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A NEW FAULT LINEAMENT IN SOUTHERN CALIFORNIA

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ABSTRACT

ERTS-1 imagery clearly shows a 50-mile wide tectonic zone across Southern California oriented about 15° to the structures of the Transverse Ranges or with an azimuth of 70°. The zone is delineated on the imagery by terrain alignments and vegetational differences. A previously undisclosed tectonic lineament extends across the Mojave Desert and appears as a line of crustal upwarping. Pressures which would have caused this plus the occurrence of many thrust faults with the 70° azimuth indicate this to be a zone of crustal compression. Recent earthquake epicenters appear to be related to this compression zone rather than the traditional fault network of Southern California.

The Los Angeles Basin and its several sub-basins have been blocked out by the intersections of the northwest-trending Peninsular fault structures of the San Andreas system with the east-west or Transverse structures related to the Murray Fracture Zone. Local seismic interest has been focused upon faults related to the two tectonic alignments. ERTS-1 imagery of Southern California clearly indicates a third tectonic lineation which appears more closely related to recent seismic activity than the traditionally recognized structures (Figures 1 and 2).

The ERTS-recognized lineations appear as a broad zone, some 50 miles in width, which intersects the Transverse Ranges at about a 15° angle or with an azimuth of 70°. Although a limited number of landform features appear to be solely the products of the forces responsible for this sub-transverse zone, extensive evidence is also to be found in elements of the larger structures of the Transverse Ranges. Ridges that form the northwestern edge of the San Gabriel Mountains, for example, are properly oriented and in turn align with Oak Ridge which extends in a west-by-southwest direction toward the Pacific Ocean to impart the same orientation to the Santa Clara River Valley. North of the valley, the prominent ridge of the Topatopa Mountains, similarly set obliquely to the Transverse Ranges of which it is part, delineates the approximate northern edge of the zone.

The southern edge follows a line of recognized faults[1] which for the most part are buried under alluvial fill of the Los Angeles Basin. At the western end of this alignment is the Santa Monica Fault while to the east the Cucamonga Fault facets the southeastern corner of the San Gabriel Mountains near the point where the San Andreas system bisects the Transverse Ranges at Cajon Pass. It is significant to note that at this point the ERTS-recognized alignment crosses the San Andreas Fault with less than a mile of right-lateral offset which may give some clue to its age. The tectonic trend has affected the San Bernardino Mountains east of Cajon Pass by giving landform orientations that are cross-grained to the trend of the mountain range. These include a major indentation on the southern mountain front, the trend of the Big Bear-Baldwin lakes trough, and the general trend of the Santa Ana River canyon. Although the lineation just described is taken as the southern edge of the zone, ridge orientations and recognized faults in the San Jose Hills south of the San Gabriel Mountains may indicate a slightly wider zone, but evidences on ERTS imagery for this are not definitive.

The most prominent single indicator, both for the existence of the zone as well as its orientation, is a single tectonic line that extends across the Mojave Desert along the zone's northern edge and about halfway between the San Andreas and Garlock faults. On the imagery, it is particularly conspicuous along the southern edge of Rosamond Dry Lake (Figure 3) where desert-floor alluvium has been upwarped into low knolls with sufficient drainage to permit heavy stands of tree yucca (Yucca brevifolia) that form dark patches on the scans (Figures 4 and 5). To the east, the tectonic line extends along the northern edge of several low domes on the desert floor to be eventually occupied by a portion of the course of the Mojave River.

The alluvium knolls south of Rosamond playa, as well as the dome landforms, suggest that the desert tectonic line has been subject to lateral pressure from the southeast. A number of faults with the sub-transverse orientation are known to be thrust faults and the San Fernando earthquake of 1971 indicated that those buried by alluvium may well be. Recognized as thrust faults are the Santa Susanna-Santa Rosa Fault, the San Cayetano Fault, the Cucamonga Fault, and, in all probability, the Santa Monica Fault. This combination of evidence strongly suggests that the sub-transverse zone here described is a zone of active crustal compression which is absorbing much of the compressional stress being exerted by the northwestward-moving blocks of the peninsula of Baja California which intrude into Southern California.

It is of particular interest to relate the tectonics of the San Fernando earthquake of February 9, 1971, to the zone of lineations observed on ERTS imagery. Surface breaks related to the Olive View Fault[2] were thrust plates with strikes close to the 70° azimuth of the ERTS-recognized zone. Several feet of crustal compression occurred.

The compressional component of earth movement lifted the surface north of the break approximately three feet and in so doing demonstrated that forces associated with the zone may well be responsible for much of the mountain-building in and around the Los Angeles Basin. The cause of the left-lateral movement associated with the quake can also be conjectured since the wedging of the shattered crustal block against the San Andreas Fault backed by the more intact Mojave block should eject the coastal structures westward. The indication provided by the Rosamond lineation that the Mojave block is absorbing some of the crustal stress may also indicate a lessened chance that severe slippage will occur along the San Andreas Fault adjacent to the Los Angeles Basin.

An epilogue to the San Fernando movements occurred on February 21, 1973, with a sizable tremor centered near the western end of the Santa Monica Mountains (Figure 6). An extension of the Olive View Fault southwest along the Simi Hills at an azimuth of 70° joins the Sycamore Fault which is believed to have caused the recent quake. This again demonstrates that the compressional zone is active. On November 28, 1972, a swarm of small tremors centered under the alluvium near Pomona, California, a location which does not fit the traditional fault network of Southern California but which would lie on a westward extension of the Cucamonga segment of the compression-zone system.

In summary, ERTS-1 imagery in concert with previously recognized evidence delineates a zone of crustal compression across Southern California which is responsible for mountain building, landform orientations, and current seismic activity. The azimuth of the lineations that comprise the zone is intermediate between that of the San Andreas-Peninsular system and that of the Transverse structures held to be related to the oceanic Murray Fracture Zone. If pressure on Southern California is being exerted parallel to the peninsular structures, the question can rightly be asked why the compression zone is not at a perfect right angle to the pressures. One answer could be that the Transverse structures provide lines of weakness that compromise a perfect strain elipsoid. Whatever the cause for its orientation, the existence of the "Southern California Zone of Compression" may shed new light on the origin of the Transverse Ranges.

FOOTNOTES

[1] Geologic Atlas of California. California. Department of Natural Resources. Division of Mines. Scale: 1:250,000. Los Angeles, 1969; San Bernardino, 1967; Long Beach, 1962; and Santa Ana, 1965 sheets.

[2] Youd, T. L., "Landsliding in the Vicinity of Van Norman Lakes," The San Fernando, California, Earthquake of February 9, 1971. U. S. Geological Survey Professional Paper 733, U. S. Government Printing Office, Washington, D.C., 1971.

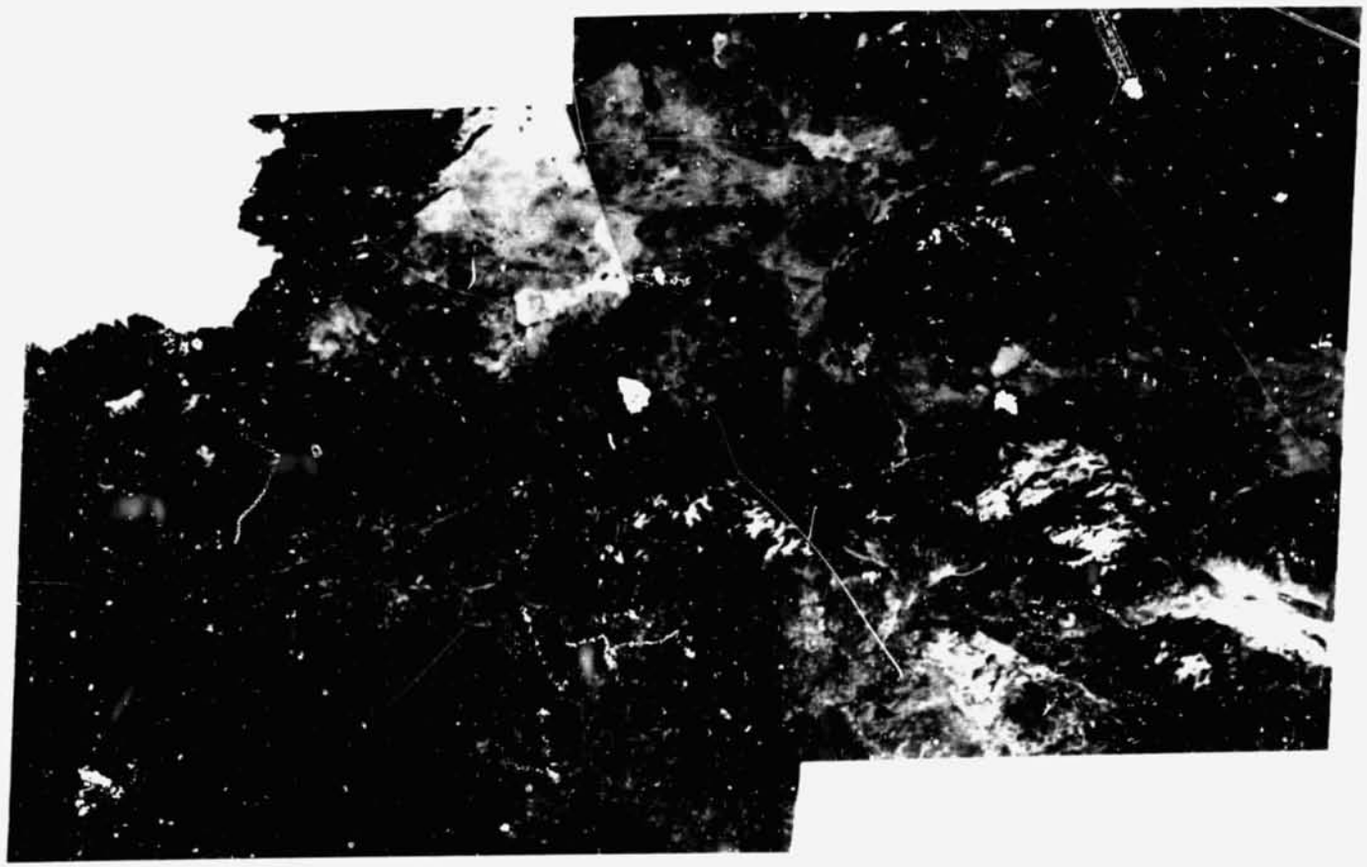

Fig. 1. A mosaic of ERTS images of 25 November (RH) and 26 November (LH) showing the Los Angeles Basin, Transverse Ranges, and Mojave Desert. The zone of tectonic lineations with the 70° azimuth is located in the accompanying map.

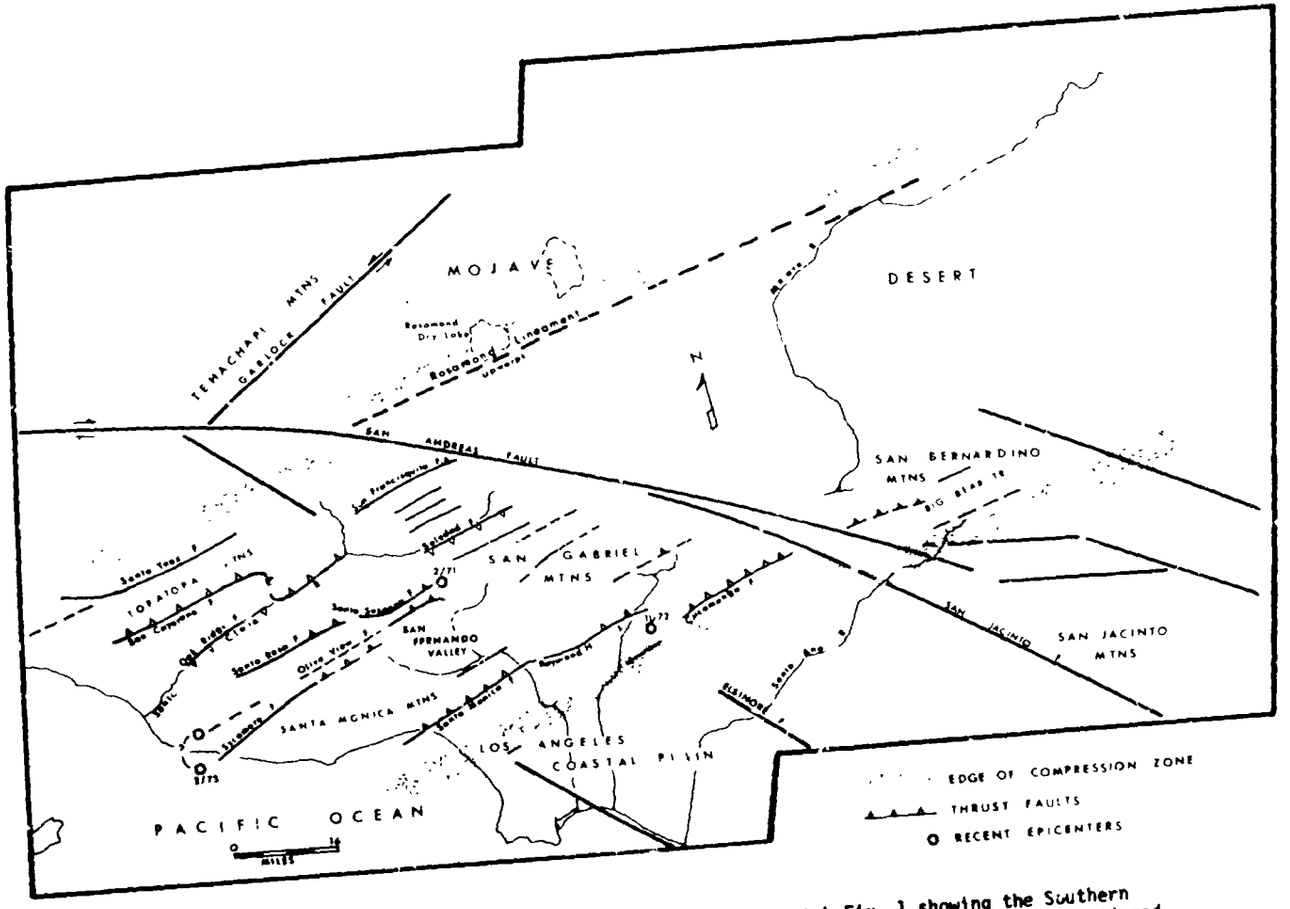

Fig. 2. A map of portions of Southern California to match Fig. 1 showing the Southern California Zone of Compression, prominent faults related to it, and place names mentioned in the text.

Fig. 3. Rosamond Dry Lake and Lineament. Band 5, November 26, 1972

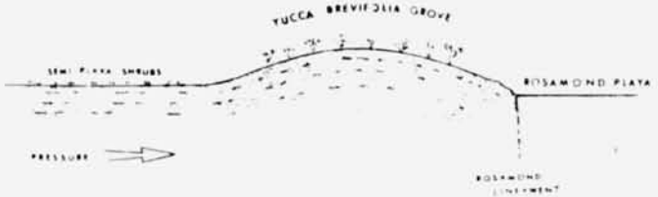

Fig. 5. Cross-section diagram of knolls along the Rosamond Lineament which appear to be upwarped from desert-floor alluvium.

Fig. 4. An oblique view of Rosamond playa showing groves of tree yucca on knolls along lineament.

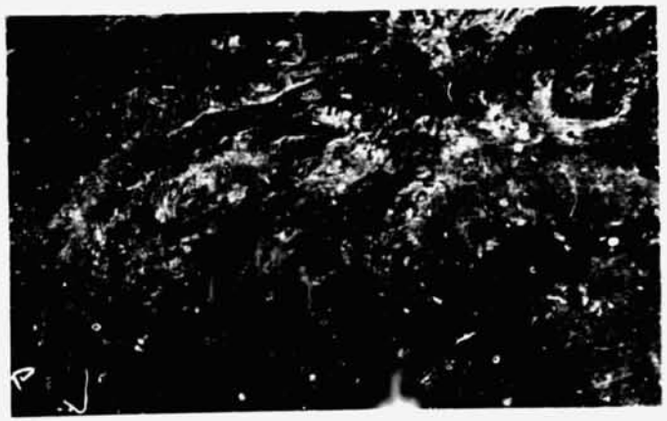

Fig. 6. The lineament of Olive View Fault connecting two recent earthquake epicenters (dots)