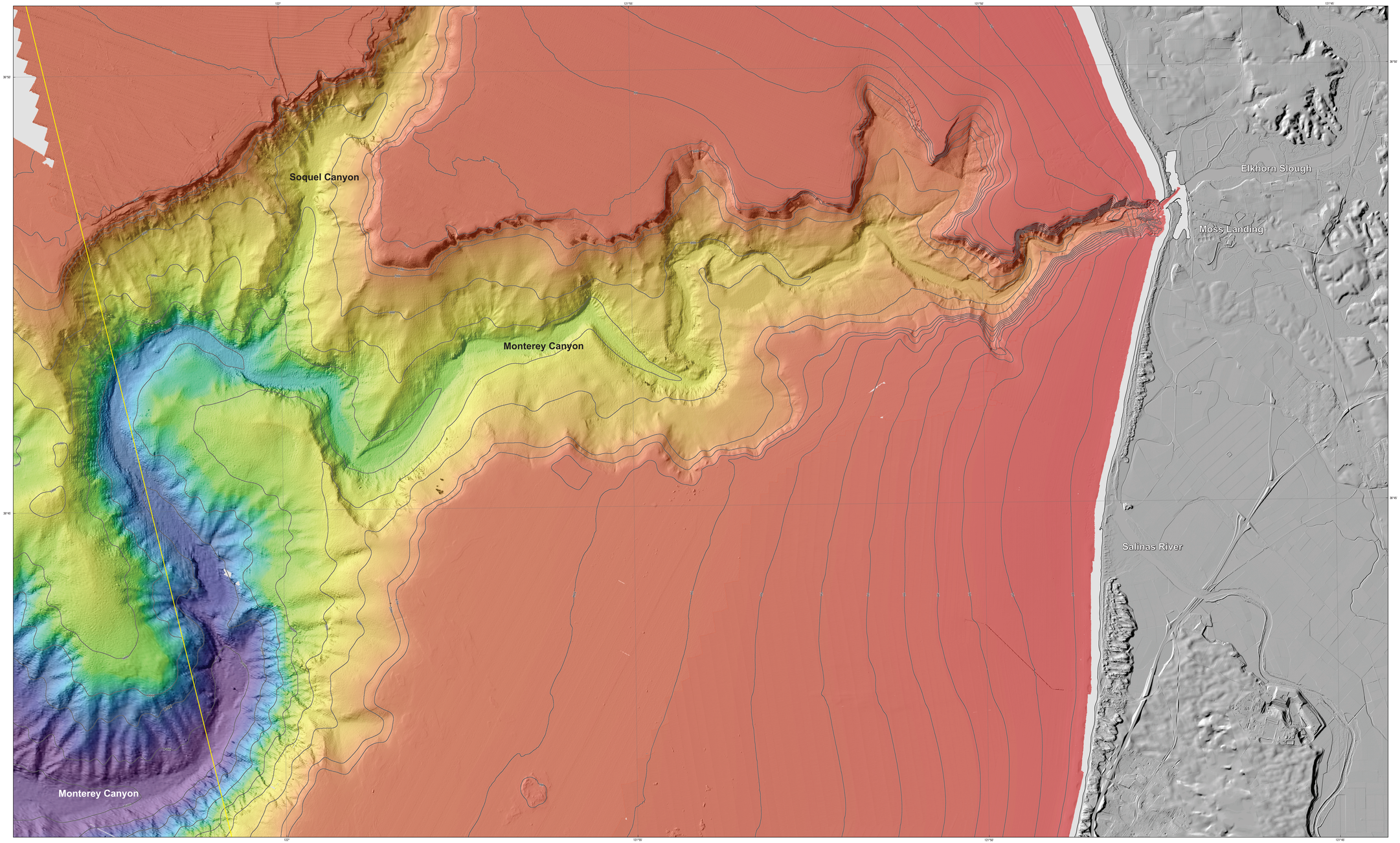
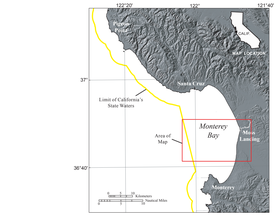
U.S. Department of the Interior
U.S. Geological Survey

Open-File Report 2016–1072
Sheet 1 of 10
Pamphlet accompanies map





DISCUSSION

This colored shaded-relief bathymetry map of the Monterey Canyon and Vicinity map area in central California was generated from bathymetry data collected by California State University, Monterey Bay (CSUMB), Monterey Bay Aquarium Research Institute (MBARI), and the U.S. Geological Survey (USGS) (fig. 1). Mapping was completed between 1998 and 2014, using a combination of 30-kHz Simrad EM-300 and 200-kHz/400-kHz Reson 7125 multibeam echosounders, as well as 234-kHz and 468-kHz SEA SWATHplus phase-differencing sidescan sonars. These mapping missions combined to collect bathymetry 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 MBARI mapping mission in 1998, an Applied Analytic POS MV (Position and Orientation System for Marine Vessels) was used to accurately position the vessel during data collection, and it also accounted for vessel motion with navigational input from a kinematic differential global positioning system (DGPS) system. Soundings were corrected for variations in water-column sound velocity using data from SeaBird CTD (conductivity, temperature, and depth) and Sippican T5 expendable bathythermographs. The USGS downloaded the original MBARI survey line files from the National Centers for Environmental Information online bathymetry server (National Centers for Environmental Information, 2015) and processed them using MB-Systems.

During the CSUMB mapping missions in 2008 and 2009, an Applanix POS MV was used to accurately position the vessels during data collection, and it also accounted for vessel motion such as heave, pitch, and roll (position accuracy, ±2 m; pitch, roll, and heading accuracy, ±0.02°; heave accuracy, ±5%, or 5 cm), with input from a NavCom 2050 GPS receiver (CNAV). Kinetic GPS (KGPS) altitude data were used to account for tide-cycle fluctuations, and sound-velocity profiles were collected with an Applied Microsystems SVPlus sound velocimeter. Soundings were corrected for vessel motion using the Applanix POS MV 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 the GPS receivers.

During the USGS mapping missions in 2009 and 2014, GPS data with real-time-kinematic corrections were combined with measurements of vessel motion (heave, pitch, and roll) in a CodaOctopus F180 attitude-and-position system (2009) and an Applanix POS MV (2014) to produce a high-precision vessel-attitude packet. This packet was transmitted to the acquisition software in real time and combined with instantaneous sound-velocity measurements at the transducer head before each ping. The returned samples were projected to the seafloor using a ray-tracing algorithm that works with previously measured sound-velocity profiles. Statistical filters were applied to discriminate seafloor returns (soundings) from unintended targets in the water column (Ritchie and others, 2010). Further sounding cleaning was completed in Caris HIPS and SIPS software.

Processed soundings from the different mapping missions were exported from the acquisition or processing software as XYZ files and bathymetric-surface models. Individual bathymetric-surface models that had similar spatial resolutions were then merged together and clipped to the boundary of the map area. The shallower USGS and CSUMB bathymetric-surface model has a spatial resolution of 2 m, whereas the deeper MBARI surface model has a 5-m resolution. 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 straight 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 modified 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 in water depths deeper than 200 m. The original surfaces were smoothed using the Focal Mean tool in ArcGIS and a circular neighborhood that has a radius of between 20 and 30 m (depending on the area). The contours were generated from these smoothed surfaces using the Spatial Analyst Contour tool in ArcGIS. The most continuous contour segments were preserved; smaller segments and isolated island polygons were excluded from the final output. 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 (NOAA) 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

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

Ritchie, A.C., Finlayson, D.P., and Logan, J.B., 2010, Swath bathymetry surveys of the Monterey Bay area from Point Año Nuevo to Moss Landing, San Mateo, Santa Cruz, and Monterey Counties, California: U.S. Geological Survey Data Series 514, available at http://pubs.usgs.gov/ds/514/.

EXPLANATION

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

Shallow
250
500
750
1000
1250
1500
1750
Deep

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; areas beyond limit of California's State Waters were not mapped as part of California Seafloor Mapping Program

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

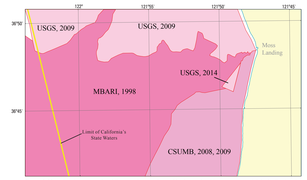


Figure 1. Map showing areas of multibeam echosounder and bathymetric-sidescan surveys (pink shading) and onshore topographic-lidar surveys (yellow shading). Also shown are data-collecting agencies (CSUMB, California State University, Monterey Bay, Seafloor Mapping Lab; MBARI, Monterey Bay Aquarium Research Institute; USGS, U.S. Geological Survey) 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 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0 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, 2014 (data collected by California State University, Monterey Bay, Seafloor Mapping Lab in 2008 and 2009, Monterey Bay Aquarium Research Institute in 1998, and U.S. Geological Survey in 2009 and 2014); Bathymetric contours by Mercedes D. Erdey, 2014

GIS database and digital cartography by Nadine E. Golden

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Colored Shaded-Relief Bathymetry, Monterey Canyon and Vicinity Map Area, California

By

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2016

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Digital files available at http://dx.doi.org/10.3133/ofr20161072

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