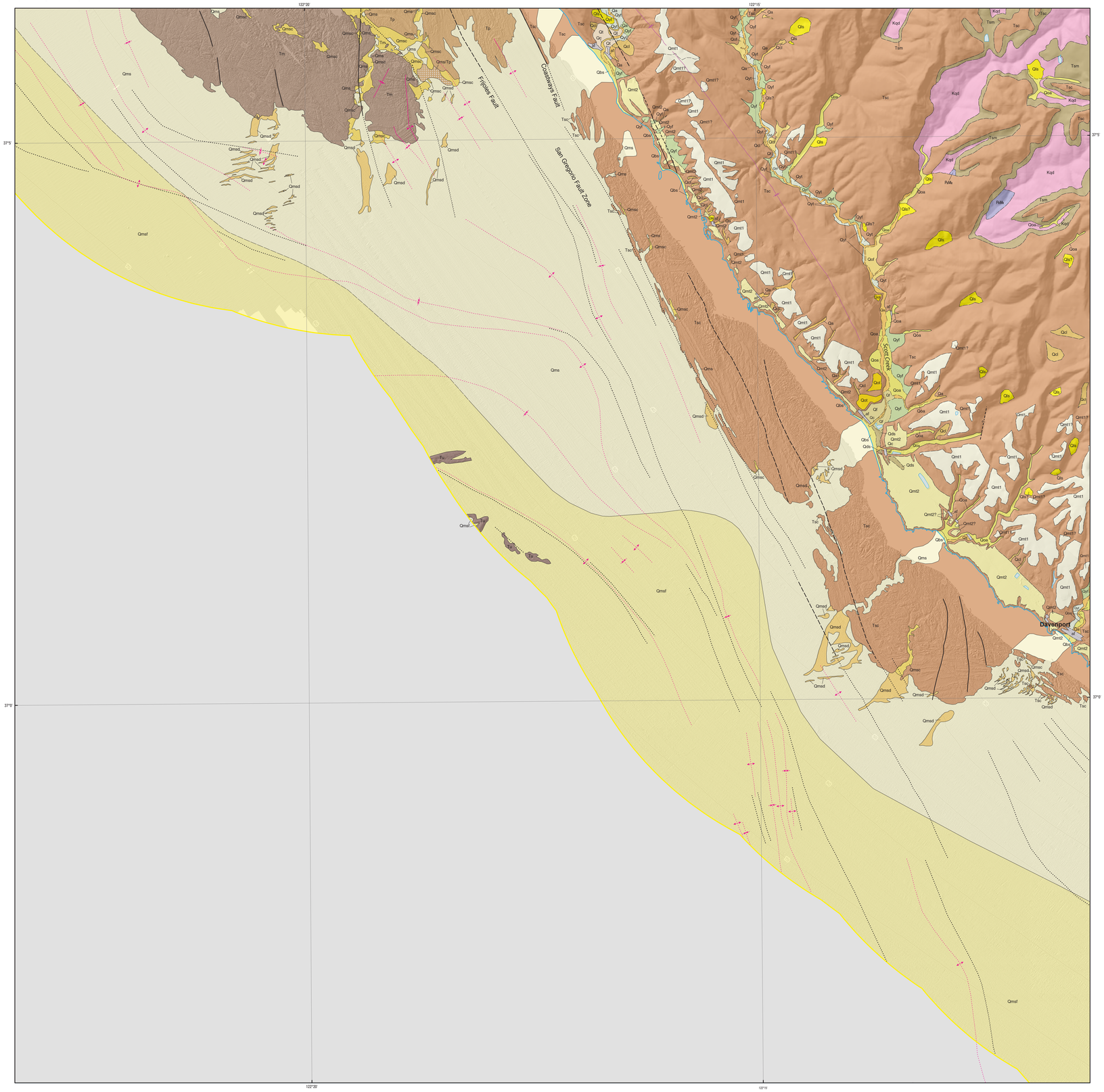
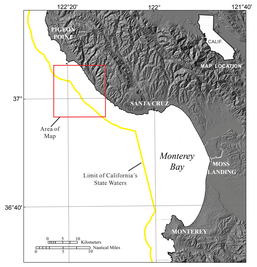
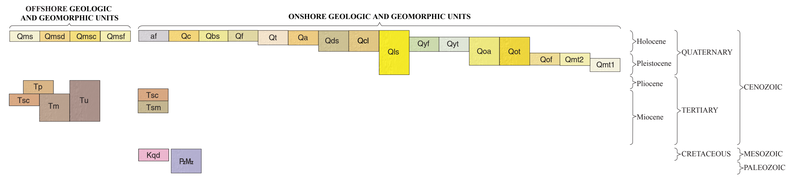
U.S. Department of the Interior
U.S. Geological Survey

Open-File Report 2015–1191
Sheet 10 of 10
Pamphlet accompanies map





CORRELATION OF MAP UNITS



LIST OF MAP UNITS

[See Description of Map Units (chapter 8, in pamphlet) for complete map-unit descriptions]

OFFSHORE GEOLOGIC AND GEOMORPHIC UNITS

[Note that composite units (gray-stippled areas) are designated on map by composite label indicating both overlying sediment cover and lower (older) unit, separated by slash (for example, Qms/Tp indicates that thin sheet of Qms overlies Tp)]

Qms **Marine nearshore and shelf deposits (late Holocene)**—Mostly sand; ripples common

Qmsd **Marine shelf scour depressions (late Holocene)**—Inferred to be coarse sand and gravel, in low-relief scours

Qmsc **Coarse-grained marine nearshore and shelf deposits (late Holocene)**—Predominantly coarse sand and gravel

Qmsf **Fine-grained marine shelf deposits (late Holocene)**—Mostly mud to muddy sand

Tp **Purisima Formation (Pliocene and late Miocene)**—Mostly medium-grained to very fine-grained, poorly indurated to friable sandstone, siltstone, and claystone

Tu **Sedimentary rocks, undivided (Pliocene and Miocene)**—May consist of rocks of the Purisima Formation (Tp), the Santa Cruz Mudstone (Tsc), or the Monterey Formation (Tm)

Tsc **Santa Cruz Mudstone (late Miocene)**—Siliceous organic mudstone and nonsiliceous mudstone, siltstone, and minor amounts of sandstone

Tm **Monterey Formation (late and middle Miocene)**—Porcelaneous shale and chert, porcelaneous mudstone, calcareous claystone, and small amounts of siltstone and sandstone

ONSHORE GEOLOGIC AND GEOMORPHIC UNITS

[Units compiled from Smith (1981), California Geological Survey (1982), Brabb (1997), and Graymer and others (2006); unit ages, which are from these sources, reflect local stratigraphic relations. In addition, some units modified by C.W. Davenport on basis of analysis of 2009 lidar imagery]

af **Artificial fill (late Holocene)**—Material placed by humans

Qc **Stream-channel deposits (late Holocene)**—Sand and gravel deposits within active stream channels

Qbs **Beach-sand deposits (late Holocene)**—Fine to very coarse sand that forms active beaches in coastal environments; may form veneer over bedrock platform

Qf **Alluvial fan deposits (late Holocene)**—Sediments derived from hillslopes in lower valley of Scott Creek; may include debris-flow and braided-stream deposits

Qt **Stream-terrace deposits (Holocene)**—Relatively smooth and undissected, low-lying terraces; found immediately adjacent to lower reaches of active stream channels

Qa **Alluvial deposits, undivided (Holocene)**—Alluvium deposited along stream channels; mapped in valley bottoms along small- to medium-sized streams. Locally, may include small terrace and channel deposits

Qds **Dune-sand deposits (Holocene)**—Very well-sorted, fine to medium sand that forms both active and stabilized dunes in coastal environments

Qcl **Colluvium (Holocene)**—Loose to firm, unsorted sand, silt, clay, gravel, rock debris, and organic material, in varying proportions; typically mapped in hillside swales and narrow immature drainages

Qls **Landslide deposits (Holocene and Pleistocene)**—Weathered and disintegrated rocks and soil

Qyf **Alluvial fan deposits (Holocene)**—Sediment (sand, gravel, silt, clay) deposited by streams emanating from canyons onto alluvial plains; identified primarily by fan morphology and topographic expression

Qyt **Stream-terrace deposits (Holocene)**—Relatively smooth, undissected, relatively low-lying terraces adjacent to active stream channels

Qoa **Alluvial deposits, undivided (Holocene and late Pleistocene)**—Found on gently sloping to level terrace surfaces adjacent to stream channels, where separate units could not be delineated at map scale

Qot **Stream-terrace deposits (Holocene and late Pleistocene)**—Sand, gravel, silt, and minor clay of uncertain age; underlies relatively flat platforms adjacent to, and elevated above, stream channels

Qof **Alluvial fan deposits (late Pleistocene)**—Sediment deposited by streams emanating from canyons; late Pleistocene age indicated by more dissection and higher elevations than adjacent Holocene fans

Qmt2 **Lowest emergent marine-terrace deposits (Pleistocene)**—Semiconsolidated sand and less common gravel deposits, on uplifted marine-abrasion platforms along coast

Qmt1 **Marine-terrace deposits, undivided (Pleistocene)**—Semiconsolidated sand and less common gravel deposits, on uplifted marine-abrasion platforms along coast; found at higher elevations than Qmt2

Tsc **Santa Cruz Mudstone (late Miocene)**—Pale-yellowish-brown, siliceous mudstone and nonsiliceous mudstone, siltstone, and minor sandstone

Tsm **Santa Margarita Sandstone (late Miocene)**—Yellowish-grey to white, friable, medium- to fine-grained arkosic sandstone; locally calcareous and bituminous; pebble conglomerate at base of section locally

Kqd **Quartz diorite (Cretaceous)**

PzMs **Metasedimentary rocks (Mesozoic or Paleozoic)**—Mainly pelitic schist and quartzite

EXPLANATION OF MAP SYMBOLS

Contact—Solid where location is certain; dashed where location is approximate, inferred, or concealed

Fault—Solid where location is certain, long-dashed where location is approximate, short-dashed where location is inferred, dotted where location is concealed, queried where uncertain

Folds—Solid where location is certain; dotted where location is approximate, inferred, or concealed
Anticline
Syncline

Approximate modern shoreline—Defined as Mean High Water (MHW) (+1.46 m), North American Vertical Datum of 1988 (NAVD 88)

3-nautical-mile limit of California's State Waters

Area of "no data"—Areas beyond 3-nautical-mile limit of California's State Waters were not mapped as part of California Seafloor Mapping Program

DISCUSSION

Marine geology and geomorphology were mapped in the Offshore of Scott Creek map area from approximate Mean High Water (MHW) to the 3-nautical-mile limit of California's State Waters. MHW is defined at an elevation of 1.46 m above the North American Vertical Datum of 1988 (NAVD 88) (Weber and others, 2005). Offshore geologic units were delineated on the basis of integrated analyses of adjacent onshore geology with multibeam bathymetry and backscatter imagery (sheets 1, 2, 3), seafloor-sediment and rock samples (Reid and others, 2006), digital camera and video imagery (sheet 6), and high-resolution seismic-reflection profiles (sheet 8). Aerial photographs taken in multiple years were used to map the nearshore area (0 to 10 m water depth) and to link the offshore and onshore geology.

Onshore geology was compiled from Smith (1981), California Geological Survey (1982), Brabb (1997), and Graymer and others (2006); unit ages, which are from these sources, reflect local stratigraphic relations. In addition, some units were modified by C.W. Davenport on the basis of analysis of 2009 lidar imagery.

The offshore part of the map area lies southwest of the southwest flank of the Santa Cruz Mountains, extending from the shoreline to water depths of about 60 to 75 m on the gently dipping (about 0.6° to 0.8°) continental shelf. The shelf is underlain by Neogene bedrock and a variably thick (as much as 24 m) veneer of upper Quaternary sediment (see sheet 9). Sea level has risen 120 to 130 m during the last about 21,000 years (see, for example, Stanford and others, 2011), leading to a broadening of the continental shelf, progressive eastward migration of the shoreline and wave-cut platform, and associated transgressive erosion and deposition. The Offshore of Scott Creek map area is now an open-ocean shelf that is subjected to full, and sometimes severe, wave energy. Shelf morphology and geology also are affected by local faulting, folding, uplift, and possibly subsidence.

The Offshore of Scott Creek map area straddles the right-lateral San Gregorio Fault Zone, an important structure in the distributed transform boundary between the North American and Pacific plates (see, for example, Dickinson and others, 2005). This fault zone is part of a regional fault system that is present predominantly in the offshore for about 400 km, from Point Conception in the south (where it is known as the Hosgri Fault; Johnson and Watt, 2012) to Bolinas and Point Reyes in the north (Bruns and others, 2002; Ryan and others, 2008). The San Gregorio Fault Zone in the map area is part of a 90-km-long offshore segment that extends northward from Point Sur (about 75 km south of the map area), across outer Monterey Bay to Point Año Nuevo (1 km north of the map area) (see sheet 9; see also, Weber and Lajoie, 1980; Brabb and others, 1998; Wagner and others, 2002). Offshore parts of this fault zone are identified in seismic-reflection profiles on the basis of abrupt truncation or warping of reflections and (or) the juxtaposition of reflection panels that have differing seismic parameters (see sheet 8). In this map area, the San Gregorio Fault forms a distributed shear zone about 2 km wide that includes two main fault strands. The nearshore east strand, known as the Coastways Fault, partly coincides with a prominent bathymetric lineament on the outer flank of nearshore bedrock outcrops present between Davenport and the mouth of Waddell Creek (see sheets 1, 2). The west strand, known as the Frijoles Fault, cuts across the flat, sediment-covered shelf. Cumulative lateral slip on the San Gregorio Fault Zone is thought to range from 4 to 10 mm/yr on the basis of field observations at Point Año Nuevo (Weber, 1994).

McCulloch (1987) considered the San Gregorio Fault Zone to be the eastern margin of the Outer Santa Cruz Basin (see fig. 8–1 in pamphlet). Farther offshore, outside California's State Waters but within the map area, this basin is cut by the northwest-striking Ascension Fault (Greene and others, 2002; U.S. Geological Survey and California Geological Survey, 2010).

The seafloor outcrops of the Miocene Monterey Formation (unit Tm) and the upper Miocene and Pliocene Purisima Formation (unit Tp; Powell and others, 2007) that are found along the north edge of the map area are continuous with onshore and nearshore outcrops at Point Año Nuevo to the north (see fig. 1–1 in pamphlet). Outcrops of the Monterey Formation are characterized by differentially eroded layers (harder and softer interbeds) that are folded and densely fractured, creating an overall "shattered" appearance on shaded-relief maps (see sheets 1, 2). Adjacent seafloor outcrops of the Purisima Formation are similarly folded but notably are much less fractured and, thus, have a distinctly different geomorphic expression. Outcrops of both the Monterey Formation and the Purisima Formation are found west of the Coastways Fault, and outcrops of the Purisima Formation straddle the Frijoles Fault.

The upper Miocene Santa Cruz Mudstone (unit Tsc) forms onshore and nearshore outcrops on the east flank of the Coastways Fault, and it notably does not crop out west of the Coastways Fault. Seafloor outcrops reveal both folding and fracturing, although not to the extent of that of the Monterey Formation to the west. Four midshelf bedrock outcrops in the central part of the map area (in the outer reaches of California's State Waters) are mapped as the undivided Miocene and Pliocene sedimentary rocks unit (Tu); these outcrops may consist of rocks of the Monterey Formation (Tm), the Santa Cruz Mudstone (Tsc), or the Purisima Formation (Tp).

Modern nearshore and inner shelf to midshelf sediments are mostly sand (unit Qms) and a mix of sand and gravel (units Qmsc and Qmsd). Unit Qms notably is also present in well-defined channels that cut through nearshore bedrock exposures at the mouths of Waddell Creek, Scott Creek, Agua Puera Creek, and San Vicente Creek (see fig. 1–2 in pamphlet). These distinct channels, which extend to water depths of 20 to 40 m, were formed by subaerial erosion during sea-level lowstands (Anima and others, 2002). The coarser grained sands and gravels (units Qmsc and Qmsd) are recognized primarily on the basis of bathymetry and (or) high backscatter (see sheets 1, 2, 3). Unit Qmsc mainly is found adjacent to bedrock, in water depths of less than 40 m.

Unit Qmsd typically is mapped as erosional lags in scour depressions (see, for example, Cacchione and others, 1984) that are bounded by relatively sharp or, less commonly, diffuse contacts with the horizontal sand sheets of unit Qms. These depressions typically are irregular to lenticular and a few tens of centimeters deep, and they range in size from a few tens of square meters to as much as about 290,000 m². They most commonly are found adjacent to seafloor bedrock exposures, at water depths that range from about 15 to 55 m. Such scour depressions are common along this stretch of the California coast (see, for example, Cacchione and others, 1984; Hallenbeck and others, 2012; Davis and others, 2013), where offshore sandy sediment can be relatively thin (and, thus, is unable to fill the depressions) owing to low sediment supply from rivers and also to significant erosion and offshore transport of sediment during large northwest winter swells. Such features have been referred to as "rippled scour depressions" (see, for example, Cacchione and others, 1984) or "sorted bedforms" (see, for example, Goff and others, 2005; Trembanis and Hume, 2011). Although the general areas in which both unit Qmsd scour depressions and surrounding Qms sand sheets are found are not likely to change substantially, the boundaries of the units is likely are ephemeral, changing seasonally and during significant storm events.

An offshore transition from unit Qms to the finer grained marine sediments of unit Qmsf is present at water depths of 50 to 65 m. Unit Qmsf primarily consists of mud and muddy sand and commonly is extensively bioturbated. These fine-grained shelf sediments are derived from local coastal watersheds, bluff erosion, and the northward advection of sediment from fluvial sources within Monterey Bay (Edwards, 2002).

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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/). 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

SCALE 1:24 000

1 MILE
1 KILOMETER
BATHYMETRIC CONTOUR INTERVAL 10 METERS
ONE MILE = 0.869 NAUTICAL MILES

Offshore geology and geomorphology mapped by Stephen R. Hartwell and Samuel Y. Johnson, 2013–2014. Onshore geology and geomorphology compiled by Clifton W. Davenport, 2014, from Smith (1981), California Geological Survey (1982), Brabb (1997), and Graymer and others (2006). Bathymetric contours by Mercedes D. Erdey, 2014

GIS database and digital cartography by Stephen R. Hartwell and Peter Dartnell

Manuscript approved for publication September 30, 2015

Offshore and Onshore Geology and Geomorphology, Offshore of Scott Creek Map Area, California

By

Stephen R. Hartwell,[1] Samuel Y. Johnson,[1] and Clifton W. Davenport[2]

2015

[1]U.S. Geological Survey;
[2]California Geological Survey

Suggested Citation: Hartwell, S.R., Johnson, S.Y., and Davenport, C.W., 2015, Offshore and onshore geology and geomorphology, Offshore of Scott Creek map area, California, sheet 10 in Cochrane, G.R., Dartnell, P., Johnson, S.Y., Greene, H.G., Erdey, M.D., Dartnell, P., Golden, N.E., Endris, C.A., Hartwell, S.R., Kvitek, R.G., Davenport, C.W., Watt, J.T., Krigsman, L.M., Rischia, A.C., Sliter, R.W., Finlayson, D.P., and Maier, K.L., (S.R. Cochrane and G.A. Cochran, eds.), California State Waters Map Series—Offshore of Scott Creek, California: U.S. Geological Survey Open-File Report 2015–1191, pamphlet 40 p., 10 sheets, scale 1:24,000, http://dx.doi.org/10.3133/ofr20151191.

ISSN 2331-1258 (online)
http://dx.doi.org/10.3133/ofr20151191