A-P file

CALIFORNIA DIVISION OF MINES AND GEOLOGY

Fault Evaluation Report FER-43

May 26, 1978

1. Name of fault:

Palos Verdes fault.

2. Location of fault:

This is a northwest-trending fault along the northeastern side of the Palos Verdes Hills, Los Angeles County, California (figure 1).

3. Reason for evaluation:

This fault is located within the 1977 study area of the 10-year program for fault evaluation.

4. List of references:

Converse-Davis-Dixon Associates, 1977, Updated geologic/seismic and earthquake engineering investigation, Petrolane LPG storage facility re-analysis, Los Angeles, California. Unpublished report for Petrolane, Inc., 23 p.

(This report is for an LNG tank site that overlies, or nearly overlies, the Palos Verdes fault zone. They conclude the fault has been inactive during Holocene time.)

(Joe Cobarrubias, Chief Geologist, City of Los Angeles, has this report.)

Envicom Corporation, 1973, City of Torrance seismic safety element: privately published report for the City of Torrance, 97 p., 5 appendices.

(They cite several tract reports which generally indicate a lack of recent activity along the Palos Verdes fault.) (Joe Cobarrubias, City of LA, has this report.)

Jennings, C.W., 1975, Fault Map of California with locations of volcanoes, thermal springs and thermal wells: California Division of Mines and Geology, California Geologic Data Map Series, Map no. 1, scale 1:750,000.

Nardin, T.R., and Henyey, T.L., 1978, Pliocene-Pleistocene diastrophism of Santa Monica and San Pedro shelves, California continental borderland: American Association of Petroleum Geologists Bulletin, v. 62, no. 2, p. 247-272.

(They believe that the northwestern continuation of the Palos Verdes fault, beneath Santa Monica Bay, has been "relatively inactive" since the beginning of late Pleistocene time.)

Nason, R.D., 1976, Vertical movements at Los Angeles Harbor before the 1933 Long Beach earthquake (abstract): EOS, Transactions, American Geophysical Union, v. 57, p. 1012.

Nicholson, G.F., 1929, Variations in levels, 1919 to 1927, in Los Angeles Harbor: Bulletin of the Seismological Society of America, v. 19, no. 4, p. 200-205.

(Nicholson, a Los Angeles Harbor engineer, attributes vertical movements of bench marks in the harbor area to activity along the presumed southeastward continuation of Palos Verdes fault.)

Real, C.R., D.L. Parke, and T.R. Toppozada, 1977, Magnetic tape catalog of California earthquakes, 1900-1974: California Division of Mines and Geology.

Riccio, J.F,, and Mills, M.F., 1977, Faulted upper Pleistocene marine terrace, Palos Verdes Hills, California: American Association of Petroleum Geologists Bulletin, v. 61, no. 11, p. 2001-2016.

(They discuss a short local fault on the western side of the Palos Verdes Hills which they believe cuts Holocene soil.)

Teng, Ta-liang, 1976, Research on earthquake prediction and control in Los Angeles basin and adjacent area. Unpublished summary report, U.S.G.S. Contract no. 14-08-0001-14558, University of Southern California, Los Angeles.

(His map shows a weak alignment of magnitude 2.0 to 3.9 epicenters along the Palos Verdes fault.)

Wehmiller, J.F., Lajoie, K.R., and seven others, 1977, Correlation and chronology of Pacific Coast marine terrace deposits of continental United States by fossil amino acid stereochemistry-technique evaluation, relative ages, kinetic model ages, and geologic implications: U.S. Geological Survey Open-File Report 77-680, 106 p.

Woodring, W.P., Bramlette, M.N., and Kew, W.S.W., 1946, Geology and paleontology of Palos Verdes Hills, California: U.S. Geological Survey Professional Paper 207, 145 p.

(They describe evidence for "Recent" and "quite modern" deformation along the northern and eastern borders of the hills.)

Yerkes, R.F., McCulloh, T.H., Schoellhamer, J.E., and Vedder, J.G., 1965, Geology of the Los Angeles Basin, California -- an introduction: U.S. Geological Survey Professional Paper 420-A, 57 pages.

(They give the only useful concise description of the Palos Verdes fault.)

Ziony, J.I., Wentworth, C.M., Buchanan-Banks, J.M., Wagner, H.C., 1974, Preliminary map showing recency of faulting in coastal southern California: U.S. Geological Survey Miscellaneous Field Studies Map MF-585.

(They show Palos Verdes fault as cutting late Pleistocene units.)

5. Summary of available data:

The Palos Verdes fault, or at least the near surface onshore part of the fault, has received surprisingly little attention. Woodring and others (1946) mapped a one-mile long segment of the fault at the northern end of the Palos Verdes Hills (figure 2), but it appears that the rest of the fault (about 8 miles of onshore length) has never been mapped by an on-the-ground investigation. At least, no such mapping is mentioned in the literature. Several of the subsequent references include maps of the fault at a scale of approximately 1:500,000. These show the fault as a solid line crossing the Palos Verdes Peninsula. The fault is placed at the topographic northeastern boundary of the Palos Verdes Hills, and it is not apparent from the texts of the reports that any more specific criteria was used to locate the fault. Envicom Corporation (1973) contains descriptions of fault exposures that are taken from tract grading reports, but no detailed maps of these fault exposures are provided.

The extensive occurrence of oil in the Los Angeles region caused the stratigraphy and structure of the region to be studied at an early date. It was observed that the Palos Verdes Hills differed greatly in these aspects from the adjacent parts of the Los Angeles basin. These differences are discussed by Woodring and others (1946, p. 109). On page 110 they discuss an "inferred subsurface fault" at the structural boundary, and refer to this fault as the "San Pedro fault." They further state, "A major structural feature corresponding to the inferred subsurface fault has not been found at the surface." They do, however, cite well data supporting the existence of the fault in the subsurface, and interpret the data as indicating a "reverse fault dipping steeply southward."

The only other significant description of the Palos Verdes fault is given by Yerkes and others (1965, p. 47):

> A conspicuous scarp along the northeast border of the Palos Verdes Hills marks a steeply southwest-dipping reverse fault zone, the Palos Verdes Hills fault zone, along which Pleistocene and older strata have been strongly tilted and folded (section E-F, plate 4). The basement surface drops across the fault zone from subsea depths of 2,000 to 4,000 feet on the upthrown southwest side to subsea depths of 5,000 to 8,000 feet on the downthrown northeast side (figures 2 & 3). Abrupt changes in configuration of the basement surface, as well as changes in the lithology and thickness of middle Miocene, upper Miocene, and Pliocene sedimentary rock units, occur at the fault zone and suggest important components of strike-slip movement. Much of the faulting along the zone evidently occurred during Quaternary time.

Unfortunately, they say nothing more about the nature of the "conspicuous scarp." Nardin and Henyey (1978, p. 263) say "... the trace of the Palos Verdes fault is not distinct along the northeastern border of the Palos Verdes Hills ...".

Several of the references contain generalized discussions about the recency of movement along the on-land part of the fault. Converse-Davis-Dixon Associates (1977, p. 5) state:

> In summary, we have found no hard data which indicates (sic) that the Palos Verdes fault has displaced Holocene deposits. There is no direct evidence to indicated (sic) that a major earthquake has occurred on the Palos Verdes fault during the past 11,000 years. Hard evidence clearly indicates that no earthquake of engineering interest has occurred on the Palos Verdes fault in the past 200 years.

They do not say what the "hard evidence" is. Envicom Corporation (1973, p. 1) makes the following general statement:

> Recent detailed investigations of the Palos Verdes fault zone indicate that it has not moved tectonically since late Lower Pleistocene, and is not considered active.

The Envicom report includes references to most of the studies cited in this FER. In addition, several tract grading reports are discussed. These are tracts where grading exposed the Palos Verdes fault, or at least, what was assumed to be that fault. Appendix A contains a reproduction of the part of the Envicom Corporation (1973, p. 11-13) report that discusses the tract grading reports. Envicom Corporation (1973, p. 13) draws the following conclusions about the Palos Verdes fault:

1. The Palos Verdes fault zone is a zone of faulting and intense folding 50-60 feet wide, or possibly more, in the Miocene Monterey Group.
2. The most recent tectonic movements cut the basal gravels and Lomita Marl Member of the San Pedro Formation (Lower Pleistocene), but do not cut the San Pedro sand.
3. The reference to the Palos Verdes (upper Pleistocene) being "broken" by the fault at two localities in Tract 30301 is unclear. However, it is not uncommon for faults to extend upward into overlying rocks

as the result of the continuing differential compaction of previously faulted units. This type of movement would not be expected to recur.

4. The weight of evidence indicates the fault zone is not active and has not been since late Lower Pleistocene. However, geologic investigations of proposed construction sites along the trend of the zone should continue to be alert for any new evidence bearing on this problem.

The Palos Verdes fault has also been inferred to continue to the northwest beneath Santa Monica Bay, and to the southeast beneath San Pedro Bay. Nardin and Henyey (1978, p. 263) state:

> The Palos Verdes fault is well defined on seismic reflection records from San Pedro Bay, and may extend as far south as the Lasuen Knoll (Figure 7; Greene et al, 1975) or farther. The fault beneath the shelf most commonly is expressed by an abrupt dislocation between folded strata and relatively undeformed layers, although in places it appears as a wide fault zone. Locally, high-resolution profiles show late Pleistocene and possibly Holocene separations along the fault.

Nason (1976) presents evidence for possible historical activity along that part of the Palos Verdes fault that passes beneath Los Angeles harbor. He discusses differential vertical movements recorded by tide gauges in the harbor during the decade preceeding the 1933 Long Beach Earthquake. Nicholson (1929) discusses significant vertical movements of bench marks on the Los Angeles area between 1919 and 1927. Figure 3 of this FER is a reproduction of Nicholson's Figure 1, showing the level changes in the bench marks. He suggests that the movement occurred along a "probable fault." That fault is positioned on his map so as to be in line with the Palos Verdes fault (figure 2). He does not indicate that any fault or fault offset was observed at the ground surface.

No historic earthquakes have been attributed to the Palos Verdes fault. However, Nicholson (1929) mentions a "shock of about two years ago, felt locally only" which he thinks may have been associated with the fault. The epicenter data of Real and others (1977) is shown on Figures 4a and 4b. It is not apparent, on these maps, that any anomalous amount of seismic activity is associated with the Palos Verdes fault. The map of Teng (1976) shows a noticeable linear pattern of seismicity along the southwestern side of the Palos Verdes fault (figure 5 of this FER). Teng says nothing about this in his text. His map includes events between 1971 and 1976 only.

6. Interpretation of aerial photography:

No aerial photos were studied. The Fairchild collection at Whittier College was searched for coverage of this area, but none was found.

7. Field observations: None.

8. Conclusions:

The only part of the Palos Verdes fault to which Holocene activity has been ascribed is the presumed southeastward continuation of the fault beneath Los Angeles Harbor and farther out beneath San Pedro Bay. However, no surface fault has been located in the harbor area. No evidence for Holocene offset has been described for the on-shore part of the fault, and, more importantly, some specific evidence (see Appendix A) has been given to support the arguement that there has been no offset since early late Pleistocene time. Furthermore, the on-shore part of the fault is, for the most part, very poorly defined.

9. Recommendations:

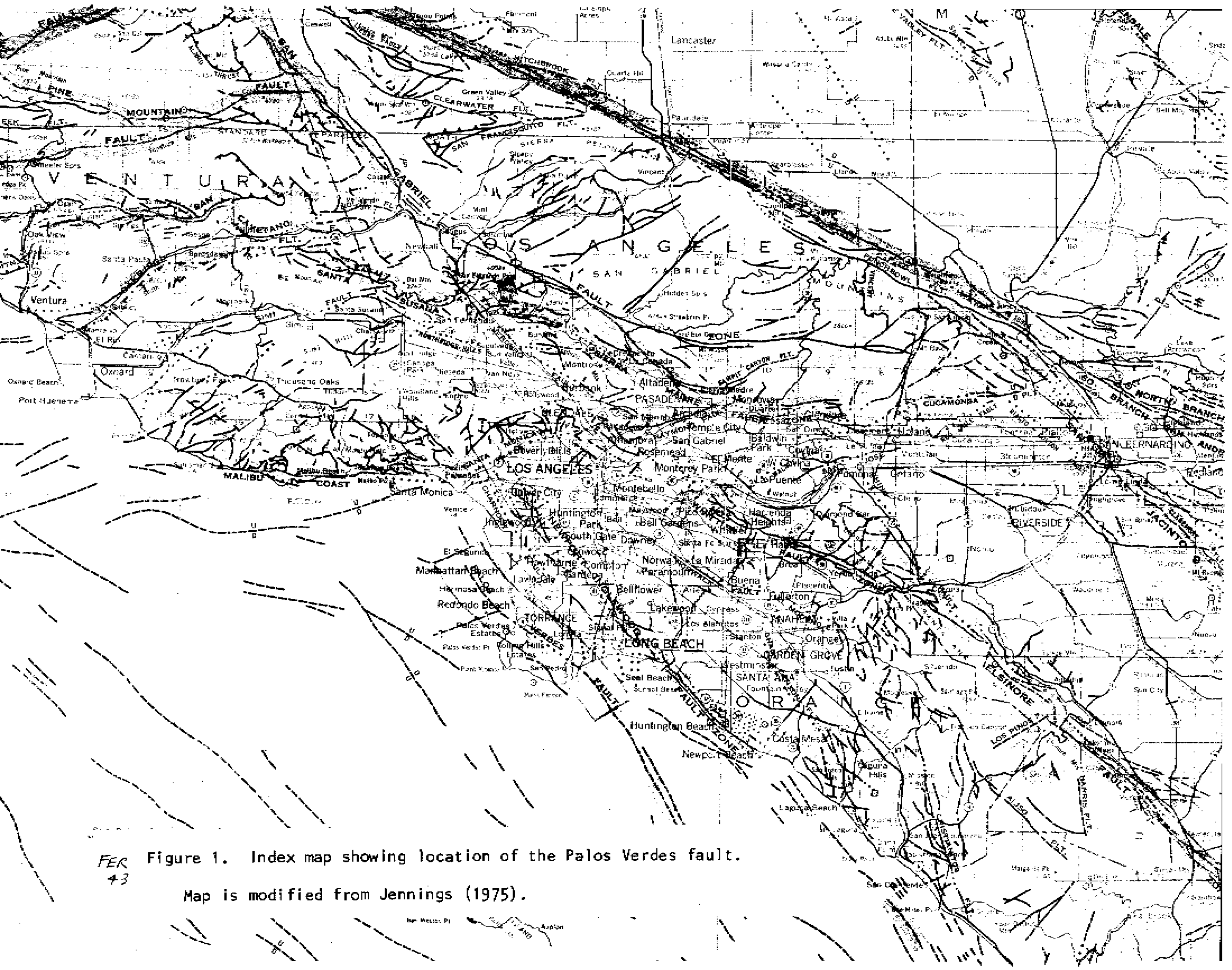
I recommend that no zones be established along this fault.

10. Investigating geologist's name and date:

Drew P. Smith

DREW P. SMITH
Assistant Geologist
May 26, 1978

I agree with the recommendations. If this fault is active at depth, as suggested by seismicity, then the recent faulting has not propagated to the surface along a well-defined trace. EWH 6/2/78



FER 43 Figure 1. Index map showing location of the Palos Verdes fault.

Map is modified from Jennings (1975).

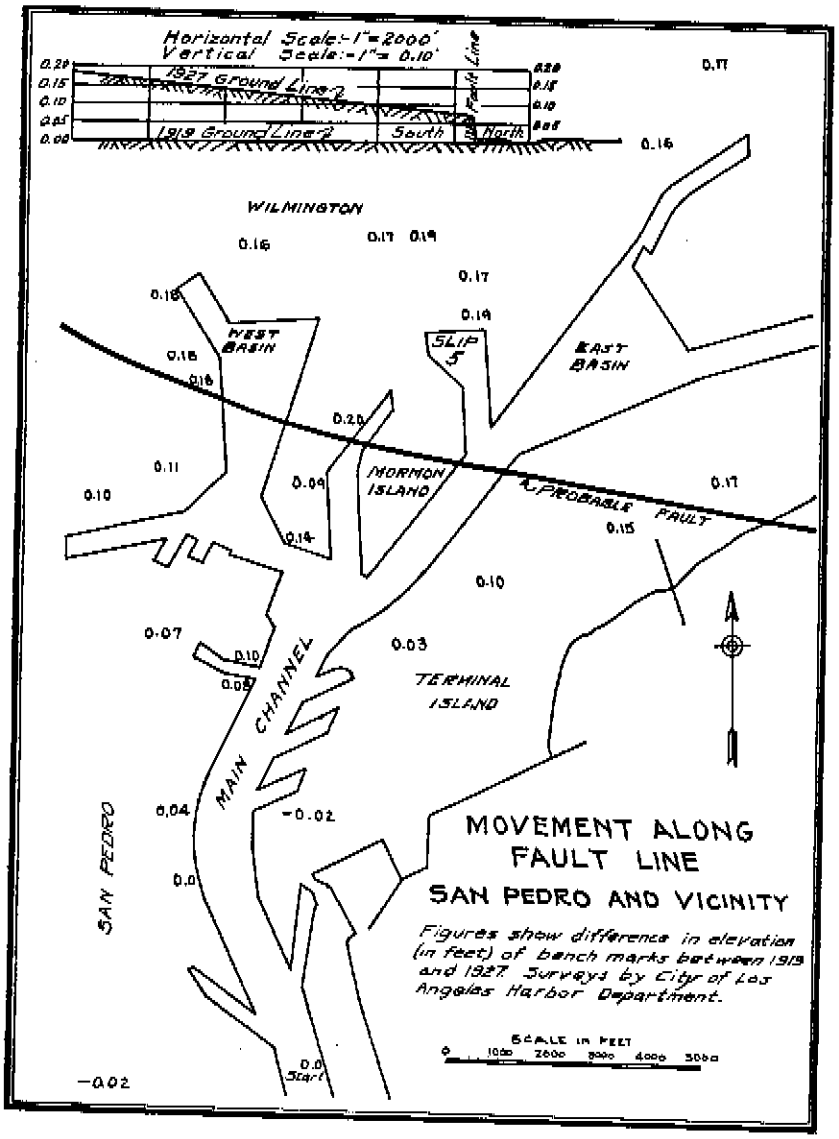
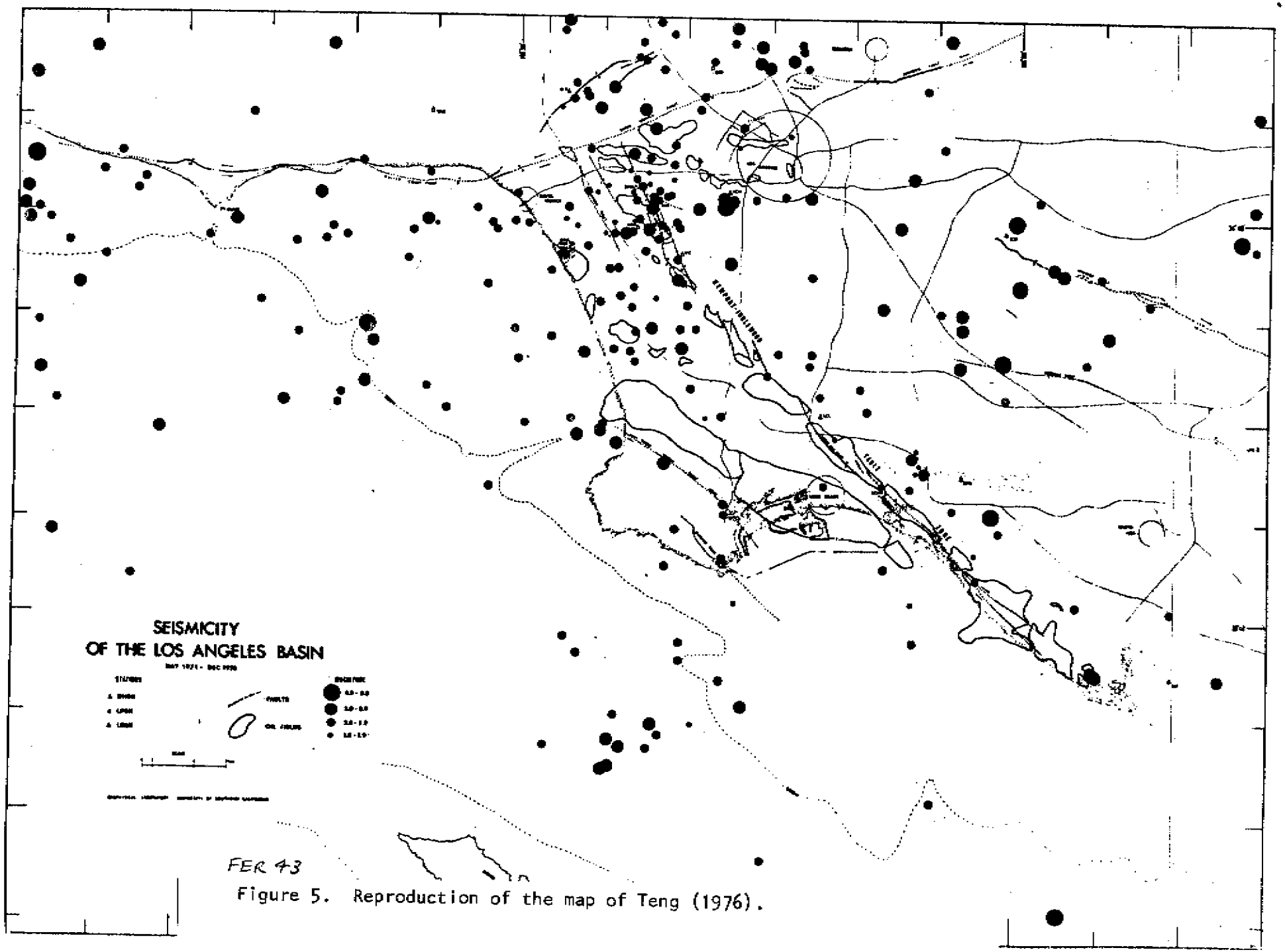


FIG. 1

FER 43

Figure 3. Reproduction of Figure 1 of Nicholson (1929).



FER 43

Figure 5. Reproduction of the map of Teng (1976).

APPENDIX A

Discussions of Tract Grading Reports by Envicom Corporation (1973, p. 11-13)

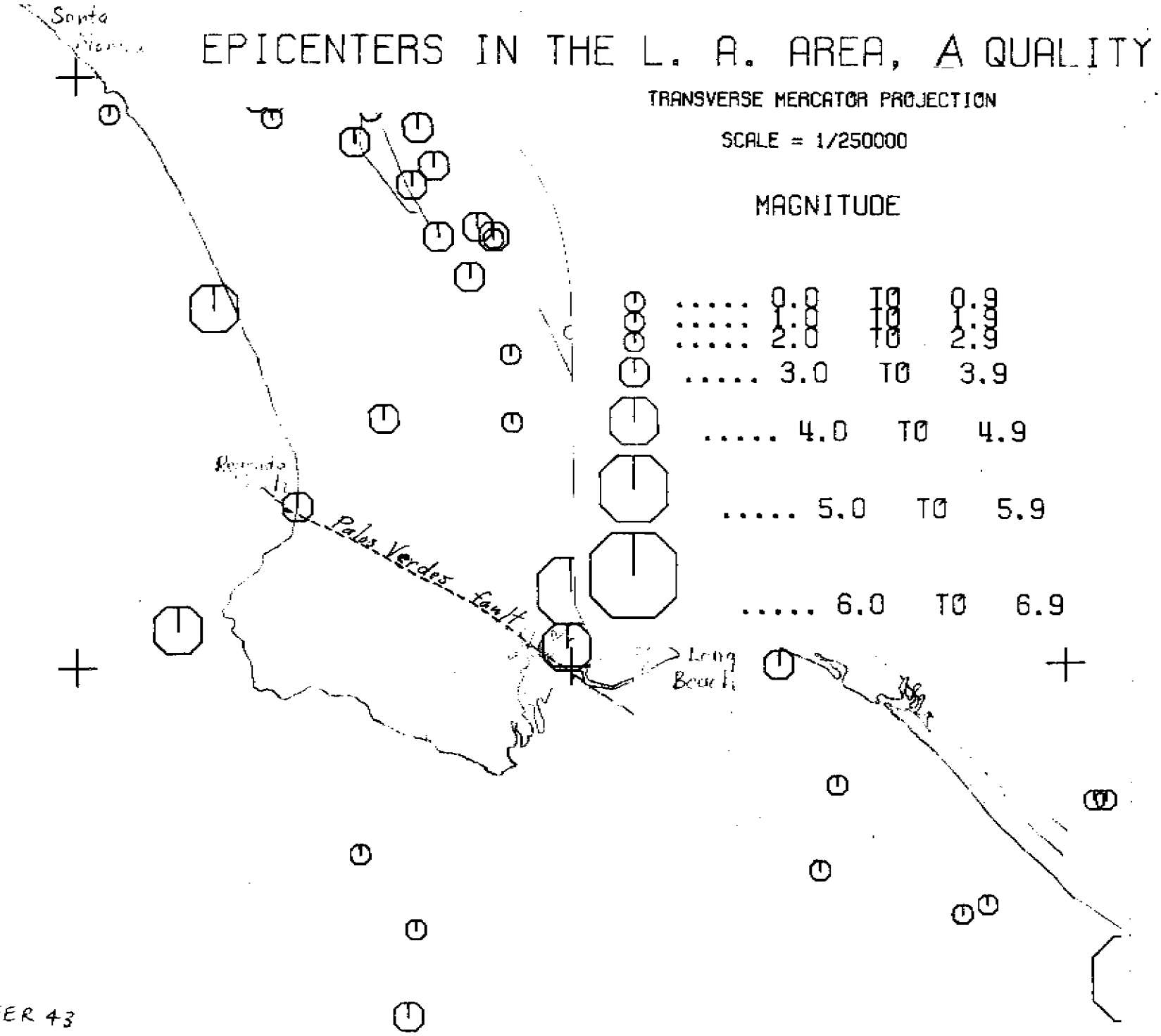
- Tract 30152. The report for the tentative tract by Geotechnical Consultants (12-28-64) states ".... the uppermost units which were faulted were gravel beds of the San Pedro sand." The report of in-grading inspections by C. A. Yelverton (5-25-65) noted that the fault zone is 50-60 feet wide, but no mention is made of the youngest rocks faulted.

- Tract 30301. The report by Geotechnical Consultants (12-29-64) states: "The Palos Verdes sand has been broken by the fault in the vicinity of Lots 36 and 38. In the other canyons to the east, the fault was observed to terminate at gravel beds of the San Pedro sand. Movement on this fault is, therefore, believed to have occurred during lower-upper Pleistocene time, or about 10,000 years ago. No indications of recent movement on this fault was observed on the property."

- Tract 26507. Investigations of the recency of movement in this tract have been much more extensive than in tracts developed earlier. Reports by Di Matteo (10-11-71 and 2-5-72) note the offset in the younger Pleistocene on the map of Poland (discussed above), correlate" with a fair degree of certainty" the "shear zone" mapped in the Tract with the Palos Verdes fault, and state that: "There is no factual basis for declaring the Palos Verdes fault to be active....".

Lindvall, Richter & Associates (4-10-72) in their review of the work done to that time observed that ".... not sufficient is known to locate the exact trace of the Palos Verdes Fault, or to place the line of its most recent displacement." They also state: "If the terrace deposits can be shown to cross the fault zone undisturbed, the fault, historically speaking at least, is in a static condition."

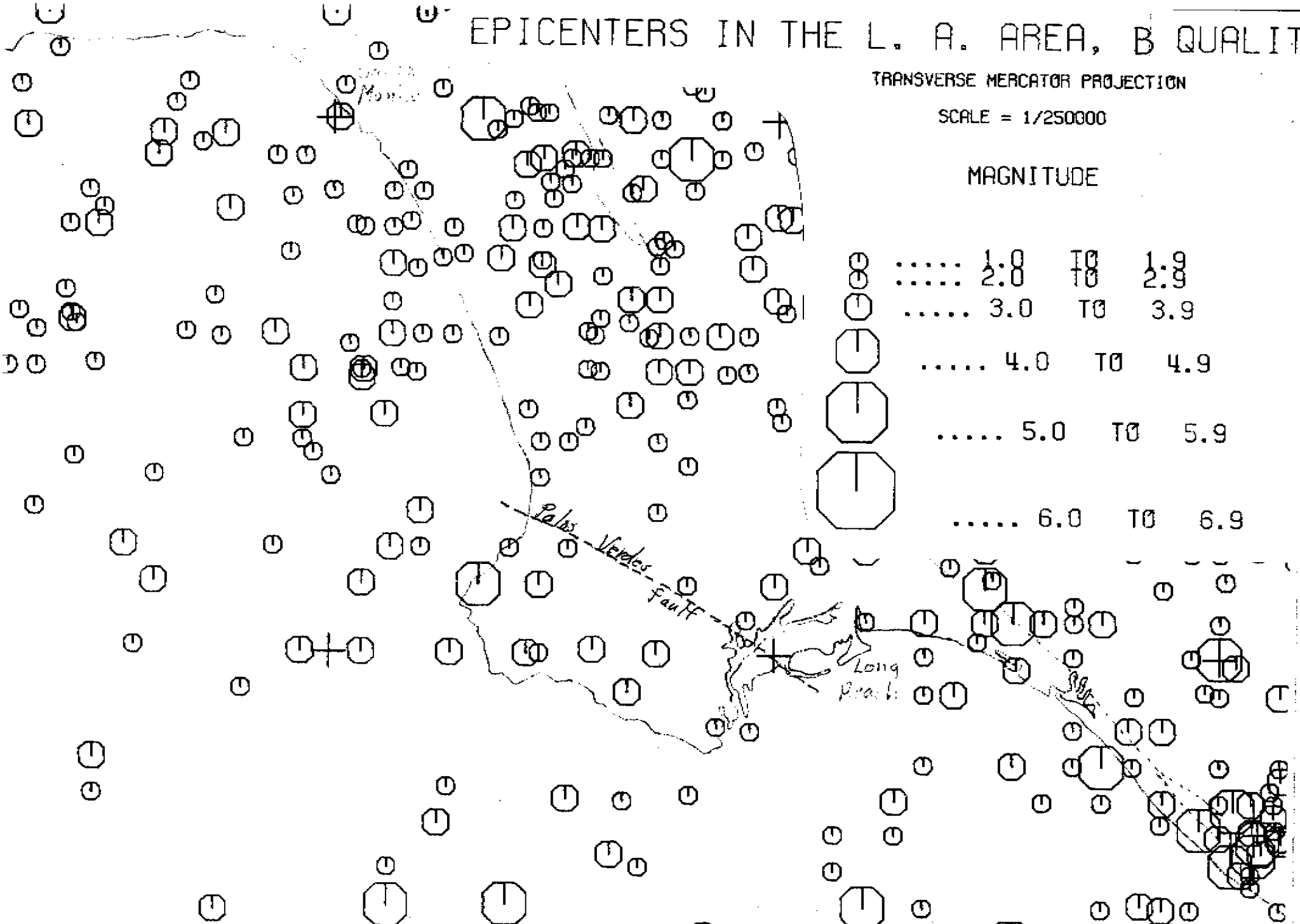
Additional field work was conducted during August, 1972. Two bulldozer pits were located and excavated under the supervision of Di Matteo, and the excavations were examined with Di Matteo by Roy Hoffman of Converse, Davis & Associates for the City of Torrance, and by C. Eric Lindvall of Lindvall, Richter & Associates. The report of this investigation by Di Matteo (9-5-72) states: "No evidence of fault disruption was found within the San Pedro Sand, which overlies the fault zone in a continuous blanket, simultaneously concealing and dating the fault. Field evidence from this latest excursion indicates that no fault disruptions have occurred since Lower Pleistocene time....". Di Mateo translates this phrase as "in the last 285,000 years".



FER 43

Figure 4a. Seismicity in the vicinity of the Palos Verdes fault.

"A" quality epicentral plots from Real, et al (1977).



FER 43 Figure 4b. Seismicity in the vicinity of the Palos Verdes fault.

"B" quality epicentral plots from Real, et al (1977).