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

Open-File Report 2015–1088
Sheet 4 of 10
Pamphlet accompanies map

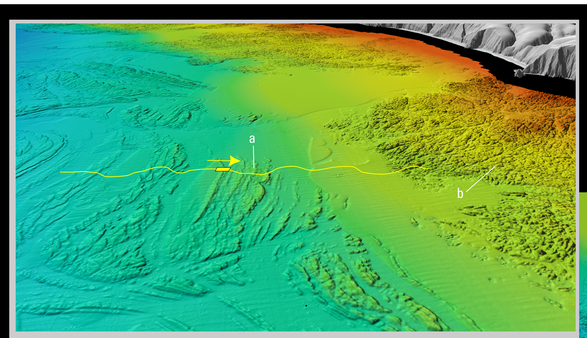


Figure 1. Perspective view to north along west flank of Point Reyes National Seashore. View highlights two distinct rock outcrop types; outcrops offshore (a) are linear, folded, west-dipping sedimentary rocks, while nearshore outcrops (b) comprise massive, disorganized and fractured granitic rocks. Thin yellow line shows path of camera sled (towed 1 to 2 m above seafloor) that captured video and photographs. Yellow rectangle shows location of video mosaic (fig. 3) generated from video captured above linear sedimentary-rock outcrop. Yellow arrow shows towing direction of camera sled. Vertical exaggeration of perspective view, 2x; distance across bottom about 1.4 km.

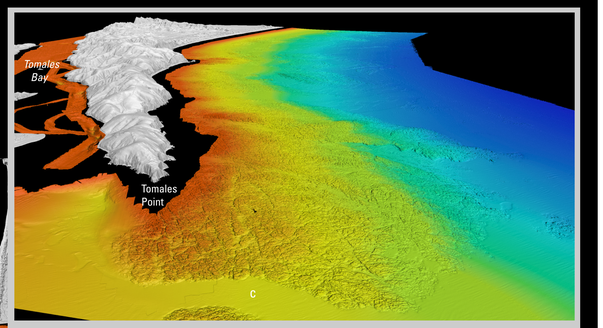


Figure 2. Perspective view to south, down coast, past Tomales Point and into Tomales Bay. Massive granitic seafloor outcrop extends north and west from Tomales Point. Locally, outcrop has low relief (less than 4 m) but overall surface grades relatively steeply from shoreline to depth of about 60 m at transition to smooth, sediment-covered seafloor in a distance of only 2 km. Low-relief channel cut into granitic seafloor outcrops (c) that trends offshore north of Tomales Point probably served as sediment pathway for sediment moving out of Tomales Bay during lower sea levels. Vertical exaggeration of perspective view, 2x; distance across bottom, about 3 km.

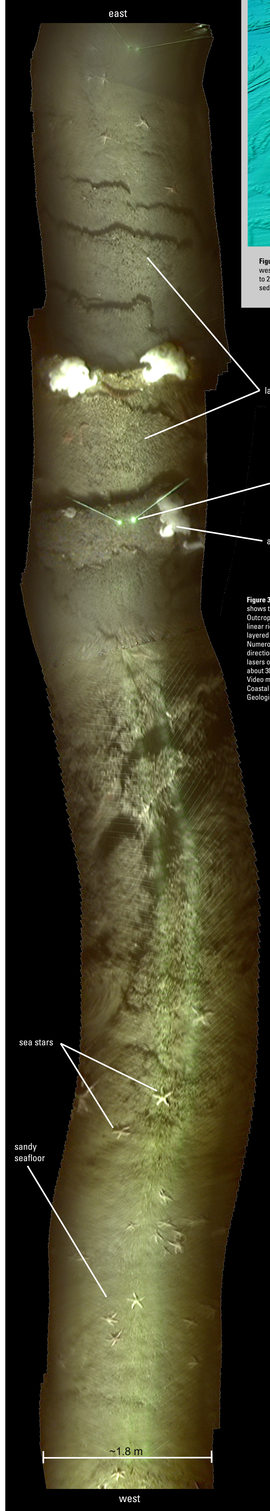


Figure 3. Video mosaic of area offshore of Point Reyes National Seashore, which shows transition from sandy seafloor to rock outcrop (see fig. 1 for location). Outcrop is relatively clean of encrusting organisms, algae, and kelp and has linear ridges perpendicular to path of camera sled. Outcrop appears to be layered sedimentary rock, consistent with overall morphology seen in figure 1. Numerous sea stars are found at transition from sand to rock. Camera sled tow direction is from bottom to top. Bright green dots within mosaic are from paired lasers on camera sled used to size objects on seafloor. Mosaic is comprised of about 30 seconds of video recorded as camera sled traveled above seafloor. Video mosaic created using software developed by Dr. Yuri Rzhanov, Center for Coastal and Ocean Mapping, University of New Hampshire, through joint U.S. Geological Survey–University of New Hampshire cooperative agreement.

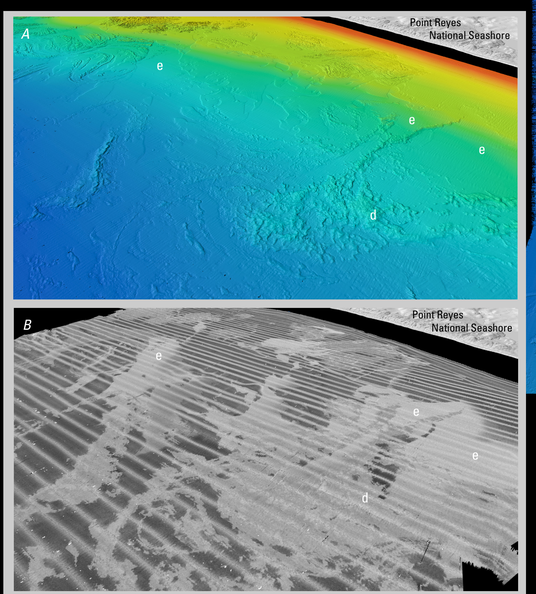


Figure 4. Perspective views to northeast of both colored shaded-relief bathymetry (*A*), and gray-scale acoustic backscatter (*B*). In backscatter imagery, lighter tones indicate stronger backscatter intensity suggesting rock or coarser grained sediment, whereas darker tones indicate weaker backscatter intensity suggesting finer grained sediment. Bathymetry shows wide distribution of rock outcrop with up to 3.5 m of relief (d). Backscatter imagery shows outcrops with high backscatter intensities; however, some regions of lower relief (e) also have high backscatter intensity and are likely composed of coarser sands and (or) or mixed rock (cobbles, boulders). Parallel lines of higher backscatter (B) are data-collection and processing artifacts. Vertical exaggeration of both views, 2x; distance across bottom of both views, about 3 km.

Map view. Colored shaded-relief bathymetry map of Offshore of Tomales Point map area, generated from multibeam-echosounder and bathymetric-sidescan data. Colors show depth: reds and oranges indicate shallower areas; blues, deeper areas. Illumination azimuth is 300°, from 45° above horizon. Note that ripple patterns and parallel lines apparent within map are data-collection and processing artifacts. Lines at some borders of surveys are created by slight differences in depth measured by different mapping systems during different years. Artifacts are made obvious by hillshading process. Numbered arrows show viewing directions of perspective views shown on this sheet, numbers correspond to figure numbers of view. Black line near arrow 6 shows location of seismic-reflection profile in figure 6.

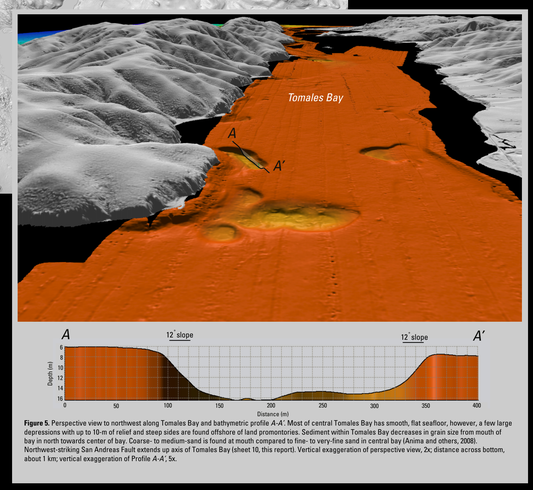


Figure 5. Perspective view to northwest along Tomales Bay and bathymetric profile *A*-*A*′. Most of central Tomales Bay has smooth, flat seafloor, however, a few large depressions with up to 10-m of relief and steep sides are found offshore of land promontories. Sediment within Tomales Bay decreases in grain size from mouth of bay in north towards center of bay. Coarse- to medium-sand is found at mouth compared to fine- to very-fine sand in central bay (Anima and others, 2008). Northwest-striking San Andreas Fault extends up axis of Tomales Bay (sheet 10, this report). Vertical exaggeration of perspective view, 2x; distance across bottom, about 1 km; vertical exaggeration of Profile *A*-*A*′, 5x.

DISCUSSION

Mapping California's State Waters has produced a vast amount of acoustic and visual data, including bathymetry, acoustic backscatter, seismic-reflection profiles, and seafloor video and photography. Researchers use these data to develop maps, reports, and other tools to assist coastal-zone managers and other stakeholders in coastal and marine spatial-planning. Seafloor-character, habitat, and geologic maps may be used for fisheries management, for designation of Marine Protected Areas, for monitoring of environmental change such as sea-level-rise impacts, for prediction of sediment and contaminant budgets and transport, and for assessment of earthquake and tsunami hazards. To achieve these goals, it is helpful to integrate the different datasets and then view the results in three-dimensional representations such as those displayed on this data integration and visualization sheet for the Offshore of Tomales Point map area.

The map view in the center of the sheet is similar to the colored shaded-relief bathymetry map of the Offshore of Tomales Point map area (see sheet 1 of this report). Numbered arrows show viewing directions of the perspective views on this sheet; the numbers indicate the figure number of the perspective view.

The perspective views and bathymetric profiles in figures 1, 2, 4, 5, and 6 show the colored shaded-relief bathymetry of the Offshore of Tomales Point map area, as viewed from different directions. These views highlight the diverse seafloor environments in this region including a featureless, sedimented seafloor interspersed with complex distributions of coarse-grained sediment, folded sedimentary rocks, and massive, fractured granite.

Video-mosaic images created from seafloor digital video (fig. 3) display the geologic (rock, sand, mud) and biologic complexity of the seafloor. Whereas photographs capture high-quality snapshots of a small area of the seafloor, video mosaics can capture larger areas and, thus, can show transitional zones between different seafloor environments.

Draping the acoustic-backscatter imagery (see sheet 3 of this report) over the bathymetry data (fig. 4) highlights the relations between the backscatter intensity and the seafloor morphology, and it also aids in seafloor habitat and geology interpretations.

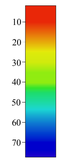
Block diagrams (fig. 6), which combine the bathymetry with seismic-reflection-profile data (see sheet 8 of this report), help show the stratigraphic and structural relations between the surface and subsurface.

REFERENCE CITED

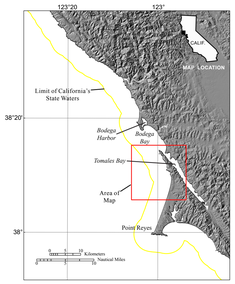
Anima, R.J., Chin, J.L., Finlayson, D.P., McGann, M.L., and Wong, F.L., 2008, Interferometric sidescan bathymetry, sediment and foraminiferal analyses; a new look at Tomales Bay, California: U.S. Geological Survey Open-File Report 2008–1237, 33 p., available at http://pubs.usgs.gov/of/2008/1237/.

EXPLANATION

Depth (in meters) and illumination (bright areas are illuminated, facing false sun; dark areas are 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]



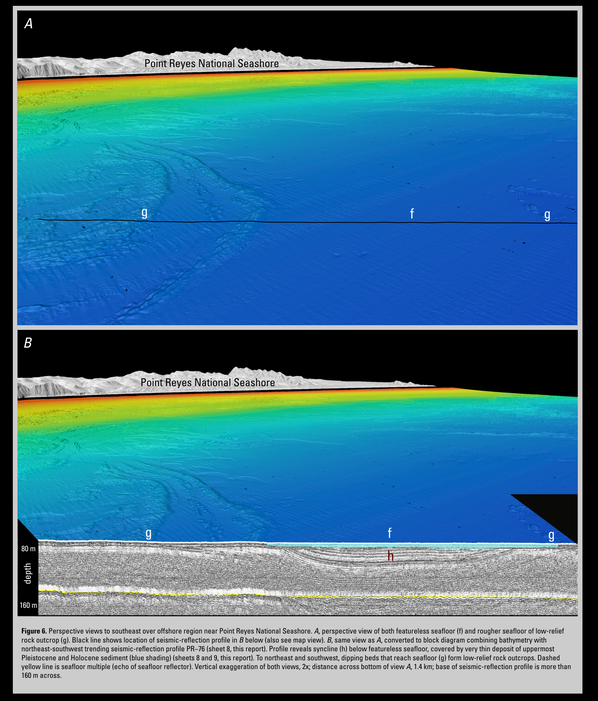


Figure 6. Perspective views to southeast over offshore region near Point Reyes National Seashore. *A*, perspective view of both featureless seafloor (f) and rougher seafloor of low-relief rock outcrop (g). Black line shows location of seismic-reflection profile in *B* below (also see map view). *B*, same view as *A*, converted to block diagram combining bathymetry with northeast-southwest trending seismic-reflection profile PR–76 (sheet 8, this report). Profile reveals syncline (h) below featureless seafloor, covered by very thin deposit of uppermost Pleistocene and Holocene sediment (blue shading) (sheets 8 and 9, this report). To northeast and southwest, dipping beds that reach seafloor (g) form low-relief rock outcrops. Dashed yellow line is seafloor multiple (echo of seafloor reflector). Vertical exaggeration of both views, 2x; distance across bottom of view *A*, 1.4 km; base of seismic-reflection profile is more than 160 m across.

Onshore elevation data from California Coastal Conservancy, available at http://www.csc.noaa.gov/digitalcoast/data/coastallidar/, and from U.S. Geological Survey, National Elevation Dataset, available at http://ned.usgs.gov/. Offshore shaded-relief bathymetry from map on sheet 2, this report. California's State Waters limit from NOAA Office of Coast Survey

Universal Transverse Mercator projection, Zone 10N

NOT INTENDED FOR NAVIGATIONAL USE

MAP LOCATION

Perspective views by Peter Dartnell, 2013. Video-mosaic image in figure 3 by Peter Dartnell, 2013, using software developed by Dr. Yuri Rzhanov, Center for Coastal and Ocean Mapping, University of New Hampshire, through joint U.S. Geological Survey–University of New Hampshire cooperative agreement. Acoustic-backscatter imagery in figure 4 from map on sheet 3, this report. Bathymetric profile in figure 5 by Peter Dartnell, 2013. Seismic-reflection profile in figure 6 from sheet 8, this report.

GIS database and digital cartography by Nadine E. Golden

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Data Integration and Visualization, Offshore of Tomales Point Map Area, California

By
Peter Dartnell

2015

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/ofr20151088 or http://pubs.usgs.gov/of/2015/1088/

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