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

Open-File Report 2015–1114
Sheet 4 of 10
Pamphlet accompanies map

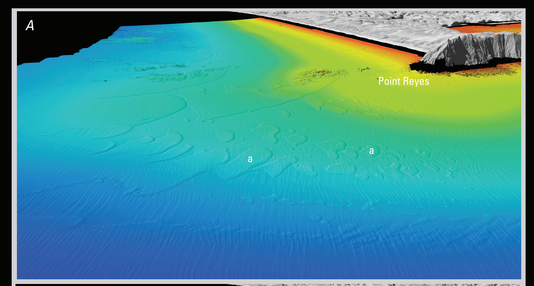


Figure 1. Perspective views to northeast over seafloor west-southwest of Point Reyes headland, showing colored shaded-relief bathymetry (*A*) and acoustic-backscatter imagery (*B*). In acoustic-backscatter imagery, lighter tones indicate stronger backscatter intensity, suggesting rock or coarser grained sediments, whereas darker tones indicate weaker backscatter intensity, suggesting finer grained sediment; long, parallel lines of high backscatter are data-collection artifacts; short, bright-white linear features roughly perpendicular to bottom edge of image are gaps in data. Colored shaded-relief bathymetry reveals complex pattern of slightly elevated sheets (a), which typically are 0.5 to 1 m higher than surrounding seafloor. Backscatter imagery shows that these sheets have lower backscatter intensity than surrounding seafloor; hence, they likely consist of finer-grained sediment. Areas of higher backscatter are mapped as marine shelf scour depressions (unit Qmsd on sheet 10 of this report) that are filled with sand and gravel. Areas of lower backscatter are mapped as marine nearshore and shelf deposits (unit Qms on sheet 10), consisting mostly of sand. Vertical exaggeration, 2x; distance across bottom of both images, about 2.2 km.

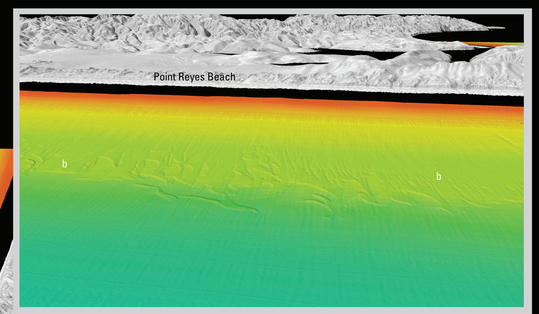


Figure 2. Perspective view to east-southeast toward Point Reyes Beach, showing exposed stretch of energetic shoreline characterized by strong winds and rough seas. Large field of dune sand (unit Qds on sheet 10) is mapped along coast. Littoral sand bar (b) runs offshore, parallel to shoreline, at depths of 10 to 25 m, extending about 2 km offshore. Scour depressions are found along outer edge of bar, normal to shoreline. Acoustic-backscatter imagery (see sheet 3 of this report) shows that bar has lower backscatter intensity than offshore areas that flank it, suggesting that bar deposit likely consists of finer grained material being transported over coarser grained material in offshore direction by energetic nearshore conditions. Vertical exaggeration, 2x; distance across bottom of image, about 1.8 km.

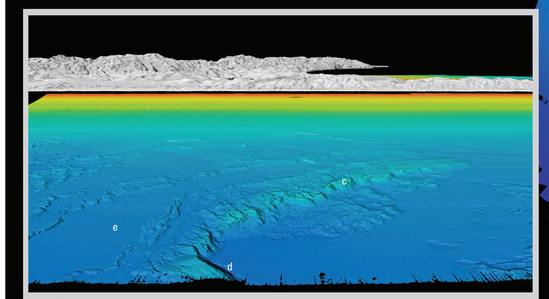


Figure 3. Perspective view to east-southeast over inner shelf offshore of Point Reyes Beach, showing areas of both low- and moderate-relief seafloor. Rougher seafloor (c) is ridge of sedimentary bedrock (mapped as the undivided sedimentary rocks unit [Tu] on sheet 10) that has as much as 7 m of relief in places (d). "Ribbed" character of outcrop reflects differential erosion of dipping beds of differing lithologies (for example, sandstone and mudstone). Intervals of more erodible bedrock (e) commonly trap sediment and, thus, are characterized by smooth seafloor. Ridge marks lithologic boundary that divides rocks that are more resistant to erosion (to north) from those that are more easily eroded (to south). Vertical exaggeration, 2x; distance across bottom of image, about 1.6 km.

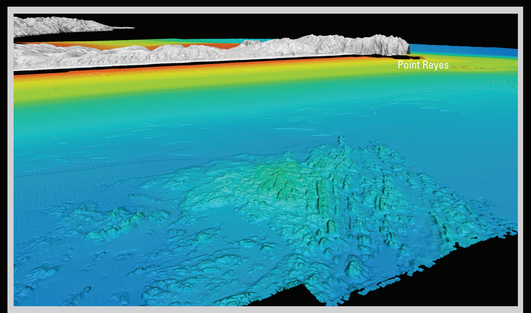
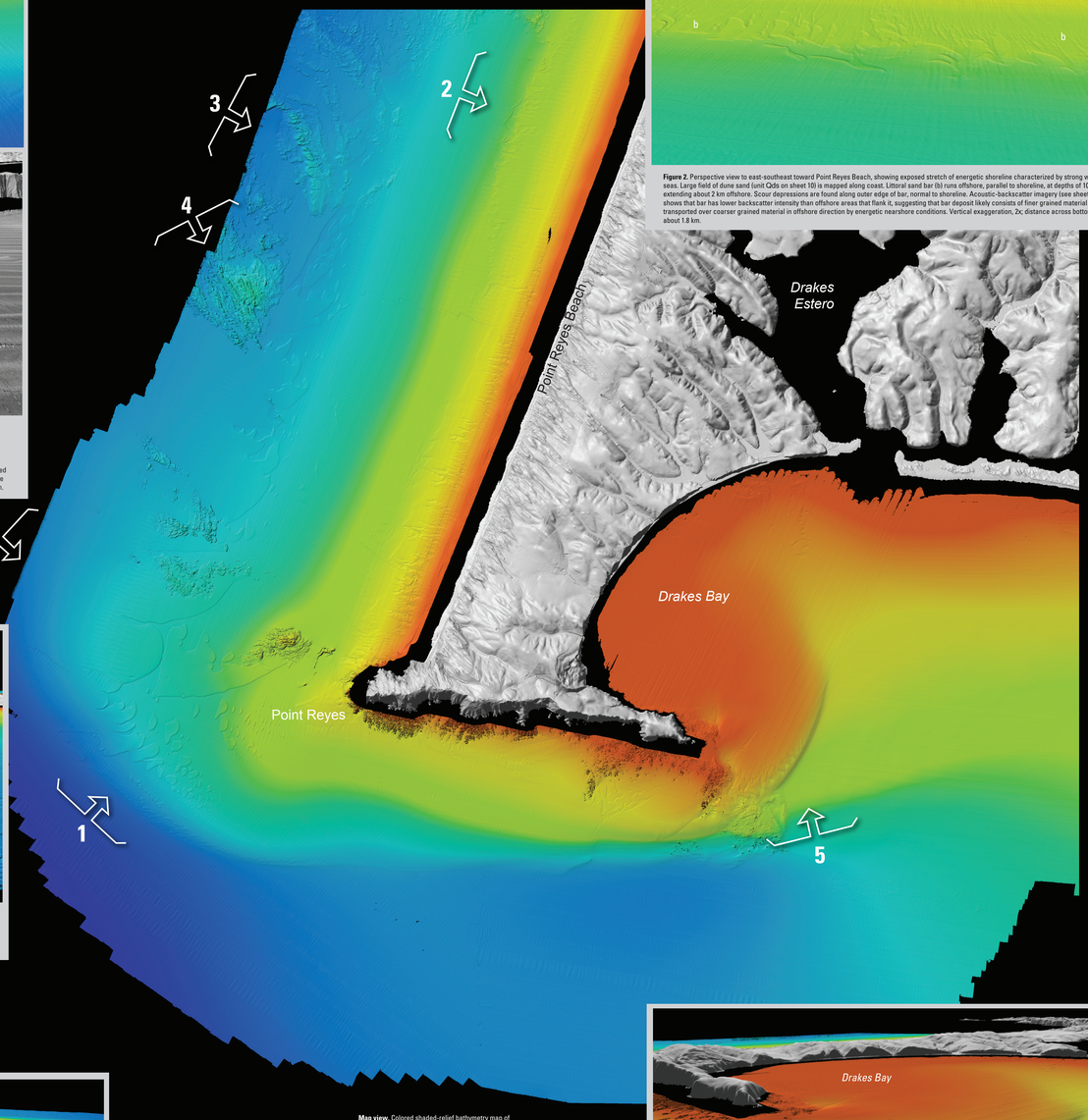


Figure 4. Perspective view to southeast towards Point Reyes headland, showing rocky outcrop mapped as the lower Eocene Point Reyes Conglomerate (unit Tpr on sheet 10), which also is exposed onshore at Point Reyes headland. Differential erosion of steeply southwest-dipping beds has created "ribbed" texture on seafloor (similar to that shown in perspective view in fig. 3). Vertical exaggeration, 2x; distance across bottom of image, about 1.7 km.



Map view. Colored shaded-relief bathymetry map of Offshore of Point Reyes 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. Numbered arrows show viewing directions of perspective views shown on this sheet; numbers correspond to figure numbers of views.

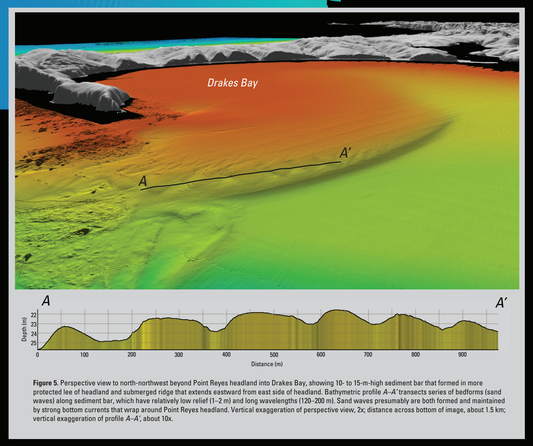


Figure 5. Perspective view to north-northwest beyond Point Reyes headland into Drakes Bay, showing 10- to 15-m-high sediment bar that formed in more protected lee of headland and submerged ridge that extends eastward from east side of headland. Bathymetric profile *A–A′* transects series of bedforms (sand waves) along sediment bar, which have relatively low relief (1–2 m) and long wavelengths (120–200 m). Sand waves presumably are both formed and maintained by strong bottom currents that wrap around Point Reyes headland. Vertical exaggeration of perspective view, 2x; distance across bottom of image, about 1.5 km; vertical exaggeration of profile *A–A′*, about 10x.

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 Point Reyes map area.

The map view in the center of the sheet is similar to the colored shaded-relief bathymetry map of the Offshore of Point Reyes 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.

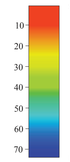
The perspective views and bathymetric profiles in figures 1 through 6 show the colored shaded-relief bathymetry of the Offshore of Point Reyes map area, as viewed from different directions. These views highlight the diverse seafloor environments in this map area, which include areas of featureless, sedimented seafloor interspersed with complex distributions of coarse-grained sediment, as well as folded sedimentary rocks and extensive areas of fractured bedrock.

Draping the acoustic-backscatter imagery (see sheet 3 of this report) over the bathymetry data (fig. 1) highlights the relations between the backscatter intensity and the seafloor morphology, and it also aids in seafloor habitat and geology interpretations.

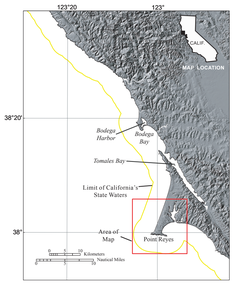
Block diagrams (fig. 6), which combine the bathymetry with seismic-reflection-profile data (see sheet 8 of this report), help reveal the stratigraphic and structural relations between the surface and subsurface.

EXPLANATION

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



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]



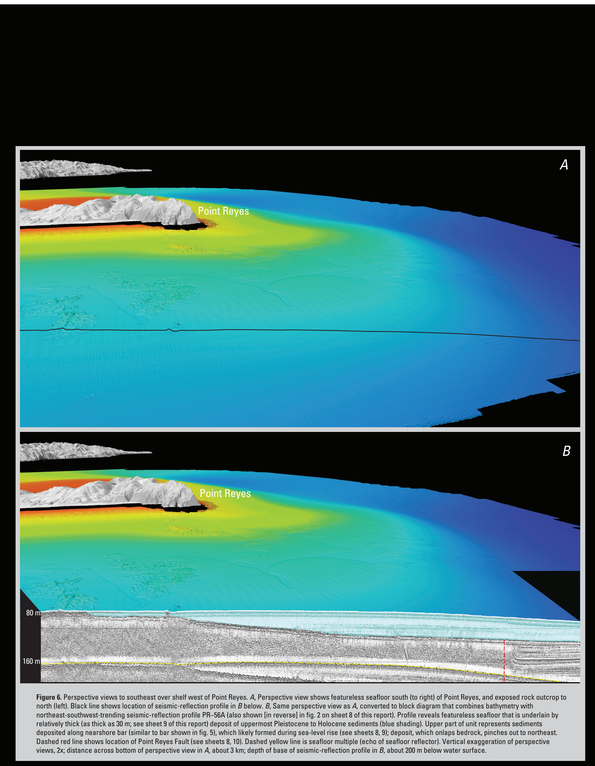


Figure 6. Perspective views to southeast over shelf west of Point Reyes. *A*, Perspective view shows featureless seafloor south (to right) of Point Reyes, and exposed rock outcrop to north (left). Black line shows location of seismic-reflection profile in *B* below. *B*, Same perspective view as *A*, converted to block diagram that combines bathymetry with northeast-southwest-trending seismic-reflection profile PR–56A (also shown [in reverse] in fig. 2 on sheet 8 of this report). Profile reveals featureless seafloor that is underlain by relatively thick (as thick as 30 m; see sheet 9 of this report) deposit of uppermost Pleistocene to Holocene sediments (blue shading). Upper part of unit represents sediments deposited along nearshore bar (similar to bar shown in fig. 5), which likely formed during sea-level rise (see sheets 8, 9); deposit, which onlaps bedrock, pinches out to northeast. Dashed red line shows location of Point Reyes Fault (see sheets 8, 10). 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 3 km; depth of base of seismic-reflection profile in *B*, about 200 m below water surface.

Onshore elevation data from NOAA Coastal Service Center's Digital Coast (available at http://coast.noaa.gov/digitalcoast/) 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

Perspective views by Peter Dartnell, 2013. Acoustic-backscatter imagery in figure 1 from map on sheet 3, this report. Bathymetric profile in figure 5 by Peter Dartnell, 2013. Seismic-reflection profile in figure 8 from sheet 8, this report

GIS database and digital cartography by Nadine E. Golden

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

By
Peter Dartnell

2015

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