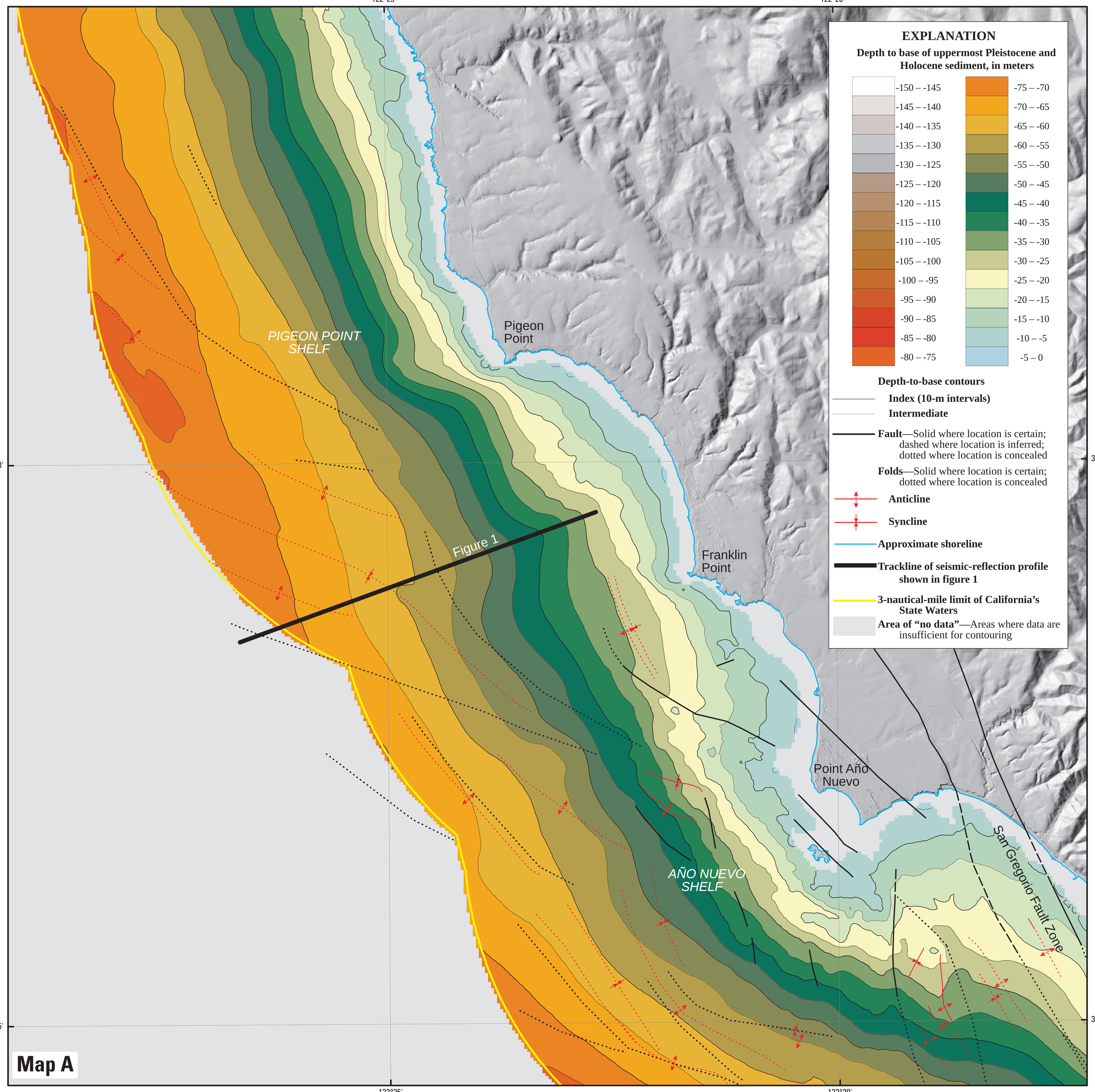
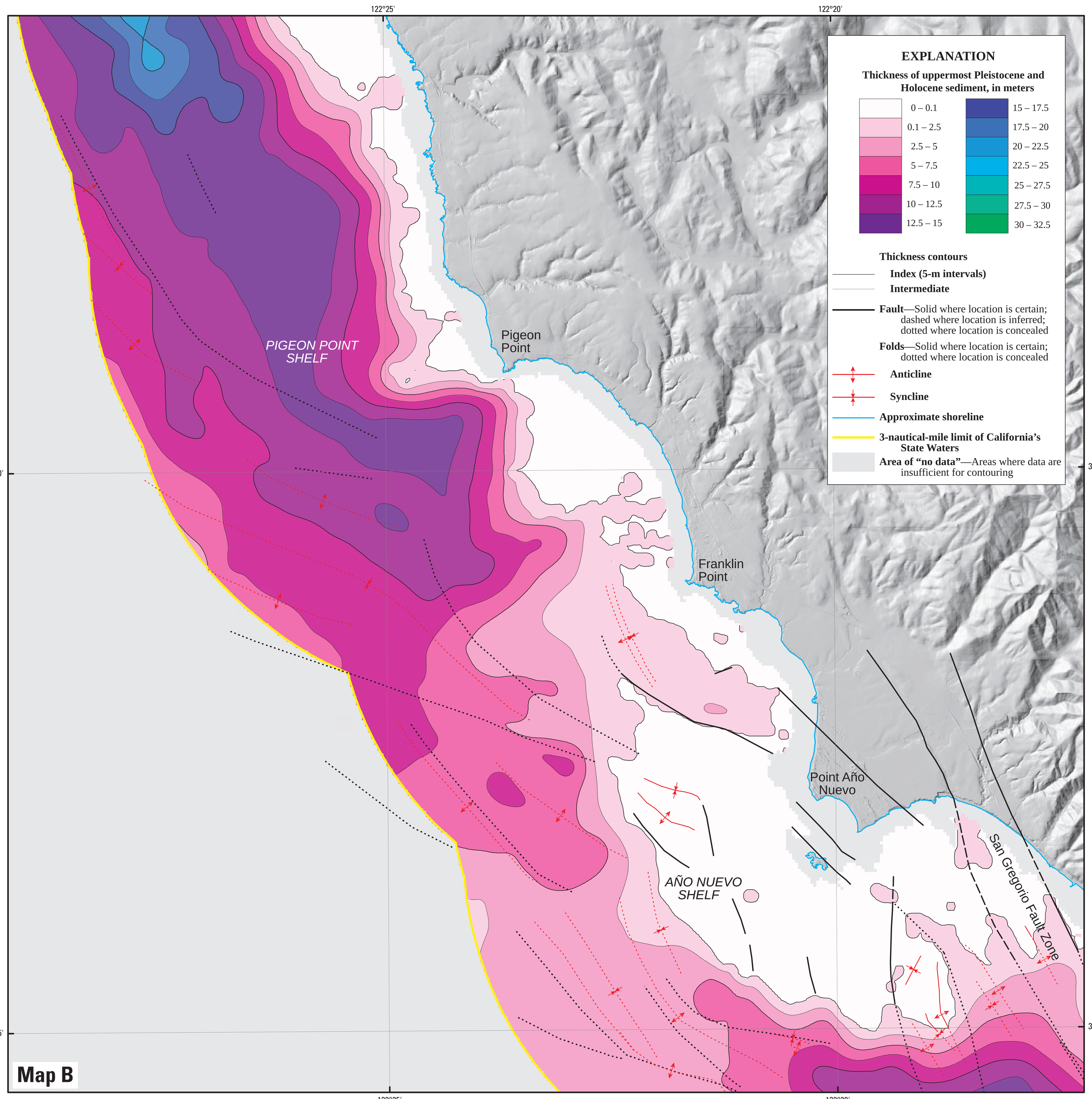
U.S. Department of the Interior
U.S. Geological Survey

Open-File Report 2015–1232
Sheet 9 of 10
Pamphlet accompanies map





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

13½°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2015

SCALE 1:50 000
2 1 0 2 MILES
7000 3500 0 7000 FEET
1 0.5 0 1 KILOMETER
ONE MILE = 0.869 NAUTICAL MILES

CALIF.
MAP LOCATION

Depth and thickness mapped by Samuel Y. Johnson and Stephen R. Hartwell, 2011–2012

GIS database and digital cartography by Stephen R. Hartwell

DISCUSSION

This sheet includes maps that show the interpreted thickness and the depth to base of uppermost Pleistocene and Holocene deposits in California's State Waters for the Offshore of Pigeon Point map area (Maps A, B), as well as for a larger area that extends along the coast from the Pigeon Point area to southern Monterey Bay (Maps C, D) to establish regional context. High-resolution seismic-reflection profiles (fig. 1; see also, sheet 8) show a lower unit of deformed Neogene bedrock and one or two upper units that consist of upper Quaternary sediments. The bedrock-sediment contact is an angular unconformity that commonly is marked by minor channeling, an eastward onlap onto reflection-free bedrock, and an upward change to lower amplitude, more diffuse reflections.

Two upper Quaternary units are recognized on high-resolution seismic-reflection profiles in the Pigeon Point to southern Monterey Bay region. Although not present in this map area, the lower unit notably includes low-amplitude, low-angle (1° to 3°), offshore-dipping clinoforms (Catuneanu, 2006). The upper unit (blue shading on fig. 1; see also, figs. 1, 2, 3, 5, 6, 8, 9 on sheet 8) typically is characterized by low-amplitude, continuous to moderately continuous, diffuse, subparallel reflections, and it has a maximum thickness of about 22 m. Our preferred hypothesis is that the lower of the two upper Quaternary units represents a prograding delta and (or) shoreface complex that formed between about 30,000 and 21,000 years ago during the pre–Last Glacial Maximum (LGM) sea-level drop of marine-isotope stage 2 (Waelbroeck and others, 2002). The overlying upper unit (blue shading) represents shelf deposits that formed during the post-LGM sea-level rise of the last about 21,000 years (Stanford and others, 2011). In this interpretation, the surface at the top of the lower, clinoform-bearing unit is a transgressive surface of erosion that formed as the shoreface migrated landward. Because these two upper Quaternary units each consist of unconsolidated upper Quaternary sediments and together overlie the prominent angular unconformity with bedrock, we have combined their thicknesses on Maps B and D.

To make these maps, water bottom and depth to base of the uppermost Pleistocene and Holocene sediment layer were mapped from seismic-reflection profiles (fig. 1; see also, sheet 8). The difference between the two horizons was exported for every shot point as XY coordinates (UTM zone 10) and two-way travel time (TWT). The thickness points were interpolated to a preliminary thickness contour surface, overlaid with zero-thickness bedrock outcrops (see sheet 10), and contoured, following the methodology of Wong and others (2012).

The thickness of the post-LGM sediments in the Offshore of Pigeon Point map area ranges from 0 to 22 m (Map B), and the depth to the unconformity at the base of this unit ranges from less than 10 to 75 m (Map A). Mean sediment thickness for the map area is 6 m, and the total sediment volume is 765×10⁶ m³ (see table 7–1 in pamphlet). The thickest sediment (22 m) is found in the northwest corner of the map area (Map B), coincident with a decrease in slope on the bedrock unconformity (Maps A, C). Sediment thickness diminishes to the southeast, and sediment cover offshore of Point Año Nuevo is either thin or nonexistent (Maps B, D). The extensive bedrock outcrop in this area coincides with an area of transpression between the Ascension Fault and the San Gregorio Fault Zone. The relative lack of offshore sediment probably is a result of both low sediment supply and ongoing exposure to erosive wave energy.

Six different informal "domains" of thickness of uppermost Pleistocene to Holocene sediment (table 7–1) are recognized on the regional sediment-thickness map (Map D on sheet 9), each with its own diverse set of geologic and (or) oceanographic controls. Note that data from within the Monterey Canyon system (including Soquel Canyon), in the southern part of the Pigeon Point to southern Monterey Bay region, were excluded from this analysis because available seismic-reflection data are insufficient to map sediment distribution in this extremely variable environment.

(1) The southern Monterey Bay domain is bounded by the Monterey Bay shoreline on the south and east, the Monterey Canyon on the north, and the limit of California's State Waters on the west. Sediment derived from the Salinas River forms a large, shore-parallel, subaqueous delta (thickness of as much as 32 m) that progrades across a thinly sediment-mantled bedrock shelf. Small changes in sediment thickness on the shelf are controlled by irregular bedrock relief that is at least partly attributable to the Monterey Bay Fault Zone (Greene, 1990).

(2) The northern Monterey Bay domain is bounded on the south by Monterey Canyon, on the north and east by the Monterey Bay shoreline, and on the west by the limit of California's State Waters. The head of Monterey Canyon extends nearly to the shoreline, and the canyon forms a sediment trap that effectively separates the littoral- and shelf-sediment transport systems of the two (northern and southern) Monterey Bay domains. The northern Monterey Bay domain is characterized by (a) a sediment-poor inner shelf cut by paleochannels of the San Lorenzo River, the Pajaro River, and Soquel Creek; (b) a midshelf depocenter that has sediment as thick as 32 m, much of which was deposited in a pre-LGM prograding delta and (or) shoreface complex and was preserved above a decrease in slope on the underlying unconformity; and (c) a midshelf to outer shelf domain in which sediment generally becomes progressively thinner in the offshore direction.

(3) The Davenport shelf domain extends from the northern limit of Monterey Bay northward to the southern margin of the Waddell Creek depocenter. The Davenport shelf domain, as well as the three domains farther north, occupy a section of open, wave-dominated coast that is exposed to wave energy higher than that of the Monterey Bay domains to the south. The Davenport shelf domain includes the Davenport depocenter, a prominent midshelf, shore-parallel depocenter present between Davenport and Santa Cruz that mostly consists of a lower, pre-LGM, clinoform-bearing unit of inferred prograding-shoreface origin. Sediment in this depocenter also is preserved in accommodation space linked to an offshore decrease in the slope of the underlying unconformity. Sediment thickness within the Davenport shelf domain decreases to both the northwest and southeast of this depocenter, owing to the presence of elevated bedrock and (or) the related absence of the lower clinoform-bearing unit.

(4) The Waddell Creek delta domain lies offshore of the mouth of the Waddell Creek coastal watershed, and it is connected to it by a submerged channel. The domain is both distinguished and delineated by the significant Waddell Creek depocenter (maximum sediment thickness of 19 m), which forms a moundlike delta that consists entirely of inferred post-LGM deposits whose primary source is Waddell Creek. Sediment thins both north and south of this moundlike delta; its preservation is attributable to its semiprotected (from erosive wave energy) location on the south flank of Point Año Nuevo.

(5) The Año Nuevo shelf domain lies offshore of Point Año Nuevo, from just north of Franklin Point on the north to just north of the mouth of Waddell Creek on the south. Bedrock exposures, which locally reach water depths of 45 m, cover a substantial part of this wave-exposed domain; in deeper waters farther offshore, sediment cover is relatively thin. Sediment thickness in this domain appears to be limited both by the lack of sediment supply (because of its distance from large coastal watersheds) and by the presence of uplifted bedrock, which is linked to a local zone of transpression in the San Gregorio Fault Zone (Weber, 1990). The uplift has raised this domain and exposed it to the high wave energy that is characteristic of this area (Storlazzi and Wingfield, 2005).

(6) The Pigeon Point shelf domain lies on the west flank of the Pigeon Point high (McCulloch, 1987). Sediment in the Pigeon Point shelf domain is thickest in a shore-parallel band that overlies a slope break in the underlying bedrock surface. Much of the sediment probably was derived from Pescadero Creek, a large coastal watershed that enters the Pacific Ocean about 3 km north of the Pigeon Point to southern Monterey Bay regional map area (see Maps C, D on sheet 9). The Pigeon Point shelf domain is transitional to the Pacifica-Pescadero shelf domain just north of it (see Watt and others, 2014).

Map E shows the regional pattern of major faults and earthquakes occurring between 1967 and April 2014 that have left interval magnitudes of 2.0 and greater. Fault locations, which have been simplified, are compiled from our mapping within California's State Waters (see sheet 10), from Wagner and others (2002), and from the U.S. Geological Survey's Quaternary fault and fold database (U.S. Geological Survey and California Geological Survey, 2010). Earthquake epicenters are from the Northern California Earthquake Data Center (2014), which is maintained by the U.S. Geological Survey and the University of California, Berkeley, Seismological Laboratory. The 1989 Loma Prieta earthquake (M6.9, 10/17/1989), on the San Andreas Fault Zone in the Santa Cruz Mountains (Spudich, 1996), is the most significant event in the region. In the Offshore of Pigeon Point area, a substantial amount of seismicity is broadly distributed between the San Gregorio Fault Zone and the Ascension Fault—the largest recorded earthquake (M3.6) having occurred on 6/28/1991.

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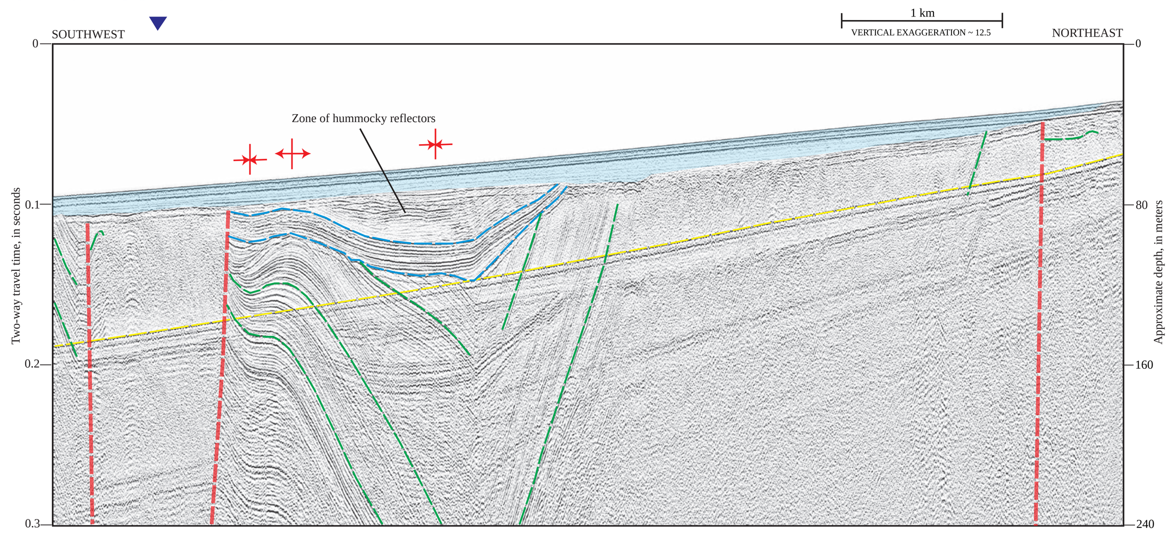
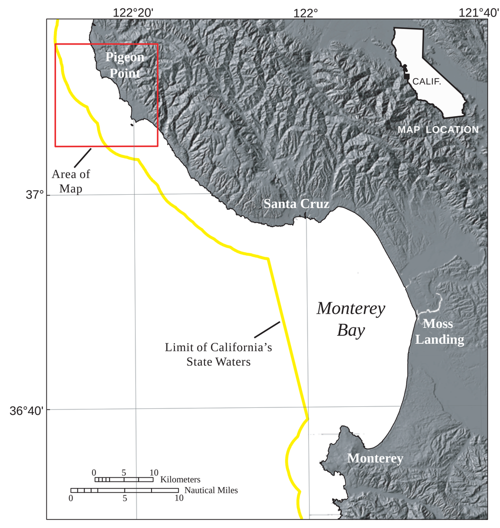
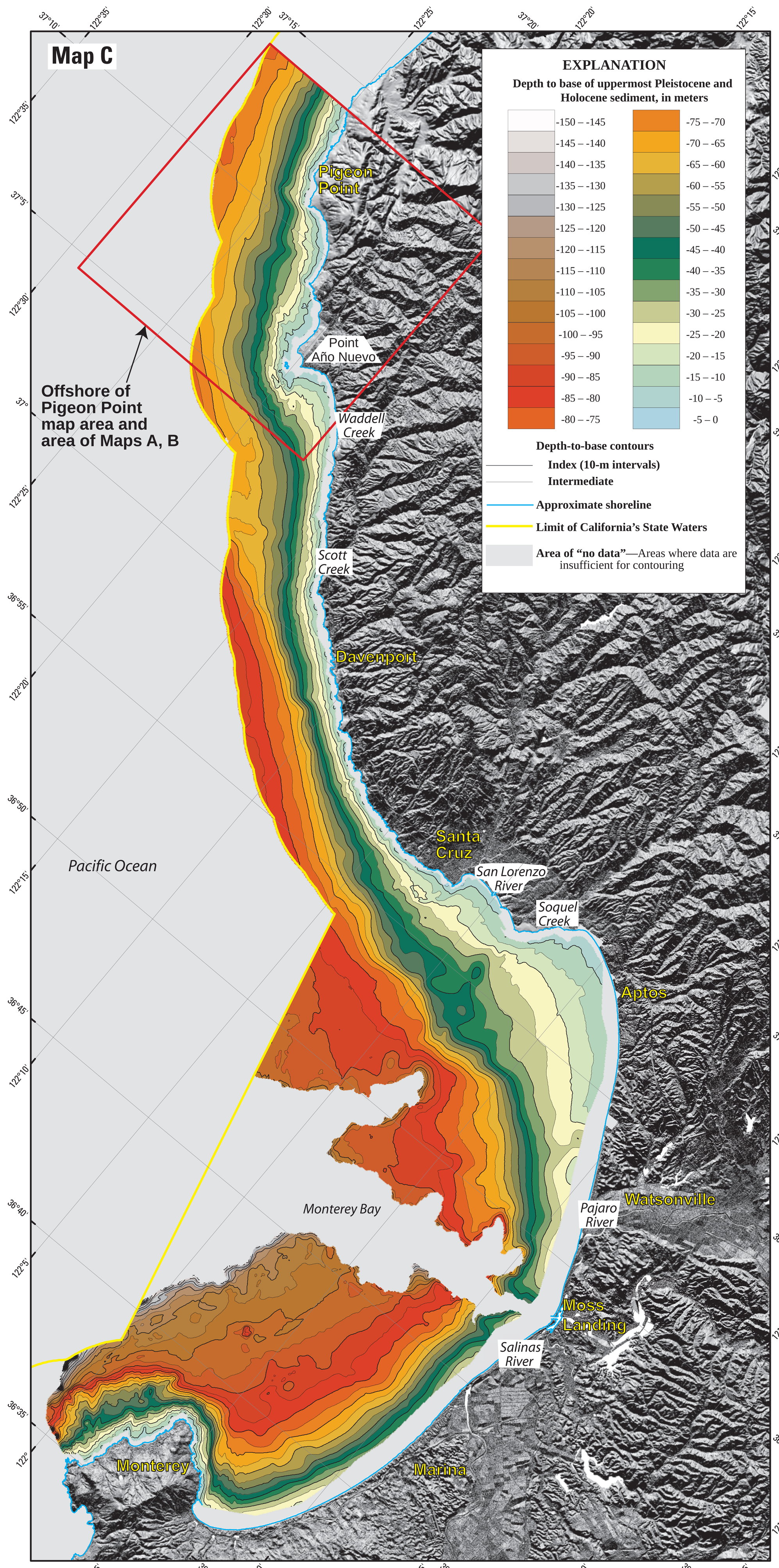


Figure 1. USGS high-resolution minisparker seismic-reflection profile P10–25 (collected in 2010 on survey S–15–10–NC, see fig. 5 on sheet 8), which crosses shelf south of Pigeon Point (see Map A for location). Profile highlights faulted and folded strata beneath continental shelf. Dashed red lines show faults. Magenta symbols show fold axes (diverging arrows, anticline; converging arrows, synclines). Blue shading shows inferred uppermost Pleistocene and Holocene strata, deposited since last sea-level lowstand about 21,000 years ago. Underlying reflectors image deformed Tertiary and Cretaceous strata. Dashed blue lines show unconformities. Note zone of hummocky reflectors between otherwise parallel to subparallel reflectors near middle of profile (see cross-line, fig. 3 on sheet 8). Dashed green lines highlight some continuous reflections that reveal structure (not distinctive stratigraphic markers). Dashed yellow line is seafloor multiple (echo of seafloor reflector). Purple triangle shows location of California's State Waters limit (yellow line on Maps A, B).

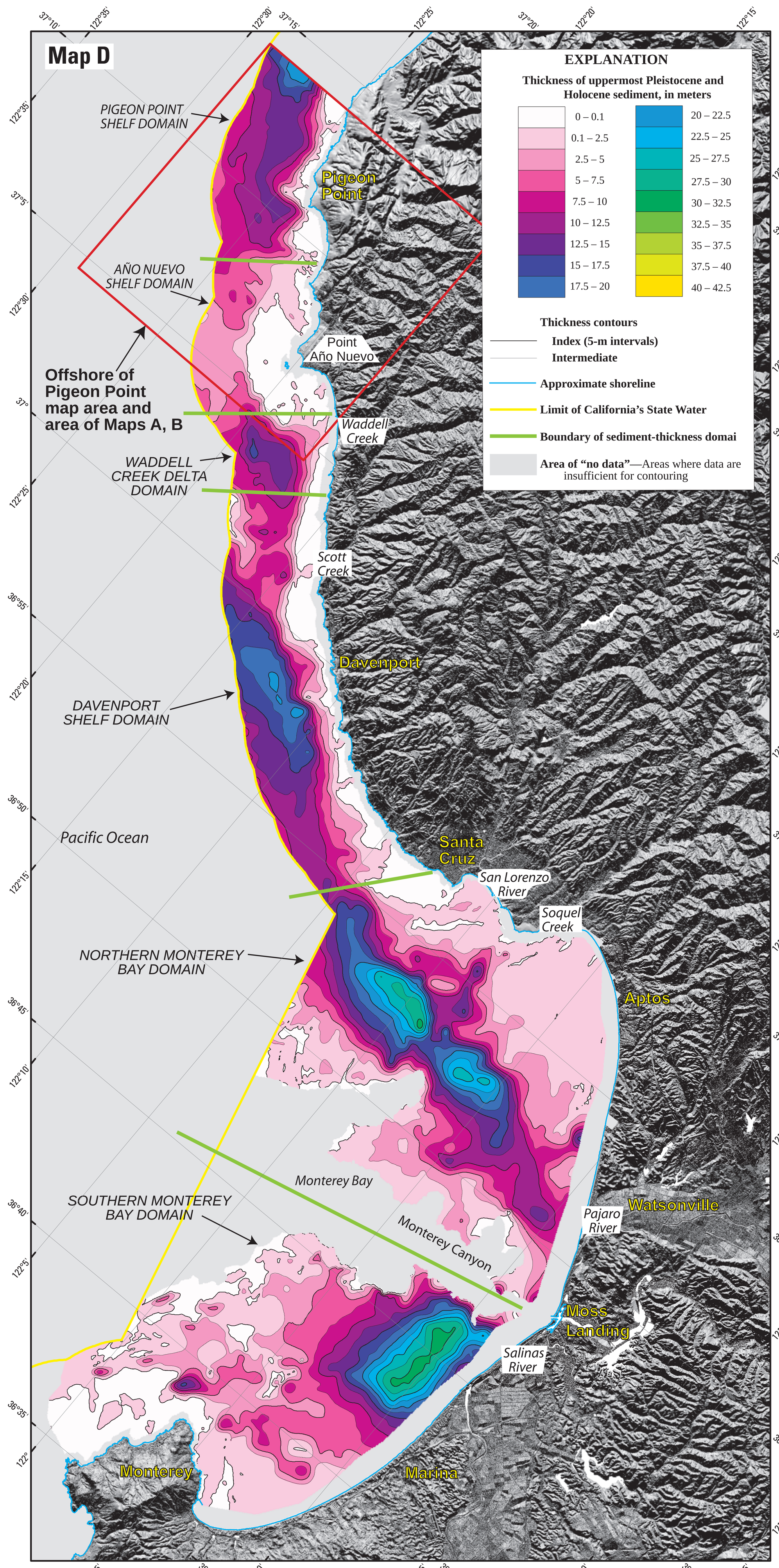




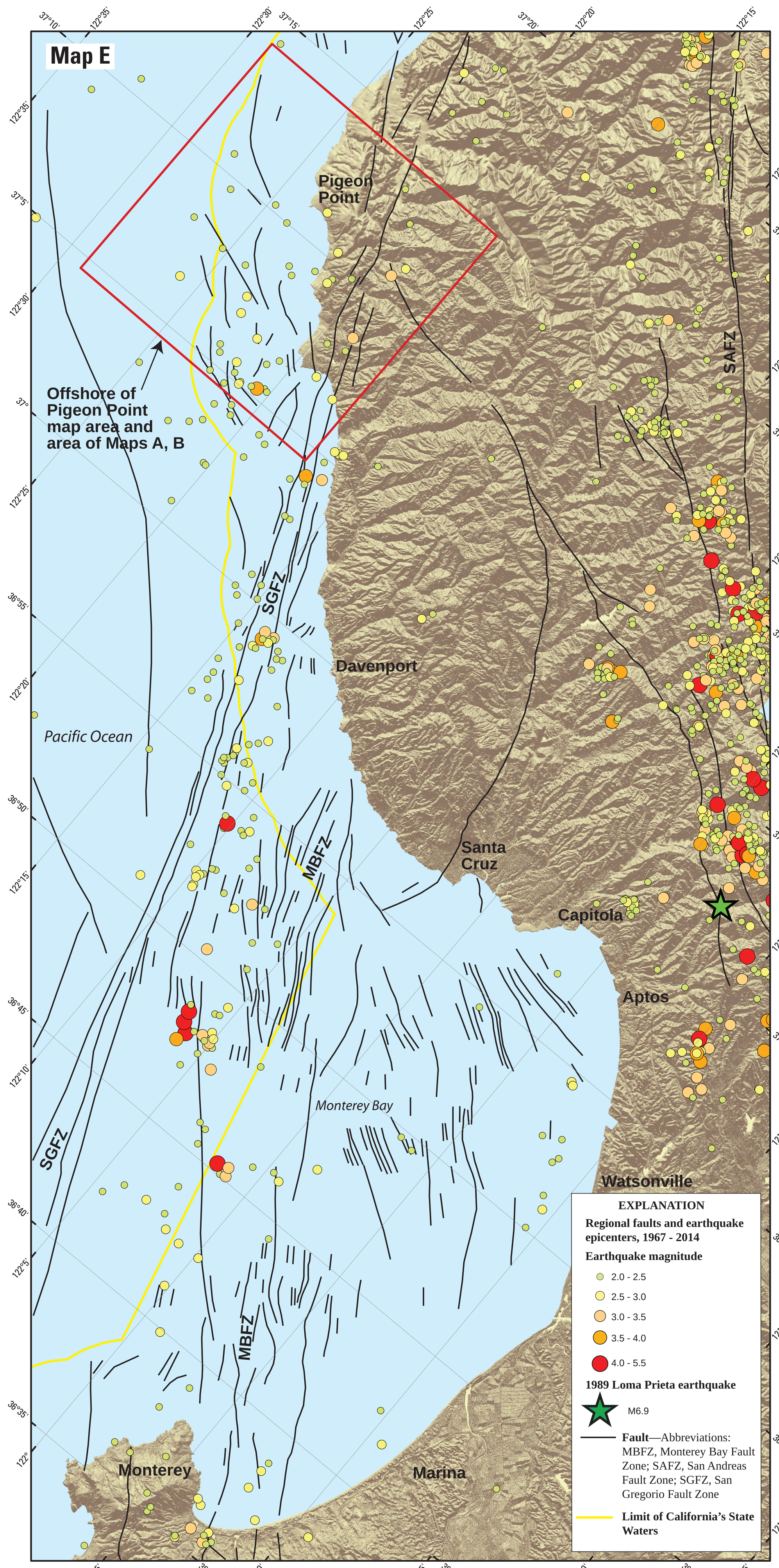
Onshore elevation data from U.S. Geological Survey's 2012 National Elevation Dataset (available at http://ned.usgs.gov/). California's State Waters limit from NOAA Office of Coast Survey

Universal Transverse Mercator projection, Zone 10N

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2015



SCALE 1:200 000
10 5 0 10 MILES
40000 30000 20000 10000 0 40000 FEET
10 5 0 10 KILOMETERS
ONE MILE = 0.869 NAUTICAL MILES



CALIF.
MAP LOCATION

Depth and thickness mapped by Samuel Y. Johnson and Stephen R. Hartwell, 2011–2012

GIS database and digital cartography by Stephen R. Hartwell

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Local (Offshore of Pigeon Point Map Area) and Regional (Offshore from Pigeon Point to Southern Monterey Bay) Shallow-Subsurface Geology and Structure, California

By

Janet T. Watt, Samuel Y. Johnson, Stephen R. Hartwell, Ray W. Sliter, and Katherine L. Maier

2015

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