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

Open-File Report 2016–1072
Sheet 3 of 10
Pamphlet accompanies map

DISCUSSION

This acoustic-backscatter map of the Monterey Canyon and Vicinity map area in central California was generated from acoustic-backscatter data collected by California State University, Monterey Bay (CSUMB), Monterey Bay Aquarium Research Institute (MBARI), and the U.S. Geological Survey (USGS) (fig. 3). Mapping was completed between 1998 and 2014, using a combination of 30-kHz Sonrad 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 acoustic-backscatter 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-System.

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. Multibeam backscatter data were processed using Geocoder. Within Geocoder, the backscatter intensities were radiometrically corrected (including despeckling and angle-varying gain adjustments), and the position of each acoustic sample was geometrically corrected for slant range on a line-by-line basis. After the lines were corrected, they were mosacked into 1- or 2-m-resolution images. Overlap between parallel lines was resolved using a priority table whose values were based on the distance of each sample from the ship track, with the samples that were closest to and furthest from the ship track being given the lowest priority. An anti-aliasing algorithm was also applied. The mosaics were then exported as georeferenced TIFF images, imported into a geographic information system (GIS), and converted to GRIDs at 2-m resolution.

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. Finally, the soundings were converted into 2-m-resolution bathymetric-surface-model grids.

The backscatter data collected by CSUMB and USGS were postprocessed using USGS software (D.P. Finlayson, 2011, written commun.) that normalizes for time-varying signal loss and beam directivity differences. Thus, the raw 16-bit backscatter data were gain-normalized to enhance the backscatter of the SWATHplus system. The resulting normalized-amplitude values were rescaled to 16-bit and gridded into GeoTIFFs using GRID Processor Software, then imported into a GIS and converted to GRIDs.

The acoustic-backscatter imagery from each different mapping system and processing method were merged into their own individual grids. The shallower USGS and CSUMB acoustic backscatter grids have a spatial resolution of 2 m, whereas the deeper MBARI grid has a 5-m resolution. These individual grids, which cover different areas, were displayed in a GIS to create this map, on which brighter tones indicate higher backscatter intensity, and darker tones indicate lower backscatter intensity. The intensity represents a complex interaction between the acoustic pulse and the seafloor, as well as characteristics within the shallow subsurface, providing an indication of seafloor texture and composition. Backscatter intensity depends on the acoustic source level, the frequency used to image the seafloor, the grazing angle; the composition and character of the seafloor, including grain size, water content, bulk density, and seafloor roughness; and some biological cover. Harder and rougher bottom types such as rocky outcrops or coarse sediment typically return stronger intensities (high backscatter, lighter tones), whereas softer bottom types such as fine sediment return weaker intensities (low backscatter, darker tones). Note that the ripple patterns and straight lines that are apparent within the map area are data-collection and -processing artifacts. Data gaps in the deeper section of Monterey Canyon (in the southwest corner of the map area) are where backscatter soundings are less dense, which results in no data being found within a 5-m grid cell.

Bathymetric contours were generated from modified 2- and 5-m-resolution bathymetric surfaces (see sheets 1, 2 of this report). 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 ombre-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

Backscatter intensity

High

Low

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

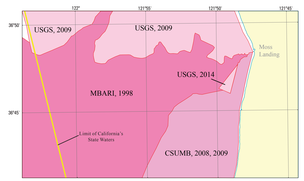

Figure 1. Map showing areas of multibeam echosounder and bathymetric-sidescan surveys (pink shading) and onshore topographic-lidar surveys (yellow shading). Also shown are data-collecting agencies (CSUMB, California State University, Monterey Bay; Seafloor Mapping Lab; MBARI, Monterey Bay Aquarium Research 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

15½°
APPROXIMATE MEAN DECLINATION, 2016

SCALE 1:24 000

1 ½ 0 1 MILE

1500 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

CALIF.
MAP LOCATION

Acoustic-backscatter imagery by Peter Dartnell, 2014 (data collected by U.S. Geological Survey in 2009 and 2014, by Monterey Bay Aquarium Research Institute in 1998, and by California State University, Monterey Bay; Seafloor Mapping Lab in 2008). Bathymetric contours by Mercedes E. Erdey, 2014

GIS database and digital cartography by Nadine E. Golden

Manuscript approved for publication May 16, 2016

Acoustic Backscatter, Monterey Canyon and Vicinity Map Area, California

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2016

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Digital files available at http://dx.doi.org/10.3133/ofr2016-1072

Suggested Citation: Dartnell, P., Ritchie, A.C., Finlayson, D.P., and Kvitek, R.G., 2016, Acoustic backscatter, Monterey Canyon and Vicinity map area, California, *sheet 3 in* Dartnell, P., Maier, K.L., Erdey, M.E., Dieter, B.E., Golden, N.E., Johnson, S.Y., Hartwell, S.R., Cochrane, G.R., Ritchie, A.C., Finlayson, D.P., Kvitek, R.G., Sliter, R.W., Greene, H.G., Davenport, C.W., Enlow, H.A., and Krigsman, L.M., eds., Seafloor mapping offshore Santa Cruz and Monterey Counties, California: U.S. Geological Survey Open-File Report 2016–1072, pamphlet 46 p., 10 sheets, scale 1:24,000, http://dx.doi.org/10.3133/ofr2016-1072.

ISSN 2331-1258 (online)
http://dx.doi.org/10.3133/ofr2016-1072