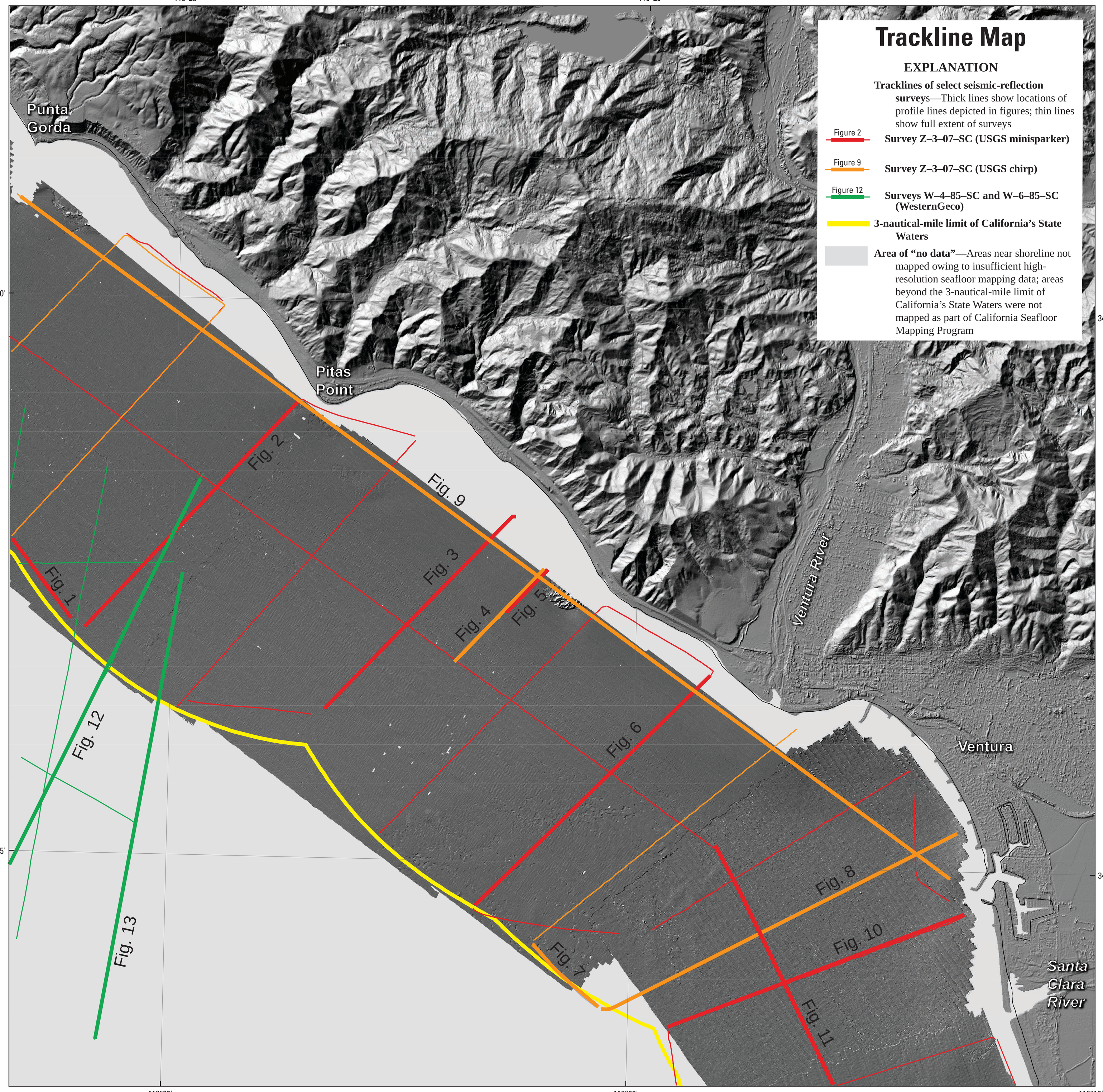


Onshore elevation data from NOAA Coastal Services Center (data collected by EarthData International in 2002-2003)
Offshore shaded-relief bathymetry from map on sheet 2, this report. California's State Waters limit from NOAA Office of Coast Survey
Universal Transverse Mercator projection, Zone 11N
NOT INTENDED FOR NAVIGATIONAL USE

SCALE 1:50 000
ONE MILE = 0.869 NAUTICAL MILES

APPROXIMATE MEAN DECLINATION, 2013

MAP LOCATION

GIS database and digital cartography by Eleyne L. Phillips and Florence L. Wong
Edited by Taryn A. Lindquist
Manuscript approved for publication March 11, 2013

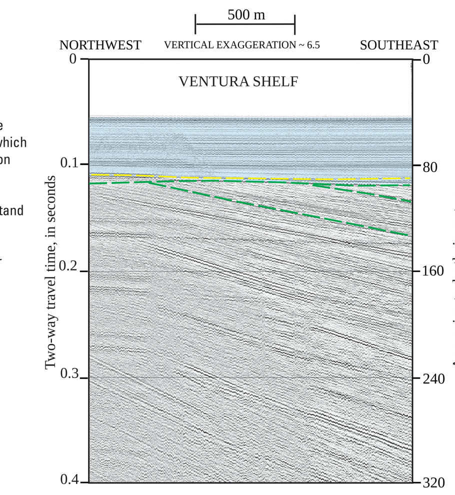


Figure 1. USGS minisparker seismic-reflection profile SB–79 (survey Z–3–07–SC; Sliter and others, 2008), which extends northwest from end of profile SB–78 (fig. 2) on Ventura shelf; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene strata, deposited since last sea-level lowstand about 21,000 years ago. This upper unit overlies prominent angular unconformity; dashed green lines highlight discordance. Dashed yellow line is seafloor multiple (echo of seafloor reflector).

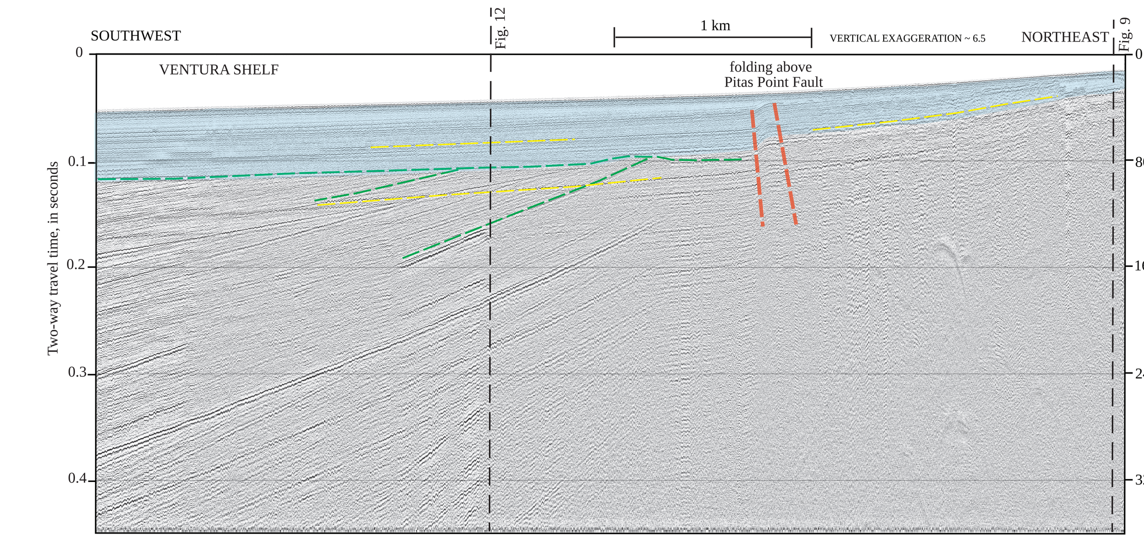


Figure 2. USGS minisparker seismic-reflection profile SB–78 (survey Z–3–07–SC; Sliter and others, 2008), which extends southwest from Pitas Point across Ventura shelf; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene shelf deposits. Dashed red lines show axial planes of fold that formed above blind-reverse, steeply north-dipping Pitas Point Fault (Sorlien and others, 2000; Fisher and others, 2009). Dashed green lines southwest of Pitas Point Fault and associated fold highlight significant angular unconformity, below which inferred upper Pliocene and Pleistocene beds dip about 5° offshore. Dashed yellow lines are seafloor multiples (echoes of seafloor reflector).

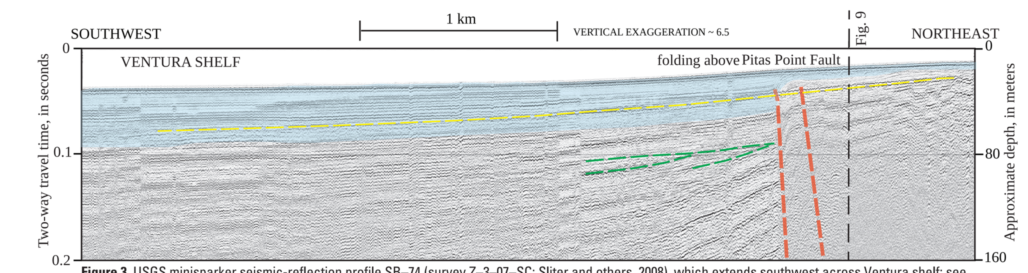


Figure 3. USGS minisparker seismic-reflection profile SB–74 (survey Z–3–07–SC; Sliter and others, 2008), which extends southwest across Ventura shelf; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits. Dashed red lines show axial planes of fold that formed above blind-reverse, north-dipping Pitas Point Fault (Sorlien and others, 2000; Fisher and others, 2009). Dashed green lines southwest of Pitas Point Fault highlight prominent angular unconformity (figs. 1, 2), below which inferred upper Pliocene and Pleistocene beds dip about 5° offshore. Dashed yellow line is seafloor multiple (echo of seafloor reflector). Note that southwestern half of profile has low signal to noise ratio and, thus, is of poor quality.

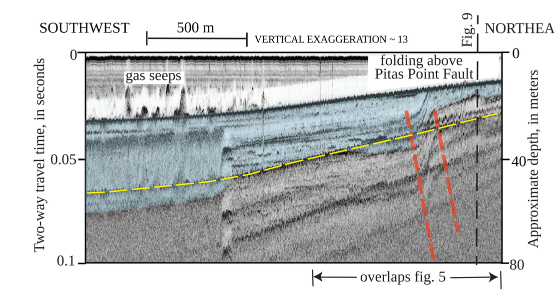


Figure 4. USGS chirp seismic-reflection profile SBC–72 (survey Z–3–07–SC; Sliter and others, 2008), which crosses inner Ventura shelf and partly overlaps minisparker profile in figure 5; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits. Dashed red lines show axial planes of fold that formed above blind-reverse, north-dipping Pitas Point Fault (Sorlien and others, 2000; Fisher and others, 2009). Dashed yellow line is seafloor multiple (echo of seafloor reflector). Cone-shaped reflections in water column are associated with gas seeps. Chirp seismic-reflection profile has less depth penetration than minisparker profile collected on same transect (fig. 5), but it shows greater geologic detail in upper few tens of meters.

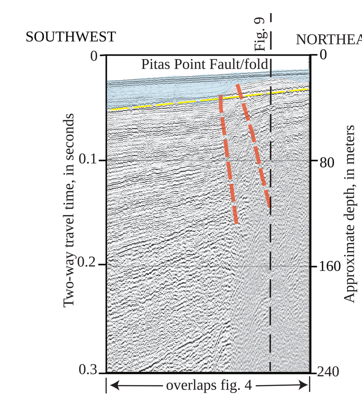
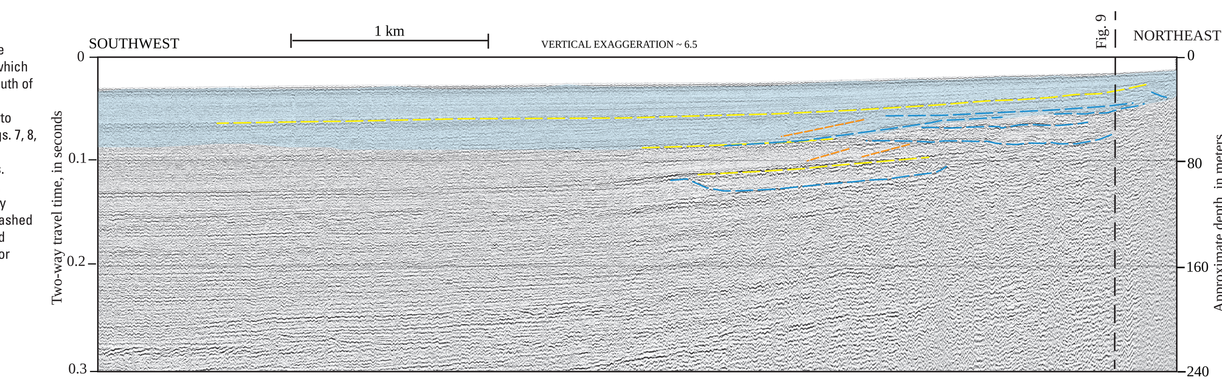


Figure 5. USGS minisparker seismic-reflection profile SB–73A (survey Z–3–07–SC; Sliter and others, 2008); see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits. Dashed red lines show axial planes of fold that formed above blind-reverse, north-dipping Pitas Point Fault (Sorlien and others, 2000; Fisher and others, 2009). Dashed yellow line is seafloor multiple (echo of seafloor reflector). Minisparker line has more depth penetration than chirp seismic-reflection profile collected on same transect (fig. 4) but, in its upper section, lacks level of detail provided by higher frequency chirp system.

Figure 6. USGS minisparker seismic-reflection profile SB–64 (survey Z–3–07–SC; Sliter and others, 2008), which extends southwest from area directly offshore of mouth of Ventura River; see trackline map for location. Profile crosses undeformed area between Pitas Point Fault to north (figs. 2, 3, 4, 9) and Oak Ridge Fault to south (figs. 7, 8, 10, 11, 13). Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits. Dashed blue lines show low-angle erosion surfaces, representing oblique intersections of channels cut by Ventura River at lower stands of sea level. Orange dashed lines are offshore-dipping delta foreset beds. Dashed yellow lines are seafloor multiples (echoes of seafloor reflector).



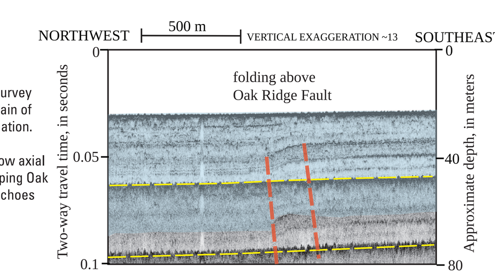


Figure 7. USGS chirp seismic-reflection profile SBC–68 (survey Z–3–07–SC; Sliter and others, 2008), offshore of alluvial plain of Santa Clara and Ventura Rivers; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits. Dashed red lines show axial planes of fold that formed above blind-reverse, south-dipping Oak Ridge Fault. Dashed yellow lines are seafloor multiples (echoes of seafloor reflector).

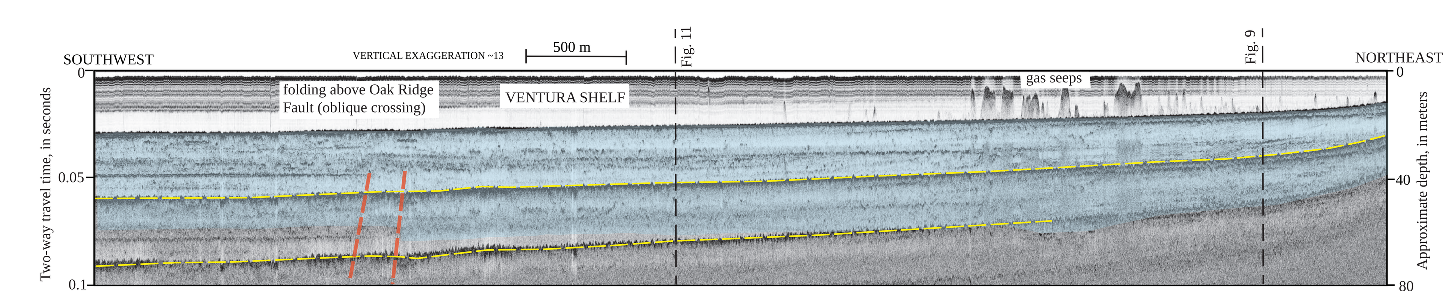


Figure 8. USGS chirp seismic-reflection profile SBC–69 (survey Z–3–07–SC; Sliter and others, 2008), which crosses inner Ventura shelf offshore of alluvial plain of Santa Clara River; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits; however, unit is difficult to map in this area owing to poor depth of penetration, and its base on this profile is inferred largely on correlation with other nearby profiles. Dashed red lines show inferred (poorly imaged) axial planes of fold that formed above blind-reverse, south-dipping Oak Ridge Fault (see fig. 7). Dashed yellow lines are seafloor multiples (echoes of seafloor reflector). Cone-shaped reflections in water column are associated with gas seeps.

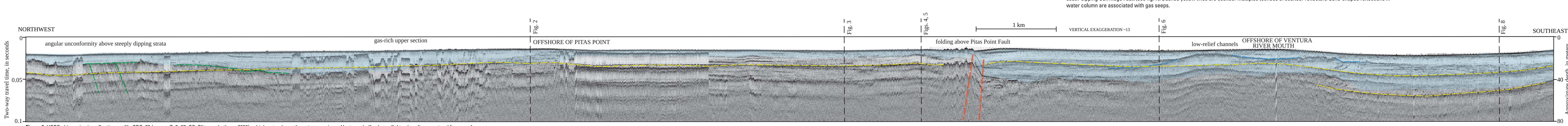
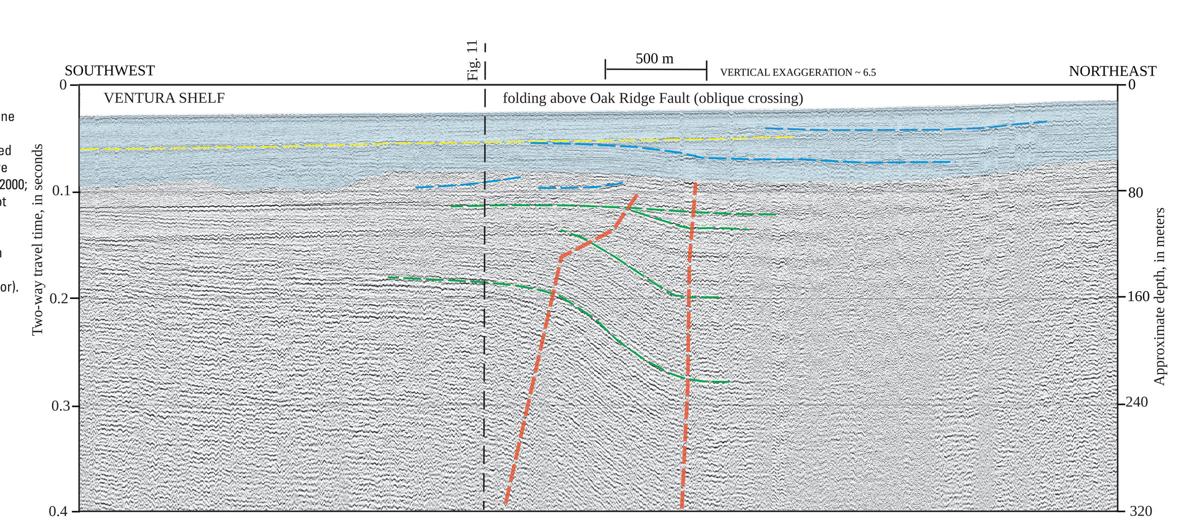


Figure 9. USGS chirp seismic-reflection profile SBC–70 (survey Z–3–07–SC; Sliter and others, 2008), which extends northwest across inner Ventura shelf subparallel to shoreline; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits. Dashed red lines show axial planes of asymmetric fold associated with blind-reverse, north-dipping Pitas Point Fault (see, for example, Sorlien and others, 2000; Fisher and others, 2009). Dashed blue lines show low-relief channels offshore of Ventura River mouth. Area northwest of Pitas Point lies offshore of a few steep coastal watersheds and may include channels cut during low sea-level stands; however, shallow stratigraphy in this area is largely obscured by gas seeps. Dashed green lines in northwestern part of profile highlight prominent angular unconformity. Dashed yellow lines are seafloor multiples (echoes of seafloor multiple). Chirp seismic-reflection profile has less depth penetration than minisparker profiles in figures 1, 2, 3, 5, 6, 10, and 11, but it shows greater geologic detail in upper few tens of meters.

Figure 10. USGS minisparker seismic-reflection profile SB–60 (survey Z–3–07–SC; Sliter and others, 2008), which extends southwest across Ventura shelf offshore of Ventura; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits. Dashed red lines show axial planes of asymmetric fold that developed above south-dipping Oak Ridge Fault (Yeats, 1988; Sorlien and others, 2000; Fisher and others, 2005, 2009), a blind-reverse fault that does not clearly offset upper about 200 to 300 m of stratigraphic section; dashed green lines highlight folded reflections in zone of deformation and also prominent angular unconformity shown in figure 11. Dashed blue lines show low-angle erosion surfaces. Dashed yellow line is seafloor multiple (echo of seafloor reflector).



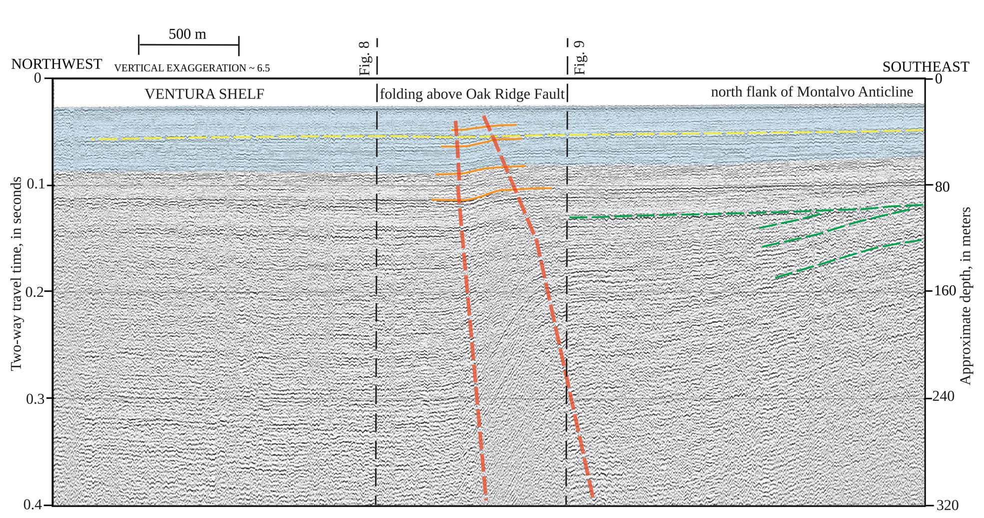


Figure 11. North end of USGS minisparker seismic-reflection profile SB–51T (survey Z–3–07; Sliter and others, 2008), which extends northwest across Ventura shelf, subparallel to shoreline in southern part of map area, about 4 km offshore; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene deltaic and shelf deposits. Dashed red lines show axial planes of asymmetric fold that developed above south-dipping Oak Ridge Fault (Yeats, 1988; Sorlien and others, 2000; Fisher and others, 2005, 2009), a blind-reverse fault that does not clearly offset upper about 200 to 300 m of stratigraphic section; orange lines highlight folded reflections and show upward-decreasing structural relief within upper stratigraphic unit. Dashed green lines show angular unconformity on north flank of Montalvo Anticline (Greene and others, 1978; Fisher and others, 2005). Dashed yellow line is seafloor multiple (echo of seafloor reflector).

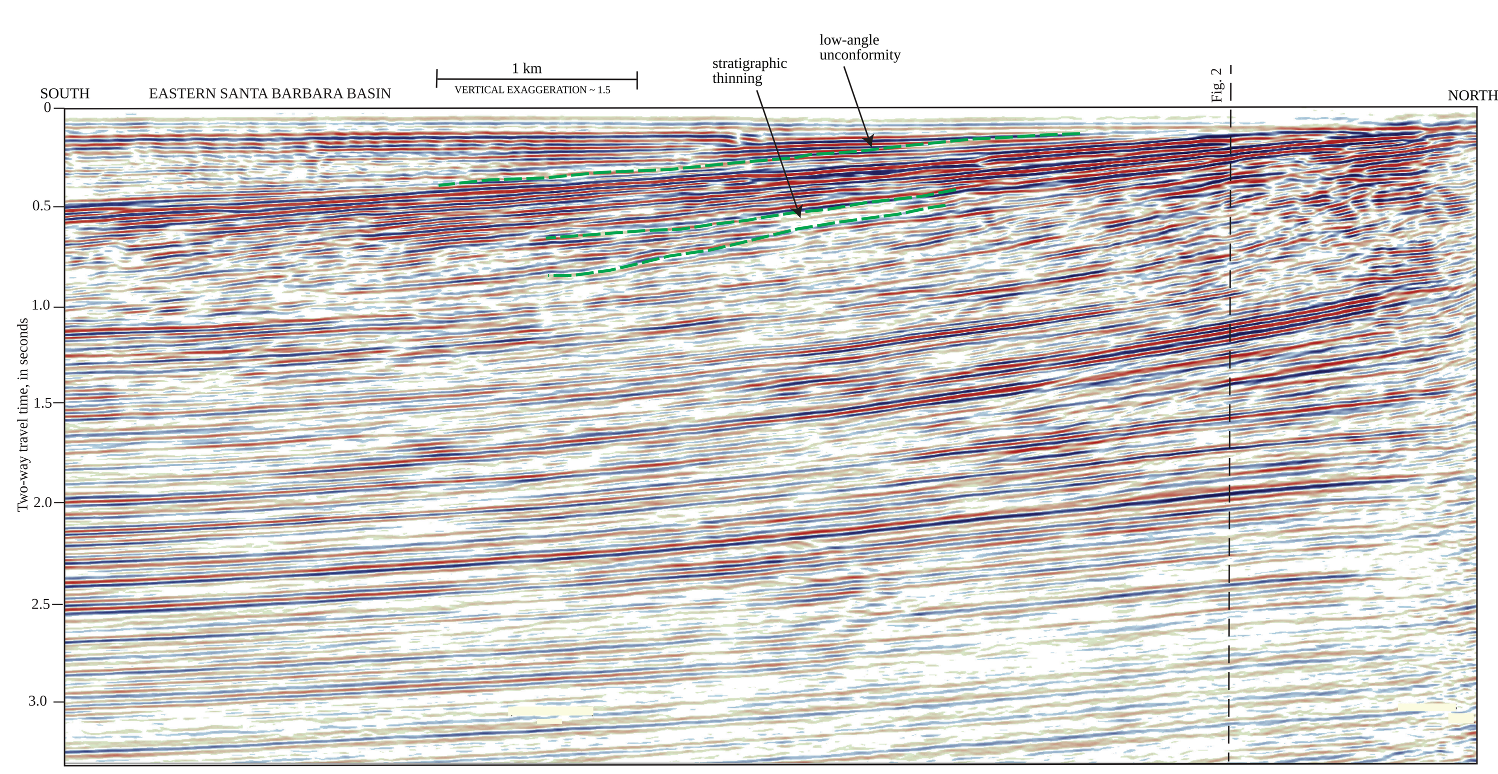


Figure 12. Industry 2-D migrated multichannel air-gun seismic-reflection profile SB85–35 (collected in 1985 on survey W–6–85–SC), which extends south across Ventura shelf; see trackline map for location. Note that profile has similar horizontal scale to USGS high-resolution seismic-reflection profiles shown in figures 1 through 11, but it has much less vertical exaggeration (1.5:1). Note also that profile has not been depth converted and so no depth scale is shown, but it probably extends to depths of 4 to 5 km. Profile reveals gently south-dipping (about 5°) strata on south flank of gentle, growing structural arch associated with Pitas Point Fault (figs. 2, 3, 4, 5, 9). Dashed green lines show prominent low-angle unconformity near top of section, as well as good example of south-to-north stratigraphic thinning within section. Previous workers (Greene and others, 1978; Redin and others, 1998; Sorlien and others, 2000; Fisher and others, 2009) have suggested that imaged section includes (from oldest to youngest) the upper Miocene Monterey Formation, the Miocene and Pliocene Sisquoc Formation, the Pliocene Repetto Formation, and the Pliocene to Pleistocene Pico, Santa Barbara, and Saugus Formations.

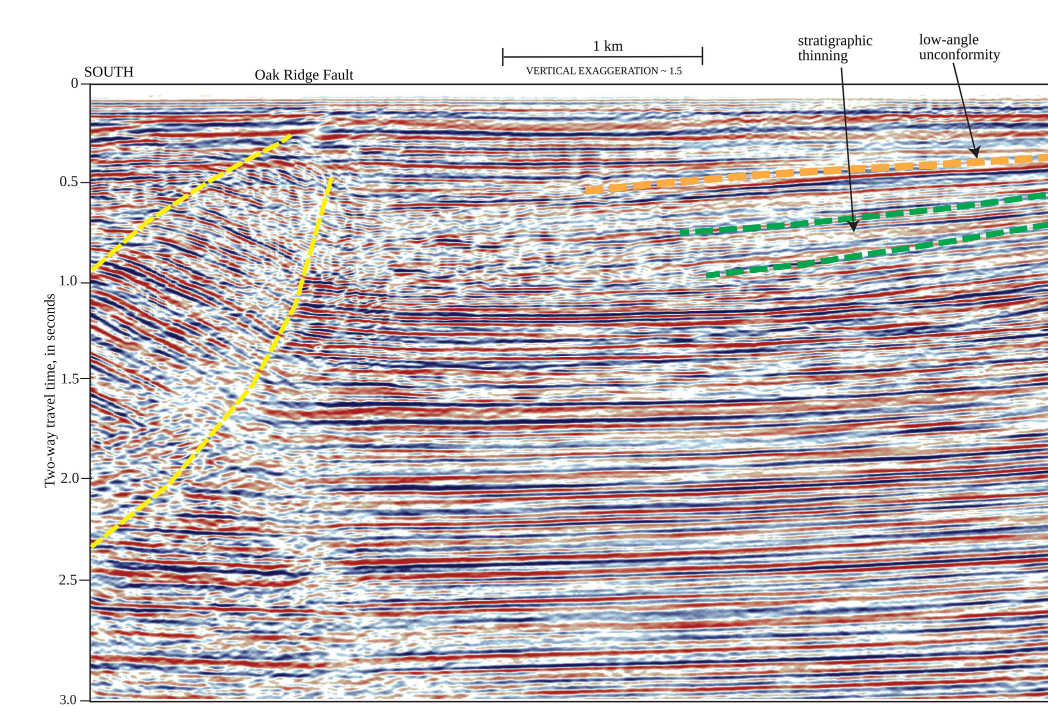
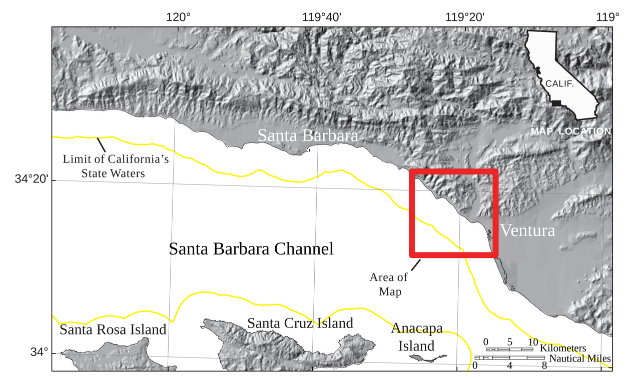


Figure 13. Industry 2-D migrated multichannel air-gun seismic-reflection profile WC–85–170 (collected in 1985 on survey W–4–85–SC), which extends south across Ventura shelf; see trackline map for location. Note that profile has similar horizontal scale to USGS high-resolution seismic-reflection profiles shown in figures 1 through 11, but it has much less vertical exaggeration (1.5:1). Note also that profile has not been depth converted and so no depth scale is shown, but it probably extends to depths of 4 to 5 km. Profile reveals gently south-dipping (about 5°) strata on south flank of active structural arch associated with Pitas Point Fault (figs. 2, 3, 4, 5; see also, sheet 10). Dashed yellow lines show upward-narrowing "growth triangle" (Suppe and others, 1992) associated with Oak Ridge Fault, a blind-reverse fault that folds but appears not to offset strata in upper 0.5 sec of two-way travel time (about 400 m) of section, an observation confirmed by USGS high-resolution seismic-reflection profiles to east (for example, figs. 7, 8, 10, 11). Dashed orange line shows prominent low-angle unconformity near top of section. Dashed green lines show marker horizons within section that reveal south-to-north stratigraphic thinning related to uplift along Pitas Point Fault. Previous workers (Greene and others, 1978; Redin and others, 1998; Sorlien and others, 2000; Fisher and others, 2009) have suggested that imaged section includes (from oldest to youngest) the upper Miocene Monterey Formation, the Miocene and Pliocene Sisquoc Formation, the Pliocene Repetto Formation, and the Pliocene to Pleistocene Pico, Santa Barbara, and Saugus Formations.



DISCUSSION

This map sheet shows seismic-reflection profiles from two different surveys of the Offshore of Ventura map area, providing imagery of the subsurface geology. The area, which lies offshore of the mouths of the Santa Clara and Ventura Rivers, is characterized by a broad, relatively shallow (less than 40 m), flat, wave-cut shelf. The seismic-reflection data reveal that the shelf is underlain by thick upper Pleistocene and Holocene marine, deltaic, and fluvial strata (blue shading in profiles; Dahlen, 1992; Slater and others, 2002; Sommerfield and others, 2009; Draut and others, 2009) deposited in the last about 21,000 years, following the last major sea-level lowstand (see, for example, Fleming and others, 1998). The rivers are major sediment sources (Warrick and Farnsworth, 2009a), and the depocenter in the map area contains the largest mass of sediment anywhere on the entire southern California shelf (Sommerfield and others, 2009). The map area is cut by two important active faults. The east-west-striking, south-dipping Oak Ridge Fault (figs. 7, 8, 10, 11, 13), which cuts across the southern part of the map area, forms part of a fault system that extends for about 100 km through the Ventura and Santa Barbara Basins (Fisher and others, 2009). Both the Oak Ridge and Pitas Point Faults are thought to be blind-thrust or blind-reverse faults associated with folds that clearly deform Holocene strata. Both high-resolution and deeper industry seismic-reflection profiles indicate that the area between the two faults is relatively undeformed.

Most profiles displayed on this map sheet (figs. 1 through 11) were collected in 2007 on U.S. Geological Survey (USGS) cruise Z–3–07–SC (Sliter and others, 2008). Single-channel seismic-reflection data were acquired using two different sources, the SIG 2Mille minisparker (figs. 1, 2, 3, 5, 6, 10, 11) and the EdgeTech 512 chirp (figs. 4, 7, 8, 9). The SIG minisparker system used a 500-J high-voltage electrical discharge fired 1 to 4 times per second, which, at normal survey speed of 4 to 4.5 nautical miles per hour, gives a data trace every 0.5 to 2.0 meters. The data were digitally recorded in standard SEG-Y 32-bit floating-point format using PC-based Triton Subbottom Logger (SBL) software that merges seismic-reflection data with differential GPS-navigation data. The EdgeTech 512 chirp subbottom-profiling system consists of a source transducer and an array of receiving hydrophones housed in a 500-lb fish towed at a depth of several meters below the sea surface. The swept-frequency chirp source signal was 500 to 4,500 Hz and 50 ms in length, and it was recorded by hydrophones located on the bottom of the fish. After the survey, a short-window (20 ms) automatic gain control algorithm was applied to both the chirp and minisparker data, and a 160- to 1,200-Hz bandpass filter was applied to the minisparker data. The vertical scale on the high-resolution seismic-reflection profiles (figs. 1 through 11) is shown as two-way travel time in seconds, as well as in meters on the basis of an inferred velocity of 1,600 m/sec for near-surface sediments.

Figures 11 and 12 show deep-penetration, migrated, multichannel seismic-reflection profiles collected in 1985 by WesternGeco on cruises W–6–85–SC and W–4–85–SC. These profiles and other similar data were collected in many areas offshore of California in the 1970s and 1980s when the area was considered a frontier for oil and gas exploration. Much of these data have been publicly released and are now archived at the USGS National Archive of Marine Seismic Surveys (U.S. Geological Survey, 2009). These data were acquired with a large-volume air-gun source that has a frequency range of 3 to 40 Hz and recorded with a multichannel hydrophone streamer about 2 km long; shot spacing was about 30 m. These data can resolve geologic features that are 20 to 30 m thick, down to subbottom depths of about 4 km.

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Seismic-Reflection Profiles, Offshore of Ventura Map Area, California

By

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2013