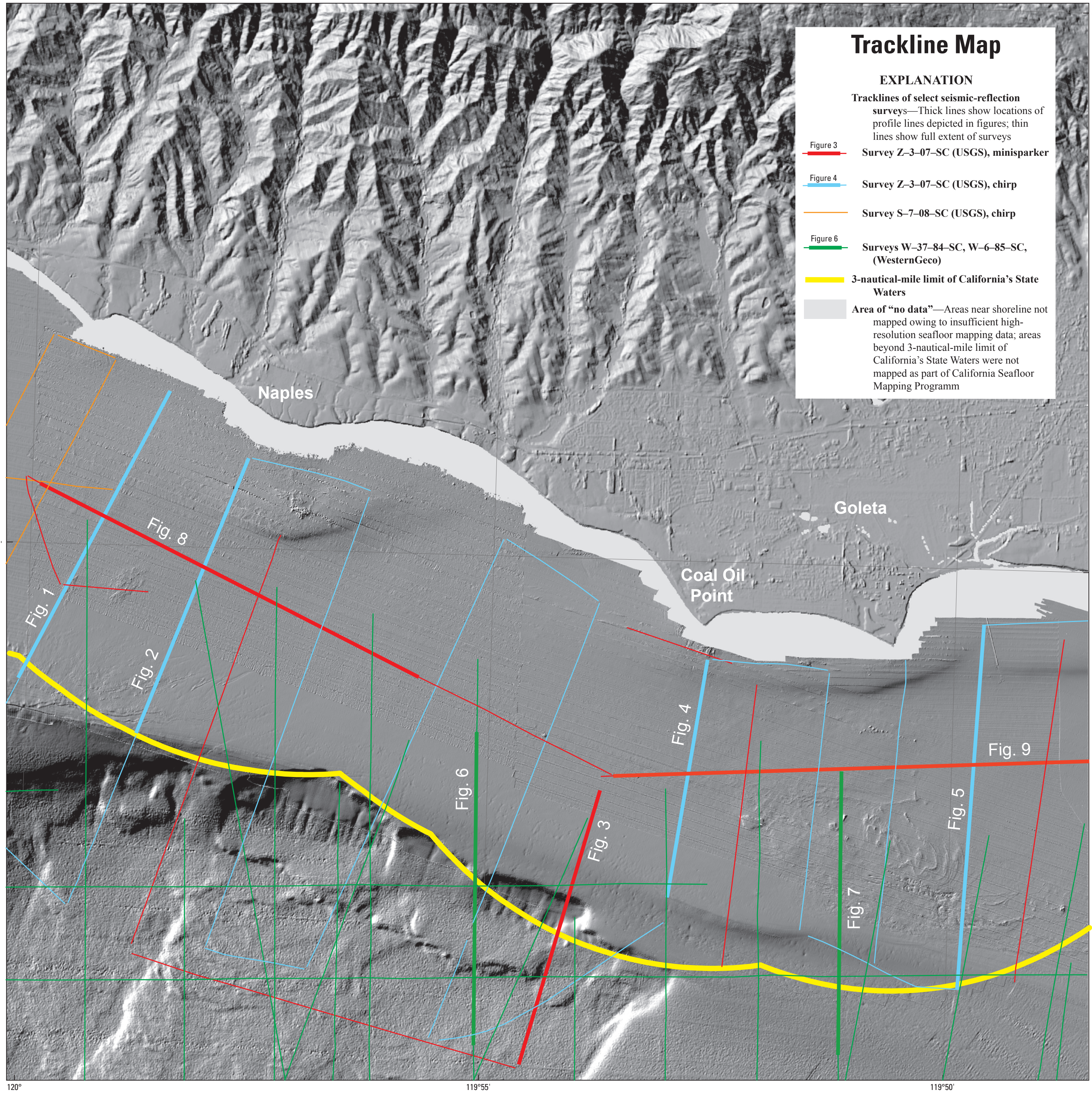
U.S. Department of the Interior
U.S. Geological Survey

Scientific Investigations Map 3302
Sheet 8 of 12
Pamphlet accompanies map



Trackline Map

EXPLANATION

Tracklines of select seismic-reflection surveys—Thick lines show locations of profile lines depicted in figures; thin lines show full extent of surveys

Survey Z–3–07–SC (USGS), minisparker

Survey Z–3–07–SC (USGS), chirp

Survey S–7–08–SC (USGS), chirp

Surveys W–37–84–SC, W–6–85–SC, (WesternGeco)

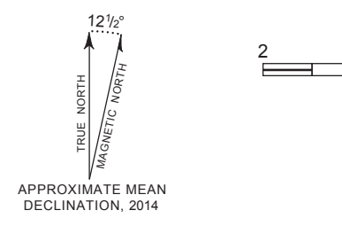
3-nautical-mile limit of California's State Waters

Area of "no data"—Areas near shoreline not mapped owing to insufficient high-resolution seafloor mapping data; areas beyond 3-nautical-mile limit of California's State Waters were not mapped as part of California Seafloor Mapping Programm

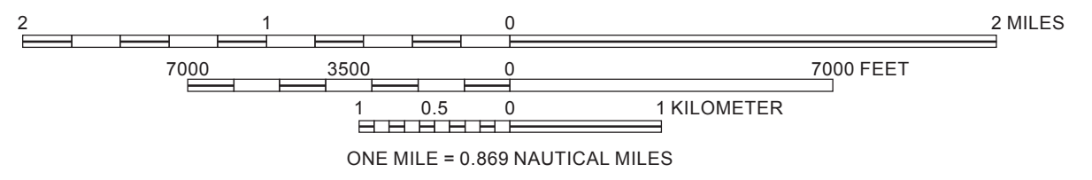
Onshore elevation data from NOAA Coastal Services Center (data collected by EarthData International in 2002-2003) and from U.S. Army Corps of Engineers (data collected by Fugro Pelagos in 2009). Offshore shaded-relief bathymetry within California's State Waters from map on sheet 2, this report. Offshore shaded-relief bathymetry outside California's State Waters from Monterey Bay Aquarium Research Institute (2001). 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

GIS database and digital cartography by Eleyne L. Phillips and Florence L. Wong
Edited by Taryn A. Lindquist
Manuscript approved for publication June 2, 2014

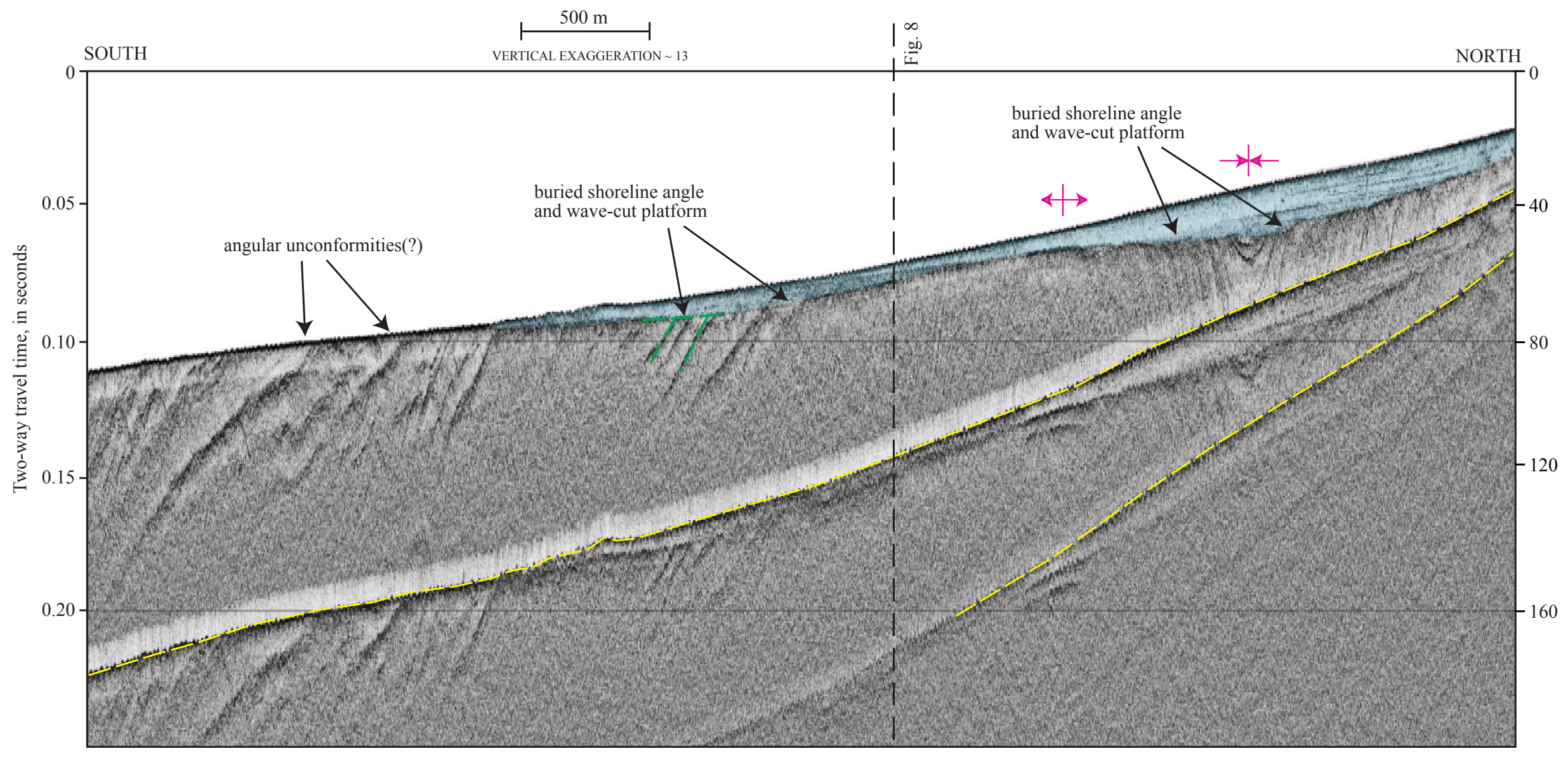


Figure 1. USGS chirp seismic-reflection profile SBC–138A (survey Z–3–07–SC; Sliter and others, 2008), which crosses Santa Barbara shelf offshore of Naples; see trackline map for location. Magenta symbols show fold axes (diverging arrows, anticline; converging arrows, syncline). Blue shading shows inferred uppermost Pleistocene and Holocene nearshore and shelf deposits, which have maximum thickness of about 18 m on this transect but pinch out near south end of profile. Upper stratigraphic unit overlies prominent angular unconformity; dashed green lines partly highlight this discordance. Dipping strata beneath unconformity are undivided Miocene, Pliocene, and Pleistocene rocks, which are folded close to shore but dip generally to south in broad homocline. Dashed yellow lines are seafloor multiples (echoes of seafloor reflector).

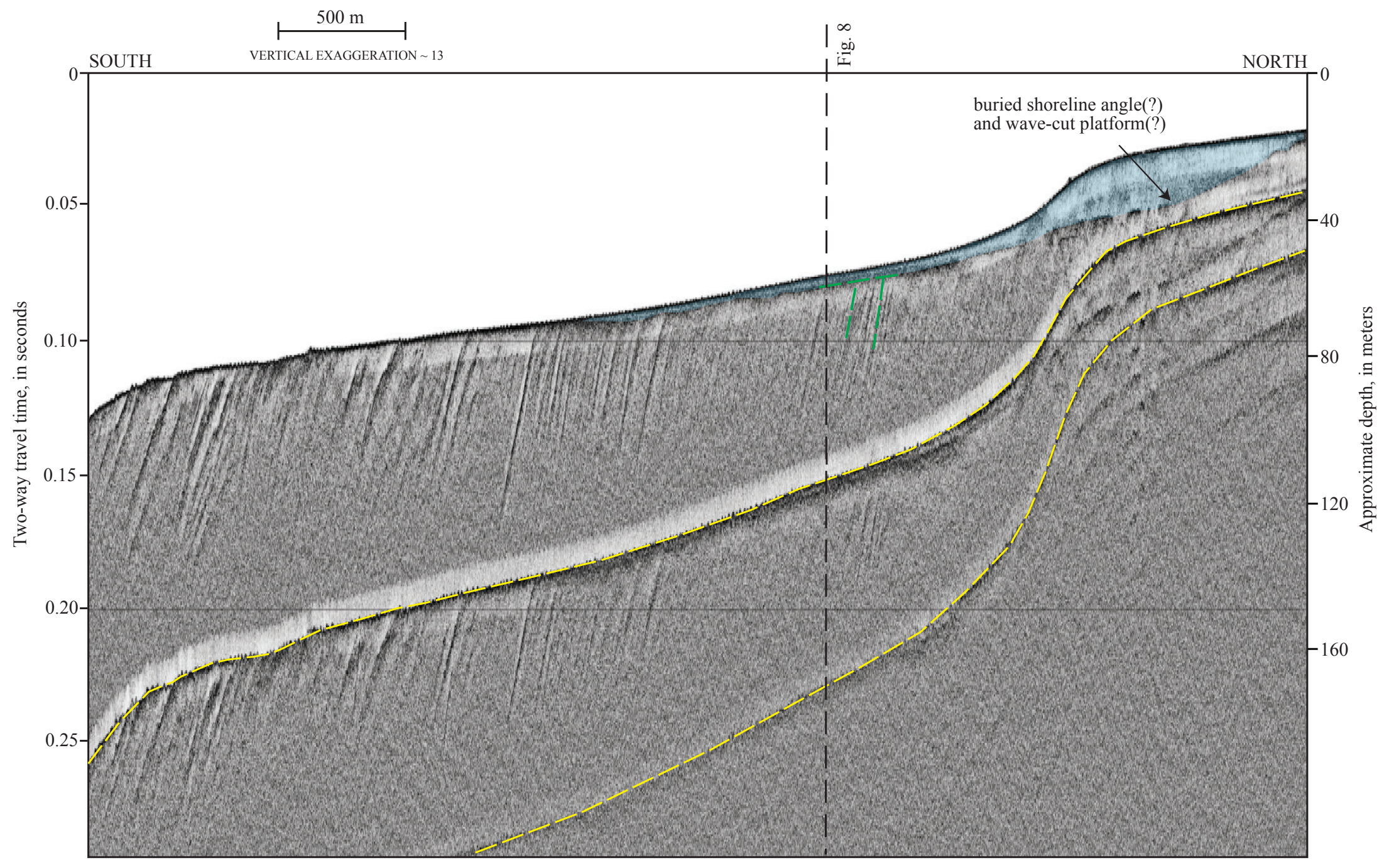


Figure 2. USGS chirp seismic-reflection profile SBC–136 (survey Z–3–07–SC–SC; Sliter and others, 2008), which crosses Santa Barbara shelf offshore of Naples; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene nearshore and shelf deposits, which have maximum thickness of about 18 m this transect but pinch out in central part of profile. Upper stratigraphic unit overlies prominent angular unconformity; dashed green lines partly highlight this discordance. Dipping strata beneath unconformity are undivided Miocene, Pliocene, and Pleistocene rocks that dip generally to south in broad homocline. Blue shading near north end of profile shows young nearshore delta deposits that overlie probable buried shoreline angle and wave-cut platform. Dashed yellow lines are seafloor multiples (echoes of seafloor reflector).

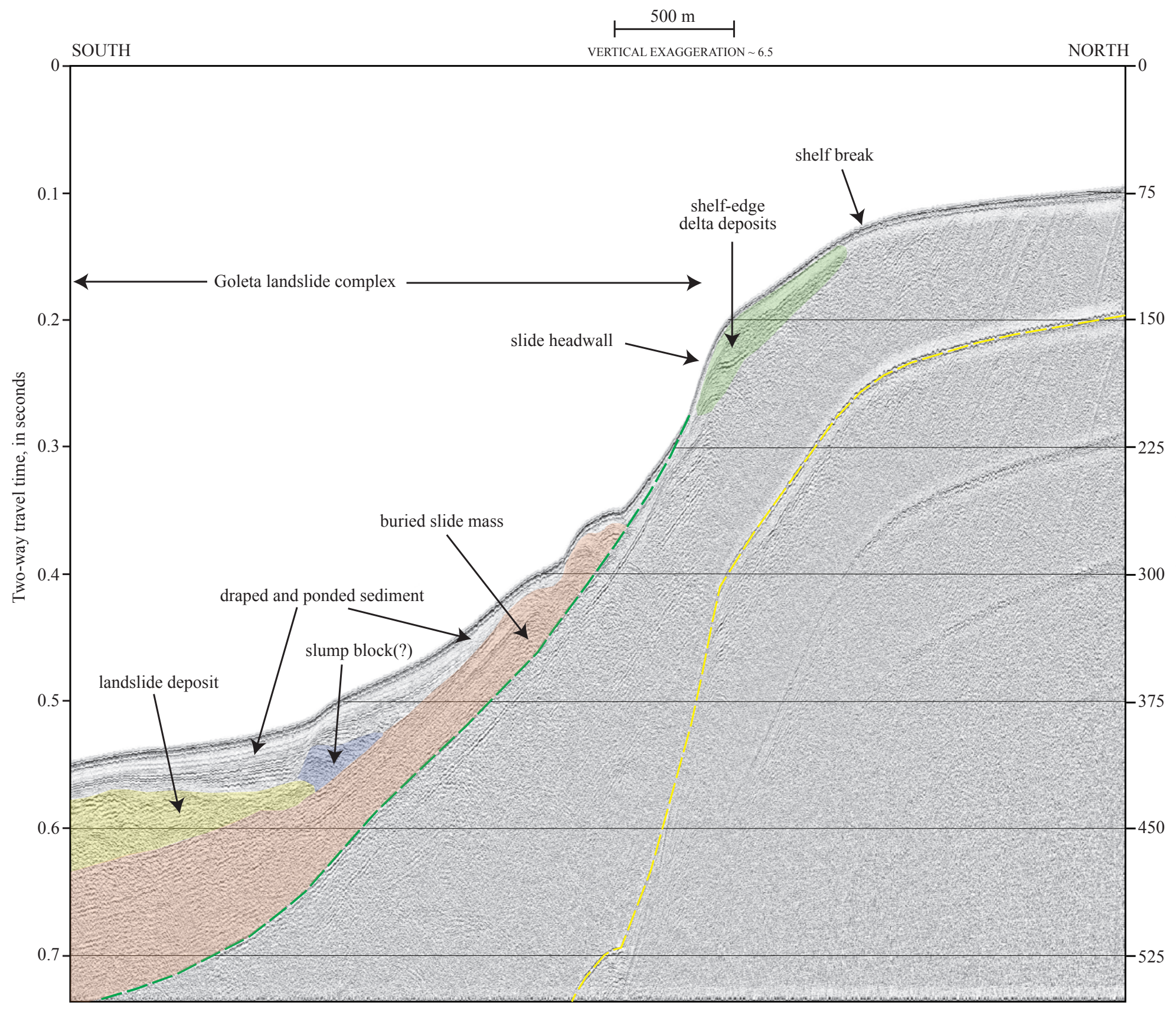


Figure 3. USGS minisparker seismic-reflection profile SB–145 (survey Z–3–07–SC; Sliter and others, 2008), which crosses outer shelf and upper slope offshore of Coal Oil Point; see trackline map for location. Profile shows upper part of submarine Goleta landslide complex (Greene and others, 2006); headwall is underlain by inferred shelf-edge delta deposits (green shading). Discrete parts of landslide mass are shown by orange, yellow, and purple shading; these inferred landslide deposits are overlain by younger ponded and draped sediments. Dashed green line shows possible basal slide surface. Dashed yellow line is seafloor multiple (echo of seafloor reflector).

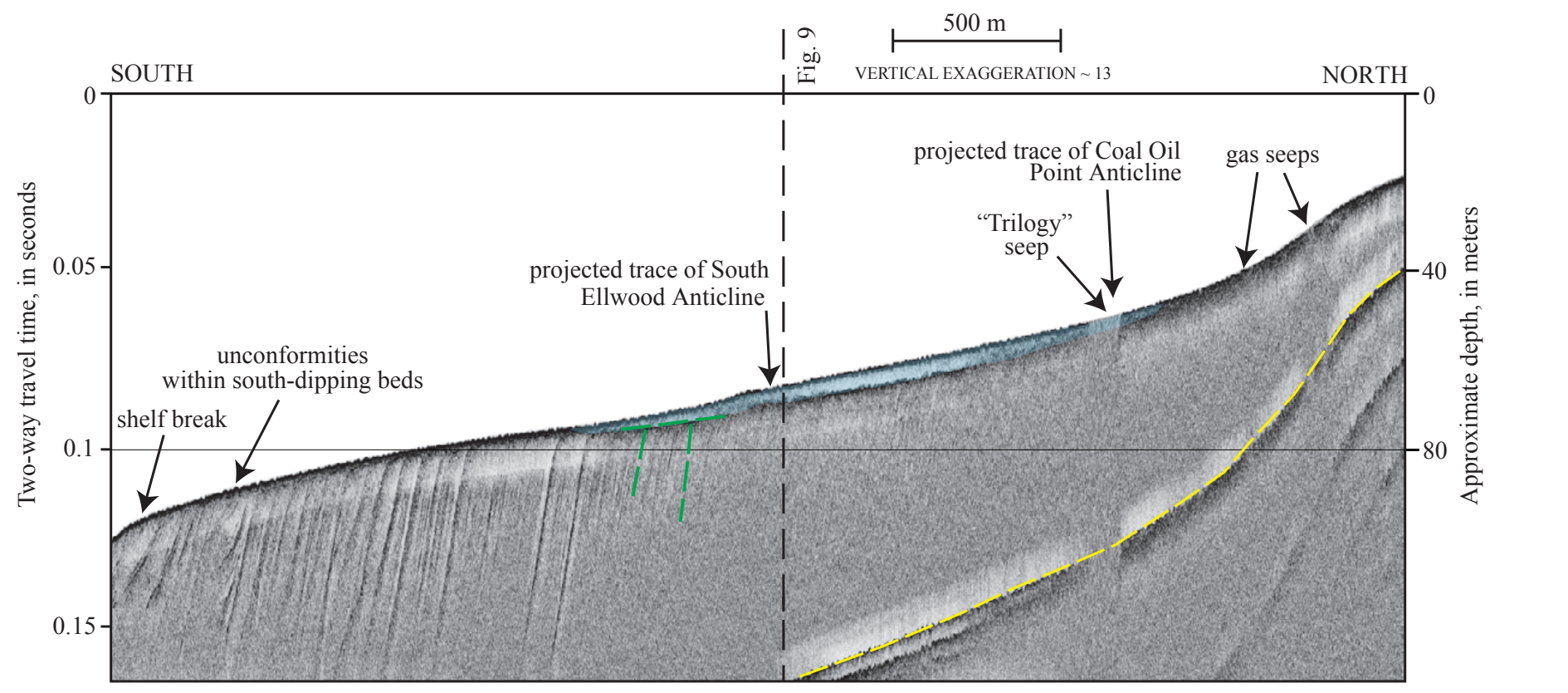


Figure 4. USGS chirp seismic-reflection profile SBC–128 (survey Z–3–07–SC; Sliter and others, 2008), which crosses Santa Barbara shelf offshore of Coal Oil Point; see trackline map for location. Blue shading shows inferred uppermost Pleistocene and Holocene nearshore and shelf deposits, which have maximum thickness of about 8 m on this transect but pinch out in central part of profile. Upper stratigraphic unit overlies prominent angular unconformity; dashed green lines partly highlight this discordance. Dipping strata beneath unconformity are undivided Miocene, Pliocene, and Pleistocene rocks. Several gas seeps, including "Trilogy" seep (sheet 11 of this report; see also, Lorenson and others, 2011), are shown near north end of profile; gas from these seeps in water column and shallow subsurface obscures geologic features such as South Ellwood and Coal Oil Point Anticlines, traces of which are projected onto profile. Slight angular unconformities within south-dipping strata near shelf break at south end of profile are interpreted to be deltas deposited at shelf edge during sea-level lowstands, when sea level was at or near shelf break. Dashed yellow line is seafloor multiple (echo of seafloor reflector).

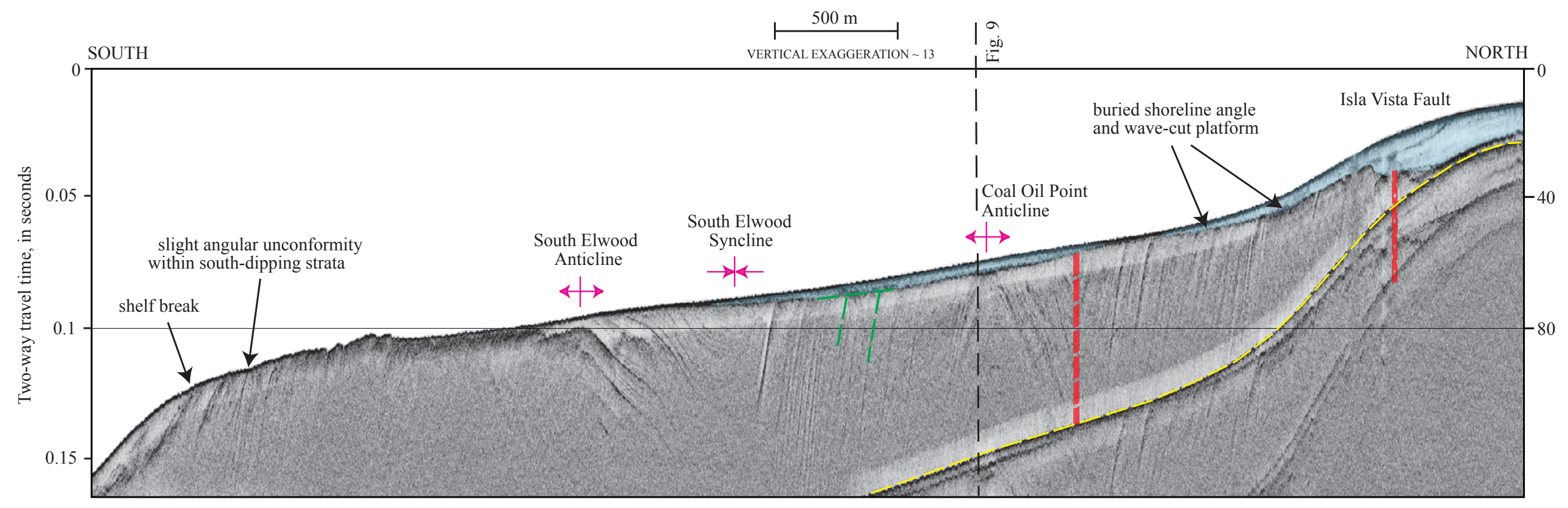


Figure 5. USGS chirp seismic-reflection profile SBC–124 (survey Z–3–07–SC; Sliter and others, 2008), which crosses Santa Barbara shelf offshore of Goleta; see trackline map for location. Dashed red lines show faults, including Isla Vista Fault (Minor and others, 2009). Magenta symbols show fold axes (diverging arrows, anticlines; converging arrows, syncline); fold names from Leifer and others (2010). Blue shading shows inferred uppermost Pleistocene and Holocene nearshore and shelf deposits, which have maximum thickness of about 15 m on this transect but pinch out midshelf. Upper stratigraphic unit overlies prominent angular unconformity; dashed green lines partly highlight this discordance. Folded strata beneath unconformity are undivided Miocene, Pliocene, and Pleistocene rocks. Dashed yellow line is seafloor multiple (echo of seafloor reflector).

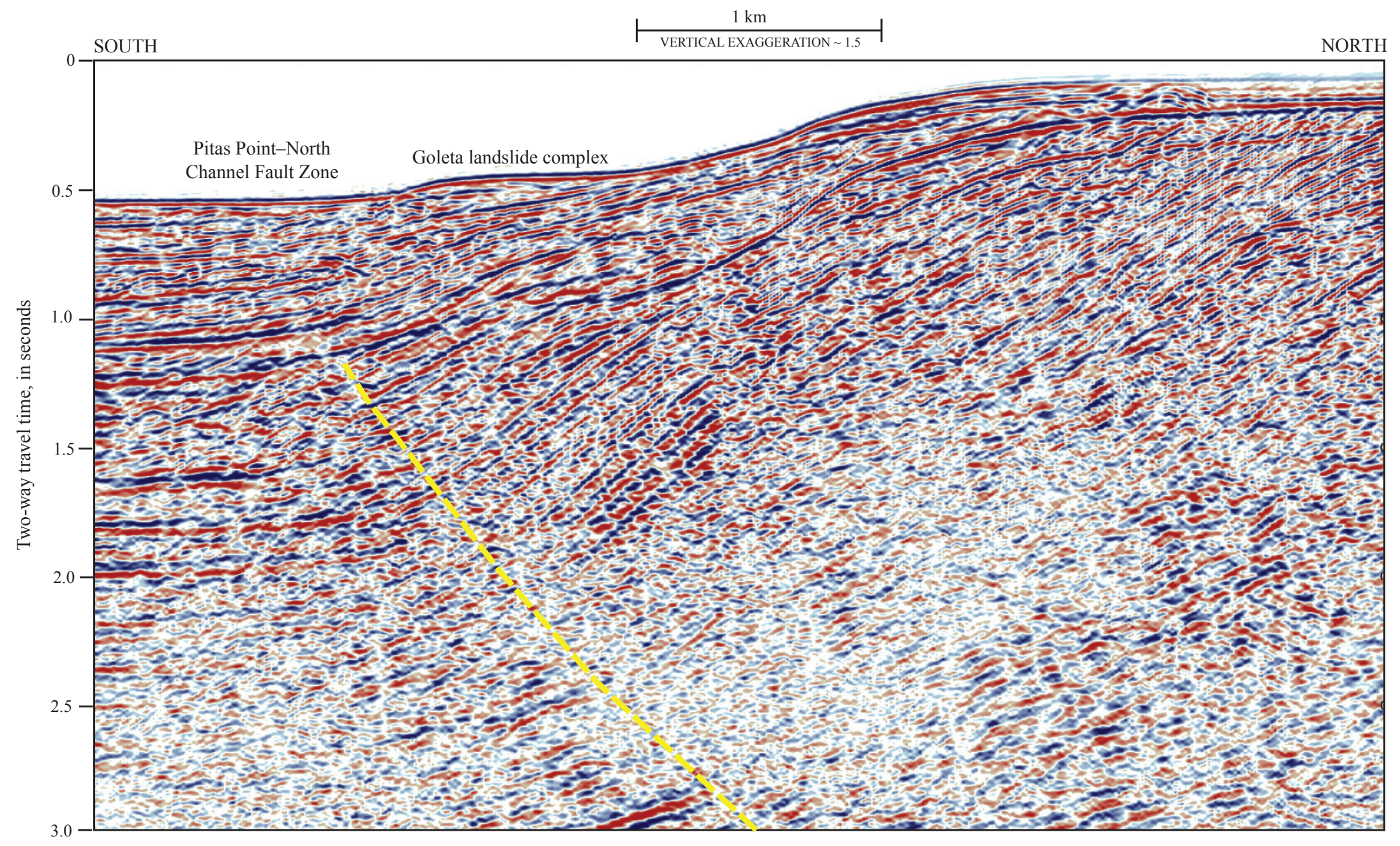


Figure 6. Industry 2-D, migrated multichannel air-gun seismic-reflection profile WC84–232 (collected in 1984 on WesternGeco survey W–37–84–SC), which traverses part of Santa Barbara shelf offshore of Coal Oil Point, extending south across upper part of submarine Goleta landslide complex; see trackline map for location. Note that profile has similar horizontal scale to USGS high-resolution seismic-reflection profiles shown in figures 1, 2, 3, 4, 5, 8, and 9, 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 extends to depths of more than 2.5 km, more than six times that of USGS profiles (compare with fig. 3, which shows similar part of shelf). Pitas Point–North Channel Fault Zone is shown by dashed yellow line; fault zone is "blind" at this resolution, as it appears to cut strata well below seafloor but does not appear to deform young, shallow sediments.

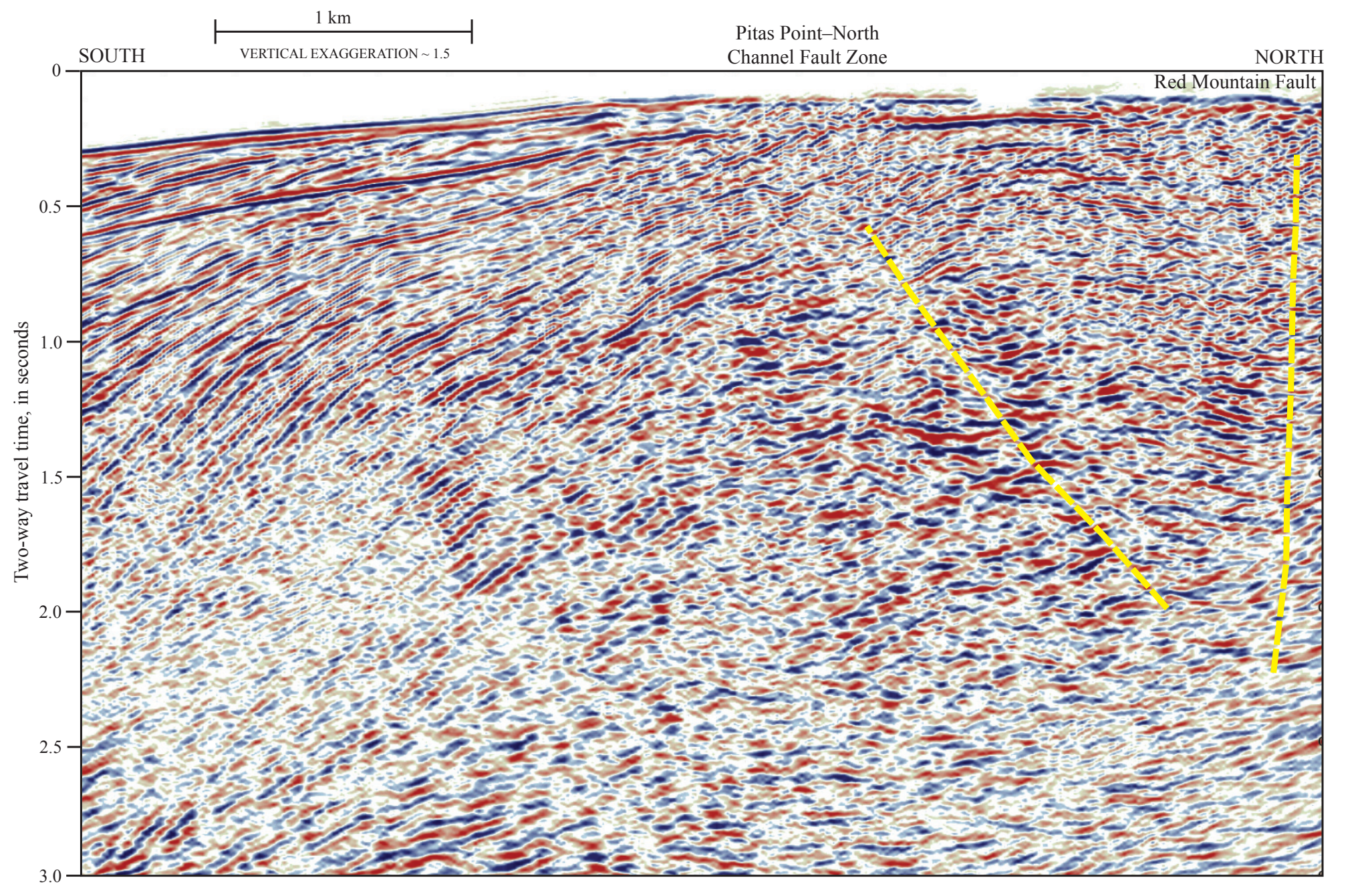


Figure 7. Industry 2-D, migrated multichannel air-gun seismic-reflection profile WC85–224 (collected in 1985 on WesternGeco survey W–6–85–SC), which extends south across Santa Barbara shelf offshore of Coal Oil Point; see trackline map for location. Note that profile has similar horizontal scale to USGS high-resolution seismic-reflection profiles shown in figures 1, 2, 3, 4, 5, 8, and 9, 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 extends to depths of more than 2.5 km, more than six times that of USGS profiles (compare with figs. 4 and 5, which show similar part of shelf). Pitas Point–North Channel Fault Zone and Red Mountain Fault are shown by dashed yellow lines.

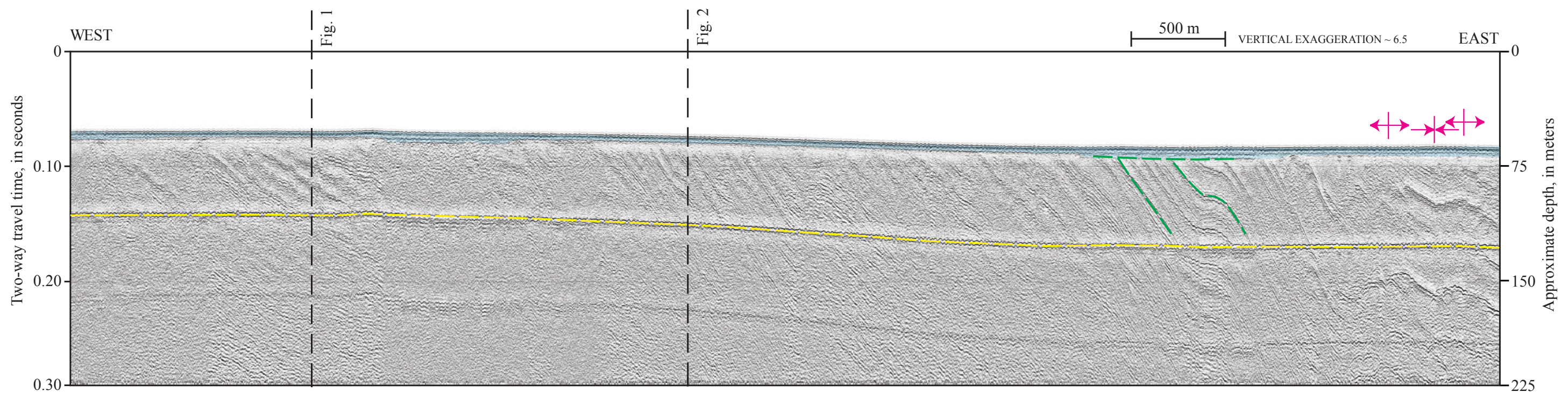


Figure 8. USGS minisparker seismic-reflection profile SB–141T (survey Z–3–07–SC; Sliter and others, 2008), which crosses Santa Barbara shelf offshore of Naples; see trackline map for locations. Magenta symbols show fold axes (diverging arrows, anticlines; converging arrows, syncline). Blue shading shows inferred uppermost Pleistocene and Holocene nearshore and shelf deposits, which have maximum thickness of about 5 m on this transect. Upper stratigraphic unit overlies prominent angular unconformity; dashed green lines partly highlight this discordance. Folded strata beneath unconformity are undivided Miocene, Pliocene, and Pleistocene rocks. Dashed yellow line is seafloor multiple (echo of seafloor reflector).

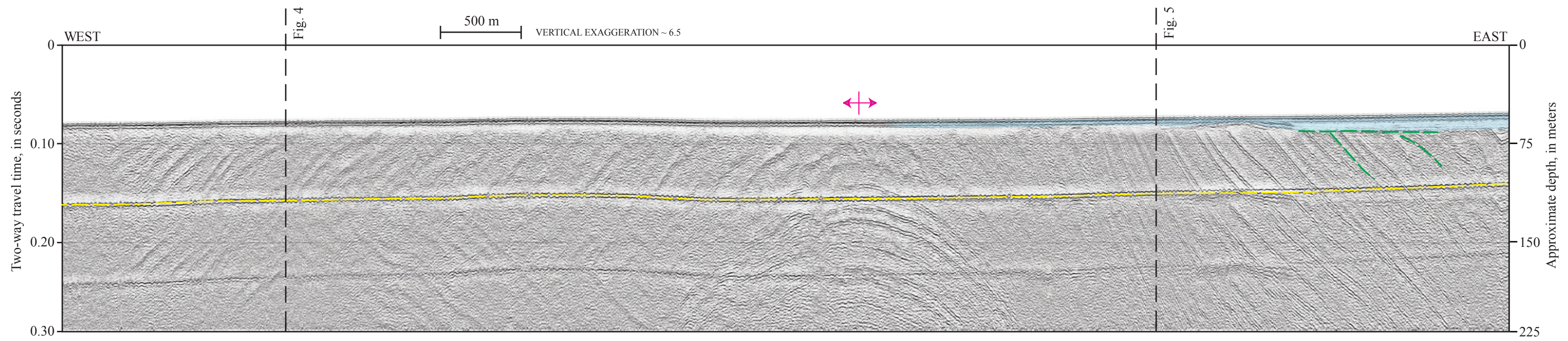
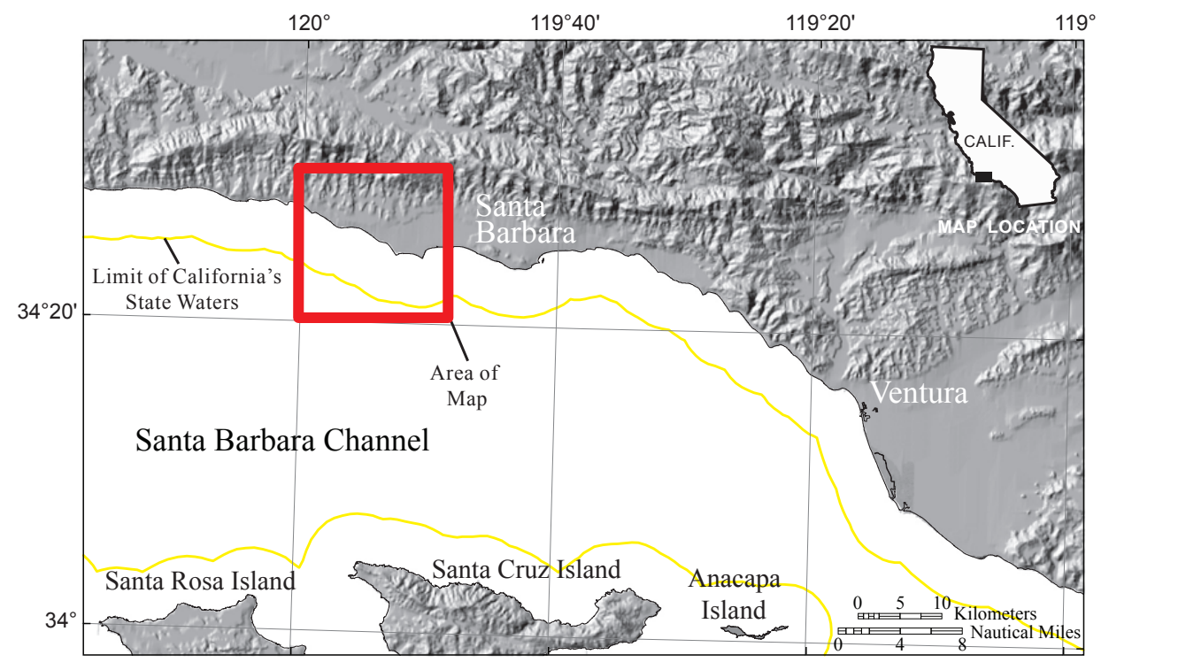


Figure 9. USGS minisparker seismic-reflection profile SB–146T (survey Z–3–07–SC; Sliter and others, 2008), which crosses Santa Barbara shelf offshore of Coal Oil Point; see trackline map for location. Magenta symbol shows anticline axis. Blue shading shows inferred uppermost Pleistocene and Holocene nearshore and shelf deposits, which have maximum thickness of about 12 m on this transect. Upper stratigraphic unit overlies prominent angular unconformity; dashed green lines partly highlight this discordance. Folded strata beneath unconformity are undivided Miocene, Pliocene, and Pleistocene rocks. Dashed yellow line is seafloor multiple (echo of seafloor reflector).



DISCUSSION

This map sheet shows seismic-reflection profiles from three different surveys of the Offshore of Coal Oil Point map area, providing imagery of the subsurface geology. The area extends from the nearshore across the continental shelf to the shelf break (water depth, about 90 m) and upper slope, with maximum water depths more than 300 m. Geologic units exposed on the shelf, which are Miocene and younger in age, include the Miocene Monterey Formation, the upper Miocene and lower Pliocene Sisquoc Formation, and younger unnamed Pliocene and Pleistocene marine sedimentary rocks. These rocks are warped into asymmetric folds that generally strike west to northwest, roughly parallel to the coastline; some of these folds probably root into blind faults at depth. Faults known to be present in the subsurface include the Isla Vista Fault (fig. 5; see also, Minor and others, 2009) and the Red Mountain Fault (fig. 7; see also, Redin and others, 2005; Leifer and others, 2010). In addition, the Pitas Point Fault underlies the upper slope at depth in the eastern part of the map area (fig. 7; see also, Fisher and others, 2009). The North Channel Fault also is present at depth beneath the upper slope in the western part of the map area (fig. 6; see also, Redin and others, 2005; Fisher and others, 2009).

Pliocene and older rocks are unconformably overlain by upper Pleistocene and Holocene marine sediments (blue shading in profiles; Sommerfield and others, 2009; Draut and others, 2009) deposited in the last about 21,000 years, following the last major glaciation and sea-level lowstand (see, for example, Fleming and others, 1998). This postglacial stratigraphic unit has a maximum thickness of about 18 m (fig. 2) in the map area, but it typically is less than 5 m thick and pinches out locally over bedrock highs. Two or three submerged and buried shoreline angles and wave-cut platforms (see, for example, Kern, 1977) may have formed during relative stillstands during late Quaternary sea-level fluctuations (figs. 1, 2, 5). Nearshore and shelf sediment is derived mainly from eastward littoral drift, bluff erosion, and local coastal watersheds (Warrick and Farnsworth, 2009; see also, fig. 1–2 in pamphlet).

A substantial part of the large, compound, submarine Goleta landslide complex is located along the shelf break and upper slope in the southwestern part of the map area (fig. 3; see also, sheet 10). This landslide complex, which is about 11 km wide, extends about 14 km downslope into Santa Barbara Channel, much of it beyond the limit of California's State Waters. The most recent large slide events for the Goleta landslide complex probably occurred about 8,000 to 10,000 years ago (Eichhubl and others, 2002; Fisher and others, 2005; Greene and others, 2006).

All but two profiles displayed on this map sheet (figs. 1, 2, 3, 4, 5, 8, 9) 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 EdgeTech 512 chirp (figs. 1, 2, 4, 5), and the SIG 2Mille minisparker (figs. 3, 8, 9). 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. 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. 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, 2, 3, 4, 5, 8, 9) 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 6 and 7 show deep-penetration, migrated, multichannel seismic-reflection profiles collected by WesternGeco in 1984 (cruise W–37–84–SC; fig. 6) and 1985 (cruise W–6–85–SC; fig. 7). 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 Coal Oil Point Map Area, California

By

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2014

ISSN 2329-132X (online)
http://dx.doi.org/10.3133/sim3302

For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225, 1–888–ASK–USGS

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Suggested Citation: Conrad, J.E., Hart, P.E., Sliter, R.W., Johnson, S.Y., Ritchie, A.C., Draut, A.E., and Phillips, E.L., 2014, Seismic-reflection profiles, Offshore of Coal Oil Point map area, California, *sheet 8 in* Johnson, S.Y., Dartnell, P., Cochrane, G.R., Golden, N.E., Phillips, E.L., Ritchie, A.C., Kvitek, R.G., Dieter, B.E., Conrad, J.E., Lorenson, T.D., Krigsman, L.M., Greene, H.G., Endris, C.A., Seitz, G.G., Finlayson, D.P., Sliter, R.W., Wong, F.L., Erdey, M.D., Gutierrez, C.I., Leifer, I., Yoklavich, M.M., Draut, A.E., Hart, P.E., Hostettler, F.D., Peters, K.E., Kvenvolden, K.A., Rosenbauer, R.J., and Fong, G. (S.Y. Johnson and S.A. Cochran, eds.), California State Waters Map Series—Offshore of Coal Oil Point, California: U.S. Geological Survey Scientific Investigations Map 3302, pamphlet 57 p., 12 sheets, scale 1:24,000, *http://dx.doi.org/10.3133/sim3302*.