

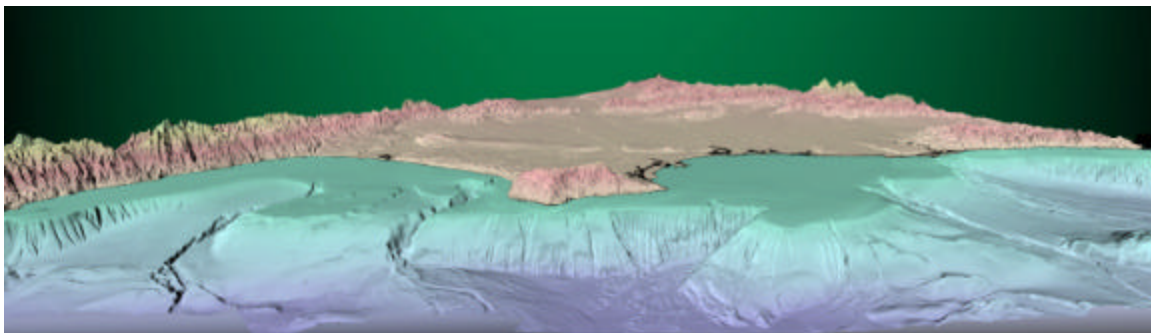
Mapping a continental shelf and slope in the 1990s: A tale of three multibeam

James V. Gardner, US Geological Survey, Menlo Park, CA, USA,
John E. Hughes Clarke and Larry A. Mayer, Univ. of New Brunswick, Fredericton, NB, Canada,
Art Kleiner, C&C Technologies, Inc, Lafayette, LA, and
Mark Paton, Interactive Visualization Systems, Fredericton, NB, Canada

ABSTRACT

Increasing societal pressures on the U.S. continental shelves adjacent to dense population centers have brought to light the lack of accurate base maps in these areas. Existing bathymetric maps and random sidescan sonar surveys are either not accurate enough or do not provide the coverage necessary to make policy decisions. Until the mid 1990s, it was not financially prudent nor technically efficient to map the shallow shelves. However, the availability of high-resolution multibeam mapping systems now allow efficient and accurate mapping of the continental margins. In 1996 the U.S. Geological Survey began a large-scale seafloor mapping campaign on the continental shelf and slope adjacent to Los Angeles, CA. The first survey used a Kongsberg Simrad EM1000 (95 kHz). The survey continued in 1998 by mapping the slope and proximal basins from Newport to Long Beach, CA, using a Kongsberg Simrad EM300 (30 kHz). The area was completed in May 1999 by mapping the entire shelf adjacent to Long Beach, CA using an EM3000D (a dual-headed 300-kHz system). The mapping used both INS from the vehicle motion sensor and DGPS to provide position accuracies of ~1 m. All the data were processed in the field in near realtime using software developed at the Univ. of New Brunswick. Because of the different systems used and the range of water depths, the spatial resolution of the processed data varies from <0.5 m on the inner shelf to 8 m on the basin floors.

Perspective overviews of backscatter draped over bathymetry reveals a host of geological features unknown to exist in this area. These features include shallow, linear gullies, barchan dunes, small-scale bedforms in shallow troughs, major canyon system complexes, large- and small-scale mass movements, faults, and large areas of outcrop. The effects on sediment transport of man-made features, such as sewer outfall pipes and dredge-disposal fields, are clearly delineated on the new maps. The maps provide the fundamental base maps for studies as varied as those involving benthic habitats, marine disposal sites, sediment transport, and tectonic map



INTRODUCTION

In the 1980s, the US Geological Survey ran a 10-year program to map the US Exclusive Economic Zone deeper than 100 m with the only cost-efficient technology available at that time...a long-range sidescan sonar. This technology provided a method of rapidly mapping the vast deep-water EEZ but only provided sidescan images and left the continental shelves unmapped because of the inefficiency of the technology. However, by the mid 1990s, high-resolution multibeam systems became available making it possible to finally begin systematically mapping the bathymetry and acoustic backscatter of continental shelves and margins. Highly accurate maps of the continental shelves and margins are becoming increasingly necessary because it is these regions, not the deep sea, that are the regions being most utilized and impacted by society...from fishing, waste outfalls, dumping grounds, telecommunications cables, and routes for ever-increasing shipping. The mapping of benthic habitats is presently a very hot topic within the US Government because of the pressure being put on commercial fisheries. A recent law enacted by Congress requires the determination of commercial fish stocks and the restoration of those stocks back to 1970 levels. Fundamental to this process is the identification and mapping of identifiable benthic habitats. Another example of the need for shelf mapping is the establishment of Marine Sanctuaries around the US. Once established, the Sanctuaries Act requires a census of what is contained within the Sanctuaries, yet even something as fundamental as the bathymetry of the sanctuaries is not well known.

In 1996 the USGS began a program to systematically map the US continental shelves and margins using state-of-the-art high-resolution multibeam systems. Let me emphasize that the objective of this program is to generate highly accurate base maps for a wide variety of studies, NOT to generate nautical charts....that's the charter of NOAA. To ensure that we were kept abreast of, and would use, the latest technology, we formed a formal Cooperative Agreement with the Ocean Mapping Group of the Univ. of New Brunswick, Canada.

In addition to the high-resolution bathymetry required for the base maps, we were especially interested in obtaining high-quality coregistered backscatter data. We quickly realized that multibeam systems are still evolving, that there was not one unique multibeam system that could meet our overall mapping needs, so to guarantee highly accurate maps using the appropriate system, we were best served by contracting with commercial marine surveying companies.

The Pacific phase of this new mapping program started in the Southern California Bight area off Los Angeles, one of the most impacted areas of the US. The first survey in 1996 was designed to map Santa Monica Bay from the inner shelf from the 20-m isobath to the base of the slope at about 800 m. This large depth range required a multibeam system with a frequency around 100 kHz. After reviewing the available systems, we determined that the Kongsberg Simrad EM1000 system best met our needs.

The second survey was in 1998 and was designed to map the continental slope from the shelf break to the basin in the region adjacent to and south of Long Beach, CA. We opted to use a Kongsberg Simrad EM300 for this mapping after our success with this system in the Gulf of Mexico and Hawaii.

The third mapping was designed to complete the regional coverage of the Los Angeles area by mapping the shelf adjacent to Long Beach, but we needed to map to the 5-m isobath. We chose a Kongsberg Simrad EM3000D, a dual configuration of two EM3000s for this mapping..

Navigation for all three mapping campaigns utilized both INS from the vehicle motion sensor and DGPS to provide position accuracies of ~1 m. All the data were processed in the field in near realtime using software developed by the Ocean Mapping Group, Univ. of New Brunswick.

Perspective overviews of backscatter draped over bathymetry reveals a host of geological features unknown to exist in this area. These features include shallow, linear gullies, barchan dunes, small-scale bedforms in shallow troughs, major canyon system complexes, large- and small-scale mass movements, faults, and large areas of outcrop. The effects on sediment transport of man-made features, such as sewer outfall pipes and dredge-disposal fields, are clearly delineated on the new maps. The base maps have proved to be extremely useful to a host of Federal and State agencies for studies as varied as those involving benthic habitats, marine disposal sites, sediment transport, and tectonic mapping.