A COMPILATION OF MAGNETIC OBSERVATIONS FROM THE ARCTIC & NORTH ATLANTIC OCEANS AND ADJACENT LAND AREAS

Geological Survey of Canada
Open File 3282a

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INTRODUCTION

Begun in late 1988 at the GSC Atlantic (a division of the Geological Survey of Canada), this project acquired and merged data sets from numerous organizations for the purpose of developing a digital data base of coherent magnetic observations suitable for quantitative tectonic interpretations, and for the automated production of accurate maps. To promote widespread use of the new data base, three sets of products are being released to the geoscientific community:

Digital Grids defining the regional magnetic fields of the Arctic and North Atlantic, produced from the final data base after all assembled data sets have been adjusted and merged; where necessary, some data sets have been filtered to protect contributors' proprietary interests. The 5-km grids are distributed on a CD-ROM issued as GSC Open File Number 3125a.

Maps portraying the regional magnetic fields of the Arctic and the North Atlantic, compatible with General Bathymetric Charts of the Oceans (GEBCO): scale 1:6M north of 64N, and 1:10M between 35N and 80N; these maps are distributed as GSC Open File Numbers 3281 and 3280, respectively.

A comprehensive ***Project Report*** describing the assembled data sets and their sources, and explaining procedures for their handling and processing. A hardcopy version of the Report is available as GSC Open File 3125b; Hypertext and PostScript versions are also distributed on the CD-ROM released as GSC Open File 3125a.

Organizations that have contributed data to the compilation have already received advance copies of the grids and maps for their exclusive use. Some of these organizations have participated in the project's active phases through the joint processing and interpretation of their contributed data sets on the computer facilities of the GSC Atlantic.

A few statistical highlights offer some insights into the size of the data base:

Present holdings comprise nearly 40 million data points. Nearly half are grid points derived from maps and pre-existing compilations; the remainder consists of marine and aeromagnetic observations.

Making reasonable assumptions, this quantity of data points translates into roughly 3,000,000 line-km of marine data (about 75 times around the Earth), and 14,000,000 line-km of aeromagnetic data (more than 18 round trips to the Moon). These numbers represent about 7000 24-hour ship days (close to twenty years of non-stop operations), and about 4000 12-hour aircraft days (around eleven operating years).

In 1996 US dollars, it would cost about $250,000,000 to re-acquire these data sets from scratch. In contrast, the total cost of compiling and merging the existing data has amounted to significantly less than 1% of the expense of re-acquiring the data.

DATA CONTRIBUTORS

The following organizations have contributed magnetic data to this project.

Applied Geophysics Unit, University College; Galway, Ireland

British Geological Survey; Edinburgh, Scotland

British Petroleum Exploration; London, UK

Bullard Laboratories, Cambridge University; Cambridge, UK

Bundesanstalt fur Geowissenschaften und Rohstoffe; Hannover, Germany

Centro de Geofisica de Universidade de Lisboa; Lisbon, Portugal

Conoco Inc.; Ponca City OK, USA

Department of Energy of the Republic of Ireland; Dublin, Ireland

Dublin Institute for Advanced Studies; Dublin, Ireland

Esquimalt Defence Research Establishment; Victoria BC, Canada

Falconbridge Ltd.; Windsor NS, Canada

Geologian Tutkimuskeskus; Espoo, Finland

Geological Survey of Canada; Dartmouth NS and Ottawa ON, Canada

Grant Institute of Geology, University of Edinburgh; Edinburgh, Scotland

Gronlands Geologiske Undersogelse; Copenhagen, Denmark

IFREMER Centre de Brest; Brest, France

Institut du physique du globe, Universite de Paris VI; Paris, France

Institute for Aerospace Research; Ottawa, Canada

Instituto de Geologia Jaume Almera; Barcelona, Spain

Instituto Geografico Nacional; Madrid, Spain

Lamont Doherty Earth Observatory; Palisades NY, USA

Norges Geologiske Undersokelse; Trondheim, Norway

Petro-Canada Resources Limited; Calgary AL, Canada

Raunvisindastofnun Haskolans; Reykjavik, Iceland

Royal Netherlands Navy; The Hague, The Netherlands

SEVMORGEOLOGIA; St. Petersburg, Russia

Shirshov Institute of Oceanology; Moscow, Russia

Southampton Oceanography Centre; Southampton, UK

SPbF IZMI RAN; St. Petersburg, Russia

Sveriges Geologiska Undersokning; Uppsala, Sweden

University of Liverpool; Liverpool, UK

US Geological Survey; Woods Hole MA, USA

US National Geophysical Data Center; Boulder CO, USA

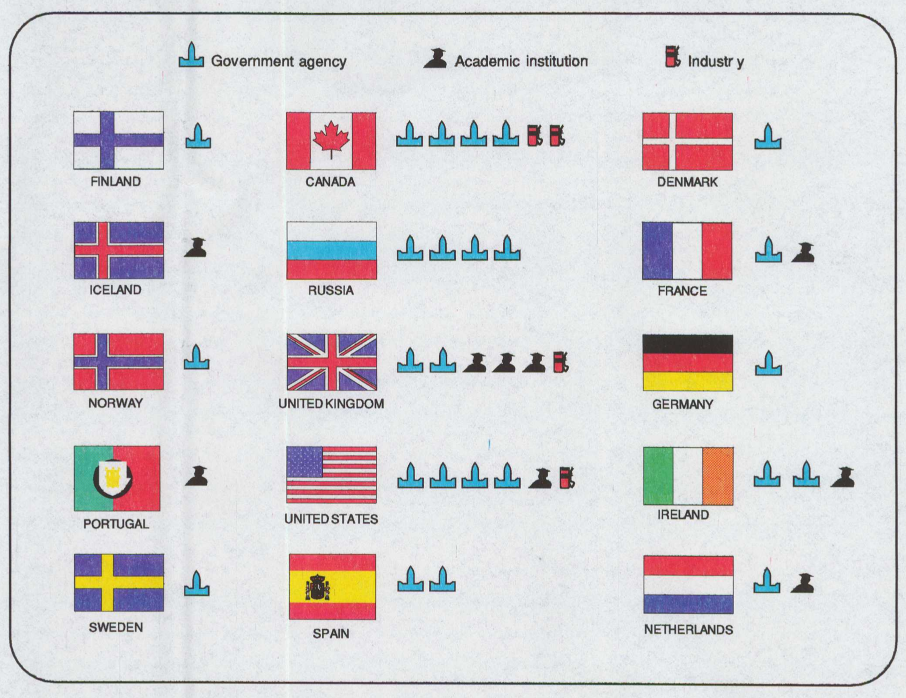
US Naval Oceanographic Office; Stennis Space Center MS, USA

US Naval Research Laboratory; Washington DC, USA

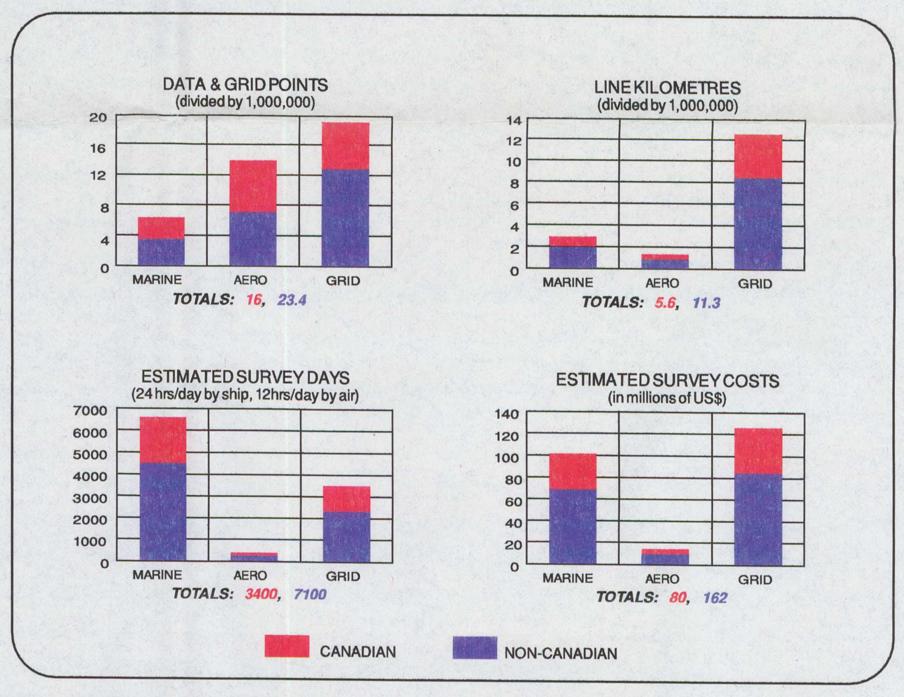
Vening Meinesz Laboratorium; Utrecht, The Netherlands

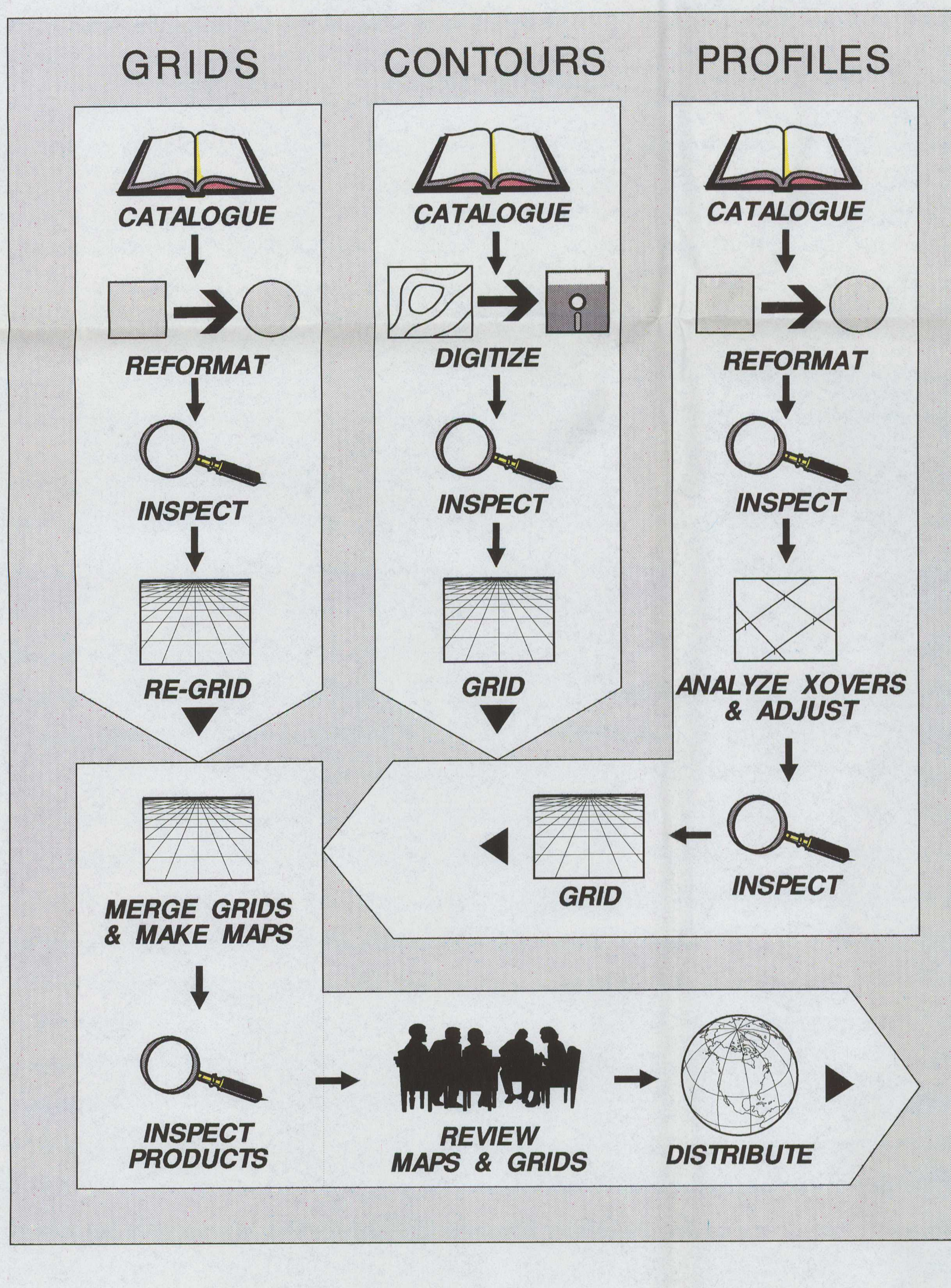
VNIIOkeangeologia; St. Petersburg, Russia

DATA SOURCES



DATA BASE STATISTICS





DATA PROCESSING

General procedures for treating the three classes of data - grids, contour maps, and profiles - are illustrated in the diagram at left.

All individual data sets were treated in various ways preparatory to definitive gridding and merging, with rigourous checking at intermediate points to ensure that errors were neither retained nor inserted in the final data base through faulty methodology. As an additional precaution, techniques and results were reviewed at key stages by external advisors with demonstrated expertise in the handling and analysis of large sets of magnetic data.

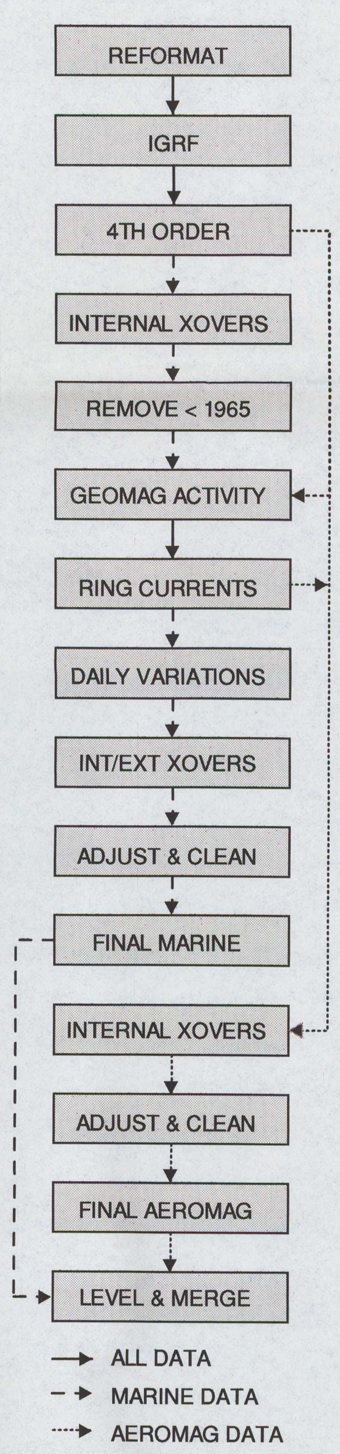
Specific steps for treating profile data are shown in the diagram at right. The different branches in this diagram reflect the dissimilar error characteristics of marine and airborne data, as well as the differences in recording techniques.

After reformatting, all profile sets were reduced to anomaly values and de-spiked with a fourth-order difference routine. Marine data sets were subjected to a rigourous crossover analysis to determine the degree of self-consistency within each data set, and to detect overall level differences between data sets through comparison of discrepancies at mutual track intersections. This analysis identified portions of the data base that could be eliminated on account of unacceptably high errors.

Selected profile segments were treated for problems related to short-term temporal variations: most observations could be corrected by a variety of means, but some had to be rejected as uncorrectable.

A minimum curvature algorithm was applied to the combined marine and aeromagnetic data sets to create two sets of 5 km grids on a transverse Mercator projection with a central meridian of 50W. The grid size was chosen to protect proprietary information in some of the constituent data sets.

Before merging the different grid sets, we eliminated all magnetic field wavelengths longer than 400 km. Gridded data sets were merged in the following order of priority according to their origin: (1) aeromagnetic; (2) marine; (3) pre-existing grids; and (4) grids created from digitized contour maps. The accompanying plot illustrates which data sets were retained in the final merged grid, and where.



The procedure for merging included an extrapolation function for closing data gaps up to 15 km wide. Isolated ship tracks or aircraft flight lines therefore appear as 30-km swaths.

A complete description of all data processing procedures is included in the final Project Report.

APPLICATIONS

As a resource for regional studies, the new data base has already demonstrated its value by providing a departure point for a wide range of ongoing geomagnetic investigations performed jointly with personnel from data-contributing organizations.

One of the most interesting results of the new data base is been the fresh perspective it offers on the tectonic framework and history of the Arctic Ocean basin - one of the world's most poorly known. Marked disparities in the magnetic fields of the Amerasian and Eurasian Basins reflect major differences in the structures and formation modes of these two segments of the ocean floor, while anomaly patterns along the outer continental shelf off Siberia may indicate important tectonic plate adjustments during the opening of the Arctic Ocean.

In the North Atlantic, the new data base provides an enhanced definition of the seafloor spreading magnetic anomalies. Detailed mid-ocean maps show interesting new evidence of ridge axis propagation and jumps of oceanic fracture zones. Accurate portrayals of the magnetic field over the Continent-Ocean Boundaries invite and facilitate comparisons of the characteristics of conjugate margins, and shed new light on the rift processes that resulted in the formation of major sedimentary basins on the continental shelves.

ORDERING INFORMATION

For information on how to order copies of this poster or other products of this compilation, send an inquiry by e-mail to agc@agc.bio.ns.ca, by fax to +1(902)426-4266, or by letter to:

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