EVIDENCE OF FAULTING ALONG A PROJECTION OF THE SAN ANDREAS FAULT, SOUTH OF THE SALTON SEA

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INTRODUCTION

The San Andreas fault has been extensively mapped and well documented as far south as Durmid Hill just east of the Salton Sea (Allen, 1957; Proctor, 1968; Babcock, 1974; Norris and others, 1979). In the Durmid Hill area (Figure 1) the San Andreas fault has displaced Salt Creek by 850 meters right-laterally since deposition of the Pleistocene Borrego Formation, and it exhibits vertical separation of as much as 1,120 meters (Babcock, 1974). Beyond this locality there is much uncertainty as to the nature and location of the San Andreas fault. Kovach and others (1962) have stated that the San Andreas fault zone more likely enters the Gulf of California as a series of *en echelon* breaks rather than as a single curving feature. Elders and

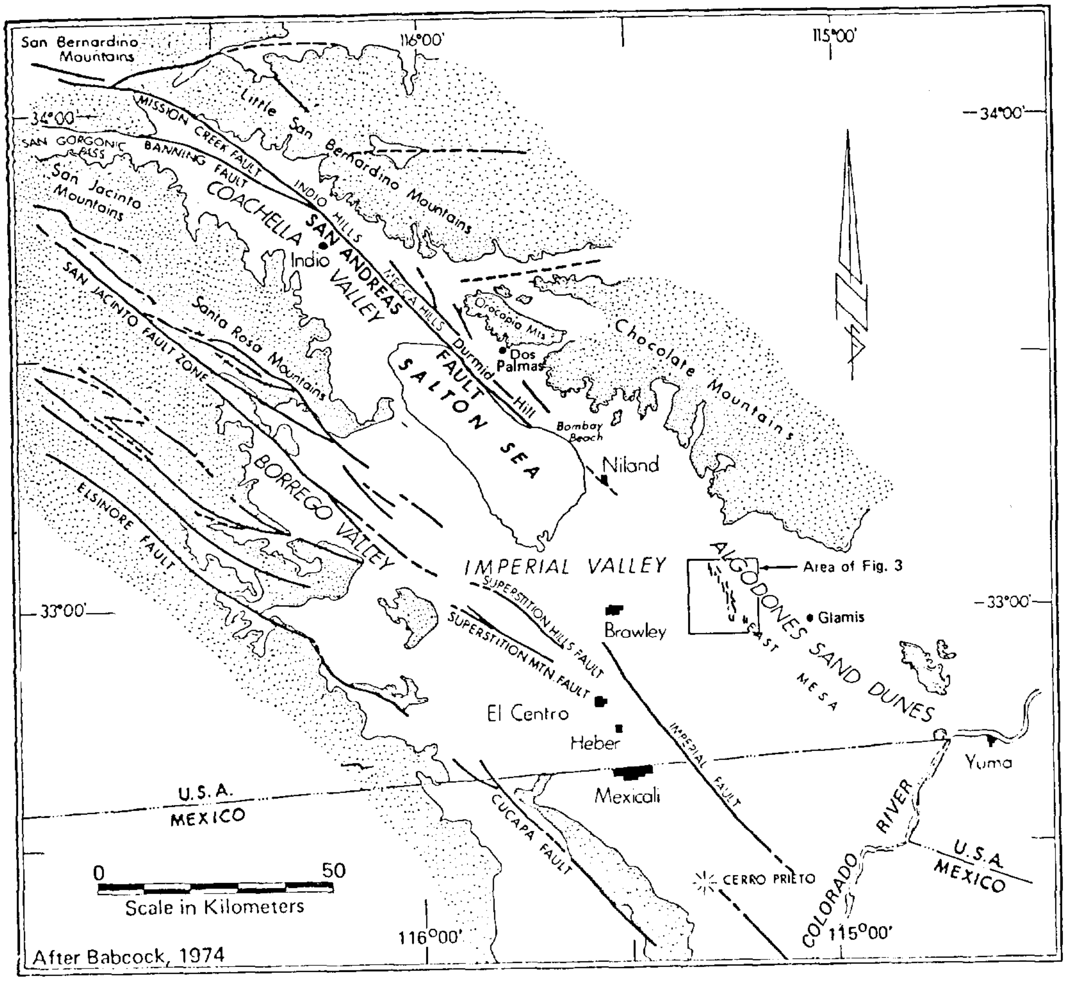

Figure 1. Index map of the Salton Trough, California. Mapped lineaments are shown on East Mesa about 25 kilometers east of Brawley.

and others (1972) have elaborated upon this concept by relating rifting in the Salton Trough to crustal spreading and to right-stepping transform faults and have postulated that the San Andreas fault zone ends at a spreading center south of the Salton Sea. Farther south, right-stepping en echelon transform faults and left-stepping spreading centers extend the length of the Gulf of California. Another widely held theory is that the San Andreas fault zone continues along the eastern margin of the Imperial Valley to the southwest corner of Arizona and into Mexico. This projection would tie the inferred Sand Hills fault to the Algodones fault zone, and thus both would be included as members of the San Andreas fault zone (Olmstead and others, 1973; van de Kamp, 1973; Merriam, 1968).

The problem with accepting any one of these theories has been the lack of strong surface or subsurface evidence for the location of suspected fault traces south of the Salton Sea.

Evidence of recency of faulting in the area of the Salton Sea has been suggested by several authors. Babcock (1971) has reported evidence of an offset on an irrigation ditch that he attributed to creep occurring on the San Andreas fault approximately 6 km south of Niland (Figure 1). Buckley and others (1977) have reported a zone of numerous fractures along the northeastern margin of the Salton Trough near Dos Palmas. These fractures trend northwest for a distance of 4 km and lie 7 km northeast of the San Andreas fault and thus appear to be more directly related to the trough margin than to the San Andreas fault. The fractures exhibit greater offset on a road built in 1942 than on a road graded in 1972 and are believed to be caused by a slow, continuing process of aseismic tensional creep (Buckley and others, 1977). Norris and others (1979) have reported a late Pleistocene to Holocene fan that has been offset by the Mission Creek fault near its intersection with the Banning fault north of Indio. They have reported that the modern fan is partially offset about 200 m, indicating Holocene movement, and that the minimum displacement on the whole fan complex is 900 meters (right-lateral).

SEARCH FOR EVIDENCE OF ADDITIONAL FAULTING

As part of a power plant siting study in southeastern Imperial Valley, an investigation was made of possible southern projections of the San Andreas fault zone and for possible other faults along the northeastern margin of the Salton Trough. Initially this investigation consisted of stereoscopic examination of true-color vertical aerial photographs, at the scale of 1:30,000, of East Mesa and the Algodones Sand Dunes areas. A number of faint, narrow, slightly sinuous lineaments lying west of the sand dunes were identified and were recognized to be possibly fault related (Figure 2). The lineaments are unique to the terrain because they trend north-south in a direction oblique to the more general northwest-southeast trend of longitudinal sand ridges characteristic of East Mesa. They are commonly expressed by thin vegetation contrasts and typically follow the eastern edges of small, interdune playas (Figure 2). The overall pattern of these generally north-south lineaments is en echelon and left-stepping to the northwest, as shown in Figure 3.

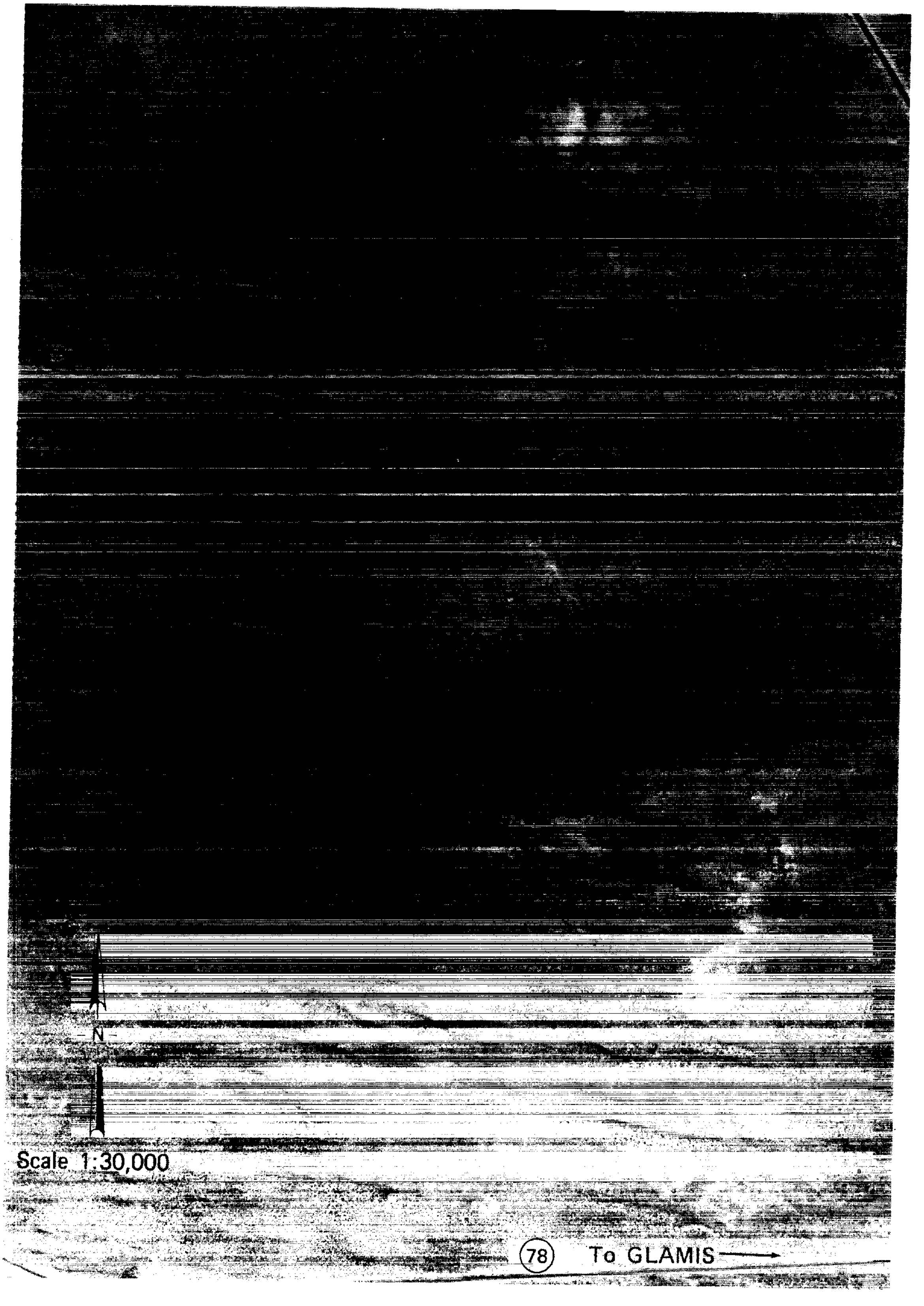

FIGURE 2: Aerial photo of a portion of East Mesa showing lineaments and geologic trench sites.
Photo by I. K. Curtis 10-31-73

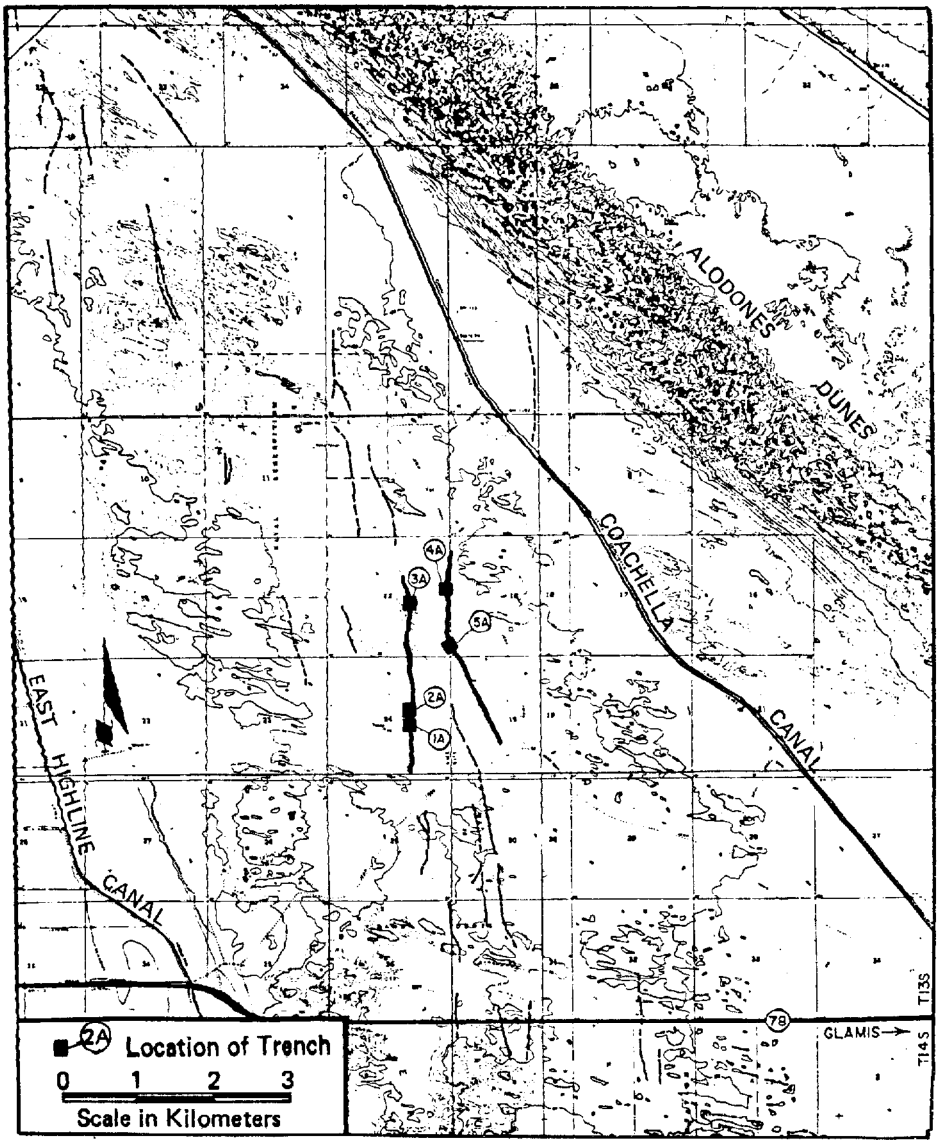

Figure 3: Map of aerial photo lineaments covering part of East Mesa, Imperial Valley. Solid lines show where trenches confirmed faulting.

TRENCHING OF LINEAMENTS

These lineaments were suspected of being surface fault traces and thus were examined in the field. Five trenches averaging 1.5 to 2 m deep and 6 m long were excavated across two of the major lineaments. Three of the five trenches revealed layered sediments offset by faults, while the other two showed only unfaulted recent windblown sand.

The three trenches that revealed faulted sediments exposed sections consisting of 7.5 to 50 cm of recent windblown sand overlying nearly horizontally bedded older and more indurated units of silty sand, thinly laminated sand, and mudstone. These older units contain concentrations of pedogenic carbonate and some thin layers of well-cemented silty sandstone. These units apparently represent older alluvial deposits composed of interlayered windblown sand and playa sediments.

The faulting in all three trenches appears to be confined to the older units, however, cracks have propagated up to the surface through the overlying young thinly laminated sand deposits, but without offset. Trenches 3A and 5A best represent the stratigraphic and geologic relationships encountered; they are discussed separately below.

Trench 3A was excavated across a vegetation lineament in an area of transverse longitudinal sand ridges (Figures 2 and 4). The trench revealed 1.3 m of older alluvial beds cut by a fault trending north-south in excellent alignment with the vegetation lineament. Four thin lithologic units consisting of alternating layers of hard brown mudstone and light-tan, coarse-grained sandstone were exposed east of the fault. West of the fault only one thicker bed of each of these units was exposed (Figure 5). This variation in stratigraphy across the fault suggests that fault displacement may be primarily lateral. The probability of lateral displacement is also supported by the irregular appearance of the fault plane in cross section (Figure 5). The fault and the older alluvial units are overlain by about 20 cm of thinly bedded, loose, windblown sand that was not offset but that did exhibit a crack appearing to have propagated to the surface from the fault plane below.

Trench 5A was excavated across a low slope and possible fault scarp along the eastern edge of a small playa (Figures 2 and 6). The trench revealed a nearly vertical, northsouth-trending fault in the older alluvial sand beds (Figure 7). The fault appears to offset a thin, well-cemented, silty sandstone by approximately 20 cm down to the west, however, total displacement and sense of movement along the fault could not be determined. The older units were overlain by approximately 60 cm of light-tan unconsolidated windblown sand that was not faulted but that also exhibited a crack extending up to the surface from the underlying fault. The fault surface here, as well as those in trenches 2A and 3A, is thin, nearly vertical, irregular, unstriated, and shows little or no gouge material, making it difficult to determine the sense of displacement; however, there is at least some vertical separation in this trench.

CONCLUSIONS

Trenching confirms that the lineaments investigated are indeed faults and strongly suggests that the other lineaments mapped on Figure 3 also represent surface fault traces. The displacement is apparently down to the west in trenches 2A and 5A in general agreement with west-facing scarps along the east side of several playas. However, the different lithologies juxtaposed in trench 3A suggest lateral displacement. The exact age of the faulted materials was not determined; however, they appear to be quite young, either late Pleistocene or Holocene.

These north-south trending lineations form a "left-stepping" en echelon pattern often characteristic of faulting in areas of young sediments lying along zones of deep right-slip faults. These faults are aligned with the southern projection of the San Andreas fault zone along the western side of the Algodones Sand Hills and may possibly represent the surface expression of at least a portion of the San Andreas fault zone. An alternate possibility is that they are normal, down-to-the-west faults representing tensional stress along the eastern margin of the Salton Trough.

FIGURE 4: Test trench 3A. Looking south along vegetation lineament. Geologist is pointing to fault at base of recent wind blown sand deposit. See Figure 5 for detail.

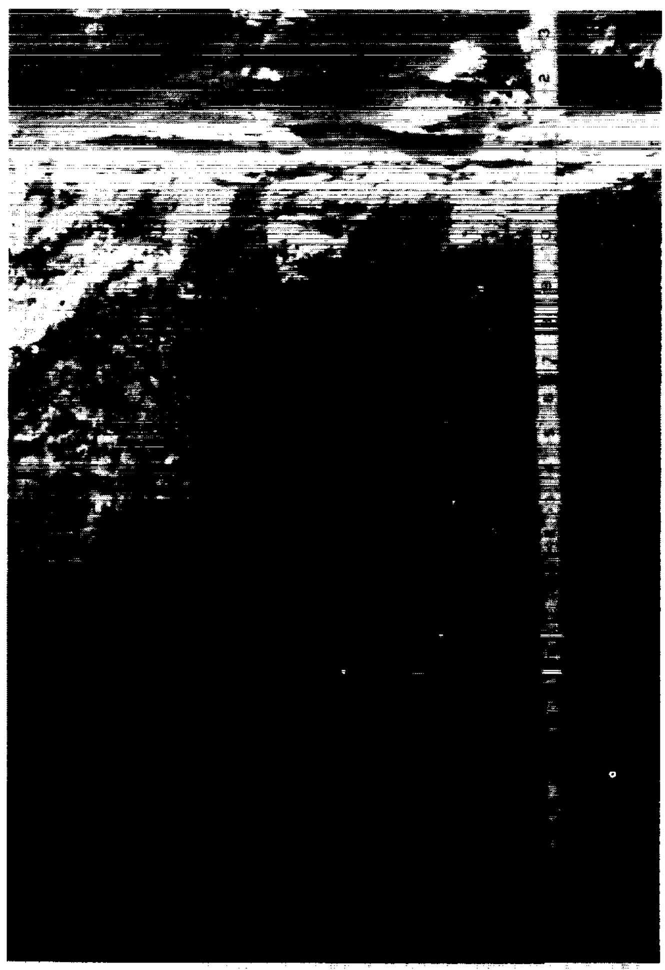

FIGURE 5: View of fault on south wall in trench 3A. Note different lithologies across fault and irregular nature of fault surface.

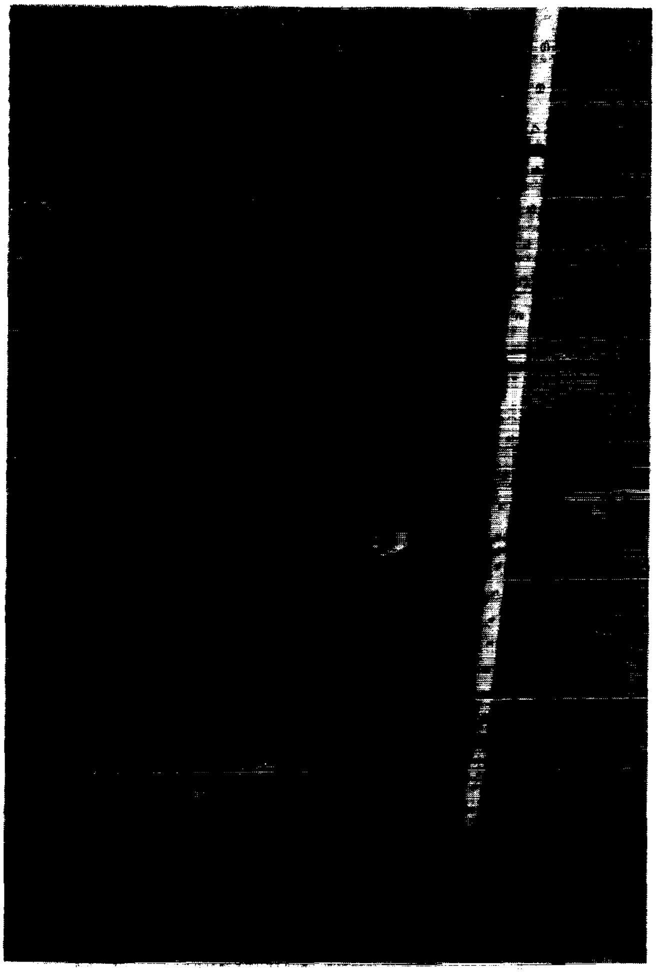

FIGURE 6: View of trench 5A looking northeast. Photo lineament follows east edge of small playa and may represent a low fault scarp.

FIGURE 7: North wall of trench 5A. Nearly horizontal, well-cemented, thin sandstone bed has apparently been down-dropped to the west by about 20 cm. Note that fault line continues into the overlying sand but does not displace thin laminae.

However, if the north-south trend and en echelon pattern have resulted from right-slip faulting, they would extend the surface evidence of the San Andreas fault some 60 km southeasterly from its southernmost exposure at Durmid Hill.

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