DEPARTMENT OF THE INTERIOR
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FOR EARTHQUAKE RESEARCH

PREPARED IN COOPERATION WITH THE
CALIFORNIA DIVISION OF MINES AND GEOLOGY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-575

MAP SHOWING LOCATION OF STRIP MAP SEGMENTS

PURPOSE OF THIS STRIP MAP

This strip map is one of several designed to show the location of the most recent movements on the San Andreas fault. The character and location of these lines are important to scientists and engineers who study faulting and earthquakes and should be helpful to those concerned with land use and development on or near the fault. The lines on the strip map mark displacements of the ground surface by rupture or creep along the San Andreas fault. Map users should keep in mind that these lines are primarily guides for locating fault breaks on the ground and are not necessarily located with the precision demanded by every engineering or land utilization need.

THE SAN ANDREAS FAULT AND FAULT ZONE

The San Andreas fault zone is a major flaw or break in the earth's crust. It extends from the Gulf of California in northern Mexico northwestward through western California and under the Pacific Ocean off Point Arena in northern California, a distance of more than 600 miles. Movement within the fault zone has been distributed along many nearly parallel fault lines that differ in age and in amount of total relative displacement. This complex zone of movement—active over a span of millions of years and marked by displacements measurable in tens or hundreds of miles—varies in width from a few hundred feet to several miles. It is termed the *San Andreas fault zone* (or rift zone), as distinguished from the *San Andreas fault*, which consists of the traces of the most recent (in many places, historic) movement (Noble, 1926, p. 416–417).

Historic movement on the San Andreas fault is predominantly in the horizontal plane, with the earth's crust southwest of the fault relatively displaced toward 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 on the opposite side is displaced to his right. The right-slip character of the modern San Andreas fault is well established by observations of the surface faulting accompanying numerous earthquakes, by precision surveys of triangulation nets that cross the fault, by geodimeter measurements across the fault, and by linear features—both man-made and natural—that are displaced right laterally where they cross the fault. Vertical movements along the modern San Andreas fault are also known, but historically these have been small and localized as compared to right slip.

LOCATION OF THE FAULT BREAKS

The fault breaks were located by study of 1:12,000 scale aerial photographs flown on June 22, 1966, and were transferred to topographic maps by visual inspection. On this map some breaks were located by on-the-ground mapping following an earthquake of moderate magnitude accompanied by significant fault movement in 1966.

Map users should consider a line on the map not as a precisely located fault, but as a guide for field location of fault-break features. Where such features are large enough or distinctive enough to be shown by the contours of the topographic map, the fault break is accurately located to within 100 feet laterally. Where these features are more subtle or where topographic maps show comparatively little detail, the mapped line may be as much as 200 feet from the actual fault break, and in areas of featureless topography, the accuracy of location may be even less. Consulting geologists, engineers, and others making specific and direct use of these strip maps will need to make ground surveys to confirm and refine the positions of these fault lines in relation to structures and land boundaries.

FIELD RECOGNITION OF MOST RECENT FAULTING

The most recent fault breaks can generally be recognized by topographic discordance or a contrast in vegetation reflecting varying depth to ground-water or soil differences across the fault trace. The most common features are scarps, trenches, notches, ridges, offset streams, sag ponds and other small undrained depressions, and lines of springs or trees. [illegible]

LAND USE SIGNIFICANCE OF LOCATING RECENT FAULT BREAKS

The most recent breaks along the San Andreas fault should be recognized [illegible]

SPECIAL FEATURES OF THE SEGMENT FROM THE NORTHERN GABILAN RANGE TO CHOLAME VALLEY

[illegible]

North of Middle Mountain

[illegible]

South of Middle Mountain

[illegible] the fault south of Middle Mountain was strikingly demonstrated during the Parkfield-Cholame earthquakes of June-August 1966. All of the fault marked on the map by short en echelon dashes broke during that earthquake sequence. A discussion of the fracture zones, rates of movement, and other data pertinent to the Parkfield-Cholame earthquakes is given elsewhere (Brown and others, 1967) and need not be repeated here, but it may be worthwhile to indicate briefly some of the distinctive features of the segment south of Middle Mountain.

From the strip map, it is obvious that the fault south of Middle Mountain is a relatively continuous break and lacks the segmented character that it exhibits to the north. Historic records indicate other differences: for example, the southern segment has repeatedly been the site of moderate magnitude earthquakes, many of them accompanying fault displacement along the line of the active break. The segment north of Middle Mountain seems to have as many or more earthquakes, but relatively minor ones. Moreover, fault movement north of Middle Mountain appears to be relatively continuous, a form of tectonic creep, whereas fault movement south of Middle Mountain is spasmodic. Rates of movement are also different; for the past half century, the fault south of Middle Mountain shows a rate of movement about half of that to the north. These differences are discussed more fully by Brown and Wallace (1968), who also contrast this segment of the fault with the segment immediately to the south, between Cholame Valley and the southern end of the Carrizo Plain, which exhibits no evidence of movement in the past 40 years.

ANNOTATED BIBLIOGRAPHY

Allen, C. R., and Smith, S. W., 1966, Pre-earthquake and post-earthquake surficial displacements, *in* Parkfield earthquakes of June 27–29, 1966, Monterey and San Luis Obispo Counties, California—preliminary report: Seismol. Soc. America Bull., v. 56, no. 4, p. 966–967.
Cites what may have been fault activity just before the June 27, 1966, earthquake and gives evidence of earlier historic breaks along the same fault.

Brown, R. D., Jr., Vedder, J. G., Wallace, R. E., Roth, E. F., Yerkes, R. F., Castle, R. O., Waananen, A. O., Page, R. W., and Eaton, J. P., 1967, The Parkfield-Cholame, California, earthquakes of June-August 1966—Surface geologic effects, water-resources aspects, and preliminary seismic data: U.S. Geol. Survey Prof. Paper 579, 66 p.
Describes surface faulting, movement rates, engineering geology, and seismic activity along an active 23-mile segment of the San Andreas fault. Fault movements are related to a 5.5 magnitude earthquake and to its aftershocks of lower magnitude.

Brown, R. D., Jr., and Wallace, R. E., 1968, Current and historic fault movement along the San Andreas fault between Paicines and Camp Dix, California, *in* Conference on geologic problems of the San Andreas fault system: Stanford Univ. Pubs. Geol. Sci., v. 11, 374 p.
Between Paicines and Cholame rates of movement at the fault zone are determined from offset fences, and recent activity is shown by fresh breaks in pavement. South of Cholame the most recent break along the fault shows no evidence of movement for at least 40 years, although this break was active during the great Fort Tejon earthquake of 1857.

Brune, J. N., and Allen, C. R., 1967, A micro-earthquake survey of the San Andreas fault system in southern California: Seismol. Soc. America Bull., v. 57, no 2, p. 277–296.
Micro-earthquakes (magnitude less than 3) and ultramicro-earthquakes (magnitude between −1.5 and 0) recorded at several stations along the San Andreas fault indicate that the fault segment from Cholame south to Valyermo is relatively quiet now, although it was the site of the Fort Tejon earthquake of 1857. The frequency of micro-earthquakes correlates well with that of larger seismic events.

Burford, R. O., 1966, Strain analysis across the San Andreas fault and Coast Ranges of California: Acad. Sci. Fennicae Annales, Ser. A, III, Geologica-Geographica 90, p. 99–110.
Analysis of geodetic data along two strips approximately normal to the fault—one near Paicines on the north and the other near Cholame on the south—shows a dominant pattern of NE–SW crustal shortening. Locally, near the San Andreas fault, right-lateral strike slip at the fault results in a strain pattern characterized by N-S contraction and E-W extension.

Byerly, Perry, and Wilson, J. T., 1935, The central California earthquakes of May 16, 1933, and June 7, 1934: Seismol. Soc. America Bull., v. 25, no. 3, p. 223–246.
Describes two earthquakes about 18 minutes apart, near Parkfield on June 7, 1934. Contains a brief description by Graham B. Moody of en echelon fractures in a zone 2 miles long on Middle Mountain.

Crowell, J. C., 1962, Displacement along the San Andreas fault, California: Geol. Soc. America Spec. Paper 71, 61 p.
Review of previously described displacement along the fault and discussion of suggested displacements of hundreds of miles in southern California.

Dibblee, T. W., Jr., 1966, Evidence for cumulative offset on the San Andreas fault in central and northern California, *in* Bailey, E. H., ed., Geology of northern California: California Div. Mines and Geology Bull. 190, p. 375–384.
Describes offset geologic units and other criteria that substantiate right-lateral movement on the San Andreas fault. Maps show offset geologic units of several ages in the segment of the fault from the northern Gabilan Range to Cholame.

Fletcher, G. T., 1967, Post late Miocene displacement along the San Andreas fault zone, central California, *in* Guidebook, Gabilan Range and adjacent San Andreas fault: Am. Assoc. Petroleum Geologists—Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., Field Trip, October 1967, p. 74–80.
Correlation of rocks now in the vicinity of the Pinnacles with units far to the south in the Temblor Range suggests that there has been 160 miles of right-lateral movement on the San Andreas fault since late Miocene time.

Flynn, D. B., 1963, The San Benito-Waltham Canyon trough—possible oil province, *in* Guidebook to the geology of Salinas Valley and the San Andreas fault: Am. Assoc. Petroleum Geologists—Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., Ann. Spring Field Trip, 1963, p. 27–33.
Lists exploratory wells and indicates Tertiary paleogeographic relations, Hollister to Middle Mountain.

Gribi, E. A., Jr., 1963, *Bitterwater oil field, San Benito County, California, in Guidebook to the* geology of Salinas Valley and the San Andreas fault: Am. Assoc. Petroleum Geologists—Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., Ann. Spring Field Trip, 1963, p. 74–75.
Structure contour map and summary of data from an oil field bounded on the northeast by the San Andreas fault.

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Lists fossils from San Benito area and presents paleontologic evidence for offset of late Miocene molluscan provinces along the San Andreas fault.

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Chiefly concerned with earthquake damage and ground fractures north of the Gabilan Range, but contains numerous photographs and discussions of the fault trace from the northern Gabilan Range to Cholame. See particularly: Pajaro River to the north end of the Colorado Desert, v. 1, pt. 1, p. 38–47, by H. W. Fairbanks.

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Describes various kinds of evidence of tectonic creep along the Hayward fault zone.

Ross, D. C., 1969, Recently active breaks along the San Andreas fault between Tejon Pass and Cajon Pass, southern California: U.S. Geol. Survey Misc. Geol. Inv. Map I–553, scale 1:24,000.
Strip map of a part of the San Andreas fault.

Steinbrugge, K. V., and Zacher, E. G., 1960, Creep on the San Andreas fault [California]—Fault creep and property damage: Seismol. Soc. America Bull., v. 50, no. 3, p. 389–396.
Damage to a winery just north of the northern edge of this strip map is recognized as due to tectonic creep on the San Andreas fault.

Tocher, Don, 1960, Creep on the San Andreas fault [California]—Creep rate and related measurements at Vineyard, California: Seismol. Soc. America Bull., v. 50, no. 3, p. 396–404.
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Turner, F. E., 1963, The Mee Ranch area, Peachtree Valley, Monterey County, California, *in* Guidebook to the geology of Salinas Valley and the San Andreas fault: Am. Assoc. Petroleum Geologists—Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., Ann. Spring Field Trip, 1963, p. 35–37.
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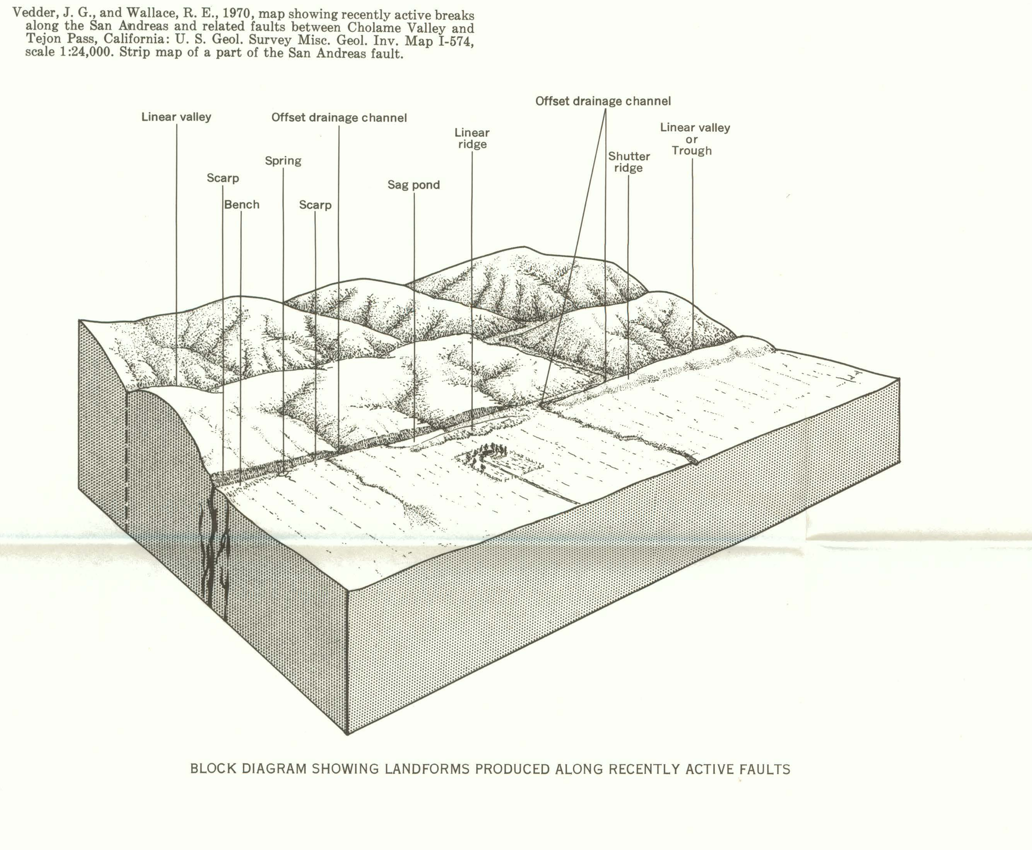

BLOCK DIAGRAM SHOWING LANDFORMS PRODUCED ALONG RECENTLY ACTIVE FAULTS

EXPLANATION

Fault breaks associated with 1966 fault movement

En echelon pattern, ground fractures arranged en echelon and exhibiting measurable right slip. Mapped June-August 1966 (Brown and others, 1967). Pattern is diagrammatic and exaggerates fracture zone width

Dots, ground fracturing was discontinuous or missing, or fault break was mapped on the basis of other evidence such as sand flows, boils, or fault-line topographic features

Interpreted fault breaks

Solid line, obvious photogeologic evidence of recent movement shown by scarp lines, trenches, sag ponds, spring lines, and vegetation contrasts

Dashed line, less obvious photogeologic evidence of recent movement, but very probably a fault break

Brief notes along fault breaks indicate locations where features mentioned are especially clear. Visible fault features are not limited to the locations noted, but are present to some degree all along the mapped fault lines

Fracture-controlled drainages

Short, unusually straight stream segments or gullies, in places bounded on one side by scarps that are relatively uneroded. Drainages and scarps are presumed to be tectonically controlled

Landslide

Enclosed by solid line where limit is well defined, by dashed line where limit is approximate or uncertain. Arrows show direction of movement

MAP SHOWING RECENTLY ACTIVE BREAKS ALONG THE SAN ANDREAS AND RELATED FAULTS BETWEEN THE NORTHERN GABILAN RANGE AND CHOLAME VALLEY, CALIFORNIA

By
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1970

Other recently active breaks that have not produced distinctive surficial features may be present

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