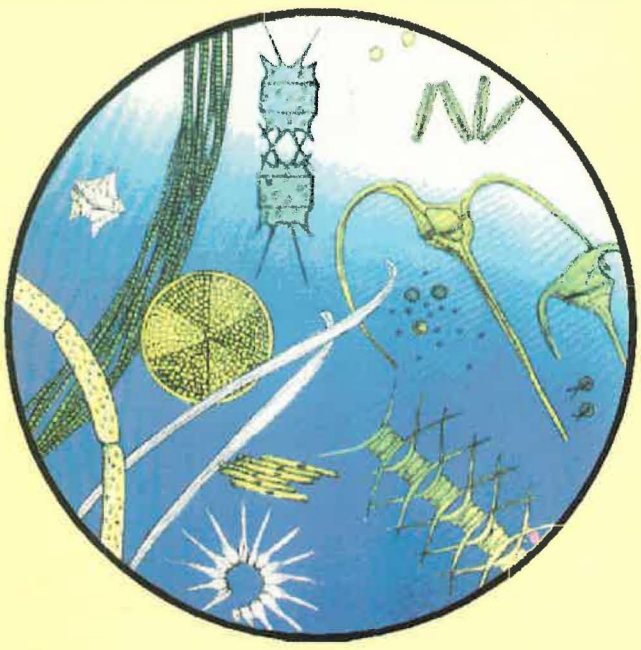
NATURAL ENVIRONMENT RESEARCH COUNCIL

BOFS



USERS' GUIDE TO THE BOFS NORTH ATLANTIC DATA SET

A Users' Guide for access to oceanographic data collected during the North Atlantic cruises of the NERC Biogeochemical Ocean Flux Study (1989-1991). This volume accompanies a CD-ROM.

The CD-ROM data system was produced at the British Oceanographic Data Centre by:-

Dr. R.K. Lowry	Data management, data set synthesis and Users' Guide
Ms. P. Machin	Database assembly, data processing and data documentation
Dr. R.N. Cramer	Software development

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USERS' GUIDE TO THE BOFS NORTH ATLANTIC DATA SET

R.K. Lowry, P. Machin and R.N. Cramer

March 1994

The Biogeochemical Ocean Flux Study (BOFS) was a Community Research Project of the Natural Environment Research Council's Marine and Atmospheric Sciences Directorate hosted by the Plymouth Marine Laboratory, 1987-1992

BODC

British Oceanographic Data Centre,
Proudman Oceanographic Laboratory,
Bidston Observatory, Birkenhead,
Merseyside L43 7RA, United Kingdom

PREFACE

The Biogeochemical Ocean Flux Study (BOFS) 1988-93 was one of the first of NERC's Community Research Projects. It served as the principal UK contribution to the International Joint Global Ocean Flux Study, and provided a substantial part of the 1989 North Atlantic Bloom Experiment of JGOFS. The BOFS data set collected during that experiment and subsequent BOFS studies in 1990 and 1991 are presented here on a CD-ROM.

The British Oceanographic Data Centre (BODC) was responsible for BOFS data management. The procedure followed that pioneered by BODC for the NERC North Sea Community Research Project (published on a CD-ROM in 1992). Further refinements were introduced to deal with the new classes of data collected by BOFS.

All members of the Biogeochemical Ocean Flux Study have benefited from the effective data management of BODC, who are to be congratulated on their work culminating in this CD-ROM.

J.D. Woods
Director, Marine and Atmospheric Sciences
Natural Environment Research Council, Swindon

ACKNOWLEDGEMENTS

The data set presented on this CD-ROM represents the efforts of a vast number of individuals within NERC and the university departments who worked on the project. A quick head count reveals that well over a hundred individuals have contributed in some way to the collection, processing and publication of the data set.

We must first acknowledge the efforts of the officers and crew of RRS Discovery and RRS Charles Darwin. Each cruise was ably supported by members of the Research Vessel Services team. Rob Lloyd and Robin Powell deserve special thanks for their role as RVS contacts for BODC ensuring the timely supply of data and operational information from the ships.

An army of scientists manned the research cruises. Without exception they have cooperated with BODC, providing data and information on very short timescales. Without this level of assistance, the electronic publication of the data set less than three years after the last cruise docked would not have been possible. Our thanks to all who supplied data to BODC: we trust that you appreciate that the numbers are too great for individual mentions.

BODC adopted a central role working up the automatically logged data: 535 CTD casts and the underway data from 11 research cruises. Instrument calibrations were achieved by working in close cooperation with project scientists. Our thanks to all who offered advice, assistance and calibration sample data.

Within BODC the working up and assembly of the data set presented a mammoth task. Much of the routine work was undertaken by industrial training students. Pete Brocklehurst and Gareth Trevor made a valuable contribution during their time with us.

Colleagues within BODC provided much needed assistance. Mairi Marshall supplied keyboard support, accurately keying data and converting screeds of text into aesthetically formatted documents. Lesley Rickards patiently read through this manual and the data documentation, providing valued constructive criticism.

Finally, our thanks go to all those involved with the management and organisation of the project. The project was hosted by the Plymouth Marine Laboratory. Without the organisational efforts provided by PML, particularly Phil Williamson and Carol Turley there would be no data set. Meirion Jones (Head of BODC) and the BOFS Scientific Steering Group provided active support and encouragement at all stages of the data management project.

Funds for BODC data management were provided by NERC through the Marine and Atmospheric Sciences Directorate (Dr. J.D. Woods), with the approval of the Marine Sciences Committee and were managed through BODC's host laboratory, the Proudman Oceanographic Laboratory.

CONTENTS

The User-Guide comprises four parts:-

SECTION I : INTRODUCTION - presents an overview of the BOFS field programme and a conceptual overview of the CD-ROM data system.

SECTION Q : QUICK REFERENCE GUIDE - a set of organograms which provide an overview of the CD-ROM at a glance.

SECTION S : SOFTWARE - the reference manual for the software interface supplied with the CD-ROM on floppy disc.

SECTION D : DATA - specification of the contents and format of the data files on the CD-ROM.

SECTION I : INTRODUCTION

Section I1

The Biogeochemical Ocean Flux Study (BOFS)

I1.1 BOFS: An Introduction

The Biogeochemical Ocean Flux Study (BOFS) was a Community Research Project within the Marine and Atmospheric Sciences Directorate (MASD) of the Natural Environment Research Council. The project provided a major United Kingdom contribution to the international Joint Global Ocean Flux Study (JGOFS).

The project ran from April 1987 until March 1992 but was extended through bridging funds until March 1993. The BOFS North Atlantic Data Set was collected during the initial five year period. Fieldwork in the bridging year focused on the Antarctic in late 1992. These data will form part of a subsequent electronic publication of Antarctic data and are not included on this CD-ROM.

The primary aims of the BOFS programme were:

> To improve the understanding of the biogeochemical processes influencing the dynamics of the cycling of the elements in the ocean and related atmospheric exchanges with particular reference to carbon.
>
> To develop, in collaboration with other national and international programmes, models capable of rationalising and eventually predicting the chemical and biological consequences of natural and man-induced changes to the atmosphere ocean system.

A Community Research Project brings together scientists from NERC institutes and UK universities to work on a common problem. In this way resources far beyond the scope of individual research groups may be brought to bear on a common problem. The project is coordinated through a host laboratory which has responsibility for financial management, organisation and logistics. The host laboratory for BOFS was the Plymouth Marine Laboratory.

The BOFS community included scientists scattered over the length and breadth of the UK. The following organisations were represented:

NERC Laboratories

Plymouth Marine Laboratory
IOS Deacon Laboratory
Dunstaffnage Marine Laboratory

Universities

Bristol
Cambridge
East Anglia
Edinburgh
Liverpool
Plymouth
Queen's Belfast
Royal Holloway and Bedford NC
Scottish Universities Research Reactor Centre
Southampton
University College of North Wales

The main themes and cross projects covered by these groups were:

Air sea interaction
Primary production
Particle production and fate
Benthic processes
Modelling
Organic and inorganic geochemistry
Physical oceanography
Remote sensing

It can be seen that BOFS considered a wide range of processes throughout the water column, in the air above and in the sediment below. This resulted in a large and diverse collection of data which are presented on the BOFS North Atlantic Data Set CD-ROM.

I1.2 **BOFS Fieldwork**

The BOFS North Atlantic Data Set was the result of three field seasons in 1989, 1990 and 1991. These incorporated 11 research cruises, five of which were undertaken by RRS Charles Darwin and six by RRS Discovery. A brief description of each field season follows and the fieldwork is summarised graphically in Figure I.1.

I1.2.1 **The 1989 North Atlantic Bloom Experiment**

The 1989 field season was the United Kingdom contribution to the JGOFS pilot study in the North Atlantic, known generally as the North Atlantic Bloom Experiment (NABE). The objective of this was to provide the most complete time series possible along 20°W from 47°N to 60°N by pooling resources from Canada, Germany, the Netherlands, United States and United Kingdom.

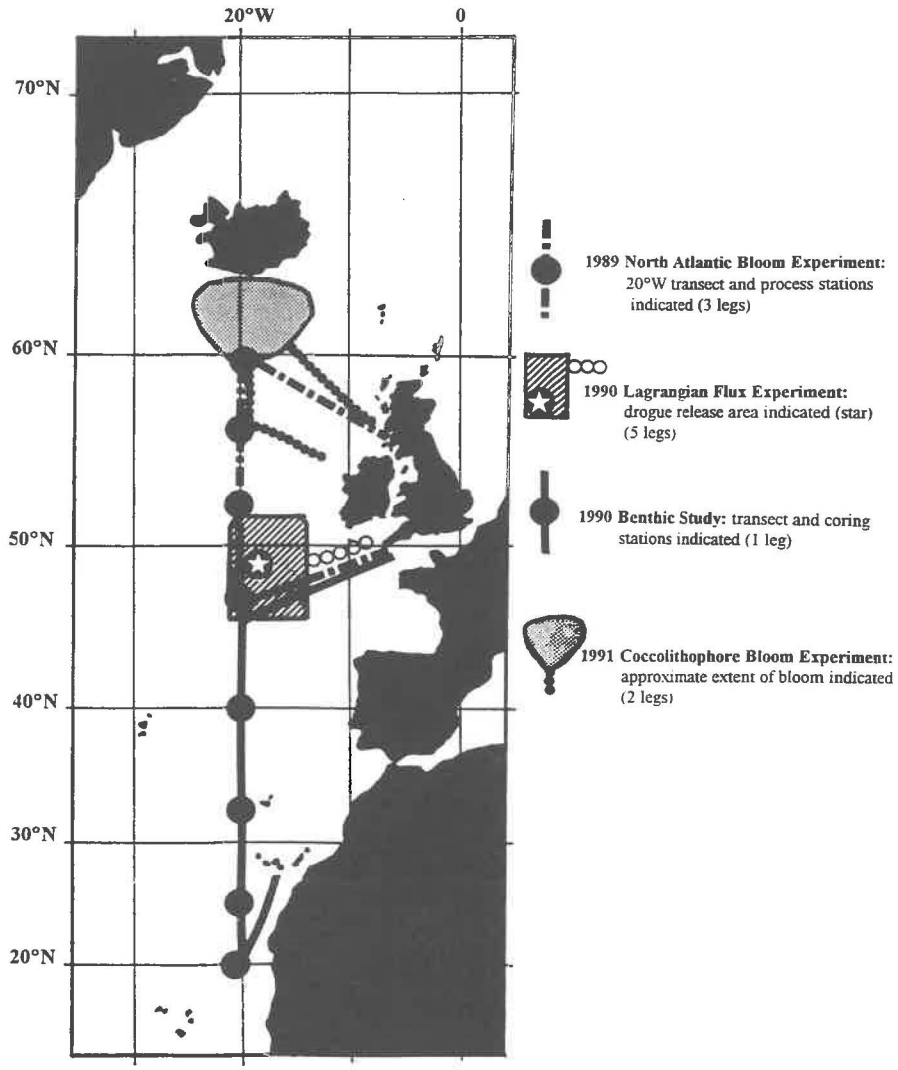


Figure I.1: Graphical Summary of BOFS Fieldwork in the North Atlantic

Each of the 1989 BOFS cruises worked the 20°W transect and each cruise made measurements of the JGOFS Level 1 parameters, namely:

Meteorology and positioning
CTD, oxygen probes and fluorometry
Oxygen titration
Nutrients
Optics
Carbon dioxide
Particulate organic carbon and nitrogen
Dissolved organic carbon
Pigments (especially chlorophyll)
Bacteria and cyanobacteria biomass
Mesoplankton biomass
Microplankton biomass
Primary production by ^{14}C
Oxygen production
New production by ^{15}N
Bacterial production
Mesoplankton grazing
Microplankton grazing
Sediment traps
Phytoplankton composition

However, in addition to as many of these basic measurements as possible, the work of these cruises centred around three different themes.

Discovery 182 (May/June) concentrated on intensive measurements of the carbonate system and phytoplankton production. Discovery 183 (June/July) was focused towards understanding the roles of zooplankton and bacteria and the study of particulate material. Discovery 184 (July/August) was primarily a benthic cruise, collecting multicore, box core and Kasten core samples in addition to water column studies.

I1.2.2 **The 1990 Lagrangian Experiment**

In 1990, the BOFS community mounted a major two ship study in the North Atlantic. The study centred on a region just NE of the JGOFS 47°N 20°W station. The first cruise, Discovery 190 (April/May), undertook a physical and chemical survey around the JGOFS station in order to identify a suitable body of water for the experiment. Once found, the site was marked by a drifting buoy release.

The Lagrangian station was occupied by two cruises, Charles Darwin 46 (April/May) and Charles Darwin 47 (May/June). During the changeover between the two legs, the station was occupied by cruise Discovery 191. These process cruises continuously sampled the water column and ran a range of production experiments almost daily.

Once her station keeping duties were complete, Discovery embarked on a study of particulate material, zooplankton netting and a mooring recovery at 59°N 20°W. The final cruise, Discovery 192, repeated the physical and chemical survey around the

position of the drogued buoy marking the Lagrangian station at the end of the experiment.

I1.2.3 **The 1990 BOFS Benthic Study**

The primary objective of this cruise was to collect a further set of cores to the south of the area sampled during Discovery 184. In addition, some JGOFS Level 1 parameters were measured, mostly by continuous sampling of the surface waters whilst the ship was underway. Core samples were collected from a number of sites along 20°W between 18°N and 47°N.

I1.2.4 **The 1991 Coccolithophore Study**

Two cruises, Charles Darwin 60 (June) and Charles Darwin 61 (July), studied the coccolithophore bloom to the south of Iceland. This included a reworking of the 20°W line north of 55°N. Both cruises undertook intensive physical, chemical and biological measurements, including primary production. A stronger emphasis was placed on studies of grazing by mesozooplankton and microzooplankton during the second cruise.

I1.3 **BOFS Data Management**

Project data management for BOFS was the responsibility of the British Oceanographic Data Centre (BODC). Automatically logged data were supplied in their raw form directly from the ships for calibration and quality control. This work was carried out in close collaboration with the principal investigators.

These data were combined with individual submissions of sample data into a coherent data base under the Oracle RDBMS following the procedures established for another MASD Community Research Project, the North Sea Project. Project participants were provided with on-line access to these data over the UK academic wide area network, JANET.

The BOFS North Atlantic Data Set CD-ROM is the electronic publication of this database.

I1.4 **The BOFS North Atlantic Data Set**

The most noticeable characteristic of the BOFS North Atlantic Data Set is its diversity which manifests itself in several ways. First, there is the range of parameters measured. A browse through sections D2 and D3 of this manual is the best way to appreciate the scale of the problem.

Secondly, there is a diversity in the media studied. These range from atmospheric measurements, through most types of property of the water column to properties of the sediments underlying the water column.

Thirdly, there is a dramatic diversity in the volume of the different components of the data set. At one end of the scale are the automatically logged underway data: typically several megabytes per cruise. At the other are hard won experimental data where the results from an entire cruise may be presented on a single sheet of paper.

It is difficult to provide a brief description of such a diverse data set. Providing a fuller description would only repeat information presented elsewhere in this manual. The user wishing to get a feel for the data set is recommended to read through the Quick Reference Guide (Section Q) and then browse through the descriptions of the 'kit-form database' (Section D2) and underway data set (Section D3).

Section I2

Introduction to the CD-ROM and its Supporting Software

I2.1 Concepts behind the CD-ROM

The BOFS North Atlantic Data Set CD-ROM is first and foremost an electronic publication of the data collected during the project. Like other CD-ROMs in circulation it is accompanied by visualisation software which allows graphical images to be displayed on a PC.

However, this is just one facet of the product. Much of the data on the CD-ROM are stored in flat ASCII files. The pathnames and structures of these files are fully documented in this manual. Consequently, the CD-ROM may also be regarded as a very large floppy disk from which data may be loaded into the user's home system.

Compared to modern magnetic disks, some CD-ROM readers are relatively slow devices. Some of the data files, particularly the underway files, are quite large and consequently reading through them may take a long time.

However, the software interfaces have been designed in such a way that no part of the file pathname is assumed. Consequently, users are actively encouraged to copy heavily used data from the CD-ROM onto their hard disks which will give a marked increase in performance.

The data files used by the display and retrieval programs must be copied following certain rules and detailed instructions are included in the software documentation. However, any of the flat ASCII files, such as the 'kit-form' database included on the CD-ROM may be copied to any other device without restriction on directory structure or naming convention.

I2.2 Components of the Software Interface

The software interface consists of three separate programs to avoid excessive demands on system resources, particularly memory. It should be noted that, with the exception of the underway data set, the data on the CD-ROM have been formatted in such a way that they may be used in conjunction with readily available commercial, shareware and public domain software.

The major programs in this interface are as follows:

I2.2.1 **Underway Data Visualisation Program**

The underway data files contain the information logged every 30 seconds during a cruise. In addition to navigation, parameters measured include water depth, surface salinity, surface temperature, surface chlorophyll, meteorology and, on some cruises, surface nutrients and measurements on the carbonate system.

The visualisation program allows a user specified subset of channels to be displayed on the PC screen as time series plots. The time interval displayed is under user control. Hard copy plots may be generated directly on some devices or through Windows applications onto any device supported by Windows drivers.

I2.2.2 **Underway Data Retrieval Program**

The underway data set is supplied on the CD-ROM in a compact binary format which may not be viewed easily by operating system utilities or commercial software. The Underway Data Retrieval Program allows a user specified subset of any underway data file to be reformatted as a flat ASCII file.

The user is free to select the data subset in a variety of ways. For example, the parameters listed may be restricted, a time window may be chosen or the location of data listed may be specified.

I2.2.3 **Database File Merge Utility**

The 'kit-form' database supplied on the CD-ROM has a logical structure which mimics a relational database. This is perfect for users wishing to load the data into a relational system. However, other users will encounter problems. For example, a spreadsheet user will find nutrient concentrations in one file, sample depths in another and time and position in a third. Whilst there are links between these files, spreadsheet software cannot exploit them in the same way as the relational database software for which they were designed.

The Database File Merge Utility provides some of the capability of a database system for spreadsheet users. In database parlance, the program executes joins between related data files through their key fields. For the example above, the program would produce an output file with date, time, position, and depth fields added to every record of the NUTRI file. This file may then be loaded into a spreadsheet and interrogated as required.

I2.3 **Components of the CD-ROM Data Set**

The data set on the CD-ROM may be regarded as a number of clearly defined subsets. For convenience, each of these is stored in a separate directory. A brief description of each subset follows. In Section D of this manual a chapter is devoted to a detailed description of each subset.

I2.3.1 **Documentation and Meta Data**

This directory contains a series of ASCII plain language files describing how individual components of the data set were collected and processed together with information on any known problems with subsets of the data. In addition, copies of each documentation file are included in PostScript and WordPerfect 5.1 formats which contain a more aesthetic version of the document.

I2.3.2 **The 'Kit-Form' Database**

The 'kit-form' database comprises a series of flat ASCII files which are designed to map to tables within a relational database schema. The files cover all the data collected during the project with the exception of the high volume surface underway data. They therefore include CTD, XBT, SeaSoar, water bottle, net haul, benthic, sediment trap and incubation experiment data.

Whilst the primary objective of these data files is to allow the BOFS North Atlantic database (or a subset thereof) to be created under any relational database management system, they also provide the user with the project data set in an easily accessible form.

I2.3.3 **The Underway Data Set**

This contains the high volume underway data for all 11 cruises included on the CD-ROM. In order to keep their bulk to a minimum, the data are stored in a binary time series format (Binary Merge Format) documented in Appendix 1. Software is supplied to either examine the data graphically as time series plots or convert subsets of the data into ASCII.

The full parameter set covered by the underway files is given below. However, it must be appreciated that not every parameter was measured on every cruise.

Navigation (latitude, longitude and distance run)
Surface temperature
Surface salinity
Surface chlorophyll
Surface dissolved oxygen
Surface attenuance
Surface nutrients
Surface carbonate chemistry (pCO_2, TCO_2, pH and alkalinity)
Photosynthetically active radiation
Solar radiation
Air temperature
Wind velocity
Barometric pressure
Water depth

I2.3.4 **CTD Profile Plots**

For each CTD cast taken (over 500), a profile plot of measured parameter against depth has been produced as a PostScript file. These may either be viewed on the

screen using GhostScript (a public domain utility) or produced as hard copy on a PostScript printer.

I2.3.5 **Kasten Core X-Ray Images**

X-Ray photograhs of the Kasten cores collected on Discovery 184 have been scanned, annotated with scale bars and included on the CD-ROM as Tagged Image Format (TIF) files. These may be viewed using commercial (such as Corel Draw) or shareware (such as Paintshop Pro) software. The images are accompanied by plain language core descriptions in ASCII, PostScript and WordPerfect 5.1 formats.

I2.3.6 **Satellite Images**

Processed AVHRR reflectance images (visible and infra-red), obtained to support BOFS cruises whilst at sea, are included on the CD-ROM in both compressed TIF and PCX formats. Like the Kasten Core X-Rays, the images may be viewed using readily available software.

SECTION Q : QUICK REFERENCE

Section Q1

The BOFS North Atlantic Data Set CD-ROM Quick Reference Guide

Q1.1 Introduction

The Quick Reference Guide is a set of seven organograms which gives a rapid overview of the CD-ROM contents and directory structure. The first shows the top level directory structure of the CD-ROM. There are six user directories plus two directories which contain files to support the software interface and need not concern the user.

The other six organograms summarise the contents and structure of these user directories. Note that the information given is limited. Each directory has a section describing it in detail in Section D of this manual.

Q1.2 Data Set Summary

The six components of the data set are as follows:

CTD Profile Plots:	PostScript plot files of 534 CTD casts.
Satellite Images:	17 visible reflectance and 5 infra-red reflectance AVHRR satellite images in compressed TIF and PCX formats.
Kasten Core X-Ray Images:	X-Ray photographs of 14 Kasten cores in TIF format.
Data Documentation:	A collection of 57 plain language documents describing the protocols used to obtain the data in the surface data set, the 'kit-form' database and the satellite images. Documents are supplied in ASCII, WordPerfect 5.1 and PostScript formats.
Surface Data Set:	11 cruises of automatically logged underway data with between 11 and 27 data channels. Each cruise had a duration of at least 3 weeks and underway data were logged every 30 seconds giving a data set in excess of 665,000 individual measurements.

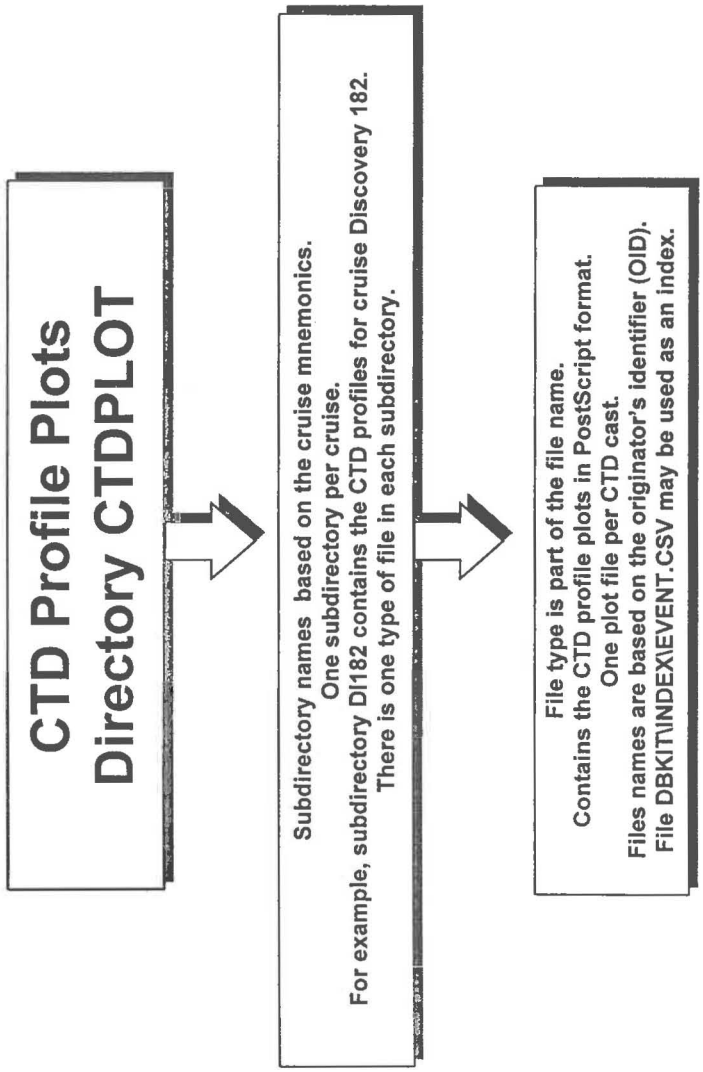
'Kit-form' Database:

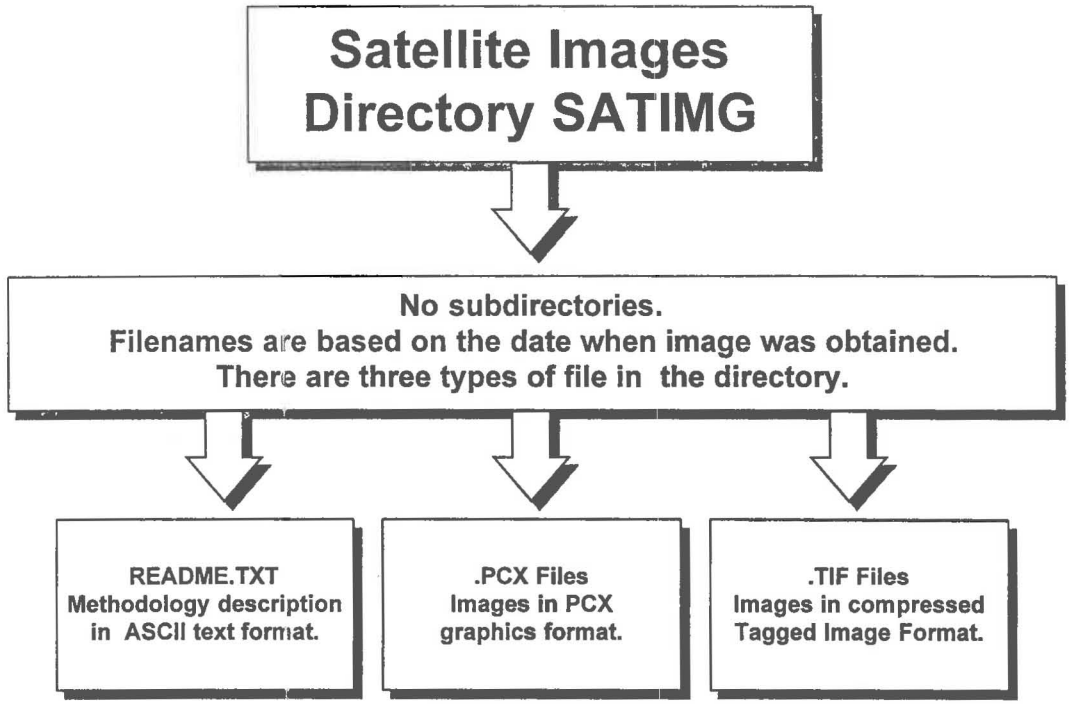
The 'kit-form' database contains all of the BOFS data set with the exception of the high volume underway data in the surface data set.

Such is the diversity of the BOFS data set that the 'kit-form' database consists of 93 files. Each of these represents a table in a relational database schema.

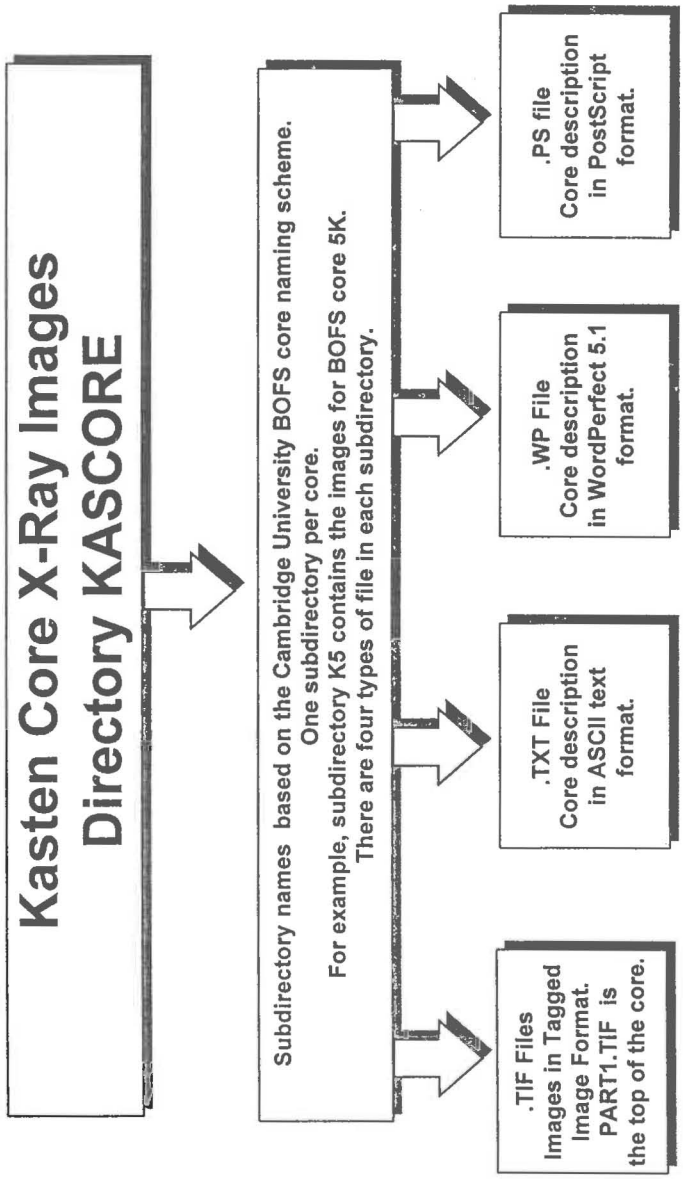
Included in the data set are 534 CTD casts, 246 XBT drops, 6230 water samples, 1080 SeaSoar profiles, 116 zooplankton net hauls, over 380 incubation experiments, 68 grazing experiments and data on over 75 cores.

BOFS North Atlantic Data Set CD-ROM Organogram


CTD Profile Plots
Directory CTDPLOT
Subdirectory names based on the cruise mnemonics.
One subdirectory per cruise.
For example, subdirectory DI182 contains the CTD profiles for cruise Discovery 182.
There is one type of file in each subdirectory.
File type is part of the file name.
Contains the CTD profile plots in PostScript format.
One plot file per CTD cast.
Files names are based on the originator's identifier (OID).
File DBKIT\INDEX\EVENT.CSV may be used as an index.


Satellite Images
Directory SATIMG
No subdirectories.
Filenames are based on the date when image was obtained.
There are three types of file in the directory.
README.TXT
Methodology description
in ASCII text format.
.PCX Files
Images in PCX
graphics format.
.TIF Files
Images in compressed
Tagged Image Format.

Kasten Core X-Ray Images Organogram



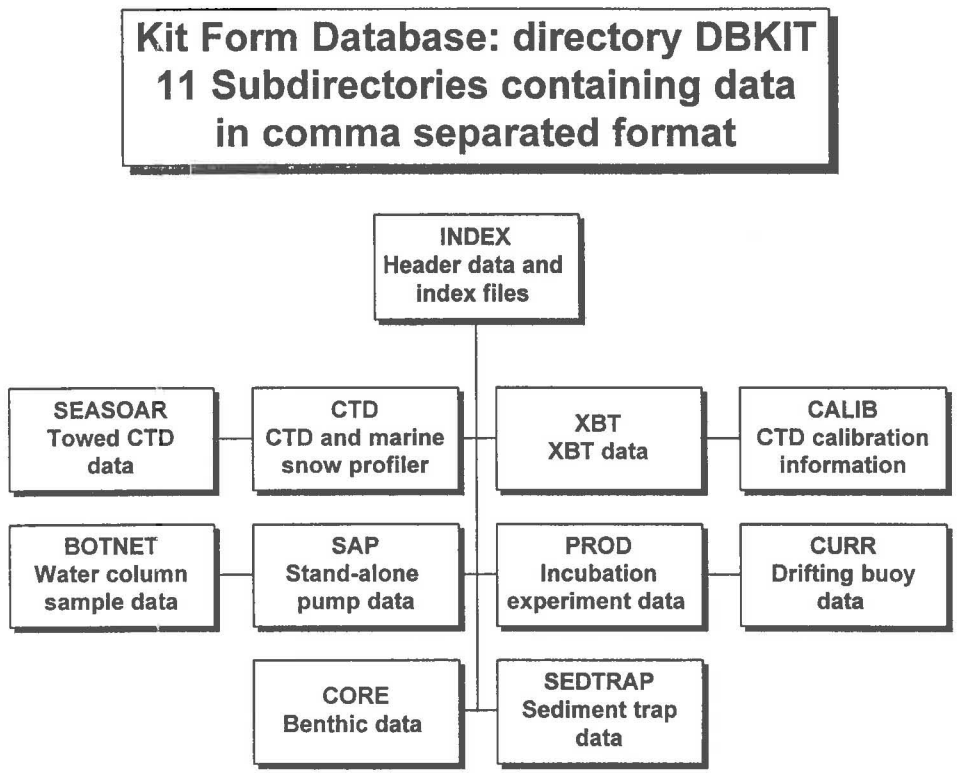
Data Documentation Directory DOCU
Each subdirectory contains metadata documents pertaining to the data in the subdirectory of that name. For example, documents for DBKIT\PROD are in DOCU\DBKIT\PROD. There are three types of file in the directory.
.TXT Files Methodology description in ASCII text format.
.WP Files Methodology description in WordPerfect 5.1 format.
.PS Files Methodology description in PostScript format.

Surface Data Set Directory UNDERWAY

No Subdirectories.

One file per cruise (file type .BMM) containing the surface underway data logged every 30 seconds during the cruise. These files are stored in binary merge format (Section A) and should be accessed by users through the programs UWPLOT and UWLIST described in section S. Files are named using the cruise mnemonic.For example, subdirectory DI182 contains the data for cruise Discovery 182. Parameters present in these files include:

Navigation and bathymetry
Surface temperature and salinity
Surface dissolved oxygen and CO_2 parameters
Surface chlorophyll, attenuance and nutrients
Meteorological measurements


Kit Form Database: directory DBKIT
11 Subdirectories containing data
in comma separated format
INDEX
Header data and
index files
SEASOAR
Towed CTD
data
CTD
CTD and marine
snow profiler
XBT
XBT data
CALIB
CTD calibration
information
BOTNET
Water column
sample data
SAP
Stand-alone
pump data
PROD
Incubation
experiment data
CURR
Drifting buoy
data
CORE
Benthic data
SEDTRAP
Sediment trap
data

SECTION S : SOFTWARE

Section S1

Introduction to the CD-ROM Software

S1.1 Introduction

The software provided with the CD-ROM is designed to provide users of the data with at least some of the tools required to visualise what is by any standards a large and extremely diverse data set. In an ideal world, it would satisfy every user's data presentation requirements. Unfortunately, the provision of software to such a specification is way beyond the resources available to the data management project.

However, the software, the data set and the documentation have been put together in as open a manner as possible. Consequently, the way is left open for users to interface the data system presented here with whatever other tools are available. In some cases, a little ingenuity may be required but, hopefully, not too much work.

The software should therefore be viewed as but one facet of the data system. A brief read through this section will reveal what it is capable of doing. If it satisfies your requirement then go ahead and use it. If not, don't give up. Read through the sections describing how the data are presented and you should be able to find a simple mechanism to get what you want.

S1.2 Required Hardware Configuration

The software has been written to run on IBM or fully compatible platforms. VGA graphics are required and, due to the nature of the graphical user interface, a mouse with at least two buttons is essential. Program memory usage is dynamic, so it is difficult to specify a minimum memory requirement. However, all programs have been run successfully on a system with 450 Kbytes of available base memory.

The programs and their ancillary data files require 2 Mbytes of free space on the hard disk. They use disk caching to avoid excessive memory usage and may run into problems if there is less than 0.5 Mbytes of hard disk available at execution time. From this it can be seen that a hard disk is essential. Additional hard disk will be required if data files are to be copied from the CD-ROM onto magnetic disk to enhance performance.

The software is provided on a 1.4 Mbyte 3.5 inch floppy disk. Access to a suitable

disk drive is required. It may be possible to provide the software on alternative floppy disk formats by special request. As the data set is provided on CD-ROM, access to a CD-ROM reader, connected either directly or over a network, is also required.

S1.3 Installing the Software

The installation procedure depends upon whether the software is being installed on a stand-alone machine or on a local area network. In the latter case, different procedures are required for server installation by the network administrator and system initialisation on individual workstations by users.

S1.3.1 Installation on Stand-alone Machines

The installation of the software on a stand-alone machine is straightforward. Insert the floppy disk and enter the following commands.

```
a:
cd \
install
```

Note that this assumes that the floppy disk drive is configured as the 'A' drive. If not, modify the first command accordingly. A simple menu allows the floppy disk, hard disk and CD-ROM drive designators to be modified from the default values.

To change these defaults use the mouse to highlight the menu option to be modified and press the left mouse button. The install program prompts for the desired disk letter.

By default, the install program creates a directory called 'BOFS' and stores all the .EXE and ancillary data files under this. This may be changed to any legal directory name if required. The programs should be run with this as the current directory. If the directory name chosen already exists, the installation will proceed adding files to the directory. If files already exist, they will be overwritten.

The software as supplied assumes that the CD-ROM reader is the D disk. If this is not the case, the user can specify the correct drive letter during installation. The files DEFAULT.CFG and DBMERGE.BOF are updated automatically by the installation program.

S1.3.2 Server Installation

Server installation is identical to installation on a stand-alone machine except is is done by the network administrator and the software is installed onto a disk which has read only access for network users.

S1.3.3 Network Workstation Installation

The purpose of workstation installation is to copy files which the user may wish to modify (such as the configuration file DEFAULT.CFG) onto a disk for which the workstation has write permission. This may be the workstation hard disk or, for

diskless machines, a partition of the server hard disk which has appropriate permissions.

The installation is done by running the NETINST program. This creates a working directory, called BOFS by default, into which the files are copied. To run the software, make this the current directory and change the network read only partition to the BOFS software directory.

For example, consider a diskless workstation which has read only access to the server P drive and write access to the server H drive. In both cases the default directory name (BOFS) has been used. The commands required to run the UWPLOT program would be:

```
h:
cd \bofs
cd p:\bofs
p:uwplot
```

If the workstation has its own hard drive, this simplifies to:

```
cd \bofs
cd p:\bofs
p:uwplot
```

S1.4 **DIY Troubleshooting**

BODC will provide a user support service as described in the next section. The aim of this section is to offer some simple troubleshooting procedures for what we predict will be the most commonly reported system error.

The error in question is the 'file not found' message. The programs require numerous control and data files, some of which normally reside on magnetic disk and others which are expected to be on the CD-ROM. The software is written in such a way that it will run with a file missing if at all possible. However, in these circumstances it may have some facilities withdrawn.

If you have reason to suspect that the program has failed to find a file, the following checklist may help to find the problem.

1) It is recommended that the program is run with \BOFS specified as the current directory. If a path command has been set up to allow it to run from other directories, problems will certainly result unless the configuration file is modified accordingly and the program is given the full configuration file pathname as a command line parameter.

   So, the first thing to do is to rerun the program with \BOFS as the current directory. If all goes well here, double check the configuration file used. Advice on changing configuration files is given in the program documentation that follows.

2) The documentation encourages users to work from magnetic disk rather than the

CD-ROM if at all possible to enhance performance. If the BOFS North Atlantic Data Set CD-ROM is not currently in the reader, insert it and rerun the program.

If this clears the problem, then either some of the files required have not been copied from the CD-ROM or the configuration file has not been modified to reflect the fact that the files have moved.

S1.5 **BODC User Support**

With a data system as complex as the BOFS North Atlantic Data Set CD-ROM there will inevitably be a learning overhead. The manual includes a lot of information but this is structured and has been written to be as readable as possible. The answers to many queries will be located in the following pages: please try and find them.

If the query concerns the data, then the data documentation included on the CD-ROM may well contain the answer. These files are there for your information: please look at them.

There are three circumstances where users should contact BODC. First, if you have a query concerning the data or the software and cannot find the answer in the manual or the data documentation. Secondly, if you have any comments on any aspect of the data product: we place a high value on user feedback.

Thirdly, whilst every effort has been made to test the software thoroughly, it is impossible to guarantee that programs of this complexity are totally bug free. If bugs are reported to BODC, they will be investigated and fixed. The main purpose of CD-ROM user registration is to allow BODC to communicate known problems and, if necessary, issue subsequent software releases.

When reporting a bug please prepare a thorough description of the problem, the circumstances which generated it and the environment in which the program was being run. Should the program give a diagnostics window please include the information presented verbatim.

The provision of a user support service over the telephone is difficult if not impossible. Please use either e-mail, fax or letter post to communicate with BODC. All communications concerning the CD-ROM should be directed to:

BOFS CD-ROM Support
BODC
Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead
Merseyside L43 7RA,
United Kingdom.

Telefax : 051-652-3950
Email : BODCMAIL@UK.AC.NBI.UA

BODC undertake to acknowledge all enquiries within 48 hours. In most cases, the full response will be available on this timescale. If not, an estimate will be given of the anticipated delay.

Section S2

Underway Data Display

S2.1 Introduction

Whilst at sea, Discovery and Charles Darwin continuously monitored the surface water which, together with meteorological measurements, forms the surface underway data set. Included on the CD-ROM are 11 files (one per cruise) of underway data. These are large data files, typically containing 50,000 records with up to 27 data channels. The programs described in this section and in Section S3 provide the user with simple, relatively rapid access to these vast quantities of data.

Program UWPLOT allows user specified subsets of the data to be plotted as time series on the screen. Program UWLIST, described in Section S3, allows such subsets to be listed to screen, printer or disk, thus overcoming the problems associated with binary data storage.

S2.2 Getting Started

UWPLOT is a menu driven program which plots up to six channels on the y-axis against a common time x-axis. Due to the quantity of data and PC memory limitations, the program requires 320 Kbytes of free space on the hard disk for use as a disk cache.

The program is run from the BOFS directory thus:

```
cd \BOFS
uwplot <filename.cfg>
```

The command line parameter is the name of the configuration file to be used. If none is specified, the program uses the file DEFAULT.CFG. Advice on customising the program by means of the configuration file is given in section S2.6 below.

S2.3 The Underway Data Menu

Once the program has started the Underway Data Menu, accessed by pressing any mouse button, appears thus:

Select Cruise	CD46
Select Time Scale	24 Hour
Select Date	28/4/1990
Select Channels	
Select Flags	GUI
Display Underway Data	
Display Location Map	
Save Screen	
Print Screen	

General Utilities
QUIT

It can be seen that on each line of the menu, one character is underlined. This denotes the 'hot key' for the menu option. Thus, the 'Select Cruise' option may be invoked by either pointing to the menu item with the mouse cursor and clicking the left mouse button or by selecting Alt-R (pressing Alt and R keys simultaneously) on the keyboard, no matter where the mouse cursor is located. 'Hot keys' are available throughout the menu interface. The menu options may also be traversed using the up and down arrow keys.

At this stage, the user makes a decision concerning the manner in which the program is to be used. Data selections may be totally text based. Alternatively, the selection process may be supported graphically by a bathymetric chart of the North Atlantic Ocean.

The choice is governed by the user's familiarity with the data, the power of the PC running the program and the user's patience. The graphical option puts the data selected into its spatial context and consequently provides a lot of help to users who are unsure where the Charles Darwin was on 28/4/1990. However, it involves plotting a large amount of data to the PC screen and consequently it can take time on less powerful (386 or 486SX) machines.

The manual is written on the assumption that most users will want to take advantage of the graphical support. Consequently, this option is documented first. Users wishing to work in text only mode should move on to Section S2.5.

S2.4 **Using the Location Map**

Selecting 'Display Location Map' from the Underway Data Menu results in a bathymetric map of the North Atlantic to be drawn, using equidistant cylindrical projection, from the GEBCO 5th edition contour data. Once the map has been drawn, pressing the left mouse button brings up the Location Map Menu thus:

Select Cruise	CD46
Select Date	28/4/1990
Toggle Plot Area	Full BOFS
Cruise Track Plot	Off
Lat/Long Grid Menu	
Select Depths	
Display Underway Data	
Display Location Map	
Save Screen	
Print Screen	
General Utilities	
QUIT	

S2.4.1 **Select Cruise**

Choosing the 'Select Cruise' causes a subsidiary menu to appear containing the

mnemonics, start dates and end dates of all the cruises included in the data set. The required cruise is selected by highlighting it and pressing the left mouse button.

If the data for the cruise selected cannot be found, a windowed error message is displayed. This may be cleared by pressing the left mouse button, leaving the previous cruise definition in force. It is unlikely that this error will be encountered unless the configuration file has been edited or the wrong CD-ROM is in the drive.

The 'Select Cruise' option does not automatically cause the screen to redraw. The only visible change is the mnemonic displayed in the menu window. To redraw the screen, select 'Display Location Map' after making any other desired changes to the menu settings.

S2.4.2 **Select Date**

The 'Select Date' option is used to specify which day of data from the cruise is to be displayed. The initial result depends upon the other Location Map Menu options in force. If, for any of a number of reasons, the track plot of the current cruise is not displayed an automatic redraw including the cruise track is enforced.

The cruise track may be displayed in segments of two alternating colours. The colours change at midnight each day. The letters 'S' and 'E' are plotted at the start and end of the currently selected (initially the first) day of the cruise. Pressing the left mouse button moves these forwards one day: pressing the right mouse button moves them backwards one day. Moving backwards from the first day selects the last day and vice versa.

Through this mechanism it is possible to see where the ship was located during each day of the cruise. Once the required day is bounded by the 'S' and the 'E' it may be selected by pressing the 'Enter' key, pressing the middle mouse button (for those with a three button mouse and driver) or by pressing the left and right mouse buttons simultaneously.

S2.4.3 **Toggle Plot Area**

The background plot may be specified to cover either the area occupied by the current cruise or the area occupied by all 11 cruises. Selecting the 'Toggle Plot Area' switches from one choice to the other.

The 'Toggle Plot Area' option does not automatically cause the screen to redraw. The only visible change is the display in the menu window. To redraw the screen, select 'Display Location Map' after making any other desired changes to the menu settings.

S2.4.4 **Cruise Track Plot**

The 'Cruise Track Plot' option determines whether or not the cruise track is to be drawn on the background map. When one considers that the main objective of the location map is to allow a subset of the cruise track to be chosen, the ability to turn off the cruise track might seem a little strange. However, the cruise track consists of thousands of points and takes quite a long time to draw. Consequently, interactive development of base map appearance is speeded up considerably if cruise track plotting is suppressed.

The 'Cruise Track Plot' option does not automatically cause the screen to redraw. The only visible change is the display in the menu window. To redraw the screen, select 'Display Location Map' after making any other desired changes to the menu settings.

S2.4.5 **Lat/Long Grid Menu**

Selecting the 'Lat/Long Grid Menu' brings up a subsidiary menu which allows the appearance of the grid overlying the base map to be controlled through the following options:

Display Grid	Off
Select Colour	
Plot Mode	Copy
Previous Menu	

The 'Display Grid' option controls whether (On) or not (Off) a grid is produced. Choosing 'Select Colour' brings up a chart of the available colours. Simply place the mouse cursor on the desired colour and press the left mouse button to select it. The 'Plot Mode' option determines whether the grid is simply superimposed over the background (Copy) or allows the background to show through (Xor). Note that some experimentation may be required to determine the optimum grid colour if the latter option is selected.

The 'Lat/Long Grid Menu' option does not automatically cause the screen to redraw. This is done by selecting 'Display Location Map' after making any other desired changes to the menu settings.

S2.4.6 **Select Depths**

Choosing the 'Select Depths' option allows the depth contours included in the base map to be specified. By default, the 200m, 300m, 400m, 500m, 600m, 700m, 800m, 900m, 1000m, 2000m, 3000m, 4000m and 5000m contours are included. However, contours at 100m intervals from 100m to 5500m plus the 50m contour are available and the user is free to choose as many or as few of these as desired.

The selection mechanism is simple. A window is presented containing all the available depths. Contours are selected or deselected by pointing to them with the mouse cursor and clicking the left mouse button. Selected contours are flagged by chevrons. An 'Invert' option is available. This selects all deselected contours and deselects all selected contours. Once the required contours have been specified, select 'Done' to return to the Location Map Menu.

The 'Select Depths' option does not automatically cause the screen to redraw. This is done by selecting 'Display Location Map' after making any other desired changes to the menu settings.

S2.4.7 **Display Underway Data**

Choosing this option causes the track plot and background map to be replaced, after a delay for reading in the data, by the time series plot of the data for the date specified. Unless specified previously, the parameters displayed will be the first 6

channels in the binary merge file. However, these may be easily changed by pressing the left mouse button to reveal the Underway Data Menu (Section 2.5) and invoking the 'Select Channels' option.

Any of the options from the Underway Data Menu may be invoked at this stage. To return to the base map, select 'Display Location Map'.

S2.4.8 **Display Location Map**

The purpose of this option is to redraw the base map bringing into effect any changes made to the Location Map Menu options.

S2.4.9 **Save Screen**

Choosing 'Save Screen' allows the screen image to be saved to disk in a user specified file. A subsidiary menu appears that allows the cursor to be hidden on the saved screen and offers three file formats: 'PCX', 'IMG' and unformatted as well as HP PaintJet or LaserJet print images. The latter options are useful for printing to disk: the resulting files may then be copied to the appropriate printer. The PaintJet option offers paper or transparency output (differing ink densities) and a choice of portrait or landscape orientation.

'PCX' is a popular PC graphics format which may be imported into a range of software packages including the Paintbrush package supplied as part of Windows. Shareware packages such as Paintshop Pro and commercial packages such as Corel Draw can also import PCX files.

The ability to export into PCX provides a powerful tool for Windows users who wish to produce hard copy screen dumps. Whilst UWPLOT has a 'Print Screen' option, the devices supported are restricted to HP LaserJet and PaintJet printers. However, a PCX file loaded into Paintbrush may be printed on any device for which Windows printer drivers are available. In other words, virtually anything.

'IMG' is a standard format used by older PC artwork packages, sometimes referred to as a 'GEM File'. It is anticipated that most users will use PCX in preference to IMG.

The unformatted option produces a file containing a VGA bit plane dump: essentially the screen memory is dumped to disk. A simple utility, 'DISPLAY', is provided to allow these files to be displayed on the screen within seconds. Unformatted files are of fixed size (156482 bytes). PCX and IMG formats employ compression and, consequently, are more compact.

Once the format has been selected, the program prompts for the filename into which the image is to be written. This should be provided without a file extension. The program automatically appends .PCX, .IMG or .WDG as appropriate.

If the cursor is to be displayed, it can be moved to its required position, maybe pointing out an area of interest, and a mouse button pressed to lock it in position for the duration of the screen save.

Saving the image to disk can take some time. Completion is signalled by the return of the menu to the screen.

S2.4.10 **Print Screen**

The 'Print Screen' option allows a hard copy of the screen to be obtained on either an HP PaintJet colour graphics printer or an HP LaserJet laser printer. Additional options on the menu allow control over whether the mouse cursor is hidden and specification of the printer port.

When a hard copy output has been requested, the program checks whether a device is connected to the specified port. It cannot, however, check that the device is of the required type. The result of an attempt to output to a device other than those specified (or a suitable emulation) is unpredictable but a system crash is likely.

S2.4.11 **General Utilities**

Choosing this option brings up the General Utilities Menu which allows user control over screen colours and program operation through the following options:

Change Screen Colour	
Change Menu Colours	
Change Plot Defaults	
Save Configuration File	
Colour Palettes	
Menu Hierarchy	On
Disk Buffering	Off
Previous Menu	

The 'Change Screen Colour' option allows the background colour to be changed. A colour from the available palette is selected by pointing to it with the mouse cursor and clicking the left mouse button.

Selecting 'Change Menu Colours' allows the colour of the menu components listed below to be adjusted:

Highlighted Option
Available Option
Unavailable Option
Title
Background
Border
Previous Menu

Once again selecting a menu component brings up a colour palette from which the desired colour is chosen by pointing and clicking. The 'highlighted' option requires colours to be specified for the foreground (the text) and background.

The 'Change Plot Defaults' option brings up a menu which allows various aspects of both Location Map and Time Series Plot to be changed. The choices offered are:

Set Cruise Track Options
Set Map Background Colour
Set Map Border Colour
Set Key Columns
Set Key Background Colour
Set Key Foreground Colour
Set Key Border Colour
Underway Axes Colour
Underway Title Colour
Underway Time Bar Colour
Previous Menu

The bulk of the options provided by this menu allows the colour of various components of the plots to be set as desired using the point and click mechanism described above. The exceptions are 'Set Cruise Track Options' and 'Set Key Columns'. The former allows the user to choose between the two colour track plot showing day boundaries and a single colour track plot. The latter gives user control over the shape of the map key: this may be tall and thin (1 column), short and wide (7 columns) or somewhere in between.

The 'Save Configuration File' option allows changes made through the General Utility Menu to be saved to disk for use with subsequent program executions. The changes may either be saved to the default file (DEFAULT.CFG) or to a user specified filename. In general, the latter option would appear the safer course. The customised configuration file may then be invoked as a command line parameter on future program runs.

The 'Colour Palettes' option requires a little explanation. The program runs in VGA 16 colour mode. In other words, 16 colours may be displayed on the screen at any one time. However, these colours are selected from a palette of 65,536 different hues. This option allows the actual hues mapped to the 16 screen colours used (the palette) to be changed by the user. It is possible to load palettes from a disk file, to interactively modify the palette and to save a modified palette to a disk file. Filenames only should be specified as the program automatically appends a .PAL file extension.

The 'Menu Hierarchy' option toggles automatic transfer of control between menus on and off. If the option is switched on, simply moving the mouse pointer from the current menu to a higher level menu transfers control to the higher level menu. If it is switched off, transfer of control may only be achieved by selecting the 'Previous Menu' option.

The 'Disk Buffering' option toggles disk buffering on and off. If the option is turned off, the program runs faster but consumes more memory. The option should only be turned on if problems due to memory shortage are encountered.

S2.5 **Using the Underway Data Menu**

The Underway Data Menu is encountered either at the start of the program or when the left mouse button is pressed with an Underway Time Series Plot on the screen. The options offered by this menu are as follows:

Select Cruise	CD46
Select Time Scale	24 Hour
Select Date	28/4/1990
Select Channels	
Select Flags	GUI
Display Underway Data	
Display Location Map	
Save Screen	
Print Screen	
General Utilities	
QUIT	

Defaults have been assigned for the cruise, time scale, date, channels and flags. Thus, assuming the defaults are as supplied, if the 'Display Plot' option is executed immediately, a plot is displayed of the data collected on Charles Darwin 46 during 28/4/1990 which have the quality control flags set to 'G', 'U' or 'I'. The default channels plotted are whatever happen to be the first six channels in the data file.

The first task for the user is to replace these defaults with the values required to produce the desired image. Menu selections are made by manipulating the mouse to highlight the required option and pressing the left mouse button. If the cursor is moved from a menu into the bounds of a higher level menu window, control is passed to that higher level menu unless the 'Menu Hierarchy' option has been switched off (Section 2.5.10).

S2.5.1 **Select Cruise**

Choosing the 'Select Cruise' causes a subsidiary menu to appear containing the mnemonics, start dates and end dates of all the cruises included in the data set. The required cruise is selected by highlighting it and pressing the left mouse button.

If the data for the cruise selected cannot be found, a windowed error message is displayed. This may be cleared by pressing the left mouse button, leaving the previous cruise definition in force. It is unlikely that this error will be encountered unless the configuration file has been edited or the wrong CD-ROM is in the drive.

S2.5.2 **Select Time Scale**

Choosing the 'Select Time Scale' option in the Underway Data Menu brings up a subsidiary menu containing the following options:

Full Cruise
24 Hours
12 Hours
6 Hours
4 Hours
1 Hour

These specify the time span represented by the x-axis which is plotted across the full width of the screen. If the interval selected is less than 24 hours, a further menu appears to allow the part of the day to be specified.

S2.5.3 **Select Date**

Choosing the 'Select Date' option from the Underway Data Menu produces a subsidiary menu containing all the dates spanned by the current cruise. The date required is selected by pointing and clicking. Note that if 'Full Cruise' has been selected from the 'Select Time Scale' option, the 'Select Date' option is unavailable.

S2.5.4 **Select Channels**

Choosing the 'Select Channels' option from the Underway Data Menu displays a subsidiary menu showing the parameters currently assigned to each of the six plots which will appear on the screen. The parameters to be changed are selected one at a time by pointing and clicking. Each time a further menu appears offering the available alternatives and one of these is selected, again by pointing and clicking.

An 'Unused Channel' option is included in the parameter list. This allows control over the number of plots which appear on the screen. If all six plot channels are assigned, the screen is subdivided into three horizontal segments and two channels are plotted in each segment. If, for example, channels 1 and 2 are assigned to actual parameters and the other four are set to 'Unused Channel', the full height of the screen is used for the plot, giving improved vertical resolution.

The following table summarises the results of some example combinations of used and unused channels:

Channel	*Number of*	*Plots per segment*		
123456	*screen segments*	*Seg 1*	*Seg 2*	*Seg 3*
XXXXXX	*3*	*2*	*2*	*2*
XXXXX-	*3*	*2*	*2*	*1*
XXXX--	*2*	*2*	*2*	*-*
XX----	*1*	*2*	*-*	*-*
-X-X-X	*3*	*1*	*1*	*1*
-XXXX-	*3*	*1*	*2*	*1*
X-X-X-	*3*	*1*	*1*	*1*
X-X---	*2*	*1*	*1*	*-*
-----X	*3*	*0*	*0*	*1*
--X---	*2*	*0*	*1*	*-*

X = Channel assigned to a data parameter
- = Channel assigned as unused

Of the examples shown, the latter two produce results which are less desirable with two thirds or a half of the screen used to no good effect. The best way to fully appreciate the capabilities provided by the 'Unused Channel' option is to run the program and experiment.

S2.5.5 **Select Flags**

Each data value in the underway data files has an associated quality control flag assigned during BODC screening of the data set. The flag values used are:

'G' - Good data value
'I' - Interpolated data value
'U' - Value outside range of calibration

'N' - Null (absent) data
'S' - Suspect data value
'B' - Bad data value

The program only includes in the plot those data points associated with the flags selected. In general, data points flagged 'G', 'U' or 'I' represent the 'acceptable' data in the data set: hence the default flag settings. However, the user is free to choose any subset of flags.

To do this, choose the 'Select Flags' option. A menu appears with the the six possible flags. With the defaults set, three of these (G, U and I) will be marked as selected by a chevron. Choosing a marked flag deselects it: choosing an unmarked flag selects it. Once the desired list of flags has been assembled, return to the main menu.

S2.5.6 **Display Underway Data**

Selecting this option causes the data to be read in from disk and displayed as a time series plot. The read delay depends upon the hardware used and the amount of data required. Reading an entire cruise can take several minutes on slower machines. The full file is only read when necessary: a temporary file is used wherever possible to speed up the process. Once the plots have been produced, the Underway Data Menu may be restored by pressing the left mouse button.

S2.5.7 **Display Location Map**

Choosing this option causes a bathymetric base map to be drawn. Once the map is drawn, transfer may be controlled to the Location Map Menu documented in Section 2.4 by pressing the left mouse button.

S2.5.8 **Save Screen**

Choosing 'Save Screen' allows the screen image to be saved to disk in a user specified file. A subsidiary menu appears that allows the cursor to be hidden on the saved screen and offers three file formats: 'PCX', 'IMG' and unformatted, as well as output in HP PaintJet or LaserJet print images. The latter options are useful for printing from disk on other machines linked to these printeres. The PaintJet option offers paper or transparency output (which use different ink densities) and portrait or landscape orientation.

'PCX' is a popular PC graphics format which may be imported into a range of software packages including the Paintbrush package supplied as part of Windows. Shareware packages such as Paintshop Pro and commercial packages such as Corel Draw can also import PCX files.

The ability to export into PCX provides a powerful tool for Windows users who wish to produce hard copy screen dumps. Whilst UWPLOT has a 'Print Screen' option, the devices supported are restricted to HP LaserJet and PaintJet printers. However, a PCX file loaded into Paintbrush may be printed on any device for which Windows printer drivers are available. In other words, virtually anything.

'IMG' is a standard format used by older PC artwork packages, sometimes referred to as a 'GEM File'. It is anticipated that most users will use PCX in preference to IMG.

The unformatted option produces a file containing a VGA bit plane dump: essentially the screen memory is dumped to disk. A simple utility, 'DISPLAY', is provided to allow these files to be displayed on the screen within seconds. Unformatted files are of fixed size (156482 bytes). PCX and IMG formats employ compression and, consequently, are more compact.

Once the format has been selected, the program prompts for the filename into which the image is to be written. This should be provided without a file extension. The program automatically appends .PCX, .IMG or .WDG as appropriate.

Saving the image to disk can take some time. Completion is signalled by the return of the menu to the screen.

S2.5.9 **Print Screen**

The 'Print Screen' option allows a hard copy of the screen to be obtained on either an HP PaintJet colour graphics printer or an HP LaserJet laser printer. Additional options on the menu allow control over whether the mouse cursor is hidden and specification of the printer port.

When a hard copy output has been requested, the program checks whether a device is connected to the specified port. It cannot, however, check that the device is of the required type. The result of an attempt to output to a device other than those specified (or a suitable emulation) is unpredictable but a system crash is likely.

S2.5.10 **General Utilities**

Choosing this option brings up the General Utilities Menu which allows user control over screen colours and program operation through the following options:

Change Screen Colour	
Change Menu Colours	
Change Plot Defaults	
Save Configuration File	
Colour Palettes	
Menu Hierarchy	On
Disk Buffering	Off
Previous Menu	

The 'Change Screen Colour' option allows the background colour to be changed. A colour from the available palette is selected by pointing to it with the mouse cursor and clicking the left mouse button.

Selecting 'Change Menu Colours' allows the colour of the menu components listed below to be adjusted:

Highlighted Option
Available Option
Unavailable Option
Title
Background
Border
Previous Menu

Once again selecting a menu component brings up a colour palette from which the desired colour is chosen by pointing and clicking. The 'highlighted' option requires colours to be specified for the foreground (the text) and background.

The 'Change Plot Defaults' option brings up a menu which allows various aspects of both Location Map and Time Series Plot to be changed. The choices offered are:

Set Cruise Track Options
Set Map Background Colour
Set Map Border Colour
Set Key Columns
Set Key Background Colour
Set Key Foreground Colour
Set Key Border Colour
Underway Axes Colour
Underway Title Colour
Underway Time Bar Colour
Previous Menu

The bulk of the options provided by this menu allows the colour of various components of the plots to be set as desired using the point and click mechanism described above. The exceptions are 'Set Cruise Track Options' and 'Set Key Columns'. The former allows the user to choose between the default two colour track plot showing day boundaries and a single colour track plot. The latter gives user control over the shape of the map key: this may be tall and thin (1 column), short and wide (7 columns) or somewhere in between.

The 'Save Configuration File' option allows changes made through the General Utility Menu to be saved to disk for use with subsequent program executions. The changes may either be saved to the default file (DEFAULT.CFG) or to a user specified filename. In general, the latter option would appear the safer course. The customised configuration file may then be invoked as a command line parameter on future program runs.

The 'Colour Palettes' option requires a little explanation. The program runs in VGA 16 colour mode. In other words, 16 colours may be displayed on the screen at any one time. However, these colours are selected from a palette of 65,536 different hues. This option allows the actual hues mapped to the 16 screen colours used (the palette) to be changed by the user. It is possible to load palettes from a disk file, to interactively modify the palette and to save a modified palette to a disk file. Filenames only should be specified as the program automatically appends a .PAL file extension.

The 'Menu Hierarchy' option toggles automatic transfer of control between menus on and off. If the option is switched on, simply moving the mouse pointer from the current menu to a higher level menu transfers control to the higher level menu. If it is switched off, transfer of control may only be achieved by selecting the 'Previous Menu' option.

The 'Disk Buffering' option toggles disk buffering on and off. If the option is turned off, the program runs faster but consumes more memory. The option should only be turned on if problems due to memory shortage are encountered.

S2.6 **Customising the program**

Customisation of the program is achieved by editing various files used by the program. The most important of these is the configuration file. By default, the program uses the file DEFAULT.CFG but a custom file may be specified as a command line parameter. As the default is used by several of the programs supplied with the CD-ROM it is safer to use customised copies. However, if the default is to be customised make a backup of it before making any changes.

Only a subset of the records in the configuration file has an effect on this program. These records are listed below and their function described. The text up to and including the first colon of each line is a comment. Everything following the first colon is regarded as a variable and is taken literally. Particular care must be taken when editing to avoid the insertion of additional embedded blanks: LIGHT CYAN is NOT the same as LIGHTCYAN.

Some changes may be made to the configuration file using the 'General Utilities' option within the program. The following records may be changed in this way:

```
Screen background      :WHITE
Menu background        :CYAN
     active options    :LIGHTCYAN
     inactive options  :LIGHTGRAY
     border            :WHITE
     title             :RED
     highlight text    :LIGHTRED
          Background   :BLACK
Menu Hierarchy         :TRUE
Default underway axes colour        :BLACK
Default underway title colour       :BLACK
Default underway timebar colour     :BLACK
Default Map background              :WHITE
Default Map border                  :LIGHTRED
Default Key background              :WHITE
Default Key foreground              :BLACK
Default Key border                  :LIGHTRED
Default Cruisetrack Colour 1        :CYAN
Default Cruisetrack Colour 2        :LIGHTCYAN
Single Colour Cruisetrack           :FALSE
Plot Cruisetrack                    :FALSE
Latitude/Longitude Grid Colour      :DARKGREY
Latitude/Longitude Grid Display     :FALSE
Latitude/Longitude Grid write mode :COPY
```

However, some users may wish to do all the changes to the configuration file in a single text editing session and the following notes are provided for their assistance. Most of the records above control the colours used for the user interface menus and the screen plots. The following colours are available:

Black	Blue	Green	Cyan
Red	Magenta	Brown	LightGray
DarkGray	LightBlue	LightGreen	LightCyan
LightRed	LightMagenta	Yellow	White

With one exception, the remaining options are control switches which may be set to TRUE to turn the option on or FALSE to turn it off. The Latitude/Longitude Grid write mode must be set to either COPY or XOR. The effects of these switches are documented in the 'General Utilities' section above (S2.5.10).

The remainder of the configuration file may only be changed using an editor or word processor. Windows users will find Notepad ideally suited to the job. These records specify where various files required by the software may be found and the default cruise.

The default cruise is specified by the record:

```
Default cruise          :CD46
```

Note that the cruise mnemonic must be in upper case.

The following tell the program where to look for its internal control files and the data.

```
Parameter filename      :C:\BOFS\PARA.DAT
BM Cruise filename      :C:\BOFS\BMCRUISE.DAT
Underway limits file    :C:\BOFS\BMLIMITS.DAT
BM file directory       :D:\UNDERWAY
Bathymetry directory    :D:\BATHY
Working directory       :C:\BOFS
Software directory      :C:\BOFS
Depth values file       :C:\BOFS\DEPCODES.DAT
```

Additional customisation is possible by directing the program to modified copies of some of these control files. The file PARA.DAT should be left well alone: customisation using this file is possible but is beyond the scope of this manual. However, the following changes controlling the extent and location of the input data are straightforward and advantageous.

As supplied, the program works from the full set of binary merge files on the CD-ROM reading the data from that device. Although the technology is currently improving rapidly, many CD-ROM readers are slow devices and the binary merge files are big files.

Consequently, extensive use of UWPLOT can become very time consuming. Transferring the data set onto a hard disk will speed things up considerably. However, the entire data set requires some 100 Mbytes of hard disk which are unlikely to be available.

Let us therefore consider how to work from a subset of the data on hard disk. For example, consider a user who wishes to work on the data set from the three 1989 North Atlantic Bloom Experiment (NABE) cruises (Discovery 182, 183 and 184). Assuming that the CD-ROM is the D disk and the hard disk is the C disk, the data may be transferred from the CD-ROM using the commands:

```
mkdir c:\nabe
copy d:\underway\di18*.bmm c:\nabe\di18*.bmm
```

The next stage is to tell the program that there are only three cruises of data available. This is done by making a copy of the file BMCRUISE.DAT and editing the copy so that only those cruises that are available remain. The copy, let us call it NABE.DAT, must reside in the same directory as BMCRUISE.DAT.

Finally, the following changes need to be made to DEFAULT.CFG:

```
Default cruise          :CD46
BM Cruise filename      :C:\BOFS\BMCRUISE.DAT
BM file directory       :D:\UNDERWAY

to

Default cruise          :DI182
BM Cruise filename      :C:\BOFS\NABE.DAT
BM file directory       :C:\NABE
```

Note that the default cruise has been changed to one that exists in the reduced data set. The program would still work if BMCRUISE.DAT were used. However, the user would be able to select cruises for which there were no data files, resulting in system error messages and user frustration.

The CD-ROM directory BATHY contains the contour information used to produce the base map. If users find base map drawing painfully slow, the contents of this directory should be transferred to hard disk and the 'Bathymetry Directory' entry in the configuration file changed accordingly. The disk space used is relatively small (1-2 Mbytes) but, unless the CD-ROM drive is one of the latest SCSI devices, the increase in performance is dramatic.

Section S3

Underway Data Selection and Format Conversion

S3.1 Introduction

Whilst at sea, Discovery and Charles Darwin continuously monitored the surface water which, together with meteorological measurements, forms the surface underway data set. Included on the CD-ROM are 11 files (one per cruise) of underway data. These are large data files, typically containing 50,000 records with up to 27 data channels. The programs described in this section and in Section S2 provide the user with simple, relatively rapid access to these vast quantities of data.

The basic function of program UWLIST is to list the data from an underway data file in binary merge format to screen, printer or disk. It is, however, a far more flexible tool than this brief description suggests. Using the program it is possible to extract subsets of the data using a variety of techniques.

Further, the binary merge file consists of spot values collected every 30 seconds. UWLIST can either output these spot values or generate averages over a user specified time interval. BOFS participants who have used the underway data files available over JANET will recognise UWLIST as MRGLIST with a vastly improved user interface.

S3.2 Getting Started

The program is run from the BOFS directory thus:

```
cd \BOFS
uwlist <filename.cfg>
```

The command line parameter is the name of the configuration file to be used. If none is specified, the program uses the file DEFAULT.CFG. Advice on customising the program by means of the configuration file is given in section S3.4 below.

Once the title screen appears, pressing the left mouse button brings up the Underway Data Retrieval menu.

S3.3 Underway Data Retrieval Menu

The Underway Data Retrieval Menu provides the following options:

Select Cruise	CD46
Select Parameters	
Select Null Flags	
Select Spot or Mean	Spot All
Select Output Device	Printer

Select Output Format Blank
Display Selection Criteria
Output Selected Data
General Utilities
QUIT

Menu options may be selected by moving the cursor with the mouse (pointing) to the option, thus highlighting it, and clicking the left mouse button. Alternatively, 'hot keys' may be used. Each menu option has one character underlined to signify its 'hot key'. Thus selecting Alt-C (pressing the Alt and C keys together) invokes the 'Select Cruise' option. The menu options may also be transferred using the up and down arrow keys.

Unless 'Menu Hierarchy' is turned off using the 'General Utilities', control is transferred from a subsidiary menu to a menu higher in the hierarchy by simply moving the mouse cursor into the higher level menu.

S3.3.1 **Select Cruise**

The 'Select Cruise' option allows the user to choose the cruise of interest. A menu is offered containing the identifying mnemonics of the available cruises (11 if working from the CD-ROM) together with the dates when data logging commenced and ceased. The desired cruise is selected by pointing and clicking.

S3.3.2 **Select Parameters**

The 'Select Parameters' option brings up a menu offering the parameters that are available for the selected cruise. Date, time, latitude and longitude are always included in the output listing and may not be suppressed by the user. Parameters are selected and deselected by pointing and clicking. Selected parameters are marked as such by chevrons on the menu display. Once all the desired parameters have been selected, control is returned to the Underway Data Retrieval menu by selecting 'Previous Menu'.

It can be seen from Section D3 that the parameter set differs markedly from cruise to cruise. The parameter set offered by the program is obtained by interrogating the binary merge file header. Consequently, it is a nonsense to select the parameters before selecting the cruise. If no parameters are selected, any output will contain date, time, latitude and longitude only.

S3.3.3 **Select Null Flags**

The 'Select Null Flags' option is the first in the list to offer data subsetting. In the case of spot values (i.e. not averages) it is helpful to consider the records of the binary merge file as bricks which have a number of different shapes. The data subsetting options may then be regarded as a set of sieves with holes whose shape is controlled by the option settings. By default, these sieves have holes which allow any shaped brick to pass through. However, holes may be selectively closed off so that only bricks of the required shape are obtained.

The first 'sieve' is controlled by the 'Select Null Flags' option. Choosing this produces a menu which is almost identical to that presented for the 'Select Parameters' option. The only difference is the parameters available for user tagging are latitude, longitude and those parameters selected for inclusion in the output file. The desired parameters are again chosen by pointing and clicking.

Let us now consider the effect on the output of specifying parameters through the 'Select Null Flags' option. The binary merge files contain a data value for every 30 second time slot within their time spans. If a parameter was logged less frequently, the missing time slots are filled with null values. UWLIST only outputs those records from the binary merge file which have non-null values for all parameters specified in the 'Select Null Flags' list.

For example, let us consider a case where the relationship between dissolved oxygen and chlorophyll is to be examined. The parameters required would be oxygen, chlorophyll, temperature and salinity. However, dissolved oxygen was sampled every 5 minutes whereas the other parameters were sampled every 30 seconds. Records with null oxygen are useless: all they do is increase the volume of output. If oxygen is specified using the 'Select Null Flags' option, only records which include an oxygen value are output.

S3.3.4 **Select Spot or Mean: Spot Values**

The 'Select Spot or Mean' option gives access to a suite of additional 'sieves' which may be used to further the subsetting of the data. On selection, a menu offering 'Use Spot Values' or 'Use Average Values' is offered. If the former is selected, the following menu appears:

Output All Records
Use Time Range
Use Position Range
Use Parameter Range
Use Subset of Data
Previous Menu

Please note that these are offered as alternatives. It is not possible to have a subset of the data specified by 'Use Time Range' and 'Use Position Range'. It is, however, possible to specify one of these secondary sieves whether or not a primary sieve has been specified through the 'Select Null Flags' option.

The 'Output All Records' option is provided to allow recovery should a secondary sieve be specified accidentally. The other options are now discussed in detail.

'Use Time Range'

The 'Use Time Range' option allows the data output to be restricted to those records logged within a specified time range. For example, users can select data from a particular event described in a cruise report.

When the option is selected a menu appears requesting the desired start date. This contains a list of all the dates covered by the cruise. The required date is highlighted

and then selected by pressing the left mouse button. A further window appears asking for the start time to be supplied from the keyboard. This procedure is repeated for the end date and time.

'Use Position Range'

The 'Use Position Range' option allows data to be selected from within a user specified box. For example, one may want to extract data for the JGOFS 47°N station from each of the BOFS cruises that visited the region.

A menu is presented offering either a graphical interface ('Select Using the Map') or the keyboard. If the graphical interface is chosen, a map of the cruise track overlain on a bathymetric chart (GEBCO 5th Edition drawn using equidistant cylindrical projection) is produced. A 'rubber banding' method is used to define the area of interest. The cursor is moved to one corner of the desired box and the left mouse button is pressed to anchor it. Further movements of the cursor cause an elastic sided box to be drawn with its diagonal between the cursor and the anchor point. Once this box covers the desired region, press the left mouse button again to complete the selection. Should the anchor be dropped in the wrong place, it may be released by pressing the right mouse button.

The main cost of using the graphical interface is the time taken to draw the base map. This may be speeded up considerably by copying the contents of the CD-ROM BATHY directory and the binary merge file onto the PC's hard disk and modifying the configuration file accordingly as described in section S3.4.

If keyboard input is selected, the program prompts for the southern, northern, western and eastern limits of the desired box. Values are required in decimal degrees (e.g. -20.5 for 20°30'W). Note that as all BOFS longitudes lie west of Greenwich, they must be supplied as negative values.

'Use Parameter Range'

The 'Use Parameter Range' option allows output to be restricted to those records where the values of a user specified parameter are confined within a user specified range. For example, data from surface waters where blooms are active may be obtained by specifying a chlorophyll range.

On selecting the option a menu is offered containing the available parameters. The parameter to be used is selected by pointing and clicking. The program then prompts for the minimum and maximum values to be considered. All records where the specified parameter value lies between these limits (inclusive) are output.

'Use Subset of Data'

The 'Use Subset of Data' option allows the volume of the output data file to be reduced by picking spot records from the binary merge file at regular intervals. For example, every tenth record may be picked giving an output file of spot values at 5 minute intervals. This option will behave more predictably if it is not used in conjunction with null value output suppression.

When the option is selected, it requires the time of the first value to be included in the output. This is designed to allow output to be selected so it falls on the hour etc., but may also be used to suppress output from the beginning of a binary merge file.

The start date is specified first. A menu appears containing the dates within the cruise. Simply highlight the desired date and select it by pressing the left mouse button. Next the program prompts for the start time to be entered via the keyboard. Finally, the program asks for the number of input records to be skipped after each record that is output. Thus, to obtain a data value every 5 minutes (i.e. every 10 records), the number of records which must be skipped is 9.

S3.3.5 **Select Spot or Mean: Mean Values**

The above section describes the methods available for reducing the volume of the output data by pulling out a subset of spot readings. If the data are of a consistent high quality, this presents no problems. Indeed, the flexible way in which the subsets may be defined bestows a clear advantage on the method. However, if the data include a significant proportion of values flagged as spikes then it is quite possible for the data coverage to be unnecessarily degraded by this method.

An alternative technique is to average the data. UWLIST is able to generate averages over a range of time intervals. The averages are computed using only those values which have been flagged as acceptable during quality control: any data flagged 'B' (bad), 'S' (suspect) or 'N' (null) are excluded from the computation of the mean. Should no good data be encountered, the average is set null.

Averaged data are obtained by choosing the 'Select Spot or Mean' option followed by 'Use Average Value'. A menu offering the available averaging intervals is presented and the desired interval selected by pointing and clicking. A further menu is presented allowing the averages to be determined for the entire file or for a specified time span within the file. If a limited time span is desired, it is specified in exactly the same way as is described for 'Use Time Range' above.

In order that the output from the program be understood, the averaging algorithm needs to be defined. Let us consider the derivation of hourly means for the entire file. The first mean will be determined from cycles 1 to 121 of the input file, and the output record is labelled with the time stamp from cycle 61. The next mean includes cycles 121 to 241 centred on cycle 181 and so on. Note that this will result in a rolling average if an interval of 1 minute is specified.

It is possible to use averaging in combination with null value output suppression described above. If this is the case, the average is determined first and if the nominated parameters have null means, output of the record is suppressed. Null value output suppression is less powerful when used with averaged data but may be used to reduce the output volume if there are significant gaps in the data. If required it is specified using the 'Select Null Flags' option as described in Section S3.3.3.

One word of caution. Included in the binary merge files for most cruises is a wind direction channel. Averaging this channel should NOT be attempted: the result will be garbage because of the effect of wrap around from 360 to zero.

S3.3.6 **Select Output Device**

By default, the program output is as ASCII codes directed to a printer connected to port LPT1. This may be changed through the 'Select Output Device' option. The output device may be chosen to be either the screen, a printer or a disk file.

If the screen is selected, a menu appears which allows the text, background and border colours to be specified. Colours are chosen by pointing and clicking on the palette offered. It is also possible to specify the number of lines of header information. These are lines of text at the top of the screen which are not overwritten when the screen is refreshed allowing the header information to remain visible whilst all the data are listed. If the number of lines is set to the number of user selected parameters plus 6, the entire header is preserved.

If a printer is selected, the menu interface allows the printer port to be changed from the default (LPT1) and for the printer driver to be selected. Drivers for generic text (ASCII), PostScript, LaserJet, PaintJet and Epson FX80 are available.

If disk output is chosen, the user is able to specify the output filename. Otherwise the default, OUTPUT.DAT, is used.

S3.3.7 **Select Output Format**

The 'Select Output Format' option allows the delimiters between items of text to be changed. By default, the text is blank delimited. This may be changed to comma delimited or 'Lotus 123 delimited text'. The latter option is NOT Lotus 123 internal format (WK1, WK2 etc.) but comma delimited text with alphanumeric fields enclosed by double quotes. Microsoft Excel 4 users will know this as CSV format.

S3.3.8 **Display Selection Criteria**

Once the desired data subset has been specified, the user is almost ready to generate the reformatted output data. However, before doing this it is wise to check that the data subset has been specified correctly. This is achieved by selecting the 'Display Selection Criteria' option which lists the chosen selection criteria in an information window. Pressing the left mouse button returns control to the Underway Data Retrieval menu.

S3.3.9 **Output Selected Data**

Selecting 'Output Selected Data' causes the binary merge file to be output according to the options currently in force. This process takes time, even if the data are on magnetic disk, because the binary merge files are very large. The program's progress is continuously displayed on the screen to allow accurate estimates to be made of how long the formatting will take to complete. The output process may be aborted at any time by pressing the Esc key, or the right mouse button.

Output to the screen is done on a screen by screen basis. Once a screen full of information has been digested, the next screen is obtained by pressing any key on the left mouse button.

S3.3.10 **General Utilities**

Choosing this option brings up the General Utilities Menu which allows user control over screen colours and program operation through the following options:

Change Screen Colour	
Change Menu Colours	
Save Configuration File	
Colour Palettes	
Menu Hierarchy	On
Disk Buffering	Off
Previous Menu	

The 'Change Screen Colour' option allows the background colour to be changed. A colour from the available palette is selected by pointing to it with the mouse cursor and clicking the left mouse button.

Selecting 'Change Menu Colours' allows the colour of the menu components listed below to be adjusted:

Highlighted Option
Available Option
Unavailable Option
Title
Background
Border
Previous Menu

Once again selecting a menu component brings up a colour palette from which the desired colour is chosen by pointing and clicking. Some of these require two colours to be specified: one for the foreground (the text) and one for the background.

The 'Save Configuration File' option allows changes made through the General Utility Menu to be saved to disk for use with subsequent program executions. The changes may either be saved to the default file (DEFAULT.CFG) or to a user specified filename. In general, the latter option would appear the safer course. The customised configuration file may then be invoked as a command line parameter on future program runs.

The 'Colour Palettes' option requires a little explanation. The program runs in VGA 16 colour mode. In other words, 16 colours may be displayed on the screen at any one time. However, these colours are selected from a palette of 65,536 different hues. This option allows the actual hues mapped to the 16 screen colours used (the palette) to be changed by the user. It is possible to load palettes from a disk file, to interactively modify the palette and to save a modified palette to a disk file. Filenames only should be specified as the program automatically appends a .PAL file extension.

The 'Menu Hierarchy' option toggles automatic transfer of control between menus on and off. If the option is switched on, simply moving the mouse pointer from the current menu to a higher level menu transfers control to the higher level menu. If it is switched off, transfer of control may only be achieved by selecting the 'Previous Menu' option.

The 'Disk Buffering' option toggles disk buffering on and off. If the option is turned off, the program runs faster but consumes more memory. The option should only be turned on if problems due to memory shortage are encountered.

S3.4 **Customising the program**

Customisation of the program is achieved by editing various files used by the program. The most important of these is the configuration file. By default, the program uses the file DEFAULT.CFG but a custom file may be specified as a command line parameter. As the default is used by several of the programs supplied with the CD-ROM it is safer to use customised copies. However, if the default is to be customised make a backup of it before making any changes.

Only a subset of the records in the configuration file has an effect on this program. This subset is listed below and its function described. The text up to and including the first colon of each line is a comment. Everything following the first colon is regarded as a variable and is taken literally. Particular care must be taken when editing to avoid the insertion of additional embedded blanks: LIGHT CYAN is NOT the same as LIGHTCYAN.

Some changes may be made to the configuration file using the 'General Utilities' option within the program. The following records may be changed in this way:

```
Screen background      :WHITE
Menu background        :CYAN
     active options    :LIGHTCYAN
     inactive options  :LIGHTGRAY
     border            :WHITE
     title             :RED
     highlight text    :LIGHTRED
          Background   :BLACK
Menu Hierarchy         :TRUE
```

However, some users may wish to do all the changes to the configuration file in a single text editing session and the following notes are provided for their assistance. Most of the records above control the colours used for the user interface menus and the screen plots. The following colours are available:

Black	Blue	Green	Cyan
Red	Magenta	Brown	LightGray
DarkGray	LightBlue	LightGreen	LightCyan
LightRed	LightMagenta	Yellow	White

The remaining option is a control switch which may be set to TRUE or FALSE. Users unsure of the effect of this switch should refer to Section S3.3.10.

The remainder of the configuration file may only be changed using an editor or word processor. Windows users will find Notepad ideally suited to the job. These records specify where various files required by the software may be found and the default cruise.

The default cruise is specified by the record:

```
Default cruise         :CD46
```

Note that the cruise mnemonic must be in upper case.

The following tell the program where to look for its internal control files and the data.

```
Parameter filename     :C:\BOFS\PARA.DAT
BM Cruise filename     :C:\BOFS\BMCRUISE.DAT
Underway limits file   :C:\BOFS\BMLIMITS.DAT
BM file directory      :D:\UNDERWAY
Bathymetry directory   :D:\BATHY
Working directory      :C:\BOFS
Software directory     :C:\BOFS
Depth values file      :C:\BOFS\DEPCODES.DAT
```

Additional customisation is possible by directing the program to modified copies of some of these control files. The file PARA.DAT should be left well alone: customisation using this file is possible but is beyond the scope of this manual. However, the following changes controlling the extent and location of the input data are straightforward and advantageous.

As supplied, the program works from the full set of binary merge files on the CD-ROM (which is assumed to be the D disk) reading the data from that device. Although the technology is currently improving rapidly, many CD-ROM readers are slow devices and the binary merge files are big files.

Consequently extensive use of UWLIST can become very time consuming. Transferring the data set onto a hard disk will speed things up considerably. However, the entire data set requires some 100 Mbytes of hard disk which are unlikely to be available.

Let us therefore consider how to work from a subset of the data on hard disk. For example, consider a user who wishes to work on the data set from the three 1989 North Atlantic Bloom Experiment (NABE) cruises (Discovery 182, 183 and 184). Assuming that the CD-ROM is the D disk and the hard disk is the C disk, the data may be transferred from the CD-ROM using the commands:

```
mkdir c:\nabe
copy d:\underway\di18*.bmm c:\nabe\di18*.bmm
```

The next stage is to tell the program that there are only three cruises of data available. This is done by making a copy of the file BMCRUISE.DAT and editing the copy so that only those cruises that are available remain. The copy, let us call it NABE.DAT must reside in the same directory as BMCRUISE.DAT.

Finally, the following changes need to be made to DEFAULT.CFG:

```
Default cruise          :CD46
BM Cruise filename      :C:\BOFS\BMCRUISE.DAT
BM file directory       :D:\UNDERWAY

to

Default cruise          :DI182
BM Cruise filename      :C:\BOFS\NABE.DAT
BM file directory       :C:\NABE
```

Note that the default cruise has been changed to one that exists in the reduced data set. The program would still work if BMCRUISE.DAT were used. However, the user

would be able to select cruises for which there were no data files, resulting in system error messages and user frustration.

The CD-ROM directory BATHY contains the contour information used to produce the base map. If users find base map drawing painfully slow, the contents of this directory should be transferred to hard disk and the 'Bathymetry Directory' entry in the configuration file changed accordingly. The disk space used is relatively small (1-2 Mbytes) but, unless the CD-ROM drive is one of the latest SCSI devices, the increase in performance is dramatic.

Section S4

Database Merge Program

S4.1 Introduction

The 'kit-form' database supplied on the CD-ROM is designed to be loaded into a relational database management system. Consequently, the files which make up the 'kit' are not self contained data units in the classical sense. Rather than having a file header and a series of datacycles together in the same file all the header information is contained in a header file whilst the datacycles are held in a second file. The linkages between the two are established by special fields common to both files termed keys.

Not all users will wish to use the 'kit-form' database for its intended purpose. DBMERGE is designed to assist in this task. In database jargon, the program executes a two or three way join between the data file and the appropriate header file or files. In other words, fields from the appropriate records in the header files are added to fields from the data record to create a new output file.

Thus the desired header information is replicated on each datacycle record producing a result which may be loaded into a spreadsheet, input to contouring packages (although it may need editing first) or used in many other ways.

DBMERGE has an additional capability. The program is able to generate a subset of the data according to user specified criteria. For example, output may be restricted to data from a particular area described by a rectangular box.

S4.2 Getting Started

The program is run from the BOFS directory by entering the commands:

```
cd  c:\bofs
dbmerge <filename.cfg>
```

The command line parameter is the name of the configuration file to be used. If none is specified, the program uses the file DEFAULT.CFG. Advice on customising the program by means of the configuration file is given in section S4.11 below.

When the title screen appears, pressing the left mouse button brings up the Database File Merge Menu containing the following options:

```
Select MAIN DATA file                    D:\DBKIT\BOTNET\NUTRI.CSV
Select Parameters from EVENT file
Select Parameters from BOTTLE file
Select Parameters from CORE file
Select Parameters from SAP file
```

Select Parameters from SEDTRAP file
Select Parameters from NET file
Select Parameters from HEADER file
Select Parameters from MAIN DATA file
Define Data Range
Define Order of Output
Execute File Merge
Select Output Format — Blank
Select Output Device — Printer
General Utilities
QUIT

Menu options are selected by highlighting the option with the mouse cursor (pointing) and clicking the left mouse button. One letter from each menu option is underlined. This denotes the 'hot key' for that menu option, which allows menu option selection without using the mouse. For example, selecting Alt M (pressing the Alt and M keys simultaneously) chooses the 'Select MAIN DATA File' option. The menu options may also be traversed by pressing the up and down arrow keys.

S4.3 **Select MAIN DATA File**

DBMERGE takes parameters from a 'kit-form' database data file and merges them with header parameters from its associated index files. The program is able to work out which index files are associated with a given data file. All the user has to do is to choose the desired data file. These are in the 'kit-form' database directories other than DBKIT\INDEX and DBKIT\CALIB.

To set the input file choose 'Select DATA File'. The Input File Menu appears thus:

Drive : D:
Path : \DBKIT\BOTNET\
File : NUTRI.CSV

Set the drive first if required (e.g. if the CD-ROM drive is not the 'D' drive). This is simply a case of choosing 'Drive' and keying in the desired drive letter when prompted by the program. Next select 'Path'. A menu appears containing all the subdirectories under the path currently specified (if any) together with the two 'special' directories encountered in DOS ('.' - current directory: '..' - parent directory).

The process of specifying the path may be visualised as a walk through the tree structure until the required subdirectory is reached. The starting point is either DBKIT\BOTNET by default or the current directory if the drive letter has been changed. At each stage, 'Path' is selected followed by the subdirectory name to go down a level or '..' to go up a level. Section D2 of the manual will be of assistance here. For example to get to the CTD data specify '..' followed by 'CTD'.

This may seem a little painful to those who know exactly where they want to go but it does enable a totally unfamiliar directory structure (e.g. the CD-ROM) to be navigated with relative ease.

Once the path has been set to the required subdirectory, choose the 'File' option. A menu appears containing all the files within the subdirectory. Simply choose the desired file.

S4.4 **Select Parameters**

Having selected the data file, the next stage is the selection of the parameters which are to be included in the output. On returning to the Database File Merge Menu, it will be noted that the program has recognised the data file chosen and made available the 'Select Parameters' options for the files to which it may be joined. The user simply chooses each available 'Select Parameters' option and specifies the parameters that are required.

On choosing a 'Select Parameters' option a menu appears offering a list of the available parameters. Each parameter is described as a mnemonic with a brief plain language description (providing the file PARADESC.DAT has been found. Otherwise, only the mnemonic is given). The space for this is limited. If the description is not fully understood, a fuller description may be obtained from Section D2 of this manual.

Parameters are selected and deselected by pointing and clicking. Selected parameters are flagged by arrow symbols at either end of the menu entry. By default, all parameters of the main data file are selected, and all parameters from the index files are deselected.

S4.5 **Define Data Range**

DBMERGE has a limited data subsetting capability. It is possible to select the data from a specified cruise OR from a specified time interval OR from a specified area (rectangular box) OR from a specified depth range (for data files linked to index file BOTTLE). Time spans and positional ranges may be input from the keyboard or through a graphical interface based on a bathymetric chart and cruise tracks.

S4.5.1 **Define Data Range: Non-Graphical Options**

Selecting 'Define Data Range' brings up the Data Range Menu which contains the following options for menu-based data subsetting.

Output All Data
Specify Cruise
Specify Area from Keyboard
Specify Start Time Range
Specify Bottle Depth Range

It must be emphasised that these options are alternatives and not cumulative. Thus choosing 'Specify Cruise' followed by 'Specify Area from Keyboard' results in data for the designated area from ALL cruises: the 'Specify Cruise' selection is overridden.

The 'Output All Data' option is provided to allow a change of mind and will override any previously selected option.

'Specify Cruise'

The 'Specify Cruise' option allows the user to choose the cruise of interest. A menu is offered containing the identifying mnemonics of the 11 available cruises together with the dates when data logging commenced and ceased. The desired cruise is selected by pointing and clicking.

'Specify Area from Keyboard'

The 'Specify Area from Keyboard' option allows data to be selected from within a user specified box. For example, one may want to extract data for the JGOFS 47°N station from each of the BOFS cruises that visited the region.

The program prompts for the southern, northern, western and eastern limits of the desired box. Values are required in decimal degrees (e.g. -20.5 for 20°30'W). Note that as all BOFS longitudes lie west of Greenwich, they must be supplied as negative values.

Record selection is based on the LAT and LON fields from the EVENT file.

'Specify Start Time Range'

The 'Specify Start Time Range' option allows the data output to be restricted to those records associated with a specified time range. For example, users can select data from a particular event described in a cruise report.

When the option is selected the program prompts for the start and end of the desired time span. Record selection is based on the TBEGNS field from EVENT. Generally, selecting data using a time span also restricts data to a single cruise. However, during 1990 two ships were operating simultaneously and consequently a subset based on time may include data from two cruises.

'Specify Bottle Depth Range'

The 'Specify Bottle Depth Range' option allows the data output to be restricted to a specified depth range in the water column. This is obviously only possible for data files which contain water column data: it cannot be used with other data types, such as benthic data, for obvious reasons.

The program prompts for the minimum and maximum depths (in metres) required. The inclusive selection is based on the DEPTH field from file BOTTLE.

S4.5.2 Define Data Range: Graphical Options

Choosing 'Specify using Map' causes a base map covering the BOFS area based on GEBCO 5th Edition contour data to be drawn using equidistant cylindrical projection. Pressing the left mouse button brings up the Location Map Menu. This allows the appearance of the map to be modified and data subsetting on the basis of time or position.

The options controlling the appearance, saving and printing of the map are:

Toggle Plot Area	Full BOFS
Cruise Track Plot	Off
Lat/Long Grid Menu	
Select Depths	
Select Cruise	CD46
Display Location Map	
Save Screen	
Print Screen	
Map Utilities	

'Toggle Plot Area'

The background plot may be specified to cover either the area occupied by the current cruise or the area occupied by all 11 cruises. Selecting the 'Toggle Plot Area' switches from one choice to the other.

The 'Toggle Plot Area' option does not automatically cause the screen to redraw. The only visible change is the display in the menu window. To redraw the screen, select 'Display Location Map' after making any other desired changes to the menu settings.

'Cruise Track Plot'

The 'Cruise Track Plot' option determines whether or not the cruise track is to be drawn on the background map. When one considers that the main objective of the location map is to allow a subset of the cruise track to be chosen, the ability to turn off the cruise track might seem a little strange. However, the cruise track consists of thousands of points and takes quite a long time to draw. Consequently, interactive development of base map appearance is speeded up considerably if cruise track plotting is suppressed.

The 'Cruise Track Plot' option does not automatically cause the screen to redraw. The only visible change is the display in the menu window. To redraw the screen, select 'Display Location Map' after making any other desired changes to the menu settings.

'Lat/Long Grid Menu'

Selecting the 'Lat/Long Grid Menu' brings up a subsidiary menu which allows the appearance of the grid overlying the base map to be controlled through the following options:

Display Grid	Off
Select Colour	
Plot Mode	Copy

The 'Display Grid' option controls whether (On) or not (Off) a grid is produced. Choosing 'Select Colour' brings up a chart of the available colours. Simply place the mouse cursor on the desired colour and press the left mouse button to select it. The 'Plot Mode' option determines whether the grid is simply superimposed over the background (Copy) or allows the background to show through (Xor). Note that some experimentation may be required to determine the optimum grid colour if the latter option is selected.

The 'Lat/Long Grid Menu' option does not automatically cause the screen to redraw. This is done by selecting 'Display Location Map' after making any other desired changes to the menu settings.

'Select Depths'

Choosing the 'Select Depths' option allows the depth contours included in the base map to be specified. By default, the 200m, 300m, 400m, 500m, 600m, 700m, 800m, 900m, 1000m, 2000m, 3000m, 4000m and 5000m contours are included. However, contours at 100m intervals from 100m to 5500m plus the 50m contour are available and the user is free to choose as many or as few of these as desired.

The selection mechanism is simple. A window is presented containing all the available depths. Contours are selected or deselected by pointing to them with the mouse cursor and clicking the left mouse button. Selected contours are flagged by chevrons. An 'Invert' option is available. This selects all deselected contours and deselects all selected contours. Once the required contours have been specified, select 'Done' to return to the Location Map Menu.

The 'Select Depths' option does not automatically cause the screen to redraw. This is done by selecting 'Display Location Map' after making any other desired changes to the menu settings.

'Select Cruise'

Choosing the 'Select Cruise' causes a subsidiary menu to appear containing the mnemonics, start dates and end dates of all the cruises included in the data set. The required cruise is selected by highlighting it and pressing the left mouse button.

If the data for the cruise selected cannot be found, a windowed error message is displayed. This may be cleared by pressing the left mouse button, leaving the previous cruise definition in force. It is unlikely that this error will be encountered unless the wrong CD-ROM is in the drive.

The 'Select Cruise' option does not automatically cause the screen to redraw. The only visible change is the mnemonic displayed in the menu window. To redraw the screen, select 'Display Location Map' after making any other desired changes to the menu settings.

The 'Select Cruise' option only influences the appearance of the base map by changing the area covered. It does NOT restrict the data output to the cruise selected.

'Display Location Map'

The purpose of this option is to redraw the base map bringing into effect any changes made to the Location Map Menu options.

'Save Screen'

Choosing 'Save Screen' allows the screen image to be saved to disk in a user specified file. A subsidiary menu appears that allows the cursor to be hidden on the saved screen and offers three file formats: 'PCX', 'IMG' and unformatted, as well as HP PaintJet or LaserJet print images. The latter options are useful for printing from disk or other machines linked to these printers. The PaintJet option offers paper or transparency output (which use different ink densities) and portrait or landscape orientation.

'PCX' is a popular PC graphics format which may be imported into a range of software packages including the Paintbrush package supplied as part of Windows. Shareware packages such as Paintshop Pro and commercial packages such as Corel Draw can also import PCX files.

The ability to export into PCX provides a powerful tool for Windows users who wish to produce hard copy screen dumps. Whilst DBMERGE has a 'Print Screen' option, the devices supported are restricted to HP LaserJet and PaintJet printers. However, a PCX file loaded into Paintbrush may be printed on any device for which Windows printer drivers are available. In other words, virtually anything.

'IMG' is a standard format used by older PC artwork packages, sometimes referred to as a 'GEM File'. It is anticipated that most users will use PCX in preference to IMG.

The unformatted option produces a file containing a VGA bit plane dump: essentially the screen memory is dumped to disk. A simple utility, 'DISPLAY', is provided to allow these files to be displayed on the screen within seconds. Unformatted files are of fixed size (156482 bytes). PCX and IMG formats employ compression and, consequently, are more compact.

Once the format has been selected, the program prompts for the filename into which the image is to be written. This should be provided without a file extension. The program automatically appends .PCX, .IMG or .WDG as appropriate.

Saving the image to disk can take some time. Completion is signalled by the return of the menu to the screen. If the cursor is to be included, it may be moved to its required position, maybe pointing to an area of interest, and locked in place for the duration of the screen save by pressing a mouse button.

'Print Screen'

The 'Print Screen' option allows a hard copy of the screen to be obtained on either an HP PaintJet colour graphics printer or an HP LaserJet laser printer. Additional options on the menu allow control over whether the mouse cursor is hidden and specification of the printer port.

When a hard copy output has been requested, the program checks whether a device is connected to the specified port. It cannot, however, check that the device is of the required type. The result of an attempt to output to a device other than those specified (or a suitable emulation) is unpredictable but a system crash is likely.

'Map Utilities'

Choosing the 'Map Utilities' option brings up a menu offering the following options:

Set Cruise Track Options
Set Map Background Colour
Set Map Border Colour
Set Key Columns
Set Key Background Colour
Set Key Foreground Colour
Set Key Border Colour

The bulk of the options provided by this menu allow the colour of various components of the background map to be set as desired using a point and click mechanism against a colour chart. The exceptions are 'Set Cruise Track Options' and 'Set Key Columns'. The former allows the user to choose between the default two colour track plot showing day boundaries and a single colour track plot. In both cases, the colour(s) used are user selected. The latter gives user control over the shape of the map key: this may be tall and thin (1 column), short and wide (7 columns) or somewhere in between.

'Data Selection'

The two remaining options in the Location Map Menu specify the desired data subset. This may either be on the basis of time or space. In the former case, data from any desired day during the cruise may be chosen. In the latter case, data from within a rectangular box are selected.

'Select Date'

The 'Select Date' option is used to specify which day of data is to be output. The initial result depends upon the other Location Map Menu options in force. If, for any of a number of reasons, the track plot of the current cruise is not displayed an automatic redraw including the cruise track is enforced.

The cruise track may be displayed in segments of two alternating colours. The colours change at midnight each day. The letters 'S' and 'E' are plotted at the start and end of the first day of the cruise. Pressing the left mouse button moves these forwards one day: pressing the right mouse button moves them backwards one day. Moving backwards from the first day selects the last day and vice versa.

Through this mechanism it is possible to see where the ship was located during each day of the cruise. Once the required day is bounded by the 'S' and the 'E' it may be selected by pressing the 'Enter' key, pressing the middle mouse button (for those with a three button mouse and driver) or by pressing the left and right mouse buttons simultaneously.

Record selection is based on the TBEGNS field from EVENT. Generally, selecting data using a time span also restricts data to a single cruise. However, during 1990 two ships were operating simultaneously and consequently a subset based on time may include data from two cruises.

'Select Area'

The 'Select Area' option allows the data output to be restricted to those records located within a user defined box. A 'rubber banding' method is used to define the area of interest. The cursor is moved to one corner of the desired region and the left mouse button is pressed to anchor it. Further movements of the cursor cause an elastic sided box to be drawn with its diagonal between the cursor and the anchor point. Once this box covers the desired region, the left mouse button is pressed again to complete the selection. Should the anchor be dropped in the wrong place, it may be released by pressing the right mouse button.

Record selection is based on the LAT and LON fields from the EVENT file.

S4.6 **Define Order of Output**

The 'Define Order of Output' option provides some control over where fields are located in the output record. The program classifies data fields into four categories:

Primary Index Fields
Secondary Index Fields
Ancilliary Data Fields
Main Data Fields

Primary index fields are fields selected from EVENT. Secondary Index fields are fields selected from the secondary index file (BOTTLE, COREINDX, SAPINDX, STINDX or NETINDX). Ancilliary data fields are fields selected from the ancilliary header file included in four-way joins (e.g. C14HDR). The main data fields are those from the user-selected data file.

By default, the fields are output in the order listed above going from left to right along the record. This may be changed if desired by choosing 'Define Order of Output' and selecting, by pointing and clicking, the field classes in the desired order.

S4.7 **Execute File Merge**

Selecting the 'Execute File Merge' option informs the program that all user options have been set as desired and starts execution of the merge process. The program has been optimised by the inclusion of direct lookup indices. Despite this, the operation is still relatively slow because of the large amount of disk access required.

S4.8 **Select Output Format**

The 'Select Output Format' option allows the delimiters between items of text to be changed. By default, the text is blank delimited. This may be changed to comma delimited or 'Lotus 123 delimited text'. The latter option is NOT Lotus 123 internal format (WK1, WK2 etc.) but comma delimited text with alphanumeric fields enclosed by double quotes. Microsoft Excel users will know this as CSV format.

S4.9 **Select Output Device**

By default, the program output is as ASCII codes directed to a printer connected to port LPT1. This may be changed through the 'Select Output Device' option. The output device may be chosen to be either the screen, a printer or a disk file.

If the screen is selected, a menu appears which allows the text, background and border colours to be specified. Colours are chosen by pointing and clicking on the palette offered. It is also possible to specify the number of lines of header information. These are lines of text at the top of the screen which are not overwritten when the screen is refreshed allowing the header information to remain visible whilst all the data are listed. If the number of lines is set to the number of parameters selected + 1, the entire header is preserved.

If a printer is selected, the menu interface allows the printer port to be changed from the default (LPT1) and for the printer driver to be selected. Drivers for generic text (ASCII), PostScript, LaserJet, PaintJet and Epson FX80 are available.

If disk output is chosen, the user is able to specify the output filename. Otherwise the default, OUTPUT.DAT, is used.

S4.10 **General Utilities**

Choosing this option brings up the General Utilities Menu which allows user control over screen colours and program operation through the following options:

Change Screen Colour	
Change Menu Colours	
Save Configuration File	
Colour Palettes	
Menu Hierarchy	On
Disk Buffering	Off
Previous Menu	

The 'Change Screen Colour' option allows the background colour to be changed. A colour from the available palette is selected by pointing to it with the mouse cursor and clicking the left mouse button.

Selecting 'Change Menu Colours' allows the colour of the menu components listed below to be adjusted:

Highlighted Option
Available Option
Unavailable Option
Title
Background
Border
Previous Menu

Once again selecting a menu component brings up a colour palette from which the desired colour is chosen by pointing and clicking. Some options require colours to be specified for the foreground (the text) and the background.

The 'Save Configuration File' option allows changes made through the General Utility Menu to be saved to disk for use with subsequent program executions. The changes may either be saved to the default file (DEFAULT.CFG) or to a user specified filename. In general, the latter option would appear the safer course. The customised configuration file may then be invoked as a command line parameter on future program runs.

The 'Colour Palettes' option requires a little explanation. The program runs in VGA 16 colour mode. In other words, 16 colours may be displayed on the screen at any one time. However, these colours are selected from a palette of 65,536 different hues. This option allows the actual hues mapped to the 16 screen colours used (the palette) to be changed by the user. It is possible to load palettes from a disk file, to interactively modify the palette and to save a modified palette to a disk file. Filenames only should be specified as the program automatically appends a .PAL file extension.

The 'Menu Hierarchy' option toggles automatic transfer of control between menus on and off. If the option is switched on, simply moving the mouse pointer from the current menu to a higher level menu transfers control to the higher level menu. If it is switched off, transfer of control may only be achieved by selecting the 'Previous Menu' option.

The 'Disk Buffering' option toggles disk buffering on and off. If the option is turned off, the program runs faster but consumes more memory. The option should only be turned on if problems due to memory shortage are encountered.

S4.11 **Customising the program**

Customisation of the program is achieved by editing the configuration file. By default, the program uses the file DEFAULT.CFG but a custom file may be specified as a command line parameter. As the default is used by several of the programs supplied with the CD-ROM it is safer to use customised copies. However, if the default is to be customised it should be backed up before making any changes.

Only a subset of the records in the configuration file has an effect on this program. This subset is listed below and its function described. The text up to and including the first colon of each line is a comment. Everything following the first colon is regarded as a variable and is taken literally. Particular care must be taken when editing to avoid the insertion of additional embedded blanks: LIGHT CYAN is NOT the same as LIGHTCYAN.

Changes to the records listed below may be made to the configuration file using the 'General Utilities' option within the program, or by editing the configuration file:

```
Screen background      :WHITE
Menu background        :CYAN
     active options    :LIGHTCYAN
     inactive options  :LIGHTGRAY
     border            :WHITE
```

```
     title              :RED
     highlight text     :LIGHTRED
          Background    :BLACK
Menu Hierarchy          :TRUE
```

Most of the records above control the colours used for the user interface menus and the screen plots. The following colours are available:

Black	Blue	Green	Cyan
Red	Magenta	Brown	LightGray
DarkGray	LightBlue	LightGreen	LightCyan
LightRed	LightMagenta	Yellow	White

The remaining option is a control switch which may be set to TRUE or FALSE. Users unsure of the effect of this switch should refer to Section S4.10.

The remainder of the configuration file may only be changed using an editor or word processor. Windows users will find Notepad ideally suited to the job. These records specify where various files required by the software may be found and the default cruise.

The default cruise is specified by the record:

```
Default cruise          :CD46
```

Note that the cruise mnemonic must be in upper case.

The following tell the program where to look for its internal control files and the data.

```
Parameter filename      :C:\BOFS\PARA.DAT
BM Cruise filename      :C:\BOFS\BMCRUISE.DAT
Underway limits file    :C:\BOFS\BMLIMITS.DAT
BM file directory       :D:\UNDERWAY
Bathymetry directory    :D:\BATHY
Working directory       :C:\BOFS
Software directory      :C:\BOFS
Depth values file       :C:\BOFS\DEPCODES.DAT
Parameter description   :C:\BOFS\PARADESC.DAT
DBMerge linker file     :C:\BOFS\DBMERGE.BOF
```

The CD-ROM directory BATHY contains the contour information used to produce the base map. If users find base map drawing painfully slow, the contents of this directory should be transferred to hard disk and the 'Bathymetry Directory' entry above accordingly. The disk space used is relatively small (1-2 Mbytes) but, unless the CD-ROM drive is one of the latest SCSI devices, the increase in performance is dramatic.

The parameter descriptions present in the 'Select Parameters from' menus are taken from the file PARADESC.DAT. Should users wish to change these, an edited copy of the file may be produced and the 'Parameter Description' entry above changed to point to it. If the field mnemonics are required without parameter descriptions, simply delete the PARADESC.DAT file.

Section S5

Image Display Program

S5.1 Introduction

Two of the programs described in the preceding sections, UWPLOT and DBMERGE, have the ability to output screen images to disk files. One of the available formats is an unformatted screen dump which produces files with the .WDG extension. DISPLAY is a utility which allows the images in such files to be viewed.

S5.2 Getting Started

The DISPLAY program is invoked by typing:

display [/F]filename [/Ppalette_filename /Bborder_colour /Ttime /L]

The only mandatory parameter is 'filename' which is the name of the file to be displayed. If this is omitted, the program issues a help message. The /F option allows a file to be used which contains a list of acceptable command line options. This produces a smoother result when the program is used to generate a slideshow.

The palette filename is required in cases where the image saved has been generated using a modified palette. Normally, DISPLAY uses the default palette.

The border colour specifies the colour of the PC screen border. It can either be an integer number in the range 0-15, or the actual colour name, bearing in mind any palette name change will alter the actual hues. The colour mapping is as follows:

0	Black
1	Blue
2	Green
3	Cyan
4	Red
5	Magenta
6	Brown
7	LightGrey
8	DarkGrey
9	LightBlue
10	LightGreen
11	LightCyan
12	LightRed
13	LightMagenta
14	Yellow
15	White

The time parameter specifies the length of time in minutes for which the image is displayed. This may be interrupted at any time by pressing any key unless the /L (locked) parameter is specified.

S5.3 **Creating a Slideshow**

Using this program, it is possible to generate a 'slideshow' of images for presentation, demonstration or teaching purposes. This is extremely portable: the requisite batch file, DISPLAY.EXE and eight image files will fit comfortably on a single floppy disk. An example slideshow batch file is given below.

```
:loop
display image1.wdg /T1 /L
display image2.wdg /Predblue.pal /T1 /L
pause
goto loop
```

This displays two images before prompting for a keypress. If ^C (pressing ctrl and C keys together) is entered at this stage, the batch file terminates. Otherwise the image display sequence is repeated.

Alternatively, a driver file can be created. The driver file equivalent to the above batch file is:

```
image1.wdg /T1 /L
image2.wdg /Predblue.pal /T1 /L
```

If this file is called 'DRIVER' the batch file becomes:

```
:loop
display /Fdriver
pause
goto loop
```

The only difference between the two methods is that the latter produces a smoother change between images.

SECTION D : DATA

Section D1

Documentation and Metadata

D1.1 Introduction

Data are only of limited value unless the protocols used in their collection are known. This information, or meta-data, is included as a series of data documents on the CD-ROM. The subdirectory structure is designed to mimic the structures used for the data. Filenames have also been designed to be as similar as possible: identical filenames are not possible in all cases because sometimes a data document covers more than one data file.

The data documents are all held in the subdirectories of the directory DOCU.

Three copies of each document file are included on the CD-ROM. The first is a simple flat ASCII file. This has the advantage of being universally accessible but lacks the aesthetic appearance one associates with modern laser printed documents. The second copy is in PostScript format and may be printed on a PostScript printer with Times Roman font available. The third copy is in the internal format of the WordPerfect 5.1 word processor which should import, complete with layout, into most modern word processors. The versions of the document file are distinguished by their file extension. This is set to .TXT for flat ASCII files, to .PS for PostScript files and to .WP for WordPerfect 5.1 files.

Users of Windows will find that File Manager is a very powerful tool for browsing through the documentation. The files in each directory are clearly displayed. Moreover, double clicking on the icon for any .TXT file will launch Notepad with the file loaded, enabling the document to be read. Note that a small number of the documents are too large for Notepad and consequently may not be read in this manner.

Alternatively, users may establish a linkage in File Manager between the .WP extension and their favourite word processor. If this is done, double clicking a .WP file icon will launch the word processor with the appropriate document loaded.

D1.2 Subdirectory DOCU\DBKIT

This subdirectory contains the data documents covering the files which comprise the

'kit-form' database. The documents are stored in a structure which mimics that used for the actual data.

D1.2.1 **Subdirectory DOCU\DBKIT\SEASOAR**

The Seasoar data presented on the CD-ROM were collected during two cruises in 1990, Discovery 190 and Discovery 192. There is one document for each cruise and the files are named after the cruise mnemonic (e.g. DI190 for Discovery 190).

D1.2.2 **Subdirectory DOCU\DBKIT\CTD**

The CTD data set is documented on the basis of one document per cruise. The document name corresponds to the cruise mnemonic. For example, the docment files pertaining to Discovery 182 are DOCU\DBKIT\CTD\DI182.TXT (flat ASCII), DOCU\DBKIT\CTD\DI182.WP (Word Perfect 5.1 format) and DOCU\DBKIT\CTD\DI182.PS (PostScript format).

There are two additional documents describing data sets collected from other instruments which were deployed on the CTD frame. The first of these, O2PROF, describes the Endeco oxygen profiles obtained during Discovery 182 which are held in the file DBKIT\CTD\O2PROF. The second, MSP, describes the marine snow profiler data held in DBKIT\CTD\MSP.

D1.2.3 **Subdirectory DOCU\DBKIT\BOTNET**

This subdirectory contains the following documents which map simply to the data files stored under DBKIT\BOTNET. The names in brackets are the data files covered by the document file.

CN	(CN)	- Measurements of carbon and nitrogen
PPCOUNT	(PPCOUNT,PPSAMP)	- Phytoplankton species distributions
TSO	(TSO)	- Calibration samples (salinity, dissolved oxygen and reversing thermometer temperatures)
RADNUC	(RADNUC)	- Dissolved and particulate radionuclides
VOLSCT	(VOLSCT)	- Optical scattering measurements
CYANPE	(CYANPE)	- Cyanobacteria and phycoerythrin
PIGMENT	(PIGMENT)	- Chlorophyll and other pigments
LIPIDS	(LIPBOT)	- Lipid biomarkers
NUTRI	(NUTRI)	- Nutrients
SULPHUR	(SULPHUR)	- Sulphur species (DMS, DMSP)
AL	(AL)	- Dissolved aluminium
MESOZOO	(MESOMASS, MESOGRAZ, MESOGUT)	- Mesozooplankton biomass, grazing and gut content
MICROZOO	(MICGRAZ, MICMASS)	- Microzooplankton grazing and biomass

D1.2.4 **Subdirectory DOCU\DBKIT\PROD**

This subdirectory contains the following documents, describing the varied incubation

experiments undertaken during BOFS, which map simply to the data files stored under DBKIT\PROD. The names in brackets are the data files covered by the document file.

C14PROD	(C14HDR, C14DAT, PIDAT C14SURV, C14CALC)	- Primary Production by ^{14}C
THYPROD	(THYDAT, THYDIU)	- Bacterial production by ^{3}H-Thymidine and ^{3}H-Leucine. Bacteria cell counts.
O2PROD	(OXYHDR, OXYDAT)	- Oxygen, TCO_2 and pCO_2 production
N15PROD	(N15HDR, N15DAT)	- New and regenerated production by ^{15}N
NOXPROD	(NOXHDR, NOXDAT)	- High resolution NO_3 uptake experiments

D1.2.5 **Subdirectory DOCU\DBKIT\SAP**

This subdirectory contains the following documents, describing the data sets obtained using Challenger Oceanics stand-alone pumps (SAPs), which map simply to the data files stored under DBKIT\SAP. The names in brackets are the data files covered by the document file.

RADNUC	(RADSAP)	- Dissolved and particulate radionuclides
LIPIDS	(LIPSAP)	- Lipid biomarkers
PIGMENT	(PIGMENT1, PIGMENT2, PIGMENT3)	- Chlorophyll, carotenoid and particulate carbon data

D1.2.6 **Subdirectory DOCU\DBKIT\CORE**

This subdirectory contains the following documents, describing the BOFS benthic data set, which map simply to the data files stored under DBKIT\CORE. The names in brackets are the data files covered by the document file.

LIPSED	(LSBULK, LSANE, LSANOL, LSAA, LIPSED1, LIPSED2)	- Organic biomarkers
COXPROF	(COXPROF)	- Oxygen electrode profiles
CISO	(CISO, SFCISO)	- Radiocarbon dates and carbon isotope data
KASCORE	(KASCHEM, KASGEN, KASISO, KASSED, KBFHEAD, KBFDAT)	- Profile data sets obtained from Kasten cores
RADCORE	(PBISO, UTHISO)	- Radionuclide profiles
MCCN	(MCCN)	- Multicore bulk property and chemistry profiles

D1.2.7 **Subdirectory DOCU\DBKIT\SEDTRAP**

This subdirectory contains a single document, SEDTRAP, which describes the data sets obtained from the BOFS moored sediment traps. It covers all the data files in DBKIT\SEDTRAP, namely:

STCN	Carbon, nitrogen and opal content
STCNFX	Mass, carbon, nitrogen and opal fluxes
STRD	Radionuclide content

STRDFX Radionuclide fluxes
STSPFX Taxon fluxes

D1.2.8 Subdirectory DOCU\DBKIT\CURR

This subdirectory contains a single document, ARGOS, which describes the Argos Drifting Buoy data set held in DBKIT\CURR\ARGOS.

D1.2.9 Subdirectory DOCU\DBKIT\XBT

This subdirectory contains a single document, XBT, which describes the Expendable Bathythermograph data set held in DBKIT\XBT\XBT.

D1.3 Subdirectory DOCU\SATIMG

This subdirectory contains a single document, SATIMG, which describes the methodology used to obtain the satellite images contained in data directory SATIMG. A brief description of the images is included, together with references to papers in the literature which describe the oceanographic features they portray. The contents of this document (in flat ASCII format) is also included in the README.TXT file in the SATIMG directory.

D1.4 Subdirectory DOCU\UNDERWAY

The underway data set is documented on the basis of one document per cruise. The document name corresponds to the cruise mnemonic. For example, the document files pertaining to Discovery 182 are DOCU\UNDERWAY\DI182.TXT, DOCU\UNDERWAY\DI182.WP and DOCU\UNDERWAY\DI182.PS.

Section D2

The 'Kit-Form' Database

D2.1 Introduction

The 'kit-form' database is a series of flat ASCII files which contain a significant subset of the BOFS North Atlantic data set in a form suitable for loading into a relational database. The original database is held under the ORACLE RDBMS. Using the loader utility supplied by ORACLE (SQLLOAD) the database may be recreated from the files supplied in 1-2 working days. The data structures used should, however, be equally compatible with any other truly relational system. This includes PC-based systems, such as Microsoft Access and Borland Paradox.

Database programs are not the only software that can make use of the 'kit'. Individual tables may be loaded into spreadsheet programs. This approach has limited value for some tables because the primary key included conveys little meaning of the spatial and temporal coordinates for the data. However, this problem may be overcome by using the table merge utility (DBMERGE) which accompanies the CD-ROM. Some tables, such as the EVENT top level index, are ideally suited to exploration using spreadsheets.

The concept behind the 'kit' is simple. Each file corresponds to a relational database table, including the appropriate key fields. It is, of course, possible to produce a database structure which differs from that implied by the 'kit': e.g. a database including tables with fields derived from several files. This is done by creating temporary tables which map to the file structures supplied. The required columns may then be merged using the appropriate key fields.

Individual files from the 'kit' have been designed for ease of loading into a variety of systems and are biased towards the requirements of commercial software and away from the I/O requirements of programming languages. The files may be read by high level language programs, but some degree of parsing will be required. The structure is fixed, so each field occupies the same position in every record of a file. In addition, the fields are separated by commas and any text fields containing embedded commas are enclosed by double quotes (").

Fields containing null values are filled with blanks. The files have been carefully designed to ensure that the rightmost value in any record never contains a null value. Consequently, the problems associated with trailing null values, such as variable length records, have been circumvented.

Users of Microsoft Excel will recognise the structure described above as the 'Comma Separated Value' syntax available as an Excel 4 import/export option. Excel associates these files with the file extension .CSV and this convention has been followed for the files on the CD-ROM. The ORACLE data loader, SQLLOAD, describes these files as <fields separated by ',' optionally enclosed by '"">.

The 'kit-form' database files will be found on the CD-ROM under the directory DBKIT. Under this directory are the following subdirectories:

INDEX	-	contains files which hold the sample space and time coordinates together with metadata fields
SEASOAR	-	contains data collected using the SeaSoar towed undulating CTD
CTD	-	contains the CTD data together with data from additional instruments attached to the CTD frame
BOTNET	-	contains water bottle and zooplankton net data
PROD	-	contains data from productivity incubation experiments
SAP	-	contains data collected using stand-alone pumps
CORE	-	contains benthic data
CALIB	-	contains details of the CTD calibrations
SEDTRAP	-	contains data collected using moored sediment traps
CURR	-	contains drifting buoy data
XBT	-	contains expendable bathythermograph data

In general, files from the INDEX subdirectory will be needed in conjunction with files from the other subdirectories. For example, to fully describe a nutrient sample (from file DBKIT\BOTNET\NUTRI), the bottle depth from file DBKIT\INDEX\BOTTLE (note that the file extension .CSV is omitted from filenames in this document to aid readability) together with date, time, latitude and longitude from file DBKIT\INDEX\EVENT are required.

This may seem a little strange to those used to working with files rather than relational databases. Providing suitable key fields are provided, tables in relational databases may be easily joined together. The major design criterion is therefore to eliminate redundancy rather than to ensure complete information in every table/file.

It is appreciated that there will be some users who realise the potential of the 'kit-form' database files for purposes other than loading into a relational database. The relational structure of the 'kit' inevitably makes life difficult for such users. Consequently, a utility is supplied with the CD-ROM to allow header fields to be merged onto each record of a data file.

In ALL cases, dates and times quoted are GMT.

The 'kit-form' database is described below file by file. This is intended to document the data, not the methods by which the data were obtained. Protocol descriptions are to be found on the CD-ROM under the subdirectory \DOCU\DBKIT as shown by the cross-references included at file level.

D2.2 **Subdirectory INDEX**

The subdirectory contains a number of files which fall into two distinct groups. First there is file EVENT which is the top level index cataloguing the data collection events. This is supported by files ECOMM and GCODE.

The second group is the secondary indices (BOTTLE, CTDINDX, SAPINDX, NETINDX, SSINDX, COREINDX and STINDX) which fulfil one of two purposes. First, they may

implement 'one to many' relationships between data collection events and the data themselves. The classic example is file BOTTLE which manages the relationship resulting from the CTD rosette having twelve water bottles. Secondly, they provide fields which are specific to a particular data type. For example, the depth of a CTD cast is an item of information specific to CTD data and consequently it is held in the file CTDINDX. Some files, such as NETINDX, are required for both purposes.

D2.2.1 **Files EVENT, ECOMM and GCODE**

The EVENT file specifies the space/time coordinates for all data collection events. An event is defined as a deployment of equipment from which data will result. Thus, events include CTD casts, net hauls, corer deployments; but one must not forget less spectacular happenings such as the drawing of a sample from the non-toxic sea water supply.

Events are classified into two types: point events and traverse events. Point events are those events for which the ship holds station, such as a CTD cast. Traverse events are those events where the ship steams from point A to point B towing a piece of equipment, such as an RMT trawl.

The structure of the EVENT file is as follows:

OID	Originator's identifier for the event
TBEGNS	Event start date and time
TENDS	Event end date and time
GCODE	Code specifying the equipment used
LAT	Point event latitude expressed as degrees +ve North
LON	Point event longitude expressed as degrees +ve East
WDEPTH	Station bathymetric depth (m)
LATS	Traverse event start latitude expressed as degrees +ve North
LONS	Traverse event start longitude expressed as degrees +ve East
LATE	Traverse event end latitude expressed as degrees +ve North
LONE	Traverse event end longitude expressed as degrees +ve East
CRUISE	Cruise mnemonic
BEN	BODC event number (primary key)

The originator's identifier, wherever possible, is the label that was assigned to the event during the cruise. For example, for Discovery cruises, it is based on the 'Discovery number' such as 11869#1. In a few cases, usually non-toxic samples or XBT drops, no identifier was assigned during the cruise and suitable naming schemes have been devised by BODC.

Event start and end times have been specified to bracket the event. Thus, for a CTD cast, the time span is from the instrument leaving the deck until its return. Some events are regarded as instantaneous, for example non-toxic samples. In these cases, the end times are set null. Dates and times are presented in the format dd/mm/yyyy hh:mm.

The gear codes are mnemonics used to describe the data collection activity or the equipment used. The codes have been chosen to convey as much meaning as possible, but plain language descriptions of each code are provided in file GCODE.

The structure of file GCODE is:

DESCR	Plain language description
GCODE	Gear code

The position fields used depend upon the type of event. For point events, fields LAT and LON are used. These have been determined by averaging the automatically logged navigation from time TBEGNS to time TENDS. For traverse events, LATS and LONS specify the ship's position at time TBEGNS and LATE and LONE specify the position at time TENDS. Again, these positions were determined from the navigation data and not from log sheets or cruise reports. The position fields which are inappropriate for a particular type of event are set null.

The water depth, WDEPTH, has been obtained by averaging the data from the automatically logged bathymetry wherever possible. Frequently during BOFS, no bathymetry was logged and in these cases depths have been taken from log sheets or cruise reports. The depths have been corrected using Carter's Tables.

The cruise mnemonics, CRUISE, are of the form DI (Discovery) or CD (Charles Darwin) followed by the cruise number. The BODC event number, BEN, is an integer number assigned by algorithm to provide a unique identifier for each event and hence provide the file with a primary key.

File EVENT is supported by file ECOMM. This contains any plain language comments gleaned from log sheets or cruise reports pertaining to specific events. A field is also included to flag those events which were designated as JGOFS Level 1s.

The structure of file ECOMM is:

COMM	Plain language comment
L1	Flag set to '*' for JGOFS Level 1 designated events
BEN	BODC event number (primary key)

D2.2.2 **File BOTTLE**

The file BOTTLE provides the linkage for the one to many relationship between CTD or bottle station events and water bottle sample data. Records are also included for samples taken from the non-toxic supply, enabling them to be handled as if they were water bottle samples taken on the surface.

Consequently, it is structured with one record per water bottle fired and contains two key fields in addition to the bottle depth and descriptive fields. In cases where several bottles were fired at the same depth they are regarded for the purposes of the database as a single bottle firing and are consequently represented by one record in the file.

The structure of the file is:

BEN	BODC event number
BOTY	Bottle type mnemonic
F	Warning flag

DEPTH	Bottle depth (m)
IBTTLE	BODC bottle identifier (primary key)

The BODC event number, BEN, is the first of the two key fields. It is numeric but not unique, being shared between the records for all the bottles pertaining to a given event. It equates exactly with the field of the same name in the EVENT file and consequently may be used as a linkage between the two files.

The second key field, the bottle identifier IBTTLE, is a unique numeric reference to each water bottle and may therefore be used as the primary key.

The bottle type mnemonic, BOTY, is used to specify the different types of water bottle used and to identify those samples taken from the non-toxic supply. The following codes are used:

GF10	10 litre General Oceanics Go-Flo bottle
GF30	30 litre General Oceanics Go-Flo bottle
NI07	7 litre NIO bottle
NI10	10 litre Niskin bottle
TR25	25 litre transparent bottle
PUMP	Sample taken from the non-toxic supply

The flag field, F, is used to indicate bottle samples which had warnings associated with them in either log sheets or cruise reports. If no problem was reported, the field is set null. Otherwise, the following codes are used:

L	Bottle leaked contaminating sample with shallower water
M	Bottle misfire suspected and hence depth is unreliable
O	Bottle rosette fired in incorrect order (bottle 1 not fired first)

For bottles fired using the CTD rosette, the bottle depth is defined as the distance in metres from the surface of the water to the midpoint of the water bottle. It was derived from the calibrated CTD pressure channel and includes a geometrical correction for the physical separation of the water bottle from the CTD pressure sensor. Standard conversion from pressure to depth has been applied. The minimum value is constrained to 0.5m to suppress small negative values which occasionally result from pressure channel drift.

For bottles deployed using the kevlar hydrographic wire, the bottle depth has been taken from log sheets or cruise reports and is based on the length of wire out. The depth for non-toxic samples is the depth below the surface of the non-toxic inlet. A figure of 4m has been used for Discovery and 2m for Charles Darwin.

D2.2.3 **File COREINDX**

This file manages the relationship between coring events and the resulting cores. This is a one to one relationship except for multicorer samples which have a one to many relationship. The file structure is:

BEN	BODC event number
ORGREF	Originator's identifier for the core

F	Flag
ICORE	BODC core reference (primary key)

The BODC event number, BEN, is the first of the two key fields. It is numeric but not unique, being shared between the records for all the cores pertaining to a given event: i.e. the individual core tubes of a multicorer. It equates exactly with the field of the same name in the EVENT file and consequently may be used as a linkage between the two files.

The second key field, the core reference ICORE, is a unique numeric reference to each core sample and may therefore be used as the primary key.

An additional originator's reference is included for two reasons. First, on some cruises each multicorer tube has been given a separate name. Secondly, in a number of cases the core has been given a different name from its associated coring event. For example, Kasten core 5K is also known as 11882#5.

The flag is used to indicate coring failures. This is usually null, but may be set to 'S' indicating that only large stones were returned or to 'F' indicating that no core was obtained. This information has been included because it indicates sites where coring problems might be expected.

D2.2.4 **File CTDINDX**

This file contains additional information specific to CTD data. There is no one to many relationship in this case. However, the table does serve one additional purpose. Some CTD events in file EVENT have no downcasts stored in the database for reasons such as instrument failure. These events do not have an entry in CTDINDX and hence within a relational database joining EVENT and CTDINDX will restrict queries to CTD events with downcast data.

The structure of the file is:

DCSTART	Date and time of the start of the downcast
DCEND	Date and time of the end of the downcast
MAXP	Pressure recorded at the bottom of the downcast
EXTCO	Downwelling irradiance extinction coefficient
MLD	Mixed layer depth (m)
EZD	Depth of the euphotic zone (m)
BEN	BODC event number (primary key)

The downcast start and end times are the times of the first and last datacycle stored in the database and are given in the format dd/mm/yyyy hh:mm.

MAXP is the maximum pressure that was recorded during the downcast. The pressure correction given in the CTD calibration file, CTDCAL, has been applied. This field assumes importance for BOFS because a significant proportion of the CTD casts only sampled the biologically active surface waters.

The extinction coefficient, EXTCO, is the absolute slope of a plot of natural log of downwelling irradiance against pressure.

The mixed layer depth, MLD, was determined as the depth at which a gradient of 0.05°C per metre was sustained for at least 4 metres. Gradients encountered at depths shallower than 5m were ignored to eliminate diurnal thermoclines. A value of -1.0 is used to signify that no gradient satisfying the above criteria was found.

The euphotic zone depth, EZD, was determined as the depth at which the CTD downwelling irradiance sensor registered one per cent of the value measured contemporaneously by the underway sensor on the ship.

D2.2.5 **File NETINDX**

This file manages the one to many relationship between zooplankton net stations (the event) and individual net hauls which map to a single catch. In addition, it provides addional information about each individual net haul.

The structure of the file is:

BEN	BODC event number
MINDEP	Minimum depth of net haul (m)
MAXDEP	Maximum depth of net haul (m)
GCODE	Gear code
MESH	Net mesh size (microns)
INET	BODC net reference (primary key)

The BODC event number, BEN, is the first of the two key fields. It is numeric but not unique, being shared between the records for all the net hauls or trawls pertaining to a given event. It equates exactly with the field of the same name in the EVENT file and consequently may be used as a linkage between the two files.

The second key field, the bottle net reference INET, is a unique numeric reference to each net haul or individual net on a trawl rig. It may therefore be used as the primary key.

The depth fields, MINDEP and MAXDEP, are taken from logs and cruise reports and are based on the length of wire out.

The gear code, GCODE, specifies the type of net used. It is more specific than the gear code in file EVENT which is frequently set to the generic value 'ZNET'. The gear codes used in NETINDX are defined together with the codes used in file EVENT in file GCODE. Mesh sizes were obtained from log sheets.

D2.2.6 **File SAPINDX**

This file provides the one to many relationship between stand-alone pump (SAP) events and filter samples. Note that each SAP event usually comprised several SAPs at different depths, each of which sometimes carried more than one filter. Single filters were sometimes subsampled using punches. In terms of data structure, these are regarded as if they were separate filters. The file also provides information on the depth of the SAP, the volume pumped and the type of filter used.

The structure of the file is:

BEN	BODC event number
DEPTH	Depth of SAP below surface (m)
VOL	Volume of water filtered (litres)
FT	Filter type mnemonic
PSIZE	Pore size for Nuclepore filters (microns)
F	Flag
IFILT	BODC SAP filter reference (primary key)

The BODC event number, BEN, is the first of the two key fields. It is numeric but not unique, being shared between the records for all the SAPINDX entries pertaining to a given SAP event. It equates exactly with the field of the same name in the EVENT file and consequently may be used as a linkage between the two files.

The second key field, the filter reference IFILT, is a unique numeric reference to each SAP sample and may therefore be used as the primary key.

The SAP depth was taken from log sheets and cruise reports and was determined on the basis of wire out.

The volume filtered was taken from log sheets or cruise reports and was determined from the duration of pumping. If a filter has been subsampled, the volume pumped has been reduced accordingly. This is particularly important for the organic biomarker samples where only a small portion of the filter was analysed to give water volumes comparable with conventional water bottles.

The filter type mnemonics used are as follows:

GF	GF/F glass fibre filter
NP	Nuclepore polycarbonate membrane filter
NG	Nuclepore above GF/F filter sandwich
GN	GF/F above Nuclepore filter sandwich
XG	GF/F filter preceded by a 53 micron Nitex filter

The flag field is usually blank, but has been set to 'B' where filter rupture was reported.

D2.2.7 **File SSINDX**

This file provides additional information concerning SeaSoar data stored in the database as pseudo-CTD profiles. One record per profile is stored which is structured thus:

MINP	Minimum pressure stored in the profile (db)
MAXP	Maximum pressure stored in the profile (db)
BMPNTR	Binary merge file pointer
BEN	BODC event number (primary key)

The pressure range of the stored profile is given to allow identification of cases where the water column coverage was restricted. The depth to which the fish was flying may also be readily ascertained.

The binary merge file pointer is the index of the record in the underway file (i.e. the surface data files stored in directory UNDERWAY) which is contemporaneous with the SeaSoar pseudo-CTD. Application programs may use this field, together with the CRUISE field from the EVENT file, to forge linkages between the SeaSoar data set and the underway data set.

D2.2.8 **File STINDX**

This file provides the one to many relationship between a sediment trap mooring deployment and the individual samples collected by the Parflux traps.

The structure of the file is:

ISAMP	BODC sample reference (primary key)
SAMP	Originator's sample reference
SDATE	Date of start of sample collection
EDATE	Date of end of sample collection
DEPTH	Depth below water surface of sediment trap
BEN	BODC event number

The BODC event number, BEN, is the first of the two key fields. It is numeric but not unique, being shared between the records for all the STINDX entries pertaining to a given mooring deployment. It equates exactly with the field of the same name in the EVENT file and consequently may be used as a linkage between the two files.

The second key field, the sample reference ISAMP, is a unique numeric reference to each trap sample and may therefore be used as the primary key. The sediment trap community assigned each sample a character reference, maintained in field SAMP, composed of a Roman numeral mooring deployment reference, a trap identifier and a time series sequence number. For example, I/C/1 is the first sample from trap C for mooring deployment I.

The time limits for each sample were determined from the deployment and recovery dates and the trap programming. Allowance has been made for trap malfunctions (failure of the sample changer to operate). Dates are given in the form dd/mm/yyyy.

The trap depths were determined from the mooring configuration and an uncorrected bathymetric depth.

D2.3 **Subdirectory SEASOAR**

Associated data document files: ***DOCU\DBKIT\SEASOAR\DI190.TXT.***
DOCU\DBKIT\SEASOAR\DI192.TXT.

The files in this subdirectory contain the pseudo-CTD profiles derived from the Seasoar data. These profiles are derived from the gridded data files normally used for plot generation. However, these files have been used for another purpose which allows SeaSoar and CTD data to be seamlessly integrated. The data management technique involves splitting a gridded data file into individual columns. Each of these is associated with a position and a date/time and loaded into the database as if it were a CTD profile.

It is important for users to realise that there are differences between pseudo-CTDs and true CTDs as well as similarities. True CTDs show the properties of the water column at a specified point with a vertical resolution in the final data set of 2db. Pseudo-CTDs are interpolated averages which integrate information derived along a length of track: i.e. different depths are actually sampled at different positions. Vertical resolution has to be restricted to prevent the propagation of interpolation artifacts. In the case of the BOFS data, each pseudo-CTD represents 4km of track and the vertical resolution is 8db.

The profile data are stored as one file per cruise to keep file sizes down to reasonable limits. The files are named using the cruise mnemonics: e.g. DI190 for Discovery 190. Each data file contains the following fields:

PRESS	Pressure (db)
TEMP	Temperature (C)
SALIN	Salinity (PSU)
SIGMA	Density anomaly computed as sigma-theta (kg/m^3)
O2	Dissolved oxygen (µM)
O2SAT	Oxygen saturation (%)
CPHYL	Chlorophyll (mg/m^3)
BEN	BODC event number

The primary key is formed from two fields, BEN and PRESS, which satisfy the criterion of uniquely specifying any record in the file. BEN provides a linkage to the EVENT file which includes a record for each pseudo-CTD profile.

Pressure corresponds to the midpoint of the vertical averaging interval or bin. Thus, 6db indicates (assuming the 8db averaging stated above) a bin extending from 2db to 10db.

Salinity, potential temperature (not listed, but used to compute density anomaly) and density anomaly were computed using the algorithms in Fofonoff and Millard (1983). Dissolved oxygen values are quoted at in-situ temperature and salinity. Oxygen saturations were computed using the algoritm of Benson and Krause (1984). Further details of the data processing, calibrations applied and comments on data quality are presented in the data documentation files. Users of the data should read these first.

No flag channels are included in the data files. Data values are either acceptable or set null. Each profile has been topped and tailed such that datacycles with all channels except the primary key null are excluded from the data set. The file structure is a channel subset of that used for CTD data.

D2.4 **Subdirectory CTD**

This directory contains the complete project CTD data set. The data are presented in two ways: as individual casts and as CTD data contemporaneous with each water bottle fired.

In addition, there are two related data files which contain profiles obtained by additional instruments attached to the CTD frame. First, there are a series of profiles

obtained from an Endeco oxygen probe deployed during Discovery 182. Secondly, there are profiles of marine snow abundance obtained during Discovery 183 and Discovery 191.

D2.4.1 **CTD Profile Data**

Associated data document directory: ***DOCU\DBKIT\CTD.***

The CTD profile data are held as a series of files, each containing the data from a cruise. Each includes the full CTD downcasts binned at 1 (shallow casts <100db) or 2 decibar intervals. The files are named using the cruise mnemonic: e.g. DI182 contains the CTD data for cruise Discovery 182. An identical naming convention is used for the associated data documentation files.

The binned data were derived from the fully calibrated CTD downcasts. The binning program only considered data points which had been flagged as good during the CTD quality control. After binning, the data were scanned and any gaps of up to 3 bins were filled by linear interpolation. Gaps larger than this were left null.

Each file in this set has a common structure which is as follows:

PRESS	Pressure (db)
TEMP	Temperature (C)
SALIN	Salinity (PSU)
SIGMA	Density anomaly computed as sigma-theta (kg/m^3)
O2	Dissolved oxygen (µM)
O2SAT	Oxygen saturation (%)
CPHYL	Chlorophyll (mg/m^3)
ATTEN	Optical attenuance (per m)
DWIR	Downwelling irradiance ($\mu E/m^2/s$)
UWIR	Upwelling irradiance ($\mu E/m^2/s$)
BEN	BODC event number

The BODC event numbers correspond exactly to those held in file EVENT, giving access to the CTD header information. This field is identical for all records pertaining to the cast. Consequently, it must be combined with the PRESS field to form the primary key.

Pressure values represent the midpoint of the bin. Thus, a pressure of 3db specifies a bin extending from 2db to 4db.

Salinity, potential temperature (used to compute density anomaly) and density anomaly were computed using the algorithms presented in Fofonoff and Millard (1983). The dissolved oxygen concentrations are given as the value at in-situ temperature and salinity. Oxygen saturation was computed using the algorithm of Benson and Krause (1984).

No flag channels are included: data values are either acceptable or are set null.

D2.4.2 **File BOTCTD**

Associated data document files in ***DOCU\DBKIT\CTD.***

This file is intended to aid the interpretation of water bottle data by providing the CTD data for the depths at which the water bottles were fired. The data were derived by averaging the fully calibrated CTD downcast data over the depth interval sampled by the water bottle. Only values identified as good were included in the computations.

A quality control flag is included for each channel. This is used to both reflect the precision of the data point and how it was derived. In most cases, a number of data points were included in the average and a standard deviation determined. However, this was not always so, particularly when a channel had been heavily flagged. In such cases, the program made three attempts to assign a value using the algorithms outlined below. If these failed, the value was set to null.

First, if a single point was found in the required pressure range then that was taken. Secondly, the program scanned for 2db above and below the specified pressure range. If points were found each side then linear interpolation was used to obtain a value. Failing that, the value of any point within the expanded depth range was taken.

The quality control flags were assigned as follows:

G - Value is the mean of at least two values with the standard deviation within expected limits
Q - Value is the mean of at least two values with the standard deviation outside expected limits
O - Value is the only point within the specified depth range
I - Value is the result of a linear interpolation of data within 2db of the specified pressure range
C - Value is that of a single point within 2db of the specified pressure range

The standard deviation limits used were:

Temperature	-	<=0.005°C
Salinity	-	<=0.01 PSU
Chlorophyll	-	<=0.1 mg/m^3
Oxygen	-	<=0.5 µM
Attenuance	-	<=0.01 per m
Irradiance	-	<=1.0 µE/m^2/s
Sigma t	-	<=0.02 kg/m^3

The structure of the file is as follows:

TEMP	Temperature (C) 717
FTC	Temperature quality control flag
SALIN	Salinity (PSU) 716
FSC	Salinity quality control flag
SIGT	Density anomaly computed as sigma-theta (kg/m^3) 796

FST	Density anomaly quality control flag
O2	Dissolved oxygen (µM)
FO2	Dissolved oxygen quality control flag
CPHYL	Chlorophyll (mg/m^3)
FCL	Chlorophyll quality control flag
ATTEN	Optical attenuance (per m)
FAC	Optical attenuance quality control flag
DWIR	Downwelling PAR (µE/m^2/s)
FDW	Downwelling PAR quality control flag
UWIR	Upwelling PAR (µE/m^2/s)
FUW	Upwelling PAR quality control flag
IBTTLE	BODC bottle reference (primary key)

IBTTLE is the file primary key. It is identical to field IBTTLE in file BOTTLE, which can be linked to the EVENT file using the field BEN.

Salinity, potential temperature (used to compute density anomaly) and density anomaly were computed using the algorithms presented in Fofonoff and Millard (1983). The dissolved oxygen concentrations are given as the value at in-situ temperature and salinity. Oxygen saturation was computed using the algorithm of Benson and Krause (1984).

D2.4.3 **File O2PROF**

Associated data document: ***DOCU\DBKIT\CTD\O2PROF.TXT.***

This file contains dissolved oxygen profiles obtained during an experimental deployment of an Endeco pulsed oxygen electrode on the CTD frame during Discovery 182.

The structure of the file is:

BEN	BODC event number
PRESS	Pressure (db)
DOXY	Dissolved oxygen (µM)

The BODC event numbers correspond exactly to those held in file EVENT, giving access to the CTD header. This field is identical for all records pertaining to the cast. Consequently, it must be combined with the PRESS field to form the primary key. BEN may also be used to link the oxygen profiles to their associated CTD casts.

The data are given at full resolution: no binning has been done. The oxygen values are quoted at in-situ temperature and salinity.

D2.4.4 **File MSP**

Associated data document: ***DOCU\DBKIT\CTD\MSP.TXT.***

This file contains data collected by the marine snow profiler, a photographic system which provides quantitative information on marine snow abundance. In general, the instrument was deployed on the CTD frame. However, in one case the instrument

was deployed in time series mode on a sediment trap mooring. In data management terms, these are identical: both have time and pressure as independent variables and are linked to a single event. Consequently, the data are presented together within a single file. The moored series may be identified by the gear code of its record in EVENT, or by the fact that the pressure channel is constant.

The structure of file MSP is:

FRAME	Exposure number
DATIM	Date and time of exposure
PRESS	Pressure (db)
ABUND	Particle abundance (per litre)
TPV	Total particulate volume (ppm)
NS1	Abundance of particles of equivalent spherical diameter (esd) 0.6-0.98mm (per litre)
NS2	Abundance of particles of esd 0.98-1.56mm (per litre)
NS3	Abundance of particles of esd 1.56-2.48mm (per litre)
NS4	Abundance of particles of esd 2.48-3.94mm (per litre)
NS5	Abundance of particles of esd 3.94-6.25mm (per litre)
NS6	Abundance of particles of esd 6.25-9.93mm (per litre)
NS7	Abundance of particles of esd >9.93mm (per litre)
VS1	Volume of particles of esd 0.60-0.98mm (ppm)
VS2	Volume of particles of esd 0.98-1.56mm (ppm)
VS3	Volume of particles of esd 1.56-2.48mm (ppm)
VS4	Volume of particles of esd 2.48-3.94mm (ppm)
VS5	Volume of particles of esd 3.94-6.25mm (ppm)
VS6	Volume of particles of esd 6.25-9.93mm (ppm)
VS7	Volume of particles of esd >9.93mm (ppm)
BEN	BODC event number

The BODC event numbers correspond exactly to those held in file EVENT, giving access to the header information, the contemporaneous CTD data or (in the case of the moored deployment) sediment trap data. This field is identical for all records pertaining to the profile or time series. Consequently, it must be combined with the FRAME field to form the primary key. Note that PRESS cannot be used because pressure values cannot be guaranteed to be unique within a series.

Dates and times are given in the format dd/mm/yyyy hh:mm:ss

The data are presented sorted into time order for a given series. Most of the profiles include data from both the down and up casts. Details of the methodology, including the definition of 'effective spherical diameter', are presented in the accompanying data document.

D2.5 **Subdirectory BOTNET**

The files in this subdirectory are concerned with water bottle data and quantitative data obtained from zooplankton net catches. The bottle data files have been set up with the parameters clustered into related groups. This produces files, and subsequently tables, which are easy to manage. It is appreciated that the clustering

adopted will not suit all users. However, the files concerned include a common primary key field, IBTTLE, and hence the fields from the files may be merged in any desired combination within a relational database system.

D2.5.1 **Files MESOMASS, MESOGUT and MESOGRAZ**

Associated data document: ***DOCU\DBKIT\BOTNET\MESOZOO.TXT.***

These files contain the mesozooplankton biomass and grazing data. Size fractionated biomass data are presented in file MESOMASS. Experimentally determined grazing rates are presented in file MESOGRAZ. File MESOGUT includes some gut pigment analyses, but its main function is to provide a linkage for the one to many relationship which resulted from animals in grazing experiments being taken from more than one net haul.

The structure of file MESOMASS is:

C200	Carbon content of the 200-500µm size fraction (mg C/m^3)
C500	Carbon content of the 500-1000µm size fraction (mg C/m^3)
C1000	Carbon content of the 1000-2000µm size fraction (mg C/m^3)
CTOT	Carbon content of the 200-2000µm size fraction (mg C/m^3)
N200	Nitrogen content of the 200-500µm size fraction (mg N/m^3)
N500	Nitrogen content of the 500-1000µm size fraction (mg N/m^3)
N1000	Nitrogen content of the 1000-2000µm size fraction (mg N/m^3)
NTOT	Nitrogen content of the 200-2000µm size fraction (mg N/m^3)
DW200	Dry weight of the 200-500µm size fraction (mg/m^3)
DW500	Dry weight of the 500-1000µm size fraction (mg/m^3)
DW1000	Dry weight of the 1000-2000µm size fraction (mg/m^3)
DWTOT	Dry weight of the 200-2000µm size fraction (mg/m^3)
INET	BODC net reference (primary key)

The primary key is provided by the field INET. This may be linked through the BEN field in file NETINDX to the entry for the zooplankton net station in file EVENT.

The 'total' (200-2000µm) fields are generally produced by summation of the individual size fractions. However, in a few cases the samples were not size fractionated and the 'total' field presents the results of determinations on the entire catch screened through a 2000µm mesh.

The structure of the file MESOGRAZ is as follows:

I200	Ingestion by the 200-500µm size fraction (ng pigment/copepod/day)
I500	Ingestion by the 500-1000µm size fraction (ng pigment/copepod/day)
I1000	Ingestion by the 1000-2000µm size fraction (ng pigment/copepod/day)
ITOT	Ingestion by the 200-2000µm size fraction (ng pigment/copepod/day)
C200	Consumption by the 200-500µm size fraction (µg chlorophyll/m^3/day)
C500	Consumption by the 500-1000µm size fraction (µg chlorophyll/m^3/day)
C1000	Consumption by the 1000-2000µm size fraction (µg chlorophyll/m^3/day)

CTOT	Consumption by the 200-2000µm size fraction (µg chlorophyll/m^3/day)
INTI200	Integrated ingestion by the 200-500µm size fraction (mg C/m^2/day)
INTI500	Integrated ingestion by the 500-1000µm size fraction (mg C/m^2/day)
INTI1000	Integrated ingestion by the 1000-2000µm size fraction (mg C/m^2/day)
INTITOT	Integrated ingestion by the 200-2000µm size fraction (mg C/m^2/day)
IDAY	Grazing experiment label (primary key)

The grazing experiment label is an integer primary key derived from the date of the grazing experiment. It has six digits which represent yymmdd.

The (200-2000µm) total ingestion and consumption fields are the summation of the individual size fractions.

The structure of file MESOGUT is:

INET	BODC net reference
G200	Gut content of the 200-500µm size fraction (ng pigment per copepod)
G500	Gut content of the 500-1000µm size fraction (ng pigment per copepod)
G1000	Gut content of the 1000-2000µm size fraction (ng pigment per copepod)
IDAY	Grazing experiment label

This file, when joined through a one to one relationship to NETINDX, provides the linkage which converts the many to many relationship between EVENT and MESOGRAZ into two one to many relationships. Consequently, the primary key is formed from two index fields, INET and IDAY.

Many users will find that, as the primary key in MESOGRAZ may be decoded to give the date of the experiment, they are able to obtain the information they need from this table alone. Approximate positional data may be obtained by simply scanning the records in EVENT for that day. The complex linkages through MESOGUT and NETINDX to EVENT need only be pursued if specific information is required on the times and positions of the net hauls which caught the animals used in the grazing experiments.

D2.5.2 **Files MICMASS and MICGRAZ**

Associated data document: ***DOCU\DBKIT\BOTNET\MICROZOO.TXT.***

These files present the microzooplankton biomass and grazing data.

The structure of file MICMASS is:

TOTMASS	Microzooplankton biomass (µg C/litre)
UCOUNT	Microzooplankton cell count (cells/litre)
IBTTLE	BODC bottle reference (primary key)

IBTTLE is the file primary key. It is identical to field IBTTLE in file BOTTLE (includes bottle depths) and may be used to link the data from MICMASS with the header information held in EVENT.

The structure of file MICGRAZ is:

DAY	Date of the grazing experiment
GRAZ	Microzooplankton grazing rate (µg chlorophyll/litre/day)
IBTTLE	BODC bottle reference (primary key)

The date in DAY, given in the format dd/mm/yyyy, gives the date the dilution experiment was carried out and hence provides the basis for simple time series. The bottle reference, IBTTLE, provides a link to file BOTTLE where the depth from which the water sample was taken is stored. Further header information may be obtained through the linkage of BOTTLE to file EVENT via field BEN.

D2.5.3 **Files PPCOUNT and PPSAMP**

Associated data document: ***DOCU\DBKIT\BOTNET\PPCOUNT.TXT.***

These files contain the phytoplankton species distributions determined by counting preserved samples from water bottles. PPSAMP contains information concerning the count, such as when it was done. PPCOUNT contains the individual counts for each species.

The structure of the files is:

PPSAMP

CDATE	Date sample was counted
CVOL	Sample volume (ml)
ISB	Sample bottle number
IBTTLE	BODC bottle reference (primary key)

The date the sample was counted, in the format dd/mm/yyyy, is included to allow sample storage times to be ascertained. The sample bottle number, ISB, is included because it has been quoted in cruise reports. However, the main link to header information is through the primary key, IBTTLE: depths of sampling may be obtained from file BOTTLE and time and position from file EVENT. Files EVENT and BOTTLE are linked through field BEN.

PPCOUNT

IBTTLE	BODC bottle reference
CODE	PML species code
SPECIES	Species name
COUNT	Cell count for species (cells/ml)

As for PPSAMP above, the field IBTTLE may be used to link individual species counts to the header information in files BOTTLE and EVENT. This linkage may be forged through PPSAMP, but this is not mandatory. However, unlike PPSAMP, IBTTLE is not the primary key: it is replicated for every species present in a sample. The primary key for file PPCOUNT must be generated from two fields, IBTTLE and CODE.

Phytoplankton species codes have been the subject of much debate between data managers. The code used here is the one adopted by the data originator, Derek

Harbour at the Plymouth Marine Laboratory. It is composed of 6 digits. The three most significant digits are the genus code and the other three digits are the species number within genus. For example, species 213008 is Ceratium furca and 213009 is Ceratium fusus. Thus the code may be used to reduce the resolution of the data from the species level to the genus level if required.

D2.5.4 **File TSO**

Associated data document: ***DOCU\DBKIT\BOTNET\TSO.TXT.***

This file contains some of the water bottle parameters used to calibrate the CTD sensors, though of course they form a data set in their own right, particularly the dissolved oxygen data. The major omission from this file is the extracted chlorophyll data set used to calibrate the CTD fluorometer. This is included in file PIGMENT.

With the exception of temperature the data are the result of quantitative analyses on water samples. The temperatures are the mean of two or three digital reversing thermometer readings. Suspect readings were rejected from the data set and consequently there are no quality control flag channels.

The structure of the file is as follows:

TEMP	Reversing thermometer temperature (C)
SALIN	Salinity determined by salinometer (PSU)
O2	Winkler dissolved oxygen (µM at in-situ temperature)
IBTTLE	BODC bottle reference (primary key)

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

The dissolved oxygen data are presented in units of µM at in-situ temperature. This is the unit required for CTD calibration and the unit of the CTD data channel. However, it is appreciated that users might wish to work in units of µmol/kg to eliminate the influence of temperature. The conversion may be achieved using the density anomaly, SIGT, present in file BOTCTD.

D2.5.5 **File CYANPE**

Associated data document: ***DOCU\DBKIT\BOTNET\CYANPE.TXT.***

This file contains data on cyanobacteria numbers and the pigment phycoerythrin collected from CTD water bottles and surface samples during Discovery 182. Quality control was achieved by means of sample rejection and hence there are no quality control flags.

The structure of the file is as follows:

CYANO	Number of cyanobacteria cells (10^6 cells/litre)
PE	Phycoerythrin concentration (ng/l)
IBTTLE	BODC bottle reference (primary key)

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

D2.5.6 **File CN**

Associated data document: ***DOCU\DBKIT\BOTNET\CN.TXT.***

This file contains the measurements made during BOFS on the carbon and nitrogen systems. The data are mainly from CTD rosette samples, but there are also a number of measurements made on pumped surface samples. A small amount of additional data from stand-alone pumps is held in directory DBKIT\SAP.

Quality control was through exclusion from the database and consequently there are no flag fields. The flag field present is an indicator to show which TCO_2 samples were filtered prior to analysis.

The structure of the file is as follows:

PTCO2	TCO_2 determined potentiometrically (µmol/kg)
TCO2	TCO_2 determined coulometrically (µmol/kg)
FT	Coulometric TCO_2 filtration flag
PCO2	pCO_2 (µatm)
PCO2T	Temperature at which pCO_2 was determined
PALK	Alkalinity determined potentiometrically (µEq/kg)
SALK	Alkalinity determined spectrophotometrically (µEq/kg)
PH	pH (pH units)
PHT	Temperature at which pH was determined (C)
DOC	Dissolved organic carbon (µmol C/l)
POC	Particulate organic carbon (mg C/m^3)
TPC	Total particulate carbon (mg C/m^3)
CA	Calcite (mg Ca/m^3)
PON	Particulate organic nitrogen (mg N/m^3)
TPN	Total particulate nitrogen (mg N/m^3)
IBTTLE	BODC bottle reference

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

The TCO_2 filtration flag is normally null unless the samples were filtered through a 0.45µm Nuclepore filter prior to analysis in which case it is set to 'F'.

D2.5.7 **File AL**

Associated data document: ***DOCU\DBKIT\BOTNET\AL.TXT.***

This file contains a set of dissolved aluminium measurements made on unfiltered water taken from CTD rosette bottles and the non-toxic supply during Discovery 184. Quality control was by data value exclusion and hence there is no flag channel.

The structure of the file is:

AL	Aluminium concentration (nM) 8156
IBTTLE	BODC bottle reference

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

D2.5.8 **File PIGMENT**

Associated data document: ***DOCU\DBKIT\BOTNET\PIGMENT.TXT.***

This file contains the results of pigment analyses using a number of techniques on water samples from bottles and the non-toxic supply. Size fractionated chlorophyll measurements made during primary production experiments are included with the primary production data. Pigment measurements on stand-alone pump samples are also stored separately in directory DBKIT\SAP. Quality control was by deletion from the data set and consequently there are no associated quality control flags.

The structure of the file is as follows:

CHLFL	Fluorometric chlorophyll (mg/m^3) 2136
PHFL	Fluorometric phaeopigment (mg/m^3) 4677
CHLSP	Spectrophotometric chlorophyll (mg/m^3) 2136
PHSP	Spectrophotometric phaeopigment (mg/m^3) 4677
CHLHPLC	HPLC chlorophyll a (µg/l) 2136
CHLC3	Chlorophyll c3 (ng/l) 4652
CHLC1C2	Chlorophyll c1c2 (ng/l) 2140
CHLB	Chlorophyll b (ng/l) 4649
PERID	Peridinin (ng/l) 4660
BUTAN	Butanoyloxyfucoxanthin (ng/l) 4645
FUCOX	Fucoxanthin (ng/l) 4657
HEXOXY	Hexanoyloxyfucoxanthin (ng/l) 4658
DIADIN	Diadinoxanthin (ng/l) 4654
LUTEIN	Lutein (ng/l) 4659
BCAROT	Beta-carotene (ng/l) 4644
CHLIDEA	Chlorophyllide a (ng/l) 4653
PHORBA	Phaeophorbide a (ng/l) 4661
PHORBL	Phaeophorbide like (ng/l) 30000
PHPHYTA	Phaeophytin a (ng/l) 4667
PHPHYTL	Phaeophytin like (ng/l) 4671
IBTTLE	BODC bottle reference

→ µg/l
% 1000

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

Any pigment for which no explicit method is given in the field description was determined by HPLC. HPLC chlorophyll a is given units of µg/l (which is exactly the same as mg/m^3) to ease comparison with the other methods.

D2.5.9 **File RADNUC**

Associated data document: ***DOCU\DBKIT\BOTNET\RADNUC.TXT.***

This file contains dissolved and particulate radionuclide data determined on CTD water bottle samples. There are additional data from stand-alone pumps in directory DBKIT\SAP and from sediment trap samples in \DBKIT\SEDTRAP. Suspect values were deleted from the data set by the data originator. Consequently, there are no quality control flag fields.

The format of the file is:

DPO	Dissolved ^{210}Po (dpm/100l)
DPOERR	Dissolved ^{210}Po standard error (dpm/100l)
DPB	Dissolved ^{210}Pb (dpm/100l)
DPBERR	Dissolved ^{210}Pb standard error (dpm/100l)
PPO	Particulate ^{210}Po (dpm/100l)
PPOERR	Particulate ^{210}Po standard error (dpm/100l)
PPB	Particulate ^{210}Pb (dpm/100l)
PPBERR	Particulate ^{210}Pb standard error (dpm/100l)
IBTTLE	BODC bottle reference

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

D2.5.10 **File NUTRI**

Associated data document: ***DOCU\DBKIT\BOTNET\NUTRI.TXT.***

This file contains the results of nutrient analysis on discrete samples from CTD water bottles. In most cases it is the mean of replicate samples. A value of zero for any nutrient species signifies that it is below detection limit.

Nutrient data quality control occurred in two stages. First, erroneous data were deleted from the data set prior to submission to BODC. Additional data were recognised as suspect by BODC or by users of the database.

BODC established practice is to flag data, not delete them. Consequently, a flag channel is included for each nutrient species. This is set null for acceptable data and '?' for suspect values. In addition, data values were sometimes reported as >x indicating that the precise value is not known but that it exceeds the specified value. These are signified by the symbol '>' in the flag channel.

The structure of the file is:

NO3	Dissolved nitrate plus nitrite (µM)
FN3	Nitrate plus nitrite flag
NO2	Dissolved nitrite (µM)
FN2	Nitrite flag
PO4	Dissolved phosphate (µM)

FP4	Phosphate flag
SI	Dissolved silicate (µM)
FSI	Silicate flag
NH4	Dissolved ammonia (µM)
FN4	Ammonia flag
IBTTLE	BODC bottle reference

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

Note that nitrate is quoted as nitrate plus nitrite. In general, this is how the data were reported to BODC. Where this was not the case, the nitrate and nitrite channels were summed prior to loading onto the database.

D2.5.11 **File SULPHUR**

Associated data document: ***DOCU\DBKIT\BOTNET\SULPHUR.TXT.***

This file contains measurements of the sulphur species dimethyl sulphide (DMS) in the dissolved phase and dimethylsulphoniopropionate (DMSP) in the dissolved and particulate phases.

Any suspect values identified by the data originator were deleted from the data set. Consequently, there are no explicit quality control flags.

The structure of the file is:

DMS	Dissolved DMS (nM)
DMSPT	Total (dissolved+particulate) DMSP (nM)
DMSPD	Dissolved DMSP (nM)
DMSPP	Particulate DMSP (nM)
IBTTLE	BODC bottle reference

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

Total DMSP has been included in addition to the dissolved and particulate values because in some cases this is the only parameter which has been determined.

Note that DMSP data from samples for which there is no DMS datum will be uncorrected for DMS and hence will be overestimates.

D2.5.12 **File LIPBOT**

Associated data document: ***DOCU\DBKIT\BOTNET\LIPIDS.TXT.***

This file contains organic biomarker data determined from CTD water samples. Additional biomarker data from stand-alone pumps is held in directory DBKIT\SAP and associated benthic data are held in DBKIT\CORE.

The structure of the file is:

ME37_3	Heptatriaconta-8E,15E,22E-trien-2-one (%)
FAME36_3	Methyl hexatriaconta-7E,14E,21E-trienoate (%)
ME37_2	Heptatriaconta-15E,22E-dien-2-one (%)
FAME36_2	Methyl hexatriaconta-14E,21E-dienoate (%)
ET38_3	Octatriaconta-9E,16E,23E-trien-3-one (%)
ME38_3	Octatriaconta-9E,16E,23E-trien-2-one (%)
ET38_2	Octatriaconta-16E,23E-dien-3-one (%)
ME38_2	Octatriaconta-16E,23E-dien-2-one (%)
CONC	Total alkenone and alkenoate concentration (ng/l)
UK37	Ratio of ME37_2/(ME37_3+ME37_2)
UK38ME	Ratio of ME38_2/(ME38_3+ME38_2)
AA36	Ratio of ET38_3/(ET38_3+FAME36_3+FAME36_2)
SDTOTAL	Standard error for total concentration (ng/l)
SDUK37	Standard error for UK37 ratio
SDUK38ME	Standard error for UK38ME ratio
SDAA36	Standard error for AA36 ratio
IBTTLE	BODC bottle reference

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

The individual alkenones and alkenoates are expressed as a percentage of the total alkenone and alkenoate concentration. This maintains the structure of the data as supplied.

D2.5.13 **File VOLSCT**

Associated data document: ***DOCU\DBKIT\BOTNET\VOLSCT.TXT.***

This file contains optical scattering determinations on water samples collected from the CTD rosette and non-toxic supply during the coccolithophore cruise Charles Darwin 60. Suspect values were deleted from the data set prior to submission and consequently there are no quality control flag channels.

The structure of the file is:

BB45	Blue light volume scatter 45° incidence
BB90	Blue light volume scatter 90° incidence
BB135	Blue light volume scatter 135° incidence
GB45	Green light volume scatter 45° incidence
GB90	Green light volume scatter 90° incidence
GB135	Green light volume scatter 135° incidence
GBB	Total green backscatter
BBB	Total blue backscatter
GBBP	Green backscatter attributed to calcite
BBBP	Blue backscatter attributed to calcite
IBTTLE	BODC bottle reference

The BODC bottle reference may be used to link the data in this file to the sample depths held in file BOTTLE and to the primary header parameters in file EVENT. BOTTLE and EVENT are linked through field BEN.

D2.6 **Subdirectory PROD**

During BOFS, a wide range of incubation experiments was carried out which included: on deck and in-situ ^{14}C primary production, ^{15}N new and regenerated production determinations, artificial light (P:I) experiments, nutrient uptake, oxygen and carbon dioxide production and tritiated thymidine and leucine uptake.

The result is a comprehensive data set which quantifies the activities of the flora and fauna from many different perspectives. This data set is presented in the files of subdirectory PROD.

D2.6.1 **File C14HDR**

Associated data document: ***DOCU\DBKIT\PROD\C14PROD.TXT.***

This file contains one record for each ^{14}C production experiment and provides metadata pertaining to each incubation. The file also provides storage for any integrated production values supplied with the data.

The structure of the file is:

EXPREF	BODC incubation experiment reference (primary key)
TY	Incubation type
BEN	BODC event number for incubation
SDATE	Incubation start date and time
COMM	Plain language comment
INCDUR	Incubation duration (hours)
DEPINT	Depth to which integrated values were determined (m)
INTMIC	Integrated production of the >5µm fraction (mg C/m^2/day)
INTNAN	Integrated production of the 1-5µm fraction (mg C/m^2/day)
INTPIC	Integrated production of the 0.2-1µm fraction (mg C/m^2/day)
INTOT	Integrated production of the >0.2µm fraction (mg C/m^2/day)
BENCOL	BODC event number of the water collection event

The incubation experiment reference is an alphanumeric identifier generated by BODC. Its primary purpose is to provide a link between C14HDR and the data files to which it is related through one to many relationships.

The incubation type, TY, is set to 'OD' for on deck incubations and 'IS' for in-situ incubations.

The incubation event number, BEN, provides a link to records in EVENT which record the deployment and recovery times of in-situ rigs. It is important to note that it is quite possible to extend the incubation beyond the recovery time of a rig recovered in darkness by simply storing the bottles in the dark.

The date and time that the incubation commenced, taken from log sheets or cruise reports, are given in the format dd/mm/yyyy hh:mm.

Integrated production values are only stored where they accompanied the data from discrete depths submitted to BODC. The units are quoted as (mg C/m^2/day). It is important to realise that 'day' means 'duration of incubation experiment'. In the case of the BOFS ^{14}C data this is not critical as, with the exception of one 18 hour experiment, the durations are all 24 hours.

BENCOL provides a link to the entry in file EVENT which describes the sourcing of the water for the production experiment. Normally, this is a pre-dawn Go-Flo station collecting water from several depths. On Charles Darwin 46, each individual Go-Flo fired was assigned a separate identifier and consequently had to be treated as a separate event. In this case, the relationship between C14HDR and EVENT is one to many, not the one to one relationship required by the data structure. Rather than complicate matters by introducing a linker table, the one to many relationship was simplified by setting BENCOL to the BEN of the first 35m bottle taken during the pre-dawn Go-Flo station.

D2.6.2 **File C14DAT**

Associated data document: ***DOCU\DBKIT\PROD\C14PROD.TXT.***

This file contains the ^{14}C uptake data for both on deck and in-situ incubations, together with associated size fractionated chlorophyll measurements. For a few incubations, no size fractionated data are available. Records are also included where no production data were obtained due to experimental problems but which have size fractionated chlorophylls.

The structure of the file is:

EXPREF	BODC incubation experiment reference
DEPTH	Depth of incubation (m)
LIGHT	Light level for incubation (% of ambient irradiance)
PPMIC	^{14}C uptake by the >5µm size fraction (mg C/m^2/day)
PPNAN	^{14}C uptake by the 1-5µm size fraction (mg C/m^2/day)
PPPIC	^{14}C uptake by the 0.2-1µm size fraction (mg C/m^2/day)
PPTOT	^{14}C uptake by the >0.2µm size fraction (mg C/m^2/day)
CLMIC	Chlorophyll content in the >5µm size fraction (mg/m^3)
CLNAN	Chlorophyll content in the 1-5µm size fraction (mg/m^3)
CLPIC	Chlorophyll content in the 0.2-1µm size fraction (mg/m^3)
IBTTLE	BODC bottle reference for water sample

The primary key for this file must be specified from three fields, EXPREF, DEPTH and LIGHT. Use of EXPREF and either one of the other two fields is insufficient due to duplicate record specifications caused by null values.

The light level of incubation is expressed as the actual depth of incubation for in-situ experiments. In the case of on deck incubations, it is either expressed as the percentage of ambient light passing through the filter screen or as the depth where such a light level would be encountered (sometimes as both).

The units of ^{14}C uptake are expressed in terms of 'per day'. In this case 'day' means 'duration of incubation'. It can be seen from file C14HDR that this does not pose a problem for the BOFS data because all incubations except one were of 24 hours duration.

The >0.2µm size fraction, or total, is generally the sum of the data from the three size classes. If these are null, but a total value is given, then the data result from an experiment which was not size fractionated.

The field IBTTLE specifies the water sample incubated. The depth from which the sample was taken may be obtained from file BOTTLE and where and when it was collected from file EVENT (linked to BOTTLE through field BEN). In general, IBTTLE is unique indicating that different water was used for each incubation depth. There are a few duplicates which either result from the same water being incubated at different light intensities or, more commonly, from parallel incubations of different types being done on the same water.

D2.6.3 **File C14CALC**

Associated data document: ***DOCU\DBKIT\PROD\C14PROD.TXT.***

For a number of incubations undertaken on the coccolithophore cruise, Charles Darwin 60, the acidified/non-acidified method was used to discriminate between ^{14}C uptake by photosynthesis and ^{14}C uptake by calcification. The non-acidified results are included in file C14DAT. The acidified results and calcification determined by difference are presented in this file.

The structure of the file is:

EXPREF	BODC experiment reference
DEPTH	Depth of incubation (m)
MICACID	^{14}C uptake attributed to photosynthesis in the >5µm size fraction (mg C/m^3/day)
NANACID	^{14}C uptake attributed to photosynthesis in the 1-5µm size fraction (mg C/m^3/day)
PICACID	^{14}C uptake attributed to photosynthesis in the 0.2-1µm size fraction (mg C/m^3/day)
CALMIC	^{14}C uptake attributed to calcification in the >5µm size fraction (mg C/m^3/day)
CALNAN	^{14}C uptake attributed to calcification in the 1-5µm size fraction (mg C/m^3/day)
CALPIC	^{14}C uptake attributed to calcification in the 0.2-1µm size fraction (mg C/m^3/day)
IBTTLE	BODC bottle reference

The primary key may be formed from fields EXPREF and DEPTH. All incubations for the data set in file C14CALC were of 24 hours duration.

The field IBTTLE determines the water sample incubated. The depth from which the sample was taken may be obtained from file BOTTLE and where and when it was collected from file EVENT (linked to BOTTLE through field BEN).

D2.6.4 **File C14SURV**

Associated data document: ***DOCU\DBKIT\PROD\C14PROD.TXT.***

During the second coccolithophore cruise, Charles Darwin 61, two bow-tie surveys were done. During these, water samples were taken from the non-toxic supply, inoculated with ^{14}C and incubated for four hours in artificial light ($23\mu E/m^2/s$). Calcification was determined by acidification initially, but the levels were so low that this was abandoned. The experiments were not size fractionated.

The data from this survey are presented in file C14SURV which has the structure:

PPTOT	Total ^{14}C uptake by >0.2µm size fraction (mg C/m^3/hour)
CALTOT	^{14}C uptake by >0.2µm size fraction attributed to calcification (mg C/m^3/hour)
IBTTLE	BODC bottle reference (primary key)

The primary header parameters for the water samples may be obtained from file EVENT, linking through file BOTTLE. EVENT and BOTTLE are linked by field BEN.

Note the units of ^{14}C uptake. In this case the unit of time is per hour, not per day and not per duration of incubation.

D2.6.5 **File PIDAT**

Associated data document: ***DOCU\DBKIT\PROD\C14PROD.TXT.***

This file presents the results of artificial light (P:I) ^{14}C incubations which determined the photosynthetic characteristics of the phytoplankton community. The structure of the file is:

ALMIC	Alpha for >5µm size fraction (mg $C/(\mu E/m^2/s)$/mg Chl/hour)
ALNAN	Alpha for 1-5µm size fraction (mg $C/(\mu E/m^2/s)$/mg Chl/hour)
ALPIC	Alpha for 0.2-1µm size fraction (mg $C/(\mu E/m^2/s)$/mg Chl/hour)
ALTOT	Alpha for >0.2µm size fraction (mg $C/(\mu E/m^2/s)$/mg Chl/hour)
MXMIC	P_{max} for >5µm size fraction (mg C/mg Chl/hour)
MXNAN	P_{max} for 1-5µm size fraction (mg C/mg Chl/hour)
MXPIC	P_{max} for 0.2-1µm size fraction (mg C/mg Chl/hour)
MXTOT	P_{max} for >0.2µm size fraction (mg C/mg Chl/hour)
IBTTLE	BODC bottle reference (primary key)

The BODC bottle refrence, IBTTLE, may be used to obtain the depth from which the sample was taken from file BOTTLE. Primary header parameters for the sample may be obtained from file EVENT which is linked to file BOTTLE through field BEN.

The >0.2µm size fraction is sometimes referred to as the total or non size-fractionated result.

D2.6.6 **Files THYDAT and THYDIU**

Associated data document: ***DOCU\DBKIT\PROD\THYPROD.TXT.***

This file contains data from the tritiated thymidine and tritiated leucine uptake experiments. File THYDAT may be regarded as presenting the bacterial environmental data. In addition to the production data there are cell numbers of bacteria and cyanobacteria. File THYDIU contains the results of thymidine uptake diel experiments.

The structure of file THYDAT is:

TRATE	Thymidine uptake rate (pmol/litre/hour)
STRATE	Standard deviation of the thymidine uptake rate (pmol/litre/hour)
LRATE	Leucine uptake rate (pmol/litre/hour)
SLRATE	Standard deviation of the leucine uptake rate (pmol/litre/hour)
CBCOUNT	Cyanobacteria numbers (10^6 cells/litre)
CB	Cyanobacteria numbers flag
BCOUNT	Bacterial numbers (10^8 cells/litre)
BCORR	Bacterial sample degradation factor
FLAGLT	Flagellate numbers (10^3 cells/litre)
IBTTLE	BODC bottle reference (primary key)

The BODC bottle reference, IBTTLE, may be used to obtain the depth from which the sample was taken from file BOTTLE. Primary header parameters for the sample may be obtained from file EVENT which is linked to file BOTTLE through field BEN.

The cyanobacteria numbers flag has been set to '*' for values where it is known that the count was done on preserved samples.

The bacterial sample degradation factor requires some explanation. If it is null, the sample was either counted on board ship or immediately made up into a slide and frozen until counted. If the factor has a positive value, it is the empirically derived correction factor for cell number decay that has been applied to a sample which was preserved. If the factor has a value of zero, the sample was preserved and made up into a slide at a later date (sometimes up to a year later).

The upshot of this is that if BCORR is null or has a positive value the counts are believed to be accurate. If BCORR has a value of zero, it is believed that the counts are likely to be underestimates. Further details are provided in the data documentation and in Turley and Hughes (1992).

The structure of file THYDIU is:

DATIM	Date and time of the thymidine determination
TRATE	Thymidine uptake rate (pmol/litre/hour)
BCOUNT	Bacterial cell numbers (10^8 cells/litre)
BCORR	Bacterial sample degradation factor
IBTTLE	BODC bottle reference

The BODC bottle reference, IBTTLE, may be used to obtain the depth from which the sample was taken from file BOTTLE. Primary header parameters for the sample may be obtained from file EVENT which is linked to file BOTTLE through field BEN. Note that in this case, because the data presented are a time series from each bottle sampled, both IBTTLE and DATIM must be used to construct a primary key.

The sample degradation factor is the same as described above for file THYDAT. However, in the case of file THYDIU it is largely irrelevant because all the counts presented were done on frozen slides.

D2.6.7 **File OXYHDR**

Associated data document: ***DOCU\DBKIT\PROD\OXYPROD.TXT.***

This file contains the header information for the oxygen production experiments. Note that in some cases TCO_2 and pCO_2 were determined in addition to oxygen.

The structure of the file is:

EXPREF	BODC incubation experiment reference (primary key)
TY	Incubation type
SDATE	Incubation start date and time
INCDUR	Incubation duration (hours)
DEPINT	Depth to which integrated values were determined (m)
INTGOX	Integrated gross oxygen production ($mmol/m^2/day$)
INTNOX	Integrated net oxygen production ($mmol/m^2/day$)
BENCOL	BODC event number of the water collection event

The incubation experiment reference is an alphanumeric identifier generated by BODC. Its primary purpose is to provide a link between OXYHDR and the data file OXYDAT to which it is related through a one to many relationship.

The incubation type, TY, is set to 'OD' for on deck incubations and 'IS' for in-situ incubations.

The incubation event number, BEN, provides a link to records in EVENT which record the deployment and recovery times of in-situ rigs. It is important to note that it is quite possible to extend the incubation beyond the recovery time of a rig recovered in darkness by simply storing the bottles in the dark.

The date and time that the incubation commenced, taken from log sheets or cruise reports, are given in the format dd/mm/yyyy hh:mm.

Integrated production values are only stored where they accompanied the data from discrete depths submitted to BODC. The units are quoted as ($mmol/m^2/day$). It is important to realise that 'day' means 'duration of incubation experiment'. In the case of the BOFS oxygen data this is critical as 12 or 18 hour incubations were relatively common.

BENCOL provides a link to the entry in file EVENT which describes the sourcing of the water for the production experiment. Normally, this is a pre-dawn Go-Flo station collecting water from several depths. On Charles Darwin 46, each individual Go-Flo fired was assigned a separate identifier and consequently had to be treated as a separate event. In this case, the relationship between OXYHDR and EVENT is one to many, not the one to one relationship required by the data structure. Rather than complicate matters by introducing a linker table, the one to many relationship was simplified by setting BENCOL to the BEN of the first 35m bottle taken during the pre-dawn Go-Flo station.

D2.6.8 **File OXYDAT**

Associated data document: ***DOCU\DBKIT\PROD\OXYPROD.TXT.***

This file contains the gross and net oxygen, TCO_2 and pCO_2 production determined at different depths and/or natural light intensities.

The structure of the file is:

EXPREF	BODC incubation experiment reference
DEPTH	Depth of incubation (m)
LIGHT	Light level for incubation (% of ambient irradiance)
GOX	Gross oxygen production (µM/day)
SGOX	Standard error for gross oxygen production (µM/day)
NOX	Net oxygen production (µM/day)
SNOX	Standard error for net oxygen production (µM/day)
SROX	Standard error for oxygen respiration (µM/day)
GTCO2	Gross TCO_2 production (µM/day)
SGTCO2	Standard error for gross TCO_2 production (µM/day)
NTCO2	Net TCO_2 production (µM/day)
SNTCO2	Standard error for net TCO_2 production (µM/day)
SRTCO2	Standard error for TCO_2 respiration (µM/day)
GPCO2	Gross pCO_2 production (µM C/day)
SGPCO2	Standard error for gross pCO_2 production (µM C/day)
NPCO2	Net pCO_2 production (µM C/day)
SNPCO2	Standard error for net pCO_2 production (µM C/day)
SRPCO2	Standard error for pCO_2 respiration (µM C/day)
IBTTLE	BODC bottle reference

The primary key for this file must be specified from three fields, EXPREF, DEPTH and LIGHT. Use of EXPREF and either one of the other two fields is insufficient due to duplicate record specifications caused by null values.

The light level of incubation is expressed as the actual depth of incubation for in-situ experiments. In the case of on deck incubations, it is either expressed as the percentage of ambient light passing through the filter screen or as the depth where such a light level would be encountered.

The units of production are expressed in terms of 'per day'. In this case 'day' means 'duration of incubation'. It can be seen from file OXYHDR that this is significant: 12 and 18 hour incubations are relatively common. **Do not use these data without first determining the incubation duration from OXYHDR.**

The field IBTTLE specifies the water sample incubated. The depth from which the sample was taken may be obtained from file BOTTLE and where and when it was collected from file EVENT (linked to BOTTLE through field BEN). In general, IBTTLE is unique indicating that different water was used for each incubation depth. However, this was not always the case (see data document).

D2.6.9 **File N15HDR**

Associated data document: ***DOCU\DBKIT\PROD\N15PROD.TXT.***

This file contains one record for each ^{15}N production experiment and provides metadata pertaining to each incubation. The file also provides storage for any integrated production values supplied with the data.

The structure of the file is:

EXPREF	BODC incubation experiment reference (primary key)
TY	Incubation type
BEN	BODC event number for incubation
SDATE	Incubation start date and time
COMM	Plain language comment
INCDUR	Incubation duration (hours)
DEPINT	Depth to which integrated values were determined (m)
INTNO3	Integrated uptake by new production (mmol/m^2/day)
INTNH4	Integrated uptake by regenerated production (mmol/m^2/day)
BENCOL	BODC event number of the water collection event

The incubation experiment reference is an alphanumeric identifier generated by BODC. Its primary purpose is to provide a link between N15HDR and the data file N15DAT to which it is related through a one to many relationship.

The incubation type, TY, is set to 'OD' for on deck incubations and 'IS' for in-situ incubations.

The incubation event number, BEN, provides a link to records in EVENT which record the deployment and recovery times of in-situ rigs. It is important to note that it is quite possible to extend the incubation beyond the recovery time of a rig recovered in darkness by simply storing the bottles in the dark.

The date and time that the incubation commenced, taken from log sheets or cruise reports, are given in the format dd/mm/yyyy hh:mm.

Integrated production values are only stored where they accompanied the data from discrete depths submitted to BODC. The units are quoted as (mmol/m^2/day). It is important to realise that 'day' means 'duration of incubation experiment'. In the case of the BOFS ^{15}N data this is not important as the durations are all 24 hours.

BENCOL provides a link to the entry in file EVENT which describes the sourcing of the water for the production experiment. Normally, this is a pre-dawn Go-Flo station collecting water from several depths. On Charles Darwin 46, each individual Go-Flo fired was assigned a separate identifier and consequently had to be treated as a

separate event. In this case, the relationship between N15HDR and EVENT is one to many, not the one to one relationship required by the data structure. Rather than complicate matters by introducing a linker table, the one to many relationship was simplified by setting BENCOL to the BEN of the first 35m bottle taken during the pre-dawn Go-Flo station.

D2.6.10 **File N15DAT**

Associated data document: ***DOCU\DBKIT\PROD\N15PROD.TXT.***

This file presents the new and regenerated production determined by ^{15}N nitrate and ammonia uptake during BOFS.

The structure of the file is:

EXPREF	BODC incubation experiment reference
DEPTH	Depth of incubation (m)
TNO3	Total ^{15}N nitrate uptake (µM/day)
TSNO3	^{15}N nitrate uptake by <5µm size fraction (µM/day)
TLNO3	^{15}N nitrate uptake by >5µm size fraction (µM/day)
TNH4	Total ^{15}N ammonia uptake (µM/day)
TSNH4	^{15}N ammonia uptake by <5µm size fraction (µM/day)
TLNH4	^{15}N ammonia uptake by >5µm size fraction (µM/day)
IBTTLE	BODC bottle reference

The BODC bottle reference, IBTTLE, may be used to obtain the depth from which the sample was taken from file BOTTLE. Primary header parameters for the sample may be obtained from file EVENT which is linked to file BOTTLE through field BEN.

The units of ^{15}N uptake are expressed in terms of 'per day'. In this case 'day' means 'duration of incubation'. It can be seen from file N15HDR that this does not pose a problem for the BOFS data because all incubations were of 24 hours duration.

D2.6.11 **File NOXHDR**

Associated data document: ***DOCU\DBKIT\PROD\NOXPROD.TXT.***

This file contains one record for each high resolution nitrate uptake experiment and provides metadata pertaining to each incubation.

The structure of the file is:

EXPREF	BODC incubation experiment reference (primary key)
TY	Incubation type
BEN	BODC event number for incubation
SDATE	Incubation start date and time
COMM	Plain language comments
INCDUR	Incubation duration (hours)
BENCOL	BODC event number of the water collection event

The incubation experiment reference is an alphanumeric identifier generated by BODC. Its primary purpose is to provide a link between NOXHDR and the data file NOXDAT to which it is related through a one to many relationship.

The incubation type, TY, is set to 'OD' for on deck incubations and 'IS' for in-situ incubations.

The incubation event number, BEN, provides a link to records in EVENT which record the deployment and recovery times of in-situ rigs. It is important to note that it is quite possible to extend the incubation beyond the recovery time of a rig recovered in darkness by simply storing the bottles in the dark.

The date and time that the incubation commenced, taken from log sheets or cruise reports, are given in the format dd/mm/yyyy hh:mm.

BENCOL provides a link to the entry in file EVENT which describes the sourcing of the water for the production experiment. Normally, this is a pre-dawn Go-Flo station collecting water from several depths. On Charles Darwin 46, each individual Go-Flo fired was assigned a separate identifier and consequently had to be treated as a separate event. In this case, the relationship between NOXHDR and EVENT is one to many, not the one to one relationship required by the data structure. Rather than complicate matters by introducing a linker table, the one to many relationship was simplified by setting BENCOL to the BEN of the first 35m bottle taken during the pre-dawn Go-Flo station.

D2.6.12 **File NOXDAT**

Associated data document: ***DOCU\DBKIT\PROD\NOXPROD.TXT.***

This file presents the results of high resolution nitrate uptake experiments. The structure of the file is:

EXPREF	BODC incubation experiment reference
DEPTH	Depth of incubation (m)
UNO3	Nitrate uptake (µM/day)
IBTTLE	BODC bottle reference

The BODC bottle reference, IBTTLE, may be used to obtain the depth from which the sample was taken that is held in file BOTTLE. Primary header parameters for the sample may be obtained from file EVENT which is linked to file BOTTLE through field BEN.

The units of nitrate uptake are expressed in terms of 'per day'. In this case 'day' means 'duration of incubation'. It can be seen from file NOXHDR that this does not pose a problem for the BOFS data because all incubations except one were of 24 hours duration.

D2.7 **Subdirectory SAP**

This subdirectory contains the data set collected using Challenger Oceanics stand-

alone pumps. These data have many parallels with filtered water sample data. However, as they have been collected by a very different mechanism, they have been stored separately. Users wishing to blur this distinction in their own system may do so by concatenating the data from subdirectory SAP with the equivalent data in subdirectory BOTNET.

D2.7.1 **File LIPSAP**

Associated data document: ***DOCU\DBKIT\SAP\LIPIDS.TXT.***

This file contains organic biomarker data determined from SAP samples. Additional biomarker data from CTD water bottles are held in directory DBKIT\BOTNET and associated benthic data are held in DBKIT\CORE.

The structure of the file is:

ME37_3	Heptatriaconta-8E,15E,22E-trien-2-one (%)
FAME36_3	Methyl hexatriaconta-7E,14E,21E-trienoate (%)
ME37_2	Heptatriaconta-15E,22E-dien-2-one (%)
FAME36_2	Methyl hexatriaconta-14E,21E-dienoate (%)
ET38_3	Octatriaconta-9E,16E,23E-trien-3-one (%)
ME38_3	Octatriaconta-9E,16E,23E-trien-2-one (%)
ET38_2	Octatriaconta-16E,23E-dien-3-one (%)
ME38_2	Octatriaconta-16E,23E-dien-2-one (%)
CONC	Total alkenone and alkenoate concentration (ng/l)
UK37	Ratio of ME37_2/(ME37_3+ME37_2)
UK38ME	Ratio of ME38_2/(ME38_3+ME38_2)
AA36	Ratio of ET38_3/(ET38_3+FAME36_3+FAME36_2)
SDTOTAL	Standard error for total concentration (ng/l)
SDUK37	Standard error for UK37 ratio
SDUK38ME	Standard error for UK38ME ratio
SDAA36	Standard error for AA36 ratio
IFILT	BODC SAP filter reference

The BODC filter reference may be used to link the data in this file to the sample depths held in file SAPINDX and to the primary header parameters in file EVENT. SAPINDX and EVENT are linked through field BEN.

The individual alkenones and alkenoates are expressed as a percentage of the total alkenone and alkenoate concentration. This maintains the structure of the data as supplied.

D2.7.2 **File RADSAP**

Associated data document: ***DOCU\DBKIT\SAP\RADNUC.TXT.***

This file contains dissolved and particulate radionuclide data determined on stand-alone pump samples. There are additional data from CTD water bottles in directory DBKIT\BOTNET and from sediment trap samples in DBKIT\SEDTRAP. Suspect values were deleted from the data set by the data originator. Consequently, there are no quality control flag fields.

The format of the file is:

DPO	Dissolved ^{210}Po (dpm/100l)
DPOERR	Dissolved ^{210}Po standard error (dpm/100l)
DPB	Dissolved ^{210}Pb (dpm/100l)
DPBERR	Dissolved ^{210}Pb standard error (dpm/100l)
PPO	Particulate ^{210}Po (dpm/100l)
PPOERR	Particulate ^{210}Po standard error (dpm/100l)
PPB	Particulate ^{210}Pb (dpm/100l)
PPBERR	Particulate ^{210}Pb standard error (dpm/100l)
IFILT	BODC SAP filter reference

The BODC SAP filter reference may be used to link the data in this file to the sample depths held in file SAPINDX and to the primary header parameters in file EVENT. SAPINDX and EVENT are linked through field BEN.

D2.7.3 **Files PIGMENT1, PIGMENT2 and PIGMENT3**

Associated data document: ***DOCU\DBKIT\SAP\PIGMENT.TXT.***

This file contains the results of pigment analyses using HPLC on water samples collected using stand-alone pumps. Size fractionated chlorophyll measurements made during primary production experiments are included with the primary production. Pigment measurements on water bottle and non-toxic supply samples are also stored separately in directory DBKIT\BOTNET. Quality control was by deletion from the data set and consequently there are no associated quality control flags.

The structure of the file PIGMENT1 is:

AN	Analysis flag
CHLA	Chlorophyll a (ng/l)
CHLAAL	Chlorophyll a allomer (ng/l)
CHLC3	Chlorophyll c3 (ng/l)
CHLC1C2	Chlorophyll c1c2 (ng/l)
CHLB	Chlorophyll b (ng/l)
CHLIDEA	Chlorophyllide a (ng/l)
CHLCL	Chorophyll c like (ng/l)
IFILT	BODC SAP filter reference (primary key)

The structure of file PIGMENT2 is:

AN	Analysis flag
PERID	Peridinin (ng/l)
BUTAN	Butanoyloxyfucoxanthin (ng/l)
FUCOX	Fucoxanthin (ng/l)
HEXOXY	Hexanoyloxyfucoxanthin (ng/l)
DIADIN	Diadinoxanthin (ng/l)
LUTEIN	Lutein (ng/l)
CARPH	Carotene plus phaeophytin (ng/l)
IFILT	BODC SAP filter reference (primary key)

The structure of file PIGMENT3 is:

AN	Analysis flag
PHORBA	Phaeophorbide a (ng/l)
PHORBL1	Phaeophorbide like 1 (ng/l)
PHORBL2	Phaeophorbide like 2 (ng/l)
PHPHYTA	Phaeophytin a (ng/l)
PYROPH	Pyrophaeophytin a (ng/l)
TOTC	Total particulate carbon (µg/l)
TOTN	Total particulate nitrogen (µg/l)
POC	Particulate organic carbon (µg/l)
PON	Particulate organic nitrogen (µg/l)
IFILT	BODC SAP filter reference (primary key)

The BODC SAP filter reference may be used to link the data in these files to the sample depths held in file SAPINDX and to the primary header parameters in file EVENT. SAPINDX and EVENT are linked through field BEN.

The analysis flag, AN, is set to 'S' for analyses done on fresh samples at sea and to 'L' for samples that were frozen and analysed back in the laboratory.

D2.8 **Subdirectory CORE**

This subdirectory contains the benthic data collected during the project. The benthic data comprise a number of discrete data sets collected independently by groups using different methodologies. They are therefore best regarded as separate data sets.

The data sets included are: the Kasten core data set, organic biomarkers from multicorer samples, radionuclides, dissolved oxygen profiles, multicorer carbon and nitrogen profiles and carbon date and stable isotope data.

D2.8.1 **Kasten Core Data Set**

Associated data document: ***DOCU\DBKIT\CORE\KASCORE.TXT.***

This is an extensive set of measurements made on a set of Kasten Cores collected on Discovery 184. The data set has been subdivided into a number of files to keep it manageable. The files are:

KASGEN	Age, sedimentation rates, dry bulk density, water content and magnetic susceptibility.
KASCHEM	Carbon and nitrogen profiles.
KASISO	Foraminifera test carbon and oxygen isotope data.
KASSED	Sediment grain size parameters
KBFDAT	Benthic foraminifera species distributions (with KBFHEAD)

The structure of these files is as follows:

File KASGEN

Associated data document: ***DOCU\DBKIT\CORE\KASCORE.TXT.***

CORDEP	Distance along core to midpoint of core segment (cm)
SEGLEN	Core segment length (cm)
BASIS	Plain language description of correlation basis for segment
AGE	Uncalibrated age for segment (years)
F	Age flag
SRATE	Sedimentation rate (cm/ka)
MAR	Mass accumulation rate (g/cm^2/ka)
DBD	Dry bulk density (g/cm^3)
PCWAT	Water content (%)
MAGSUS	Bulk magnetic susceptibility of fresh core slab (cgs unit)
MSCGNC	Non-carbonate mass normalised magnetic susceptibility of the dried coarse fraction (cgs unit/g non-carbonate)
MSFGNC	Non-carbonate mass normalised magnetic susceptibility of the dried fines fraction (cgs unit/g non-carbonate)
MSC	Mass normalised magnetic susceptibility of the dried coarse fraction (cgs unit/g)
MSF	Mass normalised magnetic susceptibility of the dried fines fraction (cgs unit/g)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into 1cm segments. Alternate slices were analysed and the remaining slices archived giving a 2cm resolution profile. Note that bulk magnetic susceptibility is an instrumental profile along the fresh core slab which has been mapped onto the segment-based scale.

The age flag is set to 'Y' for samples dated by AMS and to 'N' for samples dated by correlation.

Mass normalised magnetic susceptibility was determined by measuring samples of the dried coarse and fines fractions obtained by wet sieving through a 63µm mesh. The results were divided by the sample weight to give fields MSC and MSF and by the sample weights multiplied by the proportion of non-carbonate material to obtain fields MSCGNC and MSFGNC.

File KASCHEM

Associated data document: ***DOCU\DBKIT\CORE\KASCORE.TXT.***

CORDEP	Distance along core to midpoint of core segment (cm)
SEGLEN	Core segment length (cm)
CTOT	Total carbon in bulk sediment (wt %)
CINORG	Inorganic carbon in bulk sediment (wt %)
CORG	Organic carbon in bulk sediment (wt %)

FCTOT	Total carbon in fines fraction (wt %)
FCINORG	Inorganic carbon in fines fraction (wt %)
FCORG	Organic carbon in the fines fraction (wt %)
NTOT	Total nitrogen in bulk sediment (wt %)
NINORG	Inorganic nitrogen in bulk sediment (wt %)
NORG	Organic nitrogen in bulk sediment (wt %)
FNTOT	Total nitrogen in fines fraction (wt %)
FNINORG	Inorganic nitrogen in fines fraction (wt %)
FNORG	Organic nitrogen in fines fraction (wt %)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into 1cm segments. Alternate slices were analysed and the remaining slices archived giving a 2cm resolution profile.

The fines fraction was obtained by wet sieving through a 63 µm mesh. The term 'organic' is defined as material lost through combustion at 400°C for 3 hours.

File KASISO

Associated data document: ***DOCU\DBKIT\CORE\KASCORE.TXT.***

CORDEP	Distance along core to midpoint of core segment (cm)
SEGLEN	Core segment length (cm)
O18BULL	Delta-^{18}O determination on Globigerina bulloides tests
C13BULL	Delta-^{13}C determination on Globigerina bulloides tests
O18PACHY	Delta-^{18}O determination on Neoglobigerina pachyderma tests
C13PACHY	Delta-^{13}C determination on Neoglobigerina pachyderma tests
O18CIB	Delta-^{18}O determination on Cibicidoides wuellerstorfi tests
C13CIB	Delta-^{13}C determination on Cibicidoides wuellerstorfi tests
O18UVIG	Delta-^{18}O determination on Uvigerina species tests
C13UVIG	Delta-^{13}C determination on Uvigerina species tests
O18PLAN	Delta-^{18}O determination on Planulina wuellerstorfi tests
C13PLAN	Delta-^{13}C determination on Planulina wuellerstorfi tests
O18BEN	Delta-^{18}O determination on unspecified benthic foraminifera tests
C13BEN	Delta-^{13}C determination on unspecified benthic foraminifera tests
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into 1cm segments. Alternate slices were analysed and the remaining slices archived giving a 2cm resolution profile.

File KASSED

Associated data document: ***DOCU\DBKIT\CORE\KASCORE.TXT.***

CORDEP	Distance along core to midpoint of core segment (cm)
SEGLEN	Core segment length (cm)
CRSE	Dry weight proportion of coarse material (%)
FINE	Dry weight proportion of fine material (%)
FC	Proportion of the fines fraction comprised of carbonate material (%)
FNC	Proportion of the fines fraction comprised of non-carbonate material (%)
CC	Proportion of the coarse fraction comprised of carbonate material (%)
CNC	Proportion of the coarse fraction comprised of non-carbonate material (%)
TFC	Proportion of the total sediment comprised of carbonates in the fines fraction (%)
TFNC	Proportion of the total sediment comprised of non-carbonates in the fines fraction (%)
TCC	Proportion of the total sediment comprised of carbonates in the coarse fraction (%)
TCNC	Proportion of the total sediment comprised of non-carbonates in the coarse fraction (%)
NCSLT	Proportion of the fines fraction comprising non-carbonate particles in the size range 2-63µm (%)
NC10U	Proportion of the fines fraction comprising non-carbonate particles in the size range 10-63µm (%).
MS863	Mean size of non-carbonate particles in the size range 8-63µm (µm)
MS263	Mean size of non-carbonate particles in the size range 2-63µm (µm)
MS28	Mean size of non-carbonate particles in the size range 2-8µm (µm)
NCSMED	Median size of the non-carbonate fines fraction (µm)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into 1cm segments. Alternate slices were analysed and the remaining slices archived giving a 2cm resolution profile.

The sediment was divided into coarse and fines fractions by wet sieving through a 63µm mesh.

Files KBFHEAD and KBFDAT

Associated data document: ***DOCU\DBKIT\CORE\KASCORE.TXT.***

The files KBFHEAD and KBFDAT are related through a one to many relationship. File KBFHEAD contains one record for each core sample counted whilst file KBFDAT contains one record for each taxon counted within that segment.

The structure of KBFHEAD is:

CORDEP	Distance along core to midpoint of core segment (cm)
SEGLEN	Core segment length (cm)
ISAMP	BODC sample reference (primary key)
NCOUNT	Number of specimens counted
NSPC	Number of species identified in the sample
NPGRAM	Number of foraminifera per gram of dried sediment
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. Whilst this file has an independent primary key (used to link with KBFDAT), a primary key may also be formed from ICORE and CORDEP in common with the other Kasten core data files.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into 1cm segments. Alternate slices were analysed and the remaining slices archived giving a 2cm resolution profile.

The value in NSPC is the number of species identified in the sample. This should not be confused with the number of taxa as a taxon may contain more than one species. Consequently, NSPC is either equal to or, more usually, exceeds the number of records (equal to the number of taxa identified) for a sample in file KBFDAT.

The structure of file KBFDAT is:

TAXON	Taxon name or description
KOWNT	Number of occurrences of the taxon in the sample
FLAG	Ice rafting flag
ISAMP	BODC sample reference

The primary key to this file is formed from fields ISAMP and TAXON. The file is linked to KBFDAT (and hence to COREINDX and EVENT) through the field ISAMP.

The ice rafting flag is set to '*' to indicate taxa which are believed to have been added to the indigenous fauna through ice rafting.

D2.8.2 **Organic Biomarkers**

Associated data document: ***DOCU\DBKIT\CORE\LIPSED.TXT.***

The second benthic data set consists of near surface (top 5cm) profiles from multicorer samples on which a wide range of organic species have been measured. Related data from the water column may be found in directories DBKIT\BOTNET (file LIPBOT) and DBKIT\SAP (file LIPSAP). The parameter set is extremely large and consequently the data have been split between a number of files.

These files are:

LSBULK	Bulk chemistry determinations

LSANE	Alkanes
LSANOL	Alkanols
LSAA	Alkanoic acids
LIPSED1	Lipids and sterols volume 1
LIPSED2	Lipids and sterols volume 2

File LSBULK

Associated data document: ***DOCU\DBKIT\CORE\LIPSED.TXT.***

DIST	Distance along core to mid-point of segment (cm)
SEGLEN	Core segment length (cm)
CACO3	Carbonate (%)
CORG	Total organic carbon (%)
TOTN	Nitrogen (%)
MCNRAT	Molar carbon/nitrogen ratio
SUL	Sulphur (%)
PHO	Phosphorus (%)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and DIST.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments varying in thickness from 1mm to 4mm. DIST specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

File LSANE

Associated data document: ***DOCU\DBKIT\CORE\LIPSED.TXT.***

DIST	Distance along core to mid-point of segment (cm)
SEGLEN	Core segment length (cm)
C18	C18 *n*-alkane (µg/g dry weight)
C19	C19 *n*-alkane (µg/g dry weight)
C20	C20 *n*-alkane (µg/g dry weight)
C21	C21 *n*-alkane (µg/g dry weight)
C22	C22 *n*-alkane (µg/g dry weight)
C23	C23 *n*-alkane (µg/g dry weight)
C24	C24 *n*-alkane (µg/g dry weight)
C25	C25 *n*-alkane (µg/g dry weight)
C26	C26 *n*-alkane (µg/g dry weight)
C27	C27 *n*-alkane (µg/g dry weight)
C28	C28 *n*-alkane (µg/g dry weight)
C29	C29 *n*-alkane (µg/g dry weight)
C30	C30 *n*-alkane (µg/g dry weight)
C31	C31 *n*-alkane (µg/g dry weight)
C32	C32 *n*-alkane (µg/g dry weight)

C33	C33 *n*-alkane (µg/g dry weight)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and DIST.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments varying in thickness from 1mm to 4mm. DIST specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

File LSANOL

Associated data document: ***DOCU\DBKIT\CORE\LIPSED.TXT.***

DIST	Distance along core to mid-point of segment (cm)
SEGLEN	Core segment length (cm)
OH16	C16 *n*-alkanol (µg/g dry weight)
OH18	C18 *n*-alkanol (µg/g dry weight)
OH20	C20 *n*-alkanol (µg/g dry weight)
OH22	C22 *n*-alkanol (µg/g dry weight)
OH23	C23 *n*-alkanol (µg/g dry weight)
OH24	C24 *n*-alkanol (µg/g dry weight)
OH25	C25 *n*-alkanol (µg/g dry weight)
OH26	C26 *n*-alkanol (µg/g dry weight)
OH27	C27 *n*-alkanol (µg/g dry weight)
OH28	C28 *n*-alkanol (µg/g dry weight)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and DIST.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments varying in thickness from 1mm to 4mm. DIST specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

File LSAA

Associated data document: ***DOCU\DBKIT\CORE\LIPSED.TXT.***

DIST	Distance along core to mid-point of segment (cm)
SEGLEN	Core segment length (cm)
FA15	C15 *n*-alkanoic acid (µg/g dry weight)
FA17	C17 *n*-alkanoic acid (µg/g dry weight)
FA22	C22 *n*-alkanoic acid (µg/g dry weight)
FA23	C23 *n*-alkanoic acid (µg/g dry weight)

FA24	C24 *n*-alkanoic acid (µg/g dry weight)
FA25	C25 *n*-alkanoic acid (µg/g dry weight)
FA26	C26 *n*-alkanoic acid (µg/g dry weight)
FA27	C27 *n*-alkanoic acid (µg/g dry weight)
FA28	C28 *n*-alkanoic acid (µg/g dry weight)
FA29	C29 *n*-alkanoic acid (µg/g dry weight)
FA30	C30 *n*-alkanoic acid (µg/g dry weight)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and DIST.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments varying in thickness from 1mm to 4mm. DIST specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

File LIPSED1

Associated data document: ***DOCU\DBKIT\CORE\LIPSED.TXT.***

DIST	Distance along core to mid-point of segment (cm)
SEGLEN	Core segment length (cm)
NORSTAN	27-nor-24-methylcholesta-5,22E-dien-3ß-ol (µg/g dry weight)
C27D522	Cholest-5,22-dien-3ß-ol (µg/g dry weight)
C27D22	5α-cholest-22E-en-3ß-ol (µg/g dry weight)
CHOL	Cholest-5-en-3ß-ol (µg/g dry weight)
C27D7	Cholest-7-en-3ß-ol (µg/g dry weight)
ASTAN	5α-cholestan-3ß-ol (µg/g dry weight)
C28D522	24-methylcholesta-5,22-dien-3ß-ol (µg/g dry weight)
C28D22	24-methyl-5α-cholesta-22-en-3ß-ol (µg/g dry weight)
C28D5	24-methylcholest-5-en-3ß-ol (µg/g dry weight)
C29D522	24-ethylcholesta-5,22-dien-3ß-ol (µg/g dry weight)
C29D5	24-ethylcholest-5-en-3ß-ol (µg/g dry weight)
ETASTAN	24-ethyl-5α-cholestan-3ß-ol (µg/g dry weight)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and DIST.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments varying in thickness from 1mm to 4mm. DIST specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

File LIPSED2

Associated data document: ***DOCU\DBKIT\CORE\LIPSED.TXT.***

DIST	Distance along core to mid-point of segment (cm)
SEGLEN	Core segment length (cm)
DINO	4α-,23,24-trimethyl-5α-cholest-22-en-3ß-ol (µg/g dry weight)
HOPA1	C32 hopanoic acid (µg/g dry weight)
HOPA2	C32 hopanol (µg/g dry weight)
C373ME	Heptatriaconta-8E,15E,22E-trien-2-one (µg/g dry weight)
C372ME	Heptatriaconta-15E,22E-dien-2-one (µg/g dry weight)
C363FAME	Methyl hexatriaconta-7E,14E,21E-trienoate (µg/g dry weight)
C362FAME	Methyl hexatriaconta-14E,21E-dienoate (µg/g dry weight)
C383ET	Octatriaconta-9E,16E,23E-trien-3-one (µg/g dry weight)
C383ME	Octatriaconta-9E,16E,23E-trien-2-one (µg/g dry weight)
C382ET	Octatriaconta-16E,23E-dien-3-one (µg/g dry weight)
C382ME	Octatriaconta-16E,23E-dien-2-one (µg/g dry weight)
C30DIOL	C30 1,15-alkanediol (µg/g dry weight)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and DIST.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments varying in thickness from 1mm to 4mm. DIST specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

D2.8.3 **Radionuclides**

Associated data document: ***DOCU\DBKIT\CORE\RADCORE.TXT.***

The data presented here are down core profiles of radionuclides. Lead isotope profiles were determined from either multicorer or box core samples. Uranium and thorium data were collected for some of the box core samples. The data are presented in two files, PBISO and UTHISO which contain the lead and uranium/thorium data respectively.

The structure of these files is:

File PBISO

Associated data document: ***DOCU\DBKIT\CORE\RADCORE.TXT.***

CORDEP	Distance along core to mid-point of segment (cm)
SEGLEN	Segment length (cm)
PB210	^{210}Pb content of the sediment (dpm/g)
SPB210	Standard error of the ^{210}Pb content (dpm/g)
XPB210	^{210}Pb content in excess of the value predicted for steady state conditions (dpm/g)

SXPB210	Standard error of XPB210 (dpm/g)
XPBINV	Excess ^{210}Pb inventory (dpm/cm^2)
SXPBINV	Standard error of XPBINV (dpm/cm^2)
BCOEFF	Bioturbation coefficient (cm^2/year)
DENS	Dry bulk density (g/cm^3)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments of varying thickness. CORDEP specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

File UTHISO

Associated data document: ***DOCU\DBKIT\CORE\RADCORE.TXT.***

CORDEP	Distance along core to mid-point of segment (cm)
SEGLEN	Segment length (cm)
U	Uranium content (ppm)
SU	Standard error of the uranium content (ppm)
TH	Thorium content (ppm)
STH	Standard error of the thorium content (ppm)
UAR	^{234}U/^{238}U activity ratio
SUAR	Standard error of the ^{234}U/^{238}U activity ratio
THAR	^{230}Th/^{232}Th activity ratio
STHAR	Standard error of the ^{230}Th/^{232}Th activity ratio
U234	^{234}U activity (dpm/g)
SU234	Standard error of the ^{234}U activity (dpm/g)
TH230	^{230}Th activity (dpm/g)
STH230	Standard error of the ^{230}Th activity (dpm/g)
XTH	^{230}Th excess (dpm/g)
SXTH	Standard error of the ^{230}Th excess (dpm/g)
DENS	Dry bulk density (g/cm^3)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments of varying thickness. CORDEP specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

D2.8.4 **Dissolved Oxygen Profiles**

Associated data document: ***DOCU\DBKIT\CORE\COXPROF.TXT.***

This data set comprises dissolved oxygen profiles, measured using a micromanipulator-mounted electrode, from pore waters in multicorer samples. Replicate profiles within a single core tube are presented as separate fields within the file. In some cases, profiles were determined from more than one core tube from a single deployment. These are treated as separate cores: i.e. each core tube measured has a unique value of ICORE assigned.

The data are presented in a single file, COXPROF. The structure of this file is:

DIST	Distance from the sediment/water interface (cm)
PROF1	Oxygen saturation for replicate profile 1 (%)
PROF2	Oxygen saturation for replicate profile 2 (%)
PROF3	Oxygen saturation for replicate profile 3 (%)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and DIST.

The field DIST is the distance of the probe tip from the sediment/water interface. Negative values mean that the measurement was taken in the bottom water overlying the sediment in the core tube. Positive values are below the sediment surface.

The probe was calibrated in terms of oxygen saturation. The data presented are therefore as measured and not algorithmically derived from a measured oxygen concentration.

D2.8.5 **Carbon and Nitrogen Profiles from Multicorer Samples**

Associated data document: ***DOCU\DBKIT\CORE\MCCN.TXT.***

The data presented here are profiles of basic sediment properties and carbon and nitrogen content from multicorer samples. Some of the lead isotope data presented in file PBISO were taken from the same samples. These will have common values of ICORE and CORDEP.

The data are presented in a single file, MCCN. The structure of this file is:

CORDEP	Distance from the sediment/water interface to the mid-point of the segment (cm)
SEGLEN	Segment length (cm)
WATER	Water content (%)
POROS	Porosity
TOTC	Total carbon content (%)
STOTC	Standard error of the total carbon content (%)
ORGC	Organic carbon content (%)
SORGC	Standard error of the organic carbon content (%)

CACO3	Calcium carbonate content (%)
TOTN	Total nitrogen content (%)
DENS	Dry bulk density (g/cm^3)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments of varying thickness. CORDEP specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

D2.8.6 **Radiocarbon Dates and ^{13}C Profiles**

Associated data document: ***DOCU\DBKIT\CORE\CISO.TXT.***

The data presented here are radiocarbon dates and profiles of the stable isotope ^{13}C. The bulk of the data is for the total sediment which are presented in file CISO. In addition, there is a small amount of size fractionated data, presented in file SFCISO. These data were obtained from box core samples. Additional radionuclide data from these cores are presented in files PBISO and UTHISO. These may be linked through fields ICORE and CORDEP. Note, however, that sometimes data were obtained from separate subcores from a box core sample and therefore the CORDEP values for the two profiles need not necessarily match.

The structure of these files is:

File CISO

Associated data document: ***DOCU\DBKIT\CORE\CISO.TXT.***

CORDEP	Distance along core to mid-point of segment (cm)
SEGLEN	Segment length (cm)
C13	Delta-^{13}C (ppt)
CACO3	Calcium carbonate content (%)
CAGE	Radiocarbon age (conventional years BP)
SCAGE	Standard deviation of the radiocarbon age (years)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments of varying thickness. CORDEP specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

The term BP used for the radiocarbon dates is 'Before Present'. In this context, 'Present' is defined as the year 1950 AD.

File SFCISO

Associated data document: ***DOCU\DBKIT\CORE\CISO.TXT.***

CORDEP	Distance along core to mid-point of segment (cm)
SEGLEN	Segment length (cm)
FC13	Delta-^{13}C in the <5µm size fraction (ppt)
CC13	Delta-^{13}C in the >5µm size fraction (ppt)
FCACO3	Proportion of calcium carbonate in the <5µm size fraction (%)
FCAGE	Radiocarbon date from the <5µm size fraction (conventional years BP)
SFCAGE	Standard deviation of the radiocarbon age from the <5µm size fraction (years)
CCAGE	Radiocarbon date from the >5µm size fraction (conventional years BP)
SCCAGE	Standard deviation of the radiocarbon age from the >5µm size fraction (years)
ICORE	BODC core reference

The BODC core reference may be used to link the data to header parameters in files COREINDX and EVENT. These files are linked together through field BEN. The primary key is formed from ICORE and CORDEP.

The distance along core of the profiles is defined in terms of segments. The cores were subdivided into segments of varying thickness. CORDEP specifies the distance from the sediment/water interface to the mid-point of the segment and hence may be used as the independent variable for profile plots. The sampling scheme may be determined by looking at SEGLEN.

The term BP used for the radiocarbon dates is 'Before Present'. In this context, 'Present' is defined as the year 1950 AD.

D2.9 **Subdirectory CALIB**

This subdirectory presents the calibrations applied to the CTD data by BODC during the post-cruise data processing. These calibrations therefore describe the difference between data as they came off the ship and the final data set.

The data are held in a single file, CTDCAL. The data processing system used allowed separate calibrations to be specified for each CTD cast. However, calibrations were generally determined on a cruise basis and consequently significant numbers of CTD casts share the same calibration coefficients.

Null values in this table mean that, for the CTD cast in question, the channel with null calibration coefficients must be considered as unavailable, even if data were logged for the channel. This generally means that no calibration samples were taken and calibrations from another cruise could not be used.

The structure of file CTDCAL is:

PCOR	Pressure correction (db)
SALINS	Salinity calibration slope
SALINC	Salinity calibration intercept
TEMPS	Temperature calibration slope
TEMPC	Temperature calibration intercept
CHLS	Chlorophyll calibration slope
CHLPAR	Chlorophyll calibration quench term
CHLC	Chlorophyll calibration intercept
O2S	Oxygen calibration slope
O2C	Oxygen calibration intercept
UWIRS	Upwelling irradiance calibration slope
UWIRC	Upwelling irradiance calibration intercept
DWIRS	Downwelling irradiance calibration slope
DWIRC	Downwelling irradiance calibration intercept
BEN	BODC event number

To be of use, the equation to which the coefficients pertain must be known. These equations are specified below:

The pressure correction, PCOR, is a simple offset which is added to the uncalibrated CTD pressure.

The salinity and temperature and oxygen calibrations are simple linear equations of the form:

TCAL = TRAW*TEMPS + TEMPC
SCAL = SRAW*SALINS + SALINC
OCAL = ORAW*O2S + O2C

The chlorophyll concentration (in mg chlorophyll-a/m^3) is obtained from the fluorometer voltage and downwelling irradiance (PAR) in units of $\mu E/m^2/s$ using the following equation:

CHLOROPHYLL = EXP (VOLTS*CHLS +PAR*CHLPAR + CHLC)

The irradiance calibrations (upwelling and downwelling) are of the form:

IRRADIANCE = EXP (VOLTS*SLOPE + INTERCEPT)

This equation returns values in $\mu W/cm^2$ which are converted to $\mu E/m^2/s$ by multiplying by 0.0375. Note that this is an empirically determined conversion for the type of light meter used on the CTD during BOFS. The calibration is valid over the range -1.5V to 1.0V.

D2.10 **Subdirectory SEDTRAP**

The files in this subdirectory contain data collected from the moored sediment traps deployed during BOFS. In addition to the basic mass flux determinations, are carbon, nitrogen and opal data, radionuclide data and data on species distributions in the trapped material.

D2.10.1 **File STCN**

Associated data document: ***DOCU\DBKIT\SEDTRAP\SEDTRAP.TXT.***

This file contains carbon, nitogen and opal content data for the trapped material. The structure of the file is:

TC	Total carbon content (%)
STC	Total carbon content error (%)
IC	Inorganic carbon content (%)
SIC	Inorganic carbon content error (%)
OC	Organic carbon content (%)
SOC	Organic carbon content error (%)
TN	Total nitrogen content (%)
STN	Total nitrogen content error (%)
CA	Calcite content (%)
SCA	Calcite content error (%)
ORG	Organic matter content (%)
SORG	Organic matter content error (%)
OP	Opal content (%)
SOP	Opal content error (%)
CNRAT	Molar organic carbon/total nitrogen ratio
SCNRAT	Molar organic carbon/total nitrogen ratio error
ISAMP	BODC sediment trap sample reference (primary key)

The BODC sediment trap reference provides a linkage to the trap depth and sampling period information held in file STINDX. It is also possible to link to details of the mooring deployment held in file EVENT through file STINDX. Files EVENT and STINDX are linked through field BEN.

D2.10.2 **File STCNFX**

Associated data document: ***DOCU\DBKIT\SEDTRAP\SEDTRAP.TXT.***

This file contains mass, carbon, nitogen and opal flux data. The structure of the file is:

MFX	Mass flux (mg/m^2/day)
SMFX	Mass flux error (mg/m^2/day)
TCFX	Total carbon flux (mg/m^2/day)
STCFX	Total carbon flux error (mg/m^2/day)
ICFX	Inorganic carbon flux (mg/m^2/day)
SICFX	Inorganic carbon flux error (mg/m^2/day)
OCFX	Organic carbon flux (mg/m^2/day)
SOCFX	Organic carbon flux error (mg/m^2/day)
TNFX	Total nitrogen flux (mg/m^2/day)
STNFX	Total nitrogen flux error (mg/m^2/day)
CAFX	Calcite flux (mg/m^2/day)
SCAFX	Calcite flux error (mg/m^2/day)
ORGFX	Organic matter flux (mg/m^2/day)
SORGFX	Organic matter flux error (mg/m^2/day)

OPFX	Opal flux (mg/m^2/day)
SOPFX	Opal flux error (mg/m^2/day)
ISAMP	BODC sediment trap sample reference (primary key)

The BODC sediment trap sample reference provides a linkage to the trap depth and sampling period information held in file STINDX. It is also possible to link to details of the mooring deployment held in file EVENT through file STINDX. Files EVENT and STINDX are linked through field BEN.

The mass flux values quoted combine the results of several laboratories that were supplied with splits of the trap samples. The value in this file should be used in preference to mass flux estimates in other data sets which were based on a single split.

D2.10.3 **File STRD**

Associated data document: ***DOCU\DBKIT\SEDTRAP\SEDTRAP.TXT.***

This file contains radionuclide content data for the trapped material. The structure of the file is:

TH230	^{230}Th content (dpm/g)
STH230	^{230}Th content error (dpm/g)
PB210	^{210}Pb content (dpm/g)
SPB210	^{210}Pb content error (dpm/g)
TH232	^{232}Th content (dpm/g)
STH232	^{232}Th content error (dpm/g)
ISAMP	BODC sediment trap sample reference (primary key)

The BODC sediment trap sample reference provides a linkage to the trap depth and sampling period information held in file STINDX. It is also possible to link to details of the mooring deployment held in file EVENT through file STINDX. Files EVENT and STINDX are linked through field BEN.

D2.10.4 **File STRDFX**

Associated data document: ***DOCU\DBKIT\SEDTRAP\SEDTRAP.TXT.***

This file contains radionuclide flux data. The structure of the file is:

MFX	Mass flux for radiochemical split (mg/m^2/day)
TH230FX	^{230}Th flux (dpm/m^2/day)
STH230FX	^{230}Th flux error (dpm/m^2/day)
PB210FX	^{210}Pb flux (dpm/m^2/day)
SPO210FX	^{210}Pb flux error (dpm/m^2/day)
PO210FX	^{210}Po flux (dpm/m^2/day)
SPB210FX	^{210}Po flux error (dpm/m^2/day)
POPB	^{210}Po/^{210}Pb flux ratio
SPOPB	^{210}Po/^{210}Pb flux ratio error
TH232FX	^{232}Th flux (dpm/m^2/day)
STH232FX	^{232}Th flux error (dpm/m^2/day)
ISAMP	BODC sediment trap sample reference (primary key)

The BODC sediment trap sample reference provides a linkage to the trap depth and sampling period information held in file STINDX. It is also possible to link to details of the mooring deployment held in file EVENT through file STINDX. Files EVENT and STINDX are linked through field BEN.

D2.10.5 **File STSPFX**

Associated data document: ***DOCU\DBKIT\SEDTRAP\SEDTRAP.TXT.***

This file contains the fluxes of taxa which were identified and counted in the sediment trap material. The structure of the file is:

FLUX	Taxon flux (number of specimens/m^2/day)
TAXON	Taxon name
COMM	Plain language comment concerning the taxon
ISAMP	BODC sediment trap sample reference

The BODC sediment trap sample reference provides a linkage to the trap depth and sampling period information held in file STINDX. It is also possible to link to details of the mooring deployment held in file EVENT through file STINDX. Files EVENT and STINDX are linked through field BEN.

Unlike the other sediment trap data files in subdirectory DBKIT\SEDTRAP, the relationship between this file and STINDX is one to many, not one to one. Consequently, the primary key must be formed from the fields ISAMP and TAXON.

D2.11 **Subdirectory CURR**

Associated data document: ***DOCU\DBKIT\CURR\ARGOS.TXT.***

This subdirectory contains a single file, ARGOS, which presents the Lagrangian current data collected by Argos drifting buoys released during BOFS. The structure of the file is:

DATIM	Date and time of position fix
LAT	Latitude (degrees +ve N)
LON	Longitude (degrees +ve E)
BEN	BODC event number

The BODC event number, BEN, provides a linkage to buoy deployment details in file EVENT. The primary key for this file may be formed from BEN and DATIM.

Dates and times are presented in the format dd/mm/yyyy hh:mm.

D2.12 **Subdirectory XBT**

Associated data document: ***DOCU\DBKIT\XBT\XBT.TXT.***

This subdirectory contains a number of files which contain the expendable

bathythermograph (XBT) data collected during BOFS. The data have been split on a cruise basis, with the cruise mnemonics used for filenames. Thus the file DBKIT\XBT\DI182 contains the XBT data for cruise Discovery 182.

The structure of these files is:

DEPTH	Depth(m)
TEMP	Temperature (C)
F	Temperature quality flag
BEN	BODC event number

The BODC event number, BEN, provides a linkage to the header parameters held in file EVENT. The primary key for this file must be formed from fields BEN and DEPTH.

The temperature quality control flag is set to 'G' for temperatures considered acceptable and to 'S' for temperatures considered suspect.

D2.13 **Corrigenda**

One cause of unease about the electronic publication of a data set on CD-ROM is that once the disks have been produced, the data are cast in stone. Errors cannot be corrected and additional data may not be incorporated without the CD-ROM equivalent of a reprint.

However, in the case of the 'kit-form' database, a relatively straightforward update mechanism is possible. The 'kit' is made up of a large number of files which are relatively small. Consequently, implementing corrections by placing updated versions of a subset of the files on hard disk is feasible.

When the software is installed, a set of directories mirroring the 'kit-form' database structure on the CD-ROM are created under the installation directory (\BOFS by default). Any future corrections may then be issued on floppy disk with an installation program which copies the data into the mirrored structure and updates the DBMERGE program driver file.

In this way, the correction is implemented transparently for DBMERGE users. A catalogue documenting the nature of the problem and the files affected would also be issued to allow users who have loaded the files directly to make any necessary corrections to their system.

STOP PRESS: An error in the BOFS CD-ROM 'kit-form' database has come to light just as this manual was going to press. The data in columns NTOT and CTOT in file DBKIT\BOTNET\MESOMASS have been transposed for one cruise (Discovery 183). The corrected file has been included on the software installation disk and will be automatically copied to the hard disk as described above when the software is installed. DBMERGE users will automatically access the corrected file: other users should use the version of the file on their hard-disk and not the version on the CD-ROM.

D2.14 **References**

Benson, B.B. and Krause, D. Jr. (1984). The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. Limnol. Oceanogr. 29: 620-632.

Fofonoff, N.P. and Millard, R.C. Jr. (1983). Algorithms for the computation of fundamental properties of sea water. UNESCO Tech. Pap. Mar. Sci. 44, 53 pp.

Turley, C.M. and Hughes, D.J. (1992). Effects of storage on direct estimates of bacterial numbers in preserved sea water samples. Deep Sea Res. 39: 375-394.

Section D3

The Underway Data Set

D3.1 Introduction

During all BOFS cruises, the ship's computers automatically logged a range of sensors mostly sampling surface sea water. The files described in this chapter, termed the underway data set, contain these data merged on a common time base with a sampling interval of 30 seconds.

The data from 11 research cruises have been worked up and included on the CD-ROM. For each cruise, a document has been written describing the protocols followed, calibrations applied and any problems noted either during the cruise or the subsequent data processing. These may be found in the subdirectory DOCU\UNDERWAY.

D3.2 Directory UNDERWAY

The data are stored in directory UNDERWAY with one file per cruise named using the cruise identifier and the file extension BMM (e.g. DI182.BMM). The data are stored in a compact binary format termed 'Binary Merge Format' which is fully documented in Appendix 1. However, software utilities (documented in Section S) are provided to present the underway data graphically or to list binary merge files to screen, printer or disk. Consequently, most users should not need to work directly with the binary files and need not be concerned with their structure.

D3.2.1 Parameters Measured

The CD-ROM contains data from 11 BOFS cruises. The range of sensors deployed varied from cruise to cruise both intentionally and due to equipment failures. The table below summarises the parameters available for each cruise:

Cruise	Parameter Set	Logging started	Logging ceased
DI182	ABCFDIQGEHLYZMNKT1WOa	08/05/1989 23.33	07/06/1989 12.10
DI183	ABYZDGILCFKO1TUVWa	11/06/1989 08.25	11/07/1989 20.18
DI184	ABKJO1CFLYZa	15/07/1989 13.01	12/08/1989 06.35
DI190	ABKY1CFQOZDGLITUVWEHa	14/04/1990 08.28	08/05/1990 06.52
CD46	ABKDGLCF/?!YZIOab	28/04/1990 09.31	21/05/1990 15.12
DI191	ABKCFILYZ1a	12/05/1990 14.59	06/06/1990 17.08
CD47	ABKCFYZ/DGLI?!Oab	25/05/1990 11:02	16/06/1990 20.34
DI192	ABKQTUVWDGCFYZO124ILEH{a	09/06/1990 15.52	27/06/1990 07.00
CD53	ABKCFL?!VWTJ1E	18/09/1990 19.44	22/10/1990 21.28
CD60	ABKYZ1/CFLTPJI?DEHG!_OabUVQ	13/06/1991 09.09	02/07/1991 16.01
CD61	ABKYZ1/CFLUTWJI?DEG!abOQ	06/07/1991 06.47	28/07/1991 09.11

Where: A = Latitude (deg +ve N)
B = Longitude (deg +ve E)
C = Temperature (C)
D = Raw fluorescence from Turner Designs through-flow fluorometer
E = pCO_2 (µatm)
F = Salinity (PSU)
G = Chlorophyll from Turner Designs (mg/m^3)
H = TCO_2 (µmol/kg)
I = Optical attenuance (per m)
J = Bathymetric depth (m)
K = Distance run (km)
L = Photosynthetically available radiation (W/m^2)
M = pH (pH units)
N = Temperature of the pH determination (C)
O = Solar radiation (W/m^2)
P = Ammonia (µM)
Q = Dissolved oxygen at in-situ temperature and salinity (µM)
T = Nitrate + nitrite (µM)
U = Nitrite (µM)
V = Phosphate (µM)
W = Silicate (µM)
Y = Absolute wind speed (knots)
Z = Absolute wind direction (degrees from which the wind blows)
1 = Barometric pressure (mb)
2 = Dry bulb air temperature from port bridge sensor (C)
4 = Dry bulb air temperature from starboard bridge sensor (C)
/ = Long wave radiation (W/m^2)
? = Raw signal from Chelsea Instruments Aquatracka fluorometer (V)
! = Chlorophyll from Aquatracka (mg/m^3)
_ = Attenuance calibrated in terms of calcite (mg Ca/m^3)
} = Potentiometric alkalinity (µEq/kg)
a = Combined dry bulb air temperature (C)
b = Combined wet bulb air temperature (C)

Before using the underway data set, it is strongly recommended that the data documents in directory DOCU\UNDERWAY are consulted. A brief summary of the protocols used and the major pitfalls awaiting the unwary user follows, but full details cannot be given without reproducing the full documentation.

Note that where an underway data set comprised a small (tens or hundreds) number of discrete samples taken from the non-toxic supply, the data are managed as water bottle samples in the 'kit-form' database (section D2). Exceptions are the underway nutrients from Discovery 183 and alkalinity data from Discovery 192 which have been included in the underway files to maintain consistency with other cruises, or with related automatically logged parameters.

Each data channel, except the time channel, carries a quality control flag channel. These form the only mechanism of quality control: any suspect data values, including total garbage, are just flagged 'S' and not deleted from the data set. Users therefore ignore flags at their peril.

Navigation

Navigation on BOFS cruises was predominantly based on GPS combined with em-log, retrospectively corrected dead reckoning. The major source of positional error is therefore the intentional GPS degradation imposed to render the system useless for military purposes.

Temperature and Salinity

Temperature and salinity were usually measured by a thermosalinograph intercalibrated against CTD data and discrete salinometer salinity determinations. On cruises CD60 and CD61 a SeaBird 'CTD in a bucket' was used. On other cruises, the instrument was a TSG103. The thermosalinograph conductivity was not operational for Discovery 190. The salinity data present in the file were obtained from calibrated SeaSoar (towed undulating CTD) data.

Chlorophyll

Chlorophyll was measured by either a Turner Designs through flow fluorometer or a Chelsea Instruments Aquatracka fluorometer in a pond. Sometimes both types of instruments were deployed giving parallel chlorophyll channels. These were calibrated using extracted chlorophyll data, but the sophistication and quality of the calibration varied according to the availability of calibration data. Full details of the calibrations are given in the data documentation.

Attenuance

With one exception, optical attenuance was measured using a SeaTech 661 nm transmissometer with a 25 cm path length. The exception was Charles Darwin 60 where a 531 nm instrument was used. Corrections were applied wherever possible for light source decay. However, air readings were not always available and consequently some cruises remain uncorrected. Details are given in the data documentation.

Nutrients

Nutrients were measured by autoanalyser. During DI183 the determinations were done on discrete samples taken from the ship's non-toxic sea water supply. For the other cruises the autoanalyser was connected up to the non-toxic supply by a continuous filter block and the output voltages were logged on the ship's computers. A segmented baseline correction and calibration was subsequently determined and applied.

Dissolved Oxygen

Dissolved oxygen was determined using a pulsed electrode system calibrated against Winkler titrations on discrete samples.

Carbonate System

TCO_2 was determined coulometrically and recomputed per kilogram using calibrated thermosalinograph data. On Charles Darwin 60, a continuous filter block was used to remove coccoliths prior to analysis.

pCO_2 was measured using a shower head equilibrator and gas chromatography. Values are computed at in-situ temperature.

Alkalinity was measured by potentiometric titration. Some additional discrete surface spectrophotometric measurements are included in the 'kit-form' database.

pH was measured by glass electrode potentiometry in a continuous automated flow system with a free diffusion liquid junction.

Irradiance

For the 1989 cruises, photosynthetically available radiation was measured by a single planar Plessey light meter. On subsequent cruises, twin PML 2-pi PAR irradiance meters were used and a combined channel derived by taking the maximum of the two readings. Because of the geometrical differences between these instruments, the two data sets are NOT comparable except through complex mathematical relationships.

Solar radiation was measured by twin Kipp and Zonen planar solarimeters and a combined channel was generated by taking the maximum of the two readings. These are geometrically compatible with the Plessey meters but not the PML instruments.

Air Temperature

Air temperature was measured by either two (Discovery) or five (Charles Darwin) wet and dry bulb psychrometers located at various points on the ship. These were averaged to produce a single air temperature channel, excluding any anomalous data that were identified. In the case of Discovery 192, the match between the two instruments was so poor that the source data have been left in the data set so that users can make their own assessment of the severity of the problem.

Wind Velocity

Wind velocity was derived from the relative wind velocity, ship's velocity over the seabed and ship's heading.

Section D4

The CTD Plot Files

D4.1 Introduction

The CTD data form a significant part of the BOFS data set, with over 500 separate profiles. The CTD instrument used was a complex package including dissolved oxygen, fluorescence, optical transmittance and irradiance sensors in addition to temperature and conductivity.

Graphical images are useful aids to the assimilation of large quantities of numerical information. For example, questions such as 'was there a well-developed mixed layer at station 11865 (worked during Discovery 182)?' may be readily answered by a quick look at a set of CTD profile plots.

The problem is how to supply the CD-ROM user with such graphical information. The solution adopted was to produce a series of plot files in PostScript format which are presented on the CD-ROM. These may be either viewed on the screen (using a utility) or produced as hard copy by simply copying the file to a PostScript printer. The files were generated using the Uniras 6 PostScript driver.

The plots have been produced in black and white using different styles of dotted line to identify the different channels. Use of colour was avoided to allow hard copy to be produced on commonly available laser printers. Each plot is labelled with originator's identifier, date and time, position and cruise mnemonic.

D4.2 Plot Description

A sample profile plot is presented in figure D4.1. It can be seen that all channels are overlain on a common set of axes with individual scales on the X-axis. A maximum of 9 channels are displayed. If no good data were obtained for a parameter, that parameter is totally excluded from the plot including axis labels and the key.

Both X and Y scaling have been automatically adjusted following an algorithm which was designed to make comparison between plots as easy as possible. However, any such algorithm is inevitably a compromise and users are strongly advised to check the axis scales, particularly the X-axis, carefully when comparing plots.

The scales on the X-axis are labelled using the letters A-I which cross reference to a key giving the line style used and the parameter description, including units. Each plot is labelled with the originator's identifier for the CTD cast (field OID in the kit-form database file \DBKIT\INDEX\EVENT.CSV), the date and time when the cast was done (GMT), its position, and the cruise on which it was taken.

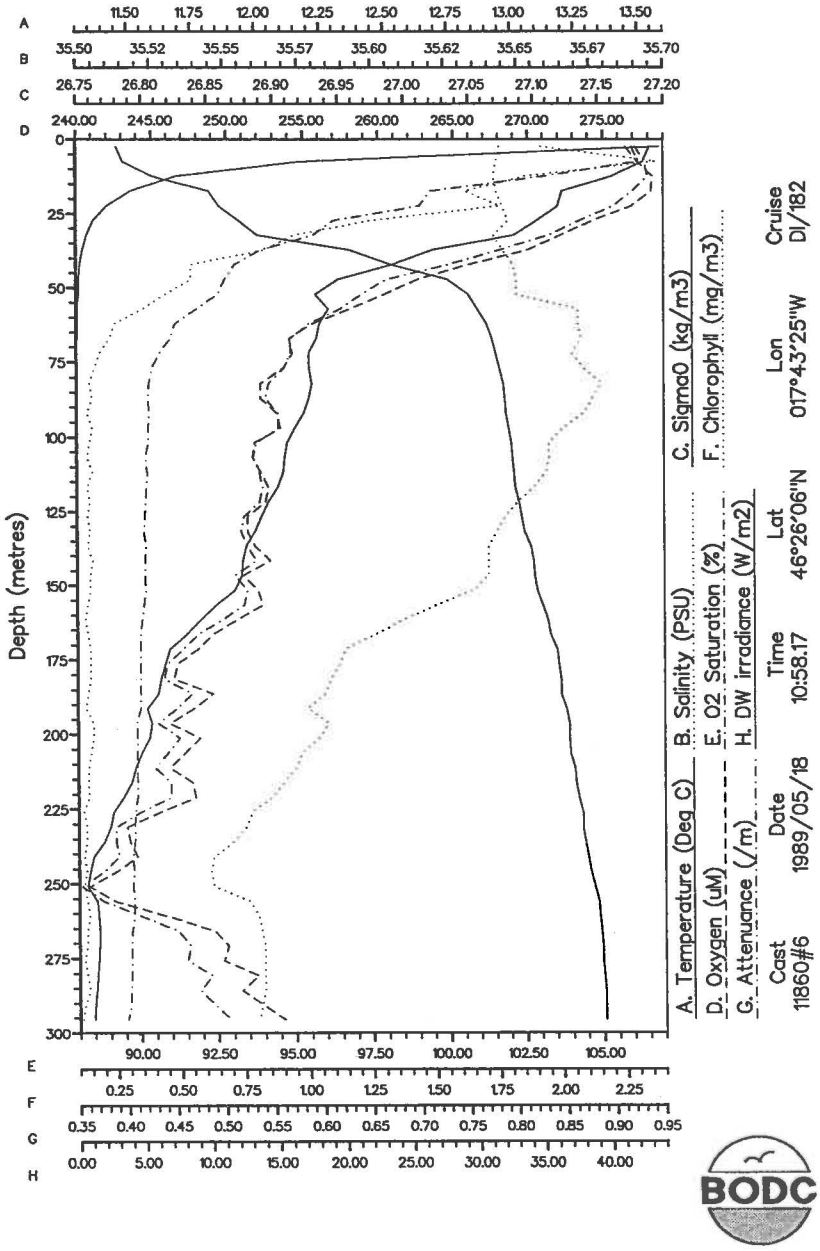


Figure D4.1: Example CTD Profile Plot

D4.3 **File Naming Convention**

The files are stored under the directory CTDPLOT. In this directory there is one subdirectory per cruise named using the cruise mnemonic. For example, the plot files for Discovery 182 are stored in the directory \CTDPLOT\DI182. Each plot file has the form PLTxxxxx.yyy where 'xxxxx' and 'yyy' make up the originator's identifier for the XTD cast. For example, the plot file for CTD cast 11864#57 is stored in file \CTDPLOT\DI182\PLT11864.57.

D4.4 **Using the Plot Files**

A collection of over 500 CTD plot files might seem at first sight to be a daunting prospect. If one is interested in all data from a particular cruise, the problem is reduced to reasonable proportions through the directory structure used. Even then, some cruises have of the order of 100 CTD casts and wading through these to find just what is required is a major task.

Some form of indexing is obviously required which is provided by the 'kit-form' database file \DBKIT\INDEX\EVENT.CSV. This file may be perused using a text editor or wordprocessor but it contains thousands of entries and scanning through these for CTD data from a particular latitude might not appeal to most users.

The answer is provided by commercial database software. The job of extracting the subset of records that are of interest may be handled with equal ease using any of the workstation (or mainframe) relational database packages (Oracle, Ingres, Empress and the like) or with the current generation of PC (or Mac) based packages.

Microsoft Access has been used as a test bed. Loading the data file into the system took ten minutes. Creating a display form took a further five. Once this was done, the record filter capability of the package made searching for exactly what was required a pleasant and easy task. Whilst it has not been tested, information from reviews on Borland Paradox indicates that it would be equally suited to the task. Other packages may also do the job but, one suspects, not as easily.

If one is working in a PC/Mac environment and no database program is available an alternative would be to use a spreadsheet package. Whilst more suited to the task than a text editor, this has to come a poor second to a database package which was designed for precisely this kind of task. It's a bit like the difference between a Stilson wrench and a good set of spanners.

Once the CTD cast or casts have been identified, locating the plot files is a simple task. In the EVENT record there is the cruise mnemonic which locates the directory of interest and the OID field is used as shown above to derive the filename.

The chosen plot files may then be printed by simply copying them onto a PostScript printer or viewed using the public domain program GhostScript.

Section D5

Kasten Core X-Ray Images

D5.1 Introduction

On Discovery 184, a set of Kasten cores was taken from a number of locations close to 20°W, north of 47°N. Kasten cores are typically up to 3m long, penetrating into Holocene sediments, and 15cm square. After removing a 6cm slice along the length of the core, plastic trays (33cm by 15cm by 2cm deep) were pressed into the remaining core and released using cheese wire.

These samples were X-Rayed on board ship and the negatives printed to produce positive composite images. These were pieced together to produce an X-Ray image along the whole length of the core. These were supplied to BODC where they were scanned, merged with computer-generated scale bars and added to the CD-ROM.

D5.2 The Kasten Cores

X-Ray images are included for the following Kasten cores:

Cambridge Name	Discovery Name	Date	Latitude	Longitude
2K	11879#2	20/7/89	47.7697	-21.6250
3K	11880#2	21/7/89	47.7845	-20.3200
4K	11881#5	25/7/89	49.8475	-21.2720
5K	11882#4	26/7/89	50.6876	-21.8630
6K	11883#3	27/7/89	51.1155	-21.2000
7K	11884#4	28/7/89	51.7531	-22.5390
8K	11886#2	30/7/89	52.5033	-22.0620
9K	11889#2	31/7/89	53.6963	-21.3200
10K	11890#2	01/8/89	54.6671	-20.6540
11K	11891#4	01/8/89	55.1928	-20.3460
14K	11896#1	03/8/89	58.6288	-19.4350
15K	11898#1	04/8/89	59.0894	-20.1130
16K	11902#1	07/8/89	59.4693	-23.2430
17K	11905#1	10/8/89	58.0010	-16.5010

D5.3 Digitisation Procedures

The material arrived at BODC as strips up to 3m long and 12.5cm wide made up of 33cm (approx.) segments joined together. It was decided that separating the segments was unwise due to the risk of damage and of getting the unlabelled segments out of order. Consequently, the use of a flatbed A4 scanner was ruled out as such scanners are invariably hinged along their short axis. However, scanning long images accurately with a hand scanner is virtually impossible.

The problem was solved by building a jig for the hand scanner. The photograph was clamped to the base of the jig and the scanner was kept accurately on track by rails along each side. The joins between the individual photographs were not perfectly flat. Consequently, each segment was scanned as a separate image to prevent distortion when the scanner ran over these joins.

The images were scanned using a Logitech ScanMan 256 level grey scale hand scanner. The scan head was not wide enough for the image to be recorded on a single pass. As a result, the image was recorded in two overlapping passes which were stitched together using the FotoTouch software supplied with the scanner. This proved to be a simple and effective procedure.

The images were saved out of FotoTouch in PCX format and processed using a bespoke program to incorporate the scale bars. After viewing to check the scale bars against actual measurements on the photographs, the images were converted into Tagged Image Format (TIF) format using FotoTouch.

TIF format has been used because it is generally regarded to be the most portable image format between platforms. Unlike the compressed TIF format used for satellite images (see section D6), the TIF files produced by FotoTouch have proved to be highly portable and have been successfully imported into every shareware and commercial image handling package available for testing.

Should any problem be encountered reading the TIF files or if another format is specifically required, the shareware package Paintshop Pro may be used to import the data and export them into a wide range of formats including JIF, BMP and PCX.

D5.4 **File Naming Convention**

The files are all stored in directory KASCORE. Underneath this are a series of subdirectories, one for each core, named using the originator's convention (modified to avoid a leading digit) such as K5, K8 etc.. Within each subdirectory are two types of file: image files and core description files.

The image files are named using the convention PARTx.TIF where x is a single digit number. Each image represents approximately 33cm of the core and the files are numbered from 1 at the top of the core. Thus the file KASCORE\K5\PART1.TIF contains the image of the top 33cm of Kasten core K5.

The core description files contain plain language descriptions of the core sections that were supplied with the photographic material. These are named using the convention BOFSxxx.yyy where xxx is the originator's name for the core. The file extension, yyy, specifies the format of the document which is either WordPerfect 5.1 (.WP), flat ASCII text (.TXT) or PostScript (.PS). For example, the flat ASCII description of core K5 is in file KASCORE\K5\BOFS5K.TXT.

D5.5 **Using the Image Files**

The scale of the core image data set is small enough to allow it to be navigated with

ease using the description of the directory structure given above. Simply move to the directory of the core of interest and view the images in ascending numerical order.

Viewing the images is simply a matter of loading them into a suitable utility. Paintshop Pro is a shareware Windows utility which is both readily available and ideally suited to the purpose. The package is not simply a viewer: images may be printed, resized, subsampled, filtered, contrast adjusted or exported in different formats using the package. Packages offering similar capabilities abound in both the shareware and commercial sectors of the software market.

The core descriptions may be accessed in a number of ways. The flat ASCII versions may be read by loading them into any text editor or word processor. Windows users will find that if the directories are examined using File Manager, the .TXT files may be read in Notepad by simply double clicking them.

The WordPerfect and PostScript versions of the files are more aesthetically pleasing than the flat text files. The WordPerfect files may be read using most of the modern word processors. Hard copy may be produced from the PostScript files by copying them to a suitable printer.

Section D6

BOFS Satellite Images

D6.1 Introduction

During the BOFS programme, significant efforts were made to supply research vessels at sea with processed satellite images in as near to real time as possible to assist in the direction of cruise operations.

During 1989 and 1990, the techniques were developed and a small number of images were sent to the ships at sea. However, largely due to abundant cloud cover, the results were useful but not dramatic. Drama came in 1991 when clear skies and a massive coccolitophore bloom coincided with cruise Charles Darwin 60. The resulting images not only influenced the scientific programme of the cruise but also clearly showed the evolution of structure in the North Atlantic over a period of several days.

The images were taken by the AVHRR on the NOAA satellites and show reflectance in either the visible or infra-red bands. A full description of the image processing methodology, the images themselves and bibliography are included with the data on the CD-ROM.

D6.2 File Naming Convention

The images are presented in the directory SATIMG. The filenames reflect the date on which the image was taken, followed by an 'I' for infra-red images. Thus the visible image for 17th June 1991 is in file 17JUN91 and the infra-red image for the same day is in file 17JUN91I.

The file extension refers to the image format. This is either TIF or PCX. Every image is present in both formats. The reason for this is that the images were supplied to BODC and copied onto the CD-ROM in a compressed variant of TIF. It was found that several packages had problems reading this format. In fact, of the packages available, only Paintshop Pro could import the images. Consequently, they were converted into PCX to make them accessible to a wider range of software packages.

The image documentation is contained in the directory DOCU\SATIMG which contains a single document (SATIMG) in three formats as shown by their file extension. These are flat ASCII (.TXT), WordPerfect 5.1 (.WP) and PostScript (.PS). The document may be consulted using a text editor or Windows Notepad (.TXT), most modern word processors (.WP) or as hard copy by copying the .PS file to a PostScript printer. For convenience, the same document is included in flat ASCII format in the SATIMG directory under the name README.TXT.

D6.3 **Using the Image Files**

The scale of the satellite image data set is small enough to allow it to be navigated by simply browsing through the contents of SATIMG directory.

Viewing the images is simply a matter of loading them into a suitable utility. Paintshop Pro is a shareware Windows utility which is both readily available and ideally suited to the purpose. The package is not simply a viewer: images may be printed, resized, subsampled, filtered, contrast adjusted or exported in different formats using the package. This is the only package tested by BODC which was able to import the files in TIF format. Windows users should not forget that PCX files may be viewed using the Paintbrush package in the accessories program group.

Appendix 1

File Formats Used on the CD-ROM

A1.1 Introduction

Much of the data on the CD-ROM is supplied as simple comma separated value (CSV) or flat ASCII files which require no further documentation. However, the surface underway data set is present in a structured binary format termed 'binary merge format'. Software utilities are supplied with the CD-ROM which will satisfy the requirements of users equipped with PC clones. However, due to the flexibility of ISO 9660, it is possible to access the data on the CD-ROM from other platforms such as Unix or Macintosh.

Users on these platforms wishing to access the underway data will need to develop interface software. The description of binary merge format in this section is provided to make this possible.

A1.2 Binary Merge Format

Binary merge format is a binary format for the compact storage of high volume time series data. The format was initially developed for use on an IBM main-frame and subsequently adapted for use on Unix workstations.

The file structure comprises a single header record followed by the datacycles. All the data on the CD-ROM in binary merge format have a regular time channel with a sampling interval of 30 seconds.

The structure of the header record is:

Cruise identifier	- 12 byte character
Pointer to first data record	- 4 byte integer
Pointer to last data record	- 4 byte integer
Number of data channels excluding date and time (always present)	- 4 byte integer
Processing status mask	- 4 byte integer
Data source indicator	- 4 byte integer
Project indicator word	- 4 byte integer
Padding	- set to binary zero
Channel identifiers	- 1 byte per flagged channel

The cruise identifier is of the form DInnn/yy (for Discovery cruises) or CDnn/yy (for Charles Darwin cruises) where nn is the cruise number and yy is the year in which the data were collected. It is stored in ASCII character code.

The processing status mask indicates the data processing operations to which the data have been subjected. The principle of a bit mask is that each bit in the word is

given a specialised meaning. In the description of the meanings of each bit below, the description is true when the bit is set on. The bit numbering convention used is 1 (most significant) through 32 (least significant).

The bit meanings are:

1 - Thermosalinograph salinity calibrated
2 - Thermosalinograh temperature calibrated
3 - Navigation checked and gaps filled by interpolation
4 - Unassigned
5 - Unassigned
6 - Unassigned
7 - Unassigned
8 - Transmissometer converted from voltage to attenuance
9 - Unassigned
10 - Unassigned
11 - Unassigned
12 - Unassigned
13 - Unassigned
14 - Unassigned
15 - Unassigned
16 - Phosphate baseline correction applied
17 - Phosphate calibrated
18 - Nitrate calibrated
19 - Nitrite calibrated
20 - Silicate calibrated
21 - Silicate drift corrected
22 - Ammonia calibrated
23 - File has been workstation screened
24 - Irradiance channels calibrated
25 - Nitrate baseline corrected
26 - Nitrite baseline corrected
27 - Silicate baseline corrected
28 - Ammonia baseline corrected
29 - Urea baseline corrected
30 - Urea channel calibrated
31 - Unassigned
32 - Unassigned

The data source and project indicator words have no relevance to the data stored on the CD-ROM. They will always be set to zero and one respectively.

The padding words are included to ensure that the header contains the same number of bytes as the data records which follow. Consequently, the number of words of padding depends upon the number of data channels (it is in fact the number of data channels minus 7).

The channel identifiers are single characters, encoded in ASCII, which specify the channels (other than date and time which are always present) in the file. The order of the identifiers in the header specifies the order of the data channels in the data records.

The channel identifiers are defined as follows:

A = Latitude (deg +ve N)
B = Longitude (deg +ve E)
C = Temperature (C)
D = Raw fluorescence from Turner Designs through-flow fluorometer
E = pCO_2 (µatm)
F = Salinity (PSU)
G = Chlorophyll from Turner Designs (mg/m^3)
H = TCO_2 (µmol/kg)
I = Optical attenuance (per m)
J = Bathymetric depth (m)
K = Distance run (km)
L = Photosynthetically available radiation (W/m^2)
M = pH (pH units)
N = Temperature of the pH determination (C)
O = Solar radiation (W/m^2)
P = Ammonia (µM)
Q = Dissolved oxygen at in-situ temperature and salinity (µM)
T = Nitrate + nitrite (µM)
U = Nitrite (µM)
V = Phosphate (µM)
W = Silicate (µM)
Y = Absolute wind speed (knots)
Z = Absolute wind direction (degrees from which the wind blows)
1 = Barometric pressure (mb)
2 = Dry bulb air temperature from port bridge sensor (C)
4 = Dry bulb air temperature from starboard bridge sensor (C)
/ = Long wave radiation (W/m^2)
? = Raw signal from Chelsea Instruments Aquatracka fluorometer (V)
! = Chlorophyll from Aquatracka (mg/m^3)
_ = Attenuance calibrated in terms of calcite ($mg\ Ca/m^3$)
} = Potentiometric alkalinity (µEq/kg)
a = Combined dry bulb air temperature (C)
b = Combined wet bulb air temperature (C)

At the right hand end of the header record are up to 3 blank padding bytes to ensure that the record length is a multiple of 4 bytes (to allow it to be specified in terms of words). The same number of padding bytes is also added to each datacycle record.

Each datacycle contains the date (word 1), time (word 2), the data values (words 3 to number of channels plus 2) and their flags. Date is stored in binary integer form as a 'Loch day number', defined as the number of days elapsed since the start of the Gregorian calendar. Time is stored in IEEE binary floating point representation (as used on Unix systems) as a day fraction (06:00 = 0.25, 12:00 = 0.5 etc.).

The data values are stored as IEEE binary floating point numbers in the order prescribed by the channel identifiers in the header. At the rightmost end of the record are the data quality control flags occupying one byte each. The flag definitions used are as follows:

B - Bad data
G - Good data
I - Interpolated data
N - Null data
S - Suspect data
U - Data outside range of calibration

The main problem awaiting those who wish to access the binary merge files without the assistance of the software interface provided is the conversion of 'Loch day numbers' into calendar dates. IEEE floating point structure is rapidly establishing itself as a de facto standard and therefore should not prove to be a problem.

The following subroutine listings, one in Fortran and one in Pascal, convert a Loch day number into year, month and day.

```
      SUBROUTINE CMAADY(IDY,IDATE)
C#S   ************************************************************
C      TITLE - S CMAADY   VR - 1.0   AUTHOR - MDBS/SGL   DATE - 79FEB01
C
C      S/R calculates date given the number of (complete) days since
C      1760.01.01  (= 0 days elapsed). Not valid for 21'st century
C#E   ************************************************************
C
C  ARGUMENTS
C  ---------
C
C   IDY       -      No. of complete days elapsed
CO  IDATE     -      3 element array containing 1) year, 2) month
C                    and 3) day of month
C
      DIMENSION IDATE(3)
      INTEGER MONTH(12)/0,31,59,90,120,151,181,212,243,273,304,334/
      IC  =  0
C
      IDYC0 =  IDY - 51133
      ICEN  =  19
  10    IF(IDYC0.GT.0) GO TO 20
        ICEN  =  ICEN - 1
        IDYC0  =  IDYC0 + 36524
        GO TO 10
  20  IDYC  =  IDYC0 - 365
      IF(IDYC.GT.0) GO TO 30
      IDYC = IDYC0
      IDATE(1)  =  ICEN*100
      GO TO 40
C
C  NOW DETERMINE NO OF FULL LEAP YEAR CYCLES PRESENT
C
   30 NLPYR  =  (IDYC-1)/1461
      IYR  =  4*NLPYR
      IDYC  =  IDYC - NLPYR*1461
      IYRX  =  (IDYC-1)/365
      IF(IYRX.EQ.4) IYRX = 3
      IDYC  =  IDYC -  IYRX*365
      IDATE(1)  =  IYR + IYRX + ICEN*100 + 1
      IF(IYRX.EQ.3) IC = 1
C
C  NOW GET MONTH AND DAY
C
   40 L  =  13
      DO  50  I =1,12
```

```
        L  =  L - 1
        IF(L.EQ.2) IC = 0
        MN  =  MONTH(L) + IC
        IF(IDYC.GT.MN) GO TO 60
   50   CONTINUE
C
   60 IDATE(2) = L
      IDATE(3) = IDYC - MN
C
      RETURN
      END
```

```
Type
  IntArr = Record
             Y : Word;
             M,D : Byte
           End;
Const
     M o n t h S u m     :     A r r a y [ 1 . . 1 2 ]     o f
Word=(0,31,59,90,120,151,181,212,243,273,304,334);

Procedure Cmaady(Var Idy : LongInt; Var tDate : IntArr);
{     S/R calculates date given the number of (complete) days since  }
{     1760.01.01  (= 0 days elapsed). Not valid for 21'st century    }
Var
  iC,iCen,nLpYr,iYr : LongInt;
  mn,i,L,iYrx : LongInt;
  iDyc,iDyc0 : LongInt;
Begin
  IC := 0;
  IDYC0 :=  IDY - 51133;
  ICEN :=  19;
  While IDYC0 <= 0 Do
  Begin
    ICEN := ICEN - 1;
    IDYC0 := IDYC0 + 36524
  End;
  IDYC := IDYC0 - 365;
  IF IDYC<=0 Then
  Begin
    IDYC:= IDYC0;
    tDate.Y:= ICEN*100
  End
  Else
  Begin
    {  NOW DETERMINE NO OF FULL LEAP YEAR CYCLES PRESENT }
    NLPYR := Trunc((IDYC-1)/1461);
    IYR  :=  4*NLPYR;
    IDYC  :=  IDYC - NLPYR*1461;
    IYRX  :=  Trunc((iDYC-1)/365);
    IF IYRX=4 Then
      IYRX := 3;
    IDYC  :=  IDYC - IYRX*365;
    tDate.Y :=  IYR + IYRX + ICEN*100 + 1;
    IF IYRX=3 Then
      IC := 1
  End;
  { NOW GET MONTH AND DAY }
  L := 13;
  I:=1;
  While I<13 Do
  Begin
```

```
    L := L-1;
    IF L=2 Then
      IC:= 0;
    MN := MonthSum[L] + IC;
    IF IDYC>MN Then
      I:=13
    Else
      Inc(I)
  End;

  tDate.M:= L;
  tDate.D:= Integer(IDYC) - Mn
End;
```

British
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British Oceanographic Data Centre, Proudman Oceanographic Laboratory,
Bidston Observatory, Birkenhead, Merseyside L43 7RA, United Kingdom