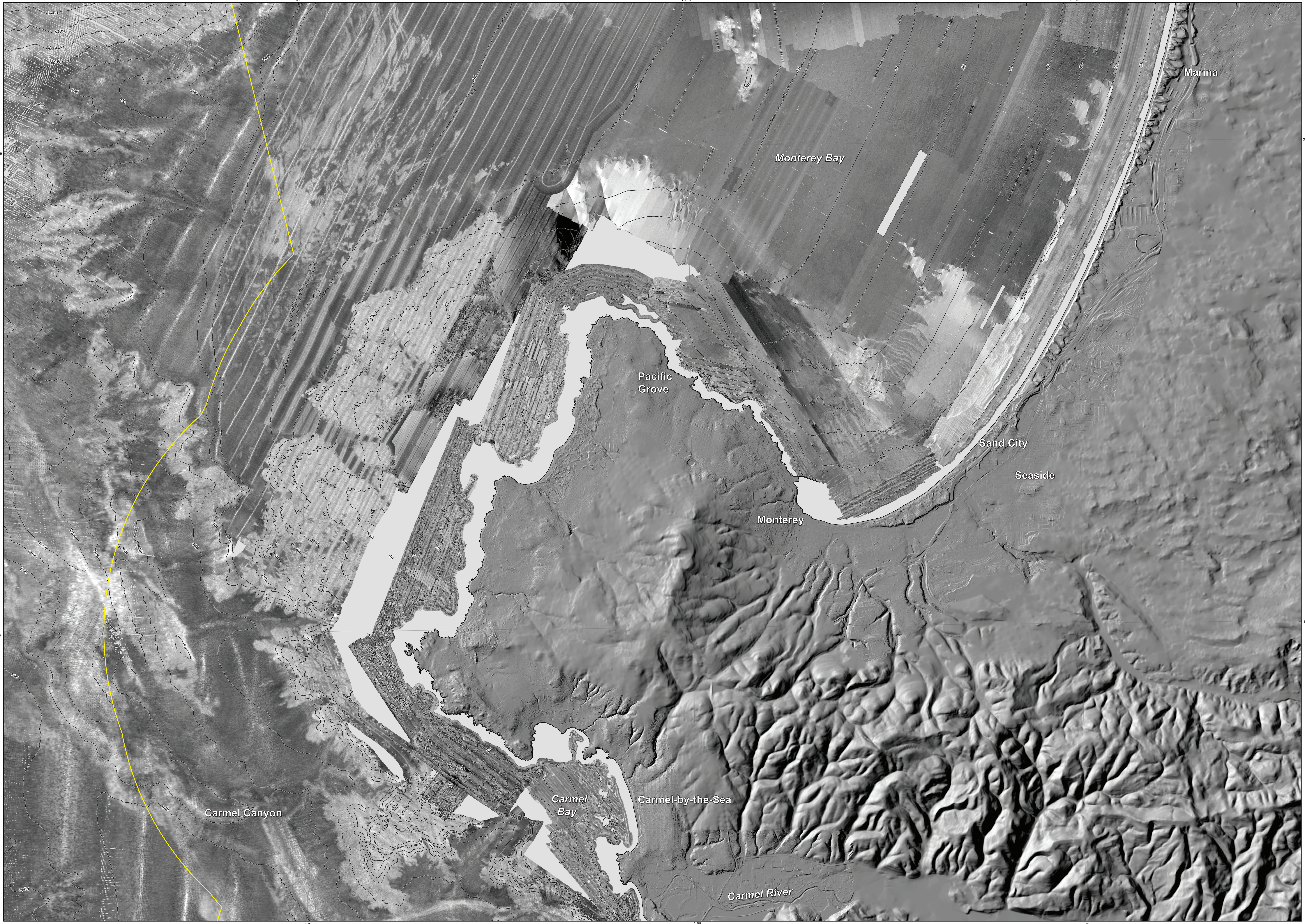
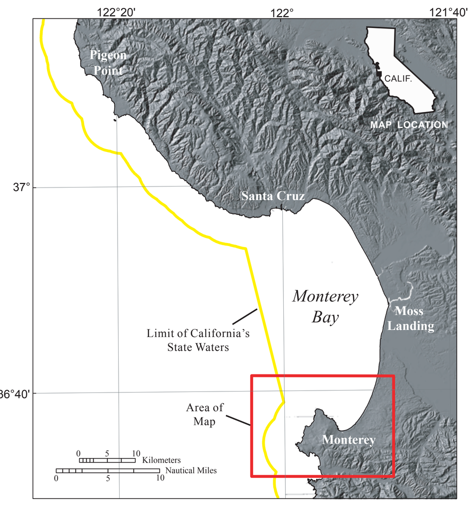
U.S. Department of the Interior
U.S. Geological Survey

Open-File Report 2016–1110
Sheet 3 of 10
Pamphlet accompanies map





DISCUSSION

This acoustic-backscatter map of the Offshore of Monterey map area in central California was generated from acoustic-backscatter data collected by California State University, Monterey Bay (CSUMB), and by Monterey Bay Aquarium Research Institute (MBARI) (fig. 1). Mapping was completed between 1998 and 2012, using a combination of 200-kHz/400-kHz Reson 7125, 240 kHz Reson 8101, and 30-kHz Simrad EM-300 multibeam echosounders, as well as 234-kHz and 468-kHz SWATHplus bathymetric sidescan-sonar systems. These mapping missions combined to collect acoustic-backscatter data from about the 10-m isobath to beyond the limit of California's State Waters (note that the California's State Waters limit, which generally is 3 nautical miles from shore, extends farther offshore between Santa Cruz and Monterey, so that it encompasses all of Monterey Bay).

During the CSUMB mapping missions between 2000 and 2012, either an Applanix POS MV (Position and Orientation System for Marine Vessels) or a Teledyne TSS HDMS (Hydrographic Data Maintenance System) was used to accurately position the vessels during data collection, and they also accounted for vessel motion such as heave, pitch, and roll, with navigational input from Trimble 4700 GPS or CNAV®-enabled NavCon 2050 GPS receivers. Kinetic GPS (KGPS) altitude data were used to account for tide-cycle fluctuations and sound velocity profiles were collected with an Applied Microsystems (AM) SVPlus sound velocimeter. Soundings were corrected for vessel motion using the Applanix POS MV or Teledyne TSS HDMS data, for variations in water-column sound velocity using the AM SVPlus data, and for variations in water height (tides) using vertical-position data from postprocessed GPS data (California State University, Monterey Bay, Seafloor Mapping Lab, 2015).

The Reson backscatter data were postprocessed using a variety of methods, which include Geocoder, Isis Sonar, Delph Map, and TNT Mips geographic information system (GIS) software. For the data postprocessed using Geocoder, the backscatter intensities were radiometrically corrected (including despeckling and angle-varying gain adjustments), and the position of each acoustic sample was geometrically corrected for slant range on a line-by-line basis. After the lines were corrected, they were mosaicked into 1- or 2-m-resolution images. Overlap between parallel lines was resolved using a priority table whose values were based on the distance of each sample from the ship track, with the samples that were closest to and furthest from the ship track being given the lowest priority. An anti-aliasing algorithm was also applied. The mosaics were then exported as georeferenced TIFF images, imported into a GIS, and converted to GRIDs at 2-m resolution (California State University, Monterey Bay, Seafloor Mapping Lab, 2015).

For the backscatter data postprocessed using the Isis Sonar, Delph Map, and TNT Mips methods, individual tracklines were replayed, and the bottom tracking of the sonar was supervised to aid in proper slant-range correction. Line files were snipped to remove parts that have poor imagery from the beginning and (or) end of the tracklines. Tracklines then were corrected for slant range and layback, and the position data for each line was smoothed using a speed filter. Each line was then gridded, georeferenced, and exported from Isis Sonar or Delph Map in GeoTIFF format. Individual trackline TIFF images were imported into TNT Mips GIS software, and areas of poor image quality were extracted and removed. Individual tracklines were then overlaid to produce a mosaic image. GeoTIFFs were exported from TNT Mips, imported into a GIS, and converted to GRIDs at 2-m spatial resolution (California State University, Monterey Bay, Seafloor Mapping Lab, 2015).

The SWATHPlus backscatter data were postprocessed using USGS software (D.P. Finlayson, written commun., 2011) that normalizes for time-varying signal loss and beam directivity differences. Thus, the raw 16-bit backscatter data were gain-normalized to enhance the backscatter of the SWATHplus system. The resulting normalized-amplitude values were rescaled to 16-bit and gridded into GeoJPEGs using GRID Processor Software, then imported into a GIS and converted to GRIDS (California State University, Monterey Bay, Seafloor Mapping Lab, 2015).

During the MBARI mapping mission in 1998, an Applied Analytic POS MV was used to accurately position the vessel during data collection, and it also accounted for vessel motion with navigational input from a kinematic differential GPS (DGPS) system. Soundings were corrected for variations in water-column sound velocity using data from SeaBird CTD and Sippican T5 expendable bathythermographs. The USGS downloaded the original MBARI survey line files from the National Centers for Environmental Information's online bathymetry server (National Centers for Environmental Information, 2015). Using MB-Systems, bathymetry and amplitude values were extracted from the line files and exported as bathymetry and amplitude XYZ files.

The acoustic-backscatter imagery from each different mapping system and processing method were merged into their own individual grids. These individual grids, which cover different areas, were displayed in a GIS to create this map, on which brighter tones indicate higher backscatter intensity, and darker tones indicate lower backscatter intensity. The intensity represents a complex interaction between the acoustic pulse and the seafloor, as well as characteristics within the shallow subsurface, providing an indication of seafloor texture and composition. Backscatter intensity depends on the acoustic source level; the frequency used to image the seafloor; the grazing angle; the composition and character of the seafloor, including grain size, water content, bulk density, and seafloor roughness; and some biological cover. Harder and rougher bottom types such as rocky outcrops or coarse sediment typically return stronger intensities (high backscatter, lighter tones), whereas softer bottom types such as fine sediment return weaker intensities (low backscatter, darker tones). Note that the differences in backscatter intensity that are apparent in some parts of the map area are due to the different frequencies of the mapping systems, as well as to different processing techniques. Parallel lines of higher backscatter intensity throughout the map area are data-collection and -processing artifacts.

Bathymetric contours were generated from merged 2- and 5-m-resolution bathymetric surfaces. Contours were generated at 10-m intervals for water depths shallower than 100 m, at 50-m intervals for water depths between 100 and 200 m, and at 200-m intervals for water depths deeper than 200 m. The most continuous contour segments were preserved; smaller segments and isolated island polygons were excluded from the final output. Contours were smoothed using a polynomial approximation with exponential kernel algorithm and a tolerance value of 60 m. The contours were then clipped to the boundary of the map area.

The onshore-area image was generated by applying an illumination having an azimuth of 300° and from 45° above the horizon to 2-m-resolution topographic-lidar data from National Oceanic and Atmospheric Administration Office for Coastal Management's Digital Coast (available at http://www.csc.noaa.gov/digitalcoast/data/coastallidar/) and to 10-m-resolution topographic-lidar data from the U.S. Geological Survey's National Elevation Dataset (available at http://ned.usgs.gov/).

REFERENCES CITED

California State University, Monterey Bay, Seafloor Mapping Lab, 2015, Monterey Bay data: California State University, Monterey Bay, Seafloor Mapping Lab Data Library, accessed October 2015 at http://seafloor.otterlabs.org/SFMLwebDATA_SURVEYMAP.htm.

National Centers for Environmental Information, 2015, Bathymetric data viewer: National Oceanic and Atmospheric Administration, National Centers for Environmental Information (formerly National Geophysical Data Center), Bathymetric data viewer and database, accessed October 10, 2015, at http://www.ngdc.noaa.gov/maps/bathymetry/.

EXPLANATION

Backscatter intensity
High
Low

Area of "no data"—Areas near shoreline not mapped owing to insufficient high-resolution seafloor mapping data or gaps in data collection

Limit of California's State Waters

20 **Bathymetric contour (in meters)**—Derived from modified 2- and 5-m-resolution bathymetry grids. Contour intervals: 1–100 m water depth, 10 m; 100–200 m water depth, 50 m; >200 m water depth, 200 m

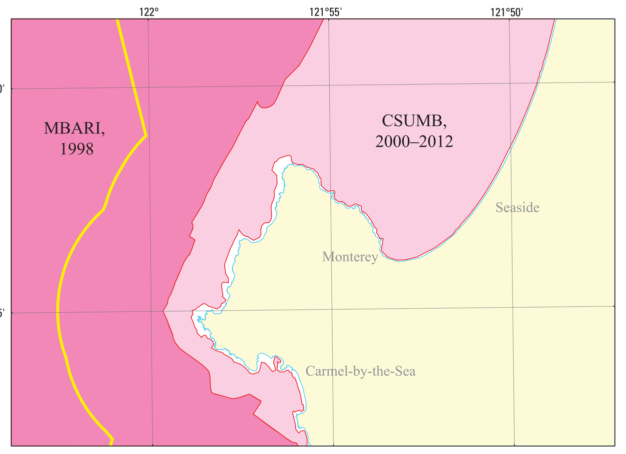


Figure 1. Map showing areas of multibeam-echosounder and bathymetric-sidescan surveys (pink shading), as well as onshore topographic-lidar surveys (yellow shading). Also shown are data-collecting agencies (CSUMB, California State University, Monterey Bay, Seafloor Mapping Lab; MBARI, Monterey Bay Aquarium Research Institute) and dates of surveys if known. Yellow line shows limit of California's State Waters.

Onshore elevation data from National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management's Digital Coast (available at http://www.csc.noaa.gov/digitalcoast/data/coastallidar/) and from U.S. Geological Survey's National Elevation Dataset (available at http://ned.usgs.gov/). California's State Waters limit from NOAA Office of Coast Survey

Universal Transverse Mercator projection, Zone 10N

NOT INTENDED FOR NAVIGATIONAL USE

APPROXIMATE MEAN DECLINATION, 2016

SCALE 1:24 000

BATHYMETRIC CONTOUR INTERVALS 10 METERS, 50 METERS, AND 200 METERS

ONE MILE = 0.869 NAUTICAL MILES

MAP LOCATION

Acoustic-backscatter imagery by Peter Dartnell, 2015 (data collected by California State University, Monterey Bay, Seafloor Mapping Lab between 2000 and 2012 and by Monterey Bay Aquarium Research Institute in 1998). Bathymetric contours by Peter Dartnell, 2015

GIS database and digital cartography by Nadine E. Golden

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Acoustic Backscatter, Offshore of Monterey Map Area, California

By

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2016

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For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225, 1–888–ASK–USGS

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