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

DISCUSSION

This shaded-relief bathymetry map of the Offshore of Santa Barbara map area in southern California was generated from bathymetry data collected by California State University, Monterey Bay (CSUMB), by the U.S. Geological Survey (USGS), and by Fugro Pelagos for the U.S. Army Corps of Engineers (USACE) Joint Airborne Lidar Bathymetry Technical Center of Expertise (fig. 1). Most of the offshore area was mapped by CSUMB in the summer of 2007, using a 244-kHz Reson 8101 multibeam echosounder. Smaller areas in the far-east nearshore, as well as further offshore to the west and in the southeast outer shelf area, were mapped by the USGS in 2005 and 2006, using a combination of 468-kHz (2005) and 117-kHz (2006) SEA (AP) Ltd. SWATHplus-M phase-differencing sidescan sonars. The nearshore bathymetry and coastal topography were mapped for USACE by Fugro Pelagos in 2009, using the SHOALS-1000T bathymetric-lidar and Leica ALS60 topographic-lidar systems. These mapping missions combined to collect bathymetry from the 0-m isobath to beyond the 3-nautical-mile limit of California's State Waters.

During the CSUMB mapping mission, 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 velocometer. 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.

During the USGS mapping missions, differential GPS (DGPS) data 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 the raw samples that discriminate the seafloor returns (soundings) from unintended targets in the water column. Finally, the soundings were converted into 2-m-resolution bathymetric-surface-model grids.

During the Fugro Pelagos mapping mission that was completed as part of the National Coastal Mapping Program of USACE, the Leica ALS60 topographic-lidar and the SHOALS-1000T bathymetric-lidar systems were mounted on an aircraft that flew survey lines at an altitude of 300 to 400 m (bathymetry) and 300 to 1,200 m (topography), at speeds of between 135 and 185 knots. The ALS60 system collected data at a maximum pulse rate of 200 kHz, and the SHOALS system collected data at 1 kHz. Information on aircraft position, velocity, and acceleration were collected using the Novatel and POS A/V 410 systems (SHOALS) and the onboard GPS/IMU system (ALS60). Aircraft-position data were processed using POSPac software, and the results were combined with the lidar data to produce 3-D positions for each lidar shot. Various commercial and proprietary software packages were used to clean the data, to convert all valid data from ellipsoid to orthometric heights, and to export the data as a series of topography and bathymetry ASCII files.

Soundings from the different mapping missions were converted into individual 2-m-resolution bathymetric-surface-model grids. The individual bathymetric-surface models were then merged into one overall 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 bathymetric surface to create the shaded-relief imagery. 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-ninth to each cell in a 3-pixel by 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 the coastal airborne topographic-lidar data, as well as to publicly available, 3-m-resolution, interferometric synthetic aperture radar (ifSAR) data, available from National Oceanic and Atmospheric Administration (NOAA) Coastal Service Center's Digital Coast, at http://csc-s-maps-q.csc.noaa.gov/dataviewer/viewer.html (last accessed April 5, 2011).

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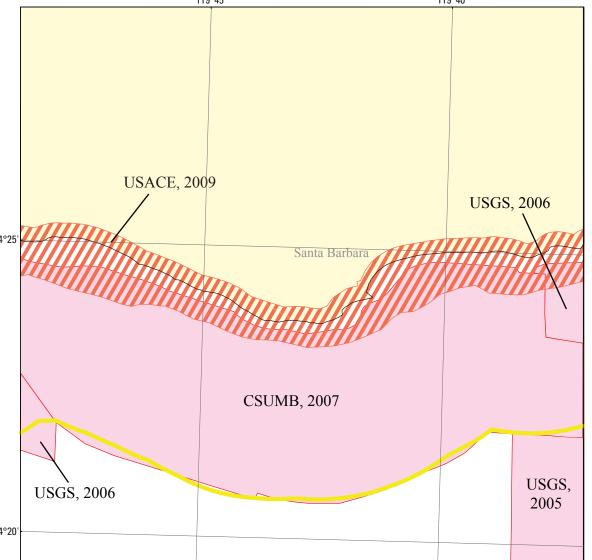
3-nautical-mile limit of California's State Waters

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

Santa Barbara

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

USACE, 2009
USGS, 2006
Santa Barbara
CSUMB, 2007
USGS, 2006
USGS, 2005

Onshore elevation data from NOAA Coastal Services Center (data collected by EarthData International in 2002–2003 and from U.S. Army Corps of Engineers (data collected by Fugro Pelagos in 2009). California's State Waters limit from NOAA Office of Coast Survey.

Universal Transverse Mercator projection, Zone 11N

NOT INTENDED FOR NAVIGATIONAL USE

APPROXIMATE MEAN DECLINATION, 2013

SCALE 1:24 000

BATHYMETRIC CONTOUR INTERVAL 10 METERS
ONE MILE = 0.869 NAUTICAL MILES

MAP LOCATION

Shaded-relief bathymetry by Peter Dartnell, 2013 (data collected by U.S. Geological Survey in 2005 and 2006, by California Stat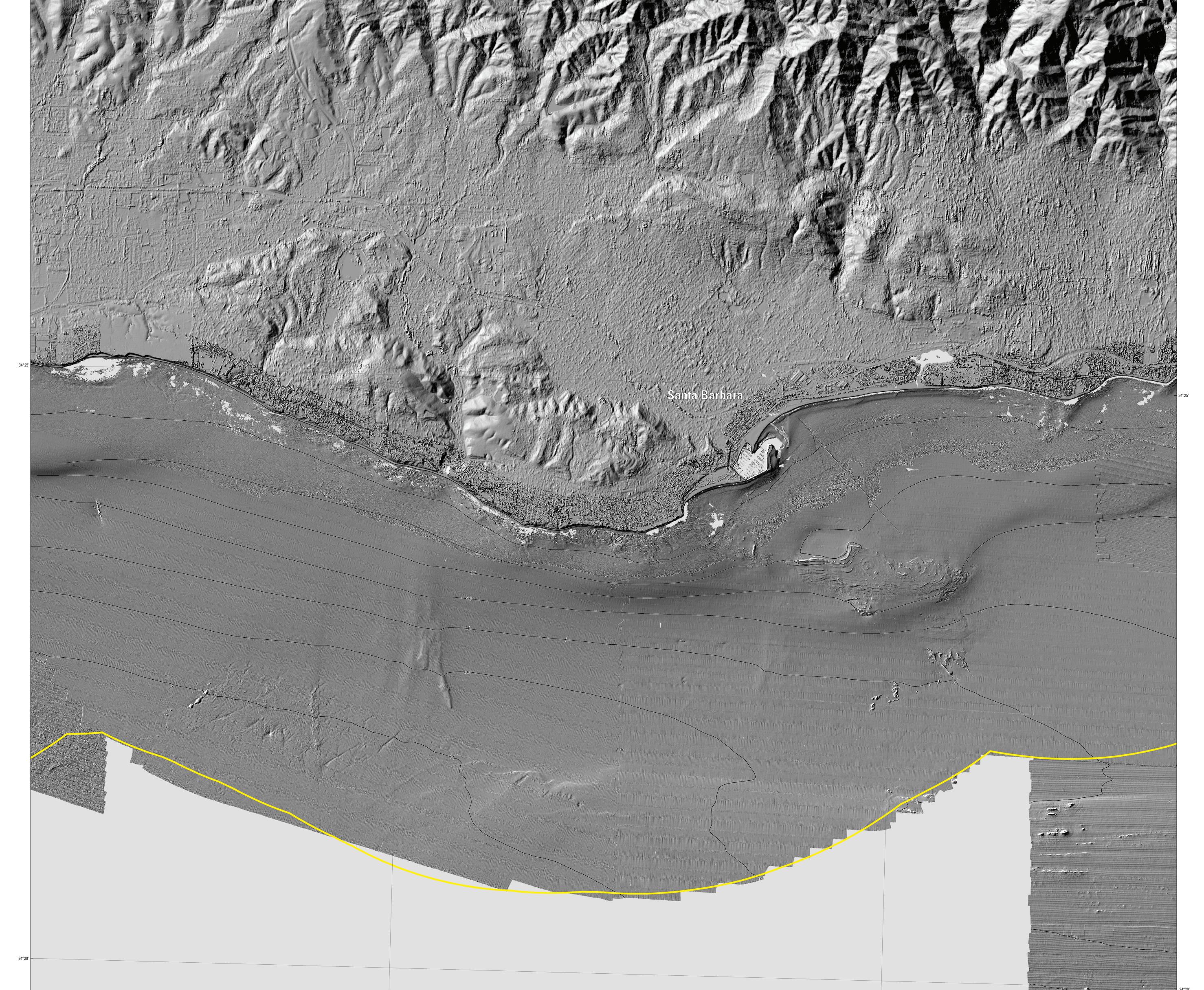e University, Monterey Bay, Seafloor Mapping Lab in 2007, and by U.S. Army Corps of Engineers in 2009). Bathymetric contours by Andrew C. Ritchie, 2011.

GIS database and digital cartography by Nadine E. Golden and Eleyne L. Phillips.

Edited by Taryn A. Lindquist

Manuscript approved for publication December 12, 2013

Shaded-Relief Bathymetry, Offshore of Santa Barbara Map Area, California

By

Rikk G. Kvitek,[1] Peter Dartnell,[2] Eleyne L. Phillips,[2] and Guy R. Cochrane[2]

2013

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