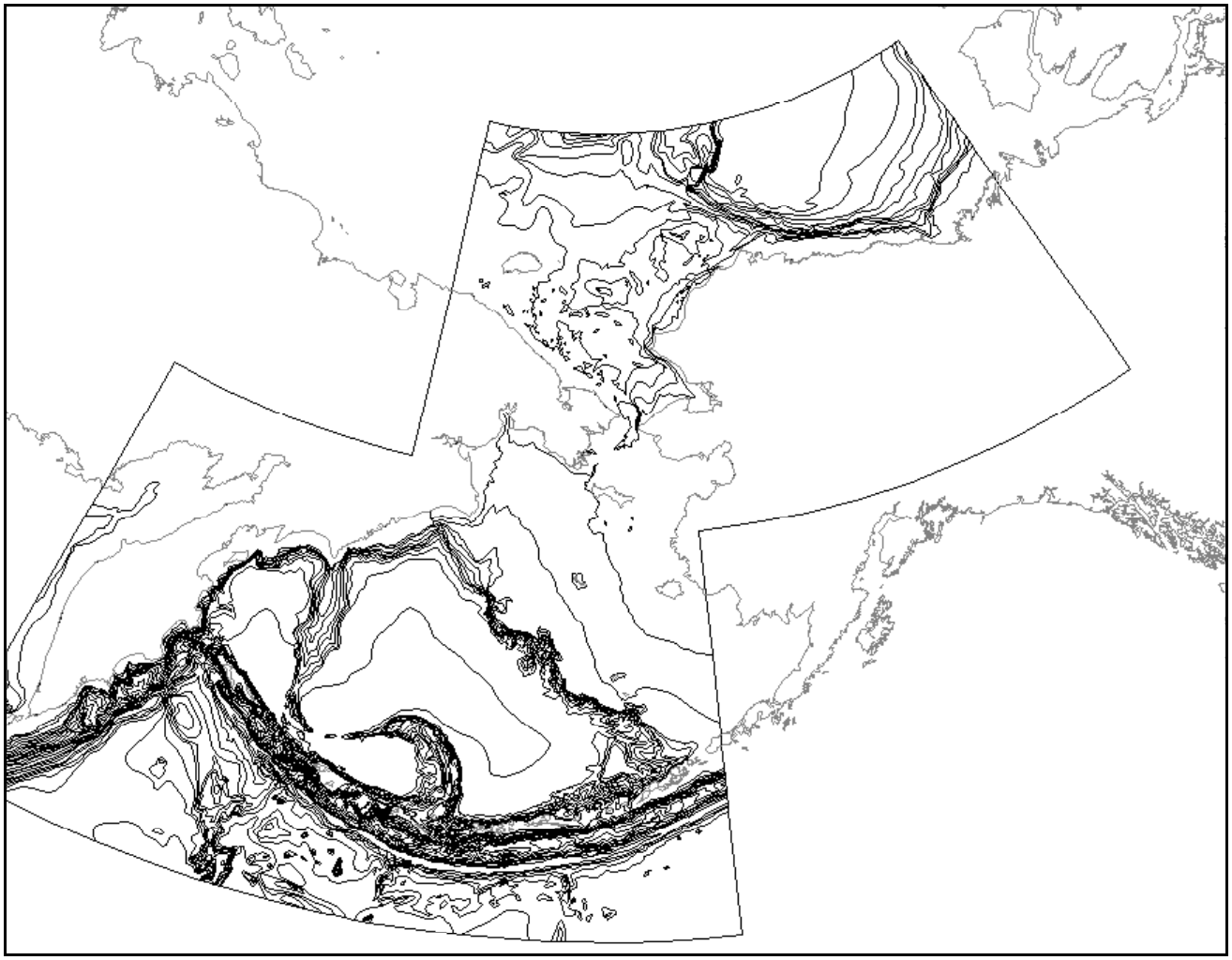
# BERING AND CHUKCHI SEA BATHYMETRY



Alaska Biological Science Center
Biological Resources Division
U S Geological Survey

July 1997

# Bering and Chukchi Sea Bathymetry Coverages

Compiled by
Donna G. Robertson [1]

## OVERVIEW

The Alaska Biological Science Center (ABSC), of USGS Biological Resources Division, has conducted research on marine animals in the Bering and Chukchi seas since the mid-1980s. These bathymetry coverages were created to make available seafloor topography data useful to assist analysis of marine animal movement and distribution.

This report describes the bathymetry coverages, which describe an area bounded by the western Alaska coast to Point Barrow (155 W longitude) and eastern Russia coast to Wrangel Island (182 E longitude), Aleutian Islands in the south (51 N latitude) and approximately 75 N latitude in the north.

## TABLE OF CONTENTS



[1]Present address: Western Ecosystems Technology, Inc., 6705 Lisa Court, Anchorage AK 99516.

## BATHYMETRY

### *BATHYMETRY REQUIREMENTS*

Bathymetry is an important parameter in examining marine animal locations and movements. ABSC requirements for bathymetric layers for the Bering/Chukchi Sea Ecosystem Database included high resolution within the continental shelf, knowledge of data sources and data quality control and coverage of large, contiguous regions of the area. The coverages in this database meet these requirements.

### *BATHYMETRY SOURCES*

Bathymetric data from a variety of sources were evaluated, including published paper maps, and point, line, and grid data on CD-ROM.

**Paper maps**.--The National Ocean Service (NOS), a division of the National Oceanographic and Atmospheric Administration (NOAA), has a complete set of published and blueprint maps for all U.S. coastal waters at 1:250,000 scale. The maps are comparable to USGS topographic maps of the same scale. Depth data for the maps were collected by NOS ships and scientists from the early 1900s to the 1980s. The maps contain bathymetric contours at 10-meter resolution with supplemental contours at 2-meter intervals. NOAA also published nautical charts at varying scales for U.S. waters. Many of these contain a combination of bathymetric contours and point depths. The Strategic Environmental Assessment Division of NOAA published the Bering, Chukchi, and Beaufort Seas Coastal/Ocean Zones Strategic Assessment ("BCB Atlas"), which contains a bathymetric map of the Bering/Chukchi/Beaufort region. The bathymetry map was derived from several map sources and contains no original data.

The USGS produced several bathymetric maps of regions within the Bering/Chukchi Sea area. Data for the maps were collected during mineral and geologic surveys of specific areas. The maps were developed for different projects and purposes, and vary in scale, projection, resolution, and size of area covered.

The Geological Society of America (GSA) published a map of the Arctic Ocean and adjoining seas. Bathymetric contours were derived from a variety of international sources, and no original data were collected for the map. The map is no longer in print and is difficult to find. In addition, GSA published a high resolution map, *Bathymetric Map of the Bering Shelf*, in 1974 which contains 10-meter resolution bathymetry in US and Russian waters. The map was compiled and contoured by NOS, using data collected by NOS, the Hydrographic Office, and the Coast and Geodetic Survey.

The *General Bathymetric Charts of the Oceans* (GEBCO) is an international map series developed with cooperation from multiple countries. Depth data were collected using varying methods by many sources, however the data were reviewed to meet established standards before they were used for generating contours. The maps are at 1:10,000,000 scale with contours at 500-m intervals. Supplemental contours are included at 50, 100, and 200 m where data are available.

**Digital Data**.--The National Geophysical Data Center (NGDC), a division of NOAA, developed several CD-ROMs that include bathymetric data. The CD-ROM sets are: (1) *NOS Hydrographic Survey Data*, (2) *Marine Geophysical Trackline Data*, (3) *Global Relief*, and (4) *TerrainBase*. The *NOS Hydrographic* CD-ROM contains point data for NOS bathymetry surveys. The data range from highly concentrated points along navigation corridors, coastal areas, and ports, to sparse points in coastal areas without ports, to no data in off-shore waters. The *Marine Geophysical Trackline* CD-ROM contains bathymetric point

data from a wide variety of sources covering a broad area. The tracklines are predominantly off-shore within the continental shelf, complementing the *Hydrographic* CD-ROM, however, the tracklines are sporadic in coverage, and the quality of the data cannot be easily verified. The *Global Relief* CD-ROM contains a variety of marine and terrestrial databases. For bathymetry the CD-ROM contains a gridded database called *ETOPO-5* which contains global bathymetry at 5-minute latitude/longitude resolution. *ETOPO-5* was derived from unpublished 1:5,000,000 scale U.S. Naval Oceanographic Office bathymetric contours. The *TerrainBase* contains data similar to *Global Relief*, including *ETOPO-5*. *TerrainBase* no longer appears on NGDC order forms.

There are two additional sources of digital bathymetric data. GEBCO developed a *Digital Atlas* CD-ROM which contains worldwide bathymetric contours at 1:10,000,000 scale with contours at 500-m intervals. The NOAA World Data Center for Marine Geology and Geophysics is developing techniques for examining the ocean floor using a radar altimeter aboard a satellite. Current radar altimeter technology has low resolution, and is being used to map seamounts and other large topographic features in regions where sounding data are sparse, and as a precursor to ship-board surveys.

**Other sources**.--Oil companies collected seismic and depth data within the Bering/Chukchi study area. However, these data are proprietary - which would prevent ABSC from redistributing coverages derived from them - and limited in scope. The Defense Mapping Agency (DMA), Department of Defense, also has bathymetric charts. Many DMA charts are classified, and all are difficult to obtain.

## *BATHYMETRY SELECTED FOR DIGITIZING*

Based on ABSC established requirements, 5 bathymetry sources were selected for the database. All maps were digitized from paper sources, except where noted, to produce Arc/INFO coverages that contain polygons. Each polygon contains the mid-depth between its bounding contours (e.g. the mid-depth between 10 and 20 m is 15 m). Depths for all coverages are in meters. All coverages are stored in geographic projection, to facilitate reprojection as needed by users. Metadata for each coverage contain information in addition to that listed below. Individuals accessing the bathymetry coverages are highly encouraged to examine the associated metadata.

Polygon coverages, rather than grids, were produced for the database because the original map sources were line contour maps and polygon coverages maintain the original integrity of the source contours, and because reprojection errors may occur with grids. When reprojecting coverages in a grid format, some projections delete grid cells, while others may add cells. Therefore, each time a coverage is reprojected, data may be lost or arbitrarily added. Polygon coverages may be converted to grids if desired.

File names for the bathymetry coverages are in three parts: a 7 or 8 letter description of the location of the data or the data source followed by an underscore, the number "3" which indicates polygon topology, and the 3-letter code "geo" which labels the coverages as geographic or latitude/longitude projections.

(Online linkage at **http://www.absc.usgs.gov/research/bering/bathy**)

**NOS Bathymetry of U.S. Waters (nosbath_3geo)**. The highest resolution bathymetry in the database is a coverage digitized from more than 90 NOS maps (Figure 2). Map source resolution is 1:250,000. Point data from the NOS Hydrographic CD-ROM where were used to generate contours in areas where data points were highly concentrated and produced high quality contours that resembled the paper maps. The NOS coverage includes Bristol Bay, the Bering Sea shelf, the Bering Strait, the Chukchi Sea, and the Beaufort Sea. The maps end at the U.S. Exclusive Economic Zone (EEZ), i.e. only U.S. bathymetry. Contours are at 10-m intervals from 0 to 200 m (for budget reasons our coverage ends at 200 m, but the NOS maps contain data to several thousand meters in the Bering and Beaufort seas). Intermediate contours at 2-m intervals were not included in the coverage because the scale was considered too fine for most research needs, and the supplemental lines often ended without polygon closure.

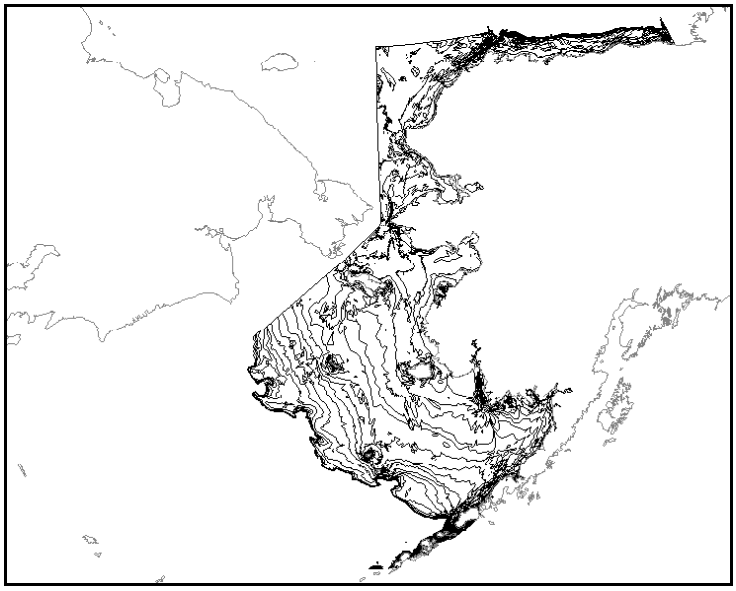


Figure 2. Image of bathymetry polygon coverage of National Ocean Service maps. Filename NOSBATH_3GEO.

**USGS Chukchi Sea Bathymetry (chukbath_3geo)**. The Bathymetric Map of the Chukchi Sea (USGS Miscellaneous Investigations Map I-1182-D) contains contours of the Chukchi Sea from Smith Bay, east of Point Barrow, Alaska to Herald Island, east of Wrangel Island, Russia, and ends at the Bering Strait (Figure 3). The resolution is similar to, but slightly lower than, the NOS bathymetry, and contributes the Russian side of the Chukchi Sea. Original map resolution is 1:1,000,000.

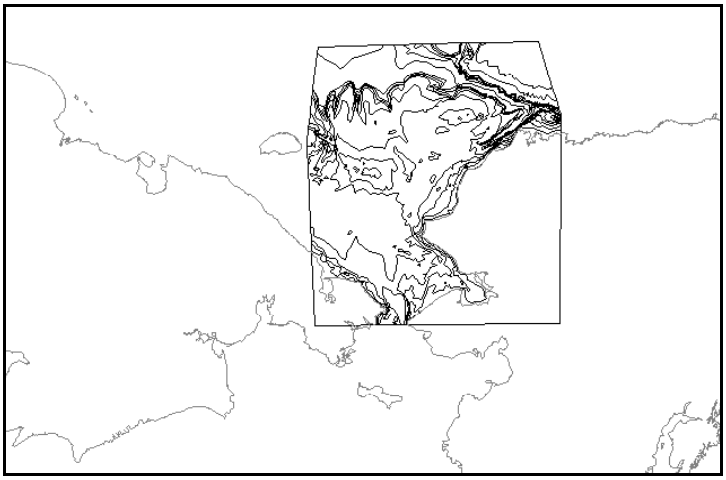


Figure 3. Image of bathymetry polygon coverage of U.S. Geological Survey Misc. Investigations Map I-1182-D. Filename CHUKBATH_3GEO.

**USGS Bering and Chukchi Sea Bathymetry (berchuk_3geo)**. Two USGS Open File Report (OFR) maps were joined together to create one coverage of the Bering and Chukchi seas. The Bathymetric Map of the Chukchi Sea and Arctic Ocean (USGS OFR 76-823) is a low resolution map of the Chukchi Sea and southern Arctic Ocean (Figure 4). The resolution is low (1:2,500,000), but contributes contours around Wrangel Island, Russia not found on other maps. The Bathymetric Map of the Aleutian Trench and Bering Sea (USGS OFR 76-821), companion to OFR 76-823, has the same low resolution but contributes bathymetric contours around the entire Aleutian Island chain and on the Russian side of the Bering Sea not otherwise available on a contiguous map (Figure 4).

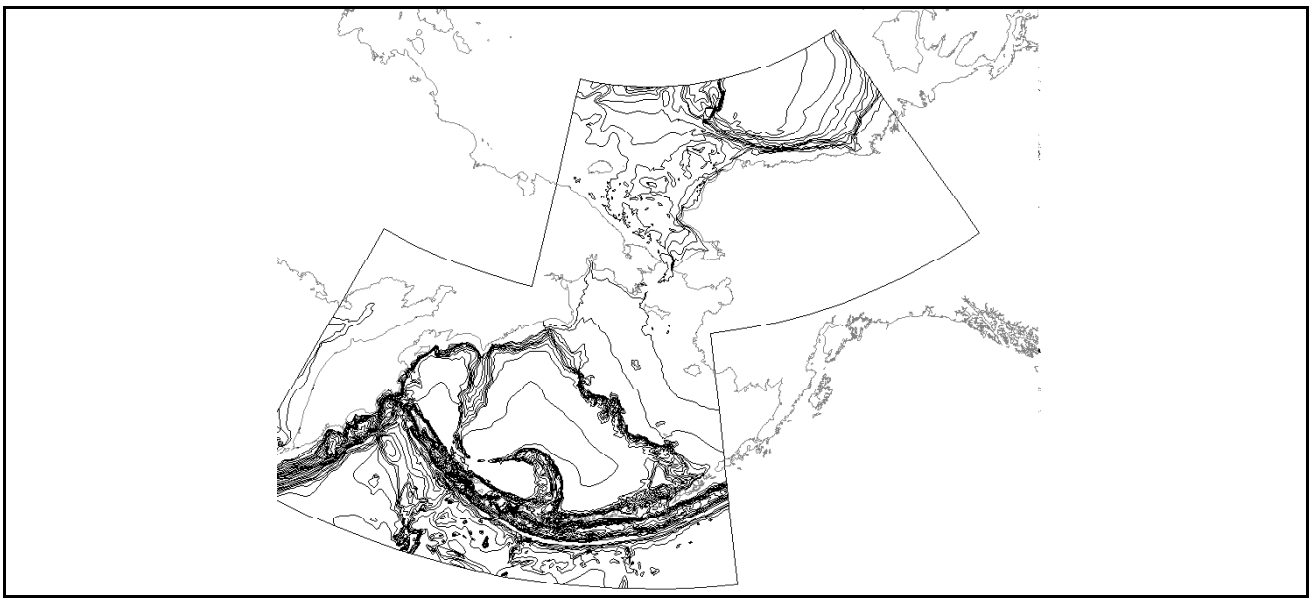


Figure 4. Image of bathymetry polygon coverage of U.S. Geological Survey Open File Reports 76-821 and 76-823. Filename BERCHUK_3GEO.

**USGS Bering Strait Bathymetry (berstrat_3geo).** The Topographic and Bathymetric Map of the Northern Bering Sea Region (USGS Professional Paper 759-B) contains a small section of the Bering Strait (Figure 5). This map was included because it provides high resolution bathymetry of the Russian side of the EEZ that complements the NOS maps. Source resolution is 1:1,000,000.

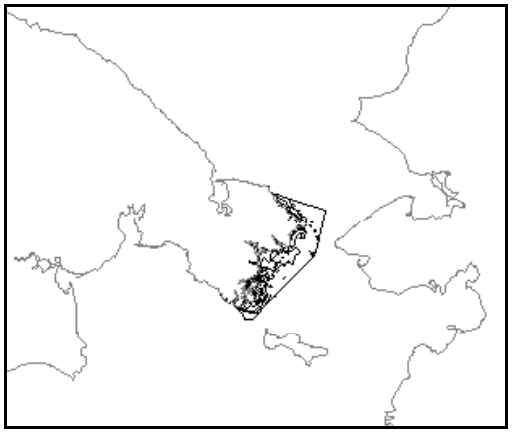


Figure 5. Image of bathymetry polygon coverage of a map from U.S. Geological Survey Professional Paper 759-B. Filename BERSTRAT_3GEO.

**GSA Gulf of Anadyr Bathymetry (anadbath_3geo)**. The Bathymetric Map of the Bering Shelf (Geological Society of America 1974) contains bathymetry for Russia in the Bering Strait, Gulf of Anadyr, and north Bering Sea shelf (Figure 6). The map complements the NOS bathymetry, and contours overlap well to about 60 or 70 meters. Sources for the map include data from the Hydrographic Office, NOS, and Coast and Geodetic Survey. This map was included because it provides good resolution bathymetry from quality sources for Russian waters not found on any other source. The line across contours is overlap for merging with NOS bathymetry (nosbath_3geo).

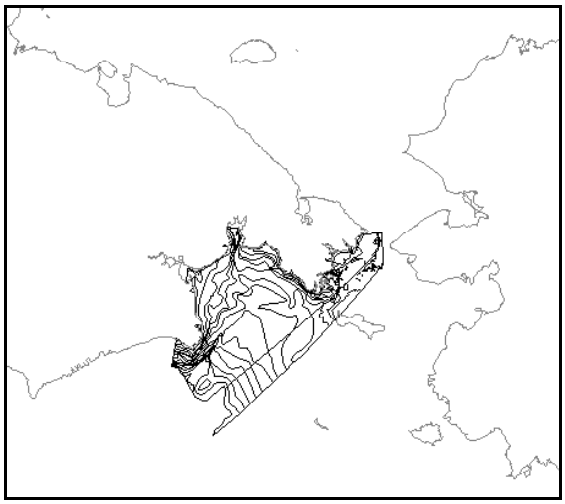


Figure 6. Image of bathymetry polygon coverage of Geological Society of America, Bathymetric Map of the Bering Shelf. Filename ANADBATH_3GEO.

*BATHYMETRY NOT SELECTED FOR DIGITIZING*

There were several reasons why other bathymetric data were not selected for the database. The GEBCO maps and CD-ROM, NOAA charts, and radar altimetry data contained high quality data at a low resolution, with contour intervals too sparse for wildlife research needs. The *GSA map of the Arctic Ocean* and the *BCB Atlas* derived contours from other sources, diluting and altering the original data. The *Marine Geophysical Trackline Data* contained inconsistencies and varied data collection methods that could not be resolved. Bathymetric data from oil companies were not considered because they are proprietary - which would prohibit ABSC from freely distributing the data - and of limited geographic extent. The Defense Mapping Agency maintains the highest quality and resolution charts and maps; however, the maps are either classified, no longer in distribution, or extremely difficult to obtain.

*ETOPO-5* was not included directly in the database because it is readily available on the *Global Relief* CD-ROM from NGDC, and since it contains global bathymetry, individual scientists should extract data from selected areas as necessary. In addition, the 5-minute pixel resolution may be too course for many wildlife research applications.

# REFERENCES


***DATABASE BATHYMETRIC MAPS***

**Hill, E.R., A. Grantz, S.D. May, and M. Smith**. Bathymetric Map of the Chukchi Sea. 1984. Miscellaneous Investigations Series I-1182-D. Department of the Interior, U.S. Geological Survey.

**Hopkins, D.M., C.H. Nelson, R.B. Perry, and T.R. Alpha**. 1976. Topographic and Bathymetric Map of the Northern Bering Sea Region, Plate 1, *in* Physiographic Subdivisions of the Chirikov Basin, Northern Bering Sea, Studies on the Marine Geology of the Bering Sea. Geological Survey Professional Paper 759-B. U.S. Government Printing Office, Washington, D.C.

**Pratt, R., and F. Walton**. 1974. Bathymetric Map of the Bering Shelf. The Geological Society of America, Boulder, CO, USA.

**National Geophysical Data Center**. 1996. NOS Hydrographic Survey Data, U.S. Coastal Waters, CD-ROM Set, Version 3.2. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, CO.

**National Ocean Service**. Various dates. Bathymetric Maps; Series NN, NO, NP, NQ, NR, and NS; UTM Zones 1-7, and 60. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Washington, D.C.

**Schumacher, G.M**. 1976. Bathymetric Map of the Aleutian Trench and Bering Sea. U.S. Geological Survey Open File Report 76-821.

**Schumacher, G.M**. 1976. Bathymetric Map of the Chukchi Sea and Arctic Ocean. U.S. Geological Survey Open File Report 76-823.

***OTHER BATHYMETRY SOURCES***

**Jones, M.T**. 1994. General Bathymetric Chart of the Oceans, GEBCO Digital Atlas. British Oceanographic Data Centre, United Kingdom.

**International Hydrographic Organization, and Intergovernmental Oceanographic Commission**. 1984. General Bathymetric Chart of the Oceans (GEBCO), Maps 5-02 and 5-03. Canadian Hydrographic Service, Ottawa, Canada.

**National Geophysical Data Center**. 1993. Global Relief Data on CD-ROM. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, CO.

**National Geophysical Data Center**. 1996. Marine Geophysical Trackline Data, Worldwide, CD-ROM Set, Version 3.2. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, CO.

**Row, L.W., III, D.A. Hastings, and P.K. Dunbar**. 1995. TerrainBase, World Digital Terrain Data, Documentation Manual, CD-ROM Release 1.0. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Geophysical Data Center, Boulder, CO.

**Sanwell, D.T., and W.H.F. Smith**. 1996. Exploring the Ocean Basins with Satellite Altimeter Data. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Geophysical Data Center and World Data Center A for Marine Geology and Geophysics.