CHAPTER III

DATA PROCESSING
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3.1 INTRODUCTION

Processing of underway marine geophysical data demands additional attention as voluminous data are collected during a single cruise. In order to process large amounts of data a computer oriented approach is followed. The data are routinely processed onboard during the survey is in progress, primarily to check the quality of the data and to make decisions onboard regarding the track spacing, areal extent and also to improve the data quality. In addition, onboard processing gives an opportunity to work with the data while on location. However, onboard post processing requires appropriate computer and software facilities. Additional processing is carried out in the laboratory to further refine the data and to merge various types of data in order to generate maps. These maps aid interpretation and meet the requirements of presentation.

Essentially three different approaches have been followed to process the data during the present study, depending on the mode of collection and the type of data. The data acquired using the chartered vessels which do not have onboard computer facilities for data logging are in the form of analog records and navigation print outs. A scheme (Figure 3.1), for processing of
Figure 3.1 Schematic illustration of the data processing scheme followed for the processing of underway data collected in analog form.
these data was designed by me in association with other colleagues (Kamesh Raju et al., 1986). MECON (Metallurgical Engineering Consultants, India), has developed the computer programs based on this scheme. This software was initially developed and used on UNIVAC 1100/60 system at MECON, Ranchi and subsequently it was installed on NIO's Norsk Data computer, ND570. Onboard ORV Sagar Kanya, the bathymetric, magnetic and gravity data are logged by the Integrated Navigation System and are digitally recorded on magnetic tapes. These data are processed onboard by making use of HP 1000 general purpose computer and the Magnavox supplied software and at the laboratory by using ND570 system.

The multibeam sonar data which requires specialized processing was processed onboard by using the Krupp Atlas Electronics supplied Hydromap System, based on EPR1300 computer. The various steps involved in each of these approaches are briefly described in the following sections.

3.2 UNDERWAY DATA PROCESSING

3.2.1 PROCESSING OF DATA ACQUIRED IN ANALOG MODE

The data outputs from the chartered vessels are in the form of analog records of total magnetic intensity data, bathymetry in the form of echograms and navigation data as position printouts. The post processing of these data involved digitization of the analog records and merging these digitized
records with corrected navigation data. Position dependent corrections such as the IGRF correction (IAGA, *I Division study group*, 1985) and Matthews correction (*Carter*, 1980) were applied to these merged data files. The merged and corrected files were used for the generation of various types of outputs. Figure 3.1 shows the schematic representation of the scheme followed.

**Digitization**

Digitization of the Analog records of magnetic and bathymetric data were digitized by using digitizer boards. The digitization was accomplished by manually moving the digitizer’s cursor along the curve defining the data, and picking the representative data points by activating the cursor switch. This procedure resulted in digitized values at random time intervals. At places of rapid variations, the data points were picked at very closely spaced intervals in order to ensure true representation of the field data. After digitizing each segment of the record the digitized data were checked using graphics display to detect erroneous values and to check the quality of digitization. When fully satisfied the data were saved and the digitization process is continued. The digitized values are converted into time series data files by linearly interpolating the data in between the digitized points.
**Navigation Data**

The chartered vessels are equipped with dual channel Magnavox MX1107 satellite receivers to provide navigation. These systems are based on Transit satellites, as mentioned in the preceding chapter, accurate position information can be obtained only during a satellite fix and the accuracy of positioning deteriorates during dead-reckoning process. At the time of post processing, only good satellite fix data are considered and the positions in between the satellite fixes are computed. This process involved computation of distance, speed and course in between the satellite position fixes over a spherical surface, by taking into account WGS 72 spheroid constants. Satellite fix data are compiled using the print outs from the satellite receiver. While compiling these data, besides the good satellite fix data, the positions at the start of a line and at places of sudden speed increase and course change are also taken, in order to avoid erroneous interpolation of navigation data. From these position data, time series navigation data files were generated.

**Merging and Reduction**

The time series data files of bathymetry, magnetics and navigation are merged to assign corrected position information to the measurements. While merging, the ship code, date and time were used as reference parameters
(these parameters are incorporated in all the time series data files), to make appropriate merging. The merged data file thus contained ship code, line code, date, latitude, longitude, speed, course, water depth, total magnetic intensity values and the cumulative distance travelled along the line of survey. The merged data file was then used to apply position related corrections to magnetics and bathymetric data. The total magnetic intensity values are reduced by subtracting International Geomagnetic Reference Field (IAGA, I Division study group, 1985) computed at each observation point and the bathymetric data are corrected for regional variations in the sound velocity by applying Matthews correction (Carter, 1985). The processed data file contains reduced magnetic anomaly and corrected depth values in addition to the data fields in the uncorrected merged file.

The processed data file was then used for generating various types of outputs, such as the cruise tracks, profile plots, annotated charts and hard copy listings. Mercator Projection was used for the representation of data on maps on user selectable scales.

3.2.2 PROCESSING OF DATA ACQUIRED IN DIGITAL MODE

The INS system onboard ORV Sagar Kanya logs the digital data on magnetic tape from various geophysical sensors along with the navigation information in a merged format. These data are required to be post processed to correct for the uncertainties in the position data and to reduce
gravity, magnetic and bathymetric data by applying position dependent corrections. The post processing of the data has been carried out both onboard and at the laboratory. The processing procedure remains essentially same as that applied to the data collected in analog mode, for the position correction, IGRF correction and Matthew's correction are concerned. The processing of gravity data is outlined below.

1 Processing of Gravity Data

The on-line processing of gravity data is performed by the ZE 30 data handling subsystem of the Gravimeter using the position information obtained from INS system. During on-line processing, Eotvos correction, free-air correction and Bouguer corrections are applied to the measured gravity to compute Eotvos corrected gravity, Free-air anomaly, and Bouguer anomaly. As there are uncertainties in the navigation data, these values are computed again during post processing using the corrected navigation data. The following formulae were used during post processing to compute these anomalies:

Free-air anomaly, \( F = (G-G_H) \cdot K + G_{ABS} - G_N + E \)

Where,

- \( G \) is the measured gravity in mgal
- \( G_H \) is the measured gravity at harbour in mgal
- \( G_{ABS} \) is the absolute gravity at harbour in mgal
$G_N$ is the normal gravity computed from International gravity formula.

$K$ is the gravimeter sensor constant.

$E$ is the eotvos correction

Among the above parameters $G_H$ is noted at the start of the cruise while the ship is in the berth and the $G_{ABS}$ is the absolute gravity tied to the Marmugao harbour (Subbaraju and Sreekrishna, 1989).

$$E = 7.508 \ V \ Sin \alpha \cdot Cos \phi + 0.004154 \ V^2$$

(after Nettleton, 1976)

Where,

- $E$ is the Eotvos correction in mgals
- $V$ is the speed of the vessel in knots
- $\alpha$ is the course of the vessel
- $\phi$ is the geographical latitude

$$G_N = 978.03185 \ [1 + 0.005278895 \ Sin^2 \phi + 0.000023462 \ Sin^4 \phi]$$

(after Garland, 1979)

Where,

- $\phi$ is the geographical latitude

Eotvos corrected gravity, $E_G = G.K + E$

Bouguer anomaly, $B = F + B.K$
Where $B_K = 2\pi G \sigma h$

$G = 6.6732 \times 10^{-8}$; $\sigma =$ density; $h =$ water depth

where $B_K$ is the Bouguer correction applied to remove the effect of water by replacing the water column with a material of the same density of the crust. In the present study, this correction is not applied to the data due to the uncertainties in assuming the crustal densities. For all interpretation purposes free-air gravity anomalies are used.

### 3.3 PROCESSING OF HYDROSWEEP DATA

The post processing of the Hydrosweep data was carried out by making use of the Krupp Atlas Electronics Hydromap system. The Hydromap system consists of a EPR 1300 computer with alphanumeric and colour graphics monitors, winchester drive, a floppy drive, a function key board, a text key board and a roll ball. The system has a magnetic tape drive to read in the Hydrosweep field tapes and to take backup of the processed data. The system has Fortran 77 and META compilers and software to process the Hydrosweep data. The post processing software is written in Fortran 77 and META languages. The post processing is accomplished by making use of the menu driven software to correct the raw data and to generate various types of outputs such as, the swath coverage plots, depth contour maps, profile plots and 3-D plots. A typical processing sequence (Figure 3.2) involves,
Figure 3.2 Processing sequence followed to process the Hydrosweep data.
reading the Hydrosweep field tape, performing position correction, editing of
the erroneous data by graphic evaluation and produce various types of
outputs. These steps are briefly described below.

1 Read Hydrosweep Data

The Hydrosweep field data tape contains data records with a maximum
record length of 132 characters in ASCII. These data contain the tape
header, measurement section header, event records and measurement data
records. Various combinations of these records are written on the tape (cf.
Operators manual, Hydrosweep system). The measurement data records are
always written as a combination of four records in the following order:

--Measurement data for starboard cross-track deviations,
   ie., lateral distances to the starboard preformed beams
--Measurement data for starboard depth data
--Measurement data for port cross-track deviations
   ie., lateral distances to the port side preformed beams
--Measurement data for port depth data

When the read option is selected from the menu, all the event records
with position information and the measurement data records are transferred
to the Hydromap system from the tape. These data are stored in binary data files with a record length of 168 words and are organized with reference to tracks.

**ii Position Correction**

After the data are loaded into the system, a position correction is performed to correct for the uncertainties in the position data. This correction is very critical if transit satellites are used as the primary navigation. However, with 24 hours GPS coverage this correction is required, if there are gaps in GPS coverage during the survey. The position corrected data are used to generate track plot and swath coverage plots.

**iii Editing of Depth Data**

During the course of survey, data from all the 59 preformed beams may not get registered and some times the depth data from the outer beams result in erroneous data. These errors arise due to a variety of reasons resulting from a combination of instrument errors, sea conditions and bottom topography. Therefore, it is important that the recorded data are checked before they are actually used for the generation of maps. The checking is accomplished through the Profile Editor option. With the selection of this option, it is possible to display the depth data corresponding to each swath on the graphics monitor and to correct the erroneous data points using the
roll ball and function keyboard. The edited/corrected data are stored for further processing.

**iv Grid Generation**

The grid generation option permits comprehensive processing of several tracks at a time, to create grid file containing depth values over a selected area. In this option, grid cells are created with discrete depth values from the measured depth values and the missing depth values are computed by interpolation. After the creation of the grid file, if there are data gaps in the area covered, these gaps can be blanked by using the blanking editor option, in order to avoid erroneous extrapolation of gridded data while contouring. The edited grid file serves as the basic input file for the generation of contour maps, profile plots and 3-D plots. The various outputs can be displayed on the graphics monitor before actually plotting on the plotter. Mercator projection has been used for the generation of contour maps.