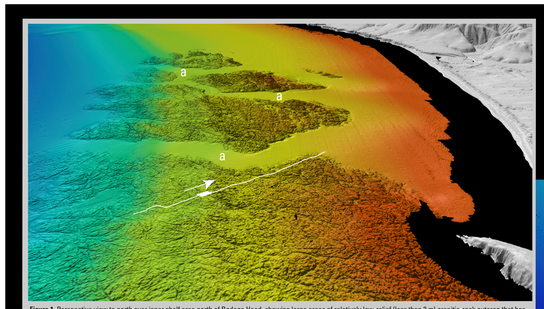


Figure 1. Perspective view to north over inner shelf area north of Bodega Head, showing large areas of relatively low-relief (less than 3 m) granitic-rock outcrop that has intervening, offshore-trending, sediment-filled channels (a), which probably were cut during sea-level lowstands (see also, fig. 4). Thin white line shows path of camera sled, towed 1 to 2 m above seafloor, that captured video and photographs; white arrow shows tow direction. White rectangle shows location of video mosaic (fig. 3) generated from video captured over rock outcrop. Vertical exaggeration, 2x; distance across bottom of image, about 1.8 km.

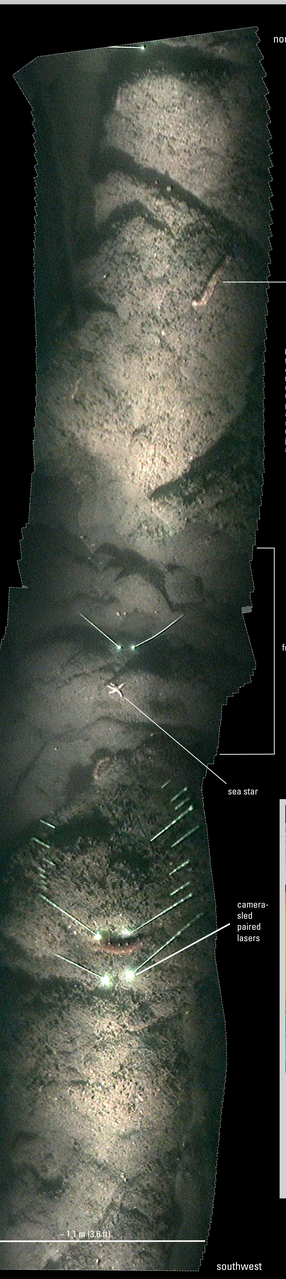
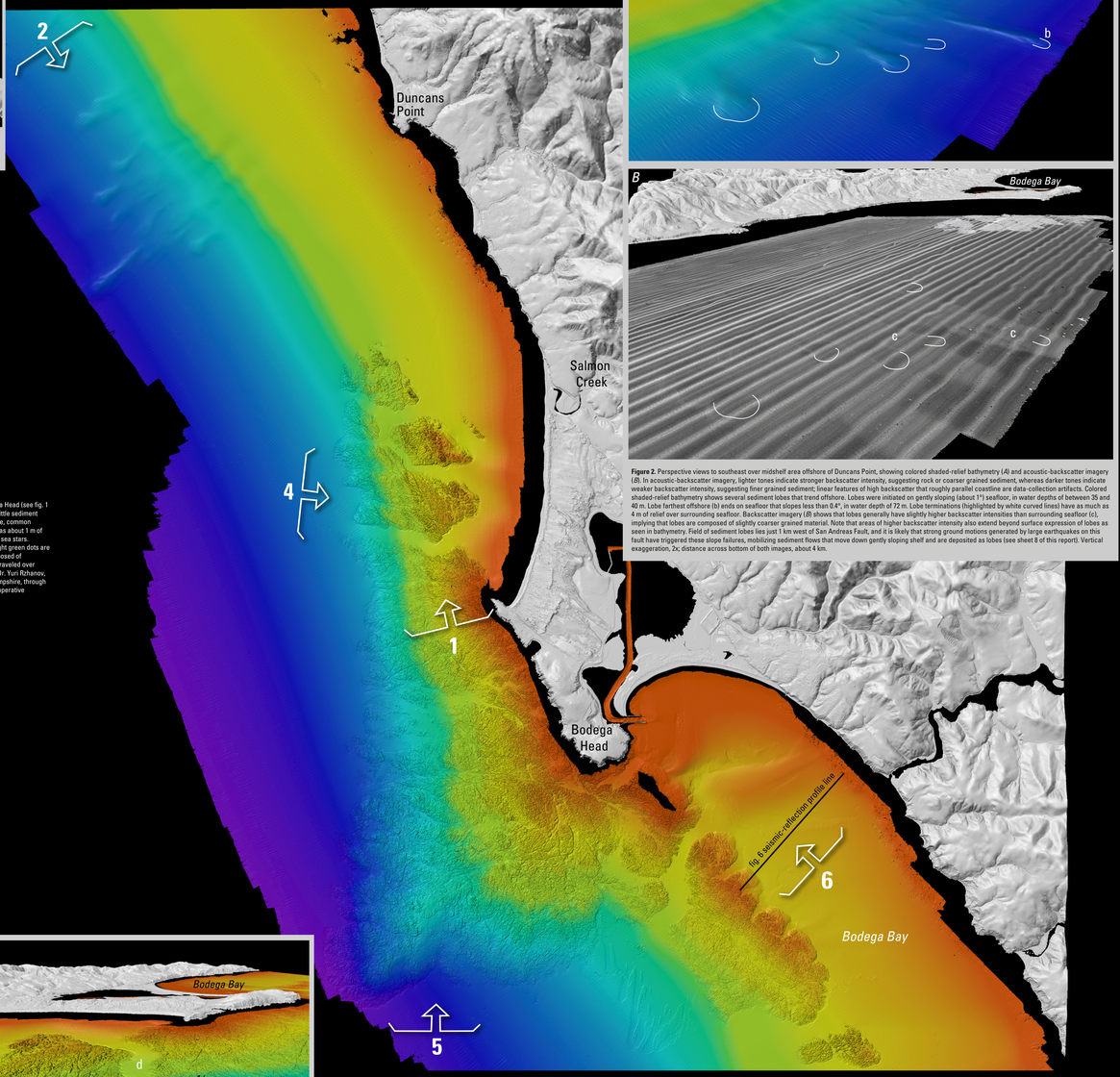


Figure 3. Video mosaic of inner shelf area northwest of Bodega Head (see fig. 1 for location), revealing blocky, granitic-rock outcrop that has little sediment cover or encrusting organisms. Mosaic captures small fracture, common throughout outcrop; bathymetry data show that this fracture has about 1 m of relief. Invertebrates found in area include sea cucumbers and sea stars. Camera-sled tow-direction is from bottom to top of image. Bright green dots are paired lasers used to size objects on seafloor. Mosaic is composed of approximately 30 seconds of video, captured as camera sled traveled over 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.



Map view. Colored shaded-relief bathymetry map of Offshore of Bodega Head map area, generated from multibeam-echosounder and bathymetric-sidescan data. Colors show depths: reds and oranges indicate shallower areas; purples, deeper areas. Illumination azimuth is 300°, from 45° above horizon. Numbered arrows show viewing directions of perspective views shown on this sheet; numbers correspond to figure numbers of views. Black line in Bodega Bay shows location of seismic-reflection profile in figure 8.

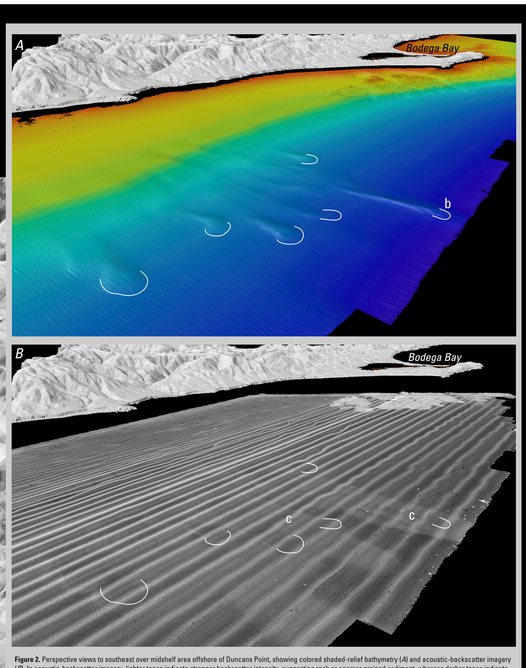


Figure 2. Perspective views to southeast over midshelf area offshore of Duncans Point, showing colored shaded-relief bathymetry (*A*) and acoustic-backscatter imagery (*B*). In acoustic-backscatter imagery, lighter tones indicate stronger backscatter intensity, suggesting rock or coarser grained sediment, whereas darker tones indicate weaker backscatter intensity, suggesting finer grained sediment; linear features of high backscatter that roughly parallel coastline are data-collection artifacts. Colored shaded-relief bathymetry shows several sediment lobes that trend offshore. Lobes were initiated on gently sloping (about 1°) seafloor, in water depths of between 35 and 40 m. Lobe farthest offshore (b) ends on seafloor that slopes less than 0.4°, in water depth of 72 m. Lobe terminations (highlighted by white curved lines) have as much as 4 m of relief over surrounding seafloor. Backscatter imagery (*B*) shows that lobes generally have slightly higher backscatter intensities than surrounding seafloor (c), implying that lobes are composed of slightly coarser grained material. Note that areas of higher backscatter intensity also extend beyond surface expression of lobes as seen in bathymetry. Field of sediment lobes lies just 1 km west of San Andreas Fault, and it is likely that strong ground motions generated by large earthquakes on this fault have triggered these slope failures, mobilizing sediment flows that move down gently sloping shelf and are deposited as lobes (see sheet 8 of this report). Vertical exaggeration, 2x; distance across bottom of both images, about 4 km.

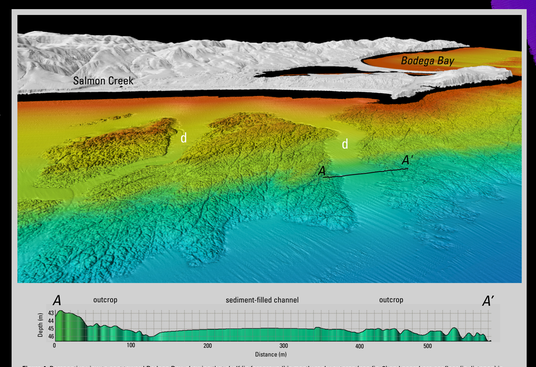


Figure 4. Perspective view to east toward Bodega Bay, showing that shelf (in foreground) is mostly rocky outcrop (see fig. 3) and nearshore seafloor (in distance) is smooth and sediment covered. Large, sediment-filled channels (*d*) that bisect outcrop likely were cut by Salmon Creek during sea-level lowstands. Bathymetric profile *A*–*A′* across southern channel shows that some erosion of bedrock has occurred at both north and south channel margins. Vertical exaggeration of perspective view, 2x; distance across bottom of image, about 1.7 km; vertical exaggeration of profile *A*–*A′*, 10x.

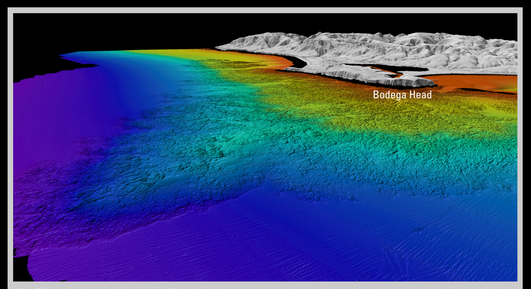


Figure 5. Perspective view to north along coast past Bodega Head, showing extensive area of massive, low- to moderate-relief bedrock, which extends from Bodega Head to limit of California's State Waters. Outcrop is continuous with Cretaceous granitic rocks exposed onshore at Bodega Head (see sheet 10 of this report). Vertical exaggeration, 2x; distance across bottom of image, about 2.5 km.

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. These data are used by researchers to develop maps, reports, and other tools to assist in the coastal and marine spatial-planning capability of coastal-zone managers and other stakeholders. 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 Bodega Head map area.

The map view in the center of the sheet is similar to the colored shaded-relief bathymetry map of the Offshore of Bodega Head 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 Bodega Head map area, as viewed from different directions. These views highlight the diverse seafloor environments in this map area, which include areas of smooth, sediment-covered seafloor and rugged bedrock outcrop, as well as a field of large sediment lobes.

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. 2) 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 reveal the stratigraphic and structural relations between the surface and subsurface.

EXPLANATION

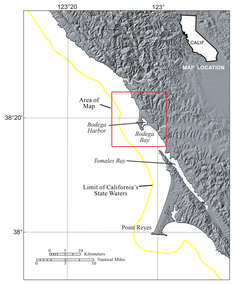
Depth (in meters) and illumination (bright areas are illuminated, facing false sun; dark areas are in shadow, facing away from false sun)

Shallow

10
20
30
40
50
60
70
80

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]



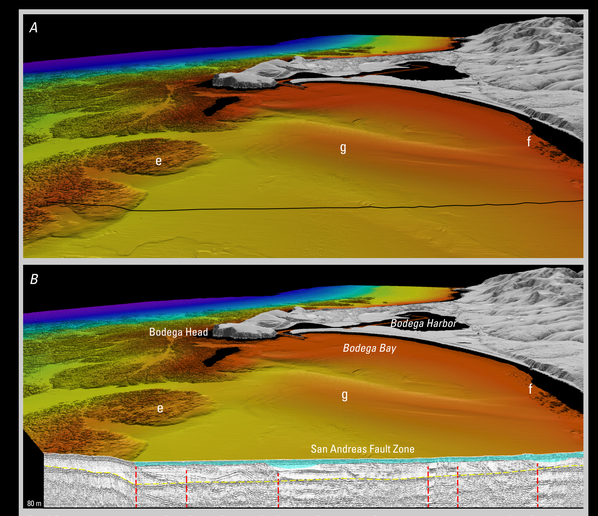


Figure 6. Perspective views to northwest over Bodega Bay along San Andreas Fault Zone, toward Bodega Harbor. *A*, Perspective view shows relatively smooth seafloor in Bodega Bay, flanked by seafloor outcrops of Cretaceous granitic rocks (*e*) on southwest (to left) and rocks of the Jurassic and Cretaceous Franciscan Complex (*f*) on northeast (to right). Black line shows location of seismic-reflection profile in *B* below. *B*, Same perspective view as *A*, converted to block diagram that combines bathymetry with part of northeast-southwest-trending seismic-reflection profile PR–62 (see fig. 9 on sheet 8, this report). Dashed red lines on seismic profile show faults within this complex fault zone. Light-blue shading shows inferred uppermost Pleistocene and Holocene strata, deposited since last sea-level lowstand about 21,000 years ago. These young deposits include large transverse sediment bar (*g*) that was deposited in lee of Bodega Head. Dashed yellow line is seafloor multiple (echo of seafloor reflector). Vertical exaggeration of perspective views, 2x; distance across bottom of perspective view in *A*, about 2.5 km; base of seismic-reflection profile is about 80 m below sea level.

Onshore elevation data from California Coastal Conservancy (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/). Offshore shaded-relief bathymetry from map on sheet 1, this report

Universal Transverse Mercator projection, Zone 10N

NOT INTENDED FOR NAVIGATIONAL USE

Perspective views by Peter Dartnell, 2013. Acoustic-backscatter imagery in figure 2 from map on sheet 3, this report. 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. Bathymetric profile in figure 4 by Peter Dartnell, 2013. Seismic-reflection profile from sheet 8, this report

GIS database and digital cartography by Nadine E. Golden

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Data Integration and Visualization, Offshore of Bodega Head Map Area, California

By
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