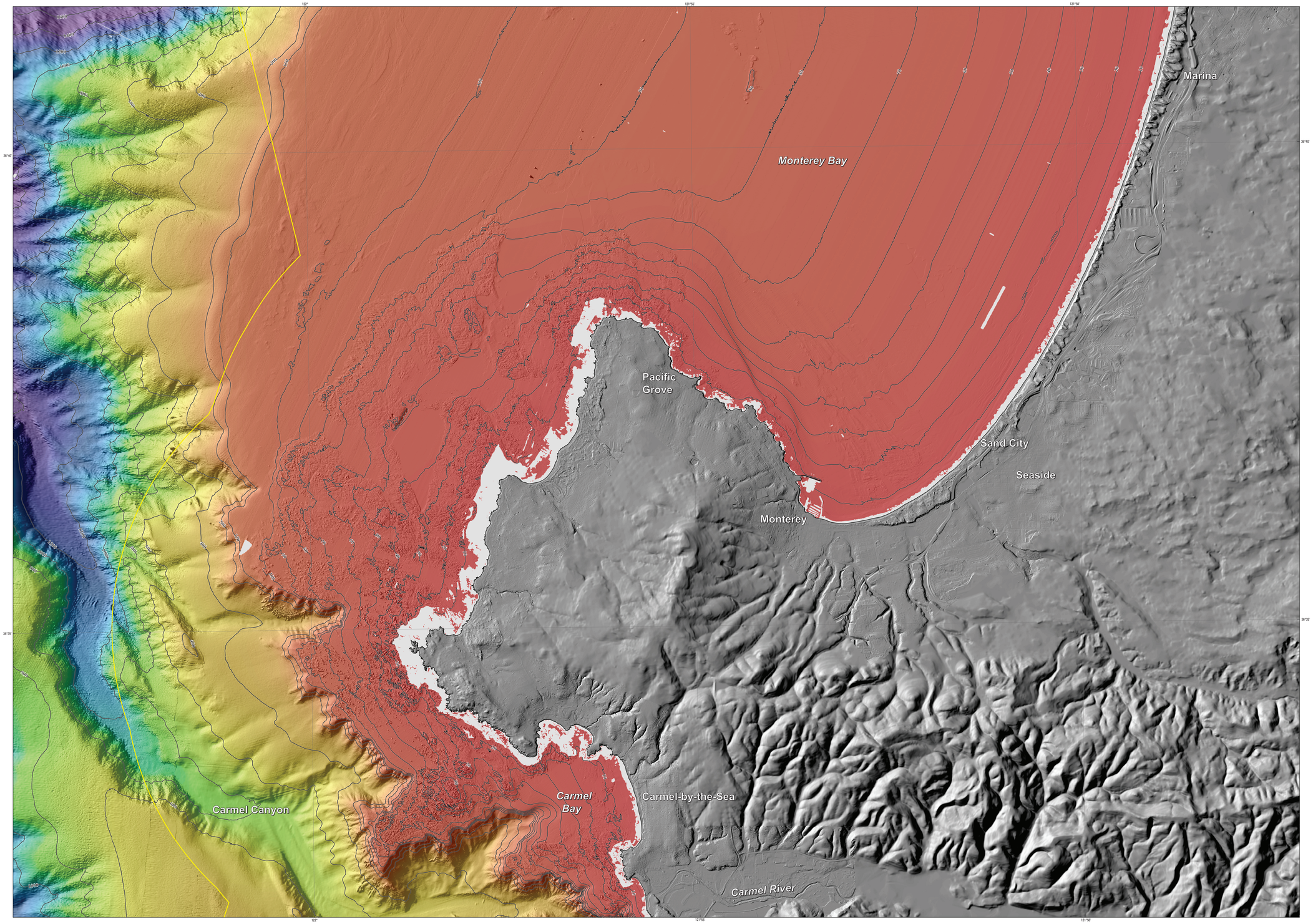
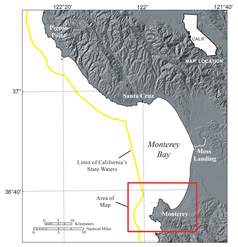
U.S. Department of the Interior
U.S. Geological Survey

Open-File Report 2016–1110
Sheet 1 of 10
Pamphlet accompanies map





DISCUSSION

This colored shaded-relief bathymetry map of the Offshore of Monterey map area in central California was generated from acoustic-bathymetry data collected by California State University, Monterey Bay (CSUMB), and by Monterey Bay Aquarium Research Institute (MBARI), as well as from bathymetric-lidar data collected by the U.S. Army Corps of Engineers Joint Airborne Lidar Bathymetry Technical Center of Expertise. Acoustic 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. Bathymetric-lidar mapping was completed in 2009 and 2010 for the California Coastal Mapping Project. These mapping missions combined to collect bathymetry data from the shoreline 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 (KiGPS) 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).

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) and processed them using MB-Systems.

Nearshore bathymetric-lidar data and acoustic-bathymetric data from within California's State Waters were merged together as part of the 2013 National Oceanic and Atmospheric Administration (NOAA) Coastal California TopoBathy Merge Project (National Oceanic and Atmospheric Administration, 2013). Merged bathymetry data from within the Offshore of Monterey map area were downloaded from this dataset and resampled to 2-m spatial resolution, then the deeper MBARI, 5-m-resolution bathymetric data outside of California's State Waters were added. An illumination having an azimuth of 300° and from 45° above the horizon was then applied to the bathymetric surfaces to create the shaded-relief imagery. In addition, a "rainbow" color ramp was applied to the bathymetry data, using reds to represent shallower depths, and purples to represent greater depths. This colored bathymetry surface was draped over the shaded-relief imagery at 60-percent transparency to create this colored shaded-relief map. Note that the ripple patterns and parallel lines that are apparent within the map area are data-collection and -processing artifacts. These various artifacts are made obvious by the hillshading process.

Bathymetric contours were generated from the 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 the same illumination (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/SFML/webDATA_SURVEYMAP.htm.

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EXPLANATION

Depth (in meters) and illumination (bright areas are illuminated, facing false sun; dark areas are in shadow, facing away from false sun)

Direction of illumination from false sun—Position of false sun is at 300° azimuth, 45° above horizon [arrow included in explanation for illustration purposes only; not shown on map]

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

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

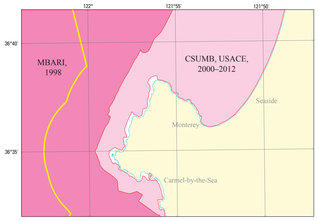

Figure 1. Map showing areas of multibeam-echosounder, bathymetric-sidescan, and bathymetric-lidar surveys (pink shading), as well as onshore topographic-lidar surveys (yellow shading). Also shown are data-collecting agencies (CSUMB, California State University, Monterey Bay, Seafloor Mapping Lab; MBARI, Monterey Bay Aquarium Research Institute; USACE, U.S. Army Corps of Engineers) 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

1 MILE
1 KILOMETER

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

ONE MILE = 0.869 NAUTICAL MILES

MAP LOCATION

Shaded-relief bathymetry by Peter Dartnell, 2015 (data collected by California State University, Monterey Bay, Seafloor Mapping Lab between 2000 and 2012, by Monterey Bay Aquarium Research Institute in 1998, and by U.S. Army Corps of Engineers in 2009 and 2010). Bathymetric contours by Peter Dartnell, 2015

GIS database and digital cartography by Nadine E. Golden

Manuscript approved for publication June 27, 2016

Colored Shaded-Relief Bathymetry, Offshore of Monterey Map Area, California

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2016

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Digital files available at http://dx.doi.org/10.3133/ofr20161110

Suggested Citation: Dartnell, P., and Kvitek, R.G., 2016, Colored shaded-relief bathymetry, Offshore of Monterey map area, California: U.S. Geological Survey Open-File Report 2016–1110, 1 sheet, 2 pamphlet pages, scale 1:24,000. [Also in Dieter, B.E., Chezar, H., Ohlsen, D.J., Rosenberger, K.J., Hart, P.E., Kvitek, R.G., Johnson, L.M., Silber, R.W., and Maier, K.L., 55 Johnson and E.A. Cochran, eds.), California State Waters Map Series—Offshore of Monterey, California: U.S. Geological Survey Open-File Report 2016–1110, pamphlet 44 p., 10 sheets, scale 1:24,000, http://dx.doi.org/10.3133/ofr20161110].

ISSN 2331-1258 (online)
http://dx.doi.org/10.3133/ofr20161110