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The Rinconada fault in the southern Coast Ranges, California, and its significance (Preliminary expanded abstract)

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Introduction

This expanded abstract, together with its illustrations, was prepared at the request of the AAPG (Pacific Section) for the convenience of the convention audience. It is based in large part on the author's geologic mapping which has been placed on open file by the U.S. Geological Survey (Dibblee, 1967; 1971), and in part on published geologic mapping by Vedder and others (1967) and Vedder and Brown (1968).

A more comprehensive manuscript is in preparation for publication, in which a more detailed discussion will be presented pertinent to the Rinconada and Reliz faults.

Location

The position of the Rinconada fault as herein recognized within the southern Coast Ranges, and with respect to the San Andreas and other major faults, is shown on figure 1. This illustration also shows its location relative to the Salinia block, which has a crystalline basement complex of plutonic and metamorphic rocks, and to the unnamed block to the west herein referred to as the "Coastal block," which has an eugeosynclinal basement complex of Franciscan rocks.

Physiographic features, major faults, and towns of the area within that of figure 1 are shown on figure 2. Southeast of Santa Margarita the Rinconada fault is within a mountainous terrain; but to the northwest the hills and mountains that bound the Salinas Valley on the southwest are uplifted along it.

Nomenclature and definition

The nomenclature of the major faults shown on published geologic maps within the area of figures 1 and 2 is as shown on figure 3a. From extensive geologic mapping I have found that some faults given local names are continuous into each other. As a result, the complex nomenclature can be much simplified to that indicated on figure 3b.

The Rinconada fault has not been defined but is depicted on the Geologic Map of California (Jennings, 1959) as extending for about 25 miles in the vicinity of Santa Margarita toward Paso Robles (fig. 3a). Geologic mapping indicates that this fault is continuous southeastward into the fault referred to as the Nacimiento fault, and northwestward into faults called San Marcos, Espinosa, San Antonio and Jolon (in part) faults (fig. 3a), for a total distance of 160 miles (fig. 3b). All but the Jolon and San Antonio faults are aligned and continuous, so that these named segments, including those called Rinconada and Nacimiento (fig. 3a) are parts of a single major fault. Accordingly, in order to simplify the nomenclature, it is proposed to apply only a single name, Rinconada, to this major fault. The local names shown on figure 3a are retained for its segments, but the major fault as a whole is designated as the Rinconada fault (fig. 3b).

The Rinconada fault is in most places a high-angle fault that extends from its intersection with the Big Pine fault in the San Rafael Mountains northwestward for some 160 miles to a point 7 miles west of King City, where its surface trace dies out (figs. 2 and 3b). In places the fault dips at moderate or even low angles. Relative vertical displacements are controversial, inconsistent, reversed from one segment to another; the major movement may be strike-slip, as on the San Andreas fault.

The northwest end of the Rinconada fault is separated by a 2-mile gap from the Reliz fault, which is aligned to the northwest and which must extend about 30 miles along the base of the steep northeast front of Sierra de Salinas of the northern Santa Lucia Mountains, then dies out to the northwest.

The Rinconada and Reliz faults together form a zone some 190 miles long, nearly parallel to the San Andreas fault. This parallelism together with evidence of right-lateral movements indicate that this zone is part of the San Andreas fault system.

Geologic setting and stratigraphy

The geologic setting of the Rinconada and Reliz faults is shown on figure 4, in relation to major rock units. Southeast of Santa Margarita the Rinconada fault (the segment generally called Nacimiento fault) follows the border between the Salinia and Coastal blocks (fig. 1). The Nacimiento fault of Taliaferro (in Jennings, 1959) (figs. 3b, 4), near the Nacimiento River, does not join the Rinconada fault, and since middle Tertiary time may be unrelated to it.

The stratigraphic units of the Salinia block within the area of figures 1 to 4 are as shown on table 1, and of the Coastal block on table 2. The Paso Robles Formation is very widespread on the Salinia block but is restricted to a very small area near Santa Margarita on the Coastal block. The nonmarine Morales and Quatal Formations are present only in Cuyama Valley and Carrizo Plain. The Santa Margarita Formation and Branch Canyon Sandstone are the southeastern sandy equivalents of the siliceous Monterey Shale of areas to the west and northwest.

Geology of vicinity of the Rinconada fault

The geology along and near the Rinconada and Reliz faults is shown on figures 5, 6, 7, 8, 9 and 10. Both faults are nearly vertical but locally dip in either direction. On the Reliz fault (figs. 4, 10) the southwest block is elevated to form the Sierra de Salinas mountain block. However on the Rinconada fault, vertical displacements vary in magnitude and in relative movement from segment to segment. They are difficult to measure because the stratigraphy is different on the opposite blocks as shown on figures 5 to 8. This condition suggests that the terrain on opposite sides was juxtaposed along this fault from areas once far apart, thus suggesting transcurrent movement.

The structural pattern as shown on all six figures is similar, that is, the axes of folds in the sedimentary rocks consistently trend more east-west than do both the Rinconada and Reliz faults. This pattern combined with the intensity of folding along and near these faults, suggests right lateral (dextral) transcurrent movement, as on the San Andreas. These folds appear to be drag features formed in large part by right-lateral movement at depth in the underlying basement rocks.

Thrust or reverse faults of Quaternary age are associated with the Rinconada fault along much of its course on one or both sides, within 9 miles, especially in areas of intense folding. In the northern part several, including the San Antonio fault, are present along both margins of the range of hills between the Salinas and Lockwood Valleys (figs. 8 and 9) along which this range was elevated in part. Near the southern part are the major southwest-dipping South Cuyama and Ozena faults along which the Sierra Madre Range was elevated against Cuyama Valley (figs. 5 and 6), with vertical displacements possibly up to 8,000 feet. All these thrust or reverse faults dip inward toward the Rinconada fault and presumably either splay from it at depth, or are branches of it. These faults, combined with the intense folding between them, indicate that severe compression accompanied possible transcurrent movement along the Rinconada fault.

The La Panza fault along which the La Panza Range was elevated (fig. 6) in Quaternary time, is a reverse fault that dips northeast under the range, and is not directly related to the Rinconada fault.

The Big Pine fault against which the Rinconada fault abuts (fig. 5) is a high-angle left-lateral transcurrent fault active in Quaternary time (Hill and Dibblee, 1953). The Pine Mountain fault south of it (figs. 4, 5) is a northeast-dipping reverse fault along which the Pine Mountain Range was elevated in Quaternary time. This fault may have been reactivated along an earlier fault that may have been continuous with the Rinconada fault, but displaced about 8 miles from it by left slip on the Big Pine fault (Vedder and Brown, 1968) in Quaternary time.

The Rinconada and Reliz faults were active after deposition of the Monterey Shale and Pancho Rico formations, which are severely deformed adjacent and near the faults. The faults were again active after deposition of the Paso Robles Formation but to a lesser degree (figs. 7, 8, 9, and 10). These faults do not affect the alluvium or terrace deposits. There are no offset stream-channels along these faults. However in two areas several canyons and streams are deviated, possibly by right-lateral movement on the Rinconada fault, as shown on figures 11 and 12. There are no indications that these faults are presently active.

Evidence of large strike-slip movement

Along the southern part of the Rinconada fault (Nacimiento segment) strike-slip (transcurrent) movement is difficult to recognize because the stratigraphy on opposite sides is different and there is nothing that can be matched across the fault. Vedder and Brown (1968) suspected such movement but found no evidence for it.

In the northern part, the configuration of the buried surface of the crystalline basement complex, based on surface geology supplemented by well data, as shown on figure 13 suggests possible large strike-slip displacement. The buried basement "high" east of Jolon on the west side of the Rinconada fault may have been displaced right laterally from the exposed basement high east of the fault near Paso Robles about 22 miles southeast, if these basement highs were once a single mass. Similarly, the Arroyo Seco trough west of King City and west of the Rinconada-Reliz fault zone may have displaced from the trough east of this fault zone and south of San Ardo about 25 miles southeast, if these troughs were once continuous. The time of this displacement is not known, but presumably it is post-Miocene.

Possible large strike-slip displacement on the Rinconada fault since deposition of the Santa Margarita and Pancho Rico Formation is suggested by the upper Miocene and lower Pliocene stratigraphic relations across this fault in and west of southern Salinas Valley, as shown on figure 14, and as pointed out earlier by Durham (1965). The subsurface distribution of the Santa Margarita and Pancho Rico Formations is based on well data. The northern limit of the Santa Margarita sandstone, or where this sandstone grades laterally or intertongues into the Monterey Shale, is about 11 miles farther north on the west side of the fault. Similarly, the southern limit of the Pancho Rico Formation .(diatomaceous shale or mudstone) is about 11 miles farther south on the east side of the fault, suggesting about that much right-lateral displacement on that segment of the Rinconada fault since early Pliocene time. Much of this movement happened during late Pliocene time, before deposition of the Paso Robles Formation.

Evidence of even larger strike-slip displacement on the Rinconada fault since early Tertiary time is suggested by the stratigraphy and structure of pre-Oligocene rocks on opposite sides of the major part of this fault. Figure 15 shows rock units that are present below the middle and upper Cenozoic sedimentary blanket on the Salinia block. Significantly, this brings out the fact that the very thick upper Cretaceous and lower Tertiary marine sedimentary sequence which rests unconformably on the crystalline basement complex, its basal conglomerate, and its major synclinal structure, all of which I recognized on each side of the Rinconada fault, appear to be displaced about 40 miles in a right-lateral sense, if once continuous. Therefore a right-lateral displacement of some 40 miles on the Rinconada-Reliz fault zone since early Tertiary time is suggested, if not indicated, by this condition. Much of this happened presumably in Oligocene time, before deposition of the middle Tertiary sedimentary sequence.

Tectonic problems

If the interpretations of movements on the Rinconada-Reliz fault zone presented herein are correct, then this fault zone is a major one, 190 miles long, active in Oligocene, Pliocene, and late Quaternary times and possibly in between, with many miles of cumulative strike-slip movement. If this is so, why is it not presently active? Why is there a gap between the Rinconada and Reliz faults? Why does this fault zone die out at the northeast base of the northern Santa Lucia Mountains? What is the relationship of this fault zone to the Sur-Nacimiento fault zone in time and movements, and what is the relationship of the Rinconada-Reliz fault zone to the mountain ranges to the west and to the valley areas such as Salinas and Cuyama Valleys to the east? Answers to these and other tectonic problems within this area will be attempted in the report in preparation.

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TABLE 1. ROCK UNITS OF THE SALINIA BLOCK

Sequence	Formation	Lithology & thickness	Age	
Surficial deposits*	Alluvium and older alluvium	0-300 ft.	Holocene and upper Pleistocene	? QUATERNARY
Valley sediments*	Paso Robles Formation	terrestrial gravel, sand, clay 0-3000 ft.	Pleistocene and Pliocene	? QUATERNARY
Upper Tertiary sedimentary sequence	Morales Formation[x]	terrestrial gravel, sand, clay 0-5000 ft.	Pliocene	TERTIARY
	Quatal Formation[x]	terrestrial clay, sand 0-1000 ft.	Pliocene	TERTIARY
	Unnamed sandstone[x]	marine 0-700 ft.	lower Pliocene	TERTIARY
	Pancho Rico Formation[x]	marine mudstone diatomite sandstone 0-2000 ft.	lower Pliocene	TERTIARY
Middle Tertiary sedimentary sequence*	Santa Margarita Formation	marine sandstone 0-2000 ft	upper Miocene	TERTIARY
	Monterey Shale	marine siliceous shale 0-7000 ft.	upper middle (& lower[δ]) Miocene	TERTIARY
	Branch Canyon Sandstone[†]	marine 0-3000 ft.	middle Miocene	TERTIARY
	Basalt	flows, dikes	middle Miocene	TERTIARY
	Vaqueros Formation	marine sandstone & shale 0-7000 ft.	lower Miocene & upper Oligocene	TERTIARY

TABLE 1 continued

	Simmler & Berry Formations	terrestrial strata 0-3000 ft.	Oligocene	
Upper Cretaceous and lower Tertiary marine sedimentary sequence*	Unnamed sandstone, shale and conglomerate	(marine) 25,000 ft.	Eocene, Paleocene and Upper Cretaceous	CRETACEOUS AND TERTIARY
Crystaline basement complex	Plutonic rocks	granite to diorite & gabbro mainly granodiorite	Cretaceous	MESOZOIC
	Metamorphic rocks	marble quartzite schist gneiss	Mesozoic or older	

* Regional unconformity at base
x Unconformity at base along basin margins
† Intertongued with Monterey Shale
δ Only lowest part in few places of this age

TABLE 2. ROCK UNITS OF THE COASTAL BLOCK

Sequence	Formation	Lithology & thickness	Age	
Surficial sediments*	Alluvium and older alluvium	0-150 ft.	Holocene and upper Pleistocene	QUATERNARY
Valley sediments*	Paso Robles Formation	terrestrial gravel 0-1200ft.	Pleistocene and Pliocene?	?
Middle Tertiary sedimentary sequence*	Santa Margarita Formation	marine sandstone 600-5000 ft.	upper Miocene	TERTIARY
	Monterey Shale	marine siliceous shale 600-5000 ft.	upper and middle Miocene	
	Volcanic rocks	tuff, basalt 0-2000 ft.	lower Miocene	
	Vaqueros Formation	marine sandstn. 0-3200 ft.		
	Red beds, conglomerate	terrestrial 0-600 ft.	Oligocene	
Cretaceous (and Upper Jurassic?)† marine sedimentary sequence	Sandstone, shale conglomerate	marine 10,000±ft.	Upper Cretaceous	CRETACEOUS
	Shale sandstone	marine 0-3000 ft.	Lower Cretaceous (& Upper Jurassic†)	?
Franciscan basement complex	Franciscan rocks‡	basalt, chert	Cretaceous and Upper Jurassic	JURASSIC ?
		graywacke, shale, chert greenstone		

* Regional unconformity at base
‡ Injected by serpentine, mafic rocks
† Ages in parentheses apply to only very small part of unit and only local

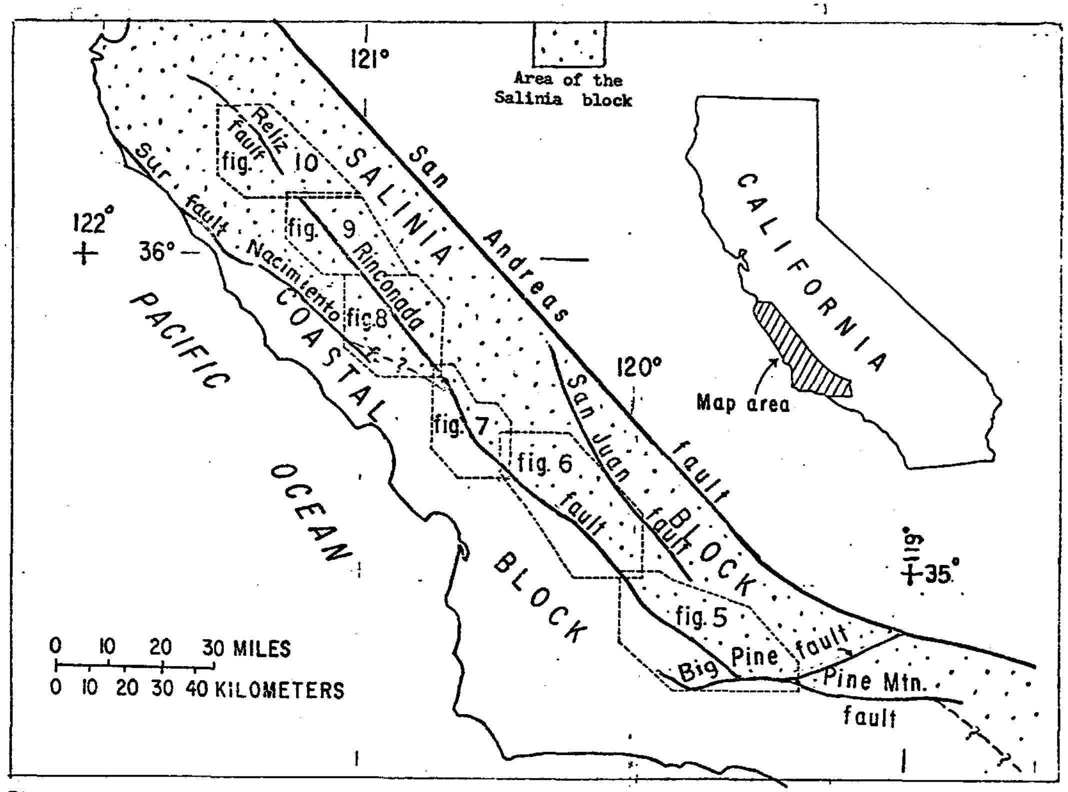

Figure 1. Index map showing positions of the Rinconada and Reliz faults relative to the Salinia block and the San Andreas fault. Dashed outlines indicate locations of areas of figures 5 to 10 that show geology along Rinconada and Reliz faults.

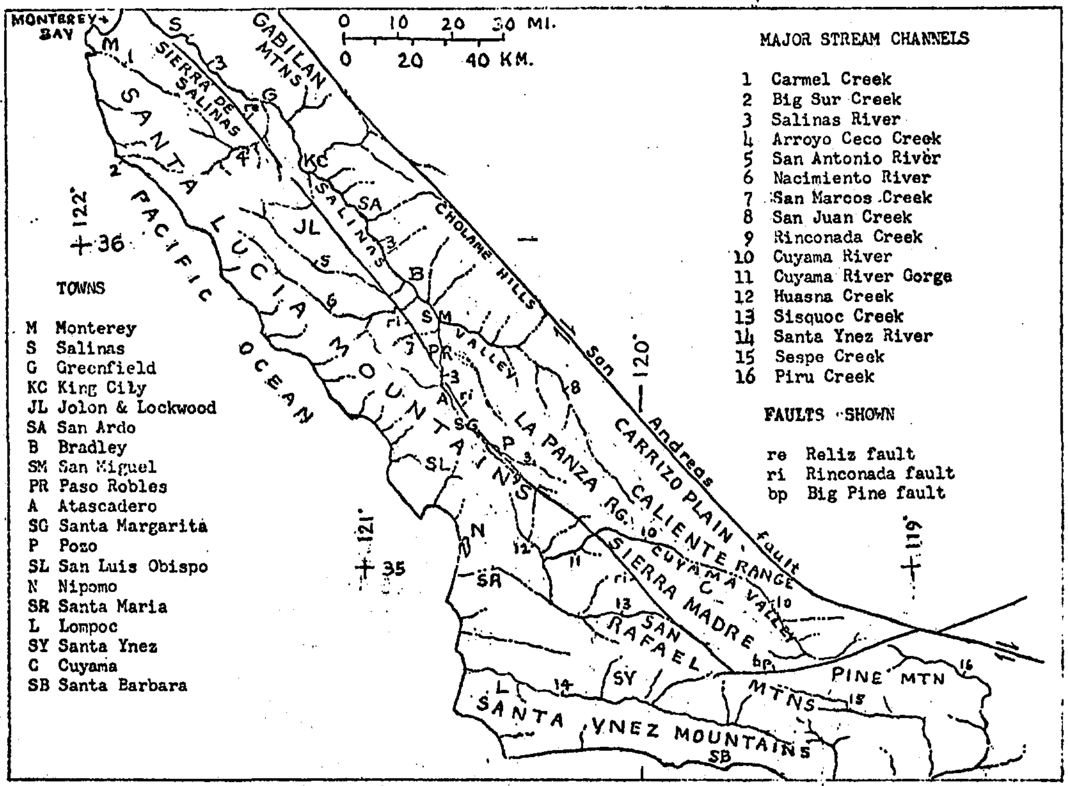

Figure 2, Physiographic features and drainage along and near the Rinconada and Reliz faults

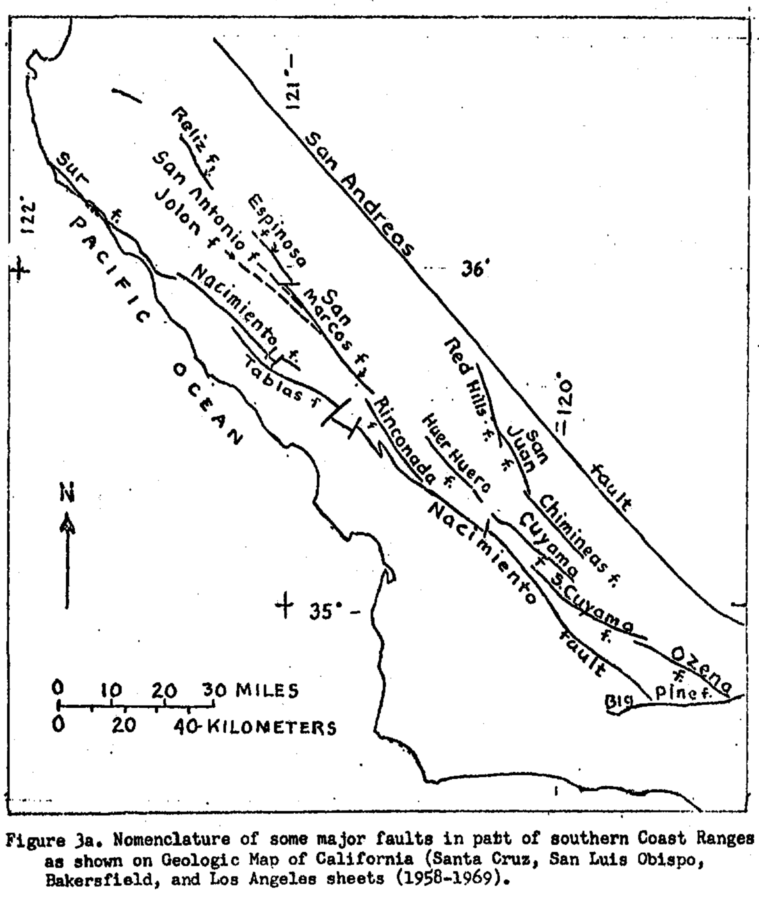

Figure 3a. Nomenclature of some major faults in part of southern Coast Ranges as shown on Geologic Map of California (Santa Cruz, San Luis Obispo, Bakersfield, and Los Angeles sheets (1958-1969).

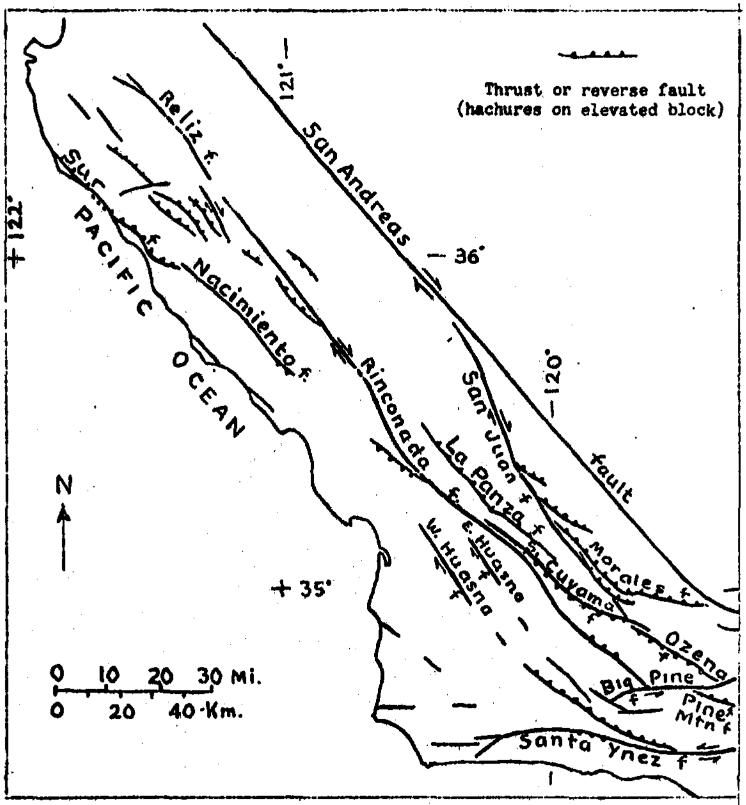

Figure 3b. Major faults recognized, and nomenclature proposed.

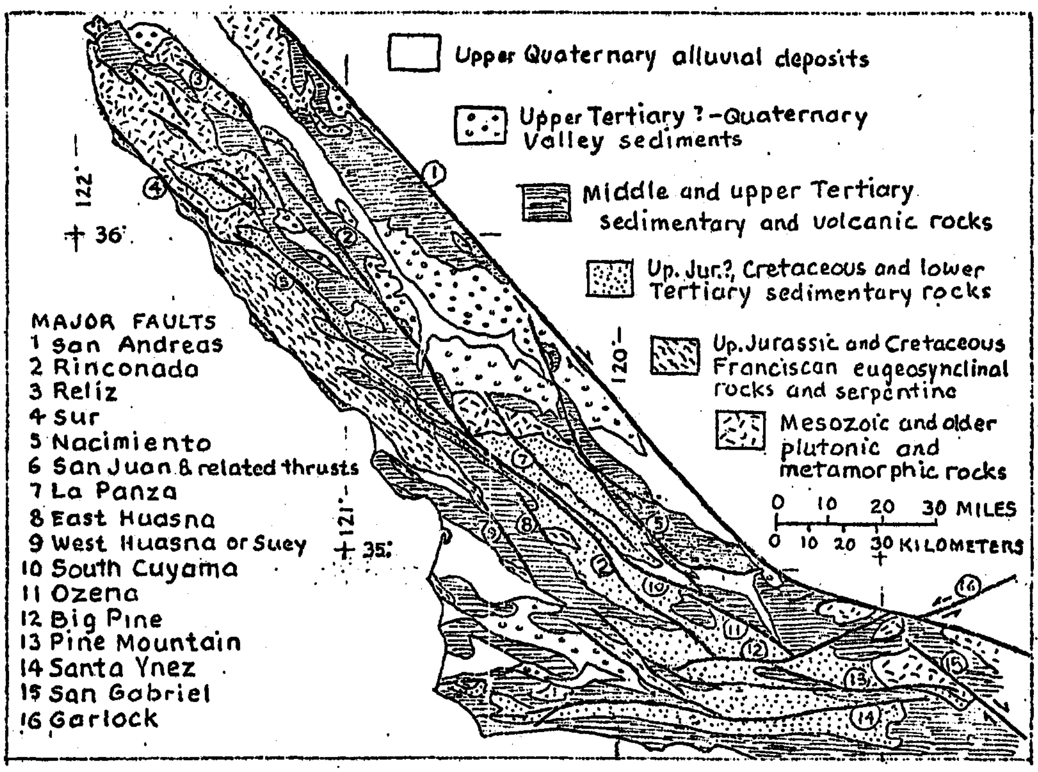

Figure 4. Simplified regional geology along and near the Rinconada and Reliz faults.

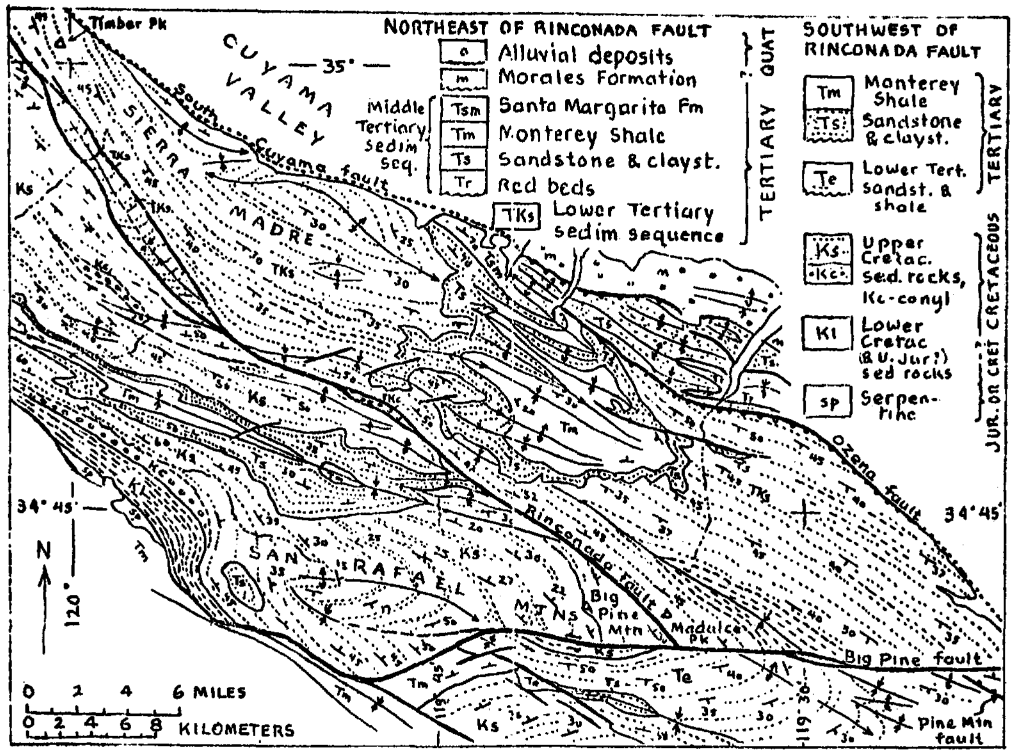

Figure 5. Geology along and near the Rinconada fault (Nacimiento segment) from Big Pine Mountain to Timber Peak (Modified after Vedder and Brown, 1968).

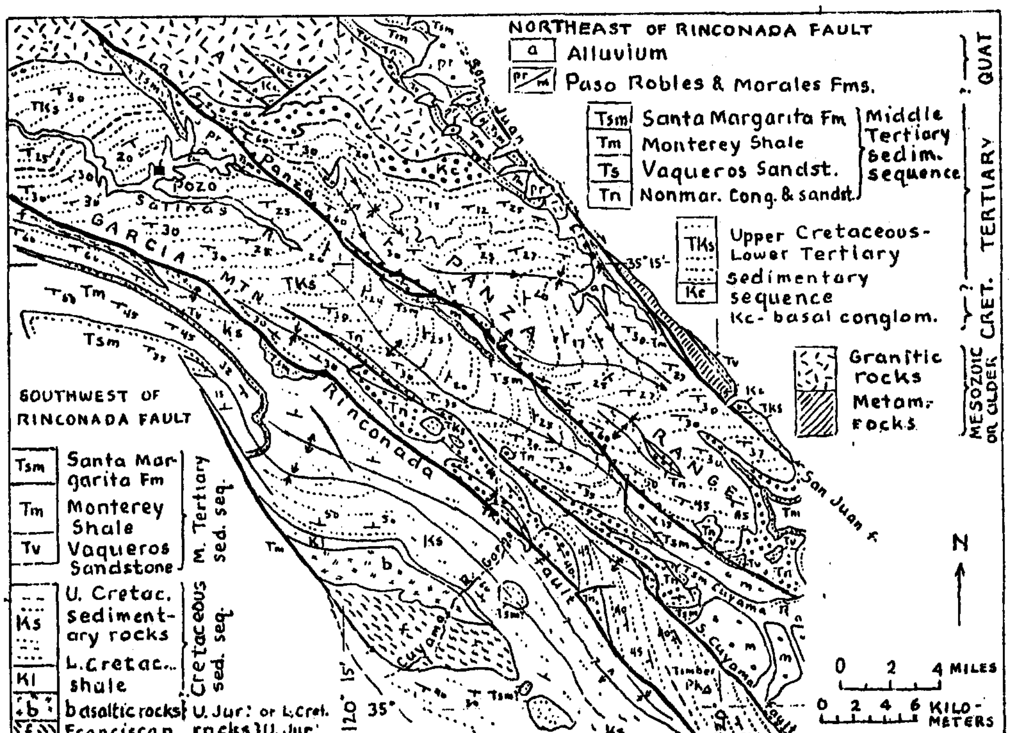

Figure 6, Geology along and near the Rinconada fault (Nacimiento segment) from Timber Peak to Pozo (modified after Vedder and Brown, 1968).

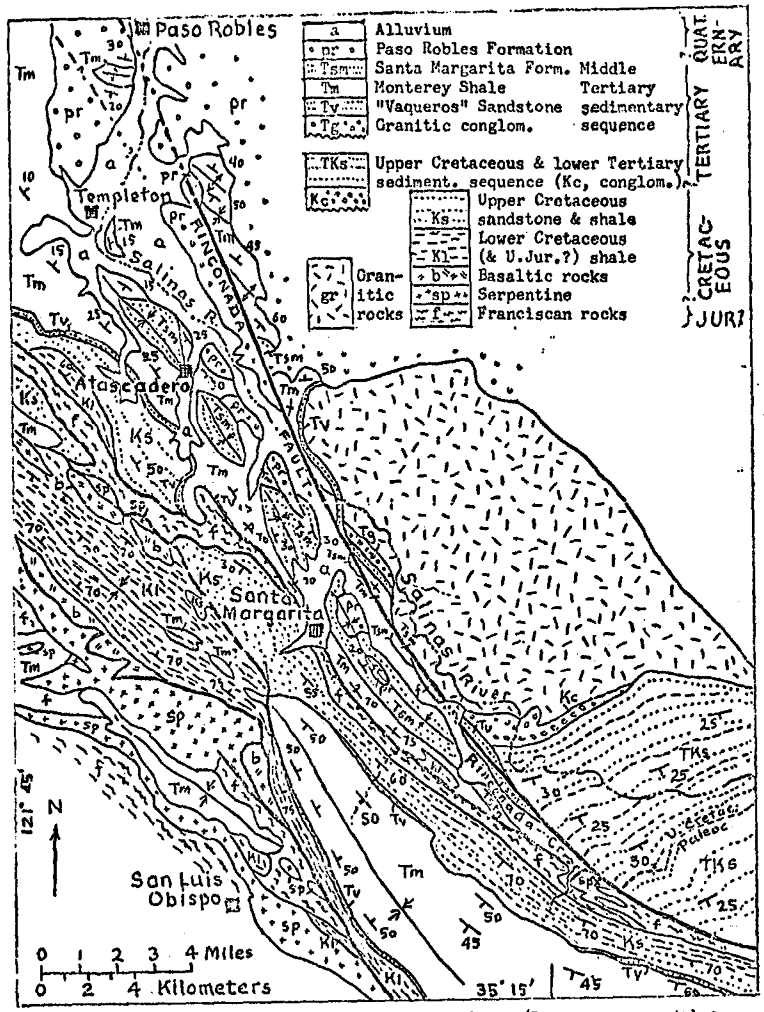

Figure 7. Geology along and near the Rinconada fault (Rinconada segment) from Rinconada Creek to Paso Robles

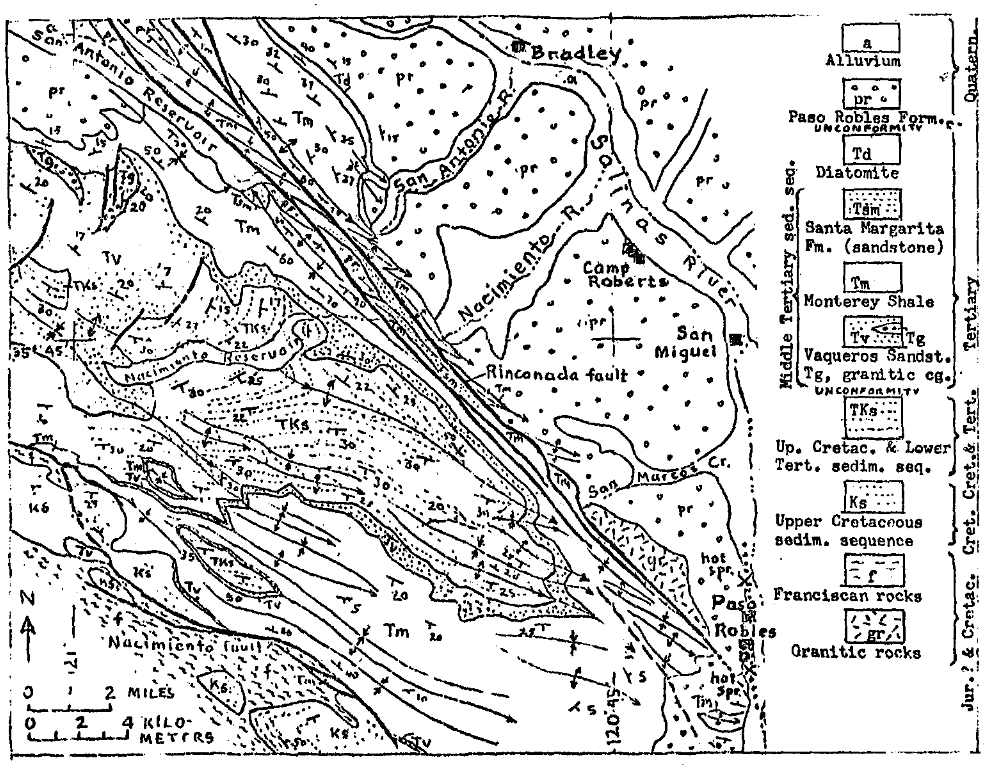

Figure 8. Geology along and near the Rinconada fault (San Marcos segment) from Paso Robles to San Antonio Reservoir.

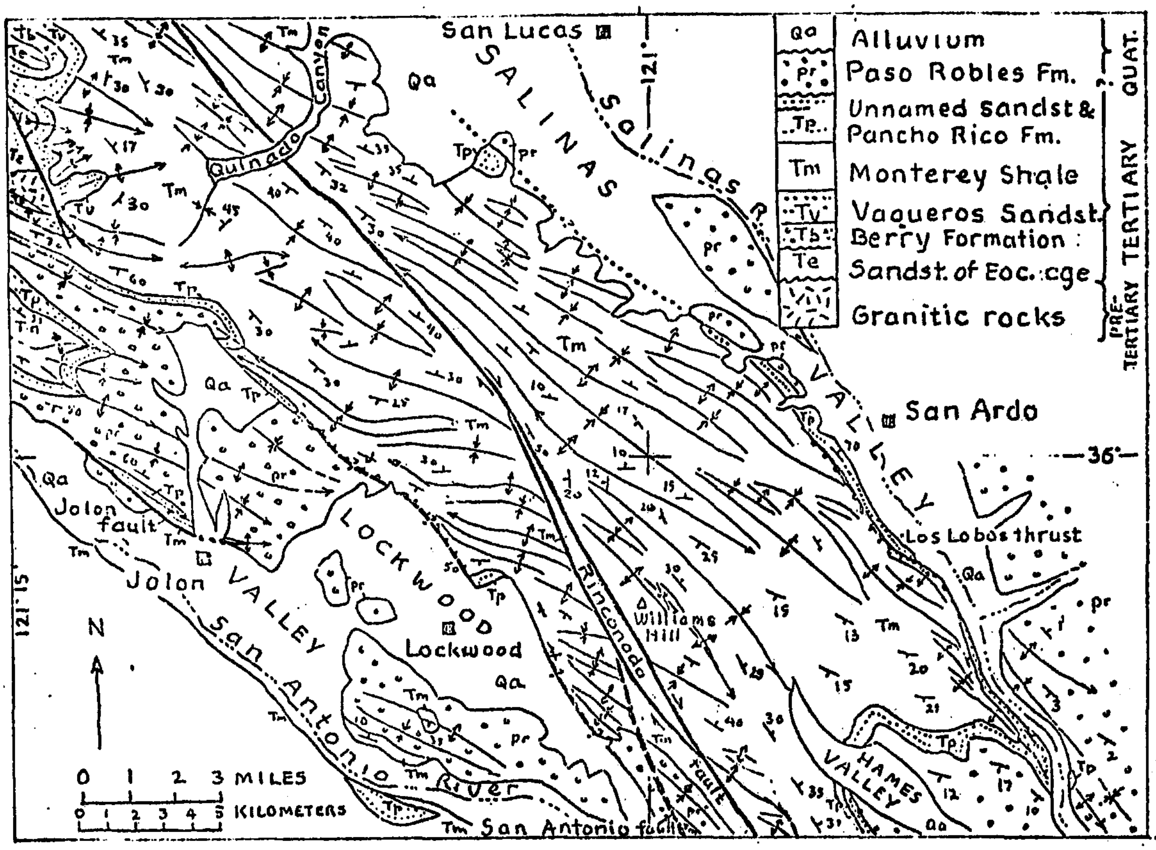

Figure 9. Geology along and near the Rinconada fault (Espinosa segment) between San Ardo and Lockwood.

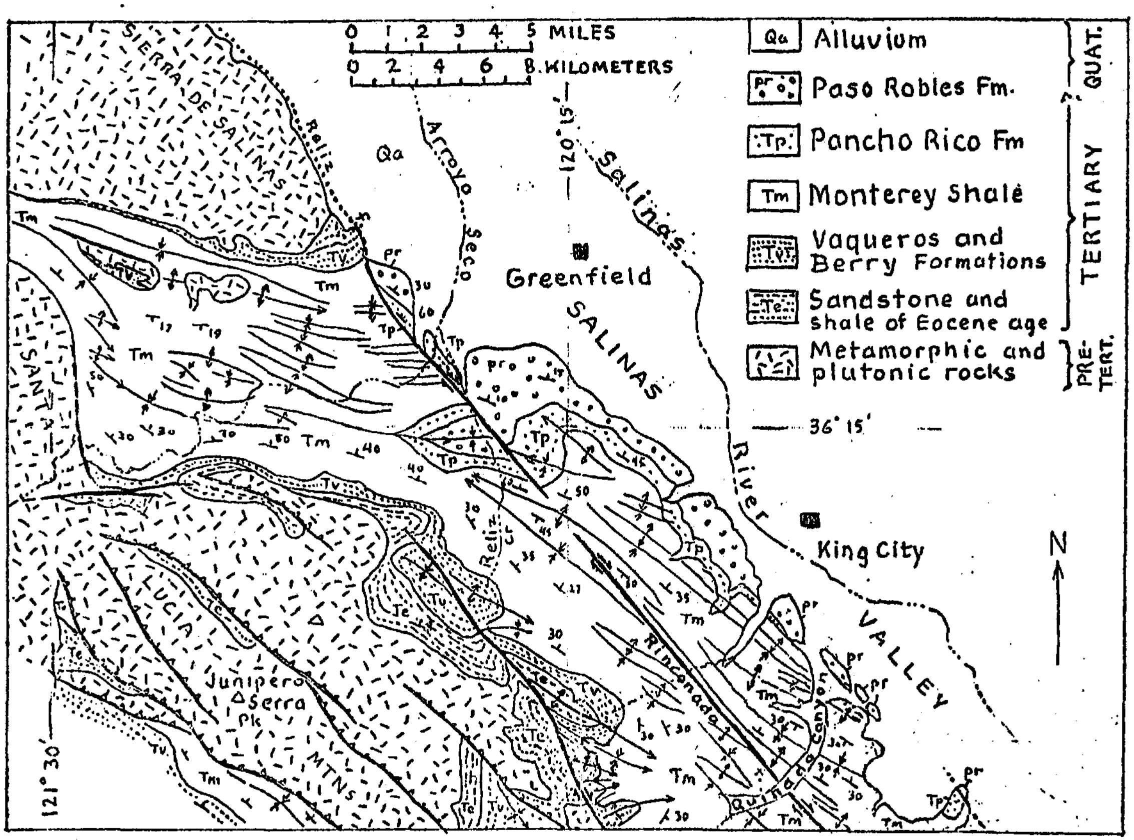

Figure 10. Geology along and near the Rinconada fault (Espinosa segment) and Reliz fault near King city and Greenfield.

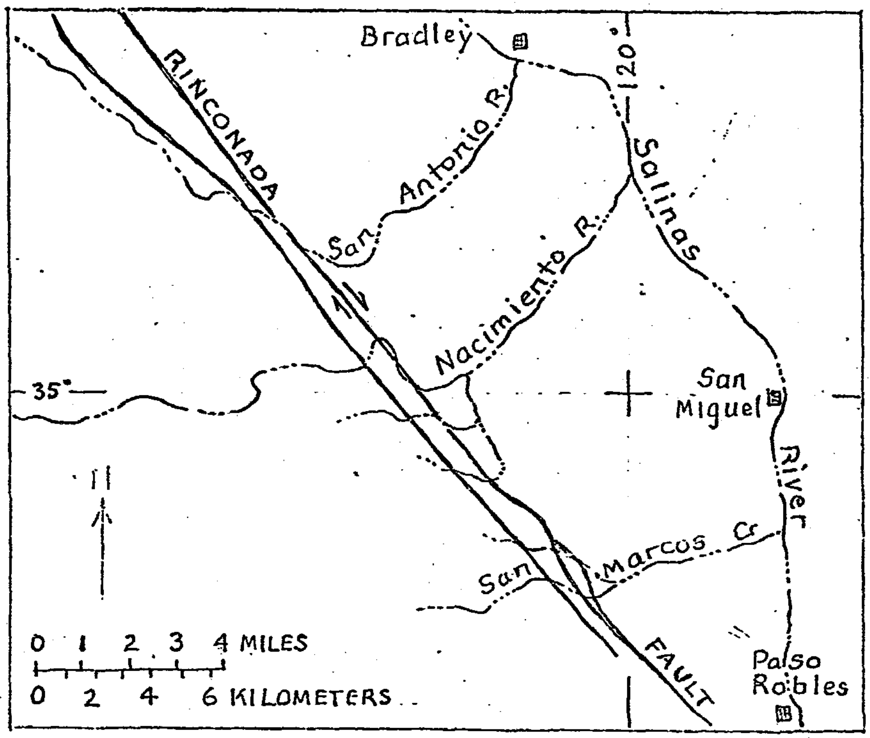

Figure 11. Stream-channels deflected possibly by right lateral movement of the Rinconada fault (San Marcos segment) northwest of Paso Robles.

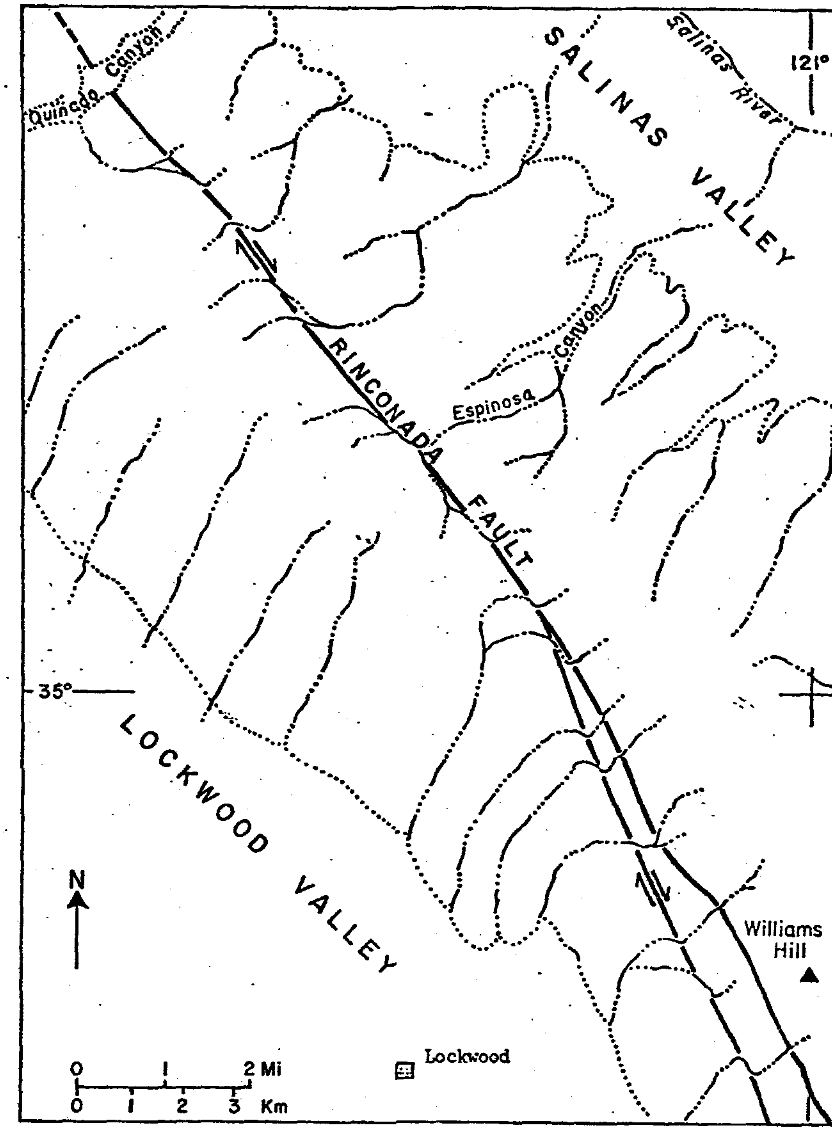

Figure 12. Stream-channels deflected possibly by right lateral movement of the Rinconada fault (Espinosa segment) near Lockwood.

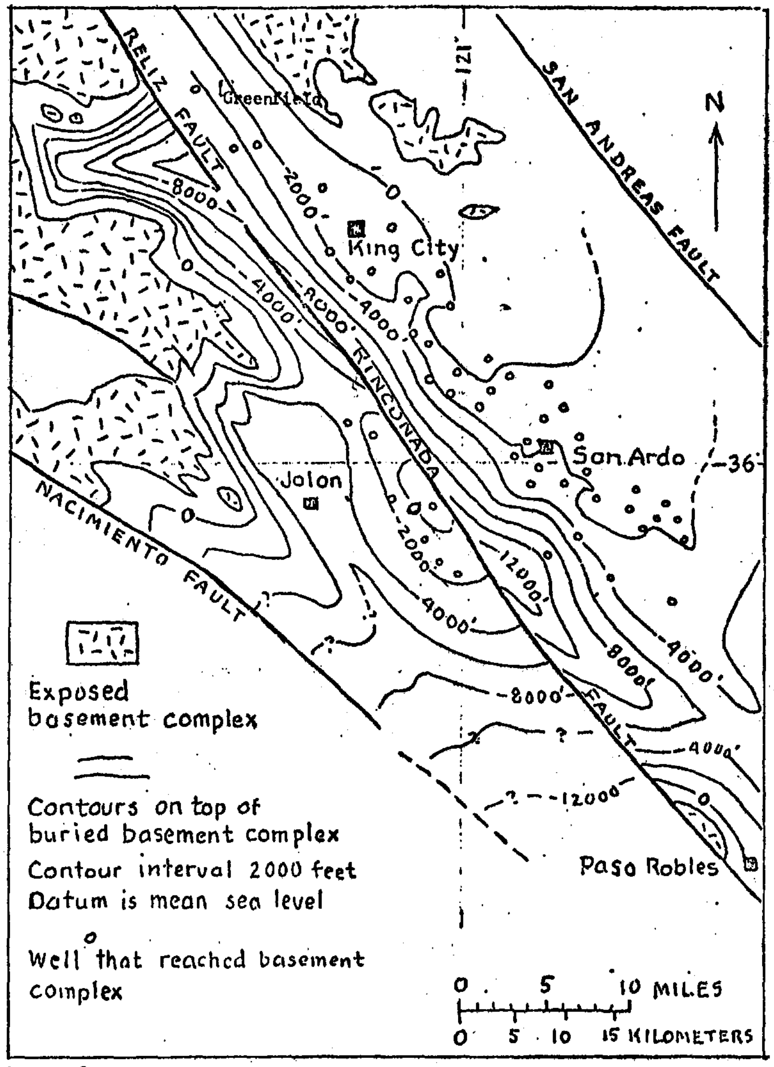

Figure 13. Probable configuration of buried surface of crystalline basement complex alon Rinconada and Reliz faults form Paso Robles to Greenfield. (Modified after Gribi, 1963).

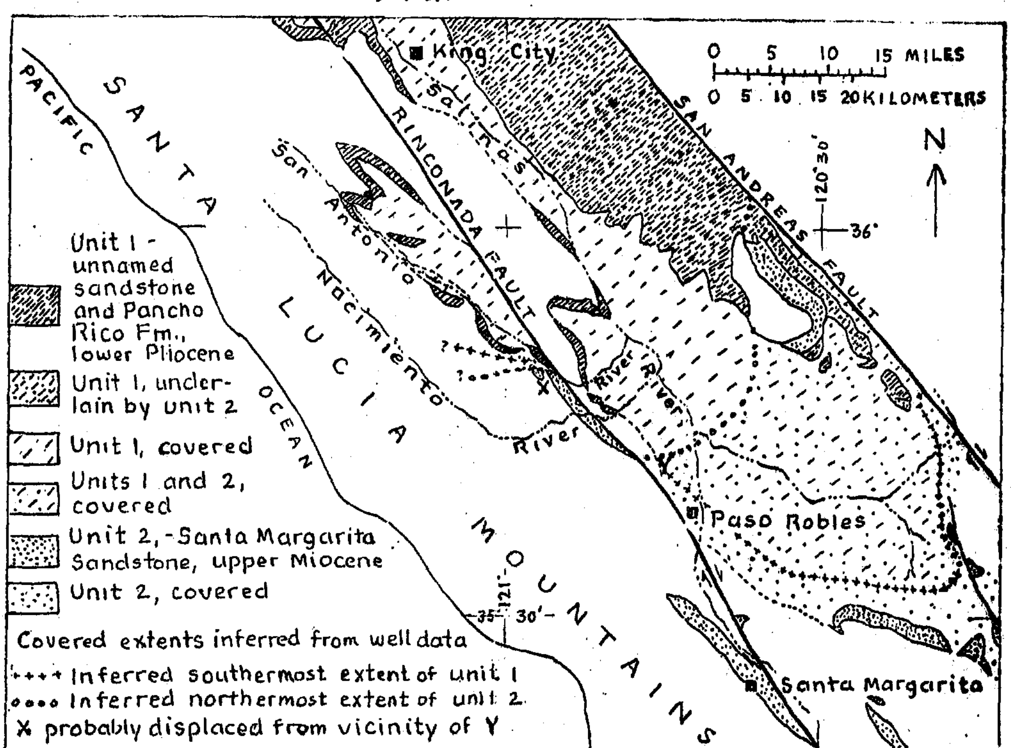

Figure 14. Probable displacement of upper Miocene and lower Pliocene stratigraphic units by right lateral strike-slip movement on the Rinconada fault (in part modified from Durham, 1965).

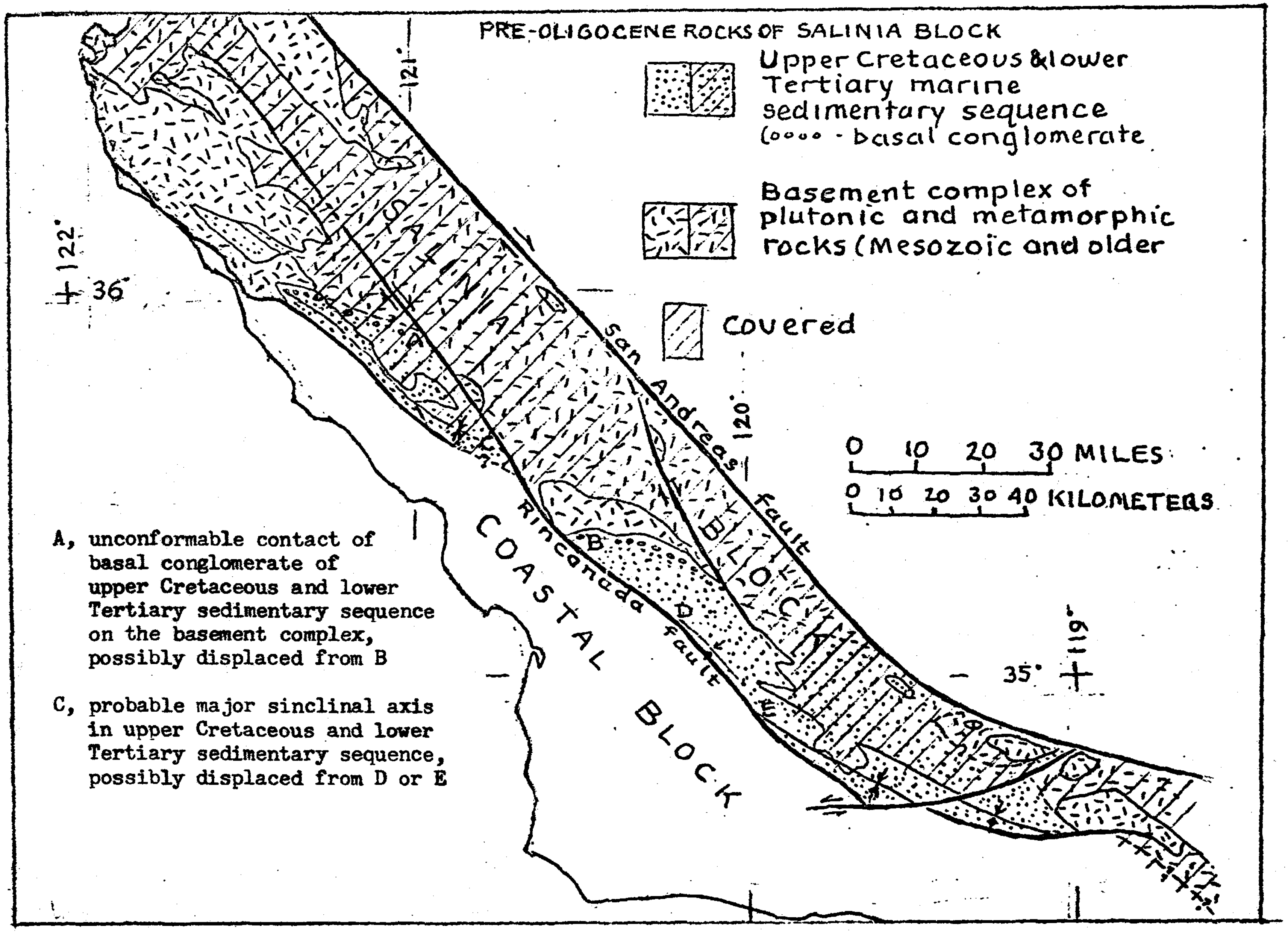

Figure 15. Pre-Oligocene rocks of Salinia block, probably displaced by right lateral transcurrent movement on Rinconada fault