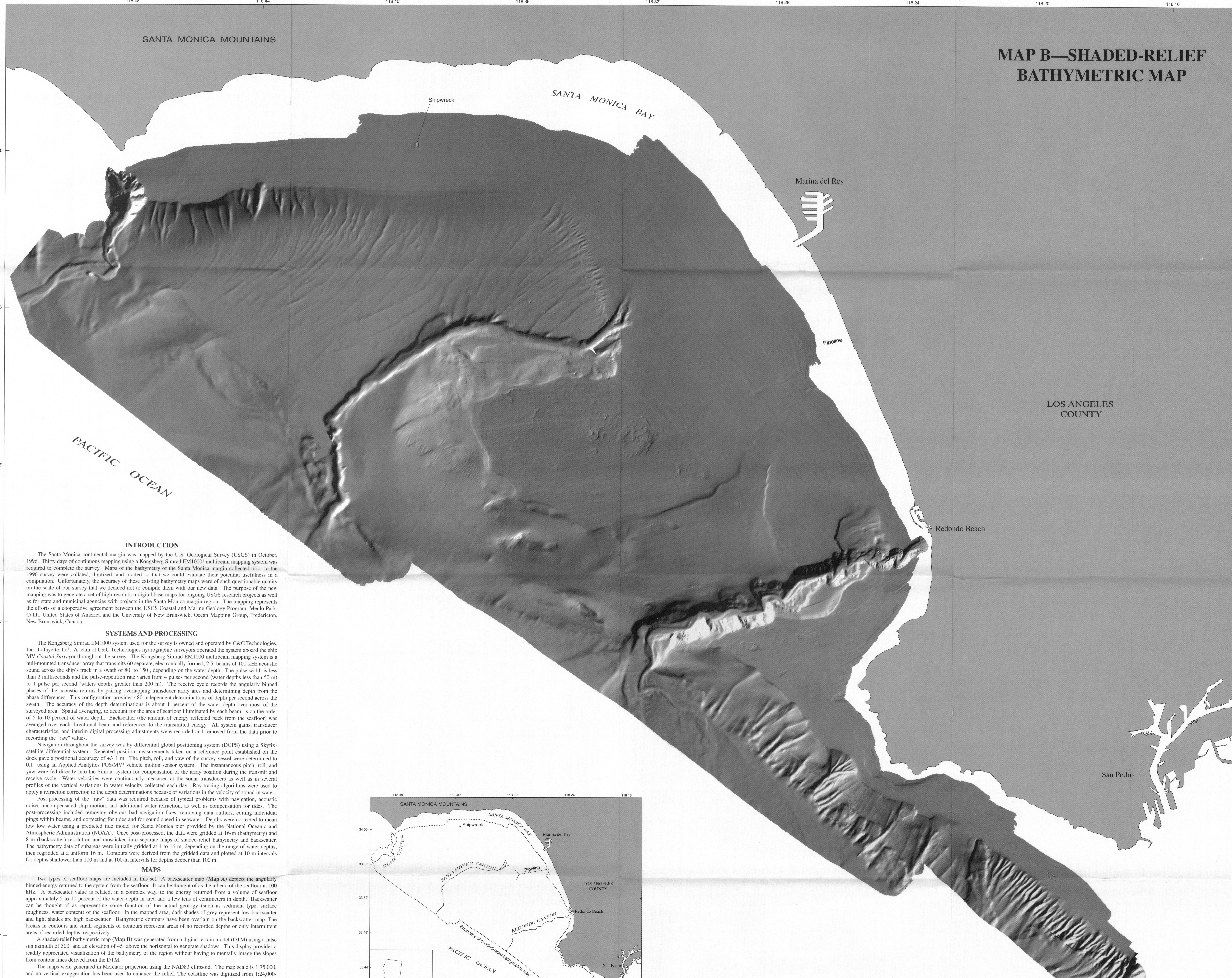
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
UNIVERSITY OF NEW BRUNSWICK

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2648 SHEET 2 OF 2

MAP B—SHADED-RELIEF BATHYMETRIC MAP



INTRODUCTION

The Santa Monica continental margin was mapped by the U.S. Geological Survey (USGS) in October, 1996. Thirty days of continuous mapping using a Kongsberg Simrad EM1000[1] multibeam mapping system was required to complete the survey. Maps of the bathymetry of the Santa Monica margin collected prior to the 1996 survey were collated, digitized, and plotted so that we could evaluate their potential usefulness in a compilation. Unfortunately, the accuracy of these existing bathymetry maps were of such questionable quality on the scale of our survey that we decided not to compile them with our new data. The purpose of the new mapping was to generate a set of high-resolution digital base maps for ongoing USGS research projects as well as for state and municipal agencies with projects in the Santa Monica margin region. The mapping represents the efforts of a cooperative agreement between the USGS Coastal and Marine Geology Program, Menlo Park, Calif., United States of America and the University of New Brunswick, Ocean Mapping Group, Fredericton, New Brunswick, Canada.

SYSTEMS AND PROCESSING

The Kongsberg Simrad EM1000 system used for the survey is owned and operated by C&C Technologies, Inc., Lafayette, La[1]. A team of C&C Technologies hydrographic surveyors operated the system aboard the ship MV *Coastal Survey*or throughout the survey. The Kongsberg Simrad EM1000 multibeam mapping system is a hull-mounted transducer array that transmits 60 separate, electronically formed, 2.5 beams of 100-kHz acoustic sound across the ship's track in a swath of 80 to 150 , depending on the water depth. The pulse width is less than 2 milliseconds and the pulse-repetition rate varies from 4 pulses per second (water depths less than 50 m) to 1 pulse per second (waters depths greater than 200 m). The receive cycle records the angularly binned phases of the acoustic returns by pairing overlapping transducer array arcs and determining depth from the phase differences. This configuration provides 480 independent determinations of depth per second across the swath. The accuracy of the depth determinations is about 1 percent of the water depth over most of the surveyed area. Spatial averaging, to account for the area of seafloor illuminated by each beam, is on the order of 5 to 10 percent of water depth. Backscatter (the amount of energy reflected back from the seafloor) was averaged over each directional beam and referenced to the transmitted energy. All system gains, transducer characteristics, and interim digital processing adjustments were recorded and removed from the data prior to recording the "raw" values.

Navigation throughout the survey was by differential global positioning system (DGPS) using a Skyfix[1] satellite differential system. Repeated position measurements taken on a reference point established on the dock gave a positional accuracy of +/- 1 m. The pitch, roll, and yaw of the survey vessel were determined to 0.1 using an Applied Analytics POS/MV[1] vehicle motion sensor system. The instantaneous pitch, roll, and yaw were fed directly into the Simrad system for compensation of the array position during the transmit and receive cycle. Water velocities were continuously measured at the sonar transducers as well as in several profiles of the vertical variations in water velocity collected each day. Ray-tracing algorithms were used to apply a refraction correction to the depth determinations because of variations in the velocity of sound in water.

Post-processing of the "raw" data was required because of typical problems with navigation, acoustic noise, uncompensated ship motion, and additional water refraction, as well as compensation for tides. The post-processing included removing obvious bad navigation fixes, removing data outliers, editing individual pings within beams, and correcting for tides and for sound speed in seawater. Depths were corrected to mean low low water using a predicted tide model for Santa Monica pier provided by the National Oceanic and Atmospheric Administration (NOAA). Once post-processed, the data were gridded at 16-m (bathymetry) and 8-m (backscatter) resolution and mosaicked into separate maps of shaded-relief bathymetry and backscatter. The bathymetry data of subareas were initially gridded at 4 to 16 m, depending on the range of water depths, then regridded at a uniform 16 m. Contours were derived from the gridded data and plotted at 10-m intervals for depths shallower than 100 m and at 100-m intervals for depths deeper than 100 m.

MAPS

Two types of seafloor maps are included in this set. A backscatter map **(Map A)** depicts the angularly binned energy returned to the system from the seafloor. It can be thought of as the albedo of the seafloor at 100 kHz. A backscatter value is related, in a complex way, to the energy returned from a volume of seafloor approximately 5 to 10 percent of the water depth in area and a few tens of centimeters in depth. Backscatter can be thought of as representing some function of the actual geology (such as sediment type, surface roughness, water content) of the seafloor. In the mapped area, dark shades of grey represent low backscatter and light shades are high backscatter. Bathymetric contours have been overlain on the backscatter map. The breaks in contours and small segments of contours represent areas of no recorded depths or only intermittent areas of recorded depths, respectively.

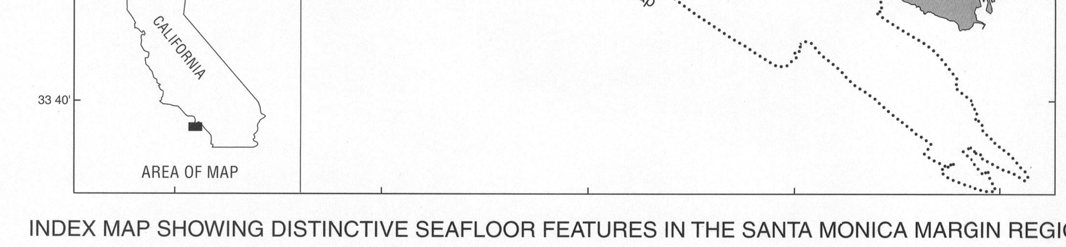
A shaded-relief bathymetric map **(Map B)** was generated from a digital terrain model (DTM) using a false sun azimuth of 300 and an elevation of 45 above the horizontal to generate shadows. This display provides a readily appreciated visualization of the bathymetry of the region without having to mentally image the slopes from contour lines derived from the DTM.

The maps were generated in Mercator projection using the NAD83 ellipsoid. The map scale is 1:75,000, and no vertical exaggeration has been used to enhance the relief. The coastline was digitized from 1:24,000-scale topo sheets by the California State Lands Commission. For more information on mapping of the Santa Monica Continental Shelf, visit the website (http://walrus.wr.usgs.gov/pacmaps/).

ACKNOWLEDGMENTS

We thank Art Kleiner (C&C Technologies, Inc.) for his diligence as Party Chief of the cruise.

[1] Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.



INDEX MAP SHOWING DISTINCTIVE SEAFLOOR FEATURES IN THE SANTA MONICA MARGIN REGION

Mercator Projection
NAD83 Ellipsoid

NOTE: THIS MAP IS NOT INTENDED FOR NAVIGATION

SCALE 1:75,000

1 0 1 2 3 4 5 KILOMETERS

1 0 1 2 3 4 5 MILES

CONTOUR INTERVAL VARIES WITH DEPTH; 100 METERS AND 10 METERS

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SHADED-RELIEF BATHYMETRIC AND BACKSCATTER MAPS OF SANTA MONICA MARGIN, CALIFORNIA

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1999

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