

**DISCUSSION**

This colored shaded-relief bathymetry map of the Offshore of Pacifica map area in northern California was generated from bathymetry data collected by Fugro Pelagos and by California State University, Monterey Bay (CSUMB) (fig. 1). Mapping was completed in 2005, 2006, and 2007, using a combination of 400-KHz Reson 7125 and 244-KHz Reson 8101 multibeam echosounders. These mapping missions combined to collect bathymetry data from about the 10-m isobath to beyond the 3-nautical-mile limit of California's State Waters. During all the mapping missions, an Applanix POS MV (Position and Orientation System for Marine Vessels) 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). To account for tidal-cycle fluctuations, CSUMB used NavCom 2050 GPS receiver (CNAV) data, and Fugro Pelagos used KGPS data (GPS data with real-time kinematic correction); 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 KGPS receivers.

Processed soundings from the different mapping missions were exported from the acquisition or processing software as XYZ files and bathymetric surfaces. All the surfaces 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 bathymetric surface to create the shaded-relief imagery. In addition, a modified "rainbow" color ramp was applied to the bathymetry data, using reds and oranges to represent shallower depths, and greens to represent greater depths (note that the Offshore of Pacifica map area requires only the shallower part of the full-rainbow color ramp used on some of the other maps in the California State Waters Map Series; see, for example, Kvitck and others, 2012). This colored bathymetry surface was draped over the shaded-relief imagery at 60-percent transparency to create this colored shaded-relief map. Gray areas in the map are gaps in data.

Bathymetric contours were generated at 10-m intervals from the merged 2-m-resolution bathymetric surface. 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.

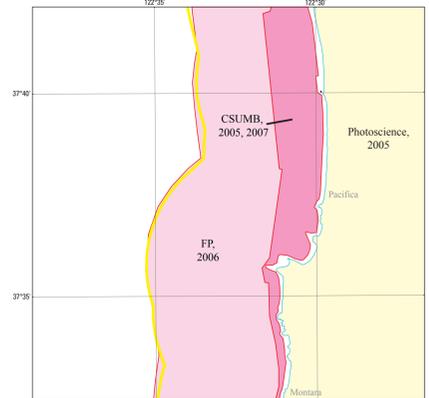
The onshore-area image was generated by applying the same illumination (azimuth of 300° and from 45° above the horizon) to 1-m-resolution topographic-lidar data collected by Photoscience in 2005 for the U.S. Geological Survey and the County of San Mateo.

**REFERENCE CITED**

Kvitck, R.G., Phillips, E.L., and Dartnell, P., 2012, Colored shaded-relief bathymetry, Huene Canyon and vicinity, California, *sheet 1* in Johnson, S.Y., Dartnell, P., Cochrane, G.R., Golden, N.E., Phillips, E.L., Ritchie, A.C., Kvitck, R.G., Greene, H.G., Kringsman, L.M., Endres, C.A., Chaban, R.B., Slier, R.W., Wong, F.I., Nolkovick, M.M., and Normark, W.R. (S.Y. Johnson, ed.), California State Waters Map Series—Huene Canyon and vicinity, California: U.S. Geological Survey Scientific Investigations Map 3225, pamphlet 41 p., 12 sheets, available at <http://pubs.usgs.gov/sim/3225/>.

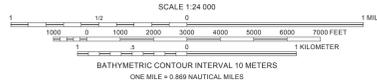
**EXPLANATION**

- Depth (in meters) and illumination (bright areas are illuminated, facing false sun; dark areas are in shadow, facing away from false sun)
- 0 Shallow
- 20
- 30
- 40 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 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
- 10 Bathymetric contour (in meters)—Derived from 2-m-resolution bathymetry grid. Contour interval: 10 m



**Figure 1.** Map showing areas of multibeam-echosounder 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; FP, Fugro Pelagos) and dates of surveys if known. Yellow line shows limit of California's State Waters.

Onshore elevation data collected by Photoscience in 2005 for U.S. Geological Survey and County of San Mateo, California's State Waters limit from NOAA, Office of Coast Survey. Universal Transverse Mercator projection, Zone 10N. NOT INTENDED FOR NAVIGATIONAL USE



Shaded-relief bathymetry by Peter Dartnell, 2012 (data collected by Fugro Pelagos in 2006 and by California State University, Monterey Bay, Seafloor Mapping Lab in 2005 and 2007). Bathymetric contours by Carrie K. Bretz, 2008. GIS database and digital cartography by Nadine E. Golden. Manuscript approved for publication December 22, 2014.

**Colored Shaded-Relief Bathymetry, Offshore of Pacifica Map Area, California**

By  
Carrie K. Bretz,<sup>1</sup> Rikk G. Kvitck,<sup>1</sup> Peter Dartnell,<sup>2</sup> and Eleyne L. Phillips<sup>2</sup>  
2014

<sup>1</sup>California State University, Monterey Bay, Seafloor Mapping Lab; <sup>2</sup>U.S. Geological Survey



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. The map was printed on an electronic platform directly from digital files. Dimensional calibration may vary between electronic platforms and between A and B directions on the same plate, 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 2088, Federal Center, Denver, CO 80225, 1-888-ASIS-0555. Digital files available at <https://pubs.usgs.gov/ofr/2014/1260/>. Suggested Citation: Bretz, C.K., Kvitck, R.G., Dartnell, P., and Phillips, E.L., 2014, Colored shaded-relief bathymetry, Offshore of Pacifica map area, California, sheet 1 of 10, in Bretz, C.K., Kvitck, R.G., Dartnell, P., Greene, H.G., Endres, C.A., Chaban, R.B., Slier, R.W., Johnson, S.Y., Cochrane, G.R., Wong, F.I., Nolkovick, M.M., Normark, W.R., and Johnson, S.Y. (eds.), California State Waters Map Series—Offshore of Pacifica, California: U.S. Geological Survey Scientific Investigations Map 3225, pamphlet 41 p., 12 sheets, scale 1:24,000, <http://pubs.usgs.gov/sim/3225/pamphlet/01/>.