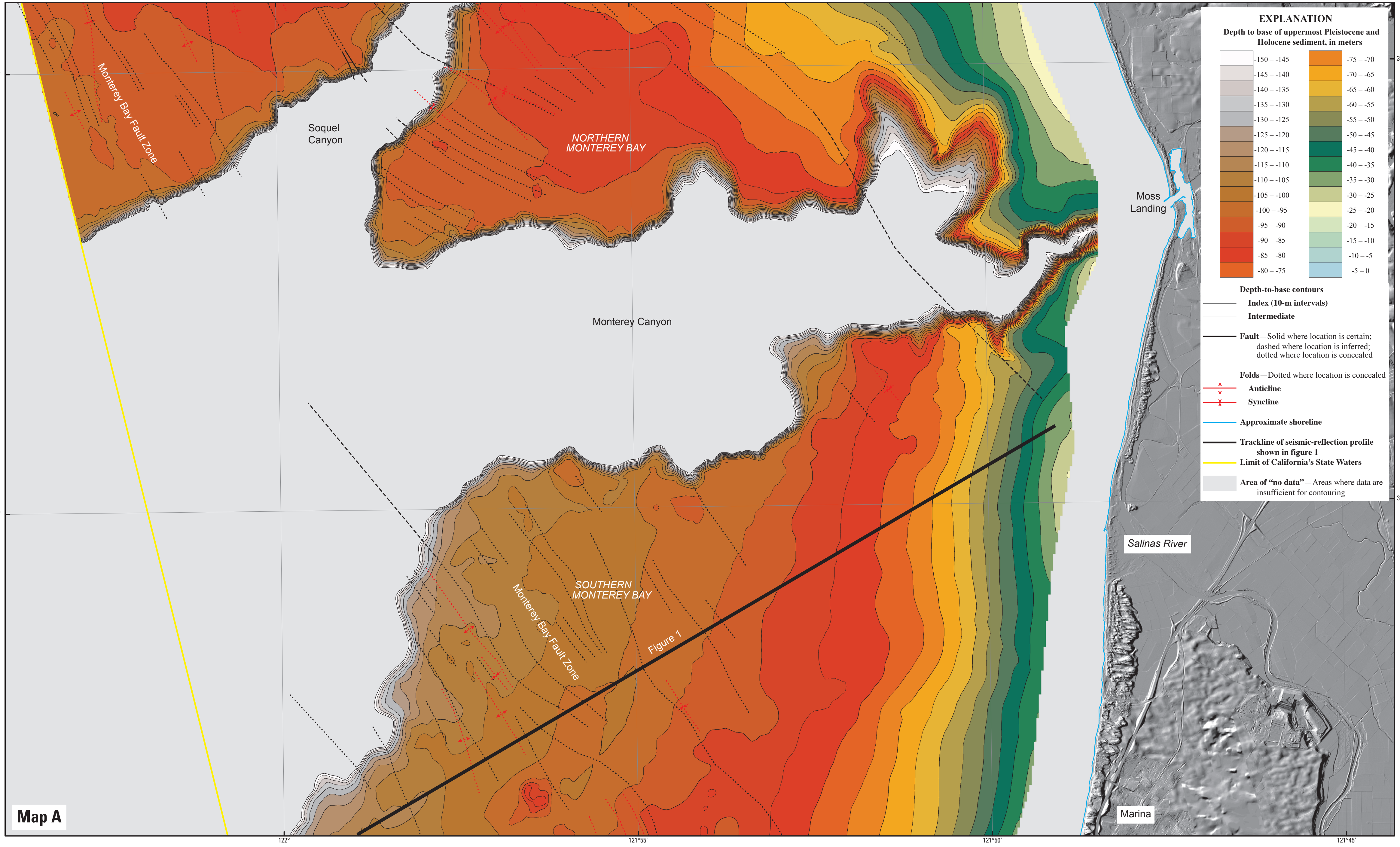
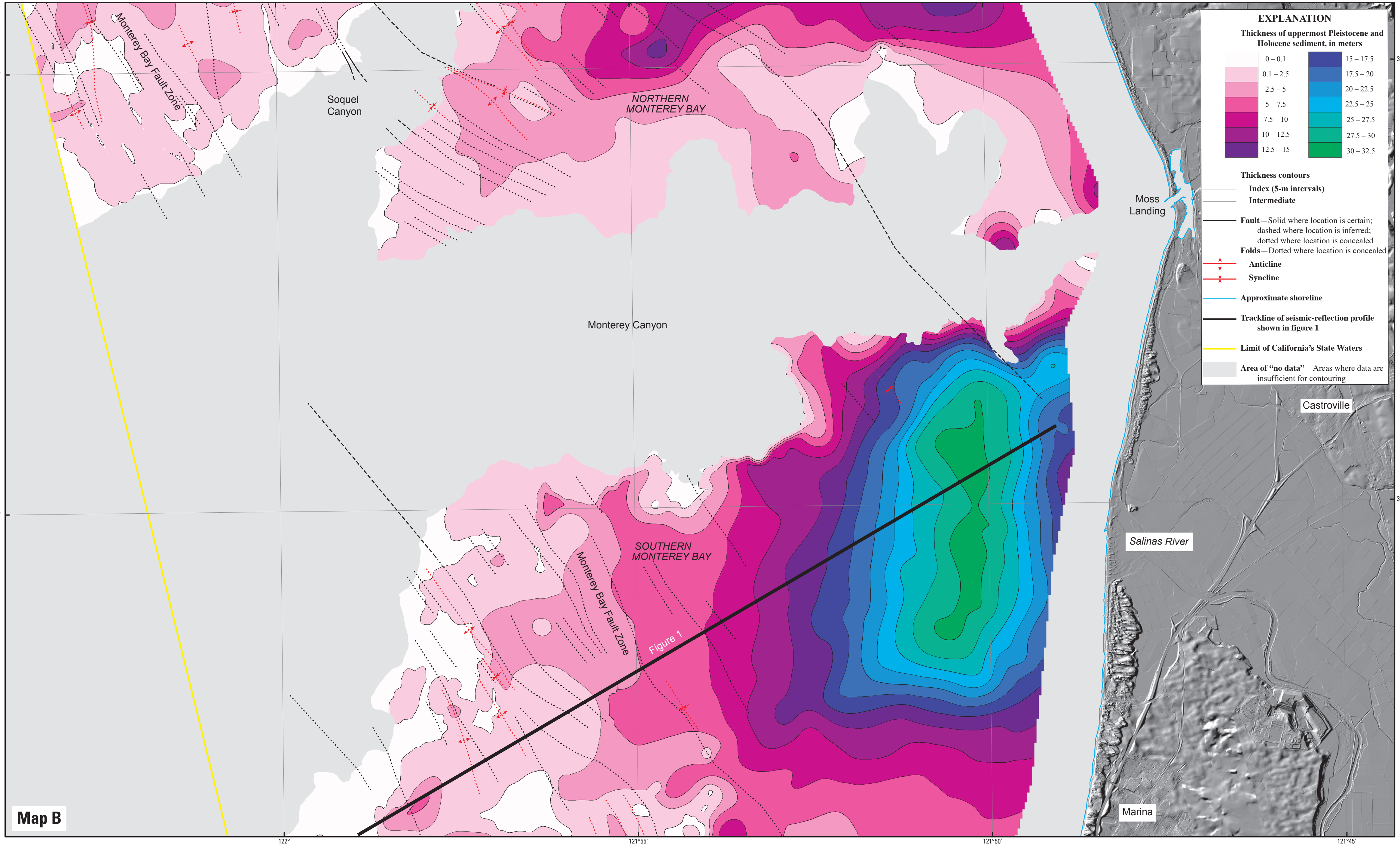
U.S. Department of the Interior
U.S. Geological Survey

Open-File Report 2016–1072
Sheet 9 of 10
Pamphlet accompanies 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/). 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, 2016

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

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 Monterey Canyon and Vicinity map area (Maps A, B), as well as for a larger area that extends about 91 km along the coast from Pigeon Point to southern Monterey Bay (Maps C, D) to establish a regional context. Mapping, which is based on high-resolution seismic-reflection profiles (fig. 1; see also, sheet 8), is restricted to the continental shelf. 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, is excluded from this analysis because available seismic-reflection data are insufficient to map sediment distribution and thickness in the extremely variable submarine-canyon environment.

High-resolution seismic-reflection profiles (fig. 1; see also, figs. 1, 2, 3, 4, 5, 7, 8, 10, 11 on sheet 8) image a lower unit that consists of deformed Neogene bedrock; a middle unit that consists of Pleistocene submarine-canyon, fluvial, and eolian deposits, present locally in the eastern part of the map area; and an upper unit of inferred upper Quaternary marine sediments, shown by blue shading on the seismic-reflection profiles. The contact between this upper stratigraphic unit and the underlying strata is a prominent, locally angular unconformity, commonly marked by minor channeling and an upward change to lower amplitude, more diffuse reflections. This unconformity is an inferred transgressive surface of erosion, and the upper stratigraphic unit is inferred to have been deposited during the post–Last Glacial Maximum (LGM) sea-level rise of the last about 21,000 years (see, for example, Stanford and others, 2011).

To make these maps, water bottom and depth to base of the post-LGM horizons 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 of the post-LGM unit (Maps B, D) was determined by applying a sound velocity of 1,600 m/sec to the TWT. The thickness points were interpolated to a preliminary continuous surface, overlaid with zero-thickness bedrock outcrops (see sheet 10), and contoured, following the methodology of Wong and others (2012).

The thickness of the uppermost Pleistocene and Holocene sediments on the continental shelf in the Monterey Canyon and Vicinity map area ranges from 0 to 32 m (Map B), and the depth to the unconformity at the base of this unit ranges from less than 10 m in the nearshore to more than 100 m along the rim of Monterey Canyon (Map A). Mean sediment thickness for the map area (excluding Monterey Canyon) is 7.3 m, and the total sediment volume in these areas is $1{,}480\times10^6$ m^3 (table 7–1 in pamphlet). Mean sediment thickness south of Monterey Canyon (10.0 m) is more than three times greater than mean thickness north of the canyon (2.9 m).

The thickest sediment in the map area (about 32 m) is found south of Monterey Canyon offshore of the mouth of the Salinas River (Map B), at water depths of between 10 and 30 m. The Salinas River is the second largest coastal watershed in California (10,800 km^2), and it is a significant sediment source (Farnsworth and Warrick, 2007). The depocenter is a large (about 4 km long and 2 km wide), elongate, shore-parallel bar that forms a mound above a uniformly offshore dipping (about 1.5°) basement surface (Map A). The geometry of reflections on seismic-reflection profiles (fig. 1; see also, figs. 8, 10, 11 on sheet 8) indicates both vertical aggradation and low-angle seaward progradation. Bar morphology and internal structure are consistent with depositional patterns outlined by Wright (1977) for wave-dominated river mouths. Within the map area, sediment cover thins gradually to the south and west, away from this delta-mouth bar, and bedrock is exposed in places along the rim of Monterey Canyon to the west. The head of Monterey Canyon bounds the north flank of the delta-mouth bar, consistent with the hypothesis that a significant part of the sediment load of the Salinas River is transported down Monterey Canyon (see, for example, Johnson and others, 2001).

No comparable delta-mouth bar is present north of Monterey Canyon offshore of the mouth of the smaller Pajaro River (watershed of 3,400 km^2), where the thickest sediment in this part of the map area (about 14 m) lies on the south flank of a shallow, west-trending paleochannel (Map D). Sediment cover thins on the shelf to the south and west, where bedrock is locally exposed on the walls of Monterey Canyon and Soquel Canyon, respectively.

Six different informal "domains" of thickness of uppermost Pleistocene to Holocene sediment (see table 7–1 in pamphlet) are recognized on the regional sediment-thickness map (Map D), each with its own diverse set of geologic and (or) oceanographic controls. Again, data from within the Monterey Canyon system were excluded from this analysis.

(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 bedrock 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 zone 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 (to the north in the Waddell Creek delta domain). 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 the 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 attributed to its semi-protected (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). 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 of earthquakes occurring between 1967 and April 2014 that have inferred or measured 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), the epicenter of which is located 21 km north of the map area, is the most significant event in the region. The largest recorded earthquake in the Monterey Canyon and Vicinity map area (M4.7, 8/04/1970) occurred within the Monterey Bay Fault Zone.

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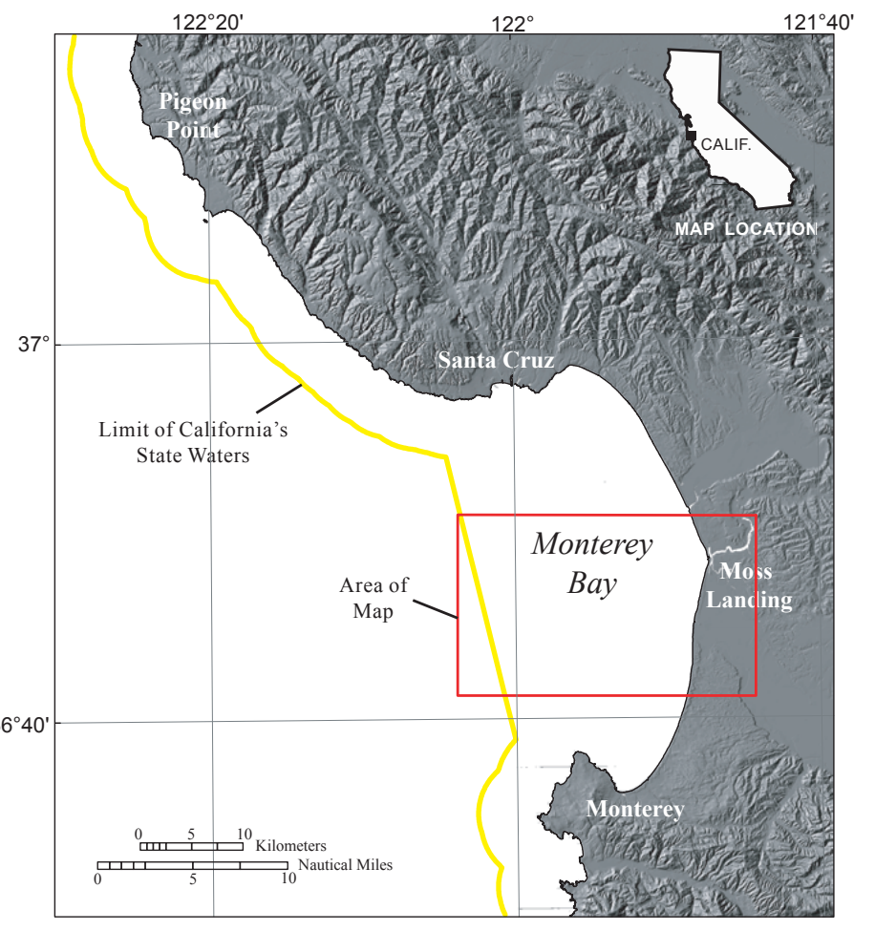


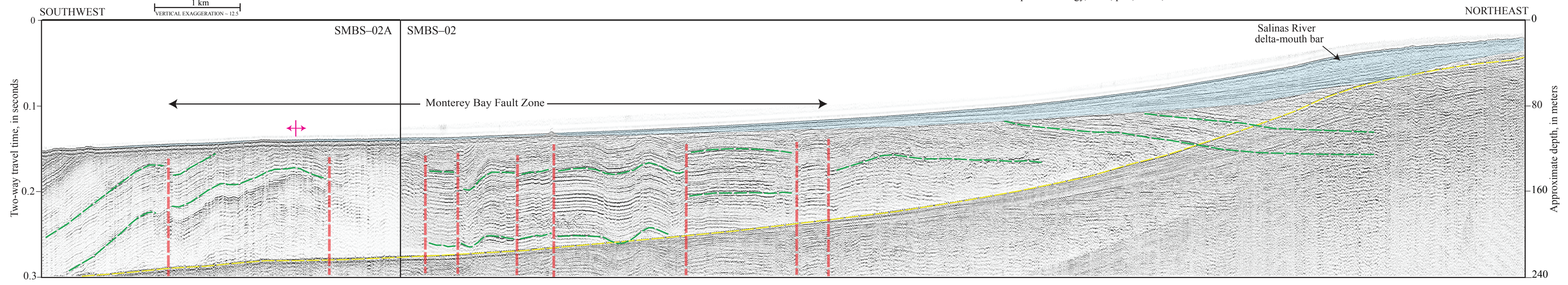
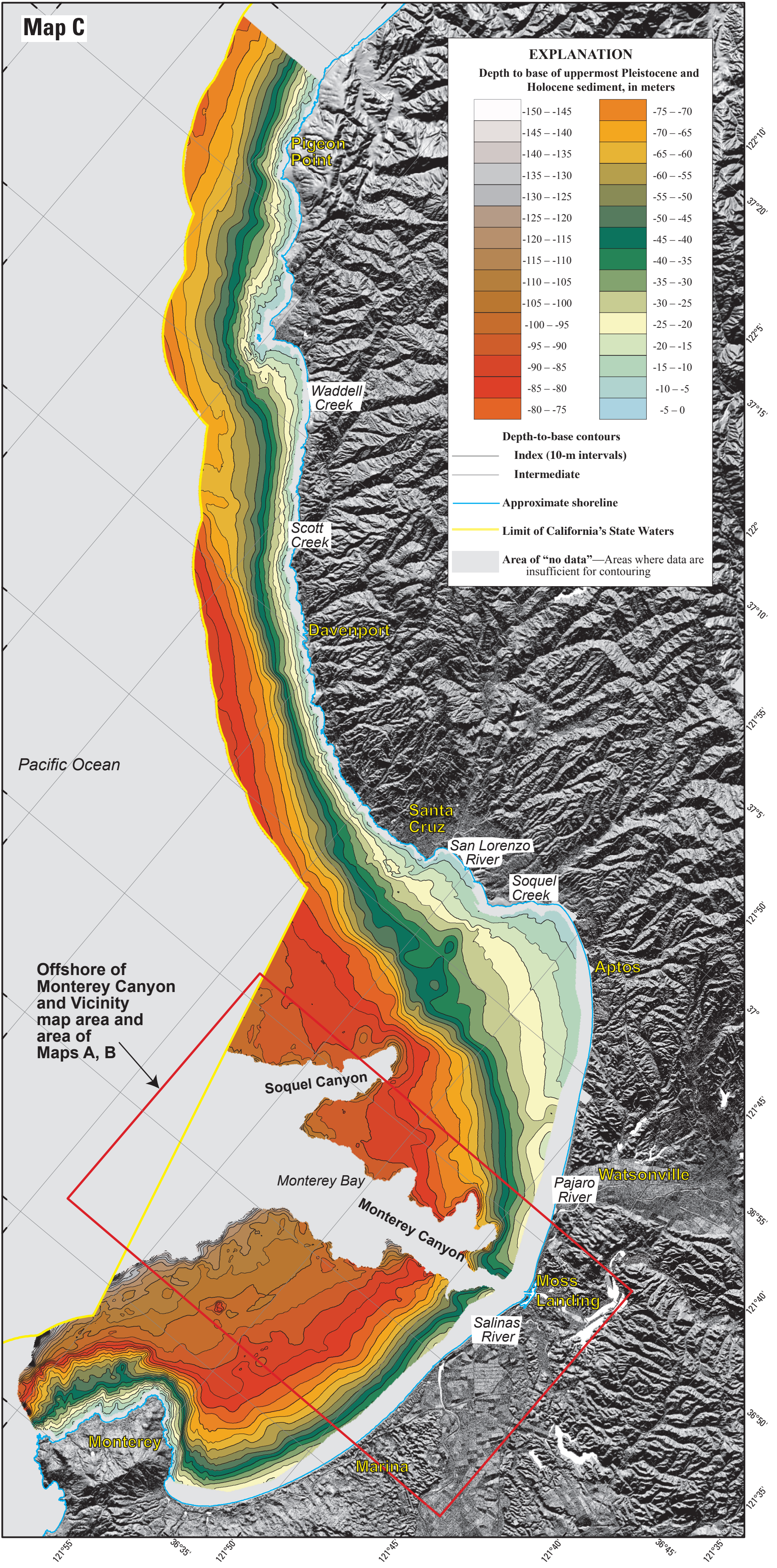
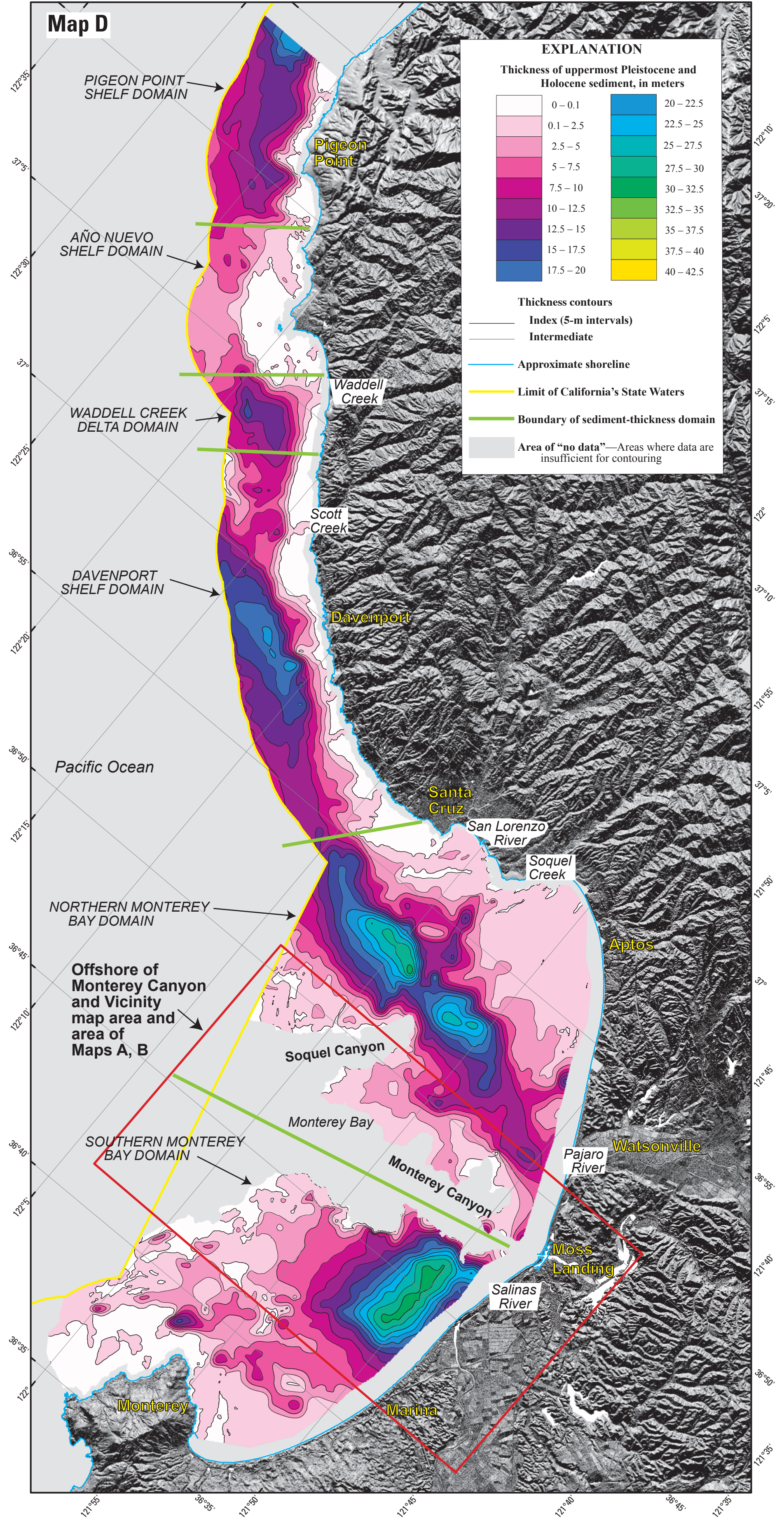
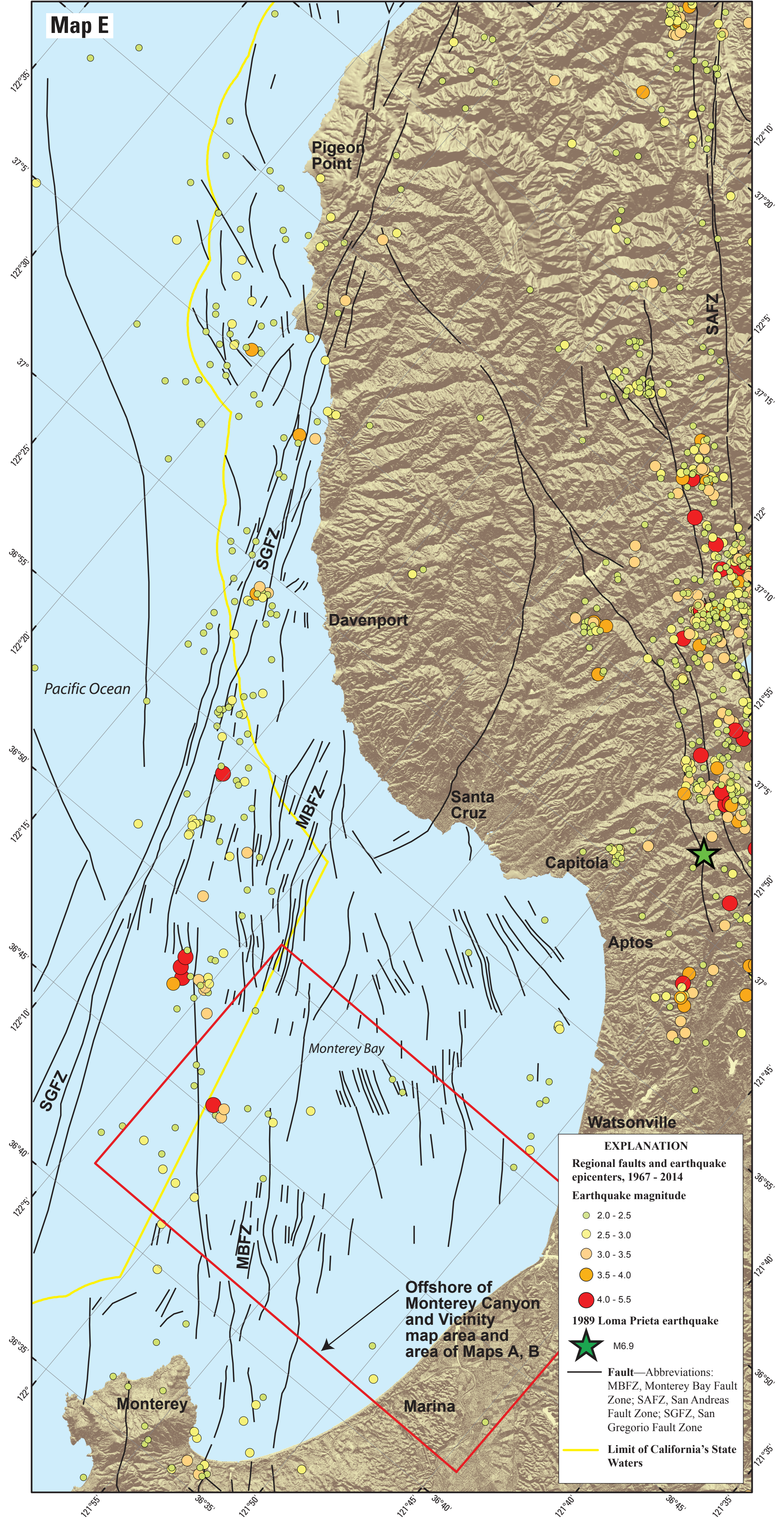


Figure 1. USGS high-resolution minisparker seismic-reflection profiles SMBS–02A and SMBS–02 (left and right sides of fig. 1, respectively; collected in 2011 on cruise S–6–11–MB), which cross shelf south of Monterey Canyon (see Maps A, B for location; see also, fig. 8 on sheet 8). Profile highlights Salinas River delta-mouth bar, Monterey Bay Fault Zone, and beveled bedrock that underlies continental shelf. Dashed red lines show faults. Magenta symbol shows anticline axis. Blue shading shows inferred uppermost Pleistocene and Holocene strata, deposited in last about 21,000 years. Underlying reflectors image gently folded Neogene strata, likely consisting of the upper Miocene and Pliocene Purisima Formation. Dashed green lines highlight some continuous reflections that reveal structure (not distinctive stratigraphic markers). Dashed yellow line is seafloor multiple (echo of seafloor reflector).







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

By

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

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