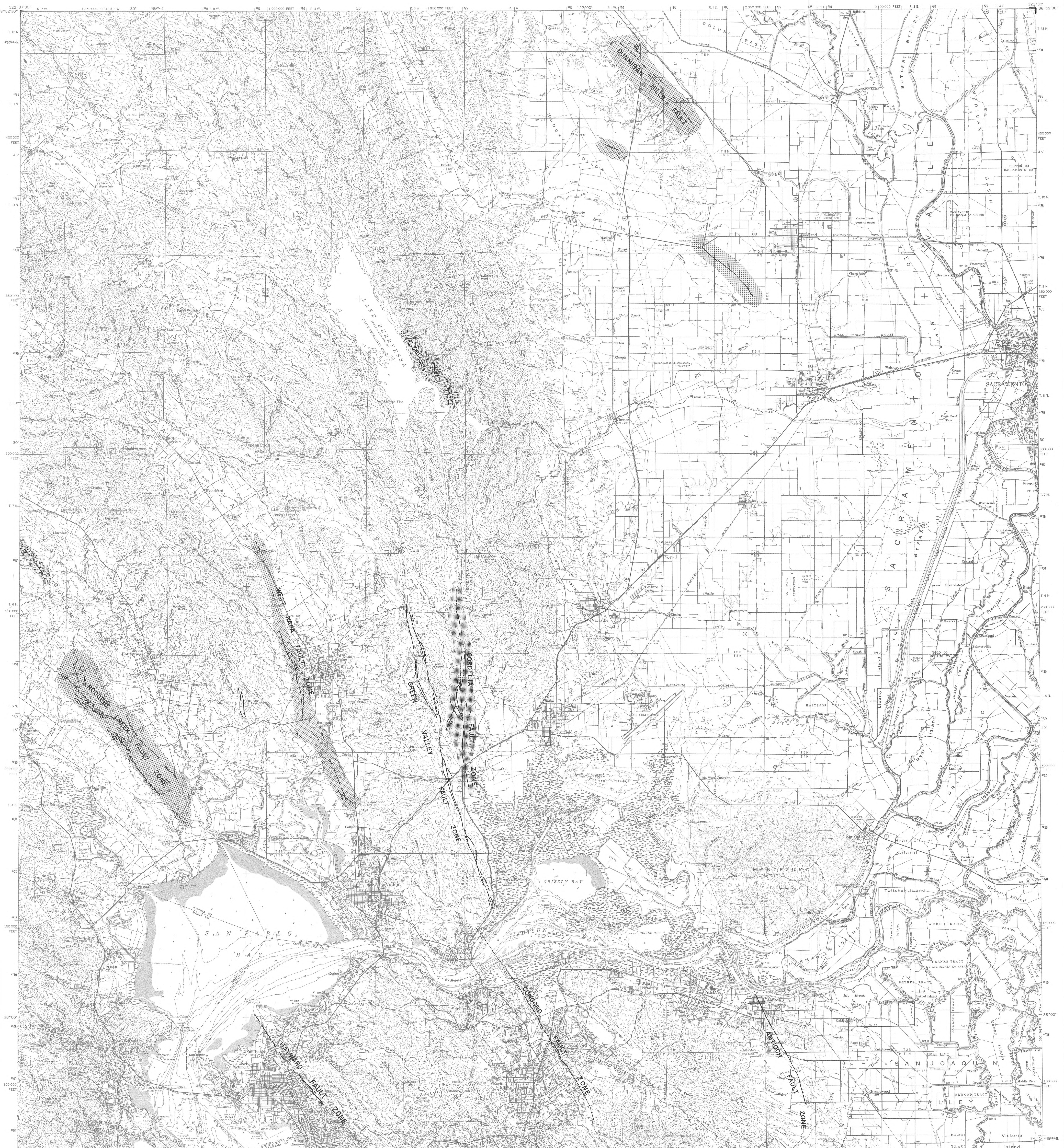
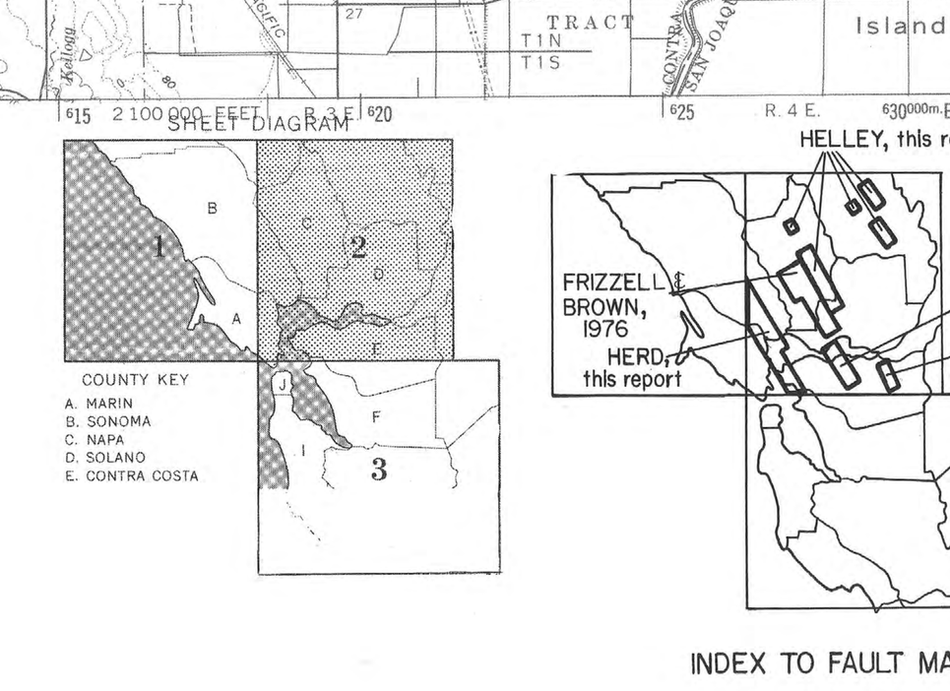
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY



Base by the United States Geological Survey
San Francisco Bay Region, Sheet 2 of 3, 1970

SCALE 1:125 000

APPROXIMATE MEAN DECLINATION, 1977



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MAP SHOWING FAULTS WITH QUATERNARY DISPLACEMENT, NORTHEASTERN SAN FRANCISCO BAY REGION, CALIFORNIA

BY

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1977

Map showing faults with Quaternary displacement,
northeastern San Francisco Bay region

By Edward J. Helley and Darrell G. Herd

Introduction

This map shows faults with Quaternary displacement in the northeast San Francisco Bay region of California. Faults that have been historically active or that show evidence of movement during approximately the last 2 million years (the Quaternary Period) are delineated and are classified according to the age of their last surface displacement.

The map is designed to provide a synopsis of Quaternary faulting in the northeast San Francisco Bay area contributing toward an understanding of neotectonic crustal deformation in the central Coast Range of California. Surface faulting during the most recent geologic period, the Quaternary, is largely confined to these faults. Future crustal movement will most likely occur along these fault breaks.

San Andreas fault system[1/]

The San Francisco Bay area is cut by a system of predominantly northwest-trending, right-lateral strike-slip faults. This group of faults, the San Andreas fault system, mark the boundary between two great portions of the earth's crust, the American and Pacific plates. Since early Miocene time, northwestward movement of the Pacific plate relative to the North American continent along the present San Andreas fault system has slivered the San Francisco Bay area into several elongated, northwest-trending fault-bounded blocks.

Quaternary faulting in the northeast San Francisco Bay region has occurred principally along four faults in the San Andreas system. Although no direct physical connection has been established, those faults recognized on the south side of San Francisco Bay and the Sacramento River may extend to faults on the north shore. Different names are now applied to the fault systems on opposite sides of the bay and the river as, for example, the Hayward and Rodgers Creek fault system, the largest of the four fault zones. The Concord-Green Valley is of next importance, followed by the Cordelia, West Napa and Antioch fault systems. Those along the western margin of the Sacramento Valley have not been thoroughly investigated.

Location of fault breaks[2/]

The fault breaks were located chiefly by study of aerial photographs of the northeast San Francisco Bay region (table 1) for geomorphic evidence of faulting during the recent geologic past. Soil stratigraphy and geomorphic analyses of land forms were also used to search for incompatibilities between deposits and the processes by which they were formed. The faults on the photographs were transferred by visual inspection to 7.5-minute topographic maps (scale 1:24,000) and compiled at a scale of 1:125,000.

Geomorphic evidence for Quaternary faulting along the Green Valley fault has been previously studied by Frizzell and Brown (1976), along the Concord fault by Sharp (1973), and along the Antioch fault by Burke and Helley (1973).

The faults are shown on the map only where there is convincing evidence that Quaternary deposits have been offset. Fault strands are not shown if obscured by younger alluvium, landslides, or water, except where their position can be closely approximated. Faults are not joined into longer segments unless there is historic, geomorphic, or geologic evidence of continuous rupture.

[1/] The San Andreas fault system includes the San Andreas fault zone and all faults and fault zones connected to or branching from the San Andreas fault zone. The San Andreas fault zone is those fault strands in proximity to and roughly parallel with the most recent lines of rupture. The San Andreas fault consists of the traces of the most recent (in many places historic) movement (Noble, 1936, p. 416-417).

[2/] 7.5-minute topographic quadrangles (scale 1:24,000) summarizing geomorphic, geologic, and historic evidence for Quaternary faulting in the northeast San Francisco Bay area used to compile this map are being concurrently published (Herd and Helley, 1976).

Geomorphic evidence of Quaternary faulting

Faults that have moved during the Quaternary can generally be recognized by a distinctive group of associated alined landforms (fig. 1). Scarps, trenches, notches, saddles, linear valleys, troughs, ridges, offset streams, and sag ponds and other small undrained depressions have developed by repeated movements along a fault or by erosion along its trace. Movement of opposing fault blocks past one another juxtaposes topographic irregularities across the fault. When ridges are moved against gullies, streams are offset or blocked by shutter ridges. Scarps are cut across ridges and hills, and topographic surfaces are displaced or deformed. Trenches, notches, linear valleys, troughs, ridges, and saddles may reflect accelerated erosion of crushed and broken rock in fault zones or may be downdropped slivers lying between parallel fault breaks. Linear patterns of trees or shrubs and contrasts in vegetation type, color, and density may develop along fault zones owing to differences in soils or depths to ground water across or within the fault zones. Springs and seeps may emerge at the base of fault scarps or in fault-controlled depressions.

Geomorphic features associated with faulting are ephemeral in the landscape; they are destroyed by erosion unless they are rejuvenated by repeated displacement along the fault. The degree to which fault-created landforms are preserved depends on such interrelated variables as the rate, periodicity, and character of fault movement, bedrock type, climate, and soil cover. The rate at which geomorphic features associated with faulting are destroyed in the northeast San Francisco Bay region is not known. However, erosion and sediment transport studies in the south and central San Francisco Bay area (Brown and Jackson, 1973) suggest that the land surface in the central Coast Range is lowered at an average rate of 0.05-0.75 m/1000 yr (table 2). At this pace, erosion of fault-associated landforms in the San Francisco Bay region would be rapid. Youthful, fresh-looking fault features would surely be no older than Holocene; mature, eroded and subdued fault landforms would probably be Pleistocene. Few pre-Quaternary geomorphic features created by faulting would persist in the landscape. For example, in a study of 50 sag ponds along the San Andreas fault, Sarna (1972) determined that under the range of conditions observed in the central Coast Ranges of California, most sag ponds are probably younger than 10,000 years. More importantly, faults in the San Francisco Bay region with youthful or even mature fault topography that cross alluviated basins have all been found to offset Pleistocene or Holocene sediments somewhere along their length.

Categorization of recency of faulting

The faults have been classified as historic, Holocene, Pleistocene, or late Cenozoic of probable Quaternary age according to the time of their last surface displacement:

Historic faults are those that have had documented contemporary surface fault displacement either accompanying earthquakes or by slow tectonic creep.
Holocene faults offset geologic deposits (especially alluvium and colluvium) and soils developed on them less than 10,000 years old.
Pleistocene faults displace geologic materials of Pleistocene age (between 10,000 and 2,000 years old) but do not offset Holocene deposits along their lengths.
Late Cenozoic faults of probable Quaternary age have topographically expressed scarps, linear valleys, and trenches and displace Tertiary rocks but lack Holocene and Pleistocene deposits along their lengths.

All faults within a fault zone are here considered to be as young as the youngest surface displacement along any strand of the fault zone, although the entire fault zone may not have ruptured during the last faulting event. The ages of many fault strands within a fault zone cannot be accurately determined owing to the lack of associated Quaternary deposits or to uncertainties in the rates of formation and erosion of geomorphic features associated with faulting.

Holocene and Pleistocene ages have been assigned to alluvial deposits offset by overlying faults on the basis of radiocarbon dating of the sediments (Wright, 1971) or by the type and degree of soil development on the alluvial materials (E. J. Helley and K. R. Lajoie, unpub. data 1976). Ages and formational names of older rocks displaced by the faults are taken from previous geologic studies (Fox and others, 1973; Sims and others, 1973).

Seismicity

We studied the association of small earthquakes in the northeast San Francisco Bay region recorded by the U.S. Geological Survey from 1969 through 1972 (Lee and others, 1972a, 1972b, 1972c; U.S. Geological Survey, 1972; Wesson and others, 1972a, 1972b, 1973, 1974) with faults with Quaternary displacement. Although numerous small earthquakes have been instrumentally located near all of the faults, few of the earthquakes are sufficiently well located to be directly assigned to any one fault or fault zone. Most of the faults on the map are outside the area where small earthquake epicenters can be located accurately (see discussion by Brown and Lee, 1971).

Description of the Quaternary faults

The Rodgers Creek fault zone

Extending northwest across the Sonoma Mountains, the Rodgers Creek fault zone is a major right-lateral strike-slip fault zone north of San Pablo Bay. The fault zone extends from near Sears Point northwestward past Wildcat Mountain to the vicinity of Petaluma Reservoir. At the north shore of San Pablo Bay, near Tubbs Island, the Rodgers Creek fault zone is expressed by alined southwest-facing scarps in the sedimentary Petaluma Formation. Approximately 0.6 km southeast of California Highway 121 is an unusual closed alluvial depression which lies along the line of scarps. Although no fault can be seen directly entering the depression, the feature may be a sag. Approximately 0.8 km northwest of Highway 121, the Rodgers Creek fault zone traverses and is partially obscured by a large landslide complex in the Sonoma Mountains that extends northward to California Highway 116.

No recently active expression of the fault zone can be seen immediately southeast of Wildcat Mountain, as the trace of the fault zone is completely obscured by one slide in the landslide complex. From Wildcat Mountain northwestward to California Highway 116, the fault zone is delineated by a narrow line of scarps, linear troughs, right-laterally offset streams, and very well developed sag ponds and sags. Because this part of the fault zone is within a large landslide complex, only the most recently active traces of the fault zone can be seen.

Just north of Highway 116, the trend of the Rodgers Creek fault zone changes from N.39°W. to a more northwesterly heading of N.43°W. The channel of Rodgers Creek north to near Petaluma Reservoir is controlled by the fault zone. Several sharp scarps, linear troughs, sags and sag ponds occur throughout the fault-controlled valley. The Rodgers Creek fault zone is obscured north of Petaluma Reservoir by many landslides which have dislocated the entire western face of the Sonoma Mountains north of Petaluma.

The Rodgers Creek fault zone, as shown on this map, has an irregular width. The fault zone between Petaluma Reservoir and California Highway 116 to the south is partly obscured by other landslides.

In a trench across the Rodgers Creek fault zone, approximately 1-3/4 km northwest of Wildcat Mountain, we observed different Holocene soils juxtaposed across one strand of the Rodgers Creek fault, indicating late Holocene movement along the fault zone (D.G. Herd and M.G. Bonilla, unpub. data, 1976). The fault zone does not visibly displace bay muds on the north shore of San Pablo Bay, and there has been no documented tectonic creep of the fault zone. The faults from California Highway 121 northwestward to a point approximately 1.7 km north of California Highway 116 are expressed by a discontinuous line of northeast-facing scarps, saddles, and troughs in the Sonoma Volcanics. Recent movement along the fault is evidenced by a prominent northeast-facing ramp and scarp in a Holocene alluvial fan approximately 0.6 km northwest of California Highway 121.

Faults east of Bennett Valley

A fault with probable Quaternary displacement is evidenced along the east side of Bennett Valley by a prominent southwest-facing scarp in the Sonoma Volcanics. The fault extends southeastward 3 km from the south side of Bennett Mountain. It underlies a linear stream course on the south side of Bennett Mountain and parallels a linear trough at the base of the scarp along the east side of Bennett Valley. The fault is covered by and does not visibly displace late Pleistocene alluvium, but the freshness of the scarp and associated landforms indicates that it was active at least in the late Quaternary.

This fault may be the southern continuation of a northwest- to north-trending fault zone fronting the Sonoma Mountains immediately east of Santa Rosa Reservoir, shown on a U.S. Geological Survey map (Herd and Helley, 1976). As that fault zone does displace late Pleistocene alluvium and the one east of Bennett Valley does not, the fault east of Bennett Valley is shown separately.

Hayward fault zone

The Berkeley Hills south of San Pablo Bay are crossed by the Hayward fault zone, which extends from the shore of San Pablo Bay near Pinole Point southeastward through the cities of San Pablo, Richmond, El Cerrito, and Berkeley. The fault zone parallels the south shore of Pinole Point, following a linear trough on the southwest flank of the peninsula. Several small undrained depressions that may be formed by faulting occur within the trough. Linear northwest-trending ridges parallel or strike slightly oblique to the trace of the fault northwest of where it crosses the Southern Pacific Railroad tracks. From the railroad tracks to the Tank Farm in northeastern San Pablo, the fault zone is expressed by a line of sharp west-facing scarps in sedimentary rocks of the late Tertiary Orinda(?) Formation and in early Pleistocene(?) alluvium. From the Tank Farm southeastward to San Pablo Avenue, the fault zone crosses the southwest flank of the hills immediately north of San Pablo. In aerial photographs of the area taken by the Soil Conservation Service in 1939 (photographs BUU-290-23 and BUU-290-24), the trace of the fault system was expressed as a faint linear trough and a linear soil pattern.

From San Pablo Avenue southeastward to San Pablo Creek, the fault zone crosses the flood plain of San Pablo Creek. Although the landforms created by recent movement along the fault system have been destroyed by land development in San Pablo, the trace was clearly visible in aerial photographs taken in 1939 (photographs BUU-290-24 and BUU-290-25). The fault zone could be seen as a faint linear trough and linear soil pattern immediately southeast of San Pablo Avenue and as a low southwest-facing scarp in late Pleistocene alluvium along San Pablo Creek, extending from the present site of Contra Costa College southeastward to San Pablo Creek. The aerial photographs also show a right-laterally offset stream channel near the present site of Contra Costa College.

The fault zone is obscured southeast of San Pablo Creek at the north end of San Pablo Ridge by a large landslide now crossed by Interstate 80. It emerges to the southeast from beneath the landslide at the north end of the Berkeley Hills at Wildcat Creek and follows the crest of the Berkeley Hills southeastward into El Cerrito. The fault zone here is a narrow line of southwest- and northeast-facing scarps, linear troughs and notches, and benches. Five sags and sag ponds lie astride the trace of the fault zone in central El Cerrito. From El Cerrito southeastward to the University of California campus in Berkeley, the trace is obscured by a large complex of landslides descending from the west face of the Berkeley Hills. At the campus the fault may be expressed by a line of prominent sharp west-facing scarps, although these scarps could also be caused by landslides.

Tectonic creep, first reported by Radbruch and Lennert (1961), is occurring along parts of the Hayward fault zone. Streets, curbs, sidewalks, and homes have been right-laterally offset and deformed along the trace in San Pablo, from the Tank Farm northwest to Pinole Point (Nason, 1971; Radbruch-Hall, 1974). Tracks of the Southern Pacific Railroad southeast of Pinole Point are right-laterally deformed across the trace. No tectonic creep has been observed along the fault system in the Berkeley Hills immediately southeast of Wildcat Creek.

Two historic earthquakes are believed to have been associated with surface faulting along the Hayward fault zone. On October 21, 1868, a large earthquake occurred along the southern reach of the fault zone. Surface breaks were observed for 37 km, from present-day Fremont to San Leandro (Lawson and others, 1908). Radbruch (1967) reported a personal recollection of an individual who lived in Berkeley at the time of the 1868 earthquake who believes that he saw a furrow created by surface faulting in the Berkeley area. This report is in conflict with Louderback (1937), who said that there was no faulting in the Lake Temescal Dam area, which lies astride the Hayward fault 3 km southeast of Berkeley. Another major earthquake was centered along the Hayward fault zone on June 11, 1836. Although Radbruch (1967) has reported that the 1836 earthquake was associated with surface rupture along the fault system from San Pablo Bay south to Mission San Jose (now Warm Springs District of Fremont), reexamination of the newspaper references to the earthquake do not confirm this inference. The principal report concerning the 1836 earthquake, a small article in the Oakland Daily News of 1868 (Louderback, 1947), states simply that an earthquake was felt from San Pablo to Mission San Jose, and that earthfissures formed during the earthquake. There is no evidence in the article to confirm the idea that the surface fissures were surface breaks on the Hayward fault zone. They may well have been associated with ground shaking or slope failure.

West Napa fault

The West Napa fault zone was first recognized in fresh fault topography southwest of Napa in the Sonoma Volcanics. These fault features extend due north from Oat Hill north of Vallejo as two discontinuous traces of linear troughs and scarps. Due west of Napa the zone narrows, and strong lineaments and a trough with distinct vegetation boundaries are present. The eastern boundary of Brown's Valley is marked by scarps and a ground-water barrier. North of Redwood Creek a single trace extends northward, cutting older terrace deposits and leaving a scarp as much as 24 m high. Examination of water well logs in this area reveals a very thick section of unconsolidated alluvium adjacent to the fault scarp, some in excess of 100 m. Northward near Yountville the evidence is less compelling but exists as photolineaments, a possible ground-water barrier, and geophysical anomalies (proprietary information from magnetic and resistivity surveys) in the alluvium just north of Yountville.

The sense of motion of the west Napa fault is probably right-lateral strike slip with a dip-slip component, east side downward. The amount of displacement could not be determined.

Green Valley fault zone

The Green Valley fault zone extends 30 km northwest from Bahia on the north shore of Suisun Bay to Wooden Valley. It may extend farther north, but any traces of activity are obscured by landslides (Frizzell and Brown, 1976). A southerly extension and connection of this fault with the Concord fault was proposed by Frizzell and Brown (1976), requiring only a short en echelon step. The southern part of the Green Valley fault involves the juxtaposition of the Sonoma Volcanics of Pliocene age against marine sedimentary rocks of Jurassic and Cretaceous age. The fault contact is marked by very fresh topographic features such as alined saddles and notches, linear depressions, springs, sags, and well-developed shutter ridges. Approximately 10 km north of Bahia, the Green Valley fault cuts through Pleistocene and Holocene alluvium filling a reentrant into the range. There the fault offsets a stream course and possibly a barbed-wire fence (Frizzell and Brown, 1976). From there northward the Green Valley splits into two main traces for 6.5 km. The western trace forms a linear valley and the eastern one forms a prominent east-facing bench. Frizzell and Brown (1976) noted that the western trace offsets a 1922 power line by 0.27 m. The fault crosses Interstate Highway 80 in a series of linear valleys, ridges, and trenches in bedrock. About 1 km north of Highway 80 the fault again cuts Holocene alluvium as a single trace altering stream courses and marking distinct color changes in moist alluvium. The fault passes through Green Valley and splays into about four traces as it offsets bedrock again. From there to Wooden Valley, about 9 km to the north, the Green Valley fault is defined by two linear valleys with scarps, springs, benches, and trenches.

Concord fault zone

The Concord fault zone, described by Sharp (1973), forms the abrupt and linear eastern boundary between Ygnacio Valley and the Diablo Range. It extends northwest through the alluvial plain west of Concord and through the mud on the south shore of Suisun Bay. The Concord fault probably extends across the Carquinez Strait as evidenced by right-lateral offset in a railroad track on the north side of the strait on the projected trace of the fault. The southern part of the Concord fault shows the least amount of youthful geomorphic evidence for faulting. However, according to Sharp, the most compelling evidence of faulting here is the marked concentration of small earthquakes along the linear boundary of Ygnacio Valley. North of Ygnacio Valley and west of Concord, the fault forms a ground-water barrier, sag ponds, and southwest-facing scarps. Right-lateral tectonic creep has been determined on this fault from offsets of cultural features in the city of Concord and the oil refinery and railroad sidings at Avon. Right-lateral offsets as much as 0.15 m have been measured on five southwest-trending streets in the city (Sharp, 1973). No clear estimate of rate of movement could be made.

Cordelia fault zone

The Cordelia fault zone is named for a small village between State Highway 21 and Interstate 80 northwest of Suisun Bay. This fault lies only a few kilometers east of the Green Valley fault and may represent a branch of it. The fault was first recognized just south of Cordelia as a linear contact between soils developed on Holocene basin deposits on the west and older alluvial fan deposits on the east, with the older soils anomalously on the downslope side. This contact also appears to be a ground-water barrier as shown by a near-surface wet zone. Photolineaments allow extension of the fault north of Cordelia into the bedrock hills underlain by the Sonoma Volcanics. Approximately 3 km north of Interstate 80, the fault splays into a series of four or more traces, each marked by vegetation lineaments, scarps, linear troughs, notches, and shutter ridges. The zone there is about 2 km wide. The fault zone narrows northward but can be traced by a few scarps, photolineaments and vegetation lineaments to the western shore of Lake Curry. No evidence for young faulting was seen in the alluvium in Wragg Canyon, a linear valley extending to the southeastern end of Lake Berryessa along the projected strike of the Cordelia fault. The east side of Lake Berryessa shows some features of young faulting. Here, shutter ridges and alinements of notches, saddles, and closed depressions are common.

Some earthquakes attributed to the active Green Valley fault by Frizzell and Brown (1976) may, in fact, originate on the Cordelia fault. Where exposed in new roadcuts, the Cordelia fault appears to displace A horizons on soils formed on the Sonoma Volcanics. Sense of motion is right-lateral strike-slip, and all slickensides observed to date have been horizontal.

Dunnigan Hills fault zone

The Dunnigan Hills form a topographic anomaly on the flat floor of the Sacramento Valley in central Yolo County. The northeast side of the Dunnigan Hills is a very straight front trending about N.40-45°W. and standing about 50 m above the floor of the Sacramento Valley. The southwest side shows a less abrupt break with the valley floor, suggesting that the Dunnigan Hills may be a tilted block with the northeast side up. The northeast side of the hills is marked by photolineaments, benches, linear trenches, strong linear soil series contacts, and linear sag ponds just west of the village of Zamora.

Two major ephemeral streams, Bird and Oat Creeks, traverse the Dunnigan Hills. These streams are incised into the Dunnigan Hills. The incision is further confined to the north side of each stream's respective flood plain, which suggests that these two streams are antecedent to the Dunnigan Hills. Late Pleistocene alluvium is the oldest deposit in the two stream valleys, suggesting that most incision occurred after that time. An alternative explanation is that a changing climate could have also altered the streams, again causing the same incision. The streams are not offset as they emerge from the Dunnigan Hills, perhaps because the inferred sense of fault motion is primarily vertical. Faulting is probably Holocene because of the sharp escarpment and fresh linear features in Holocene deposits.

Antioch fault

The Antioch fault (Burke and Helley, 1973) is exposed in the low hills just south of the city of Antioch. There it cuts Tertiary rocks such as the Neroly and Cierbo Sandstones of Miocene age, which are drag folded, brecciated and secondarily cemented with calcite. Excellent exposures of the fault were seen at a construction site near the intersection of Roosevelt Lane and Mayberry Drive. There the Tehama Formation of Pliocene age is fractured and sheared and has gouge zones containing organic A-horizon soil material. The major fault zone strikes N.10-15°W., and the attitude of the fault is vertical with a dip-slip component of about 0.4-0.5 m. A projection of the Antioch fault north-northwestward through Antioch is coincident with fractures with right-lateral offsets and compressional buckles in walks and curbs that are the most compelling evidence for recent movement on the fault. The seismic record for the Antioch area supports the likelihood of young faulting. Locations of epicenters plotted for the past decade appear to coincide with the mapped fault and inferred fault-produced features. A swarm of small earthquakes in 1965 (McEvilly and Casaday, 1967) is believed to have been generated by right-lateral motion of a fault having a north-northwest strike within the vicinity of the Antioch fault. For a more detailed description of the fault-produced features, see Burke and Helley (1973).

MISCELLANEOUS FIELD STUDIES
MAP MF-881
Helley and Herd - Quaternary faults
northeastern S.F. Bay region, Calif.

Other Sacramento Valley faults

Geomorphic evidence for young faulting was found just southwest of the city of Woodland. A northwest-trending trench and linear valley within the Pliocene Tehama Formation extend southeast from Weggers Airport just south of Cache Creek. These fault features trend into Quaternary alluvium exhibiting strong soil moisture contrasts probably owing to the existence of a ground-water barrier. Juxtaposition of Holocene deposits along a linear contact in this area suggests young faulting.

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Table 1.--Aerial photography of the northeastern San Francisco Bay region used in this report

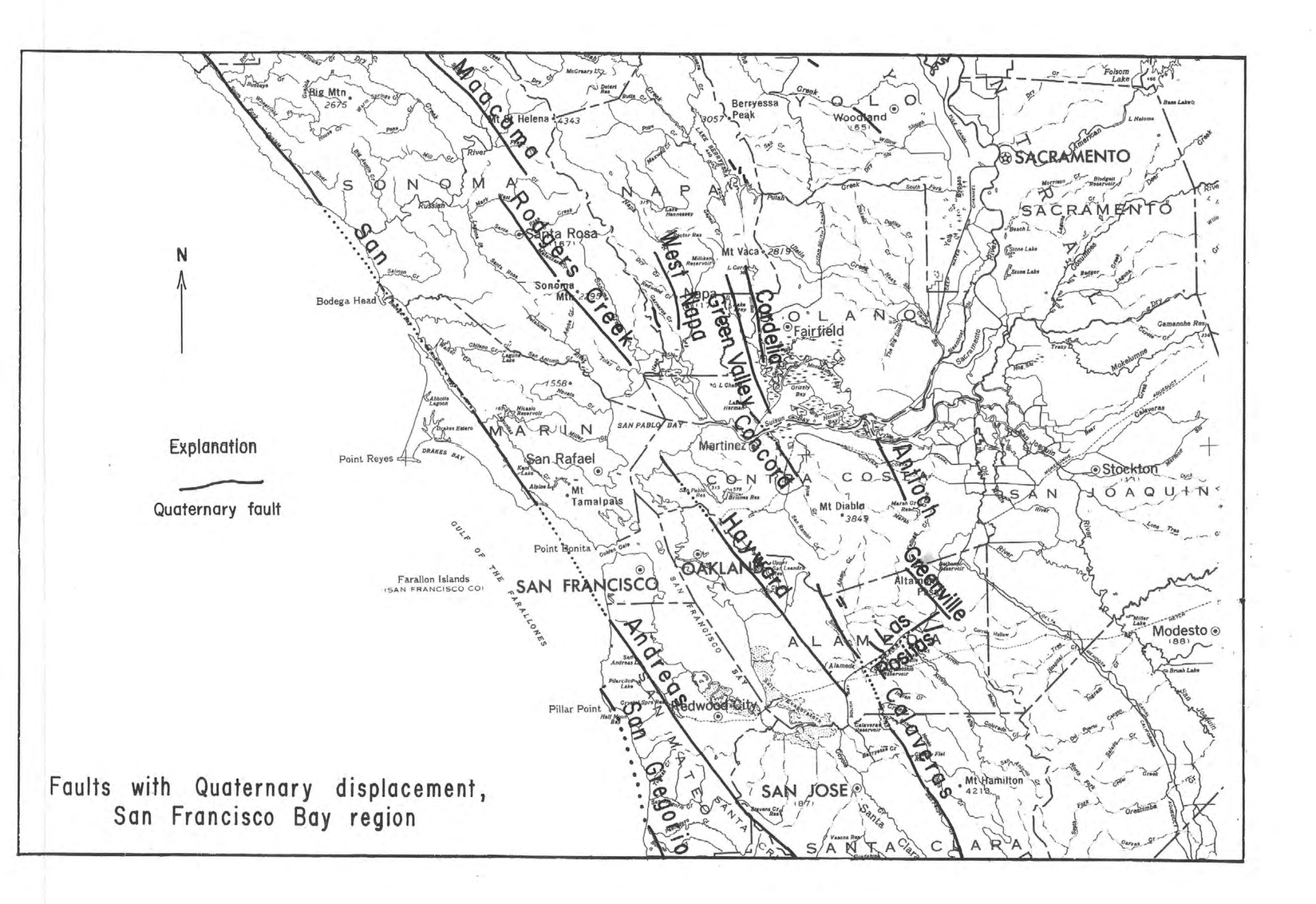
Area	Year	Scale	Agency	Availability
Black and white				
Napa and Sonoma Counties	1965	1:12,000	U.S. Dept. Agriculture	U.S. Dept. Agriculture, Salt Lake City, Utah
	1973	1:12,000	California Dept. of Transportation	California Dept. of Transportation, Sacramento, Calif.
	1941-42	1:20,000	U.S. Dept. Agriculture	National Archives and Record Services, Washington, D. C.
	1970	1:80,000	U.S. Geol. Survey	U.S. Geol. Survey, Menlo Park, Calif.
Yolo and Solano Counties	1937	1:20,000	U.S. Dept. Agriculture	National Archives and Record Services, Washington, D.C.
Color prints				
Rodgers Creek fault zone (Sonoma County)	1973,1974	1:20,000	U.S. Geol. Survey	Keith Cole Photography, Redwood City, Calif.
Infrared transparencies				
Western Sacramento Valley Yolo, Solano Counties	1973,1974	1:20,000	U.S. Geol. Survey	Available only as black and white prints I.K. Curtis Services 2901 Empire Ave., Burbank, Calif. 91504

Table 2.--Average annual sediment yield and average lowering of land surface, south and central San Francisco Bay region (Brown and Jackson, 1973)

Area	Years	Sediment Yield[1/] (kg/km²/yr)	Average basin-wide lowering of land surface[2/] (meters/1,000 yr)
Upper Crystal Spring Reservoir, San Mateo County	1878-1935	810,000	0.67
Uvas Reservoir, Santa Clara County	1962-1970	351,000	0.22
Coyote Creek, Santa Clara County	1962-1970	160,000	0.10
Alameda Creek, Alameda County	1957-1970	80,000	0.05
San Pablo, Upper San Leandro, and Chabot Reservoirs, Alameda and Contra Costa Counties	1875-1965	970,000- 1,200,000	0.61- 0.75

[1/] Assuming a dry specific weight of 1,200 kg/m^3.

[2/] Assuming a unit weight of in place material of 1,600 kg/m^3.



Faults with Quaternary displacement,
San Francisco Bay region

EXPLANATION

Fault with historic displacement:
Historic surface rupture or creep

Fault with Holocene displacement (the past 10,000 years):
Recent alluvium, soils, and colluvium offset

Fault with Pleistocene displacement (10,000 - 2,000,000 years ago)
Holocene deposits unbroken along fault; Pleistocene units offset (none on this sheet)

Fault with late Cenozoic displacement of probable Quaternary age:
Fault topography; offset Tertiary strata, but no Quaternary deposits along fault length

Note: the age of all faults within a fault zone is arbitrarily considered as the age of the youngest surface displacement along any strand.

Faults dashed where approximately located, queried where uncertain, and dotted where concealed

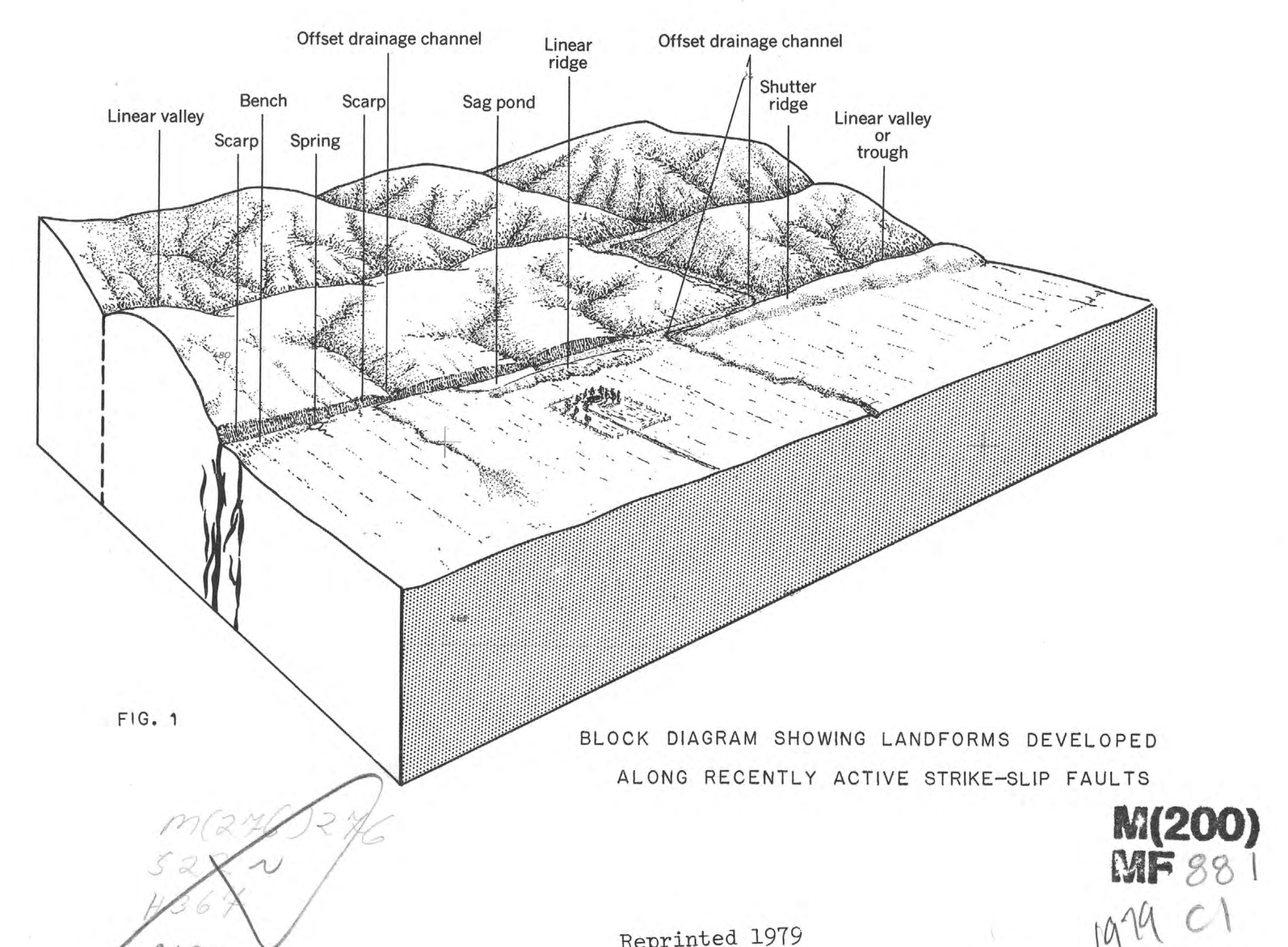


FIG. 1

BLOCK DIAGRAM SHOWING LANDFORMS DEVELOPED ALONG RECENTLY ACTIVE STRIKE-SLIP FAULTS

Reprinted 1979
Interior—Geological Survey, Reston, Va.—1977
For sale by Branch of Distribution, U.S. Geological Survey
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