle files have been made for all the casts,however due to the data interruption during water collection these files should be treated with caution. (pressure averaged files are named JA02*.prs and bottle files JA02*.btl). **THESE DATA ARE UNCALIBRATED.**

Deployment

Working with the ships crew and officers was a pleasure. The AB's on deck were friendly,enthusiastic and very competent,also thanks go to John and Colin for their excellent winch driving.

The traction winch system caused problems throughout the cruise. Its built in time delays make deployments very slow at critical moments ie just as the CTD enters and leaves the water, it also required constant repairs and adjustments by Simon Wright, without his skill and dedication the CTD programme would not have been successful.

In the future I would not be prepared to work round obstacles in front of the CTD hanger (ie the SAPs winch).

Also the 30 tonne coring block on the A frame chaffed and kinked the wire and pulled it off the top roller on two occasions. Greasematics falling from the gantry made the working environment hazardous and reminding the scientific community to wear their safety helmets was a chore throughout the programme.

The UIC room was a excellent to work in, the close proximity of the CTD PC,winch control and PES made operations very smooth. However I would recommend that one of the scientific watch keepers be available to start the computers logging and to fill in the log sheets etc. while the CTD operator is on deck during deployment.

TABLE 1

REVERSING THERMOMETER DATA SHEET

CAST No.	CTD TEMP	RTM 179	RTM 179 CORR.	CTD-RTM 179	RTM 213	RTM 213 CORR.	CTD-RTM 213
6	-0.532	-0.514	-0.506	-0.026	-0.516	-0.514	-0.018
7	-1.727	-1.669	-1.661	-0.066	-1.710	-1.708	-0.019
9	-1.824	-1.827	-1.819	-0.005	-1.838	-1.836	0.012
10	-0.449	-0.438	-0.430	-0.019	-0.404	-0.402	-0.047
18	-1.802	-1.804	-1.796	-0.006	-1.817	-1.815	0.013
19	1.147	1.145	1.153	-0.006	1.132	1.134	0.013
20	-1.840	-1.832	-1.824	-0.016	-1.847	-1.845	0.005
23	0.163	0.148	0.156	0.007	0.134	0.136	0.027
24	0.202	0.199	0.207	-0.005	0.183	0.185	0.017
26	1.159	1.159	1.167	-0.008	1.145	1.147	0.012
27	1.392	1.384	1.392	0.000	1.372	1.374	0.018
28	1.486	1.469	1.477	0.009	1.457	1.459	0.027
31	1.280	1.271	1.279	0.001	1.255	1.257	0.023
32	-1.809	-1.810	-1.802	-0.007	-1.824	-1.822	0.013
33	-1.817	-1.823	-1.815	-0.002	-1.837	-1.835	0.018
34	-1.374	-1.808	-1.800	0.426	-1.821	-1.819	0.445
35	1.297	1.256	1.264	0.033	1.245	1.247	0.050
36	-0.371	-0.379	-0.371	0.000	-0.390	-0.388	0.017
37	-1.809	-1.809	-1.801	-0.008	-1.825	-1.823	0.014
38	1.553	1.548	1.556	-0.003	1.534	1.536	0.017
39	-1.813	-1.815	-1.807	-0.006	-1.828	-1.826	0.013
40	-1.822	-1.825	-1.817	-0.005	-1.838	-1.836	0.014
41	-1.812	-1.812	-1.804	-0.008	-1.827	-1.825	0.013
43	-0.109	-0.114	-0.106	-0.003	0.125	0.127	-0.236
44	-1.832	-1.839	-1.831	-0.001	-1.852	-1.850	0.018
45	-1.777	-1.781	-1.773	-0.004	-1.795	-1.793	0.016
46	-1.830	-1.835	-1.827	-0.003	-1.849	-1.847	0.017
48	0.769	0.766	0.774	-0.005	0.753	0.755	0.014
49	0.796	0.734	0.742	0.054	0.747	0.749	0.047
50	-1.119	-1.120	-1.112	-0.007	-1.136	-1.134	0.015
51	-1.469	-1.495	-1.487	0.018	-1.511	-1.509	0.040

CAST No.	CTD TEMP	RTM 179	RTM 179 CORR.	CTD-RTM 179	RTM 213	RTM 213 CORR.	CTD-RTM 213
52	-1.243	-1.249	-1.241	-0.002	-1.261	-1.259	0.016
56	-1.322	-1.329	-1.321	-0.001	-1.341	-1.339	0.017
57	-1.168	-1.156	-1.148	-0.020	-1.170	-1.168	0.000
58	-1.123	-1.126	-1.118	-0.005	-1.140	-1.138	0.015
59	-1.157	-1.356	-1.348	0.191	-1.376	-1.374	0.217
60	-1.257	-1.253	-1.245	-0.012	-1.263	-1.261	0.004
61	-1.673	-1.667	-1.659	-0.014	-1.653	-1.651	-0.022
62	-1.106	-1.115	-1.107	0.001	-1.125	-1.123	0.017
63	-1.335	-1.332	-1.324	-0.011	-1.341	-1.339	0.004
65	0.336	0.333	0.341	-0.005	0.317	0.319	0.017
67	-1.650	-1.682	-1.674	0.024	-1.693	-1.691	0.041
69	1.127	1.123	1.131	-0.004	1.112	1.114	0.013
72	-1.173	-1.184	-1.176	0.003	-1.192	-1.190	0.017
73	-0.918	-0.925	-0.917	-0.001	-0.935	-0.933	0.015
75	-0.934	-0.941	-0.933	-0.001	-0.974	-0.972	0.038
78	-1.248	-1.242	-1.234	-0.014	-1.255	-1.253	0.005
79	0.348	0.334	0.342	0.006	0.330	0.332	0.016

TABLE 2

SALINITY CALIBRATION

SAL BOTTLE	CTD SALINITY	AUTOSAL SALINITY	CTD - AUTOSAL
4	34.037	34.139	-0.102
47	NO DATA	34.169	-34.169
48	NO DATA	34.078	-34.078
1	NO DATA	34.064	-34.064
3	34.345	34.432	-0.087
4	34.240	34.324	-0.084
5	34.095	34.173	-0.078
6	33.873	33.967	-0.094
7	33.729	33.820	-0.091
8	33.710	33.801	-0.091
9	33.710	33.800	-0.090
10	33.710	33.800	-0.090
11	33.710	33.800	-0.090
12	33.709	33.799	-0.090
13	33.708	33.799	-0.091
14	34.345	34.430	-0.085
15	34.240	34.328	-0.088
16	34.095	34.171	-0.076
17	34.873	34.966	-0.093
18	33.729	33.818	-0.089
19	33.710	33.798	-0.088
20	33.710	33.798	-0.088
21	33.710	33.798	-0.088
22	33.710	33.798	-0.088
23	33.709	33.798	-0.089
24	33.709	33.797	-0.088
3	34.522	34.605	-0.083
10	34.629	34.713	-0.084
11	33.945	34.035	-0.090
12	34.635	34.721	-0.086
13	34.645	34.727	-0.082

14	34.645	34.724	-0.079
15	34.639	34.720	-0.081
16	34.634	34.714	-0.080
28			0.000
29			0.000
30			0.000
31			0.000
32			0.000
33			0.000
34			0.000

FAO Bill Miller/Jane Read RRS Discovery
Here are the results from the CTD salinity intercalibration.
We have just arrived back on station today and should start CTD's fisrt thing in the morning.
All the best.
Regards Simon

SALINITY SAMPLES TAKEN FROM JCR CTD CAST 27

Wire Out	JCR Bottle No.	Salinity	Disco. Bottle No.	Salinity	Diff.
250	14	34.430	3	34.432	0.002
200	15	34.328	4	34.324	0.004
150	16	34.171	5	34.173	0.002
100	17	33.966	6	33.967	0.001
80	18	33.818	7	33.820	0.002
60	19	33.798	8	33.801	0.003
40	20	33.798	9	33.800	0.002
30	21	33.798	10	33.800	0.002
20	22	33.798	11	33.800	0.002
10	23	33.798	12	33.799	0.002
2	24	33.797	13	33.799	0.002

SALINITY SAMPLES TAKEN FROM DISCOVERY

Wire Out	Disco Bottle No.	Salinity	JCR Bottle No.	Salinity	Diff.
250	B31	34.446	S1	34.445	0.001
	B33		S2	34.445	
200	B32	34.314	S3	34.313	0.001
	B34		S4	34.131	
150	B35	34.187	S5	34.186	0.001
	B36		S7	34.184	
100	B37	33.976	S6	33.976	0.000
	B38		S9	33.975	
80	B39	33.819	S8	33.818	0.001
	B40		S11	33.818	
60	B41	33.801	S10	33.800	0.001
	B44		S12	33.801	
40	B42		S14	33.798	
	B43	33.800	S15	33.799	0.001
30	B45	33.799	S13	33.798	0.001
	B46		S16	33.799	
20	B47	33.800	S17	33.799	0.001
	B48		S20	33.798	
10	B49	33.800	S18	33.798	0.002
	B50		S21	33.798	
2	B51	33.799	S19	33.797	0.002
	B52	33.799	S22	33.797	0.002
2	B53	33.799	S23	33.797	0.002
	B54		S24	33.797	

TABLE 4

CTD S/N 01-2073

TEMPERATURE COEFFICIENTS

Term	Coefficient
0	6.0353E-03
1	4.999941E-04

PRESSURE COEFFICIENTS

Term	Coefficient
0	-17.65
1	9.98146E-02

LIGHTS METERS
S/N 1 UPWELLING
Volts Out Blanked off 2.946v

S/N 2 DOWNWELLING
Volts Out Blanked off 3.003v

TRANSMISSOMETER S/N 115

Vout in air	4.753v
Vout blocked	0.001v

FLUOROMETER S/N 234

Vblanked	0.4-0.5v
Vwhite card	3.75v

REVERSING THERMOMETERS
S/N 179

TERM	COEFFICIENTS
0	8.2E-03
1	0.9991
2	4.35E-05

S/N 213

TERM	COEFFICIENTS
0	3.4E-03
1	0.9984
2	7.3E-05

SURFACE TRANSMISSOMETER
S/N 101

Vout in air	4.754v
Vout blocked	0.004v

AUTOSAL

S/N 56747
STANDARD SEA WATER BATCH P119 K15 0.99990

4. 20. ELECTRONICS. - P. WOODROFFE.

GENERAL

By any standards this has been an extremely quiet cruise in terms of electronics support required, this been due to the lack of actual science days and, rather more satisfyingly, due to the good reliability achieved with the systems we've been operating.

Since the pre-sailing panic, I have been mainly occupied with CTD activities and writing a couple of programs for logging and converting the echo sounder data.

The only major equipment failure was early on in the cruise when I was asked to look at a problem with the Mass spec which had caused a major blow up. After many red herrings I eventually traced the fault to a pair of interconnecting cables which had been transposed during installation. It was very fortunate that we happened to have the correct components on board to replace the ones that were vapourised during the blow up. A later problem with noise spikes on the same bit of equipment was solved by the relocation of an oven.

OCEANLOGGER

A major part of my efforts, before leaving Port Stanley, were concentrated on getting the new Oceanlogger (sea surface and meteorological monitoring) system up and running.

Problem number one was with the Turner Fluorometer which had not been tried before. Its enormous appetite for mains fuses was caused by the fact that it was actually wired, internally, for 115V operation. The usual lack of technical data, or even sensible labelling on the instrument, meant that this fact could only be ascertained by opening the case and looking at the mains transformer therein. Fortunately my assumptions proved correct and fortunately the electronics remained undamaged by their previous ordeal by over voltage.

The Seabird thermosalinograph was producing highly intermittent readings. Disassembly and careful reassembly to ensure the mechanical integrity of the internal connectors solved the problem but the readings were consistently low. Cleaning the cell with a 10% solution of "Decon" solved the problem which was presumably due to biological fouling.

All instruments seemed to have performed well throughout the cruise with the exception of the humidity sensor, which gave extremely suspect readings and the thermosalinograph which suffered a reoccurring problem which I have not yet solved. The readings, which were normally very reliable, would start to gradually decrease until someone noticed. At this point I would cure the problem by draining, and then refilling the thermosalinograph. I am sure that the low reading was caused by some foreign body (possibly small ice crystals or dirt) becoming trapped inside the narrow glass tube that forms the body of the conductivity cell.

I am not really sure what our approach should be to solving this problem but some sort of in-line filter may be the solution (fitted over the ends of the cell, perhaps?) though obviously we must be careful not to compromise the salinity and chlorophyll measurements.

Oceanlogger Instruments

Parameter	ABC name	Units	Instrument
Met sea temp	MSTEMP	°C	Met office PRT
Sci sea temp	SSTEMP	°C	Uncontam PRT
Salinity	SAL	PPt	SBE 21
Fluorescence	FLUOR	%FSD	TURNER
TIR	TIR	W/M^2	Kipp & Zonen
PAR	PAR	W/M^2	Didcot
Flow	FLOW	L/min	Litermeter
Wind Speed	WSPD	Knots(rel)	Vector Inst
Wind Dir	WDIR	0-360°(rel)	Vector Inst
Air Temp	ATEMP	°C	Vector Inst
Humidity	HUM	%	Vaisala
Atmos Pressure	PRESS	mBar	Vaisala

ECHOSOUNDERS

It was necessary, at the start of the cruise, to fit a new 120KHz transceiver module to the EK500 sounder. This was a consequence of the tests that we had performed during the gear trials this summer. We had found that the 120KHz transceiver suffered from excessive internal noise. Simrad admitted that there was a problem and agreed to provide a replacement board, free of charge. This replacement, although an improvement, was certainly not perfect.

The second problem that I had to solve was that of synchronising the EA (wheelhouse echo sounder) with the EK to resolve a problem that had with the transmit pulse of the EA influencing the integrated values from the EK. I connected the trigger output of the EK with the sync input of the EA but to no avail. One fax to Norway later and I was the proud owner of the information that Simrad had managed to build an echosounder that was incompatible with itself (trigger output = positive, required input = negative). Fortunately a simple modification corrected the problem.

The echosounder calibration (at Potter Cove, King George Island) went very well, with no delays though it was noted that it was not possible to run the system on "Reduced power" without the 120KHz transceiver going int oscillation. Fortunately this was not a problem for us on this cruise as we only required full power operation.

The integrator data were being logged using "Kermit" so I wrote a program to extract the data and comments and convert the data to more familiar values than those output by the EK. Later on I modified this program to log the data also, so that Kermit was no longer necessary. The original intention was to log these data to the ABC system but this would have meant having an impossibly large SMP message. Perhaps in future we will bypass A and B and log straight to the level C (as with the ADCP), though obviously this ignores the ABC philosophy.

The EK500 performed very well, even in difficult circumstances - such as during ice breaking but the problems with the 120KHz sounder are rather disconcerting and their resolution is down to the engineering might of Simrad, which is also disconcerting.

EK400

I wasn't actually expecting to have to do anything to the BAS EK400, as it was installed on RRS Discovery, however my presence was requested to solve a problem with the echo integrator. One extremely scary boat ride later and I am happy to say that I was able to resolve the problem, which was actually in the Biosonics integrator, rather than the Simrad. I sincerely hope that I am never on a two-ship cruise again.

4. 21a COMPUTING. - P. DUNCAN.

Objectives

1. To operate and maintain the RVS ABC computer system during the cruise.

2. Using the above system, to log the following instruments:

Electro-magnetic and Doppler logs
Trimble GPS
Ships gyro
CTD
6 channel nutrients analyser (continuous and discreet measurements)
Transmissometer
Total CO_2
The Undulating Ocean Recorder (UOR)
The BAS "Oceanlog" PC, which itself logs the following variables

- air temperature
- air pressure
- wind speed & direction
- sea temperature
- fluorescence
- two sets of light levels (PAR & TIR)

3. To assist scientists in calibrating some of the data into real units (as opposed to volts) whilst on the ship to enable them to draw some preliminary conclusions from these data, and as an aid in deciding where to take the ship next.

4. To enable scientists to send and receive email via the RVS Ship to shore transfer system.

5. To provide a limited general computing support for non RVS hardware and software brought on the cruise by scientists.

6. To Provide plots (line, scatter, & contour) and data (usually ASCII on a 3.5" floppy disk) on an *ad-hoc* basis.

Report

1. The ABC system was run continuously apart from periods when the ship was stationary at bases or in port. There was minimal loss of data, total approximately 45 minutes due to Level B failure.

2. All objectives bar total CO_2 were achieved, although with a few problems. Part downcasts of some CTD dips were lost due to the MK II CTD Level A crashing.

3. All CTD data has been calibrated, and some nutrients data has been calibrated with the help of Malcolm Woodward. I expect some more of this data to be calibrated before the end of the trip.

4. A number of email messages have been received and sent by scientists, most to the U.K., but one to the U.S.A. Unfortunately an attempt to send data to RRS Discovery using this method failed.

5. Some support was given to scientists, mainly in the areas of formatting disks, recovering corrupted files and printing. A *quick and dirty* label printing program was written in BASIC for one of the scientists.

6. Various multi-variable plots were provided for each CTD dip logged. Single variable plots were undertaken by Carolyn Symons of BAS, who was also trained up to take over contour plotting of the UOR data. Several small amounts of ASCII data were dumped to floppy disc for several of the scientists.

Additional Information

Certain of the above report topics deserve slightly more detailed explanation. This is given in the paragraphs laid out below.

Level A Computers

The navigation type Level A's (Both Logs, GPS & Gyro) were the Mk II units installed just aft of the Bridge. These were already switched on and working when I joined the ship. The only problem with these units was that they occasionally output an alarm message stating that the master clock had jumped. The only way to stop this message being output was to reset the Level A. Apparently these machines are using old versions of the Level A software, so perhaps this problem has been fixed now. In all it only happened 3 or 4 times during the whole cruise.

The CTD Level A was a brand new Mk II CTD Level A, using the same Motorola 68030 based board as the Mk II Level B. Unfortunately the Level A had just been mounted in a rack and left in place of the standard Mk II Level A which it had replaced. Nothing had been done to cable the machine into the ship. The standard Mk II Level A uses Lemo plugs, as the Mk I Level A and Mk I CTD Level A had. Unfortunately no front or rear panel had been built for the Mk II CTD Level A to accommodate the sockets

for these plugs, and so, for the moment it uses standard 25 way D type connectors. So the first job was to remove the Lemo type cables and use D type cables instead. This was done and the CTD, for the most part worked satisfactorily, crashing only two or three times.

The nutrients analyser and transmissometer instruments needed to be logged by Mk I Level A computers because they output analogue signals, not RS-232 signals as the other instruments do, and no analogue board is available for the Mk II Level A's as yet, although one is in development. Once the Level A's had been found it was a simple matter of installing the EPROMs for the "NUTRI2" application, for the autoanalyser. No new 27128 EPROMs were on board, so I had to erase a set of EPROMs that I brought down with me, and blow the "FLUTE" application into these chips.

I had hoped to log total CO_2 in real time using a Mk II Level A. Unfortunately the TCO2 application on the system did not appear to work with the data coming out of Carol Robinson's PC. The data did eventually arrive on the system, I wrote a program to generate "listit" type records from the data logged to disc by the TCO_2 system.

UOR data is normally formatted into "listit" type records on a PC using a program called "prouor". Unfortunately this only caters for 16 variables, so it needed to be modified to take the 26 variables. This was done, but the C compiler on the PC (Microsoft C v6.00) didn't appear to work properly, so I eventually compiled it for the Level C and ran it on there. It still didn't work, because the format of the UORs ".sal" type file had changed slightly. A newline character had been added between the 25th and 26th variables. So I wrote another program, "fixuor", to correct this problem. Once the file supplied by Ian Bellan had been through fixuor and then through prouor, one more thing needed to be done. There were two Chlorophyll variables and both had the same name, "CHLORJ5". I used an existing RVS program, "bdi", to change the second variable to "CHLORJ6". The data was then loaded onto the system.
The BAS Oceanlog PC reads the master clock, in a similar way to a standard Level A computer. Unfortunately the date/time it reads sometimes gets corrupted. This results in either a 1936 date/time, or a 1970 date/time. This caused problems with the RVS data files. A standard program, "modtime", exists which will in theory eliminate any backwards going times. Unfortunately this program would not handle the 1936 times. This necessitated going through the file manually with other editing utilities in order to correct the offending dates.

Level B Computer

The Level B computer installed on the James Clark Ross was the first Mk II unit to enter service. In general it is working well, and there were no hardware failures during the cruise. The system received a software update in August, but unfortunately this does not solve problems which were originally observed on RRS Challenger. The problem is not immediately obvious unless a close watch is kept on either the Level C data files, the Level B tape backlog display, or the actual Level B tape drives. During normal operation the standard underway logging files, e.g. "em_log" grow at a steady rate which can be observed using the "dfinfo" command., the tape backlog display should alternate between 1024 and 0 within every five seconds, by listening and watching the tape drive in use, you should see it run once every five seconds, not continuously. When the Level B fails none of this happens, but if you only take a casual glance at the system nothing appears to be wrong. This type of fault occurred twice on this cruise, luckily not much data was lost.

Level C Computer

The parsing, calibration, and output software worked relatively well with only a few bugs being observed, one of which only becomes apparent in Southern latitudes. Information about these bugs, together with suggested fixes was forwarded to the Electronics & Logistics Group at Barry via the BLAST system.

Recomendations

Given the problems with the TCO2 Level A, perhaps a new Level A application could be written for this equipment - I tried and failed. I think part of the problem may lie in the fact that the actual program on the Total CO_2 computer is written in compiled BASIC, and thus the output message and baud rate are easily changed - perhaps a little too easily. In addition the program crashes occaisonally (more than the Level B!) loosing valuable data. Perhaps RVS ISG could design and implement both a new PC program in compiled C, and a matching Level A application.

A bespoke front panel could be designed for the Mk II CTD Level A, with Lemo sockets common to all the other Level A's, and a "Data On/Off" switch. This work may all ready be in hand.

It would be nice if the PML UOR group could finally agree on a standard set of variable names for their UOR. It would make things much simpler for us. Perhaps if they have the source to the UOR processing package that runs on the PC, they could write a new section that would output the following variables in listit form:-

depth, temp, salin, fluor (or chlor).

Maybe there could be a few other standard variables as well. I don't think these variable names need to be changed. 90% of the time this system would suffice. The only other sensors that are not included are light sensors. Obviously some thought would have to go into standard light variable names. One important thing to note in any case, there should be no two variables with the same name.

BAS ISG should try and sort out the problems with the Oceanlog P.C. A simple solution to the problems of incorrect times coming out, would be to set the P.C. internal clock to the approximate time (within say 30 seconds) in GMT, and then perform a range check on the time it reads in from the external clock to see if that time is within say a minute of the PC's clock. If it is not, it is to be rejected. If a number of these range check errors happen in a row, then the PC should sound an alarm, and display an appropriate message on the screen. The other problem is that occaiosonally it fails to send out a message. I don't know if there is a simple solution to this problem.

4. 21b COMPUTING. - G.BUTCHER.

1. Objectives

1. To support all aspects of Scientific Computing on the JGOFS/BOFS Cruise.
2. To learn about the ABC, RVS data acquisition System.
3. To assist, time permitting, with the non - scientific computing on the JCR.

2. Methods

1. To provide various services (listed below).
2. To assist Paul Duncan with level C software and the production of level C plots, graphs and tracks.
3. To assist JCR permanent personnel with computing problems.

3. Services

The Scientific Computing Services were on 3 platforms :

1. Communal, networked PCs
2. Sun workstations
3. DEC VAX mini computers

<u>PCs</u>

The networked PCs enabled distributed computing and using the usual client/server model provided the following services :

remote file sharing
remote disk sharing
shared printing
e-mail
terminal emulation (X11, VT320, Tektronix)
distributed database processing

Daily backups were carried out on all networked PC disks. Continuous Virus Checking and weekly backups of all local disks was also performed. The following were some of the PC packages made available for general use :

Word for Windows
Excel
WordPerfect
Lotus 1-2-3
Microsoft C
Borland C++
Oracle

PC networking products included :

Pathworks
PC-NFS
Kermit
Blast (for the Marinet e-mail System)

Sun Workstations

The Sun workstations provided the level C Data Acquisition, Processing, Visualisation and Presentation software. Data was collected and logged from 12 multi-channel instruments. Output was produced to 4 devices :

Postscript laser printer
Zeta A1 colour vector plotter
HP7475 A3 colour vector plotter
Tektronix colour printer

2D, multi-layered 2D, contoured 2D and 3D plots, graphs and tracks were produced on these devices.

DEC Vaxes

The VAX computers provided the PC Services, the BAS Messaging System and the following data processing tools :

Uniras
Oracle
SAS
Genstat
Minitab
C, Pascal and Fortran compilers

All VAX and Sun disks were backed up daily. A service was provided where users could back up laptop or personal computers in case of disk failure.

4. Additional

Work was carried out for :

Ships Chief Engineer	-	improving the ships computerised Cargo Management System.
Ship's Radio Officer	-	helping with Data and Message Scheds, modem configuration and PC software.
Ship's Catering Officer	-	helping with a PC printing problem.

5. Conclusions

There seems to be a wide variation in Scientific Computing requirements between different cruises. This can be seen as a leaning towards different computing platforms eg IBM PCs, Sun Workstations, VAXes or IBM mainframes. The specific needs of the Scientists involved should to be ascertained so that these needs can be fully met.

6. Additional Information

Scientific data can be taken off the ship to respective Institutes by a range of computer tape types :

PC tape streamer (Everex)	150 MByte
Sun Exabyte	2 GByte
Sun UC6-150	150 Mbyte
DEC VAX TK70	300 Mbyte
DEC VAX TK85	2.6 Gbyte

All file types can be transferred to all types of tape. Additionally laptop or personal computers can be backed up in case of damage in transit.

4. 22 DECK ENGINEERING. - S. WRIGHT.

General Comments.

Although the cruise has not gone as smoothly as could have been wished, it is to be hoped that the facilities have not been detrimental and that most of the problems identified have been solved or bypassed. Being the first major scientific cruise using the labs the failure of the lab gas supplies was a disappointment which will receive attention in the summer during refit. The number of people on the cruise has left some people being situated in far from ideal conditions although I understand that this is a one off number for any one cruise.

The non-contaminated supply was a problem while travelling through the ice as the probe kept being blocked by ice which meant the transects were not as continuous as may have been hoped for. Without effecting the sample taken I am at present unsure of a method to allow this to take place.

Operations involving the Stern gantry.

These involved towing the UOR using the articulating arm and the port Gilsen winch. This arrangement appeared to be successful although the lead and lack of a spooling mechanism made it not ideal.

The box corer was deployed on three occasions from this gantry to save disconnecting the CTD termination. It only caused any problems on the final drop when there was a reasonable swell making it ungainly to handle and attach lines. The fact that the RMT nets had to be stored at the forward end of the bulwark area only added to the potential of damage being caused.

The RMT nets where deployed on the Biological wire without apparent problems. The need to operate the two tonne winches from the local position was hampered as were all operations by the number of containers on the after deck severely restricting the winch drivers view of any operations in the bulwark area.

The main problems experienced in this area were the articulating motor relief valves which reached a stage that they were lifting on most deployments of the gantry. However spares were received and things improved until the end of the cruise when the port valve started to lift periodically.

The RMT starting slot was delayed for an evening as the one of the two tonne winches was found to be veering but not hauling a fault traced to a faulty control card in the local control panel. This slot also suffered from

delay one night because of a faulty solenoid valve on the articulating arm controls.

The only damage that occurred to the gantry was due to the poor stowage of one of the two tonne winch wires which resulted in shearing a hydraulic connection. This was quickly fixed and operations continued.

The longest single delay to operations involving this gantry was a CTD in ice conditions where one of the power pack pumps sheared a coupling. The delay being due to replacing the oil and making the room safe for working again, probably about five hours.

Operations involving the Midships Gantry.

These mainly involved CTDs' using the 10 tonne traction winch, with SAPs and nets using the RVS clean chemical winch. Due to the failure of the Hydrographic wire in its present configuration to perform satisfactorily the deep SAPs deployment was carried out using the Coring warp on the 30 Tonne system along with a box core on this gantry.

The 10 tonne worked reasonably although not as well as during trials last summer, but only one CTD was lost due to its failure. The RVS clean chemical winch had to be spooled manually due to the unsatisfactory spool obtained by the present gear. Its brakes release mechanism never appeared to work properly as the drum ran warm in the early stages of the cruise. Although it worked in its present position I would suggest a different arrangement be developed to avoid having to raise large pieces of equipment eg. CTD and Box corer over it making them harder to handle.

The main problems experienced with this system were failures of parts of the traction winch system or just poor running due to the design problems already identified with the system. The lost CTD was due to the failure of two control fuses in the control circuit for the inboard compensator. The only oil leak that was a major problem was with the forward articulating motor seal on the gantry. This had been replaced before the cruise due to failure during the passage south, but once again developed a regular leak when operated during the cruise. The operating parameters have now been changed and it is hoped that the replacement of the seal as soon practicable will solve this problem.

This was my first scientific cruise and therefore would like to thank the cruise participants for their patience and understanding when operations maybe not have gone as smoothly as I or them would have liked. A big surprise to me, considering the location of the cruise, was that some of equipment that people had borrowed arrived on the ship either having not

been checked or just not working. It was then expected that the ships engineering department would sort them out in order for the experiments to take place.

I hope that when we next meet we will have a fully functioning winch system so that we can operate even more effectively.

APPENDIX 1. SCIENTIFIC & TECHNICAL PERSONNEL.

NICK	OWENS	Plymouth Marine Laboratory, Chief Scientist.
EILEEN	ALDWORTH	Scott Polar Research Institute
STEPHEN	ARCHER	British Antarctic Survey
ANGUS	ATKINSON	British Antarctic Survey
RAY	BARLOW	Plymouth Marine Laboratory
ALAIN	BEDO	Plymouth Marine Laboratory
IAN	BELLAN	Plymouth Marine Laboratory
PHIL	BOYD	Queens University, Belfast
PETER	BURKILL	Plymouth Marine Laboratory
SARAH	BURY	University of Glasgow
GRAHAM	BUTCHER	British Antarctic Survey
GEOFF	CRIPPS	British Antarctic Survey
PAUL	DUNCAN	Research Vessel Services, Barry
ELAINE	EDWARDS	Plymouth Marine Laboratory
NICKY	FENTON	Scott Polar Research Institute
TIM	FILEMAN	Plymouth Marine Laboratory
ROGER	HARRIS	Plymouth Marine Laboratory
HELEN	HILL	British Antarctic Survey
RAY	LEAKEY	British Antarctic Survey
DUNCAN	PLUMMER	Plymouth Marine Laboratory
RICK	PRICE	British Antarctic Survey
JULIAN	PRIDDLE	British Antarctic Survey
ANDY	REES	Plymouth Marine Laboratory
GEORGE	RITCHIE	University of Edinburgh
DAVE	ROBINS	Plymouth Marine Laboratory
CAROL	ROBINSON	University of Wales
GRAHAM	SHIMMIELD	University of Edinburgh
CAROLYN	SYMON	British Antarctic Survey
SUE	TURNER	University of East Anglia
JON	WATKINS	British Antarctic Survey
SIMON	WATTS	Research Vessel Services, Barry
STEVEN	WELLS	Scott Polar Research Institute
MICK	WHITEHOUSE	British Antarctic Survey
PAUL	WOODROFFE	British Antarctic Survey
MALCOLM	WOODWARD	Plymouth Marine Laboratory

APPENDIX 2. SCIENTIFIC LOG (all times GMT).

Wednesday, 21 October 1992

8:00 Commenced unpacking

Setting up labs all day

Thursday, 22 October 1992

Continued setting up labs

Friday, 23 October 1992

18:00 All scientists now present

Setting up labs all day

Saturday, 24 October 1992

Continued setting up labs

Sunday, 25 October 1992

Continued setting up labs

Monday, 26 October 1992

6:00 Departed Stanley
13:00 Arrived Mare Harbour, refuelling
20:00 Departed Mare Harbour for Mackinnon Cove

Setting up equipment all day
Remained Mackinnon overnight

Tuesday, 27 October 1992

6:00 Continued setting up equipment
14:57 CTD o/b - test
15:19 CTD i/b -
16:00 Departed Mackinnon Cove, course set for Potter Cove
21:20 UOR o/b - Test tow

Day 301
Passage S. overnight

Wednesday, 28 October 1992

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   0:51  UOR i/b
  11:10  Stopped on station, problem with bow-thrust & winch
  15:57  Test weight deployed
  16:20  Test weight recovered
  17:10  CTD o/b - problems with winch
  17:50  CTD i/b
  18:23  CTD o/b -  Dip 1. Problems with CTD
  19:10  CTD i/b - unsuccessful
  19:29  UOR o/b Tow 1
  21:40  Container lab flooded
  22:30  UOR i/b too rough for towing

Day 302
Passage South
More or less hove to overnight


Thursday, 29 October 1992

  13:41  UOR o/b Tow 2

Day 303
Passage South
UOR towed throughout day


Friday, 30 October 1992

   0:14  UOR i/b
   1:18  UOR o/b Tow 3
   9:11
   9:12  UOR i/b
  10:09  UOR o/b Tow 4
  13:25  UOR i/b
  13:36  Stopped on station for CTD
  13:50  Problem with winch system
  14:10  Deployment of test weights
  14:30  Deployment aborted - still winch problems
  15:05  UOR o/b Tow 5
  20:14  UOR i/b
  21:15  UOR Tow 6

Day 304
Passage South
```

Saturday, 31 October 1992

1:22	UOR i/b
10:00	Arrived Potter Cove, King George Is. - at anchor.
10:21	UOR package vertical profile
10:32	vertical profile ended
11:00	Echo sounder calibrations commenced
21:00	Departed Potter cove.

Day 305
Potter Cove

Sunday, 01 November 1992

11:12	Test weight deployed
11:37	Test weight recovered
11:58	CTD o/b - Dip 2.
12:35	CTD i/b
14:30	SAPS deployed
16:10	SAPS recovered
17:45	CTD o/b - water only
18:00	CTD i/b
19:00	Departed station - course made for Faraday
23:00	Decision made to return to Falkland Is. - medical case.

Day 306
Inside Deception

Monday, 02 November 1992

Day 307
Passage North

Tuesday, 03 November 1992

Day 308
Passage North

Wednesday, 04 November 1992

10:30	Passed through Stanley Harbour Narrows.
12:00	Bunkering from Bransfield
19:00	Departed Stanley

Day 309
Passage then return,

Thursday, 05 November 1992

11:14 UOR Tow 7
17:08 UOR i/b
17:55 UOR Tow 8
21:02 UOR i/b

Day 310
Passage South

Friday, 06 November 1992

16:26 UOR Tow 9

Day 311
Passage South

Saturday, 07 November 1992

0:00 UOR i/b
0:50 UOR Tow 10
9:08 UOR i/b
10:18 UOR Tow 11
18:09 UOR i/b
18:43 CTD o/b Dip 3. - Test
18:50 CTD i/b

Day 312
Passage South

Sunday, 08 November 1992

14:00 Arrived Faraday

Day 313
Faraday Base relief

Monday, 09 November 1992

14:00 Departed Faraday - passage towards Bellinghasen Sea.

Day 314

Tuesday, 10 November 1992

13:23 UOR Tow 12
18:05 UOR i/b
18:48 UOR Tow 13

Day 315
Passage towards Bellingshausen Sea

Wednesday, 11 November 1992

0:12 UOR i/b
1:01 UOR Tow 14
9:09 UOR i/b
10:26 UOR Tow 15
18:17 UOR i/b
19:48 UOR Tow 16

Day 316
Passage towards Bellingshausen Sea

Thursday, 12 November 1992

0:31 UOR i/b
3:15 First crossing of Antarctic Circle.

Day 317
Passage towards ice-station

Friday, 13 November 1992

1:00 Location of suitable ice floe
11:30 Station 'F'lossie starts: CTD o/b Dip 6 - on ice activiti
es begin
12:21 CTD i/b
12:45 - 13:00 z nets
14:00 - 14:30 z nets
14:40 CTD o/b Dip 7 - with chemistry pump.
14:45 Under-ice diving commenced
20:00 Diving ops. completed
20:30 Ice ops. completed
21:00 SAPS commenced
21:45 - 22:00 Krill net deployments

Day 318
Shakedown station 'F'lossie.

Saturday, 14 November 1992

1:25	SAPS completed
1:34	Station 'F'lossie ends. - Passage S.
13:50	Station 'G'ertie starts.
14:00	Ice ops. commenced. Ice-holes, snow transects etc.
20:00	Box-corer deployed
20:50	Box-corer recovered

Day 319
Station 'Gertie'
Preparation of ice-site during PM

Sunday, 15 November 1992

12:20	CTD o/b - Dip 8
13:18	CTD i/b
14:05	CTD o/b - Dip 9
14:25	CTD i/b
16:15	z nets commenced
17:00	Diving ops. commenced
19:15	z nets ceased
20:12	CTD o/b - Dip 10, Level 1 cast.
21:05	CTD i/b
21:25	SAPS commenced
21:30	Diving ops. ceased

Day 320
Ice station 'G'ertie

Monday, 16 November 1992

0:50	SAPS completed
1:25	- 01:45 Krill net deployments
2:25	CTD o/b Dip 11 - Prodn. Rigs cast 1
2:50	CTD i/b
3:20	CTD o/b Dip 12 - Prodn. Rigs cast 2
3:40	CTD i/b
3:50	CTD o/b Dip 13 - Prodn. Rigs cast 3
4:09	CTD i/b
5:00	CTD o/b Dip 14 - Prodn. Rigs cast 4
5:15	CTD i/b
5:30	Incubation rigs deployed through ice-hole
6:30	CTD o/b Dip 15 - Prodn. Rigs cast 5
7:00	CTD i/b
7:30	Sediment traps deployed through ice-hole
10:20	CTD o/b Dip 16
11:01	CTD i/b
12:45	z netting commenced
14:30	z netting ceased
14:35	- 14:50 Krill net deployments
15:39	CTD o/b Dip 17
16:04	CTD i/b
16:55	SAPS commenced
17:30	Diving ops.
18:30	Diving ops.
20:10	SAPS concluded
21:30	- 21:40 z nets
22:00	- 23:00 Krill net deployments

Day 321
Ice station 'G'ertie
On ice activities all day

Tuesday, 17 November 1992

```
   2:30  Diving ops. on rigs
   3:15  z nets commenced
   4:00  Diving ops. ceased, commenced rig recovery
   5:00  z nets ceased
   5:45   - 06:00 Krill net deployments
   7:30  Incubation rig finally recovered
   9:34  CTD o/b Dip 18
  10:32  CTD i/b
  16:00  Diving ops. commenced
  17:21  CTD o/b Dip 19
  18:39  CTD i/b
  19:36  CTD o/b Dip 20
  19:56  CTD i/b
  20:00  Diving ops. ceased
  22:03  CTD o/b Dip 21
  22:06  CTD i/b
  22:10  CTD o/b Dip 22
  23:00  CTD i/b
```

Day 322
Ice station 'G'ertie
On ice activities all day

Wednesday, 18 November 1992

```
   1:28  CTD i/b
   2:00  Diving ops. on rigs
   3:00  Krill netting
   4:15  Krill netting ceased
   4:30  z netting commenced
   8:45  z netting ceased
   9:42  CTD o/b Dip 23 + UOR package
  10:15  CTD i/b
  11:34  CTD o/b Dip 24 + UOR package
  12:15  CTD i/b
  13:37  CTD o/b Dip 25
  14:00  CTD i/b
  15:00  Diving ops. commenced
  16:00  z netting commenced
  17:15  z netting ceased
  17:20  CTD o/b Dip 26
  18:31  CTD i/b
  19:00  Diving ops. ceased
  20:05  Station 'G'ertie ends: Passage N.
```

Day 323
Ice station 'G'ertie
On ice activities continued until departure

Thursday, 19 November 1992

Day 324
On passage N.

Friday, 20 November 1992

16:00 Rendezvous with Discovery 65 01S; 79 21W
18:21 CTD o/b Dip 27 - Intercalibration with Discovery
19:04 CTD i/b
22:15 Departed N with medical case.

Day 325
Passage N. continued during AM

Saturday, 21 November 1992

Day 326
Passage towards Falkland Is

Sunday, 22 November 1992

Day 327
Passage continued

Monday, 23 November 1992

16:00 Arrived Mare Harbour FI.
21:00 Departed FI - Passage S.

Day 328
Passage continued

Tuesday, 24 November 1992

Day 329
Passage continued

Wednesday, 25 November 1992

Day 330
Passage continued

Thursday, 26 November 1992

Day 331
Passage continued

Friday, 27 November 1992

2:38	UOR Tow 17
10:11	UOR i/b
11:00	UOR Tow 18
18:23	UOR i/b

Day 332

Saturday, 28 November 1992

19:04	CTD o/b Dip 28 - Ice edge station.
19:48	CTD i/b
20:00	Re-entered ice - proceeded S.

Day 333

Sunday, 29 November 1992

12:12	Station 'H'erbie starts:
12:28	CTD o/b Dip 29
13:09	CTD i/b
14:00	On ice activities commenced
14:15	Krill netting commenced
15:00	Krill netting ceased
15:15	z netting commenced
16:45	z netting ceased
17:03	CTD o/b Dip 30 - Level 1
17:48	CTD i/b
18:34	CTD o/b Dip 31 - Level 1
19:29	CTD i/b
19:54	CTD o/b Dip 32 - Level 1
20:11	CTD i/b
20:30	Diving ops. commenced
22:00	SAPS commenced

Day 334
Ice - Station 'H'erbie

Monday, 30 November 1992

1:30	SAPS concluded
1:45	CTD o/b Dip 33
1:55	CTD i/b
2:20	Krill netting commenced
3:00	Krill netting ceased
3:30	Diving & on-ice ops. ceased
3:45	Station 'H'erbie ends. Passage N.
9:45	Vertical drop with UOR package
12:22	Vertical drop with UOR package
16:25	Vertical drop with UOR package
20:00	Vertical drop with UOR package
21:30	Out of ice
22:54	Station 'I'solde starts.

Day 335
Station 'I'solde

Tuesday, 01 December 1992

0:00	Commenced deployment of sediment trap + Langdon rigs
0:45	Completed deployments
2:07	CTD o/b Dip 34
2:26	CTD i/b
3:00	SAPS deployed
6:15	SAPS recovered
6:30	z netting commenced
8:00	z netting ceased
8:30	Krill netting commenced
9:30	Krill netting ceased
9:51	CTD o/b Dip 35
10:20	CTD i/b
12:00	Box corer deployed
13:14	Box corer on bottom
14:15	Box corer recovered
15:00	z netting commenced
17:15	z netting ceased
17:30	CTD o/b Dip 36 - Level 1
18:09	CTD i/b
18:56	CTD o/b Dip 37 - Level 1
19:14	CTD i/b
19:42	CTD o/b Dip 38 - Level 1
20:19	CTD i/b
21:00	Commenced Krill search transect

Day 336
Station 'Isolde'

Wednesday, 02 December 1992

```
   1:40  Krill transect ceased
   2:37  CTD o/b Dip 39 Prodn. rig cast 1
   2:54  CTD i/b
   3:19  CTD o/b Dip 40 Prodn. rig cast 2
   3:30  CTD i/b
   3:52  CTD o/b Dip 41 Prodn. rig cast 3
   4:02  CTD i/b
   4:28  CTD o/b Dip 42 Prodn. rig cast 4
   4:36  CTD i/b
   5:40  Incubation rigs deployed
   6:00  CTD o/b Dip 43 Prodn. rig cast 5
   6:33  CTD i/b
   7:17  CTD o/b Dip 44 Prodn. rig cast 6
   7:27  CTD i/b
   7:45  z netting commenced
   9:49  CTD o/b Dip 45
  10:10  z netting ceased
  10:14  CTD i/b
  11:08  CTD o/b Dip 46
  11:18  CTD i/b
  13:30  ice and diving party departed by boat
  14:50  z netting commenced
  15:35  Dive ops. ceased
  17:00  z netting ceased
  17:55  CTD o/b Dip 47 + UOR package
  18:22  CTD i/b
  19:10  ice ops. ceased
  19:22  CTD o/b Dip 48
  20:26  CTD i/b
  21:50  RMT deployed

Day 337
Station 'I'solde


Thursday, 03 December 1992

   1:25  RMT recovered
   4:00  Recovered sediment trap rig
   4:25  Station 'I'solde ends: search for prodn. rig.
  10:00  Abandoned box search: passage N.
  12:44  Vertical profile with UOR package
  14:38  CTD o/b Dip 49 - Midway between 'I' and 'J'
  15:35  UOR Tow 19
  18:15  slowed ship: vertical profile with UOR
  19:55  UOR i/b: Station 'J'ules starts.
  21:00  Commenced deployment of sediment trap rig and Langdon rig
           s
  21:55  SAPS deployed

Day 338
```

Friday, 04 December 1992

0:15	SAPS recovered
0:27	CTD o/b Dip 50
0:44	CTD i/b
1:15	z netting commenced
3:45	z netting ceased
4:00	Sounding run commenced
5:30	RMT deployed - abandoned - problems with gantry
6:45	z netting commenced
7:00	z netting ceased
9:15	RMT deployed
10:15	RMT recovered
10:20	z netting commenced
11:00	z netting ceased
11:50	CTD o/b Dip 51
12:21	CTD i/b
13:00	z netting commenced
17:00	z netting ceased
17:09	CTD o/b Dip 52 - Level 1
17:47	CTD i/b
18:25	CTD o/b Dip 53 - Level 1
18:49	CTD i/b
19:20	CTD o/b Dip 54 - Level 1
19:51	CTD i/b
20:29	CTD o/b Dip 55 - Level 1
20:43	CTD i/b
21:00	Ian Bellan, UOR & wire transferred to Discovery.
23:30	z netting commenced
23:45	z netting ceased

Day 339
Station 'J'ules

Saturday, 05 December 1992

1:00	RMT deployed
2:00	RMT recovered
2:40	CTD o/b Dip 56 - rig cast 1
3:02	CTD i/b
3:38	CTD o/b Dip 57 - rig cast 2
3:53	CTD i/b
4:19	CTD o/b Dip 58 - rig cast 3
4:32	CTD i/b
4:50	CTD o/b Dip 59 - rig cast 4
5:03	CTD i/b
5:40	Incubation rigs deployed - attached to sed.trap.
5:51	CTD o/b Dip 60 - rig cast 5
6:06	CTD i/b
6:15	z netting commenced
7:15	z netting ceased
7:25	RMT deployed
9:30	RMT recovered
9:37	CTD o/b Dip 61
10:08	CTD i/b
11:06	CTD o/b Dip 62
11:15	CTD i/b
12:02	CTD o/b Dip 63
12:22	CTD i/b
15:42	CTD o/b Dip 64 - abandoned - winch problems
16:00	z netting commenced
17:45	z netting ceased
18:23	CTD o/b Dip 65
21:02	CTD i/b
21:15	Box corer deployed
22:15	30 litre Go-flo's deployed
22:39	Box corer on bottom
22:45	30 litre Go-flo's deployed

Day 340
Station 'J'ules

Sunday, 06 December 1992

0:20	Box corer recovered
0:45	Sounding run for RMT
1:10	RMT deployed
2:00	RMT recovered
3:50	Rigs recovered
4:00	Sounding run for RMT
6:00	RMT deployed
7:15	RMT recovered
7:20	z netting commenced
8:00	z netting ceased
8:08	Station 'J'ules ends: Passage N.
10:16	CTD o/b Dip 66 - midway between 'J' & 'K'
10:56	CTD i/b
13:54	Station 'K'atie starts.
15:00	Sediment traps and Langdon rig deployed
16:07	CTD o/b Dip 67
16:32	CTD i/b
18:30	Test weight deployed on hydrographic wire - problems
19:50	Recovered test weight
20:10	SAPS commenced
23:25	SAPS concluded
23:30	z netting commenced

Day 341
Stations 'J'ules & 'K'atie

Monday, 07 December 1992

0:00	z netting ceased
0:10	CTD o/b Dip 68
0:45	CTD i/b
1:00	z netting commenced
1:35	z netting ceased
1:45	Sounding run
4:10	RMT deployed
4:55	RMT recovered
5:15	z netting commenced
6:00	z netting ceased
6:15	Sounding run
12:00	Ian Bellan & UOR returned to JCR.
14:00	z netting commenced
14:55	
15:54	z netting ceased
16:00	Sounding run commenced
17:00	Sounding run ceased
17:59	CTD o/b Dip 69 - Level 1
18:35	CTD i/b
19:26	CTD o/b Dip 70 - Level 1
20:00	CTD i/b
20:19	CTD o/b Dip 71 - Level 1
20:35	CTD i/b
21:25	30 litre Go-flo water bottle
21:40	Sounding run
22:20	RMT deployed

Day 342
Station 'K'atie

Tuesday, 08 December 1992

0:10	RMT recovered
0:45	z netting commenced
1:20	z netting ceased
1:40	Sounding run
2:35	CTD o/b Dip 72 - rig cast 1
2:55	CTD i/b
3:25	CTD o/b Dip 73 - rig cast 2
3:35	CTD i/b
3:55	CTD o/b Dip 74 - rig cast 3
4:05	CTD i/b
4:22	CTD o/b Dip 75 - rig cast 4
4:34	CTD i/b
5:30	Deployed incubation rig
6:12	CTD o/b Dip 76 - rig cast 5
6:23	CTD i/b
6:30	z netting commenced
7:15	z netting ceased
8:10	RMT deployed
9:20	RMT recovered
9:33	CTD o/b Dip 77
10:12	CTD i/b
11:03	CTD o/b Dip 78
11:16	CTD i/b
13:20	z netting commenced
13:45	z netting ceased
13:56	CTD o/b Dip 79 - Deep
16:48	CTD i/b
17:15	UOR light package deployed
17:50	UOR light package recovered
18:10	Box corer deployed with SAPS

Day 343
Station 'K'atie

Wednesday, 09 December 1992

1:38	Box corer on bottom
4:00	Box corer recovered
5:15	Recovered rigs
5:40	z netting commenced
6:20	z netting ceased
6:36	Sounding run N
7:33	RMT deployed
8:20	RMT recovered
10:30	Station 'K'atie ends. Passage NE
11:01	UOR Tow 25
20:04	UOR i/b. Resume passage to Rothera

Day 344
Passage to Rothera

Thursday, 10 December 1992

17:00 Abandoned passage to Rothera - ice conditions
18:00 Proceeded towards Palmer

Day 345
Passage to Rothera then Palmer

Friday, 11 December 1992

11:00 Arrived Palmer
15:00 Departed Palmer
19:00 Arrived Faraday
23:30 Departed Faraday

Day 346
Palmer AM Faraday PM
Then Passage to Rothera

Saturday, 12 December 1992

16:00 Ice-edge

Passage to Rothera

Sunday, 13 December 1992

9:00 Arrived Rothera

Rothera relief

Monday, 14 December 1992

18:00 Departed Rothera, Passage N

Rothera relief
Passage to Falkland Is.

Tuesday, 15 December 1992

Passage to Falkland Is.

CTD No	J. Day	Time	Lat (S)	Lon (W)	CTD Depth	Comment
1	302	16:42				Unsuccessful test
2	306	11:58	62 56.91	60 38.33	150	Deception
3	306				10	Surface water collection
4	312	18:43	62 49.60	62 05.45	130	Test
5						Test
6	318	11:30	69 25.61	85 04.45	250	Shakedown station Flossie
7	318	14:04	69 29.39	85 04.00	51	With chemistry pump attached
8	320	12:20	70 19.30	85 16.20	601	Station G. Stern deployment
9	320	14:05	"	"	52	" " "
10	320	20:12	"	"	220	" " " Level 1
11	321	2:25	"	"	50	" " " Rig #1 water collection, CTD Frozen - data US
12	321	3:20	"	"	50	" " " Rig #1 water collection, CTD Frozen - data US
13	321	3:50	"	"	7	" " " Rig #1 water collection, CTD Frozen - data US
14	321	5:00	"	"	10	Elaines water, CTD Frozen - data US
15	321	6:30	"	"	40	Level 1, data US
16	321	10:20	"	"	250	Transmissometer data doubtful, CTD frozen
17	321	15:39	"	"	30	Phil's
18	322	9:34	"	"	250	Dave's
19	322	17:21	"	"	618	Andy's defrost required
20	322	19:36	"	"	60	Sue's - Data US
21	322	22:03	"	"	150	Scan over period for Carolyn
22	322	22:10	"	"	150	Scan over period for Carolyn part II
23	323	9:42	"	"	250	Dave's, Level C data incomplete
24	323	11:34	"	"	250	plus UOR package
25	323	13:37	"	"	50	Peter/Carol's
26	323	17:20	"	"	623	Last CTD @ station G. To bottom, for Malcom.
12263 — 27	325	18:21	65 01.28	79 20.48	250	Calibration with Discovery
28	333	19:04	69 21.12	85 06.49	250	Ice-edge station
29	334	12:28	70 14.84	85 06.81	250	Station Herbie - Dave's
30	334	17:03	"	"	300	Level 1
31	334	18:34	"	"	550	Level 1
32	334	19:54	"	"	60	Level 1

CTD No	J. Day	Time	Lat (S)	Lon (W)	CTD Depth	Comment
33	335	1:45	"	"	10	Last cast @ Herbie
34	336	2:07	69 34.78	84 59.01	250	Station Isolde
35	336	9:51	"	"	250	
36	336	17:30	"	"	200	Level 1
37	336	18:56	"	"	200	Level 1
38	336	19:42	"	"	200	Level 1
39	337	2:37	"	"	50	Rig cast 1
40	337	3:19	"	"	20	Rig cast 2
41	337	3:52	"	"	10	Rig cast 3
42	337	4:28	"	"	10	Elaine's
43	337	6:00	"	"	200	Elaine's/Peter's
44	337	7:17	"	"	30	Carol's
45	337	9:49	"	"	250	Dave's
46	337	11:08	"	"	50	Phil's (?)
47	337	17:55	"	"	200	Ian's light calibration + UOR
48	337	19:22	"	"	1390	Last cast @ Isolde Graham's deep radio-chem
49	338	14:38	68 59.87	85 03.22	200	Midway between I and J
50	339	0:27	68 15.51	85 03.61	100	Station Jules Sarah's
51	339	11:50	"	"	250	Dave's
52	339	17:09	"	"	200	Level 1
53	339	18:25	"	"	200	Level 1 - Part II
54	339	19:20	"	"	500	Level 1 Radio-chem
55	339	20:29	"	"	50	Level 1 Radio-chem
56	340	2:40	"	"	100	Rig part 1
57	340	3:38	"	"	20	Rig part 2
58	340	4:19	"	"	10	Rig part 3
59	340	4:50	"	"	40	Elaine's
60	340	5:51	"	"	30	Carol's
61	340	9:37	"	"	250	Dave's
62	340	11:06	"	"	60	Phil's
63	340	12:02	"	"	150	Sue's/Andy's
64	340	16:00	"	"		Cast abandoned
65	340	18:23	"	"	3770	Last cast @ station Jules - Deep Radio-chem.

CTD No	J. Day	Time	Lat (S)	Lon (W)	CTD Depth	Comment
66	341	10:16	68 00.12	85 00.17	200	Midway between J and K
67	341	16:07	67 30.30	84 59.99	100	Station Katie Dave's/Carol's
68	342	0:10	"	"	500	Sarah's/Carol's
69	342	17:59	"	"	200	Level 1
70	342	19:26	"	"	500	Level 1 radio-chem data drop-out
71	342	20:19	"	"	50	Level 1 radio-chem II
72	343	2:35	"	"	100	Rig part 1
73	343	3:25	"	"	20	Rig part 2
74	343	3:55	"	"	10	Rig part 3
75	343	4:22	"	"	30	Elaine's
76	343	6:12	"	"	30	Carol's
77	343	9:33	"	"	500	Dave's
78	343	11:03	"	"	100	Phil's
79	343	13:56	"	"	4104	Last cast of cruise, Deep Radio-chem.

Note: Where CTD's carried out at the same station, positions of first cast only given. Actual positions are slightly different.

TOW No	DATE	LOCAL TIME	TIME GMT	Event	LAT (S)	LONG (w)	Depth range	COMMENTS	DATA
01 31.10.92 JUBANY POTTERS COVE	31.10.92	0721 0732	1021 1032	IN OUT			36m	Data for divers i.e. density no light	13 min at 1 sec
'02	13.11.92		1950 2013	IN OUT	6926.08	8459.99	27	Station F Shakedown Profile light set 2	23 min at 1 sec
'03	15.11.92	1859 1839	2159 2239	IN OUT	7019.36	8515	50	Station G through ice with Malcs pump light 2	40 min at 1 sec
'04	15.11.92	2004 2028	2304 2338	IN OUT	7019.36	8515	28	Station G light profile under ice hand rig light (2)	24 min 1 sec
'05	17.11.92	1345 1356	1645 1656	IN OUT	7019.9	8542	N.A.	light rig on top of snow Station G Light 2	11 min at 1 sec
'06	17.11.92	1405 1414	1705 1714	IN OUT	7019.9	8542	N.A.	Station G	9 min at 1 sec
'07	18.11.92	1432 1450	1732 1750	IN OUT	7019.23	8541.9	250	Station G Day 4 Fix U.O.R. sensors to CTD 24 U.O.R light set	46 min at 1 sec
'08	18.11.92	1432 1450	1732 1750	IN OUT	7019.23	8541.9	63	Light under ice U.O.R. R.V.P. Rig set 1	18 min at 1 sec
'09	20.11.92	1353 1432	1653 1732	IN OUT	6501.2	7919.6	N.A.	Meet DISCOVERY light run on deck	39 min at 1 sec
10	20.11.92	1521 1606	1821 1906	IN OUT	6501.2	7919.6	250	U.O.R. set fixed to CTD 27 set 1	45 min at 1 sec
11	20.11.92	1614 1728	1914 2028	IN OUT	6501.2	7919.6	N.A.	Still with DISCO all U.O.R. light facing up	74m at 1 sec
12	29.11.92 30.11.92	1908 2219	2208 '0119	IN OUT	7016.5	8519	200	with SAPS	3 hr 11 min 10 sec
13	30.11.92	'0650 '0709	'0950 1009	IN OUT	7007.4	8519.62	185	CTD onlly no light through ice transect to station	19 min 1 sec
14	30.11.92	'0926 '0955	1226 1255	IN OUT	6957.3	8517.7	195	CTD onlly no light through ice transect to station	29 min at 1 sec
15	30.11.92	1328 1400	1628 17000	IN OUT	6947	8519	200	CTD onlly no light through ice transect to station	32 min at 1 sec
16	30.11.92	1709 1733	2009 2053	IN OUT	6937	8522	200	CTD onlly no light through ice transect to station	24 min at 1 sec
17	30.11.92 1.12.92	2245 2327	'0145 '0227	IN OUT	6934	8459	200	with CTD 34 in clear water no light	42 min at 1 sec
18	30.11.92 1.12.92	2347 '0312	'0247 '0612	IN OUT	6934	8459	200	D.R.A. instruments and logger with SAPS no light	9 hrs 45 mins at 10 secs

19	2.12.92	1455 1526	1755 1826	IN OUT	6952.5	8540.5	190	temp incorrect? on CTD frame with light arm set 2 CTD 47	31 min at 1 sec
20	3.12.92	'0944 1008	1244 1308	IN OUT	6915.27 6914.01	8502.70 8501.92	170	towed at 3 knots in UOR body	24 mins at 4 sec
21	4.12.92	1410 1450	1710 1750	IN OUT	6818	8456	180	on CTD frame with D.O. on light arm set 2 CTD 52	40 min at 1 sec
22	8.12.92	1416 1438	1716 1738	IN OUT	6740	8451	170	U.O.R. package only with light for level 1 (Phil Boyd)	22 min at 1 sec

UOR TOW LIST

TOW No	TIME GMT	Event	LAT (S)	LONG (w)	TOW TIME	TOW length	No UNDs	Depth range	Speed (knots)	COMMENTS	DATA
01.DAT 28.10.92	19.29 22.28	IN OUT	5446.13 5508.3	58 05.37 5745.8	2.59	58	24	2 to 60	10.5	8"wings rough. conditions mostly cloudy	4 secs
02.DAT 29.10.92 30.10.92	13.42 00.14	IN OUT	56 36.2 58 17.5	5850.4 6016.9	10.33	215	87	2 to 62	11	Snow, sun, snow. 8" wings	4 secs
03 DAT 30.10.92	'0118 '0912	IN OUT	5822.1 5938.0	6014.3 5906.3	8.04	164	47	2 to 62	11	Krill in U.O.R. 8" wings	4 secs
04 DAT 30.10.92	1009 1325	IN OUT	5947.09 6017.8	5859.2 5832.9	3.16	63.5	31	2 to 62	10.5	Krill in U.O.R. 8" wings	4 secs
05 DAT 30.10.92	1505 2014	IN OUT	6021.7 6111.49	5830.4 5743.3	5.09	100	49	2 to 62	10.5	Lots of Krill in body. 8" wings	4 secs
06 DAT 30.10.92 31.10.92	2115 '0122	IN OUT	6114.5	5745.5	4.07	80	40	2 to 62	10.5	Overcast. Icebergs. Ice in water. 8" wings	4 secs
07 DAT	1114 1708	IN OUT	5502.0 5605.6	5901.6 5929.4	5.55	137	62	2 to 45	12.5	Rough Seas. No wings	4 secs
08 DAT 5.11.92	1755 2102	IN OUT	5613.3 5638.46	5937.6 6004.4	3.07	52	26	5 to 45	8 10 8	No wings. Cond and temp failed after 24 h. Diodes U.S. in backplane.	4 secs
09 DAT 6.11.92	1626 '0000	IN OUT	5735.14 5906.6	6239.62 6229.2	7.34	168	83	5 to 45	12	No wings	4 secs
10 DAT 7.11.92	'0050 '0908	IN OUT	5914.3 6056.6	6229.2 6236.43	8.18	192	(72*)	4 to 40	12.5	No wings. * 3 prop blades lost. 1 hr 40 mins no undulating	4 secs
11 DAT 7.11.92	1018 1809	IN OUT	6110.67 6248.82	6237.11 6206.54	7.51	182	63	4 to 40	13	No wings. Small prop fitted. Poor und. Crank going past stop. Slow to 4kts to reset servo. O.K.	4 secs
12 DAT 10.11.92	1323 1805	IN OUT	6509.8 6509.52	7327.1 7529.17	4.43	92	27	5 to 63	10.5	8" wings	4 secs
13 DAT 10.11.92	1848 '0012	IN OUT	6509.64 6511.0	7550.18 7825.5	5.24	110	27	5 to 63	11	8" wings. chlor. failed after 45 mins suspect battery contact in "c" cells	4 secs
14 DAT 11.11.92	'0101 '0909	IN OUT	6511.2 6510.36	7825.5 8141.6	8.08	158	41	2 to 62	10.5	8" wings V.P.	4 secs
15 DAT 11.11.92	1026 1817	IN OUT	6510.59 6511.6	8208.51 8500.6	7.51	160	38	2 to 60	11	8" wings End of weterly transect with V.P.	4 secs
16 DAT 11.11.92	1948 '0031	IN OUT	6510.34	8501.98	4.43	79	19	2 to 62	8 8 10.5	8" wings. Heding south. Recover because of ice.	4 secs

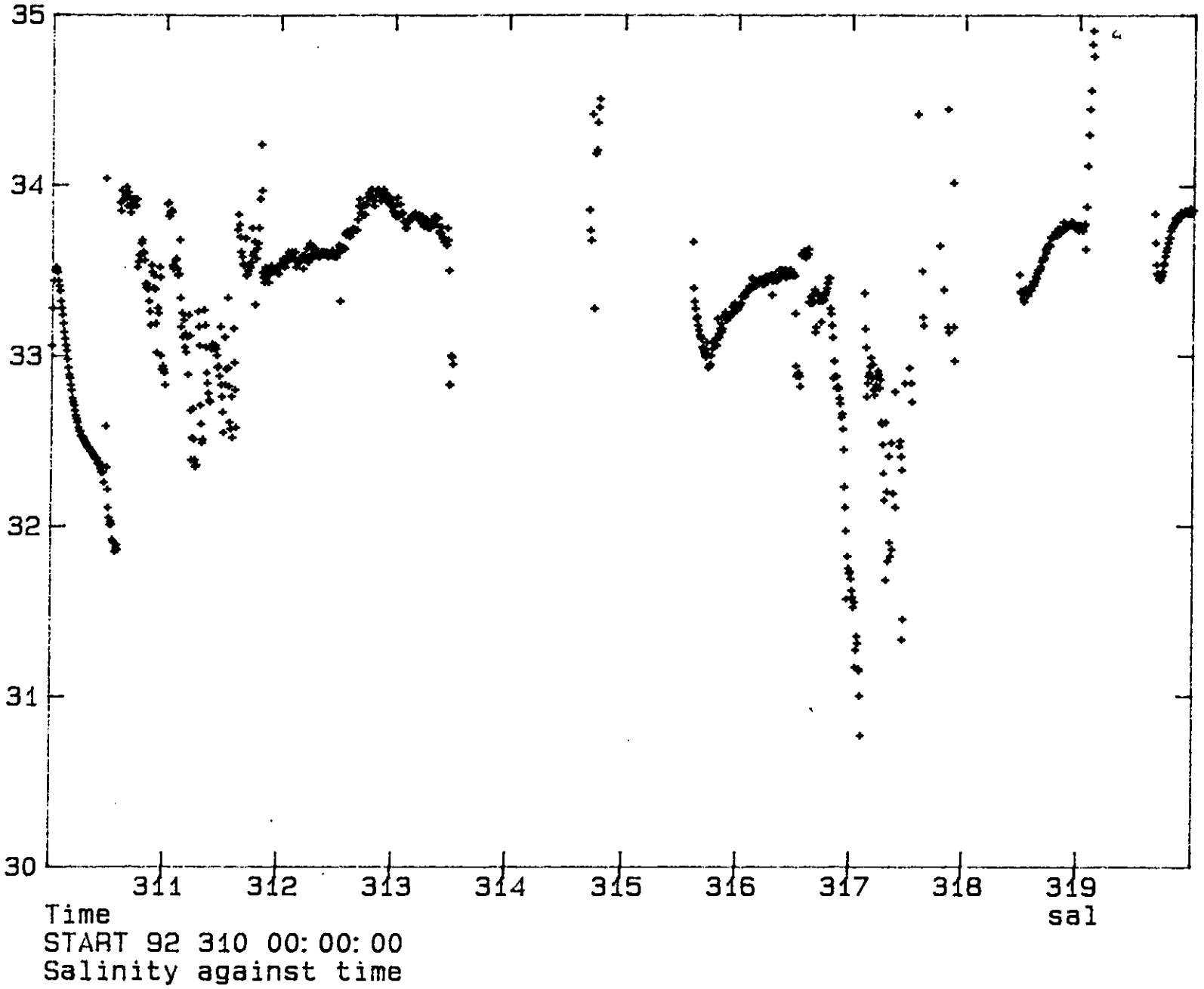
17 DAT 27.11.92 218.11.92	'0238 1011	IN OUT	6700.48 6811.52	8458.2 8452.95	7.33	154	38	2 to 62	10.5 11.0	8" wings. 375 wire 24m tape	4 secs
18 DAT 28.11.92	1100 1823	IN OUT	6812.02 6921	8456.50 8506	7.23	144	37	2 to 68	10.5 9. 7. 5 10.5	8" wings various speeds, towing through ice *ice catcher under tow wire & lifts. U.OR	4 secs
19 DAT 3.12.92	15.35 19.55	IN OUT	6858.87 68.15	8503.23 85.00	4.2	88	17	7 to 70	11	8" wings 24m tape 500m wire with 2 profiles	4 secs
20 D198001 5.12.92	'0518 1345	IN OUT	6737.2 6842.0	8520.4 8517.7	8.27		20	18 to 75	10 6	temp failed 1st tow on DISCOVERY too slow to und	4 secs
21 D1980002 5.12.92	1700 1809	IN OUT	6800.4 6859.35	8532.9 8552.85	1.09		3		10 4	too slow to und (fog)	4 secs
22 D198003 5.12.92 6.12.92	2312 '0719	IN OUT	6833.1 6728	8537.42 8559.8	8.07		29	20 to 85	10	fitted D.R.A sensor cyl cond failed & corrupted other channnels. Switch O.K. before and after tow!	4 secs
23 D198004 6.12.92	'0905 1730 1755	IN OUT	6727.9 6849.8	8500 8600	8.43		30	18 to 85	10 7 10	change sas cond board into dracyl to O.K.	4 secs
24 D198005 6.12.92 7.12.92	1958 '04000 '0518	IN OUT	6900.4 6797.22	8530.0 8554.92	9.2		22	18 to 85	10 6 8 6	Fog too slow. Wire jumped block!	4 secs
JCR 25	11.01 20.04	IN OUT	6737.,85 6721.05	8423.52 7913.68	9.03	235	65	2.42 x 30000	14	no wings within 750kg strain	4 secs

APPENDIX 5. THERMOSALINOGRAPH SALINITY CALIBRATIONS & SURFACE TRANSECT PLOTS

JULIAN DAY	TIME (GMT)	TSG SALINITY	AUTOSAL SALINITY	TSG-AUTOSAL
304	17:57	33.660	33.828	-0.168
304	21:54	33.376	33.928	-0.552
306	13:28	33.391	34.039	-0.648
307	13:40	33.930	34.130	-0.200
307	20:48	33.680	33.869	-0.189
309	21:53	33.160	33.804	-0.644
310	16:17	33.910	34.102	-0.192
311	09:29	32.272	34.133	-1.861
311	12:44	32.288	34.133	-1.845
312	02:36	33.359	33.815	-0.456
312	03:00	33.359	33.802	-0.443
312	05:00	33.550	33.787	-0.237
312	07:00	33.620	33.835	-0.215
312	09:00	33.590	33.811	-0.221
312	11:00	33.590	33.797	-0.207
312	13:00	33.680	33.184	0.496
312	16:32	33.920	34.057	-0.137
315	16:33	33.070	33.771	-0.701
316	07:00	33.550	33.791	-0.241
316	20:00	33.180	33.840	-0.660
316	21:00	32.860	33.833	-0.973
316	22:09	33.350		33.350
316	23:01	32.070	33.840	-1.770
317	00:01	31.770	33.758	-1.988
317	01:02	31.520	33.671	-2.151
317	02:01	31.260	33.685	-2.425
317	03:00	33.390	33.621	-0.231
317	04:00	32.930	33.719	-0.789
317	05:00	32.282	33.728	-1.446
317	06:00	32.289	33.683	-1.394
317	07:00	32.215	33.655	-1.440
317	08:00	24.190	33.740	-9.550

317	09:00	31.690	33.674	-1.984
317	10:32	34.000	33.951	0.049
317	11:00	32.320	33.943	-1.623
317	12:18	33.590	33.935	-0.345
317	12:18	33.590	33.945	-0.355
317	15:03	33.350	33.954	-0.604
317	18:40	33.990	33.954	0.036
333	02:46	33.100	33.702	-0.602
333	03:30	32.990	33.720	-0.730
333	04:00	32.930	33.762	-0.832
333	04:30	32.920	33.785	-0.865
333	05:00	32.940	33.686	-0.746
333	05:30	32.850	33.708	-0.858
333	06:00	32.690	33.823	-1.133
333	06:30	32.620	33.815	-1.195
333	07:00	32.550	33.825	-1.275
333	07:30	32.540	33.824	-1.284
333	08:00	32.460	33.828	-1.368
333	08:30	32.400	33.805	-1.405
333	09:00	32.390	33.881	-1.491
333	09:30	32.310	33.887	-1.577
333	10:00	32.280	33.888	-1.608
333	11:10	32.380	33.893	-1.513
333	11:30	32.360	33.871	-1.511
333	12:00	32.440	33.834	-1.394
333	12:30	32.320	33.786	-1.466
333	13:00	32.360		32.360
333	13:30	32.300	33.811	-1.511
333	14:00	32.410		32.410
333	14:30	32.480	33.815	-1.335
333	15:00	32.530	33.820	-1.290
333	17:00	32.420	33.843	-1.423
333	19:00	32.580	33.943	-1.363
333	21:55	33.670	33.948	-0.278

334	01:13	33.250	33.999	-0.749
334	03:06	32.650	34.013	-1.363
334	04:46	33.010	34.019	-1.009
334	06:49	34.340	34.023	0.317
334	08:52	33.810	34.018	-0.208
338	11:01	30.790	33.822	-3.032
338	12:00	30.920	33.823	-2.903
338	13:00	30.680		30.680
338	16:04	30.330	33.825	-3.495
338	17:00	30.350	33.805	-3.455
338	18:00	30.110	33.788	-3.678
341	09:00	33.680		33.680
341	12:00	33.680		33.680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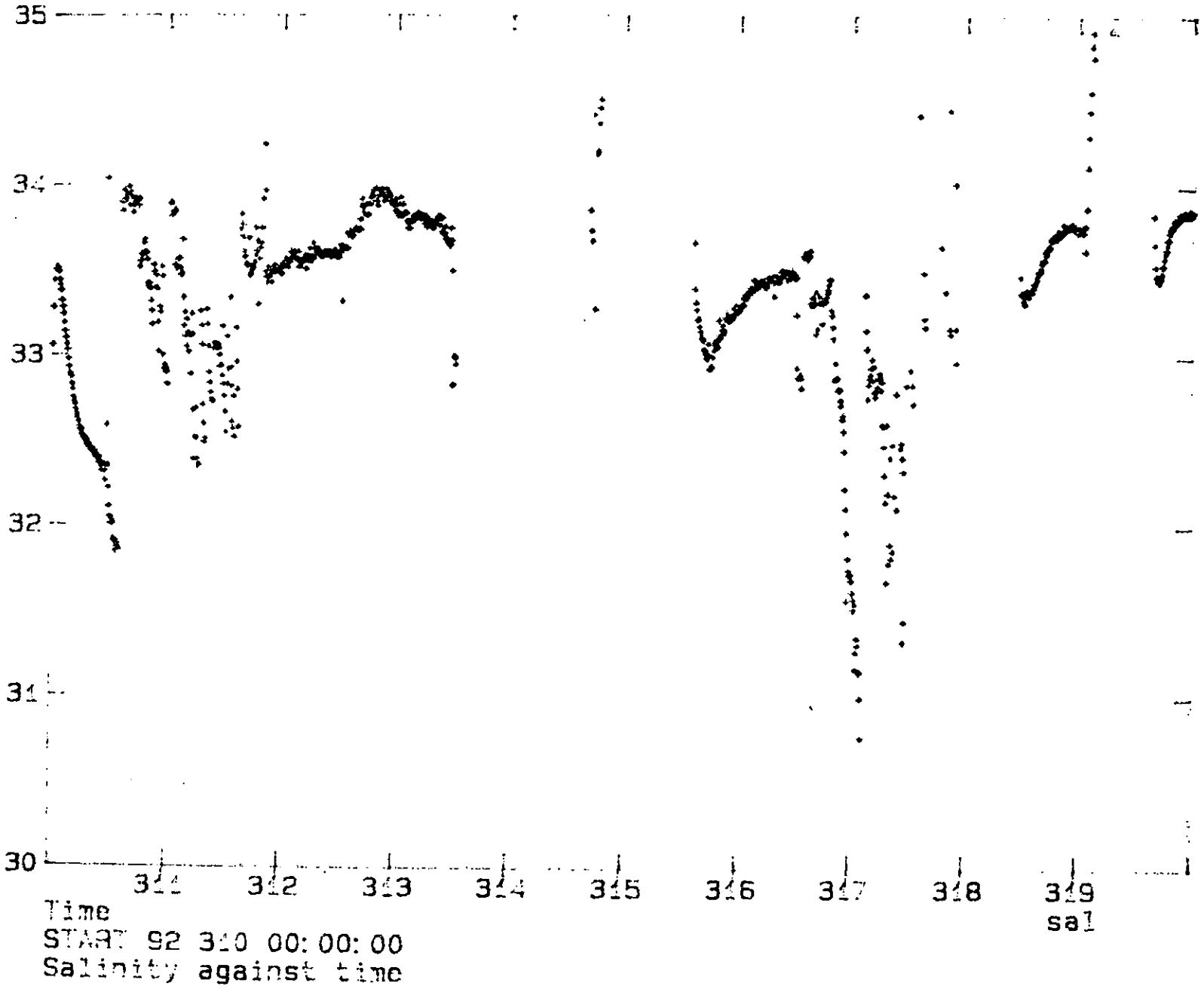
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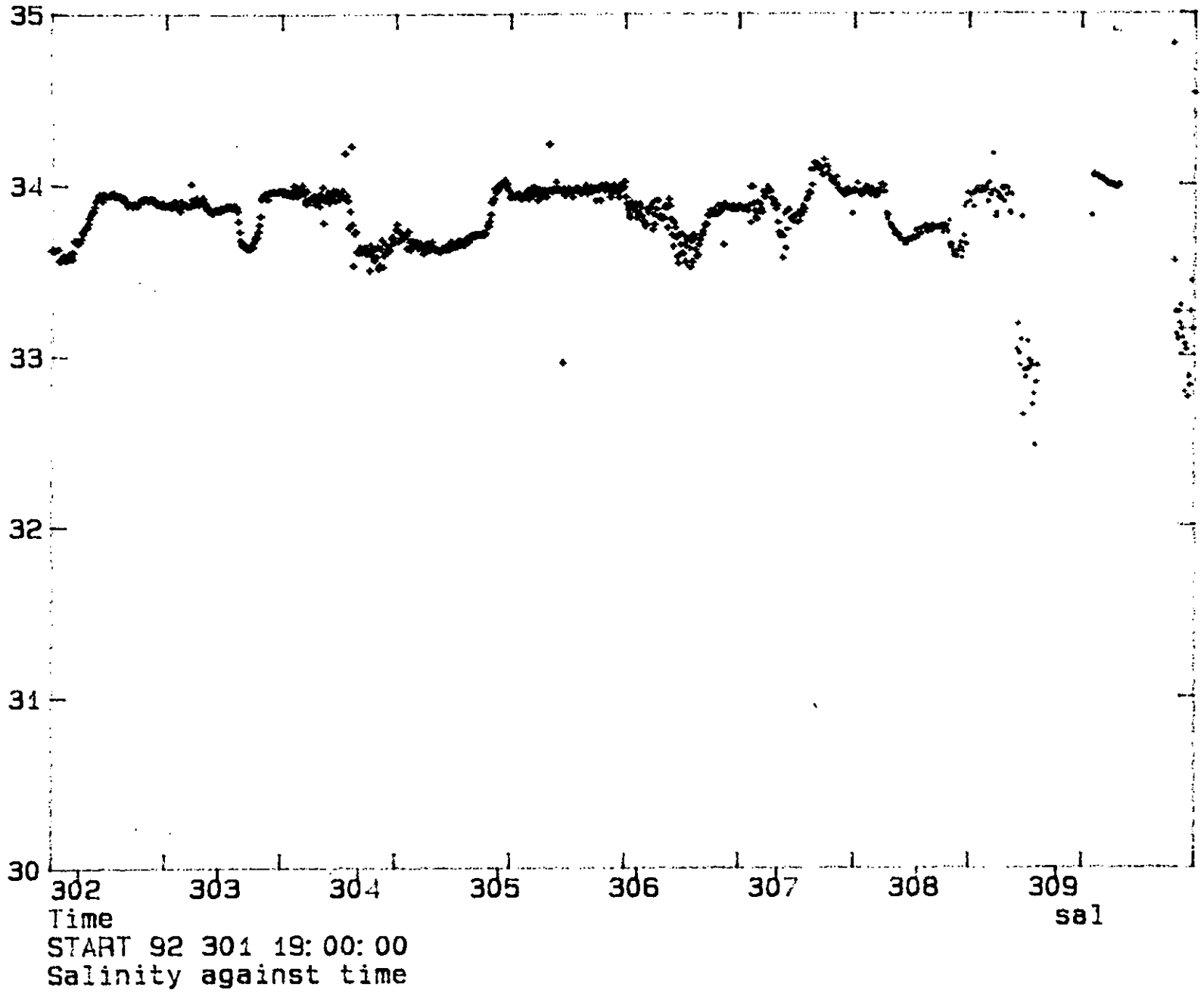
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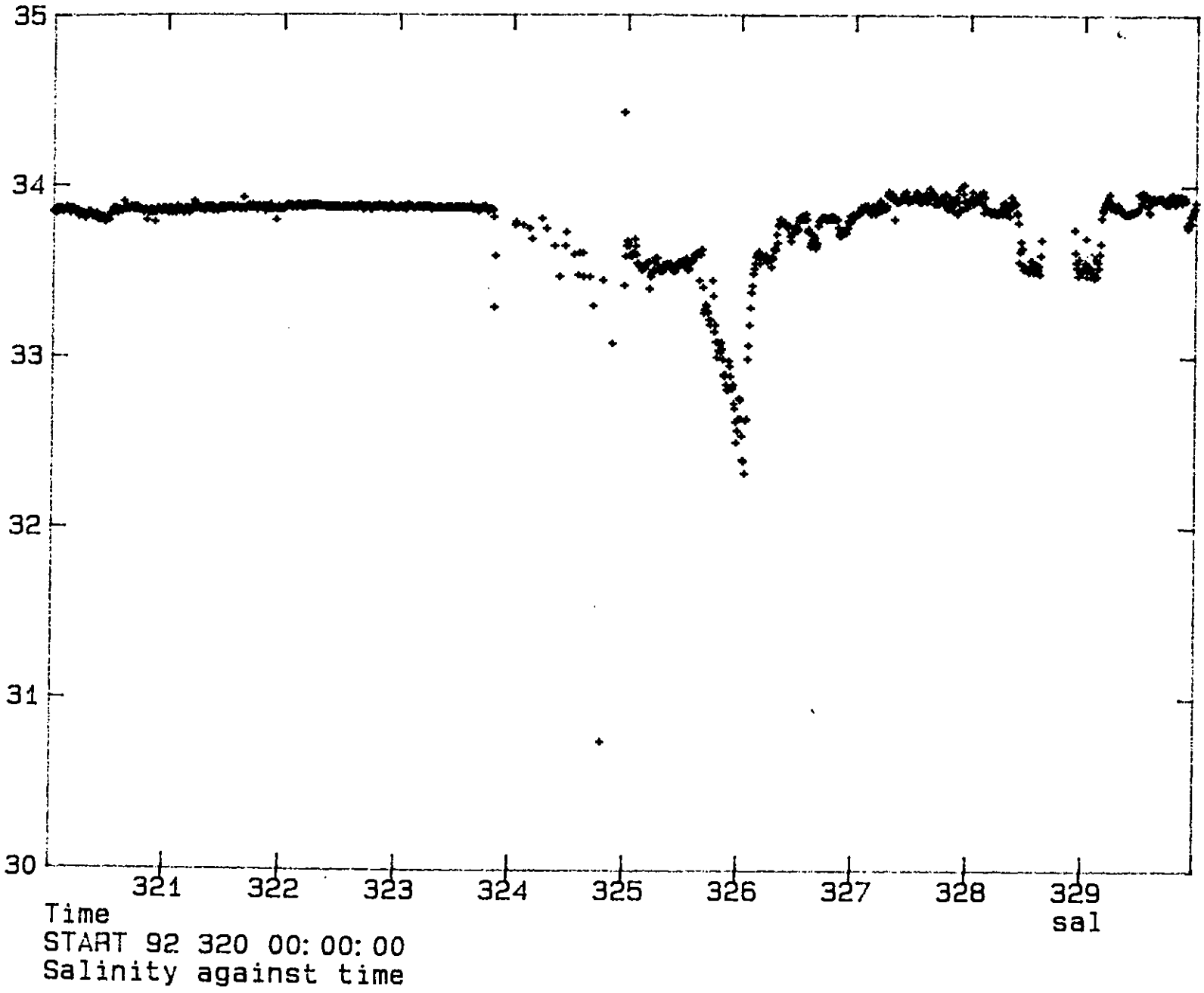
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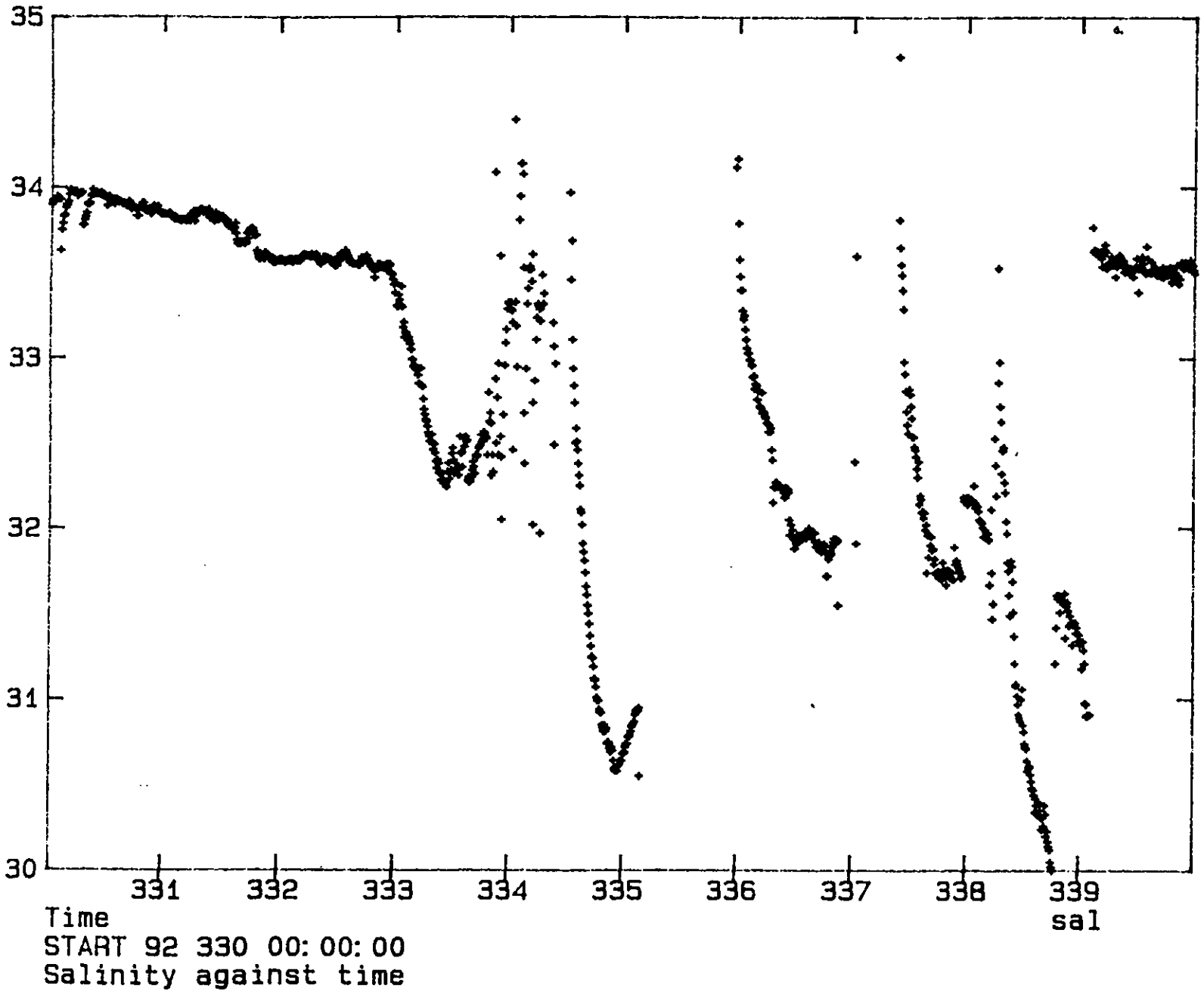
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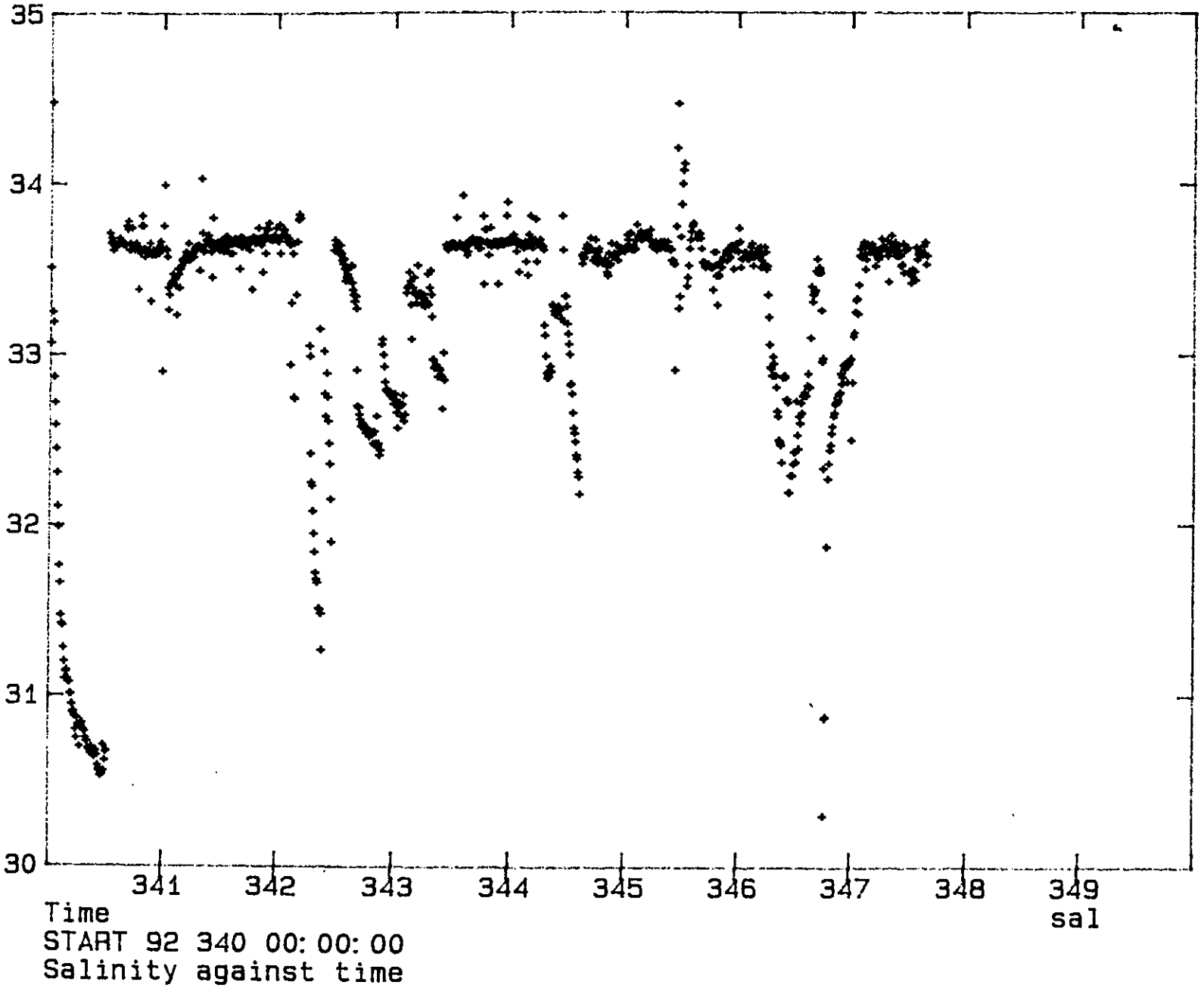
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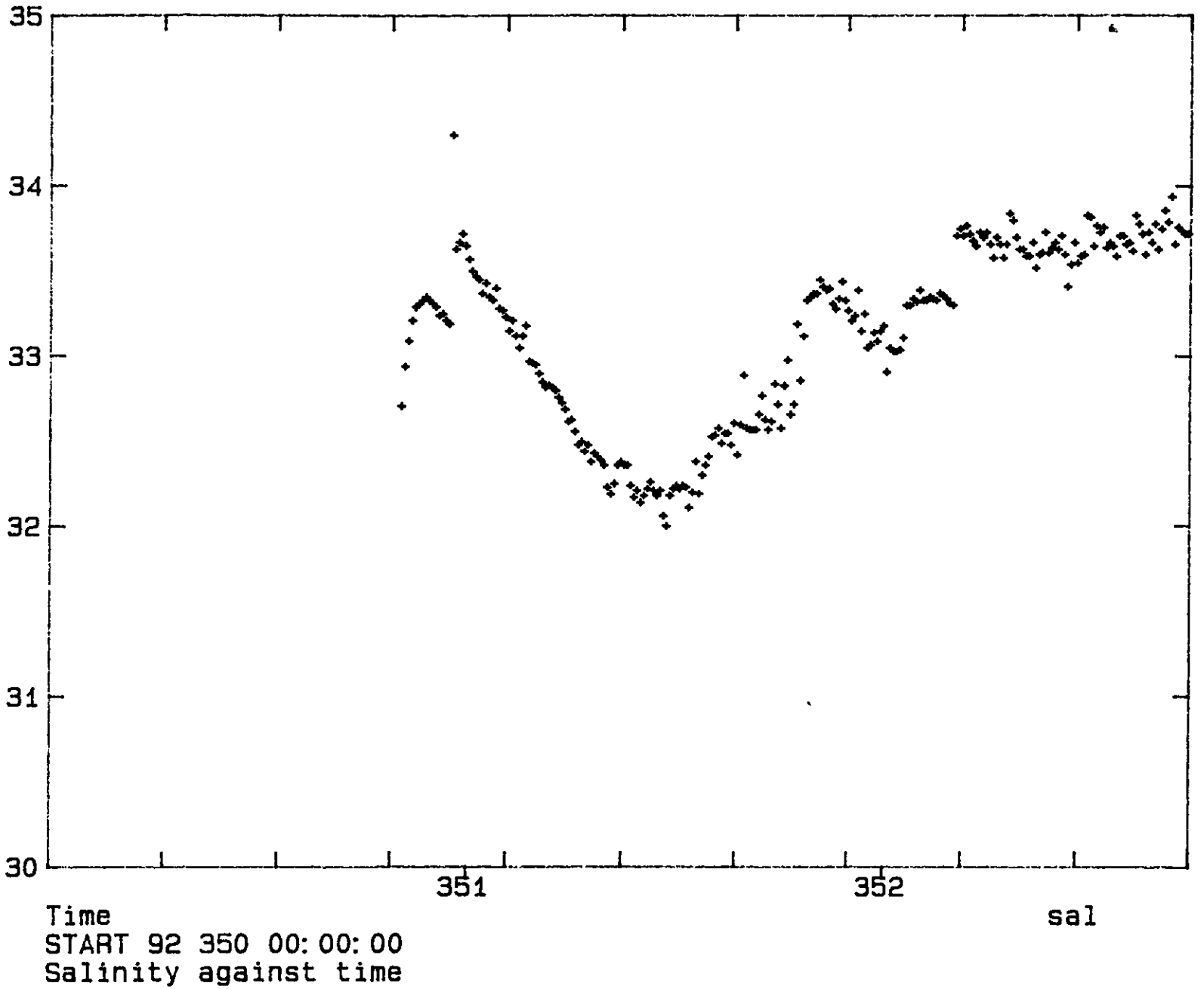
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APPENDIX 6. POST CRUISE RADIO-ISOTOPE INSPECTION REPORT

STERNA '92 CRUISE **JAMES CLARK ROSS**

OCTOBER - DECEMBER '92

RADIOTRACER LAB AND OTHER AREAS WHERE RADIOTRACERS USED

INSPECTION DETAILS

WORKSPACES MONITORED

RADIOTRACER LAB - ALL SURFACES
FUME HOOD - ALL SURFACES
MIDDLE CONTAINER - INSPECTED

WORKSPACES SWABBED

RADIOTRACER LAB
COUNTS FROM SWABS WERE NOT SIGNIFICANTLY DIFFERENT FROM BACKGROUND - DETAILS ENCLOSED IN RADIOCHEMICAL CONTAMINATION LOG

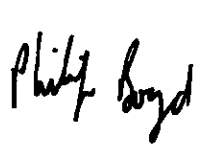
DETAILS OF SPILLAGES / CONTAMINATION

NONE FOUND

ACTION TAKEN

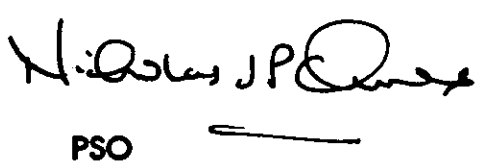
NONE

SIGNED



RPS

MATE



PSO

RADIOCHEMICALS BEING TRANSPORTED TO THE UK ON JCR AFTER THE STERNA '92 CRUISE

RADIOISOTOPES IN RADIOCHEMICAL LOCKER/RADIOCHEMICAL LAB UNLESS OTHERWISE STATED

RADIOISOTOPE	QUANTITY	NAME	INSTITUTE
14C	23 mCi (7* 3mCi +2 mCi)	P. BOYD FAX	QUEENS, BELFAST (02477-28902)
14C STDS	10 INTERNAL STDS F.A.O ALAN POMROY	c/o P. BOYD	QUEENS BELFAST PML
14C STD	1 INTERNAL STD	P. BOYD	QUEENS BELFAST
14C	2.25 mCi	S. ARCHER FAX	BAS/SOTON UNIV 0223 462840
14C -METHANE	8mCi	N.OWENS FAX 0752-670637	PML
3H-Tdr FRIDGE/BIO LAB	3mCi	R.HARRIS	PML FAX 0752-670637
3H-Tdr FRIDGE/BIO LAB	3mCi	D.PLUMMER	PML FAX 0752-67063

WASTE DISPOSAL ARRANGMENTS

ISOTOPES USED	NAME	INSTITUTE	FAX
^{14}C	P.BOYD	QUEENS BELFAST	O2477-28902
	S.ARCHER	BAS/SOTON UNIV	0223-462840
3H-Tdr	D.PLUMMER	PML	0752-670637
^{208}Po	G.RITCHIE	EDINBURGH UNIV	031-668-1000
^{234}Th	G.RITCHIE		

DRY WASTE

TRIPLE CONTAINED IN LABELLED BAGS. SOME BAGS PLACED INTO A LABELLED PLASTIC DRUM.

DRUM	BAG	ISOTOPE	ACTIVITY	NAME
1	1	^{14}C	0.3mCi	P.BOYD
1	2	^{14}C	0.2mCi	P.BOYD
1	3	^{14}C	0.2mCi	P.BOYD
2	4	^{14}C	0.4mCi	P.BOYD
2	5	^{14}C	0.3mCi	P.BOYD
	6	^{14}C	0.3mCi	P.BOYD
	7	^{14}C	0.3mCi	P.BOYD
	8	^{14}C	<0.1mCi	S.ARCHER
3	9	3H-Tdr	0.2mCi	D.PLUMMER
4	10	3H-Tdr	0.2mCi	D.PLUMMER
5	11	3H-Tdr	0.2mCi	D.PLUMMER
	12	^{14}C	0.3mCi	P.BOYD
	13	^{14}C	<0.1mCi	S.ARCHER
	14	^{14}C	0.2mCi	P.BOYD
	15	$^{208}Po/^{234}Th$	<0.1mCi	G.RITCHIE

LIQUID WASTE

DOUBLE CONTAINED - IN A LABELLED METAL DRUM AND THEN PLACED INTO A LABELLED PLASTIC DRUM CONTAINING FERMICULITE ABSORBANT

DRUM	ISOTOPE	ACTIVITY	NAME
1	^{14}C	2mCi	P.BOYD/S.ARCHER
2	^{14}C/3H-Tdr	8mCi	P.BOYD/D.PLUMMER/ S.ARCHER

SCINTILLATION VIALS

USED CAPPED PLASTIC VIALS DOUBLE CONTAINED IN TWO LABELLED PLASTIC BAGS AND THEN PLACED INTO A LABELLED PLASTIC BIN WITH A FIXED LID

BIN	ISOTOPE	ACTIVITY	NAME
1	^{14}C	1mCi	P.BOYD

ID:PHILIPB14C 13 DEC 1992

USER: 1 COMMENT:

PRESET TIME : 5.00
DATA CALC : SL DPM H# :YES SAMPLE REPEAT
COUNT BLANK : NO IC# : NO
TWO PHASE : NO
SCINTILLATOR: LIQUI
LOW LEVEL :
SATS : 1
AMPLE REJ: 0
LIFE CORRECTION DATE: none

14C %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0

QUENCH CURVE: Off COLOR QUENCH CORRECTION: On

Quench Limits Low:13.500 High:329.70

SAM NO	POS	TIME MIN	H#	14C CPM	14C %ERROR	14C DPM	14C EFF-1	LUMEX %	ELAPSED TIME
1	1-1	5.00	49.7	24.00	18.26	25.27	94.97	5.08	5.72
2	1-2	5.00	49.7	28.80	16.67	30.32	94.97	3.88	11.44
3	1-3	5.00	51.5	24.20	18.18	25.50	94.91	3.84	17.25
4	1-4	5.00	47.6	20.00	20.00	21.04	95.05	4.40	23.06
5	1-5	5.00	47.7	25.60	17.68	26.93	95.05	3.44	28.78
6	1-6	5.00	47.2	21.40	19.33	22.51	95.06	3.15	34.49
7	1-7	5.00	41.5	20.00	20.00	20.99	95.28	2.06	40.09
8	1-8	5.00	39.9	19.60	20.20	20.56	95.34	1.89	45.78
9	1-9	5.00	532.1	22.60	18.81	161.49	13.99	1.10	51.69
		WARNING: QUENCH VALUE IS OUTSIDE QUENCH LIMIT							
10	1-10	5.00	527.9	21.60	19.25	147.13	14.68	1.29	57.70
		WARNING: QUENCH VALUE IS OUTSIDE QUENCH LIMIT							
11	1-11	5.00	529.4	22.00	19.07	152.55	14.42	1.10	63.69
		WARNING: QUENCH VALUE IS OUTSIDE QUENCH LIMIT							
12	1-12	5.00	527.2	19.80	20.10	133.87	14.79	1.07	69.70
		WARNING: QUENCH VALUE IS OUTSIDE QUENCH LIMIT							

R.R.S.JAMES CLARK ROSS

EXCERPTS FROM THE MASTER'S VOYAGE REPORT

STAP CRUISE, JCR 02, 17TH.OCTOBER TO 18TH.DECEMBER 1992

Masters Voyage Report, Voy 02, Part 1.

Stanley

During the afternoon we disembarked the four expedition staff, Burkitt, Donlon, Day and Foden. Miss Ruth Flowers (BBC) also disembarked. This enabled the catering department to get the cabins ready for the expected influx of STAP personnel arriving on the flight the next day. At 0800 on the following morning the deck crew began moving some of the scientific equipment into the warehouse on the jetty. Also the cargo for Stanley was discharged. The first fifteen of the scientists for the STAP cruise arrived on the jetty at 1700. The first day after their flight (Wednesday) was spent largely recovering and mobilisation for the cruise began in earnest on the Thursday morning. It was a tremendously hectic period with the laboratories and decks in turmoil. The pace increased after the remaining scientists joined the vessel on the Friday evening. Most persons on board worked very long hours over the weekend to ensure that the vessel was prepared for an 0600 departure on the Monday morning.

Eight officers and eighteen scientists were entertained to cocktails at G.H. on the Friday evening. The Governor and his wife having been given a tour of the ship and entertained to tea on board the previous day.

We had ordered a sludge tanker to take away 4 cubic metres of waste fuel but, even after several reminders, the contractor did not turn up. Some fresh salad vegetables were ordered from Stanley Growers and some small items bought for the ship by Myriam.

We let go and sailed for Mare Harbour at 0600 on Monday 26th. October.

Mare Harbour

We arrived at the S.P.M. at 0930 hours. Having collected the pelican connector from an Army CSB we moved up to the mooring and held position using thrusters. Unfortunately the hard eye at the end of the messenger had been changed since our last visit and the new one would not fit through our fairleads. After some abortive attempts to moor using our own lines through the hard eye we eventually cut away the hard eye and pulled the mooring chain aboard using strops. We were finally connected securely to the buoy at 1130 at which time the hose was passed aboard by Oil Mariner and bunkering commenced. During these proceedings and while holding position off the S.P.M. with Oil Mariner alongside our port side. the Indomitable carrying Rear Admiral Rankin the CBIFFI came alongside our starboard side. Dr. Owens, the Chief Scientist gave him a quick tour of the labs and then I talked with him on the bridge while holding station. He was very enthusiastic indeed about the ship and BAS in general. He offered help of any sort should it be required and in particular with flights over the Christmas period.

Bunkering was complete at 1830. We let go of the SPM and sailed for Mackinnon Creek in Choiseul Sound. There we

anchored just at nightfall.
The next morning (27th) was spent in further preparations for sea and science. Among other things the CTD was put in the water and tested. Both instrument and gantry/winch systems seemed to work well although we had a slight suspicion about the winch operation. We sailed for the South Shetlands at 1530.

At Sea

We carried out a test deployment of the UOR during the first evening while en route to the first CTD station at the beginning of a North/South transect. We reached the CTD station at 0800 on the morning of the 28th. The wind was force 7 with quite steep seas so it was decided, through fear of damage to the instrument, to cancel the CTD requirement and proceed to the next station. The night previously had been very rough and so some time was spent resecuring things in the laboratories and repairing a fault with the bow thruster. By the time we were ready to go the wind had moderated somewhat and it was decided because of the suspicions of the winch operation we should deploy a test weight in the first instance. This we did without incidence. We then coupled up the CTD and on lowering it into the water to a depth of 5m and beginning to hoist the wire slipped off the inboard sheave of the traction winch. Fortunately the Deck Engineer was continuously monitoring the operation in the winch room and the hoisting was immediately stopped. He had witnessed the inboard compensator acting against the storage drum and on coming hard onto its stops a loop of slack wire enabling the wire to slip off the sheave. This is almost certainly what occurred before Stanley when the acoustic release was lost. We stoppered off the wire, reeved the wire back onto the sheave and with the inboard compensator locked recovered the CTD. After some lengthy discussions it was decided to continue with the drop with the compensator in the locked position. This was carried out successfully but, unfortunately, the CTD would not activate the water bottles. This was subsequently discovered to be due to a short in the cable where it had come off the sheave. The gantry was then housed and course for the next station was resumed with the UOR streamed. The ship was rolling quite heavily on this course although the wind was not stronger than 6-7. Throughout the day, even hove to on station, small waves had lapped over the starboard side and after decks. When we resumed course we shipped a couple of waves over the after deck and one of the container laboratories was flooded. The particular container laboratory belongs to IOS/RVS and is in very poor state of repair. The rusty door opens inwards and does not seal so it was not surprising that the shipping of a small sea should enable a large amount of water to get into the container. On hearing of this occurrence the course was altered and the transect abandoned. A more favourable course in the

conditions was chosen and a new transect to the SW was begun. This enabled the ship's company to have a reasonably quiet night. When fully loaded with fuel and cargo the after deck is very vulnerable to shipping seas and any equipment stored there should be thoroughly watertight and strong enough to withstand being washed by the occasional sea. I believe that in the worst weather conditions, no matter what course or speed is chosen, the after deck will be awash.

The following morning heralded better weather, work commenced on modifications to the winch system on the advice of Anderson Caleys and the crew and Electrician assisted the scientists in strengthening and making watertight the laboratory container. Having given up the idea of CTD's on the transect we continued on the new course of 205° towing the UOR. At 1030 on the morning of the 30th. October we recovered the UOR and got ready for a test CTD drop. Unfortunately, once again, we were dogged by problems. On this occasion the CTD storage drum was not operating correctly and the operation was abandoned almost before it had begun. The UOR was again streamed and a new course towards Bridgeman Island was steered. We reached Cape Melville and altered course into Bransfield Strait at 2300.

Potter Cove

The port anchor was dropped in Potter Cove at 0450 on 31st October. In virtually ice free conditions and with a gentle NxE'ly wind echo sounder calibrations were begun at 0600. A team of scientists accompanied by the Chief Officer went to pay our compliments at the Argentinean base "Jubany". They were well received and entertained to lunch. In the afternoon most scientists had the opportunity of a walk ashore while the echo sounding calibrations were being completed. Six of the diving team were also able to try out their equipment whilst diving off the base point. Eleven of the base members toured the ship.

At 1730, with all boats recovered and all personnel at their respective correct ends, the anchor was weighed and course was set for Deception Island.

Deception Island

Conditions were not ideal on our arrival. We passed through The Bellows at 0630 and were in position to carry out a CTD at 0700. The wind was E'ly 8 which prevented any landings. The problems with the CTD continued with, on this occasion, an electronic control fault delaying the deployment until 0810. But after an initial test deployment with a dummy weight the CTD was then successfully deployed and was greeted on deck by many smiling faces and even a little dance by the PSO ! It's amazing how, even the smallest success takes on importance when preceded by continual failure. Following on from this the SAPS winch

was successfully used. At 1300 we then tried to deploy the bucket dredge using the stern gantry at that time the short run of success ended. Both relief valves on the hydraulic motors blew consequently drenching the after deck in oil. Fortunately even this minor setback could not entirely dampen the raised spirits. An additional CTD deployment was made before setting off for Faraday at 1530. The wind was still blowing very strongly from the East but the morning low cloud had dispersed and Deception appeared at its snow covered best for the photographers.

At Sea

During that evening (1/11) the doctor brought news of a medical problem that needed attention ashore. I was left with no alternative but to turn the ship around and head northwards. The ship was turned at 2345 by which time we had reached the top end of the Gerlache Strait. I determined to proceed at speed for Stanley but while passing the Chilean Base at Marsh to investigate any possible alternative means of medical evacuation. BAS (WMS) was contacted at 0530 the following morning and the situation explained. The nature of the medical problem was by this time also becoming clearer and, as it was not life-threatening, it was decided that we should proceed direct to Stanley.
Fortunately we had a very good crossing with moderate Easterly winds for most of the time.

Stanley

We altered course into Port William at 0700 on 4th. November and came alongside the Bransfield at FIPASS at 0800. Julian Priddle was immediately disembarked in order to catch that mornings flight. The unexpected visit had coincided with his wish to return home for compassionate reasons. During the day we refuelled from Bransfield and discharged two persons to the care of Stanley Hospital. One additional person (SG1) had also received notification that tests carried out at the hospital previously had indicated the need for further treatment and, once again, this unexpected visit had proved opportune. The Bransfield kindly transferred an SG1 as a replacement as recruitment would have been impossible at this short notice. Two days prior to our arrival I had notified Myriam of our probable requirement for an additional crew member to help in the galley. The post had been advertised but nobody had come forward to take up the position. The first fortnight of the cruise had indicated a necessity, on this occasion, for this extra person. The galley staff were hard pressed to get the food prepared and thus the cleanliness of the galley and messrooms was suffering. I believe this to be purely a function of the numbers of scientists aboard on this occasion rather than an indication of a continuing need for a permanent galley assistant. With the refuelling

completed we were just preparing to leave when a chap (Derek Lea) came on board enquiring as to whether it would be too late to ask for the galley assistants position. He was given ½ hour to pack his things which deadline he met thus enabling us to sail at 1615. Wind SW 6.

At sea

We commenced UOR deployment at 0800 the following morning. The wind, by this time, was Swxw'ly 6/7 and increasing. The deterioration in the weather continued throughout the day and at 1800 with a WxN'ly wind of 7/8 we brought the UOR inboard and steered a more westerly course in order to protect the afterdeck.

The seas continued to build up overnight and we were forced to alter gradually more westwards until by 0200 we were fully hove-to in westerly gale conditions. Under these circumstances the forecastle and foredeck are surprisingly wet. With on occasions very heavy water being taken for'd. This is another indication that, when fully loaded and down to her marks the weather working parameters will be quite low and the security of anything on the foredeck will be at risk. Had the wind been force 10 or greater I believe the foredeck would have been permanently awash whatever course or power settings had been chosen.

During the morning of 6th. November the wind suddenly backed and dropped and by lunchtime we were able to stream the UOR and resume our S'ly course. During this day the Bransfield was only a few miles away. She, while not having a comfortable night, had been able to retrieve one of the POL tide gauges and, albeit, slowly and slightly off ideal course had been able to maintain her southerly heading at a reasonable speed. This emphasises even more that this ship is unusually wet in rough sea conditions.

Faraday

We reached the top end of the Neumayer Channel at 0600 on the 7th. November and stood off the entrance to Meek Channel at 1000. The weather conditions were ideal for the refuelling operation. Corner Rock was conveniently marked by a grounded bergy bit and so the passage into Meek Channel began almost at once. A thin strip of fast ice off the refuelling point enabled the ship to stop in the middle of the channel. Unfortunately, had I known that the ice was going to be strong enough to hold the ship, I could have positioned the ship much closer but, in any case, after digging all the available hose out it reached the ship and refuelling was commenced at 1330. The scientists much enjoyed the ability to walk ashore to the base and the fine weather helped to make it a memorable day for them. The diving contingent too were happy to be able to test out their pack ice diving routine and all eight divers went for a swim. Refuelling was completed 1722 and all available personnel then were exercised in a traditional FID fashion

while snaking the full refuelling hose off the ice and onto the land. Unfortunately an oversight has meant that this ship does not have the ability to "suck back" the fuel remains out of the pipe at completion of the fuelling exercise. This will form a modification at the next refit. A social evening followed with most of the base personnel walking out to the ship. The last of them went ashore at 0600 prior to the vessel moving ahead through the fast ice and out to Drum Rock anchorage. The anchor was dropped at 0650 and the cargo tender was prepared and sent into the base in order to collect the outgoing 54 drums of waste fuel. This was completed at 1030 and the vessel weighed anchor and proceeded westwards through French Passage. Wind still light southerly and 9/10 small floes.

At sea

The wind increased steadily as we neared the ice edge (066°30'W) until when open water was seen ahead it was SW'ly 8. The steep seas caused us some problems at the ice edge as small pieces of ice were shipped on the forecastle even at very slow speed. We persevered and came through into open water at 1745. Due to the weather conditions we were unable to maintain the required 10.5 knots and thus the UOR could not be deployed. However a moderation in wind and sea enabled the instrument to be deployed the following morning as we continued our Westerly course to the northern end of a planned N/S transect.

At 1500 hrs on 11/11 we reached 085°W but once more high winds (NxW 8) combined with an unusual failure of the stabilising system caused us to adjust our planned southerly course slightly. We steered 160°T until 2006 at which time with a moderating wind and repaired stabilisers we were able to alter to the required 180°T.

At 2155 we reached the ice edge (65°55'S) and the UOR was recovered. We then continued south in very open pack ice. Good progress was made in steadily more ice until at 2030hrs 12/11 in Lat. 69°24'S and 9/10 small and medium floes. Having decided that the whole area seemed to consist of brash and generally soft ice which had slowed our progress to 2 or 3 knots on full power I decided to stop and try and make a "berth" in one of the larger floes (1+km dia). This in the event proved impossible. The ice was so weak that it split at the merest touch. We stopped off a likely floe for the night and at 0600 the following morning a party was put ashore using the crane to survey the ice.

"Flossie" 69°25.6'S 085°04.4'W

They returned at 0700 and reported that it was workable and therefore a day of "shake down" activities was planned and carried out successfully. (station "FLOSSIE") At the completion of the day most of the scientists were happy with the results obtained and saw no need to progress further south. (We had already come 200' in from the ice edge which was far more than had been bargained for) The

ice scientist from SPRI and some of the physical oceanographers were unsatisfied with the ice station however and it was therefore decided to spend the night making what southerly progress we could. Almost immediately better conditions were found. The ship made better progress than the previous day in the open water between large floes and as we ventured further south the ice became more solid with less brash. At 0600 14/11, we had arrived at Lat 70°S. The floes were, by this time, large/vast and the leads were getting less frequent and narrower. The ship stopped, the overside discharges were closed in order that we should retain all our effluent on board, and a suitable "berth" was sought. We were in position 150m inside a huge floe by 1050. (station "GERTIE" Lat 70°18'S Long 085°18'W)

"Gertie" 70°17.0'S 085°12.0'W

A reconnaissance party was put ashore immediately and on their reporting excellent conditions the science areas were mapped out and marked by flags. It was decided that the science programme could not begin in earnest until the following morning and so the first day was utilised in getting holes cut through the ice and in deploying and preparing equipment. A successful haul with the bucket corer was made over the stern however. It had been our intention to cut a large hole in way of the midships gantry for CTD and net deployment but, due to the amount of ice forced under the main floe by the ship, this was found impossible and after hours of very hard labour the attempt was abandoned at 0400 15/11. As the CTD was essential to the programme a method whereby the cable from the CTD winch could be led via the midships gantry to the after gantry was devised. Both the CTD and the SAPS winch were repositioned to be deployed over the after gantry. The jury rigged methods worked well. Unfortunately it was reported at 0830 that the retention tank was full to overflowing and we therefore had to open overboard discharges again. Meanwhile the engineers worked on possible solutions to this problem. We could not understand why our 14 cubic meter tank had been unable to provide storage for our daily FW consumption especially as strict rationing had been in force to, hopefully, enable us to go 48 hrs without the need for overboard discharge. It had in the event only coped with 22hrs. A possible solution involving one of the ballast tanks was devised and put into effect immediately. By 1030 we were once again retaining all our waste products on board without the science programme being affected. A very successful day followed with scientific parties working at both ends of the ship and at several locations ashore simultaneously. One CTD cast was delayed for three hours while a major oil leak in the traction winch system was repaired but with no other problems the pace was hectic. The momentum was successfully maintained through the night.

Over the next two days (16/11 and 17/11) the work continued using the stern gantry for all deployments. We were continually beset by oil leaks on the gantry more often than not caused by the relief valves lifting. Fortunately the Deck Engineer maintained his sense of humour but oil was frequently spilt on the after deck and into the water astern. Under the circumstances nothing more could have been done to prevent this. The ice showed no visible signs of weakening and therefore the scientific programme ashore went on apace with ice cores, snow profiling and very frequent diving operations. Unfortunately much effort went into setting up radar reflectors some distance from the ship in order that German Scientists at O'Higgins Base could, I believe, calibrate satellite data only to discover after the event that the scientists had been unable to get to the base due to bad weather.
On the evening of the 17/11 a tug-of-war took place on the ice next to the ship when virtually all the scientists annihilated a team of 15 crew. Mulled wine followed by a volley ball game and back on board for sandwiches in the bar completed a very enjoyable evening.
We, reluctantly, left ice station "Gertie" at 1700 on the 18th. November in order to make our way northwards towards ice station "Herbie"

<u>At Sea</u>

The ice situation had changed somewhat from that encountered southbound a few days earlier. The floes seemed larger and were certainly more consolidated. On occasions the ship struggled to get between large floes and backing-and-foreing became a frequent necessity. After achieving only 20 miles in the first seven hours the ice encountered was weaker and better progress was able to be made. By 0800 we had got to the same latitude as "Flossie". It had taken us 15 hours as opposed to the 7 hours on the previous occasion. At 0500 the engineers reported a serious leak from the stern tube seals. After further investigation it appeared as though the two inner stern tube seals had been damaged. The engineers set about increasing the head on the "seal header" tank in order to equalise the pressures and ensure that no water leaked in. This exercise was reported as having been largely successful at 0900. The situation would be carefully monitored over the next few days.
We had been stopping every hour or so on the way north in order that water samples could be obtained from the uncontaminated sea water supply (this gets blocked up in ice while underway). The biochemists were using this data in order to make the choice of location for station "Herbie".
During the afternoon of Thursday 19/11 it became apparent

that Discovery needed medical assistance for their chief cook. It was decided at 1600 hours to proceed to a rendezvous with the Discovery who at that time were 400 miles NE of our position and hove-to in bad weather. At first we continued out transect on a northerly course but at maximum safe speed in the ice. By this time there was enough open water for the chemists to be able to sample the water without the ship having to stop. At midnight it was reported that the information required from the transect had been gained and course was altered directly towards Discovery.

Discovery Rendezvous

At 1305 both ships stopped in the water head to wind about 2 cables apart and the Humbers were launched. The wind was 15 to 20 knots from the NW and a fairly large swell was running. The doctor, principal scientist and Paul Woodroffe were taken across and embarked on Discovery. The boats were fine alongside James Clark Ross but, due to projections on the side and the tendency for the ship to roll, they were not comfortable alongside Discovery. However the transfer was made and two boxes of airfreight were lowered down and landed into the boats before they safely returned and were hoisted aboard. While the doctor was seeing the patient the two ships both carried out shallow CTD drops in order to intercalibrate the instruments. On completion the boats were again launched and the water samples were swapped and two of the personnel transferred earlier were brought back aboard. After discussions with Aberdeen, Cambridge and Barry it was decided that the patient was seriously at risk and therefore should be transferred to a hospital ashore as soon as possible. From the scientific point of view it was decided that Discovery should perform this role but, on reflection, the doctor stated that he would feel much happier with the chap onboard James Clark Ross with its greater speed and better hospital facilities. In gradually increasing wind conditions the boats were again launched and sent away to Discovery. Our lifting pennant was transferred and one of the boats was lifted to the Discovery's main deck. In this way the doctor and patient were safely transferred.

The decision as to where to head for then had to be made. Although Punta Arenas was some 240' closer the prospect of trying to arrange a pilot over the weekend for the 120' pilotage, the potential immigration problems, the doctor's definite preference for the Stanley medical facilities and our requirement to take another 300 cubic metres of fuel all led to Mare Harbour being chosen. At 1905 from position 65°01S 079°19'W a course of 042°T was set at full speed.

At Sea

The scientists although very dejected by the thought of yet another delay in their programme were amazingly philosophical. It was understood by all on board that the diversion was the only sensible outcome under the circumstances. Blood was needed and volunteer donors immediately came forward. The patient after the stressful and tiring trip across from Discovery seemed to settle in well. The weather stayed exceptionally good and very fast speeds were maintained.

Mare Harbour

On approaching Mare Harbour during the morning of 23rd. November we were asked to go to the SPM rather than East Cove as had been expected. As Oil Mariner must operate on our port side the cargo tender was launched while approaching the buoy. The customs officer and some of the fresh salad provisions were collected while the vessel tied up. Since our last visit a new and smaller hard eye had been spliced into the messenger rope which made the securing process very easy and straightforward. The doctor and patient were taken ashore in a humber as soon as we were informed that the ambulance had arrived at the East Cove Slipway. The weather was very good and so the fairly long boat journeys from the SPM to the slipway were accomplished comfortably. The cargo tender was held up on occasions due to its intakes blocking with kelp. The 54 drums of waste fuel were discharged without incident and a party of four scientists were transported ashore to go on a shopping foray at M.P.A. For some reason the pumping rate was slower than before and it took us over 4 hours to take 280 cubic metres of fuel. The doctor arrived back from the hospital at 1800 to coincide with the end of fuelling. The SPM was released immediately, cargo tender recovered, and the vessel departed for the science area at 1830.

At Sea

Unfortunately the weather on the journey south was not as kind as it had been northbound. However, everything was securely battened down, and, except for a few hours on one occasion, the course was maintained. The passage will be memorable for some of the intermittent rolls of over 40°. No damage was sustained and, although the after deck did take some green water, no water got into the laboratory containers. During the evening of Tuesday 24th. November it was reported that one of the large main engines was out of commission due to problems with one governor. After many hours investigating the problem it was pronounced, on Wednesday morning, that that engine would not be useable until a spare governor could be obtained. This effectively cuts our available shaft horse power by half but, with my understanding at that time, I did not think that this would

have any effect on our ability to carry out the rest of the scientific programme. I could, however, foresee problems getting into Rothera unless the presently reported fast ice were to break out. Cambridge were informed and ways by which the governor could be got down to the Peninsular were discussed. In the meantime the ship's progress was slowed further and morale onboard lowered accordingly. It was apparent at this time that, principally, the two medevacs and the associated delays had "knocked the stuffing" out of many of the scientists' enthusiasm. In reality it had been surprising that morale had remained high for so long. News that the Discovery was continuing to be dogged by bad weather and that she had problems with her after gantry made people feel that life on the James Clark Ross perhaps wasn't that bad after all. We got back into the marginal ice zone and calmer waters during the late morning of Saturday 28th. November and reached a definite ice edge at 1530. After carrying out a CTD at the ice edge we proceeded into the ice with a view of regaining the position of ice station "Gertie". With only half power the ship really did remarkably well in ice that for most of the time was 10/10ths small floes and brash. A constant average of 3-4 knots was maintained until at a position in the vicinity of the original "Gertie" was reached at 0900 on 29/11.

"Herbie" 70°14.8'S 085°06.8'W

With the bow into a medium sized flow and constant bow thrust a position was maintained whereby we could land people over the bow using the for' crane while still being able to work nets and CTD's over the stern in the open water created by the propeller. The weather was very good with light easterly winds, few clouds and good contrast. The ice researchers and a diving party worked on the ice during the day while a constant stream of nets and CTD's were carried out aft. The frenetic activity was maintained late into the evening until at 0100 30/11 the last of the divers was lifted back aboard and the vessel pushed itself back northwards through the increasingly pressured "porridge" ice and in poor visibility due to mist and fog. During that night the ship was stopped many times and only by backing and foreing could any sort of progress be made. However progress was maintained albeit averaging only 2 knots at times and the site of the next station "Isolde" at the ice edge was reached in the early evening.

"Isolde" 69°34.0'S 085°01.1'W

We remained at this station until 0500 on the morning of 3rd.December and during that time a constant succession of nets, CTD's, dredges kept us all amused. Unfortunately the wind was too strong (35-40 knots) during the day on the 1/12 for the divers and ice researchers to be able to leave the ship but we put the launch and humber in the water on two occasions during Wednesday 2nd.December to enable the

scientists to go ice coring and diving on and around some of the floes at the ice edge. The wind had dropped but the visibility was still very poor so the ship stayed close to remain in sight of the boat party all the time. A sediment trap rig was deployed during the first night and, alongside this rig, an incubation rig on the second night. There were many strips of brash ice in the vicinity and it was not long before the rigs were enveloped in the ice. The sediment trap rig was fitted with a VHF transmitter and the associated VHF DF unit was used to good effect to relocate the unit in the early hours of the morning of the 3/12. Unfortunately no sign of the "Dan" buoy on the incubation rig could be seen. The rigs had been last seen some 15 hours previously, both together, in amongst a strip of brash ice. The sediment trap rig was successfully recovered albeit with some difficulty owing to the lines being caught in the ice. Having carefully scanned the area immediately around this site without any sign of the other rig an expanding square search pattern based on an initial ½ mile leg was begun. This should have taken us to within a maximum of ¼ mile of the rig. The visibility was poor but at least half a mile and the sea in amongst the strips of ice was calm. We continued this search until 3 miles away from the site of the sediment trap rig without success. The whole area was then dissected diagonally a couple of times before the search was called off at 0500. It is a possibility that the lines attached to the "Dan" buoy had got tangled in the ice floes and that the different relative movements of the floes had caused the buoy to tip over. Having seen the condition of the other "Dan" buoy I could very well imagine this to have been the case. We set off northwards making all speed through strips of pack ice towards our next station "Jules".

"Jules" 68°15'S 085°00.0'W

The amount of ice in the early stages precluded the towing of the UOR. A CTD station was carried out at the halfway point in the 90' passage and the UOR was towed for the final 45'. "Jules" was reached in the early evening of the 3rd. December and the sediment trap rig was immediately redeployed. On this occasion a flag and sonde balloon were used to make the rig more visible and everyone agreed that apart from making the "dan" buoy look very "pretty" they serve a very useful purpose indeed. CTD,RMT and vertical net stations were carried out throughout the night and the morning of the 4th. December. It was at 1030 on that morning that news first came through that the Discovery had lost their main scientific tool the "See-saw". After discussion and commiserations it was decided that the two ships should rendezvous again and that our UOR and technician should be transferred for a period of 48 hours so that their survey could be completed. They were about 40' away at the time. The rendezvous took place at 1800 on the 4th. in 15-20 knot NNE'ly winds. Our boats were used

and the whole process was completed at 1930 at which time the Discovery left for her work area. During the early hours of Saturday 5th. December a replacement incubation rig was deployed. On this occasion the rig was attached to the highly visible sediment trap rig in order to ensure relocation. Some delay was experienced during the planned afternoons deployment of a deep CTD (3800m) due to problems with no.3 sheave on the small traction winch system. The problem was resolved finally and the CTD successfully deployed about 2 hours late. An attempt to take a bucket core sample at this depth was made after the CTD but unfortunately the corer seemed to have tripped on the way down as no sample was collected. Both rigs were recovered in the early hours of Sunday morning only to discover that one Langdon Rig and both sediment traps had been apparently "torn" from their securing points and were missing. This can only be explained as the action of a whale or some whales. As they were secured by brand new 8mm wire strops considerable effort must have been expended. After a few more RMT's in a final and unsuccessful attempt at this station to catch some krill the vessel move northwards towards "Katie" at 0500.

"Katie" 67°30'S 085°00'W

The sediment trap rig was deployed on our arrival at the station at 1100 and afterwards the, now familiar, series of CTD's and nets was commenced. During the early hours of Tuesday 8th.December the incubation rig was deployed and attached to the sediment trap rig. We rendezvoused with Discovery at 0900 on that morning. Our boats were used to collect Ian Bellan and the UOR without incident. A "welcome back" party on deck with banners and flares made for a colourful scene. The Discovery then departed north after a "fly past" on our starboard side. After that the day continued uneventfully. The sediment trap and incubation rigs were recovered at 0100 9/12 and once again the sediment traps were "missing". The whale theory now seemed unlikely and chaff due to continuous movement became the favoured cause. After some more RMT's in an unsuccessful attempt to catch krill at this station the vessel set off for Rothera at 0700. Initially problems with the after gantry delayed us towing the UOR but this was streamed in good time to carry out the required short transect.

At Sea

The ice edge was reached at 0730 10/12 at position 67°42'S 070°11'W. We entered the ice heading due East but came to a grinding halt within ½ mile of the edge. After discussions with the engineers it was decided to attempt the passage with the fourth engine in hand control. In the event this gave me the full 8500 SHP but as the load must be maintained on the engine under these circumstances I could not reduce power below a certain level and could not,

therefore, back and fore. Within a further ½ mile it became apparent that the ice was very compacted (small floes and brash) and would not allow continuous forward movement even with the use of full power. I had some trouble turning the ship due to the pressure of the ice but eventually managed it and made the open water again at 0930. As the fourth engine was taken off the board we experienced our first complete blackout of the day. I then took the ship up the ice edge to attempt a southward course through Johnston Passage. We again entered the ice at 1130 but once again made very slow progress for ½ mile before, bringing the fourth engine on line. After our second blackout and a further ¼ mile progress the ship once again came to a grinding halt. I had never before experienced ice as compacted and yet very close to the ice edge. I surmised that the almost continuous northerly winds that the area had experienced over the last two weeks had driven the ice down the West coast of Adelaide Island and pressured it against the pack/fast ice in Marguerite Bay. In any case it was very obvious that in our present mechanical state we were not able to progress towards Rothera Base. I left the ice edge again at 1300 and headed towards Palmer Station in order to carry out the tasks in that area and, hopefully, get the spare governor for the fourth engine. There followed several communications with BAS HQ and Rothera. During this time it was made abundantly clear that the ship's/BAS's first priority lay in getting the avcat and cargo to Rothera all else was to take second place to this activity. As if to emphasise this a communication came through informing me that the flights for the scientists on the 19th. December had been cancelled and that temporary reservations had been made for them on either the 23rd. or the 1st January. I wasn't sure why BAS had taken this precipitous action at this time but, if nothing else, it did allow me to totally commit the ship to the relief of Rothera assuming that the governor was delivered and that it fitted and worked.

Palmer/Faraday

We arrived to anchor in Arthur Harbour at 0800 11/12 and, miraculously, the BAS Twin Otter landed with the governor at 0805. After collecting the cargo for Faraday and very briefly exchanging visits between scientists the vessel sailed for Faraday at 1230. Numerous bergy bits at the southern end of Lemaire Channel delayed progress somewhat but we anchored at Drum Rock eventually at 1620. The humber and cargo tender were sent away immediately but some brash ice within the island group made the journey to the slipway troublesome. Jonathan Shanklin was brought out to the ship to have a look at our satellite picture receiver which had been giving us trouble. The cargo tender very full of gash from the base was lifted aboard in deteriorating ice conditions at 1930 and the humber at

2030. The vessel departed immediately for Rothera.

At Sea

I had been waiting for the governor to be fitted and tested before speaking to the scientists on board and apprising them on the situation regarding the ships movements and flights. The Principal Scientist, of course, had been fully informed of the situation at every turning point. The engineers, in the meantime, had offered the new governor up to the engine only to find that the drive shaft was completely of the wrong design. They had spent the day deliberating and finally fabricating a new drive shaft from parts of the new and the old ones. This was reported as having been a successful exercise at 2030 and so I called a meeting and faced the scientists with the latest blow to the cruise at 2100. Although most seemed to accept the news with the now customary philosophical attitude some were very disappointed and even a little angry at the apparent lack of any sort of priority being given to meeting the flight of the nineteenth. Most of these people, although experienced seagoers, have not met the situation before where the ship is committed to other activities in addition to the carrying out of the planned science cruise. They may have been warned that their flights home could not be guaranteed but, in truth, none of them even dreamt that that could become a reality. Holidays had been booked and plans made. The effect of the news on the morale of scientific party should not be underestimated. It had been a mistake to try to combine science and logistics on the ship's first STAP cruise. We had worked hard on board to try to impress and to show BAS's commitment to this sort of science and to a very large extent we had succeeded in this respect. Unfortunately, though, the cruise is more likely to be remembered for its bad points than for its good ones.
Fortunately the aircraft that had delivered the governor to Palmer had been able to carry out an ice reconnaissance of the area to the SW of Adelaide Island and that had shown the band of pressured porridge ice to be less than 15' in depth with another 20' or so of less pressured larger floes to the south. Although the aircraft had indicated that less ice existed on the route through Johnston Passage I decided that as we had strong N'ly winds and very poor visibility in snow that I would try and take the ship just to the south of the Amiot Islands in order to take any advantage there might be from the islands and their associated bergs having broken up the flow of ice from north to south. I again entered the ice at 1300 on 12/12 at position 67°36'S 069°56'W using the ice heeling tanks and full power we were at first able to maintain continuous progress albeit at only 2 knots. The visibility was only 200 metres or so which made avoiding the numerous bergy bits quite tricky. For one period, about 3 miles in from the ice edge, the ship was halted. For approximately 1

mile we only made progress by backing and foreing and because the "porridge" was closing in so rapidly behind the ship we could not back more than a ships length. It took three hours to cover that mile before the pressure decreased and continuous progress was again possible. We reached the open water to the south of Cape Alexandria at about 2230 and stopped in the fast ice to the south of Rothera Point at 2400 on the 12th. December.

Rothera

The fast ice was a good 50cm thick but presented no problem to the ship. We steamed up to the jetty at 0600 on the morning of the 13th December. After chipping gently away at the ice alongside the jetty we were eventually able to get alongside at 0800. Cargo work started immediately from both for'd hatches. The scientists had willingly volunteered to assist in the discharge and parties went both into the holds and up to the base to help "chaining" food boxes into their stowage positions. After an excellent start progress was slowed for five hours by a breakdown of the for'd crane. By mid-afternoon however the cargo was once again flowing rapidly ashore. Cargo work continued until 2100 by which time approximately 3/4's of the cargo had been discharged. Work continued at 1730 on the 14/12 and continued to a finish at 1500. During the day we had received the news that BAS had been able to re-book the flight seats for the 19th. December. This news was greeted by many smiling faces on board. Everyone was aware, however, that being able to achieve the required ETA at Stanley was largely dependent on getting through the ice northbound without too much trouble.

At Sea

We departed Rothera on completion of the cargo and were clear of the jetty by 1530. Once again we had not had time for any social exchange with the base. A fact that I am sure has not gone unnoticed by some of the base members. Certainly some of the pleasure of working for BAS has been the close relationship of all BAS personnel in the Antarctic and I believe it is essential to find time in the future for something more than long cargo working days at each base if that special BAS relationship is not to suffer.

Initially we were able to progress rapidly through our own lead in the fast ice and good speed was made until south of Cape Alexandria where we again encountered quite heavy pack ice. The ice continued 8 to 9 tenths small/medium floes until north of Cone Island. Better progress was made northbound through this area than had been the case southbound. I believe that the slight easterly element in the wind on the previous day had loosened the ice somewhat. This fact encouraged me to continue up Johnston Passage rather than to retrace our track south of the Amiots. This seemed to have been the correct decision until north of

Fullastern Rock where we met very thick, if now soft, ice. Having progressed very slowly through a band of that ice we then encountered what appeared to be a very thick fast ice edge which was totally impenetrable. I then chose to follow this edge further west and fortunately came to some close pack ice within a couple of miles. This we entered in the expectation that we had only 4 or 5 miles to work through before we would reach open water. It was heavy going but to a large extent the vessel kept going forward albeit at a snails pace. The ice healing tanks proved of tremendous value under these conditions. We eventually came out into open water at the northern end of Johnston Passage at 2330. Course was set directly for Cape Pembroke some 1000 miles distant.

The passage north proved remarkable in that, for the first time this voyage, the weather was exceptionally good. Very light winds interspersed with calms, blue skies and little swell. Economical power settings were used but it was hard to slow the shi[p down under these conditions. We easily made our hoped for ETA and went alongside FIPASS at 0800 on the 18th. December.

12th. November 1992 N.A.B.

R.R.S.JAMES CLARK ROSS

SAFETY RULES FOR WORKING ON PACK ICE

During this cruise we will be intentionally working in different types of pack ice ranging from hard solid ice in large floes to brash ice/porridge. For this reason different safety rules must be formulated to best cope with each individual situation both to enable the work to be carried out and also so that undue restrictions are not placed on other personnel. However, in general, the following guidelines should apply :-

1. On reaching a possible site, the Master, P.S.O., and Eileen Aldworth with, additionally, the Chief Officer and Rick Price should decide on its apparent suitability for the purposes of the scientific requirement and the security of the ship.

2. If it is a station where access onto the ice will be needed Rick Price and an assistant should go onto the ice with "bog chisels" in order to make an assessment on the stability and uniformity of the ice on the chosen transect to the diving station and in the area there about.

3 On their return the situation should again be discussed and rules for that station formulated. These will include, safety clothing and equipment requirements, means of access, distance from the ship restrictions.

4 A meeting should then be held with all interested scientists where the rules and guidelines for that station are communicated and the working practices and scientific activities are outlined. I imagine that this discussion would include such items as the practicalities of CTD's, nets etc at that particular location.

5 Subsequently the P.S.O., or someone delegated by him, should produce a programme of events so that bridge watch officers and others can be aware of what to expect. The safety and practicality of that programme should be reviewed regularly by the P.S.O. and the Master.

6 In all cases before **anyone** leaves the ship for whatever purpose they must complete the "walks" book which will be kept on the bridge. This book must also be completed on an individuals return to the ship.

7 We have **no field safety equipment on board** and very few people with polar safety experience. For this reason, even in the most ideal conditions, a **limit of 400m** as a maximum distance from the ship, will be imposed. Notwithstanding this limit, or a lower limit imposed because of the particular conditions, all work should be carried out as **close to the ship** as practical.

8 Routes that will be regularly used should be marked by flags (or otherwise). Remember that in low visibility or "white out" conditions, or because of blowing snow, skidoo tracks and footprints may not be seen. Danger areas, blow holes, cracks etc that are discovered must be marked with flags or dunnage.

9 REMEMBER THAT WEATHER CONDITIONS IN THE ANTARCTIC CAN CHANGE VERY RAPIDLY AND DRAMATICALLY. Anyone venturing onto the ice must be prepared to cope with unexpected weather changes.

10 A signal consisting of **one prolonged blast of the ships whistle** will be used to indicate that all personnel are to return to the ship **immediately** as an emergency situation exists. This signal will not be used flippantly and therefore equipment etc should be left on the ice rather than cause a delay in an individuals return.

11 Where a party of scientists are to be on the ice for some time one member of the team must carry a V.H.F. radio and be in contact with the deck officer on watch.

N.A.Beer,
Master,
R.R.S.James Clark Ross