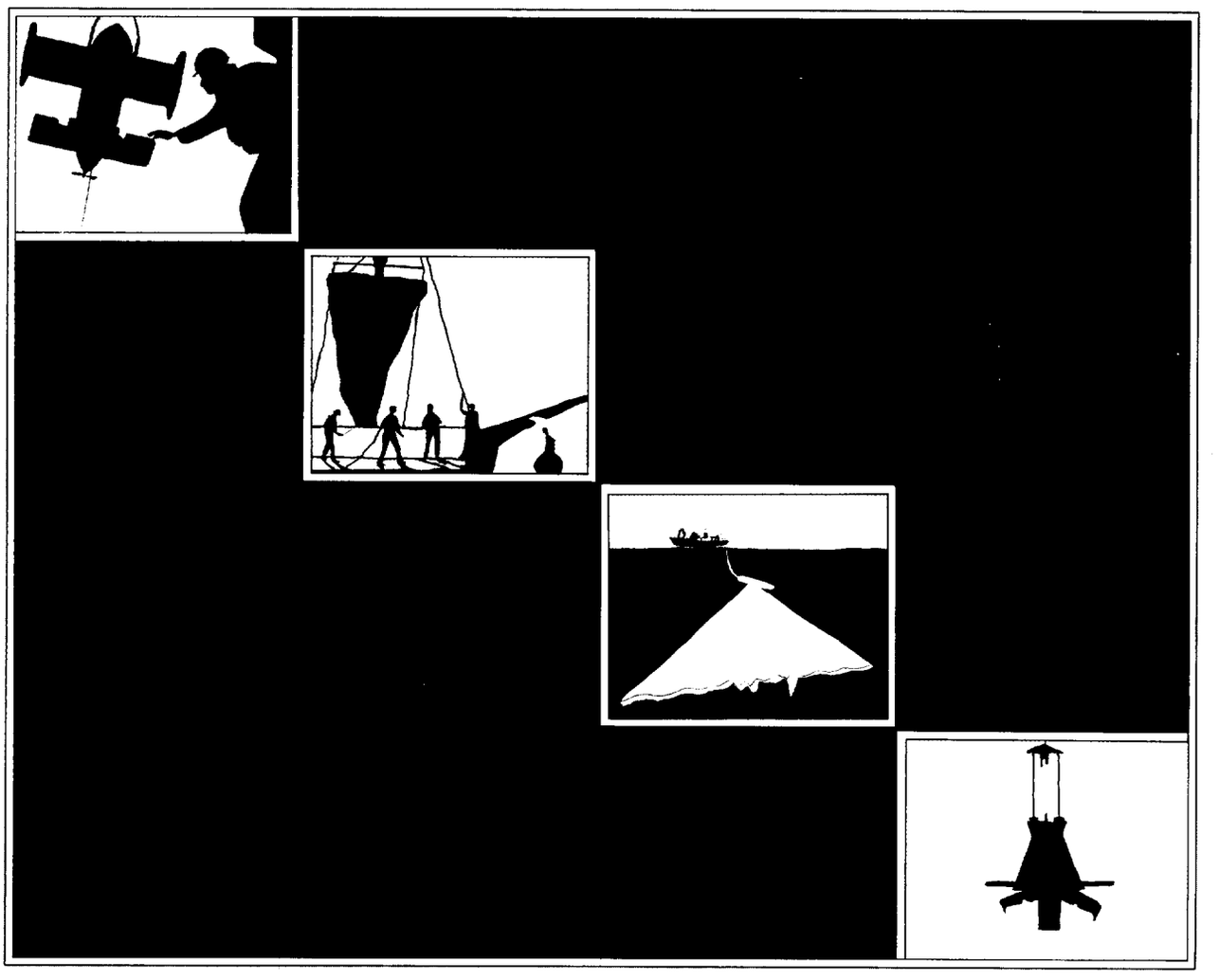
Institute of
Oceanographic Sciences
Deacon Laboratory

GEOPLOT: User guide and programmer's guide

S D Buxton & T P LeBas

Report No 279 1990



INSTITUTE OF OCEANOGRAPHIC SCIENCES

DEACON LABORATORY

Wormley, Godalming,
Surrey, GU8 5UB, U.K.

Telephone: 0428 79 4141
Telex: 858833 OCEANS G
Telefax: 0428 79 3066

Director: Dr. C.P. Summerhayes

INSTITUTE OF OCEANOGRAPHIC SCIENCES

DEACON LABORATORY

REPORT NO. 279

GEOPLOT: User guide and programmer's guide

S D Buxton & T P LeBas

1990

DOCUMENT DATA SHEET

AUTHOR
BUXTON, S D & LEBAS, T P

PUBLICATION DATE 1990

TITLE

GEOPLOT: User guide and programmer's guide.

REFERENCE

Institute of Oceanographic Sciences Deacon Laboratory, Report, No. 279, 89pp.

ABSTRACT

The program GEOPLOT can plot ship's tracks and their associated geophysical data in several ways. This report is intended as a complete guide for both users and programmers. It gives full instructions and example plots for the novice user. For the programmer it includes a structural description of the program and all its subroutines, together with details of the library subroutines used.

KEYWORDS

COMPUTER GRAPHICS
COMPUTER PROGRAMMES
DATA PROCESSING
GEOPHYSICAL DATA
INSTITUTE OF OCEANOGRAPHIC SCIENCES - cruises

ISSUING ORGANISATION

Institute of Oceanographic Sciences
Deacon Laboratory
Wormley, Godalming
Surrey GU8 5UB. UK.

Director: Colin Summerhayes DSc

Telephone Wormley (0428) 684141
Telex 858833 OCEANS G.
Facsimile (0428) 683066

Copies of this report are available from: ***The Library,***

PRICE £23.00

CONTENTS Page

1 INTRODUCTION

1.1 The Data

Cruises by the Institute of Oceanographic Sciences Deacon Laboratory and other organisations collect geophysical data such as bathymetry, magnetics and gravity. During the cruises the data is recorded on tape in Merge-Merge format, together with navigational fixes and time. The completed tapes are loaded on the Natural Environment Research Council's IBM 4381 computer at Wormley, Surrey, and the data is placed in the ORACLE database system. It may be retrieved from the database by specifying either the name of the cruise or a geographical area [Drake & Miles, 1985; LeBas & Evans, 1988].

Data Description:

Cruise name:	consists of an abbreviation of the ship's name and a reference number, eg DIS161 is *Discovery* cruise number 161. This generally has a maximum of 8 alphanumeric characters.
Date:	day, month and year, e.g. 010289 represents 1st February 1989.
Time:	hour and minute, GMT, e.g. 1620 represents 4.20 pm.
Latitude and longitude:	in decimal degrees (to 4 or 5 decimal places). Negative values correspond to the Southern Hemisphere and west of the Greenwich Meridian, respectively.
Water depth:	in metres, measured using an echo sounder, uncorrected for variation in transmission speed through the water column. Assumed velocity = 1500 m/s.
Water depth:	in metres, corrected using Carter's tables [Carter, 1980].

Total magnetic field:	in nanoteslas, acquired using a proton precession magnetometer towed behind the ship.
Residual magnetic anomaly:	in nanoteslas, calculated by taking the background magnetic field for that area and time (given by the International Geomagnetic Reference Field [IAGA 1986]) from the total magnetic field.
Free air anomaly:	in milligals, calculated from the 1967 geodetic reference system [UGGI, 1971] and readings from the onboard gravimeter.

1.2 Program Features

GEOPLOT is a program for plotting cruise data on a chart. A simple map of the ship's track may be produced, or the data (as described in the previous section) may be plotted on the track. Options include:

Plotting bathymetry, magnetic or gravity data as a series of number annotations.
Plotting profiles of bathymetry, magnetic and gravity data along the ship's track.
Plotting the sections of the track where certain chosen data is available.
Plotting dates and times on the track.
Plotting cruise names on the track (especially useful when the data has been obtained by an area search and several cruise tracks cross each other).

The program will accept data in Merge-Merge format, or from the ORACLE database, or in the standard MGD-77 format [USDC, 1981]. It is also possible to enter a user-defined format.

The form of the chart can be controlled by specifying different map projections, adding a grid of latitude and longitude, and by changing the colours used within the plot. Plots may be displayed on graphics terminals (including PCs emulating graphics terminals) or sent to pen plotters, both colour and black & white.

2 USER GUIDE

The purpose of this section is to explain how to use GEOPLOT to plot cruise data. Details of the programming language, program structure, etc. can be found in the programmer's guide which follows.

It gives a step-by-step description of how to run the program, how to operate it, and how to produce plots on paper.

2.1 Running the Program

2.1.1 Hardware and software requirements

GEOPLOT runs on an IBM 4381 mainframe with the CMS operating system together with a GRAFIX/GKS graphics system. Output devices supported are IBM 3192 and Tektronix 4205/4211 graphics terminals, Calcomp 1075 colour plotter, Versatec 80 black and white plotter and IBM PS/2 in Tektronix 4205 emulation mode. GEOPLOT itself requires two files: GEOPLOT EXEC and TRACKS MODULE.

2.1.2 Starting GEOPLOT

There are two ways of starting the program. One is simply to type 'GEOPLOT'. If this is done the screen will prompt you for the name of the file containing the data to be plotted. The name can then be typed at the keyboard. If the file mode is omitted it is assumed to be 'A'; if the file type is omitted it is assumed to be 'IN'.

e.g	CRUISE DATA G	will cause the computer to search for the file CRUISE DATA on your G disk.
	CRUISE DATA	will cause the computer to search your A disk.
	CRUISE	will cause the computer to search for the file CRUISE IN on your A disk.

Alternatively the program can be started by entering 'GEOPLOT' followed on the same line by the file name, e.g. 'GEOPLOT CRUISE DATA', which will use CRUISE DATA on your A disk as its input data file.

There is a short delay while the graphics are initialised and the program is loaded. When this is completed the screen clears and the program title and a menu of options are displayed.

2.2 Using the Program

When the program has finished loading an initial menu of options is displayed:

1 Plot ship's track only
2 Plot data annotation along track
3 Plot data profile along track
4 Plot ship's track only when data valid
5 Plot ship's track with time
6 Plot ship's track with cruise names
7 Plot data profiles and time along track

Type the number of the option required and press ENTER.

2.2.1 Plotting the ship's track only

The ship's track is plotted on a map annotated with latitude and longitude. Any coastlines within the area covered by the map are also plotted.

2.2.2 Plotting data annotation along track

The program offers a choice of three different variables for annotation:

1 Depth
2 Residual Magnetic Anomaly
3 Free Air Anomaly

If you choose depth you are asked:

Corrected depth? (Y/N)

Answering 'N' to this question will give the original uncorrected depth data. Answering 'Y' will give the depth corrected for variation in water transmission speed through the water column [Carter, 1980]. If any corrected depths are missing from the data file it is possible to plot uncorrected depths to fill the gap. This is done by replying 'Y' to the question which follows:

Use uncorrected depth if corrected is unavailable? (Y/N)

If you choose residual magnetic anomaly, you are given the dates of the latest DGRF (Definitive Geomagnetic Reference Field) and the IGRF (International Geomagnetic Reference Field). A new IGRF is defined every five years. The old one is corrected and becomes a DGRF [IAGA, 1986]. The residual magnetic anomaly contained in the data file will have been calculated from the total field using the IGRF current at the time of data acqusition. Thus it is often possible to get a more accurate residual anomaly by recalculating it using an improved reference field. This is done by replying 'Y' to the question:

Recalculate Residual Magnetic Anomaly ? (Y/N)

The variable selected is plotted as a series of numbers along the course of the ship's track. If uncorrected depths are being used to fill gaps in the corrected depths, the uncorrected depths are plotted in a different colour, so that they can be identified. To avoid overcrowding the plot, numbers are only plotted when they do not overlap with the previous value plotted.

2.2.3 Plotting data profiles along the track

A data profile is a line plotted on top of the ship's track which shows how a value varies along its course. The value is represented by the displacement of the profile from the line representing the ship's track.

Profiles may be plotted of the same three variables described above:

1 Depth
2 Residual Magnetic Anomaly
3 Free Air Anomaly

Since it is possible to plot more than one profile on the same track you can choose more than one variable. The variables are selected by typing the appropriate number and pressing ENTER. An asterisk appears next to the number in the menu to show it has been selected. If you choose a variable by mistake you can cancel it by entering its number again. When you are ready to proceed press ENTER without typing a number.

Next you will be asked for the bearing for the data profiles. This is an angle between 0° and 360° measured clockwise from north. The bearing is the direction in which the profile is to be offset from the ship's track. It should usually be approximately perpendicular to the direction of the track, if possible.

The program then asks for two values for each variable to be profiled. These are the 'Scaling factor for data', a value to convert from the variable's units to sheet millimetres, and an 'Origin to be subtracted' from the scaled value, also in millimetres. Default values for the scale and origin are supplied, which should suit most plots. These are available by pressing ENTER when the program requests these values. The default values are:

	Scale	Offset
Depth	5 mm / 1000 m	0 mm
Residual Magnetic Anomaly	10 mm / 100 nanoteslas	0 mm
Free air Anomaly	20 mm / 100 milligals	0 mm

As with annotation plots and depending on the variables selected, you may be asked the following questions:

Corrected depth? (Y/N)
Use corrected depth if corrected is unavailable? (Y/N)
Recalculate residual magnetic anomaly? (Y/N)

These questions are explained in section 2.2.2.

2.2.4 Plotting the ship's track only when the data is valid

This is essentially the same as the first option ('Plot ship's track only') except that if a specified variable is absent from the data file the track will not be plotted.

The variable is selected from the three described above:

Depth
Residual Magnetic Anomaly
Free Air Anomaly

If you select depth you are given the option of corrected or uncorrected depth, as in section 2.2.2.

2.2.5 Plotting the ships track with time

With this option the track is annotated with the day and/or time that the ship was sailing along each part of the track. You will be asked for a tick interval in minutes. It must either be an exact division of an hour (e.g. 30 minutes) or an exact multiple (e.g. 60 minutes, 120 minutes, 180 minutes etc.). This controls how often the time is marked on the track.

The information plotted depends on the tick interval. If it is 1440 minutes (one day) or greater, the Julian day number is plotted. The Julian day number is a number between 1 (1st January) and 365 (31st December) in a non-leap year, or 1 and 366 in a leap year.

If the tick interval is less than 1440 minutes, the time in hours and minutes is plotted, e.g. 2145. This is except for every 6 hours, when the Julian day number and hour are plotted, e.g. noon on the 16th October 1990 is equivalent to 1200, day 289, and would be plotted as 289/12.

2.2.6 Plotting the ship's track with cruise names

With this option the beginning of each section of the ship's track (i.e. every uninterrupted line) is annotated with the cruise name and Julian day. This information is also plotted at the start of each new day. This is useful if the data file contains the results from more than one cruise.

2.2.7 Plotting data profiles and time along track

This is a combination of options to give data profiles annotated with the time (as described in sections 2.2.3 and 2.2.5).

2.2.8 Choosing devices

After setting up the type of plot required, the next stage is to choose an output device. The program allows four different devices:

1	Graphics Terminal (IBM 3179 or Tektronix 4211 directly connected)
2	Calcomp (Calcomp 1075 colour plotter)
3	Versatec (Versatec 80 B+W plotter)
4	IBM PS/2 (Emulating a Tektronix 4205)

It is possible to select more than one device. Type the number of each device required and press ENTER. Asterisks will appear next to the numbers to show which devices have been selected. To cancel a selection re-enter the appropriate number. When you are ready to proceed press ENTER without typing a number.

2.2.9 Choosing a projection

Once the devices have been selected, the next stage is to choose a map projection. This is selected from a list of five:

1	Ellipsoidal Mercator
2	Universal Transverse Mercator
3	Gnomonic Transverse
4	Lambert Cylindrical
5	Orthographic Transverse

Type the number of the projection and press ENTER.

The irregular projections (2, 3 and 5) require you to enter a central meridian. This is the line of longitude which will be plotted as a straight vertical line and which should pass through the area covered by the map. All longitudes are entered as a decimal number of degrees between -180 and 180. Positive numbers are used for degrees east and negative for degrees west.

For all projections it is necessary to enter a standard latitude. This is the latitude at which the scale is correct (see choosing an area, section 2.2.10). All latitudes are entered as a decimal number of degrees between -90 and 90. Positive numbers are used for degrees north and negative for degrees south.

2.2.10 Choosing an area

When you have set up a projection the program will require you to choose the area to be covered by the map. This is done by asking for a series of longitude and latitude limits, in the order:

Longitude of left edge
Longitude of right edge
Latitude of lower edge
Latitude of upper edge

Latitudes and longitudes are entered in degrees, with north or east values being positive and south or west values being negative. Note that if the value entered for the right edge is less than that entered for the left edge, the program will assume that the map is to cross the 180° meridian.

2.2.11 Choosing a scale

Once the area has been entered the program calculates a range of scales which will produce a map of a sensible size. The calculations are based on the Ellipsoidal Mercator Projection but provide a rough guide for all projections. An example display is given below.

Suggested scales:	
Approximate size	Scale
100 mm N-S, 100 mm E-W	1140000
200 mm N-S, 200 mm E-W	570000
400 mm N-S, 390 mm E-W	290000
800 mm N-S, 780 mm E-W	140000

After displaying the suggested scales the program asks:

Scale (eg 0.0000001 or 10000000)

If the entered scale is less than 1 it is treated as a fraction (e.g. 0.0000001 = 1 : 10,000,000) otherwise it is treated as the 'x' in the ratio '1:x' (e.g. 10000000 = 1 : 10,000,000). You may also enter the scale in scientific notation (e.g. 10E6 or 1E–7).

2.2.12 Completing the input

The final question asked is:

Title (up to 45 characters)

The purpose of the title is to identify the map. It is plotted in the box containing a description of the map (see section 2.3). If the title has more than 45 characters it will be truncated.

When you have entered the title a summary appears on the screen giving title, grid limits, scale, projection and output devices. At this stage you are asked if you want to re-enter the parameters. Replying 'Y' will take you back to the start of the program. For each question the program asks you can either enter a new response, or press ENTER to keep the old response. The old one is displayed on the screen so that you can check it. When you reach the question 'Re-enter these parameters?' again press 'N' to continue or 'Y' to make further changes.

2.2.13 Changing default parameters

At this point the program is ready to begin the plot. However you may want to change some of the default values for the plot and data file. These values are displayed at the top of the screen:

Format	Oracles
Grid	On
Coastline	Black
Track	Black
Annotation	Black
Bathymetry	Green
Magnetics	Red
Gravity	Blue

Below that is a menu:

Please select an option:

1. Choose different format
2. Turn grid off
3. Change default colours
4. Start plot

Entering 1 allows you to change the format that the program will use to read the data file. The preprogrammed formats are:

1. ORACLES (ORACLE relational database format)
Fixed length lines, 80 characters per line, two-line header

Cruise name	A8
Day	1X, I2
Month	1X, I2
Year	1X, I2
Hour	1X, I2
Minute	I2

Latitude	2X, F9.4
Longitude	2X, F9.4
Uncorrected Depth	2X, F5.0
Corrected Depth	2X, F5.0
Total Mag. Anomaly	2X, F5.0
Resid. Mag. Anomaly	2X, F5.0
Free Air Anomaly	2X, F5.0

2. Merge-Merge (DXFMT)

Fixed length lines, 80 characters per line, no header

Cruise name	A8
Year	5X, I2
Month	I2
Day	I2
Hour	1X, I2
Minute	I2
Latitude	1X, F8.4
Longitude	F9.4
Uncorrected Depth	10X, F5.0
Corrected Depth	F5.0
Total Mag. Anomaly	3X, F5.0
Resid. Mag. Anomaly	F5.0
Free Air Anomaly	F5.0

3. MGD-77 (Marine Geophysical Data Exchange Format) [USDC, 1981]

Fixed length lines, 120 characters per line, 24-line header

Cruise name	1X, A8
Year	5X, I2
Month	I2
Day	I2
Hour	I2
Minute	I2

Latitude	3X, F8.0 (and divide by 100000)
Longitude	F9.0 (and divide by 100000)
2-way Travel Time	1X, F6.0 (and divide by 10000)
Corrected Depth	F6.0 (and divide by 10)
Total Mag. Anomaly	3X, F6.0 (and divide by 10)
Resid. Mag. Anomaly	6X, F6.0 (and divide by 10)
Free Air Anomaly	25X, F5.0 (and divide by 10)

Uncorrected depth = 2-way travel time * speed of sound / 2
(The program assumes the speed of sound,is 1500 m/s)

Alternatively you can type 4 for a user-defined format. The program will assume that it has the same fields as in the ORACLES format in the same order. It is entered using the same syntax as a FORTRAN format statement, including the brackets, e.g. (A8, 1X, 3I2, 1X, 2I2, 2X, F8.4, 1X, 2I2, 2X, F8.4, 1X, F9.4, 2X, 5 (F5.0, 1X)). Note that the cruise name is a character variable, the day, month, year, hour and minute are integers, and the other variables are real. The program will also ask for the number of lines in the header.

The default is that grid lines are drawn on the map. The lines plotted are chosen by the software at an appropriate spacing which will not obscure the data. To prevent the grid from being drawn enter 2 from the 'Please select an option' menu.

Entering 3 allows you to change the colours used for the plot. Normally the plot will be in black and white, except for the data profiles which will be in colour. For the coastline, track, annotation, bathymetry, magnetics and gravity you have a choice of 4 colours:

1 Black
2 Red
3 Green
4 Blue

If the graphics output device you are using cannot produce colour, the plot will default to black and white.

Entering 4 from the 'Please select an option' menu will start the plot.

2.3 The Plots

The program actually plots two pictures. The first is a box containing the title, a description of the map, and the time and date when the program was run. The second is the map itself. If you are using a graphics terminal you will need to press ENTER after each plot. If you are using either of the Calcomp or Versatec plotters the pictures go to a file which can be plotted later.

When the plot has finished you are asked 'Run program again for same data?'. Entering 'Y' restarts the program, 'N' finishes. After entering 'N' you can send the plot file to the plotter by typing 'NPLOT' and entering the data requested, specific to the plotter required.

Example Plots

The scales given below are for the original plots, which are reproduced here smaller than their actual size. The standard latitude for all the plots is 0°.

Plot 1: Box containing description of data profile plot (plot 8). The scaling factor is 5, i.e. 5 mm per hundred nanoteslas, and the offset is 0 mm.

Plot 2: *Discovery* cruise 161, Mercator projection, 1 : 15 million, plot of ship's track only.

Plot 3: *Farnella* cruise 2/90, Mercator projection, 1 : 1 million, data annotation (residual magnetic anomaly).

Plot 4: *Charles Darwin* cruise 20/87, Mercator projection, 1 : 1 million, data profiles (corrected depth and free air anomaly). Plotted without grid.

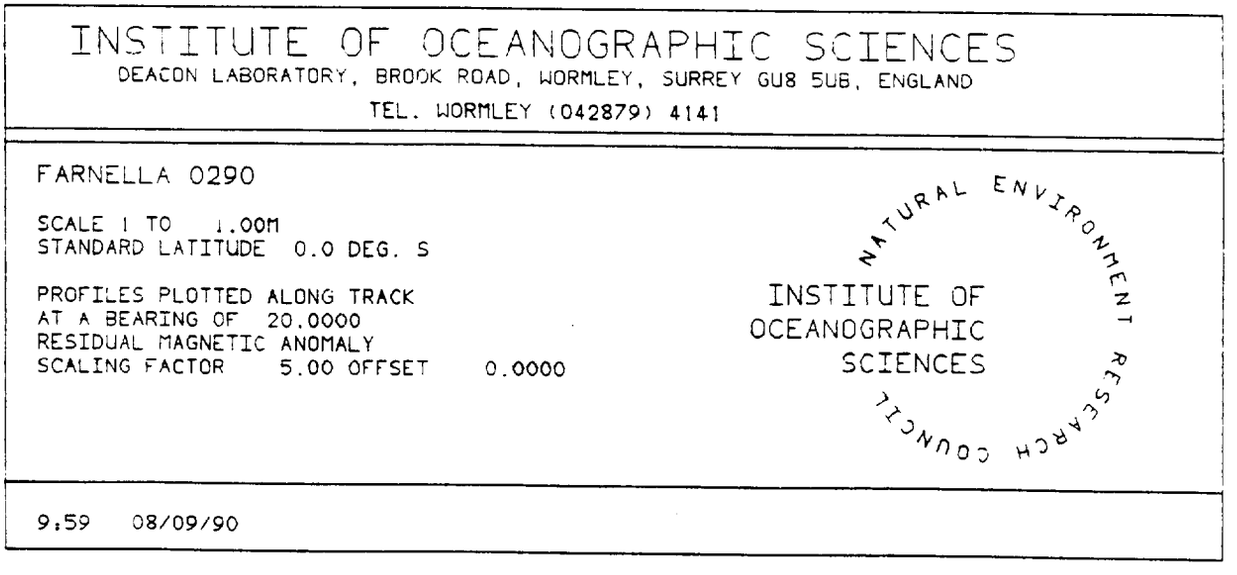
Plot 5: *Discovery* cruise 161, Mercator projection, 1 : 15 million, plot where data is valid (residual magnetic anomaly). This plot can be compared with plot 2 to show the sections of the cruise where magnetic data was collected.

Plot 6: *Discovery* cruise 189, Mercator projection, 1 : 15 million, annotated with time every 1440 minutes to give day numbers.

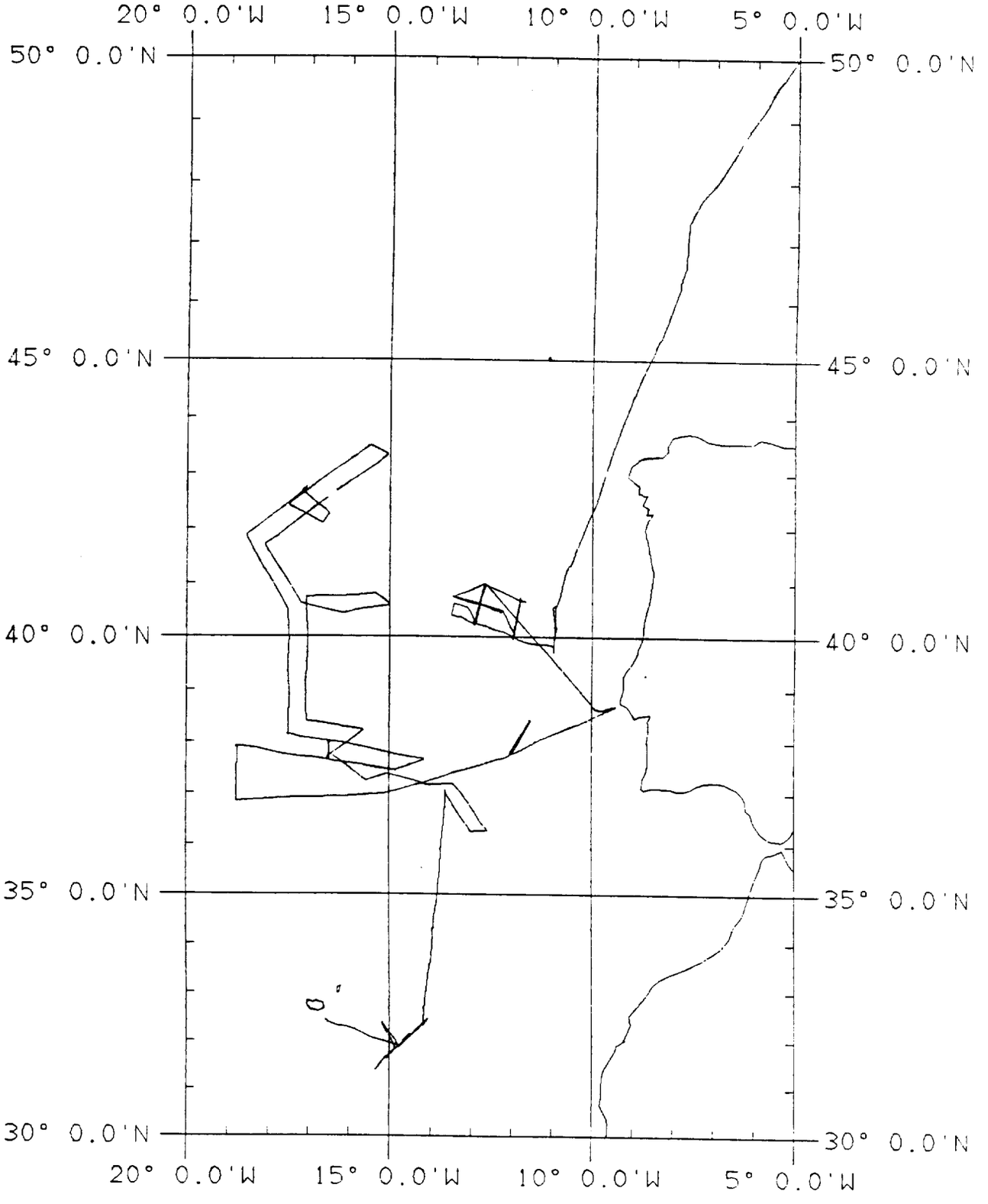
Plot 7: Section of the Madeira Rise showing all IOS cruises, Mercator projection, 1 : 750,000, plot of ships' tracks with cruise names, without grid.

Plot 8: *Farnella* cruise 2/90, Mercator projection, 1:1 million, data profile (residual magnetic anomaly) with time annotation . This plot shows the same area as plot 3.

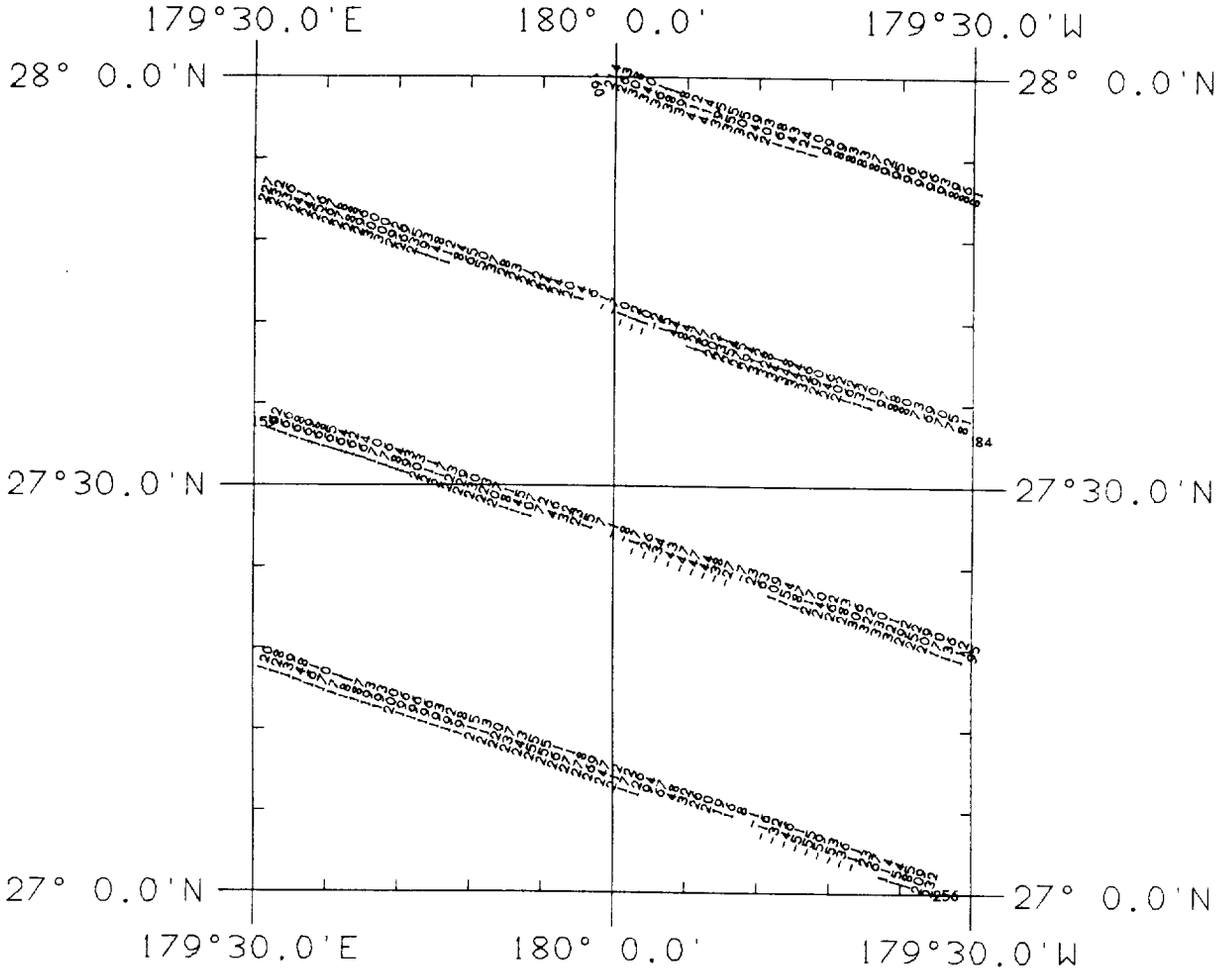
Plot 1: Box containing description of data profile plot (plot 8). The scaling factor is 5, i.e. 5 mm per hundred nanoteslas, and the offset is 0 mm.



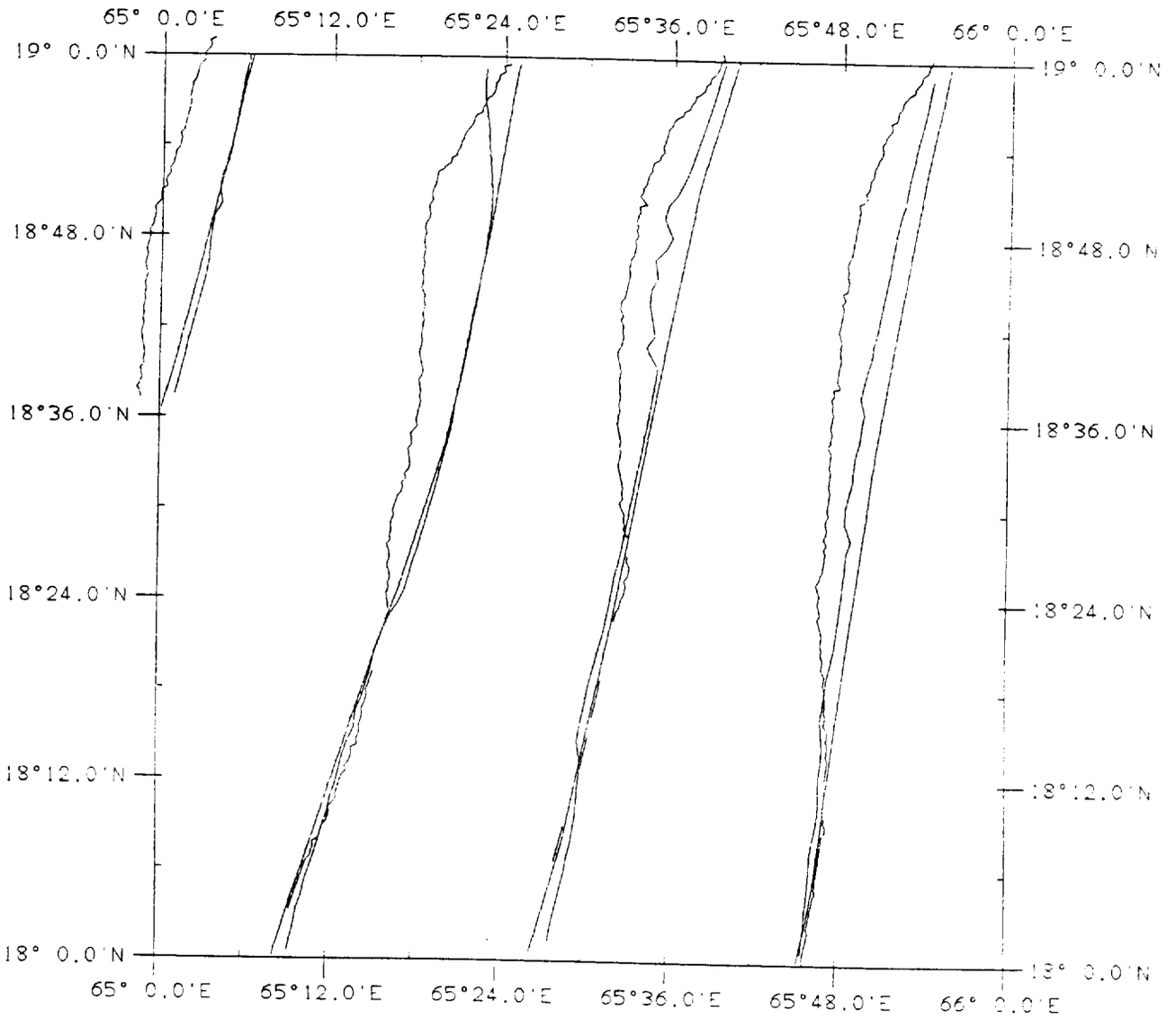
Plot 2: *Discovery* cruise 161, Mercator projection, 1 : 15 million, plot of ship's track only.



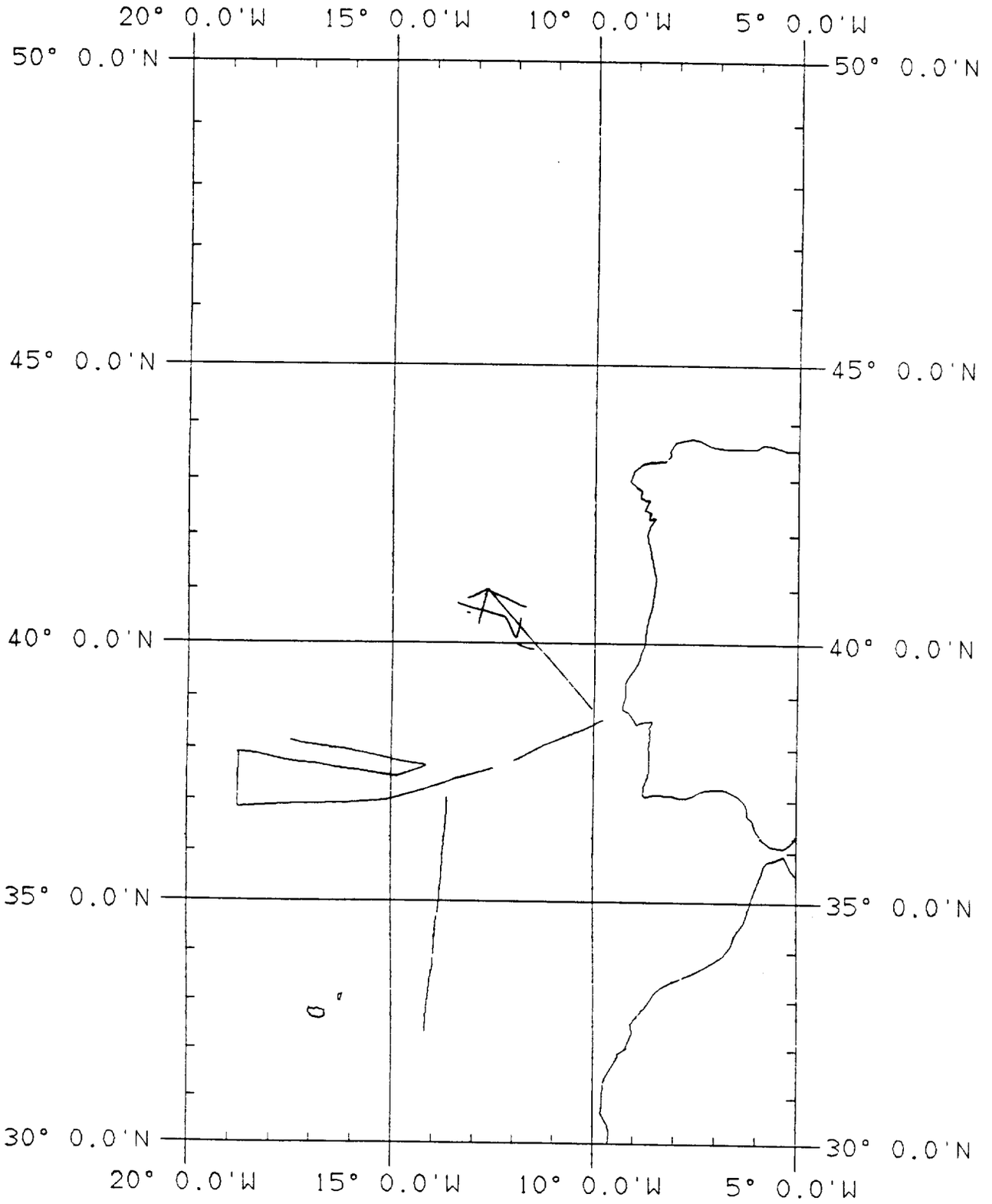
Plot 3: *Farnella* cruise 2/90, Mercator projection, 1 : 1 million, data annotation (residual magnetic anomaly).



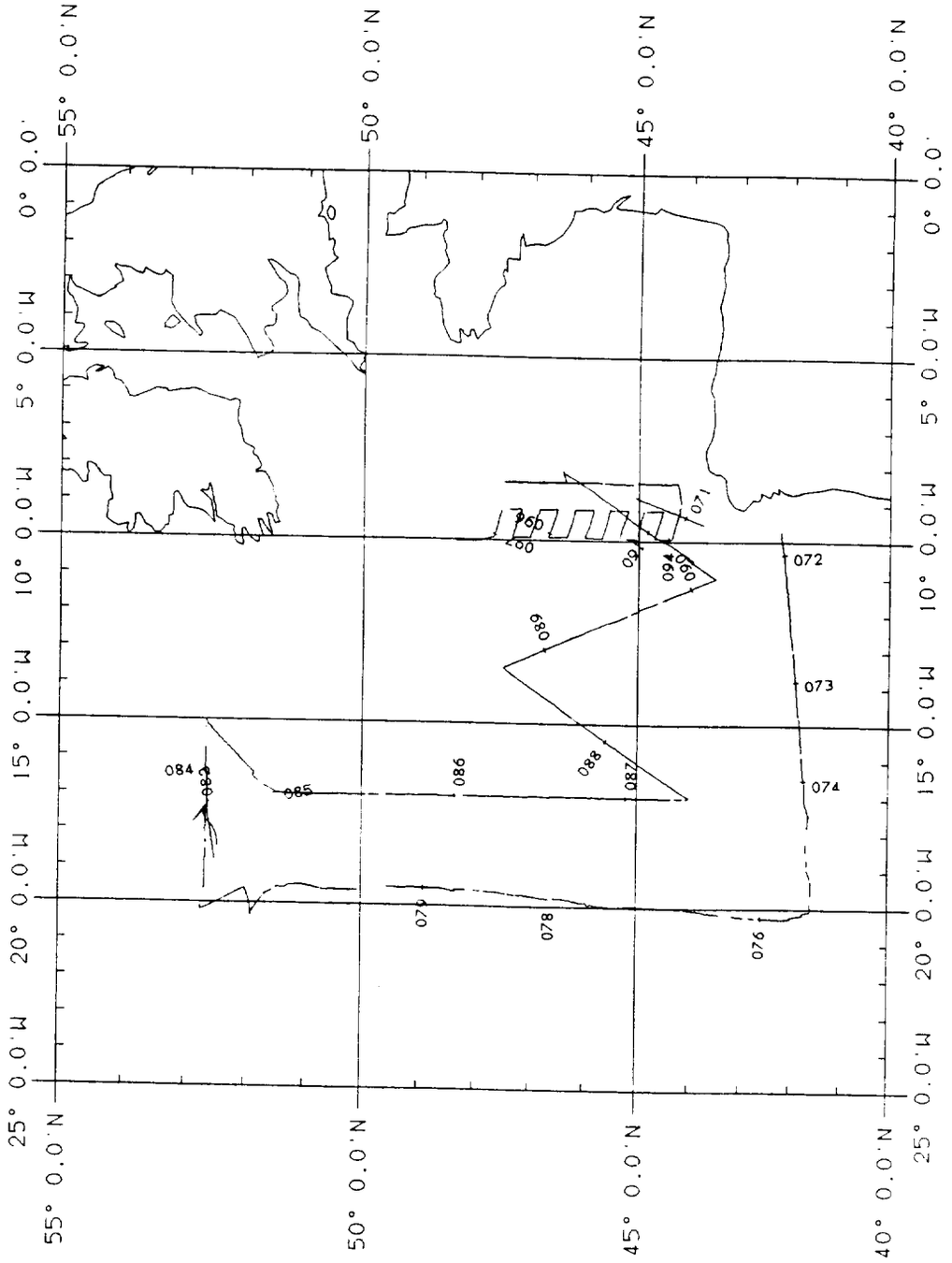
Plot 4: *Charles Darwin* cruise 20/87, Mercator projection, 1 : 1 million, data profiles (corrected depth and free air anomaly). Plotted without grid.



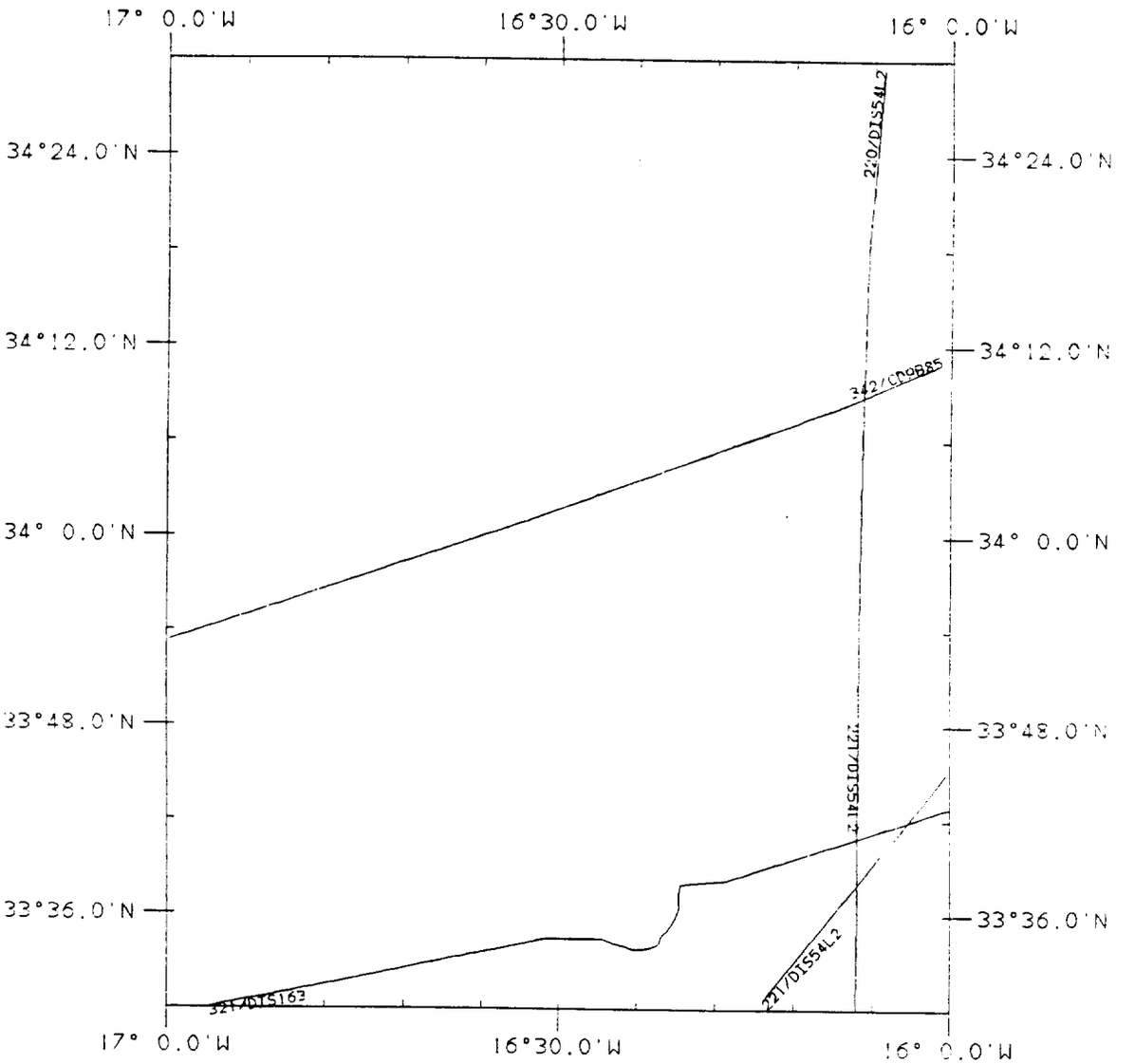
Plot 5: *Discovery* cruise 161, Mercator projection, 1 : 15 million, plot where data is valid (residual magnetic anomaly). This plot can be compared with plot 2 to show the sections of the cruise where magnetic data was collected.



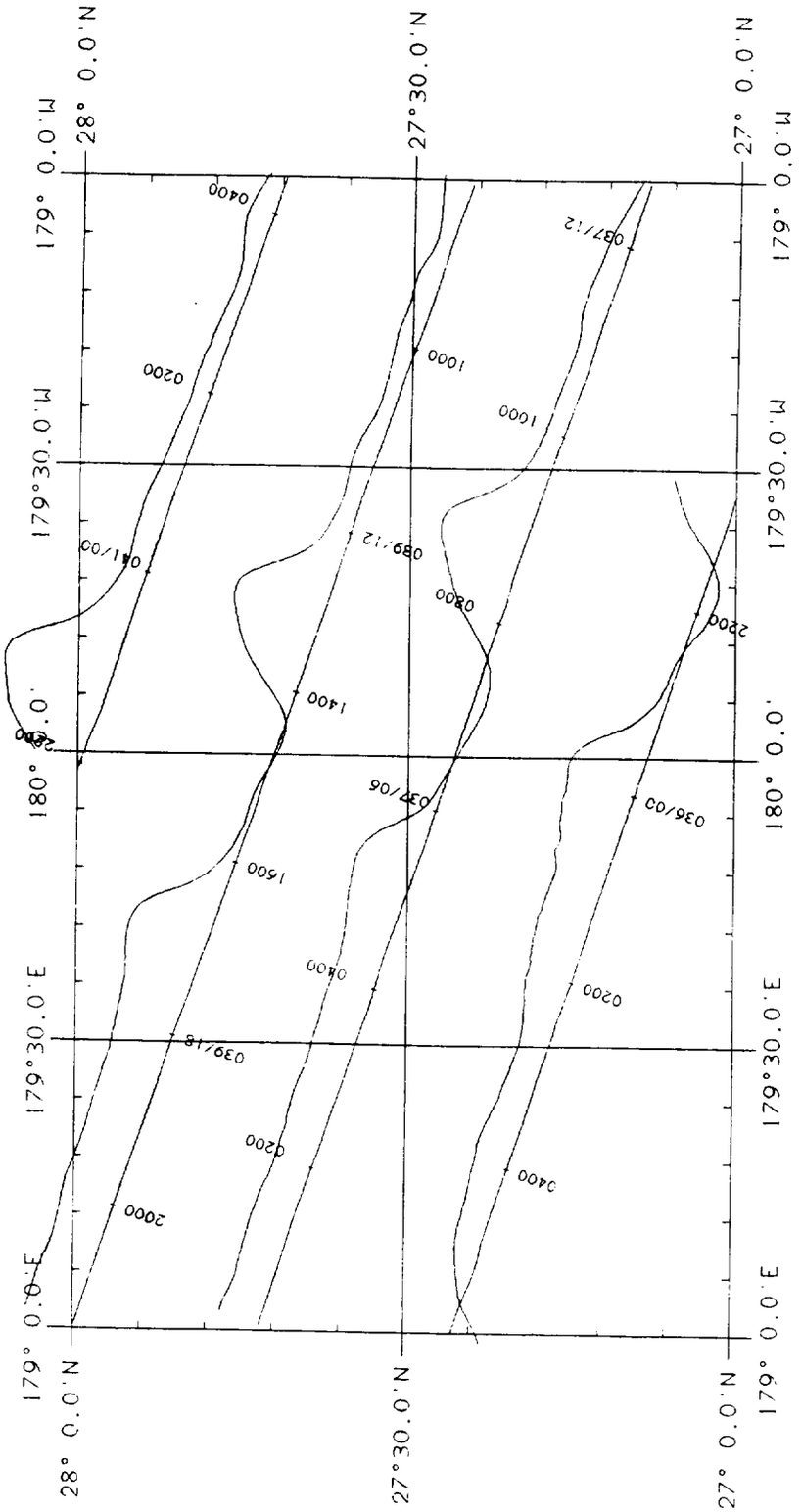
Plot 6: *Discovery* cruise 189, Mercator projection, 1 : 15 million, annotated with time every 1440 minutes to give day numbers.



Plot 7: Section of the Madeira Rise showing all IOS cruises, Mercator projection, 1 : 750,000, plot of ships' tracks with cruise names, without grid.



Plot 8: *Farnella* cruise 2/90, Mercator projection, 1:1 million, data profile (residual magnetic anomaly) with time annotation . This plot shows the same area as plot 3.



3 PROGRAMMER'S GUIDE

The purpose of this section is to aid understanding of the program so that it may be modified. It describes the language used, file names, program structure, the routines and the macro used to run it.

3.1 Language Details

GEOPLOT runs on an IBM mainframe using the CMS operating system. It is written in standard FORTRAN 77 [Metcalf 1985], with the exception that it makes use of the END DO statement as implemented by most compilers. The macro language used in the control program is IBM REXX [Jones, 1987].

3.2 Files

GEOPLOT EXEC G	macro to run program
TRACKS MODULE G	executable code. Generated from TRACKS TRAK by typing 'F77C TRACKS TRAK', 'LOAD TRACKS' then 'GENMOD TRACKS'.
TRACKS TRAK G	FORTRAN source code

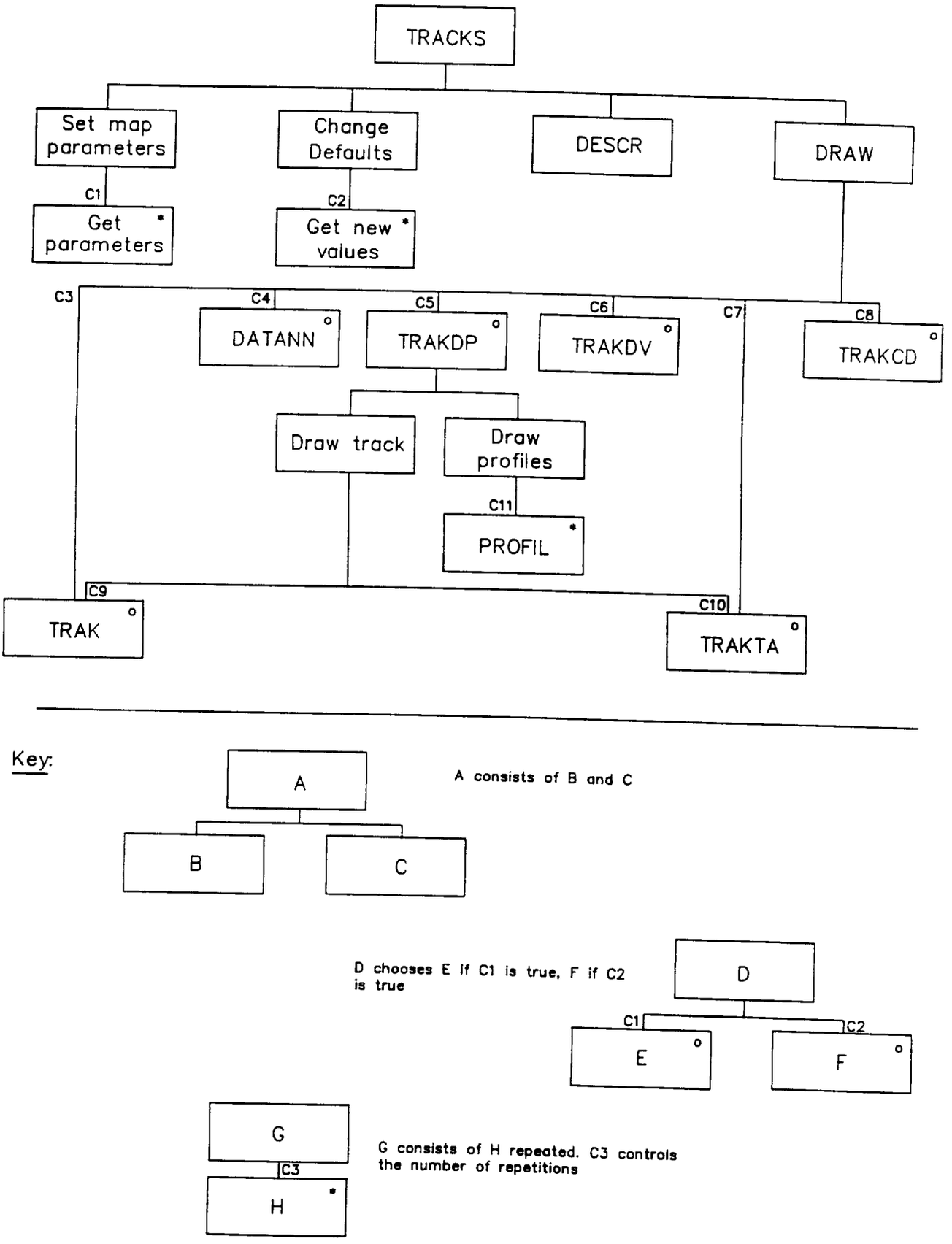
3.3 Program Structure

Figure 3.1 shows the structure of the TRACKS TRAK source code. Each procedure is shown above the subprocedures that it may involve. For instance TRAKDP involves drawing the track and then drawing the profiles. FORTRAN subroutines are shown in capital letters.

C1 to C11 are conditions which control how often a procedure is called, or whether it is called at all (see key below diagram).

C1: Until user answers 'N' to 'Re-enter parameters'
C2: Until user starts plot
C3: Plot of ship's track only required
C4: Data annotation required
C5: Plot of track with profile required
C6: Plot when variable is present required
C7: Plot with time annotation required
C8: Plot with cruise names
C9: Time not required on data profiles
C10: Time required on data profiles
C11: For each profile

Figure 3.1: Structure diagram of TRACKS TRAK



3.4 Routines

This section describes the input, output and action of each routine in the program.

Key to variable types:

[I] = integer
[R] = real
[C] = character * (*), i.e. unknown length
[Cn] = character * n, i.e. fixed length
[L] = logical
[F] = function

3.4.1 Program TRACKS

Gets the input parameters from the keyboard and calls the plot routines.

Action:
```
Set up initial values
Repeat
        Display title
        Call MENU to get plot option
        If option = 2 or 4
                Call MENU to get variable
                Get data associated with variable
        If option =  5 or 7
                Get time interval
        If option = 3 or 7
                Call CLIST to get variables
                Get data associated with variables
        If corrected depth required
                Ask if uncorrected depth should be used when corrected depth
                is unavailable
        Call CLIST to get devices
        Call MENU to get projection
        If irregular projection
                Get central meridian
        Get standard latitude
        Get map limits
        Display list of suggested scales
        Get scale
        Get title
        Display summary
        Ask if user wants to re-enter parameters
Until user replies 'N'
```

```
Repeat
        Display default values
        Call MENU to get option
        If option = 1
                Call MENU to get format
                If user defined format
                        Get format details
        Else if option = 2
                toggle grid
        Else if option = 3
                call MENU to get new colours
                set colour for uncorrected depth
        Set up format
Until option = 4
Open path to devices
Call DESCR to plot description
Call DRAW to plot map
Terminate program
```

3.4.2 Subroutine MAGMES

Displays information about the geomagnetic reference fields available.

Called by: PROGRAM TRACKS

Action:
Call MAGSYN to get date of latest DGRF
Display date, followed by date + 5 (= date of IGRF)

3.4.3 Subroutine GETINT (PROMPT, NUMBER)

Prompts the user for an integer.

Called by: PROGRAM TRACKS

In:
PROMPT [C]: character string used to prompt user
NUMBER [I]: previous value of the number (-999 if no previous value)

Out:
NUMBER [I]: new value of the number

Action:

```
Display prompt
Loop
        Get input
        If input present
                NUMBER = input
                Exit loop
        Else if previous value of NUMBER present
                Exit loop
End loop
```

3.4.4 Subroutine GETLOG (PROMPT, LVALUE, SET)

Prompts the user for a YES/NO answer, using the reply to set a logical variable.

Called by: PROGRAM TRACKS

In:
- PROMPT [C]: character string used to prompt user
- LVALUE [L]: previous value of logical variable
- SET [L]: true if LVALUE has been previously set

Out:
- LVALUE [L]: new value of logical variable

Action:

```
If SET
        If LVALUE
                Set previous reply to 'Y'
        Else
                Set previous reply to 'N'
Else
        Set previous reply to 'null' character ('$')
Repeat
        Call GETSTR to get new reply
Until reply = 'Y' or 'N'
Set LVALUE to (reply = 'Y')
```

3.4.5 Subroutine GETREL (PROMPT, LENGTH, MIN, MAX, NUMBER)

Prompts the user for a real number.

Called by: PROGRAM TRACKS

In:
- PROMPT [C]: character string used to prompt user
- LENGTH [I]: number of characters used for prompt
- MIN [I]: minimum value of number
- MAX [I]: maximum value of number
  (MIN and MAX are both 0 if there are no limits)
- NUMBER [R]: previous value of the number (-999. if no previous value)

Out:
- NUMBER [R]: new value of number

Action:

```
Display prompt, with range if specified
Loop
        Get input
        If input present
                NUMBER = input
                If within limits (or no limits)
                        Exit loop
        Else if previous value of NUMBER present
                Exit loop
End loop
```

3.4.6 Subroutine GETSTR (PROMPT, STRING)

Prompts the user for a string.

Called by: PROGRAM TRACKS, SUBROUTINE GETLOG

In:
- PROMPT [C]: character string used to prompt user
- STRING [C]: previous value of the string ('$' if no previous value)

Out:
- STRING [C]: new value of string

Action:

```
Display prompt
Loop
        Get input
        If input present
                STRING = input
                Exit loop
        Else if previous value of STRING present
                Exit loop
End loop
```

3.4.7 Subroutine MESSGE (MESS, LENGTH, NOLINS)

Displays a message on the screen.

Called by: PROGRAM TRACKS, SUBROUTINE MAGMES

In:
- MESS [C]: array containing lines of message
- LENGTH [I]: maximum line length
- NOLINS [I]: number of lines in message

Action: Display message

3.4.8 Subroutine MENU (TITLE, LENGTH, NOLINS, CHOICE, SELECT)

Prompts the user to choose from a menu.

Called by: PROGRAM TRACKS

In:	TITLE [C]:	header for menu
	LENGTH [I]:	maximum length of elements of CHOICE
	NOLINS [I]:	number of lines of choices
	CHOICE [C]:	array containing choices, one per element
	SELECT [I]:	number of previous selection (0 if no previous selection)
Out:	SELECT [I]:	number of new selection

Action:

```
Display menu
Loop
        Get input
        If input present
                SELECT = input
If SELECT is valid choice number
        Exit loop
End loop
```

3.4.9 Subroutine CLIST (TITLE, LEMGTH, NOLINS, CHOICE, SELECT)

Prompts the user to choose one or more items from a checklist.

Called by: PROGRAM TRACKS

In:	TITLE [C]:	header for checklist
	LENGTH [I]:	maximum length of elements of CHOICE
	NOLINS [I]:	number of lines of choices
	CHOICE [C]:	array containing choices, one per element
	SELECT [L]:	array containing previous selections
Out:	SELECT [L]:	array containing new selections

Action:

```
Count number of items selected
Loop
        Display checklist, marking those items selected
        SEL = 0
        Get input
        If input present
                SEL = input
        If SEL = 0 and number of items selected > 0
                Exit loop
        If SEL is valid selection
                If already selected
                        SELECT (SEL) = false
                        decrement number of items selected
                Else
                        SELECT (SEL) = true
                        increment number of items selected
        End loop
```

3.4.10 Subroutine DESCR (TITLE, SCALE, SLAT, PLOT, VARNO, DPVAR, PANGLE, PSCALE, PSTART, COLOUR, UNCCOL, FILLIN, RECALC)

Draws a box containing a description of the plot.

Called by: PROGRAM TRACKS

In:

TITLE [C45]:	title of plot
SCALE [R]:	scale of map
SLAT [R]:	standard latitude
PLOT [I]:	number of plot option
VARNO [I]:	number of variable selected
DPVAR [I]:	array containing numbers of variables selected for profiles
PANGLE [R]:	angle for profiles
PSCALE [R]:	array containing scale factors for profiles
PSTART [R]:	array containing offsets for profiles
COLOUR [I]:	array containing pen numbers for profiles
UNCCOL [I]:	pen number to be used for uncorrected depth, if FILLIN is true
FILLIN [L]:	true if uncorrected depth is being used to fill gaps in corrected
RECALC [L]:	true if residual magnetic anomalies are to be recalculated

Action:

Draw box
Write box header
Clear text array
Write descriptions to array
Plot title
For each array element
    If data profile variable name
        change pen to correct colour
    If 'Uncorrected depth' line in corrected depth annotation
        change pen to UNCCOL
    Plot element
    Change to black pen
Plot IOS logo

3.4.11 Subroutine DRAW (MAP2)

Sets up the map and calls the routines to plot the track.

Called by: PROGRAM TRACKS

In:

MAP2 [F]: map projection function
XLEFT [R] : longitude of left map limit
XRIGHT [R]: longitude of right map limit
YBASE [R]: latitude of lower map limit
YTOP [R]: latitude of upper map limit
PLOT [I]: number of plot option
SCALE [R]: scale of map
SLAT [R]: standard latitude
SLONG [R]: central meridian
VARNO [I]: number of variable selected
DPVAR [I]: array containing numbers of variables selected for profiles
PANGLE [R]: angle for profiles
PSCALE [R]: array containing scale factors for profiles
PSTART [R]: array containing offsets for profiles
INTVAL [I]: time interval between tick marks
GRID [L]: true if grid is required
LNDCOL [I]: pen number used to plot land
TRKCOL [I]: pen number used to plot the ship's track
ANNCOL [I]: pen number used to plot annotation
UNCCOL [I]: pen number used to plot uncorrected depth where this is plotted in place of corrected
COLOUR [I]: array containing pen numbers for profiles
NUNITS [I]: array containing number of units used whencalculating scale factors
FILLIN [L]: true if uncorrected depth is being used to fill gaps in corrected
RECALC [L]: true if residual magnetic anomalies are to be recalculated
PROJ [I]: projection number
NHLINS [I]: number of lines in file header

Action:

Set up plot
Plot and annotate axes
Set pen colours
Read file header
Case PLOT of 1: call TRAK
2: call DATANN
3: call TRAKDP, passing 0 as time interval
4: call TRAKDV
5: call TRAKTA
6: call TRAKCD
7: call TRAKDP, passing INTVAL as time interval
Plot land outline

3.4.12 Subroutine TRAK (MAP2)

Draws the ship's track.

Called by: SUBROUTINEs DRAW, TRAKDP

In:
- MAP2 [F]: map projection
- FMTA [C]: input file format
- FMTNO [I]: format number
- XLEFT [R] : longitude of left map limit
- XRIGHT [R]: longitude of right map limit
- YBASE [R]: latitude of lower map limit
- YTOP [R]: latitude of upper map limit

Action:

```
repeat
        read line from file
        if longitude < XLEFT
                longitude = longitude + 360
        if latitude and longitude are on map and less than 20 minutes since last
        plot
                plot point
        else
                signal break
until end of file
```

3.4.13 Subroutine DATANN (MAP2, VARNO, UNCCOL, ANNCOL, FILLIN, RECALC)

Plots a variable along the ship's track.

Called by: SUBROUTINE DRAW

In:
- MAP2 [F]: map projection function
- VARNO [I]: number of variable to be plotted
- ANNCOL [I]: pen number used to plot annotation
- UNCCOL [I]: pen number used to plot uncorrected depth where this is plotted in place of corrected
- FILLIN [L]: true if uncorrected depth is being used to fill gaps in corrected
- RECALC [L]: true if residual magnetic anomalies are to be recalculated
- FMTA [C80]: input file format
- FMTNO [I]: format number
- XLEFT [R] : longitude of left map limit
- XRIGHT [R]: longitude of right map limit
- YBASE [R]: latitude of lower map limit
- YTOP [R]: latitude of upper map limit

Action:

```
repeat
        read line from file
        if longitude < XLEFT
                longitude = longitude + 360
        if MGD-77 format
                convert to ORACLES format
        if RECALC and variable is residual magnetic anomaly
                recalculate residual magnetic anomaly
        if latitude and longitude are on map and less than 20 minutes since last
        plot
                if variable present
```

plot variable
else if FILLIN and variable is corrected depth and uncorrected is available
change pen to UNCCOL
plot uncorrected depth
change pen to ANNCOL
until end of file

3.4.14 Subroutine TRAKDP (MAP2, VARNO, COLOUR, FILLIN, RECALC, OFFSET, ANGLE, SCALE, NUNITS, INTVAL, NHLINS

Plots data profiles along the ship's track.

Called by: DRAW

In:

MAP2 [F]:	map projection function
VARNO [I]:	array containing numbers of variables selected for profiles
COLOUR [I]:	array containing pen numbers for profiles
FILLIN [L]:	true if uncorrected depth is being used to fill gaps in corrected
RECALC [L]:	true if residual magnetic anomalies are to be recalculated
OFFSET [R]:	array containing offsets for profiles
ANGLE [R]:	angle for profiles
SCALE [R]:	array containing scale factors for profiles
NUNITS [I]:	array containing number of units used when calculating scale f factors
INTVAL [I]:	time interval between tick marks
NHLINS [I]:	number of lines in file header

Action:

If INTVAL > 0
Call TRAKTA to plot ship's track
Else
Call TRAK to plot ship's track
For each variable to be plotted
Select pen
Call PROFIL

3.4.15 Subroutine PROFIL (MAP2, VARNO, FILLIN, RECALC, OFFSET, ANGLE, SCALE, NHLINS)

Plots one data profile.

Called by: TRAKDP

In:

MAP2 [F]:	map projection function
VARNO [I]:	number of variable selected for profile
FILLIN [L]:	true if uncorrected depth is being used to fill gaps in corrected
RECALC [L]:	true if residual magnetic anomalies are to be recalculated
OFFSET [R]:	offsets for profile
ANGLE [R]:	angle for profile
SCALE [R]:	scale factors for profile
NHLINS [I]:	number of lines in file header
FMTA [C80]:	input file format
FMTNO [I]:	format number
XLEFT [R] :	longitude of left map limit
XRIGHT [R]:	longitude of right map limit
YBASE [R]:	latitude of lower map limit
YTOP [R]:	latitude of upper map limit

Action:

```
rewind file and skip header
set up profile mode
        repeat
        read line from file
        if longitude < XLEFT
                longitude = longitude + 360
        if RECALC and variable is residual magnetic anomaly
                recalculate residual magnetic anomaly
        if FILLIN and no corrected depth and uncorrected available
                corrected depth = uncorrected
        if MGD-77 format
                convert to ORACLES format
        if latitude and longitude are on map and variable present
                if less than 20 minutes since last plot
                        plot profile point
                else
                        signal break
        else
                signal missing point
until end of file
```

3.4.16 Subroutine TRAKDV (MAP2, VARNO)

Plots the ship's track when a variable is present.

Called by: SUBROUTINE DRAW

In:

MAP2 [F]:	map projection function
VARNO [I] :	variable whose presence is to be checked
FMTA [C80]:	input file format
FMTNO [I]:	format number
XLEFT [R] :	longitude of left map limit
XRIGHT [R]:	longitude of right map limit
YBASE [R]:	latitude of lower map limit
YTOP [R]:	latitude of upper map limit

Action:

```
repeat
        read line from file
        if longitude < XLEFT
                longitude = longitude + 360
        if MGD-77 format
                convert to ORACLES format
        if latitude and longitude are on map and variable present
                if less than 20 minutes since last plot
                        plot point
                else
                        signal break
        else
                signal missing point
until end of file
```

3.4.17 Subroutine TRAKTA (MAP2, INTVAL)

Plots the ship's track annotated with the time

Called by: SUBROUTINEs DRAW, TRAKDP

In:

MAP2 [F]:	map projection function
INTVAL [I]:	time interval between tick marks in minutes
FMTA [C80]:	input file format
FMTNO [I]:	format number
XLEFT [R] :	longitude of left map limit
XRIGHT [R]:	longitude of right map limit
YBASE [R]:	latitude of lower map limit
YTOP [R]:	latitude of upper map limit

Action:

```
repeat
        read line from file
        if longitude < XLEFT
                longitude = longitude + 360
        if latitude and longitude are on map and less than 20 minutes since last
        plot
                if interval has passed
                        if interval is at least a day
                                plot point and annotate with day
                        number
                        else if six-hour mark
                                plot point and annotate with day
                        number and hour
                        else
                                plot point and annotate with hour and
                        minute
                        else
                                plot point
                else
                        signal break
until end of file
```

3.4.18 Subroutine TRAKCD (MAP2)

Plots the ship's track and annotates it with the day number and cruise name.

Called by: SUBROUTINE DRAW

In:

MAP2 [F]:	map projection
FMTA [C80]:	input file format
FMTNO [I]:	format number
XLEFT [R] :	longitude of left map limit
XRIGHT [R]:	longitude of right map limit
YBASE [R]:	latitude of lower map limit
YTOP [R]:	latitude of upper map limit

Action:

```
WANT = false
repeat
        read line from file
        if longitude < XLEFT
                longitude = longitude + 360
        if latitude and longitude are on map and less than 20 minutes since last
        plot
                if midnight has passed
                        WANT = true
                if WANT and the ship is moving
                        calculate the ship's bearing
                        annotate with day and cruise number  in the
                        direction of the bearing.
                        WANT = false
                else plot point
        else
                signal break
                WANT = true
until end of file
```

3.4.19 Logical Function ONMAP (X, Y)

Tests if the coordinates are within the map limits.

Called by: SUBROUTINEs TRAK, DATANN, PROFIL, TRAKDV, TRAKTA, TRAKCD

In:	X [R]:	longitude to be tested
	Y [R]:	latitude to be tested
	XLEFT [R] :	longitude of left map limit
	XRIGHT [R]:	longitude of right map limit
	YBASE [R]:	latitude of lower map limit
	YTOP [R]:	latitude of upper map limit
Out:	ONMAP [L]:	true if the coordinates are within the map limits

Action: ONMAP = (X >= XLEFT and X <= XRIGHT and Y >= YBASE and Y <= YTOP)

3.4.20 Subroutine MGDZOR (VAR)

Converts MGD-77 format variables to ORACLES format.

Called by: SUBROUTINEs DATANN, PROFIL, TRAKDV

In:	VAR [R]:	array containing MGD-77 variables
Out:	VAR [R]:	array containing ORACLES variables

Action:
if VAR (1) [two way travel time] > 99
VAR (1) = 0
if VAR (2) [corrected depth], VAR (3) [total magnetic anomaly] or VAR (4) [residual magnetic anomaly] > 99999
VAR (2, 3, or 4) = 0
if VAR (5) [free air anomaly] > 9999
VAR (5) = 0
multiply VAR (1) by 750 to get uncorrected depth

3.4.21 Integer Function DAYNO (DAY, MONTH, YEAR)

Converts a date from day/month/year format to the Julian day.

Called by: SUBROUTINEs TRAK, DATANN, PROFIL, TRAKDV, TRAKTA, TRAKCD

In:	DAY [I]:	day of the month
	MONTH [I]:	month number
	YEAR [I]:	year
Out:	DAYNO [I]:	Julian day

Action:
DAYNO = number of days from start of year to end of previous month + DAY
if YEAR is a leap year and MONTH > 2
DAYNO = DAYNO + 1

3.4.22 Integer Function FULLYR (YEAR)

Converts a 2-digit year to a 4-digit year.

Called by: SUBROUTINEs DATANN, PROFIL

In: YEAR [I]: 2-digit year

Out: FULLYR [I]: 4-digit year

Action:
```
if YEAR > 30
        FULLYR = 1900 + YEAR
else
        FULLYR = 2000 + YEAR
```

3.4.23 Subroutine MAGSYN (DATE, ITYPE, ALT, COLAT, ELONG, X, Y, Z, F)

Calculates the expected total magnetic field.

Called by: SUBROUTINEs MAGMES, DATANN, PROFIL

In:
- DATE [R]: date in years and fractions of a year, or 0 to return date of latest DGRF
- ITYPE [I]: 1 if geodetic coordinates are being used, 2 if geocentric
- ALT [R]: height above sea level in km (ITYPE = 1), or distance from centre of earth in km (ITYPE = 2)
- COLAT [R]: colatitude in degrees
- ELONG [R]: east longitude in degrees

Out:
- DATE [R] Date of latest DGRF (only returned if a DATE of 0. is passed to the subroutine)
- X [R]: north component of magnetic field (nanoteslas)
- Y [R]: east component of magnetic field (nanoteslas)
- Z [R]: vertical component of magnetic field (nanoteslas)
- F [R]: total magnetic field (nanoteslas)

Action:
```
if date is out of bounds
        if date is 0
                return date of latest DGRF
        else
                abort
set initial values
if ITYPE = 1
        convert to geocentric coordinates
compute Schmidt quasi-normal coefficients
synthesize X, Y and Z
if ITYPE = 1
        convert back to geodetic coordinates
calculate F
```

3.5 Listing of PROGRAM TRACKS TRAK

```
      PROGRAM TRACKS

C Plots ships' tracks with optional annotation

C Written May 1990 by Stephen Buxton, Institute of Oceanographic
C Sciences, Wormley, Surrey.

C Based on an earlier program COMTRACK, written by Tim Le Bas, IOS.

      EXTERNAL EMERC, EUTM, SGNOMT, SLEAC, SORTHT

      CHARACTER * 1 NULL
      CHARACTER * 9 UNITS (3)
      CHARACTER * 10 COLNAM (4)
      CHARACTER * 20 FMTNAM (4), DEVNAM (4)
      CHARACTER * 30 OPTNAM (4)
      CHARACTER * 40 PRONAM (5), VARNAM (3), DEFNAM (8), MSIZE (6)
      CHARACTER * 43 SCALEQ
      CHARACTER * 45 TITLE
      CHARACTER * 50 PLTNAM (7)
      CHARACTER * 70 VALNAM (11)
      CHARACTER * 80 IN, OUT, FMTA

      INTEGER PLOT, PROJ, INTVAL, VAR, VARNO, DPVAR (3)
      INTEGER FMTNO, DEVNO, OPTION, NUNITS (3), NHLINS
      INTEGER LNDCOL, TRKCOL, ANNCOL, UNCCOL, COLOUR (3)
      INTEGER BLACK, RED, GREEN, BLUE
      REAL XLEFT, XRIGHT, XR0, YBASE, YTOP, SCALE, SLONG, SLAT
      REAL PANGLE, PSCALE (3), PSTART (3), SM, SN, C1, C2
      LOGICAL VARSEL (3), USEDEV (4), GRID, FILLIN, RECALC, REDO
      LOGICAL CORDEP, SET

      COMMON /FMT/ FMTA, FMTNO
      COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP
      COMMON /PARAMS/ PLOT, SCALE, SLAT, SLONG, VARNO, DPVAR, PANGLE,
     & PSCALE, PSTART, INTVAL, GRID, LNDCOL, TRKCOL, ANNCOL, UNCCOL,
     & COLOUR, NUNITS, NHLINS, FILLIN, RECALC, PROJ
      COMMON /CLEAR/ OUT
```

```
      PARAMETER (BLACK = 1, RED = 2, GREEN = 3, BLUE = 4)
      PARAMETER (NULL = '$')
      DATA PRONAM /'Ellipsoidal Mercator                ',
     & 'Universal Transverse Mercator          ',
     & 'Gnomonic Transverse                    ',
     & 'Lambert Cylindrical                    ',
     & 'Orthographic Transverse                ' /
      DATA DEVNAM /'Graphics Terminal   ', 'Calcomp            ',
     & 'Versatec           ', 'IBM PS/2           ' /
      DATA VARNAM /'Depth                               ',
     & 'Residual Magnetic Anomaly              ',
     & 'Free Air Anomaly                       ' /
      DATA OPTNAM /'Choose different format      ',
     & 'Turn grid off                  ',
     & 'Change default colours         ',
     & 'Start plot                     ' /
      DATA FMTNAM /'Oracles             ', 'Merge-Merge        ',
     & 'MGD-77             ', 'User-Defined       ' /
      DATA COLNAM /'Black    ', 'Red      ', 'Green    ',
     & 'Blue     ' /
      DATA PLTNAM /'Plot ship''s track only                     ',
     & 'Plot data annotation along track       ',
     & 'Plot data profile along track          ',
     & 'Plot ship''s track only when data valid  ',
     & 'Plot ship''s track with time           ',
     & 'Plot ship''s track with cruise names     ',
     & 'Plot data profile and time along track   '/
```

```
C Set up initial values

      PLOT = 0
      VAR = 0
      PROJ = 0
      PANGLE = -999.
      SLONG = -999.
      SLAT = -999.
      XLEFT = -999.
      XR0 = -999.
      YBASE = -999.
      YTOP = -999.
      SCALE = -999.
      INTVAL = -999
      NHLINS = -999
      TITLE (1 : 1) = NULL
      FMTA (1 : 1) = NULL
      PSTART (1) = 0.
      PSTART (2) = 0.
      PSTART (3) = 0.
      PSCALE (1) = 5.
      PSCALE (2) = 10.
      PSCALE (3) = 20.
      NUNITS (1) = 1000.
      NUNITS (2) = 100.
      NUNITS (3) = 100.
      UNITS (1) = 'm'
      UNITS (2) = 'nanoTesla'
      UNITS (3) = 'milligals'
      SET = .FALSE.
      CORDEP = .FALSE.
      DO I = 1, 3
         VARSEL (I) = .FALSE.
      END DO
      DO I = 1, 4
         USEDEV (I) = .FALSE.
      END DO

      IN = 'EXEC CLRSCRN'
      OUT = ' '
      CALL TOKEN (IN, OUT, NTOK, ISTAT)
C     CALL CMSCMD (OUT, ISTAT) will now clear the screen ***
    1 CALL CMSCMD (OUT, ISTAT)
      WRITE (6, '(37X, A6)') 'TRACKS'
      WRITE (6, '(37X, A6/)') '------'
      WRITE (6, '(25X, A30/)') 'Program to plot ships'' tracks'
      CALL MENU ('Please choose an option', 50, 7, PLTNAM, PLOT)
```

```
      IF (PLOT .EQ. 2 .OR. PLOT .EQ. 4) THEN
C       Plot variable / track when variable present
        CALL CMSCMD (OUT, ISTAT)
         CALL MENU ('Which variable?', 40, 3, VARNAM, VAR)
        CALL CMSCMD (OUT, ISTAT)
         IF (VAR .EQ. 1) THEN
C          Depth, so ask if corrected
 10         CALL GETLOG ('Corrected depth (Y/N)', CORDEP, SET)
           IF (CORDEP) THEN
              VARNO = 2
           ELSE
              VARNO = 1
           END IF
         ELSE IF (VAR .EQ. 2) THEN
C          Magnetics, so ask if recalculated
           CALL MAGMES
           CALL GETLOG
     &        ('Recalculate residual magnetic anomaly? (Y/N)',
     &       RECALC, SET)
           VARNO = 4
         ELSE IF (VAR .EQ. 3) THEN
C          Gravity
           VARNO = 5
         END IF
      END IF

      IF (PLOT .EQ. 5 .OR. PLOT .EQ. 7) THEN
C       Plot with time
        CALL CMSCMD (OUT, ISTAT)
 30     CALL GETINT ('Tick interval in minutes (must be exact divisio
     &n/multiple of an hour)', INTVAL)
C       Is INTVAL an exact division/multiple of an hour?
        IF (MOD (60, INTVAL) .NE. 0 .AND. MOD (INTVAL, 60) .NE.
     &    0) INTVAL = -999
        IF (MOD (60, INTVAL) .NE. 0 .AND. MOD (INTVAL, 60) .NE.
     &    0) GO TO 30
      END IF
```

```
      IF (PLOT .EQ. 3 .OR. PLOT .EQ. 7) THEN
C       Data profile
        CALL CLIST ('Which variables?', 40, 3, VARNAM, VARSEL)
       CALL CMSCMD (OUT, ISTAT)
        CALL GETREL ('Bearing for data profile ', 25, 0, 360, PANGLE)
        DO I = 1, 3
          IF (VARSEL (I)) THEN
            CALL CMSCMD (OUT, ISTAT)
             WRITE (6, *) VARNAM (I)
              WRITE (SCALEQ, '("Scaling factor for data (mm/",
     &             I4, 1X, A, ")")') NUNITS (I), UNITS (I)
            CALL GETREL (SCALEQ, 43, 0, 0, PSCALE (I))
            CALL GETREL
     &        ('Origin to be subtracted (mm)              ',
     &        43, 0, 0, PSTART (I))
          END IF
        END DO
        DPVAR (1) = 0
        DPVAR (2) = 0
        DPVAR (3) = 0
       CALL CMSCMD (OUT, ISTAT)
        IF (VARSEL (1)) THEN
C         Depth, so ask if corrected
  20      CALL GETLOG ('Corrected depth? (Y/N)', CORDEP, SET)
          IF (CORDEP) THEN
            DPVAR (1) = 2
          ELSE
            DPVAR (1) = 1
          END IF
        END IF
        IF (VARSEL (2)) THEN
C         Magnetics, so ask if recalculated
          CALL MAGMES
          CALL GETLOG
     &      ('Recalculate residual magnetic anomaly? (Y/N)',
     &      RECALC, SET)
          DPVAR (2) = 4
        END IF
        IF (VARSEL (3)) THEN
C         Gravity
          DPVAR (3) = 5
        END IF
      END IF

      IF ((PLOT .EQ. 2 .OR. PLOT .EQ. 3 .OR. PLOT .EQ. 7) .AND. CORDEP)
     & THEN
  35    CALL GETLOG ('Use uncorrected depth if corrected is unavailab
     &le? (Y/N)', FILLIN, SET)
      END IF

      CALL CLIST ('Which devices?', 20, 4, DEVNAM, USEDEV)

C Get projection and map limits

      CALL CMSCMD (OUT, ISTAT)
       CALL MENU ('Which projection?', 40, 5, PRONAM, PROJ)
      CALL CMSCMD (OUT, ISTAT)
```

```
C     Ask for Central Meridian if transverse projection
      IF (PROJ .EQ. 2 .OR. PROJ .EQ. 3 .OR. PROJ .EQ. 5) CALL GETREL
     & ('Central Meridian (positive = east)  ', 36, -180, 180, SLONG)
       CALL GETREL ('Standard Latitude (positive = north)', 36,
     & -90, 90, SLAT)
      CALL CMSCMD (OUT, ISTAT)
       CALL GETREL ('Longitude of left edge  (positive = east )',
     & 42, -180, 180, XLEFT)
       CALL GETREL ('Longitude of right edge (positive = east )',
     & 42, -180, 180, XR0)
      CALL CMSCMD (OUT, ISTAT)
       CALL GETREL ('Latitude of lower edge (positive = north)',
     & 41, -90, 90, YBASE)
       CALL GETREL ('Latitude of upper edge (positive = north)',
     & 41, -90, 90, YTOP)
C     Right limit must be greater than left limit
      IF (XR0 .LT. XLEFT) THEN
          XRIGHT = XR0 + 360.
      ELSE
          XRIGHT = XR0
      END IF

C Suggest scales and get the actual scale from the user

       C1 = 111317099.7 * COS (SLAT * 0.017453292)
       C2 = 57.29577951 * (ALOG (TAN (0.785398163 + YTOP * 0.008726646))
     & - ALOG (TAN (0.785398163 + YBASE * 0.008726646)))
      MSIZE (1) = 'Suggested scales:'
      MSIZE (2) = 'Approximate size            Scale'
      DO I = 0, 3
          SN = (2 ** I) * 100
          SM = SN / C2
           WRITE (MSIZE (3 + I), '(I3, " mm N-S,", I4, " mm E-W,",
     &      I10, "0000")') NINT (SN), 10 * NINT (SM / 10. * (XRIGHT
     &     - XLEFT)), NINT (C1 / (SM * 10000))
      END DO
      CALL CMSCMD (OUT, ISTAT)
      CALL MESSGE (MSIZE, 40, 6)
       CALL GETREL ('Scale (eg 0.0000001 or 10000000)   ', 35, 0, 0,
     & SCALE)
      IF (SCALE .LT. 1) SCALE = 1. / SCALE
```

```
      CALL CMSCMD (OUT, ISTAT)
       CALL GETSTR ('Title (up to 45 characters)', TITLE)
      CALL CMSCMD (OUT, ISTAT)
       WRITE (VALNAM (1), '("Title", T21, A)') TITLE
       WRITE (VALNAM (2), '("Left grid limit", T21, F10.2)') XLEFT
       WRITE (VALNAM (3), '("Right grid limit", T21, F10.2)') XR0
       WRITE (VALNAM (4), '("Lower grid limit", T21, F10.2)') YBASE
       WRITE (VALNAM (5), '("Upper grid limit", T21, F10.2)') YTOP
       WRITE (VALNAM (6), '("Scale", T19, F10.0)') SCALE
       WRITE (VALNAM (7), '("Projection", T21, A)') PRONAM (PROJ)
       DEVNO = 0
       DO I= 1, 4
          IF (USEDEV (I)) THEN
             DEVNO = DEVNO + 1
              WRITE (VALNAM (7 + DEVNO), '("Device", I2, T21, A)')
     &            DEVNO, DEVNAM (I)
          END IF
       END DO
       CALL MESSGE (VALNAM, 70, 7 + DEVNO)
       SET = .TRUE.
       CALL GETLOG ('Re-enter these parameters? (Y/N)', REDO, .FALSE.)
      IF (REDO) GO TO 1

C Set up default values

      FMTNO = 1
       GRID = .TRUE.
      LNDCOL = BLACK
      TRKCOL = BLACK
      ANNCOL = BLACK
      COLOUR (1) = GREEN
      COLOUR (2) = RED
      COLOUR (3) = BLUE
     50 WRITE (DEFNAM (1), '("Format", T12, A)') FMTNAM (FMTNO)
      IF (GRID) THEN
           WRITE (DEFNAM (2), '("Grid", T12, A)') 'On'
      ELSE
           WRITE (DEFNAM (2), '("Grid", T12, A)') 'Off'
      END IF
      WRITE (DEFNAM (3), '("Coastline", T12, A)') COLNAM (LNDCOL)
      WRITE (DEFNAM (4), '("Track", T12, A)') COLNAM (TRKCOL)
       WRITE (DEFNAM (5), '("Annotation", T12, A)') COLNAM (ANNCOL)
      WRITE (DEFNAM (6), '("Bathymetry", T12, A)') COLNAM (COLOUR (1))
      WRITE (DEFNAM (7), '("Magnetics", T12, A)') COLNAM (COLOUR (2))
      WRITE (DEFNAM (8), '("Gravity", T12, A)') COLNAM (COLOUR (3))
     CALL CMSCMD (OUT, ISTAT)
      CALL MESSGE (DEFNAM, 40, 8)
```

```
      OPTION = 0
      CALL MENU ('Please select an option', 30, 4, OPTNAM, OPTION)
      IF (OPTION .EQ. 1) THEN
C        Choose a different format
         CALL CMSCMD (OUT, ISTAT)
          CALL MENU ('Which format', 20, 4, FMTNAM, FMTNO)
         IF (FMTNO .EQ. 4) THEN
             CALL GETSTR ('Enter format (Fortran syntax)', FMTA)
             CALL GETINT ('Number of lines in header', NHLINS)
         END IF
      ELSE IF (OPTION .EQ. 2) THEN
C        Toggle grid
         IF (GRID) THEN
             GRID = .FALSE.
             OPTNAM (2) (11 : 13) = 'on'
         ELSE
             GRID = .TRUE.
             OPTNAM (2) (11 : 13) = 'off'
         END IF
      ELSE IF (OPTION .EQ. 3) THEN
C        Change default colours
         CALL CMSCMD (OUT, ISTAT)
          CALL MENU ('Coastline', 10, 4, COLNAM, LNDCOL)
         CALL CMSCMD (OUT, ISTAT)
          CALL MENU ('Track', 10, 4, COLNAM, TRKCOL)
         CALL CMSCMD (OUT, ISTAT)
          CALL MENU ('Annotation', 10, 4, COLNAM, ANNCOL)
         CALL CMSCMD (OUT, ISTAT)
          CALL MENU ('Bathymetry', 10, 4, COLNAM, COLOUR (1))
         CALL CMSCMD (OUT, ISTAT)
          CALL MENU ('Magnetics', 10, 4, COLNAM, COLOUR (2))
         CALL CMSCMD (OUT, ISTAT)
          CALL MENU ('Gravity', 10, 4, COLNAM, COLOUR (3))
      END IF
      IF (OPTION .NE. 4) GO TO 50
C     Set up colour for uncorrected depth annotation
      IF (ANNCOL .EQ. RED) THEN
         UNCCOL = GREEN
      ELSE
         UNCCOL = RED
      END IF
```

```
      IF (FMTNO .EQ. 1) THEN
C        Oracles format
         FMTA =
     &   '(A8, 1X, 3 (I2, 1X), 2I2, 2X, 2 (F9.4, 2X), 5(F5.0, 2X))'
         NHLINS = 2
      ELSE IF (FMTNO .EQ. 2) THEN
C        Merge-Merge format
         FMTA =
     &   '(A8, 5X, 3I2, 1X, 2I2, 1X, F8.4, F9.4, 10X, 2F5.0, 3X, 3F5.0)'
         NHLINS = 0
      ELSE IF (FMTNO .EQ. 3) THEN
C        MGD77 format
         FMTA = '(1X,A8,5X,5I2,3X,F8.5,F9.5,1X,F6.4,F6.1,3X,F6.1,6X,F6
     &.1,25X,F5.1)'
         NHLINS = 24
      END IF

C Open path to devices

      IF (USEDEV (1)) CALL DEVICE (3179)
      IF (USEDEV (2)) CALL DEVICE (1075)
      IF (USEDEV (3)) CALL DEVICE (80)
      IF (USEDEV (4)) CALL DEVICE (4205)

      CALL PAGBEG
      CALL DESCR (TITLE, SCALE, SLAT, PLOT, VARNO, DPVAR, PANGLE,
     & PSCALE, PSTART, UNCCOL, COLOUR, FILLIN, RECALC)
      IF (PROJ .EQ. 1) THEN
         CALL DRAW (EMERC)
      ELSE IF (PROJ .EQ. 2) THEN
         CALL DRAW (EUTM)
      ELSE IF (PROJ .EQ. 3) THEN
         CALL DRAW (SGNOMT)
      ELSE IF (PROJ .EQ. 4) THEN
         CALL DRAW (SLEAC)
      ELSE IF (PROJ .EQ. 5) THEN
         CALL DRAW (SORTHT)
      END IF
      CALL GCLOSE
      CALL NCLOSE (2, ISTAT)
      END

C-------------------------------------------------

      SUBROUTINE MAGMES

C Calls MAGSYN to get the date of the latest DGRF, then displays the
C date, together with the date of the latest IGRF.

      REAL DGRF
      CHARACTER * 20 MESS (2)

      DGRF = 0.
      CALL MAGSYN (DGRF, 0, 0., 0., 0., X, Y, Z, F)
      WRITE (MESS (1), '("Latest DGRF is ", I4)') NINT (DGRF)
      WRITE (MESS (2), '("Latest IGRF is ", I4)') NINT (DGRF) + 5
      CALL MESSGE (MESS, 20, 2)
```

```
      END
C-------------------------------------------
      SUBROUTINE GETINT (PROMPT, NUMBER)

C Prints a prompt and gets an integer from the user. If the NUMBER
C parameter is -999 then a value must be input, otherwise the previous
C value is available by pressing Enter.

      CHARACTER * (*) PROMPT, LINE * 80
      INTEGER NUMBER, INPUT
      DATA LINE /'_____
     &_____' /

      WRITE (6, '(2X, A)') LINE (:LEN (PROMPT))
       WRITE (6, '(" ]", A, "]")') PROMPT
       WRITE (6, '(" ]", A, "]")') LINE (:LEN (PROMPT))
       IF (NUMBER .NE. -999) WRITE (6, '(" Or press enter for ", I8)')
     & NUMBER

   10 REWIND 5
       READ (5, '(BN, I8)', END = 100) INPUT
      NUMBER = INPUT
      RETURN

C No number has been input, so check for previous value
  100 IF (NUMBER .NE. -999) RETURN
C No previous value, so request input again
      WRITE (6, *) '* PLEASE TRY AGAIN *'
      GO TO 10
      END

C-------------------------------------------
      SUBROUTINE GETLOG (PROMPT, LVALUE, SET)

C sets a logical value by prompting the user for a 'Y' or 'N' answer.
C SET is true if the value has been set previously.

      CHARACTER * 1 REPLY, NULL
      CHARACTER * (*) PROMPT
      LOGICAL LVALUE, SET
      PARAMETER (NULL = '$')
```

```
      IF (SET) THEN
         IF (LVALUE) THEN
            REPLY = 'Y'
         ELSE
            REPLY = 'N'
         END IF
      ELSE
         REPLY = NULL
      END IF

   10 CALL GETSTR (PROMPT, REPLY)
      IF (REPLY .NE. 'Y' .AND. REPLY .NE. 'N') GO TO 10

      LVALUE = REPLY .EQ. 'Y'
      END

C-------------------------------------------

      SUBROUTINE GETREL (PROMPT, LENGTH, MIN, MAX, NUMBER)

C Prints a prompt of the length given and gets a real number from the
C user, within the range given by MIN & MAX. If MIN & MAX are both zero
C any value is accepted. A default can be passed in using NUMBER, if
C this is not required NUMBER should be -999.

      CHARACTER * (*) PROMPT, LINE * 50, SPACE * 50
      INTEGER LENGTH, MIN, MAX
      REAL NUMBER, INPUT
      LOGICAL DEFALT
      DATA LINE /'__________________________________________________'/
      DATA SPACE /'                                                  '/

      WRITE (6, '(2X, A)') LINE (:LENGTH)
      WRITE (6, '(" ]", A, "]")') PROMPT
      IF (MIN .NE. 0 .OR. MAX .NE. 0) THEN
C        Print range
         WRITE (6, '(" ]Between", I7, " and", I7, A, "]")')
     &   MIN, MAX, SPACE (:LENGTH - 25)
      END IF
      WRITE (6, '(" ]", A, "]")') LINE (:LENGTH)
      DEFALT = ABS (NUMBER + 999.) .GT. 0.01
      IF (DEFALT) WRITE (6, '(" Or press enter for ", F12.3)') NUMBER

   10 REWIND 5
      READ (5, '(BN, F10.0)', END = 100) INPUT
      NUMBER = INPUT
      IF (MIN .EQ. 0 .AND. MAX .EQ. 0) RETURN
      IF (NUMBER .GE. REAL (MIN) .AND. NUMBER .LE. REAL (MAX)) RETURN
      WRITE (6, *) ' * OUT OF RANGE *'
      GO TO 10
```

```
C     No number has been input, so check for default
  100 IF (DEFALT) RETURN
C     No default, so request input again
      WRITE (6, *) '* PLEASE TRY AGAIN *'
      GO TO 10
      END

C-------------------------------------------

      SUBROUTINE GETSTR (PROMPT, STRING)

C Prints a prompt and gets a string from the user. If the STRING
C parameter is NULL then a value must be input, otherwise the previous
C value is available by pressing Enter.

      CHARACTER * (*) PROMPT, STRING, LINE * 80, INPUT * 80, NULL * 1
      PARAMETER (NULL = '$')
      DATA LINE /'_____
     &_____' /

      WRITE (6, '(2X, A)') LINE (:LEN (PROMPT))
      WRITE (6, '(" ]", A, "]")') PROMPT
      WRITE (6, '(" ]", A, "]")') LINE (:LEN (PROMPT))
      IF (STRING (1 : 1) .NE. NULL) WRITE (6,
     & '(" Or press enter for ", A)') STRING

   10 REWIND 5
      READ (5, '(A)', END = 100) INPUT
      STRING = INPUT
      RETURN

C No string has been input, so check for previous value
  100 IF (STRING  (1 : 1) .NE. NULL) RETURN
C No previous value, so request input again
      WRITE (6, *) '* PLEASE TRY AGAIN *'
      GO TO 10
      END

C-------------------------------------------

      SUBROUTINE MESSGE (MESS, LENGTH, NOLINS)

C Prints a message stored in the array MESS, with maximum line length
C and no. of lines as given

      CHARACTER * (*) MESS (*), LINE * 80, SPACE * 80
      INTEGER LENGTH
      DATA LINE /'_____
     &_____' /
      DATA SPACE /'
     &                    ' /

C     One has to be added to LENGTH to avoid a null string
      WRITE (6, '(2X, A)') LINE (:LENGTH + 1)
      DO I = 1, NOLINS
          WRITE (6, '(" ]", A, A, "]")') MESS (I), SPACE (:LENGTH
     &     - LEN (MESS (I)) + 1)
```

```
      END DO
       WRITE (6, '(" ]", A, "]")') LINE (:LENGTH + 1)
      RETURN
      END

C-------------------------------------------

      SUBROUTINE MENU (TITLE, LENGTH, NOLINS, CHOICE, SELECT)

C Displays a menu with NOLINS selections. TITLE is displayed at the top
C and the choices are in array CHOICE. The user's selection is returned
C in SELECT. If SELECT > 0 is passed to the subroutine, pressing enter
C will keep the current value of SELECT.

      CHARACTER * (*) TITLE, CHOICE (NOLINS), LINE * 80, SPACE * 80
      INTEGER LENGTH, NOLINS, SELECT, INPUT
      DATA LINE /'_____
     &_____'/
      DATA SPACE /'
     &                    ' /

      WRITE (6, '(2X, A)') LINE (:LENGTH + 4)
       WRITE (6 ,'(" ]", A, A, "]")') TITLE, SPACE (:LENGTH + 4 -
     & LEN (TITLE))
       WRITE (6, '(" ]", A,  "]")') LINE (:LENGTH + 4)

      DO I = 1, NOLINS
           WRITE (6, '(" ]", I2, " ]", A, "]")') I, CHOICE (I)
      END DO
       WRITE (6, '(" ]___]", A, "]")') LINE (:LENGTH)
      IF (SELECT .GT. 0) WRITE (6, '(" Or press enter for ", A)')
     & CHOICE (SELECT)

   10 REWIND 5
       READ (5, *, END = 100) INPUT
      SELECT = INPUT
  100 IF (SELECT .GE. 1 .AND. SELECT .LE. NOLINS) RETURN
       WRITE (6, *) '* PLEASE CHOOSE AGAIN *'
       GO TO 10
       END
```

```
C-------------------------------------------

      SUBROUTINE CLIST (TITLE, LENGTH, NOLINS, CHOICE, SELECT)

C Displays a checklist from which the user can make one or more choices.
C TITLE is displayed at the top, LENGTH is the line length, NOLINS is
C the number of lines of choices, CHOICE is an array containing the
C choices and SELECT is an array containing the user's selections. The
C subroutine terminates when the user selects 0.

      CHARACTER * 80 OUT, LINE, SPACE
      CHARACTER * (*) TITLE, CHOICE (NOLINS)
      INTEGER LENGTH, NOLINS, NOSELS, SEL, INPUT
      LOGICAL SELECT (NOLINS)
      DATA LINE /'_____
     &_____'/
      DATA SPACE /'
     &                    '/
      COMMON /CLEAR/ OUT

      NOSELS = 0
      DO I = 1, NOLINS
         IF (SELECT (I)) NOSELS = NOSELS + 1
      END DO

   10 CALL CMSCMD (OUT, ISTAT)
      WRITE (6, '(2X, A)') LINE (:LENGTH + 5)
      WRITE (6 ,'(" ]", A, A, "]")') TITLE, SPACE (:LENGTH + 5 -
     & LEN (TITLE))
      WRITE (6, '(" ]", A, A, "]")') 'Enter to finish', SPACE
     & (:LENGTH - 10)
      WRITE (6, '(" ]", A,  "]")') LINE (:LENGTH + 5)

      DO I = 1, NOLINS
C        Mark choice if already selected
         IF (SELECT (I)) THEN
               WRITE (6, '(" ]*", I2, " ]", A, "]")') I, CHOICE
     &         (I)
         ELSE
               WRITE (6, '(" ] ", I2, " ]", A, "]")') I, CHOICE
     &         (I)
         END IF
      END DO
      WRITE (6, '(" ]____]", A, "]")') LINE (:LENGTH)
```

```
C Read and examine selection

      SEL = 0
      REWIND 5
      READ (5, *, END = 100) INPUT
      SEL = INPUT
  100 IF (SEL .EQ. 0 .AND. NOSELS .GT. 0) RETURN
      IF (SEL .GE. 1 .AND. SEL .LE. NOLINS) THEN
         IF (SELECT (SEL)) THEN
            SELECT (SEL) = .FALSE.
            NOSELS = NOSELS - 1
         ELSE
            SELECT (SEL) = .TRUE.
            NOSELS = NOSELS + 1
         END IF
      END IF
      GO TO 10
      END

C-------------------------------------------------

      SUBROUTINE DESCR (TITLE, SCALE, SLAT, PLOT, VARNO, DPVAR, PANGLE,
     & PSCALE, PSTART, UNCCOL, COLOUR, FILLIN, RECALC)

C Draws a box containing a description of the plot

      CHARACTER * 45 TITLE, LINE (11)
      CHARACTER * 1 PIC (36)
      CHARACTER * 8 DATE
      CHARACTER * 30 VNAM (5)
      CHARACTER * 16 DT

      INTEGER PLOT, VARNO, DPVAR (3), NEXT, HOUR, MINUTE, COLOUR (3)
      INTEGER KEYCOL (3), VAR, UNCCOL
      REAL SCALE, SLAT, PANGLE, PSCALE (3), PSTART (3), TIME
      LOGICAL FILLIN, RECALC

       DATA PIC /'N', 'A', 'T', 'U', 'R', 'A', 'L', ' ', 'E', 'N', 'V',
      & 'I', 'R', 'O', 'N', 'M', 'E', 'N', 'T', ' ', 'R', 'E', 'S', 'E',
      & 'A', 'R', 'C', 'H', ' ', 'C', 'O', 'U', 'N', 'C', 'I', 'L'/
      DATA VNAM /'UNCORRECTED DEPTH            ',
     & 'CORRECTED DEPTH              ',
     & 'NOT USED                     ',
     & 'RESIDUAL MAGNETIC ANOMALY    ',
     & 'FREE AIR ANOMALY             ' /
```

```
C Draw box

      CALL GRAFIX (210., 110., 0.)
      CALL DEFLA2 (0., 210., 0., 110.)
      CALL RECLA2 (10., 10., 190., 90., 1, 1)
      CALL LINLA2 (10., 20., 190., 20., 2)
      CALL LINLA2 (190., 70., 10., 70., 2)
      CALL LINLA2 (10., 72., 190., 72., 2)

C Write box header

      CALL CHSETS (2)
      CALL CHHITS (4.)
      CALL TEXLB2 (90., 83., 'INSTITUTE OF OCEANOGRAPHIC SCIENCES', 1,
     & 35, 0., 2, 4, 0, 2)
      CALL CHHITS (2.)
       CALL TEXLB2 (90., 79.,
     &'DEACON LABORATORY, BROOK ROAD, WORMLEY, SURREY GU8 5UB, ENGLAND',
     & 1, 63, 0., 2, 4, 0, 2)
       CALL TEXLB2 (90., 74., 'TEL. WORMLEY (0428) 684141', 1, 26, 0., 2,
     & 4, 0, 1)

C Clear text array

      DO I = 1, 11
          LINE (I) = ' '
      END DO

C Write plot descriptions to array

      WRITE (LINE (1), '("SCALE 1 TO ", -6PF6.2, "M")') SCALE
      IF (SLAT .GT. 0) THEN
          WRITE (LINE (2), '("STANDARD LATITUDE", F5.1,
     &     " DEG. N")') SLAT
      ELSE
          WRITE (LINE (2), '("STANDARD LATITUDE", F5.1,
     &     " DEG. S")') -SLAT
      END IF

      IF (PLOT .EQ. 1 .OR. PLOT .EQ. 6) THEN
          WRITE (LINE (4), *) 'PLOT OF SHIP"S TRACK'

      ELSE IF (PLOT .EQ. 2) THEN
          WRITE (LINE (4), *) 'ANNOTATION ALONG SHIP"S TRACK'
          WRITE (LINE (5), *) VNAM (VARNO)
          IF (VARNO .EQ. 2 .AND. FILLIN) WRITE (LINE (6), *)
     &     'UNCORRECTED DEPTH'
          IF (VARNO .EQ. 4 .AND. RECALC) WRITE (LINE (6), *)
     &     '(RECALCULATED)'
```

```
      ELSE IF (PLOT .EQ. 3 .OR. PLOT .EQ. 7) THEN
          WRITE (LINE (4), *) 'PROFILES PLOTTED ALONG TRACK'
           WRITE (LINE (5), '("AT A BEARING OF ", F8.4)') PANGLE
           VAR = 0
           DO I = 1, 3
              IF (DPVAR (I) .GT. 0) THEN
                  WRITE (LINE (6 + VAR * 2), *) VNAM (DPVAR (I))
                   WRITE (LINE (7 + VAR * 2), '("SCALING FACTOR",
     &             F8.2, " OFFSET", F10.4)') PSCALE (I), PSTART (I)
                  VAR = VAR + 1
                 KEYCOL (VAR) = COLOUR (I)
              END IF
          END DO

      ELSE IF (PLOT .EQ. 4) THEN
          WRITE (LINE (4), *) 'PLOT WHERE VARIABLE IS PRESENT'
          WRITE (LINE (5), *) VNAM (VARNO)

      ELSE IF (PLOT .EQ. 5) THEN
          WRITE (LINE (4), *)
     &     'PLOT OF SHIP"S TRACK WITH TIME ANNOTATION'
       END IF

C     Set date and time of plot.
      CALL DATIM (DATE, TIME)
C     Time is real number in hours, so convert to hours and minutes
      HOUR = INT (TIME)
      MINUTE = INT ((TIME - HOUR) * 60)
       WRITE (DT, '(I2, ":", I2.2, 3X, A8)') HOUR, MINUTE, DATE

C Plot descriptions

      CALL CHHITS (2.5)
      CALL TEXLA2 (15., 64., TITLE, 1, 45, 2)
      CALL CHHITS (2.)
       Y = 57.
      DO I = 1, 11
C          Change pens for data profile variable names...
          IF ((PLOT .EQ. 3 .OR. PLOT .EQ. 7) .AND. (I .EQ. 6 .OR. I
     &     .EQ. 8 .OR. I .EQ. 10)) CALL TXPENS (KEYCOL ((I - 4) / 2))
C          ...and for uncorrected depth on corrected depth plot
          IF (PLOT .EQ. 2 .AND. I .EQ. 6 .AND. FILLIN) CALL TXPENS
     &     (UNCCOL)
           CALL TEXLA2 (15., Y, LINE (I), 1, 45, 2)
          CALL TXPENS (1)
           Y = Y - 3.5
      END DO
       CALL TEXLA2 (15., 13., DT, 1, 16, 2)
```

```
C Plot IOS logo

      CALL TXUPRS (0)
       AA = 155.
      BB = 45.
       RAD = 20.
      THET = 153.0
      DO I = 1, 36
         THETW = THET - 90.
         RTHET = (THET / 180.) * 3.14
         XP = RAD * COS (RTHET) + AA
         YP = RAD * SIN (RTHET) + BB
          CALL TEXLB2 (XP, YP, PIC (I), 1, 1, THETW, 2, 3, 0, 2)
         THET = THET - 8.5
         IF (THET .LE. 0.) THET = 360.
      END DO
      CALL CHHITS (2.7)
       CALL TEXLB2 (155., 47., 'INSTITUTE OF', 1, 12, 0., 3, 4, 0, 2)
       CALL TEXLB2 (155., 42., 'OCEANOGRAPHIC', 1, 13, 0., 3, 4, 0, 2)
       CALL TEXLB2 (155., 37., 'SCIENCES', 1, 8, 0., 3, 4, 0, 2)

      CALL PAGEND
      RETURN
      END

C-------------------------------------------

      SUBROUTINE DRAW (MAP2)

C Sets up the chart and calls the routines to plot the track

      EXTERNAL MAP2

      REAL EQSC, XLEFT, XRIGHT, YBASE, YTOP, SCALE, SLAT, SLONG
      REAL PANGLE, PSCALE (3), PSTART (3)

      INTEGER PLOT, VARNO, DPVAR (3), INTVAL, LNDCOL, TRKCOL, ANNCOL
      INTEGER UNCCOL, COLOUR (3), NUNITS (3), PROJ, NHLINS
      LOGICAL GRID, FILLIN, RECALC

      COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP
      COMMON /PARAMS/ PLOT, SCALE, SLAT, SLONG, VARNO, DPVAR, PANGLE,
     & PSCALE, PSTART, INTVAL, GRID, LNDCOL, TRKCOL, ANNCOL, UNCCOL,
     & COLOUR, NUNITS, NHLINS, FILLIN, RECALC, PROJ
      PARAMETER (BLACK = 1)
```

```
C    Reserve space for annotation
     CALL FMTANN (1, 12, 12)
C    Find scale at equator
     CALL MAPSCL (MAP2, 1 / SCALE, SLAT, EQSC)
C    Set central latitude and longitude
     CALL MAPCEN (SLONG, SLAT)
     IF (PROJ .EQ. 1 .OR. PROJ .EQ. 4 .OR. PROJ .EQ. 5) THEN
C       Rectangular projection
        CALL FMTCHR (MAP2, XLEFT, XRIGHT, YBASE, YTOP, EQSC)
     ELSE
C       Irregular projection
        CALL FMTCHI (MAP2, XLEFT, XRIGHT, YBASE, YTOP, EQSC)
     END IF

C Annotate axes

     CALL GRASET
     CALL LNPENS (BLACK)
     CALL TXPENS (BLACK)
     CALL MKPENS (BLACK)
     CALL ANNGEO (2, 1)
     IF (GRID) THEN
        CALL GRISEL (3, 3, 1)
     ELSE
        CALL GRISEL (3, 3, 0)
     END IF
     CALL AXIFA2 (MAP2, 1)
     CALL AXIFA2 (MAP2, 2)
     CALL PL2STD
```

```
C Plot track

      CALL ERRSET (255, 50, -1)
     CALL TXPENS (ANNCOL)
     CALL LNPENS (TRKCOL)
     CALL MKPENS (ANNCOL)
C    Turn off marks
     CALL MARSEL (0)
C    Skip header information
     DO I = 1, NHLINS
          READ (2, '()')
     END DO
     IF (PLOT .EQ. 1) THEN
          CALL TRAK (MAP2)
     ELSE IF (PLOT .EQ. 2) THEN
          CALL DATANN (MAP2, VARNO, UNCCOL, ANNCOL, FILLIN, RECALC)
     ELSE IF (PLOT .EQ. 3) THEN
          CALL TRAKDP (MAP2, DPVAR, COLOUR, FILLIN, RECALC, PSTART,
    &     PANGLE, PSCALE, NUNITS, 0, NHLINS)
     ELSE IF (PLOT .EQ. 4) THEN
          CALL TRAKDV (MAP2, VARNO)
     ELSE IF (PLOT .EQ. 5) THEN
          CALL TRAKTA (MAP2, INTVAL)
     ELSE IF (PLOT .EQ. 6) THEN
          CALL TRAKCD (MAP2)
     ELSE IF (PLOT .EQ. 7) THEN
          CALL TRAKDP (MAP2, DPVAR, COLOUR, FILLIN, RECALC, PSTART,
    &     PANGLE, PSCALE, NUNITS, INTVAL, NHLINS)
     END IF

C Plot land outline. Terminate

     CALL LNPENS (LNDCOL)
     CALL WORLDM (MAP2)
     CALL PAGEND
     RETURN
     END

C-------------------------------------------------

     SUBROUTINE TRAK (MAP2)
```

```
C Plots track of ship

      EXTERNAL MAP2

      CHARACTER * 80 FMTA
      CHARACTER * 8 CNAME
      INTEGER DAY, MONTH, YEAR, HOUR, MINUTE, FMTNO
      INTEGER TIME, TIME0, DAYNO
      REAL LAT, LONG, VAR (5)
      LOGICAL ONMAP
      COMMON /FMT/ FMTA, FMTNO
      COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP

C     Adjacent points are joined up
      CALL LINSEL (1)
      CALL POIBEG

   10 IF (FMTNO .EQ. 1 .OR. FMTNO .EQ. 4) THEN
         READ (2, FMTA, END = 100) CNAME, DAY, MONTH, YEAR, HOUR,
     &      MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
      ELSE
         READ (2, FMTA, END = 100) CNAME, YEAR, MONTH, DAY, HOUR,
     &      MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
      END IF
C     Ensure that lines which cross 180 degrees are plotted correctly
      IF (LONG .LT. XLEFT) LONG = LONG + 360.
      IF (ONMAP (LONG, LAT)) THEN
C        Check for gap in data
         TIME0 = TIME
         TIME = DAYNO (DAY, MONTH, YEAR) * 1440 + HOUR * 60 + MINUTE
         IF (TIME - TIME0 .LE. 20 .AND. TIME - TIME0 .GE. 0) THEN
            CALL POIFA2 (MAP2, LONG, LAT)
         ELSE
            CALL POIBRK
         END IF
      ELSE
         CALL POIBRK
      END IF
      GO TO 10

  100 CALL POIEND
      RETURN
      END

C-------------------------------------------------

      SUBROUTINE DATANN (MAP2, VARNO, UNCCOL, ANNCOL, FILLIN, RECALC)

C Plots the given variable along the track. If FILLIN is true, gaps in
C the corrected depth are filled by uncorrected depth. If RECALC is
C true, the residual magnetic anomaly is recalculated using the latest
C version of the IGRF.
      EXTERNAL MAP2

      CHARACTER * 80 FMTA
      CHARACTER * 8 CNAME
      CHARACTER * 6 NUMBER
```

```
      INTEGER DAY, MONTH, YEAR, HOUR, MINUTE, VARNO, FMTNO
      INTEGER FULLYR, DAYNO, UNCCOL, ANNCOL
      REAL LAT, LONG, VAR (5), TOTMAG
      LOGICAL ONMAP, FILLIN, RECALC
      COMMON /FMT/ FMTA, FMTNO
      COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP

C     Don't mark points
      CALL MARSEL (0)
C     Numbers are centred on ship's track
      CALL PANLIS (2, 3)
C     Extended ASCII set
      CALL CHSETS (1)
C     Include spaces in strings
      CALL TXSPAS (0)
C     Set character height
      CALL CHHITS (1.2)
      CALL POIBEG
```

```
 10 IF (FMTNO .EQ. 1 .OR. FMTNO .EQ. 4) THEN
        READ (2, FMTA, END = 100) CNAME, DAY, MONTH, YEAR, HOUR,
    &     MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
    ELSE
        READ (2, FMTA, END = 100) CNAME, YEAR, MONTH, DAY, HOUR,
    &     MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
    END IF
C   Ensure that lines which cross 180 degrees are plotted correctly
    IF (LONG .LT. XLEFT) LONG = LONG + 360.
C   Convert MGD-77 format to Oracles
    IF (FMTNO .EQ. 3) CALL MGD2OR (VAR)
    IF (RECALC .AND. VARNO .EQ. 4) THEN
C       Recalculate RMA
        CALL MAGSYN (FULLYR (YEAR) + DAYNO (DAY, MONTH, YEAR) /
    &    365.0, 1, 0., 90. - LAT, LONG, X, Y, Z, TOTMAG)
        IF (VAR (3) .GT. 0.) VAR (4) = VAR (3) - TOTMAG
    END IF
    IF (ONMAP (LONG, LAT)) THEN
        IF (VAR (VARNO) .NE. 0) THEN
C           Plot specified value
            WRITE (NUMBER, '(I5)') NINT (VAR (VARNO))
            CALL POIFC2 (MAP2, LONG, LAT, NUMBER, 5)
        ELSE IF (FILLIN .AND. VARNO .EQ. 2 .AND. VAR(1) .NE. 0.) THEN
C           Plot uncorrected depth in place of corrected
            CALL TXPENS (UNCCOL)
            WRITE (NUMBER, '(I5)') NINT (VAR (1))
            CALL POIFC2 (MAP2, LONG, LAT, NUMBER, 5)
            CALL TXPENS (ANNCOL)
        END IF
    END IF
    GO TO 10

100 CALL PANOFF
    CALL POIEND
    RETURN
    END

C-------------------------------------------------

    SUBROUTINE TRAKDP (MAP2, VARNO, COLOUR, FILLIN, RECALC, OFFSET,
    & ANGLE, SCALE, NUNITS, INTVAL, NHLINS)

C Plot data profiles of the given variables along ship's track, using
C the colours given. If INTVAL > 0, the ship's track is annotated with
C the time every INTVAL minutes.

    EXTERNAL MAP2

    INTEGER VARNO (3), COLOUR (3), NUNITS (3), INTVAL, NHLINS
    REAL OFFSET (3), ANGLE, SCALE (3)
    LOGICAL FILLIN, RECALC

C   Draw ship's track

    IF (INTVAL .GT. 0) THEN
        CALL TRAKTA (MAP2, INTVAL)
    ELSE
```

```
      CALL TRAK (MAP2)
    END IF

    CALL POIBEG
    DO I = 1, 3
      IF (VARNO (I) .GT. 0) THEN
C       Select pen
        CALL LNPENS (COLOUR (I))
C       Plot profile
        CALL PROFIL (MAP2, VARNO (I), FILLIN, RECALC,
     &    OFFSET (I), ANGLE, SCALE (I) / NUNITS (I), NHLINS)
      END IF
    END DO
    CALL POIEND
    RETURN
    END

C-------------------------------------------------

    SUBROUTINE PROFIL (MAP2, VARNO, FILLIN, RECALC, OFFSET, ANGLE,
    & SCALE, NHLINS)

C Plot data profile of the given variable. If FILLIN is true gaps in
C the corrected depth are filled by uncorrected depth. If RECALC is
C true, the residual magnetic anomaly is recalculated using the latest
C version of the IGRF.

    EXTERNAL MAP2

    CHARACTER * 80 FMTA
    CHARACTER * 8 CNAME
    INTEGER DAY, MONTH, YEAR, HOUR, MINUTE, VARNO, FMTNO
    INTEGER TIME, TIME0, DAYNO, FULLYR, NHLINS
    REAL LAT, LONG, OFFSET, ANGLE, SCALE, VAR (5), TOTMAG
    LOGICAL FILLIN, RECALC, ONMAP
    COMMON /FMT/ FMTA, FMTNO
    COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP

C Go back to start of file and skip header information

    REWIND 2
    DO I = 1, NHLINS
      READ (2, '()')
    END DO
```

```
C Set up profile mode

      CALL PL2PRF (-OFFSET, 90 - ANGLE, SCALE)

C Points within 3 readings are joined up

      CALL LINSEL (3)

   10 IF (FMTNO .EQ. 1 .OR. FMTNO .EQ. 4) THEN
         READ (2, FMTA, END = 100) CNAME, DAY, MONTH, YEAR, HOUR,
     &      MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
      ELSE
         READ (2, FMTA, END = 100) CNAME, YEAR, MONTH, DAY, HOUR,
     &      MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
      END IF
C     Ensure that lines which cross 180 degrees are plotted correctly
      IF (LONG .LT. XLEFT) LONG = LONG + 360.
C     Convert MGD-77 format to Oracles
      IF (FMTNO .EQ. 3) CALL MGD2OR (VAR)
C     Check if uncorrected depth should be plotted instead of corrected
      IF (FILLIN .AND. VAR (2) .EQ. 0. .AND. VAR (1) .NE. 0) VAR (2) =
     & VAR (1)
      IF (RECALC .AND. VARNO .EQ. 4) THEN
C        Recalculate RMA
         CALL MAGSYN (FULLYR (YEAR) + DAYNO (DAY, MONTH, YEAR) /
     &      365.0, 1, 0., 90. - LAT, LONG, X, Y, Z, TOTMAG)
         IF (VAR (3) .GT. 0.) VAR (4) = VAR (3) - TOTMAG
      END IF
      IF (ONMAP (LONG, LAT) .AND. (VAR (VARNO) .NE. 0.)) THEN
C        Check for gap in data
         TIME0 = TIME
         TIME = DAYNO (DAY, MONTH, YEAR) * 1440 + HOUR * 60 + MINUTE
         IF (TIME - TIME0 .LE. 20 .AND. TIME - TIME0 .GE. 0) THEN
            CALL POIFR2 (MAP2, LONG, LAT, VAR (VARNO))
         ELSE
            CALL POIBRK
         END IF
      ELSE
C        Missing point
         CALL POIMIS
      END IF
      GO TO 10

  100 RETURN
      END

C-------------------------------------------------

      SUBROUTINE TRAKDV (MAP2, VARNO)

C Plots track of ship when the given variable is valid

      EXTERNAL MAP2

      CHARACTER * 80 FMTA
      CHARACTER * 8 CNAME
      INTEGER DAY, MONTH, YEAR, HOUR, MINUTE, VARNO, FMTNO
```

```
      INTEGER TIME, TIME0, DAYNO
      REAL LAT, LONG, VAR (5)
      LOGICAL ONMAP
      COMMON /FMT/ FMTA, FMTNO
      COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP

C     Points within 3 readings are joined up
      CALL LINSEL (3)
      CALL POIBEG

   10 IF (FMTNO .EQ. 1 .OR. FMTNO .EQ. 4) THEN
         READ (2, FMTA, END = 100) CNAME, DAY, MONTH, YEAR, HOUR,
     &      MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
      ELSE
         READ (2, FMTA, END = 100) CNAME, YEAR, MONTH, DAY, HOUR,
     &      MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
      END IF
C     Ensure that lines which cross 180 degrees are plotted correctly
      IF (LONG .LT. XLEFT) LONG = LONG + 360.
C     Convert MGD-77 format to Oracles
      IF (FMTNO .EQ. 3) CALL MGD2OR (VAR)
      IF (ONMAP (LONG, LAT) .AND. VAR (VARNO) .NE. 0.) THEN
C        Check for gap in data
         TIME0 = TIME
         TIME = DAYNO (DAY, MONTH, YEAR) * 1440 + HOUR * 60 + MINUTE
         IF (TIME - TIME0 .LE. 20 .AND. TIME - TIME0 .GE. 0) THEN
            CALL POIFA2 (MAP2, LONG, LAT)
         ELSE
            CALL POIBRK
         END IF
      ELSE
C        Missing point
         CALL POIMIS
      END IF
      GO TO 10

  100 CALL POIEND
      RETURN
      END

C-------------------------------------------------------

      SUBROUTINE TRAKTA (MAP2, INTVAL)

C Plots the ship's track, annotated with the time at the given interval
C (measured in minutes)

      EXTERNAL MAP2

      CHARACTER * 80 FMTA
      CHARACTER * 8 ANNOT, CNAME
      INTEGER DAY, MONTH, YEAR, HOUR, MINUTE, FMTNO, INTVAL
      INTEGER DAYNO, TIME, TIME0
      REAL LAT, LONG, VAR (5)
      LOGICAL ONMAP
      COMMON /FMT/ FMTA, FMTNO
      COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP
```

```
C    Extended ASCII set
     CALL CHSETS (1)
C    Include spaces in strings
     CALL TXSPAS (0)
C    Set character height
     CALL CHHITS (2.0)
C    Adjacent points are joined up
     CALL LINSEL (1)
     CALL POIBEG
```

```
 10 IF (FMTNO .EQ. 1 .OR. FMTNO .EQ. 4) THEN
        READ (2, FMTA, END = 100) CNAME, DAY, MONTH, YEAR, HOUR,
    &     MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
    ELSE
        READ (2, FMTA, END = 100) CNAME, YEAR, MONTH, DAY, HOUR,
    &     MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
    END IF
C   Ensure that lines which cross 180 degrees are plotted correctly
    IF (LONG .LT. XLEFT) LONG = LONG + 360.
    IF (ONMAP (LONG, LAT)) THEN
        TIME0 = TIME
        TIME = DAYNO (DAY, MONTH, YEAR) * 1440 + HOUR * 60 + MINUTE
C       Check for gap in data
        IF (TIME - TIME0 .LE. 20 .AND. TIME - TIME0 .GT. 0) THEN
            IF (TIME / INTVAL .NE. TIME0 / INTVAL) THEN
C               Interval has passed
                IF (INTVAL .GE. 1440) THEN
C                   Interval is at least a day
                    WRITE (ANNOT, '(1X, I3.3, 1X)') DAYNO (DAY,
    &                 MONTH, YEAR)
                    CALL MARLIN
                    CALL PANLIS (3, 3)
                    CALL POIFC2 (MAP2, LONG, LAT, ANNOT, 5)
                    CALL PANOFF
                    CALL MARSEL (0)
                ELSE IF (MOD (HOUR, 6) .EQ. 0 .AND. MINUTE .LT.
    &             INTVAL) THEN
C                   Six-hour mark
                    WRITE (ANNOT, '(1X, I3.3, "/", I2.2, 1X)')
    &                 DAYNO (DAY, MONTH, YEAR), HOUR
                    CALL MARLIN
                    CALL PANLIS (3, 3)
                    CALL POIFC2 (MAP2, LONG, LAT, ANNOT, 8)
                    CALL PANOFF
                    CALL MARSEL (0)
                ELSE
C                   Ordinary time mark
                    WRITE (ANNOT, '(3X, 2I2.2, 1X)') HOUR, MINUTE
                    CALL MARLIN
                    CALL PANLIS (3, 3)
                    CALL POIFC2 (MAP2, LONG, LAT, ANNOT, 8)
                    CALL MARSEL (0)
                    CALL PANOFF
                END IF
            ELSE
C               No time mark
                CALL POIFA2 (MAP2, LONG, LAT)
            END IF
        ELSE
            CALL POIBRK
        END IF
    ELSE
        CALL POIBRK
    END IF
    GO TO 10

100 CALL PANOFF
```

```
      CALL POIEND
      RETURN
      END

C-----------------------------------------------------

      SUBROUTINE TRAKCD (MAP2)

C Plots track of ship and annotates with day and cruise name

      EXTERNAL MAP2

      CHARACTER * 80 FMTA
      CHARACTER * 8 CNAME
      CHARACTER * 12 ANNOT
      INTEGER DAY, MONTH, YEAR, HOUR, MINUTE, FMTNO, DAYNO, TIME, TIME0
      REAL LAT, LONG, LAT0, LONG0, BEARNG, VAR (5)
      LOGICAL ONMAP, WANT
      COMMON /FMT/ FMTA, FMTNO
      COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP
      PARAMETER (PI = 3.1416)

C Statement function to covert radians to degrees

      DEG (RAD) = RAD / PI * 180.

C     Extended ASCII set
      CALL CHSETS (1)
C     Set character height
      CALL CHHITS (2.)
C     Adjacent points are joined up
      CALL LINSEL (1)
C     Don't mark points
      CALL MARSEL (0)
      CALL POIBEG
      WANT = .FALSE.
```

```
   10 LAT0 = LAT
      LONG0 = LONG
      IF (FMTNO .EQ. 1 .OR. FMTNO .EQ. 4) THEN
          READ (2, FMTA, END = 100) CNAME, DAY, MONTH, YEAR, HOUR,
     &      MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
      ELSE
          READ (2, FMTA, END = 100) CNAME, YEAR, MONTH, DAY, HOUR,
     &      MINUTE, LAT, LONG, (VAR (I), I = 1, 5)
      END IF
C     Ensure that lines which cross 180 degrees are plotted correctly
      IF (LONG .LT. XLEFT) LONG = LONG + 360.
      IF (ONMAP (LONG, LAT)) THEN
C         Check for gap in data
          TIME0 = TIME
          TIME = DAYNO (DAY, MONTH, YEAR) * 1440 + HOUR * 60 + MINUTE
          IF (TIME - TIME0 .LE. 20 .AND. TIME - TIME0 .GE. 0) THEN
C             If new day then want to annotate plot
              IF (TIME / 1440 .NE. TIME0 / 1440) WANT = .TRUE.
              IF (WANT .AND. (LAT0.NE.LAT .OR. LONG0.NE.LONG)) THEN
C                 Bearing is calculable, so annotate parallel to
C                 ship's track
                  BEARNG = DEG (ATAN2 (LAT - LAT0, LONG - LONG0))
                  WRITE (ANNOT, '(I3, "/", A8)') DAYNO (DAY, MONTH,
     &              YEAR), CNAME
                  CALL TEXFB2 (MAP2, LONG, LAT, ANNOT, 1, 12, BEARNG,
     &              1, 1, 1, 1)
                  WANT = .FALSE.
              ELSE
                  CALL POIFA2 (MAP2, LONG, LAT)
              END IF
          ELSE
              CALL POIBRK
              WANT = .TRUE.
          END IF
      ELSE
          CALL POIBRK
          WANT = .TRUE.
      END IF
      GO TO 10

  100 CALL POIEND
      RETURN
      END

C-------------------------------------------------

      LOGICAL FUNCTION ONMAP (X, Y)
```

```
C Returns true if X and Y are within the limits given

      REAL X, Y, XLEFT, XRIGHT, YBASE, YTOP
      COMMON /LIMITS/ XLEFT, XRIGHT, YBASE, YTOP

      ONMAP = X .GE. XLEFT .AND. X .LE. XRIGHT .AND. Y .GE. YBASE .AND.
     & Y .LE. YTOP

      END

C-----------------------------------------------------

      SUBROUTINE MGD2OR (VAR)

C Converts MGD-77 format variables to Oracles format.

      REAL VAR (5)

C Convert unused records from all 9's to 0.

      IF (VAR (1) .GT. 99.) VAR (1) = 0.
      DO I = 2, 4
          IF (VAR (I) .GT. 99999.) VAR (I) = 0.
      END DO
      IF (VAR (5) .GT. 9999.) VAR (5) = 0.

C     Convert travel time to uncorrected depth
      VAR (1) = VAR (1) * 750.

      END

C-----------------------------------------------------

      INTEGER FUNCTION DAYNO (DAY, MONTH, YEAR)

C Converts a date from day/month/year format to the day number (eg
C 1/1/90 = 1, 31/12/92 = 366)

      INTEGER DAY, MONTH, YEAR, NDAYS (12)
      DATA NDAYS /0, 31, 59, 90, 120, 151, 181, 212, 243, 273, 304, 334/

      DAYNO = NDAYS (MONTH) + DAY
C     Check for leap year
      IF (MOD (YEAR, 4) .EQ. 0 .AND. MONTH .GT. 2) DAYNO = DAYNO + 1

      END

C-----------------------------------------------------
```

```
      INTEGER FUNCTION FULLYR (YEAR)

C Converts a two-digit year to a four-digit year. Works for dates in the
C range 1931 to 2030.

      INTEGER YEAR

      IF (YEAR .GT. 30) THEN
          FULLYR = 1900 + YEAR
      ELSE
          FULLYR = 2000 + YEAR
      END IF
      END

C-------------------------------------------------
      SUBROUTINE MAGSYN(DATE,ITYPE,ALT,COLAT,ELONG,X,Y,Z,F)
C
C THIS ROUTINE COMPUTES VALUES OF X,Y,Z AND F FOR A GIVEN
C POSITION AND DATE(BETWEEN 1960.0 AND 1990.0) FROM THE
C SPHERICAL HARMONIC COEFFICIENTS OF THE 1985 INTERNATIONAL
C GEOMAGNETIC REFERENCE FIELD.
C
C IF THE DATE SUPPLIED IS 0, THE ROUTINE RETURNS THE YEAR OF THE LATEST
C DGRF, IN THE DATE PARAMETER.
C
C DATA   DATE=REQUIRED DATE IN YEARS AND DECIMALS OF A YEAR, A.D.
C       ITYPE=1 IF GEODETIC COORDINATES ARE BEING USED
C       ITYPE=2 IF GEOCENTRIC COORDINATES ARE BEING USED
C        ALT=HEIGHT ABOVE MEAN SEA LEVEL IN KM         (ITYPE=1)
C       ALT=RADIAL DISTANCE FROM CENTRE OF EARTH IN KM(ITYPE=2)
C        COLAT=COLATITUDE     IN DEGREES(0.0 TO 180.0)
C        ELONG=EAST LONGITUDE IN DEGREES(0.0 TO 360.0)
C
C OUTPUT   X=NORTH    COMPONENT OF MAGNETIC FORCE IN NT
C          Y=EAST
C          Z=VERTICAL
C                  POSITIVE DOWN
C         F=TOTAL MAGNETIC FORCE IN NT
C N.B. THE COORDINATE SYSTEM FOR X,Y, AND Z IS THE SAME AS THAT
C SPECIFIED BY ITYPE.
C
      DIMENSION GH(720),G1(120),G2(120),G3(120),G4(120),G5(120),
     &         G6(120),P(66),Q(66),CL(10),SL(10)
      EQUIVALENCE(G1,GH(  1)),(G2,GH(121)),(G3,GH(241)),(G4,GH(361)),
     &          (G5,GH(481)),(G6,GH(601))
C
C IGRF 1985 COMPRISES MAIN-FIELD COEFFICIENTS FOR 1965, 70, 75, 80, 85,
C AND SECULAR VARIATION COEFFICIENTS FOR THE INTERVAL 1985-1990.
C THE 1965 COEFFICIENTS ARE IN G1, 70 IN G2, 75 IN G3, 80 IN G4,
C 85 IN G5.
C G6 CONTAINS THE 1985-90 DATA IN THE FORM-  1985+5*S.V.(1985-90).
C
C THE S.H.COEFFICIENTS ARE SUPPLIED BY THE FOLLOWING DATA STATEMENTS.
C FOR UPDATE OF THE PROGRAM EVERY 5 YEARS WITH NEW VALUES OF THE GEO-
C MAGNETIC REFERENCE FIELD 6 ALTERATIONS OR ADDITIONS MUST BE MADE.
C      1.  INCREASE THE DIMENSION STATEMENT ON GH( ) BY 120 AND ADD
C          ANOTHER G#(120)
```

```
C     2. ADD ANOTHER VARIABLE ON THE EQUIVALENCE STATEMNT TO MATCH
C     3. CHANGE THE LAST IGRF TO DGRF
C     4. CHANGE THE LAST PGRF TO IGRF
C     5. ADD THE LATEST PGRF
C     6. CHANGE LDYEAR IN THE INITIAL SETUP TO THE DATE OF THE
C        LATEST DGRF
C
C
C 1965 DGRF
      DATA G1/ -30334.,-2119., 5776.,-1662., 2997.,-2016., 1594.,  114.,
     &          1297.,-2038., -404., 1292.,  240.,  856., -165.,  957.,
     &           804.,  148.,  479., -269., -390.,   13.,  252., -269.,
     &          -219.,  358.,   19.,  254.,  128.,  -31., -126., -157.,
     &           -97.,  -62.,   81.,   45.,   61.,  -11.,    8.,  100.,
     &          -228.,   68.,    4.,  -32.,    1.,   -8., -111.,   -7.,
     &            75.,  -57.,  -61.,    4.,  -27.,   13.,   -2.,  -26.,
     &             6.,   -6.,   26.,   13.,  -23.,    1.,  -12.,   13.,
     &             5.,    7.,   -4.,  -12.,  -14.,    9.,    0.,  -16.,
     &             8.,    4.,   -1.,   24.,   11.,   -3.,    4.,  -17.,
     &             8.,   10.,  -22.,    2.,   15.,  -13.,    7.,   10.,
     &            -4.,   -1.,   -5.,   -1.,   10.,    5.,   10.,    1.,
     &            -4.,   -2.,    1.,   -2.,   -3.,    2.,    2.,    1.,
     &            -5.,    2.,   -2.,    6.,    4.,   -4.,    4.,    0.,
     &             0.,   -2.,    2.,    3.,    2.,    0.,    0.,   -6./
C 1970 DGRF
      DATA G2/ -30220.,-2068., 5737.,-1781., 3000.,-2047., 1611.,   25.,
     &          1287.,-2091., -366., 1278.,  251.,  838., -196.,  952.,
     &           800.,  167.,  461., -266., -395.,   26.,  234., -279.,
     &          -216.,  359.,   26.,  262.,  139.,  -42., -139., -160.,
     &           -91.,  -56.,   83.,   43.,   64.,  -12.,   15.,  100.,
     &          -212.,   72.,    2.,  -37.,    3.,   -6., -112.,    1.,
     &            72.,  -57.,  -70.,    1.,  -27.,   14.,   -4.,  -22.,
     &             8.,   -2.,   23.,   13.,  -23.,   -2.,  -11.,   14.,
     &             6.,    7.,   -2.,  -15.,  -13.,    6.,   -3.,  -17.,
     &             5.,    6.,    0.,   21.,   11.,   -6.,    3.,  -16.,
     &             8.,   10.,  -21.,    2.,   16.,  -12.,    6.,   10.,
     &            -4.,   -1.,   -5.,    0.,   10.,    3.,   11.,    1.,
     &            -2.,   -1.,    1.,   -3.,   -3.,    1.,    2.,    1.,
     &            -5.,    3.,   -1.,    4.,    6.,   -4.,    4.,    0.,
     &             1.,   -1.,    0.,    3.,    3.,    1.,   -1.,   -4./
```

```
C 1975 DGRF
      DATA G3/ -30100.,-2013., 5675.,-1902., 3010.,-2067., 1632.,  -68.,
     &          1276.,-2144., -333., 1260.,  262.,  830., -223.,  946.,
     &           791.,  191.,  438., -265., -405.,   39.,  216., -288.,
     &          -218.,  356.,   31.,  264.,  148.,  -59., -152., -159.,
     &           -83.,  -49.,   88.,   45.,   66.,  -13.,   28.,   99.,
     &          -198.,   75.,    1.,  -41.,    6.,   -4., -111.,   11.,
     &            71.,  -56.,  -77.,    1.,  -26.,   16.,   -5.,  -14.,
     &            10.,    0.,   22.,   12.,  -23.,   -5.,  -12.,   14.,
     &             6.,    6.,   -1.,  -16.,  -12.,    4.,   -8.,  -19.,
     &             4.,    6.,    0.,   18.,   10.,  -10.,    1.,  -17.,
     &             7.,   10.,  -21.,    2.,   16.,  -12.,    7.,   10.,
     &            -4.,   -1.,   -5.,   -1.,   10.,    4.,   11.,    1.,
     &            -3.,   -2.,    1.,   -3.,   -3.,    1.,    2.,    1.,
     &            -5.,    3.,   -2.,    4.,    5.,   -4.,    4.,   -1.,
     &             1.,   -1.,    0.,    3.,    3.,    1.,   -1.,   -5./
C 1980 DGRF
      DATA G4/ -29992.,-1956., 5604.,-1997., 3027.,-2129., 1663., -200.,
     &          1281.,-2180., -336., 1251.,  271.,  833., -252.,  938.,
     &           782.,  212.,  398., -257., -419.,   53.,  199., -297.,
     &          -218.,  357.,   46.,  261.,  150.,  -74., -151., -162.,
     &           -78.,  -48.,   92.,   48.,   66.,  -15.,   42.,   93.,
     &          -192.,   71.,    4.,  -43.,   14.,   -2., -108.,   17.,
     &            72.,  -59.,  -82.,    2.,  -27.,   21.,   -5.,  -12.,
     &            16.,    1.,   18.,   11.,  -23.,   -2.,  -10.,   18.,
     &             6.,    7.,    0.,  -18.,  -11.,    4.,   -7.,  -22.,
     &             4.,    9.,    3.,   16.,    6.,  -13.,   -1.,  -15.,
     &             5.,   10.,  -21.,    1.,   16.,  -12.,    9.,    9.,
     &            -5.,   -3.,   -6.,   -1.,    9.,    7.,   10.,    2.,
     &            -6.,   -5.,    2.,   -4.,   -4.,    1.,    2.,    0.,
     &            -5.,    3.,   -2.,    6.,    5.,   -4.,    3.,    0.,
     &             1.,   -1.,    2.,    4.,    3.,    0.,    0.,   -6./
C 1985 IGRF
      DATA G5/ -29877.,-1903., 5497.,-2073., 3045.,-2191., 1691., -309.,
     &          1300.,-2208., -312., 1244.,  284.,  835., -296.,  937.,
     &           780.,  233.,  363., -250., -426.,   68.,  169., -298.,
     &          -215.,  356.,   47.,  253.,  148.,  -94., -155., -161.,
     &           -75.,  -48.,   95.,   52.,   65.,  -16.,   50.,   90.,
     &          -186.,   69.,    4.,  -50.,   17.,   -4., -102.,   20.,
     &            75.,  -61.,  -82.,    2.,  -26.,   24.,   -1.,   -6.,
     &            23.,    4.,   17.,    9.,  -21.,    0.,   -6.,   21.,
     &             6.,    7.,    0.,  -21.,  -11.,    5.,   -9.,  -25.,
     &             2.,   11.,    4.,   12.,    4.,  -16.,   -6.,  -10.,
     &             5.,   10.,  -21.,    1.,   16.,  -12.,    9.,    9.,
     &            -5.,   -3.,   -6.,   -1.,    9.,    7.,   10.,    2.,
     &            -6.,   -5.,    2.,   -4.,   -4.,    1.,    2.,    0.,
     &            -5.,    3.,   -2.,    6.,    5.,   -4.,    3.,    0.,
     &             1.,   -1.,    2.,    4.,    3.,    0.,    0.,   -6./
```

```
C 1990 Predicted model
      DATA G6/
     &-29761., -1853.,5374.5,-2141.5,3062.,-2248.5,1726.,-410.,
     &  1325.5,-2231.,-285.5,1241., 295.5, 835.5,-350., 937.5,
     &   777.,   252., 324.,-239.,-433.,  80.5, 135.,-293.5,
     &  -208.5,   356.5,  47.5, 245.5, 147.,-110.,-155.5,-160.5,
     &   -72.,   -48.5,  95.,  59.,  63.5, -18.,  58.5,84.5,
     &  -183.,    65.,   4., -61.5,  21.5,  -6.5, -96.,  19.5,
     &    76.,   -64., -81.,  -0.5, -21.,  28.,   4.5,  -1.,
     &    32.5,     6.,  18.5,   6.5,-20.,  -0.5,  -1.5,  24.5,
     &     6.,     7.5,   1.5, -26.,  -9.,   5.5,-10.5, -29.,
     &     0.5,    12.,   4.5,   8.,  1.5, -16.5, -10.,  -3.5,
     &     5.,  10., -21.,   1.,  16., -12.,   9.,   9.,
     &    -5.,  -3.,  -6.,  -1.,   9.,   7.,  10.,   2.,
     &    -6.,  -5.,   2.,  -4.,  -4.,   1.,   2.,   0.,
     &    -5.,   3.,  -2.,   6.,   5.,  -4.,   3.,   0.,
     &     1.,  -1.,   2.,   4.,   3.,   0.,   0.,  -6./
C
C SET INITIAL VALUES
C
      X=0.0
      Y=0.0
      Z=0.0
      LDYEAR=1980
      IF(DATE.LE.1960.0.OR.DATE.GE.LDYEAR+10.0) GOTO 9
      T=0.2*(DATE-1965.0)
     LL=T
     ONE=LL
     T=T-ONE
      LL=120*LL
     TC=1.0-T
     R=ALT
      ONE=COLAT*0.0174533
     CT=COS(ONE)
     ST=SIN(ONE)
      ONE=ELONG*0.0174533
     CL(1)=COS(ONE)
     SL(1)=SIN(ONE)
      CD=1.0
      SD=0.0
     L=1
     M=1
      N=0
     IF(ITYPE.EQ.2) GOTO 1
C
```

```
C CONVERSION FROM GEODETIC TO GEOCENTRIC COORDINATES
C
      A2=40680925.
      B2=40408585.
     ONE=A2*ST*ST
     TWO=B2*CT*CT
     THREE=ONE+TWO
     RHO=SQRT(THREE)
      R=SQRT(ALT*(ALT+2.0*RHO)+(A2*ONE+B2*TWO)/THREE)
      CD=(ALT+RHO)/R
      SD=(A2-B2)/RHO*CT*ST/R
      ONE=CT
     CT=CT*CD- ST*SD
     ST=ST*CD+ONE*SD
C
    1 RATIO=6371.2/R
      RR=RATIO*RATIO
C
C COMPUTATION OF SCHMIDT QUASI-NORMAL COEFFICIENTS P AND X(=Q)
C
      P(1)=1.0
      P(3)=ST
      Q(1)=0.0
     Q(3)=CT
      DO 8 K=2,66
      IF(N.GE.M) GOTO 2
      M=0
      N=N+1
      RR=RR*RATIO
      FN=N
      GN=N-1
    2 FM=M
      IF(M.NE.N) GOTO 3
      IF(K.EQ.3) GOTO 4
      ONE=SQRT(1.0-0.5/FM)
      J=K-N-1
     P(K)=ONE*ST*P(J)
     Q(K)=ONE*(ST*Q(J)+CT*P(J))
     CL(M)=CL(M-1)*CL(1)-SL(M-1)*SL(1)
     SL(M)=SL(M-1)*CL(1)+CL(M-1)*SL(1)
      GOTO 4
C
    3 GM=M*M
     ONE=SQRT(FN*FN-GM)
     TWO=SQRT(GN*GN-GM)/ONE
      THREE=(FN+GN)/ONE
      I=K-N
      J=I-N+1
     P(K)=THREE*CT*P(I)-TWO*P(J)
     Q(K)=THREE*(CT*Q(I)-ST*P(I))-TWO*Q(J)
C
```

```
C SYNTHESIS OF X,Y AND Z IN GEOCENTRIC COORDINATES
C
   4 LM=LL+L
     ONE=(TC*GH(LM)+T*GH(LM+120))*RR
     IF(M.EQ.0) GOTO 7
     TWO=(TC*GH(LM+1)+T*GH(LM+121))*RR
     THREE=ONE*CL(M)+TWO*SL(M)
     X=X+THREE*Q(K)
     Z=Z-(FN+1.0)*THREE*P(K)
     IF(ST.EQ.0.0) GOTO 5
     Y=Y+(ONE*SL(M)-TWO*CL(M))*FM*P(K)/ST
     GOTO 6
C
   5 Y=Y+(ONE*SL(M)-TWO*CL(M))*Q(K)*CT
     6 L=L+2
     GOTO 8
C
   7 X=X+ONE*Q(K)
     Z=Z-(FN+1.0)*ONE*P(K)
     L=L+1
   8 M=M+1
C
C CONVERSION TO COORDINATE SYSTEM SPECIFIED BY ITYPE
C
     ONE=X
     X=X*CD+Z*SD
     Z=Z*CD-ONE*SD
     F=SQRT(X*X+Y*Y+Z*Z)
     RETURN
C
C ERROR RETURN IF DATE OUT OF BOUNDS, PASSING DATE OF DGRF IF DATE IS 0
C
   9 IF (DATE.EQ.0) DATE=LDYEAR
       F=99999.0
     RETURN
C
C
C LIBRARY FUNCTIONS USED BY THIS ROUTINE ARE- SIN,COS,SQRT
C
C SAMPLE RESULTS-
C  MAGSYN(1962.0,1,   0.0,0.0,30.0,2520.,  -98.,56107.,56164.,)
C  MAGSYN(1969.3,1,    0.0,57.0,195.0,25036.,5682.,30100.,39561.,)
C  MAGSYN(1973.0,2,6371.2,45.0,10.0,22108.,-798.,40372.,46036.,)
C  MAGSYN(1977.7,2,9000.0,31.0,359.0,5832.,-1152.,17832.,18797.,)
C  MAGSYN(1980.5,1,    0.0,57.0,195.0,24923.,5606.,29984.,39390.,)
C  MAGSYN(1982.0,1,   0.0,40.0,  5.0,19897.,-1124.,43236.,47608.,)
C  MAGSYN(1986.5,1,    0.0,55.0,2.0,27850.,-1269.,31708.,42221.,)
     END
```

3.6 Listing of GEOPLOT EXEC

This is the macro which runs the TRACKS MODULE. It is written in REXX, the CMS operating system's macro language.

```
/* GEOPLOT EXEC: macro to run TRACKS MODULE                    */
'CLRSCRN'
say' '
say'       GEOPLOT Package'
say'       ---------------'
/* Look for arguments */
arg FILNA FILNB FILNC .
/* Test for filename */
if FILNA <> '' then signal GO
/* No filename, so prompt the user */
say' ____________________________________________________________'
say']Before running this program you should have produced an input]'
say'] file using ORACLES                                         ]'
say']____________________________________________________________]'
say ' ___________________________________'
say ']Input file? (Filename Filetype Filemode)]'
say ']_____________________________________]'
pull FILNA FILNB FILNC

GO:
/* Use default filetype and filemode if not specified */
if FILNB='' then FILNB='IN'
if FILNC='' then FILNC='A'
/* Check that file exists, by turning screen output off and attempting*/
/* to list file */
'SET CMSTYPE HT'
'LISTF' FILNA FILNB FILNC
TC = RC
'SET CMSTYPE RT'
if TC <> 0 then do
              say ' '
              say ' Input File' FILNA FILNB FILNC 'does not exist'
              say ' '
              exit
              end
/* Set up GRAFIX library */
'SETUP GRAFIX'

/* Ensure that input file has 120 character records */
/* Set current status values of messages          */
cmstype_status=qsetval('CMSTYPE')
emsg_status=qsetval('EMSG')
imsg_status=qsetval('IMSG')
/* Place selected files on the program stack   */
'LISTFILES' FILNA FILNB FILNC '(DATE STACK'
/* While there is still something on the stack */
do while queued() > 0
  pull fn ft fm format .
/* Test for variable length and FIX */
  if format = 'V' then 'FIX' fn ft fm '(LRECL 120'
end
/* Set messages to original status  */
```

```
'SET EMSG' emsg_status
'SET IMSG' imsg_status
'SET CMSTYPE' cmstype_status

/* Give file logical device number 2 */
'FILEDEF 2 DISK' FILNA FILNB FILNC '(RECFM F LRECL 120 '

Y:
say '_____'
say ']Program loading and executing]'
say ']_____]'
/* Run module */
'TRACKS'
'CLRSCRN'
say '_____'
say ']Do you want to run the program again for the same data? (Y or N)]'
say ']_____]'
/* Rerun module if 'Y' input */
parse pull ANSA
if ABBREV(ANSA,'Y') then signal Y
if ABBREV(ANSA,'y') then signal Y
exit
```

4 REFERENCES

CARTER, D.J.T. 1980. Echo-sounding Correction Tables (formerly Matthews' Tables), 3rd Edition. Taunton: Hydrographic Department, Ministry of Defence.

DRAKE, S. & MILES P.R. 1985. IOS geophysical data held on magnetic tape - summary. Bathymetry, magnetic and gravity data collected during marine geology and geophysics cruises 1973-1984 Institute of Oceanographic Sciences Report, No. 194, 129pp.

IAGA DIVISION 1, WORKING GROUP 1 1986. International Geomagnetic Reference Field Revision 1985.

JONES, S.R. 1987. An Introduction to the NERC IBMs Version 6. Swindon: NERC Computer Services.

LE BAS, T.P. & EVANS, J.M.; 1988, Marine geophysical data acquired 1984 - 1987: database summary, Institute of Oceanographic Sciences Deacon Laboratory Report, No. 254, 83pp.

METCALF, M.; 1985, Effective FORTRAN 77. Oxford: Oxford Science Publications.

READ, M.G.C. & NEALE, R.; 1987, A Comprehensive Guide to GRAFIX/GKS Version 3.0. Swindon: NERC Computer Services.

UGGI, 1971, Geodetic Reference System 1967. IAG Publication Special No. 3.

US DEPARTMENT OF COMMERCE, 1981, The Marine Geophysical Data Exchange Format - 'MGD77' (Bathymetry, Magnetics and Gravity), KGRD No. 10 (Revised).

5 ACKNOWLEDGEMENTS

We would like to thank NERC Computer Services for their assistance in the writing of this program. Thanks must also go to several members of the Geology and Geophysics group for their suggestions and improvements during the writing of this program and documentation.

APPENDIX A: GRAFIX ROUTINES USED BY PROGRAM

This appendix describes the GRAFIX routines used by GEOPLOT, as an aid to understanding the program [Read & Neale, 1987].

A.1 Beginning and ending the plot

DEVICE (NDEV) initialises GRAFIX and selects device number NDEV.
GCLOSE ends the plot.

A.2 Beginning and ending a page

PAGBEG begins a new page
PAGEND closes the current page

A.3 Defining the data area

GRAFIX (XLENG, YLENG, ZLENG) initialises a data area of XLENG by YLENG mm (ZLENG is ignored).
GRASET initialises a data area covering the whole page.
DEFLA2 (XPRI, XSEC, YPRI, YSEC) defines a linear coordinate system (L-space) with XPRI at the left edge of the data area, XSEC at the right edge, YPRI at the lower edge and YSEC at the upper edge.
EMERC Mercator projection for ellipsoidal Earth.
EUTM Universal transverse Mercator projection for ellipsoidal Earth.
SGNOMT Gnomonic transverse projection for spherical Earth.
SLEAC Lambert equal-area cylindrical projection for spherical Earth.
SORTHT Orthographic transverse projection for spherical Earth.
MAPCEN (CENLON, CENLAT) specifies the CENtral LONgitude and CENtral LATitude for map plotting.
MAPSCL (MAP2, SCALE, SLAT, STDSCL) converts the SCALE of a map at the latitude SLAT to the value at the equator, STDSCL. MAP2 is the projection.
FMTCHR (MAP2, STLON, FILON, STLAT, FILAT, SCALE) defines a coordinate system (F-space) based on rectangular projection MAP2 with the STarting LONgitude, FInal LONgitude, STarting LATitude, FInal LATitude and SCALE given.
FMTCHI (MAP2, STLON, FILON, STLAT, FILAT, SCALE). Same as FMTCHR but for irregular projections.
FMTANN (KTOP, NLEFT, NRIGHT) reserves space for annotation. KTOP = 1 means allow space at the top of the data area, KTOP = 0 means don't allow space at the top. NLEFT is the number of characters for which space is to be allowed on the left of the data area, NRIGHT is the number on the right.

A.4 Drawing axes

ANNGEO (NFIELD, NDEC) sets axis annotation to latitude and longitude. NFIELD = 1 for degrees, 2 for degrees and minutes, 3 for degrees, minutes and seconds. NDEC is the number of decimal places.
GRISEL (LGRI1, LGRI2, LGRID). LGRI is the level of annotation on the primary axes, LGRI2 is the level of annotation on the secondary axes. They take the values 0 to suppress the axis, 1 to draw the axes only, 2 to draw the axes and annotate only where there is space, 3 to draw the axes and annotate without checking if there is space. LGRID = 0 for no grid, 1 for a partial grid using the annotation marks, 2 for a full grid using the annotation marks and tick marks.
AXIFA2 (MAP2, NAXIS) draws the specified axis in the F-space defined by the projection MAP2. NAXIS = 1 for the X-axis, 2 for the Y-axis.

A.5 Plotting points

LINLA2 (X1, Y1, X2, Y2, NSTYLE) draws a straight line between (X1, Y1) and (X2, Y2) in L-space. NSTYLE is the line style.

RECLA2 (XL1, YL1, XL2, YL2, NLSTYL, NASTYL) draws a rectangle with opposite corners at (XL1, YL1) and (XL2, YL2) in L-space. NLSTYL is the line style, NASTYL is the area-fill style.

PL2STD selects standard plotting mode.

PL2PRF (OFFSET, ANGLE, SCALE) selects profile plotting mode, where the X value is offset by (AUXVAL * SCALE + OFFSET) * COS (ANGLE) mm and the Y value is offset by (AUXVAL * SCALE + OFFSET) * SIN (ANGLE) mm.

PANLIS (NHOFF, NVOFF) selects point annotation mode, with annotation perpendicular to the line through the data points. NHOFF = 1 for left justified, 2 for centred, 3 for right justified. NVOFF = 1 for aligned at top of characters, 2 for top of capitals, 3 for halfway point, 4 for base.

PANOFF terminates point annotation.

LINSEL (LINE) selects the minimum number of missing points which will cause the line joining the points to be broken. If LINE = 0, no line will be drawn through the points at all.

MARSEL (MARK) selects the mark used to mark points (MARK = 0 gives no marks).

MARLIN selects a line to mark points, plotted perpendicular to the line through the data points.

POIBEG initialises low-level plotting of a set of points (i.e. one at a time).

POIEND terminates low-level plotting.

POIFA2 (MAP2, X, Y, VALUE) plots the point (X, Y) in the F-space defined by the projection MAP2.

POIFC2 (MAP2, X, Y, TEXT, NCHAR) plots the point (X, Y) in the F-space defined by the projection MAP2 and annotates with TEXT. NCHAR is the number of characters.

POIFR2 (MAP2, X, Y, VALUE) plots the point (X, Y) in the F-space defined by the projection MAP2, offset by the values given in PL2PRF (profile plotting).

POIBRK signals a discontinuity in the points being plotted.

POIMIS signals a missing point.

A.6 Plotting text

CHSETS (NSET) selects character set number NSET.

CHHITS (HEIGHT) sets character height in mm.

TXSPAS (NSPA). If NSPA = 1, preceding and trailing blanks will be deleted from strings plotted. If NSPA = 0, the string is plotted as it is.

TXUPRS (IONOFF). If IONOFF = 0, text will be plotted at the angle specified. If IONOFF is 1, the text will be turned the right way up before plotting.

TEXLA2 (XL, YL, STRING, NBEG, NEND, NSTYLE) plots characters NBEG through to NEND of the given string horizontally in L-space, starting at the coordinates (XL, YL) and using text style NSTYLE.

TEXLB2 (XL, YL, STRING, NBEG, NEND, ANGLE, NHOFF, NVOFF, NBLNK, NSTYLE) plots characters NBEG through to NEND of the given string at the given angle in L-space, starting at the coordinates (XL, YL) and using text style NSTYLE. NFOFF = 1 for left justified, 2 for centred and 3 for right justified. NVOFF = 1 for text aligned at the top of the characters, 2 for the top of capitals, 3 for the halfway point and 4 for the base. NBLNK = 1 to remove leading and trailing blanks, 0 to output the whole string.

TEXFB2 (XL, YL, STRING, NBEG, NEND, ANGLE, NHOFF, NVOFF, NBLNK, NSTYLE) is the F-space equivalent of TEXLB2.

A.7 Changing pens

TXPENS (NPEN) changes the pen used for text plotting.
LNPENS (NPEN) changes the pen used for line plotting.
MKPENS (NPEN) changes the pen used for mark plotting.

A.8 Plotting land outlines

WORLDM (MAP2) plots land outlines in medium resolution in the F-space defined by projection MAP2.

APPENDIX B: OTHER ROUTINES USED BY PROGRAM

This appendix describes the NERC and other non-GRAFIX routines used by GEOPLOT, as an aid to understanding the program.

TOKEN (INSTR, OUTSTR, NTOKEN, ISTAT) tokenises INSTR and puts the result in OUTSTR. The number of tokens is returned in NTOKEN and the error code in ISTAT.
CMSCMD (CMDSTR, ISTAT) executes a CMS command. CMDSTR must be the result of tokenising the string 'EXEC *command-name*'. The error code is returned in ISTAT.
NCLOSE (K, ISTAT) closes stream number K and is used instead of the CLOSE statement. The error code is returned in ISTAT.
DATIM (DATE, TIME) returns the current date and time. DATE is an 8-character string in the form '12/06/90', TIME is a real number measured in hours.
ERRSET (NERR, N, NACT) changes the behaviour of the program when it encounters an error.

APPENDIX C: REXX COMMANDS AND MACROS

This appendix describes the REXX commands and the presupplied macros used in GEOPLOT EXEC, as well as NPLOT, the macro for sending a file to a plotter [Jones, 1987].

C.1 CMS COMMANDS

CLRSCRN: clears the terminal screen.
SET CMSTYPE HT: turns screen messages off.
SET CMSTYPE RT: turns screen messages on again.
LISTF filename filetype filemode: lists the filename(s) specified
FILEDEF m DISK filename filetype filemode (RECFM F LRECL n: sets logical device number m to the filename specified, with a fixed length of n characters per line.
filename: runs module 'filename MODULE'

C.2 REXX COMMANDS

SAY 'message': displays a message on the screen
ARG argument1 argument2...: puts the arguments after the macro name into the variables 'argument1', 'argument2' etc.
IF condition THEN action: performs the action if the condition is true
SIGNAL label: transfers control to the line following 'label'.
PULL variable1 variable2...: sets the variables 'variable1', 'variable2' etc. from what is typed at the keyboard.
variable 1 = variable 2: assigns the contents of 'variable2' to 'variable1'.
RC: variable containing the return code from a command.

DO ... commands ... END: marks the beginning and end of a set of commands, eg after a THEN.
EXIT: end execution of the macro.
ABBREV (string1, string2): is a function which returns true if string1 starts with string2.

C.3 MACROS

SETUP package: sets up the library required for 'package'.
FIX filename filetype filemode (LRECL n: converts the variable line length file specified to a fixed line length n.
NPLOT: prompts the user for information and then sends the file requested to the plotter requested.