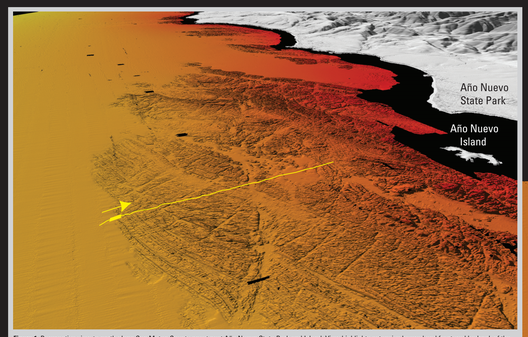


Figure 1. Perspective view to north along San Mateo County coast past Año Nuevo State Park and Island. View highlights extensive layered and fractured bedrock of the middle and upper Miocene Monterey Formation (see sheets 8 and 10 of this report) with featureless seafloor offshore. Thin yellow line shows 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. 3) generated from video captured over the transition from featureless seafloor to rock outcrop. Vertical exaggeration, 2x; distance across bottom of image, about 1.7 km.

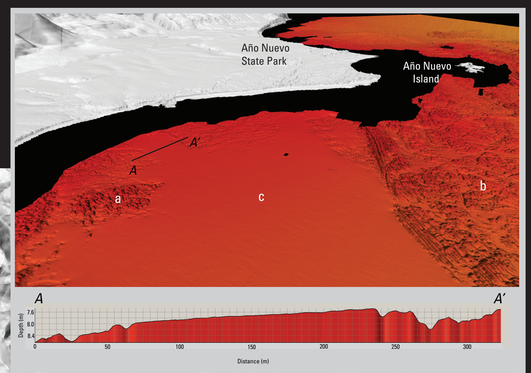


Figure 2. Perspective view to southeast over area offshore of Año Nuevo State Park and bathymetric profile *A–A′*. Moderate-relief rock outcrop is exposed on seafloor directly offshore (a) as well as farther offshore surrounding Año Nuevo Island (b). In between outcrops (a, b) is smooth, featureless seafloor (c), likely composed of sand. Profile *A–A′* reveals field of sand in nearshore that is at same depth or shallower than outcrop. Sand, likely transported down coast, covers outcrop and may also contribute to sand dunes onshore in Año Nuevo State Park. Vertical exaggeration of perspective view, 2x; distance across bottom of image, about 1.3 km, vertical exaggeration of profile *A–A′*, about 20x.

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 Pigeon Point map area.

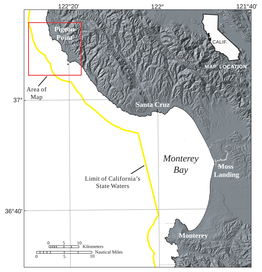
The map view in the center of the sheet is similar to the colored shaded-relief bathymetry map of the Offshore of Pigeon Point map area (see sheet 1 of this report). Numbered arrows show viewing directions of the perspective views on this sheet; the numbers indicate the figure number of the perspective 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 Pigeon Point 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 shallow depressions, as well as folded and fractured sedimentary rocks.

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 (see sheet 6 of this report), video mosaics can capture larger areas and, thus, can show transitional zones between different seafloor environments.

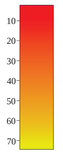
Draping the acoustic-backscatter imagery (see sheet 3 of this report) over the bathymetry data (fig. 4) highlights the relations between the backscatter intensity and the seafloor morphology. It also aids in seafloor habitat and geology interpretations, as well as mapping sediment-transport pathways.

Block diagrams (fig. 5), 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]

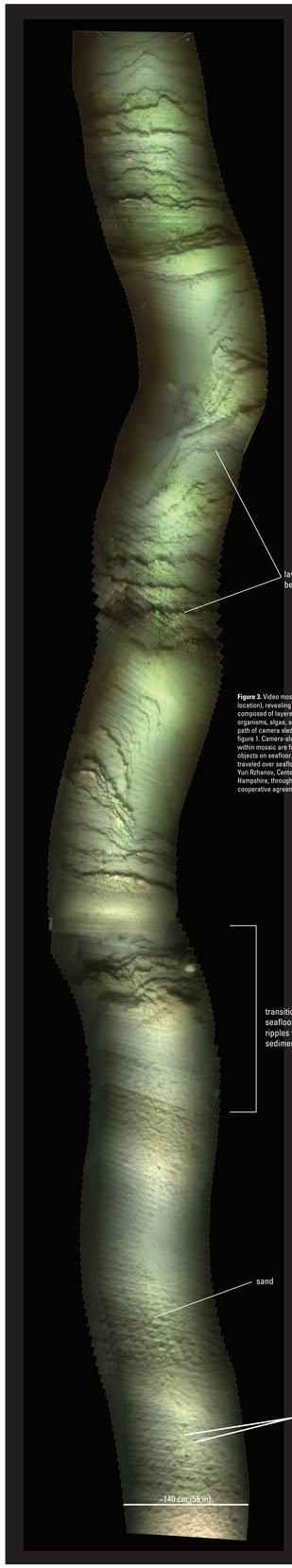


Figure 3. Video mosaic of area offshore of Año Nuevo Island (see fig. 1 for location), revealing transition from sandy seafloor to rock outcrop. Outcrop is composed of layered sedimentary bedrock that is relatively clean of encrusting organisms, algae, and kelp. Image shows linear ridges of rock, perpendicular to path of camera sled, that are consistent with seafloor morphology shown in figure 1. Camera-sled tow direction is from bottom to top. Green and red dots within mosaic are from paired lasers on camera sled, used to determine scale of objects on seafloor. Mosaic made up of about 1 minute of video 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.

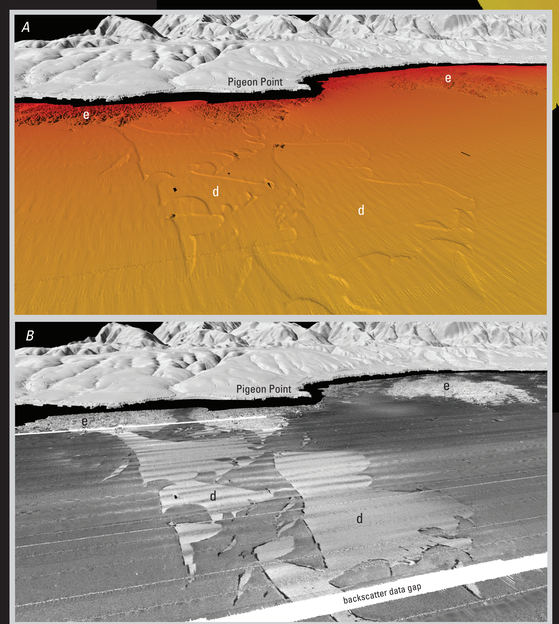
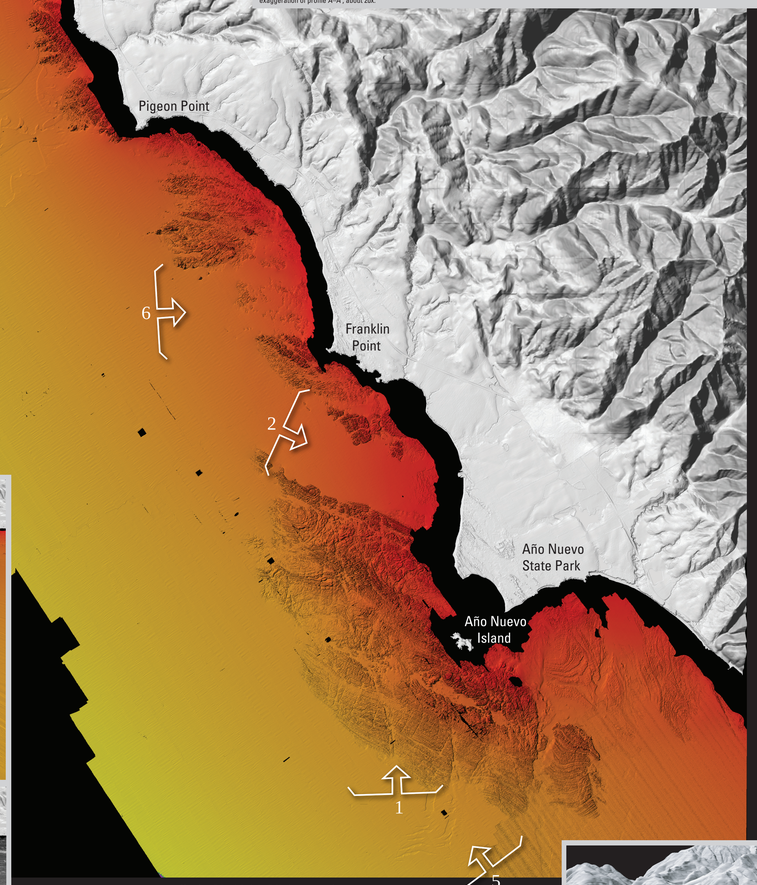


Figure 4. Perspective views to northeast over nearshore area offshore of Pigeon Point, showing colored shaded-relief bathymetry (*A*) and acoustic-backscatter imagery (*B*). In acoustic-backscatter imagery, lighter tones indicate stronger backscatter intensity, suggesting rock or coarser grained sediment, whereas darker tones indicate weaker backscatter intensity, suggesting finer grained sediment. Colored shaded-relief bathymetry shows complex distribution of low-relief scour depressions (*d*) and rock outcrop in nearshore (*e*). Acoustic-backscatter imagery reveals that shallow depressions contain very high backscatter intensities suggesting depressions are filled with coarser grained sands and gravels. Backscatter intensities of scour depressions are similar to nearshore rock outcrop. Parallel lines of higher backscatter in (*B*) are data-collection and -processing artifacts. Vertical exaggeration of perspective views, 2x; distance across bottom of both views, about 1.3 km.



Map view. Colored shaded-relief bathymetry map of Offshore of Pigeon Point map area, generated from multibeam-echosounder and bathymetric-sidescan data. Colors show depth: reds indicate shallower areas; yellows, deeper areas. Illumination azimuth is 300°, from 45° above horizon. Ripple patterns and parallel lines that are apparent within map area are data-collection and -processing artifacts. Lines at borders of some surveys result from slight differences in depth, as measured by different mapping systems in different years. These various 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 views.

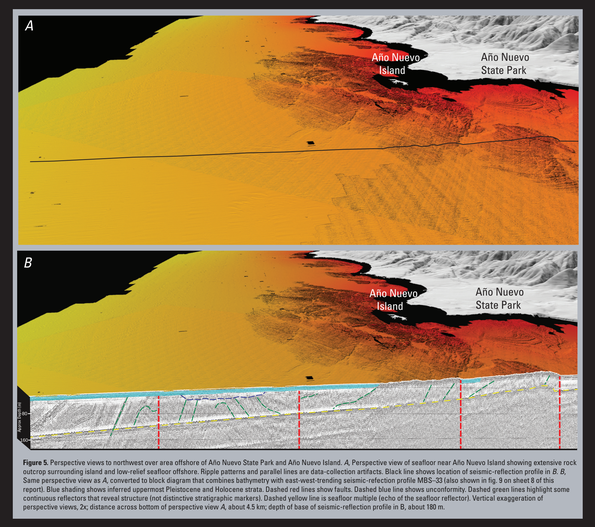


Figure 5. Perspective views to northwest over area offshore of Año Nuevo State Park and Año Nuevo Island. *A*, Perspective view of seafloor near Año Nuevo Island showing extensive rock outcrop surrounding island and low-relief seafloor offshore. Ripple patterns and parallel lines are data-collection artifacts. Black line shows location of seismic-reflection profile in *B*. *B*, Same perspective view as *A*, converted to block diagram that combines bathymetry with east-west-trending seismic-reflection profile MBS–23 (also shown in fig. 3 on sheet 8 of this report). Blue shading shows inferred uppermost Pleistocene and Holocene strata. Dashed red lines show faults. Dashed blue line shows unconformity. Dashed green lines highlight some continuous reflectors that reveal structure (not distinctive stratigraphic markers). Dashed yellow line is seafloor multiple (echo of the seafloor reflector). Vertical exaggeration of perspective views, 2x; distance across bottom of perspective view *A*, about 4.5 km; depth of base of seismic-reflection profile in B, about 180 m.

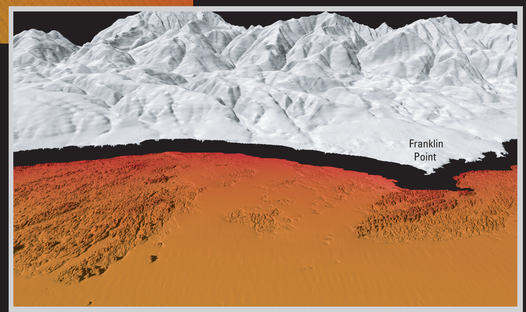


Figure 6. Perspective view to east over nearshore area offshore of Franklin Point, showing rock outcrop in nearshore and featureless seafloor offshore. Outcrop mapped as Upper Cretaceous Pigeon Point Formation, which consists of sandstone and conglomerate, interbedded with siltstone and mudstone (see sheet 10 of this report). To north and south, outcrop has as much as 6 m of seafloor relief. In center of perspective view, outcrop has less than 2 m of relief and is mainly covered by upper Holocene shelf deposits. Rock burial rates likely fluctuate from season to season along this energetic stretch of coast. Vertical exaggeration, 2x; distance across bottom of image, about 2.5 km.

Onshore elevation data from California Coastal Conservancy (available from National Oceanic and Atmospheric Administration [NOAA] Coastal Service Center's Digital Coast 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

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

By
Peter Dartnell

2015

Perspective views by Peter Dartnell, 2014. Bathymetric profile in figure 2 by Peter Dartnell, 2014. Video-mosaic image in figure 3 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 4 from map on sheet 3, this report. Seismic-reflection profile in figure 6 from sheet 8, this report

GIS database and digital cartography by Nadine E. Golden

Manuscript approved for publication December 4, 2015

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Suggested Citation: Dartnell, P., 2015, Data integration and visualization, Offshore of Pigeon Point map area, California, sheet 4 in Cochrane, G.R., Watt, J.T., Dartnell, P., Greene, H.G., Erdey, M.D., Dieter, B.E., Golden, N.E., Johnson, S.Y., Endris, C.A., Hartwell, S.R., Kvitek, R.G., Davenport, C.W., Krigsman, L.M., Ritchie, A.C., Sliter, R.W., Finlayson, D.P., and Maier, K.L. (G.R. Cochrane and S.A. Cochran, eds.), California State Waters Map Series—Offshore of Pigeon Point, California: U.S. Geological Survey Open-File Report 2015–1232, pamphlet 40 p., 10 sheets, scale 1:24,000, http://dx.doi.org/10.3133/ofr20151232.

ISSN 2331-1258 (online)
http://dx.doi.org/10.3133/ofr20151232