

Marine Geophysical Data Management and Presentation System

Pravin D. Kunte

National Institute of Oceanography, Dona Paula, Goa 403 004, India

Abstract

The Geophysical Data Management and Presentation System (GPDMP) constitutes an integral part of the large Geological Oceanographic Database (GOD BASE) which is under development at the Indian National Oceanographic Data Centre (INODC) of the National Institute of Oceanography (NIO). GPDMP is designed for the computerized storage, retrieval and presentation of marine geophysical data and information. For the systematic management of geophysical data and information, GPDMP is subdivided into various databases depending upon disciplines, namely, navigation, bathymetry, magnetics and gravity. The Navigational database, which contains inventory level information along with assimilation, search and presentation modules, exists on microcomputer (DCM PSI/386 system) whereas the geophysical database resides on a NORISK DATA 570 (ND 570) computer system. GPDMP is a user friendly software system that a) processes underway marine geophysical data into a database with a common structured format b) provides inventory and data retrieval capabilities, and c) presents information as contour maps, anomaly maps, profiles and 3-D surface topography maps. This paper examines the principle underlying the GPDMP and describes supportive information presentation facilities.

1 Introduction

The Geophysical Data Management and presentation System (GPDMP) constitutes an integral part of large Geological Oceanographic Database (GOD BASE) that is under development at the Indian National Oceanographic Data Centre (INODC) of the National Institute of Oceanography (NIO).

GPDMP is designed for the computerized storage, retrieval and presentation of marine geophysical data and information. For the systematic storage and management of geophysical data and information, GPDMP is subdivided into various databases depending upon the discipline. Specific disciplines that are included in the present database system are navigation, bathymetry, magnetics and gravity.

Initially formats developed by an ad hoc working group for the Ocean Science Committee of the National Academy of Sciences/National Research Council [Tal70] were

adopted by INODC for acquisition and dissemination of marine geophysical data. Later, the marine geophysical data-exchange format known as MGD-77, developed by Hittelman and others [Hit79], superseded an earlier exchange format. The MGD-77 format is presently being used internationally for data exchange purpose. The final database structure of GPDMPMS has been maintained, structure wise, in accordance with the final merged-merged format of MGD77.

GPDMPMS is a software system that a) processes marine geophysical data into a database with a common structured format, b) provides inventory and data retrieval capabilities and c) presents information as contour maps, anomaly maps, profiles and 3-D surface topography maps. The Navigational database containing inventory level information along with assimilation, search and presentation modules exists on microcomputer (DCM PS/386 system) where as the geophysical database resides on main frame (Norsk Data 570) system.

This paper examines the principles underlying GPDMPMS and describes supportive information presentation facilities.

2 Organisation of GPDMPMS

At INODC, oceanographic data has been classified according to the following four major categories :

1. Station data : Physical, Chemical, Biological etc.
2. Underway data : Bathymetry, Magnetics, Gravity, etc.
3. Time Series Data : Currents, waves, MBT, XBT etc.
4. Remote Sensing data : Chlorophyll, Turbidity etc.

Within each category, four different levels are identified.

- Inventory level information
- Documentation level
- Processed data level
- Merged data level

The INODC has designed discipline-wise data formats [Kun88] for acquisition of marine geophysical data from originators and national and international data centres. For systematic management of geophysical data, the GPDMPMS is subdivided into various databases (Figure.1). Database numbers (DB no.) and the names of various databases that comprise the complete GPDMPMS are given in Table 1. The First digit of DB No. indicates category, second indicates level and third and fourth indicate discipline type.

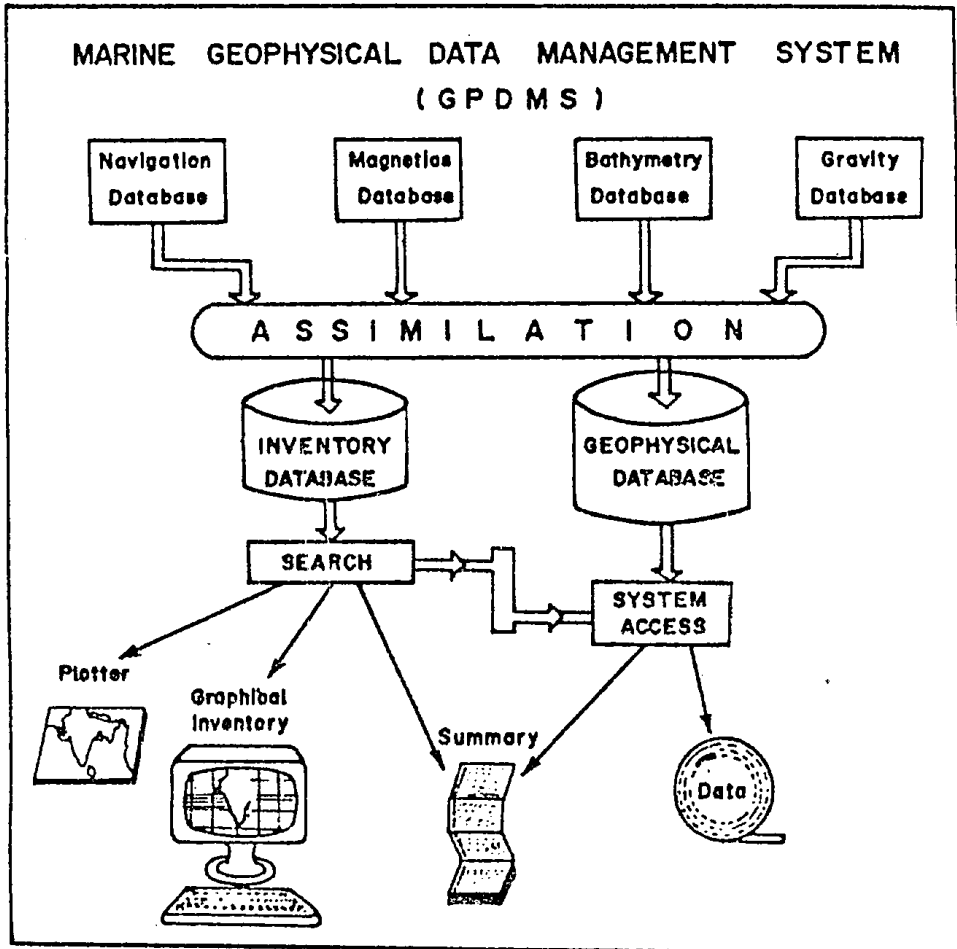


Figure 1.

Category	level	Database type	DB No.	Database Name
2	1	01	2101	Navigation Database
2	2	01	2201	Documentation
2	2	09	2209	to Databases
2	3	01	2301	Bathymetry Database
2	3	02	2302	Magnetic Database
2	3	03	2303	Gravity Database
2	4	01	2401	Intermediate
2	4	09	2409	to Merge Databases
2	4	10	2410	Final Merge-Merge (Geophysical) database.

Table 1. GPDMPD Databases.

3 Description of sub-databases

3.1 Navigation Database (2101)

This database is designed for management of inventory level geophysical data collected during various cruises. A navigation point is defined as the location of a fix or a point at which either geophysical data is collected or ship has changed speed or direction. Geophysical data is collected with reference to these navigational points or fixes. Thus, this navigation database contains inventory level information of the geophysical data.

The Navigational data obtained from satellite navigation system (SAT-NAV) contains date, time, latitude, longitude, speed, and course for each fix along with 'satellite pass' information. Pre-processing of this navigation data is carried out by an inventory-quality-control program (IQC program). The first task of the program is to calculate/generate the accurate position data for each fix. An analysis is performed on the original data in which turning point, speed and satellite pass values are considered. The second task is to find obvious spurious values and flag them accordingly. For example a ship cannot travel at 50 knots, nor can it be at 400 degree longitude. After data standardization, INODC cruise and fixes numbers, ship code, country code, security code, line identity code, line continuation code etc. are assigned. The parameter code, which indicates whether the measurement of the particular parameter corresponding to a particular fix is made, are also assigned and finally data is stored in the navigation database.

To generate an exhaustive oceanographic inventory database, each navigation fix of each cruise is considered as a single record and information pertaining to 29 fields are stored against each fix. Each fix and cruise is assigned a specific INODC code number and so INODC_CR.N and INODC_FX.N are considered as key fields.

3.2 Bathymetry Database (2301)

It was developed for management of bathymetry data. Corrected bathymetry measurements corresponding to navigational fixes are stored in this database. Observations (also called sets) measured between the two fixes are also accommodated. Fields like INODC cruise and fixes numbers, originator's cruise and fixes number, sampling interval, number of sets, time for first set, time interval, corrected bathymetry data are included in this database.

3.3 Magnetic Database (2302)

It is designed for storage and management of magnetic data. Magnetic observations, residual field, diurnal corrections (in nanoteslas), depth of the sensor (in meters), INODC cruise and fixes number, originator's cruise and fixes number, sampling interval, number of sets, time for first set, and time interval are different fields which are included in this database.

3.4 Gravity Database (2303)

This database includes fields like observed gravity, Eotvos correction, Free-air anomaly, depth of the sensor (in meters), INODC cruise and fixes number, originator's cruise and fixes number, sampling interval, number of sets, time for first set, time interval, etc.

3.5 Intermediate Merged Databases (No.2401 to 2409)

These databases are developed by merging navigation database with magnetic database or navigation database with, say, bathymetry or gravity database.

3.6 Final Merge-Merge Database (No. 2410)

This database, also called the geophysical database, is created by merging the above described databases. Database software modules are used for merging databases. The geophysical database contains corrected values of marine geophysical data (bathymetry, gravity and magnetics) in correlative manner along with the corresponding navigation fix data.

A relational structured database package has been utilized for organizing the above databases on a DCM/PS 386 microcomputer, working under MS-DOS. The relation between the data is represented by a two dimensional table in which the related data items are entered into corresponding columns. Each column, contains data that is related to the data in the other column by the virtue of being in the same record (or row). The relationships are completely flexible and hence all combinations are possible at any time.

The final geophysical database file can be converted into formatted flat file. The format of this file exactly resembles the Marine Geophysical Data format (MGD-77) which is used internationally for marine geophysical data exchange. Thus the geophysical database file can be converted into MGD77 format file and vice-versa if required.

3.7 Quantity of data

NIO has conducted 57 cruises with the RV Gaveshani and 8 cruises with ORV Sagar Kanya for collecting marine geophysical data. Geophysical data along approximately 56,000 line kms. has been collected by NIO scientists. GPDMPMS contains inventory level line coverage information along approximately 26,000 line kms. In addition to this, 1,17,096 records of geophysical data for the Arabian sea from 43 cruises has been acquired, in MGD77 format, from National Geophysical Data Centre, Colorado, U.S.A. and accommodated in GPDMPMS.

4 Software modules

Software modules, namely a management module, search module, and presentation module, were developed to support GPDMPMS. These modules are written in a database command level language.

4.1 The Management module of GPDMPMS

This module supports the following functions:

1. Cruise and fix wise appending, editing and viewing of data.
2. Printing cruise catalogue and fixes catalogue [Kun89].
3. Statistics of coverage of geophysical data (Table 2).

4.2 Search modules

Data search is performed by accessing the navigation database. Various search criteria include:

1. Cruise numbers
2. Area Limits (Latitude & Longitude)
3. Survey dates
4. Parameter surveyed a) Bathymetry b) Magnetism c) Gravity

A user-friendly interactive program has been designed to permit user access to this inventory database. Once a customized search has been completed, INODC cruise and fix numbers are stored in a temporary disk file which acts as a drive for accessing information from geophysical database residing on NORISK DATA 570 computer system.

Cr.No	Vessel	Starting Date	Ending Date	Bathymetry L.Kms.	Magnetic L.Kms.	Gravity L.Kms.	Seismics L.Kms.	Area Coverage
C0910	LAMONT	06/13/65	07/01/65	640	642	0	642	Arabian sea
C1215	LAMONT	03/31/69	05/05/69	191	176	207	430	Arabian sea
C1707	LAMONT	05/17/74	05/28/74	284	284	283	284	Arabian sea
C1708	LAMONT	06/22/74	07/22/74	1153	1153	1138	1164	Arabian sea
V1910	LAMONT	08/08/63	08/26/63	675	672	672	675	Arabian sea
V2902	LAMONT	12/18/71	01/17/72	241	241	241	241	Arabian sea
V3306	LAMONT	04/19/76	05/15/76	381	0	667	0	Arabian sea
V3307	LAMONT	05/16/76	06/12/76	862	0	844	0	Arabian sea
V3406	LAMONT	08/01/77	08/27/77	62	62	62	0	Arabian sea
V3407	LAMONT	08/30/77	09/28/77	2509	2118	2346	0	Arabian sea
V3408	LAMONT	10/02/77	10/29/77	3473	2196	2377	0	Arabian sea
V3502	LAMONT	03/09/78	04/05/78	582	582	582	0	Arabian sea
V3617	LAMONT	10/15/80	11/13/80	712	712	712	0	Arabian sea
CH100L05	WOODS HOLE	04/25/71	05/12/71	686	686	686	686	Arabian sea
CH100L06	WOODS HOLE	05/17/71	06/10/71	198	198	167	198	Arabian sea
A2008L02	WOODS HOLE	08/19/63	09/30/63	1683	1441	0	0	Arabian sea
A2015L02	WOODS HOLE	02/24/65	04/09/65	2508	640	0	0	Arabian sea
A2015L03	WOODS HOLE	04/12/65	06/21/65	555	0	0	0	Arabian sea
A2093L17	WOODS HOLE			291	291	240	291	Arabian sea
WI343802	USNAVY	11/05/77	11/27/77	58	53	51	0	Arabian sea
WI343813	USNAVY	03/09/78	04/24/78	195	194	0	195	Arabian sea
WI373821	USNAVY	06/27/78	08/24/78	1852	1793	0	0	Arabian sea
WI330581	USNAVY	05/23/81	07/09/81	3485	2819	0	3499	Arabian sea
WI330382	USNAVY	01/07/82	03/23/82	2936	1712	0	0	Arabian sea
DODO08AR	SCRIPPS INST.OC	09/10/64	10/10/64	297	297	0	0	Arabian sea
LUSI6AAR	SCRIPPS INST.OC	10/04/62	10/26/62	783	205	0	0	Arabian sea
LUSI7AAR	SCRIPPS INST.OC	02/16/63	03/17/63	292	292	0	0	Arabian sea
LUSI7BAR	SCRIPPS INST.OC	03/21/63	04/12/63	260	260	0	0	Arabian sea
LUSI7CAR	SCRIPPS INST.OC	04/17/63	05/15/63	457	444	0	0	Arabian sea
LUSI03AR	SCRIPPS INST.OC	06/28/62	07/24/62	180	0	0	0	Arabian sea
LUSI04AR	SCRIPPS INST.OC	07/28/62	08/25/62	634	0	0	0	Arabian sea
ANTP10MV	SCRIPPS INST.OC	03/18/71	04/04/71	853	834	0	853	Arabian sea
DSDP23GC	SCRIPPS INST.OC	03/08/72	05/01/72	1171	1171	0	1171	Arabian sea
ZEPH09HO	SCRIPPS INST.OC	06/01/62	08/01/62	601	0	0	0	Arabian sea
LUSI01HO	SCRIPPS INST.OC	10/04/62	10/26/62	843	0	0	0	Arabian sea
RC2704	U RODE ISLAND	05/14/86	06/15/86	1350	0	0	0	Arabian sea
DME07	USSR	12/29/71	04/14/72	149	0	152	0	Arabian sea
DME10	USSR	06/27/73	10/10/73	154	0	154	0	Arabian sea
UM68	JAPAN	10/16/68	02/04/69	955	953	0	0	Arabian sea
— Total—				38890	24193	15280	10329	

Table 2 Cruise wise Geophysical Data Coverage

4.3 Presentation modules

Once the search is completed, an interim disk file is created which contains all position information within area specified and parameter codes.

The presentation modules help users in plotting,

1. Geophysical line coverage maps according to cruise.
2. Entire inventory file that meet the specific criteria.
3. Plot tracks for a specified time period.
4. Plot tracks containing only magnetic, gravity or bathymetry or their combination.
5. Zoom on any portion of plot.

Any or all of these plots can be generated either on the monitor, printer or plotter. The DM/PL command language merged with Basic language is used in writing plot modules. To improve information presentation, GPDMPMS is further upgraded by integrating it with PC based contouring software.

5 Utilization of GPDMPMS

Using GPDMPMS system, 1,17,096 records of geophysical data, from 43 cruises conducted during the International Indian Oceanographic Expedition, were extracted and sorted according to discipline for ten grids, each of five degree square grid. Sub databases were created by selecting longitude, latitude and parameter values. These data files were used as input to PC based contouring software for plotting contour maps, 3-D topography plots, anomaly maps and section profiles during preparation of Geophysical Atlas of Eastern Arabian Sea [Kun90].

Management modules, search modules and presentation modules of GPDMPMS were found extremely useful in preparation of the Geophysical Atlas. Bathymetry maps, 3-D surface topography plot and section profiles prepared for the atlas are presented in figures 2, 3, 4 respectively. GPDMPMS is also being used, in a variety of ways to prepare data reports, inventories and for presenting selected track plots.

6 GPDMPMS summary

1. Navigational database along with assimilation and search modules exists on a DCM PS/386 microcomputer whereas the geophysical database resides on Norsk Data 570 main frame computer system.
2. Exchange formats accelerates the transfer of data and reduce the risk of data deterioration owing to formatting errors.

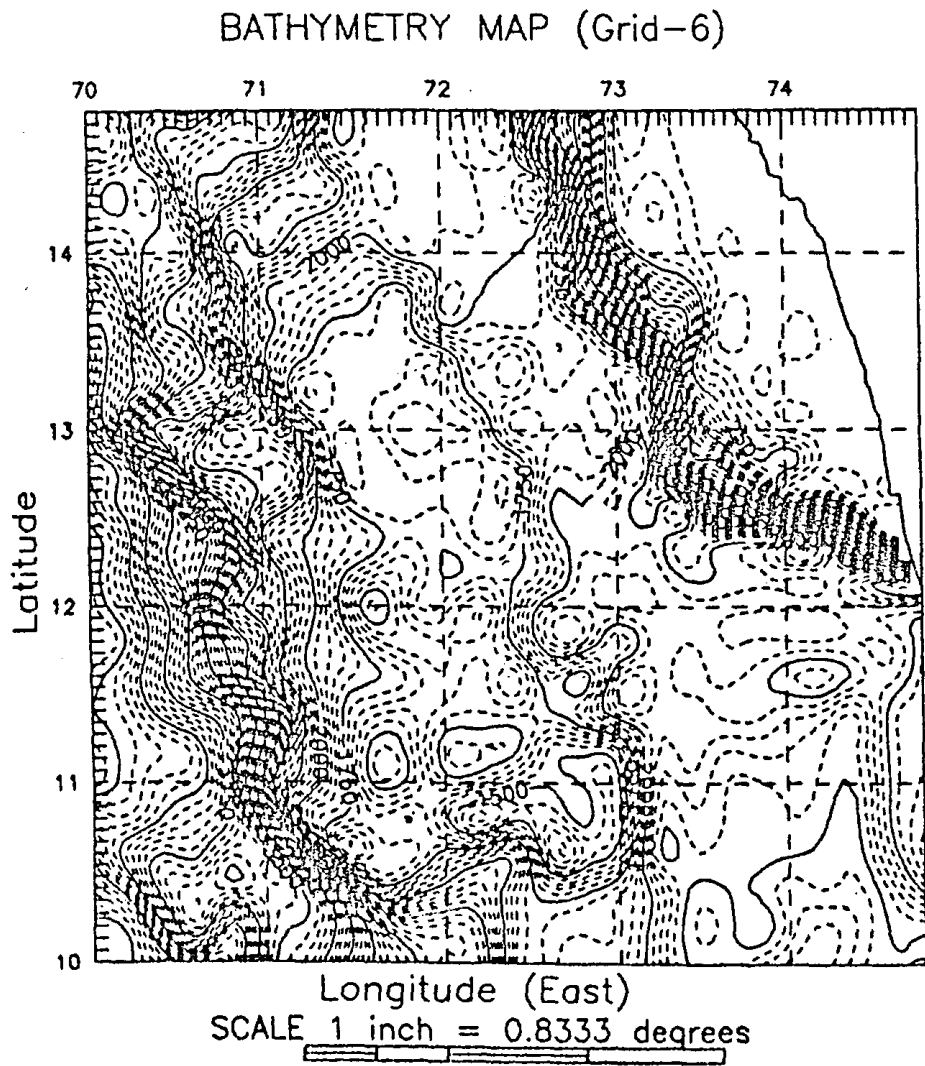


Figure 2.

Sea Bottom Topography Plot (Grid-3)

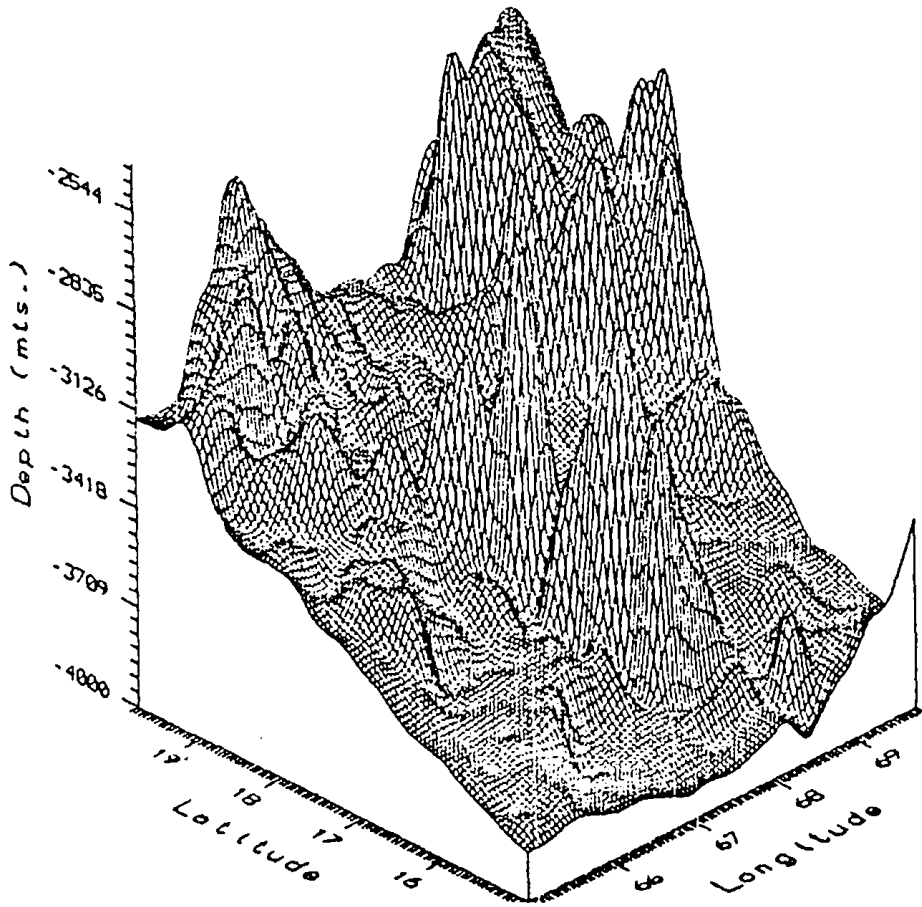


Figure 3.

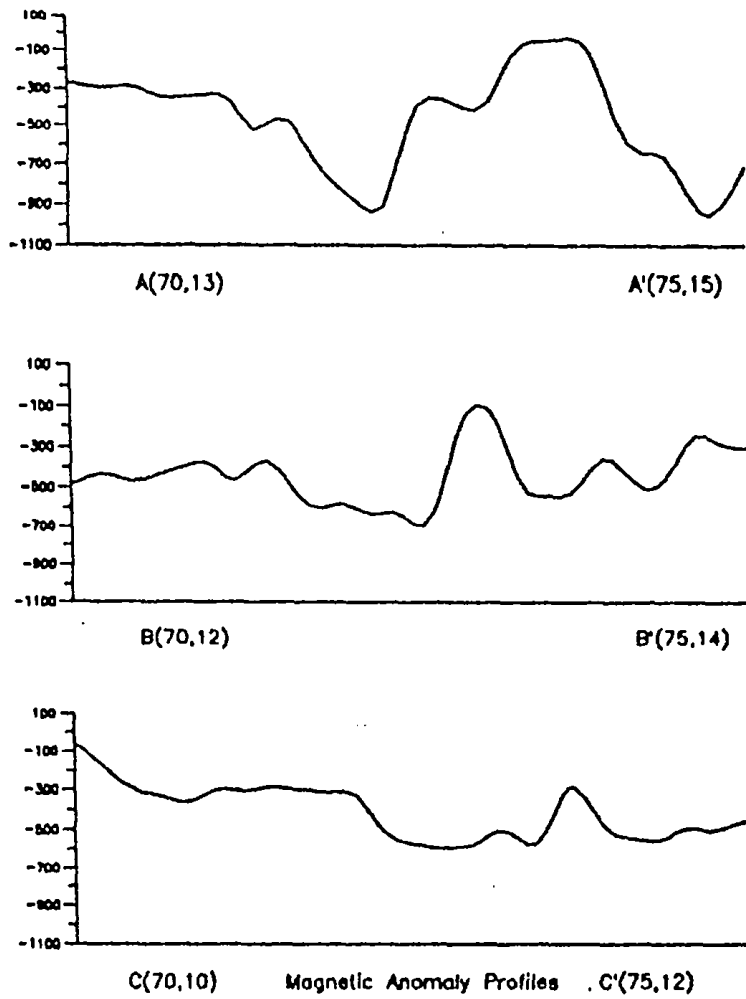


Figure 4.

3. Interactive searches are enhanced greatly by accessing an inventory file rather than accessing a large database.

4. User friendly system promotes broader usage.

In conclusion, the Marine Geophysical Database Management System is very useful and user-friendly software system for a) processing underway marine geophysical data into a database with a common structured format b) providing inventory and data retrieval capabilities, and c) presenting information in graphic forms.

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