THE BATHYMETRIC MAPPING PROGRAM OF THE NATIONAL OCEAN SURVEY

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Abstract

Systematic mapping is a prerequisite for any major activity contemplated, be it on land or in the ocean. This realization motivated the National Ocean Survey (NOS) to establish a systematic mapping program for its area of responsibility in the ocean environment. Mounting national pressure for accelerated development of gas and oil reserves on the Outer Continental Shelf (OCS) and the protection and development of the land and water resources of the country's coastal zone mandates a systematic series of maps varying in scale and detail. NOS is making significant progress in producing such a series of maps in cooperation with the United States Geological Survey (USGS).

1. Introduction

Oceans are no longer just a vehicle for commerce or a source for recreation or food, but have increasingly become a source for vital natural resources for the United States and many other nations.

For scientists and engineers to make sound decisions in developing unique means for extracting, managing, and conserving these important resources, they must be provided with sound basic information of the ocean's environment. Very basic tools that effectively convey this are detailed bottom contour, or bathymetric, maps portraying a complete picture of the topographic/geologic features of the ocean floor. Recognizing this need led NOS to establish a bathymetric mapping program in 1966.

This program includes a series of 1:250,000-scale bathymetric maps covering the OCS and, under a joint effort with USGS, a unique series of 1:250,000-, 1:100,000-, and 1:250,000-scale topographic/bathymetric (topo/bathy) maps of the coastal zone.

2. History

Prior to 1966, NOS had no systematic bathymetric mapping program to address the needs of the ocean-oriented community. An increased demand for ocean bottom topographic information, coupled with NOS' availability of enormous amounts of oceanographic data and existing expertise, led NOS to establish a bathymetric mapping program in 1966.

Due primarily to a lack of funds, production remained at a comparatively low level between 1966 and 1974. During this time period, approximately 54 maps of various scales, formats, and contour intervals were produced. In 1975, the pace of exploration for gas and oil on the OCS increased to the point where an accelerated bathymetric mapping program became necessary to maintain pace with this increased OCS activity as it moved further and further offshore. At the same time, the need for knowledge of the coastal zone environment moved from a passive to a very active national, state, and civic concern. This acceleration resulted in NOS producing over 300 bathymetric products between 1975 and 1982 to assist OCS resource development, support numerous scientific and engineering endeavors, and assist coastal zone programs.

3. Bathymetric Maps

The catalyst for the accelerated map production within NOS resulted primarily from the need to keep abreast with the OCS requirements, as requested by the United States Department of the Interior's Minerals Management Service (MMS), formerly called the Bureau of Land Management. It is MMS responsibility to evaluate and lease the federally controlled OCS land for all resources, including gas and oil. Bathymetric maps are required, in unison with other information, to prepare comprehensive Environmental Impact Statements of potential gas and oil areas that will be leased to the private sector for exploration and development.

In the past 7 years, NOS has produced 96 bathymetric maps for MMS. Of this total, 32 maps are of the Gulf of Mexico, 47 are of the Atlantic coast, 4 are of the west coast, and 13 are of Alaska's Shelikof Strait, Cook Inlet, and Norton Sound. In addition, five of the Atlantic coast, two of the west coast, and three of Alaska are presently in various stages of production.
Bathymetric maps are produced on the Universal Transverse Mercator projection at 1:250,000 scale. Each map covers a geographic area of 1 degree of latitude by 2 degrees of longitude, except for Alaska, where the longitudinal coverage is 3 degrees. The OCS map coverage extends out to the United States' 200-mile fishing conservation boundary. As with all maps produced by NOS, the contours are in meters. All contouring is done manually at the scale of the original hydrographic surveys, which vary from 1:2,500-to-1:120,000 scale and smaller. Compilation at the original survey scale ensures that all data collected are utilized, maximizes development of the smaller detail, and maintains uniformity in the different scale maps produced by NOS.

To portray the tremendously varied configurations of the shelf and slope that occurs from one geographic region to another, various contour intervals are used. This maximizes the amount of detail which can be shown while maintaining clarity. Contour interval determination is based on the complexity of the bottom terrain, slope, and amount of hydrographic data available. Typically, on the east coast, the 1:250,000-scale maps south of 42° north latitude have 10-meter contour intervals supplemented by 2 meters out to the 200-meter contour line. Beyond the 200-meter contour, the interval is every 50 meters supplemented by 10-meter contours. For those maps covering the areas north of 42° latitude, the steep slope and terrain complexity will allow the 10-meter contours to be shown only out to the 200-meter contour line.

Once the surveys are compiled, the compilations are photographically reduced and mosaicked at the final map scale, or assembled and inked directly at the final 1:250,000 scale. The intermediate assembly of the manuscript is often used to facilitate the inking process and to ensure that only a minimal amount of generalization occurs. Some generalization is introduced when the larger scale hydrographic contoured compilations are reduced and manually transferred to the much smaller scale final manuscript.

To ensure the immediate availability and distribution of the maps produced to the public, advanced black and white copies are made from the inked manuscripts until the map is printed.

Published maps are prepared from the manuscripts and are multicolor with varying tints of blue to emphasize the bottom gradient. Additional information includes names of underwater features, gas and oil platforms, pipelines, spoil areas and dump sites, maintained channels, the 200-mile fishing conservation boundary line, and, overprinted in red, the MMS offshore lease block information. Each lease block represents approximately 5,700 acres of land. Border information includes a hydrographic survey index, survey information, depth gradients, and an index showing the adjacent maps published. While certain basic information shown on these maps has become standard, NOS seeks to improve the usefulness of the product by inviting users' suggestions and/or comments.

4. Topographic/Bathymetric Maps

To assist Federal and state agencies in effectively managing, developing, and protecting the United States coastal areas, NOS and USGS of the Department of the Interior formally agreed in 1975 to jointly produce a unique new series of maps that would portray both the land and ocean topography on a single map. These maps are called topographic/bathymetric maps, or as more commonly referred to, topo/bathy maps. This new series of maps combines NOS bathymetry and shoreline with existing 1:24,000-, 1:100,000-, and 1:250,000-scale topographic maps in the National Mapping Series produced by USGS.

Combining the bathymetry and topography on one map is cost effective in that only one product is required instead of the previous two. More important, users for the first time can visualize the transition from land to water, or vice-versa, and select the appropriate scale and detail desired for their planning, investigations, and studies. This new map series has been immensely helpful to the Federal, state, and private sector who use them for resource development, restoration of beach erosion, site selection for channels and dredging operations, landuse planning, establishing fishing and wildlife reserves, developing recreational areas, hurricane surge modeling, placement of offshore facilities, bay and estuarine studies, computing sediment transport benthic marine resource identification, water pollution investigation, coastal energy impact program studies, establishment of seaward coastal zone boundaries, site placement studies, coastal engineering studies, waste disposal site selection, locating potential ground water discharge, and recreational activities.

Compilation techniques for the preparation of the water portion of the topo/bathy manuscripts follow the same procedures used to produce the "all wet" bathymetric maps. Additional information, shoreline (mean high water line), and the mean low water line are also added to the manuscript prior to delivery of the manuscript to USGS. Both the shoreline and the mean low water line are compiled by NOS from tide-coordinated aerial photographs. The compilation procedures involve the development of a closer contour interval to accommodate the contour intervals carried on the 1:24,000- and 1:100,000-scale topo/bathy maps. Typically, a 1:24,000-scale topo/bathy map on the east coast carries a 1-meter contour interval supplemented by 1/2-meter contours where necessary to give a better definition of the bottom topography. The 1:100,000-scale topo/bathy map carries a 2-meter contour interval supplemented by a 1-meter contour line. While these contours may appear to be extremely close, for being generated
By hydrographic data, they are justified because most surveys used in compiling the 1:24,000- and 1:100,000-scale topo/bathy maps are 1:40,000 scale or larger. NOS surveys at these scale ranges normally have between 10,000 and 35,000 data points. This large amount of data allows the compiler to develop the closer contour intervals so the smaller underwater features can be portrayed on the large scale topo/bathy maps.

The land topography is portrayed in the same detail as the bathymetry, either in the standard line or orthophoto form. The standard line topographic maps at 1:24,000-scale are compiled or revised using photogrammetric methods supplemented by field data as necessary. In areas where orthophoto portrayal is considered the best means for showing the land relief and features, a photo image base is prepared from 1:80,000-scale aerial photographs and enhanced by overprinting photogrammetrically-derived land contours.

The land topography for the new 1:100,000- and 1:250,000-scale maps is generally derived by cartographic methods from the basic 1:24,000-scale maps. Since the land contours for the 1:24,000- and 1:250,000-scale topographic maps were previously compiled in feet, they are shown in these units on the topo/bathy series. On the all new 1:100,000-scale maps, both the land and bathymetric contours and elevations are shown in metric units, with the offshore lease blocks overprinted in red.

Since 1975, nearly 200 bathymetric manuscripts have been provided by NOS to USGS for publishing topo/bathy maps. To date, over 70 maps have been published. At present, NOS places approximately 60 new topo/bathy maps into production every year. The emphasis is toward completing coverage of the conterminous United States with 1:250,000- and 1:100,000-scale topo/bathy maps by the late 1980's. The 1:24,000-scale coverage will take considerably longer since these maps are produced only when coastal states identify a need for them and because it will require nearly 1,800 maps to cover the conterminous United States.

At present, published topo/bathy coverage exists at 1:250,000 scale for the east coast from New Jersey to Georgia, nearly all of the California coastline, and most of the coastal Gulf States. Coverage at 1:100,000 scale exists for most of South Carolina and a portion of Georgia and Virginia's eastern shore. The published 1:24,000-scale maps cover the entire coastline of the State of Georgia and portions of the States of Washington, Wisconsin, and Michigan.

Coastal regions covered by existing bathymetric manuscripts which have not yet been published include: 1:250,000--Texas, Louisiana, Florida, Georgia, North Carolina, Maryland, Virginia, New York, New Jersey, Massachusetts, Washington, and Alaska; 1:100,000--Washington, Orgeon, California, Texas, Louisiana, Alabama, Florida, Georgia, and Virginia; 1:24,000--Puget Sound, west coast of Florida, and the Chesapeake Bay (Potomac River, Maryland, and Virginia). Black and white copies of these manuscripts are made available, by NOS, to potential users having an immediate requirement for this information.

The current status of all bathymetric and topo/bathy maps is updated and published on a yearly basis by NOS through the publication of the "Bathymetric Maps and Special Purpose Charts," Map and Chart Catalog 5.

Conclusion

NOS and USGS foresee an urgent and growing need for seafloor topographic information. Both agencies are striving to meet today's demands for bathymetric and topo/bathy maps while preparing for tomorrow's challenges for more and better map products. A basic knowledge of the ocean environment remains an essential prerequisite toward any ocean-oriented endeavor.

It is hoped that these brief highlights will serve as a primer to examine some of the products discussed during this presentation. If you are already familiar with the products, NOS looks forward to hearing your comments on how these products may be improved to better serve the wide spectrum of users in the ocean community.