

**DISCUSSION**

This shaded-relief bathymetry map of the offshore of Ventura map area in southern California was generated from bathymetry data collected by California State University, Monterey Bay (CSUMB), and by the U.S. Geological Survey (USGS) (fig. 1). Most of the offshore area was mapped by CSUMB in the summers of 2006 and 2007, using a 234-kHz Reson 8101 multibeam echosounder. The seafloor west of Ventura Harbor was mapped by the USGS in 2006 and 2010, using 117-kHz (2006) and 234.5-kHz (2010) SEA (AP) Ltd. SWATHplus-M phase-differencing sidescan sonars. These mapping missions combined to collect bathymetry from about the 10-m isobath to beyond the 3-nautical-mile limit of California's State Waters.

In 2009, Fugro Pelagos collected bathymetric and topographic-lidar data along the Ventura and Santa Barbara County coastlines for the U.S. Army Corps of Engineers Joint Lidar Bathymetry Technical Center of Expertise. Although bathymetric coverage was good northwest and southeast of the map area, coverage within the offshore of Ventura map area was very sparse; therefore, these data are not included in this map.

During the CSUMB mapping missions, an Applanix position and motion compensation system (POS/MV) 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). NavCom 2050 GPS receiver (CNAV) data were used to account for tidal-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 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 CNAV receiver. Final XYZ soundings and bathymetric-surface models were referenced to the World Geodetic System of 1984 (WGS 1984) relative to the North American Vertical Datum of 1988 (NAVD 1988).

During the USGS mapping missions, differential GPS (DGPS) data (2006) and GPS with real-time kinematic corrections (2010) were combined with measurements of vessel motion (heave, pitch, and roll) in a Codarcopus 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 precisely measured sound-velocity profiles. Statistical filters were applied to the raw samples that discriminate the seafloor returns (soundings from unintended targets) in the water column. The original 2006 soundings were referenced to the WGS 1984 datum relative to the MLLW (Mean Lower Low Water) tidal datum, but, through postprocessing using National Oceanic and Atmospheric Administration's (NOAA's) VDatum tool, the soundings were transformed to the NAVD 1988. The original 2010 soundings were referenced to the WGS 1984 datum using real-time kinematic GPS and then transformed through postprocessing to the NAVD 1988 (Dartnell and others, 2012). Finally, the soundings were converted into 2-m-resolution bathymetric-surface-model grids. Note that the northwest-southeast-trending lines offshore of Ventura Harbor are data-collection artifacts.

Once all the bathymetric-surface models were transformed to a common projection and datum, the files were merged into one overall 2-m-resolution bathymetric-surface model and clipped to the boundary of the map area. An illumination having an azimuth of 300° and from 45° above the horizon was then applied to the surface to create this shaded-relief map. Bathymetric contours were generated from a modified 10-m-resolution bathymetric surface where a smooth arithmetic mean convolution function that assigns a weight of one-tenth to each cell in a 3-pixel matrix was applied iteratively to the surface ten times.

The onshore-area image was generated by applying the same illumination (azimuth of 300° and from 45° above the horizon) to publicly available, 3-m-resolution, interferometric synthetic aperture radar (ISAR) data, available from NOAA Coastal Services Center's Digital Coast, at <http://coast-maps-and-csc.noaa.gov/dataviewer/viewer.html> (last accessed April 5, 2011).

**REFERENCE CITED**

Dartnell, P., Philayson, D.P., Ritchie, A.C., Cochran, G.R., and Friley, M.D., 2012, Bathymetric and acoustic backscatter—Outer mainland shelf, eastern Santa Barbara Channel, California: U.S. Geological Survey Data Series 702, 6 p., available at <http://pubs.usgs.gov/ds/702/>.

**EXPLANATION**

Amount of illumination  
Illuminated (facing false sun)

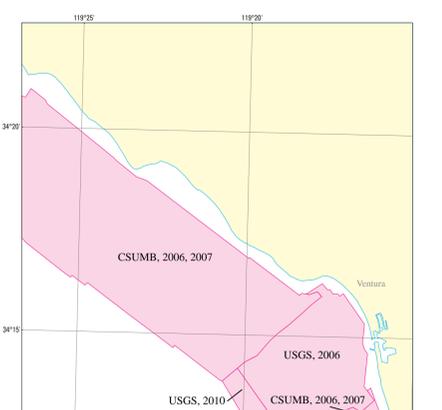
In shadow (facing away from false sun)

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; areas beyond 3-nautical-mile limit of California's State Waters were not mapped as part of California Seafloor Mapping Program

3-nautical-mile limit of California's State Waters

Bathymetric contour (in meters)—Derived from modified 10-m-resolution bathymetry grid. Contour interval: 10 m

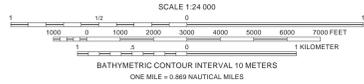


**Figure 1.** Map showing areas of multibeam-echosounder and bathymetric-sidescan surveys (pink shading) and publicly available interferometric synthetic aperture radar (ISAR) topography (yellow shading). Also shown are data-collecting agencies (CSUMB, California State University, Monterey Bay, Seafloor Mapping Lab; USGS, U.S. Geological Survey) and dates of surveys if known.

Onshore elevation data from NOAA Coastal Services Center (data collected by EarthData International in 2002–2003). California's State Waters limit from NOAA Office of Coast Survey Universal Transverse Mercator projection, Zone 11N.

**NOT INTENDED FOR NAVIGATIONAL USE**

APPROXIMATE MEAN RESOLUTION 2011



Shaded-relief bathymetry by Peter Dartnell, 2011 (data collected by U.S. Geological Survey in 2006 and 2010) and by California State University, Monterey Bay, Seafloor Mapping Lab in 2006–2007. Bathymetric contours by Andrew C. Ritchie, 2011. GIS database and digital cartography by Nadine E. Golden and Elyse L. Phillips. Edited by Bryan A. Linkquist. Manuscript approved for publication March 11, 2013.



## Shaded-Relief Bathymetry, Offshore of Ventura Map Area, California

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