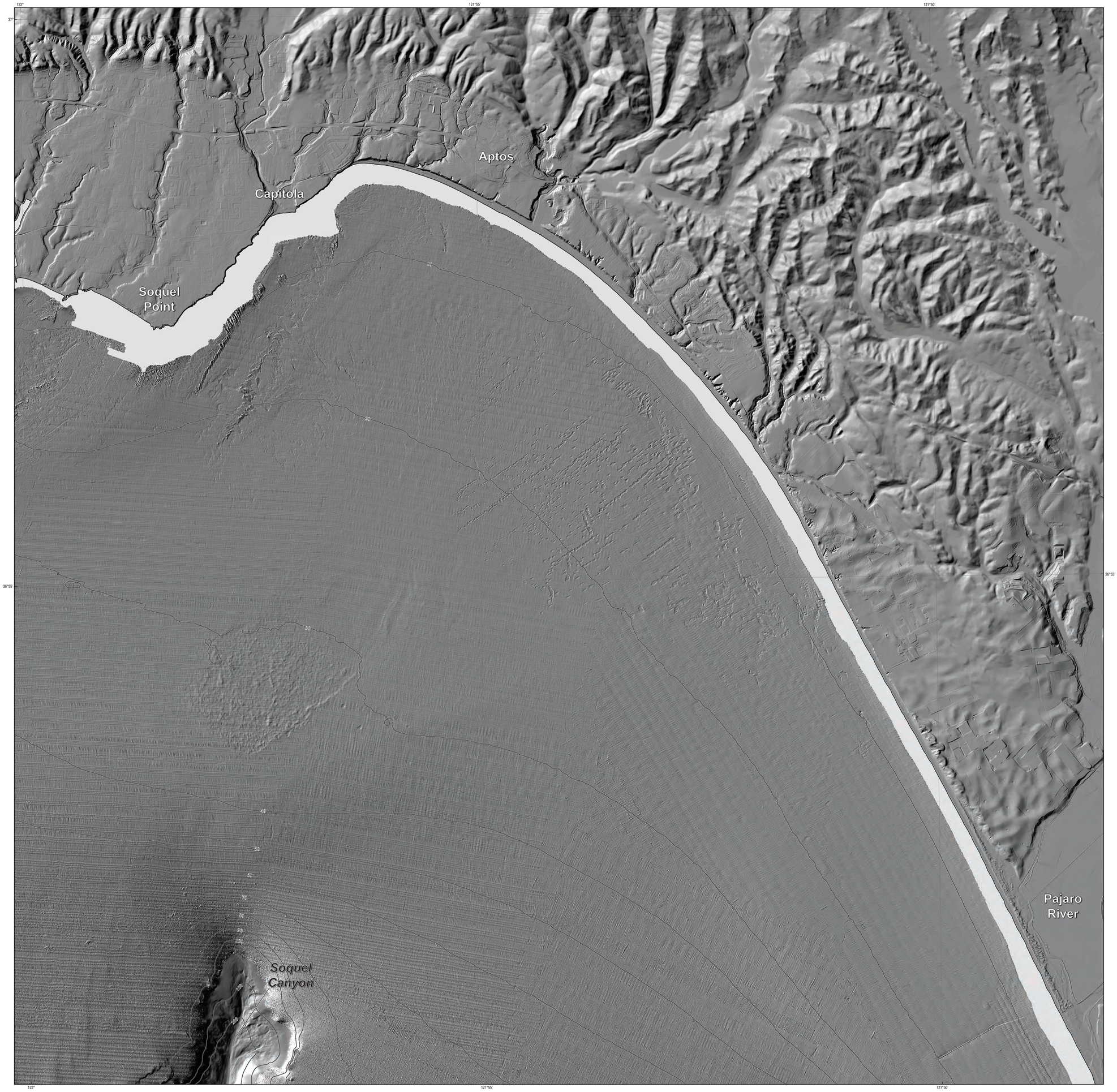
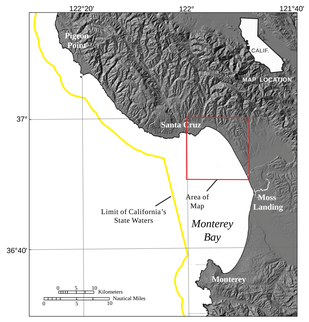
U.S. Department of the Interior
U.S. Geological Survey





DISCUSSION

This colored shaded-relief bathymetry map of the Offshore of Aptos map area in central California was generated from bathymetry data collected by California State University, Monterey Bay (CSUMB), and the U.S. Geological Survey (USGS) (fig. 1). Mapping was completed in 2006 and 2009, using a combination of a 244-kHz Reson 8101 multibeam echosounder and a 234-kHz SEA SWATHplus bathymetric sidescan-sonar system. These mapping missions combined to collect bathymetry data in all of the Offshore of Aptos map area deeper than about 10 m.

During the CSUMB multibeam mapping mission, an Applanix 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 such as heave, pitch, and roll (position accuracy, ±2 m; pitch, roll, and heading accuracy, ±0.02°; heave accuracy, ±5%, or 5 cm). A NavCom 2050 global positioning system (GPS) receiver was used to measure tidal-cycle fluctuations; in addition, sound-velocity profiles were collected with an Applied Microsystems (AM) 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 mission, 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 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).

Processed soundings from the different mapping missions were exported from the acquisition or processing software as XYZ files and bathymetric surfaces. All surfaces with similar spatial resolutions were then merged together and clipped to the boundary of the map area. The shallower USGS bathymetric surface has 2-m spatial resolution, while the deeper CSUMB surface has 3-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. Note that ripple patterns and parallel lines that are apparent within the map area are data-collection and -processing artifacts. These artifacts are made obvious by the hillshading process.

Bathymetric contours were generated at 10-m intervals for water depths shallower than 100 m and at 50-m intervals for water depths deeper than 100 m from the merged 2-m- and 3-m-resolution bathymetric surfaces. The merged 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 location). 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/).

REFERENCE CITED

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

Amount of illumination

Illuminated (facing false sun)

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

20 **Bathymetric contour (in meters)**—Derived from modified 2-m- and 3-m-resolution bathymetry grids. Contour intervals: 1–100 m water depth, 10 m; >100 m water depth, 50 m

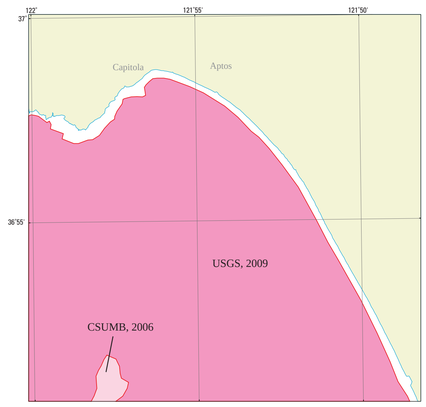


Figure 1. Map showing areas of multibeam-echosounder and bathymetric-sidescan surveys (pink shading) and onshore topographic-lidar surveys (yellow shading). Also shown are data-collecting agencies (CSUMB, California State University, Monterey Bay; Seafloor Mapping Lab; USGS, U.S. Geological Survey) and dates of surveys if known.

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/)

Universal Transverse Mercator projection, Zone 10N

NOT INTENDED FOR NAVIGATIONAL USE

13½°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2016

SCALE 1:24 000

1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

BATHYMETRIC CONTOUR INTERVALS 10 METERS AND 50 METERS

ONE MILE = 0.869 NAUTICAL MILES

CALIF.
MAP LOCATION

Shaded-relief bathymetry by Peter Dartnell, 2014 (data collected by U.S. Geological Survey in 2009 and by California State University, Monterey Bay, Seafloor Mapping Lab in 2006). Bathymetric contours by Mercedes D. Erdey, 2014

GIS database and digital cartography by Nadine E. Golden, 2014

Manuscript approved for publication February 19, 2016

Shaded-Relief Bathymetry, Offshore of Aptos Map Area, California

By

Peter Dartnell,[1] Andrew C. Ritchie,[1] David P. Finlayson,[1] and Rikk G. Kvitek[2]

2016

[1]U.S. Geological Survey;
[2]California State University, Monterey Bay, Seafloor Mapping Lab

ISSN 2331-1258 (online)
http://dx.doi.org/10.3133/ofr20161025

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

This map was printed on an electronic plotter directly from digital files. Dimensional calibration may vary between electronic plotters and between X and Y directions on the same plotter, and paper may change size due to atmospheric conditions; therefore, scale and proportions may not be true on plots of this map.

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

Digital files available at http://dx.doi.org/10.3133/ofr20161025

Suggested Citation: Dartnell, P., Ritchie, A.C., Finlayson, D.P., and Kvitek, R.G., 2016, Shaded-relief bathymetry, Offshore of Aptos map area, California, *sheet 2 in* Cochrane, G.R., Johnson, S.Y., Dartnell, P., Greene, H.G., Erdey, M.D., Dieter, B.E., Golden, N.E., Hartwell, S.R., Ritchie, A.C., Kvitek, R.G., Maier, K.L., Endris, C.A., Davenport, C.W., Watt, J.T., Sliter, R.W., Finlayson, D.P., and Krigsman, L.M. (G.R. Cochrane and S.A. Cochran, eds.), California State Waters Map Series—Offshore of Aptos, California: U.S. Geological Survey Open-File Report 2016–1025, pamphlet 43 p., 10 sheets, scale 1:24,000, http://dx.doi.org/10.3133/ofr20161025.