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

Open-File Report 2016–1072
Sheet 4 of 10
Pamphlet accompanies map

Figure 4. Video mosaic generated from seafloor video captured over rock outcrop in midshelf area, south of Monterey Canyon (see fig. 1 for location). Outcrop is mapped as the upper Miocene and Pliocene Purisima Formation, composed of sandstone, siltstone, and mudstone (see sheet 10). Mosaic reveals blocky outcrop, boulders, and intervening coarse sand and gravel. Camera-sled tow direction is from bottom to top; mosaic is made up of 40 seconds of video as camera sled travels 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.

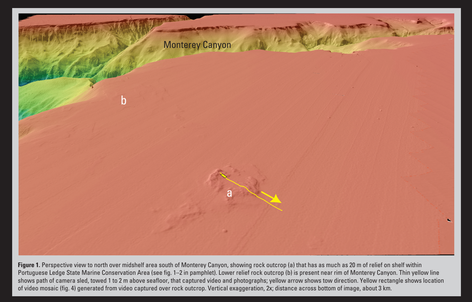


Figure 1. Perspective view to north over midshelf area south of Monterey Canyon, showing rock outcrop (a) that has as much as 20 m of relief on shelf within Portuguese Ledge State Marine Conservation Area (see fig. 1–2 in pamphlet). Lower relief rock outcrop (b) is present near rim of Monterey Canyon. Thin yellow line shows path of camera sled, towed 1 to 2 m above seafloor, that captured video and photographs; yellow arrow shows tow direction. Yellow rectangle shows location of video mosaic (fig. 4) generated from video captured over rock outcrop. Vertical exaggeration, 2x; distance across bottom of image, about 3 km.

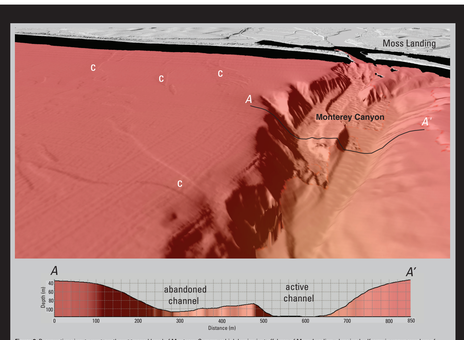


Figure 2. Perspective view to east-northeast toward head of Monterey Canyon, which begins just offshore of Moss Landing, showing bedforms in upper reaches of main channel that are as high as 2 m (Smith and others, 2007). Bathymetric profile *A*–*A*′ highlights active channel, which bends south (to right) around bathymetric high in center of canyon, as well as older abandoned channel, located to north (left) between bathymetric high and north wall of Monterey Canyon. Where profile crosses canyon, base of active channel is 8 m below that of abandoned channel. Complex pattern of shallow depressions (c) are barely visible on shelf north (to left) of canyon; however, seafloor within depressions has high acoustic-backscatter intensities (see sheet 3 of this report). Depressions likely are composed of sand that is coarser than surrounding shelf. One of larger depressions (in foreground) "spills" into Monterey Canyon. Vertical exaggeration of perspective view, 2x; distance across bottom of image, about 1 km; no vertical exaggeration in profile *A*–*A*′.

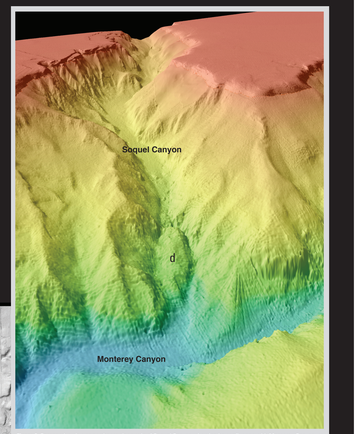
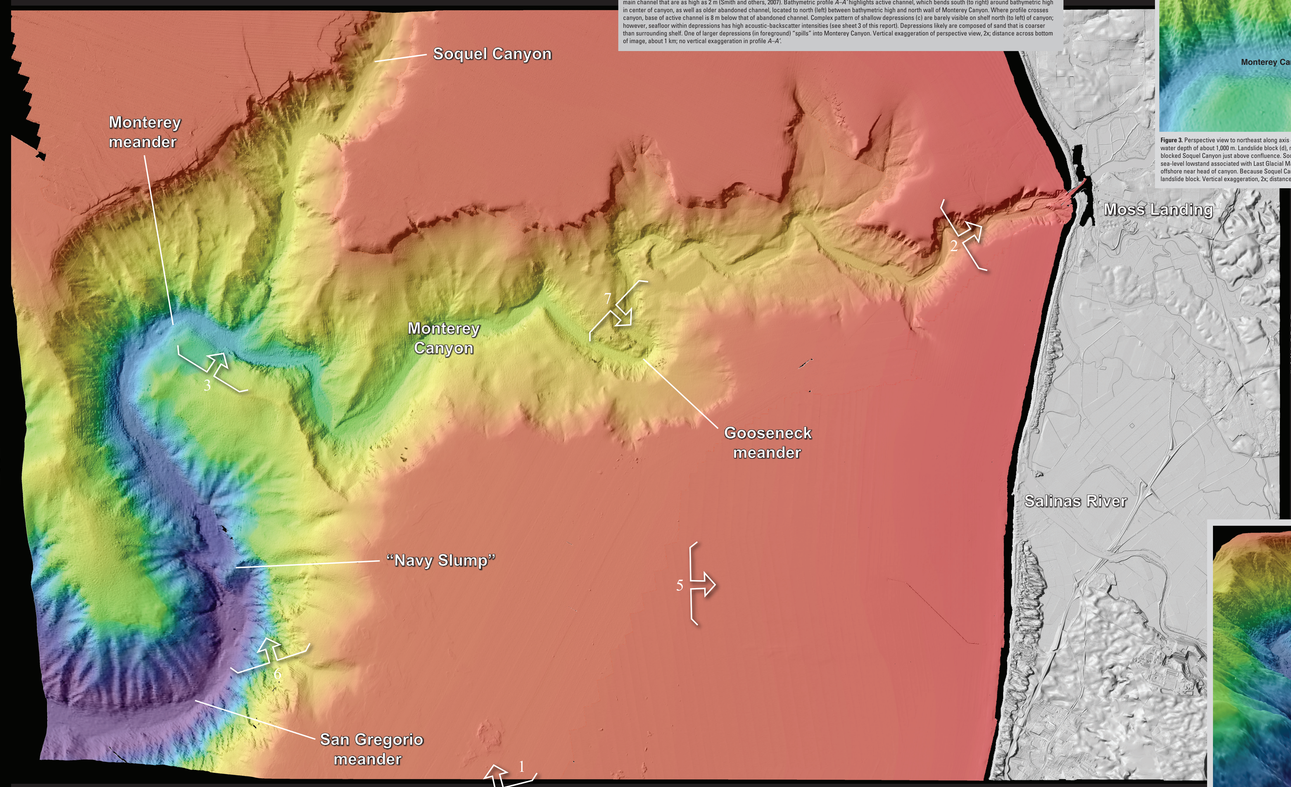


Figure 3. Perspective view to northeast along axis of Soquel Canyon, showing its confluence with Monterey Canyon, at water depth of about 1,000 m. Landslide block (d), mapped as unit Qtlsmb (see sheet 10 of this report), has partly blocked Soquel Canyon just above confluence. Soquel Canyon has not been active sediment-transport pathway since sea-level lowstand associated with Last Glacial Maximum (about 21,000 years ago) when shoreline was farther offshore near head of canyon. Because Soquel Canyon is not active, sediment does not appear to be built up behind landslide block. Vertical exaggeration, 2x; distance across bottom of image, about 2.5 km.



Map view. Colored shaded-relief bathymetry map of Monterey Canyon and Vicinity map area, generated from multibeam-echosounder and bathymetric-sidescan data. Colors show depth: 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.

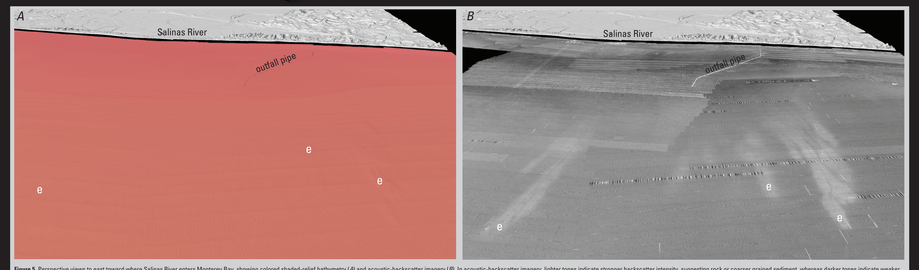


Figure 5. Perspective views to east toward where Salinas River enters Monterey Bay, showing colored shaded-relief bathymetry (*A*) and acoustic-backscatter imagery (*B*). In acoustic-backscatter imagery, lighter tones indicate stronger backscatter intensity, suggesting rock or coarser grained sediment, whereas darker tones indicate weaker backscatter intensity, suggesting finer grained sediment. Although bathymetry has very little relief in this midshelf area, acoustic-backscatter imagery reveals lobes of higher backscatter (e) that suggest presence of flows of coarse sediment associated with large delta-mouth bar offshore of Salinas River (see sheets 8, 9). Linear feature in nearshore area is outfall pipe. Vertical exaggeration of perspective views, 2x; distance across bottom of both views, about 4 km.

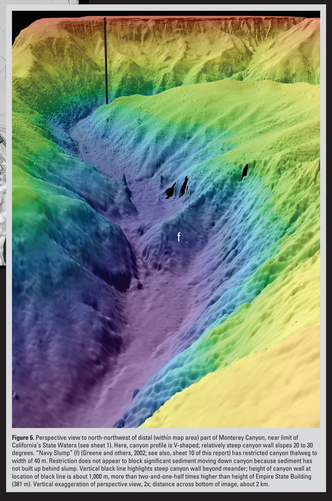


Figure 6. Perspective view to north-northwest of distal (within map area) part of Monterey Canyon, near limit of California's State Waters (see sheet 1). Here, canyon profile is V-shaped; relatively steep canyon wall slopes 20 to 30 degrees. "Navy Slump" (f) (Greene and others, 2002; see also, sheet 10 of this report) has restricted canyon thalweg to width of 40 m. Restriction does not appear to block significant sediment moving down canyon because sediment has not built up behind slump. Vertical black line highlights steep canyon wall beyond meander; height of canyon wall at location of black line is about 1,000 m, more than two-and-one-half times higher than height of Empire State Building (381 m). Vertical exaggeration of perspective view, 2x; distance across bottom of image, about 2 km.

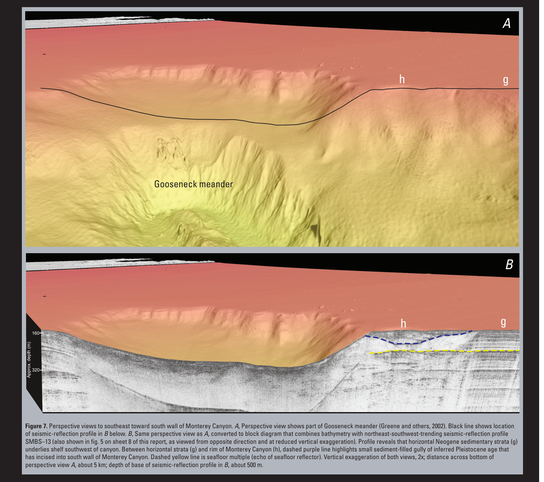


Figure 7. Perspective views to southeast toward south wall of Monterey Canyon. *A*, Perspective view shows part of Gooseneck meander (Greene and others, 2002). Black line shows location of seismic-reflection profile in *B* below. *B*, Same perspective view as *A*, converted to block diagram that combines bathymetry with northeast-southwest-trending seismic-reflection profile SMBS–13 (also shown in fig. 5 on sheet 8 of this report, as viewed from opposite direction and at reduced vertical exaggeration). Profile reveals that horizontal Neogene sedimentary strata (g) underlies shelf southwest of canyon. Between horizontal strata (g) and rim of Monterey Canyon (h), dashed purple line highlights small sediment-filled gully of inferred Pleistocene age that has incised into south wall of Monterey Canyon. Dashed yellow line is seafloor multiple (echo of seafloor reflector). Vertical exaggeration of both views, 2x; distance across bottom of perspective view *A*, about 5 km; depth of base of seismic-reflection profile in *B*, about 500 m.

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 Monterey Canyon and Vicinity map area.

The map view in the center of the sheet is similar to the colored-shaded-relief bathymetry map of Monterey Canyon and Vicinity 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, 3, 5, 6, and 7 show the colored shaded-relief bathymetry of the Monterey Canyon and Vicinity map area, as viewed from different directions. These views mainly show detailed views of Monterey Canyon, the deepest and most complex submarine canyon along the California coast.

Video-mosaic images created from seafloor digital video (fig. 4) 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 (see sheet 6 of this report), 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. 5) highlights the relations between the backscatter intensity and the seafloor morphology. It also aids in benthic habitat and geology interpretations, as well as documenting anthropogenic influences on the seafloor.

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.

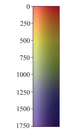
REFERENCES CITED

Greene, H.G., Maher, N.M., and Paull, C.K., 2002, Physiography of the Monterey Bay National Marine Sanctuary and implications about continental margin development: Marine Geology, v. 181, p. 55–82.

Smith, D.P., Kvitek, R., Iampietro, P. J., and Wong, K., 2007, Twenty-nine months of geomorphic change in upper Monterey Canyon (2002–2005): Marine Geology, v. 236, p. 79–94, doi:10.1016/j.margeo.2006.09.024.

EXPLANATION

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



Shallow

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]

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/). Offshore shaded-relief bathymetry from map on sheet 1, this report.

Universal Transverse Mercator projection, Zone 10N

NOT INTENDED FOR NAVIGATIONAL USE

MAP LOCATION

Data Integration and Visualization, Monterey Canyon and Vicinity Map Area, California

By
Peter Dartnell

2016

Perspective views by Peter Dartnell, 2014. Bathymetric profile in figure 2 by Peter Dartnell, 2014. Video-mosaic image in figure 4 by Peter Dartnell, 2014, 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 5 from map on sheet 3, this report. Seismic-reflection profile in figure 7 from sheet 8, this report

GIS database and digital cartography by Nadine E. Golden

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