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SUBJECT: Transcript of JL Smith & PL Ehlig 810622 direct testimony on Contention 3 re seismic design basis.

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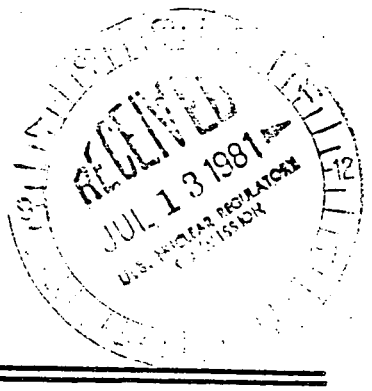

In the Matter of:

SOUTHERN CALIFORNIA EDISON COMPANY, ET AL., (SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3	)	DOCKET NOS. 50-361, OL and 50-236, OL

DATE: June 22 ,1981, ff. PAGES: _____

AT: San Diego, California

APPLICANTS' DIRECT TESTIMONY

ON

CONTENTION NO. 3

TR01
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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket Nos. 50-361 OL
	)	50-362 OL
SOUTHERN CALIFORNIA EDISON COMPANY, ET AL.	)	
	)	
(San Onofre Nuclear Generating Station, Units 2 and 3)	)	
	)	

APPLICANTS' DIRECT TESTIMONY OF JAY L. SMITH AND DR. PERRY L. EHLIG ON CONTENTION #3:

"Whether the seismic design basis for SONGS 2 & 3 is inadequate to protect the public health and safety as a result of discoveries subsequent to issuance of the construction permit of the following geologic features:

(1) ABCD features at the site.

(2) Features located at Trail 6, Target Canyon, Dead Dog Canyon, Horno Canyon, and "onshore faults E and F".

(3) Such other features as the parties may agree are relevant to the seismology of the SONGS site or with respect to which Intervenor Friends of the Earth makes a threshold showing of relevance.

TESTIMONY OF JAY L. SMITH

1. Q. Would you please state your name?

A. Jay L. Smith

2. Q. Are you the same Jay L. Smith who appeared earlier in this proceeding?

A. Yes.

3. Q. What is the purpose of your testimony in this portion of the proceeding?

A. One of the issues in this proceeding is whether as a result of certain geologic features discovered subsequent to issuance of the construction permit, the seismic design basis for SONGS is inadequate to protect the public health and safety. I will testify concerning the significance of certain of those features.

4. Q. What geologic features does your testimony address?

A. I have studied and will testify concerning the following geologic features:

(a) ABCD features at the site

(b) Trail 6 landslide

(c) Target Canyon offsets

(d) Horno Canyon landslide

5. Q. Would you locate what have been designated the ABCD features?

A. The ABCD features are located at the SONGS site. The specific location is shown on Figure JLS-N,

"Location Map, ABCD Features, SONGS 2 & 3," which is attached hereto.

6. Q. Would you describe your investigation of the ABCD features?

A. My full investigation of these features is set forth in the following: Exhibit JLS-1, "Analysis of geologic features at the San Onofre Nuclear Generating Station," Exhibit JLS-2, "Analysis of C and D type features at SONGS," Exhibit JLS-3, "Final report on grading and analysis of geologic features at the San Onofre Nuclear Generating Station."

7. Q. Would you summarize the investigations and their results?

A. Yes. The ABCD features are narrow, linear, light gray or white streaks within the otherwise light brown San Mateo Formation, Figure JLS-0, "Photograph of an 'A' Feature". They display a twisted-rope appearance indicating shear displacement along them, which is confirmed by offsets of siltstone clasts lying across them.

During site grading operations in 1974, the features were discovered by geologists on the staff of Southern California Edison Company. I was asked to examine them and to begin an investigation that

///

would determine their nature and significance for SONGS.

Under my supervision about a dozen geologists mapped the features, examining them in detail on the floor of the site excavation and in trenches excavated several feet deep to expose them in cross section. The objectives of the mapping were to locate all features, determine their physical and structural characteristics, evaluate the evidence for their age, and to interpret their mode of formation.

Initial findings, from mapping accomplished while the excavation was at an elevation a few feet lower than the position of the Stage 5e marine-terrace platform, disclosed positive evidence of continuous marine terrace deposits across the features. This indicated a minimum age of last displacement of 125,000 years. On this basis, and in view of other characteristics I will describe shortly, the NRC approved continuing of the excavation and my proposed plans for further mapping and analysis of the features as grading progressed.

As excavation continued, additional mapping was performed utilizing motorized scrapers to produce fresh horizontal exposures that were then

scraped with shovels and brushed with brooms to permit examination of every square foot of undisturbed San Mateo Formation and those parts traversed by the ABCD features. Each feature was carefully brushed by hand and examined and recorded on a map, with particular attention and documentation of feature intersections with each other, with siltstone clasts, and with the overlying terrace deposits. JLS-N is a plan view of the site showing the distribution of the features as mapped at final site grade.

At several locations, trenches and 24-inch diameter borings were excavated across the features to allow in-place observation of the features below site grade and to determine the three-dimensional nature and distribution of the features.

Samples of the features and adjoining San Mateo Formation were collected for preparation of thin sections and for examination through a petrographic microscope. The microscopic examination studied the composition, texture, cementation, and orientation of the grains in the rock.

In addition to the site mapping and sample analysis, similar features were sought outside the site boundaries. The objectives of this search

were to determine the areal extent of the features, their character and geometry elsewhere, and their relationships to structural and stratigraphic elements in the region.

There are four types of features recognized and described by their orientation. For simplicity, we called them features A, B, C, and D.

The A and B features are by far the most abundant and prominent features, and are most continuous. They form conjugate sets, as shown in Figure JLS-P, "Photograph of 'A' and B' Feature Intersection". They are narrow, from a quarter of an inch to a maximum of 6 inches wide, and they are quite straight. They are resistant to brushing in the more easily eroded sandstone because of the slight amount of crushing and compaction that has occurred along them during their formation.

They clearly exhibit evidence of lateral shear only, and a total absence of vertical displacement.

The A features strike nearly north-south and dip vertically. The longest feature is about 800 feet. Their greatest width collectively and singularly is in the central part of the site, and they narrow perceptibly to the north and to the south, suggesting that they are dying out as they reach the northern and southern margins of the

site. They have a left-lateral displacement of about a quarter of an inch on a single element, to a maximum of 4 inches cumulative over a zone that is a few inches wide.

The B features strike about north 45 to 55 west, and they dip nearly vertically also. They are more discontinuous laterally and they die out completely to the east and west within the site. At depth, while the A features tend to remain vertical, the B features tend to converge toward one another. The B features are characterized by right-lateral displacement only, with maximum offsets being on the order of 1/2 to 2 inches.

At intersections, as displayed in Figure JLS-P, the A and B features mutually offset one another at nearly equal intervals, so that neither one dominates. This figure shows the intersection of slightly broader portions of the A and B features, and it can be seen that both features are offset by similar amounts.

The A and B features are found in several locations within about a five square-mile area, including that area well outside the San Onofre site. They occur both near and far from the coast, and without any particular pattern. They display no zonal distribution nor do they maintain any

constant proximity to any known fault, including the Cristianitos fault.

The C and D features are relatively rare, in contrast, and they have not been found outside the site. The C feature is limited to a small area in the northeastern part of the site, near the toe of the cut slope. It is very short, about 60 feet altogether, with 30 feet in the slope and 30 feet in the pad. It is similar in appearance to the A and B features in that it is white, sinuous, and contains resistant ridges because of a slight amount of crushing of the grains along the feature.

The C feature is less straight and more irregular than the D features. It dies out completely within that 60 foot area and does not intersect any other feature. There is no clear displacement on C except for the physical appearance of the zone itself. It strikes about north 50 to 60 east, dipping 10 to 20 degrees into the slope roughly parallel to the bedding. The amount and direction of displacement on the C feature is questionable, but would be no more than 2-1/2 inches.

The D feature is quite different from the other ones because of its striking lack of linearity. Unlike the A, B, and C features, the D

feature consists of hairline planar fractures containing little or no evidence of crushed grains and no evidence of compaction. Consequently, it is not resistant to erosion by the brush, and its elements do not stand out from the sandstone. Its pattern is commonly a single trace, but it is complex and has a number of discontinuous branches going off in different directions; and where a single trace dies out, it is commonly superceded by another overlapping element.

The D feature also has an attitude that is very similar to the bedding, particularly in parts of the site where it is exposed in deeper excavations. The displacement on the D features is in a reverse sense, with the northern part being up. Displacement ranges from as low as an eighth of an inch to a maximum of 2-3/4 inches. The direction of slip is south, parallel with or along the line of the A features.

With respect to the origin and age of these features, all of them must have occurred after the San Mateo Formation became lithified, so they are clearly younger than 4 million years. However, they are all overlain by deposits of the Stage 5e marine terrace. Therefore, they are all older than 125,000 years. In the site area, the mapping

indicates that all of these features where they are traced to the northwest or to the east, clearly underlie that terrace without any displacement whatsoever.

This was also apparent in the cut slope where surface mapping of natural exposures and careful logging of trenches demonstrated the lack of terrace offset. Figure JLS-Q, "Log of Trench Across 'A' Feature" displays essentially a vertical plane in which San Mateo Formation is overlain by the marine terrace deposits, and one of the features -- in this case, an A feature -- coming up with no disturbance of that surface.

The A and B features formed simultaneously, since they are a conjugate set. The C feature probably formed about the same time. The minimum age would be during the Pleistocene, when the land surface was at least some 300 feet higher than the Stage 5e terrace platform, probably more than 300,000 years ago.

The D features are youngest. They probably formed on the land surface when it was within a few hundred feet of its present elevation, but before development of the Stage 5e platform.

All of the features formed under stress conditions quite different or somewhat different

from those of the modern tectonic regime, and certainly different from those that produced the Cristianitos fault, Figure JLS-R, "Regional Stress Conditions".

The broad distribution of the A and B features, without any zonal occurrence, indicates that their formation was in response to a slight amount of regional compression acting on a large mass of relatively homogenous sandstone. Some 10 million to 4 million years ago, the region was subject to extension in an east-west direction, with very slight amounts of north-south compression. However, in the period after lithification, 4 million to 125,000 years ago, compression increased and the direction of maximum compression became south 20 east and north 20 west. In modern time, the site region has been and is under the influence of the San Andreas fault movement far to the east, which clearly is in a dominant north-south compressive mode.

21. Q. What are the conclusions you draw from your investigations?

A. I have concluded that the ABCD features are joints (not faults) displaying small amounts of mutual shear displacement. They are discontinuous. Those that are A, B, and C formed in response to small

amounts of regional compression, acting over an area many times larger than the site, during the period of 4 million to 125,000 years ago, and very likely several hundred-thousand years ago.

The D features formed during a time of reduced overburden pressures and when regional compression was generally north-south. Chiefly they are related to stress release that resulted from removal of several hundred feet of overburden during Late Pleistocene time.

None of the features has moved since at least the last 125,000 years, and their formation took place under stress conditions quite different from those that existed during the time when the Cristianitos fault was active and from those that prevail in the modern regime.

These features are not unique to the SONGS site. The A and B features have been found within about a five square mile area, and as much as five or six miles from SONGS. They are peculiar, however, to a formation like the San Mateo Formation, which is massive homogeneous sandstone -- a somewhat brittle formation that has high strength, but relatively little tenacity -- such that small amounts of compression can cause small amounts of internal readjustments to produce local

shearing that quickly dies out within the mass. Features somewhat similar to A and B might be found elsewhere, but not so sharply expressed, in the fine-grained rocks that are more common up and down the coast. Even those features which, like D, are due to removal of erosion, are probably present in many places, but are rarely seen because most rocks in California contain so many hairline fractures. The San Mateo Formation, on the other hand, is so remarkably unbroken that there are places where one can walk half a mile or almost a mile along a river course and see complete exposure of the San Mateo almost without a single fracture.

In summary, their distribution and discontinuous short lengths, particularly their small displacements and great age, indicate that the ABCD features are joints and, thus, very minor elements of the San Mateo Formation. The ABCD features have no significance for the SONGS site.

22. Q. Would you describe the geologic features found at Trail 6?

A. The features at Trail Six are vertical offsets of the bedrock/marine terrace contact in the seacliff. They are approximately three miles south of San Onofre at a place called Trail Six, Figure JLS-S, "Location Map, Trail Six and Dead Dog/Horno

Canyons". They were noted during 1977 by one of the geologists for the California Energy Commission. Although the offsets were small--one or two feet, they occurred across planar fractures trending north-northwest (comparable with the attitude of the Cristianitos fault), and they were therefore suspected of being faults of tectonic origin.

23. Q. Would you describe your investigation of the features at Trail Six?

A. An investigation of these displacements was initiated by Applicants. Geologists under my supervision evaluated the extent, nature, and origin of the offsets. The scope of investigation included very detailed geologic mapping on specially prepared topographic maps, aided by analysis of low-altitude vertical and oblique aerial photographs; logging of natural exposures in the seacliff and transecting gullies; and excavation of trenches to remove overburden that concealed critical relationships.

The geologic materials at this location are sandstone of the Monterey Formation, overlying marine and nonmarine terrace deposits, landslide deposits, and colluvium. The contact between the marine terrace deposits and the Monterey Formation

is sharply defined and crudely planar, and represents the 125,000-year old Stage 5e marine erosional platform.

Large landslides are common along the coast south of San Onofre where the relatively incompetent Monterey Formation is exposed in high bluffs under attack by wave erosion. The offsets in question exist with the southeastern boundary of a large landslide (6 acres) displaying many of the features common to massive rotational movement in response to gravity: A semi-arcuate pull-away zone and distinct scarp at the head or landward part of the mass, several blocks or slices that have been downdropped and their surfaces rotated toward the scarp, and generally hummocky topography with poorly-developed drainage on the slide mass, Figure JLS-T, "Trail Six Offsets in Seacliff Exposure," and Figure JLS-U, "Aerial Photograph of Trail Six Landslide."

While there are some planar fractures that trend north-northwest, the dominant strike is northwest, with some fractures striking north 60 degrees west. The traceable length of the fractures responsible for the offsets is about 80 feet, and a northwest projection of them intersects the backscarp of the main landslide. The

bedrock/marine terrace deposit contact is not exposed at the backscarp, but a nearly complete section of inplace and undisturbed nonmarine terrace deposits is exposed. Projections of the fractures farther inland do not coincide with any mapped faults, nor are similar fractures or offsets found in the seacliff outside the landslide boundaries.

24. Q. What conclusions do you draw from your investigations?

A. My conclusion from the investigation is that the displacements at Trail Six are of landslide origin, and are not faults of tectonic origin. Consequently, they are of no significance to the SONGS site.

25. Q. Would you describe the features known as the "Horno-Dead Dog Canyon Offsets"?

A. Offsets of the 125,000-year old bedrock/marine terrace contact exist near the mouth of Horno and Dead Dog Canyons, Figure JLS-V, "Photograph of Offset, Horno Canyon Wall," approximately 5 miles southeast of SONGS.

26. Q. Would you describe your investigation of the features known as the "Horno-Dead Dog Canyon Offsets"?

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A. An investigation of these offsets by geologists under my supervision in 1977 included mapping of the ground surface, detailed logging of canyon-wall exposures, and air-photo analysis. The investigation disclosed abundant evidence of seacliff failure in the Monterey Formation and massive seaward landsliding that includes 200-300 feet of Horno and Dead Dog Canyons, Figure JLS-W, "Aerial Photograph of Landslide Topography, Horno Canyon". Landsliding has been episodic and has occurred recently near the present beach and in ancient times farther inland. The location, orientation, sense of slip and nature of the offsets in the bedrock/terrace contact indicate they are the result of landsliding.

27. Q. What conclusions do you draw from your investigation?

A. My conclusion from the investigation is that the features known as the "Horno-Dead Dog Canyon Offsets" are of landslide origin. Accordingly, they are of no significance to the SONGS site.

28. Q. Would you describe your investigation of the features known as the "Target Canyon Offsets"?

A. Near the mouth of Target Canyon, about 6-1/2 miles southeast of SONGS, Figure JLS-X, "Location Map Target Canyon," the 125,000-year old bedrock/marine

terrace contact is displaced small amounts by narrow shears. An investigation was initiated in 1977 by geologists under my supervision. The objectives of the investigation were to document the displacements, interpret their origin, and judge their significance to SONGS.

The scope of the investigation included detailed mapping of the ground surface and canyon-wall exposures, logging of trenches excavated to expose important relationships, and air-photo analysis.

29. Q. Would you describe the features known as the "Target Canyon Offsets"?

A. Offsets of the bedrock/terrace contact were observed at seven localities, Figure JLS-Z, "Location of Observed Offsets, Target Canyon," within an area 2000 feet long by 1000 feet wide. Bedrock shears coincident with the offsets strike between north-south and north 15 degrees east, and dip in the range 26-90 degrees, Figure JLS-Y, "Photograph of Offset, Target Canyon." Displacements of the terrace/bedrock contact are no more than 14 inches vertically, and are generally less than 12 inches. The displacements are chiefly dip-slip normal, with minor apparent horizontal and reverse slip on some shears. The displacements die

out upward above the marine terrace deposits, and shears in the overlying nonmarine deposits (several tens of thousands of years old) die out about 17 feet below the ground surface.

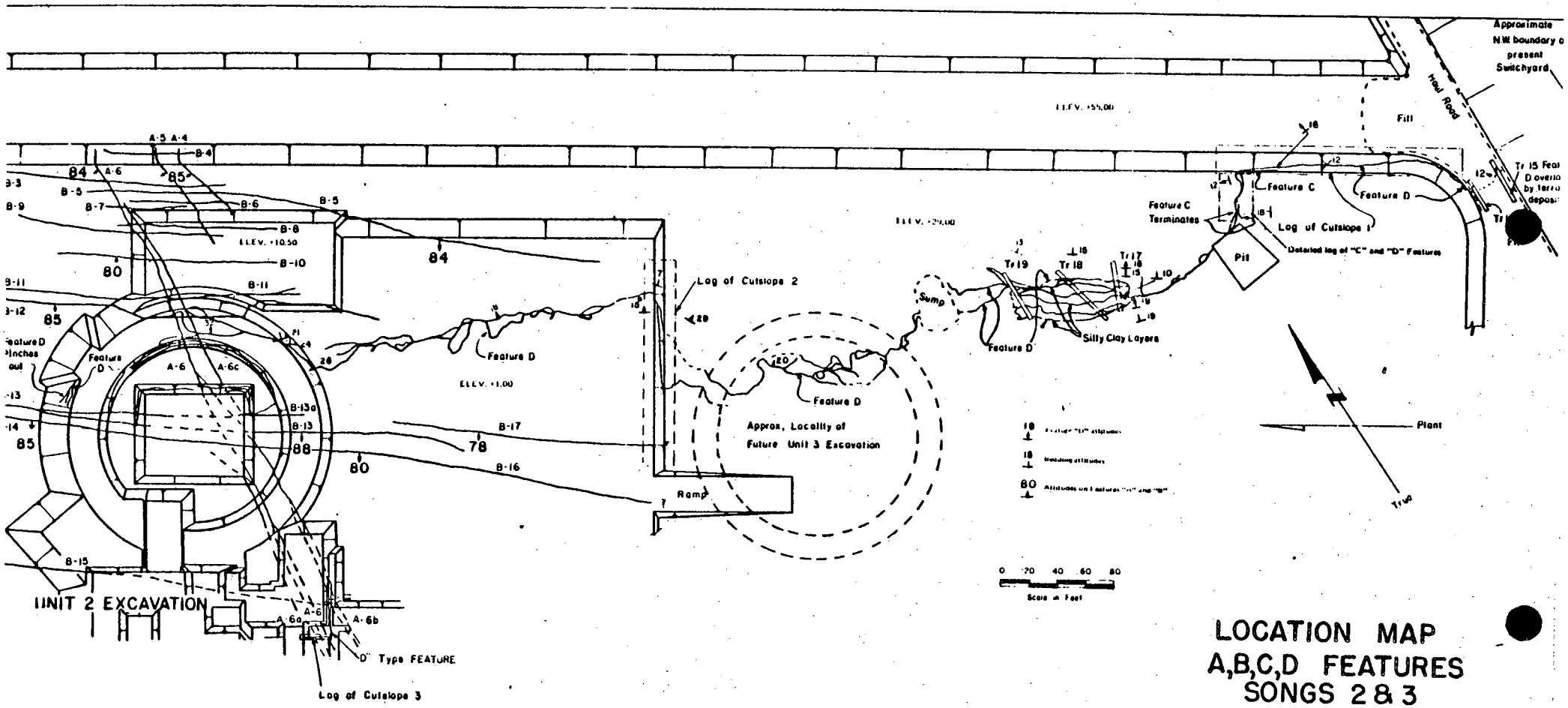
Although the offsets are caused by shearing in the bedrock, they have no association or alignment with any faults landward or seaward. Any zonal distribution of the shears is poorly developed, but conservative projection of a presumed shear zone toward the north, along strike of the shears, would head toward distinct and continuous tuff layers in the San Onofre Formation that are not faulted.

The association of the shears with conjugate sets of fractures adjacent to a buried ridge of San Onofre Breccia suggests an origin related to differential compaction of the overlying softer sediments. The gradual dying-out upward of the displacements tends to support this possibility, rather than that of fault origin which would more likely have displacements indicating abrupt episodic movements.

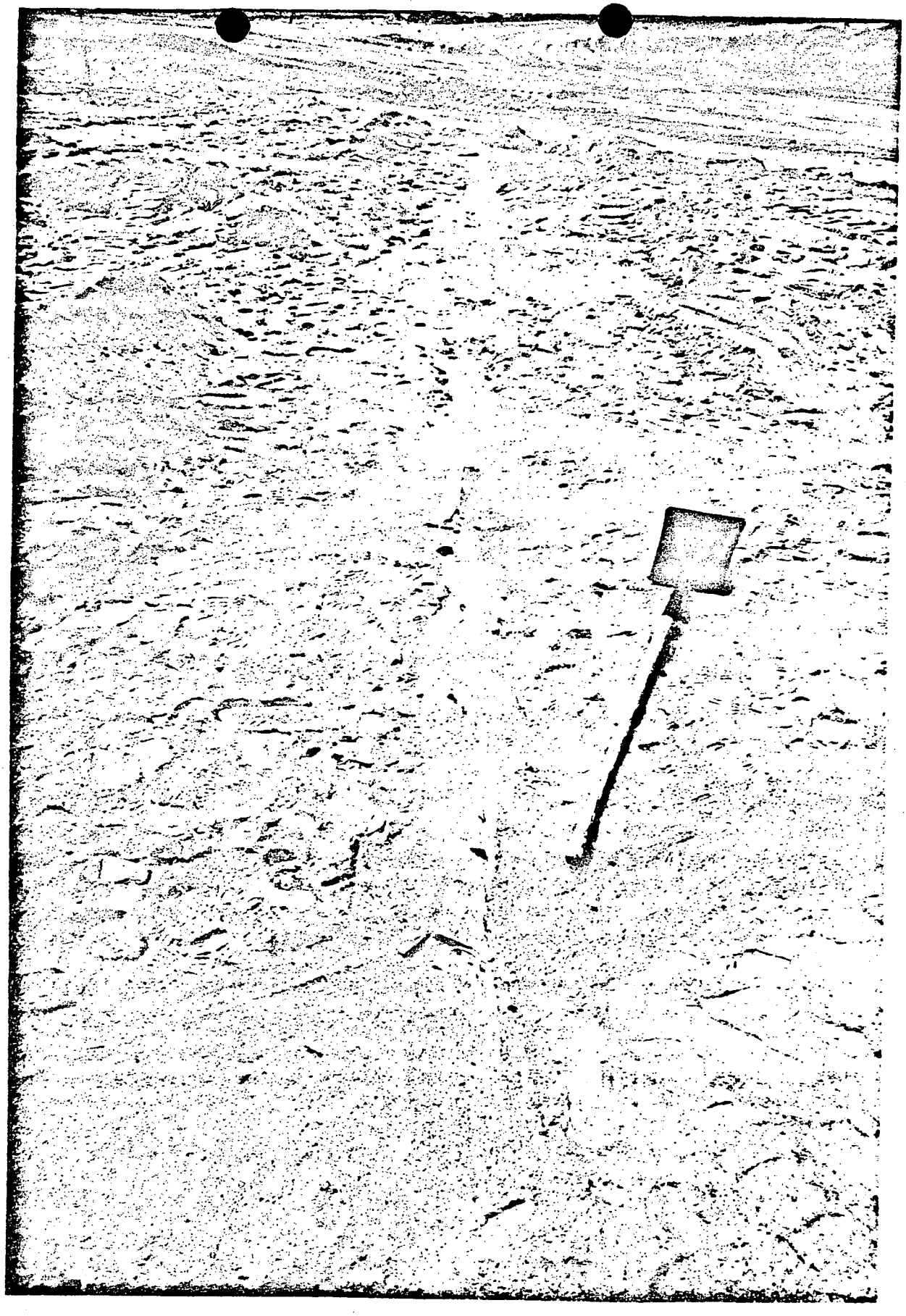
30. Q. What conclusions do you draw from your investigations?

A. At this time a conclusion that these offsets have either a tectonic or nontectonic origin can be supported. In my opinion the weight of the

evidence favors a nontectonic origin. To place this into perspective, it should be noted that the offsets are small, old (tens of thousands of years), and have a different orientation from most faults in the region. Furthermore, they are more than 5 miles from SONGS and even their projection beyond known locations would be tangent to a five-mile radius drawn around SONGS. Accordingly, they are not significant for the site.

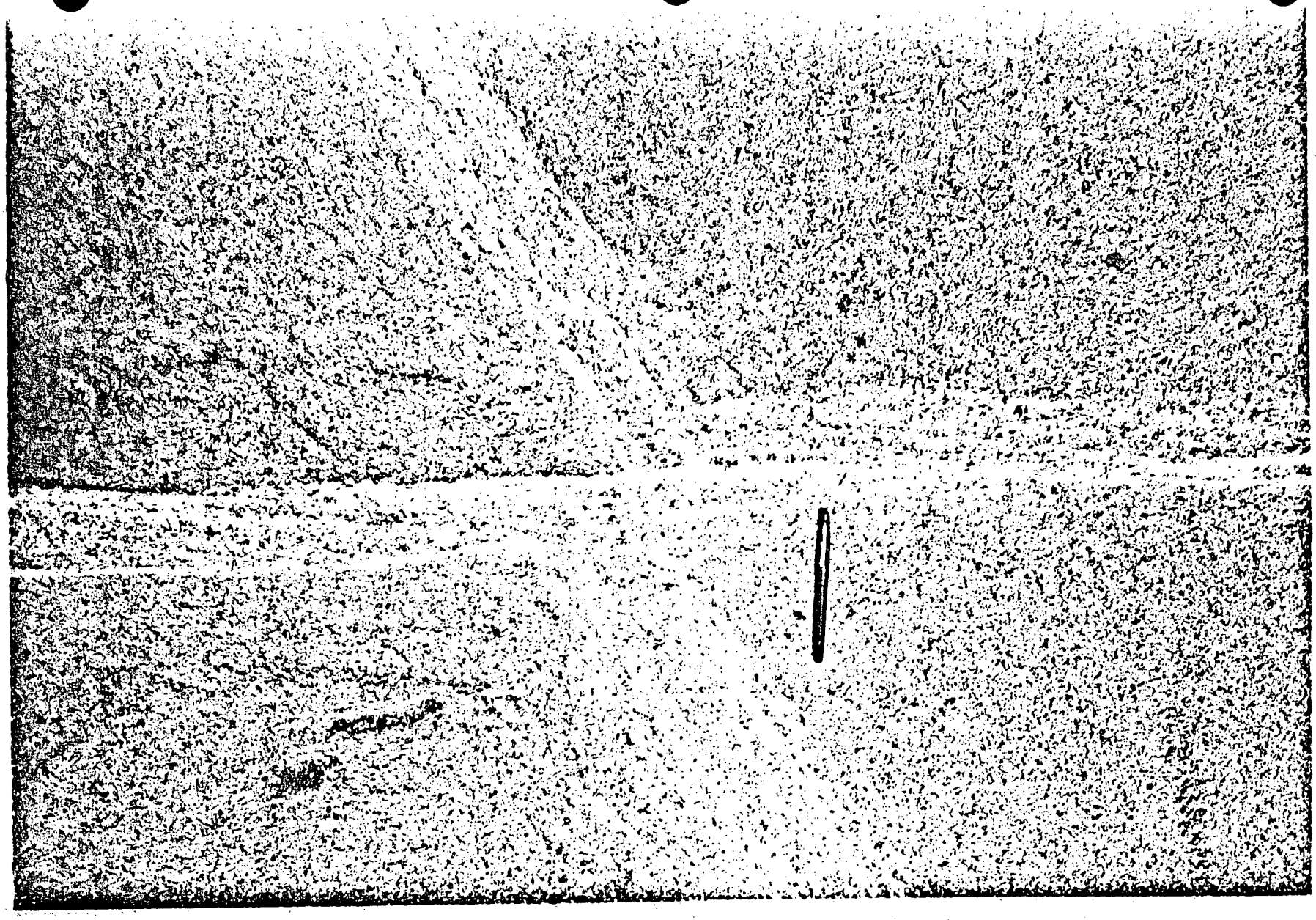


LOCATION MAP
A,B,C,D FEATURES
SONGS 2 & 3
Fig. JLS-N



PHOTOGRAPH OF AN "A" FEATURE

Figure JLS-O



PHOTOGRAPH OF "A" AND "B"
FEATURE INTERSECTION

Figure JLS-P

TRENCH 4
North Wall

N 30° E

FEET

0 1 2 3 4 5 6 7 8

5 4 3 2 1 0

FEET

DATUM

Terrace Deposits (Qt)
(Nonmarine)—orange-brown; gravel, and cobbles; sand medium- to coarse-grained /rust colored with light brown and gray lenses of fine sand; gravel and cobbles commonly imbricated indicating apparent horizontal bedding

Spoil

Spoil

Larger cobbles in matrix of coarse sand and gravel

Qt

Layer of imbricated pebbles and cobbles

Light brown fine sand lens

Distinct contact

Imbricated cobbles

Gray fine sand with silt

Slight Ridge

White

Light brown

White and light brown streaked sand

FEATURE A

Clay inclusions

Trench floor

San Mateo Formation

Orange, gray, and green-brown silty clay

White to light gray, cemented sandstone

Clay inclusions

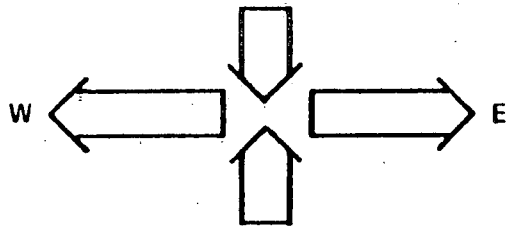
San Mateo Formation
Brown to orange-brown sandstone, medium- to coarse-grained with pebbles, well consolidated, dry to damp, massive with random sized clay inclusions

Geology mapped 6-4-74
by D. Egner

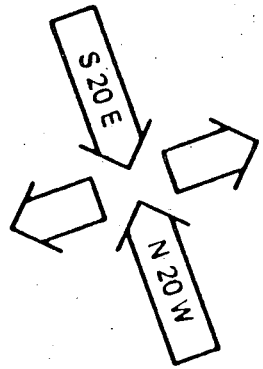
Horizontal and Vertical Scale
1 Inch = 1 Foot

LOG OF TRENCH ACROSS
"A" FEATURE
Fig. JLS-Q

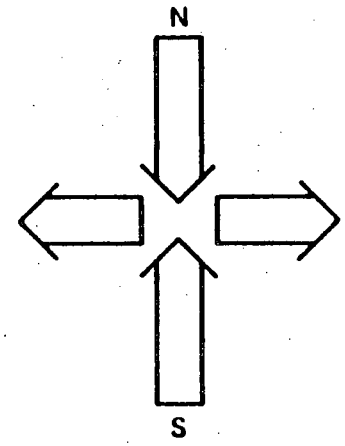
REGIONAL STRESS CONDITIONS



Capistrano Embayment and Cristianitos fault time (10m.y. - 4m.y.)

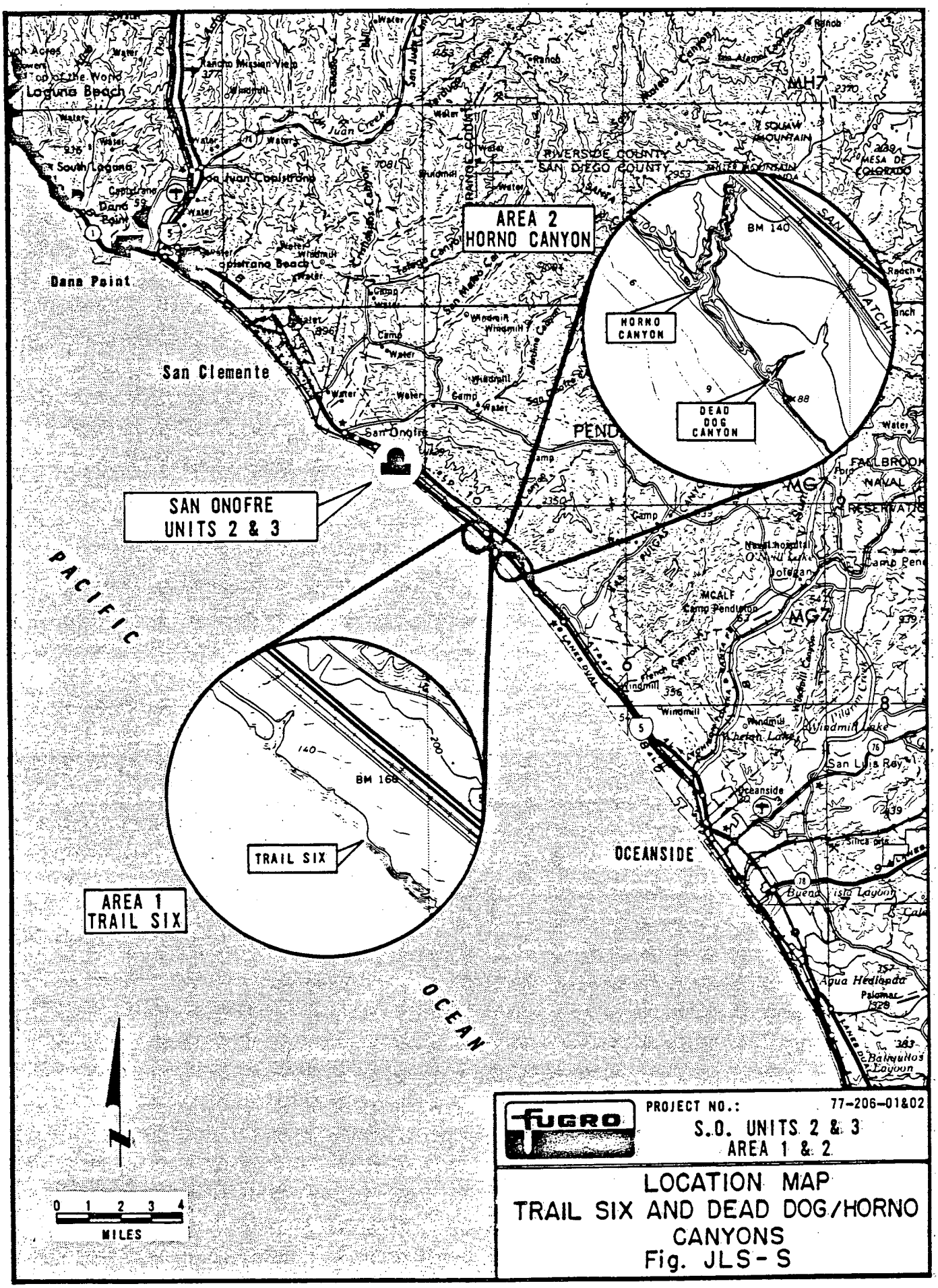


ABC features time (4m.y. - 125,000+yrs.)



Modern time

REGIONAL STRESS CONDITIONS
Fig. JLS-R

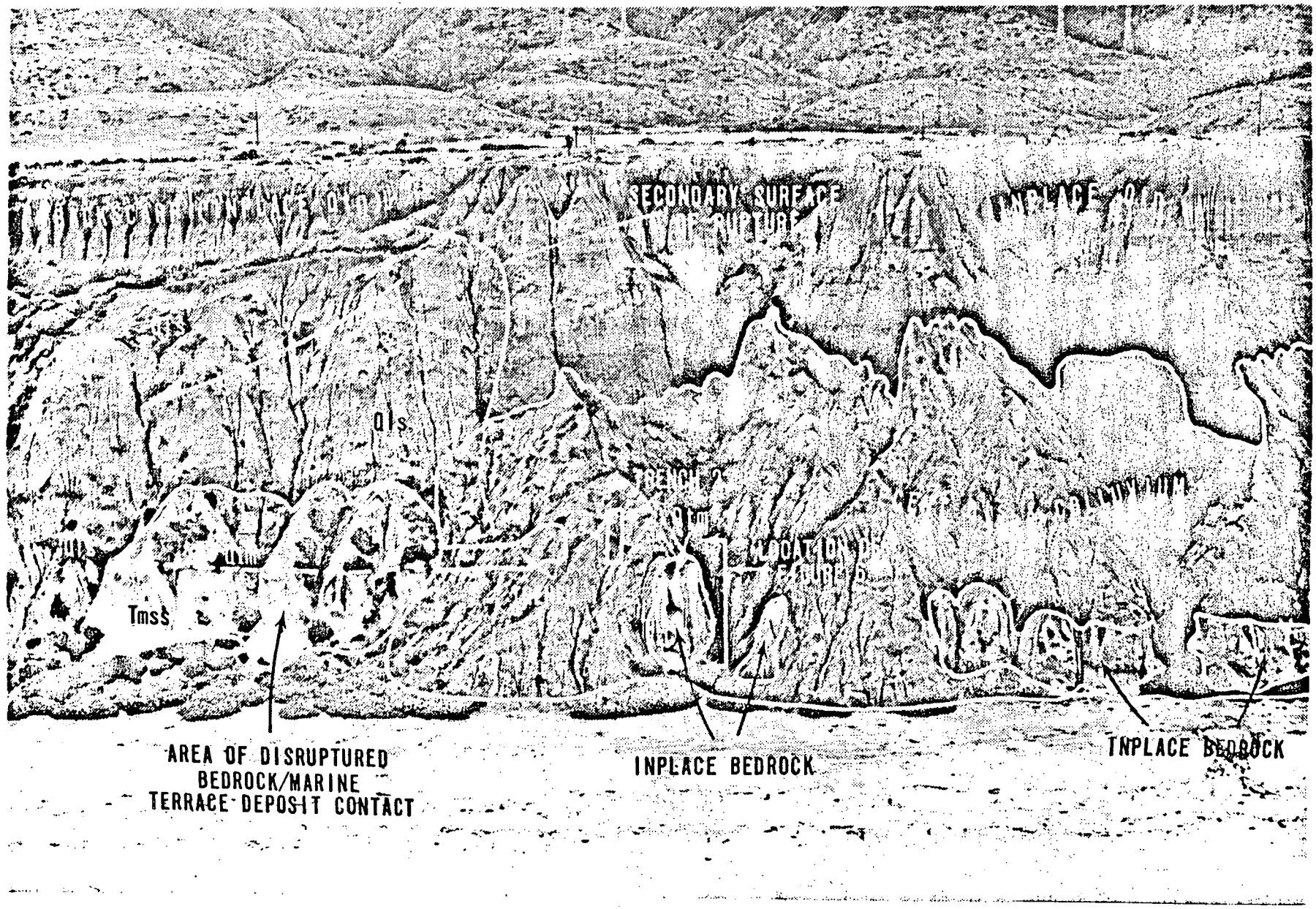


FUGRO

PROJECT NO.: 77-206-01&02

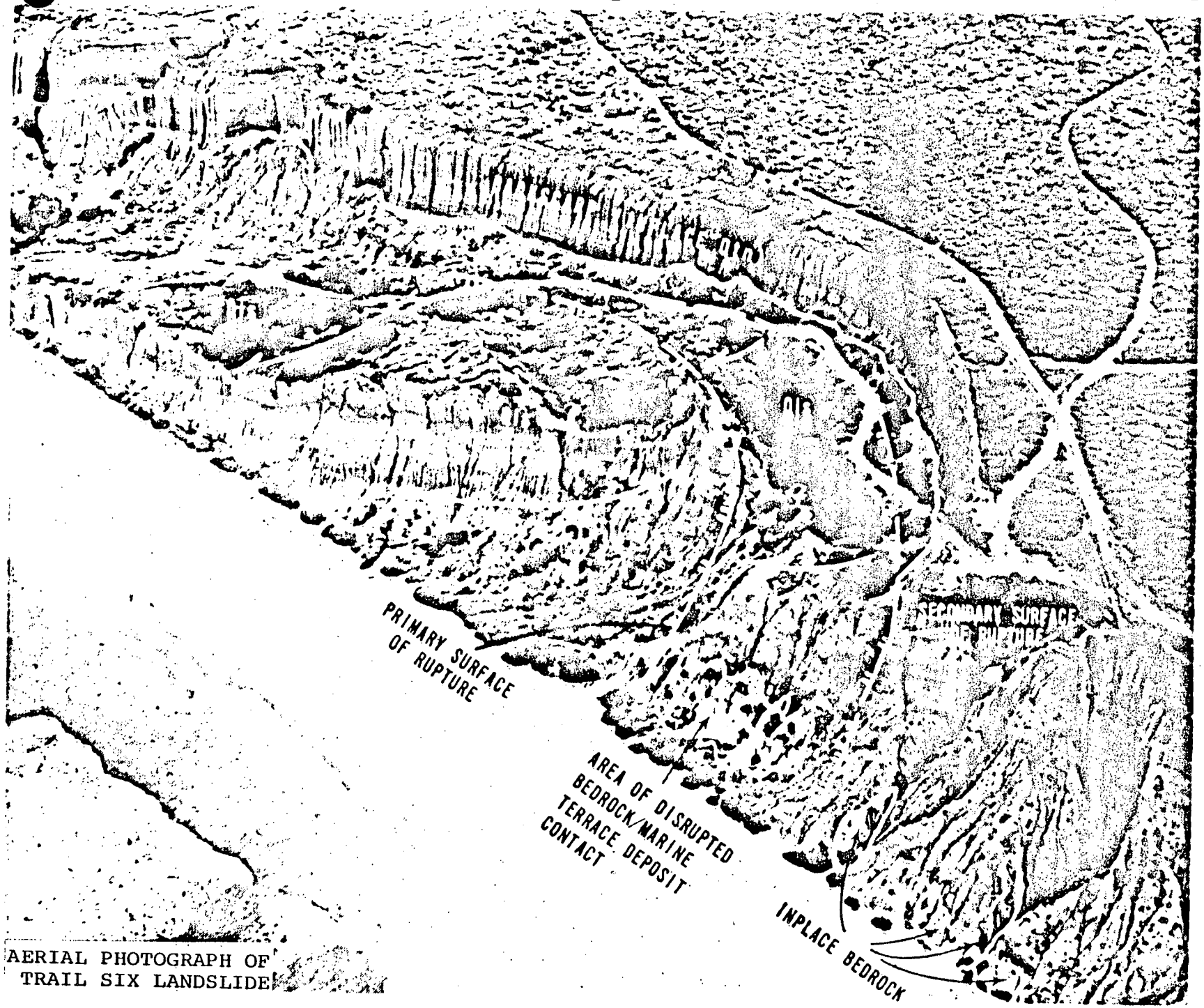
S.O. UNITS 2 & 3
AREA 1 & 2

LOCATION MAP
TRAIL SIX AND DEAD DOG/HORNO CANYONS
Fig. JLS-S



TRAIL SIX OFFSETS IN
SEACLIFF EXPOSURE

Figure JLS-T

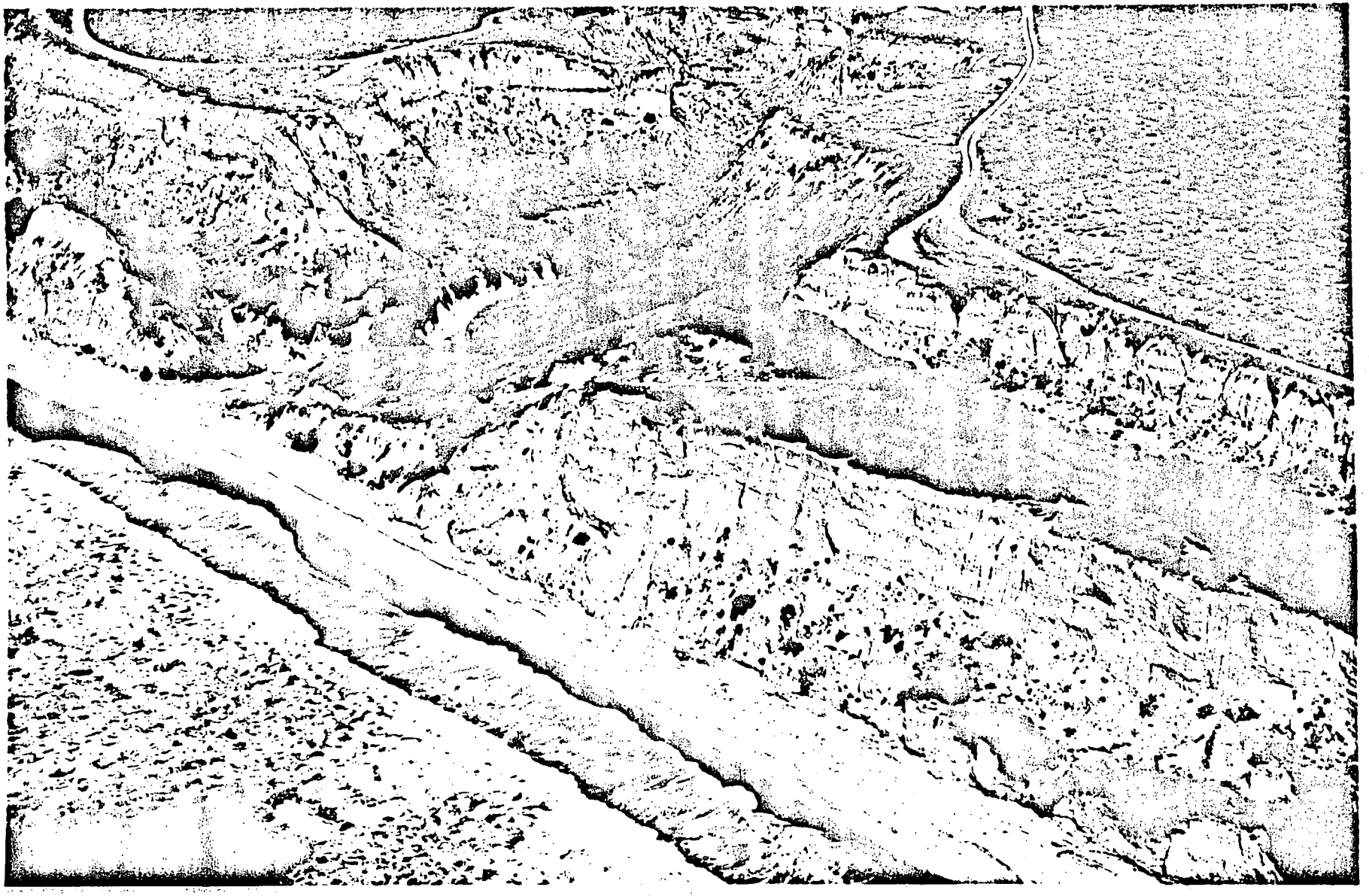


AERIAL PHOTOGRAPH OF TRAIL SIX LANDSLIDE

Figure JLS-U

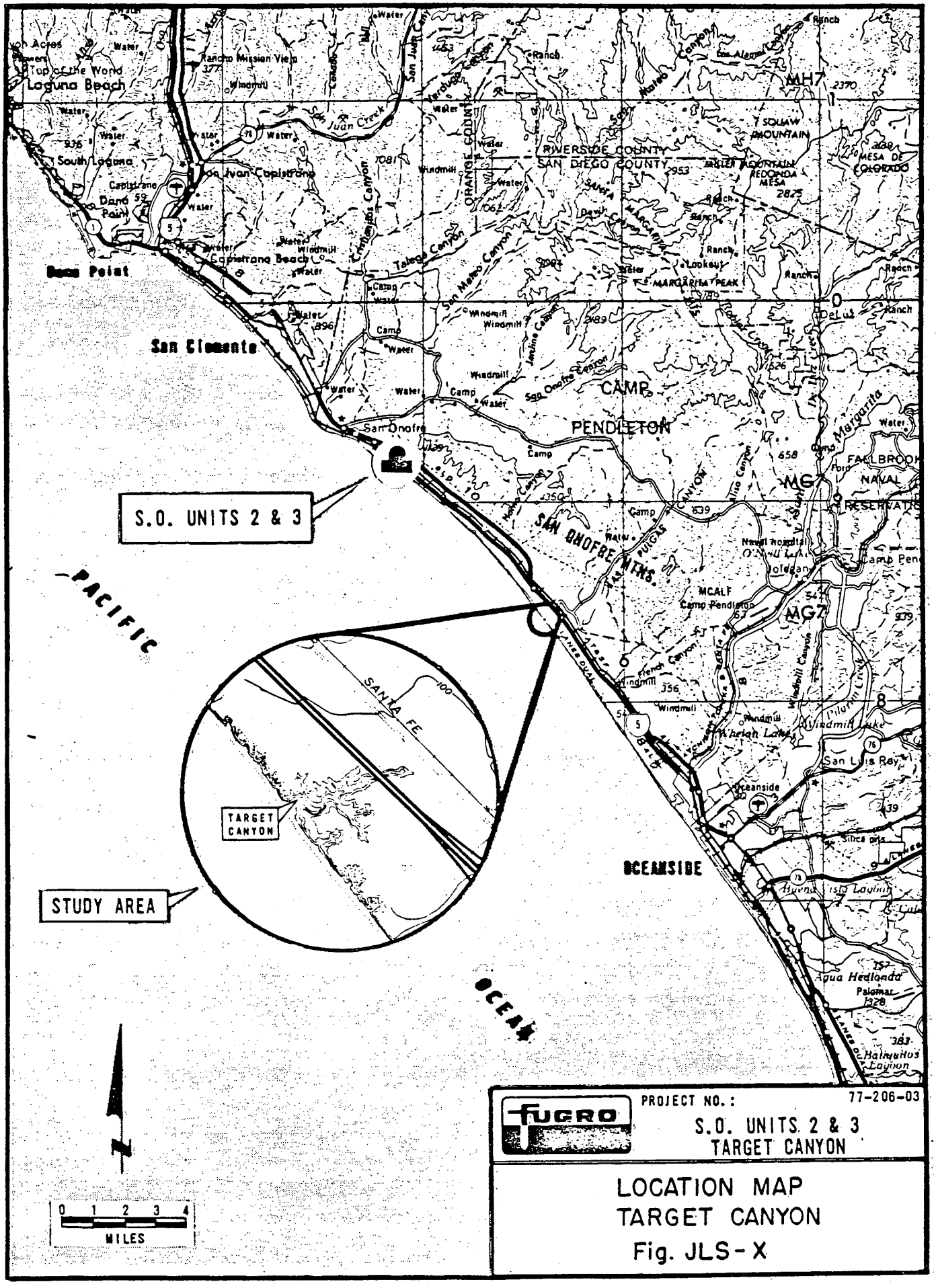
PHOTOGRAPH OF OFFSET,
HORNO CANYON WALL

Figure JLS-V



AERIAL PHOTOGRAPH OF LANDSLIDE TOPOGRAPHY, HORNO CANYON

Figure JLS-W



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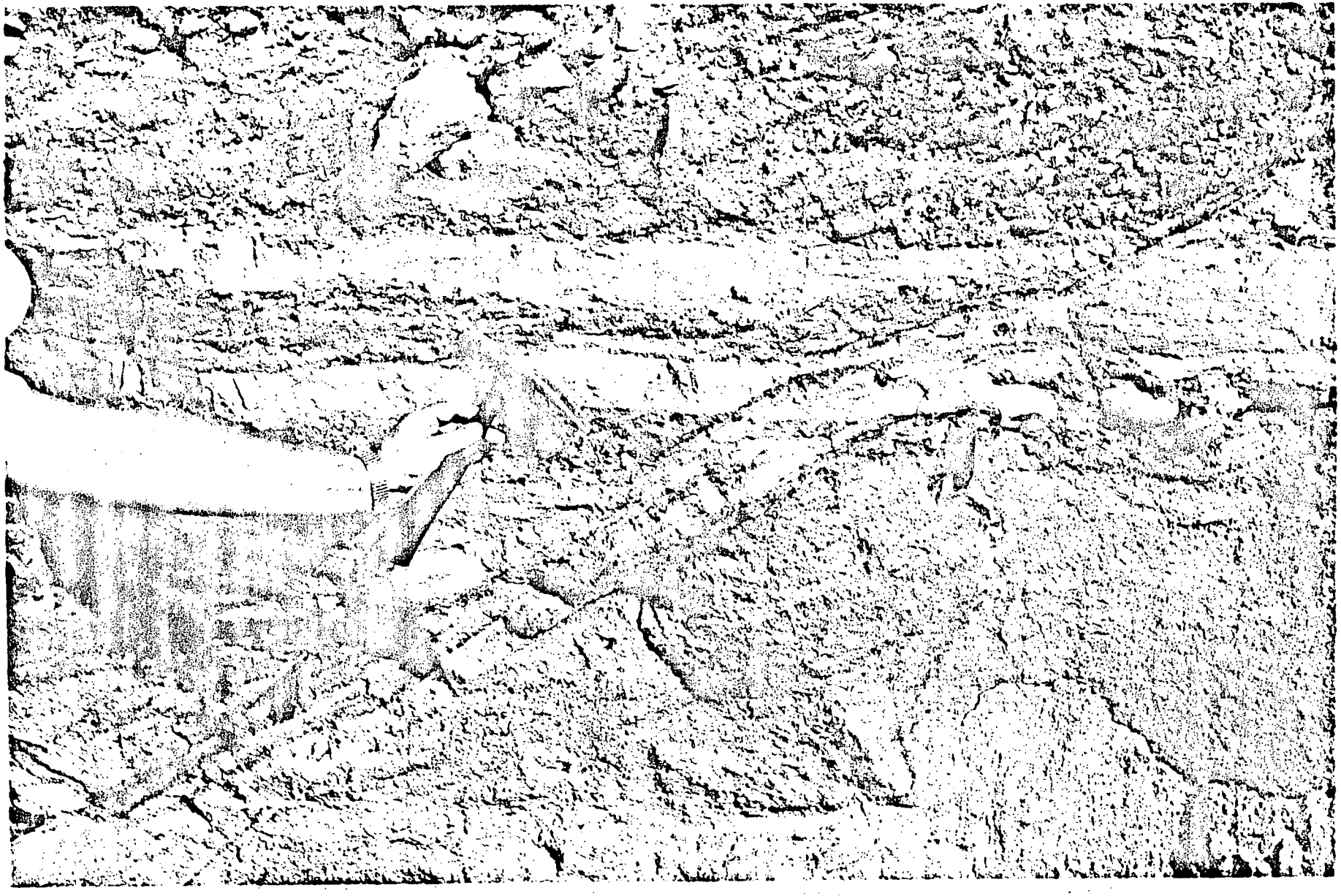
PROJECT NO.: 77-206-03

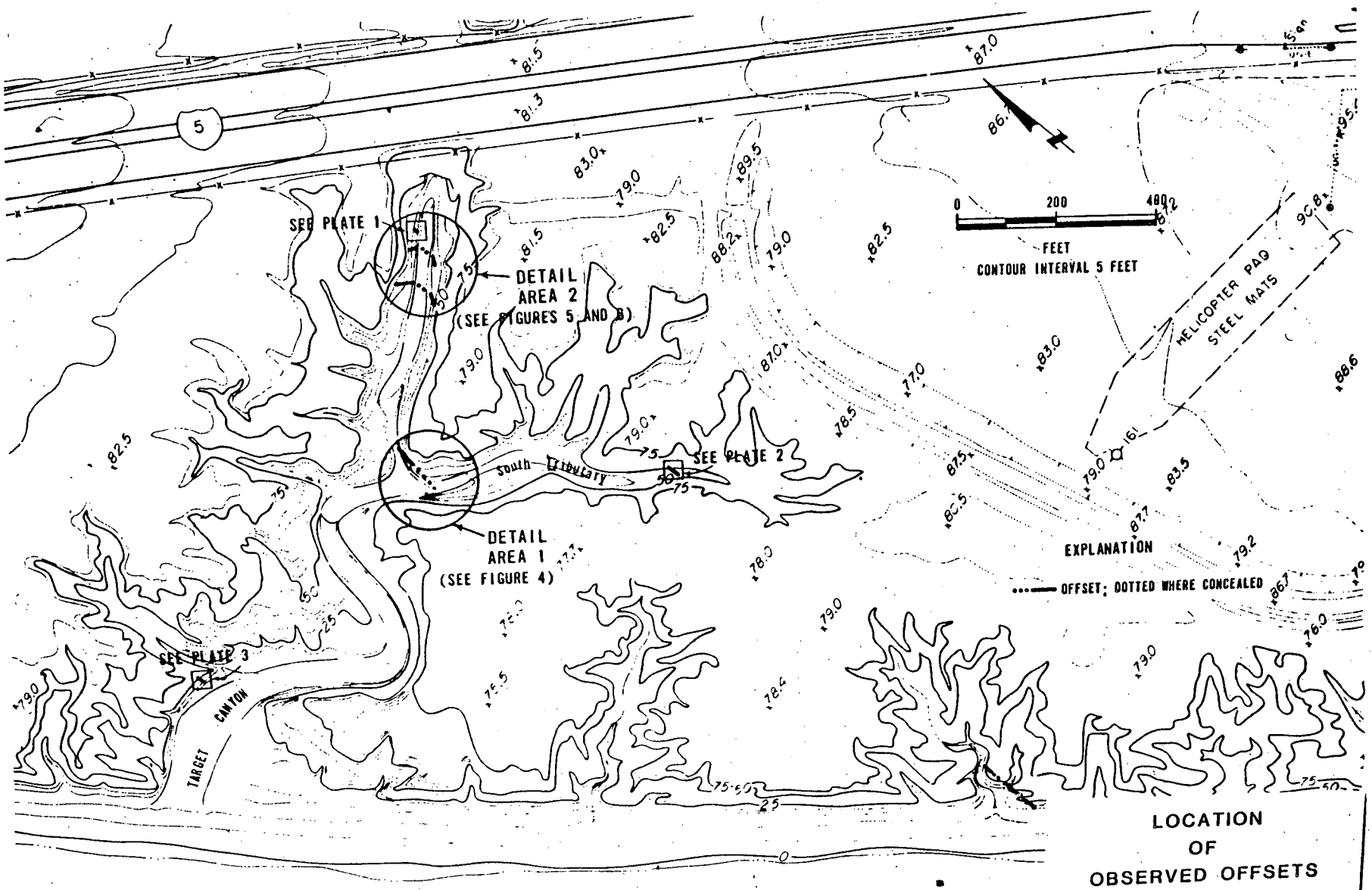
S.O. UNITS 2 & 3
TARGET CANYON

LOCATION MAP
TARGET CANYON
Fig. JLS-X



PHOTOGRAPH OF OFFSET,
TARGET CANYON

Figure JLS-Y



LOCATION OF OBSERVED OFFSETS

Figure JLS-Z

TESTIMONY OF DR. PERRY L. EHLIG

Q. Would you please state your name?

A. Dr. Perry L. Ehlig

Q. Are you the same Dr. Perry L. Ehlig who appeared as a witness earlier in this proceeding?

A. Yes.

Q. What is the purpose of your testimony in this portion of this proceeding?

A. One of the issues in this proceeding is whether as a result of certain geologic features discovered subsequent to issuance of the construction permit the seismic design basis for SONGS 2 and 3 is inadequate to protect the public health and safety. My testimony here will address two onshore features which I have studies and which are referred to as the E and F features.

Q. Would you describe the location of these onshore E and F features?

A. The E and F faults are on the lower south flank of the San Onofre mountains upslope from the Immigration and Naturalization Service Inspection Station on Interstate 5 about two miles southeast of the SONGS site. The E fault occurs about 2,000 ft. west of the F fault.

Q. Would you describe your investigation of the onshore faults E and F?

A. The E and F faults were mapped and studied by me in the summer of 1977 during my geologic investigation of the onshore area adjacent to SONGS (Figure PLE-Q, "Fault E and Fault F Shown on a Portion of the Geology Map Adjacent to San Onofre Nuclear Generating Station").I made an additional study of the E fault during the winter of 1977-78 including the inspection of two trenches excavated across it.

The two faults have subparallel trends oriented nearly north-south but dip steeply toward each other such that the unconformity between the Monterey Formation and underlying San Onofre Breccia has been downdropped in the area between them. The unconformity has a dip-separation of about 25 feet on the F fault where the fault surface is exposed in a quarry adjacent to the old Coast Highway. The fault surface contains striations in more than one direction but down dip striations predominate indicating it is a normal dip-slip fault.

The separation on the E fault cannot be determined by direct observation because the unconformity has been removed by erosion along the west side of the fault; however, projections in cross-sections constructed across the fault indicate a dip-separation of between 300 and 400

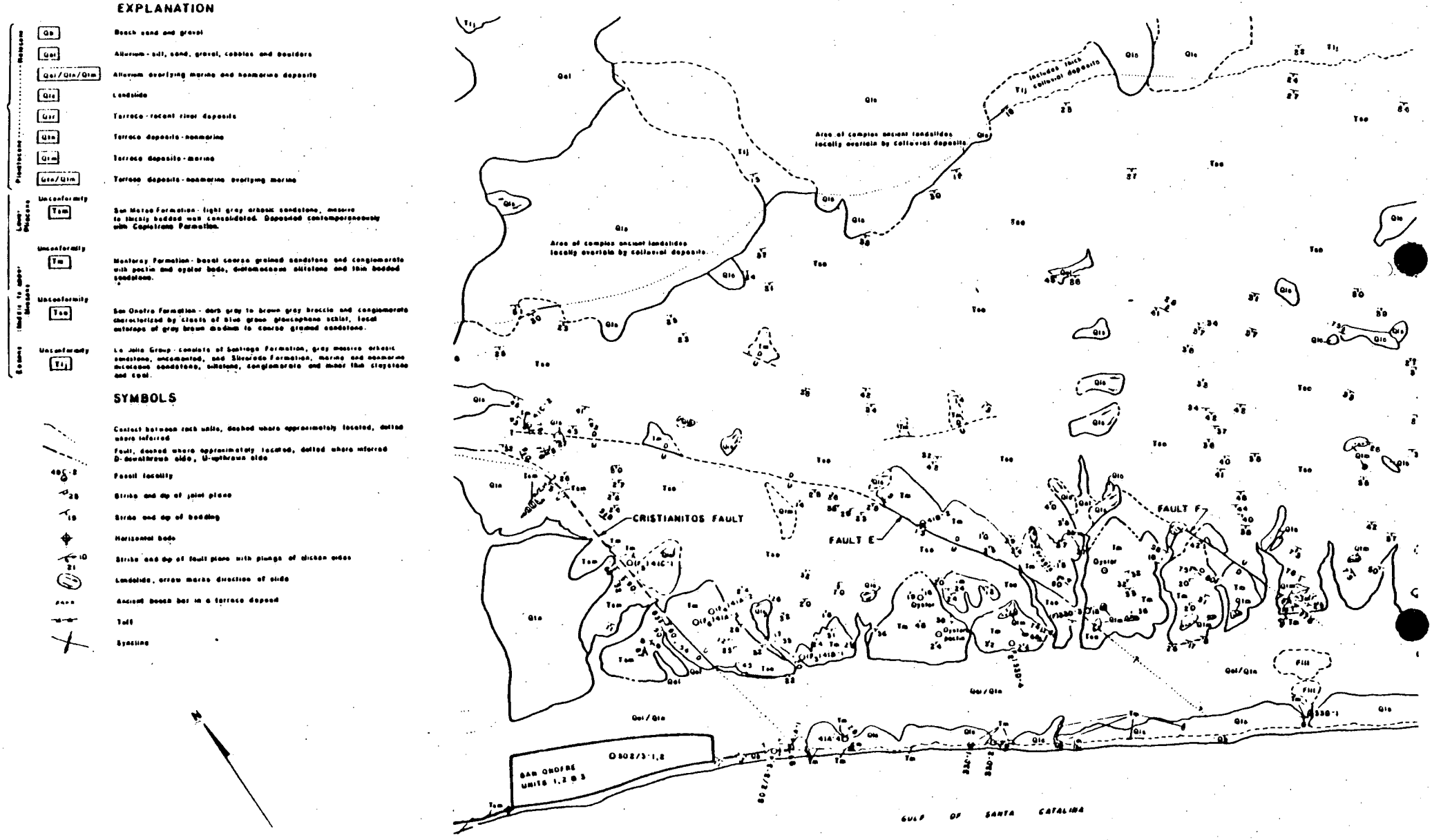
feet. Striations have been observed on the fault at only one location. At this location they trend directly down-dip indicating the fault is a normal dip-slip fault. The age of the E and F faults is imprecisely known. Displacement is younger than about 14 to 15 m.y. old, the age of the Monterey formation adjacent to the faults. The faults lack physiographic expression and show no evidence of cutting the coastal terrace.

The E fault passes beneath the remnant of the wave-cut terrace bench at an elevation of about 350 feet without displacing the bench or a hematitic soil developed on the bench. The bench is probably a few hundred thousand years old, thus suggesting that fault movement ceased by Late Pleistocene. This age agrees with the terrace studies performed by Dr. Shlemon who I understand will testify later in this proceeding.

Q. What conclusions do you draw from your investigations?

A. The most likely timing for formation of these faults is on the order of four to ten million years ago. They were most likely formed in an east-west extensional tectonic regime and thus do not fit the present north-south compressional regime. The faults have had no movement in the past several

hundred thousand years and therefore are not capable faults.



FAULT E AND FAULT F
SHOWN ON
A PORTION OF THE GEOLOGY MAP
ADJACENT TO SAN ONOFRE
NUCLEAR GENERATING STATION

FIGURE PLE-Q

FROM EHLIG, 1977