

CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

DMG OPEN-FILE REPORT 76-5

SEISMIC HAZARDS STUDY OF VENTURA COUNTY, CALIFORNIA 1975



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Special Report

SEISMIC HAZARDS STUDY OF VENTURA COUNTY, CALIFORNIA

1975

Revised July 1976

California Division of Mines and Geology

In cooperation with the County of Ventura

**STATE OF CALIFORNIA
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Special Report

SEISMIC HAZARDS STUDY OF VENTURA COUNTY, CALIFORNIA

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fault traces; the lines, instead, represent linear photo features which suggest for one or more reasons that they might be faults (see map explanations for specific reasons).

In addition, it is very difficult to prove whether faults extend to the surface of unconsolidated or very poorly consolidated alluvial materials, and hence displace these materials. Obvious fault breaks which displaced the ground surface on top of such materials in the epicentral area of the 1971 San Fernando earthquake commonly could not be discerned well immediately beneath the ground surface where observed in trenches soon after the earthquake. In addition, strong vegetational lineaments may occur along ground surface projections of faults even though the faults do not necessarily displace near-surface materials. This is because the control of groundwater at greater depths by faults which displace older sediments may be reflected at the ground surface because of transpiration along the approximate surface projections of the faults.

Descriptions of Faults

Fig 9
Table 3

The general characteristics and relative activity of thirty seven individual faults, zones made of more than one fault, and zones made up of both faults and aerial-photograph lineaments of the County are described in Table 3 (see also figure 9). The descriptions also include for each fault or zone an estimate of (1) the most recent geologic time span of activity, and (2) the "maximum credible earthquake."

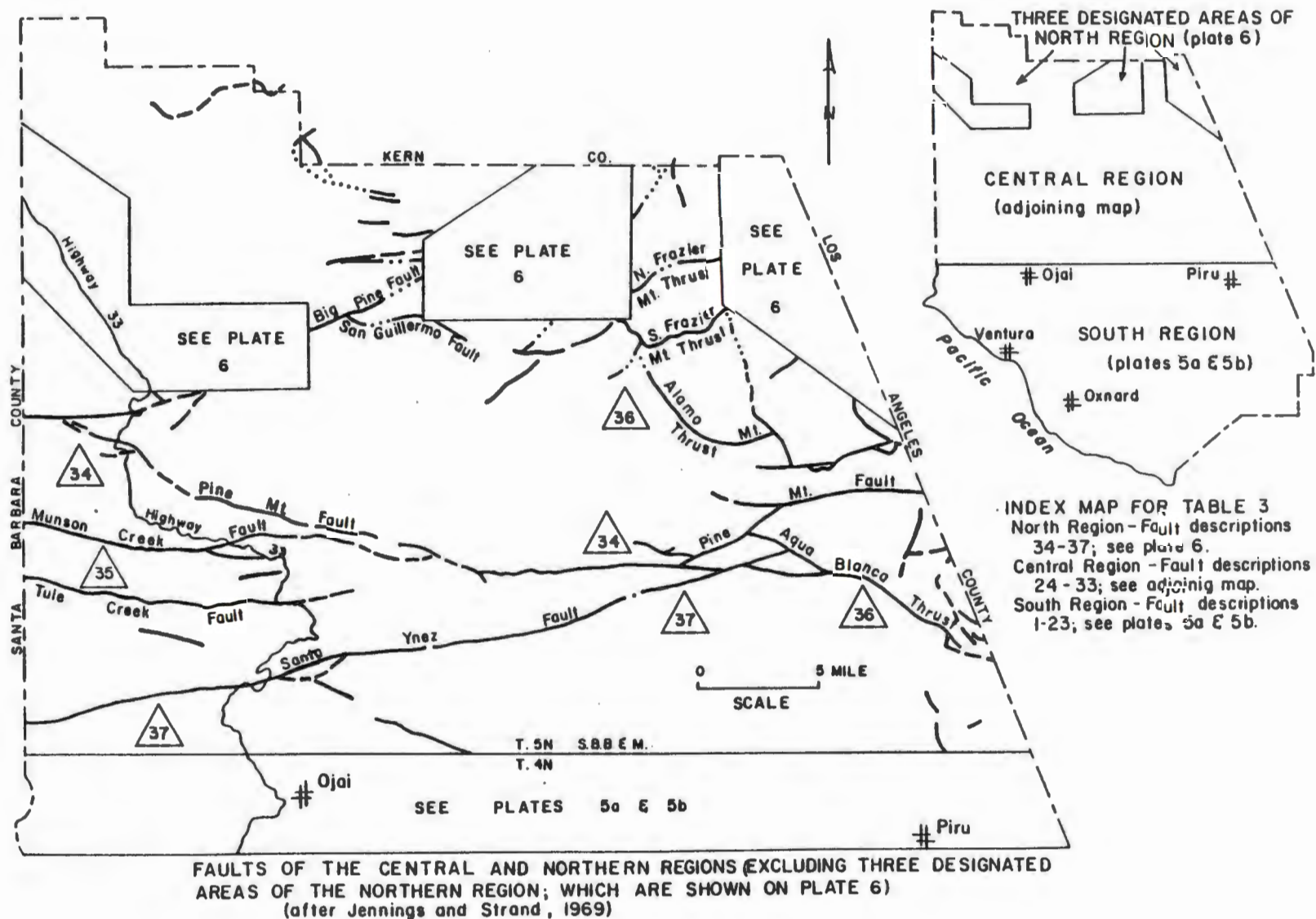


Figure 9. On right: Index map for Table 3, "Descriptions of faults of Ventura County." On left: map showing faults of the central and parts of northern region of the county.

Table 3 Descriptions of faults, evidence for recency of activity, and maximum credible expected earthquakes.

REGION (1)	NAME	DESCRIPTION	EVIDENCE FOR REGENCY OF ACTIVITY	Probable age of latest movement (2); plus magnitude of maximum credible expected earthquake (3)
SOUTH (1)				
	1. Unnamed-north of Chismahoo Mtn.	Displaces contact between Coldwater and Sespe Formations left laterally for about 5,000 feet, as mapped by Dibblee (1930-45). To east along trend, in vicinity of Coyote Creek, California State Water Resources Board (1953, plate B-1a) also shows a fault; and a strong air photo lineament occurs in same area, about on contact between Coldwater and Sespe Formation. Farther to east, linear canyons (Rice Canyon, for example) suggest possible sites for concealed faults, which could be links to additional faults in northern Ojai Valley area to east. The faults described herein probably are principally bedding plane faults which dip steeply north.	Undetermined. In Coyote Creek area, older alluvial deposits lie to south of possible fault; this suggests possible relative uplift to north.	Undetermined; not attempted.
	2. Bear Canyon	Reverse fault north of Ojai Valley (Bailey, 1951; Fine, 1954; and others); also in area are strong lineaments suggesting north-dipping bedding plane fault and a possible north-dipping fault at base of hills. If faults, they may die into the bedding of the lower and middle tertiary formations to the west, or they may continue subtly to the west as bedding plane faults.	Undetermined.	Undetermined; not attempted.
	3. San Cayetano Zone	Strong, gently to moderately north-dipping thrust faults (20° - 50°) extend 17 miles from east edge of Ojai Valley east to Sespe Creek; related faults continue east along base of hills to Piru. In Sespe Creek area, estimated 30,000 feet of stratigraphic throw of post Cretaceous rocks was calculated by Fine (1954).	Youthfulness of faulting suggested by: modified scarps and linear fault features; scarp along north side of Upper Ojai Valley, along which late Quaternary gravels are faulted upward to north at least 200 to 300 feet; abundant oil and tar seeps; apparent faulting of older and possibly younger alluvium in southeast corner of Ojai Valley; and steep south front of Santa Paula Ridge (upper plate). Landslides are common in conjunction with fault. Faults of Sulphur Mountain and other zones seem to die into this zone, indicating its dominance.	Holocene; 7.5 (or 8.0?)
	4. Arroyo Parida-Santa Ana Zone	Eastward continuation of Mission Ridge fault of Santa Barbara area, extends to point at southeast end of Ojai Valley where San Cayetano zone apparently begins. Dips are moderately steeply south, and contact between Coldwater and Sespe Formation is displaced left laterally 2,500 to 4,000 feet along the Arroyo Parida fault (Chauvel, 1958). Adjacent faults and lineaments also are considered to be part of the zone. See also Lamar and Merrifield (1974).	Strong, well developed geomorphic features of faulting suggest youthful activity: north-facing scarp in older alluvial gravels along Villanova Road implies at least 200 feet of displacement of gravels; also deflection of Poplin and Coyote Creeks; very youthful scarps occur along the south side of Ojai Valley. Water-bearing, older and younger alluvial gravels in Ventura River are 200 feet thick north of fault and 65 feet thick to the south (Turner, 1971), implying relatively recent displacement. A second fault, affecting ground water-bearing alluvium of the Ventura River, was mapped by Montgomery Research, Inc. (1972) to the north of the Santa Ana. Some epicenters of magnitude 3 - 4 are crudely aligned along this zone.	Holocene; 7.5
	5. Catharina Creek lineament	West edge of county, 4 - 5 miles long; extends into Arroyo Parida fault.	Undetermined	Undetermined; not attempted.

REGION (1) Name	Description	Evidence for recency of activity	Probable age of latest movement (2); plus magnitude of maximum credible expected earthquake (3)
6. Lion Canyon Zone (herenamed)	Zone of faults which extends west from Santa Paula Creek along south edge of Upper Ojai Valley, through Lion Canyon area, and possibly to Oak View and beyond to Lake Casitas area. Generally the faults dip south and have a sense of reverse displacement. Large landslides partly obscure relationships.	Well-developed, youthful scarps along south edge of Upper Ojai Valley, accompanied by steeply uptilted older alluvium (as reported by T. L. Bailey, personal communication to B. L. Cilweck, 1972); conglomeratic gravels of Quaternary age are apparently displaced in Lion Canyon area; and probable displacement of gravels and development of scarps occur in the Oak View area.	Holocene(?); 7
7. Big Canyon and Sisar faults	Extend west from Santa Paula Creek along north side of Sulphur Mountain (Bailey, 1951; Fine, 1954), but are obscured to west by landsliding. Big Canyon dips steeply north, and Sisar gently south.	Low, modified scarps in older alluvium at east edge of Upper Ojai Valley suggest youthfulness.	Late Quaternary; 6 - 6.5.
8. Red Mountain Zone (including Rincon Creek and Padre Juan faults)	Extends eastward onshore and from Santa Barbara County into county; the more northerly, reverse faults dip moderately to steeply north, whereas some of the more southerly faults dip steeply south. Severely faulted and folded shale of the Pico, Rincon and other Formations are severely landslid. Zone joins Sulphur Mountain zone, east of Ventura River.	Faults near Rincon Point are indicated to have Holocene displacement by Ziony and others (1974). Near Punta Gorda terrace deposits at 600-foot level are displaced in excess of 25 - 50 feet vertically, and accompanying apparent, modified scarps suggest youthfulness. Rincon Creek and nearby faults displace Casitas Formation of earlier Quaternary age. Adjacent to Ventura River on east, terrace gravels at 400-foot and 700-foot levels apparently are faulted; surveys indicate that between 1934 and 1968 the region north of the fault rose as a block 0.83 feet (Buchanan and others, 1973).	Late Quaternary (Holocene in western-most portion); 7.5
9. Sulphur Mountain Zone	Apparent continuation northeast of Red Mountain zone; extends 12 miles along south face of Sulphur Mountain to Santa Paula Creek where it joins San Cayetano zone. Dip of principal reverse fault: 60° - 70° N. at west end; 40° N. (Bailey, 1951, cross section), eastern part.	Steepness of upper part of south face of Sulphur Mountain may reflect relatively recent faulting, although up-faulted Monterey Formation on north is more resistant generally than down-faulted Santa Margarita and Pico Formations to south.	Late Quaternary (?); 6.5 - 7.
10. Ventura River area faults (midway between sea-coast and Red Mtn. Zone)	Series of faults and possible faults strike about east (several were mapped by Bailey, 1951).	Apparently up-faulted ridge protrudes into river area and deflects river channel; fault is slightly south of trace of Ventura anticline, across which Putnam (1942) calculated 400 feet of uplift of middle -late Quaternary river terraces.	Late Quaternary; 6.5
11. Ventura and Country Club faults	Fault shown by Ogle (1969) in cross section to dip 60° N., as part of Pitas Point zone; name "Ventura fault" applied by Cilweck (1975). Fault extends east along base of hills through Ventura City area. Relationships with Country Club fault - discovered by Ventura County Flood Control District because of differences in ground water levels, are described by Quick (1974) and Mukae. and Turner (1975).	Prominent scarp and other geomorphic features of Ventura fault identified as an aerial photographic and topographic lineament by Weber and others (1973); complex nature of fault breaks at surface of weathered older alluvium at one Ventura locality are described by Cilweck (1975). Landsliding (plate 2a; Ab or Ad) possibly may be related to ground water conditions and faulting. Displacement to 6 feet of terrace deposits in hills to north of Ventura fault is described by Bailey (1943, p. 1554).	Holocene; (7; 7.5 if closely related to Pitas Point fault).

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REGION (1)			
Name	Description	Evidence for recency of activity	Probable age of latest movement (2); plus magnitude of maximum credible expected earthquake (3)
12. South edge of hills, Ventura to Santa Paula	Topography and aerial photo interpretive features suggest that north dipping, relatively low angle reverse faults extend along south edge of hills from Ventura to Santa Paula, about 10 miles.	Suggested are modified low fault scarps in older alluvium, deflected creeks, and faceted ridges indicating relatively recent activity.	Late Quaternary; not attempted.
13. Oak Ridge Zone (including McGrath fault) also Eureka and other faults to east (4)	Moderately steep, south-dipping reverse faults extend east from offshore area, along north edge of South Mountain and Oak Ridge to apparent junction with Santa Susana fault. At east end dips are 75° - 80° N., but for most of length faults dip 55° - 70° S. Some geologists (eg., Bailey, 1951), continue Oak Ridge zone east along base of Oak Ridge, instead of joining to Santa Susana. In South Mountain area, Baddley (1954) estimated "several thousands of feet" of reverse displacement involving rocks of Pliocene and Pleistocene age. McGrath fault, which branches away, near Montalvo, is not shown on all map sources. Recent studies of zone are by Yeats (1975) and Whaley (1975).	Large Quaternary displacements are indicated in vicinity of area south of Fillmore-Piru area, as San Pedro Formation is apparently displaced thousands of feet, based on surface exposures, as well as subsurface data in cross sections of Bailey (1951). Steepened north slope of Oak Ridge and South Mountain, indirectly caused by relatively recent faulting, contain numerous large landslides. Along base of slope, some portions of zone are concealed, but modified scarps in older and younger(?) alluvium in other areas attest to relative recency of faulting. Near Saticoy faulting in middle-late Quaternary sediments has created a ground water barrier (California State Water Resources Board, 1953; Turner, 1975).	Holocene; east part, 7.5 - 8(?); west part, 7 - 7.5.
14. Area of faults and lineaments between Moorpark and Montalvo	West-southwest trending faults and lineaments between Oak Ridge and Simi zones, extends into Oak Ridge zone at Montalvo. Dips appear to be steep, with displacements of Quaternary rocks relatively small.	Features are not well defined or exposed, because of subtleness of faulting features in younger sediments and gentle topography. Accompanying faulting are folds involving late Quaternary older alluvium; near Epworth, a fault apparently dies out to the east into a fold which warps the surface of an older alluvial fan.	Late Quaternary; 6 - 6.5
15. Simi Zone (including CDLB, Springville, and Camarillo faults)	Zone extends from Los Angeles County west to where concealed beneath Oxnard Plain west of Camarillo, a distance of 27 miles. Faults are mostly of reverse displacement and dip 70 - 80 N., although frontal fault at South edge of Camarillo dips 20° N., according to a Bailey (1951) cross section; apparent topographic configuration of Simi fault at mouth of Simi Valley also suggests a dip of 45° or less. Left lateral displacement of contact between lower Tertiary Santa Susana and Lajas Formations in eastern Simi Valley is about 6,000 - 7,000 feet. CDLB fault has been studied recently by Canter (1975). Name Santa Rosa, which has been used for fault in Santa Rosa Valley, not used herein because of confusion with Santa Rosa fault of Santa Rosa Island.	Youthful geomorphic features along western part of Simi Valley, and displacement of ground water-bearing, late Quaternary sediments at mouth of valley and by Camarillo and Springville faults indicate relatively recent movement. Relatively recent appearing geomorphic features also occur along trace of frontal fault of Camarillo Hills, along north side of Santa Rosa Valley, and north side of Tierra Rejada Valley. At Mouth of Tapo Canyon, older alluvium is apparently displaced, but gradually to east, especially east of Marr Ranch, fault movement seems to be less recent.	Late Quaternary; 7
16. "Bailey" fault	Unnamed fault first mapped by T. L. Bailey (1951); concealed along east edge of Oxnard Plain, at base of west edge of Santa Monica Mountains. Steeply dipping.	Northeastern portion: late Quaternary ground water-bearing sediments are displaced. Southwestern portion: floor of Oxnard Plain depositional basin apparently is displaced, but apparently not mid-late Quaternary sediments (Turner, 1975).	Late Quaternary in part; 6

REGION (1)			
Name	Description	Evidence for recency of activity	Probable age of latest movement (2); plus magnitude of maximum credible expected earthquake (3)
17. Sycamore Canyon-Boney Mountain Zone.	Extends onshore to the northeast in vicinity of Point Mugu. At least 25 miles long. Steeply dipping, left lateral.	Apparently does not displace offshore "Holocene marine" and "upper Pleistocene deposits" of Greene and others (in press). Strong linear features onshore extend to south Thousand Oaks area: lineament in La Jolla Valley, if fault may displace older alluvium. Zone continues northeastward into central and northern Thousand Oaks area in form of apparently shorter fault segments, partly concealed: late-middle to late Miocene Modelo Formation is faulted, one very small fault seems to displace older alluvium, as shown in cut along Rancho Road, about 500 feet south of Ventura Freeway. Late Quaternary erosion surface and overlying sediments may be displaced slightly along Boney Mountain Extension fault (Weber, in press).	Late (?) Quaternary; 6.5
18. South of Port Hueneme	North-northeast trending fault along east edge of Hueneme submarine canyon (Greene and others, in press)	Apparently cuts late Quaternary sediments.	Quaternary; not attempted.
19. Malibu Coast	Extends west offshore, just east of Ventura County line; major, bounding fault between Transverse and Peninsular Ranges provinces. Dips 30 - 70°N.; may have very substantial reverse and left lateral displacement (Verkes and Campbell (1971); and other references).	West of Malibu Canyon, and south of Pepperdine University, in Los Angeles County, artificial cut at about 200-foot elevation discloses low angle fault displacing terrace deposits. Other examples of late Quaternary sediments being faulted noted by Birkeland (1972). Epicenter for possible future earthquake at depth of 1971 San Fernando or 1973 Point Mugu, could be in vicinity of southern Thousand Oaks area.	Late Quaternary; 7.5 (or 8.0?).
20. Del Valle and Holser faults	High angle faults in northeastern corner of south region which displace Pliocene rocks at surface. Partially concealed by abundant landslides. In a sense, an eastward continuation of San Cayetano zone, although sense of displacement is up relatively to the south instead of north.	Not determined.	Not determined; not attempted.
21. Santa Susana Zone	Gently north-dipping (20 - 45°) thrust faults extend south-southeast as an apparent, more gently dipping continuation of the Oak Ridge zone to the west. The zone ultimately joins the Sierra Madre zone about 10 miles to the east, in Los Angeles County.	Geomorphic features suggesting recent activity are weak, but late Quaternary terrace deposits and overlying erosional surface are displaced in upper Tapo Canyon area. Springs or seeps and asphaltic material occur in faults. Small ground displacement along fault in San Fernando Pass area, east of County, during 1971 San Fernando earthquake.	Late Quaternary; 7 - 7.5
22. Big Mountain	Apparent continuation east by Canter (1975) of short fault first(?) mapped by Van Camp (1959) in western portion of upper Happy Camp Canyon area. (Shown fully by Zloty and others, 1974; only short fault of Van Camp shown herein on plate 5b).	Apparently San Pedro/Saugus Formation of Quaternary age is displaced.	Quaternary; not attempted.

REGION (1)	Name	Description	Evidence for recency of activity	Probable age of latest movement (2); plus magnitude of maximum credible expected earthquake (3)
	23. Burro Flats	East part of fault zone which extends southwest from Northridge Hills fault through Chatsworth Reservoir area. Left lateral displacement of Upper Cretaceous-Lower Tertiary rocks.	In Los Angeles County, near Northridge Hills fault, ground water-bearing late Quaternary sediments apparently are displaced (California State Water Rights Board, 1962). Some subtle geomorphic features in Chatsworth Reservoir area suggestive of late Quaternary activity. Aftershocks of 1971 San Fernando earthquake, were partly aligned in a southwesterly direction in the vicinity of a portion of this fault in the western San Fernando Valley (plate 1); this alignment was involved in the reasoning by Whitcomb and others (1973) that a zone of seismicity extends from Palmdale southwest to Point Dume. See also Wentworth and others (1969) and Weber (in press), for a discussion of the seismicity.	Late Quaternary, at least east of Ventura County; 6-6.5
NORTH REGION (1)	24. San Andreas	Cuts northeast corner of county; right lateral. (Crowell, 1962; Hill and Dibblee, 1953, and many other reports).	Part of so-called "locked-in" portion of San Andreas fault which moved violently in this vicinity during 1857 Fort Tejon earthquake, and may have moved slightly in Gorman area during 1916 earthquake. In county area, fault is at south edge of area of many historic epicenters (plate 1). Fault in County area may partly consist of zone 400 to 1,000 feet wide of disturbed and displaced terrain and alluvium, and severely fractured and brecciated landslide(?) rock and bedrock. Adjacent, subsidiary faults also may have moved during 1857 earthquake.	Holocene; 8.6
	25. Garlock	Major east-trending, left lateral fault extends barely into northeast corner of County, and abuts San Andreas fault, as mapped by Crowell (1956); more likely, principal fault extends west, concealed by alluvium in Cuddy Canyon north of county line, and joins San Andreas beneath alluvium.	Clark (1973) shows younger fault segments on north side of Cuddy Canyon. Strong geomorphic evidence northeast of County line indicates youthfulness.	Late Quaternary; 7.5 - 8.0
	26. San Gabriel (including Piru fault)	Extends north-northwest into Northeast map area.	Strong linear feature. Crowell (1954) indicates that Pliocene-early Pleistocene Hungry Valley Formation overlies north end of fault; but photo lineaments and geomorphic evidence indicate that portions of fault zone may cut Hungry Valley Formation and possibly late Quaternary older alluvium. To southeast in Newhall-Saugus region, R. B. Saul (California Division of Mines and Geology, personal communication, 1975) suggests on the basis of his mapping that late Quaternary terraces are displaced along the fault. Castle and others (1974) suggest that the San Gabriel fault was activated slightly during the 1971 San Fernando earthquake.	Late Quaternary (7); 7 - 7.5

REGION (1)			Probable age of latest movement (2); plus magnitude of maximum credible expected earthquake (3)
Name	Description	Evidence for recency of activity	
27. Frazier Mountain and related thrust and accompanying higher angle faults (includes North and South Frazier Mountain, Dry Creek and Cuddy Canyon faults)	Commonly very low angle north dipping faults, mostly south of San Andreas and west of San Gabriel zone, which bring basement rocks over younger sedimentary rocks - including Hungry Valley Formation, which is as young as earliest Quaternary age. High angle faults (North-Central area) including Cuddy Canyon, appear to branch away from thrusts.	These faults, at least in part, may represent "dead" thrusts-partly of gravity origin ?; or, if "alive," they should be judged potentially active.	Quaternary; ?
28. Big Pine Zone (including Big Spring fault)	Major east-trending left lateral fault joins or abuts San Andreas fault north of county line. Fault is boundary between Transverse Ranges and Coast Ranges province. In County, zone consists of series of anastomosing, moderately to steeply dipping normal and reverse faults. Left slip since Miocene time is estimated at 4 to 30 miles by various authors, as discussed by Lamar and Merrifield (1974). Major references are Carman (1964) and Hill and Dibblee (1953).	In North area, Carman (1964) stated that youngest activity was pre-Quaternary; however, Kahle (1966) suggested that 4 miles of left lateral displacement has occurred since late Pliocene time; and a brief aerial photograph and field study for this report suggests late Quaternary activity. In Northwest area evidence for similar activity is stronger: here terrace deposits apparently are displaced (see also Larsen, 1957; and Lamar and Merrifield, 1974). Hill and Dibblee (1953) suggest that offsets of streams to 3,000 feet occur along fault. Some epicenters of magnitude 3 to 4 are grouped vaguely along fault zone just west of its junction with the San Andreas fault. Report of ground breaks for 30 miles in Lockwood Valley during November 26, 1852 earthquake is controversial (see text under Historical earthquakes); to west, Los Alamos earthquakes of 1902 and 1915 M _{6.7} -(Richter, 1958, p. 353) may have occurred on the westward continuation of the fault zone.	Late Quaternary (at least in part); 7.5 - 8.0
29. Lockwood Valley	Concealed, east-trending fault mapped by Carman (1964) on the basis of apparent displacement of Quatal and Caliente Formations along linear trend.	Apparent displacement of Pliocene rocks.	Pliocene or younger; not attempted.
30. Mount Pinos	North of Big Pine fault; low angle thrust similar to Frazier Mountain; displaces Plush Ranch Formation.	Not determined.	Not determined; not attempted.
31. San Guillermo	Small portion in southwest corner of North-Central area. High angle reverse fault dips south.	Cuts Quatal Formation of Pliocene age.	Pliocene or younger; not attempted.

REGION (1)	Name	Description	Evidence for recency of activity	Probable age of latest movement (2); plus magnitude of maximum credible expected earthquake (3)
CENTRAL REGION (1)	32. Ozena	Southeast end of major, steeply south-dipping reverse fault zone, apparently abuts Big Pine zone just south of southwest corner of Northwest area. Zone may itself be displaced to east along south side of Big Pine fault (continuation to south, San Guillermo fault?). Amount of displacement gradually decreases along zone to south-east: Schwade (1954) describes major displacements to northwest, whereas Frakes (1959) describes 3,000 feet of maximum dip-slip displacement in map area. Frakes implies dip is about 75° southwest in his area; but topographic configuration suggests that dip could be more gentle at some localities.	Youngest rock apparently displaced in map area is Quatal Formation of Pliocene age; Jennings (1974) shows that it has Quaternary displacement. Geomorphic features are not definitive.	Quaternary(?); 6 - 7.
	33. Apache Canyon fault	Northwest area; youngest rocks displaced are Pliocene.	Not determined	Pliocene; not attempted.
	34. Pine Mountain	Strong, north-dipping reverse fault (Larsen, 1957; Merrill, 1954; Dickinson, 1969a, b; Jennings and Strand, 1969). Dips 75° north; alluvial cover confuses exact configuration of fault (Dickinson, 1969b).	Shown by Jennings (1974) as having Quaternary movement; one southeasterly branch apparently is displaced left laterally by Santa Ynez fault; main branch apparently is truncated, offset, or deflected by San Gabriel fault.	Quaternary; not attempted.
	35. Munson Creek and Tule Creek faults	East-west faults between Pine Mountain and Santa Ynez faults. (Fisher and Dibblee, 1961)	Strong linear features, but evidence for possible recent activity not studied for this report.	Not determined; not attempted.
	36. Agua Blanca and Alamo Mountain thrusts	Similar to Frazier Mountain thrust.	Not studied.	Not determined; not attempted.
	37. Santa Ynez Zone	Very strong linear feature which extends west from San Gabriel fault perhaps to Pacific Ocean in vicinity of Point Arguello, a distance of slightly more than 100 miles. Dip near surface apparently ranges from steeply north to steeply south. Rocks on south are faulted relatively upward - Dibblee (1966) calculated 9,500 feet of vertical displacement of base of Eocene sediments; left slip displacement has been estimated at 9 to 37 miles, and one study has suggested 30 miles of right slip of Eocene rocks; (see Lamar and Merrifield, 1974, p. 21-22 for discussion of these factors).	Major geomorphic factor is that terrain to south of fault is higher than to north; also left slip of Santa Barbara County stream courses of a few hundred meters to 5 km (3 miles) was suggested by Dibblee (1966). In Ventura County, older alluvium may be displaced along fault in vicinity of Matilija Creek; large landslides occur along steep slopes in vicinity of fault; fault may be over-ridden by Agua Blanca thrust to east, near San Gabriel fault. Historic epicenters (plate 1) are vaguely aligned along fault in Ventura County; and on west end, 1927 Point Arguello earthquake may have been involved with zone. Willis (1925a) discussed possibility that fault was involved with 1925 Santa Barbara earthquake.	Late Quaternary 7.5 - 6.0.

- (1) Fault data for South region, see plates 5a and 5b for North region, plate 6; and for Central region, faults are shown on plate 1.
 (2) Ages used: Holocene (< 10,000-11,000 years); Late Quaternary (< 500,000 years); Quaternary (< 2 million years); Pliocene (< 5 million years)
 (3) Maximum credible expected earthquake - estimated, taking into account all available data known about fault or fault zone, partly based on report and map of Greensfelder (1975).
 (4) Oak Ridge zone is not shown in western, coastal area as the trace of its surface projection to surface, of alluvial sediments is shown differently by most map references. Fault zone is shown on plate 1 and figure 11.

The subjective estimate of the latest span of geologic time during which faults have been active is based on the overall evidence available. The younger and shorter this time period for each fault, therefore the more active the fault is considered. For example, a fault with sufficient evidence to indicate that it has moved during the Holocene epoch is considered to be more active than one for which evidence suggests only that it has moved during the Quaternary period; but this comparative relationship obviously does not mean for certain that the latter fault could not have moved during Holocene time.

The time boundary between the Pleistocene and the Holocene epochs is a subjective one, generally set at about 10,000 to 12,000 years B.P. (Before Present); [see Morrison (1969) for a discussion of this subject]. Hopkins (1975, p. 10) reviews the latest thought with regard to the Pleistocene-Holocene time boundary problem and concludes that expert opinion places the boundary within a range of 4,000 to 18,000 years B. P.; Hopkins would place the boundary at 10,000 years, a point of arbitrary compromise. Therefore, to state that a fault is "active" because it has moved during Holocene time is really not precisely meaningful.

The "maximum credible earthquake" ratings give in Table 3 were deduced subjectively from the overall data available, somewhat^{as} by Greensfelder (1974), who prepared a very small scale map of California showing "maximum expected earthquake magnitude" for individual faults, in addition to "maximum credible bedrock acceleration." In the table prepared for the present report, magnitudes for "maximum credible earthquakes" suggested for Ventura County faults range from 6 to $8\frac{1}{2}$, with a minimum increment of one-half a magnitude. Greensfelder used one-quarter of a magnitude. In the present report less emphasis is placed on overall length of faults, with regard to estimating potential magnitudes and more emphasis is placed on cumulative (especially Quaternary) displacement and surficial features (especially geomorphic) which together suggest overall strength of faulting.

Following, the general characteristics of faulting are discussed for the major populated areas of the south part of the County, and for the central and north parts of the County.

Ventura-Oxnard-Camarillo region

The low-lying region of the Oxnard Plain and the adjacent Ventura and Camarillo areas is the most populous of the County; yet detailed knowledge of faulting in the alluvial sediments of late Quaternary age, which underlie most of the region, is lacking. In contrast, the general characteristics of faulting in pre late Quaternary rocks (San Pedro Formation and older rocks) is relatively well known on a broad, regional scale, as this knowledge has been important to petroleum companies in the exploration for petroleum and the development of oil fields.

Broad, general knowledge of the important Oak Ridge and McGrath faults has been established primarily because of their importance in the entrapment of oil. In this regard, data on faulting within the subsurface, oil-bearing rocks of the Oxnard region are included in descriptions of oil fields of the area by Dosch and Mitchell (1964), Hardoin (1961), and others. The "Bailey" fault, at the southeast edge of the Oxnard Plain, was first recognized by a well-known petroleum geologist, T. L. Bailey. A fault which extends through the City of Ventura was first made known publicly by a petroleum geologist, B. A. Ogle, in a cross section published in 1969. Subsequently, geologists have determined that this fault, named the Ventura fault by Cilweck (1975), has had significant Holocene activity and therefore should be considered very seriously as the possible future site of a large earthquake.

Much of the information available on the subsurface geology of late Quaternary sediments of the area has been derived from ground water studies by California State Water Resources Board (1953; partially

reprinted as Thomas and others, 1954), Turner (1975), Turner and Mukae (1975), and Page (1963). These and other studies show that the Oak Ridge, Camarillo, Springville, "Bailey," and Country Club faults act as ground water barriers, and thus are known to extend into, and displace, rocks of early and mid Quaternary age, and commonly late Quaternary (including Holocene) age (figure 11). Greene and others (1975, plate 10) show short, west-trending faults cutting the sea floor, just south of the southeast edge of the Oxnard Plain.

When the data available publicly on faulting in the Oxnard-Ventura area were compiled by the writers onto Plate 5a, they seemed too ambiguous to allow straight-forward plotting of the surface traces of the Oak Ridge and Mc Grath fault zones on that 1:48,000 scale map. Therefore the faults of this zone are not shown west of Saticoy on Plate 5a; they are shown only on the smaller scale maps of Plate 1 and Figures 10 and 11. Data regarding faulting at specific localities in the area of these faults, as derived from various references, are notated on Plate 5a, however.

Figure 10
Figure 11

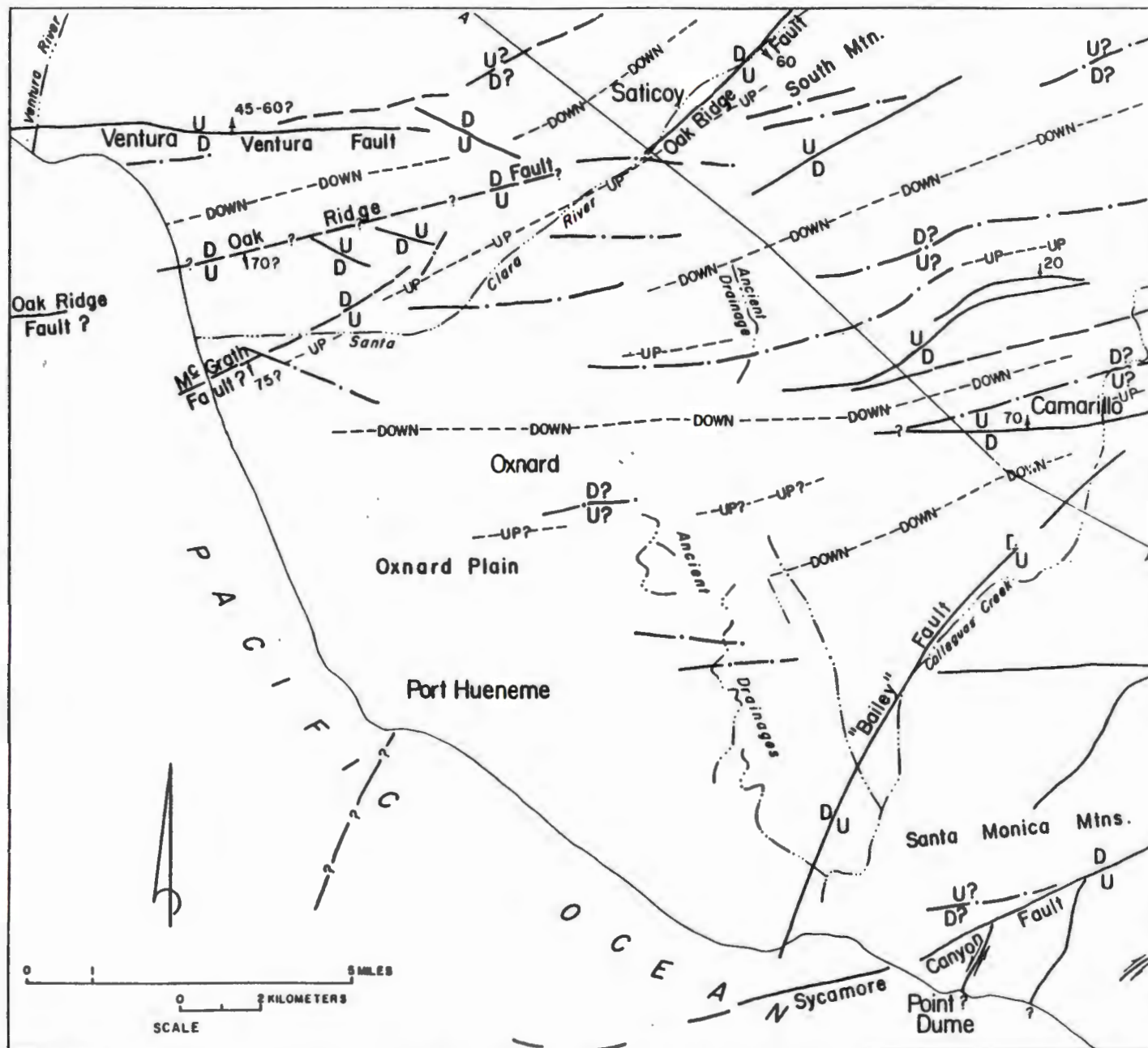


Figure 10. Tectonic features of Ventura-Oxnard Plain-Camarillo area, as deduced from available data. Solid lines or dashed lines are faults showing dip, and dot-dashed lines are photo lineaments (both from plate 5a); D = down, U = up; arrows show relative horizontal displacement. Linear trends labeled "down" are areas or blocks dropped downward relatively, whereas "up" trends represent blocks raised upward. Although subtle, this pattern of tectonic activity probably is occurring at the present time geologically, and may have been involved in the prehistoric changing of the flow of the Santa Clara River at Saticoy from south to west-southwest.