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MAPS SHOWING RECENTLY ACTIVE FAULT BREAKS ALONG THE SAN ANDREAS FAULT FROM MUSSEL ROCK TO THE CENTRAL SANTA CRUZ MOUNTAINS, CALIFORNIA

By

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PURPOSE OF THIS MAP

This map shows the location of lineaments and other geomorphic features interpreted to be the result of historic or relatively recent breaks within the San Andreas Fault Zone. It was compiled primarily to provide information for those concerned with land use and development on or in the fault zone, but it should also be useful in scientific studies of faulting and earthquakes. The lines on the map mark the location of suspected displacements of the ground surface by rupture along the San Andreas Fault. Map users should keep in mind that these lines are primarily guides for locating fault traces on the ground and are not necessarily located with the precision needed for every engineering or land-use project.

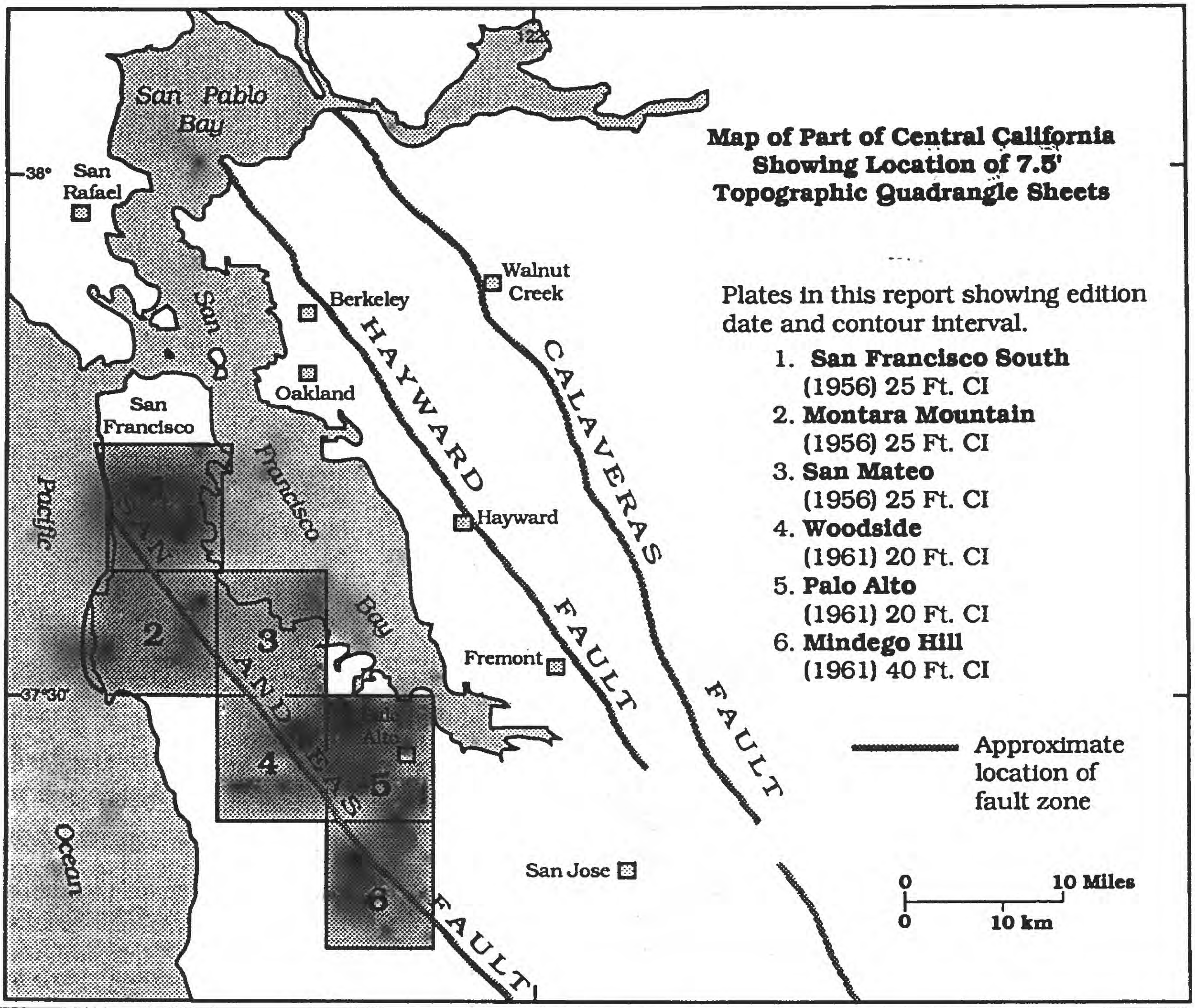
THE SAN ANDREAS FAULT AND FAULT ZONE

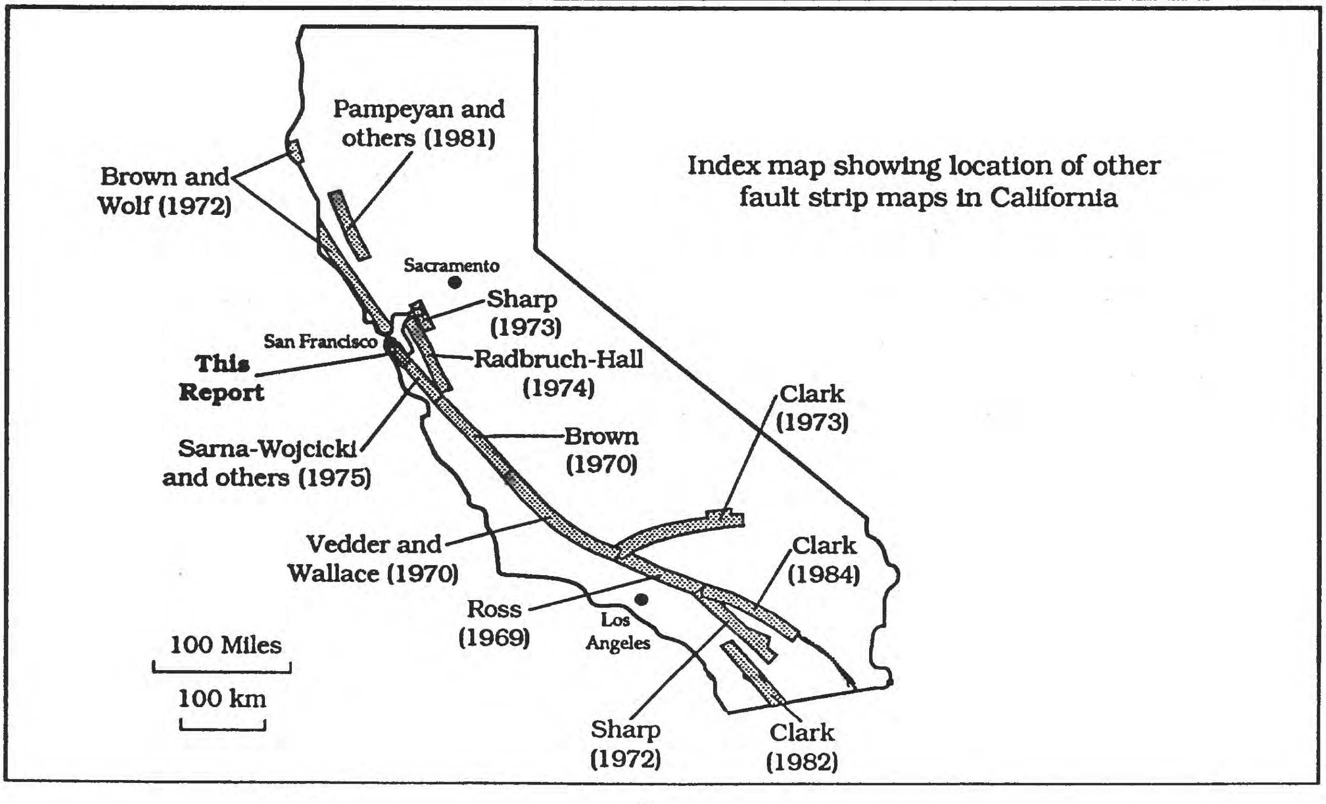
The San Andreas Fault Zone is a major structural break in the earth's crust that can be traced for more than 600 miles from the head of the Gulf of California in northern Mexico through western California. It passes offshore near Point Arena and is believed to extend northward offshore at least as far as Cape Mendocino. Movement within the fault zone has been distributed along many parallel or subparallel faults that differ in age and amount of relative displacement. This complex zone of movement ranges in width from a few hundred feet to several miles and in this region has had cumulative horizontal offset during late Cenozoic time (~ 23 million years) of about 185 mi (Dibblee, 1966; Cummings, 1968; Graham and others, 1989), indicating an average annual rate of movement of 0.3 to 0.8 in. during that time period. This zone or band of interrelated faults is termed the **San Andreas Fault Zone** (or **Rift Zone**) in contrast to the **San Andreas Fault**, which is the surface trace of the most recent, or historic, movement (Noble 1926, p. 416-417). The **San Andreas Fault System** is a much broader term (Crowell, 1962, p. 4) that incorporates subparallel major fault zones, similar to the San Andreas Fault Zone, that incorporates subparallel major fault zones, similar to the San Andreas Fault Zone, that forms a belt more than 40 mi wide at the latitude of San Francisco

Surface movement on the San Andreas Fault in the map area during historic time has been predominantly along a vertical plane, with the area southwest of the fault displaced relatively towards the northwest. This type of movement is termed right-lateral strike-slip, or, for brevity, right slip, because to an observer standing on one side of the fault the land surface across the fault is displaced to the right. The right-slip character of the San Andreas Fault is well established observations of surface features accompanying numerous earthquakes, by precision surveys of triangulation nets and alignment arrays that cross the fault, by matching unique formations across the fault, and by linear features–both man-made and natural–that are displaced right of an old topographic map (U.S. Coast Survey, 1867) and later field-checked when the lake was laterally where they cross the fault. Vertical displacements along the San Andreas Fault in the map area are also known, but historically these have been very small as compared with right slip.

LOCATION OF FAULT BREAKS

The faults shown on this map were located initially in 1967 by interpretation of vertical aerial photographs and were confirmed in many places by on-the-ground mapping. Several sets of black-and-white aerial photographs were used, including those flown by the U.S. Department of Agriculture,


San Pablo Bay
38°
San Rafael
San Francisco Bay
Berkeley
Oakland
San Francisco
Pacific Ocean
Walnut Creek
HAYWARD FAULT
CALAVERAS FAULT
SAN ANDREAS FAULT
Hayward
Fremont
Palo Alto
San Jose
37°30'
122°
Map of Part of Central California Showing Location of 7.5' Topographic Quadrangle Sheets
Plates in this report showing edition date and contour interval.
1. San Francisco South (1956) 25 Ft. CI
2. Montara Mountain (1956) 25 Ft. CI
3. San Mateo (1956) 25 Ft. CI
4. Woodside (1961) 20 Ft. CI
5. Palo Alto (1961) 20 Ft. CI
6. Mindego Hill (1961) 40 Ft. CI
Approximate location of fault zone
0
10 Miles
0
10 km


Index map showing location of other fault strip maps in California
Pampeyan and others (1981)
Brown and Wolf (1972)
Sacramento
Sharp (1973)
San Francisco
This Report
Radbruch-Hall (1974)
Sarna-Wojcicki and others (1975)
Brown (1970)
Clark (1973)
Vedder and Wallace (1970)
Clark (1984)
Ross (1969)
Los Angeles
100 Miles
100 km
Sharp (1972)
Clark (1982)

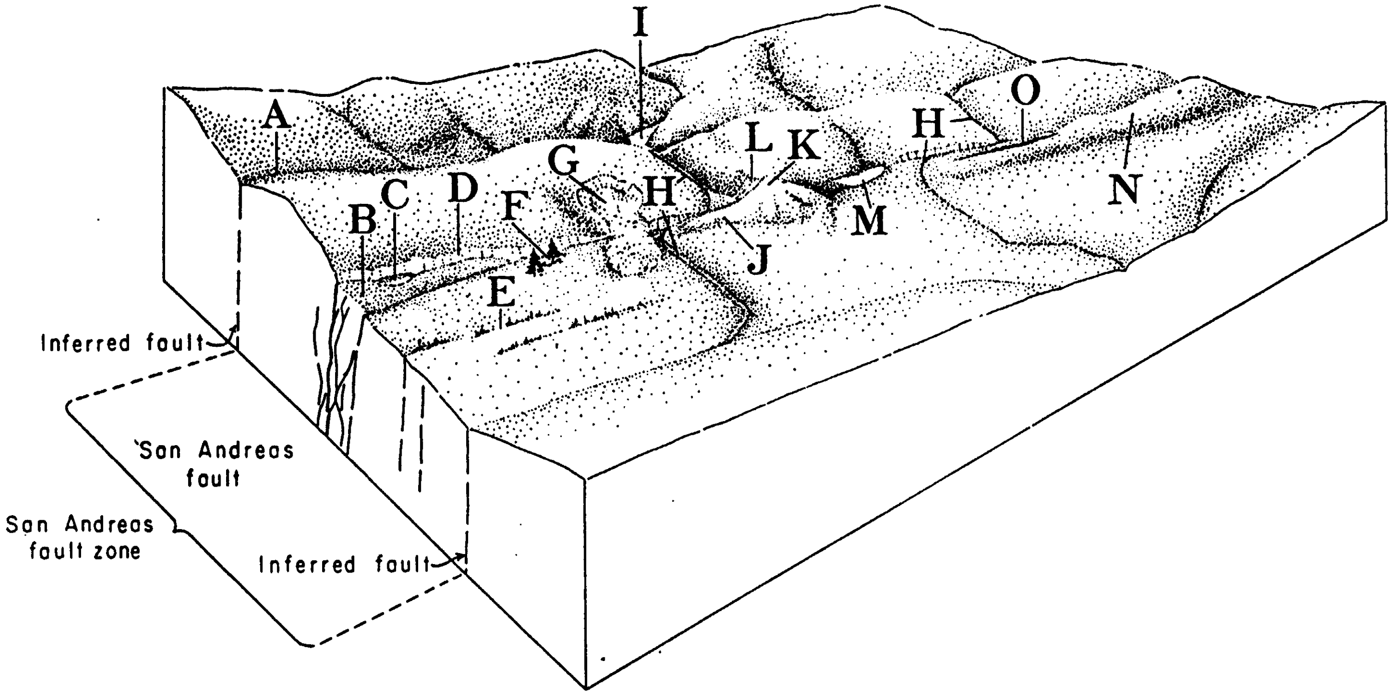
Commodity Stabilization Service, in 1943 at a scale of 1:20,000, and by the U.S. Department of the Interior, Geological Survey, in 1946, 1956, 1966, and 1967 at scales of 1:6,000, 1:12,000, and 1:24,000. A few features in San Andreas Lake were located by inspection of an old topographic map (U.S. Coast Survey, 1867) and later field-checked when the lake was drawn down for construction purposes in 1972 (Pampeyan, 1975). Some features in Lower Crystal Springs Reservoir were observed during a period of low water in 1976. In addition, attempts were made to relocate sites described by observers following the 1906 earthquake using data mostly from Lawson (1908), but also including data from 1906 field notes of Prof. J.C. Branner and his students H.W. Turner and H.P. Gage, and others, whose observations were incorporated in the Lawson (1908) volume. Recollections by survivors of the 1906 event also are noted on the map.

Lineaments and other fault-related features identified during the photointerpretation study were transferred from the photographs to topographic base maps by visual inspection whereas fault traces identified in the field were plotted directly on the base maps. Features large enough to show at the scale of this map are generally accurate to within 50 ft along the main trace, but may be mislocated as much as 150 ft in areas of low relief where map contours are far apart and do not delineate small-scale fault features. In areas of dense vegetation, fault-trace features are difficult to see and locate accurately, and the cause of origin of lineaments difficult to assess. It is also difficult to locate or relocate these features in areas where urban development has taken place, however, use of historic maps and photographs ease this problem somewhat. It is important that geologists, engineers, and others who make specific use of this strip map should confirm the location of lines shown by surveying from control points on the ground and should determine by trenching or other methods whether the mapped features are truly fault controlled.

Other interpretations are available. The California State Geologist has responsibility under the provisions of the Alquist-Priolo Act of 1972 (Hart, 1993) to designate active faults in California, and those faults are included in Special Studies Zones (California Division of Mines and Geology, 1974a, b, c, d; 1982a, b), the current boundaries of which are shown on this map. The lines on the State maps do not necessarily correspond with the lines on this map, but some of the information gained in this study has been made available to the State Geologist. Similarly, other authors cited in subsequent sections of this report, have prepared maps showing recently active breaks in part or all of the San Andreas Fault Zone within the map area. In addition, several municipalities have had reports prepared which provide data on recent fault activity in their spheres of influence. All of these data should be consulted and analyzed for comprehensive knowledge of past and potential movement on the San Andreas Fault.

LAND-USE SIGNIFICANCE OF LOCATING RECENT FAULT BREAKS

Ground breakage during the 1966 Parkfield-Cholame earthquakes closely followed previously mapped fault traces (Brown and Vedder, 1967, p. 4), and geomorphic studies of the fault zone by Wallace (1968) within the Carrizo Plain showed that displacements have recurred many times along the same trace during the last 10,000 to 20,000 yrs. These observations imply that the line of most recent ground breakage is likely to break again during future major earthquakes. Thus the most recently active breaks should be recognized as geologically hazardous by builders, planners, engineers, public works agencies, utility companies, homeowners, landowners, highway departments, school boards, natural disaster preparedness officials, in other words by anyone concerned with existing man-made structures, land utilization, or planned construction on or near these most recent fault breaks. At present, no one can predict with certainty when movements on these faults will recur or which ones will move next, but it is virtually certain that some will move again. It should not be assumed, however, that movements will be confined entirely to these mapped features or that movements will occur on all of them. Surface fracturing may develop anywhere within the fault zone or on branching or otherwise related faults beyond the fault zone, as occurred in the Loma Prieta earthquake of 1989 (Plafker and Galloway, 1989). Gaps or discontinuities



A. Linear valley
B. Bench
C. Closed Depression
D. Scarp
E. Vegetation lineation
F. Spring
G. Landslide
H. Offset drainage
I. Ponded alluvium
J. Shutter ridge
K. Knob
L. Notch
M. Sag pond
N. Linear ridge
O. Trough or trench

Block diagram showing physiographic features produced along recently active faults along the main fault trace do not necessarily represent stable or unfaulted segments; they are merely places where no evidence for recently active faulting was observed. On this map urban growth, cultivation for crops, and landslides have, in places, effectively erased evidence of recent displacement.

FIELD RECOGNITION OF MOST RECENT FAULTING

Recently active breaks can generally be recognized by topographic features, or by contrasts in vegetation that reflect varying ground water depths or soil differences across the fault. The most common topographic features are scarps, trenches or troughs, notches, parallel ridges, offset drainage channels, sag ponds and closed (undrained) depressions, and shutter ridges. These features have been developed by repeated movements and by erosion and deposition along the fault. Annotations along the fault traces indicate selected examples of these features that are not limited to the designated localities; similar features are present–to some degree–along all of the mapped fault lines. As opposing fault blocks slide laterally, some blocks are relatively depressed to form closed depressions or sags–which may appear as sag ponds or ponded alluvium–or an elongate graben may form between parallel breaks. Other blocks are raised, tilted, compressed, or slid diagonally to produce elongate ridges, shutter ridges, and pressure ridges. Aligned notches and trenches or troughs along the fault may reflect increased erosion of the crushed and broken rocks in the fault zone, or they may be primary fault features. Linear growths of vegetation, and alignments of springs and marshy areas, often occur where faults, acting as groundwater barriers, force water to the land surface.

Most surface features due to faulting are geologically temporary. Their recognition is limited by the durability of small, easily destroyed geomorphic features whose preservation is largely dependent on climate. In the map area, they may be obliterated by erosion or vegetation; may be obscured or covered by deposition of alluvium or other sediment; or may be modified or destroyed by works of man. Where slip has been entirely lateral (strike slip), vertical relief may not have been produced and the recently active break may not be identifiable.

SPECIAL FEATURES OF THE SEGMENT BETWEEN MUSSEL ROCK AND THE CENTRAL SANTA CRUZ MOUNTAINS

From Mussel Rock at the north end to San Andreas Lake the fault trace features are almost entirely obliterated by urban development which began in the early 1950's; most of the sag ponds, linear trenches, and scarps have been reshaped by grading and covered by homes, shopping centers, and a school or two. Photogeologic interpretation of the area suggests relatively recent fault activity as much as 2,000 ft northeast of the main fault break in the vicinity of San Bruno. Whether these features resulted from actual displacements along faults or are the manifestation of slope failures or of "churned ground" along ridge tops adjacent to the main fault (Lawson, 1908, p. 253) is unknown, but they were formed recently enough to be well preserved until being obliterated by grading in the early 1950's. Smith (1981a) suggests that some of these features represent bedding planes in the Merced Formation or were caused by lateral spreading.

Study of pre-development aerial photographs, maps, and reports indicate historic faulting in the area northwest of San Andreas Lake was confined to a fairly narrow zone. The principal offset caused by the 1906 earthquake was along a zone a few feet wide, but there are numerous citations of branching fractures that extended as much as several hundred yards away from the main break and secondary fractures as far as 200 ft away on either side of the main break, on which there were varying amounts of horizontal displacement. In addition to the 6 to 10 ft of actual right slip measured along the main break, several fences crossing the fault at right angles apparently were deformed over distances as great as 2,250 ft (Lawson, 1908, p. 94-101; Symington, 1911) resulting in total apparent displacements of 13 to 17 ft.

There was some question, however, about the validity of the original fence-line surveys required to produce these apparent displacements (Reid, 1910).

In the area of San Andreas Lake, the 1906 break was along the east side of the valley, most likely along a narrow zone marked by sag ponds and linear features exposed when the lake was drawn down in 1972 (Pampeyan, 1975). This area, underlain by sheared Franciscan rocks (mélange) in which the shear planes are predominantly sub-horizontal, also contains several narrow zones in which the shear planes are vertical, all of which line up with sag ponds, scarps, and displacements in man-made structures. The San Andreas Lake outlet tunnel showed about 8 ft of right slip as well as being deformed over a width of at least 75 ft (Pampeyan, 1986) and the waste weir tunnel showed about 8 ft of right slip over a width of 20 ft (Pampeyan, 1983).

Between San Andreas Lake and Lower Crystal Springs Reservoir, the fault-trace features visible on aerial photographs and on the ground are short and discontinuous. Alignment of broken fences and riveted iron pipe remnants, and short discontinuous linear features suggests that historic fault movement between the two lakes may have been distributed along *en echelon* breaks in a zone about 200 ft wide. Diagrams of some offset fences (Schussler, 1906; Lawson, 1908, figs. 29, 31-34, 38) show major offset on one break and minor offsets on one or more parallel breaks up to 100 ft apart. One offset line of fence posts crossing a prominent sag pond about 3,400 ft southeast of San Andreas dam was still visible in 1976 (Bonilla and others, 1978; Pampeyan, 1983). In 1970, a fence and row of cypress trees (Lawson, 1908, pl. 61B) clearly showed a single offset of about 9 ft. Remnants other of pre-1906 fences and pipelines which crossed the fault also exist but are either too poorly preserved or overgrown to help pinpoint actual 1906 breaks. West of the main fault breaks, ridge-top fractures and disturbed ground were reported on Cahill and Sawyer Ridges (Lawson, 1908, p. 253) but the localities were not documented well enough to be relocated. Pipeline construction work between San Mateo Canyon and San Andreas Dam in 1966-67, a few tens of feet east of the 1906 fault trace, left a long linear scar interpreted by some later workers to be the trace of the 1906 fault.

At the north end of Lower Crystal Springs Reservoir, the offset of several drainages, a sag pond, and a prominent east-facing linear scarp exposed at low water, are in line with monuments set in 1906 by the State Earthquake Investigation Commission. The offset drainages here, however, are not as well preserved as they are in more arid reaches of the fault. A short distance northwest of the confluence of San Mateo Creek and San Andreas Valley, the 37 in. Locks Creek pipeline and old Hayward dam, near the site of the Crystal Springs Hotel, were both offset, apparently along a single break (Pampeyan, 1983). There may have been subsidiary or branching breaks nearby similar to those reported by Lawson (1908, p. 93) near the Lower Crystal Springs dam, but no evidence of these remain.

The dam separating Upper and Lower Crystal Springs Reservoirs (presently the causeway for Highway 92) was offset about 8 ft at its eastern end in 1906, along a prominent fault separating serpentinite from gravels of the Santa Clara Formation. The Upper Crystal Springs outlet tunnel showed 8.8 ft of right slip and 1 ft of dip slip, east side up (Lawrence, 1924; Pampeyan, 1983). (The outlet tunnel shown on the San Mateo 7½' quadrangle is only diagrammatic and is incorrectly located about 300 ft west of its actual position.)

South of Upper Crystal Springs Reservoir, recent fault trace features appear, in general, to cover a wider zone than those to the north and have a more diverse pattern. The discontinuous nature of the fault pattern in Woodside is presumed to be the result of artificial modification by cultivation and natural modification by excessive rainfall and slope failures. Landslides, debris flows, and dense tree cover also account for gaps in fault trace features. On this map only those landslides close to the fault and most obvious on the aerial photographs are shown. For additional reports on landslides, see Brabb and Pampeyan (1972) and Brabb and others (1972).

At the southwest end of Upper Crystal Springs Reservoir a prominent east-facing scarp follows along the east base of the Santa Cruz Mountains for two miles before being interrupted by some *en echelon* lineaments which shift the main trace eastward. Taber (1906, p. 307, fig. 2) described a belt of north-south cracks, a quarter mile or more wide, that interrupted the main break two miles south of the lake, and his map appears to be the first published map showing *en echelon* breaks along the 1906 surface rupture on the San Francisco Peninsula. Taber's map and Lawson's report (1908, p. 105) also indicate a belt of north-south fractures, 4 ft wide showing 6 in. vertical and 1 ft horizontal displacement, was found west of the main break at the south end of Upper Crystal Springs Reservoir.

From the reservoir south through Woodside, the fault zone is as much as a mile wide, but the freshest fault features are northeast-facing scarps along the southwest edge of the zone, where the zone appears to be less than a half mile wide. Between McGarvey Gulch and Adobe Corner, the linear features step to the east and follow a prominent southwest-facing scarp on to the intersection of Mountain Home Road and Portola Road. Dickinson (1973) shows a lineament, the Cañada trace of the San Andreas Fault Zone, along Cañada Road, which closely follows an unnamed fault mapped by Branner and others (1909). The linear features along this trace are very subtle, and trenches across it, between Sand Hill Road and Manzanita Way in Woodside, exposed no fault break (R.H. Wright, written commun., 1983).

Through Woodside the most recent appearing fault traces are marked by ponds and closed depressions, some of which are natural and some of which may be artificial or modified natural features owing to intensive landscaping on private properties. Between Woodside and Searsville Lake, the fault scarp is well developed and is emphasized by closed depressions and marshy areas. From Searsville Lake to near Alpine Road, in the Town of Portola Valley, the main fault trace mainly follows Sausal Creek, but where the creek crosses Portola Road the most recently active trace steps east about 200 ft (Taylor and others, 1980) and continues southeast amongst a series of linears. In Los Trancos Woods, on and near Coal Mine Ridge, widespread landsliding in Santa Clara Formation deposits has produced a profusion of linear features which have obscured any through-going breaks that formed in 1906.

According to Lawson (1908, p. 36), the 1906 fault breaks south of Page Mill Road, at the head of Stevens Creek Canyon, were up on the southwest wall of the canyon. In contrast, this map shows a narrow zone of prominent linear features, marked by sag ponds, notches, trenches, shutter ridges, and offset drainages, that runs along the northeast slope of Stevens Creek Canyon, for a distance of about 2½ mi before crossing to the southwest canyon slope in the vicinity of Table Mountain, near the southern end of this map. Young fault features in soft sedimentary rocks of the southwest slope, if displayed in 1906, were not apparent in 1965 or later years.

COMPARISON WITH OTHER MAPS OF SAME AREA

The State Earthquake Investigation Commission report on the 1906 earthquake (Lawson, 1908, Atlas maps 21, 22) showed the 1906 surface rupture between Mussel Rock and the vicinity of Saratoga on the San Mateo 15' (edition of 1899) and Santa Cruz 30' (edition of 1902) 1:62,500- and 1:125,000-scale topographic quadrangles. More recently, Schlocker and others (1965) transferred Lawson's fault line to a modern 1:62,500-scale base map (reduced and mosaicked 1:24,000-scale quadrangles) and made adjustments to the line where field mapping and references to other reports dictated changes were required. Subsequent interpretative studies by Brown (1970) of 1:80,00-scale aerial photos covering the San Francisco Peninsula and of other geologic data (Brown, 1972) in San Mateo County, resulted in two maps, at 1:250,000- and 1:62,500-scale, respectively, confirming the view (Taber, 1906) that Lawson's portrayal of the 1906 fault break as a single line, was a simplification of actual facts. A map showing young faults and earthquake epicenters in San Mateo County (Brabb and Olson, 1986) includes data from sources named above and some new interpretations of possible thrusting in the San Andreas Fault Zone. Recently, the 1989 Loma Prieta (Plafker and Galloway, 1989) and 1992 Landers (U.S. Geological Survey, 1992) earthquakes have shown that a through-going fault trace can be a complex zone of fractures rather than a single clear-cut break. A comparison of the present map with other overlapping maps follows by quadrangles.

San Francisco South and Montara Mountain quadrangles

Smith's (1981c) map of Holocene movement of the San Andreas Fault Zone shows a similar position for the 1906 surface rupture but concludes that other linear features, ponds, and closed depressions in the San Francisco South quadrangle probably are the result of lateral spreading. The lineaments and ponds shown on this map may be due to mechanisms other than fault rupture but were prominent and well-enough developed to indicate that they were formed in relatively recent time, possibly caused by an earlier historic earthquake, *e.g.*, June 1838 or November 1852 (Tocher, 1959). The two northern arms of San Andreas Lake most likely are fault-controlled but evidence for recent activity there is lacking or questionable. The principal San Andreas Fault break appears to pass through the northeastern arm of the lake and follows close to the axis of San Andreas and Spring Valleys, west of the most recent break, separating layered units of the Franciscan Complex on the west from sheared Franciscan rocks (mélange) on the east.

Grading of a construction site between San Bruno Creek and San Bruno Avenue in 1976 exposed an alignments of seeps and sheared rocks. A review of 1946 aerial photos showed two significant lineaments and small sag ponds at that site. The linear features were confirmed by Smith (1981b) and referred to as faults A and B.

The shoreline of San Andreas Lake was mapped in 1972, when the lake was drawn down for construction purposes. Although no prominent through-going fault displacing rock units was exposed, an alignment of vertically sheared zones cutting predominantly flat-lying mélange followed an alignment of sag ponds and low scarps, all in line with breaks in San Andreas dam and San Andreas outlet structures at the southeast end of the lake, and offset fences near the north end of the lake (Pampeyan, 1983, 1986, 1994).

The position of the 1906 break between San Andreas Lake and Lower Crystal Springs reservoir differs little in detail with that of Smith (1981c); the numerous discontinuous linears nearby were prominent enough on the aerial photographs I used to be recorded, and some of these fell close to locations of broken pipelines and fences. The few north-trending linears shown appear to be similar to the *en echelon* breaks described by Taber (1906) south of Upper Crystal Springs Reservoir. The fault lines shown in Pampeyan (1983, 1994) represent the approximate trace of the 1906 surface rupture after eliminating less prominent or questionable data. Brabb and Olson's (1986) map of this area is based on data gathered for the present study.

Woodside and Palo Alto quadrangles

The east edge of the San Andreas Fault Zone is shown by Branner and others (1909) as an unnamed fault extending from Upper Crystal Springs Reservoir, south along Cañada Road through the Town of Woodside, to the intersection of Sand Hill and Whiskey Hill Roads. Subsequently, Dickinson (1973) named this fault the Cañada Trace of the San Andreas Fault and extended it south into the Palo Alto quadrangle and Town of Portola Valley. More recently Brabb and Olson (1986) have interpreted Dickinson's Cañada Fault to be part of the Hermit Fault, a southwest-dipping thrust fault which skirts the east edge of Jasper Ridge and merges southeastward with the Monta Vista Fault of Sorg and McLaughlin (1975).

In the Town of Woodside, trenching across the Cañada Fault exposed no evidence of faulting (R.H. Wright, written commun., 1983) and I saw no displaced strata along the Hermit Fault in the Palo Alto quadrangle (Pampeyan, 1993). This strip map shows the position of the Cañada Fault, but its existence and geometry have not been demonstrated adequately and its geomorphic features do not indicate recent activity.

Dickinson's (1973) Vineyard trace of the San Andreas Fault Zone is approximately the same as the lineaments shown here between Portola Road and Mountain Home Road, 300 and 600 ft east of a former mill pond. Lineaments corresponding to Dickinson's (1973) West Union Creek traces may extend as far south as Kings Mountain Road, but I believe the most recently active ones step east to the east side of the fault zone, a half mile north of Kings Mountain Road.

Dickinson (1970, 1973) shows fault traces extending southeast from Searsville Lake to the vicinity of Portola Road. Some of these displace Pliocene and Pleistocene Santa Clara Formation deposits but probably have been inactive in Holocene time.

Mindego Hill quadrangle

Lawson (1908, p. 36) reports that the 1906 fault break crossed the saddle separating Black Mountain from the mountains to the west and "descends to the narrow canyon of Stevens Creek. It crosses the canyon at a small angle near its upper end and parallels the creek on the southwestern side, at an elevation of about 500 feet above it." Lawson must have meant "northeastern" instead of "southwestern" for no evidence of recent fault activity was found where he describes, and the major elements along the presumed 1906 fault, near the head of the canyon, are up on the northeastern slope of Stevens Creek Canyon.

On this strip map the area south of Page Mill Road overlaps a similar strip map prepared by Sarna-Wojicki, Pampeyan, and Hall (1975). That map benefited from interpretations of three authors whereas the lines on this map are based on an earlier study (E.H. Pampeyan, unpubl. data, 1965). The overlapping maps are similar but I saw no evidence of a recently active through-going break in the bottom of Stevens Creek Canyon.

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_____1974c, Special Studies Zones, San Mateo [7½'] quadrangle: California Division of Mines and Geology, scale 1:24,000.

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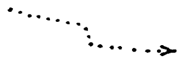
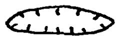
EXPLANATION

Solid line, a fault with obvious photogeologic or field evidence of recent movement shown by scarp lines, trenches, sag ponds, systematically diverted drainages, other surface features and offset manmade structures. Long-dashed line, a probable fault with less obvious photogeologic or field evidence of recent movement, but probably a fault break. Short-dashed line, subtle photogeologic linear feature which may or may not represent a recent fault break. Dotted line, position of fault break projected in reservoirs. Hachures on apparent downthrown side of fault

Area underlain by landslide deposits. Arrows show generalized direction of movement. Hachures on headwall scarp. Only those landslides most obvious are shown even though geomorphic features suggest other areas may be underlain by landslide deposits



Offset drainage



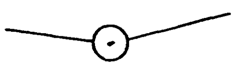
Sag pond or closed depression

Marshy area

××××××

Vegetation lineation along probable groundwater barrier

Spring



Turning point for Alquist-Priolo Special Studies Zones boundary compiled from California Division of Mines and Geology maps (1974a, b, c, d, 1982a, b)

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Monument of quadrilateral established in 1906 by State Earthquake Investigation Commission