FS "POLARSTERN"

Expeditionsprogramm Nr. 24

ANTARKTIS X/3-5
1992

Fall in the Ice '92

The Winter Weddell Gyre Study 1992 - WWGS '92

Marine Geology in the Southern Atlantic

Alfred-Wegener-Institut
für Polar- und Meeresforschung
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Expedition Program No 24

RV "Polarstern"

ANTARKTIS X/3-5

1992

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Inhaltsverzeichnis

		Seite/page
1.	Zusammenfassung	3
2.	Summary	6
3.	Research Programmes	8
3.1	Fall in the Ice '92 (ANT X/3)	8
3.2	The Winter Weddell Gyre Study 1992 - WWGS '92 (ANT X/4)	16
3.3	Marine Geology in the Southern Atlantic (ANT X/5)	24
4.	Zeitplan/Time Table	33
5.	Beteiligte Institute/Participating Institutions	33
6.	Fahrtteilnehmer/Participants	37
7.	Schiffsbesatzung/Ship's Crew	40
	Fig. 1	10
	Fig. 2	18
	Fig. 3	26

1. Zusammenfassung

Die Abschnitte 3, 4 und 5 der Polarstern Expedition ANT X beschäftigen sich mit Unternehmungen, die unter den Begriffen "Herbst im Eis", "Winter im Eis" und "Rekonstruktion von paläozeanographischer Verhältnisse" zusammengefaßt werden können.

Unser Verständnis der saisonalen Veränderungen im Bereich physikalischer, chemischer und biologischer Prozesse des antarktischen Packeisgürtels beschränken sich auf Beobachtungen, die zum größten Teil aus den Frühjahrs- und Sommermonaten stammen. Zu einem geringen Teil sind gerade in den letzten Jahren auch Untersuchungen während des Winters durchgeführt worden. Aus der Jahreszeit jedoch, in der sich die Packeiszone am raschesten ausbreitet, dem Herbst, liegen nur wenige Daten vor. Gerade die bei der Meereisbildung ablaufenden Prozesse beeinflussen aber das Schicksal und das Vorkommen vieler Organismen in der Wassersäule und in dem entstehenden Meereis besonders im Hinblick auf die nachfolgenden Wintermonate.

Das Hauptuntersuchungsziel des Fahrtabschnittes ANT X/3 ist eine interdisziplinäre Studie von Biologen, physikalischen Ozeanographen und Nährstoffchemikern zu den Vorgängen vor, während und nach der Eisbildung sowohl in der Wassersäule als auch im Eis. Parallel dazu laufen Untersuchungen über die Fischphysiologie, das Tiefseebenthos und die Mikrobiologie. Einen größeren Rahmen nimmt eine Studie über Massengrenzen kontinentalen Wassers ein. Außerdem sollen zwei Dauerverankerungen im nordöstlichen Weddellmeer ausgetauscht werden.

Dieser Fahrtabschnitt beginnt am 27. März 1992 in Kapstadt, Süd Afrika, und wird dort am 19. Mai 1992 auch wieder enden. Der Fahrtverlauf ist der Fig. 1 zu entnehmen. Nach dem Austausch der Tiefseeverankerungen nahe der Insel Bouvet ist ein kurzer Besuch der Georg-von-Neumayer-Station geplant. Die Hauptuntersuchungen werden dann sowohl im Bereich der sich ausweitenden Eiskante aber auch im freien Wasser und im festeren Packeis im östlichen Weddellmeer durchgeführt.

Der vierte Abschnitt dieser Expedition (ANT X/4) beginnt am 21. Mai 1992 in Kapstadt und endet am 5. August 1992 in Puerto Madryn. Er umfaßt im wesentlichen zwei hydrographische WOCE-Schnitte (SR2 und SR4) und ein fernerkundliches Bodenprogramm für den europäischen Satelliten ERS-1. Das ozeanographische Programm beginnt in Kapstadt mit der Messung vertikaler Profile von Temperatur, Salzgehalt, Sauerstoff, CO_2, Nährstoffen und einigen natürlichen und anthropogenen Spurenstoffen (Tritium, ^3He, He, Ne, Freon-11 und Freon-12) auf einem Schnitt (SR2) längs dem Greenwich-Meridians. Es schließt sich eine Traverse durch den Weddellwirbel von Kap Norwegia nach King-Georg-Island an (SR4), auf dem gleichartige Messungen durchgeführt werden. Der Schnitt SR4 wird - nach Sept. 89 und Dez. 90 - zum drittenmal durchgeführt und ermöglicht damit Abschätzungen zur Variabilität der Wassermassenproduktion im südlichen Weddellmeer.

Die Energiebilanz der Meereisoberfläche steht im Zentrum der meteorologischen Meßprogramme. Dazu gehört die Bestimmung der kurz- und langwelligen Strahlungsbilanz, der turbulenten Flüsse sensibler und latenter Wärme und des Wärmestroms durch Schnee und Meereis. Von besonderem Interesse ist der Wärmeaustausch zwischen Wasser und Luft über Polynyen als Funktion des Abstandes vom Eisrand. Es wird die vertikale Struktur der gesamten Troposphäre mit Hilfe von Radiosonden und Omega-Windmeßsystemen erfaßt. Ferner werden 6 Argos-Bojen auf Eisschollen ausgesetzt, von denen 2 außer der Position und dem Luftdruck noch Temperaturprofile in Luft, Schnee, Eis und Wasser, die Schneeakkumulation und den Salzgehalt in zwei Tiefen messen.

Ein wesentlicher Bestandteil des vierten Fahrtabschnittes ist das fernerkundliche Bodenmeßprogramm für das Synthetic Aperture Radar (SAR) und das Along Track Scanning Radiometer (ATSR) des ERS-1, für das Real Aperture Radar (RAR) auf dem russischen OKEAN-Satelliten, sowie für infrarote sichtbare und Mikrowellenkanäle anderer Satelliten. Außerdem werden physikalische Eigenschaften von Schnee und Meereis untersucht. Dazu werden Salz- und Temperaturprofile, Porengröße, Textur, Dichte, Dielektrizitätskonstante und die kleinskalige (mm-cm) Oberflächenrauhigkeit gemessen. Diese Daten ermöglichen eine verbesserte Analyse der Satellitenbeobachtungen bezüglich der Meereisbedeckung und -bewegung.

Die Emissions- und Reflektionscharacteristica der Meereisoberfläche werden mit Infrarot- und Mikrowellenradiometern und mit einem Scatterometer bestimmt. Referenzwerte (ground truth) der Meereiskonzentration liefert eine digitale optische Zeilenrasterkamera. Eine neu entwickelte Infrarot-Zeilenrasterkamera soll auch erprobt werden. Die großskalige Oberflächenrauhigkeit (Rückenstatistik) erfaßt ein Laser-Entfernungsmesser vom Hubschrauber aus. In einem ersten Versuch soll die Meereisdicke mit seismischen Mehr-Frequenz Reflektionsverfahren großflächig registriert werden.

Schließlich wird die Planktonökologie im Meereis und in den oberen Ozeanschichten untersucht. Insbesondere werden die Verteilungsmuster von Phyto- und Zooplankton, von partikulärem, organischen Kohlenstoff und Stickstoff und von Chlorophyll a gemessen.

Die chemische Belastung der antarktischen Meereisgebiete soll anhand ausgewählter lipophiler organischer Spurenstoffe in der oberen Wassersäule, im Schnee und im Meereis abgeschätzt werden. Aus Lipiduntersuchungen lassen sich Rückschlüsse auf die physiologische Anpassung der Copepoden in Bezug auf Lebensraum und Nährstoffangebot ziehen.

Zwischen Kapstadt und dem antarktischen Kontinent sollen mit Hilfe eines unter der CTD-Rosette angebrachten Minicorers Oberflächensedimentproben gewonnen werden. Diese Proben werden auf ihren Gehalt an kalkigen und kieseligen Mikrofossilien, sowie abiogenen Sedimentkomponenten analysiert. Sie bilden eine wichtige Grundlage für paläozenographische und -klimatologische Rekonstruktionen.

Während des Fahrtabschnittes ANT-X/5, der am 8. August 1992 in Puerto Madryn beginnen und am 26. September in Punta Arenas enden soll, werden schwerpunktmäßig marin-geologische Untersuchungen vorgenommen, die sich auf verschiedenen Profilschnitten im südlichen Argentinien Becken, östlichen Georgia Becken, im Bereich des Südsandwich Grabens und des Scotia Meeres konzentrieren (Abb.3). Die isotopengeologische, mikropaläontologische und sedimentologische Auswertung der mit Hilfe von Bodengreifern und Kerngeräten gewonnenen Sedimentproben soll zur Rekonstruktion der paläozeanographischen Entwicklung im Grenzbereich zwischen antarktischer Kaltwasserzone und subantarktisch/subtropischer Warmwasserzone während des Quartärs und oberen Pliozäns (ca. letzte 3 Mio. Jahre) beitragen. Es werden Ergebnisse zur Entwicklung des Antarktischen Zirkumpolarstromes (ACC), der Verbreitungsvariabilität des antarktischen Meereises und zur Geschichte von Tiefen- und Bodenwassermassen im westlichen atlantischen Sektor des Südpolarmeeres erwartet, die laufende paläozeanographische Rekonstruktionen im östlichen atlantischen Sektor ergänzen. Diese Thematik wird insbesondere im Rahmen des Sonderforschungsbereiches 261 ("Der Südatlantik im Spätquartär: Rekonstruktion von Stoffhaushalt und Stromsystemen") behandelt, der sich auf Rekonstruktionen im Zeitabschnitt der letzten 300.000 Jahre konzentriert. Ein weiteres Ziel der Auswertungen ist die Verbesserung von zeitlich hochauflösenden Sedimentdatierungsmethoden für das Quartär südlicher hoher Breiten. Daneben stehen Programme, die sich mit dem biogeochemischen Stoffkreislauf von Barium sowie mit der Wirkung von Mikroben auf die Zusammensetzung von Tiefseesedimenten beschäftigen. Zur Erfassung geodynamischer Prozesse in den Randbereichen konvergierender Platten ist ein Programm zur Erkundung der Stofftransportvorgänge und der Umwandlungen im Bereich der tektonischen Einheiten der Süd-Sandwich Kollisions-Zone geplant. Dabei sollen auch Tiefseedredgen eingesetzt werden. Zur Unterstüzung der marin-geologischen Arbeiten werden auf den Untersuchungsprofilen kontinuierlich bathymetrische Vermessungen mit einem flächendeckenden Echolotsystem (Hydrosweep) durchgeführt. Parallel dazu wird die Verteilung der Oberflächensedimente (bis ca. 100 m Sedimenttiefe) mit Hilfe des PARASOUND-Systems flachseismisch hochauflösend dokumentiert.

Die marin-geologische Probennahme wird von umfangreichen Untersuchungen der Wassersäule begleitet. Im Rahmen eines hydrographischen Programmes mit CTD- und XBT-Profilen soll insbesondere der Bereich des Falkland Stromes, des ACC´s im südlichen Argentinien Becken und im Scotia Meer erkundet werden. Dabei werden auch Driftbojen eingesetzt. Erstmalig soll eine hydrographische Aufnahme des ACC´s quer zur Drake Passage während des antarktischen Winters durchgeführt werden. Daneben werden Wasserproben zur Untersuchung von stabilen Isotopen, Nährstoffgehalten sowie verschiedener andere Stoffe (u. a. Barium, Helium) entnommen. Bei aktuopaläontologischen Untersuchungen sollen Verbreitungsmuster planktischer und benthischer Mikroorganismen, deren kalkige oder kieselige Hartteile als Umweltsignale im Sediment überliefert werden und mit hydrographischen Daten

(Nährstoffangebot, Wassertemperatur, Salzgehalt) in Verbindung gesetzt werden. Dazu werden neben Plankton- und Vertikalnetzen auch Bodengreifer verwendet. Zusätzliche Netzfänge sollen einen Beitrag zu den Tag/Nacht-Zyklen des Makrozooplanktons erbringen. Während des Abschnitts ANT-X/5 sollen auch Messungen der UV-Strahlung vorgenommen und deren Wirkung auf das Phytoplankton abgeschätzt werden, um vergleichbare Untersuchungen während der vorausgehenden und folgenden Fahrtabschnitte zu ergänzen.

Das Personal der Bordwetterwarte ist für die dreistündlichen meteorologischen Beobachtungen auf allen Fahrtabschnitten verantwortlich. Es beteiligt sich ferner maßgeblich an den aerologischen Sondierungen. Ein Teil der Daten wird regelmäßig in das Global Telecommunication System /GTS) eingespeist.

Der Bordmeteorologe des Seewetteramtes informiert außerdem die Fahrtleitung und die Schiffsführung über die zu erwartenden Wetter- und Eisverhältnisse. Darüber hinaus versorgt er die Hubschrauberbesatzungen mit Hinweisen über die Flugwetterbedingungen im Einsatzgebiet.

2. Summary

The cruise leg ANT X/3 commences in Cape Town, South Africa, on 27th March 1992 and ends there on the 19th May 1992. The cruise track is outlined in Fig. 1. The major goal of this part of the expedition is to obtain a comprehensive picture of physical, chemical and biological processes associated with the onset of sea ice formation. Investigations will thus involve various disciplines. Additional programmes more remotely affiliated to the main theme include a study of the continental water boundary in the eastern Weddell Sea, recovery and deployment of sediment trap moorings in the vincinity of Bouvet Island, programmes on fish physiology, deep sea benthos and deep sea microbiology.

The fourth leg of the Polarstern Expedition (Ant X/4) with departure of Cape Town on 21 May 1992 and arrival on 5 August 1992 at Puerto Madryn is mainly dedicated to two WOCE hydrographic sections (SR2 and SR4) and to ground truth measurements for the European ERS-1 satellite. During the oceanographic programme vertical profiles of temperature, salinity, oxygen, CO_2, nutrients and a variaty of natural and anthropogenic tracers will be obtained along transects from Cape Town to Antarctica (SR2, along the Greenwich meridian) and from Kapp Norwegia to King-Georg-Island across the center of the Weddell Gyre (SR4). The section SR4 is visited the third time (after WWGS-'89 and SWGS-'90) and will provide data (together with the previous cruise) on the variability of the water mass formation in the Southern Weddell Sea.

The meteorological programme focuses on the ocean-ice-air interaction in mid winter. In order to determine the surface energy balance the short- and longwave radiation balance, the turbulent fluxes of sensible and latent heat and the heat conduction through the sea ice will be measured. Furthermore, the vertical structure of the entire troposphere will be de-

tected with radiosondes and Omega-windfinding equipment. Several Argos-buoys will be deployed on ice floes to obtain time series of the atmospheric and oceanic forcing parameters and on sea ice motions.

A core goal of ANT X/4 is the ground truth programme for the ERS-1, SAR and ATSR instruments, the RAR on the Russian OKEAN satellite, the NOAA-AVHRR and the DMSP-SSM/I. Together with the sea ice group several characteristics of sea ice and snow like salinity- and temperature-profiles, pore-size, texture, density, dielectric constant and small-scale surface roughness, will be determined for improvements of algorithms for satellite measurements.

In addition to material properties surface emission and reflection characteristics will be measured with shipborne passive microwave and infrared radiometers and with a scatterometer. Information on sea ice concentration is obtained from a digital line-scan camera. The large-scale surface roughness (ridge statistics) is determined with the aid of a laser profilometer mounted on a helicopter. In a pilot study we will try to measure sea ice thickness with the aid of multi-channel reflection seismics.

The biological programme focuses on the plankton ecology in the sea ice and in the upper ocean. The distribution patterns of phyto- and zooplankton, of particulate organic carbon and nitrogen and of chlorophyll a will be investigated.

Organic trace compounds in water, ice and snow will be examined in order to obtain information on the transport processes of such tracers in the atmosphere. Furthermore, lipids will be investigate the physiological adaption of copepods to the environment and to the food supply.

Together with CTD-casts surface sediments will be collected with a microcorer, installed 20 m below the CTD-rosette. These sediment samples will be analysed with response to their content of calcareous and siliceous microfossils as well as to their composition of chemical and abiogenic particles.

The main goal of the cruise leg ANT-X/5, which is scheduled to start at Puerto Madryn on August 8, 1992 and to end at Punta Arenas on September 26, 1992, is a marine geological survey on transects in the southern Argentine Basin, the eastern Georgia Basin and in the area of the South Sandwich Trench and the Scotia Sea (Fig.3). Isotope, micropaleontological and sedimentological investigations will contribute to the knowledge of the Quaternary to late Pliocene (ca. 3 Ma) paleoenvironmental evolution in the boundary area between the Antarctic cold water belt and the subantarctic/subtropic warm water zone. The studies are part of the scientific programmme of the "Sonderforschungsbereich 261", which is concerned with "The South Atlantic Ocean during the late Quaternary: Reconstruction of compound budgets and current systems". Another goal of the investigation is the improvement of high resolution dating methods for the Pleistocene of the southern high-latitudes. Additionally the biogeochemical cycle of barium and the microbe-particle interactions in deep-

sea biosiliceous sediments will be studied. In the area of the South Sandwich Trench geochemical programs are focused on the localization of sites of fluid venting in fore-arc and back-arc settings, the search for chemical and acoustic anomaly patterns across a plate boundary collision zone, and at the petrologic and geochemical evolution of the Scotia arc and associated back-arc magmatism. The geological programme and the determination of sampling sites are supported by a continuous bathymetric surveys of the seafloor with the multibeam sonar system "Hydrosweep". Additionally, the distribution and stratification of the upper sediment layers (up to 100 m below sea floor) will be documented with a high resolution sediment echo-sounding system "Parasound".

The marine geological survey will be accompanied by multiple investigations of the water column and of the sediment/water interface. Physical oceanographic measurements with CTD and XBT will be carried out in the Falkland Current and in the Antarctic Circumpolar Current (ACC). Satellite tracked drifting buoys will be released in the western Argentine Basin. For the first time a hydrographic section will be made across the ACC near Drake Passage during austral winter. Additionally, water samples will be collected for the investigation of stable isotopes, nutrients and other compounds (barium, helium). The distribution pattern of living planktonic and benthic microorganisms with calcareous or siliceous hardparts, which are preserved in the sedimentary record and can be used as indicators of paleoenvironmental conditions, will be related to the hydrographic data set (nutrients, water temperature and salinity), in order to gather autecological data of these microorgansims. Additional net hauls are planned for the investigation of diel cycles of macrozooplankton organisms. During ANT-X/5 measurements of solar ultraviolet radiation and its effect on plankton production will also be conducted, as planned during other cruises of the ANT-X campaign.

The personal of the ship's meteorological station is responsible for the three hourly WMO-observations and participates in the aerological programme. Selected data will be routinely transfered into the Global Communication System (GPS).

The meteorologist of the Seewetteramt provides regularly forecasts on the weather- and sea ice conditions to the chief scientist and the ship's master. He furthermore informs the helicopter crews on the flight - weather conditiones in the operating area.

3. Research Programmes

3.1 Fall in the Ice '92 (ANT X/3)

3.1.1 Introduction

Our knowledge of the seasonal changes in the interactions between physical, chemical and biological processes of the Antarctic Pack Ice zone is based mainly on information obtained during summer, winter and spring.

Almost no information is available for autumn or the period when sea ice formation is rapidly progressing. But processes associated with sea ice formation have a marked influence on the fate and distribution of organisms (from microorganisms to warmblooded animals such as penguins, seals and whales) in the water column.

Therefore, the major incentive of this cruise leg is to obtain as comprehensive a picture as possible of the processes associated with the formation of sea ice during autumn. Our investigations will encompass several interdisciplinary projects dealing concurrently with the water column and new sea ice.

Additionally, we plan to carry out projects more remotely affiliated to the above theme. The major project in this sense, is the study of the continental water boundary in the Eastern Weddell Sea which together with other subsidiary projects, is outlined below.

The cruise leg begins in Cape Town on 25th march 1992. Polarstern's track line is shown in Fig. 1. Three sediment trap moorings will be recovered and redeployed near Bouvet Island on the southbound track. The ship will stopover at the Georg von Neumayer Station (GvN) in order to offload supplies and to carry out research work on fast ice in Atka Bay. A dedicated survey of the continental shelf area in the region of Atka Bay as well as in a region where new ice is being formed will follow. Depending on ice conditions either a contiguous area of about 150 x 150 km will be surveyed or 2 separate study regions, one ice-free and the other ice-covered will be chosen. Stations to describe the ambient conditions will be carried out during the approach to the GvN. The work will be of a multi-disciplinary nature including physics, nutrient chemistry and biology. If sea ice conditions permit, a comprehensive ice station carried out at the beginning of the cruise will be reoccupied towards the end in order to manifest the development of sea ice over a period of several weeks. The cruise will end in Cape Town on 19th May 1992.

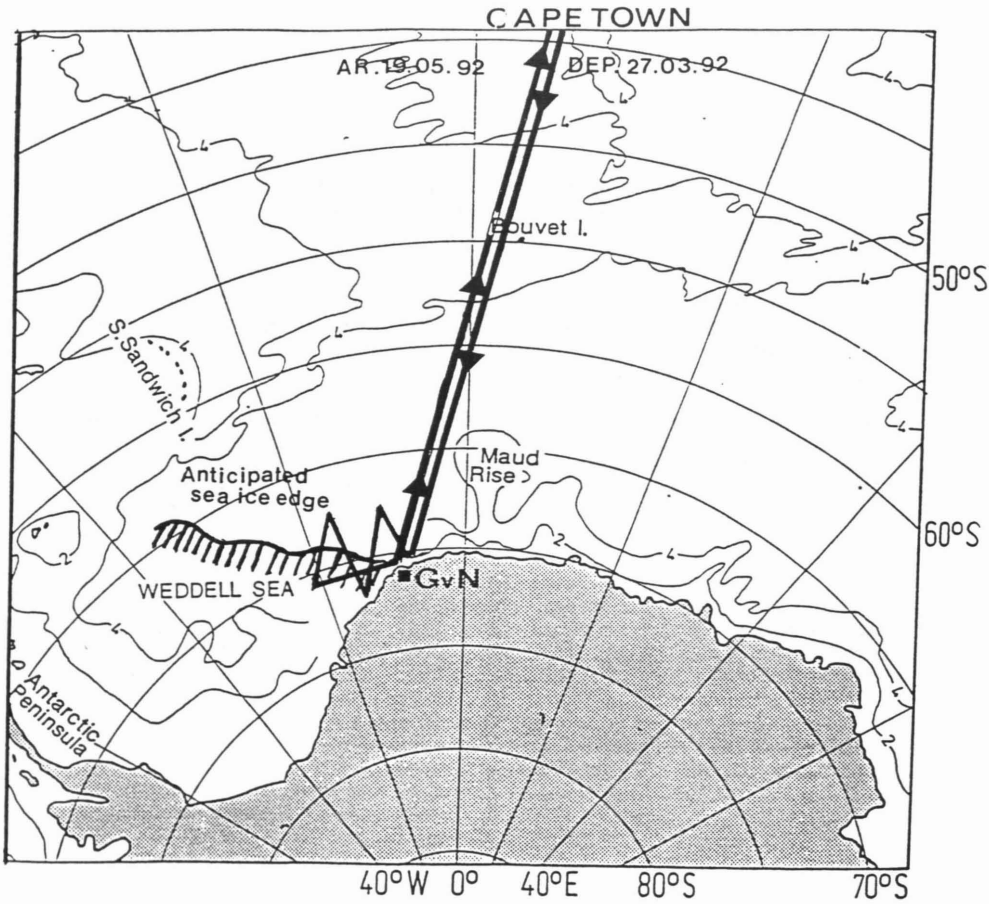

Fig.1: Cruise track of RV "Polarstern" during the leg ANT X/3

3.1.2 Sea Ice Formation Processes and their Impact on the Plankton and Sea Ice Biota. (AWI, BAH, CSIC, IFS, IFSB, IPÖ, OUCT, OUQ, RUG, SIO, UPR, UCSC, USC, ZIUB, ZIU, ZUCT)

Drifting pack ice covers vast regions of the Southern Ocean. The biota in pack ice are found throughout the ice floes, since the organisms are harvested from the water during frazil ice formation and are then concentrated in the ice. The frequent formation of frazil ice and the harvesting and concentration of organisms in newly-forming ice is one of the fundamental differences between the pack ice and the fast ice habitats. During the transition from autumn to winter light levels and atmospheric temperatures decrease and a considerable amount of seasonal sea ice forms. Organisms incorporated into ice floes during this season will be subjected to low temperatures, high *in situ* salinities and low light values. We will examine the processes of incorporation of planktonic organisms as a means for insuring overwinter survival. We will also examine the biota of older ice floes to obtain information on the seasonal dynamics of the ice community. Our investigations will be supported by physical, chemical and biological measurements in the ice and in the water column.

3.1.2.1 The Foraminifer *Neogloboquadrina Pachyderma.*

Foraminifers do not show significant values of biomass in Antarctic waters, but their calcareous shells, which sink to the ocean floor, are indicators of climatological and oceanic events.

The abundance and distribution of *Neogloboquadrina pachyderma* will be analysed. These results will be used to assess the mode of incorporation of this species into the ice during ice formation and its potential influence on the reproductive cycle.

Young individuals of *N. pachyderma* will be collected and kept in the laboratory under controlled conditions of temperature, salinity and food. Growth rate as well as shell morphology and formation will be analysed. Also, the synchronisation of the reproduction cycle with respect to light (day-night) and/or moon cycles will be studied.

Specimens will be fixed on board for later investigation of vacuoles (especially food vacuoles) using a transmission electron microscope. A few specimens will be collected for rRNA sequence analysis.

3.1.2.2 Microbiology of Sea Ice.

Microbiological investigations will focus upon the distribution patterns and activity of bacteria living within the sea ice habitat. Special attention will be paid to the new ice formation and the impact of this event on natural bacterial populations. Comparative distribution patterns of bacterial cells and biomass between new ice and associated water samples will be obtained by microscopic epifluorescence-direct count techniques. To achieve further information about the fate of bacteria being incorporated within sea ice, subsequent investigations of successive stages of the

growing ice will be carried out. They will focus mainly on bacterial activity.

To examine the productivity of sea ice as a whole and the ecological coupling between sea ice and the pelagic environment, combined microbiological and planktological investigations are planned. They will be carried out on successive stages of the ice and associated water bodies. Comparisons of the primary productivity with heterotrophic degradation processes will provide information about fluxes of energy and organic matter among these compartments.

3.1.2.3 Ecophysiology of Microalgae

The aim of this investigation is to measure physiological and biochemical changes that take place within algal communities during the transition from the open water column to as many stages of ice formation as are encountered during the expedition. In particular, we want to determine in which way primary production, carbon metabolism, biochemistry and species composition are affected by shifts from a turbulent low light environment to a stabilized, increasingly saline, colder medium with a (presumably) higher light availability for photosynthesis. The physiological capacity of species to survive and acclimate to such changes will be of major importance for the initial composition and seasonal succession of sea ice microbial communities. Experiments will be primarily conducted with field samples from different stages of ice formation. Complimentary measurements will be made in laboratory studies in which temperature, salinity and light conditions can be controlled to simulate the physicochemical changes taking place in the field.

Photosynthetic carbon assimilation over a range of irradiances as well as the incorporation of carbon into the major metabolic pools of the algae will be measured by standard radiotracer techniques. Measurements of oxygen production/consumption with a Winkler titration system will supplement carbon flux studies. Samples will be taken for pigment analysis, total carbon and nitrogen, lipid, carbohydrate, protein, ATP, biogenic silicate and species composition. Physiological changes recorded during the experiments will be correlated with variations in physicochemical parameters. In addition to measurements of nutrient concentrations, light, salinity and temperature, we aim to record changes in the carbonate system (i.e. pH, alkalinity and C_t) that occur in seawater during ice formation.

3.1.2.4 Taxonomy and Ecology of Ice-Flagellates

The ice of polar seas harbour a special biocoenosis, in which unicellular algae are the primary producers. The biology of the ice algae has been investigated intensively up to now and first studies on the biology of foraminifera and ciliates are in progress. Only little is known on the biology of flagellates and in particular of the heterotrophic ones. Therefore, the taxonomy of phototrophic and heterotrophic flagellates of the sea ice will be studied. The organisms will be fixed from field samples for electron

microscopy. Light microscopy including video documentation will support the observations. Cultures will give additional material for electron microscopy. In addition, growth rates and feeding rates as well as food selection experiments are planned.

3.1.2.5 Zooplankton

The "switching" of zooplankton from the summer to the winter state will be investigated. Herbivorous calanoid copepods in particular are known to cease feeding, descend to greater depths and to go into a resting stage (diapause) during autumn, in order to survive the food paucity in winter. Other species such as the calanoid copepod *Metridia gerlachei* or cyclopoid copepods appear to stay active in winter and to turn to alternative food sources. These mechanisms have not yet been analysed in detail. We intend to study these different "adaptive strategies" in selected zooplankton species (meso- and macroplankton) in the field as well as with experiments. To characterize the "autumn state" of these species our research will focus on the following issues: vertical distribution, population structure, maturity of gonads, gut content, feeding activity, respiration as well as quality and quantity of accumulated lipids. These investigations should improve our understanding of the different planktonic life cyles, elucidate their dependency on seasonal factors (light, ice) and hence contribute to a differentiated analysis of this high polar ecosystem.

3.1.2.6 Antarctic Ciliates (protozoa) of the Sea Water and Sea Ice

Ciliates of the marine Antarctic ecological system have been poorly studied. Because flagellates and ciliates occur in high abundances, it might well be however, that their significance is not irrelevant. In spite of their obvious importance, only very few studies of sea water and sea ice ciliates exist and taxonomic studies are almost completely missing. A precise knowledge of the species is, however, an essential prerequisite for a sound ecological treatment of these organisms.

The main objective of the study will be a taxonomic treatment of the ciliates of the plankton and the sea ice. For this purpose, detailed in vivo observations with the light microscope (measurements of the organisms, preparation of drawings of the live organisms, etc.) are required. These studies, being carried out on living organisms, will be complemented by diverse impregnation methods (e.g. methyl green pyronin, silver impregnation after Fernandez-Galiano, dry and wet silver impregnation after Foissner und Chatton-Lwoff, impregnation with protargol after Wilbert).
As far as possible, autecological data (e.g. nutrition, growth rate, vertical distribution in water and ice) of the ciliate species in question will also be obtained. Furthermore, in order to clarify the physiological principles of the adaption of cold of ciliates it is planned to raise cultures of selected ciliate species.

3.1.2.7 Nutrients

The determination of nutrients is closely connected to the biological and physical investigations. Nutrients are essential for the phytoplankton growth and,they may be used as indicators for water masses. From water samples collected with the rosette sampler nutrients will be determined with the Technicon Autoanalyser II system. From each sample nitrate, nitrite, ammonium, silicate and phosphate will be measured simultanously.

3.1.3 Physical Oceanography (AWI, OUCT)

3.1.3.1 The Continental Water Boundary in the Eastern Weddell Sea

The Continental Water Boundary has been observed as a clearly defined front over the shelf edge at a number of locations along the Antarctic coast. It has been studied in some detail in the Ross Sea, but hardly anywhere else. Preliminary measurements at the shelf edge in the Atlantic sector of Antarctica has shown that it also occurs here, that is has as distinct a thermal and saline expression as elsewhere and that it has an exceptionally strong biological character. Phytoplankton density south of this front often exceeds all concentrations measured between Africa and Antarctica.

Both the physical and ecological role of the Continental Water Boundary, particularly in this area in the eastern Weddell Sea, is poorly understood. It is thought that its occurrence is closely related to the coastal current in the Weddell Sea which carries shelf water in and out of this sea and which plays an important role in its heat and salinity balance. The manner in which shelf-water in this area may leak into the deep sea is not known. The observed very high values of primary productivity suggest that the shelf water mass and the behaviour of its boundary play an important role in the ecology of the Antarctic coast. The high phytoplankton density in shelf waters may furthermore control the carbon flux into deep or abyssal waters.

3.1.3.2 The Onset of Convection, and Ice Formation

The formation of deep-water in the open polar oceans of both hemispheres starts off with convection in the top layer. As the decrease of temperature alone is generally not sufficient to produce heavy water masses which could sink to any larger depth the adding of salt is a further necessary prerequisite. The freezing of sea water makes salt available, and it could start a cascade process which ends up with deep-reaching convection.

Only a few observations are available which indicate that the formation of ice could be the appropriate trigger for such a process. Therefore, various experiments are planned to test existing hypotheses. They include continuous measurements from the ship underway of temperature, salinity,

chlorophyll fluorescence, Mie backscattering and light attenuation to indicate the presence of ice cristals and phytoplankton. Probably such measurements will simultaneously provide information on the transport mechanisms of phytoplankton into the ice sheet forming at the sea surface. The infrared temperature of the sea surface will also continuously be monitored.

The measurements will be performed with 2 instrument packages. One is operated in the hydrographic well of the ship. The other will be towed in the surface layer some 20 m away from the ship`s hull in open conditions. This package will also be used for profiling versus depth in the top layer.

3.1.4 Sediment Trap Moorings (FGB, AWI)

The particle flux from the photic zone in the deeper water layers will be monitored over several years at two postions, near Bouvet Island and at the Polar Front. The objective is to quantify seasonal changes in primary production and the export production of settling material out of the photic zone. It is also intended to determine the settling velocities of particles. These experiments are linked to other sediment trap experiments of the Sonderforschungsbereich 261 in the South Atlantic.

3.1.5 Deep Sea Microbiology (AWI)

Investigations will be done on the adaptation of the bacterial flora in sediments and water to cold temperatures and to depth. Information on the composition and tolerance of the bacterial populations of different depths as well as on the fate of the bacteria which are carried to greater depths during vertical transport processes will be gained using cultures and activity tests under different conditions of temperature and pressure. An understanding of the role and efficiency of cold and depth adapted bacteria is expected to be gained from substrate expositions at geological mooring systems

3.1.6 Investigations on Reproductive Adaptations of Antarctic Polynoids (Polychaeta) to the Environmental Conditions

Most polynoid polychaetes are benthic predators which do not depend directly on the period of primary production which is extremely short in polar regions. Contrary to their feeding mode the reproduction might be coupled to the short local summer season by planctotrophic trochophora larvae. However, this kind of reproduction can be modified either in reducing the duration of this stage or in a complete absence of pelagic larvae. As latitude increases, from equatorial to polar regions, the tendency in benthic invertebrates is found to display reduced yearly fecundity, with larger yolky eggs combined with brood protection. This phenomenon is generally known as "Thorsons rule". Our knowledge about these features in Antarctic polychaetes is limited to some shallow-water sites.

Previous expeditions of the RV "Polarstern" into the eastern Weddell Sea were mainly performed during austral spring and summer. During these cruises only a limited number of polynoid samples has been taken with reduced spatial solution and temporal continuity. Preliminary results indicate that oogenesis may start in February whereas ovigerous females have been found in October. Due to the lack of samples taken during the long Antarctic winter it is rather unknown how long the oogenesis lasts.

The main objectives of this study are to answer the questions:
How long does the oogenesis in common polynoid species last, e.g. at which date will eggs be spawned? Are there species with planctonic larvae, if so, where and how long do they stay in the water column? Are there evident differences in the reproduction between different species ? Which reproduction modes are represented by Weddell Sea polynoids (multivoltine / univoltine)?

To obtain as much information as possible the polynoid polychaetes should be sorted out carefully of Agassiztrawl catches. Specimens should be preserved single (formalin-seawater solution 4 %) and formalin solution should be injected to larger individuals to avoid autolysis.

3.1.7 Fish Programme (IPÖ, CNR)

Earlier investigations of the fish fauna of the eastern Weddell Sea yielded a generally low biomass of bottom fishes which decreases with increasing latitude. Moreover, we find a uniformly high species diversity and an extraordinarily high capacity for long periods of starvation. In order to investigate overwintering strategies of fishes in Antactica, we plan to investigate the occurrence, distribution and adaptation of fishes under autumn conditions. It is also intended to continue studies on the mode of life and evolutionary relationships of this group of teleosts in relation to their habitat with reference to the structure and function of their haemoglobins. Furthermore we will study respiration and behaviour of bathydraconids and the blood physiology of bathypelagic fishes such as macrourids and myctophids caught in the offshore area.

3.2 The Winter Weddell Gyre Study 1992 - WWGS '92 (ANT X/4)

This cruise leg serves as the third part of the Weddell Gyre Study. It is the second winter investigation concerned with oceanic, sea ice and atmospheric observations. The specific element of this cruise is the simultaneous intensive observation of the sea ice cover in the Weddell Sea by the ERS-1 satellite with the aid of its synthetic aperture radar (SAR).

3.2.1 Oceanography (AWI, NIOZ, UNIB)

3.2.1.1 Circulation and Water Mass Formation

Physical oceanographic measurements comprise profiles of temperature, salinity, oxygen, nutrients, and a variety of natural and anthropogenic

tracers. In support of the World Ocean Circulation Experiment (WOCE) two hydrographic sections (SR 2 / A 12, SR 4) will be carried out to continue the investigation of the seasonal as well as the interannual variability of the Antarctic Circumpolar Current (ACC) and the Weddell Gyre (Fig. 2).

The CTD-transect from Cape Town to the Antarctic continent in winter completes data sets of 'Polarstern', and 'Meteor' taken during summers '89 and '90. Together with XBT surveys which are repeated almost every year the long term fluctuations of the temperature field and the movements of oceanic fronts will be analysed. From Cape Town to the sea-ice boundary vertical current profiles will be measured in the upper layer with an acoustic doppler current profiler (ADCP) mounted on the vessel to detect the spatial variability of the velocity field in the circumpolar current. These measurements, together with XBT launches, will be continued across Drake Passage enroute to Puerto Madryn.

The hydrographic section between Kapp Norvegia and the northern tip of the Antarctic Peninsula (SR 4) represents the third one out of four, two in the summer and two in the winter season. The survey started in winter 1989 (WWGS '89), it was continued in summer 1990 (SWGS '90) and it will be finished in summer '92/'93. The full data set will provide a description of the seasonal variability of the Weddell Gyre circulation and of the water mass modification in the northern Weddell Basin. Direct measurements of the ocean currents at 21 moorings together with the hydrography will allow to determine the barotropic and the baroclinic currents across the transect. The moorings were deployed in summer '90/'91 (SWGS '90) and will be recovered in early 1993. From the mass, heat, and salt transports across the transect the formation rates of Weddell Sea Bottom Water (WSBW) can be derived. The time scales for the exchanges and modifications of water masses will be estimated from oxygen, nutrient, and tracer data.

Within icefree areas on-line measurements of surface temperature and salinity by the ship's thermosalinograph provide information on the surface layer variability.

3.2.1.2 Tracer Studies and Nutrients

Along the hydrographic sections, the tracers: Freon-11, Freon-12, Tritium, ^{3}He, He, and Ne.will be analysed from water samples. The samples will be treated with a new technical system, which improves the data quality. Most of the tracers belong to the WOCE tracer list which are to be analysed from the rosette water samplings as far as possible (about 50 measurements per day are feasible). Sampling of other tracers will be restricted to a subset of the hydrographic stations (about 50 total).

Freons, Tritium and partially ^{3}He are transient tracers. Their regional and depth distributions provide information on subsurface water renewal in the ocean surface layer from yearly to decadal time scales. From natural ^{3}He, He, and Ne information is expected on the deep oceanic ventilation and on water mass modification (Ice Shelf water contribution). The hy-

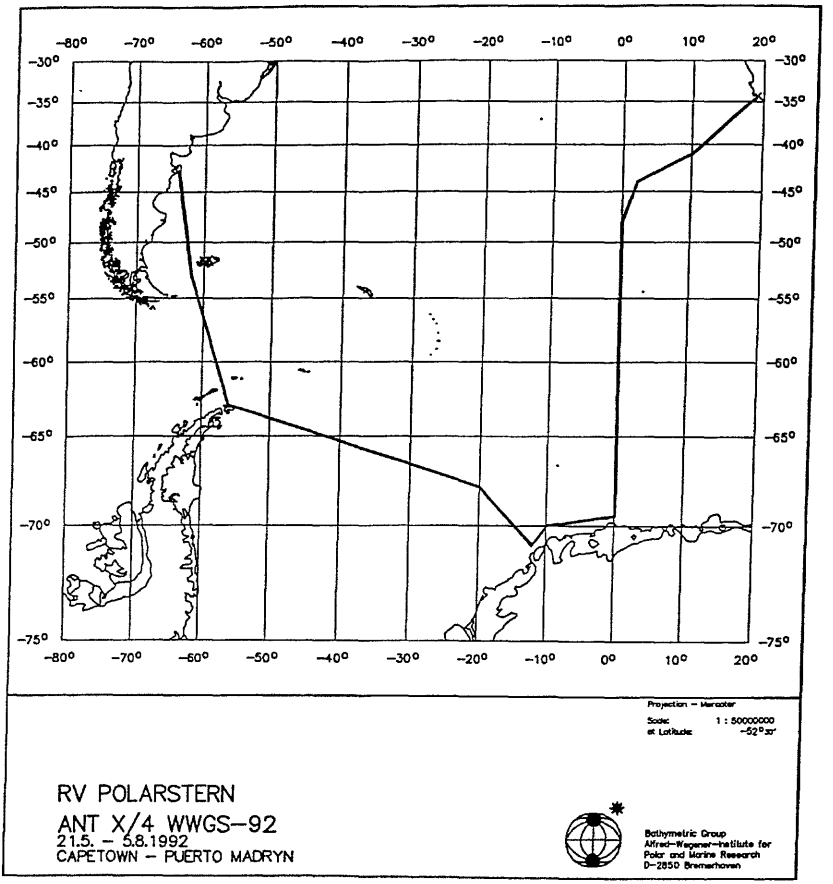

Fig. 2: Cruise track of RV "Polarstern" during leg ANT X/4

drographic sections cover important renewal pathways for all relevant subsurface water mases of the region (South Atlantic Central Water, Antarctic Intermediate Water, North Atlantic Deep Water, Circumpolar Deep Water/Warm Deep Water, Antarctic Bottom Water, Weddell Sea Deep and Bottom Water). The water mass renewal can be more or less concluded from the large scale tracer distributions. Near the Antarctic Peninsula and in the Antarctic Circumpolar Current, the excistence of small-scale structures is rather likely as detected earlier in the Drake Passage. Therefore, measurements north of the tip of the Antarctic Peninsula will be given a special attention.

Nutrients will be determined in the same way as stated under paragraph 3.1.2.7.

3.2.1.3 The Carbon Dioxide System in Antarctic Waters

The Weddell Sea deep water formation may be accompanied by a transfer of CO_2 into deeper ocean layers. Especially in winter it will be interesting to perform measurements of CO_2 in this area since such data are sparse. Measurements of CO_2 will be performed both in the ocean and in the atmosphere. In sea water total inorganic carbon will be measured by coulometry. During open water transects this will be done continuously, whereas discrete samples will be taken in the ice covered area. For these purposes CO_2 is extracted from the sea water to react quantitatively with ethanolamine. The product of this reaction is racktitrated with OH^- ions, which are electrogenerated. The amount of electricity used is directly proportional to the amount of CO_2 molecules extracted.

The exchange of CO_2 between the ocean and the atmosphere is governed by the difference of the partial pressures (pCO_2) in both reservoirs. The pCO_2 in sea water and in the air is measured by non-dispersive IR analysis. The pCO_2 of sea water is determined from air equilibrated with a sea water sample in a specially designed equilibrator. The IR analyzer measures the CO_2 content alternately in the sea water sample and in the air in comparison with reference gases.

3.2.2 Meteorology (AWI, IMH, SWA)

The atmospheric studies focus on sea ice-atmosphere interactions in midwinter. Emphases will be put on measurements for the surface energy balance, the momentum exchanges between ice/ocean and air and the atmospheric boundary layer structure. The observations will hopefully lead to parameterizations in numerical models which are required to predict ice concentration, polynyas and leads in the sea ice area of the Weddell Sea. The data will be also applied as boundary conditions for sea ice and atmosphere models. Since the turbulent fluxes of sensible heat play an important role over leads and polynyas, its values will be measured with particular care when the ship crosses open water patches.

The observational programme will contain the following measurements:

- Short- and longwave radiation as well as surface albedo for the various snow and ice conditions met during the cruise.

- Turbulent fluxes of sensible heat and momentum with an ultrasonic device during ships stops of durations longer than a couple of hours. Turbulent fluxes of latent heat will be determined with the aid of bulk aerodynamic formulae.

- The conductive heat flux through the ice-/snow cover will be determined repeatedly during longer stations through measurements of the temperature profile through the sea ice together with other sea ice characteristics.

- The vertical thermodynamic and kinematic structure of the atmosphere with radiosondes and an Omega-windfinding equipment.

Finally, an array of Argos-surface buoys will be deployed by which the atmospheric and sea ice quantities will be measured for several months to aid the evaluation of the ERS-1 satellite data for a longer time span.

We want in particular to relate the energy balance components to the observed concentration, thickness and floe structure of sea ice.

These midwinter observations will complement our Weddell Sea data set and - similar important - they will serve as ground thruth for satellite values and to test numerical model computations.

3.2.3 Remote Sensing (AWI, CRREL, GSFC, JPL)

Several remote sensing techniques including optical, infrared, passive and active microwave sensors will be applied for sea ice investigations. The combined data set will be utilized to properly describe the characteristics of sea ice. We assume that parameters can be defined from the remote sensing signals which improve the determination of the air-ice/ocean energy and momentum exchanges.

The main objectives of the passive microwave programme are to study the microwave emissivity and polarization of various types of new ice, the Antarctic snow cover and its effect on the radiative properties and the effect of flooding and slush on the microwave signals. We will furthermore attempt to discriminate the radiative signatures of first and multiyear ice in the Antarctic. If this goal can be achieved the accuracy of ice interpretations derived from satellite microwave data could be improved. For these investiations two dual polarized 37 GHz radiometers together with 10 GHz and 85 GHz radiometers will be applied from the ship.

Within the framework of the Programme of International Polar Oceans Research (PIPOR) an extensive ground truth study will be carried out for

the validation of ERS-1 data. Therefore, the field measurements had to be coordinated with the Earthnet ERS-1 Central Facility (EECF) at Frascati, Italy and with the ERS-1 receiving station at O'Higgins to assure that the SAR will be operated simultaneous with the ships activities and vice versa.

A calibrated microwave sea ice data set will be aquired with the aid of a C-band shipborne scatterometer operating at VV,VH,HH and HV polarizations and varying incidence angles. This data set will be used for calibration/validation studies of the ERS-1 SAR. Extensive 2-dimensional microsurface roughness measurements as well as Laser altimeter measurements by helicopter will be conducted to support the microwave measurements. Up to 15 radar point targets will be placed on the sea ice in order to supplement the ice tracking capabilities from ERS-1 SAR images. These data will be used to validate the ice motion vectors generated at AWI and ASF (Alaska SAR Facility). It is expected that the Japanese JERS-1 L-band SAR and OPS sensors are also operating during the expedition. Images from this satellite have been requested to be compared after the cruise with the ERS-1 data. Additionally, the medium resolution (1 Km) active microwave SLAR images from the Russian OKEAN-4 satellite will be collected via a shipborne APT-receiving station for further intercomparisons.

AVHRR optical and infrared images will be obtained with the aid of a shipborne HRPT receiving station to study the large scale ice motion under cloudfree conditions and to collect a data set for floe size distribution and lead statistics. These measurements will be validated by helicopter based optical and infrared LineScan camera observations as well as by infrared radiometer measurements onboard the ship. In parallel to the remote sensing activities the physical and chemical properties of snow and sea ice will be measured.

A remote sensing team at the Antarctic base O'Higins will supply the ship with SAR images and further ice information deduced from SAR, SSM/I (as received from AWI/AES-ICEC) and AVHRR signals to demonstrate the power of satellite data for ship routing in polar regions during the International Space Year. Concurrently the shipborne AVHRR HRPT receiving station will be used for navigational support.

3.2.4 Properties of Sea Ice and Snow (AWI, UNIK, UNIH)

The distribution of ice and snow thickness along the cruise track will be measured during oceanographic stations. Simultaneously ice cores will be drilled to provide additional information on the prevailing growth mechanisms and the incorporation of meteoric ice into the sea-ice cover. Thickness measurements (in particular in the vicinity of the ULS-moorings) in combination with ice-core data shall be utilized to determine isostatic correction factors for sonar- and laser-studies.

In a pilot study, thickness and material properties of sea ice will be assessed with the aid of multi-channel reflection seismics.

The salinity, density and temperature of the ice together with specification of pores will be used as ground truth information for remote sensing studies. The ice-cores will be analysed also to derive the circulation of brine within the ice column. In particular textural studies in combination with permeability measurements will serve for this purpose. Salinity and ^{18}O concentrations of ice and brine contain information on the drainage and exchange of brine.

During ice stations the following work will be generally carried out:

- Measurements of ice thickness and snow depth along 100 m profiles supported from the ship and/or from a helicopter.

- Extraction of sea ice cores for determination of the texture, temperture, salinity, density, ^{18}O concentration and chlorophyll a content.

- Surface characterization of the ice covered ocean, i.e. sampling of snow for determination of density, salinity, ^{18}O concentration, temperature, and texture.

- Sampling of sea ice, brine and snow for chemical analyses.

- Multi-channel reflection seismics for the determination of ice thickness and ice mechanical properties.

- Standardized ice observations from the ship's bridge in collaboration with other groups.

- Video recordings in connection with LineScan flights for the larger-scale characterization of ice conditions.

3.2.5 Plankton Ecology in and under Sea Ice (AARI, AWI, FUB)

Investigations of plankton in the Weddell Sea have shown a dominance of small autotrophic and heterotrophic flagellates in the pelagic system throughout the year; diatom blooms occur rather seldom. The distribution pattern of plankton biomass in space and time is fairly heterogeneous. Phytoplankton biomass is in general low as has been demonstrated from satellite data. Higher concentrations of algae only occur in small areas and for short time periods. The higher biomass appearance is assumed to be correlated to sea ice melting.

For a complete description of the plankton development in the Weddell Sea data for all seasons are necessary. With the full data set the following questions should be answered:

- Are there regional differences in the seasonal distribution patterns of plankton?

- Which are the most remarkable features?

- How is the influence of the abiotic factors?

- How is the relationship between algal growth and grazing pressure?

- How does seasonality in the pelagial influence vertical particle flux?

For these studies the subsequent observations will be carried out:

- Distribution of particulate organic carbon (POC), nitrogen (PON) and chlorophyll a at different depths along the cruise track. The comparison of POC/PON or POC/chlorophyll a data may reflect seasonal and regional differences.

- Distribution and growth of phytoplankton in relation to physical and chemical environmental conditions.

- Distribution of zooplankton (herbivorous and organisms who are remineralizers), interaction with phytoplankton and other zooplankton species, to estimate grazing pressure.

- The Chlorophyll a, particulate organic carbon and nitrogen, biogenic silica, species composition and biomass of phyto- and protozooplankton will be obtained from the rosette water samples and with the aid of a special L-shaped gear directly under the sea ice and from ice core analyses in the sea ice. The vertical distribution of dominant zooplankton and larger protozooplankton will be determined from multinet hauls.

Furthermore, experiments in a cold laboratory will be carried out to study the ecology of plankton in winter

3.2.6 Organic Trace Compounds in Water, Ice and Snow (AWI)

The contamination of water, snow and sea ice with respect to selected lipophilic organic trace compounds will be frequently measured. These xenobiotic compounds are mostly transported by the atmosphere to this region and they are subsequently stored in all water phases.

The water will be collected with glass-sphere samplers from different depths of the water column. Differences between the open ocean and ice covered areas will be particularly studied. From vertical profiles of special tracers in the ocean conclusions on the transport mechanisms in relation to their physico-chemical properties will be drawn. Former inputs of xenobiotic compounds to that area are to be found in ice cores and rather likely also in samples of melt water from icebergs. The final analysis of the samples will be carried out in the Alfred Wegener Institute with the aid of Multidimensional High Resolution Gas Chromatography and Mass Spectrometry.

3.2.7 Lipid Investigations (AWI)

Phytoplankton provides the main food supply for most of the calanoid copepod species in the Weddell Sea. The herbivorous copepods incorporate the polyunsaturated fatty acids into the storage and the membrane lipids. With the aid of the high unsaturated fatty acids as markers it is possible to obtain more information on the physiological adaptation concerning the environment and food supply.

At different stations the dietary stage of the copepod species, the turnover of the lipids in dependence on the stage of developement and the incorporation of the phytoplankton fatty acids in the copepods will be determined by gas chromatography. The incorporation of fatty acids will be determined in additional experiments. For this purpose the use of radioactiv material is required.

Besides the *in-situ* experiments phytoplankton and zooplankton samples will be taken to the home institute for further studies.

3.2.8 Marine Geology (AWI, UNIK)

Sampling of surface sediments for marine geological investigations is planned at selected CTD stations on the transect between Cape Town and the Antarctic Continent. For the collection of surface sediments a microcorer (MIC) will be applied, which consists in a weight bomb and four tubes (Ø 6 cm) installed 20 m below the CTD. The samples (uppermost centimeter of collected sediment) are needed for the completion of our data sets, which form an important background for the field work planning of the Sonderforschungsbereich 261. The calcareous (foraminifera) and siliceous (diatoms, radiolarians) microfossils as well as their chemical composition and the composition of abiogenic particles (e.g. clay minerals) will be determined quantitatively. In addition to the surface sediments some sediment cores recovered with the MIC in the Weddell Basin will also be collected.

3.3 Marine Geology in the Southern Atlantic (Ant X/5)

3.3.1 Paleoceanographic Studies (AWI)

The major scientific goals of the paleoceanographic programme are focused on the reconstruction of paleoenvironmental conditions during Quaternary and late Pliocene climatic changes, such as:

- the paleotemperature and location of the ACC and its frontal systems,
- the distribution of sea ice,
- the paleoproductivity and location of high productivity belts,
- the paleotemperature and circulation of deep- and bottom-water (e. g. production of Antarctic Bottom Water).

The general aim is to decipher the evolution of oceanographic parameters which control large-scale oceanographic circulation and heat transport, the CO_2 budget, and the atmospheric circulation. The results should contribute to the understanding of paleoceanographic events that trigger the major shorter-term climatic changes between glacial and interglacial time periods, and the mechanisms which control the glacial/interglacial atmospheric CO_2 changes We furthermore aim to reconstruct the southern hemisphere climate during the major glaciation event that affected the northern hemisphere at ca. 2.6 to 2.4 Ma.

Surface water temperature and the location of the sea-ice boundary from the composition of calcareous (foraminifera) and siliceous (diatoms, radiolaria) microfossil assemblages. Furthermore, paleotemperatures of surface and bottom waters can be calculated using the ratio of oxygen isotopes in benthonic and planktonic foraminifera. The reconstruction of paleoproductivity and distribution of water masses can be based on the ratio of carbon isotopes in benthonic and planktonic foraminifera. Other methods for the estimation of paleoproductivity are the determination of accumulation rates of biogenic opal, organic carbon and long-chain unsaturated ketones. Additionally, the species composition of microfossil assemblages will be used for paleoproductivity estimations. Velocity changes of the bottom water currents, and distribution of sea-ice and icebergs will also be studied using sedimentological and mineralogical methods (e. g. XRD radiography, granulometry, terrigeneous components, distribution of tephra and tephra isopachs, distribution of ice-rafted detritus). Especially the Antarctic Bottom Water and its northward flow into the Argentine Basin will be reconstructed on the basis of the distribution pattern of clay minerals from polar sources, e.g. chlorite and Al-rich illite.

The geological materials for the paleoenvironmental reconstructions will be recovered with a gravity corer (SL) or a piston corer (KOL) on transects across the frontal systems of the ACC and potential regions of AABW-outflow (Fig. 3). Major areas of interest are the southern Argentine Basin, the eastern Georgia Basin, the area of the South Sandwich Trench and in the central Scotia Sea. This sampling programme will complete the collection of core materials during the previous expeditions ANT-VIII/3 and ANT-IV/4 to the eastern part of the Atlantic sector of the Southern Ocean. The already available data bases on microfossil and sediment particle distribution in surface sediments from the Weddell Sea and the eastern sector of the atlantic Southern Ocean will be enlarged by sampling undisturbed surface sediments with box corers (GKG) or multicorers (MUC) at all geoscience stations. Additionally a minicorer (MIC) will be installed below the CTD to recover surface sediments at hydrographic stations. The surface sediment data form an important reference for further paleoenvironmental reconstructions based on statistical methods and for the understanding of microfossil and stable isotope signals in the sediment record.

Besides paleoceanographic goals the investigation of the sediment cores should lead to further improvement of the methods for age determination of sediments in southern high latitudes. This can best be accomplished

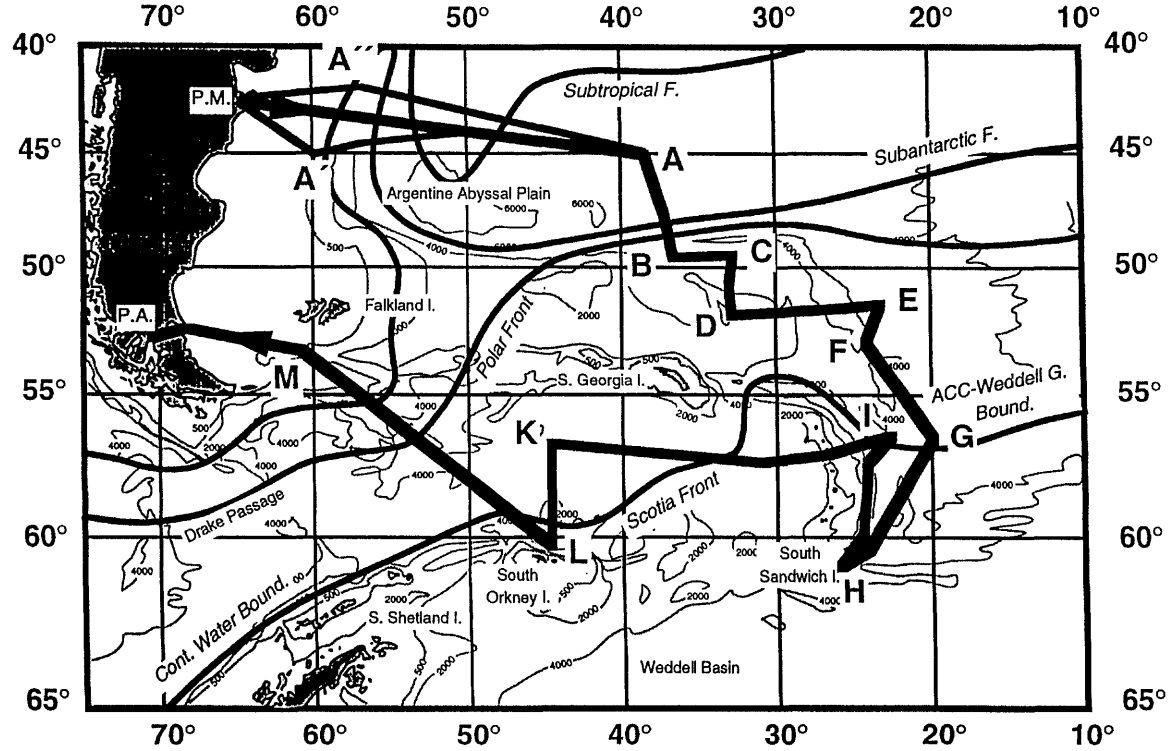

Fig. 3

preliminary track ANT-X/5

using a combination of different paleontological, isotopic and geophysical dating methods.

3.3.2 Biogeochemical Cycle of Barium (Geomar, AWI)

High concentrations of barium characterize deep-sea sediments underlying zones of higher biological productivity and the geochemical cycle of barium seems to be controlled by biomass. For a better understanding of the barium/barite signal as a productivity indicator, water samples, surface samples and sediment cores will be investigated. Within the Antarctic Circumpolar Current (ACC) oceanographic fronts seem to be documented by the distribution of barium in surface sediments. High concentration of dissolved barium and particulate barite crystals occur in the water column of the Antarctic Zone south of the Polar Front. North of the Subantarctic Front dissolved and particulate barium decreases rapidly.

Suspended particulate barite crystals of the water column will be obtained by *in situ* filtration pumps at different depths. Based on barium measurements of surface sediment samples accumulation rates of barite will be calculated for different areas.

Studies of early diagenetic barium mobilisation and precipitation are planned on sediment cores in different environments (oxic/anoxic zones; different C_{org}-fluxes). Porewater measurements will be done aboard (e.g. Si, SO_4^{2-}, H_2S and NO_3^{2-}).

3.3.3 Microbe-particle Interactions in Deep-Sea Bosiliceous Sediment (DPVA)

The programme concerns an investigation of microbe-particle interactions in the surface layers of deep-sea diatomaceous sediments. The term "interactions" includes the physiological relationships betwen bacteria and particles within the biofilm, as well the influence of the bacteria on particle alterations. The techniques contain standard biological methods and maintenance of the deep-sea sediment in a pressure chamber. Samples of the surface layer of deep-sea diatom ooze will be collected aseptically and bacterial biomass will be estimated from counts and chromatographic methods. Additionally, samples will be treated for scanning and transmission eletron microscope investigation of the relationship between bacteria, particles and the biofilm. Other samples, with one part sterilized to act as a control, will be incubated in a pressure vessel in order to observe any changes in the sediment with time. It will be determined whether there is any difference in the dissolution of the biosiliceous sediment in the presence of bacteria, and if mineralization of the bacteria can be observed.

3.3.4 South Sandwich Plate Project (Geomar/OSU)

Two major objectives will be addressed by the South Sandwich Plate project: Submarine fluid venting at the collision zone and the back-arc area

and the petrologic and geochemical evolution of the Scotia Arc and associated back-arc magmatism.

a) Submarine fluid venting processes at convergent plate boundaries is a current research frontier of marine science. The long-term scientific emphasis is on a comprehensive view of the hydrology of the oceanic lithosphere. Fluid injection at such boundaries plays an important role in mass transfer between the hydrosphere and lithosphere and in the recycling of matter at the benthic interface. This emergent field of research has the potential of generating as much new knowledge as did the discovery of hydrothermal fluid circulation systems at mid-oceanic ridges. Convergent forces in the present plate tectonic framework generate excess fluid pressures at the colliding plate boundaries which leads to subduction venting. The program at the South Sandwich subduction zone, which is a classic area of ocean-ocean crustal collision, is to advance our basic knowledge of marine geochemical cycling of elements, specifically in problems of fluid and gas fluxes, fluid evolution, dissolved mass transport, benthic biological activity as influenced by fluid discharge, gas-fluid-sediment interaction, physical controlls on flow rates and source depths of fluids. Two specific goals will be intially adressed:

- Expand and up-date background information to better localize the most likely sites of fluid venting, both in the fore-arc and back-arc settings

- Establish the presence and magnitude of chemical and acoustic anomaly patterns across the collision zone and into the active back-arc basin.

b) Interactions between the subducted slab and the overlying mantle wedge are fundamental to the petrogenesis of island arc and back-arc magmas. We propose to study the nature and the early evolution of these interactions as they are reflected in the chemistry of lavas from the Scotia (South Sandwich) island arc and its associated back arc basin. The Scotia arc/back-arc system has a number of features which combine to make it an ideal, perhaps unique, location for such study. The arc itself is young (< 8 my), predominantly basaltic and build on young oceanic-type crust remote from possible contamination by continental or pre-existing island arc crust. Towards its northern and southern extremities, the arc curves strongly and the islands give way to a series of sucessively smaller seamounts which appear to have been build on progressively younger crust. Spreading along the Scotia back-arc spreading center is unusually well organized, relative to other active back-arcs. The back-arc basin is characterized by regularly spaced, parallel magnetic lineations, except at its southern extremity where rift propagation may have occured relatively recently. Existing data appear to show sympathic variation in basalt chemistry along both the island arc and the back-arc spreading axis. Centrally located basalt samples have chemical signatures (e. g. Na_2O, Sr, high CaO/Al_2O_3) consistent with higher degrees of melting and higher concentrations of "slab-derived" components (e. g. high Ba/La, $^{87}Sr/^{86}Sr$ and, in case of the back-arc, high volatile contents) than do those from the

outermost islands or from the edges of the back-arc rift. The combination in the East Scotia Sea of predominantly basaltic volcanism, excellent tectonic control, and the potential to sample both spatial variability and temporal evolution for both the arc and the back-arc provides an unparalleled opportunity to document the magmatic evolution of a young arc/back-arc system.

The tools and methods used in this study include hydrosweep (3.3.5) and parasound (3.3.6) survey, coring, dredging, and water column sampling. A documentation of the chemical anomaly pattern would be based on ΣCO_2, CH_4 (and light hydrocarbons if present), and ∂^3He in conjunction with the hydrographic parameters of T°C, S‰, O_2 µM (see 3.2.1).

3.3.5 Bathymetry and Seafloor Mapping with the Multibeam Sonarsystem Hydrosweep (AWI)

Bathymetric survey of the seafloor will be carried out continuously during this cruise leg. The digital Hydrosweep data will be used for the improvement of bathymetric charts like GEBCO, plotting sheets and nautical charts. In addition boxed surveys are scheduled in areas of interest. At geological sampling locations detailed mapping of a small areas is planned. This will provide fundamental scientific information about bottom morphology in the vicinity of the sampling sites. Charts with scales of 1:50000 to 1:100000 will be processed during the expedition to allow better scientific interpretation.

Precise ship's position and Hydrosweep data free of systematic and random errors are pre-requisite for the compilation of bathymetric charts. Therefore the navigational data and the Hydrosweep raw measurements are verified and corrected during the cruise.

3.3.6 Sediment echo-soundings (Parasound) and Physical Property Measurements (AWI)

The Parasound-system of RV "Polarstern" allows the digital acquisition of sediment echo-soundings which will be analysed by reflection seismic methods. The seismograms can be compared with physical properties and sedimentological parameters measured on sediment cores, which help to characterize and discriminate sediment types, as well as to identify cyclic layering within the sediment column and to compile maps of sediment echo-types. Parasound frequency-tests are planned at the sediment sampling sites for acquisition of undisturbed echo-sounding signals. Magnetic volume susceptibility will be measured immediately after core recovery in order to achieve a high resolution of the structure

The continuous measurements of magnetic volume susceptibility provides preliminary information on the sediment composition. High values are often indicative for higher input of terrestrial and volcanic sediment components while lower values are correlated biogenic components.

Thus, the signatur of susceptibility curves can used with certain limitations as a tool for preliminary age determination in Quaternary sediment cores.

3.3.7 Hydrographic Survey (Scripps, AWI)

The hydrographic conditions in the area of investigation will be documented with

- CTD measurements of top-to-bottom vertical profiles of salinity and temperature,
- bottle samples of salinity and dissolved oxygen, nitrate, nitrite, phosphate and silicate at 24 levels in the water column at each CTD station,
- XBT measurements of the upper-level temperature structure at selected locations interspersed among the CTD stations; and
- the release of 8 satellite-tracked drifting buoys.

Except for the westernmost portions of the Argentine Basin and the northern Drake Passage, there have been no previous CTD, XBT, or detailed hydrographic surveys made during the austral winter in the southwestern South Atlantic. In addition, the barotropic component of flow in region is poorly known.

It has long been believed that the Falkland Current transport is in the range of 10 - 20 Sv (1 Sv = 10^6 m^3 sec^{-1}), but recent inverse calculations say that it may be as high as 80 Sv. Such a discrepancy has great significance in our understanding of the heat and mass balances of the entire South Atlantic. The use of the drifting buoys in conjunction with CTD profiles will help to resolve this issue.

In the Argentine Basin winter conditions are thought to be favorable for vertical overturning in the upper few hundred meters and for the production of Subantarctic Mode Water. This will be studied for the frist time with CTD and XBT measurements, and at the same time our full-depth casts will add much to the existing data base regarding the deep water masses.

In the southern Argentine Basin and the Scotia Sea, the structures of the ACC and deep western boundary currents will be measured, with one aspect never studied before being the possibility of deep vertical convection occurring in the Weddell-Scotia Confluence Zone and the associated ventilation of deep water masses. Finally, for the first time a winter CTD/hydrographic/XBT section spanning the ACC near Drake Passage will be made from South Orkney to the Falkland Islands. Upper-level water mass modifications will be studied, including the relation of ice cover to the position of the Polar Front, as well as any seasonal change in the location of the core of the current which has been suggested by earlier year-long current meter observations.

The hydrographic data are also necessary for the selection of sample depth and sample areas for actuopaleontological, biological and isotope studies in the water column and for paleoceanographic oriented studies of the sediment surface.

3.3.8 Stable Isotopes in bottom water and within the water column (AWI)

Water masses in the oceans can be characterized by stable carbon and oxygen isotopes in sea water. These isotopes provide information on the provenance and history of water masses and reflect the biological productivity in surface waters. Apart from a few GEOSECS stations, data sets of the isotopic composition of the water column of the southern Atlantic ocean could be obtained at two transects, one from Capetown to Cape Norvegia, the other from Cape Norvegia to the southern end of South America.

The sampling programme planned for the cruise leg ATN-X/5 will enlarge the existing station net to the northwestern Weddell Sea and connect the westerly stations of the expedition ANT-VIII/3 at the south Sandwich trench with the ANT-X/5 transects.
Beneath the sampling of the water column which will be carried out at the oceanographic stations with the help of a water rosette, a second topic of the isotope programme consists of sampling bottom water and the coexisting surface sediment. The carbon isotope composition of benthic foraminifera and their ambient sea water should provide information on the species' specific isotope fractionation effect (vital effect) of the species. With these data the reconstruction of paleowatermass distribution through the analysis of carbon isotopes of fossil benthic foraminifera should be possible.

3.3.9 Microplankton Studies (AWI)

The vertical and horizontal distribution of diatoms, silicoflagellates and radiolarians will be documented on transects from the Subantarctic zone across the Polar Frontal Zone to the Antarctic Zone at the edge of winter sea ice using plankton tows and the ship's water pumping system. Sampling of diatoms and silicoflagellates which dwell in the euphotic zone will be concentrated in the surface water layer. Radiolarians will also be sampled at selected depth intervals in the uppermost 500 - 1000 m of the water column by vertical plankton tows. These samples will also be used for the study of copepods. Vertical CTD profiles and water samples for analysing nutrient contents at selected depth levels will shed light on the relationships between hydrography and nutrient availability, the species distribution and abundance of microorganisms.

3.3.10 Macrozooplankton Studies (COM)

The main goal of these studies is the evaluation of the vertical migrations of macrozooplankton organisms (particularly *Euphausiaceae* and *Mysidaceae*) in different water masses and at different latitudes, in relation to light-dark phases of the nycthermal cycle. The materials will be sampled with a pelagic net device equipped with a mechanical opening and closing system with two messengers. Vertical profiles of light in the water column will be obtained by a high sensibility irradiancemeter. The reaction of macrozooplankton organisms to currents will be observed in a rheotaxis-tank with the aid of an actograph. The locomotion reactions of the macrozooplankton will be studied as well.

3.3.4 Ultraviolet Radiation and its Effect on Marine Life (HUX)

Destruction of the stratospheric ozone layer by anthropogenic chlorofluorocarbons and other trace gases has led to increased levels of middle ultraviolet radiation (UVBR 280 - 320 nm) reaching the earth's surface at both polar and temperate latitudes. Small increases in UVBR can reduce growth, photosynthesis or reproduction in a variety of marine species.

Strong depletion of stratospheric ozone over Antarctica during the past few decades (the ozone hole) has led to seasonal UVBR levels that exceed pre-ozone hole levels by a factor of four. Furthermore, a 20-fold increase in under-ice UV irridiance in early October results from the coincident presence of the ozone hole and the period of relatively high tranparency for sea ice. Such findings have led to serious concern about the effects of increased UVBR on marine life in the Southern Ocean.

The objectives of the study are to determine incident doses of UVBR in the Southern Ocean and the effects of present and future increased levels of UVBR on biogeochemical processes including photosynthesis carbon fixation.

Daily measurements will be made of deck-level incident wavelenght-specific UVBR and PAR (320 - 750 nm). In addition, at selected sites, measurements of UVBR and chlorophyll fluorescence will be made through the water column down to about 40 meters. Samples of water, containing natural resident plankton populations, will be collected and incubated onboard to determine primary productivity. Oxygen evolution will be measured unter 3 UVBR treatment conditions: 1) solar UVBR excluded, 2) under UVBR treatment conditions, and 3) enhanced UVBR. All treatments will receive ambient solar PAR. A microprocessor-controlled on-deck incubator will be used to control radiation levels, simulate the diel solar curve, and maintain a constant percentage of UVBR enhancement in the case of treatment 3.

Results of this study will provide information on the depth distribution of chlorophyll (and thus primary productivity) as well as ambient UVB radiation. The data on incident and depth-attenuated UVBR and UVBR-in-

duced photosynthetic inhibition, as well as future ozone depletion, will be used to estimate the effects of present and future levels of UVBR on photosynthetic carbon fixation in the Southern Ocean.

4. Zeitplan/Time Table

Departure from Cape Town	(ANT X/3)	27 March 1992
Arrival at Cape Town		19 May 1992
Depature from Cape Town	(ANT X/4)	21 May 1992
Arrival at Puerto Madryn		05 August 1992
Departure from Puerto Madryn	(ANT X/5)	08 August 1992
Arrival at Punta Arenas		26 September 1992

5. Beteiligte Institute / Participating Institutions

Adresse / Address		Teilnehmer / participants	Fahrtabschnitt / leg
Federal Republic of Germany			
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung Postfach 12 01 61 2850 Bremerhaven	53	3, 4, 5
AWI/ Potsdam	Alfred-Wegener-Institut Forschungsstelle Postdam Auf dem Telegrafenberg O-1561 Potsdam	1	3
BAH	Biologische Anstalt Helgoland Wattenmeerstation Sylt 2282 List/Sylt	1	3
Geomar	Geormar Forschungszentrum für marine Geowissenschaften Wischofenstr. 1-3 2300 Kiel 14	5	5
HSW	Helicopter Service Wasserthal GmbH Kätnerweg 43 2000 Hamburg 65	6	3, 4
IFSB	Institut für Systematische Botanik Altensteinstr. 6 1000 Berlin 33	1	3

IMH	Institut für Meteorologie und Klimatologie der Universität Hannover Nienburger Staße 6 3000 Hannover	4	4
IPÖ	Institut für Polarökologie Universität Kiel Olshausenstr. 40-60	2	3
MER	Dr. Gerhard Beese Quedlinburger Weg 4 2000 Hamburg	1	3
UNIB	Universität Bremen Bibliothekstraße 2800 Bremen	6	3, 4
UNIK	Universität Kiel Institut für Geophysik Leibnitzstr. 2300 Kiel	1	4
SWA	Seewetteramt Deutscher Wetterdienst Bernhard-Nocht-Str. 76 2000 Hamburg	5	3,5
ZIUB	Zoologisches Institut Universität Bonn Poppelsdorfer-Schloss 5300 Bonn	1	3
Austria			
ZIU	Zoologiches Institut der Universität Hellbrunnerstr. 34 A-5020 Salzburg	1	3
Belgium			
VUB	Vrije Universiteit Brussels Laboratory for Ecotoxicology Pleinlaan 2 B-1050 Brussel	1	4

Canada			
AES	AES/Cress Microwave Group Petrie 214-York University 4700 Keele Street North York, Ontario Canada M3J 1P3	1	4
China			
SIO	Second Institute of Oceanography State Oceanic Administration P.O. BOX 507 Hangzhou Zhejiang 310012	1	3
OUQ	Ocean University Qingdao College of Fisheries Yüshan Road 5 Qingdao 266003	1	3
Denmark			
IFS	Institut for Sporeplanter University of Copenhagen Øster Farimagsgade 2D DK-13532 Copenhagen K	1	3
France			
COM	Centre d'Oceanologie de Marseille (O.S.U.) Station Marine d'Endoume-Luminy Case 901 13288 Marseille Cedex	2	5
Great Britain			
DGGE	Department of Geology and Geophysics University of Edinburgh Grant Institute West Mains Road Edinburgh EH9 3JW	1	5
Italy			
CNR	Consiglio Nazionale delle Ricerche Instituto di Biochimica delle Proteine ed Enzimologia Via Marconi 10 I-80125 Napoli	2	3

Netherlands

NIOZ	Nederlands Instituut voor Onderzoek der Zee PO Box 59 NL-1790 Ab den Burg, Texel	2	4
RUG	Biological Sciences Department of Marine Biology University of Groningen P.O. Box 14 9750 AA Haren Netherlands	1	3

Republic of South Africa

OUCT	Dept. of Oceanography University of Cape Town Private Bag Rondebosch 7700	5	3
ZUCT	Department of Zoology University of Cape Town Private Bag Rondebosch 7700	3	3

Russia

AARI	Arctic and Antarctic Research Institute 38 Bering Street 19226 St. Petersburg	1	4

Spain

CSIC	Institut de Ciències del Mar Passeig Nacional S/N 08039 Barcelona	1	3
DGS	Department of Geology University of Salamanca 37008 Salamanca	1	5

United States of America

CRREL	US Army Cold Regions Research and Engineering Laboratory 72 Lyme Road Hanover, NH 03755	1	4

GSFC	NASA/Goddard Space Flight Center Laboratory for Oceans, Code 61 Greenbelt, Maryland, 2077	1	4
HUX	Huxley College of Environmental Studies Western Washington University Bellingham, Washington 98225	2	5
JPL	Jet Propulsion Laboratory 300-323 4800 Oak Grove Drive Pasadena, California, 91109	1	4
OSU	Oregon State University College of Oceanography Corvallis, OR 97331	2	5
Scripps	Scripps Institution of Oceanography La Jolla, Cal. 92093	4	5
TAMU	Department of Oceanography Texas A&M University College Station, Texas 77843	1	5
UCSC	Institute of Marine Sciences University of California Santa Cruz Santa Cruz California 95064	1	3
UPR	University of Puerto Rico P.O. Box 5000 Mayaguez Puerto Rico 00681-5000	1	3
USC	Hancock Institute for Marine Sciences University of Southern California Los Angeles, CA 90089-0373	1	3

6. Fahrtteilnehmer/Participants

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Attwood, Colin	ZUCT
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ANT X/4

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N.N.	AWI
N.N.	AWI

ANT X/5

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Dersch-Hansmann, Manuela	AWI
Derrick, Shirley	DGGE
Gersonde, Rainer (chief scientist)	AWI
Hardy, Jack	HUX
Keller, Randy	Geomar/OSU
Kopsch, Conrad	AWI/Potsdam
Kreuz, Mattias	Geomar
Kuhn, Gerhard	AWI
Lensch, Norbert	AWI
Mann, Ute	AWI
Mattson, Carl	Scripps
Niebler, Hans-Stefan	AWI
Patrick, Ron	Scripps
Passelaigue, Francoise	COM
Peterson, Ray G.	Scripps
Petschick, Rainer	AWI
Richter, Bernd	SWA
Schlüter, Michael	Geomar
Schröder, Andrea	Geomar
Sonnabend, H.	SWA
Spears, Mark	Scripps/TAMU
Streib, Becky	Scripps
Westall, Frances	DPVA
N.N., Hydrosweep	AWI
N.N., Hydrosweep	AWI
N.N., Hydrosweep	AWI
N.N.	AWI

7. Schiffsbesatzung/Ship's Crew

ANT X/3

Kapitän	H. Jonas
I. Offz.	K.D. Gerber
Naut. Offz.	M. Rodewald
Naut. Offz.	U. Grundmann
Naut. Offiz.	N.N.
Meteorologe	F.-U. Dentler
Wettertechniker	H. Sonnabend
Arzt	Dr. A. Stecher
Ltd. Ingenieur	K. Müller
1. Ingenieur	G. Erreth

2. Ingenieur	R. Fengler
2. Ingenieur	O. Ziemann
Elektriker	G. Schuster
Elektroniker	H. Elvers
Elektroniker	J. Muttersbach
Elektroniker	H. Muhle
Elektroniker	J. Roschinsky
Elektroniker	M. Arndt
Funkoffizier	H. Geiger
Funkoffizier	K.H. Wanger
Koch	E. Kubicka
Kochsmaat	M. Dutsch
Kochsmaat	H. Hüneke
1. Steward	D. Peschke
Steward./Krankenschw.	M. Reitz
Stewardess	M. Hoppe
Stewardess	K. Helpap
Stewardess	J. Hasler
2.Steward	Ch. L. Yu
2. Steward	K. Yu
Wäscher	Ch. Chang
Bootsmann	R. Zulauf
Zimmermann	K. Marowsky
Matrose	A. Meis Torres
Matrose	J. Soage Curra
Matrose	J. Pousada Martinez
Matrose	F. B. Pereira Portela
Matrose	A. Prol Otero
Matrose	S. Moser
Lagerhalter	K. Müller
Maschinenwart	G. Jordan
Maschinenwart	M. Lesch
Maschinenwart	U. Husung
Maschinenwart	M. Reitz
Maschinenwart	G. Dufner
Maschinenwart	K. Müller

ANT X/4

Kapitän	Jonas
1. Offizier	Gerber
Naut. Offizier	M. Rodewald
Naut. Offizier	Grundmann
Naut. Offizier	N.N.
Meteorologe	E. Roed
Wettertechniker	H. Köhler
Arzt	Dr. A. Stecher
Ltd. Ingenieur	K. Müller
1. Ingenieur	G. Erreth

2. Ingenieur	R. Fengler
2. Ingenieur	O. Ziemann
Elektriker	G. Schuster
Elektroniker	H. Elvers
Elektroniker	J. Muttersbach
Elektroniker	H. Muhle
Elektroniker	J. Roschinsky
Funkoffizier	H. Geiger
Funkoffizier	K.H. Wanger
Koch	E. Kubicka
Kochsmaat	M. Dutsch
Kochsmaat	H. Hüneke
1. Steward	D. Peschke
Steward,/Krankenschw.	M. Reitz
Stewardess	M. Hoppe
Stewardess	K. Helpap
Stewardess	J. Hasler
2. Steward	Ch. L. Yu
2. Steward	K. Yu
Wäscher	Chang
Bootsmann	R. Zulauf
Zimmermann	K. Marowski
Matrose	J. Novo Loveira
Matrose	J. Soaga Curra
Matrose	J. Pousada Martinez
Matrose	B. Pereira Portela
Matrose	S. Moser
Lagerhalter	K. Müller
Maschinenwart	M. Lesch
Maschinenwart	U. Husung
Maschinenwart	M. Reitz
Maschinenwart	G. Dufner
Maschinenwart	K. Müller

ANT X/5

Kapitän	L. Suhrmeyer
1.Offizier	P. Pönitzsch
Naut. Offizier	M, Bürger
Naut. Offizier	S. Schwarze
Naut. Offizier	N.N.
Meteorologe	B. Richter
Wettertechniker	H. Sonnabend
Arzt	N.N.
Ltd. Ingenieur	D. Knoop
1. Ingenieur	W. Delff
2. Ingenieur	W. Simon
2. Ingenieur	H. Folta
Elektriker	R. Erdmann
Elektroniker	K. Hoops

Elektroniker	U. Lembke
Elektroniker	A. Piskorzynski
Elektroniker	J. Roschinsky
Elektroniker	N.N.
Funkoffizier	J.Butz
Funkoffizier	E. Müller
Koch	W. Köwing
Kochsmaat	F. Roggatz
Kochsmaat	M. Kästner
1. Steward	D. Peschke
Stewardess	G. Meier
Stewardess	A. Hopp
Stewardess	K. Mund
Stewardess	A. Neves
2. Steward	Ch. L. Yu
2. Steward	Ch. Yang
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Matrose	J. Novo Loveira
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Matrose	A. Prol Otero
Matrose	N.N.
Matrose	N.N.
Lagerhalter	F. Barth
Maschinenwart	E. Heurich
Maschinenwart	G. Jordan
Maschinenwart	F. Buchas
Maschinenwart	S. Reimann
Maschinenwart	G. Fritz